

**WETLAND AND AQUATIC ECOLOGICAL ASSESSMENT AS
PART OF THE ENVIRONMENTAL ASSESSMENT AND
AUTHORISATION PROCESS FOR THE GREATER
SOUTPANSBERG GENERAAL PROJECT, LIMPOPO
PROVINCE**

Prepared for

Coal of Africa Limited

2013

Report authors **S. van Staden (Pr. Sci. Nat)**
 N. van de Haar (Pr.Sci. Nat)
 D. Crafford Ph. D.
Report Reference: **SAS 213143**
Date: **November 2013**

SAS CC
CC Reg No 2003/078943/23
Vat Reg. No. 4020235273
91 Geldenhuis Rd
Malvern East, Ext 1

Tel: 011 616 7893
Fax: 011 615 6240
E-mail: admin@sasenvironmental.co.za



FINAL REPORT**Declaration of Independence**

This report has been prepared according to the requirements of Section 32 (3b) of the Environmental Impact Assessments Regulations, 2010 (GNR 543). We (the undersigned) declare the findings of this report free from influence or prejudice.

Report Authors:

Stephen van Staden *Pr Sci Nat* (Ecological Sciences) 400134/05

BSc. Hons (Aquatic Health) (RAU);

M.Sc. Environmental Management (RAU).

Field of expertise:

Wetland, aquatic and terrestrial ecology.



Date: 2013/11/29

Stephen van Staden

Natasha van de Haar *Pri Sci Nat* (Botanical Science) 400229/11

M.Sc. Botany (RAU)

Field of expertise:

Botanical specialist



Date: 2013/11/29

Natasha van de Haar



EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the wetland, aquatic and riparian resources as part of the environmental assessment and authorisation process for the proposed Greater Soutpansberg Generaal project, located approximately 70km to the south of Musina within the Limpopo Province hereafter referred to as the „study area“.

Specific outcomes required from this report in terms of the wetland assessment include the following:

- Compile a desktop study with all relevant information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (<http://bgis.sanbi.org>) as well as location of Freshwater Ecosystem Priority Areas (FEPAs) in relation to the study area;
- Delineation of the wetland temporary zones by means of "Department of Water Affairs (DWA), 2005: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones" and through the use of aerial photography;
- Define wetland functional units based on observed characteristics;
- Map functional units and apply applicable assessment methods to each functional unit;
- Assess the wetland services provided by the resources on the study area according to the method of Kotze *et al* (2005) in which services to the ecology of the site are defined and services to the people of the area are defined;
- Assess the wetland Present Ecological State (PES) according applicable methods such as WET Health or WET Ecoservices;
- Define the Ecological Importance and Sensitivity (EIS) according to the DWA 1999 method;
- Compile a detailed impact assessment on all identified significant impacts including cumulative impacts on wetland resources in the region; and
- Provide recommendations on management and mitigation measures (including opportunities and constraints) with regards to mining related activities within the study area in order to improve, manage and mitigate impacts on the wetland ecology of the area.

Specific outcomes required from this report in terms of the aquatic assessment include the following:

- Define the ecostatus of the river systems;
- Define the ecological importance and sensitivity of the systems based on stressor and receptor assessments, including habitat assessments;
- Biota specific water quality assessment;
- Aquatic community integrity assessments;
- Define impacts on the systems;
- Provide an opinion based on the study from an aquatic ecological point of view; and
- Present required mitigation measures.

The following general conclusions were drawn upon completion of the literature review:

The Generaal Project Area falls within the Limpopo Plain Ecoregion and is located within the A71K, A80F and A80G quaternary catchments although the area within the A71K quaternary catchment is very limited. According to the ecological importance classification for the A80 quaternary catchments, the system can be classified as a *Sensitive* system which, in its present state, can be considered a Class D (largely modified) stream. The most significant riverine resource within the Generaal Project area within the A80F quaternary catchment is the Mutamba River, a major tributary of the Nzhelele River and the Nzhelele River itself. The Dolidoli River was the only other system observed with surface water at the time of assessment. These systems all form part of the Sand River catchment which in turn is a large tributary of the Limpopo River. The RSA Wetland Types (2010) and National Freshwater Ecosystem Priority Areas (NFEPA) (2011) databases were consulted to define the ecology of the wetland or river systems within the Generaal Project Area that may be of ecological importance. Aspects applicable to the Generaal Project Area and surroundings are discussed below:

- The Generaal Project Area falls within the Limpopo Water Management Area (WMA). The subWMA indicated for the Generaal Project Area is the Sand subWMA.
- The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors.
- The subWMA is not listed as a fish Freshwater Ecosystem Priority Area.
- Both the Mutamba and Nzhelele Rivers are perennial systems classified as Class D (largely modified) rivers and are not indicated as free flowing, flagship or as FEPA Rivers.
- The Sand River is a perennial system classified as a Class B (largely natural) river and is not indicated as a free flowing or flagship river. However, the Sand River is indicated as a FEPA river.



- Numerous wetland features are located within the Generaal Area, these include bench slope and valley floor wetland features.
- Both natural and artificial wetland features occur within the Generaal Area, two wetland features are considered natural while five are considered artificial (Figure 11).
- Wetlands within the Generaal Area were ranked according to general importance. All wetland features were ranked as Rank 6 with no importance indicated.
- No wetland features within the Generaal Project Area are considered important with regards to the conservation of biodiversity.
- No wetland features within the Generaal Project Area are indicated as FEPA wetlands.
- No RAMSAR wetlands are located within or close to the Generaal Project Area.
- No wetlands are indicated to fall within 500m of an IUCN threatened frog point locality.
- According to the NFEPA database (2011), none of the wetland features within the Generaal Project Area are considered of significant biodiversity importance. All wetland features are indicated to be in a heavily to critically modified condition and are not considered important with regards to the conservation of biodiversity in the area.

The following general conclusions were drawn upon completion of the wetland assessment:

- Features within the study area were categorised with the use of the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis, 2013). Three main feature groups are present within the study area, namely depressions (small pans), rivers (Nzhelele River, Mutamba River and Dolidoli River) and smaller drainage lines. Within the area several artificial earth dams were also observed, some of which are perennial with others that only seasonally or ephemerally hold surface water and support vegetation adapted to life in saturated soils. These four groups were then assessed to determine importance in terms of function and service provision as well as PES, and EIS of the systems. The bullets below summarise the key findings:
- The average score calculated for the Mutamba River with the use of the Wetland IHI, indicates that the feature can be considered to fall within PES Category A (Unmodified). A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. It is also notable that there is a general decreasing trend in wetland habitat integrity in a downstream direction largely as a result of increased water abstraction. This results in slightly lower ecological scores in the area of the Generaal project in relation to the upstream areas although the habitat integrity at this point can still be considered largely natural with few modifications (Class B).
- The score calculated for the Nzhelele and Dolidoli Rivers with the use of the wetland IHI, indicates that these features can be considered to fall within PES Category B indicating largely natural conditions with few modifications. It is however notable that in the vicinity of the local villages a significant reduction in wetland habitat integrity is evident. The average score calculated for the smaller drainage lines with the use of the IHI, indicates that the features can be considered to fall within PES Category A (Unmodified/Natural). Smaller drainage lines have been left largely undisturbed with limited change for hydrology and geomorphology identified.
- The results obtained for the function and service provision indicated the Mutamba River, Nzhelele River and Dolidoli River to be of similar importance in terms of function and service provision, with the highest scores calculated for water supply, biodiversity and tourism and recreation. The smaller pans as well as drainage lines calculated scores that fall within a moderately low class and therefore cannot be considered of exceptional importance in terms of function and service provision despite the drainage lines being in a largely unmodified state;
- Wet-Health was used to determine the PES of the smaller pans within the study area. The pans have been largely undisturbed and therefore can still generally be considered to be in good condition and are considered to be relatively important in terms of biodiversity support in the area although overall functional importance is limited. The wetland Pans were defined as being moderately important (class B systems); and
- VEGRAI was used to assess the response of riparian vegetation to impacts within rivers as well as smaller drainage lines. The mean scores calculated for the drainage lines and Mutamba River both fall within Class B (largely natural) and mean average scores calculated for the Nzhelele River and Dolidoli River fall within Class C (moderately modified). Based on the findings of the study it is evident that from a wetland point of view, the EIS of the river systems are largely similar. All the larger riverine systems along with the smaller drainage



