water & forestry

Department:
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REPORT NO.: P 02/B810/00/0708/Volume 2/Annexure H-I

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)

DRAFT

Environmental Impact Assessment

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

ANNEXURE H-I:
Aquatic Ecology Specialist Study
Noise Impact Assessment

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AUGUST 2008

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GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)

Environmental Impact Assessment

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

ANNEXURE H: AQUATIC ECOLOGY SPECIALIST STUDY

JULY 2008

Golder Associates

Compiled by:

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DECLARATION OF CONSULTANTS' INDEPENDENCE

Peter Kimberg and Cameron von Bratt, ecological consultants of Golder Associates (Pty) Ltd., are independent consultants to ILLISO 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 Development Project***
Report Title:	***Environmental Impact Assessment Annexure H: Aquatic Ecology Specialist Study***
Author:	***Golder Associates Africa (Pty) Ltd.***
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SPECIALIST
Approved for Golder Associates by:

Mr. Peter Kimberg *Study Leader*	*Date*

ENVIRONMENTAL ASSESSMENT PRACTIONER
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Dr Martin van Veelen *Project Director*	*Date*

EXECUTIVE SUMMARY

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 (BWI) (water treatment, pipelines, pump stations, off-takes and reservoirs) in the Limpopo province. 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 appointed Golder Associates Africa (Pty) Ltd. to undertake the Aquatic Environment Impact Report (EIR) as part of the EIA.

The scope of work as per the submitted and approved Golder proposal (PRO11418) and additional aspects from the original Terms of Reference (ToR) were assessed in terms of the impacts associated with the raising the dam wall of Tzaneen Dam, the construction and operation of the proposed Nwamitwa Dam, the proposed flow gauging weir as well as the BWI on the associated aquatic ecosystems of the Groot Letaba River and its associated tributaries.

The following conclusions were reached based on the results of the baseline assessment:

- *During the November 2007 survey the Present Ecological States (PES) at sites NWA02 and NWA03 in the Nwanedzi River were below the recommended Ecospecs. This could most likely be attributed to the non-perennial nature of the Nwanedzi River and likely represents an under estimation of the actual level of biotic integrity in the river. The presence of the aggressively invasive introduced fish species M. salmoides, may be contributing to the low FAII scores recorded in the Nwanedzi River.*

- *The PES recorded at site LET01 during the November 2007 survey exceeded the recommended Ecospecs for the reach. This is considered to be of importance in the context of this EIA and the existing Reserve Determination Study (RDS).*

- *Oreochromis mossambicus (Mozambique Tilapia) is a Near Threatened (NT) fish species that was recorded at all of the sampling sites during the November 2007 survey.*

O.mossambicus is threatened by hybridization with Oreochromis Niloticus (Nile Tilapia); a North African species introduced for aquaculture purposes. O.mossambicus is generally regarded as a hardy species which is likely to thrive in the Nwamitwa Dam.

- *Based on the FAII assessment biotic integrity within reach EWR3 complied with the recommended Ecospec of C (moderately modified). It should be noted that the November 2007 FAII results were based on a single survey and likely represent an under estimation of the actual level of biotic integrity within the reach.*

The significance of potential impacts on aquatic ecosystems within the dam basin was rated as high prior to mitigation, for construction and operational phases. The riverine habitat that fall within the full supply level of the proposed dam will be unavoidably and irrevocably lost due to inundation, siltation, change in flow regime loss of riparian vegitation and the formation of a largely anaerobic epilimnion (bottom layer of water). It is likely that at least 6 of the 17 fish species currently inhabiting reach EWR3 will permanently disappear from the dam basin due to the loss of specific habitat types. In terms of the 2006 RDS the loss of 6 species will have a negative impact on the PES and may make the Recommended Ecological Class (REC) unattainable. The level of significance after implementation of recommended mitigation decreased to medium, for both phases. Key mitigation measures include:

- *Implementation of a suitable management action plan, based on analysis of monthly water quality and bi-annual biological monitoring data collected at sites upstream, downstream and within the Nwamitwa Dam;*
- *Maintaining natural features such as trees around the proposed dam margin, so as to provide habitats for colonising aquatic biota and perches for aquatic birds;*
- *Preventing further introductions, or the proliferation of introduced fish species such as M. salmoides (Largemouth Bass) within the dam basin;*
- *Maintaining connectivity between fish assemblages and remaining riverine habitats upstream and downstream of the dam by means of a fishway;*
- *Preventing the encroachment of invasive aquatic vegetation such as Water hyacinth (Eichornia crassipes) or Kariba weed (Salvinia molesta);*

The potential significance of impacts on aquatic ecosystems downstream of the dam was rated as medium for both the construction and operational phases. Shifts can be expected in

the natural macroinvertebrate assemblages downstream of the dam due to the changes in the physical and chemical characteristics as well as the modified flows and habitats. This may reduce or eliminate certain taxa thus, while other species, such as Simuliidae sp. (Blackflies) may proliferate. The potential decrease in abundances of 14 fish species and loss or proliferation of certain species within the remaining reach (EWR3) will have a negative impact on the PES and it is uncertain whether the REC and Ecospecs set out in the 2006 RDS will be attainable. The level of significance after implementation of mitigation was rated as low for both phases. Key mitigation measures would include:

- *Ensuring adequate stabilisation of the downstream river bed and banks;*
- *Maintaining connectivity between fish assemblages and remaining riverine habitats upstream and downstream of the dam wall by means of a fishway;*
- *A properly managed timing and release strategy that will ensure that presently existing or naturally seasonal variability in flows are released and or maintained within the downstream Groot Letaba River. This will enable specific ecosystem functions such as migration queues, seasonal floodplain inundation and temperature variations to be maintained.*

The potential significance of an additional migration barrier on migratory fish species in the Groot Letaba River was rated as high for both the construction and operational phases. Sixteen of the 17 indigenous fish species currently occurring within reach EWR3 are likely to be impacted upon in terms of migration potential. The level of significance after implementation of mitigation was rated as medium for both phases. Key mitigation measures include:

- *Identifying remaining riverine habitats upstream and downstream of the Nwamitwa Dam and affording these habitats special conservation significance;*
- *Maintaining connectivity between fish assemblages and upstream and downstream riverine habitats by means of a fishway.*

As a final conclusion, the construction of the GLeWaP, in particular, the construction of the proposed Nwamitwa Dam can proceed, provided that the recommended mitigation measures as set out in this report are implemented. The mitigation measures provide the means to

reduce or even eliminate certain impacts and are therefore considered to be able to ensure continued ecosystem functioning.

With regard to the gaps in knowledge as expressed in this report, the following are required:

- *A genetic assessment of specific fish species upstream and downstream of the proposed Nwamitwa Dam site. This will provide further scientific evidence as to the transfer of genetic material between populations upstream and downstream of the Nwamitwa Dam site and thus provide information as to the connectivity and genetic importance of the reach and give further support to the need to maintain this connectivity at the dam by means of a fishway/fish ladder or not;*

- *A habitat suitability and accessibility study of the area both upstream and downstream of the Nwamitwa Dam site. This will give further scientific evidence of the availability and accessibility of suitable breeding/critical life-stage habitats required by specific fish species. This would enable required habitat areas not impacted by the GLeWaP to be identified, assessed in terms of suitability and accessibility for ecosystem functioning and conserved as a mitigation option; and*

- *A full flow regime maintenance and release management strategy for the proposed Nwamitwa Dam.*

Without these three abovementioned assessments, the level of impact on the migratory fish populations within this river reach (EWR3) is uncertain. In addition, the impact of the ability of any remaining fish species be able to find and access suitable habitats that are required for all the life stages of the species is also uncertain due to the limitations in habitat assessment. The construction of a fish ladder into the dam wall is the immediate solution to the problem of the Nwamitwa Dam as a barrier to fish migration. The option not to put a fish ladder however, will depend on the two additional studies needed (genetics and habitat).

TABLE OF CONTENTS

Page

LIST OF TABLES

List of Figures

ABBREVIATIONS

ASPT	Average Score per Taxa
BAP	Biodiversity Action Plan
BWI	Bulk Water Infrastructure
DEAT	Department of Environmental Affairs and Tourism
DO	Dissolved Oxygen
DWAF	Department of Water Affairs and Forestry
COD	Chemical Oxygen Demand
EC	Ecological Category / Electrical Conductivity (Context-dependant)
ECA	Environmental Conservation Act
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMP	Environmental Management Programme
EWR	Ecological Water Requirement
FAII	Fish Assemblage Integrity Index
FROC	Frequency of Occurrence
GLeWaP	Groot Letaba River Water Development Project
GSM	Gravel, Sand and Mud
IHAS	Invertebrate Habitat Assessment System (Version 2)
IUCN	International Union for the Conservation of Nature
KNP	Kruger National Park
LC	Least Concern
NBA	National Biodiversity Act
NEMA	National Environmental Management Act
NT	Near Threatened

NWA	National Water Act
OA	Options Analysis
PCMT	Project Co-ordination and Management Team
PES	Present Ecological State
pH	Percentage Hydrogen
POP	Persistent Organic Pollutants
PSP	Professional Service Provider
RDM	Reserve Determination Methodology
RDS	Reserve Determination Study
RU	Resource Unit
SASS5	South African Scoring System, Version 5
SCI	Stream Condition Index
SIC	Stones In Current
SOC	Stones Out of Current
TDS	Total Dissolved Solids

1. 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 appointed Golder Associates Africa (Pty) Ltd. to undertake the Aquatic Ecology Specialist Study 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	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

Peter Kimberg of Golder Associates (Pty) Ltd. undertook the Project Management and Project Review of the Environmental Impact Report (EIR) and the Environmental Management Programme Report (EMP) for the aquatic ecosystem components. He has an Honours Degree in Aquatic Health from the University of Johannesburg (UJ) and has worked as a fulltime aquatic specialist since 2003. He has extensive experience in aquatic biomonitoring, baseline assessments of aquatic ecosystems, Environmental Impact Assessment Reports (EIA's) and biodiversity assessments. Over the last four years he has worked on projects throughout sub-Saharan Africa, including: Mali, Central African Republic, Democratic Republic of the Congo, Zambia, Mozambique, Madagascar, Lesotho, Botswana, Namibia and South Africa. He is SASS5 accredited.

Cameron von Bratt of Golder Associates Africa (Pty) Ltd. undertook the Environmental Impact Report (EIR) and the Environmental Management Programme Report (EMP) for the Aquatic Ecosystem components. He has a Masters degree in Zoology (Aquatic Health). His field focuses on aquatic ecosystem functioning, habitat, flow and biotic responses. He has specialised in Aquatic Baseline Assessments, Biomonitoring and Ecosystem functioning and health and has completed numerous Aquatic Baseline Assessments, Biomonitoring Assessments and specialist Environmental Impact Reports in river systems throughout South Africa. He has worked as a guest lecturer for Aquatic Ecosystem components (in particular EcoHydraulics, EcoGeomorphology and EcoHydrology) at the University of Johannesburg (Department of Zoology) and has lectured post-graduate (B.Sc. Honours) classes on specialist Field Assessment components. He is SASS5 accredited and an executive committee member of the Vaal River Catchment Organisation (VAALCO).

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3. PURPOSE OF REPORT AND SCOPE OF WORK

The scope of work set out by ILISO Consulting (Pty) Ltd according to the submitted and approved Golder proposal (PRO11418) included the following:

- To assess the significance of the potential impact of a proposed dam on aquatic ecosystems within the dam basin and in the Groot Letaba River downstream of the dam basin;

- To assess the significance of the potential impact of a potential migration barrier on fish assemblages within the Groot Letaba River; and

- To compile an Environmental Management Plan (EMP) with relevance to the aquatic ecosystems associated with the development.

The information provided by the 2006 Letaba Catchment Reserve Determination Study (DWAF, 2006), together with the survey data collected in November 2007 was used to assess the above mentioned scope of work.

In addition, after the peer review process, the following items were assessed according to the original Terms of Reference (ToR), which were not included in the scope of work as set out in the submitted and approved Golder proposal (PRO11418):

- Assess the significance of the potential impact of raising the dam wall of Tzaneen Dam on the aquatic ecosystems both upstream and downstream of the dam wall;

- Assess the significance of the potential impact of the proposed flow gauging weir downstream of the proposed Nwamitwa Dam on the aquatic ecosystems upstream and downstream of the proposed weir;

- Assess the significance of the potential impact of the proposed Bulk Water Infrastructure (BWI) associated with the GLeWaP on the associated aquatic ecosystems.

This report presents the results of the aquatic baseline assessment conducted in November 2007 as well as an Environmental Impact Report (EIR) of the potential impacts associated with the raising the dam wall of Tzaneen Dam, the construction

and operation of the proposed Nwamitwa Dam, the proposed flow gauging weir as well as the GLeWaP BWI on the associated aquatic ecosystems of the Groot Letaba River and its associated tributaries. The EMP Report is included as a separate attachment to this report (Appendix F), and has been incorporated into the GLeWaP EMPs.

4. METHODOLOGY

The methodology of the Environmental Impact Report (EIR) and Environmental Management Plan (EMP) was conducted according to the following:

- Literature review;
- Aquatic baseline assessment site selection;
- Aquatic baseline assessment methodology;
  - *In situ* water quality;
  - Intermediate Habitat Assessment System;
  - Aquatic macroinvertebrates; and
  - Ichthyofauna.
- Assessment of Potential Impacts.

4.1 LITERATURE REVIEW

Information from the GLeWaP Specialist Scoping Phase Report (Scoping Phase Report, 2007), the DWAF Draft Scoping Phase Report (DWAF GLeWaP, 2007a), the DWAF Final Scoping Phase Report (DWAF GLeWaP, 2007b), the 2008 River Health Programme (RHP) Rivers Database and the 2006 Letaba Catchment Reserve Determination Study (RDS) (DWAF, 2006), was used as reference material in the literature review.

During the 2006 RDS, seven Ecological Water Requirement (EWR) sites were selected, each representing a critical site within the relevant river section (DWAF, 2006 and Scoping Phase Report, 2007). Site EWR3 situated between Junction Weir (B8H009) and Prieska Weir (B8H017) is the nearest EWR site to the current project study area (DWAF, 2006 and Scoping Phase Report, 2007).

The study area was thus defined as the river reaches of the Groot Letaba River below the Tzaneen Dam wall and Prieska Weir (B8H017) including the Nwanedzi River. A map of this study area is shown in **Figure 4.1**.

For the purposes of this project, this reach was henceforth referred to as EWR3.

Reach EWR3 is approximately 75 km long. Anthropogenic impacts affecting this reach include agricultural activities and water abstraction (DWAF, 2006).

The aquatic baseline assessment focused on reach EWR3 as the majority of the impacts by the GLeWaP including the raising of the Tzaneen Dam wall, the proposed Nwamitwa Dam, the flow gauging weir and the BWI, would occur within this reach.

Within reach EWR3 the major proposed change associated with this development will be the construction of the Nwamitwa Dam. An indication of the proposed inundation of this dam according to the DWAF Draft Scoping Phase Report (DWAF GLeWaP, 2007a), is provided in (**Figure 4.1**) The proposed dam wall will be approximately 30 to 35 m high and comprise a concrete structure in the river section, accommodating a spillway and outlet works, with earth embankments on both flanks. The storage capacity of the new dam will be 144 million m^3 (DWAF GLeWaP, 2008).

The river reach directly downstream of the proposed Nwamitwa Dam extends from the Nwanedzi River confluence to Prieska Weir (B8H017) (**Figure 4.1**). The Resource Unit (RU) defined by the Reserve Determination Study (RDS) for this reach is GL6 (DWAF, 2006). One Ecoregion was defined within this Resource Unit, 3.03. Anthropogenic impacts affecting this Resource Unit include agricultural activities, water abstraction and flow modification due to five in-stream weirs (DWAF, 2006).

During the Letaba River Reserve Determination Study the Present Ecological State (PES) classes were determined for each of the EWR sites based on the main ecological drivers (hydrology, geomorphology and water quality) and ecological responses (riparian vegetation, aquatic macroinvertebrates and fish) (DWAF, 2006). These PES classes were integrated into an overall EcoStatus. The PES results for site EWR3 (representing the entire reach) are summarized in **Table 4.1**. Based on the overall EcoStatus results is it can be concluded that reach EWR3 has high Ecological Importance and significance with a current PES of a C/D. Maintenance and management of this PES Ecological Category (EC) is required (DWAF, 2006).

The results in **Table 4.1** will form the basis and reference data of the EIR for the GLeWaP (DWAF, 2006 and Scoping Phase Report, 2007).

In order to meet, maintain and manage the current PES and recommended ECs as set out in the 2006 RDS for this reach (EWR3) of the Groot Letaba River, the 2006 RDS specialist results (DWAF, 2006) were considered throughout the aquatic baseline assessment and in the assessment of the potential impacts.

Table 4.1: PES results for the site EWR3 (adapted from DWAF, 2006)

Site	Hydrology	Physico-chemical	Geomorphology	Fish	Invertebrates	Riparian vegetation
EWR3	D	C	C	C	D	D
Present Ecological Status: C/D						
Ecological Importance and Significance: High						
Recommended Ecological Category: C/D						

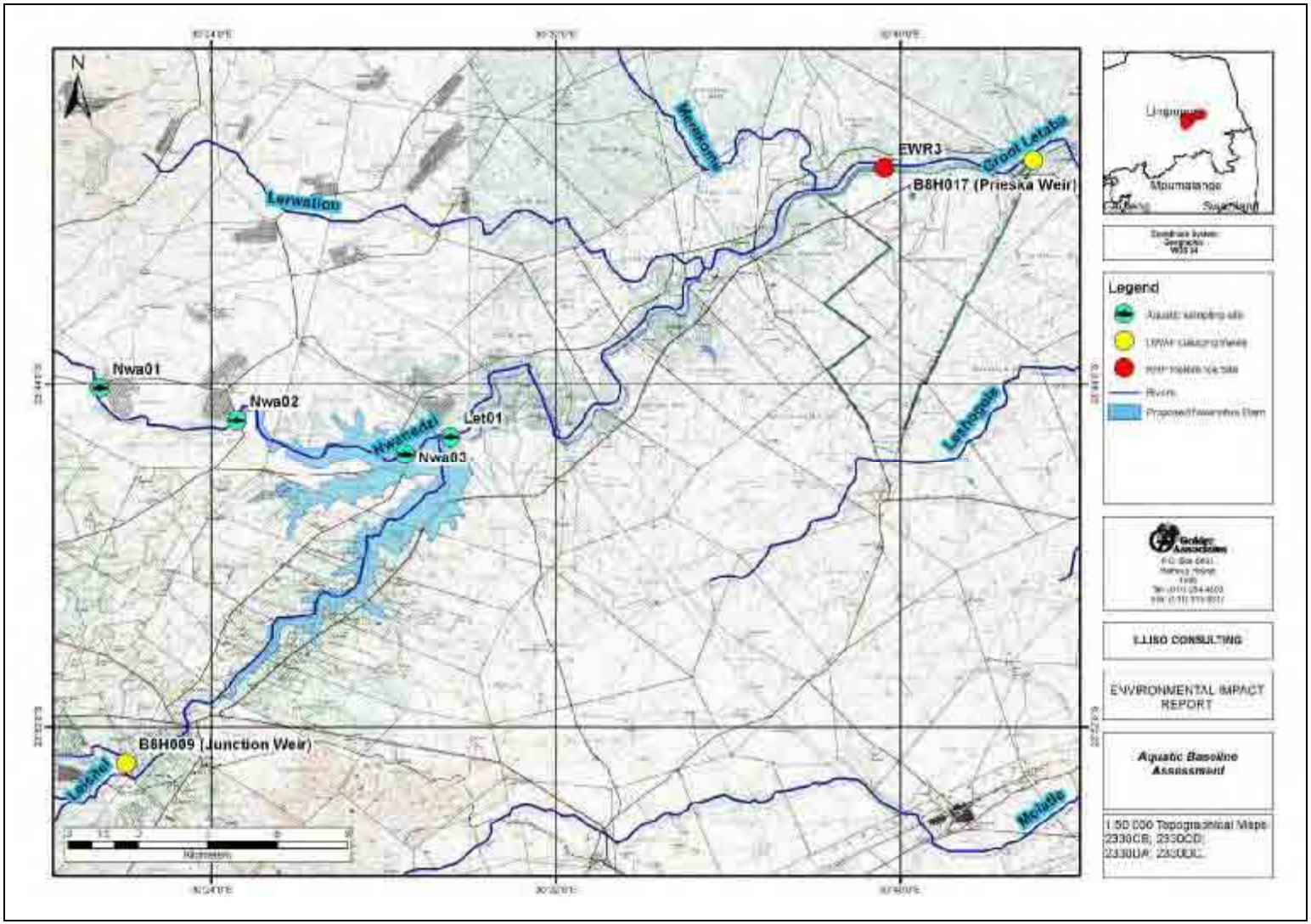

Figure 4.1: 1:50 000 Topographical map of the study area, rivers, DWAF weirs, RHP reference site and the aquatic sampling sites.

4.2 STUDY AREA

The study area of the Nwamitwa Dam falls within the Luvulvhu-Letaba Water Management Area (WMA) and the lower Lowveld Ecoregion (Level 1 Ecoregion 3) (Kleynhans *et al*., 2005a and Dallas, 2007). The Nwanedzi River is a non-perennial tributary of the Groot Letaba River which confluences with the Groot Letaba River just upstream of the proposed dam wall site.

One site was sampled in the Groot Letaba River downstream of the confluence with the Nwanedzi River (LET01) (**Figure 4.1**). Three sites were sampled in the Nwanedzi River (NWA01 – NWA03) (**Figure 4.1**). GPS coordinates of the samplings sites are provided in **Table 4.2**. Photographs of the sampling sites are provided in **Appendix A**.

Table 4.2: GPS coordinates and descriptions of the aquatic sampling sites

SITE	DESCRIPTION	CO-ORDINATES*
NWA01	Most upstream site on the Nwanedzi River, near Ruwanda village	S 23.73475 E 30.35652
NWA02	Middle section of the Nwanedzi River	S 23.74742 E 30.40978
NWA03	Most downstream site on the Nwanedzi River just upstream of the confluence with the Great Letaba	S 23.76055 E 30.47495
LET01	Groot Letaba River in the vicinity of the proposed dam wall site. Site is situated at two low water crossings.	S 23.75388 E 30.49255

* WGS_84 datum GPS coordinate system

4.3 *IN SITU* WATER QUALITY

During the field survey the following variables were measured on site with lightweight, compact field instruments:

- pH (Corning CheckMate 90: pH probe)
- Electrical Conductivity (EC) (Corning CheckMate 90: EC/TDS probe)
- Total Dissolved Salts (TDS) (Corning CheckMate 90: EC/TDS probe)
- Dissolved Oxygen (DO) (Corning CheckMate 90: DO probe)
- Temperature (Corning CheckMate 90: pH probe)

Water quality has a direct influence on aquatic life forms. Although these measurements only provide a “snapshot”, they provide valuable insight into the *in situ* characteristics of a specific sample site.

Comparison with water quality results, findings and PES obtained in the 2006 RDS were used to place this assessment within context when assessing the impacts of the proposed Nwamitwa Dam. This along with the water quality specialist study (GLeWaP, 2008a) was used in the impact assessment.

4.4 INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS, *VERSION 2*)

Habitat assessment can be defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour *et al.,* 1996). Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason habitat evaluation is conducted simultaneously with biological evaluations in order to facilitate the interpretation of results.

The Invertebrate Habitat Assessment System (IHAS, version 2) was applied at suitable sampling sites in order to assess the availability of habitat biotopes for aquatic macroinvertebrates. The IHAS was developed specifically for use with the SASS5 index in South Africa (McMillan, 1998). IHAS evaluates the availability of the macroinvertebrate habitats at each site and expresses the availability and suitability as a percentage, where 100% represents "ideal" habitat availability. It is presently

thought that a total score of over 65% represents good habitat conditions, and over 55% indicates adequate habitat conditions (McMillan, 2002).

Comparison with habitat results, findings and PES obtained in the 2006 RDS were used to place this assessment within context when assessing the impacts of the proposed Nwamitwa Dam. This along with the sediment specialist study (GLeWaP, 2008b) was used in the impact assessment.

4.5 AQUATIC MACROINVERTEBRATES

The monitoring of benthic macroinvertebrates forms an integral part of the monitoring of the health of an aquatic ecosystem as they are relatively sedentary and enable the detection of localized disturbances. Their relatively long life histories (±1 year) allow for the integration of pollution effects over time. Field sampling is easy and since the communities are heterogeneous and several phyla are usually represented, response to environmental impacts is normally detectable in terms of the community as a whole (Hellawell, 1977).

The South African Scoring System, Version 5 (SASS5) index was designed specifically for the evaluation of perennial streams and rivers and is not suitable for assessment of impoundments, isolated pools, wetlands or pans (Dickens & Graham, 2002). For the assessment of the sites, the standard SASS5 sampling methodology was applied. Stones-In-Current (SIC), Aquatic Vegetation (marginal and aquatic macrophytes), and Gravel, Sand and Mud (GSM) habitats were sampled. This was done using the standard SASS net, whereby aquatic macroinvertebrates are physically dislodged from aquatic vegetation, collected from the water column, removed from the surfaces substrate and caught in the fine mesh size of the net. Thereafter, these organisms were placed into a white tray and identified to family level (Thirion *et al*., 1995; Davies & Day, 1998; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

The endpoint of any biological or ecosystem assessment is a value expressed either in the form of measurements (data collected) or in a more meaningful format by summarising these measurements into one or several index values (Cyrus *et al*., 2000) The endpoints used for this study were, total SASS score and average score per taxa (ASPT).

SASS5 Data Interpretation Guidelines (Dallas, 2007) were used to evaluate the SASS5 results. A summary of the Ecological Categories used for the interpretation of the SASS5 data is shown in **Table 4.3**.

Table 4.3: Ecological Categories for the interpretation of SASS5 data (adapted from Dallas, 2007 and Kleynhans *et al*., 2005b)

ECOLOGICAL CATEGORY (EC)	EC NAME	DESCRIPTION
A	NATURAL	UNMODIFIED NATURAL; COMMUNITY STRUCTURES AND FUNCTIONS COMPARABLE TO THE BEST SITUATION TO BE EXPECTED. OPTIMUM COMMUNITY STRUCTURE FOR STREAM SIZE AND HABITAT QUALITY.
B	GOOD	LARGELY NATURAL WITH FEW MODIFICATIONS; A SMALL CHANGE IN COMMUNITY STRUCTURE MAY HAVE TAKEN PLACE BUT ECOSYSTEM FUNCTIONS ARE ESSENTIALLY UNCHANGED
C	FAIR	MODERATELY MODIFIED; COMMUNITY STRUCTURE AND FUNCTION LESS THAN THE REFERENCE CONDITION. COMMUNITY COMPOSITION LOWER THAN EXPECTED DUE TO LOSS OF SOME SENSITIVE FORMS. BASIC ECOSYSTEM FUNCTIONS ARE STILL PREDOMINANTLY UNCHANGED.
D	POOR	LARGELY MODIFIED; FEWER FAMILIES PRESENT THEN EXPECTED, DUE TO LOSS OF MOST INTOLERANT FORMS. AN EXTENSIVE LOSS OF BASIC ECOSYSTEM FUNCTION HAS OCCURRED.
E	SERIOUSLY MODIFIED	SERIOUSLY MODIFIED; FEW AQUATIC FAMILIES PRESENT, DUE TO LOSS OF MOST INTOLERANT FORMS.
F	CRITICALLY MODIFIED	CRITICALLY OR EXTREMELY MODIFIED; AN EXTENSIVE LOSS OF BASIC ECOSYSTEM FUNCTION HAS OCCURRED.

The November 2007 SASS5 results were compared to the 2006 RDS.results in order to illustrate possible trends in aquatic macroinvertebrate assemblage integrity.

4.6 ICHTHYOFAUNA

Whereas invertebrate communities are good indicators of localised conditions in a river over the short-term, fish are:

- relatively long-lived and mobile;

- good indicators of long-term influences;
- good indicators of general habitat conditions;
- organisms that integrate effects of lower trophic levels; and are
- consumed by humans (Uys et al., 1996)

The available habitat types are important when sampling fish, and involve an assessment of both flow-depth types and cover types. For each of these, fish species give preference depending on their specific life cycle requirements (food sources, reproduction, prey evasion, hunting, foraging, migration, diurnal/nocturnal cycles, etc.).

Electrofishing is the use of electricity to catch fish. The electricity is generated by a system whereby a high voltage potential is applied between two electrodes that are placed in the water (USGS, 2004). The responses of fish to electricity are determined largely by the type of electrical current and its wave form. These responses include avoidance, electrotaxis (forced swimming), electrotetanus (muscle contraction), Electricalarcosis (muscle relaxation or stunning) and death (USGS, 2004). Electrofishing was conducted by means of a portable battery driven electrofishing device (DC 12V pulsating). Electrofishing is regarded as the most effective single method for sampling fish communities in wadeable streams (Plafkin *et al.,* 1989). Additional gill netting and seine netting was conducted at site NWA03 due to the abundance of deep, slow flowing habitats at the site.

All fish were identified in the field and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001).

The November 2007 fish survey results were compared to the 2006 RDS results in order to detect possible trends in fish assemblage integrity.

4.6.1 Expected fish assemblage

Based on a survey of available literature a shortlist of expected species was compiled for reach EWR3 (**Table 4.4**) (Skelton, 2001; Kleynhans *et al*., 2007; and DWAF, 2006).

Table 4.4: Expected fish assemblage for study reach (EWR3), based on a survey of available literature (Skelton, 2001; Kleynhans *et al*., 2007; DWAF, 2006)

Species	Common Name	Habitat Preference	IUCN Status
Family Amphiliidae			
Amphilius uranoscopus	Stargazer Mountain Catfish	Clear and flowing water in rocky habitats	Unlisted
Family Anguillidae			
Anguilla mamorata	Giant Mottled Eel	Wide variety of habitats due to migration. Favours pools	Unlisted
Anguilla mossambica	Longfin Eel	Wide variety of habitats due to migration. Favours pools	Unlisted
Family Characidae			
Brycinus imberi	Imberi	Wide variety of habitats due to migration.	Unlisted
Micralestes acutidens	Silver Robber	In clear and open waters	Unlisted
Family Cichlidae			
Oreochromis mossambicus	Mozambique Tilapia	Wide range of habitats except fast flowing water	NT
Pseudocrenilabrus philander	Southern Mouthbrooder	Wide variety of habitats from flowing waters to lakes, usually favours vegetated zones.	Unlisted
Tilapia rendalli	Redbreast Tilapia	Quiet and well vegetated waters	Unlisted
Tilapia sparrmanii	Banded Tilapia	Tolerant of a wide range of habitats but prefers quiet or standing waters with submerged or emergent vegetation	Unlisted
Family Clariidae			
Clarias gariepinus	Sharptooth Catfish	Occurs in a wide variety of habitats but favours floodplains, large sluggish rivers, lakes and dams	Unlisted
Family Cyprinidae			
Barbus eutaenia	Orangefin Barb	Clear, flowing and rocky rivers	Unlisted
Barbus linomaculatus	Line-spotted Barb	Wide range of habitats	Unlisted
Barbus neefi	Sidespot Barb	Wide variety of habitats	Unlisted
Barbus paludinosus	Straightfin Barb	Slow flowing and vegetated habitats	Unlisted
Barbus radiatus	Beira Barb	Marginal vegetation of streams	Unlisted
Barbus toppini	East Coast Barb	Shallow and well vegetated streams	Unlisted
Barbus trimaculatus	Threespot Barb	Wide variety of habitats	Unlisted

Barbus unitaeniatus	Longbeard Barb	Wide variety of habitats	LC
Barbus viviparus	Bowstripe Barb	Vegetated pools with submerged roots	LC
Labeo cylindricus	Redeye Labeo	Clear running water in rocky habitats	LC
Labeo molybdinus	Leaden Labeo	Deep pools and rapids	LC
Labeo rosae	Rednose Labeo	Sandy stretches of large rivers	LC
Labeo ruddi	Silver Labeo	Quiet or standing waters of large rivers	LC
Labeobarbus marequensis	Lowveld Largescale Yellowfish	Flowing water	LC
Mesobola brevianalis	River Sardine	Well aerated, open water of flowing rivers	LC
Opsaridium peringueyi	Southern Barred Minnow	Shallow, clear and flowing waters. Favours sand and gravel	LC
Family Gobiidae			
Glossogobius callidus	River Goby	Cobble pools with vegetation	LC
Glossogobius giuris	Tank Goby	Quiet sandy zones of rivers	Unlisted
Family Mochokidae			
Chiloglanis paratus	Sawfin Suckermouth	Rocky riffles and rapids	LC
Chiloglanis pretoriae	Shortspine Suckermouth	Rocky riffles and rapids	LC
Synodontis zambezensis	Brown Squeaker	Pools and slow flowing reaches	Unlisted
Family Mormyridae			
Marcusenius macrolepidotus	Bulldog	Well-vegetated and muddy bottomed rivers	Unlisted
Petrocephalus wesselsi	Southern Churchill	Quiet reaches	LC
Family Schilbeidae			
Schilbe intermedius	Silver Catfish	Slow-flowing and open water with vegetation	Unlisted

NT – Near threatened; and LC – Least Concern

Based on this assessment a total of 34 fish species would historically have occurred within reach EWR3. The expected frequency of occurrences (FROC) of the expected species was obtained from Kleynhans *et al*. (2007).

4.6.2 Presence of Red Data Species

In order to assess the IUCN status of fish species occurring in the sample area, the 2007 IUCN Red List of Threatened Species (IUCN, 2007) was consulted:

Based on the 2007 IUCN list, it was shown that of the total 34 expected fish species for the study area:

- Thirteen species are currently listed as Least Concern (LC) (**Table 4.4**). A species in this category is widespread and abundant (IUCN, 2001);
- One species: *Oreochromis mossambicus* (Mozambique Tilapia) is currently listed as Near Threatened (NT) (**Table 4.4**). A species is classified as Near Threatened when it likely to qualify for a threatened category in the near future (IUCN, 2001); and
- The remaining 20 fish species are currently unlisted.

Oreochromis mossambicus is threatened by hybridization with the rapidly spreading *O. niloticus* (Nile Tilapia) (IUCN, 2007). Hybridization has already been documented throughout the northern part of the species' range, with most of the evidence coming from the Limpopo River system (IUCN, 2007). Conservation measures stipulate that river systems not yet invaded by *O. niloticus* must be protected from deliberate and accidental introductions of that species (IUCN, 2007).

4.6.3 Fish Health Assessment

For the purpose of this study the fish health assessment was based on an external examination of the skin and fins, eyes, gills, opercula and the presence of ectoparasites. This approach ensured the minimization of stress due to handling and allowed the fish to be released unharmed.

4.6.4 Biotic integrity based on the Fish Assemblage Integrity Index (FAII)

The Fish Assemblage Integrity Index (FAII) is an index which assesses the biological integrity of a river based on attributes of the indigenous fish assemblages (Kleynhans, 1999). Alien species (introduced indigenous and exotic species) are not included as metrics in the FAII (Kleynhans, 1999). Their presence and distribution are noted but interpreted as possible causes for a decline in the FAII score. Calculation of the

relative FAII score consists of the calculation of an expected score, which serves as the reference, the calculation of an observed score and the comparison of the expected and observed scores (Kleynhans, 1999).

A summary of the Ecological Categories used for the interpretation of the FAII data is shown in **Table 4.5**.

Table 4.5: Ecological Categories for the interpretation of FAII data (adapted from Kleynhans *et al*., 2005b)

ECOLOGICAL CATEGORY (EC)	EC NAME	DESCRIPTION
A	NATURAL	UNMODIFIED NATURAL; COMMUNITY STRUCTURES AND FUNCTIONS COMPARABLE TO THE BEST SITUATION TO BE EXPECTED. OPTIMUM COMMUNITY STRUCTURE FOR STREAM SIZE AND HABITAT QUALITY.
B	GOOD	LARGELY NATURAL WITH FEW MODIFICATIONS; A SMALL CHANGE IN COMMUNITY CHARACTERISTICS MAY HAVE TAKEN PLACE BUT SPECIES RICHNESS AND PRESENCE OF INTOLERANT SPECIES INDICATE LITTLE MODIFICATION.
C	FAIR	MODERATELY MODIFIED; A LOWER THAN EXPECTED SPECIES RICHNESS AND PRESENCE OF MOST INTOLERANT SPECIES. SOME IMPAIRMENT OF HEALTH MAY BE EVIDENT AT THE LOWER LIMIT OF THIS CLASS.
D	POOR	LARGELY MODIFIED; A CLEARLY LOWER THAN EXPECTED SPECIES RICHNESS AND PRESENCE OF MOST INTOLERANT SPECIES. SOME IMPAIRMENT OF HEALTH MAY BE EVIDENT AT THE LOWER LIMIT OF THIS CLASS.
E	SERIOUSLY MODIFIED	SERIOUSLY MODIFIED; A STRIKINGLY LOWER THAN EXPECTED SPECIES RICHNESS AND GENERAL ABSENCE OF INTOLERANT AND MODERATELY INTOLERANT SPECIES. IMPAIRMENT OF HEALTH MAY BECOME EVIDENT.
F	CRITICALLY MODIFIED	CRITICALLY OR EXTREMELY MODIFIED; EXTREMELY LOWERED SPECIES RICHNESS AND AN ABSENCE OF INTOLERANT AND MODERATELY INTOLERANT SPECIES. ONLY TOLERANT SPECIES MAY BE PRESENT WITH A COMPLETE LOSS OF SPECIES AT THE LOWER LIMIT OF THE CLASS. IMPAIRMENT OF HEALTH GENERALLY VERY EVIDENT.

4.7 ASSESSMENT OF POTENTIAL IMPACTS

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:

4.7.1 Nature

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

4.7.2 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.

4.7.3 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.

4.7.4 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.

4.7.5 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.

4.7.6 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.

4.7.7 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.

4.7.8 Cumulative Impacts

The possible cumulative impacts will also be considered.

4.7.9 Mitigation

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

5. ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

Certain gaps in knowledge arose during the aquatic baseline assessment that were not included in this EIR, but were recommended in the original ToR. These are considered to be of important value for the scientific analysis of the impacts outlined in this EIR. These are:

- A genetic assessment of specific fish species upstream and downstream of the proposed Nwamitwa Dam site. This will provide further scientific evidence as to the transfer of genetic material between populations upstream and downstream of the Nwamitwa Dam site and thus provide information as to the connectivity and genetic importance of the reach and give further support to the need to maintain this connectivity at the dam by means of a fishway/fish ladder or not;

- A habitat suitability and accessibility study of the area both upstream and downstream of the Nwamitwa Dam site. This will give further scientific evidence of the availability and accessibility of suitable breeding/critical life-stage habitats required by specific fish species. This would enable required habitat areas not impacted by the GLeWaP to be identified, assessed in terms of suitability and accessibility for ecosystem functioning and conserved as a mitigation option; and

- A full flow regime maintenance and release management strategy for the proposed Nwamitwa Dam.

Without these three above mentioned assessments, the level of impact on the migratory fish populations within this river reach (EWR3) is uncertain. In addition, the impact of the ability of any remaining fish species be able to find and access suitable habitats that are required for all the life stages of the species is also uncertain due to the limitations in habitat assessment.

6. RESULTS AND FINDINGS

Site conditions recorded at the sites during the survey indicated that high flows within the Great Letaba and Nwanedzi Rivers. This was evident by the excessive amount of suspended silt in the water column and inundated vegetation present at the sites. At site NWA02, very shallow depths of approximately 20 to 50 mm were recorded with little to no variation in substrate (only sand present).