lines can be defined as Class B systems indicating a high EIS. The small pans identified on site also calculated an EIS score included within a high EIS Class (Class B).

- Mining related activities and infrastructure as proposed by the present layout provided by the proponent would most likely significantly impact on the unnamed tributary of the Mutamba River in the vicinity of the proposed Generaal Mining section. Should mining activity encroach onto the allocated 100m buffer zones, effective mitigation of impacts would be unlikely;
- It should be noted that the region in the vicinity of the study area is significantly water stressed and as a result farmers depend on water from the rivers for general water provision for agriculture as well as livestock and game farming with specific reference to the Nzhelele River and Mutamba River. Furthermore, it would be difficult if not impossible to substitute the water supply from rivers with alternative water sources except for possible groundwater use. If the proposed mining activity results in a decrease in available water volumes in the aquifers associated with these water courses, or result in the formation of a cone dewatering, many farmers within the study area as well as downstream areas would be significantly affected in addition to adverse impacts on the ecology of the area.
- The Nzhelele River is also considered to be of increased significance with regards to biodiversity maintenance due to the presence of fish that would be restricted to river corridors and refugia formed during the winter months. Therefore, reduced water volumes will directly impact on the survival as well as migratory corridors of aquatic species. Any reduction of streamflow, as a result of the project that leads to the loss of refugia for aquatic species or the significant loss of downstream water supply, should be considered an high risk on the Nzhelele River.
- Due to the ephemeral nature of the drainage lines, not all drainage lines could be considered riparian habitat as defined by NWA No 36 of 1998. Therefore, distinction was made between drainage lines with riparian zones and drainage lines without riparian zones. Smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year flood lines exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA will also apply and therefore a Water Use License will be required;
- Smaller drainage lines *without* riparian zones are not considered wetlands but are still defined as watercourses. If any activities are to take place with the 1:100 year flood line exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained, however Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA does not apply and therefore no Water Use Licence will be required.

The following general conclusions were drawn upon completion of the aquatic assessment:

- Increased concentrations of dissolved salts were observed in a downstream direction on the Mutamba river with the EC being 6.3 times higher at site GSP13 site compared to the GSP9 site at the most upstream point;
- The Mutamba River is likely to display a naturally high level of variability in dissolved salt concentration linked to seasonality of flow. Close monitoring of these trends will be required in future;
- Spatially there was a 14.0% decrease in pH value in a downstream direction between sites GSP9 and GSP13;
- From a temporal perspective pH value decreased by 1.1% at GSP9 from 2009 to 2013. The observed variations can be attributed to natural temporal variation;
- Dissolved oxygen (DO) concentration decreased by 25.4% in a downstream direction between sites GSP9 and GSP13;
- Dissolved oxygen concentration at upstream site GSP9 falls well within the recommended range, whilst that at the downstream site (GSP13) is below the recommended range indicating that some limitations on the aquatic community in the lower sections of the Mutamba River in the vicinity of the Generaal project will occur;
- There is significant variation in dissolved oxygen over time. The observed variation in dissolved oxygen concentration is likely to be attributed largely to natural variation with biological activity within the system at each point considered to be a significant driver of the variation in the system;
- The temperatures observed at each of the points are deemed natural for the time of year and the nature of the systems.
- Both the Nzhelele River and the Dolidoli River have elevated salt concentrations evident prior to mining taking place indicating that the systems naturally carry a relatively high concentration of dissolved salts;



- Increased concentrations of dissolved salts were observed in a downstream direction. The change was, however, much less pronounced than that observed for the Mutamba River;
 - Compared to the Nzhelele River, EC in the Dolidoli River (GSP17) was much higher (69.3% compared to GSP15 and 88.0% compared to GSP16);
 - Spatially there was a 4.2% decrease in pH value in a downstream direction between sites GSP15 and GSP16. The observed changes in pH value thus fall within the recommended percentage change range from a spatial perspective. The pH, observed in the Dolidoli River was more neutral than that of the Nzhelele River system;
 - Dissolved oxygen (DO) concentration decreased by 8.0% in a downstream direction between sites GSP16 and GSP17. Dissolved oxygen concentration at all the sites on the Nzhelele River and Dolidoli river fall well within the recommended range; The observed variation in dissolved oxygen concentration is likely to be attributed largely to natural variation in biological activity within the system at each point;
 - It is evident that dissolved oxygen saturation was significantly lower in the Dolidoli River than in the Nzhelele River which will limit the ability to support more sensitive aquatic taxa.
 - The temperatures observed at each of the points are deemed natural for the time of year and the nature of the systems.
-
- Based on the IHIA index an overall score of 65.3% was calculated for GSP14 (class "C" and hence considered "Moderately modified"). For GSP15 an average score of 54.6% was calculated, placing this site in class "D" ("Largely modified").
 - Habitat diversity and structure at site GSP15 was considered highly suitable for supporting a diverse and sensitive aquatic macro-invertebrate community. In comparison habitat diversity and structure at site GSP14 was considered inadequate for supporting a diverse and sensitive aquatic macro-invertebrate community.
 - As for the Mutamba River, habitat limitations are likely to limit the diversity, abundance and sensitivity of the aquatic community significantly due to the ephemeral nature of the system;
 - At site GSP14, the Nzhelele River may be considered to be in a class E (severely impaired) condition according to the Dickens & Graham (2001) classification system. According to the Dallas (2007) classification system, the site can be classified as class D;
 - Stream conditions at site GSP15 may also be considered to be in a class E (severely impaired) condition according to the Dickens & Graham (2001) classification system. However, according to the Dallas (2007) classification system, the site can be classified as class C;
 - The latter classification is in agreement with the IHAS assessment, where habitat conditions at GSP15 appear more suited to supporting a diverse and sensitive aquatic macro-invertebrate community when compared to GSP14;
 - Due to the degree of sensitivity of the system to habitat changes and loss of instream flow, careful design and operational procedures will be required to limit the impact on the Nzhelele River.
 - The MIRAI results in terms of (ecological category classification) largely follow the same trends as that obtained using the SASS class classifications with both sites having an ecostatus score of Class D indicating largely modified conditions.
 - The FRAI largely corresponds to that obtained for the MIRAI. Because the habitat (and hence potential drivers) was fairly homogenous between the sites, the refined EC was also similar. The EC for the system indicates that some loss of fish community integrity of the system has occurred, however there is still a significant diversity and abundance of fish present in the system. The EC values calculated during the current assessment are, however, in congruence with results obtained using macro-invertebrate indices (MIRAI and SASS5);
 - Both the Nzhelele River and the Mutamba River, are expected to exhibit broad variability in aquatic community integrity on a temporal scale due to variations in flow and habitat availability within the system. As more data on the system is collected, better inferences on the ecological condition of the community will be possible;