6.1 *IN SITU* WATER QUALITY

In situ water quality was measured in the field with lightweight compact field instruments and the results presented in **Table 6.1**. These results are important in assisting with the interpretation of biological results because of the direct influence water quality has on aquatic life forms. It should however be noted that these values represent a single moment in time, and cannot be interpreted as representative of overall water quality conditions of the sites.

Table 6.1: *In situ* water quality parameters recorded during the November 2007 baseline assessment

Site	Time	pH	EC[1] (mS/m)	TDS[2] (mg/l)	DO[3] (mg/l)	Temp (˚C)
NWA01	16h00	7.9	112.6	732	5.4	34.9
NWA02	14h00	8.4	138.5	900	8.7	38.2
NWA03	07h55	8.3	163.1	1060	9.1	23.6
LET01	09h10	8.0	122.9	799	5.6	26.8

[1] EC – Electrical Conductivity; [2] TDS – Total Dissolved Salts; and [3] DO – Dissolved Oxygen

Water quality information provided by the 2006 RDS (DWAF 2006) was used to compare the baseline assessment data to in terms of variables and the recommended Ecospecs. Where variables such as: Electrical conductivity (EC) and TDS, were not assessed in the 2006 RDS, the South African Water Quality Guidelines for Aquatic Ecosystems and Domestic Use were applied (DWAF, 1996).

6.1.1 pH

The pH of natural waters is determined by both geological and atmospheric influences, as well as by biological activities. Most fresh waters are usually relatively well buffered with a pH range from 6 to 8, and most are slightly alkaline due to the presence of bicarbonates of the alkali and alkaline earth metals (DWAF, 1996). The pH target for fish health is presented as ranging between 6.5 and 9.0, as most species will tolerate and reproduce successfully within this pH range (Alabaster and Lloyd, 1982). According to the 2006 RDS (DWAF, 2006), pH within this reach (EWR3) is in an A category and therefore the Quality Ecospecs for pH should range from 6.5 – 8.

During the November 2007 baseline assessment survey pH levels in the Nwanedzi River ranged from 7.9 at site NWA01 to 8.4 at site NWA02 (**Table 6.1**). A pH value of 8.0 was measured at site LET01 in the Groot Letaba River (**Table 6.1**). Within this range, according to the pH target for fish, this should not have had limiting effect on aquatic biota in the sample area (**Table 6.1**) at the time of the survey. According to the Qualtity Ecospecs of the RDS, sites NWA02 and NWA03 were above the target range, but according to results obtained during the RDS, this range may be higher as pH values of 8.36 were obtained (DWAF, 2006). According to the water quality specialist study for this project (GLeWaP, 2008a), there has been a slight decreasing trend in the pH values due to processes in the catchment that are causing changes in water quality.

Within the context of the RDS, pH values from this baseline assessment were similar and within the Quality Ecospecs. Within this range pH values are not expected to have a limiting effect on aquatic biota.

6.1.2 Electrical Conductivity (EC)

Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current (DWAF, 1996). This ability is a result of the presence in water of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium, all of which carry an electrical charge (DWAF, 1996).

Electrical Conductivity (EC) values ranged from 112.6 mS/m at site NWA01 to 163.1 mS/m at site NWA03 (Table 6.1). No guideline values are available for EC levels within aquatic ecosystems. According to the water quality specialist study for this project (GLeWaP, 2008a), there has been a slight increasing trend in Electrical Conductivity (EC) values ascribed to processes in the catchment that are causing changes in water quality. 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.

6.1.3 Total Dissolved Solids (TDS)

Concentrations of Total Dissolved Solids (TDS) in water vary owing to different mineral solubilities in different geological regions. The TDS concentrations are generally in the range of 200 - 1 100 mg/l in water in contact with Paleozoic and Mesozoic sedimentary rock formations (DWAF, 1996), because of the presence of carbonates, chlorides, calcium, magnesium and sulphates (Health Canada, 2008).

The geology of the proposed Nwamitwa Dam site consists of Goudplaas Gneiss from the Swazian age (GLeWaP, 2007b) and includes both feldspar and quartzite aggregates. Underlying this is granite gneiss. The remainder of the Great Letaba catchment consists of granites that allow shallow weathering (less than 10 m) and the soils formed are expected to be more sandy. The soils present are mainly Hutton and Shortlands types. The geology of the study area therefore consists of soils and formations associated with Paleozoic and Mesozoic formations.

No TDS concentration guidelines were provided in the 2006 RDS (DWAF, 2006), however, the sum of the Inorganic Salt Quality Ecospecs is 621 mg/l, which is within the abovementioned guideline range. Therefore, a general guideline range of 200 – 1100 mg/l was used as a guideline range for this assessment.

In the Nwanedzi River, TDS concentrations increased in a downstream direction from 732 mg/l at site NWA01 to 1060 mg/l at site NWA03 just before the confluence with the Groot Letaba River (**Table 6.1**). A TDS concentration of 799 mg/l was measured at site LET01 in the Groot Letaba River (**Table 6.1**). Within this TDS range, TDS concentrations should not have a limiting effect on aquatic biota.

According to the water quality specialist study for this project (GLeWaP, 2008a), there is an increasing trend in salinity ascribed to processes in the catchment causing changes in water quality. 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.

Within the context of the 2006 RDS, the TDS concentrations obtained during the baseline assessment were above the Total Inorganic Salt Quality Ecospecs.

6.1.4 Dissolved Oxygen (DO)

The maintenance of adequate dissolved oxygen (DO) is critical for the survival and functioning of the aquatic biota because it is required for the respiration of all aerobic organisms. Therefore, DO concentration provides a useful measure of the health of an ecosystem (DWAF, 1996). The median guideline for DO for the protection of aquatic biota is > 5 mg/l (Kempster *et al*., 1980). According to the 2006 RDS (DWAF, 2006), DO within reach EWR3 is in a category A and the Quality Ecospecs for DO should range from 6 – 7 mg/l.

During the November 2007 baseline assessment survey, DO concentrations were adequate (> 5 mg/l) at all the sites and should not have a limiting effect on aquatic biota (**Table 6.1**). The lower oxygen level of 5.6 mg/l recorded at site LET01 was considered to be due to the increase turbidity observed at the site and may possibly be as a result of increased Chemical Oxygen Demand (COD).

Within the context of the 2006 RDS, the DO concentrations obtained during the baseline assessment were above the Quality Ecospecs at sites NWA02 and NWA03 and below at sites NWA01 and LET01. As discussed, the increase may have been due to the high temperatures and shallow water levels present at the two sites. The decreases at sites NWA01 and LET01 were slight and could possibly be attributed to the high turbidity and siltation present. These deviations were thus considered to be temporary.

6.1.5 Temperature

Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms (DWAF, 1996). Temperature affects the rate of development, reproductive periods and emergence time of organisms (Davies & Day, 1998). Temperature varies with season and the life cycles of many aquatic macroinvertebrates are cued to temperature. According to the 2006 RDS (DWAF, 2006), temperature within this reach (EWR3) caters for moderate changes and therefore the Quality Ecospecs for temperature stipulate that temperature values should vary by no more than 2 ºC.

During the November 2007 survey water temperatures in the Nwanedzi River ranged from 23.6 ˚C at site NWA03 to 38.2 ˚C at site NWA02 (**Table 6.1**). High temperatures recorded at sites NWA01 and NWA02 can be attributed to the shallow water depths (< 10 cm) observed at these sites. A water temperature of 26.8 ˚C was measured at site LET01 in the Groot Letaba River (**Table 6.1**).

Within the context of the 2006 RDS, temperatures at sites NWA02 and NWA01 are expected to fluctuate greatly within a 24 hour period due to the shallow water levels at the sites. It should however be noted that the Nwanedzi River is naturally non-perennial and that the biota are adapted to the fluctuating conditions in the river.

6.2 INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS, *VERSION 2*)

The availability of the instream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore evaluation of habitat availability is critical to any assessment of aquatic biota. The results of the Invertebrate Habitat Assessment System (IHAS, *Version 2*) are presented in **Table 6.2**.

Table 6.2: IHAS scores recorded during the November 2007 baseline assessment

Site	November 2007	
	IHAS Score	Description
NWA01	62	Adequate

NWA02	41	Poor
NWA03	52	Adequate
LET01	76	Good

Based on the IHAS results, adequate habitat availability exists at sites NWA01 and NWA03 (**Table 6.2**). Habitat availability at site NWA02 was poor (**Table 6.2**). This can be attributed to the low flow conditions at the site, the absence of the Stones-In-Current (SIC) habitat and of the limited availability of marginal vegetation. Therefore, habitat availability can be considered a limiting factor of SASS5 scores at site NWA02. Based on the IHAS score, habitat availability at site LET01 was good (**Table 6.2**).

6.3 AQUATIC MACROINVERTEBRATES

A list of aquatic macroinvertebrates collected during the November 2007 baseline assessment survey is provided in Appendix B. A summary of the SASS5 results is provided in **Table 6.3**.

Table 6.3: SASS5 Scores, ASPT* Scores and Number of taxa recorded during the November 2007 survey

Site	SASS5 scores	Number of taxa	ASPT*
NWA01	78	16	4.9
NWA02	40	8	5.0
NWA03	56	15	3.7
LET01	161	27	6.0

* Average Score per Taxa

In the Nwanedzi River, SASS5 scores ranged from 40 at site NWA02 to 78 at site NWA01 (**Table 6.3**). The number of taxa ranged from 8 at site NWA02 to 16 at site NWA01 (**Table 6.3**) The ASPT scores, which represent the average sensitivity of the aquatic macroinvertebrate sample, ranged from 3.7 at site NWA03 to 5.0 at site NWA02 indicating that the aquatic macroinvertebrate assemblage in the Nwanedzi River is characterised by tolerant taxa (Intolerance Rating < 5) (**Table 6.3**).

In the Groot Letaba River, a SASS5 score of 161 was recorded at site LET01 (**Table 6.3**). Twenty seven aquatic macroinvertebrate taxa were recorded at site LET01 (**Table 6.3**). An ASPT score of 6.0 was recorded at site LET01 indicating that the aquatic macroinvertebrate assemblage at the site is characterised by moderately sensitive taxa (Intolerance Rating 5 - 10) (**Table 6.3**).

6.3.1 Biotic Integrity based on SASS5 Results

The SASS and ASPT results were used to evaluate the biotic integrity of the sites using the SASS Data Interpretation Guidelines (Dallas, 2007). The biotic integrity of the various sites based on the SASS5 results is provided in **Table 6.4**.

Table 6.4: Biotic Integrity of sites in the Nwanedzi and Groot Letaba Rivers based on SASS5 data collected during the November 2007 survey

Site	Integrity Class	Class Description
NWA01	D/E	Largely/seriously impaired
NWA02	E	Seriously impaired
NWA03	F	Critically impaired
LET01	B	Minimally impaired

Based on the SASS results, biotic integrity in the Nwanedzi River ranged from largely/seriously impaired (Integrity Class D/E) in the upper reaches (Site NWA01), to critically impaired at site NWA03 (**Table 6.4**). **It should be noted that the Nwanedzi River is non-perennial and therefore SASS results obtained from this river should be interpreted with caution. The low level of biotic integrity recorded at site NWA02 can be attributed in part to the limited habitat availability at the site.**

Based on the SASS results, biotic integrity at site LET01 was minimally impaired (Integrity Class B) (**Table 6.4**). A small change in aquatic macroinvertebrate community structure is associated with this level of impairment but basic ecosystem function remains intact.

Within the context of the 2006 RDS (DWAF, 2006), the aquatic macroinvertebrates within this reach (EWR3) had a PES of D, indicating seriously modified conditions.

This was attributed to upstream abstraction which had resulted in a reduction of flow velocities, habitat availability, flushing flows and dilution of pollutants. This was determined to be a neutral trend and that the aquatic macroinvertebrate was stable and had adjusted to the present flow regime. The recommended Ecospecs for this reach is D (DWAF, 2006). During the November 2007 survey the PES at sites NWA02 and NWA03 were below the recommended Ecospecs. As discussed, this was most likely due to the non-perennial nature and limited habitat availability in the Nwanedzi River.

The PES recorded at site LET01 during the November 2007 survey was above the recommended Ecospecs. This is considered to be of importance in the context of this EIA and the existing RDS.

6.4 ICHTHYOFAUNA

6.4.1 Observed Fish Assemblage

Of the 34 expected indigenous fish species expected to occur within reach EWR3, a total of 15 indigenous and one introduced fish species were recorded during the November 2007 survey (**Table 6.5**)

Table 6.5: Number of fish individuals, species and families recorded during the November 2007 baseline assessment

Species	Common Name	IUCN Status	NWA01	NWA02	NWA03	LET01
Family Characidae						
Micralestes acutidens	Silver Robber	Unlisted				8
Family Cichlidae						
Oreochromis mmossambicus	Mozambique Tilapia	NT	9	5	3	16
Pseudocrenilabrus philander	Southern Mouthbrooder	Unlisted	25	1	2	28
Tilapia sparrmanii	Banded Tilapia	Unlisted		7	1	
Family Clariidae						
Clarias gariepinus	Sharptooth Catfish	Unlisted	1		3	2
Family Cyprinidae						
Barbus toppini	East Coast Barb	Unlisted	4		1	12

Barbus trimaculatus	Threespot Barb	Unlisted	10	10	4	1
Barbus unitaeniatus	Longbeard Barb	LC	1		7	
Barbus viviparus	Bowstripe Barb	LC	11	1	13	11
Labeo cylindricus	Redeye Labeo	LC	5			4
Labeo molybdinus	Leaden Labeo	LC	1			7
Labeo rosae	Rednose Labeo	LC			1	
Labeobarbus marequensis	Lowveld Largescale Yellowfish	LC				16
Mesobola brevianalis	River Sardine	LC				7
Family Mochokidae						
Chiloglanis pretoriae	Shortspine Suckermouth	LC				24
Family Centrarchidae						
*Micropterus salmoides**	Largemouth Bass	Unlisted			1	
Total number of individuals			67	24	36	136
Total number of species			9	5	10	12

* Introduced species

6.4.2 Nwanedzi River

Twelve fish species were recorded in the Nwanedzi River (**Table 6.5**). The most abundant fish species in the Nwanedzi River was *Pseudocrenilabrus philander* (Southern Mouthbrooder) which was collected at all of the sites and comprised 22.0% of the total catch (**Table 6.5**). Four fish species that were recorded in the Nwanedzi River were not recorded in the Groot Letaba River namely: *Barbus unitaeniatus* (Longbeard Barb), *Tilapia sparrmanii* (Banded Tilapia), *Labeo rosae* (Rednose Labeo) and *Micropterus salmoides (*Largemouth Bass) (**Table 6.5**).

The presence of the aggressively invasive alien fish species *M.salmoides* in the reach is cause for concern (**Table 6.5**). *M. salmoides* (Largemouth Bass) was introduced into South African waters from North America between 1928 and 1938 and quickly became established in natural waters (Skelton, 2001). Although this species is primarily piscivorous, it is a voracious predator that will take virtually any animal food it encounters including crabs, frogs, snakes and even small mammals. In the long term it can be expected that this species will cause extensive damage to indigenous fish populations (Skelton, 2001).

Limited availability of flowing habitat types may have a limiting effect on fish assemblages in the Nwanedzi River. Two fish species that were recorded at site NWA03 during the November 2007 survey were not recorded within reach EWR3 during the 2006 RDS namely *Labeo rosae* (Rednose Labeo) and *M. salmoides* (Largemouth Bass).

6.4.3 Groot Letaba River

Twelve of the 34 expected indigenous fish species were at site LET01 during the November 2007 survey (**Table 6.5**). The most abundant fish species was *P.philander* (Southern Mouthbrooder). Fish species collected in the Groot Letaba River that were not recorded in the Nwanedzi River included: *Chiloglanis pretoriae* (Shortspine Suckermouth), *Labeobarbus marequensis* (Lowveld Largescale Yellowfish), *Micralestes acutidens* (Slender Robber) and *Mesobola brevianalis* (River Sardine) (**Table 6.5**).

Sixteen of the 34 expected species were recorded in reach EWR3 during the 2006 RDS (DWAF, 2006). Two fish species namely *C. paratus* (Sawfin Suckermouth) and *T. rendalii* (Redbreast Tilapia) that were recorded in reach EWR3 during the 2006 RDS were not recorded during the November 2007 survey (DWAF, 2006). Based on the combined results of the 2006 RDS and the November 2007 survey it can be concluded that at least 17 indigenous and 1 exotic fish species remain within reach EWR3.

6.4.4 Presence of Red Data Species

Oreochromis mossambicus was recorded at all four sites (**Table 6.5**) and is currently listed as Near Threatened (NT) on the IUCN red data list (IUCN, 2007).

Oreochromis mossambicus is threatened by hybridization with the rapidly spreading *O. niloticus* (Nile Tilapia) (IUCN, 2007). Hybridization is already been documented throughout the northern part of the species' range, with most of the evidence coming from the Limpopo River system (IUCN, 2007). Conservation measures stipulate that river systems not yet invaded by *O. niloticus* must be protected from deliberate and accidental introductions of that species (IUCN, 2007). No evidence of *O. niloticus* was recorded within reach EWR3 during the November 2007 survey although it should be

noted that the expression of the characteristic hybrid traits would depend on the degree of hybridization and can only be verified by means of a genetic analysis.

***O. mossambicus* is generally regarded as a hardy species that inhabits a wide variety of habitats including estuaries and the sea and thrives in impoundments (Skelton, 2001). It is likely that a thriving population of *O. mossambicus* will become established in Nwanedzi Dam.**

6.4.5 Fish Health Assessment

After thorough external examination, it was determined that all individuals were free of apparent diseases, parasites and body injuries.

6.4.6 Biotic Integrity based on FAII Results

The fish assemblages at all the sites were evaluated in terms of habitats, flows present as well as expected fish habitat, flow and cover preferences.

Relative FAII scores were calculated by taking the observed FAII score as a percentage of the expected FAII score. The relative FAII scores recorded during the November 2007 survey are presented in **Table 6.6**.

Table 6.6: Relative FAII Scores recorded in the sample area during the November 2007 baseline assessment

Site	Relative FAII Score (% of expected)	Class Rating	Description
NWA01	50	D	Poor –largely modified
NWA02	41	D	Poor – largely modified
NWA03	41	D	Poor – largely modified
LET01	70	C	Fair – moderately modified

Based on the November 2007 FAII results, biotic integrity in the Nwanedzi River (sites NWA01 – NWA03) was poor (Class D) at all three sampling sites (**Table 6.6**). This can most likely attributed to the non-perennial nature of the Nwanedzi River, the naturally low flow conditions and limited habitat availability. Due to the non-perennial

nature of the Nwanedzi River the relative FAII scores likely represents an under estimation of the actual level of biotic integrity in the river. The presence of the aggressively invasive introduced fish species *M. salmoides*, may also be contributing to the low FAII scores recorded in the Nwanedzi River.

The highest FAII score in the sample area was recorded at site LET01 in the Groot Letaba River (**Table 6.6**). Based on the FAII assessment, biotic integrity at site LET01 is moderately modified (Class C) (**Table 6.6**). It should be noted that these FAII results are based on the results from a single survey. It is unlikely that all the fish species present within the reach would be recorded during a single survey. Based on this assumption it can be deduced that the results of the November 2007 survey represents an under estimation of the actual level of integrity within the reach. Anthropogenic impacts such as flow regulation, water abstraction and water quality impairment due to surrounding agricultural activities may have a limiting effect on fish assemblages with the reach.

The results of the November 2007 survey were similar to those of the 2006 RDS, with a total of 17 of the 34 expected fish recorded within the Resource Unit (RU) (EWR3). The PES for fish within reach EWR3 is set as a C (Moderately modified) with a recommended Ecospec of C.

It is likely that some of the expected fish species may no longer occur within the reach. The continued presence of two expected migratory eel species (*A. marmorata* and *A. mossambica*) within the reach is unlikely due to Massangir Dam in Mozambique. *Barbus eutaenia* is a highly sensitive flow dependant species which may be lost from the RU due to high degree of flow modification and water abstraction in the Groot Letaba River (DWAF, 2006). Abundances of all species within this RU are known to be declining (DWAF, 2006). The 16 expected fish species that have not been sampled in recent years are considered to be lost within this reach (DWAF, 2006).

The source of these losses and decreases in fish species populations may be attributed to fragmentation of the system and regulation of flows by the numerous dams and weirs upstream and downstream of the RU and which have had a limiting effect on fish recruitment and distribution (DWAF, 2006). The trend was determined to be stable and it is believed that the remaining species have adapted and are surviving

under current conditions. It was also suggest by the 2006 RDS that suitable breeding areas are still available within this RU (DWAF, 2006).

6.5 CONCLUSIONS

The following conclusions were reached based on the results of the November 2007 baseline assessment:

- The Present Ecological States (PES) at sites NWA02 and NWA03 in the Nwanedzi River were below the recommended Ecospecs. This could most likely due to the non-perennial nature of the Nwanedzi River and likely represents an under estimation of the actual level of biotic integrity in the river. The presence of the aggressively invasive introduced fish species *M. salmoides*, may be contributing to the low FAII scores recorded in the Nwanedzi River.

- The PES recorded at site LET01 exceeded the recommended Ecospecs. This is considered to be of importance in the context of this EIA and the existing RDS.

- *Oreochromis mossambicus* (Mozambique Tilapia) is a Near Threatened (NT) fish species that was recorded at all of the sampling sites during the November 2007 survey. *O.mossambicus* is threatened by hybridization with *Oreochromis niloticus* (Nile Tilapia); a North African species introduced for aquaculture purposes. *O.mossambicus* is generally regarded as a hardy species which is likely to thrive in the Nwamitwa Dam.

- Based on the FAII assessment, biotic integrity within reach EWR3 complied with the recommended Ecospec of C (moderately modified). It should be noted that these November 2007 FAII results are based on a single survey and likely represent an under estimation of the actual level of biotic integrity within the reach.

6.6 ASSESSMENT OF POTENTIAL IMPACTS

Any development in a natural system will impact on the environment, usually with adverse effects. From a technical, conceptual or philosophical perspective the focus of impact assessment ultimately narrows down to a judgment on whether the predicted impacts are significant or not (DEAT, 2002). Dams are the main reason that 20% of the world's freshwater fish species are endangered (Davies & Day, 1998).

Alterations of the natural variation of flow by river regulation through decreasing or increasing the flows can only have a profound influence upon almost every aspect of river ecological functioning (Davies *et al*., 1993).

Mitigation options should first comply with the 2006 RDS requirements.

6.6.1 Existing legislation with regards to in-stream migration barriers

Environmental legislation has recently been promulgated in South Africa that adequately protects riverine ecosystems from man-induced impacts. If correctly and strictly applied, this new legislation should ensure that appropriate mitigation (e.g. fishway provision) is taken when in-stream barriers to fish migration are constructed (Bok *et al*., 2007). This legislation includes:

The Environment Conservation Act, 1989 (No. 73 of 1989)

In terms of Regulations (Section 21, Schedule 1, No.1 (j) published in Government Gazette No. 18261, 5 September 1997, in terms of the Environment Conservation Act, 1989 (ECA), appropriate environmental investigations (EIA's) are mandatory before approval for the “construction or upgrading of dams, levees or weirs affecting the flow of a river” will be given by the relevant authority (Bok *et al*., 2007).

The National Environmental Management Act (Act 107 of 1998)

The National Environmental Management Act (Act 107 of 1998), in terms of Regulation 386, Activity 1 (m) gazetted in terms of Section 24, a basic assessment is required to be conducted before approval for any in-stream barrier construction is granted (Bok *et al*., 2007).

National Water Act, 1998 (Act No. 36 of 1998)

In the National Water Act (NWA), use of water is no longer limited to consumptive use, such as the abstraction of water, but includes non-consumptive activities that may have an impact on the resource quality (Bok *et al*., 2007). These “water uses”, which require authorization (usually in the form of a license) are given in Section 21 of the NWA, and include:

- Section 21 (a): storing water;
- Section 21 (c): impeding or diverting the flow of water in a watercourse;
- Section 21 (i): altering the bed, banks, course or characteristics of a watercourse.

6.6.2 Potential impacts of raising the dam wall of Tzaneen Dam on the aquatic ecosystems upstream and downstream of the dam wall

(a) Potential impacts on physical and chemical water conditions

As was indicated by the water quality specialist report (GLeWaP, 2008a), the raising of the Tzaneen Dam will have no water quality effects with respect to the current situation. It is expected that already existing impacts will only be compounded.

(b) Potential impacts on the physical habitat conditions

As was indicated by the sediment impact specialist report, the raising of Tzaneen Dam will not significantly alter the sediment trapping efficiency of the dam and most of the incoming sediment load will be trapped in the reservoir. Sediment deposition in the live storage will however occur further upstream than before. Storage capacity will increase, which could attenuate small and medium floods more. Large floods will not be attenuated significantly more than in the current condition (GLeWaP, 2008b).

River morphology downstream of the dam is not expected to change significantly. Small floods will be attenuated more and it is expected that the main channel width downstream of the dam to the first main tributary could decrease by less than 5 % of the current width (GLeWaP, 2008a).

(c) Potential impacts on the aquatic biota

As indicated by the impacts on the physical and chemical water conditions and on the physical habitat conditions, the raising of the Tzaneen Dam will is not expected to impact on the aquatic biota significantly with respect to the current situation. It is expected that already existing impacts will only be compounded. A further decrease in aquatic macroinvertebrate abundances and fish Frequency of Occurrences (FROCs) is expected.

(d) Potential impacts on the migration potential of fish species

No fish can currently migrate upstream in the Groot Letaba River beyond the base of Tzaneen Dam.

In terms of the 2006 RDS, the potential impacts of raising the Tzaneen Dam wall on the aquatic ecosystem ecosystems both upstream and downstream of the dam wall

may result in a decrease in PES over the short to medium term. This decrease should not compromise the Recommended Ecological Category (REC) significantly over the long term.

Mitigation measures include:

- The compilation of a management action plan whereby information from monthly water monitoring and bi-annual biomonitoring can be used to implement management actions should a significant decrease in PES (C/D EC) be noted.

The level of significance of this impact was rated as low, for the construction phase and medium for the operational phase, prior to the implementation of mitigation measures (**Table 6.7**). The level of significance remained low, for the construction phase and decreased to low for the operational phase, after implementation of recommended mitigation (**Table 6.7**).

Table 6.7: Significance of the potential impacts of raising the dam wall of Tzaneen Dam on the aquatic ecosystems upstream and downstream of the dam wall

Description of potential impact	Raising the dam wall of Tzaneen Dam on the aquatic ecosystems both upstream and downstream of the dam wall	
Nature of impact	Negative and direct	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative and direct	Negative and direct
Extent of impact	Regional	Regional
Duration of impact	Short term	Long term
Intensity	Medium	Medium
Probability of occurrence	High	High
Confidence of assessment	High	High
Level of significance before mitigation	Low	Medium
Mitigation measures (EMP requirements)	Implementation of a suitable management action plan based on monthly water quality and two biological monitoring surveys	Implementation of a suitable management action plan based on bi-annual water quality and biological monitoring data
Level of significance after mitigation	Low	Low
Cumulative Impacts	As discussed in Section 6.6.2 and include biotic and abiotic impacts	As discussed in Section 6.6.2 and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.2		

6.6.3 Potential impacts on the aquatic ecosystems within the proposed Nwamitwa Dam basin

(a) Potential impacts on physical and chemical water conditions

The water quality specialist report indicates that the impacts on physical and chemical water conditions are considered to be limited to the predicted phosphate concentration in the dam which will put the Nwamitwa Dam 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 (GLeWaP, 2008a). Mitigation of this is limited to identifying and reducing the source of this phosphate.

Concern over the amount of toxicants, especially Persistent Organic Pollutants (POPs) in the soils from years of crop spraying with fungicides, insecticides, may become suspended when the Nwamitwa Dam basin is inundated. As the presence or extent of these pollutants is not known, mitigation of this impact is limited to annual bioaccumulation studies of plant, macroinvertebrate and fish material from within the Nwamitwa Dam basin during the operation of the dam.

It is expected that 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 (GLeWaP, 2008a).

Stratification is predicted to occur in the proposed Nwamitwa Dam (GLeWaP, 2008a). Physical and chemical conditions may fluctuate greatly for some time, depending on how long the dam takes to fill, the prevailing water temperature, the quantities of nutrients made available from the inundated fauna and flora and soils and finally, the rate at which these are released into the water. Pollution from chemicals, sediments and nutrient loads (e.g. Phosphates) from upstream sources are also trapped in the dam and will impact on the physical and chemical characteristics of the water (Davies & Day, 1998). It is likely that a warm epilimnion of 18 to 24 ºC and cool lower hypolimnion of 14 to 18 ºC will develop (van Veelen *pers. comm.*, 2008). No mitigation required.

In terms of the 2006 RDS, the potential impacts on the aquatic ecosystems within the dam basin, in terms of the impacts on physical and chemical water conditions will most probably result in a large decrease in PES over the short to medium term. This decrease will compromise the Recommended Ecological Category (REC) over the

long term. Fluctuations in pH, Electrical Conductivity (EC), TDS, DO, and temperature will occur in the inundated areas as well as in the upstream river reach during flood events. These will most likely stabilize over the long term, but will differ from the PES.

Potential mitigation measures are limited due to permanent inundation of all existing riverine habitats within the dam basin. Potential mitigation should include the compilation of a management action plan whereby information from monthly water monitoring can be used to implement management actions should a significant decrease in Quality Ecospecs be noted:

- Monthly water quality monitoring should be conducted within the dam basin in order to detect trends in water quality. Suitable mitigation measures can then be implemented should it become clear that water quality is deteriorating beyond the recommended Water Quality Ecospecs.

The level of significance of this impact was rated as high during the construction and operation phases. After mitigation the significance of the impact decreased to medium for both phases (**Table 6.8**).

Table 6.8: Significance of the potential impacts on physical and chemical water conditions within the proposed Nwamitwa Dam basin

Description of potential impact	Physical and chemical water conditions within the proposed Nwamitwa Dam basin	
Nature of impact	Negative, direct and indirect	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative, direct and indirect	Negative, direct and indirect
Extent of impact	Local	Local
Duration of impact	Short term	Permanent
Intensity	Medium	Medium
Probability of occurrence	High	High
Confidence of assessment	High	High
Level of significance before mitigation	High	High
Mitigation measures (EMP requirements)	• Bioaccumulation assessments of plant and biotic tissue • Implementation of a suitable management action plan based on monthly water quality assessment and bi-annual biological monitoring surveys	• Implementation of a suitable management action plan based on monthly water quality assessment and bi-annual biological monitoring surveys
Level of significance after mitigation	Medium	Medium
Cumulative Impacts	As discussed in Section 6.6.3 (a) and include biotic and abiotic impacts	As discussed in Section 6.6.3 (a) and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.3 (a)		

(b) Potential impacts on riverine habitats within the dam basin

Sediment transport capacity is likely to decrease within the dam basin due to the decreased flows and siltation of the substrate begins. Flowing habitats are likely to be lost within the proposed Nwamitwa Dam basin. Although the sediment deposition volume in proposed Nwamitwa Dam is expected to be small over a 50 year period, deposition above full supply level will result in elevated flood levels in the river upstream of the reservoir which should be considered when floodlines are determined during the design of the dam (GLeWaP, 2008b). Mitigation is limited to accurate floodline calculation.

Surveys should be undertaken to identify red data or rare riparian plants species that may have to be removed from any of the construction sites or from the proposed inundated areas of the Nwamitwa Dam basin. Mitigation measures may include translocation of such riparian plant species to alternative areas.

The alteration of aquatic ecosystems from a lotic to a lentic ecosystem creates opportunities for exotic faunal and floral invasions (Davies & Day, 1998). Potential mitigations measures include:

- The prevention of exotic vegetation encroachment during the pre-construction and construction phases as well as bi-annual identification and removal of exotic vegetation within the Nwamitwa Dam basin during the operational phase;

- Natural features such as trees should not be removed from the proposed dam margin, so as to provide underwater habitats for colonising aquatic biota.

- The introduction of invasive alien fish species such as Carp (*Cyprinus carpio*) and bass (Centrarchidae sp.) should be prevented.

The species that make up the various animal and plant communities are altered: specialised river-adapted species will decrease or be lost and lake-tolerant species will flourish (Davies & Day, 1998). At regulated or impeded sites, the numbers of macroinvertebrates and fish are significantly lower than at unregulated sites and suggests that altered local flow hydraulics, flow depths and flow velocities have a significant effect on aquatic organisms (Jordonova *et al.*, 2004). It is expected that all fast velocity flowing habitats will be lost within the proposed Nwamitwa Dam basin

and will have resulting impacts on the aquatic organisms in terms of community structure and functioning.

Due to the currently fragmented state of reach EWR3 (DWAF, 2006), mitigation of this loss of habitat is limited to Identifying and assessing the suitability and accessibility of remaining habitats upstream for specific biota (i.e. macroinvertebrates and fish) that may migrate upstream in search of specific habitat requirements (i.e. flowing water, cobbles, cooler water temperature, etc.). Identified areas, if any, should be made conservation areas during the operational phases of the Nwamitwa Dam, thus ensuring sustainability of the aquatic biodiversity.

A management action plan should be set up; whereby information from bi-annual biomonitoring can be used to implement management actions should a significant decrease in the PES (C/D EC) (DWAF, 2006) within the reach be noted:

- Biomonitoring of selected sites within the Nwamitwa Dam basin and upstream reaches should be conducted bi-annually. This will allow trends in biotic integrity to be identified and compared to the results and recommendations of the 2006 RDS and November 2007 survey. A suitable management action plan which includes potential corrective procedures should be formulated.

The level of significance of this impact prior to mitigation was rated as high, for construction and operational phases (**Table 6.9**). The level of significance after implementation of recommended mitigation decreased to medium, for both phases (**Table 6.9**).

Table 6.9: Significance of the potential impacts on aquatic habitats within the proposed Nwamitwa Dam basin

Description of potential impact	Aquatic habitats within the proposed Nwamitwa Dam basin	
Nature of impact	Negative, direct and indirect	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative, direct and indirect	Negative, direct and indirect
Extent of impact	Local	Regional
Duration of impact	Short term	Permanent
Intensity	Medium	Medium
Probability of occurrence	High	High
Confidence of assessment	High	High
Level of significance before	High	High

mitigation		
Mitigation measures (EMP requirements)	• Phased removal of vegetation, limiting the amount of exposed areas and confining the majority of disturbance to the dry season • Translocation of red data or rare riparian plant species to alternative locations • Accurate floodline calculation • Planting larger, more developed rooted trees along the margin of the dam • Prevention of exotic vegetation encroachment • Identifying and assessing the suitability and accessibility of remaining habitats upstream for specific biota (i.e. fish) that may migrate upstream in search of specific habitat requirements • Implementation of a suitable management action plan based on bi-annual biological monitoring surveys	• Bi-annual identification and removal of exotic vegetation within the Nwamitwa Dam basin • Identified habitat areas, if any, should be made conservation areas during the operational phases of the Nwamitwa Dam. This will ensure the sustainability of the upstream aquatic biodiversity. • Implementation of a suitable management action plan based on bi-annual biological monitoring data
Level of significance after mitigation	Medium	Medium
Cumulative Impacts	As discussed in Section 6.6.3 (b) and include biotic and abiotic impacts	As discussed in Section 6.6.3 (b) and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.3 (b)		

(c) Potential Impacts on aquatic biota

Aquatic Macroinvertebrates

Thirty nine aquatic macroinvertebrate taxa were recorded in the sample area during the November 2007 baseline assessment. The potential impact of the proposed Nwamitwa Dam on aquatic macroinvertebrate assemblages within reach EWR3 was assessed in terms of flow and habitat preferences of the recorded taxa.

Flow and habitat preferences were based on the Macroinvertebrate Response Assessment Index (MIRAI) (Kleynhans *et al*., 2005b). A taxon with a high preference to a particular flow category or biotope type is rated between 3 and 5. Only taxa with a high preference rating to each flow category were assessed. These taxa are listed in Appendix C, according to their flow, biotope and water quality sensitivity preference types.

Four taxa currently occurring within the dam basin have a high preference rating for fast flow velocities > 0.6 m/s. These taxa all have high preference for cobble biotopes, and are usually associated with riffles and rapids (Gerber & Gabriel, 2002).

Of the eight taxa with high preferences for fast flow velocities of 0.3 – 0.6 m/s, five have high preferences for cobbles. Two of these five taxa are sensitive to impacts on water quality.

Two taxa with high flow preferences for slow velocities of 0.1 – 0.3 m/s (Corbiculidae and Sphaeridae) and are usually associated with gravel beds with/in slow riffles (Gerber & Gabriel, 2002).

It is likely that velocities between 0.1 and > 0.6 m/s and riffles, rapid as well as cobble and gravel biotopes will be eliminated from the proposed dam basin. Therefore, taxa that are dependant on these velocities and habitats/biotopes will be reduced in abundance or will completely disappear from the inundated areas of the basin. This accounts for 11 of the 39 aquatic macroinvertebrate taxa recorded during the November 2007 survey and is regarded as a significant loss in biodiversity in terms of maintaining the recommended Ecospecs (DWAF, 2006).

Due to the predicted increases in depth and inundation, taxa that have high preferences for slow flow velocities < 0.1 m/s and high biotope preferences to vegetation, sand or mud biotopes are most likely to be favoured. These taxa will increase in abundances and presence within the basin. Thus, a change will occur in the aquatic macroinvertebrate communities within the Nwamitwa Dam basin.

An additional cause for concern is the potential increase in the prevalence of Malaria (*Plasmodium sp*) infections due to the likely increase in the transmitter macroinvertebrate taxa Culicidae. Potential mitigation measures include creating community awareness on the preventative measures that can be take to avoid infections.

In terms of the 2006 RDS (DWAF, 2006), this change in aquatic macroinvertebrate community structure and loss of biodiversity will have a negative impact on the PES within the dam basin.

Recommended mitigation measures include:

- Natural features such as trees should not be removed from the proposed dam margin, so as to provide underwater habitats and cover for colonising aquatic biota.

- Identifying and assessing the suitability and accessibility of remaining habitats upstream of the dam. Identified areas, if any, should be made conservation areas so as to ensure the remaining viability of riverine flowing habitat types.

Ichthyofauna

Thirty four fish species are expected to occur within the study area, including one Near Threatened (NT) species: *O. mossambicus* (**Table 4.4**). According to the results of the 2006 RDS (DWAF, 2006) and the November 2007 baseline assessment, 17 indigenous and 1 exotic species are expected to remain within reach EWR3. The remaining 16 species have not been recorded in the reach for several years and are considered locally extinct due to existing impacts. Additional surveys may reveal that small isolated populations of some species remain in isolated sections of the reach.

The potential impact of the dam was assessed in terms of velocity depth, flow intolerance and migration potential preferences. The assessment was based on the Fish Response Assessment Index (FRAI) ratings (Kleynhans *et al*., 2005b). The specific species preferences for the remaining 18 species are provided in Appendix D. Species with a high preference for faster velocities, intolerance to flow modifications and high migration potential are expected to be negatively impacted upon by the construction of the dam.

Based on this assessment, six of the remaining species are likely to be negatively upon due to the construction of the dam. These species include: *Chiloglanis paratus* (Sawfin Suckermouth), *Chiloglanis pretoriae* (Shortspine Suckermouth), *Labeobarbus marequensis* (Lowveld Largescale Yellowfish), *Labeo cylindricus* (Redeye Labeo), *Labeo molybdinus* (Leaden Labeo) and *Micralestes acutidens* (Silver Robber). Of these six species, five were recorded during the baseline assessment. *C. paratus* (Sawfin Suckermouth) was not recorded during the November 2007 baseline assessment, but was recorded recorded during the 2006 RDS (DWAF, 2006) and is therefore known to remain within the reach.

It is likely that these six species will disappear from the proposed Nwamitwa Dam basin due to the change of habitat.

In terms of the 2006 RDS, the loss of these six species from reach EWR3 will have a negative impact on the PES and may have a negative implication on meeting the REC.

Mitigation includes identifying and assessing the suitability of remaining riverine habitats within reach EWR3. Remaining sections of river should be afforded special

conservation significance if there is so be any hope of maintaining the already impoverished fish diversity within the Groot Letaba River catchment.

The remaining 12 species including the aggressively invasive species: *M. salmoides* (Largemouth Bass) and the Near Threatened (NT) species *O.mossambicus* are likely to survive within the inundated waters of the proposed Nwamitwa Dam basin, some species may even flourish.

This impact is seen as negative in terms of the potential loss of six additional species from the local fish assemblage and negative in terms of the potential increase in abundance of *M. salmoides* within the dam basin. Over the long-term the increase in abundance of this exotic species will have a significant impact on the remaining indigenous fish species within the proposed Nwamitwa Dam basin.

Mitigation of this impact includes:

- Natural features such as trees should not be removed from the proposed dam margin, so as to provide underwater habitats and cover for colonising aquatic biota.

- The prevention of further introductions of *M. salmoides* into the proposed Nwamitwa Dam basin and upstream reaches;

- Control of fishing activities within the proposed Nwamitwa Dam. The role of recreational fishermen in the spread of invasive fish species should not be underestimated. The presence of introduced species within the dam basin should be monitored and the removal of any exotic fish that are caught should be encouraged.

- Setup of a management action plan based on monitoring of the population levels of *M.salmoides*. The purpose of monitoring activities should be to assess abundances of the exotic species and develop population control measures should large populations increase;

In addition, the following recommendations require further investigation:

- A genetic assessment of specific fish species upstream and downstream of the proposed Nwamitwa Dam site. This will provide further scientific evidence as to

the genetic status of fish populations upstream and downstream of the Nwamitwa Dam site and therefore provide insight on the importance of maintaining connectivity between fish populations by means of a fishway/fish ladder.

- A survey of habitat suitability for flow dependant fish species upstream and downstream of the Nwamitwa Dam. Remaining sections of riverine habitat should be afforded special conservation significance if the presence of flow dependant fish species is to be maintained.

Other aquatic-dependant fauna

Impacts on other aquatic-dependant fauna within the proposed Nwamitwa Dam basin may include impacts on the following fauna known to occur within the study area:

- Hippopotami (*Hippopotamus amphibious*) – this large mammal can adapt to dams (Stuart & Stuart, 1988 and Carruthers (Ed), 1997). This species can also migrate large distances overland if necessary to find suitable habitat or food. Therefore no mitigation is required, although the dangerous nature of the animal may require further restricted access to areas near the shoreline of the dam or alternatively the translocation of groups and individuals of this species to other locations.

- Water mongoose (*Atilax paludinosus*) – this small rodent-like mammal can adapt to large inundated waters associated with dams (Stuart & Stuart, 1988 and Carruthers (Ed), 1997). The species can also migrate large distances overland if necessary to find suitable habitat or food. Therefore no mitigation is required.

- Cape clawless otter (*Aonyx capensis*) and Spotted-necked otter (*Lutra maculicollis*) – these large rodent-like mammals can adapt to large inundated waters associated with dams (Stuart & Stuart, 1988 and Carruthers (Ed), 1997). These two species can also migrate large distances overland if necessary to find suitable habitat or food. Therefore no mitigation is required.

- Reptiles associated with aquatic ecosystems include snakes, terrapins (*Pelusios* sp.), water monitors (*Veranus niloticus*) and Nile crocodiles (*Crocodylus niloticus*). These reptiles can adapt to large inundated waters associated with dams (Carruthers (Ed), 1997). They can all migrate large distances if necessary

to find suitable habitats or food. No mitigation is required, although the dangerous nature of the Nile crocodile may require further restricted access to areas near the shoreline of the dam or alternatively the translocation of groups and individuals of this species to other locations.

- Amphibians (frogs) – are generally adaptable to large inundated waters associated with dams (Carruthers (Ed), 1997). They can move over land if necessary to find suitable habitats or food. No mitigation is required, certain species may require flowing habitats for critical life stages (i.e. tadpoles, however data is this regard is limited).

- Avifauna (birds) – various bird species are associated with aquatic ecosystems including: Reed cormorant (*Phalacrocorax africanus*), White-breasted cormorant (*P. carbo*), Darter (*Anhinga melonogaster*), Greenbacked heron (*Butorides rufiventris*), Squacco heron (*Ardeola ralloides*), Grey heron (*Ardea cinerea*), Blackheaded heron (*A. melanocephala*), Goliath heron (*A. goliath*), Hammerkop (*Scopus umbetta*), African fish eagle (*Haliaeetus vocifer*) and various Kingfisher species including the Giant kingfisher (*Ceryle maxima*), Pied kingfisher (*C. rudis*) and Brownhooded kingfisher (*Halcyon albiventris*). These species are all adaptable to dams (Carruthers (Ed), 1997). They can also fly large distances if necessary to find suitable habitats or food. No mitigation is required.

The results of the Impact Assessment are provided in Table 6.10. Prior to implementation of recommended mitigation measures the significance level of this impact was rated as medium for both the construction and operational phases (**Table 6.10**). The level of significance after implementation of mitigation was rated as low (**Table 6.10**).

Table 6.10: Significance of the potential impacts on aquatic biota within the proposed Nwamitwa Dam basin

Description of potential impact	Aquatic biota within the proposed Nwamitwa Dam basin	
Nature of impact	Negative, direct and indirect	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative, direct and indirect	Negative, direct and indirect
Extent of impact	Local	Could be international depending on environmental flows and % MAR contribution)
Duration of impact	Short term	Long term
Intensity	High	Medium
Probability of occurrence	High	High
Confidence of assessment	High	High
Level of significance before mitigation	Medium	Medium
Mitigation measures (EMP requirements)	• Limit the amount of disturbances to local construction site only • Maintain natural features such as large trees around the margin of the dam basin so as to provide underwater habitats, cover and refuge for aquatic biota. • Identifying and assessing the suitability of remaining habitats for flow dependant aquatic biota. Sections of remaining riverine habitat should be afforded special conservation significance of flow dependant species are to survive within the Groot Letaba catchment. • Implementation of a suitable management action plan based on two biological monitoring surveys •	• Prevent any introductions *of M. salmoides* (Largemouth Bass) • Control access to fishing activities within, the proposed Nwamitwa Dam basin • Identified habitat areas, if any, should be made conservation areas during the operational phases of the Nwamitwa Dam. This will ensure the sustainability of the upstream aquatic biodiversity. • Setup a management action plan based on bi-annual monitoring of the population levels of *M. salmoides*. • Assess the genetic status of the *O.mossambicus* population within the project area. • Biotic compensation through the setup of an ecoregion (a wildlife park, or eco-reserve) around the dam
Level of significance after mitigation	Low	Low
Cumulative Impacts	As discussed in Section 6.6.3 (c) and include biotic and abiotic impacts	As discussed in Section 6.6.3 (c) and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.3 (c)		

6.6.4 Potential impacts on the aquatic ecosystems of the Groot Letaba River, downstream of the proposed Nwamitwa Dam

(a) Potential impacts on physical and chemical water conditions

The natural seasonality of South African rivers influences the physical and chemical characteristics of the water. Temperatures, oxygen concentrations, silt loads and nutrient concentrations are some of the main seasonal variants in natural rivers to which biota have specifically adapted (Davies & Day, 1998).

Temperature

The potential impact on water temperature in the downstream receiving ecosystem is primarily considered to be from water released from either the hypolimnion or epilimnion waters within the dam. These usually differ from the receiving river water temperatures and may have a detrimental effect on the aquatic life up to a distance of about 15 km downstream of the dam wall (GLeWaP, 2008a). The impacts on aquatic biota may include:

- Accelerated or reduced growth rates;
- Accelerated or reduced metabolisms and digestion of food;
- Increased or decreased food availability;
- Premature or delayed emergence of aquatic macroinvertebrates;
- Retardation of or mistimed life cycles;
- Reduced diversity due to elimination of taxa with preferences for warm or cold water; and
- Temperature shock often resulting in aquatic macroinvertebrate and fish kills.

Any change from the natural pattern may result in the disruption of riverine food chains and life cycles (Davies & Day, 1998).

Mitigation of this impact includes:

Oxygen

Water is usually turbulently discharged from dams thus allowing rapid absorption of oxygen by the water. No mitigation is needed.

Silt load

As the water releases from the dam has lost most of its particulate load, water discharged from the dam has less silt than the natural receiving river water (Davies and Day, 1998). According to the sediment impact report (GLeWaP, 2008b), a decrease in sediment supply and an increase in sediment transport can be expected

downstream of the Nwamitwa Dam. This may have indirect impacts on aquatic ecosystems in terms of changes in water chemistry and biological processes and direct impacts on aquatic biota due to abrasion of gills, changes in predator-prey dynamics etc.

Large flood events may overcome this impact and reset the downstream aquatic ecosystems in terms of providing adequate silt loads. Mitigation includes the compilation of a suitable management action plan based on water quality monitored at downstream sites. This will allow the identification and characterisation of trends in water quality and biotic integrity. The potential for large flood events to reset the downstream aquatic ecosystems should be assessed.

Nutrient concentrations

Changes in may occur in terms of nutrient concentrations due to stratification of water within the Nwamitwa Dam.

The above mentioned impacts on temperature, oxygen, silt load and nutrients from the release strategy of the proposed Nwamitwa Dam are most likely to occur downstream of the Nwamitwa Dam for some length within the receiving waters of the Groot Letaba River.

The impacts of changes to water quality will have a negative impact on the PES (C/D EC) and may have a negative implication on meeting the REC (C/D EC) within reach EWR3 (DWAF, 2006).

Proper release management during the operational phase may act as a 'reset' measure for the water quality continuing to downstream reaches and improve water quality within the Groot Letaba River. Monthly monitoring of water quality and bi-annual monitoring of aquatic ecosystems should measure the effects of this release strategy.

The results of the Impact Assessment are provided in **Table 6.11**. Prior to implementation of recommended mitigation measures the significance of this impact was rated as medium for both the construction and operational phases (**Table 6.11**). The level of significance after implementation of mitigation was rated as low for (**Table 6.11**).

Table 6.11: Significance of the potential impacts on physical and chemical water conditions on the aquatic ecosystems of the Groot Letaba River, downstream of the proposed Nwamitwa Dam

Description of potential impact	Physical and chemical water conditions downstream of the proposed Nwamitwa Dam	
Nature of impact	Negative, direct and indirect	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative, direct and indirect	Negative, direct and indirect
Extent of impact	Local	Regional
Duration of impact	Short term	Long term
Intensity	Low	Medium
Probability of occurrence	Medium	High
Confidence of assessment	Medium	High
Level of significance before mitigation	Medium	Medium
Mitigation measures (EMP requirements)	• Limit disturbances to the development footprint only • Implementation of a suitable management action plan based on monthly water monitoring at selected downstream sites	• Proper release management • Setup a Management action plan based on monthly monitoring of the water quality and bi-annual biomonitoring of aquatic ecosystems at selected downstream sites
Level of significance after mitigation	Low	Low
Cumulative Impacts	As discussed in Section 6.6.4 (a) and include biotic and abiotic impacts	As discussed in Section 6.6.4 (a) and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.4 (a)		

(b) Potential impacts on aquatic habitats

Most South African rivers are naturally seasonal systems with specific high and low flow regimes as well as high variability in these regimes. Dam releases seldom follow these regimes and remove natural variability from the system. Discharges from the dam may result in increased erosion of river banks and incising of the river channel downstream of the dam (DWAF, 1999b). Downstream river habitats of the Groot Letaba River are likely to be directly altered in terms of habitat loss or modification as well as in riparian vegetation changes (Davies & Day, 1998).

The sediment impact report indicates that sediment transport will increase downstream of the proposed Nwamitwa Dam, this will result in increased scouring of the substrates and channel (GLeWaP, 2008b). Near the dam wall, the model indicated bed degradation of at least 2 m. The level of degradation depends on the number and size of large floods released from the dam into the downstream river. A

new equilibrium is typically established seven to ten years after completion of the dam.

The report also indicated that the post-dam river (Groot Letaba River downstream of the proposed Nwamitwa Dam) will become narrower due to flood attenuation (GLeWaP, 2008b). Near the dam wall, the main channel width could decrease by 19 % (resulting in a 22 m reduction on the existing 116 m channel width). The report further indicated that the river bed of the Groot Letaba River between the proposed Nwamitwa Dam and the Klein Letaba River confluence will become coarser due to sediment trapping within the dam.

Some form of channel degradation will occur despite mitigation. Construction of the dam wall and downstream stabilisation measures should provide some mitigation.

The presence of the dam is likely to cause an increase in the duration of low flow seasons and a reduction in the availability of certain habitat types (marginal vegetation, water column cover, undercut roots and banks, fast-velocity flow decreases, etc.) (DWAF, 1999). A reduction in the abundance or availability of marginal habitat types due to the expected reduction in channel width will have potentially serious biological consequences, especially for macroinvertebrates and small fish (Hughes & Münster, 2000). It is expected that riffle-rapid and pool sequences will decrease for some length downstream of the dam and that during periods of no release, only reduced pools will remain.

Based on the 2006 RDS (DWAF, 2006), the state of existing geomorphology, hydraulics and hydrology of Resource Unit EWR3 was low due to prior channel, flow and sediment transport modifications. This resulted in a PES of C/D and a RECs of C/D. The impacts on the remaining reach downstream of the proposed Nwamitwa Dam will result in a decreased PES and thus it is uncertain whether the REC and Ecospecs set out in the 2006 RDS will be attainable (DWAF, 2006).

Mitigations measures include:

- A properly managed timing and release strategy that will ensure that presently existing or naturally seasonal variability in flows are released and or maintained within the downstream Groot Letaba River. This will enable specific ecosystems functions to be maintained (migration queues, seasonal floodplain inundation, temperature variations, etc.) within the downstream river; and

- The setup of a management action plan based on bi-annual habitat integrity monitoring during both the construction and operational phases at selected sites downstream of the Nwamitwa Dam. Any major decreases in habitat integrity can thus be measured and suitable management options can thus be implemented.

The results of the Impact Assessment are provided in Table 6.12. Prior to implementation of recommended mitigation measures the significance was rated as high for both the construction and operational phases (**Table 6.12**). The level of significance after implementation of mitigation was rated as low for both phases (**Table 6.12**).

Table 6.12: Significance of the potential impacts on the aquatic habitats of the Groot Letaba River, downstream of the proposed Nwamitwa Dam

Description of potential impact	Aquatic habitats downstream of the proposed Nwamitwa Dam	
Nature of impact	Negative, direct and indirect	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative, direct and indirect	Negative, direct and indirect
Extent of impact	Local	Regional
Duration of impact	Short term	Long term
Intensity	Medium	High
Probability of occurrence	Medium	High
Confidence of assessment	High	High
Level of significance before mitigation	High	High
Mitigation measures (EMP requirements)	• Limit the amount of disturbances to local construction site only • Stabilisation of downstream river bed and banks • Implementation of a suitable management action plan based on bi-annual habitat integrity monitoring at selected downstream sites	• Proper release management from the multi-level outlets • Setup a Management action plan based on bi-annual habitat integrity monitoring at selected downstream sites
Level of significance after mitigation	Low	Low
Cumulative Impacts	As discussed in Section 6.6.4 (b) and include biotic and abiotic impacts	As discussed in Section 6.6.4 (b) and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.4 (b)		

(c) Potential impacts on aquatic biota

Aquatic Macroinvertebrates

The impact of the proposed Nwamitwa Dam on aquatic macroinvertebrate assemblage downstream of the dam basin was assessed in terms of flow and habitat preferences of the recorded taxa (Appendix C). Based on this assessment it can be

concluded that most of the taxa will have fluctuating abundances and diversities depending on the variability in timing, rate and frequency of release from the dam.

Shifts can be expected in the natural macroinvertebrate assemblages downstream of the dam due to the changes in the physical and chemical characteristics as well as the modified flows and habitats. This may reduce or eliminate certain taxa thus, while other species, such as *Simuliidae sp*. may proliferate. Outbreaks of Simuliidae and Bilharzia (from increased snail vectors) are associated with the changes to the downstream river ecosystems below large dams (Davies & Day, 1998). It is expected that most taxa with a preference to vegetation (especially marginal vegetation) will be lost due to the expected reduction in the channel width. A reduction in taxa with a preference to fine sand and mud is also expected due to the coarsening of the substrate due to expected sediment transport increases.

In terms of the 2006 RDS (DWAF, 2006), the change in aquatic macroinvertebrate community structure and loss of some taxa will have a negative impact on the PES for the downstream section of reach EWR3 and it is uncertain whether the REC and Ecospecs set out in the 2006 RDS will be attainable (DWAF, 2006).

Mitigations measures include:

- A properly managed timing and release strategy to ensure that presently existing or naturally seasonal variability in flows are maintained within the downstream Groot Letaba River. This will enable specific ecosystems functions to be maintained (migration ques, seasonal floodplain inundation, temperature variations, etc.) within the downstream river and will prevent large scale changes in the aquatic macroinvertebrate community structure;

- Identifying and assessing the suitability and accessibility of remaining habitats downstream for specific taxa that may migrate downstream in search of specific habitat requirements (i.e. marginal vegetation, flowing water, cobbles, sand, cooler water temperatures, etc.). Identified areas should be afforded special conservation significance if existing levels of biotic integrity are to be maintained.

- The setup of a management action plan based on bi-annual biomonitoring during both the construction and operational phases at selected sites downstream of the Nwamitwa Dam. A downward trend in macroinvertebrate diversity and

abundances can thus be measured and suitable management options can be implemented.

Ichthyofauna

It can be expected that a shift in the existing fish assemblage is likely to occur downstream of the proposed Nwamitwa Dam, due to the changes in the physical and chemical characteristics as well as the modified flows and habitats.

The impact of the Nwamitwa Dam on downstream habitats will reduce the abundances of at least 14 of the 18 fish species and may even eliminate certain species downstream of the dam. Species such as *M. salmoides* (Largemouth Bass), *C. gariepinus* (Sharptooth catfish) and *O. mossambicus* (Mozambique Tilapia) may proliferate. The shift in species assemblage, decrease in abundances and possible elimination and proliferation of certain species will however depend on the variability in timing, rate and frequency of release from the dam.

The potential decrease in abundances of 14 species and loss or proliferation of certain species within the remaining reach (EWR3) will have a negative impact on the PES and thus it is uncertain whether the REC and Ecospecs set out in the 2006 RDS will be attainable (DWAF, 2006).

Mitigation measures include:

- Maintenance of lateral connectivity between fish assemblages situated upstream and downstream of the proposed dam this is typically achieved by means of a fishway.

- Maintenance of connectivity between remaining riverine habitats upstream and downstream of the dam. This can be achieved by means of a fishway.

- A habitat suitability and accessibility study of the area both upstream and downstream of the Nwamitwa Dam site. Suitable habitat areas not impacted by the GLeWaP should be identified and afforded special conservation significance.

Other aquatic-dependant fauna

It is expected that these species will migrate further downstream to more suitable habitats or perhaps even migrate upstream into the areas surrounding the dam basin. No mitigation is therefore required.

The results of the Impact Assessment are provided in **Table 6.13.** Prior to implementation of recommended mitigation measures the significance level of this impact was rated as high for both the construction and operational phases (**Table 6.13**). The level of significance after implementation of mitigation was rated as low for both phases (**Table 6.13**).

Table 6.13: Significance of the potential impacts on the aquatic biota of the Groot Letaba River, downstream of the proposed Nwamitwa Dam

Description of potential impact	Aquatic biota downstream of the proposed Nwamitwa Dam	
Nature of impact	Negative and direct	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative, direct and indirect	Negative, direct and indirect
Extent of impact	Local	Regional and international
Duration of impact	Short term	Long term
Intensity	Medium	High
Probability of occurrence	Medium	High
Confidence of assessment	High	High
Level of significance before mitigation	High	High
Mitigation measures (EMP requirements)	• Limit the amount of disturbances to local construction site only • Identifying and assessing the suitability and accessibility of remaining habitats upstream for specific biota (aquatic macroinvertebrates and fish) that may migrate upstream in search of specific habitat requirements • Maintain connectivity between fish assemblages upstream and downstream of the proposed dam wall by means of a fishway. • Maintain access for downstream fish assemblages to remaining sections of riverine habitats upstream of the dam by means of a fishway.	• Comply with the 2006 RDS requirements • Prevent any new introductions *of M. salmoides* (Largemouth Bass) • Identified habitat areas should be made conservation areas during the operational phases of the Nwamitwa Dam. This will ensure the sustainability of the upstream aquatic biodiversity. • Setup a management action plan based on bi-annual monitoring of the population levels of *M. salmoides*. • Proper release management • Well managed operational procedures • Implementation of a suitable management action plan based on bi-annual biological monitoring data • Maintain connectivity between fish assemblages upstream and downstream of the proposed dam wall by means of a fishway. • Maintain access for downstream fish assemblages to remaining sections of riverine habitats upstream of the dam by means of a fishway.

Level of significance after mitigation	Low	Low
Cumulative Impacts	As discussed in Section 6.6.4 (c) and include biotic and abiotic impacts	As discussed in Section 6.6.4 (c) and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.4 (c)		

6.6.5 Potential impacts of the proposed Nwamitwa Dam as a migration barrier on fish assemblages in the Groot Letaba River

The presence of barriers to migration in rivers (weirs, dams, road bridges, causeways, etc) is considered to be a major factor responsible for the reduction in numbers and range of many migratory fish and invertebrate species throughout South Africa (Bok *et al*., 2007). Most indigenous fish species carry out annual migrations within river systems in order to optimize feeding, promote dispersal, to avoid unfavourable conditions and to enhance reproductive success.

Impassable constructed barriers to migration are partly responsible for the threatened status of a number of Red Data species in southern Africa (Bok *et al*., 2007).

The presence of migratory aquatic species within reach EWR3 is therefore critical to the assessment of this impact.

Migratory fish species

The majority of freshwater fish species undertake migrations for feeding, spawning, dispersion and recolonisation after droughts. Many of these species (e.g. *Labeobarbus sp., Barbus sp. and Clarias sp.*) are well known for undertaking spectacular spawning migrations after the 1st summer rains. However evidence exists that many fish species migrate various distances upstream and downstream into more favourable habitats, as both adults and juveniles, at various times of the year, and for a variety of reasons (Bok *et al*., 2007).

According to the 2006 RDS, (DWAF, 2006), the abundances of most of the fish species in the study area (EWR3) is declining. The main factor was attributed to fragmentation of the river reach. It is likely that some of the expected fish species may no longer occur within the reach. The continued presence of two expected migratory eel species (*A. marmorata* and *A. mossambica*) within the reach is unlikely due to Massangir Dam in Mozambique. *Barbus eutaenia* is a sensitive flow dependant species capable of extended migrations which may be lost from the RU due to high

degree of flow modification and water abstraction in the Groot Letaba River (DWAF, 2006).

The remaining 17 indigenous fish species (*M. salmoides* was excluded from this assessment) believed to remain within reach EWR3 were assessed in terms of their migration potential according to Kleynhans *et al*. (2005b)(Appendix E). Only species with a high migration potential (rating 3-5) were considered to be negatively impacted by the construction of the dam. Based on the results of this assessment, it can be concluded that of the 17 indigenous fish species expected to remain and occur within this reach (EWR3):

- 16 fish species have migration potential of 3.0 and thus migrate between reaches; and

- One species *(P.philander*) has a migration potential of 1, indicating that it only migrates within the reach.

Therefore, 16 of the 17 indigenous fish species occurring within reach EWR3 are likely to be impacted in terms of migration potential.

Based on this it can be concluded that construction of an additional migration barrier will impact the PES and will likely make the REC for this reach unattainable.

The level of impact may include loss of genetic diversity, reproduction decreases, population isolation and fish kills above or below the dam wall during migration periods. These impacts may result in the loss or reduction of species upstream and downstream of the Nwamitwa Dam.

Mitigation measures include:

- Identifying and assessing the suitability and accessibility of remaining habitats upstream and downstream of the Nwamitwa Dam. This assessment should be undertaken prior to the construction phase;

- Areas of remaining riverine habitats between impoundments should be afforded special conservation significance. This will ensure that biotic integrity is maintained within the remaining river reaches.

- Maintain connectivity between upstream and downstream riverine habitats by means of a fishway.

The results of the Impact Assessment are provided in **Table 6.14**. Prior to implementation of recommended mitigation measures the significance level of this impact was rated as high for both the construction and operational phases (**Table 6.14**). The level of significance after implementation of mitigation was rated as medium for both phases (**Table 6.14**).

Table 6.14: Significance of the potential impacts of the proposed Nwamitwa Dam as a migration barrier on fish assemblages in the Groot Letaba River

Description of potential impact	Migration barrier on fish assemblages in the Groot Letaba River	
Nature of impact	Negative and direct	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative and direct	Negative and direct
Extent of impact	Local	Regional
Duration of impact	Short term	Long term
Intensity	Medium	High
Probability of occurrence	Medium	High
Confidence of assessment	High	High
Level of significance before mitigation	High	High
Mitigation measures (EMP requirements)	• Identifying and assessing the suitability and accessibility of remaining habitats both upstream and downstream for specific biota (aquatic macroinvertebrates and fish) that may migrate in search of specific habitat requirements • Maintain connectivity between upstream and downstream riverine habitats by means of a fishway.	• Remaining segments of riverine habitat between impoundments should be identified and afforded special conservation significance. This will ensure that some habitat remains intact for flow dependant fish species and some semblance of the predevelopment fish assemblage is maintained. • Maintain connectivity between upstream and downstream riverine habitats by means of a fishway.
Level of significance after mitigation	Medium	Medium
Cumulative Impacts	As discussed in Section 6.6.5 and include biotic and abiotic impacts	As discussed in Section 6.6.5 and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.5		

6.6.6 Potential impacts of the proposed Bulk Water Infrastructure (BWI) associated with the GLeWaP on the associated aquatic ecosystems

(a) Potential impacts on physical and chemical water conditions

Water quality changes due to metal and sediment contamination, changes in pH, COD, TDS, etc. and nutrient increases from sewage contamination may occur. These may arise from underground seepage, runoff or direct discharge from the proposed BWI, sewage treatment facilities, and infrastructure associated with the GLeWaP. These changes will have negative impacts on the receiving aquatic ecosystems. Major construction activities may have a negative impact on sediment load in the rivers due to run off.

Mitigation of these impacts is limited to:

- Prevent underground seepage, runoff or direct discharge from any of the activities from entering the aquatic and wetland ecosystems through effective construction engineering;
- Prevent waste return flows from entering the river systems;
- Incorporate preventative measures into the design process to minimize the mobilization of sediments;
- Establish and maintain buffer zones;
- Limit the amount of disturbances to local construction site only and confine most major construction to the dry season;
- Implement an adequate water, sediment and biological monitoring programme together in the form of a management action plan; and
- Design and implement a Biodiversity Action Plan (BAP) to facilitate planning and zonation of human activities.

(b) Potential impacts on the physical habitat conditions

Alterations in the water flow, channel structure and riparian vegetation and may be as a result of the planned construction of the infrastructure associated with the BWI (power lines, roads, pipes, sewage treatment plants, etc.).

Mitigation measures are limited to:

- Comply with the 2006 RDS requirements;
- The use of existing impacts such as roads, bridges and servitudes;
- Maintain natural water flow through effective construction engineering;
- Keep habitat alteration to a minimum by limiting the foot print of construction activities and the spatial extent of infrastructure; and
- Implement rehabilitation where construction site footprint impacts occur.

(c) Potential impacts on the aquatic biota

As indicated by the impacts on the physical and chemical water conditions and on the physical habitat conditions, impacts on the aquatic biota may occur.

Mitigation measures are limited to a Management action plan that should be set up, whereby information from bi-annual water monitoring and biomonitoring at selected sites of potential impact can be used to implement management actions should a significant decrease in PES (C/D EC) at these selected sites occur.

In terms of the 2006 RDS, the potential impacts of this proposed BWI on the associated aquatic ecosystems may result in a slight decrease in PES within the reach (EWR3) over the short to medium term. This decrease should not compromise the recommended Ecological Category (REC) or decrease from the current Ecospecs significantly over the long term.

The level of significance of this impact was rated as medium, for construction and operational phases, prior to the implementation of mitigation measures (**Table 6.15**). The level of significance was reduced to low, for both phases, after implementation of recommended mitigation (**Table 6.15**).

Table 6.15: Significance of the potential impacts of the proposed Bulk Water Infrastructure (BWI) associated with the GLeWaP on the associated aquatic ecosystems

Description of potential impact	Proposed Bulk Water Infrastructure (BWI) associated with the GLeWaP	
Nature of impact	Negative, direct and indirect	
Legal requirements	NWA, NEMA, NBA & 2006 RDS	
Stage	Construction and commissioning	Operation
Nature of Impact	Negative, direct and indirect	Negative, direct and indirect
Extent of impact	Local	Local
Duration of impact	Short term	Long 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)	• Prevent underground seepage, runoff or direct discharge from any of the activities from entering the aquatic and wetland ecosystems through effective construction engineering • Incorporate preventative measures into the design process to minimize the mobilization of sediments • Establish buffer zones • Limit the amount of disturbances to local construction site only and confine most major construction to the dry season • Design and implement a Biodiversity Action Plan (BAP) to facilitate planning and zonation of human activities • Use of existing impacts such as roads, bridges and servitudes • Maintain natural water flow through effective construction engineering • Keep habitat alteration to a minimum by limiting the foot print of construction activities and the spatial extent of infrastructure • Implement rehabilitation where construction site footprint impacts occur • Implementation of a suitable management action plan based on bi-annual water and biological monitoring data	• Comply with 2006 RDS requirements • Maintain buffer zones • Implementation of a suitable management action plan based on bi-annual water and biological monitoring data
Level of significance after mitigation	Low	Low
Cumulative Impacts	As discussed in Section 6.6.8 and include biotic and abiotic impacts	As discussed in Section 6.6.8 and include biotic and abiotic impacts
Comments or Discussion: As discussed in Section 6.6.8		

6.6.7 Potential impacts of the proposed GLeWaP on the aquatic ecosystems of the Hans Merensky Nature Reserve, the Kruger National Park (KNP), and Mozambique

The potential impacts of the proposed GLeWaP including the raining of the Tzaneen Dam wall, the construction of the Nwamitwa Dam, the flow gauging weir and the BWI as discussed in this EIR will have a cumulative impact on the downstream reaches and users. This includes the Hans Merensky Nature Reserve, the Kruger National Park (KNP), and Mozambique. Potential impacts include indirect impacts on the low flow seasons, flow regimes and aquatic ecosystems along the downstream reaches.

According to the 2006 RDS, the ecological objectives for the PES are not currently being met in the Kruger National Park due to the existing allocation of 0.6 m^3/s from Tzaneen Dam not being sufficient. According to the sediment specialist report (GLeWaP, 2008b), the Letaba River in the KNP upstream of the Olifants River confluence will be impacted in terms of the GLeWaP by the reduction of channel width of 17 % (70 m on 411 m channel width). This is likely to have a significant impact on the aquatic ecosystems within this reach and will make compliance with the REC of C at sites EWR5, EWR6 and EWR7 unattainable and will have further implications on the Elephates River in Mozambique.

Mitigations measures as mentioned in this report may reduce or alleviate these impacts to some degree.

7. RECOMMENDED MITIGATION MEASURES

The following recommended mitigation measures were identified:

7.1 CONSTRUCTION AND COMMISSIONING PHASE

7.1.1 Raising of the Tzaneen Dam wall

Implementation of a suitable management action plan during the construction phase, based on monthly water quality and bi-annual biological monitoring surveys of sites downstream of the raised Tzaneen Dam wall. .

7.1.2 Construction of the proposed Nwamitwa Dam

- Implementation of a suitable management action plan during the construction phase, based on analysis of monthly water quality and bi-annual biological monitoring data collected at sites upstream, downstream and within the Nwamitwa Dam;

- Natural features such as trees should not be removed from the proposed dam margin, so as to provide habitats for colonising aquatic biota and perches for aquatic birds;

- Confining the majority of disturbance to the development footprint;

- Planting larger, more developed rooted riparian trees as well as suitable riparian vegetation and specific marginal aquatic macrophytes along the margin of the Nwamitwa Dam basin and in the immediate downstream river channel;

- The translocation of red data or rare riparian plant species to alternative areas;

- Prevention of exotic vegetation encroachment;

- Identifying and assessing the suitability and accessibility of remaining riverine habitats upstream or downstream of the Nwamitwa Dam. Areas of remaining riverine habitats should be afforded special conservation significance of flow

dependant fish and macroinvertebrates are to be maintained. This assessment should be initiated prior to construction;

- Ensure adequate stabilisation of the downstream river bed and banks below the Nwamitwa Dam wall;

- Assess the genetic linkage between of fish populations upstream and downstream of the proposed dam. This assessment should be conducted prior to construction;

- Maintain connectivity between fish assemblages and remaining riverine habitats upstream and downstream of the dam by means of a fishway;

- Prevent any new introductions or the further proliferation *of M. salmoides* (Largemouth Bass) and *O. niloticus* (Nile Tilapia) within the dam basin;

- Control recreational/subsistence fishing activities within the proposed Nwamitwa Dam. The role of recreational/subsistence fishermen in the spread of invasive fish species should not be underestimated;

- Utilise biotic compensation through the setup of an ecoregion (a wildlife park, or eco-reserve) around the Nwamitwa Dam basin and provide adequate habitats for species; and

- Establish eco-awareness of local communities and visitors through environmental and ecosystem education programmes.Construction of the proposed flow gauging weir

7.1.3 Construction of the Bulk Water Infrastructure (BWI) associated with the GLeWaP

- Prevent underground seepage, runoff or direct discharge from any of the activities from entering the aquatic and wetland ecosystems during the construction phase through effective construction engineering;
- Incorporate preventative measures into the design process of the BWI during the construction phase to minimize the mobilization of sediments;
- Establish buffer zones around the BWI during the construction phase;
- Maintain established buffer zones within BWI during the construction phase;
- Design and implement a Biodiversity Action Plan (BAP) to facilitate planning and zonation of human activities associated with the BWI during the construction phase;
- Make use of existing impacts such as roads, bridges and servitudes so as to minimize impacts;
- Maintain natural water flow within the BWI during the construction phase through effective construction engineering;
- Keep habitat alteration to a minimum by limiting the footprint of construction activities and the spatial extent of BWI; and
- Implement rehabilitation where construction site footprint impacts occur within the BWI.

7.2 OPERATIONAL PHASE

7.2.1 Raising of the Tzaneen Dam wall

Implementation of a suitable management action plan based on monthly water quality assessments and bi-annual biological monitoring surveys of selected sites downstream of the raised Tzaneen Dam wall.

7.2.2 Operation of the proposed Nwamitwa Dam

- Implementation of a suitable management action plan during the operational phase phases, based on monthly water quality assessments and bi-annual biomonitoring surveys of selected sites within, upstream and downstream of the Nwamitwa Dam;

- A properly managed timing and release strategy that will ensure that presently existing or naturally seasonal variability in flows are released and or maintained within the downstream Groot Letaba River. This will enable specific ecosystem functions such as migration queues, seasonal floodplain inundation and temperature variations to be maintained.

- Annual bioaccumulation assessments of plant and biotic tissues in order to assess levels of potential POPs and toxicants;

- Monitor the effects of fluctuating water levels on the marginal vegetation, recommended bi-annual biomonitoring;

- Prevention and removal of exotic vegetation encroachment;

- Identified habitat areas to which aquatic biota could migrate to, if any, should be made conservation areas during the operational phase of the Nwamitwa Dam. This will ensure the sustainability of the upstream aquatic biodiversity;

- Prevent any further introductions or the proliferation of introduced fish species such as *M. salmoides* (Largemouth Bass) and *O. niloticus* (Nile Tilapia);

- Control access to recreational/subsistence fishing activities within the proposed Nwamitwa Dam basin. The role of recreational/subsistence fishermen in the spread of invasive fish species should not be underestimated;

- Encourage ecotourism developments within this ecoregion with the specific aim of benefiting local communities;

- Establish eco-awareness of local communities and visitors through environmental and ecosystem education programmes; and

- Ensure a proper release management strategy based on the measures set out in the aquatic EIR.

7.2.3 Operation of the Bulk Water Infrastructure (BWI) associated with the GLeWaP

- Prevent underground seepage, runoff or direct discharge from any of the activities from entering the aquatic and wetland ecosystems during the operational phase through effective construction engineering;

- Monitor established buffer zones within BWI during the operational phase;

- Maintain natural water flow during construction activities by means of effective environmentally sensitive construction methods;

ENVIRONMENTALLY SENSITIVE CONSTRUCTION METHODS

It is recommended that the most of the major construction be limited to dry season so as to limit the amount of sediments or runoff that could be transported via runoff into the river. When this is not possible, a concerted effort to prevent any sediment and pollution contamination into the receiving aquatic ecosystem should be ensured.

Any rubble, sand, litter, fuels, sewage and other materials or wastes associated with the construction process must be prevented from entering the aquatic environments.

Proper storage of construction materials and storm-water runoff measures must be implemented.

MARGINAL AND RIPARIAN VEGETATION

Adequate marginal and riparian vegetation along the margin of the Nwamitwa Dam as well as downstream of the dam wall must be planted. This must be done in consultation with the aquatic ecologist and wetland specialists.

Special attention must be given to any red data or rare plants species that may have to be removed from any of the construction sites or from the proposed inundated areas of the Nwamitwa Dam basin. Mitigation measures may include translocation of such plant species to alternative areas.

BIOTIC COMPENSATION THROUGH THE SETUP OF ECOREGIONS, ECOTOURISM AND ECO-AWARENESS PROGRAMMES

In regard to the potential loss of certain macroinvertebrate taxa and fish species, one mitigation option may be in the form of biotic compensation. The loss of certain aquatic macroinvertebrate taxa and fish species may be compensated by ensuring that habitats are provided and protected for these other aquatic-dependant fauna.

This could be in the form of the setup of an ecoregion (a wildlife park, or eco-reserve) around the dam that provides adequate cover, food, and other required habitats for these biota to inhabit. Ecotourism may also benefit the local communities and create eco-awareness through environmental and ecosystem education programmes focusing on the Nwamitwa Dam and associated ecosystems.

MAINTENANCE OF EXISTING FLOW REGIME AND RELEASE STRATEGY FOR THE NWAMITWA DAM

This was not part of the scope of work, but a brief description was complied after the review process. A brief description of a recommended flow and release strategy is given in Appendix G.

It is recommended that a full assessment of this be conducted.

PRESERVATION OF NATURAL FISH MIGRATION ROUTES

In order to preserve the natural migration routes of the fish with the study reach (EWR3), it is recommended that a suitable and navigable fishway or ladder be constructed so as to allow free passage for migration.