Based on the findings of the aquatic study the Mutamba River is seen to be a water stressed system with the degree of water stress increasing in a downstream direction. Some recovery of the system does however occur in the lower reaches but impacts on the aquatic ecology of the lower reaches of the system are still considered to be likely. The Mutamba River can be considered to be a system of reduced Ecological Importance and Sensitivity in relation to the Nzhelele River due to the limited provision of refugia and in the local area and the limited support it provides to the aquatic ecology of the area. The system is however deemed important in terms of the provision of services to the terrestrial fauna of the area as well as fair significance from a socio-cultural point of view. It is deemed



essential that all effort is made to ensure that impacts on the Mutamba River as a result of the proposed Generaal Project are minimised.

The Nzhelele River can be considered to be a system of high aquatic Ecological Importance and Sensitivity due to the provision of refugia and in the local area and the support it provides to the aquatic ecology of the area. The system is also deemed important in terms of the provision of services to the terrestrial fauna, such as the provision of drinking water of the area as well as a high significance from a socio-cultural point of view, with special mention of water provision for agriculture. It is deemed essential that all effort is made to ensure that impacts on the Nzhelele River as a result of the proposed Generaal Project are minimised.

The proposed Generaal Mining project can be defined as consisting of two major “blocks”. The degree of impact on the aquatic ecology between the various blocks varies significantly. For this reason the impact assessment was divided into two sections as follows addressing the Generaal Section and the Mount Stewart section:

- From the Impact assessment for the Generaal Section it is evident that prior to mitigation the impact on instream flow and water quality is moderately high. Impacts due to a loss of aquatic habitat are considered high while the loss of aquatic biodiversity and less tolerant taxa is deemed moderately low. The impact on riparian vegetation and the loss of wetland ecoservices is considered to be high prior to mitigation. Overall the impact of the proposed Generaal section of the Generaal Project is considered to be high. If mitigation takes place all impacts can be considered to be moderately low level impacts except for the loss of aquatic biodiversity will be a low level impact while the loss of wetland and riparian habitat will remain moderately high. With mitigation the overall impact is considered to be a medium low level impact.
- From the impact assessment results for the Mount Stewart Section it is evident that prior to mitigation all impacts are low level impacts in the Mount Stewart section of the project. Overall the impact of the proposed Mount Stewart section of the Generaal Project is considered to be low prior to mitigation. If mitigation takes place all impacts except loss of aquatic biodiversity and sensitive taxa can be considered to be low while latter impacts can be considered very low. With mitigation the overall impact is considered to be a low level impact.
- The Nzhelele River and to a lesser degree the Mutamba are extremely important systems with these systems providing potable water as well as large volumes of water for the irrigation of crops to the north of the Soutpansberg mountain range. The irrigation of the crops is critical to their success and the crops produced can be considered to be of high significance as the crops are produced in winter when areas further to the south cannot produce food for the South African consumer. Prior to any large scale mining in the area both these systems can already be considered to be stressed from a water supply point of view.
- It is also important to note that no reserve determination has been undertaken for the Sand River. According to DWA (2004), the Nzhelele River is a water stressed region and therefore, the implementation of the ecological Reserve may require compulsory licensing to deal with the over-allocation to the irrigation sector.
- The Sand River system has been identified as a FEPA river system and an upstream support area for a fish FEPA and is therefore considered important in fish conservation. For these reasons extreme caution must be used in decision making in the area with regards to any activity which may affect water supply in the Sand system of which the Mutamba River and Nzhelele River form major tributaries.
- As part of the Greater Soutpansberg Project three very large scale mining operations are proposed which include the Mopane Project, the Chapudi project and the Generaal project. The activities of the Chapudi and Generaal projects are likely to contribute to the cumulative impact on the Mutamba River as well as the cumulative impact on the Nzhelele River although some very small impacts on the Limpopo River system may occur.
- For these reasons extreme caution and care should take place throughout the entire life cycle of these three projects, should they proceed, in order to ensure that the impact on the Sand River system as well as the Nzhelele River system with special mention of the Mutamba River and associated tributaries and other ephemeral systems in the area with riparian vegetation is minimised to levels which would ensure an ongoing acceptable level of functioning and biodiversity in these systems and ensure the implementation of the ecological reserve.