The successful design of a fishway or ladder depends largely on providing the hydraulic and physical characteristics that cater for all the migratory species expected to use it (Bok *et al*., 2007). The following characteristics will need to be incorporated into the fishway design:

- Biological information of the fish assemblage in the area. This will include specific data on the migratory behaviour and swimming ability of species expected to use the fishway.

- Hydrological and hydraulic characteristics needed in order to operate effectively and to ensure that the appropriate fishway type is used and that the fishway is designed correctly

- Topographical features of the site where the fishway is to be placed should be considered in the design of the fishway.

8. THE PUBLIC PARTICIPATION 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 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 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.

9. COMMENTS RECEIVED

The following relevant comments were received from the Issues and Responses Report (GLeWaP, 2008c) and have been addressed in this Specialist Study:

- 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;

- 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;

- That the ecological reserve and downstream users be considered;

- That allocations for the Kruger National Park (KNP) and the allocations for the ecological reserve from the Tzaneen Dam will be affected by the proposed Nwamitwa Dam;

- 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;

- That it was asked to what degree the proposed construction of the dam will increase evaporation losses in the river system;

- Will stream flow increase or decrease with the proposed new dam, adding that any changes in stream flow will have impacts on storks, freshwater mussels, hippo, crocodile, and birds, such as Pell's Fishing Owl, in the nature reserve;

- That Nodweni dam / weir is not mentioned when presentations refer to dams in the river system;

- That the movement of fish (the fish ladder) be considered;

- That it was enquired why ecological requirements incremented in tripled fold in the 2020 scenario that was presented;

- 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;

- That the possible increase of invader plants species that might crowd out the indigenous riverine plants, congesting the water place be investigated;

- That the impact of the proposed new project be investigated on the ecosystem and biodiversity, aquatic habitat, functioning of species;

- 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;

- That the engineering proposal factor in the expected 20% reduction in rainfall predicted by Climate Change scientists. The EIA must explain how this reduction has been factored in;

- That the riverine bush – recovery of wood should be considered;

- That indigenous knowledge on natural trees around the proposed project area be undertaken for record purposes;

- That most of the dams in the study area are silted up as a result of erosion from the adjacent badly managed land. What will the positive impacts be of a new dam in terms of the siltation situation in the river system;

- That mitigation should receive a high priority when protected species are removed;

- That safety for the people staying close to the proposed dam site should be considered when constructing the dam;

- That it was asked whether it will be considered to clear the dam basin of vegetation before inundation;

- That the effect on water quality as a result of pesticides and any other hazardous materials in the dam basin be investigated;

- That action plans when the proposed dam might be in flood should be developed;

- That it is expected that the proposed project will create many job opportunities for local stakeholders to alleviate poverty in the area;

- The EIA does not consider human-animal interaction in the region. Hippo attacking humans, and even vehicles, is highly problematic in the Tzaneen region. Environmental departments of government do not take action on this matter. Such departments should come to the region and inform stakeholders of what action will be taken regarding the matter;

- That sedimentation (likelihood of that in the dam and downstream) be investigated;

- That the environmental rehabilitation and restoration aspects and costs should be considered from inception, through operations, closure and ongoing maintenance phases of the project;

- That the question of sustainability as per the SA Water Policy must be considered by DWAF in terms of the number of dams, by infinite quantities of water, to sustain increasing numbers of people rather than the reality that ecological constraints will limit the number of people who can live in this area; and

- That the EIA specialist studies should consider the possibility of increased water borne diseases such as malaria.

- 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.

- 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

- 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

- 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

10. OTHER INFORMATION REQUESTED BY THE AUTHORITY

No additional information was required by the authority.

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APPENDIX A: SITE PHOTOS

Site NWA1

Site NWA2

Site NWA3

Site LET01

APPENDIX B: AQUATIC MACROINVERTEBRATE DATA

Taxon	Common name	Nov-07			
		NWA01	NWA02	NWA03	LET01
TURBELLARIA	Flat worms				
ANNELIDA					
Oligochaeta	Aquatic earthworm	B			B
Hirudinae	Leeches				A
CRUSTACEA					
Atyidae	Freshwater shrimps				A
Potamonautidae	Crabs				1
HYDRACARINA	Water mites			B	
EPHEMEROPTERA					
Baetidae 2sp	Small minnow mayflies		B		
Baetidae >2sp	Small minnow mayflies	B		B	B
Caenidae	Cainflies	B		A	B
Heptageniidae	Flat-headed mayflies				B
Leptophlebiidae	Prongils				B
Tricorythidae	Stout crawlers				B
ODONATA					
Aeshnidae	Dragonflies	1	A		1
Calopterygidae	Damselflies				1
Coenagrionidae	Damselflies	B		B	B
Gomphidae	Dragonflies	B	A		A
Libellulidae	Dragonflies	B	B	A	1
LEPIDOPTERA					

Taxon	Common name	Nov-07			
		NWA01	NWA02	NWA03	LET01
Pyralidae	Aquatic caterpillars				A
HEMIPTERA					
Belostomatidae	Giant water bugs		A	A	
Corixidae	Water boatmen		B	B	
Naucoridae	Creeping water bugs	B	B	B	A
Nepidae	Water scorpions			A	
Notonectidae	Back swimmers	1		B	
Pleidae	Pygmy backswimmers			A	
Velidae	Broad-shouldered water striders	A			B
TRICHOPTERA					
Hydropsychidae 1sp	Caseless caddisflies				A
COLEOPTERA					
Dytiscidae	Predacious diving beetles			B	
Elmidae	Riffle beetles				B
DIPTERA					
Ceratopogonidae	Biting midges			A	
Chironomidae	Midges	B		B	1
Culicidae	Mosquitoes			A	
Simuliidae	Blackflies	B			B
Tabanidae	Horseflies				B
GASTROPODA					
Ancylidae	Freshwater limpets	1			
Lymnaeidae	Pond snails	B	A	B	
Physidae	Pouch snails	B			A

Taxon	Common name	Nov-07			
		NWA01	NWA02	NWA03	LET01
Planorbidae	Orb snails	B			A
Thiaridae	Snails				B
PELECYPODA					
Corbiculidae	Clams				C
Sphaeriidae	Pill clams				1
SASS5 scores		78	40	56	161
Number of taxa		16	8	15	27
ASPT*		4.9	5	3.7	6

*ASPT - Average Score per Taxa

APPENDIX C: AQUATIC MACROINVERTEBRATE PREFERENCES

Preferences of aquatic macroinvertebrate taxa to flow categories, biotope types and water quality sensitivity (adapted from Kleynhans *et al*., 2005b). Species of concern loss are highlighted in red

Flow Category	Macroinvertebrate Taxa	Flow preference rating	Biotope Preference	Biotope preference rating	Water quality sensitivity rating
> 0.6 m/s	Trichorythidae	4	Cobbles	4	Moderate
Fast flows	Hydropsychidae 1sp	4	Cobbles	3	Low
	Ceratopogonidae	4	Cobbles	3	Low
	Simuliidae	4	Cobbles	3	Low
0.3 - 0.6 m/s	Elmidae	4	Cobbles	4	Moderate
Fast flows	Potamonautidae	3	Cobbles	3	-
	Heptageniidae	3	Cobbles	4	High
	Pyralidae	3	Cobbles/Vegetation	3	High
	Coenagrionidae	3	Vegetation	4	Low
	Libellulidae	3	Cobbles	4	Low
	Gomphidae	3	Gravel, Sand & Mud	5	Low
	Naucoridae	3	Water Column	4	Low
0.1 - 0.3 m/s	Chironomidae	3	-	-	-
Slow flows	Calopterygidae	3	Vegetation	3	Moderate
	Corixidae	3	Water Column	4	-
	Tabanidae	3	Gravel, Sand & Mud	3	Low
	Corbiculidae	3	Gravel, Sand & Mud	4	Low
	Sphaeridae	3	Gravel, Sand & Mud	4	-
< 0.1 m/s	Veliidae	5	Water Column	5	Moderate
Slow flows	Belostomatidae	4	Vegetation	4	-
	Nepidae	4	Vegetation	5	-
	Notonectidae	4	Water Column	4	-
	Pleidae	4	Vegetation	4	Low
	Dytiscidae	4	Vegetation	3	Low
	Culicidae	3	Water Column	5	-
	Caenidae	3	Gravel, Sand & Mud	3	Low

	Leptophlebiidae	3	Cobbles	3	Moderate
	Lymnaeidae	3	Vegetation	3	-
	Physidae	3	Vegetation	3	-
	Planorbinae	3	Vegetation	3	-
	Thiaridae	3	Vegetation	3	-

APPENDIX D: FISH PREFERENCES

Velocity-depth and flow intolerance preferences for expected fish (adapted from Kleynhans *et al*., 2005b). Species of concern (fast velocity preferenced and flow modification intolerant >3.0) are highlighted in red

Fish Species	VELOCITY-DEPTH PREFERENCE				FLOW INTOLERANCE			
	FD	FS	SD	SS	Intolerant	Moderately intolerant	Moderately tolerant	Tolerant
Barbus toppini	-	-	3.3	4.3	-	-	-	1.1
Barbus trimaculatus	-	-	3.9	3.2	-	-	2.7	-
Barbus unitaeniatus	-	-	5	4.3	-	-	2.3	-
Barbus viviparus	-	-	-	4.8	-	-	2.3	-
Clarias gariepinus	-	-	4.3	3.4	-	-	-	1.7
Chiloglanis paratus	4.2	4.9	-	-	-	3.2	-	-
Chiloglanis pretoriae	4.3	4.9	-	-	4.8	-	-	-
Laboebarbus marequensis	4.1	4.4	4.4	3.4	-	3.2	-	-
Labeo cylindricus	3.4	4.8	-	-	-	3.1	-	-
Labeo molybdinus	3.3	4.3	3.7	-	-	3.3	-	-
Labeo rosae	-	-	4.7	-	-	-	2.5	-
Micralestes acutidens	-	-	4.3	4.3	-	3.1	-	-
Mesobola brevianalis	-	-	4.3	4.2	-	-	-	1.1
Micropterus salmoides	-	-	4.5	-	-	-	-	1.1
Oreochromis mossambicus	-	-	4.6	3.8	-	-	-	0.9
Pseudocrenilabrus philander	-	-	-	4.3	-	-	-	1
Tilapia rendalli	-	-	4.9	3.9	-	-	-	1.8
Tilapia sparrmanii	-	-	-	4.3	-	-	-	0.9

Cover and tolerance to modified physico-chemical preferences for expected fish (adapted from Kleynhans *et al*., 2005b). Species of concern (cover and intolerant preferenced >4.0) are highlighted in red

Fish Species	COVER PREFERENCE					TOLERANCE: MODIFIED PHYSICO-CHEM			
	Overhanging vegetation	Undercut banks and roots	Substrates	Aquatic macrophytes and marginal vegetation	Water column	Intolerant to modification	Moderately intolerant to modification	Moderately tolerant to modification	Tolerant to modification
Barbus toppini	4.7	-	-	-	-	-	-	3	-
Barbus trimaculatus	3.9	-	-	-	-	-	-	-	1.8
Barbus unitaeniatus	4.6	-	-	-	-	-	-	2.2	-
Barbus viviparus	4.9	-	-	3.2	-	-	-	3	-
Clarias gariepinus	-	-	-	-	-	-	-	-	1
Chiloglanis paratus	-	-	4.9	-	-	-	3.1	-	-
Chiloglanis pretoriae	-	-	4.9	-	-	4.5	-	-	-
Laboebarbus marequensis	-	-	4.5	-	4.1	-	-	2.1	-
Labeo cylindricus	-	-	4.9	-	-	-	3.1	-	-
Labeo molybdinus	-	-	4.7	-	-	-	3.2	-	-
Labeo rosae	-	-	5	-	-	-	-	3	-
Micralestes acutidens	3.1	-	-	-	4	-	3.1	-	-
Mesobola brevianalis	-	-	-	-	5	-	-	2.8	-
Micropterus salmoides	3.1	-	3.1	3.2	-	-	-	2.3	-
Oreochromis mossambicus	-	-	-	-	3.9	-	-	-	1.3
Pseudocrenilabrus	4.5	3.2	-	-	-	-	-	-	1.4

Fish Species	COVER PREFERENCE					TOLERANCE: MODIFIED PHYSICO-CHEM			
	Overhanging vegetation	Undercut banks and roots	Substrates	Aquatic macrophytes and marginal vegetation	Water column	Intolerant to modification	Moderately intolerant to modification	Moderately tolerant to modification	Tolerant to modification
philander									
Tilapia rendalli	4.3	-	-	4.1	-	-	-	2.1	-
Tilapia sparrmanii	4.5	-	-	3.6	-	-	-	-	1.4

APPENDIX E: FISH MIGRATION POTENTIAL

Migration potential for expected fish (Kleynhans *et al*., 2005b). Potentially impacted species are highlighted in red

Fish Species	MIGRATION POTENTIAL
	5 - catchment scale migrations, 3 - movement between reaches & 1 - movement within reaches
Barbus toppini	3
Barbus trimaculatus	3
Barbus unitaeniatus	3
Barbus viviparus	3
Chiloglanis paratus	3
Chiloglanis pretoriae	3
Clarias gariepinus	3
Labeo cylindricus	3
Labeo molybdinus	3
Labeo rosae	3
Laboebarbus marequensis	3
Mesobola brevianalis	3
Micralestes acutidens	3
Orechromis mossambicus	3
Pseudocrenilabrus philander	1
Tilapia rendalli	3
Tilapia sparrmanii	3

APPENDIX F ENVIRONMENTAL MANAGEMENT PROGRAMME (EMP)

1. ENVIRONMENTAL MANAGEMENT PROGRAMME (EMP)

This document recommends measures that can be implemented by the Great Letaba Water Development Project (GLeWaP) for the pre-construction, construction and operation phases of the proposed dam at the Nwamitwa site, so as to minimise the potential impacts on the aquatic ecosystems identified during the compilation of the Environmental Impact Report (EIR).

1.1.1 OBJECTIVES

It is the objective of this document to ensure compliance with the following South African legislation:

1.1.2 The Environment Conservation Act, 1989 (No. 73 of 1989)

In terms of Regulations (Section 21, Schedule 1, No.1 (j) published in Government Gazette No. 18261, 5 September 1997, in terms of the Environment Conservation Act, 1989 (ECA), appropriate environmental investigations (EIA's) are mandatory before approval for the “construction or upgrading of dams, levees or weirs affecting the flow of a river” will be given by the relevant authority.

1.1.3. The National Environmental Management Act (Act 107 of 1998)

The National Environmental Management Act (Act 107 of 1998), in terms of Regulation 386, Activity 1 (m) gazetted in terms of Section 24, a basic assessment is required to be conducted before approval for any in-stream barrier construction is granted.

1.1.4. National Water Act, 1998 (Act No. 36 of 1998)

In the National Water Act (NWA), use of water is no longer limited to consumptive use, such as the abstraction of water, but includes non-consumptive activities that may have an impact on the resource quality. These “water uses”, which require authorization (usually in the form of a license) are given in Section 21 of the NWA, and include:

- Section 21 (a): storing water;
- Section 21 (c): impeding or diverting the flow of water in a watercourse;
- Section 21 (i); altering the bed, banks, course or characteristics of a watercourse.

Thus, in terms of the NWA, the erection of any in-stream structure within a watercourse, which could theoretically impede river flow, such as bridges, causeways, weirs, dams, etc., is listed as a water use, and would require a license. If the proposed structure or "alteration" of the watercourse could impede aquatic biota migration, the granting of the water license should be conditional on providing free passage of aquatic biota past the potential man-made barrier.

This also attempts to comply with the 2006 Letaba Catchment Reserve Determination Study (2006 RDS) (DWAF, 2006).

2. POTENTIAL IMPACTS ON AQUATIC ECOSYSTEMS

The EMP is based on the results of the Aquatic Environmental Impact Report (EIR). The impacts are addressed in terms of the potential mitigation measures recommended for implementation during the pre-construction, construction and operation phases of the proposed development. This was done according to the areas of potential impact identified in the EIR Report namely:

- The potential impact of raising the dam wall of Tzaneen Dam on the aquatic ecosystems both upstream and downstream of the dam wall;
- The potential impact of the proposed Nwamitwa Dam on aquatic ecosystems within the proposed dam basin, in the Nwanedzi River and in the Groot Letaba River downstream of the dam basin;
- The potential impact of the proposed Nwamitwa Dam as a migration barrier on fish assemblages in the Groot Letaba River;
- The potential impact of the proposed flow gauging weir downstream of the proposed Nwamitwa Dam on the aquatic ecosystems upstream and downstream of the proposed weir; and

- The potential impact of the proposed Bulk Water Infrastructure (BWI) associated with the GLeWaP on the associated aquatic ecosystems.

2.1 THE POTENTIAL IMPACT OF RAISING THE DAM WALL OF TZANEEN DAM ON THE AQUATIC ECOSYSTEMS BOTH UPSTREAM AND DOWNSTREAM OF THE DAM WALL

(a) Phase of Project

CONSTRUCTION	OPERATION
•	•

(b) Management Objectives

To minimize the degradation of the aquatic ecosystem due to the raising the dam wall of Tzaneen Dam, both upstream and downstream of the dam wall, during the construction and operational phases.

(c) Management and Mitigation Measures

- Comply with the 2006 RDS requirements;
- Implementation of a suitable management action plan during the construction phase, based on monthly water quality and two biological monitoring surveys of selected sites downstream of the raised Tzaneen Dam wall;
- Accurate full supply-level calculations during the construction phase, taking into account the impacts addressed in this report; and
- Implementation of a suitable management action plan during the operational phase, based on bi-annual water quality and biological monitoring surveys of selected sites downstream of the raised Tzaneen Dam wall.

2.2 THE POTENTIAL IMPACT OF THE PROPOSED NWAMITWA DAM ON AQUATIC ECOSYSTEMS WITHIN THE PROPOSED DAM BASIN, IN THE NWANEDZI RIVER AND IN THE GROOT LETABA RIVER DOWNSTREAM OF THE DAM BASIN

(d) Phase of Project

CONSTRUCTION	OPERATION
•	•

(e) Management Objectives

To minimize the degradation of the aquatic ecosystem due to the construction of the proposed Nwamitwa Dam on aquatic ecosystems within the proposed dam basin, the Nwanedzi River and in the Groot Letaba River downstream of the dam basin, during the construction and operational phases.

(f) Management and Mitigation Measures

- Comply with the 2006 RDS requirements;
- Implementation of a suitable management action plan during the construction phase, based on monthly water quality and two biological monitoring surveys of selected sites within and upstream of the Nwamitwa Dam as well as at selected sites downstream of the Nwamitwa Dam;
- Implementation of a suitable management action plan during the operational phase phases, based on bi-annual water quality and biomonitoring surveys of selected sites within and upstream of the Nwamitwa Dam as well as at selected sites downstream of the Nwamitwa Dam;
- Identifying the sources of excess phosphates entering the proposed Nwamitwa Dam and reducing them during the both construction and operational phases;
- Annual bioaccumulation assessments of plant and biotic tissues in order to assess levels of potential POPs and toxicants during the operational phases;
- Systematic removal of required riparian and terrestrial vegetation within the dam basin in phases and limiting the amount of exposed areas during the construction phase;

- Confining the majority of disturbance to construction sites and preferably within the dry season;

- Planting larger, more developed rooted riparian trees as well as suitable riparian vegetation and specific marginal aquatic macrophytes along the margin of the Nwamitwa Dam basin and in the immediate downstream river channel;

- Monitor the effects of fluctuating water levels on the marginal vegetation, recommended bi-annual biomonitoring during the operational phase;

- The translocation of red data or rare riparian plant species to alternative areas;

- Prevention of exotic vegetation encroachment at all the sites;

- Bi-annual identification and removal of exotic vegetation within the Nwamitwa Dam basin during the construction and operational phases;

- All natural obstructions (i.e. large trees and forests) should not be removed from the proposed inundated areas of the Nwamitwa Dam basin during the construction phases, so as to provide underwater habitats, cover and refuge for aquatic biota. This should be conducted and monitored by an aquatic ecologist;

- Identifying and assessing the suitability and accessibility of remaining habitats upstream or downstream of the Nwamitwa Dam for specific biota (i.e. Aquatic macroinvertebrates and fish) that may migrate upstream or downstream in search of specific habitat requirements. This should be done prior to construction;

- Identified habitat areas to which aquatic biota could migrate to, if any, should be made conservation areas during the operational phase of the Nwamitwa Dam. This will ensure the sustainability of the upstream aquatic biodiversity;

- Restrict access to areas where dangerous fauna may occur during the construction and operational phases or alternatively translocate these animals to other locations (hippopotami and crocodile) during the construction phase;

- Further investigate the life stages of occurring amphibians within the proposed inundated areas of the Groot Letaba River and implement a suitable management action plan during the construction phase;

- Construction of a multiple level outlet structure, with outlets at 4 meter intervals from 6 meters below the full supply level of the dam;

- Ensure adequate stabilisation of the downstream river bed and banks below the Nwamitwa Dam wall during the construction and operational phases;

- Assess the likelihood of genetic lineages and correlations occurring within populations of key fish species at selected sites within the study reach of the Groot Letaba River. This should be done prior to construction;

- Assess the necessity of construction of a fish ladder or fishway based on the genetic and habitat studies so as to allow these specific fish species to overcome the Nwamitwa Dam wall during migration periods. This should be done prior to construction;

- Prevent any new introductions of M. salmoides (Largemouth Bass) and O. niloticus (Nile Tilapia) at any of the sites, in particular the Nwamitwa Dam basin during both the construction and operational phases;

- Restrict access to, and prevent recreational fishing activities within the proposed Nwamitwa Dam basin during both the construction and operational phases;

- Setup of a suitable management action plan during the operational phase, based on bi-annual monitoring of the population levels of M. salmoides;

- Investigate the possibility of stocking the dam with additional indigenous: O. mossambicus individuals during the operational phase;

- Utilise biotic compensation through the setup of an ecoregion (a wildlife park, or eco-reserve) around the Nwamitwa Dam basin and provide adequate habitats for species during the construction phases;

- Establish ecotourism within this ecoregion during the operational phases that will also benefit the local communities;

- Establish eco-awareness of local communities and visitors during both the construction and operational phases through environmental and ecosystem education programmes; and

- Ensure a proper release management strategy from the multi-level outlets during the operational phase, based on the measures set out in the aquatic EIR.

2.3 THE POTENTIAL IMPACT OF THE PROPOSED NWAMITWA DAM AS A MIGRATION BARRIER ON FISH ASSEMBLAGES IN THE GROOT LETABA RIVER

(g) Phase of Project

CONSTRUCTION	OPERATION
•	•

(h) Management Objectives

To minimize the degradation of the aquatic ecosystem due to the potential impact of the proposed Nwamitwa Dam as a migration barrier on fish assemblages in the Groot Letaba River, during the construction and operational phases.

(i) Management and Mitigation Measures

- Comply with the 2005 RDS requirements;

- Identifying and assessing the suitability and accessibility of remaining habitats upstream or downstream of the Nwamitwa Dam for specific biota (i.e. Aquatic macroinvertebrates and fish) that may migrate upstream or downstream in search of specific habitat requirements. This should be done prior to construction;

- Identified habitat areas to which aquatic biota could migrate to, if any, should be made conservation areas during the operational phase of the Nwamitwa Dam. This will ensure the sustainability of the upstream aquatic biodiversity;

- Assess the likelihood of genetic lineages and correlations occurring within populations of key fish species at selected sites within the study reach of the Groot Letaba River. This should be done prior to construction; and

- Assess the necessity of construction of a fish ladder or fishway based on the genetic and habitat studies so as to allow these specific fish species to overcome the Nwamitwa Dam wall during migration periods. This should be done prior to construction.

2.4 THE POTENTIAL IMPACT OF THE PROPOSED FLOW GAUGING WEIR DOWNSTREAM OF THE PROPOSED NWAMITWA DAM ON THE AQUATIC ECOSYSTEMS UPSTREAM AND DOWNSTREAM OF THE PROPOSED WEIR

(j) Phase of Project

CONSTRUCTION	OPERATION
•	•

(k) Management Objectives

To minimize the degradation of the aquatic ecosystem due to the proposed flow gauging weir downstream of the proposed Nwamitwa Dam on the aquatic ecosystems upstream and downstream of the proposed weir, during the construction and operational phases.

(l) Management and Mitigation Measures

It was considered that there was no need for the proposed flow gauging weir due to the fact that release flows from the proposed Nwamitwa Dam can be obtained from the operational procedures and discharges from the dam wall (from the multi-level outlets). Downstream data on the flows can be obtained from the existing downstream weirs (Prieska Weir – B8H017).

Should a weir be built in spite of the fact that it is unnecessary, the following impacts and mitigation measures were assessed:

Mitigation is limited to the design of a weir that does not impede low flows and sediment transport and allows minimum base flow of the Groot Letaba River to continue throughout the year.

2.5 THE POTENTIAL IMPACT OF THE PROPOSED BULK WATER INFRASTRUCTURE (BWI) ASSOCIATED WITH THE GLEWAP ON THE ASSOCIATED AQUATIC ECOSYSTEMS

(m) Phase of Project

CONSTRUCTION	OPERATION
•	•

(n) Management Objectives

To minimize the degradation of the aquatic ecosystem due to the proposed Bulk Water Infrastructure (BWI) associated with the GLeWaP, during the construction and operational phases.

(o) Management and Mitigation Measures

- Comply with the 2006 RDS requirements;
- Prevent underground seepage, runoff or direct discharge from any of the activities from entering the aquatic and wetland ecosystems during the construction and operational phases through effective construction engineering;
- Incorporate preventative measures into the design process of the BWI during the construction phase to minimize the mobilization of sediments;
- Establish buffer zones around the BWI during the construction phase;
- Monitor established buffer zones within BWI during the construction and operational phases;
- Design and implement a Biodiversity Action Plan (BAP) to facilitate planning and zonation of human activities associated with the BWI during the construction phase;
- Make use of existing impacts such as roads, bridges and servitudes so as to minimize impacts;

- Maintain natural water flow within the BWI during the construction and operational phases, through effective construction engineering;
- Keep habitat alteration to a minimum by limiting the footprint of construction activities and the spatial extent of BWI; and
- Implement rehabilitation where construction site footprint impacts occur within the BWI;

APPENDIX G: MAINTENANCE OF EXISTING FLOW REGIME AND RELEASE STRATEGY FOR THE NWAMITWA DAM

This was not part of the scope of work, but a brief description was complied after the review process.

It is recommended that a full assessment of this be conducted.

Hydrological information on discharges for the past 30 years was obtained from the DWAF Hydrology website from two gauging weirs situated upstream (Junction weir: B9H009) and downstream (Prieska weir: B9H017) of the proposed Nwamitwa Dam site. The monthly discharge data from these two weirs was assessed in terms of seasonal differences in the annual flow regime and then plotted into hydrographs.

A large degree of similarity can be seen in the annual flow regimes over the last 30 years at these two sites (**Figure G.1** to Figure G.4). The monthly discharges and magnitude of events are slightly increased at the downstream weir, but this is considered to be normal due to three additional tributaries entering the system between the two weirs. An assessment of the annual hydrographs form both weirs indicated two distinct seasonal differences between November to April and from May to October.

These seasonal flow regimes should be mimicked by a properly managed release programme for the operation phase of the dam. This can be effectively accomplished by:

- The construction of a multiple level outlet structure, with outlets at 4 meter intervals from 6 meters below the full supply level of the dam. This will enable a range of seasonal flows and flow velocities to be released into the downstream river; and

- A properly managed timing and release strategy that will ensure that presently existing or naturally seasonal variability in flows are released and or maintained within the downstream Groot Letaba River. This will enable specific ecosystems functions to be maintained (migration ques, seasonal floodplain inundation, temperature variations, etc.) within the downstream river.

During the construction and operational phases of the Nwamitwa Dam, the seasonal flow regime in terms of timing and magnitude shown by these hydrographs should be maintained in order to reduce the potential impacts on the receiving environment.

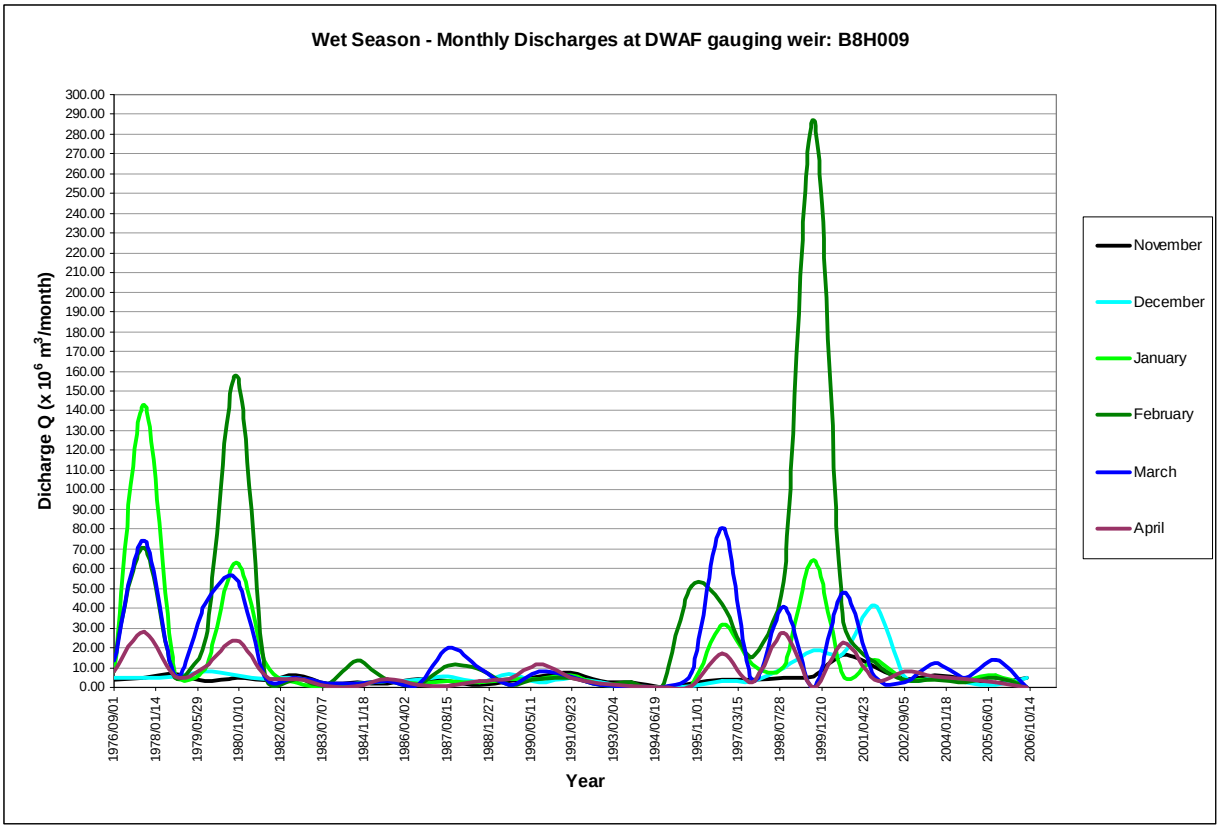

Figure G.1: Hydrograph of wet season discharges at the B8H009 weir over the last 30 years

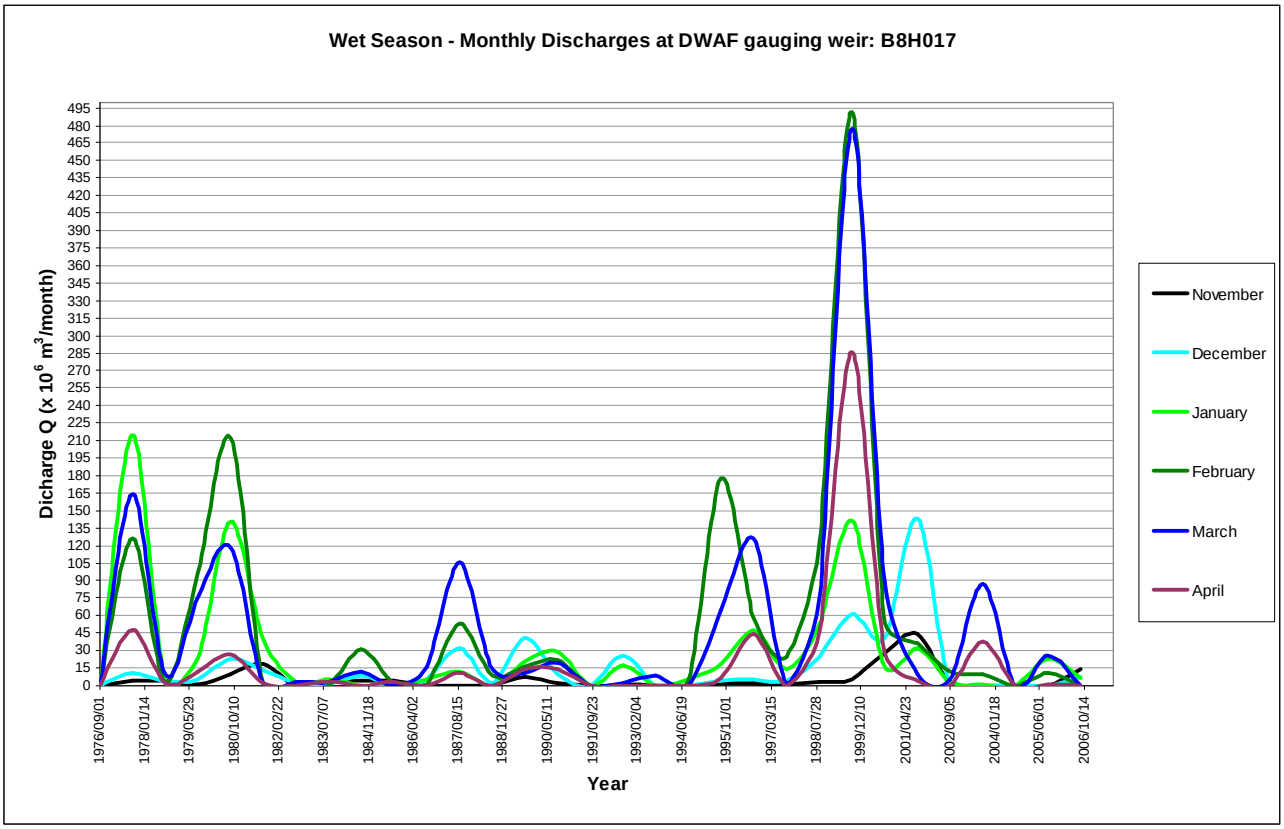

Figure G.2: Hydrograph of wet season discharges at the B8H017 weir over the last 30 years

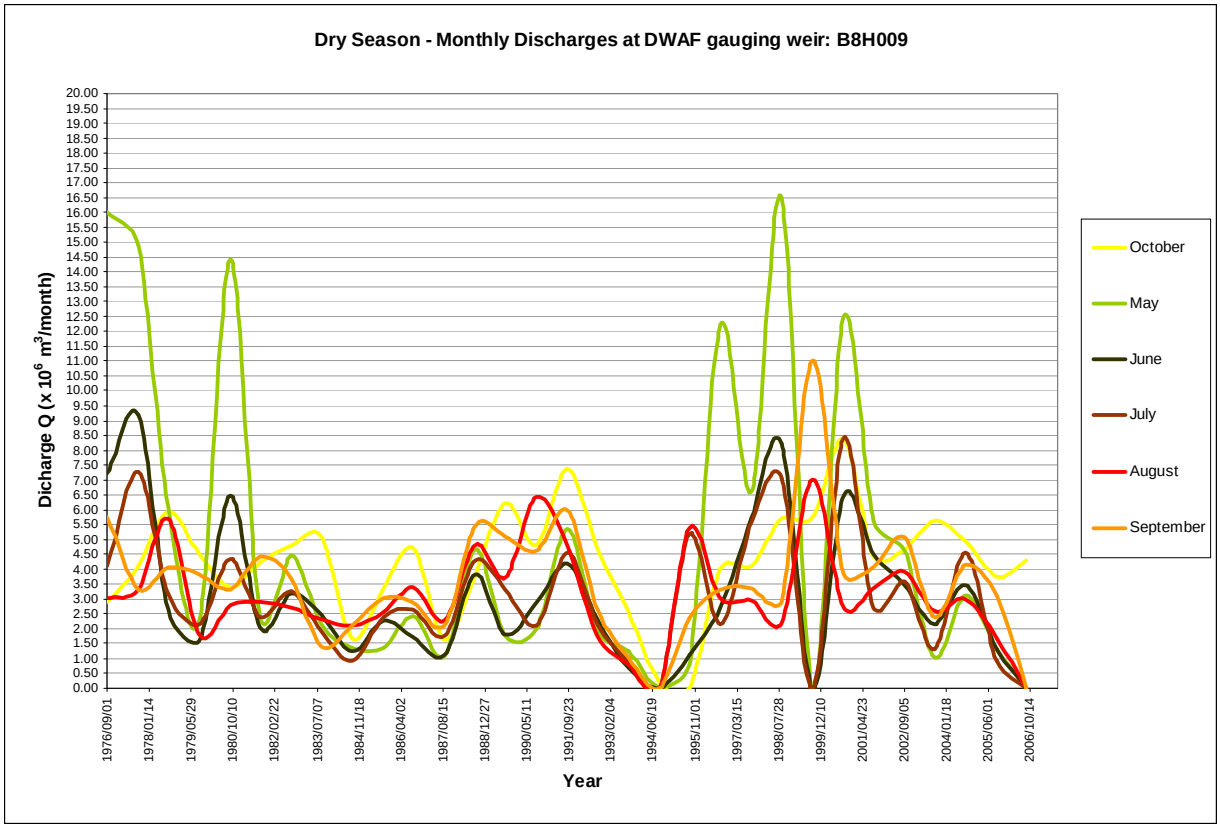

Figure G.3: Hydrograph of dry season discharges at the B8H009 weir over the last 30 years

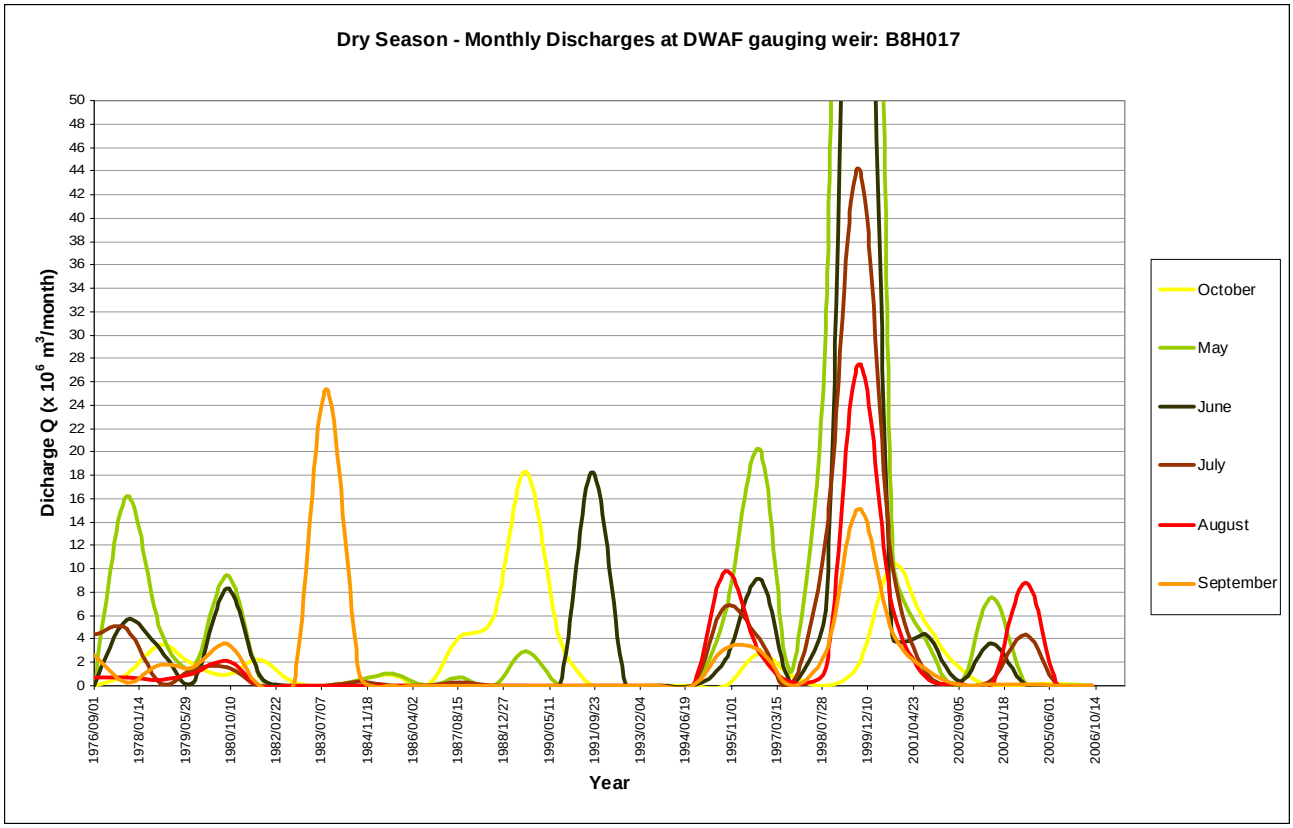

Figure G.4: Hydrograph of dry season discharges at the B8H017 weir over the last 30 years

The release strategy should have the same timing (monthly basis) and magnitude (small freshets, small flood events, high flow and low flow seasonality and larger flood events) as shown by the increases in discharge recorded at the two weirs.

Recommended monthly discharges from the Nwamitwa Dam should correspond with or be similar to the average monthly discharges of both weirs as shown in **Table G.1**.

Table G.1: Average monthly discharges of the two weirs over the last 30 years, the difference in discharge between the two weirs and the average combined discharge of the two weirs (Discharge = Q (x 10^6 m^3/month)

Month	Average discharges at B8H009 weir since 1976	Average discharges at B8H017 weir since 1976	Discharge difference	Average discharge of both weirs
January	14.623	28.285	13.661	21.454
February	26.481	50.795	24.314	38.638
March	18.451	49.387	30.936	33.919

April	9.886	19.091	9.205	14.488
May	5.880	9.705	3.825	7.792
June	3.891	5.089	1.198	4.490
July	3.403	3.138	-0.265	3.271
August	3.051	2.060	-0.991	2.555
September	3.473	2.165	-1.308	2.819
October	3.950	2.146	-1.803	3.048
November	4.231	5.230	0.999	4.731
December	7.727	15.292	7.565	11.509

According to the 2006 RDS (DWAF, 2006), specific flow scenarios are recommended in order to maintain the Present Ecological State (PES) These specific flow scenarios are summarised in **Table G.2**.

Table G.2: Recommended flow scenarios for the EWR3 site from the Reserve Determination study (DWAF, 2006)

SITE	REC	MAINTENANCE LOW FLOWS (%)	DROUGHT LOW FLOWS (%)	HIGH FLOWS (%)	LONG-TERM MEAN OF MAR (%)
EWR3	C/D	1.29	0.23	11.78	14.15
ANNUAL EWR (MILLION M^3): 42.448					
VIRGIN MAR (MILLION M^3): 364.49					
ANNUAL EWR (% NMAR): 11.65					

If the release strategy described in this report is implemented, mitigation of the potential impacts of the proposed Nwamitwa Dam may be reduced and will certainly aid in attempting to meet and maintain the requirements set out in the 2006 RDS in terms of the REC and Ecospecs for this reach (EWR3).

water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

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

GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)

Environmental Impact Assessment

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

ANNEXURE I: NOISE IMPACT ASSESSMENT

FEBRUARY 2008

JKA

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DECLARATION OF INDEPENDENCE

Jongens Keet Associates, who are noise impact specialists, 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 this specialist performing such work.

REPORT DETAILS PAGE

Project name:	***Groot Letaba River Water Development Project***
Report Title:	***Environmental Impact Assessment Appendix J: Noise Impact Assessment***
Author:	***Derek Cosijn & Erica Cosijn***
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Project Director

EXECUTIVE SUMMARY

The Groot Letaba Water Development Project (GLeWaP) is aimed at improving the management of the water resources in the Groot Letaba River catchment area and consists of non-infrastructure options to manage the available water as well as the construction of infrastructure components. The project comprises improvements at Tzaneen Dam, the construction of a new dam at the site known as Nwamitwa, the realignment of sections of two provincial roads to accommodate the backwaters of the new dam, expansion of existing water treatment works and the construction of the necessary water reticulation infrastructure in the area to the north, north-east and north-west of the new dam. Jongens Keet Associates was appointed by ILISO Consulting (Pty) Ltd to undertake the investigation to assess the potential noise impact of the project.

The general procedure used to determine the noise impact was guided by the requirements of the South African National Standard SANS 10328:2003: Methods for Environmental Noise Impact Assessments. The level of investigation was the equivalent of an Environmental Impact Assessment (EIA) of the situation. The noise impact criteria used specifically take into account those as specified in the South African National Standard SANS 10103:2004, The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and Speech Communication as well as those in the National Noise Control Regulations.

Findings: Prevailing Noise Climate:

- *Tzaneen Dam Study Area: The main sources of noise are from traffic on the main roads, the water purification works, power boats on the Tzaneen Dam and the railway line to the west of the dam. The noise sensitive receptors in the area are the residences to the south, south-west and east of the dam wall, the farmhouses to the west and north of the dam, the Merensky High School and the Tzaneen Nature Reserve. The existing noise climate close to the main roads is degraded with regard to residential living. In the existing and developing residential areas to the south and east of the Tzaneen Dam wall, at the farmhouses on the western and northern sides of the dam, and at the Merensky High School the residual (existing) noise levels are relatively low and fall within the limits recommended by SANS 10103.*

- *Nwamitwa Dam and Reticulation Study Area: The main sources of noise are from traffic on the main roads, the Nkambako water treatment works, the pump on the Groot Letaba River feeding the water treatment works. The noise sensitive receptors in the area are the farmhouses and farm labourer houses along the river valley, the rural villages to the north, north-east and north-west of the proposed dam and the village schools. The existing noise climate alongside the main roads is degraded with regard to residential living. In the areas that are not close to and are relatively shielded from the main roads the residual (existing) noise levels are relatively low. In general the conditions on the farms and villages in the area meet the acceptable standards as per SANS 10103.*

Findings: Noise Impacts during the Pre-Construction Phase

- *Activities during the planning and design phase that have possible noise implications in the Tzaneen Dam Study Area are possible concrete core testing on the spillway.*

- *Activities during the planning and design phase that have possible noise implications in the Nwamitwa Dam and Reticulation Study Area are those related to field surveys (such as seismic testing and geological test borehole drilling) mainly at planned building, bridge and other major structure sites. Although some of these activities such as the drilling operations can be noisy, a major disturbance is generally unlikely in the area as these activities are of short duration at any one site and normally take place during the day. Drilling activities near schools will cause minor problems.*

Findings: Noise Impacts during the Construction Phase

- *Tzaneen Dam Study Area: It is understood that construction will take place only during the day-time at this site. Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over any working period. From the details presently available, it appears that the construction noise impact is not likely to be too severe in the residential areas near to the dam wall.*

- *Nwamitwa Dam and Weir Study Area: It is understood that construction will take place on a 24-hour basis. There will be a significant noise impact from the construction activities at the dam on the Ka-Malubana and Ka-Mswazi Villages*

north of, and the farms to the north and east (Deeside 733-LT) of, the dam wall, particularly from the night-time construction activities. The residual noise levels in the village and on the surrounding farms are fairly quiet and significant noise nuisance effects and noise disturbance effects are anticipated from the construction in these residential areas. The main impact from the construction phase will be from the quarrying operation, namely from the rock drills and the crusher. The impact from blasting at the aggregate quarry, however, is likely to be minimal on residents in the area, provided that blasting is restricted to the day-time. Blasting is anticipated only once every two weeks and will be limited to the daytime. Although the volumes of construction site generated traffic are not expected to be high, noise from site traffic could be a problem, depending on the location of these roads relative to the Ka-Malubana Village and farmhouses.

- *Noise Impact from Road Construction: The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site. The new alignment of Road R529 (both Alternative 1 and Alternative 2) will now be routed close to a number of farmhouses on the Farm Riverside 514-LT. The new alignment of Road P43/3 to the east of the existing alignment will place the new road relatively close to farm worker residences on the farm Nagude 517-LT. As construction is likely to take place during daytime, no major noise impact is anticipated at these residences. The impacts in any one area will be relatively short-term as the construction activities progress along the route.*

- *Noise Impact related to Water Treatment Works: The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site. The noise from this site will be dominated to a large extent by the noise from the construction at the dam area and aggregate quarry, but will have a minor cumulative effect on the noise levels from the various other construction sites.*

- *Noise Impact related to Pipelines, Pump Stations and Reservoirs: The noise sensitive areas/sites that could be impacted by noise along the whole length of the respective pipeline routes are mainly residential land uses. There are also a number of schools that are potentially affected. The noise sensitive sites closest to the roads (where the pipelines are laid in the reserve) will be affected the most by the construction noise. Noise levels from all work areas will vary constantly and in many instances significantly over short periods during any day working period. If construction activities are restricted to the daytime, the impact conditions at residences will not be that severe.*

Findings: Noise Impacts during the Operational Phase

- *Tzaneen Dam: No change in the general operating noise climate is anticipated from the alterations to the dam wall.*

- *Nwamitwa Dam and Weir: No noise disturbance is anticipated from the sound of constant outflow of dam water into the stilling basin due firstly to the character of the sound (namely a waterfall sound) and secondly due to the distance attenuation of the sound. The noise from water flowing over the weir will be of a nature that will have no impact. No major change in general noise climate is anticipated from the operations at the dam.*

- *Roads: Existing noise levels close to the main roads in the Tzaneen Dam Study Area and the Nwamitwa Dam and Reticulation Study Area are already high for residential land use and particularly at night. The situation of these "noise degraded" areas will continue to worsen with the general growth of traffic through the study area. The main impact from traffic noise will be on the realigned sections of Road R529 and Road P43/3. Specifically on the realigned section of Road R529 there are a number of farm houses that will be within 500m of the realigned sections of the road and where the noise level will exceed the 45dBA (LR,dn) allowable.*

- *Water Treatment Works: Residences in the southern sector of Ka-Malubana Village could be adversely affected by the noise from the works as well as the delivery pump station, particularly at night. The exact position of the delivery pump station for the water treatment works has not yet been determined. The*

farms to the north-east and east of the Nwamitwa Dam should not be affected by the noise from these two sources.

- *Pipelines, Pump Stations and Reservoirs: As no final details of the location, position and orientation for the pump stations are available at this stage, no specific impact predictions are possible. Typically the noise impact on residences (particularly at night) and schools within 250 metres of a pump station could be significant.*

The following conclusions may be drawn from the noise impact analysis:

i) The primary source of noise impacting the respective study areas at present is from road traffic. This is likely to remain the case in the future, with the situation worsening as traffic volumes increase.

ii) The ambient noise climate at many of the areas where elements of the project are to be built can be defined as being degraded, particularly where these sites are along or close to main roads with attendant high traffic generated noise levels. The noise situation is one varying between very quiet when there is no traffic to very noisy when vehicles pass by. Noise impact thus also varies from a situation of being insignificant to one of high significance.

iii) The noise climate in the Nwamitwa Dam and Reticulation Study Area away from the main roads is relatively quiet.

iv) The noise from elements of the Project, if unmitigated, has the potential to have a negative impact on some of the noise sensitive areas surrounding the respective project sites.

v) The main impact period will be during the construction phase but noise problems are also possible during the operational phase.

vi) There are appropriate noise mitigating measures that can be implemented to reduce or prevent any noise impact during construction and operation.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

CBD	Central Business District
dBA	Decibel (A-weighted)
DWAF	Department of Water Affairs and Forestry
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GLeWaP	Groot Letaba River Water Development Project
GWW	Government Water Works
NEMA	National Environment Management Act
SABS	South African Bureau of Standards
SANS	South African National Standard
SPL	Sound Pressure Level

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 Jongens Keet Associates to undertake the Noise 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 6
(e) a description of any assumptions made and any uncertainties or gaps in knowledge	Chapter 7
(f) a description of the findings and potential implications of such findings on the	Chapter 8

impact of the proposed activity, including identified alternatives, on the environment	
(g) recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	Chapter 9
(h) a description of any consultation process that was undertaken during the course of carrying out the study	Chapter 10
(i) a summary and copies of any comments that were received during any consultation process	N/A
(j) any other information requested by the competent authority.	N/A

1.3 STUDY AREAS

The noise impact investigation focussed on the respective areas of influence (for noise) at the Tzaneen Dam Study Area and the planned Nwamitwa Dam and Reticulation Study Area (refer to **Figure 1.1).** Relevant details of the affected areas are given in **Chapter 5**.

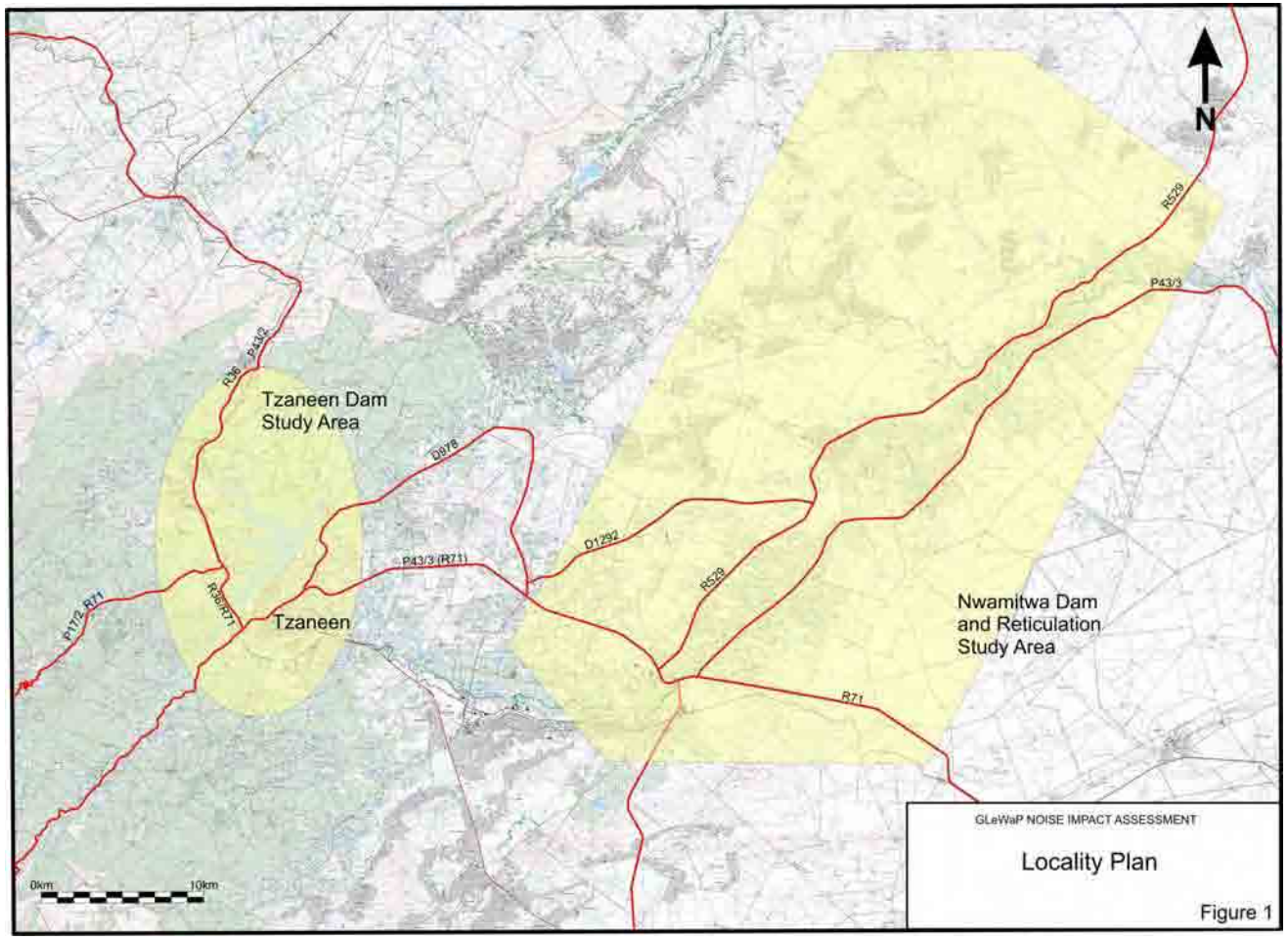

Figure 1.1: Locality PLan

2 PROJECT TEAM

Derek Cosijn of Jongens Keet Associates undertook the noise impact assessment. Derek Cosijn is a partner with Jongens Keet Associates and Calyx Environmental cc. He is a professional engineer registered with the Engineering Council of South Africa (ECSA), a Fellow of SAICE, a Member of the Southern African Acoustics Institute (SAAI) and is also certified as an Environmental Assessment Practitioner of South Africa.

He has had 40 years of professional experience over a wide range of civil engineering, transportation planning, environmental and acoustic engineering projects. He qualified as a civil engineer in 1967 and then studied further to obtain a post-graduate Diploma in Town Planning (both at the University of the Witwatersrand). He has worked in both the planning and construction aspects of the civil engineering profession gaining experience in road construction, road planning, transportation planning, traffic engineering and general environmental and environmental noise issues. He has been actively involved in numerous environmental projects since 1975, when he worked in Canada for three years. His area of special expertise is environmental noise (acoustical engineering). The environmental projects have ranged through EIAs and noise impact assessments, policy formulation and procedural guideline development. He has worked with a wide client base, ranging from the National Department of Transport, Provincial transportation/road authorities, Provincial environmental authorities, the metropolitan authorities and many local councils to private organizations. Some of the 110 odd environmental and noise impact projects with which he has been involved with over the last 10 years are the City of Tshwane Noise Management Policy, Gautrain Noise Impact Study, Tutuka Power Station Coal Supply Railway Noise Impact Assessment, Majuba Power Station Coal Supply Railway Noise Impact Assessment, Gauteng Freeway Congestion SEA Noise Impact Assessment, Petronet Multi-product Pipeline (Northern Section) Noise Impact Assessment, Matimba B Power Station Noise Impact Assessment, Olifants River Water Resources Development Project Noise Impact Assessment.

He was assisted by Dr Erica Cosijn. Erica Cosijn joined Jongens Keet Associates in October 2007. Previous employment experience includes working as an Information Specialist with consulting engineers, the CSIR and JCI and as a lecturer at the University of Pretoria. She has a Masters Degree in Philosophy (specializing in Logic), and a DPhil (Information Science). She has been involved in the following acoustics

projects: Majuba CCGT Power Station, Merensky Motocross Track, Tirisano Diamond Mine, KNP Marula Region SEA, Morupule Power Station (Botswana) and Heineken Brewery.

3 PURPOSE OF REPORT AND SCOPE OF WORK

3.1 TERMS OF REFERENCE

The terms of reference (TOR) were as follows:

i) A sufficiently detailed quantitative (by measurement) and qualitative assessment within the area of influence of the planned Groot Letaba Water Development Project (GLeWaP) (refer to **Chapter 4** and **Appendix J3** for the scope of the project) was to be undertaken in order to enable a full appreciation of the nature, magnitude, extent and implications of the potential noise impact.

ii) The level of investigation was to that of an environmental impact assessment (EIA). The analysis needed to be tailored to the situation that no final designs of the various elements of the project are available at this stage.

iii) All aspects of the investigation were to conform to the requirements of relevant environmental legislation and noise standards.

iv) The potential impacts of the pre-construction, construction and operational phases of the project were to be assessed.

v) Where relevant, appropriate noise mitigating measures were to be identified. These needed only to be conceptual at this stage.

4 DETAILS OF THE PROJECT

The project will comprise of the following components:

- The raising of the Tzaneen Dam;
- A new dam at the site known as Nwamitwa;
- A riverflow gauging weir just downstream from the Nwamitwa Dam;
- Associated relocation of roads at Nwamitwa Dam;
- Access roads to the Nwamitwa Dam;
- Upgrading of the existing Water Treatment Works just north of the Nwamitwa Dam wall site;
- Water reticulation pipelines inclusive of appurtenant infrastructure, namely pump stations and reservoirs, to the villages in the area to the north, north-east and north-west of the Nwamitwa Dam.

4.1 TZANEEN DAM

The dam wall will be raised by a maximum of 3,5m by using a labyrinth spillway, fuse-gates or a side channel spillway. The raising of Tzaneen dam will not require acquisition of additional land as the design flood level remains within the area purchased for the existing dam. The size of the downstream flood will also not be affected.

Construction facilities such as offices, workshops and stores will be required on site, and will be located within the property of the existing Government Water Works (GWW). Construction is expected to start in 2010.

4.2 NWAMITWA DAM AND WEIR

The largest component of the GLeWaP project is the proposed new dam at the site known as Nwamitwa. The dam will be located on the Groot Letaba River downstream of the confluence of the Nwandezi River. An earth fill embankment on both flanks with a central concrete spillway is envisaged. The detailed design of the dam and outlet works has not yet been completed but the structure will have an appearance similar to other composite construction type dams such as Tzaneen Dam.

The earth embankments will be protected against wave action and erosion on the upstream side by a layer of rock rip-rap. The downstream slopes will also be protected but by a layer of mainly crushed stone. The embankments are expected to have a total crest length of up to 3 000 m while the length of the concrete spillway would be about 500 m. These dimensions are subject to finalization in the detailed design phase. An outlet control structure with multiple draw-off levels will be an integral part of the concrete spillway structure and will be located on the left flank of the spillway.

Construction is expected to commence approximately in October 2009, and take 5 years to complete, with the storage of water and associated benefits expected to commence in 2012.

The site of the construction camp for the dam will be on the left bank of the Groot Letaba River, just upstream of the dam wall. The construction camp will be approximately 35.6 ha in extent excluding access roads. The site will accommodate the following:

- Concrete batching plants;
- Site Offices and Parking — comprising two office blocks (one to house the personnel of the Resident Engineer, and one to house the Site Agent and his personnel) and 20 covered parking bays per office block, and a taxi rank;
- Materials testing Laboratory;
- Workshops and Stores — approximately five buildings;
- Reinforcing Steel Bending Yard;
- Permanent Housing — Houses for two married operating personnel;
- Weather Station; and
- Sand and crushed stone Stockpile Areas — less than 450 m x 250 m with access roads (above area of inundation).

Areas for the handling of hazardous substances, an explosives storage magazine, wash bays for construction plant, radio communication infrastructure, facilities for the bulk storage and dispensing of fuel for construction vehicles, power lines, a small-scale sewage treatment plant and a temporarily licensed solid waste disposal facility will also be provided. Various temporary access roads, low level river crossings and haul roads will be required in and around the dam wall and borrow pits and quarry sites will be located within the dam basin.

Construction activities will commence with the stripping of vegetation and topsoil to establish access and construction roads, site offices, dam foundations and crusher and concrete mixer stations. Topsoil will be stockpiled for reuse during the rehabilitation stage, whilst cleared woody vegetation suitable for firewood will be stockpiled for collection by the local population for a period of time, after which it will be burnt.

Soon after commencement the river will be diverted to expose the rock foundations for the concrete spillway section. During this period, cofferdams will be constructed to protect all foundation activities in the riverbed against flood damage. Excavators, bulldozers and trucks will be engaged to remove all loose material on the foundation of the dam until rock is exposed. Blasting will be necessary.

A team specializing in quarry operations and the crushing of aggregate for concrete will be set up on site. Drill rigs will be in operation 24 hours a day. Blasting will be required, on average, every 14 days, and will be scheduled to take place only during daylight hours. A crusher will also be erected.

Sand required for the production of concrete will be collected from the identified borrow areas. Unsuitable material will be disposed of at locations to be agreed on by the Environmental Control Officer (ECO).

Concrete production at the batching plant will then commence and placement in the central spillway section, outlet works and apron areas, probably by roller compaction techniques and the use of high tower and mobile cranes, will occur 24 hours a day, seven days a week. Earth embankments will be constructed on both banks by compacting material hauled in by large trucks from the borrow areas upstream of the dam.

The temporary site administrative buildings will be erected complete with security fencing, a water supply, sewage purification plant and an electric overhead supply line.

After construction activities have been completed, estimated to be in 2013, all the crushers, mixers and site offices, etc. will be removed and the construction site rehabilitated. All temporary access roads and other hard surfaced areas will be ripped and covered with topsoil and planted with suitable grass and tree cover. The aim is to return the whole construction site as close as possible to its original appearance. Areas that are inundated by water in the dam will be shaped to accommodate storm runoff and no grass will be planted.

Two permanent houses will be erected within the project area to accommodate operation and maintenance staff.

The labour force for construction of the proposed dam will be approximately 300. Approximately 50 people will be skilled workers and be housed with their families in Letsitele. 200 workers will be recruited locally and. approximately 100 of these workers will acquire a new skill by the end of this project. The remaining 50 workers will be experienced in dam construction and will be transferred from elsewhere and be housed at Letsitele in single quarter's accommodation.

The proposed borrow area for the earthfill material is on the right flank (looking downstream) immediately upstream of the embankment. Two potential borrow areas for filter materials and concrete sand have been identified in the Merekome River on the farm Letaba Drift and in the Phatle/Lerwatlou River on the farm La Parisa. Authorisation of the borrow areas from the Department of Minerals and Energy Affairs is being applied for as a concurrent process to the EIA.

Coarse aggregates for concrete and rock for the rip-rap and rock toe zones of the embankment will be sourced from existing permitted quarries or commercial sources.

A new flow-measuring weir will be required downstream of the new dam in order to measure the flow that is released from the dam. The exact location of the weir has not yet been determined, but will be fairly close to the dam wall (downstream side). The weir will take about three months to construct and will be a low concrete structure with erosion control measures on both banks to prevent out-flanking. It is envisaged that the construction of the weir will form part of the dam construction contract.

4.3 ROADS

Main Roads

Sections of Road P43/3 and Road R529 will require re-alignment to accommodate the proposed dam. There is only one alternative alignment considered for Road P43/3. There are three alternative alignments being considered for Road R529 (Refer also to **Figure 4.1**):

- Alternative 1: The new road will deviate westwards from the existing R529 alignment approximately 5km north of the intersection with Route R71 up to Road D1292, where it turns eastward to follow the alignment of the latter for 1km where it deviates northwards again to link with the existing Road R529 alignment 1km south of Ka-Malubana Village.
- Alternative 2: The new road will deviate westwards from the existing R529 alignment approximately 5km north of the intersection with Route R71 up to Road D1292 (same as Alternative 1), where it turns directly northwards for approximately 3km, it then turns eastwards to link with the existing alignment of Road R529 just south of Ka-Malubana Village.
- Alternative 3: The new road will deviate westwards from the existing R529 alignment approximately 5km north of the intersection with Route R71 and will be aligned in a westerly direction up to Road D1292.

The re-alignment would require the construction of at least two major bridges and the upgrading of two existing bridges. The road design will be very similar to the existing roads, which are of a high standard, as well as be constructed using the same material. The road pavement will be designed to accommodate normal traffic flow.

Construction of the roads will take place only during the daytime.

Internal Roads and Constriction Site Access Roads

The exact positions of the required access roads to the construction sites and the on-site roads at the dam and appurtenant works have not yet been identified.

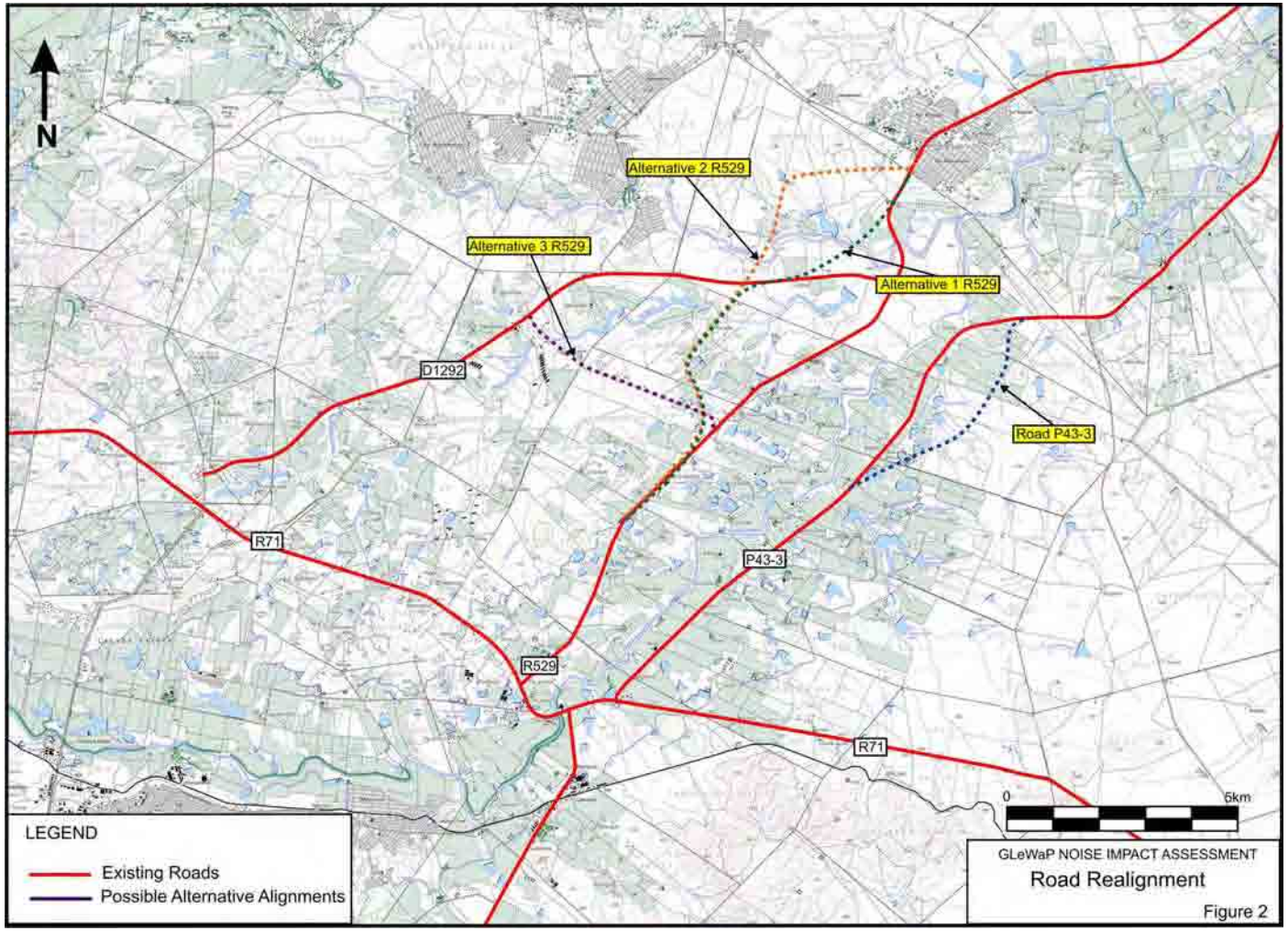

Figure 4.1: Road re-alignment

4.4 WATER TREATMENT WORKS

At present the Nkambako Water Treatment Works, which is located just south-east of Ka-Malubana Village, draws water from the Groot Letaba River about 1 km downstream from the Nwamitwa Dam site. The existing facility is to be expanded. After completion of the project, water will be abstracted from the dam and treated at the existing and new treatment works extensions located adjacent to the existing works. The existing run of river abstraction will be abandoned.

4.5 PIPELINES, PUMP STATIONS AND RESERVOIRS

Pipelines

Bulk water distribution pipelines will be constructed to augment potable water supplies in the various existing supply zones. The bulk distribution infrastructure from the treatment works will be optimised during the detailed design phase and the final configuration and sizing is not known at this stage. It is envisaged that new pipelines will be located adjacent to existing pipelines or along road reserves. Some sectors of pipeline will traverse open land. A ten metre wide strip would be impacted during construction.

Construction of the pipelines will commence with pipes being laid out along the pipeline routes and trenches up to 3,5 m deep and 2,5 m wide for the largest of the pipes being excavated. Under normal circumstances a maximum of 5 km of open trench is permitted, whilst the pipes will be strung out as they arrive from the manufacturer. Excess spoil material from the trenches will be transported to a suitable disposal site and sandy material will be brought in as selected backfill for pipe protection. Once the pipes have been laid and tested, the trench will be backfilled, compacted and shaped to the natural ground profile. Topsoil will be replaced to re-establish vegetation.

Pump Stations

Currently 4 booster pump stations are envisaged along the pipeline routes although the exact number and position will only be determined during the detail design stage. The following areas are being considered as possible sites:

- Between Ga-Mookgo Village (east) and Ga-Mookgo Village (west).

- Between Ga-Maakgo Village (west) and Ga-Moloko Village.
- Between Mawa Village and Hlohlokwe Village (the area demarcated is immediately adjacent to Hlohlokwe Village).
- On alternative pipeline route south of Hlohlokwe Village.

An area of approximately 1 – 2 ha will be fenced for each pump station. No balancing dams are envisaged. Construction of a single pump station will take approximately 24 months.

A new raw water pump station will be constructed to pump water to the Water Treatment Works.

Reservoirs

Although the reservoirs associated with the pipelines may differ according to their individual capacity and local topography, the technical details will be similar for each. Four new reservoirs are being considered at ten alternative sites within close vicinity to the following villages (See **Figure 4.2**).

- Sorolorole (Reservoir A);
- Babanana (Reservoir B);
- Mothomeng (Reservoir C1 and C3);
- Hlohlokwe (Alternative Reservoir C1 and C2)
- Mabyepelong (Reservoir C2); and
- Gamokgwathi (Reservoir D1, D2 and D3).

It is anticipated that construction will only take place during the day.

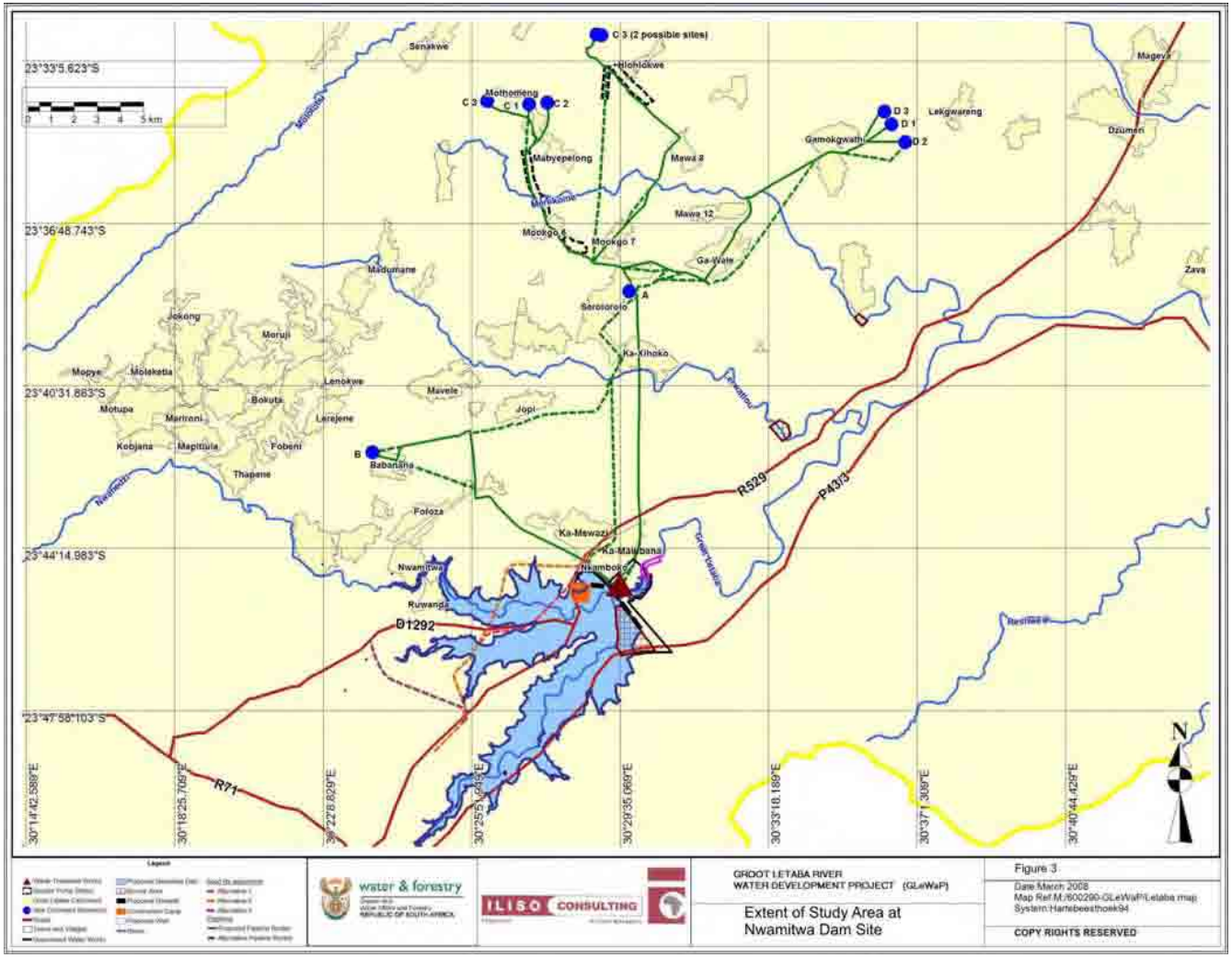

Figure 4.2: Extent of Study area at site known as Nwamitwa

5 THE DETAILS OF THE STUDY AREAS

Only the details that have an influence on aspects of the noise impact assessment are identified and analysed.

5.1 TOPOGRAPHY

The Greater Tzaneen Local Municipality area is characterised by mountainous, inaccessible terrain in the west and south, and even topography (gentle slopes) to the north and east. The Greater Letaba, Greater Giyani and Ba-Phalaborwa municipal areas are flatter than the rest of the study area. The Groot Letaba River is a major feature in both of the Study Areas.

5.2 ROAD SYSTEM

The respective study area(s) are well serviced by a provincial road network.

The main roads involved in the Tzaneen Dam Area are:

i) Section 1: Road P43/3 (Route R71) just west of Road D978 (Deerfield Road)
ii) Section 2: Road P43/2 / Road P17/3 (Route R71/Route R36) between Road P17/2 (Route R71) and Road D528.
iii) Section 3: Road P17/2 (Magoebaskloof Road) (Route R71) just west of Road P43/2 / Road P17/3.
iv) Section 4: Road P43/2 (Modjadjiskloof Road) (Route R36) north of Road P17/2 (Magoebaskloof Road).
v) Section 5: Road D978 (Deerfield Road) just north of Road P43/3 (Route R71).