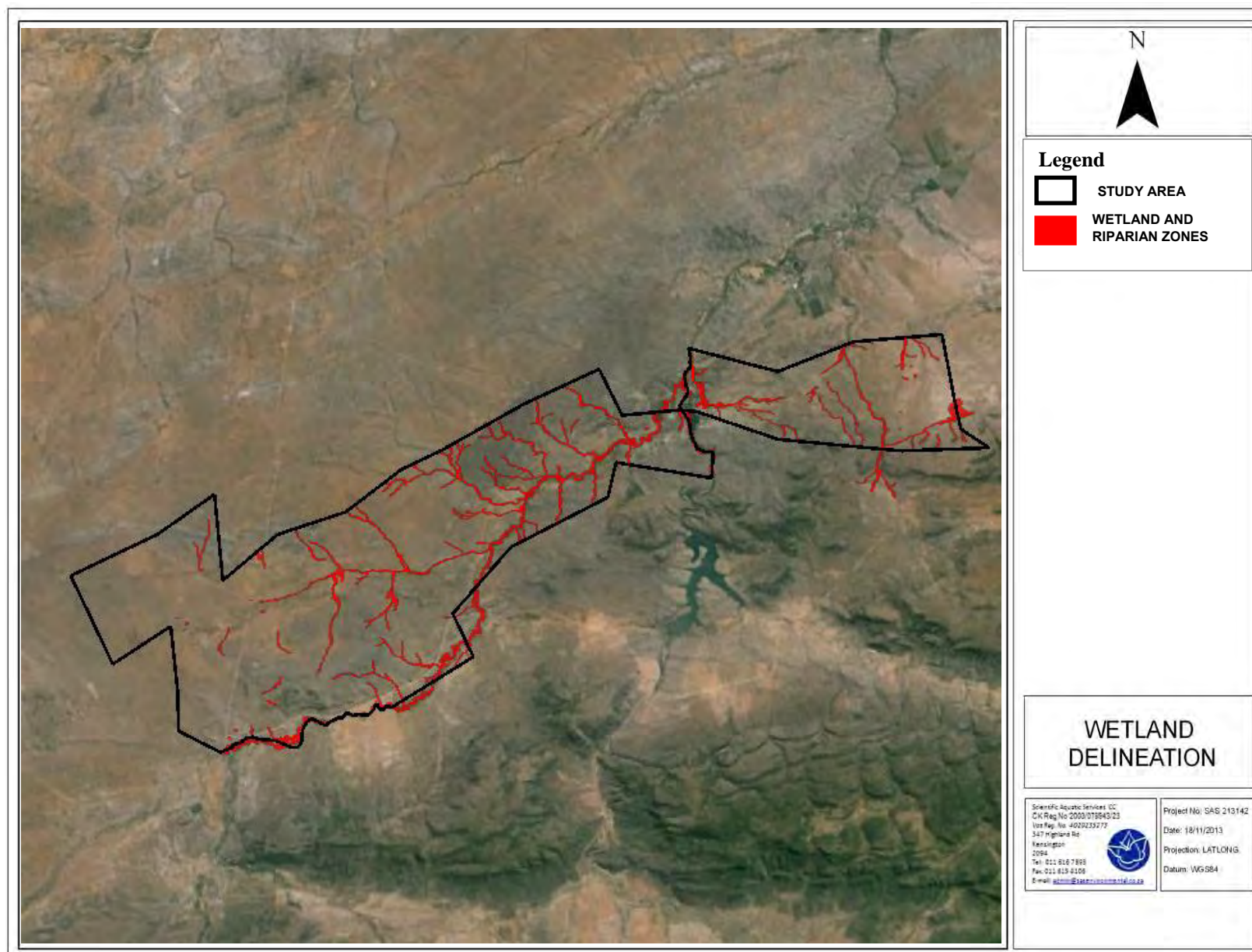


Figure A: Wetland and riparian areas in relation to the study area.



TABLE OF CONTENTS

List of Figures	xi
Acronyms	xv
1 INTRODUCTION	1
1.1 Background	1
1.2 Project Key Staff	4
1.3 Indemnity and Terms of Use of this Report	5
1.4 Legislative Requirements	6
1.5 Assumptions and Limitations	7
2 METHOD OF ASSESSMENT	7
2.1 Literature Review	7
2.2 Wetland Site Selection and Field Verification	8
2.3 Aquatic Ecological Assessment sites and site selection	9
2.4 Classification System for Wetlands and other Aquatic Ecosystems in South Africa	12
2.4.1 Level 1: Inland Systems	13
2.4.2 Level 2: Ecoregions	13
2.4.3 Level 2: NFEPA Wet Veg Groups	16
2.4.4 Level 3: Landscape Setting	16
2.4.5 Level 4: Hydrogeomorphic Units	16
2.5 WET-Health	17
2.5.1 Level of Evaluation	17
2.5.2 Framework for the Assessment	17
2.5.3 Units of Assessment	17
2.5.4 Quantification of Present State of a Wetland	17
2.5.5 Assessing the Anticipated Trajectory of Change	18
2.5.6 Overall Health of the Wetland	19
2.6 Riparian Vegetation Response Assessment Index (VEGRAI)	19
2.7 Wetland Function Assessment	19
2.8 Defining Ecological Importance and sensitivity (EIS)	20
2.9 Index of Habitat Integrity (IHI)	21
2.10 Recommended Ecological Category (REC)	21
2.11 Wetland Delineation	22
2.12 Visual Assessment of Aquatic Assessment Points	22
2.13 Physico-chemical Water Quality Data	22
2.14 Intermediate Habitat Integrity Assessment (IHIA)	23
2.15 Invertebrate Habitat Suitability (Invertebrate Habitat Assessment: IHAS)	23
2.16 Aquatic Macro-Invertebrates: South African Scoring System (SASS5) ..	23
2.17 Aquatic Macro-Invertebrates: Macro-invertebrate Response Assessment Index (MIRAI)	25
2.18 Fish biota: Habitat Cover Rating (HCR) and Fish Habitat Assessment (FHA)	25
2.19 Fish biota: Fish Response Assessment Index (FRAI)	26
2.20 Impact Assessment Report	27
2.20.1 Mitigation Measure Development	31
2.20.2 Recommendations possible	31
3 RESULTS OF LITERATURE REVIEW	31



3.1	Conservation Importance of the Study Area with Regards to Wetlands	31
3.1.1	Ecoregion	31
3.1.2	Ecostatus Classification.....	32
3.1.3	Importance according to the RSA wetland types database (2010) and the National Freshwater Ecosystem Priority Areas (2011) database.....	34
4	WETLAND ASSESSMENT SITE SELECTION RESULTS	40
5	CLASSIFICATION SYSTEM FOR WETLANDS AND OTHER AQUATIC ECOSYSTEMS IN SOUTH AFRICA.....	42
5.1	Rivers	44
5.1.1	Terrain Units	46
5.1.2	Soil	46
5.1.3	Vegetation	46
5.1.4	Surface Water.....	50
5.1.5	Biodiversity	51
5.1.6	Wetland Function Assessment	51
5.1.7	Index of Habitat Integrity (IHI).....	53
5.1.8	Conclusion.....	56
5.2	Smaller Drainage Lines	56
5.2.1	Terrain Units	57
5.2.2	Soil	57
5.2.3	Vegetation	57
5.2.4	Surface Water.....	58
5.2.5	Biodiversity	59
5.2.6	Wetland Function Assessment	59
5.2.7	Index of Habitat Integrity (IHI).....	60
5.2.8	Conclusion.....	61
5.3	Depressions and artificial impoundments	61
5.3.1	Terrain Units	61
5.3.2	Soil	61
5.3.3	Vegetation	61
5.3.4	Surface Water.....	62
5.3.5	Biodiversity	62
5.3.6	Wetland Function Assessment	62
5.3.7	Wet-Health	63
5.3.8	Conclusion.....	64
5.4	Synthesis	64
5.5	Ecological Importance and Sensitivity	65
5.6	GIS Mapping	66
5.7	Delineation and Sensitivity Mapping.....	66
5.7.1	Legislative requirements.....	68
5.7.2	Buffer Allocations.....	68
5.8	Recommended Ecological Class	78
6	AQUATIC ECOLOGICAL ASSESSMENT RESULTS	78
6.1	The Mutamba River	78
6.1.1	Visual Assessment	78
6.1.2	Physico-Chemical Water Quality	81
6.1.3	Intermediate Habitat Integrity Assessment (IHIA).....	83
6.1.4	Invertebrate Habitat Assessment System (IHAS).....	83
6.1.5	Aquatic Macro-Invertebrates:	84