The main roads in the Nwamitwa Dam and Reticulation Study Area are:

i) Section 6: Road P43/3 (Route R71) west of Road R529.
ii) Section 7: Road P43/3.
iii) Section 8: Road R529 north of the intersection with D1292.
iv) Section 9: Road R529 south of the intersection with D1292.
v) Section 10: Road D1292.

The area for reticulation to the north, north-east and north-west of the dam wall is largely characterised by a network of gravel roads that link the scattered villages. Most of these roads seem to be poorly maintained.

5.3 LAND USE

The existing land uses in the areas adjacent to the Tzaneen Dam Study Area are as follows:

i) Residential

a) The area in the river valley south of Tzaneen Dam is presently being intensively developed with housing estates.

b) Residential township of Aqua Park lies to the south-west of the dam wall and follows the frontage of the dam.

c) DWAF houses lie just to the north of the dam wall.

d) Farm houses on the western and northern banks of the dam.

ii) Educational: Merensky High School lies directly west across the dam.

iii) Retail/Commercial: Tzaneen CBD lies 3km to the south of the dam wall.

iv) Agricultural: There are farms to the east and north-east of the dam wall and on the western and northern banks of the dam.

v) Recreational: Tzaneen Dam Nature Reserve lies on the western side of the Tzaneen Dam.

There is no information on future developments in the respective study areas, but it may be anticipated that the housing estates will continue to develop in the area east of the dam.

The existing land uses in the areas in the Nwamitwa Dam and Reticulation Study Area are as follows:

i) Residential

a) There are several farmhouses and farm labourer residences in the southern part of the study area along the Groot Letaba River.

b) There are some twenty formal villages in the proposed reticulation area to the north, north-east and north-west of the proposed dam.

ii) Educational: There are several schools in the villages.

iii) Agricultural: There are several farms in the area straddling the Groot Letaba River.

iv) Recreational: There are three Nature Reserves in the close vicinity of the Study Area, but these are not directly affected by the planned water resources project.

There is no information on the future developments in the respective study areas but it may be anticipated that the formal villages will continue to develop and will expand.

The residential, educational and nature reserve land uses may be classified as being "noise sensitive".

5.4 RAILWAY LINES

The main Makhado-Tzaneen-Kaapmuiden railway line runs just to the west of the Tzaneen Dam, and to the south of Road R71 (just south of the planned Nwamitwa Dam).

5.5 ASPECTS OF ACOUSTICAL SIGNIFICANCE

The main meteorological aspect that will affect the transmission (propagation) of the noise is the wind. The wind can result in periodic enhancement downwind or reduction upwind of noise levels. Analysis of the wind records for the area indicates that the main prevailing winds blow from the north-eastern quadrant (32%). Approximately 38% *still* periods are experienced annually. The wind directions will be modified by the orientation of the hills and valleys in the respective area.

6 METHODOLOGY

6.1 GENERAL

The general procedure used to determine the noise impact was guided by the requirements of the South African National Standard (SANS) 10328:2003: *Methods for Environmental Noise Impact Assessments.* The level of investigation was the equivalent of an Environmental Impact Assessment (EIA) of the situation. The noise impact criteria used specifically take into account those as specified in the South African National Standard SANS 10103:2004, *The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and Speech Communication* as well as those in the National Noise Control Regulations. Note that the Limpopo Province has not yet promulgated its Noise Control Regulations.

The investigation comprised the following:

i) Determination of the existing situation (residual noise climate).

ii) Determination of the situation during and after construction.

iii) Assessment of the change in noise climate induced by the project and its impact during each phase.

iv) Identification of mitigating measures.

6.2 DETERMINATION OF THE EXISTING CONDITIONS

This phase comprised the following:

i) The relevant technical details of the project and the existing and planned land uses adjacent to the various elements were reviewed in order to establish a comprehensive understanding of all aspects of the project that will influence the future noise climate in the respective Study Areas.

ii) Using these data, the limits of the respective Study Area were determined and the potential noise sensitive areas, other major noise sources and potential problems in these areas were identified.

iii) Applicable noise standards were established. The National Noise Control Regulations, and the SANS 10103:2004 standards were applied.

iv) The existing *noise climates* of the respective study areas were determined by means of a field inspection and a noise measurement survey. The measurement survey appropriately covered both Study Areas, focussing specifically on the identified noise sensitive/problem areas. Measurements were taken at sixteen monitoring sites. Both the daytime and night-time conditions were measured. The sound pressure level (SPL) (noise) measurements were taken in accordance with the requirements of the Code of Practice SANS 10103:2004, *The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and to Speech Communication*. Type 1 Integrating Sound Level Meters were used for the noise measurements. All measurements were taken under dry weather and normal traffic (that is mid-week/school term) conditions. Refer to **Appendix I2**.

v) At the same time as each individual measurement was being taken, the qualitative nature of the *noise climate* in the area of the measurement site was assessed and recorded. This comprised an appraisal of the general prevailing acoustic conditions based on the subjective response to the sounds as perceived by the listener (i.e. *auditory observation* by the surveyor), as well as identifying those noise incidents which influenced the noise meter readings during that measurement period. This procedure is essential in order to ensure that that there is a *human* correlation between the noise as perceived by the human ear and that which is measured by the meter, as well as to establish any anomalies in the general ambient noise conditions.

vi) The noise generated by the main roads was also calculated to establish 24-hour noise descriptors. The existing noise climate as related to the current traffic volumes and patterns on four main roads was established. Traffic noise levels were calculated using the South African National Standard SANS 10210 (SABS 0210) *Calculating and Predicting Road Traffic Noise* for Route. The Year 2007 traffic was used as the baseline reference. Refer to **Appendix I2** for details.

vii) The baseline noise profile of pump stations typical to those being considered for the project was established from measurements at the Clapham pump station on

the Lebalelo pipeline and the Politsi Purification Scheme Final Water Pump Station.

viii) The baseline noise profile of dam outlet discharge was established from measurements at the Tzaneen Dam and the Flag Boshielo Dam.

6.3 ASSESSMENT OF PLANNING/DESIGN PHASE IMPACTS

Aspects of the pre-design field surveys and activities that potentially will have a noise impact were identified and where appropriate mitigating measures have been recommended.

6.4 ASSESSMENT OF CONSTRUCTION PHASE IMPACTS.

Aspects of the construction activities that potentially will have a noise impact were identified and where appropriate mitigating measures have been recommended. Although the exact details of the construction, that is the *modus operandi* and equipment, are not known at this stage, standard procedures and typical conditions were used to calculate the likely noise climate. A worst case scenario approach was used. Refer to **Appendix J3**.

6.5 ASSESSMENT OF OPERATIONAL PHASE IMPACTS

The main focus of the operational phase assessment was to establish the nature, magnitude and extent of the potential change in *noise climates* in the respective study areas directly related to and within the area of influence of the planned project elements. Consideration has been given mainly as to how residences and educational facilities within the area of influence of the project as well as users of adjacent facilities will be affected. Operational conditions were established as follows:

i) Tzaneen Dam. The baseline outflow condition noise (water discharge from valves into the stilling pond) was used to calculate the impact by applying the method specified in the South African National Standard SANS 10357 (SABS 0357), *Calculation of Sound Propagation by means of the Concawe Method*.

ii) Nwamitwa Dam. The baseline outflow condition noise (water discharge from valves into the stilling pond) was used to calculate the impact by applying the

method specified in the South African National Standard SANS 10357 (SABS 0357), *Calculation of Sound Propagation by means of the Concawe Method*.

iii) Water Purification Works and Pump Station. The predicted noise and impact was based on reference measurements taken at the Tzaneen Dam Water Purification Plant.

iv) Re-aligned sections of Roads R529 and P43/3. The future traffic related noise levels for the Year 2012 (anticipated commissioning date) were calculated using the South African National Standard SANS 10210. These data were used to determine impact on the adjacent areas.

v) Pipelines. The operation of the pump stations will be the main element of noise generation along the pipelines during this phase. The baseline pump station noise was based on the Clapham pump station and the Politsi Purification Scheme Final Water Pump Station noise profiles. These were used to calculate the impact by applying the method specified in the South African National Standard SANS 10357.

vi) A conservative approach was taken, that is the likely *worst condition* scenario (related to all the noise generation and attenuation factors) was modelled in all calculations.

vii) The predicted noise levels and the altered ambient noise condition (inclusive of both the quantitative and qualitative condition) were then reviewed to assess the nature, magnitude and extent of the noise impact as related to appropriate maximum noise zone (land use) standards.

viii) The final details of some of the elements of the project are not known at this stage. Where this was the case, a *worst scenario* approach was taken in the analysis of impact.

ix) Based on the findings, appropriate noise mitigating measures have been investigated and recommendations made. These are conceptual and not detailed to final design level.

6.6 SIGNIFICANCE RATING

The following criteria were used to evaluate significance:

Nature

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

Extent and location

Magnitude of the impact was 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 was 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 was 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 was 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 was 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 was determined. This is the importance of the impact in terms of physical extent and time scale, and was 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 were also considered.

Mitigation

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

7 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

In interpreting the study findings it is important to note the limitation and assumptions on which the assessment was based. The most important limitations and assumptions of the noise impact assessment were as follows:

i) The exact modus operandi for and equipment to be used during the construction works at the Tzaneen Dam and the Nwamitwa Dam and Weir are not yet available and typical conditions have been estimated on works at similar sites.

ii) The exact position of reservoirs and pump stations has not yet been finalised and the noise impact from these construction areas had to be estimated.

iii) The details of the volume of traffic generated by the various construction sites are also not available and estimates had to be made.

iv) The type of pumps at the new draw-off point (Nwamitwa Dam) and at the pump stations along the pipeline routes, and the position of these pump stations has not yet been finalised. Possible conditions had to be estimated based on noise measurements at similar type facilities.

8 FINDINGS AND ASSESSMENT OF IMPACT

The following conditions were observed in the respective study areas and the following aspects were determined from the noise surveys, calculations and the predictive modelling undertaken for the assessment of the noise impact of the planned GLeWaP works.

8.1 GENERAL ASPECTS

General aspects of note were as follows:

i) The weather conditions on the survey days were such that the measurements to establish the ambient noise levels were not adversely affected and no specific corrective adjustments needed to be made.

ii) There are a large number of noise sensitive areas/land uses (mainly residences/residential areas and schools) that have the potential to be adversely affected by elements of the project. This applies to both study areas. Refer to **Chapter 5.3**.

8.2 THE EXISTING AMBIENT NOISE CLIMATE

The findings related to the existing conditions are based on the measurements and *auditory observations* taken at 16 main sites covering the two study areas. For details about the noise measurement procedure and description of the noise measurement sites, refer to **Appendix I2** and **Figures B1** and **B2.** Conditions for the daytime and evening periods were ascertained. The summary of the noise measurements, which were taken at the various sites are given in **Tables B3** and **B4** in **Appendix I2**. The equivalent sound pressure (noise) level (L_{Aeq}), the maximum sound pressure level (L_{Amax}) and the minimum sound pressure level (L_{Amin}) are indicated. Note that the equivalent sound pressure (noise) level may, in layman's terms, be taken to be the average noise level over the given period. This "average" is also referred to as the residual noise level (excluding the impacting noise under investigation) or the ambient noise level (if the impacting noise under investigation is included). The measured data also provide an indication of the variability of the sound content, namely the variation between the maximums and minimums.

The present (Year 2007) effect of the traffic-generated noise along the main roads in the two study areas is given in **Tables B5** and **B6** in **Appendix I2**.

8.2.1 Prevailing Noise Climate in the Tzaneen Dam Study Area

In overview, the existing situation with respect to the existing *noise climate* in the study area was found to be as follows:

i) The main sources of noise in the area are from:

- Traffic of the main roads.
- Tzaneen Dam water purification works.
- Power boats on the Tzaneen dam.
- Railway line to the west of the Tzaneen Dam.

ii) The existing *noise climate* alongside the main roads is degraded with regard to residential living (using 40dBA as the night-time impact criterion). Residences in some areas are negatively impacted from traffic noise (particularly at night) for up to the following distances from these roads:

Section of Road	**Offset Distance**
Section 1: Road P43/3 (Route R71) just west of Road D978 (Deerfield Road).	500m
Section 2: Road P43/2 / Road P17/3 (Route R71/Route R36) between Road P17/2 (Route R71) and Road D528.	1000m
Section 3: Road P17/2 (Magoebaskloof Road) (Route R71) just west of Road P43/2 / Road P17/3.	250m
Section 4: Road P43/2 (Modjadjiskloof Road) (Route R36) north of Road P17/2 (Magoebaskloof Road).	800m
Section 5: Road D978 (Deerfield Road) just north of Road P43/3 (Route R71).	250m

iii) The residual (existing background) noise levels are relatively low (quiet) in the existing and developing residential areas to the south and east of the Tzaneen Dam wall. Daytime ambient conditions range from about 45dBA to 57dBA. Early evening conditions fall in the range of 54dBA to 57dBA, while the night-time ambient levels will fall to about 40dBA. These are acceptable suburban residential conditions (SANS 10103).

iv) The noise climates at the farmhouses at the western and northern sides of the dam are relatively quiet.

v) The residual noise levels at the Merensky High School fall within the limits recommended in SANS 10103.

8.2.2 Prevailing Noise Climate in the Nwamitwa Dam and Reticulation Study Area

In overview, the existing situation with respect to the existing *noise climate* in the study area was found to be as follows:

i) The main sources of noise in the area are from:

- Traffic on the main roads.
- Nkambako Water Treatment Works.
- Pump on the Groot Letaba River feeding the Nkambako Water Treatment Works.
- Noise from cicadas dominated at Sites 9 and 12, and had a significant influence on the noise levels at Site 8 as well. This was the situation during both day-time and night-time measurements. This is considered to be a seasonal condition in the normal rural climate. Without the noise from the cicadas, the noise climate will be relatively quiet.

ii) The existing noise climate alongside the main roads is degraded with regard to residential living (using 40dBA as the night-time impact criterion). This is an anomalous situation in that many of these areas are normally very quiet (rural conditions) when there is no traffic on the road but are significantly impacted when traffic passes by. There is a significant variation between the no traffic condition background noise level and each “single event” maximum noise level

as a vehicle passes. Noise levels varying between 35dBA and 80dBA can be experienced close to the respective roads. Residences in some areas are negatively impacted from traffic noise (particularly at night) for up to the following distances from these roads:

Section of Road	**Offset Distance**
Section 6: Road P43/3 (Route R71) west of Road R529.	500m
Section 7: Road P43/3.	100m
Section 8: Road R529 north of the intersection with D1292 (in KwaMalubana Village)	320m
Section 9: Road R529 south of the intersection with D1292	300m
Section 10: Road D1292.	500m

iii) The residual (existing background) noise levels are relatively low (quiet) in the areas that are not close to and are relatively shielded from the main roads. Daytime ambient conditions range from about 41dBA to 54dBA. Night-time conditions will tend to fall to between 30dBA and 35dBA. In general the conditions on the farms and villages in the area meet the acceptable standards as per SANS 10103.

For more details of the existing conditions refer to **Section B5.3** in **I2B**. The applicable acceptable noise levels (standards and impact criteria) are as prescribed by SANS 10103:2004 as indicated in **Appendix I1**.

8.3 ASSESSMENT OF THE PRE-CONSTRUCTION PHASE

Activities during the planning and design phase that have possible noise implications in the Tzaneen Dam Study Area are possible concrete core testing on the spillway.

Activities during the planning and design phase that have possible noise implications in the Nwamitwa Dam and Reticulation Study Area are those related to field surveys

(such seismic testing and geological test borehole drilling) mainly at planned building, bridge and other major structure sites. Although some of these activities such as the drilling operations can be noisy, a major disturbance is generally unlikely in an area as these activities are of short duration at any one site and normally take place during the day. Drilling activities near schools will cause minor problems.

8.4 ASSESSMENT OF THE CONSTRUCTION PHASE

8.4.1 General

By its very nature the construction phase will be noisy and has the potential for causing a noise disturbance or nuisance. The construction details of the various elements of the project, as presently known or as realistically estimated are documented in **Chapter 4** and **Section C3** of **Appendix I3**.

8.4.2 Noise Impact at the Tzaneen Dam

It has been assumed that at this site construction will take place only during the day-time.

iv) Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over any working period.

v) Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme, work modus operandi and type of equipment have not been finalised. From present information available, ambient noise levels during the daytime period at the nearest houses to the dam wall, namely the DWAF houses at the north-eastern side of the dam wall, the residences in the Tzangeni and Golden Acres Security Estates to the south-east of the dam wall and the farmhouses on the western and northern sides of the dam should not exceed 50dBA. Thus, no noise disturbance effects are predicted. Working on a worst case scenario basis, it is estimated that the maximum instantaneous noise levels from general construction operations should not exceed 72dBA at the nearest houses to the dam wall. The residual noise levels

are fairly quiet at these residences and thus there are likely to be noise nuisance effects from individual incidents from the construction in these residential areas.

vi) The Merensky High School on the western side of the dam will not be affected by the noise from the construction noise from the dam during the day. The school has residences and any night-time construction could have sleep disturbance effects at the dormitories. The school area is already impacted by the noise from traffic on the dual carriageway road to the west of the dam.

vii) Construction workers working with or in close proximity to equipment will be exposed to high levels of noise as can be seen from **Table C1** of **Appendix I3** (refer to the 5 metre offset noise levels).

viii) There will be an increase in traffic (mainly delivery vehicles) on the main routes into the area, but the volumes are unlikely to raise the ambient noise levels along the roads.

It should be noted that for residential areas, higher ambient noise levels than recommended in SANS 10103 are normally accepted as being reasonable during the construction period, provided that the very noisy construction activities are limited to the daytime and during the week, and that the contractor takes reasonable measures to limit noise from the work site. Note that it has been assumed that construction will generally take place from 07h00 to 18h00 with no activities (or at least no noisy construction activities) at night. From the details presently available, it appears that the construction noise impact is not likely to be too severe in the residential areas near to the dam wall. Refer to 8.4.2 (ii) above.

8.4.3 Noise Impact at the Nwamitwa Dam and Weir

i) There will be a significant noise impact from the construction activities at the dam on the Ka-Malubana and Ka-Mswazi Villages north of and the farms to the north and east (Deeside 733-LT) of the dam wall, particularly from the night-time construction activities.

ii) Source noise levels from many of the construction activities will be high (refer to Table C1 in Appendix J3). Noise levels from all work areas will vary constantly and in many instances significantly over any working period.

iii) Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme, work *modus operandi* and type of equipment have not been finalised. From present information available, *ambient* noise levels during the daytime period at the nearest houses to the dam wall, namely the residences in Ka-Malubana Village at the northern side of the dam wall (200m offset), should not exceed 54dBA. The residual noise levels in the village are approximately 45dBA during the day and 40dBA at night. Thus, no noise disturbance effects are predicted during the day, but significant noise impact is anticipated at night.

iv) Working on a worst case scenario basis, it is estimated that the maximum instantaneous noise levels from general construction operations could be of the order of 74dBA at the nearest houses to the dam wall in Ka-Malubana Village. The residual noise levels in the village and on the surrounding farms are fairly quiet and significant noise nuisance effects and noise disturbance effects are anticipated from the construction in these residential areas.

v) The main impact from the construction phase on the Ka-Malubana Village will be from the quarrying operation, namely from the rock drills and the crusher. When the quarrying operations are closest to the Village (estimated offset of 250 metres) ambient noise levels could be of the order of 79dBA (dependent on the number of rock drills). The residual noise levels in the village are approximately 45dBA during the day and 40dBA at night. The noise impact will be significant. The impact from blasting at the aggregate quarry, however, is likely to be minimal on residents in the area, provided that blasting is restricted to the day-time. Blasting is anticipated only once every two weeks and will be limited to the daytime.

vi) Construction workers working with or in close proximity to equipment will be exposed to high levels of noise as can be seen from **Table C1** (refer to the 5 metre offset noise levels).

vii) There will be an increase in traffic (mainly delivery vehicles) on the main routes into the area, but the volumes are unlikely to raise the ambient noise levels along the roads. Night-time traffic could cause nuisance problems at some of the noise sensitive sites along the main roads into the area of the dam.

viii) The position of the access roads to the construction site has not yet been defined. Although the volumes of construction site generated traffic are not expected to be high, noise from site traffic could be a problem, depending on the location of these roads relative to the Ka-Malubana Village and farmhouses.

It should be noted that for residential areas, higher ambient noise levels than recommended in SANS 10103 are normally accepted as being reasonable during the construction period, provided that the very noisy construction activities are limited to the daytime and during the week, and that the contractor takes reasonable measures to limit noise from the work site. Construction activities, however, will take place on a 24-hour, 7 day a week basis and therefore significant impacts are anticipated in the village and on some of the farms

8.4.4 Noise Impact for Road Construction

The nature of the noise impact from the road construction site is likely to be as follows:

i) The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

ii) As no specific construction details or possible locations of major ancillary activity sites are available at this stage, the anticipated noise from various types of construction activities cannot be calculated accurately. In general at this stage, it can be said that the typical noise levels of construction equipment at a distance of 50 metres lie in the range of 65 decibels (dBA) to 75dBA. Refer also to **Table C1** in **Appendix I3**. Based on data from similar "linear" construction sites, a one hour equivalent noise level of between 75dBA and 78dBA at a point 50 metres from the construction would be typical for the earthmoving phase. The reconstruction of these roads is in the farming areas where ambient noise levels during the day are normally of the order of 40-50dBA.

iii) All three alternatives for the re-alignment of Road R529 (Alternatives 1, 2 and 3) will now be routed close to a number of farmhouses. Alternatives 1 and 2 affect the Farm Riverside 514-LT and Alternative 3 affects residences on La Gratitude

513-LT and on Taganashoek 465-LT. There are more noise sensitive sites along Alternative 3 than on the other two. The re-alignment of Road P43/3 to the east of its existing alignment will place the new road relatively close to farm worker residences on the farm Nagude 517-LT. As construction is likely to take place during daytime, no major noise impact is anticipated at these residences.

iv) The impacts in any one area will be relatively short-term as the construction activities progress along the route.

v) The noise levels generated from the bridge construction sites will be of the order of that indicated in **Table C2** in **Appendix I3**.

vi) There is likely to be noise impact from trucks on routes to and from the various borrow sites and spoil sites.

8.4.5 Noise Impact related to Water Treatment Works

i) The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

ii) Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme, work modus operandi and type of equipment have not been finalised. Working on a worst case scenario basis, it is estimated that the maximum instantaneous noise levels from general construction operations could be of the order of 70dBA at the nearest houses to the treatment works in Ka-Malubana Village. The residual noise levels in the village are approximately 45dBA during the day and 40dBA at night. The noise from this site will be dominated to a large extent by the noise from the construction at the dam area and aggregate quarry, but will have a minor cumulative effect on the noise levels from the various construction sites.

8.4.6 Noise Impact related to Pipelines, Pump Stations and Reservoirs

The noise sensitive areas/sites that could be impacted by noise along the whole length of the respective pipeline routes are mainly residential land uses. There are

also a number of schools that are potentially affected. The nature of the noise impact from the construction activities on nearby noise sensitive areas/sites is likely to be as follows:

i) The noise level and character of the noise will vary along the project route dependant on the type of construction activity. For example, the noise from a section where only a pipeline is being laid will differ from a site where a valve box or a road crossing is also being constructed.

ii) Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over short periods during any day working period. The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

iii) Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme, work modus operandi and type of equipment have not been finalised. Typical ambient noise conditions from a small construction site are as indicated in **Table C2** (**Appendix I3**). These general noise levels are more representative of the sites where concreting operations also take place. For more specific plant/equipment related noise levels refer to **Table C1** (**Appendix I3**).

iv) If discrete sections of pipeline are completed at a time (namely excavation, laying and backfilling), the duration of the noise impact will be short-term.

v) The construction times for the pump stations and reservoirs could extend over several months with attendant variable noise impact.

vi) The noise sensitive sites closest to the roads (where the pipelines are laid in the reserve) will be affected the most by the construction noise. If construction activities are contained to the daytime, the impact conditions at residences will not be that severe.

vii) Schools close to the pipeline routes will be adversely affected.

8.5 ASSESSMENT OF THE OPERATIONAL PHASE

8.5.1 Tzaneen Dam

i) The only sources of noise during the operational phase will be:

- Water outflow from the dam outlet works valves into the stilling basin.
- Routine maintenance work on the dam infrastructure.

ii) In addition, the general noise climate of the area will also be influenced by:

- Traffic on the main roads.
- Power boats on the Tzaneen Dam.
- Tzaneen Dam water purification works.
- Rail traffic on the line to the west of the Tzaneen Dam.

iii) No change in the general noise climate is anticipated from the alterations to the dam wall.

iv) No noise disturbance is anticipated from the sound of constant outflow of dam water into the stilling basin due firstly to the character of the sound (namely a waterfall sound) and secondly due to the distance attenuation of the sound. The alterations to the dam will not affect the general pattern of outflow into the stilling basin. The noise from the outflow of water was measured at 83.6dBA at 15m from the flume, reducing to 65.2dBA at 60m from the flume. This noise level is likely to be of the order of 50dBA at a distance of 500 metres from the dam wall.

v) Maintenance works are unlikely to have an impact on the area as these will be at relatively long term intervals and will be contained to the daytime.

8.5.2 Nwamitwa Dam and Weir

i) The only sources of noise during the operational phase will be:

- Water outflow from the dam outlet works valves into the stilling basin.

- Routine maintenance work on the dam infrastructure.

ii) In addition, the general noise climate of the area will also be influenced by:

- Traffic on the main roads.
- Nkambako Water Treatment Works (expanded works).
- Pump station at the dam for feeding the water purification works.

iii) No noise disturbance is anticipated from the sound of constant outflow of dam water into the stilling basin due firstly to the character of the sound (namely a waterfall sound) and secondly due to the distance attenuation of the sound. Baseline noise measurements indicate that this noise level is likely to be of the order of 50dBA at a distance of 500 metres from the overflow section of the dam wall. The "noise" at the nearest residences will be of the order of 40dBA.

iv) Maintenance works are unlikely to have an impact on the area as these will be at relatively long term intervals and will be contained to the daytime.

v) The noise from water flowing over the weir will be of a nature that will have no impact.

vi) No major change in general noise climate is anticipated from the operations at the dam.

8.5.3 Roads

i) Sources of noise during the operating phase will be:

- General traffic.
- Routine road maintenance activities.

ii) Existing noise levels close to the main roads in the Tzaneen Dam Study Area and the Nwamitwa Dam and Reticulation Study Area are already high for residential land use and particularly at night. The situation of these "noise degraded" areas will continue to worsen with the general growth of traffic through the study area.

iii) The main impact from traffic noise will be on the realigned sections of Road R529 and Road P43/3 (see **Section C3.4.1** in **Appendix J3**). Specifically on the realigned section of Road R529 there are a number of farm houses that will be within 500m of the realigned sections of the road and where the noise level will exceed the 45dBA ($L_{R,dn}$) allowable.

iv) The character (qualitative aspect) of the traffic noise will be as follows:

a) Where the traffic is travelling at high speed, the main noise component will be that of high frequencies generated by the interaction between vehicle tyres and the road surface.

b) Where there are long steep grades and heavy vehicles on the upgrade slow down, low-frequency mechanical noise becomes more evident. There may also be mechanical noise from the heavy vehicles on the downgrade using their air-brakes. This will be a minor component on the re-aligned road.

c) There will also be a difference in the sound from continuous flow traffic versus the passing of single vehicles. The noise from continuous flow traffic tends to form a "background" of noise while, when general traffic flows are low, the noise from a single vehicle can be found to be rather intrusive. This is particularly so at night.

8.5.4 Water Treatment Works

i) The main sources of noise during the operational phase are anticipated to be:

- The expanded water treatment works.
- Extraction-pump station at the dam.

ii) The expanded water treatment works could generate noise levels of about 51dBA at 500m. The residual noise levels in the village are approximately 45dBA during the day and 40dBA at night. Residences in the southern sector of Ka-Malubana Village will be adversely affected by the noise from the works, particularly at night.

iii) The exact position of the extraction pump station for the water treatment works has not yet been determined. Conservatively it is estimated that the noise from these pumps could also be of the order of 50dBA at 500m. Residences in Ka-Malubana Village will be adversely affected by the noise from the works, particularly at night.

iv) The farms to the north-east and east of the Nwamitwa Dam should not be affected by the noise from these two sources.

8.5.5 Pipelines, Pump Stations and Reservoirs

i) The main sources of noise during the operational phase of the pipelines will be:

- The pump stations.
- Water hammer in the pipelines when the pumps are switched on.
- Routine maintenance.

ii) As no final details of the location, position and orientation for the pump stations are available at this stage, no specific impact predictions are possible. Typically the noise impact on residences (particularly at night) and schools within 250 metres of a pump station will be significant.

iii) Noise from water hammer effects, namely the noise caused by the pressure surges in the pipeline from the water when the pumps are started is unlikely to have any significant effect on people living and working along the pipelines, as there will be relatively few such occurrences due to the planned continuous pumping operation.

iv) Maintenance works are unlikely to have an impact on the areas along the pipelines as these activities will be at relatively long term intervals and will be contained to the daytime.

v) No noise impacts are anticipated from the reservoir sites.

8.6 ASSESSMENT OF IMPACT SIGNIFICANCE

The impacts identified for the construction and operational phases of the project both without and with the identified mitigating measures have been summarised in general in table format. The tables are:

i) Table 8.1: The Impact Significance Rating for the Tzaneen Dam.
ii) Table 8.2: The Impact Significance Rating for the Nwamitwa Dam and Weir.
iii) Table 8.3: The Impact Significance Rating for the Quarry at the Nwamitwa Dam.
iv) Table 8.4: The Impact Significance Rating for the Road Realignments.
v) Table 8.5: The Impact Significance Rating for the Water Treatment Works and Supply Pump Station.
vi) Table 8.6: The Impact Significance Rating for the Pump Stations.
vii) Table 8.7: The Impact Significance Rating for the Pipeline and Reservoirs.

These tables should be read in conjunction with the description of the impacts and mitigating measures as set out in **Chapters 8** and **9** respectively.

Table 8.1: The Impact Significance Rating for the Raising of the Tzaneen Dam

Description of potential impact	Noise from general construction for raising of dam wall and operation of dam	
Nature of impact	Negative, Direct	
Legal requirements	To comply with SANS 10103:2004	
Stage	Construction and decommissioning	Operation
Nature of Impact	Negative, Direct	Negative, Direct
Extent of impact	Regional	Regional
Duration of impact	Short term	Long Term
Intensity	Low	Low
Probability of occurrence	Medium	Low
Confidence of assessment	High	High
Level of significance before mitigation	Medium	Low
Mitigation measures (EMP requirements)	See Chapter 9.2	N/A
Level of significance after mitigation	Medium	N/A
Cumulative Impacts	None	None
Comments or Discussion:		

TABLE 8.2: THE IMPACT SIGNIFICANCE RATING FOR THE NWAMITWA DAM AND WEIR

Description of potential impact	Noise from general construction and operation of the dam	
Nature of impact	Negative, Direct	
Legal requirements	To comply with SANS 10103:2004	
Stage	Construction and decommissioning	Operation
Nature of Impact	Negative, Direct	Negative, Direct
Extent of impact	Regional	Regional
Duration of impact	Short term	Long Term
Intensity	Low	Low
Probability of occurrence	Medium	Low
Confidence of assessment	High	High
Level of significance before mitigation	Medium (Daytime) High (Night-time)	Low
Mitigation measures (EMP requirements)	See Chapter 9.2	N/A
Level of significance after mitigation	Medium (Daytime) High (Night-time)	N/A
Cumulative Impacts	None	None
Comments or Discussion:		

TABLE 8.3: THE IMPACT SIGNIFICANCE RATING FOR THE QUARRY AT THE NWAMITWA DAM

Description of potential impact	Noise from general construction and operation of the dam	
Nature of impact	Negative, Direct	
Legal requirements	To comply with SANS 10103:2004	
Stage	Construction and decommissioning	Operation
Nature of Impact	Negative, Direct	Negative, Direct
Extent of impact	Regional	Regional
Duration of impact	Short term	Long Term
Intensity	Low	Low
Probability of occurrence	Medium	Low
Confidence of assessment	High	High
Level of significance before mitigation	High (Daytime) High (Night-time)	Low
Mitigation measures (EMP requirements)	See Chapter 9.2	N/A
Level of significance after mitigation	High (Daytime) High (Night-time)	N/A
Cumulative Impacts	None	None
Comments or Discussion:		

TABLE 8.4: THE IMPACT SIGNIFICANCE RATING FOR THE ROAD REALIGNMENTS

Description of potential impact	Noise impact from construction and traffic noise impact along the new sections of road	
Nature of impact	Negative, direct	
Legal requirements	To comply with SANS 10103:2004	
Stage	Construction and decommissioning	Operation
Nature of Impact	Negative, Direct	Negative, Direct
Extent of impact	Regional	Regional
Duration of impact	Short term	Long Term
Intensity	Medium	Medium
Probability of occurrence	Medium	Medium
Confidence of assessment	High	High
Level of significance before mitigation	Medium	Medium
Mitigation measures (EMP requirements)	See Chapter 9.2	See Chapter 9.2
Level of significance after mitigation	Medium	Low
Cumulative Impacts	None	None
Comments or Discussion		

TABLE 8.5: THE IMPACT SIGNIFICANCE RATING FOR THE WATER TREATMENT WORKS

Description of potential impact	Noise impact related to construction and operation of the water treatment works and water supply pump station	
Nature of impact	Negative, direct	
Legal requirements	To comply with SANS 10103:2004	
Stage	Construction and decommissioning	Operation
Nature of Impact	Negative, Direct	Negative, Direct
Extent of impact	Regional	Regional
Duration of impact	Short term	Long Term
Intensity	Medium	Medium
Probability of occurrence	Medium	Medium
Confidence of assessment	High	High
Level of significance before mitigation	Medium	Medium
Mitigation measures (EMP requirements)	See Chapter 9.2	See Chapter 9.2
Level of significance after mitigation	Medium	Low
Cumulative Impacts	None	None
Comments or Discussion		

TABLE 8.6: THE IMPACT SIGNIFICANCE RATING FOR PUMP STATIONS

Description of potential impact	Noise impact related to construction and operation of the pump stations	
Nature of impact	Negative, direct	
Legal requirements	To comply with SANS 10103:2004	
Stage	Construction and decommissioning	Operation
Nature of Impact	Negative, Direct	Negative, Direct
Extent of impact	Regional	Regional
Duration of impact	Short term	Long term
Intensity	Medium	Medium
Probability of occurrence	Medium	Medium
Confidence of assessment	High	High
Level of significance before mitigation	Medium	Medium
Mitigation measures (EMP requirements)	See Chapter 9.2	See Chapter 9.2
Level of significance after mitigation	Medium	Low
Cumulative Impacts	None	None
Comments or Discussion		

TABLE 8.7: THE IMPACT SIGNIFICANCE RATING FOR THE PIPELINES AND RESERVOIRS

Description of potential impact	Noise impact related to construction and operation of the water treatment works and water supply pump station	
Nature of impact	Negative, direct	
Legal requirements	To comply with SANS 10103:2004	
Stage	Construction and decommissioning	Operation *
Nature of Impact	Negative, Direct	None
Extent of impact	Regional	N/A
Duration of impact	Short term	N/A
Intensity	Medium	N/A
Probability of occurrence	Medium	N/A
Confidence of assessment	High	N/A
Level of significance before mitigation	Medium	N/A
Mitigation measures (EMP requirements)	See Chapter 9.2	N/A
Level of significance after mitigation	Medium	N/A
Cumulative Impacts	None	None
Comments or Discussion: * During the operational phase, the only noise will occur during maintenance operations		

9 RECOMMENDED MITIGATION MEASURES

Applicable noise mitigating measures for the project were assessed. There are various measures that can, if correctly applied, significantly reduce or prevent the identified potential impacts. As many aspects of the planned project have not yet been finalised, the mitigating measures are reviewed in concept as no detailed designs are possible at this stage. Once the final design and construction details are known, the mitigating measures are to be finalised in detail and the requirements are to be included in the respective Environmental Management Plans (EMP) for the construction and operational phases.

9.1 PRE-CONSTRUCTION PHASE

Where relevant, local affected residents and affected schools are to be notified of any potentially noisy field survey works or other works during the planning and design phase and these activities are to be undertaken at reasonable times of the day. These works should not take place at night or on weekends.

During this phase, consideration must be given to the noise mitigating measures required during the construction phase for inclusion in the tender document specifications and those required for incorporation in the design.

9.2 CONSTRUCTION PHASE RELATED MEASURES

There are several general noise mitigating measures/principles which must be applied during the construction phase in order to prevent/minimise impact on the identified noise sensitive areas. The requirements apply to all of the construction areas of the project.

i) Construction site yards, concrete batching plants, asphalt batching plants, construction worker camps and other noisy fixed facilities should be located well away from noise sensitive areas. Once the proposed final layouts are made available by the contractor(s), the sites must be evaluated in detail and specific measures designed in to the system.

ii) All construction vehicles, plant and equipment are to be kept in good repair.

iii) Truck traffic should be routed away from noise sensitive areas, where possible.

iv) Noisy operations should be combined so that they occur where possible at the same time.

v) Blasting operations are to be strictly controlled with regard to the size of explosive charge in order to minimise noise and air blast, and timings of explosions. The number of blasts per day should be limited, blasting should be undertaken at the same times each day and no blasting should be allowed at night.

vi) Construction activities are to be contained to reasonable hours during the day and early evening. Night-time activities near noise sensitive areas should be avoided wherever possible.

vii) Deliveries of material and any noisy offloading activities should be restricted to the day.

viii) With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents on how best to minimise impact, and the local population should be kept informed of the nature and duration of intended activities.

ix) As construction workers operate in a very noisy environment, it must be ensured that their working conditions comply with the requirements of the Occupational Health and Safety Act (Act No 85 of 1993). Where necessary ear protection gear should be worn.

It should be noted that any mitigating measures taken for construction noise will limit the impact of only the construction generated noise, and generally will not contribute to improving the degraded noise climate from other sources in the areas where there is already a problem.

9.3 OPERATIONAL PHASE RELATED MEASURES

The following specific noise mitigating measures will need to be considered:

9.3.1 Tzaneen Dam

Noisy maintenance works should only be carried out during the day.

9.3.2 Nwamitwa Dam and Weir

Noisy maintenance works should only be carried out during the day.

9.3.3 Roads

i) Some noise mitigating measures to protect the farm houses and farm labourer residences along the realigned sections of the Road R529 and Road P43/3 may be necessary. Strategically placed sections of earth berm noise attenuation barrier may be necessary along the edges of the respective road reserves to adequately protect these noise sensitive areas. Final details of the road (and particularly the longitudinal profile design) are not yet available. These are necessary to finalise the design of the mitigating measures.

ii) The surfacing material of the road should be acoustically designed. Properly designed gap-graded rubber bitumen can reduce the tyre-road interaction noise by at least 5dBA.

iii) The speed limit along this section of road should be posted at 100 km/h.

iv) Maintenance works should only be carried out during the day.

It should be noted that any measures taken at the road will limit the impact of only the traffic generated noise, and generally will not contribute to improving the degraded noise climate from other sources in the areas where there is already a problem.

9.3.4 Water Treatment Works

i) The designs of the new water treatment works and delivery pump station are to incorporate all the necessary acoustic design aspects required in order that the overall generated noise level from the new installation does not exceed a maximum equivalent continuous day/night rating level (L_{Rdn}), namely a noise level of 70dBA (just inside the *property projection plane*, namely the property boundary) as specified for industrial districts in SANS 10103. Refer to **Appendix J1**. Notwithstanding this provision, the design is also to take into account the maximum allowable equivalent continuous day and night rating levels of the potentially impacted sites outside the water treatment works property. Where the noise level at such an external site is presently lower than

the maximum allowed, the maximum for that land use zoning shall not be exceeded. Where the noise level at the external site is presently at or exceeds the maximum, the existing level shall not be increased. Note that the induced ambient noise levels in the residential areas of Ka-Malubana Village shall not exceed 50dBA during the day and 40dBA at night.

ii) The latest technology incorporating maximum noise mitigating measures for the water treatment plant and extraction pump station components should be designed into the system.

iii) The design process is to consider, *inter alia*, the following aspects:

a) The position and orientation of buildings on the site.

b) The design of the buildings to minimise the transmission of noise from the inside to the outdoors.

c) The insulation of particularly noisy plant and equipment.

It should be noted that any mitigating measures taken at the development site will limit the impacts in the specific areas designed for, and will not necessarily contribute to improving the degraded noise climates in adjacent areas where there is already a problem from another source(s).

9.3.5 Pipelines, Pump Stations and Reservoirs

i) The pump stations should not be sited closer than 250 metres to houses or schools.

ii) The latest technology incorporating maximum noise mitigating measures for the pump station components should be designed into the system.

iii) As the internal noise levels in the pump stations are high, the buildings housing the pumps should be adequately designed to limit the transmission of the pump generated noise and other internal equipment noise to the outside of the building. Insertion losses for the building of at least 30dBA must be achieved.

iv) Where there are external sources of noise such as ventilation intake fans, appropriate measures will need to be taken. No details of the pump stations are

available at this stage but typically measures such as the following should be taken:

- Fan intakes to be low mounted (preferably ground mounted).
- Fans to have a low sound power output.
- Fan intakes to be effectively screened off by an appropriately designed noise attenuation barrier (wall) with an insertion loss capability of at least 20dBA.

v) Maintenance works should only be carried out during the day. Where close to schools, appropriate times of the day should be selected. No pump stations are presently located close to schools but this standard should be borne in mind if sites for any of these new facilities are moved.

It should be noted that any measures taken at the pump station will limit the impact of only that noise source, and generally will not contribute to improving the degraded noise climate from other sources in the areas where there is already a problem.

10 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 togain 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 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 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.

11 CONCLUSIONS

The following conclusions may be drawn from the foregoing analysis:

i) The primary source of noise impacting the respective study areas at present is from road traffic. This is likely to remain the case in the future, with the situation worsening as traffic volumes increase.

ii) The ambient noise climate at many of the areas where elements of the project are to be built can be defined as being degraded, particularly where these sites are along or close to main roads with attendant high traffic generated noise levels. The noise situation is one varying between very quiet when there is no traffic to very noisy when vehicles pass by. Noise impact thus also varies from a situation of being insignificant to one of high significance.

iii) The noise climate in the Nwamitwa Dam and Reticulation Study Area away from the main roads is relatively quiet.

iv) The noise from elements of the Project, if unmitigated, has the potential to have a negative impact on some of the noise sensitive areas surrounding the respective project sites.

v) The main impact period will be during the construction phase but noise problems are also possible during the operational phase.

vi) There are appropriate noise mitigating measures that can be implemented to reduce or prevent any noise impact during construction and operation.

12 RECOMMENDATIONS

The following are recommended:

i) The main guidelines for addressing the potential noise impact on this project are the National Noise Control Regulations and SANS 10103:2004.

ii) Various measures to prevent or reduce the potential noise impact from the elements of the Groot Letaba River Water Development Project will be necessary during all phases of the project, and the mitigating measures indicated in **Chapter 9** need to be considered.

iii) There are however gaps in the present data base. Once the final design details of the project and the construction details are known, these need to be re-evaluated for their specific noise impacts and the final appropriate mitigating measures need to be identified and adequately designed. These aspects need to be included in the design plans, the contract documents and the Environmental Management Plans as appropriate. Further investigation of the potential impacts of the following aspects may be necessary:

   a) Borrow pits.
   b) Traffic between the borrow pits and the construction sites.
   c) General construction generated traffic.
   d) Operational phase generated traffic.
   e) Pumping stations.
   f) Re-aligned sections of Road P43/3, Road R529 and Road D1292.

iv) The noise mitigating measures should be designed by an acoustical engineer in order to optimise the design parameters and ensure that the cost/benefit of the measure is optimised.

v) When the project is commissioned, the noise footprints of relevant elements of the scheme should be measured.

13 REFERENCES

- South African National Standard SANS 10103:2004 — *The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and to Speech Communication*.
- South African National Standard SANS 10210 (SABS 0210) — *Calculating and Predicting Road Traffic Noise*
- South African Bureau of Standards Code of Practice SANS 10328 (SABS 0328) — *Methods for Environmental Noise Impact Assessments*
- South African National Standard SANS 10357 (SABS 0357), — *The Calculation of Sound Propagation by the Concawe Method*
- Transportation Research Library, (1977) — *The Prediction of Noise from Road Construction Sites*, TRL, Crowthorne UK.
- Watkins, LH — *Environmental Impact of Roads and Traffic*, Applied Science Publishers Ltd, Essex, UK.
- British Standard BS 5228: 1997 — *Noise and Vibration Control on Construction and Open Sites*

14 APPENDIX I1

GLOSSARY OF TERMS AND NOISE IMPACT CRITERIA

APPENDIX I1: GLOSSARY OF TERMS AND NOISE IMPACT CRITERIA

A1. GLOSSARY OF TERMS

In order to ensure that there is a clear interpretation of this report the following meanings should be applied to the acoustic terminology:

- **Ambient sound level** or **ambient noise** means the totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far. Note that ambient noise includes the noise from the noise source under investigation. The use of the word *ambient* should however always be clearly defined (compare with *residual noise*).
- **A-weighted sound pressure, in Pascals**: The root-mean-square sound pressure determined by use of frequency-weighting network A.
- **A-weighted sound pressure level (SPL) (noise level) (L_{pA}), in decibels**: The sound pressure level of A-weighted sound pressure is given by the equation:

  $L_{pA} = 10 \log (p_A/p_o)^2$ where:

  p_A is the A-weighted sound pressure, in Pascals; and

  p_o is the reference sound pressure (p_o = 20 micro Pascals (μPa))

  Note: The internationally accepted symbol for sound pressure level, dB(A), is used.
- **Controlled areas** as specified by the National Noise Control Regulations are areas where certain noise criteria are exceeded and actions to mitigate the noise are required to be taken. Controlled areas as related to roads, airports and factory areas are defined. These Regulations presently exclude the creation of *controlled areas* in relation to railway noise.
- **dB(A)** means the value of the sound pressure level in decibels, determined using a frequency weighting network A. (The "A"-weighted noise levels/ranges of noise levels that can be expected in some typical environments are given in Table A2 at the end of this appendix).
- **Disturbing noise** means a noise level that exceeds the outdoor equivalent continuous rating level for the time period and neighbourhood as given in Table 2 of SANS 10103:2004. For convenience, the latter table is reproduced in this appendix as Table A1.

- **Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$)** means the value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval, has the same mean-square sound pressure as a sound under consideration whose level varies with time.
- **Equivalent continuous rating level ($L_{Req,T}$)** means the equivalent continuous A-weighted sound pressure level during a specified time interval, plus specified adjustments for tonal character and impulsiveness of the sound and the time of day.
- **Equivalent continuous day/night rating level ($L_{R,dn}$)** means the equivalent continuous A-weighted sound pressure level during a reference time interval of 24-hours, plus specified adjustments for tonal character and impulsiveness of the sound and the time of day. (An adjustment of +10dB is added to the night-time rating level).
- **Integrating sound level meter** means a device that integrates a function of the root mean square value of sound pressure over a period of time and indicates the result in dBA.
- **Noise** means any acoustic phenomenon producing any aural sensation perceived as disagreeable or disturbing by an individual or group. Noise may therefore be defined as any *unwanted* sound or sound that is *loud, unpleasant or unexpected*.
- **Noise climate** is a term used to describe the general character of the environment with regard to sound. As well as the ambient noise level (quantitative aspect), it includes the qualitative aspect and the character of the fluctuating noise component.
- **Noise Control Regulations** means the regulations as promulgated by the National Department of Environmental Affairs.
- **Noise impact criteria** means the standards applied for assessing noise impact.
- **Noise level** means the reading on an integrating impulse sound level meter taken at a measuring point in the presence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation, and, if the alleged disturbing noise has a discernible pitch, for example, a whistle, buzz, drone or music, to which 5dBA has been added. (The “A”-weighted noise levels/ranges of noise levels that can be expected in some typical environments are given in Table A2 at the end of this appendix).
- **Noise nuisance** means any sound which disturbs or impairs or may disturb or impair the convenience or peace of any reasonable person considering the location and time of day. This applies to a disturbance which is not quantitatively measurable such as barking dogs, etc. (compared with disturbing noise which is measurable).

- **Residual sound level** means the ambient noise that remains at a position in a given situation when one or more specific noises are suppressed (compare with *ambient noise*).
- **Sound exposure level or SEL** means the level of sound accumulated over a given time interval or event. Technically the sound exposure level is the level of the time-integrated mean square A-weighted sound for stated time or event, with a reference time of one second.
- **Sound (pressure) level** means the reading on a sound level meter taken at a measuring point.
- **SANS 10103** means the latest edition of the South African National Standard SANS 10103 titled *The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and to Speech Communication*.
- **SANS 10210** means the latest edition of the South African National Standard SANS 10210 titled *Calculating and Predicting Road Traffic Noise*.
- **SANS 10328** means the latest edition of the South African National Standard SANS 10328 titled *Methods for Environmental Noise Impact Assessments*.
- **SANS 10357** means the latest edition of the South African National Standard SANS 10357 titled *The Calculation of Sound Propagation by the Concawe Method*.
- **Sound** means the aural sensation caused by rapid, but very small, pressure variations in the air. In quantifying the subjective aural sensation, "loudness", the letters dBA after a numeral denote two separate phenomena:
    - "dB", short for *decibel*, is related to the human's subjective response to the change in amplitude (or largeness) of the pressure variations.
    - The "A" denotes the ear's different sensitivity to sounds at different frequencies. The ear is very much less sensitive to low (bass) frequency pressure variations compared to mid-frequencies.

  The level of environmental sound usually varies continuously with time. A human's subjective response to varying sounds is primarily governed by the total sound energy received. The total sound energy is the average level of the fluctuating sound, occurring during a period of time, multiplied by the total time period. In order to compare the effects of different fluctuating sounds, one compares the average sound level over the time period with the constant level of a steady, non-varying sound that will produce the same energy during the same time period. The average energy of sound varying in amplitude is thus equivalent to the continuous, non-varying sound. The two energies are equivalent.

- Refer also to the various South African National Standards referenced above and the Noise Control Regulations for additional and, in some instances, more detailed definitions.

TABLE A1: TYPICAL NOISE RATING LEVELS FOR AMBIENT NOISE IN DISTRICTS (NOISE ZONES)

Type of District	Equivalent Continuous Rating Level for Noise ($L_{Req,T}$) (dBA)					
	Outdoors			INDOORS WITH OPEN WINDOWS		
	Day-night ($L_{R,dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)	Day-night ($L_{R,dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
RESIDENTIAL DISTRICTS						
a) Rural districts	45	45	35	35	35	25
b) Suburban districts (little road traffic)	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
NON RESIDENTIAL DISTRICTS						
d) Urban districts (some workshops, business premises and main roads)	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

TABLE A2: NOISE LEVELS/RANGES OF NOISE LEVELS THAT MAY BE EXPECTED IN SOME TYPICAL ENVIRONMENTS

Noise Level dB(A)	Typical Environment	Subjective Description
140	30m from jet aircraft during take-off	
130	Pneumatic chipping and riveting (operator's position)	Unbearable
>120	Hearing damage possible even for short exposure	
120	Large diesel power generator	
105-120	Low level military aircraft flight	
110-120	100 m from jet aircraft during take-off	
110	Metal workshop (grinding work), circular saw	
105-110	High speed train at 300 km/h (peak pass-by level at 7,5m)	
90-100	Printing press room	Very noisy
95-100	Passenger train at 200km/h (peak pass-by level at 7,5m).	Very noisy
95-100	Freight train at 100 km/h (peak pass-by level at 7,5 m)	Very noisy
90-100	Discotheque (indoors)	
75-100	7,5 m from passing motorcycle (50 km/h)	
75-80	10 m from edge of busy freeway (traffic travelling at 120 km/h)	
80-95	7,5 m from passing truck (50 km/h)	
80	Kerbside of busy street	
70	Blaring radio	Noisy
70	3 m from vacuum cleaner	Noisy
60-80	7,5 m from passing passenger car (50 km/h)	
65	Normal conversation	
65	Large busy office	
60	Supermarket/small office	
50	Average suburban home (day conditions)	Quiet

40	Library	
40-45	Average suburban home (night-time)	
30-35	Average rural home (night-time)	
25-30	Slight rustling of leaves	
20	Background in professional recording studio	Very quite
20	Forest (no wind)	
0-20	Experienced as complete quietness	
0	Threshold of hearing at 1000 Hz	

A2. NOISE IMPACT CRITERIA

The international tendency is to express noise exposure guidelines in terms of absolute noise levels. These guidelines imply that in order to ascertain an acceptable living environment, ambient noise in a given type of environment should not exceed a specified absolute level. This is the approach provided by the environmental guidelines of the World Bank and World Health Organisation, which specify 55dBA during the day (06:00 to 22:00) and 45dBA during the night (22:00 to 06:00) for residential purposes, determined over any hour. SANS 10103 conforms to the described international tendency. The recommended standards to be applied are summarised in Table A1.

Communities generally respond to a change in the ambient noise levels in their environment, and the guidelines set out in SANS 10103 provide a good indication for estimating their response to given increases in noise. The suggested severity criteria for the noise impacts are summarised in terms of the above guidelines in Table A3.

TABLE A3: CATEGORIES OF COMMUNITY/GROUP RESPONSE (CRITERIA FOR THE ASSESSMENT OF THE SEVERITY OF NOISE IMPACT)

Increase in Ambient Noise Level (dBA)	**Estimated Community/Group Response**	
	Category	**Description**
0 – 10	Little	Sporadic complaints
5 – 15	Medium	Widespread complaints
10 - 20	Strong	Threats of community/group action
Greater than 15dBA	Very strong	Vigorous community/group action

Changes in noise level are perceived as follows:

- *3dBA:* For a person with average hearing acuity, an increase in the general ambient noise level of 3dBA will be just detectable.
- *5dBA:* For a person with average hearing acuity an increase of 5dBA in the general ambient noise level will be significant, that is he or she will be able to identify the source of the intruding noise. According to SANS 10103 the community response for an increase of less than 5dBA will be 'little' with 'sporadic complaints'. For an increase of equal or more than 5dBA the response changes to 'medium' with 'widespread complaints'.
- *10dBA:* A person with average hearing will subjectively judge an increase of 10dBA as a doubling in the loudness of the noise. According to SANS 10103 the estimated community reaction will change from 'medium' with 'widespread complaints' to 'strong' with 'threats of community action'.

In the National Noise Control Regulations which are applicable in Limpopo Province, an intruding noise is defined as 'disturbing' if it causes the ambient noise level to rise by 7dBA or more.

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	Day-night ($L_{R,dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)	Day-night ($L_{R,dn}$)	Daytime ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
RESIDENTIAL DISTRICTS						
a) Rural districts	45	45	35	35	35	25
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c) Urban districts	55	55	45	45	45	35
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d) Urban districts (some workshops, business premises and main roads)	60	60	50	50	50	40
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Noise Level dB(A)	Typical Environment	Subjective Description
140	30m from jet aircraft during take-off	
130	Pneumatic chipping and riveting (operator's position)	Unbearable
>120	Hearing damage possible even for short exposure	
120	Large diesel power generator	
105-120	Low level military aircraft flight	
110-120	100 m from jet aircraft during take-off	
110	Metal workshop (grinding work), circular saw	
105-110	High speed train at 300 km/h (peak pass-by level at 7,5m)	
90-100	Printing press room	Very noisy
95-100	Passenger train at 200km/h (peak pass-by level at 7,5m).	Very noisy
95-100	Freight train at 100 km/h (peak pass-by level at 7,5 m)	Very noisy
90-100	Discotheque (indoors)	
75-100	7,5 m from passing motorcycle (50 km/h)	
75-80	10 m from edge of busy freeway (traffic travelling at 120 km/h)	
80-95	7,5 m from passing truck (50 km/h)	
80	Kerbside of busy street	
70	Blaring radio	Noisy
70	3 m from vacuum cleaner	Noisy
60-80	7,5 m from passing passenger car (50 km/h)	
65	Normal conversation	
65	Large busy office	
60	Supermarket/small office	
50	Average suburban home (day conditions)	Quiet
40	Library	
40-45	Average suburban home (night-time)	
30-35	Average rural home (night-time)	
25-30	Slight rustling of leaves	
20	Background in professional recording studio	Very quite
20	Forest (no wind)	
0-20	Experienced as complete quietness	
0	Threshold of hearing at 1000 Hz	

A2. NOISE IMPACT CRITERIA

The international tendency is to express noise exposure guidelines in terms of absolute noise levels. These guidelines imply that in order to ascertain an acceptable living environment, ambient noise in a given type of environment should not exceed a specified absolute level. This is the approach provided by the environmental guidelines of the World Bank and World Health Organisation, which specify 55dBA during the day (06:00 to 22:00) and 45dBA during the night (22:00 to 06:00) for residential purposes, determined over any hour. SANS 10103 conforms to the described international tendency. The recommended standards to be applied are summarised in Table A1.

Communities generally respond to a change in the ambient noise levels in their environment, and the guidelines set out in SANS 10103 provide a good indication for estimating their response to given increases in noise. The suggested severity criteria for the noise impacts are summarised in terms of the above guidelines in Table A3.

TABLE A3: CATEGORIES OF COMMUNITY/GROUP RESPONSE (CRITERIA FOR THE ASSESSMENT OF THE SEVERITY OF NOISE IMPACT)

Increase in Ambient Noise Level (dBA)	Estimated Community/Group Response	
	Category	Description
0 – 10	Little	Sporadic complaints
5 – 15	Medium	Widespread complaints
10 - 20	Strong	Threats of community/group action
Greater than 15dBA	Very strong	Vigorous community/group action

Changes in noise level are perceived as follows:

- *3dBA:* For a person with average hearing acuity, an increase in the general ambient noise level of 3dBA will be just detectable.
- *5dBA:* For a person with average hearing acuity an increase of 5dBA in the general ambient noise level will be significant, that is he or she will be able to identify the source of the intruding noise. According to SANS 10103 the community response for an increase of less than 5dBA will be ‘little’ with ‘sporadic complaints’. For an increase of equal or more than 5dBA the response changes to ‘medium’ with ‘widespread complaints’.
- *10dBA:* A person with average hearing will subjectively judge an increase of 10dBA as a doubling in the loudness of the noise. According to SANS 10103 the estimated

community reaction will change from ‘medium’ with ‘widespread complaints’ to ‘strong’ with ‘threats of community action’.

In the National Noise Control Regulations which are applicable in Limpopo Province, an intruding noise is defined as ‘disturbing’ if it causes the ambient noise level to rise by 7dBA or more.

APPENDIX I2:

DETAILS OF THE NOISE MEASUREMENT SURVEY AND EXISTING NOISE CLIMATE CONDITION ASSESSMENT

APPENDIX I2: DETAILS OF THE NOISE MEASUREMENT SURVEY AND EXISTING NOISE CLIMATE CONDITION ASSESSMENT

B1. GENERAL

The technical details of the noise measurement survey and general *noise climate* investigation related to the potential noise impact of the proposed Groot Letaba River Development Project which is to be developed in the area to the east of Tzaneen in the Limpopo Province are dealt with in this Appendix. The noise impact was divided into two study areas, namely:

- Tzaneen Dam Area.
- Nwamitwa Dam and Reticulation Area.

The noise impact assessment was undertaken in accordance with the requirements of the South African National Standard SANS 10328 (SABS 0328) *Methods for Environmental Noise Impact Assessments*. Daytime and evening period noise measurements were taken at twelve main monitoring sites at appropriate locations in the study area in order to establish the residual (existing) *noise climate*.

B2. STANDARDS AND MEASUREMENT EQUIPMENT

The sound pressure level (SPL) (noise) measurements were taken in accordance with the requirements of the South African National Standard SANS 10103:2004, *The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and Speech Communication*. Two Type 1 Integrating Sound Level Meters, a Bruël and Kjaer Model 2230 meter and a Larson Davis 824 were used for the noise measurements. Both meters were calibrated at an accredited acoustical laboratory within the last 12 months. The calibration status of the meters was also checked before and after completion of the total measurement period of the day. A calibrated signal with a sound pressure level of 94,0dB at 1 kHz and 114,0dB at 1 kHz were applied to the Bruël and Kjaer meter and the Larson Davis meter respectively. A Larson Davis Model CAL200 was used.

For all measurements taken to establish the ambient noise levels, the equivalent noise level (L_{Aeq}), the maximum sound pressure level (L_{Amax}) and the minimum sound pressure level (L_{Amin}) during that measurement period were recorded. The frequency weighting setting was set on "A" and the time weighting setting of the meters were set on *Impulse* (I). Measurement periods of a minimum of 10 minutes were used. In addition, the variation in instantaneous sound pressure level (SPL) over a short period was also measured at some of the Sites. For these latter measurements the time weighting setting of the meter was also set on *Impulse* (I).

At all the measurement sites, the meters were set up with the microphone height at 1,3 metres above ground level and well clear of any reflecting surfaces (a minimum of 3 metres clearance). For all measurements, a standard windshield cover (as supplied by the manufacturers) was placed on the microphone of each meter.

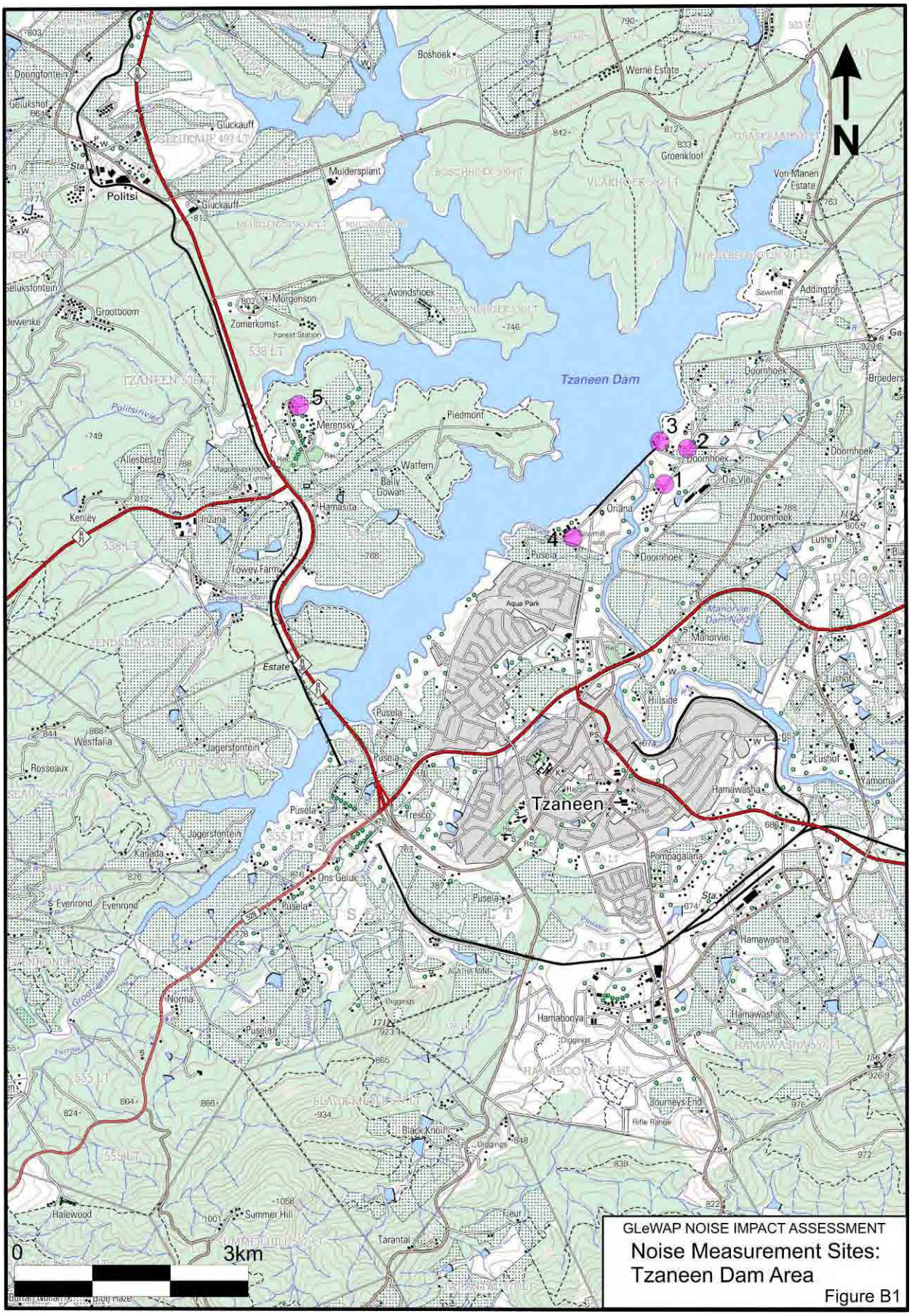
At the same time as each individual measurement was being taken, the qualitative nature of the *noise climate* in the area of the measurement site was assessed and recorded. This comprised an appraisal of the general prevailing acoustic conditions based on the subjective response to the sounds as perceived by the listener (i.e. *auditory observation* by the surveyor), as well as identifying those noise incidents, which influenced the noise meter readings during that measurement period. This procedure is essential in order to ensure that that there is a *human* correlation between the noise as perceived by the human ear and the noise, which is measured by the meter, as well as to establish any anomalies in the general ambient noise conditions.

B3. MEASUREMENT SITES

Noise measurements to establish current ambient noise conditions were taken at sixteen (16) main sites in the study area. A first set was in the Tzaneen Dam Study Area, as indicated in Table B1 and Figure B1.

TABLE B1: NOISE MEASUREMENT SITES – TZANEEN DAM STUDY AREA

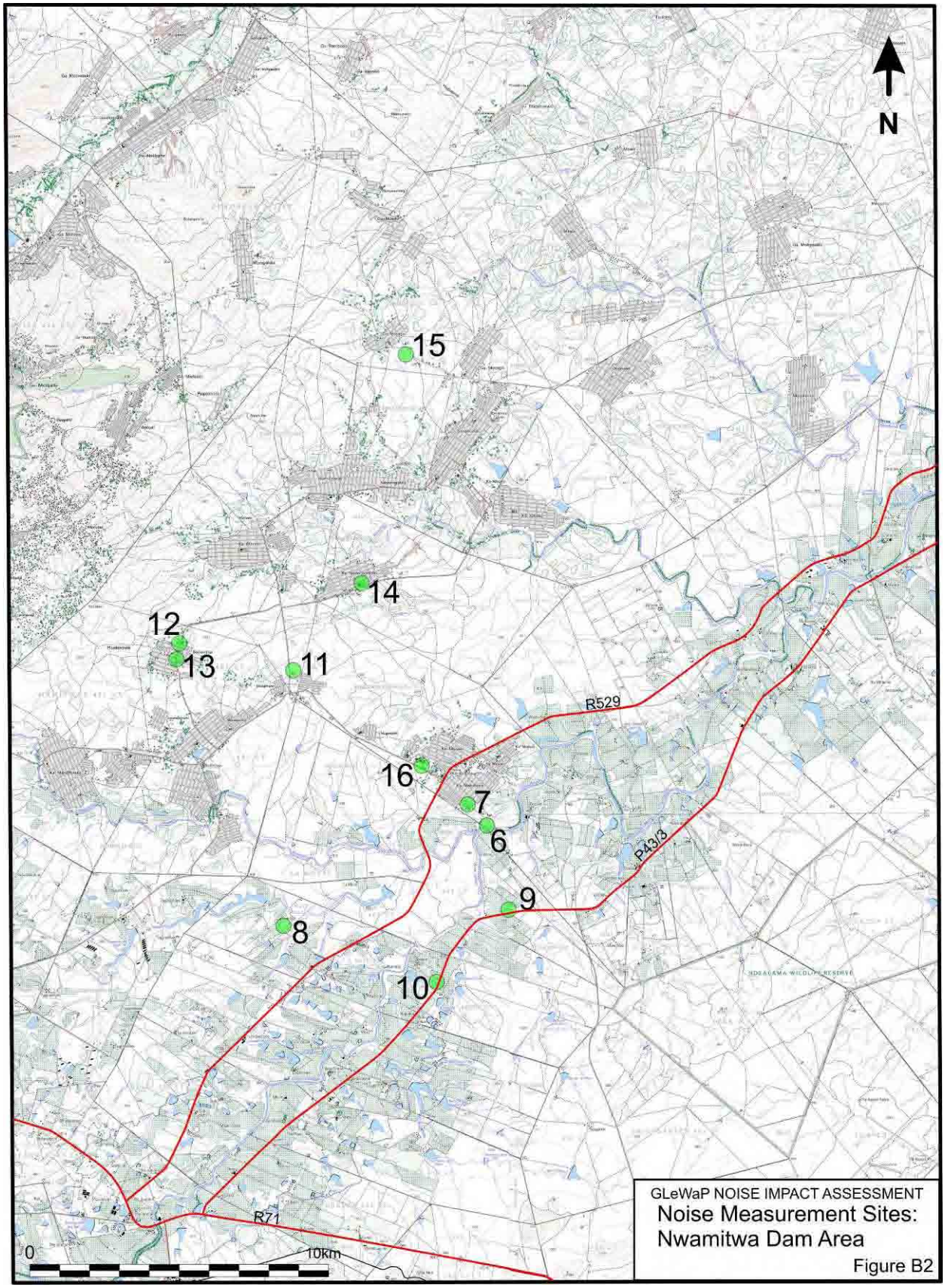
Site No	Location Description	GPS Co-ordinates
1	Outside gates of Tzaneen Dam water purification plant	S23º48.092' E030º10.114'
2	At DWAF houses on the north-eastern side of dam wall	S23º47.914' E030º10.230'
3	At DWAF houses on the north-eastern side of dam wall outside no. 13 at dam wall	S23º47.841' E030º10.000'
4	Outside DWAF Area Office and on southern boundary fence of Tzangeni Security Estate	S23º48.415' E030º09.467'
5	Merensky School on north-eastern side of school at dormitories	S23º47.617' E030º07.646'


Tzaneen Dam
Tzaneen
Politsi
Gluckauff
Muldersplant
Boshoek
Werne Estate
Groenkloof
Von Manen Estate
Addington
Grootboom
Zomerkomst
Morgenson
Avondshoek
Piedmont
Merensky
Allesbeste
Wattern
Baliy Gowan
Hamasita
Inzana
Kenley
Towey Farm
Estate
Oriana
Pusela
Doornhoek
Die Viel
Lushof
Aqua Park
Manorview
Hillside
Westfalia
Jagersfontein
Rosseaux
Tresco
Hamawasha
Pompagalana
Kanada
Ons Geluk
Evenrond
Norma
Hamaboova
Journeys End
Rifle Range
Black Knoll
Halewood
Summer Hill
Tarantal
Fleur
1
2
3
4
5
N
0
3km
GLeWAP NOISE IMPACT ASSESSMENT
Noise Measurement Sites:
Tzaneen Dam Area
Figure B1

A second set of measurements were taken in the Nwamitwa Dam and Reticulation Study Area, as indicated in Table B2 and Figure B2.

TABLE B2: NOISE MEASUREMENT SITES – NWAMITWA DAM AND RETICULATION STUDY AREA

Site No	Location Description	GPS Co-ordinates
6	South-east of KwaMalubana Village and south-east of water purification works	S23º45.071' E030º29.588'
7	On the southern edge of KwaMalubana Village	S23º44.840' E030º29.293'
8	On farm Riverside 514 Portion 14 approximately 100m west of farmhouse	S23º47.197' E030º26.046'
9	At entrance to Laborie 515 LT, approximately 20m north of centreline of Road P43-3	S23º46.654' E030º30.068'
10	50m north-west of centreline of Road P43-3 and entrance to farm Nagude (Riverside 514 LT)	S23º47.883' E030º28.659'
11	Outside Hetiseka Secondary School (Musiphane Village)	S23º42.613' E030º26.015'
12	On northern edge of Babanana Village	S23º42.093' E030º23.992'
13	On main road through Babanana Village, 200m from northern urban edge	S23º42.216' E030º23.947'
14	On south side of school on southern urban edge of Ka-Nwamngololo Village	S23º41.123' E030º27.316'
15	On road between Ga-Mookgo Village East and Ga-Mookgo Village West	S23º37.354' E030º28.437'
16	40m off centreline of gravel road on south-western side of Ka-Mswazi Village	S23º37.354' E030º28.437'


N
15
14
12
13
11
16
7
6
9
8
10
R529
P43/3
R71
0
10km
GLeWaP NOISE IMPACT ASSESSMENT
Noise Measurement Sites:
Nwamitwa Dam Area
Figure B2

B4. MEASUREMENT DATES/TIMES

General observation of the noise conditions in the study area as well as the site specific sound pressure level (noise) measurements and observations were taken on Friday 30 November, Saturday 1 December and Monday 3 December 2007 during the daytime period from 09h00 to 17h00 and in the evening/night from 19h30 to 22h30.

B5. NOISE MEASUREMENT DETAILS

B5.1. Summary of the Residual Sound Pressure Level Measurements

The results of the residual noise condition measurement survey are summarised in Table B3 (Tzaneen Dam Study area) and Table B4 (Nwamitwa Dam and Reticulation Study Area). The equivalent sound pressure (noise) level (L_{Aeq}), the maximum sound pressure level (L_{Amax}) and the minimum sound pressure level (L_{Amin}) are indicated. Note that the equivalent sound pressure (noise) level may, in layman's terms, be taken to be the average noise level over the given period. This "average" is also referred to as the residual noise level (excluding the impacting noise under investigation) or the ambient noise level (if the impacting noise under investigation is included).

TABLE B3: MEASURED CURRENT NOISE LEVELS IN THE TZANEEN DAM STUDY AREA (YEAR 2007)

Measurement Site	Measured Sound Pressure Level (dBA)					
	Daytime Period			Late Evening Period		
	L_{Aeq}	L_{max}	L_{min}	L_{Aeq}	L_{max}	L_{min}
Site 1	57.0	74.2	46.8	-	-	-
Site 2	48.3	69.6	35.9	56.9	61.1	49.8
Site 3	45.5	65.2	34.7	53.0	60.0	48.0
Site 4	46.6	62.4	39.4	54.1	60.5	51.1
Site 5	49.8	64.7	40.4	-	-	-

TABLE B4: MEASURED CURRENT NOISE LEVELS IN THE NWAMITWA DAM AND RETICULATION STUDY AREA (YEAR 2007)

Measurement Site	Measured Sound Pressure Level (dBA)					
	Daytime Period			Late Evening Period		
	L_{Aeq}	L_{max}	L_{min}	L_{Aeq}	L_{max}	L_{min}
Site 6	41.0	51.8	26.4	30.0 *	-	-
Site 7	46.3	59.8	32.3	62.9	66.4	53.7
Site 8	50.9	64.5	36.3	50.7	54.7	45.8
Site 9	70.1	76.7	64.0	48.7	56.3	32.2
Site 10	49.9	65.0	33.4	44.4	51.6	41.2
Site 11	53.7	70.3	37.3	30.0 *	-	-
Site 12	69.3	71.4	68.3	30.0 *	-	-
Site 13	42.9	50.3	37.6	30.0 *	-	-
Site 14	41.7	54.3	39.2	30.0 *	-	-
Site 15	41.7	50.3	31.2	30.0 *	-	-
Site 16	50.7	61.7	31.2	30.0 *	-	-
Note: * These are the levels to which the ambient noise climate will tend in the night-time period.						

The weather conditions on the survey days were such that the measurements to establish the ambient noise levels were not adversely affected and no specific corrective adjustments needed to be made.

B5.3. Noise Climate Related to the 24 hour Road Traffic

In order to complement the short-term noise measurements the main roads in the two study areas, the existing 24-hour residual noise levels related to the average daily traffic (ADT) flows on the main roads were also calculated. These data provide an accurate base for the SANS 10103 descriptors. The noise levels generated from the traffic on these roads were calculated using the South African National Standard SANS 10210 (SABS 0210), *Calculating and Predicting Road Traffic Noise*. Typical situations were used for the calculation site. The Year 2007 traffic data were used as the baseline for the calculations. The traffic data were obtained from ILISO Consulting (Pty) Ltd.

The noise profiles of the following roads have been calculated in the Tzaneen Dam:

- Section 1: Road P43/3 (Route R71) just west of Road D978 (Deerfield Road)
- Section 2: Road P43/2 / Road P17/3 (Route R71/Route R36) between Road P17/2 (Route R71) and Road D528.

- Section 3: Road P17/2 (Magoebaskloof Road) (Route R71) just west of Road P43/2 / Road P17/3.
- Section 4: Road P43/2 (Modjadjiskloof Road) (Route R36) north of Road P17/2 (Magoebaskloof Road).
- Section 5: Road D978 (Deerfield Road) just north of Road P43/3 (Route R71).

The noise profiles of the following roads have been calculated in the Nwamitwa Dam and Reticulation Study Area:

- Section 6: Road P43/3 (Route R71) west of Road R529.
- Section 7: Road P43/3.
- Section 8: Road R529 north of the intersection with D1292.
- Section 9: Road R529 south of the intersection with D1292.
- Section 10: Road D1292.

The noise levels at various offsets from the relevant road centrelines were established and are summarised in Table B5 for the Tzaneen Dam Study Area and in Table B6 for the Nwamitwa Dam and Reticulation Study Area. The noise descriptors used are those prescribed in SANS 10103:2004, namely:

i) Daytime equivalent continuous rating (noise) level ($L_{Req,d}$) (L_d used in Table), namely for the period from 06h00 to 22h00).

ii) Night-time equivalent continuous rating (noise) level ($L_{Req,n}$) (L_n used in Table), namely for the period from 22h00 to 06h00).

iii) Day-night equivalent continuous rating (noise) level ($L_{R,dn}$) (L_{dn} used in Table), namely for the 24 hour period from 06h00 to 06h00).

The noise levels given are for generalised and the unmitigated conditions. There will be greater attenuation than shown with distance where there are houses, other buildings and terrain restraints in the intervening ground between the source and the receiver point.