6.1.6	Fish Community Assessment	85
6.2	The Nzhelelele River and Dolidoli River	89
6.2.1	Visual Assessment	89
6.2.2	Physico-Chemical Water Quality	91
6.2.3	Invertebrate Habitat Integrity Assessment (IHIA).....	93
6.2.4	Invertebrate Habitat Assessment System (IHAS).....	93
6.2.5	Aquatic Macro-Invertebrates:	94
6.2.6	Fish Community Assessment	96
6.3	Synthesis	98
7	IMPACT ASSESSMENT	99
7.1	<i>IMPACT 1: Loss of Instream Flow, Aquatic Refugia and Flow Dependent Taxa</i>	<i>99</i>
7.1.1	Discussion	99
7.2	<i>IMPACT 2: Impacts on Water Quality Affecting Aquatic Ecology</i>	<i>103</i>
7.2.1	Introductory discussion and Rationale.....	103
7.2.2	Increased sediment load in larger rivers	103
7.2.3	Impaired water quality due to pollutants discharged from processing plant.....	104
7.2.4	Impaired water quality due to pollutants in runoff from stockpiles.....	104
7.2.5	Impaired water quality due to pollutants in water discharged from opencast pits	104
7.2.6	Impaired water quality due to petrochemical spills	104
7.2.7	Heavy metal contamination	104
7.3	<i>IMPACT 3: Loss of Aquatic Habitat.....</i>	<i>106</i>
7.4	<i>IMPACT 4: Loss of Aquatic Biodiversity and Sensitive Taxa.....</i>	<i>108</i>
7.5	<i>IMPACT 5: Loss of Wetland and Riparian Habitat.....</i>	<i>111</i>
7.6	<i>IMPACT 6: Changes to Wetland Ecological and Socio-cultural Service Provision.....</i>	<i>115</i>
7.7	SUMMARY OF AQUATIC AND WETLAND ECOLOGICAL IMPACTS	117
7.7.1	Impact assessment summary	117
7.7.2	Cumulative impacts.....	118
8	CONCLUSION.....	119
9	REFERENCES	124
Appendix 1	IHIA data.....	126
Appendix 2:	IHAS Score sheets September 2013	129
Appendix 3:	SASS5 Score sheets September 2013	133

List of Figures

Figure 1:	Location of the study area depicted on an aerial photograph in relation to surrounding areas.	2
Figure 2:	1:250 000 Topographic map depicting the location of the study area in relation to surrounding areas.	3
Figure 3:	Ecological categories (EC) eco-status A to F continuum approach employed (Kleynhans and Louw 2007)	8
Figure 4:	Aquatic ecological assessment points presented on a digital satellite image.....	10
Figure 5:	Riverine aquatic ecological assessment points presented on a 1:250 000 topographical map.....	11
Figure 6:	Map of Level 1 Ecoregions of South Africa, with the approximate position of the study area indicated in red.....	14
Figure 7:	Map of Level 1 Ecoregions of South Africa, with the study area and aquatic ecological assessment points.	15



Figure 8:	SASS5 Classification using biological bands calculated from percentiles for the Limpopo plain ecoregion, Dallas, 2007.....	24
Figure 9:	Map depicting the rivers located within the study area.....	35
Figure 10:	NFEPA wetland types within the Generaal Area.....	37
Figure 11:	Natural and Artificial wetlands within the Generaal Area.....	38
Figure 12:	NFEPA wetland conditions within the Generaal Area.....	39
Figure 13:	Areas of interest selected for assessment during the field survey.....	41
Figure 14:	Locations of the wetland types in relation to the study area.....	43
Figure 15:	Mutamba River.....	45
Figure 16:	Nzhelele River.....	45
Figure 17:	Dolidoli River.....	45
Figure 18:	Alluvial soil within the active channel of rivers.....	46
Figure 19:	Cross sectional sketch of a river system and associated riparian zone.....	47
Figure 20:	Representative points on the Mutamba River.....	48
Figure 21:	Representative points on the Nzhelele River.....	50
Figure 22:	Representative points on the Dolidoli River.....	50
Figure 23:	Radar plot of wetland services.....	52
Figure 24:	Example of a drainage line within the study area.....	57
Figure 25:	Radar plot of wetland services.....	60
Figure 26:	Radar plot of wetland services.....	63
Figure 27:	Terrestrial artificial dam (left) and a dam with artificial wetland conditions (right) observed during the field survey.....	64
Figure 28:	Terrain unit used as primary indicator and vegetation as the secondary indicator.....	67
Figure 29:	Gleying evident within the soil profile of the smaller drainage lines with riparian zones (left); gleyed soils within the permanent zone of pans (right).....	67
Figure 30:	Allocated 100m buffer zones in relation to the study area (Divided into the Generaal and Mount Stuart sections below).....	69
Figure 31:	Allocated 100m buffer zones in relation to the Generaal section.....	70
Figure 32:	Allocated 100m buffer zones in relation to the Mount Stuart section.....	71
Figure 33:	PES Maps based on the same principle as above (divided into Generaal and Mount Stuart sections).....	72
Figure 34:	PES Map (Generaal section).....	73
Figure 35:	PES Map (Mount Stuart section).....	74
Figure 36:	EIS Maps based on the same principle as above (divided into Generaal and Mount Stuart sections).....	75
Figure 37:	EIS Map (Generaal section).....	76
Figure 38:	EIS Map (Mount Stuart section).....	77
Figure 39:	Upstream view of the GSP8 site on the Mutamba River showing the very limited flow at the time of assessment.....	78
Figure 40:	Downstream view of the GSP8 site showing the excellent rocky substrate present.....	78
Figure 41:	A general view of the Mutamba River (GSP11) where the River enters the Generaal Project Area.....	79
Figure 42:	A general view of the middle section of the Mutamba River (GSP12) showing the well-developed riparian zone of the system.....	79
Figure 43:	Upstream view of the GSP13 site on the Mutamba River showing the dense reed growth.....	79
Figure 44:	Downstream view of the GSP13 site showing the small pool below the bridge.....	79
Figure 45:	Physico-chemical water quality showing spatial trends.....	82
Figure 46:	HCR scores for the GSP9 site assessed on the Mutamba River.....	86
Figure 47:	Upstream view of the GSP16 site on the Dolidoli River showing the very limited flow at the time of assessment.....	89
Figure 48:	Downstream view of the GSP16 site showing the sparse nature of the riparian zone.....	89



Figure 49:	Upstream view of the GSP14 site on the Nzelele River showing the dense reed growth on the banks.	89
Figure 50:	Downstream view of the GSP14 site on the Nzhelele River showing the slow flowing nature of the water at this point.	89
Figure 51:	Upstream view of the GSP15 site on the Nzhelele River indicating the presence of some shallows in the area and dense algal growth on the rocky substrate.....	90
Figure 52:	Downstream view of the GSP15 site showing the deeper pool and bulrush lined banks.	90
Figure 53:	Physico-chemical water quality showing spatial trends on the Nzhelele River.....	92
Figure 54:	HCR scores for the two sites assessed on the Nzhelele River	97

List of Tables

Table 1:	Classification of river health assessment classes in line with the RHP	8
Table 2:	Location of the biomonitoring points with co-ordinates	9
Table 3:	Proposed classification structure for Inland Systems, up to Level 3.	12
Table 4:	Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.	12
Table 5:	Impact scores and categories of present State used by WET-Health for describing the integrity of wetlands.....	18
Table 6:	Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.....	18
Table 7:	Descriptions of the A-F ecological categories.	19
Table 8:	Classes for determining the likely extent to which a benefit is being supplied.....	20
Table 9:	Wetland EIS category definitions, (1999).	20
Table 10:	Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).	21
Table 11:	Definition of Present State Classes in terms of SASS and ASPT scores as presented in Dickens and Graham (2001).....	24
Table 12:	Intolerance ratings for naturally occurring indigenous fish species with natural ranges included in the Mutamba and Nzhelele Rivers ⁴ (Limpopo River system) of the study area (Skelton, 2001; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).	26
Table 13:	Criteria for assessing significance of impacts.....	28
Table 14:	Significance rating matrix.....	30
Table 15:	Positive/Negative Mitigation Ratings	30
Table 16:	Summary of the ecological status of the Limpopo Plains Region.	32
Table 17:	Classification of river health assessment classes in line with the RHP.....	32
Table 18:	Summary of the ecological status of quaternary catchments A71L, A80F and A80G based on Kleynhans (1999).....	33
Table 19:	Classification for smaller pans (SANBI 2013).....	42
Table 20:	Classification for the Rivers (SANBI 2013).....	42
Table 21:	Classification for the drainage lines (SANBI 2013).....	42
Table 22:	Dominant floral species identified during the assessment of the rivers.	47
Table 23:	VEGRAI Ecological Category Description Scores for the Mutamba River.....	49
Table 24:	VEGRAI Ecological Category Description Scores for the Nzhelele River.....	49
Table 25:	VEGRAI Ecological Category Description Scores for the Dolidoli River.....	49
Table 26:	Wetland service and function assessment.	52
Table 27:	GSP 8.....	53
Table 28:	GSP 9.....	53
Table 29:	GSP 10.....	54
Table 30:	GSP 11.....	54
Table 31:	GSP 12.....	54
Table 32:	Overall PES of the Nzhelele River in the Vicinity of the Generaal mining project.....	55
Table 33:	GSP 15.....	55
Table 34:	Dominant floral species identified during the assessment of the smaller drainage lines.....	58



Table 35:	VEGRAI Ecological Category Description Scores for the drainage lines with riparian zones.....	58
Table 36:	Wetland service and function assessment.	59
Table 37:	Smaller Drainage Lines IHI.	60
Table 38:	Dominant floral species identified during the assessment of smaller pans.....	62
Table 39:	Wetland service and function assessment.	62
Table 40:	Summary of the overall health of the features based on impact score and change score.....	63
Table 41:	EIS determination for the various river systems within the study area.....	65
Table 42:	EIS determination for the smaller pans within the study area.	66
Table 43:	Assigned REC Classes.....	78
Table 44:	Visual description of the sites selected on the Mutamba River.....	80
Table 45:	Biota specific water quality data for the assessed river assessment sites.....	81
Table 46:	Oxygen measured expressed as a percentage of maximum at the temperature measured.....	82
Table 47:	A summary of the results obtained from the application of and IHAS indices to the assessment site on the Mutamba River.....	83
Table 48:	Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites.....	84
Table 49:	Summary of the results obtained from the application of the SASS5 index to the assessment site on the Matumba River.....	84
Table 50:	Summary of the results (ecological categories) obtained from the application of the MIRAI to the GSP9 assessment site on the Mutamba River, compared to classes awarded using SASS5.....	85
Table 51:	Intolerance ratings for naturally occurring indigenous fish species with natural ranges included in the Mutamba River ⁴ (Limpopo River system) of the study area (Skelton, 2001; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).	86
Table 52:	Fish species collected at the various sites indicating abundance (i.e. numbers collected used for site score evaluation in the FRAI assessment) with natural ranges included in the Mutamba River (Limpopo River system) of the study area (Skelton, 2001; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).	87
Table 53:	Summary of the results (ecological categories) obtained from the application of the FRAI to the GSP9 assessment site on the one site on the Mutamba River, compared to that obtained using MIRAI.....	88
Table 54:	Visual description of the sites selected on the Dolidoli and Nzhelele River systems.....	90
Table 55:	Biota specific water quality data for the assessed Nzhelele and Dolidoli Rivers assessment sites.....	91
Table 56:	Oxygen measured expressed as a percentage of maximum at the temperature measured.....	92
Table 57:	A summary of the results obtained from the application of and IHAS indices to the assessment site on the Nzhelele River.....	94
Table 58:	Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites.....	95
Table 59:	Summary of the results obtained from the application of the SASS5 index to the two Nzhelele River assessment sites.....	95
Table 60:	Summary of the results (ecological categories) obtained from the application of the MIRAI ecostatus tool to the GSP14 and GSP15 assessment sites on the Nzhelele River, compared to classes awarded using SASS5.....	96
Table 61:	Fish species collected at the various sites indicating abundance (i.e. numbers collected used for site score evaluation in the FRAI assessment) with natural ranges included in the Nzhelele River (Limpopo River system) of the study area (Skelton, 2001; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).	97



Table 62:	Summary of the results (ecological categories) obtained from the application of the FRAI to two assessment sites on the Nzhelele River, compared to that obtained using MIRAI.....	98
Table 63:	A summary of the results obtained from the assessment of aquatic ecological impacts for the Generaal section	117
Table 64:	A summary of the results obtained from the assessment of aquatic ecological impacts for the Mount Stewart section.....	118

Acronyms

<i>BGIS</i>	-	Biodiversity Geographic Information Systems
°C	-	Degrees Celsius.
<i>DEMC</i>	-	Desired Ecological Management Class
<i>DWA</i>	-	Department of Water Affairs
<i>EAP</i>	-	Environmental Assessment Practitioner
<i>EC</i>	-	Ecological Class or Electrical Conductivity (use to be defined in relevant sections)
<i>EIA</i>	-	Environmental Impact Assessment
<i>EIS</i>	-	Ecological Importance and Sensitivity
<i>EMC</i>	-	Ecological Management Class
<i>EMP</i>	-	Environmental Management Program
<i>FRAI</i>	-	Fish Response Assessment Index
<i>GIS</i>	-	Geographic Information System
<i>GN</i>	-	General Notice
<i>GSP</i>	-	Greater Soutpansberg Projects
<i>HCR</i>	-	Habitat Cover Ratings
<i>HG</i>	-	Hydrogeomorphic
<i>HGM</i>	-	Hydrogeomorphic Units
<i>IHAS</i>	-	Invertebrate Habitat assessment System
<i>IHIA</i>	-	Intermediate Habitat Integrity Assessment
<i>IH</i>	-	Index of Habitat Integrity
<i>m</i>	-	Meter
<i>MIRAI</i>	-	Macro-invertebrate Response Assessment Index
<i>MPRDA</i>	-	Mineral and Petroleum Resources Development
<i>NAEHMP</i>	-	National Aquatic Ecosystem Health Monitoring Programme
<i>NEMA</i>	-	National Environmental Management Act
<i>NBA</i>	-	National Biodiversity Assessment
<i>NFEPA</i>	-	National Freshwater Ecosystem Priority Areas
<i>NOMR</i>	-	New Order Mining Rights
<i>NSBA</i>	-	National Spatial Biodiversity Assessment
<i>NWA</i>	-	National Water Act
<i>NWCS</i>	-	National Wetland Classification System
<i>PEMC</i>	-	Present Ecological Management Class
<i>PPP</i>	-	Public Participation Process
<i>REC</i>	-	Recommended Ecological Category
<i>RHP</i>	-	River Health Program
<i>SACNASP</i>	-	South African Council for Natural Scientific Professions
<i>SANBI</i>	-	South African National Biodiversity Institute
<i>SAS</i>	-	Scientific Aquatic Services
<i>SASSA</i>	-	South African Soil Surveyors Association



<i>SASS5</i>	-	South African Scoring System 5
<i>VEGRAI</i>	-	Vegetation Response Assessment Index
<i>WMA</i>	-	Water Management Areas
<i>subWMA</i>	-	Sub-Water Management Area
<i>WetVeg Groups</i>	-	Wetland Vegetation Groups



1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the wetland, aquatic and riparian resources as part of the environmental assessment and authorisation process for the proposed Greater Soutpansberg Generaal Project (hereafter referred to as the „study area“) which extends over approximately 22 954ha (depicted in Figure 1 and Figure 2 below).