TABLE B5: EXISTING NOISE CLIMATE ADJACENT TO THE MAIN ROADS IN THE TZANEEN DAM STUDY AREA (YEAR 2007 TRAFFIC)

Road Section	Noise Climate Alongside the Main Roads at Given Offset from Centreline (SANS 10103 Indicator) (dBA)																	
	25m Offset			50m Offset			100m Offset			250m Offset			500m Offset			1000m Offset		
	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
1	64.2	53.8	64	61.2	50.8	61.0	58.2	47.8	58.0	54.2	43.8	54.0	51.2	40.8	51.0	48.2	37.8	48.0
2	66.3	55.9	66.1	63.3	52.9	63.1	60.3	49.9	60.1	56.3	45.9	56.1	53.3	42.9	53.1	50.3	39.9	50.1
3	59.7	49.3	59.6	56.7	46.3	56.6	53.7	43.3	53.6	49.7	39.3	49.6	46.7	36.3	46.6	43.7	33.3	43.6
4	64.6	54.2	64.5	61.6	51.2	61.5	58.6	48.2	58.5	54.6	44.2	54.5	51.6	41.2	51.5	48.6	38.2	48.5
5	60.2	49.8	60.1	57.2	46.8	57.1	54.2	43.8	54.1	50.2	39.8	50.1	47.2	36.8	47.1	44.2	33.8	44.1

TABLE B6: EXISTING NOISE CLIMATE ADJACENT TO THE MAIN ROADS IN THE NWAMITWA DAM AND RETICULATION STUDY AREA (YEAR 2007 TRAFFIC)

Road Section	Noise Climate Alongside the Main Roads at Given Offset from Centreline (SANS 10103 Indicator) (dBA)																	
	25m Offset			50m Offset			100m Offset			250m Offset			500m Offset			1000m Offset		
	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
6	63.2	52.9	63.1	60.2	49.9	60.1	57.2	46.9	57.1	53.2	42.9	53.1	50.2	39.9	50.1	47.2	36.9	47.1
7	57.4	46.5	57.1	54.4	43.5	54.1	51.4	40.5	51.1	47.4	36.5	47.1	44.4	33.5	44.1	41.4	30.5	41.1
8	61.0	51.0	61.0	58.0	48.0	58.0	55.0	45.0	55.0	51.0	41.0	51.0	48.0	38.0	48.0	45.0	35.0	45.0
9	61.1	50.8	61.0	58.1	47.8	58.0	55.1	44.8	55.0	51.1	40.8	51.0	48.1	37.8	48.0	45.1	34.8	45.0
10	61.5	53.6	64.3	58.5	50.6	61.3	55.5	47.6	58.3	51.5	43.6	54.3	48.5	40.6	51.3	45.5	37.6	48.3

B5.4. Prevailing Noise Climate in the Tzaneen Dam Study Area

In overview, the existing situation with respect to the existing *noise climate* in the study area was found to be as follows:

i) The main sources of noise in the area are from:
   a) Traffic of the main roads.
   b) Tzaneen Dam water purification works.
   c) Power boats on the Tzaneen dam.
   d) Railway line to the west of the Tzaneen Dam.

ii) The existing *noise climate* alongside the main roads is degraded with regard to residential living (using 40dBA as the night-time impact criterion). Residences in some areas are negatively impacted from traffic noise (particularly at night) for up to the following distances from these roads:

Section of Road	**Offset Distance**
Section 1: Road P43/3 (Route R71) just west of Road D978 (Deerfield Road).	500m
Section 2: Road P43/2 / Road P17/3 (Route R71/Route R36) between Road P17/2 (Route R71) and Road D528.	1000m
Section 3: Road P17/2 (Magoebaskloof Road) (Route R71) just west of Road P43/2 / Road P17/3.	250m
Section 4: Road P43/2 (Modjadjiskloof Road) (Route R36) north of Road P17/2 (Magoebaskloof Road).	800m
Section 5: Road D978 (Deerfield Road) just north of Road P43/3 (Route R71).	250m

iii) The residual (existing background) noise levels are relatively low (quiet) in the existing and developing residential areas to the south and east of the Tzaneen Dam wall. Daytime ambient conditions range from about 45dBA to 57dBA. Early evening conditions fall in the range of 54dBA to 57dBA, while the night-time ambient levels will fall to about 40dBA. These are acceptable suburban residential conditions (SANS 10103).

iv) The noise climates at the farmhouses on the western and northern sides of the dam are relatively quiet.

v) The residual noise levels at the Merensky High School fall within the limits recommended in SANS 10103.

B5.5. Prevailing Noise Climate in the Nwamitwa Dam and Reticulation Study Area

In overview, the existing situation with respect to the existing *noise climate* in the study area was found to be as follows:

i) The main sources of noise in the area are from:
   a) Traffic on the main roads.
   b) Nkambako Water Treatment Works on the south-eastern side of Ka-Malubana Village.
   c) Pump on the Groot Letaba River feeding the Nkambako Water Treatment Works.
   d) Noise from cicadas dominated at Sites 9 and 12, and had a significant influence on the noise levels at Site 8 as well. This was the situation during both day-time and night-time measurements. This is considered to be a seasonal condition in the normal rural climate. Without the noise from the cicadas, the noise climate will be relatively quiet.

ii) The existing *noise climate* alongside the main roads is degraded with regard to residential living (using 40dBA as the night-time impact criterion). Residences in some areas are negatively impacted from traffic noise (particularly at night) for up to the following distances from these roads:

Section of Road	**Offset Distance**
Section 6: Road P43/3 (Route R71) west of Road R529.	500m
Section 7: Road P43/3.	100m
Section 8: Road R529 north of the intersection with D1292 (in Ka-Malubana Village)	320m
Section 9: Road R529 south of the intersection with D1292.	300m
Section 10: Road D1292.	500m

iii) The residual (existing background) noise levels are relatively low (quiet) in the areas that are not close to and are relatively shielded from the main roads. Daytime ambient conditions range from about 41dBA to 54dBA. Night-time conditions will tend to fall to between 30dBA and 35dBA. In general the conditions on the farms and villages in the area meet the acceptable standards as per SANS 10103.

B6. BASELINE MEASUREMENTS

Baseline noise measurements were taken at the Tzaneen Dam Water Treatment Works and the Politsi Purification Scheme Final Water Pump Station. These noise data represent the typical noise conditions of the respective plant that will be installed on the GLeWaP Project.

APPENDIX I3

ASSESSMENT OF NOISE IMPACT

APPENDIX I3: ASSESSMENT OF NOISE IMPACT

C1. GENERAL

The assessment of the noise impact was guided by the requirements of the South African National Standard SANS 10328 (SABS 0328) titled *Methods for Environmental Noise Impact Assessments* and the Noise Control Regulations. A comprehensive assessment using the appropriate noise impact descriptors (standards) has been undertaken. The noise impact criteria used in this investigation specifically take into account those as specified in the South African National Standard SANS 10103:2004, *The Measurement and Rating of Environmental Noise with Respect to Land Use, Health, Annoyance and Speech Communication,* as well as those in the National Noise Control Regulations. The Limpopo Provincial Government has not yet promulgated their Noise Regulations and thus need to apply the National Noise Control Regulations. Relevant aspects of these Regulations and SANS 10103:2004 are provided in Appendix A.

The infrastructure components of the project include:

- The raising of the Tzaneen Dam;
- A new dam at the site known as Nwamitwa;
- Associated relocation of roads at Nwamitwa Dam;
- Access roads to the Nwamitwa Dam;
- A riverflow gauging weir just downstream from the Nwamitwa Dam;
- Upgrading of the existing Water Treatment Works just north of the Nwamitwa Dam;
- Water reticulation pipelines;
- Pump stations;
- Reservoirs.

Borrow areas required to provide construction materials are covered separately by submission of the relevant documentation to the Department of Minerals and Energy Affairs.

C2. ASSESSMENT OF THE PRE-CONSTRUCTION PHASE

Activities during the planning and design stages that have possible impact implications in the study area are related to field surveys (such as seismic testing and geological test borehole drilling) at Nwamitwa Dam, at pump station and reservoir sites, at the weir and along sections of the provincial roads that have to be realigned and along access road routes. These survey activities will be of short duration in any one area.

C3. ASSESSMENT OF THE CONSTRUCTION PHASE

C3.1. General

Data was sourced from officials at DWAF, from various consultants and experience that JKA has had working on similar sites. Although much of the project construction related data and exact location of facilities such as pump stations are provisional, these are adequate to provide a sound basis for analysis of typical conditions and impacts that are likely to prevail on the project.

C3.1.1. Construction Areas

The potential future noise climate was established for the construction conditions:

i) At the Tzaneen Dam.

ii) At the Nwamitwa Dam and at the riverflow gauging weir.

iii) Along the sections of Road R529 and Road P43/3 that are to be realigned, and along access roads to the Nwamitwa Dam.

iv) At the water treatment works.

v) Along the pipelines and at pump stations and reservoirs.

C3.1.2. Sources of Construction Noise

The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

The following are the potential sources of noise at the construction sites (for more specific details of the individual construction sites, refer to the relevant sections below):

i) Construction camp establishment. This will be for the site offices, workshops, accommodation camp for the workers and stores on site.

ii) Activities related to the relocation of services.

iii) Excavation of service trenches and foundations. Blasting may be required in places but in general pneumatic breakers will be used where rock is encountered.

iv) Piling operations.

v) Erection of shuttering for concrete works.

vi) Fixing of steel reinforcing.

vii) Placing and vibration of concrete. Poker vibrators will be used.

viii) Stripping of shuttering after concrete pour.

ix) Erection of structural steelwork.

x) Installation of plant and equipment.

xi) Finishing operations.

xii) General movement of heavy vehicles such as concrete delivery vehicles, mobile cranes, mechanical dumpers and water trucks (dust suppression) around the site.

xiii) De-watering pumps for storm-water and ground water in the excavations. A 24-hour operation may sometimes be necessary.

xiv) Road construction equipment. Scrapers, dozers, compactors, etc. (Construction of internal roads, access roads and relocation of sections of Provincial Roads).

xv) Construction site fabrication workshops and plant maintenance workshops.

xvi) Construction material and equipment delivery vehicles.

xvii) Drilling, blasting and crushers at quarry for aggregate (Nwamitwa Dam area)

xviii) Concrete batching plant and asphalt batching plant on site.

Typical noise levels generated by various construction equipment are given in Table C1.

TABLE C1: TYPICAL NOISE LEVELS GENERATED BY CONSTRUCTION EQUIPMENT

Plant/Equipment	Typical Operational Noise Level at Given Offset (dBA)							
	5m	**50m**	**100m**	**250m**	**500m**	**1000m**	**2000m**	**3000m**
Air compressor	91	71	65	57	51	46	40	36
Compactor	92	72	66	58	52	46	40	36
Concrete mixer	95	75	69	61	55	49	43	39
Concrete vibrator	86	66	60	52	46	40	34	30
Conveyor belt	77	57	51	43	37	32	-	-
Crusher (aggregate)	90	70	64	56	50	44	38	34
Crane (mobile)	93	73	67	59	53	47	41	37
Dozer	95	75	69	61	55	49	43	39
Loader	95	75	69	61	55	49	43	39
Mechanical shovel	98	78	72	64	58	52	46	42
Pile driver	110	91	85	77	71	65	59	55
Pump	86	66	60	52	46	40	34	30
Pneumatic breaker	98	78	72	64	58	52	48	44
Rock drill	108	88	82	74	68	62	56	52
Roller	84	64	58	50	44	38	32	28
Trucks		67	64	60	57	54	51	48

These noise levels assume that the equipment is maintained in good order. Conservative attenuation conditions (related to intervening ground cover conditions and topographical screening) have been applied.

General ambient noise conditions related to construction sites are given in Table C2.

TABLE C2: TYPICAL CONSTRUCTION NOISE LEVELS AT GIVEN OFFSETS FROM THE CONSTRUCTION SITE

Equipment	Sound pressure level at given offset (dBA)										
	200 m	400 m	500 m	600 m	700 m	800 m	1000 m	1200 m	1500 m	2000 m	2500 m
Total construction operation	53.5	46.4	43.9	41.9	40.1	38.5	35.7	33.4	30.4	26.3	22.9

C3.2. Tzaneen Dam Construction Conditions

C3.2.1. ***Details***

The dam wall will be raised by a maximum of 3,5m and the spillway will be designed to accommodate a flood of 5 100m³/s .This will be achieved by using either a labyrinth spillway, fusegates or a side channel spillway.

The raising of Tzaneen dam will not require acquisition of additional land as the design flood level remains within the area purchased for the existing dam. The size of the downstream flood will also not be affected.

Construction facilities such as offices, workshops and stores will be required on site, and will be located within the property of the existing Government Water Works (GWW). Construction is expected to start in 2010.

C3.2.2. ***Noise Impact***

It has been assumed that at this site construction will take place only during the day-time.

i) Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over any working period.

ii) Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme, work *modus operandi* and type of equipment have not been finalised. From present information available, *ambient* noise levels during the daytime period at the nearest houses to the dam wall, namely the DWAF houses at the north-eastern side of the dam wall, the residences in the Tzangeni and Golden Acres Security Estates to the south-east of the dam wall and the farmhouses on the western and northern sides of the dam should not exceed 50dBA. Thus, no noise

disturbance effects are predicted. Working on a worst case scenario basis, it is estimated that the maximum *instantaneous* noise levels from general construction operations should not exceed 72dBA at the nearest houses to the dam wall. The residual noise levels are fairly quiet at these residences and thus there are likely to be noise nuisance effects from individual incidents from the construction in these residential areas.

iii) The Merensky High School on the western side of the dam will not be affected by the noise from the construction noise from the dam during the day. The school has residences and any night-time construction could have sleep disturbance effects at the dormitories. The school area is already impacted by the noise from traffic on the dual carriageway road to the west of the dam.

iv) Construction workers working with or in close proximity to equipment will be exposed to high levels of noise as can be seen from Table C1 (refer to the 5 metre offset noise levels).

v) There will be an increase in traffic (mainly delivery vehicles) on the main routes into the area, but the volumes are unlikely to raise the ambient noise levels along the roads.

It should be noted that for residential areas, higher ambient noise levels than recommended in SANS 10103 are normally accepted as being reasonable during the construction period, provided that the very noisy construction activities are limited to the daytime and during the week, and that the contractor takes reasonable measures to limit noise from the work site. Note that it is understood that construction will generally take place from 07h00 to 18h00 with no activities (or at least no noisy construction activities) at night. From the details presently available, it appears that the construction noise impact is not likely to be too severe in the residential areas near to the dam wall.

C3.3. Nwamitwa Dam and Weir Construction Conditions

C3.3.1. ***Details***

The largest component of the GLeWaP project is the proposed new dam at the site known as Nwamitwa. The dam will be located on the Groot Letaba River downstream of the confluence of the Nwandezi River. An earth fill embankment on both flanks with a central concrete spillway is envisaged. The detail design of the dam and outlet works has not yet been completed but the structure will have an appearance similar to other composite construction type dams such as Tzaneen Dam.

The earth embankments will be protected against wave action and erosion on the upstream side by a layer of rock rip-rap. The downstream slopes will also be protected but by a layer of mainly crushed stone. The embankments are expected to have a total crest length of up to 3 000 m while the length of the concrete spillway would be about 500 m. These dimensions are subject to finalization in the detailed design phase.

An outlet control structure with multiple drawoff levels will be an integral part of the concrete spillway structure and will be located on the left flank of the spillway.

Construction is expected to commence approximately in October 2009, and take 5 years to complete, with the storage of water and associated benefits expected to commence in 2012.

The site of the construction camp for the dam will be on the left bank of the Groot Letaba River, just upstream of the dam wall. The construction camp will require approximately 35.6 ha excluding access roads. The site will accommodate the following:

- Concrete Batching Plants;
- Site Offices and Parking - comprising two office blocks (one to house the personnel of the Resident Engineer, and one to house the Site Agent and his personnel) and 20 covered parking bays per office block, and a taxi rank;
- Materials testing Laboratory;
- Workshops and Stores - approximately five buildings;
- Reinforcing Steel Bending Yard;
- Permanent Housing- Houses for two married operating personnel;
- Weather Station; and
- Sand and crushed stone Stockpile Areas – less than 450 m x 250 m with access roads (above area of inundation).

Areas for the handling of hazardous substances, an explosives storage magazine, wash bays for construction plant, radio communication infrastructure, facilities for the bulk storage and dispensing of fuel for construction vehicles, powerlines, a small-scale sewage treatment plant and a temporarily licensed solid waste disposal facility will also be provided.

Various temporary access roads, low level river crossings and haul roads will be required in and around the dam wall and borrow pits and quarry sites will be located within the dam basin.

Construction activities will commence with the stripping of vegetation and topsoil to establish access and construction roads, site offices, dam foundations and crusher and concrete mixer stations. Topsoil will be stockpiled for reuse during the rehabilitation stage, whilst cleared woody vegetation suitable for firewood will be stockpiled for collection by the local population for a period of time, after which it will be burnt.

Soon after commencement the river will be diverted to expose the rock foundations for the concrete spillway section. During this period, cofferdams will be constructed to protect all foundation activities in the riverbed against flood damage. Excavators, bulldozers and trucks will be engaged to remove all loose material on the foundation of the dam until rock is exposed. Blasting will be necessary.

A team specializing in quarry operations and the crushing of aggregate for concrete will be set up on site. Drill rigs will be in operation 24 hours a day. Blasting will be required, on average, every 14 days, and will be scheduled to take place only during daylight hours. A crusher will also be erected.

Sand required for the production of concrete will be collected from the identified borrow areas. Unsuitable material will be disposed of at locations to be agreed on by the Environmental Control Officer (ECO).

Concrete production at the batching plant will then commence and placement in the central spillway section, outlet works and apron areas, probably by roller compaction techniques and the use of high tower and mobile cranes, will occur 24 hours a day, seven days a week. Earth embankments will be constructed on both banks by compacting material hauled in by large trucks from the borrow areas upstream of the dam.

The temporary site administrative buildings will be erected complete with security fencing, a water supply, sewage purification plant and an electric overhead supply line.

After construction activities have been completed, estimated to be in 2013, all the crushers, mixers and site offices, etc. will be removed and the construction site rehabilitated. All temporary access roads and other hard surfaced areas will be ripped and covered with a topsoil and planted with suitable grass and tree cover. The aim is to return the whole construction site as close as possible to its original appearance. Areas that are inundated by water in the dam will be shaped to accommodate storm runoff and no grass will be planted.

Two permanent houses will be erected within the project area to accommodate operation and maintenance staff.

The labour force for construction of the proposed dam will be approximately 300. Approximately 50 people will be skilled workers and be housed with their families in Letsitele. 200 workers will be recruited locally and. approximately 100 of these workers will acquire a new skill by the end of this project. The remaining 50 workers will be experienced in dam construction and will be transferred from elsewhere and be housed at Letsitele in single quarter's accommodation.

The proposed borrow area for the earthfill material is on the right flank (looking downstream) immediately upstream of the embankment. Two potential borrow areas for filter materials and concrete sand have been identified in the Merekome River on the farm Letaba Drift and in the Phatle/Lerwatlou River on the farm La Parisa. Authorisation of the borrow areas from the Department of Minerals and Energy Affairs is being applied for as a concurrent process to the EIA.

Coarse aggregates for concrete and rock for the rip-rap and rock toe zones of the embankment will be sourced from existing permitted quarries or commercial sources.

A new flow-measuring weir will be required downstream of the new dam in order to measure the flow that is released from the dam. The exact location of the weir has not yet been determined, but will be fairly close to the dam wall (downstream side). The weir will take about three months to construct and will be a low concrete structure with erosion control measures on both banks to prevent out-flanking. It is envisaged that the construction of the weir will form part of the dam construction contract.

C3.3.2. ***Noise Impact***

For sources of noise, see Section C3.3.1.

i) There will be a significant noise impact from the construction activities at the dam on the Ka-Malubana and Ka-Mswazi Villages north of and the farms to the north and east (Deeside 733-LT) of the dam wall, particularly from the night-time construction activities.

ii) Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over any working period.

iii) Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme, work *modus operandi* and type of equipment have not been finalised. From present information available, *ambient* noise levels during the daytime period at the nearest houses to the dam wall, namely the residences in Ka-Malubana Village at the northern side of the dam wall (200m offset), should not exceed 54dBA. The residual noise levels in the village are approximately 45dBA during the day and 40dBA at night. Thus, no noise disturbance effects are predicted during the day, but significant noise impact is anticipated at night.

iv) Working on a worst case scenario basis, it is estimated that the maximum instantaneous noise levels from general construction operations could be of the order of 74dBA at the nearest houses to the dam wall in Ka-Malubana Village. The residual noise levels in the village and on the surrounding farms are fairly quiet and significant noise nuisance effects and noise disturbance effects are anticipated from the construction in these residential areas.

v) The main impact from the construction phase on the Ka-Malubana Village will be from the quarrying operation, namely from the rock drills and the crusher. When the quarrying operations are closest to the Village (estimated offset of 250 metres) ambient noise levels could be of the order of 79dBA (dependent on the number of rock drills). The residual noise levels in the village are approximately 45dBA during the day and 40dBA at night. The noise impact will be significant. The impact from blasting at the aggregate quarry, however, is likely to be minimal on residents in the area, provided that blasting is restricted to the day-time. Blasting is anticipated only once every two weeks and will be limited to the daytime.

vi) Construction workers working with or in close proximity to equipment will be exposed to high levels of noise as can be seen from Table C1 (refer to the 5 metre offset noise levels).

vii) There will be an increase in traffic (mainly delivery vehicles) on the main routes into the area, but the volumes involved are unlikely to raise the ambient noise levels along the roads. Night-time traffic could cause nuisance problems at some of the noise sensitive sites along the main roads into the area of the dam construction.

viii) The positions of the access roads to the construction site have not yet been defined. Although the volumes of construction site generated traffic are not expected to be

high, noise from site traffic could be a problem, depending on the location of these roads relative to the Ka-Malubana Village and farmhouses.

It should be noted that for residential areas, higher ambient noise levels than recommended in SANS 10103 are normally accepted as being reasonable during the construction period, provided that the very noisy construction activities are limited to the daytime and during the week, and that the contractor takes reasonable measures to limit noise from the work site. Construction activities, however, will take place on a 24-hour, 7 day a week basis and therefore significant impacts are anticipated in the village and on some of the farms.

C3.4. Road Construction Conditions

C3.4.1. ***Details***

Main Roads

Sections of Road R529 and Road P43/3 will require re-alignment to accommodate the backwaters of the proposed dam. There are two alternative alignments being considered for Road R529 (Refer also to Figure 3);

- Alternative 1: The new road will deviate westwards from the existing R529 alignment approximately 5km north of the intersection with Route R71 up to Road D1292, where it turns eastward to follow the alignment of the latter for 1km where it deviates northwards again to link with the existing Road R529 alignment 1km south of Ka-Malubana Village.
- Alternative 2: The new road will deviate westwards from the existing R529 alignment approximately 5km north of the intersection with Route R71 up to Road D1292 (same as Alternative 1), where it turns directly northwards for approximately 3km, it then turns eastwards to link with the existing alignment of Road R529 just south of Ka-Malubana Village.

The road re-alignment would require the construction of at least two major bridges and the upgrading of two existing bridges. The road design will be very similar to the existing roads, which are of a high standard, as well as be constructed using the same material. The road pavement will be designed to accommodate normal traffic flow.

The major items of work to be carried out are the following:

- Clearing of the road reserve;
- Installation and operation of a bitumen plant;
- Construction of the road to bituminous surfacing;

- The pavement structure for the road will consist of various gravel sub-base layers with a double stone surface seal;
- The gravel for the pavement layers and fill will be obtained from DME approved borrow pits and/or cuttings along the road;
- All stormwater drainage will be accommodated using either pipe or portal culverts; and
- The existing roads will be utilised whilst the new realigned roads are constructed so avoiding the need for temporary detours during construction.

Construction of the roads will take place only during the daytime.

Internal Roads and Construction Site Access Roads

The exact positions of the required access roads to the construction sites and the on-site roads at the dam and appurtenant works have not yet been identified.

C3.4.2. ***Noise Impact***

The nature of the noise impact from the road construction site is likely to be as follows:

i) The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

ii) As no specific construction details or possible locations of major ancillary activity sites are available at this stage, the anticipated noise from various types of construction activities cannot be calculated accurately. In general at this stage, it can be said that the typical noise levels of construction equipment at a distance of 50 metres lie in the range of 65 decibels (dBA) to 75dBA. Refer also to Table C1. Based on data from similar “linear” construction sites, a one hour equivalent noise level of between 75dBA and 78dBA at a point 50 metres from the construction would be typical for the earthmoving phase. The reconstruction of these roads is in the farming areas where ambient noise levels during the day are normally of the order of 40-50dBA.

iii) All three alternatives for the re-alignment of Road R529 (Alternatives 1, 2 and 3) will now be routed close to a number of farmhouses. Alternatives 1 and 2 affect the Farm Riverside 514-LT and Alternative 3 affects residences on La Gratitude 513-LT and on Taganashoek 465-LT. There are more noise sensitive sites along Alternative 3 than on the other two. The re-alignment of Road P43/3 to the east of its existing alignment will place the new road relatively close to farm worker residences on the farm Nagude

517-LT. As construction is likely to take place during daytime, no major noise impact is anticipated at these residences.

iv) The impacts in any one area will be relatively short-term as the construction activities progress along the route.

v) The noise levels generated from the bridge construction sites will be of the order of that indicated in Table C2.

vi) There is likely to be noise impact from trucks on routes to and from the various borrow sites and spoil sites.

C3.5. Water Treatment Works Construction Conditions

C3.5.1. ***Details***

At present the Nkambako Water Treatment Works, which is located just south-east of Ka-Malubana Village, draws water from the Groot Letaba River about 1 km downstream from the Nwamitwa Dam wall site. The existing facility is to be expanded. After completion of the project, water will be abstracted from the dam and treated at the existing and new treatment works extensions located adjacent to the existing works. The existing run of river abstraction will be abandoned.

Only daytime construction will take place at this site.

C3.5.2. ***Noise Impact***

i) The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

ii) Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme, work modus operandi and type of equipment have not been finalised. Working on a worst case scenario basis, it is estimated that the maximum instantaneous noise levels from general construction operations could be of the order of 70dBA at the nearest houses to the treatment works in Ka-Malubana Village. The residual noise levels in the village are approximately 45dBA during the day and 40dBA at night. The noise from this site will be dominated to a large extent by the noise from the construction at the dam area and aggregate quarry, but will have a minor cumulative effect on the noise levels from the various construction sites.

C3.6. Pipelines, Pump Stations and Reservoir Construction Conditions

C3.6.1. ***Details***

Pipelines

Bulk water distribution pipelines will be constructed to augment potable water supplies in the various existing supply zones. The bulk distribution infrastructure from the treatment works will be optimised during the detailed design phase and the final configuration and sizing is not known at this stage. It is envisaged that new pipelines will be located adjacent to existing pipelines or along road reserves. Some sectors of pipeline will traverse open land. A ten metre wide strip would be impacted during constructing.

Construction of the pipelines will commence with pipes being laid out along the pipeline routes and trenches up to 3,5 m deep and 2,5 m wide for the largest of the pipes being excavated. Under normal circumstances a maximum of 5 km of open trench is permitted, whilst the pipes will be strung out as they arrive from the manufacturer. Excess spoil material from the trenches will be transported to a suitable disposal site and sandy material will be brought in as selected backfill for pipe protection. Once the pipes have been laid and tested, the trench will be backfilled, compacted and shaped to the natural ground profile. Topsoil will be replaced to re-establish vegetation.

Pump stations

Currently 4 booster pump stations are envisaged along the pipeline routes although the exact number and position will only be determined during the detail design stage. The following areas are being considered as possible sites:

- Between Ga-Mookgo Village (east) and Ga-Mookgo Village (west).
- Between Ga-Maakgo Village (west) and Ga-Moloko Village.
- Between Mawa Village and Hlohlokwe Village (the area demarcated is immediately adjacent to Hlohlokwe Village).
- On alternative pipeline route south of Hlohlokwe Village.

An area of approximately 1 – 2 ha will be fenced for each pump station. No balancing dams are envisaged.

A new raw water pump would be constructed to pump water from the dam to the Water Treatment Works.

Building activities will include cranes, mixer trucks, excavators, tipper trucks, loaders and delivery vehicles (refer also to Section C3.1.2). Construction of a single pump station will take approximately 24 months.

Reservoirs

Although the reservoirs associated with the pipelines may differ according to their individual capacity and local topography, the technical details are similar for each.

Four new reservoirs are being considered at ten alternative sites within close vicinity to the following villages (See Figure 2).

- Sorolorole (Reservoir A) ;
- Babanana (Reservoir B);
- Mothomeng (Reservoir C1 and C3);
- Hlohlokwe (Alternative Reservoir C1 and C2)
- Mabyepelong (Reservoir C2); and
- Gamokgwathi (Reservoir D1, D2 and D3).

It is anticipated that construction will only take place during the day.

C3.6.2. ***Noise Impact***

The noise sensitive areas/sites that could be impacted by noise along the whole length of the respective pipeline routes are mainly residential land uses. There are also a number of schools that are potentially affected. The nature of the noise impact from the construction activities on nearby noise sensitive areas/sites is likely to be as follows:

i) The noise level and character of the noise will vary along the project route dependant on the type of construction activity. For example, the noise from a section where only a pipeline is being laid will differ from a site where a valve box or a road crossing is also being constructed.

ii) Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over short periods during any day working period. The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

iii) Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction

site layout, work programme, work *modus operandi* and type of equipment have not been finalised. Typical ambient noise conditions from a small construction site are as indicated in Table C2. These general noise levels are more representative of the sites where concreting operations also take place. For more specific plant/equipment related noise levels refer to Table C1.

iv) If discrete sections of pipeline are completed at a time (namely excavation, laying and backfilling), the duration of the noise impact will be short-term.

v) The construction times for the pump stations and reservoirs could extend over several months with attendant variable noise impact.

vi) The noise sensitive sites closest to the roads (where the pipelines are laid in the reserve) will be affected the most by the construction noise. If construction activities are contained to the daytime, the impact conditions at residences will not be that severe.

vii) Schools close to the pipeline routes will be adversely affected.

C4. ASSESSMENT OF THE OPERATIONAL PHASE

C4.1. General

The potential future noise climate was established for the operational conditions:

i) At the Tzaneen Dam.

ii) At the Nwamitwa Dam and at the riverflow gauging weir.

iii) Along the sections of Road R529 and Road P43/3 that are to be realigned, and along access roads to the Nwamitwa Dam.

iv) At the water treatment works inclusive of the delivery pump station.

v) Along the pipelines and at pump stations and reservoirs.

C4.2. Tzaneen Dam Operational Conditions

C4.2.1. ***Sources of Noise***

The only sources of noise during the operational phase will be:

i) Water outflow from the dam outlet works valves into the stilling basin.

ii) Routine maintenance work on the dam infrastructure.

iii) In addition, the general noise climate of the area will also be influenced by:

a) Traffic on the main roads.

b) Power boats on the Tzaneen Dam.

c) Tzaneen Dam water purification works.

C4.2.2. ***Noise Impact***

i) No change in the general noise climate is anticipated from the alterations to the dam wall.

ii) No noise disturbance is anticipated from the sound of constant outflow of dam water into the stilling basin due firstly to the character of the sound (namely a waterfall sound) and secondly due to the distance attenuation of the sound. The alterations to the dam will not affect the general pattern of outflow into the stilling basin. The noise from the outflow of water was measured at 83.6dBA at 15m from the flume, reducing to 65.2dBA at 60m from the flume. This noise level is likely to be of the order of 50dBA at a distance of 500 metres from the dam wall.

iii) Maintenance works are unlikely to have an impact on the area as these will be at relatively long term intervals and will be contained to the daytime.

C4.3. Operational Conditions at the Nwamitwa Dam and Weir

C4.3.1. ***Sources of noise***

The only sources of noise during the operational phase will be:

i) Water outflow from the dam outlet works valves into the stilling basin.

ii) Routine maintenance work on the dam infrastructure.

iii) In addition, the general noise climate of the area will also be influenced by:
   a) Traffic on the main roads.
   b) Nkambako Water Treatment Works (expanded works).
   c) Pump station at the dam for feeding the water purification works.

C4.3.2. ***Noise Impact***

i) No noise disturbance is anticipated from the sound of constant outflow of dam water into the stilling basin due firstly to the character of the sound (namely a waterfall sound) and secondly due to the distance attenuation of the sound. Baseline noise measurements indicate that this noise level is likely to be of the order of 50dBA at a distance of 500 metres from the overflow section of the dam wall. The “noise” at the nearest residences will of the order of 40dBA.

ii) Maintenance works are unlikely to have an impact on the area as these will be at relatively long term intervals and will be contained to the daytime.

iii) The noise from water flowing over the weir will be of a nature that will have no impact.

iv) No major change in general noise climate is anticipated from the operations at the dam.

C4.4. Operational Conditions along Roads

C4.4.1. ***Sources of noise***

Sources of noise during the operating phase will be:

i) General traffic. The noise levels generated from the traffic on the main roads at the estimated commissioning date of the dam (Year 2012) were calculated using the South African National Standard SANS 10210, *Calculating and Predicting Road Traffic Noise*. The existing traffic generated noise levels are predicted to increase by 0.6dBA by 2012. The anticipated noise levels along the roads in the Tzaneen Dam Study Area for 2012 are given in Table C3 and those for the Nwamitwa Dan and Reticulation Study Area are given in Table C4. The noise levels given are the unmitigated values. The day-night equivalent continuous rating (noise) level ($L_{R,dn}$), namely that for the 24 hour period from 06h00 to 06h00 noise descriptor is given.

The road sections analysed the Tzaneen Dam Study Area are:

- Section 1: Road P43/3 (Route R71) just west of Road D978 (Deerfield Road)
- Section 2: Road P43/2 / Road P17/3 (Route R71/Route R36) between Road P17/2 (Route R71) and Road D528.
- Section 3: Road P17/2 (Magoebaskloof Road) (Route R71) just west of Road P43/2 / Road P17/3.
- Section 4: Road P43/2 (Modjadjiskloof Road) (Route R36) north of Road P17/2 (Magoebaskloof Road).
- Section 5: Road D978 (Deerfield Road) just north of Road P43/3 (Route R71).

TABLE C3: PREDICTED NOISE LEVELS ALONG ROADS IN THE TZANEEN DAM STUDY AREA (YEAR 2012)

Road Section	Day-night Equivalent Continuous Rating (noise) Level ($L_{R,dn}$) at given Offset (dBA)					
	25m	50m	100m	250m	500m	1000m
1	64.7	61.7	58.7	54.7	51.7	48.7
2	66.8	63.8	60.8	56.8	53.8	50.8
3	60.2	57.2	54.2	50.2	47.2	44.2
4	65.1	62.1	59.1	55.1	52.1	49.1
5	60.7	57.7	54.7	50.7	47.7	44.7

The road sections analysed in the Nwamitwa Dam and Reticulation Study Area are:

- Section 6: Road P43/3 (Route R71) west of Road R529.
- Section 7: Road P43/3.
- Section 8: Road R529 north of the intersection with D1292.
- Section 9: Road R529 south of the intersection with D1292.
- Section 10: Road D1292.

TABLE C4: PREDICTED NOISE LEVELS ALONG ROADS IN THE NWAMITWA DAM AND RETICULATION STUDY AREA (YEAR 2012)

Road Section	Day-night Equivalent Continuous Rating (noise) Level ($L_{R,dn}$) at given Offset (dBA)					
	25m	50m	100m	250m	500m	1000m
6	63.7	60.7	57.7	53.7	50.7	47.7
7	57.7	54.7	51.7	47.7	44.7	41.7
8	61.6	58.6	55.6	51.6	48.6	45.6
9	61.6	58.6	55.6	51.6	48.6	45.6
10	64.9	61.9	58.9	54.9	51.9	48.9

ii) Routine road maintenance activities.

C4.4.2. ***Noise Impact***

The following impacts are anticipated:

i) Existing noise levels close to the main roads in the Tzaneen Dam Study Area and the Nwamitwa Dam and Reticulation Study Area are already high for residential land use and particularly at night. The situation of these "noise degraded" areas will continue to worsen with the general growth of traffic throughout the study area.

ii) The main impact from traffic noise will be on the realigned sections of Road R529 and Road P43/3 (see Section C3.4.1). Specifically on the realigned section of Road R529 there are a number of farm houses that will be within 500m of the road where the noise level will exceed the 45dBA ($L_{R,dn}$) allowable.

iii) The character (qualitative aspect) of the traffic noise will be as follows:

   a) Where the traffic is travelling at high speed, the main noise component will be that of high frequencies generated by the interaction between vehicle tyres and the road surface.

   b) Where there are long steep grades and heavy vehicles on the upgrade slow down, low-frequency mechanical noise becomes more evident. There may also be mechanical noise from the heavy vehicles on the downgrade using their air-brakes. This will be a minor component on the re-aligned road.

   c) There will also be a difference in the sound from continuous flow traffic versus the passing of single vehicles. The noise from continuous flow traffic tends to form a "background" of noise while, when general traffic flows are low, the noise from a single vehicle can be found to be rather intrusive. This is particularly so at night.

C4.5. Operational Conditions at the Water Treatment Works

C4.5.1. ***Sources of noise***

The main sources of noise during the operational phase are anticipated to be:

i) The expanded water treatment works.

ii) Delivery pump station at the dam.

C4.5.2. ***Noise Impact***

i) The expanded water treatment works could generate noise levels of about 51dBA at 500m. Residences in the southern sector of Ka-Malubana will be adversely affected by the noise from the works, particularly at night.

ii) The exact position of the delivery pump station for the water treatment works has not yet been determined. Conservatively it is estimated that the noise from these pumps

could also be of the order of 50dBA at 500m. Residences in Ka-Malubana will be adversely affected by the noise from the works, particularly at night.

iii) The farms to the north-east and east of the Nwamitwa Dam should not be affected by the noise from these two sources.

C4.6. Operational Conditions along the Pipelines, at the Pump Stations and Reservoirs

C4.6.1. *Sources of noise*

The main sources of noise during the operational phase are anticipated to be:

i) The pump stations. The main noise as heard externally will be from the ventilation intake fans for the building housing the pumps. Typical worst noise levels in the vicinity of the type of pump station that is likely to be built fro the project are as given in Table C5. The noise levels were established using the baseline measurements from the Clapham pump station (near Steelpoort) and the Politsi Purification Scheme Final Water Pump Station (north of Tzaneen). The calculation model SANS 10357 (SABS 0357) *The Calculation of Sound Propagation by the Concawe Method* was used. The average noise level over one hour (L_{Aeq}) and the day-night equivalent continuous rating (noise) level ($L_{R,dn}$) are indicated. These are the unmitigated values.

TABLE C5: TYPICAL NOISE LEVELS AT PUMP STATIONS

Descriptor	Noise Level at given Offset (dBA)				
	10m	25m	50m	100m	200m
L_{Aeq}	69	62	56	50	44
$L_{R,dn}$	75	67	61	56	50

The nature of the sound from the pump house area will be that of a continuous “swishing” noise of virtually unvarying intensity. It has been indicated that, in general, the pumping operations will be virtually continuous over any 24-hour period.

ii) Water-hammer in the pipelines when the pumps are switched on.

iii) Routine maintenance.

C4.6.2. *Noise Impact*

C4.6.2.1. Pump Stations

As no final details of the location, position and orientation for the pump stations are available at this stage, no specific impact predictions are possible. The following impacts are anticipated:

i) The noise impact on residences within 250 metres of a pump station will be significant particularly at night.

ii) The noise impact on schools within 250 metres of a pump station will be significant.

C4.6.2.2. Other Issues

i) Noise from water hammer effects, namely the noise caused by the pressure surges in the pipeline from the water when the pumps are started is unlikely to have any significant effect on people living and working along the pipelines, as there will be relatively few such occurrences due to the planned continuous pumping operation.

ii) Maintenance works are unlikely to have an impact on the areas along the pipelines as these activities will be at relatively long term intervals and will be contained to the daytime.

iii) No noise impacts are anticipated from the reservoir sites.