The Generaal Project forms part of the Greater Soutpansberg Projects (GSP) situated to the north of the Soutpansberg in the Limpopo Province. It is evident that they are within close vicinity of each other, permitting possible rationalisation of infrastructure. Based on the prospecting rights held the proponent submitted similar applications for New Order Mining Rights (NOMRs) in terms of Section 22 of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA). The objective is to have a consolidated project with economically minable blocks which are contiguous.

The Generaal Project is situated in the magisterial district of Vhembe, in the Limpopo Province, approximately 35 km north of the Makhado Town in the Makhado and Musina Local Municipal areas. Musina is situated approximately 70 km to the north. The Generaal Project area is located north of the Mutamba River and reaches from west of the N1 north eastwards to 5 km south of Tshipise, and is divided into two (2) sections, namely the Generaal Section and the Mount Stuart Section

The land coverage in the Generaal Project area is mixed between intensive irrigated agriculture, hunting and ecotourism. The intensive irrigated agricultural activities are focused along the Nzhelele River and to a lesser degree the Mutamba River catchment and neighbouring areas.

The majority of the intensive agricultural area is utilised for predominantly citrus production with some vegetable production and is known as the winter pantry (production area) of South Africa. Some of the properties are also focused on mixed farming, with a mixture of livestock, game and irrigated agriculture. A number of pack houses for fresh commodities are operational in the region. The fresh produce markets remain a major outlet for fresh produce. Direct marketing is also a popular marketing outlet and producers deliver direct to chain stores such as Woolworths, Pick „n Pay etc.

Hunting, game trading and eco-tourism is an established socio-economic driver in the area. There are a number of properties utilised for trophy (for local and foreign tourists) and biltong hunting with ecotourism spin-off activities.



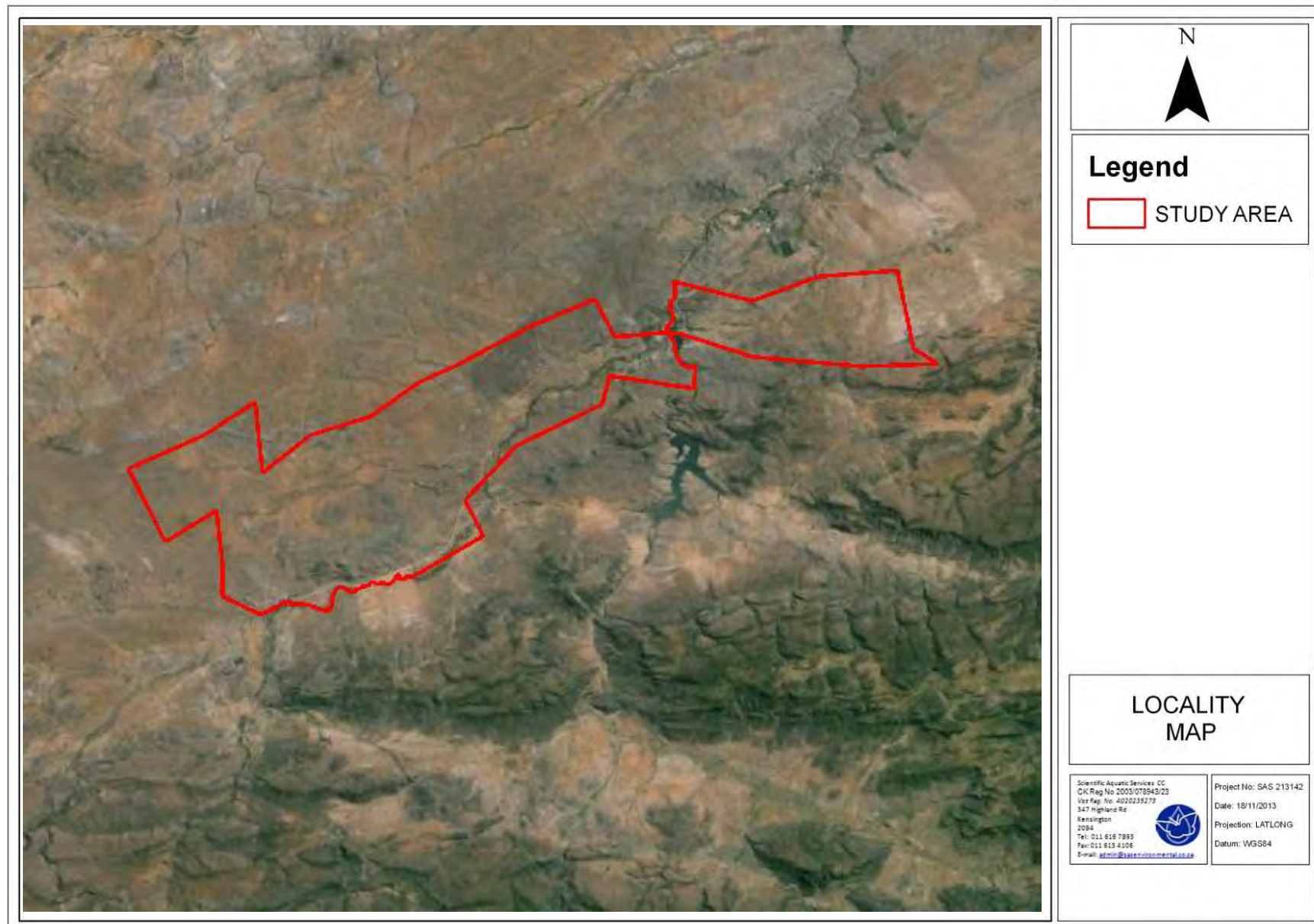


Figure 1: Location of the study area depicted on an aerial photograph in relation to surrounding areas.



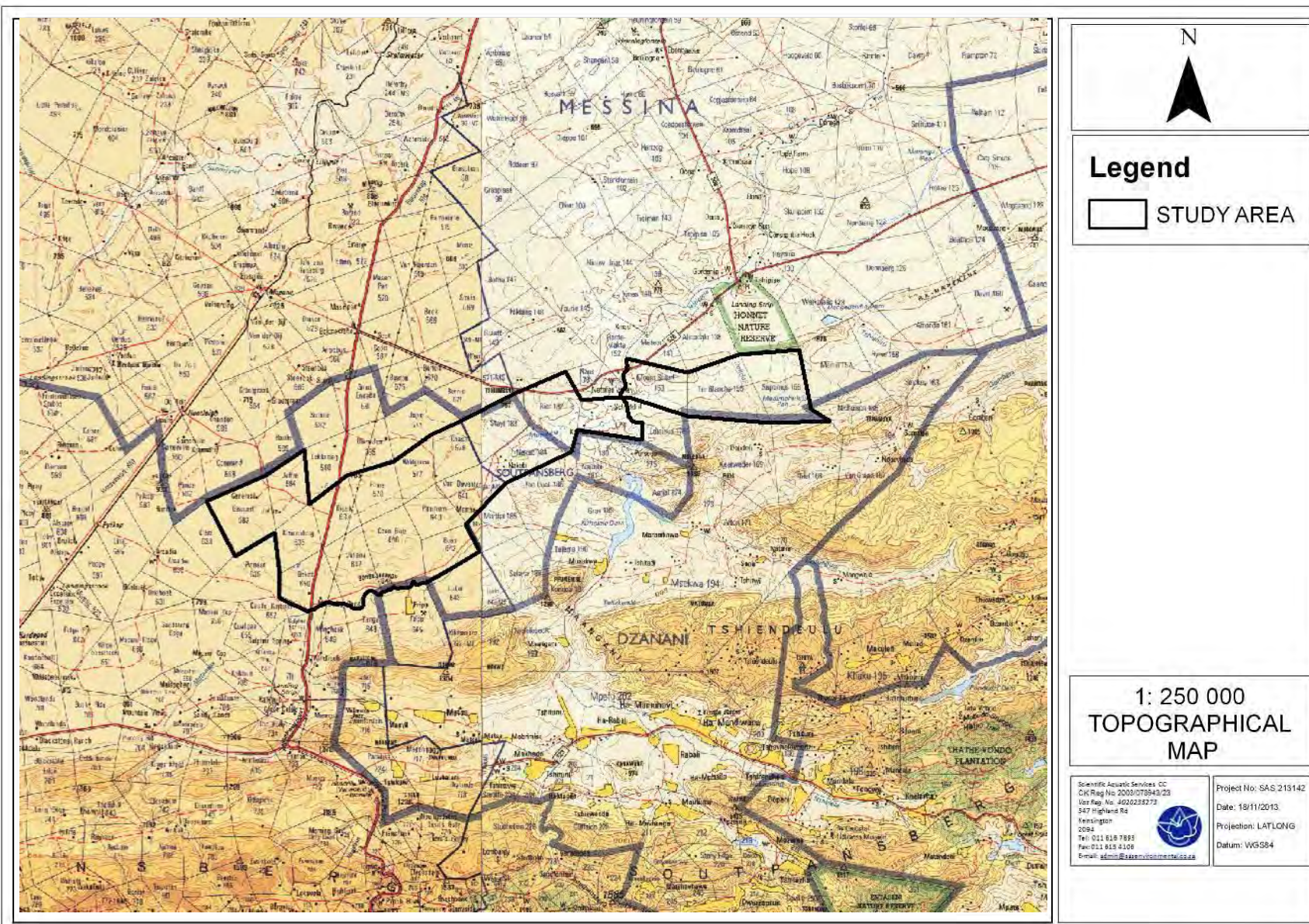


Figure 2: 1:250 000 Topographic map depicting the location of the study area in relation to surrounding areas.



1.2 Project Key Staff

Stephen van Staden

SACNASP REG.NO: 400134/05

Stephen van Staden completed an undergraduate degree in Zoology, Geography and Environmental Management at RAU. On completion of this degree, he undertook an honours course in Aquatic health through the Zoology department at RAU. In 2002 he began a Masters degree in environmental management, where he did his mini dissertation in the field of aquatic resource management, also undertaken at RAU. At the same time, Stephen began building a career by first working at an environmental consultancy specialising in town planning developments, after which he moved to a larger firm in late 2002. From 2002 to the end of 2003, he managed the monitoring division and acted as a specialist consultant on water resource management issues and other environmental processes and applications. In late 2003, Stephen started consulting as an independent environmental scientist, specialising in water resource management under the banner of Scientific Aquatic Services. In addition to aquatic ecological assessments, clients started enquiring about terrestrial ecological assessments and biodiversity assessments. Stephen, in conjunction with other qualified ecologists, began facilitating these studies as well as highly specialised studies on specific endangered species, including grass owls, arachnids, invertebrates and various vegetation species. Scientific Aquatic Services soon became recognised as a company capable of producing high quality terrestrial ecological assessments. Stephen soon began diversifying into other fields, including the development of EIA process, EMPR activities and mine closure studies.

Stephen has experience on well over 1000 environmental assessment projects with specific mention of aquatic and wetland ecological studies, as well as terrestrial ecological assessments and project management of environmental studies. Stephen has a professional career spanning more than 10 years, of which almost the entire period has been as the owner and Managing member of Scientific Aquatic Services and the project manager on most projects undertaken by the company. Stephen has also obtained extensive experience in wetland and aquatic assessments in the Limpopo Plains aquatic ecoregion.

Stephen is registered by the SA RHP as an accredited aquatic biomonitoring specialist and is also registered as a Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP) in the field of ecology. Stephen is also a member of the Gauteng Wetland Forum and South African Soil Surveyors Association (SASSO).

Natasha van de Haar

SACNASP REG.NO: 400229/11

Natasha obtained a Masters Degree in Science (M.Sc.) in the field Botany with specialisation in Molecular Biology and Biotechnology, which was conferred in 2008. Prior to the M.Sc., she obtained an Honours Degree (B.Sc. Hons.) (Botany). Her undergraduate studies took place in the science faculty (Natural and Environmental Sciences) majoring in Botany and Zoology. All degrees were obtained from the University of Johannesburg, formerly known as the Rand Afrikaans University (RAU). Natasha initiated her professional career as a micro technologist at Le-Sel Researchers. She then went on to become a researcher and Laboratory Technician for the department of Botany and Plant Biotechnology at the University of Johannesburg. The research she undertook during this time entailed the identification of micro-organisms and the role they play in the breakdown of diesel spillages. Natasha then went on to become a Laboratory Manager for Rapula Flora specialising in *Zantedeschia* tissue culture.

Natasha joined Scientific Aquatic Services in 2009, where she began undertaking studies as a field ecologist focusing on floral biodiversity and ecological functioning, with special mention of wetland ecology and functioning within South Africa (all provinces), Lesotho and Ghana. Since then she has initiated a branch of Scientific Aquatic Services in Cape Town servicing the Western Cape, Eastern Cape as well as Northern Cape Provinces. Natasha has obtained extensive experience in conducting terrestrial as well as wetland related surveys in the mining, residential and infrastructure development industries as well as development of several wind energy facilities. Natasha also gained experience in Biodiversity Offset Initiatives as well as RDL/protected plant permit applications.



Over the course of her career, Natasha has completed a number of floral identification short courses as well as wetland assessment courses and is registered as a Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP) in the field of botany. Natasha is also a member of the International Affiliation for Impact Assessments (IAIAsa) group, Botanical Society of SA as well as the Western Cape Wetlands Forum.

Dionne Crafford

Dionne Crafford matriculated in 1993 and obtained a BSc Ecology degree from the University of Pretoria in 1996. He obtained his BSc (Hons) Zoology degree with distinction at the same university in 1997, where he was awarded the Zoological Society of Southern Africa (ZSSA) award for the best honours student in Zoology. His honours project focused on behavioural ecology (grass owl acoustics).

He spent 1998 in the United States of America exploring various warm water fly fishing opportunities, before returning to enroll for an MSc in Zoology at the Rand Afrikaans University in 1999. He obtained the degree with distinction in 2000 and was awarded the Neitz Medallion for the best MSc in Zoology by the Parasitological Society of Southern Africa (PARSA). His MSc project was on aquatic environmental management/biological monitoring using catfish and their parasites as indicators of water quality.

From 2001 to 2006 he was first employed as "Veterinary Researcher" and later "Specialist Veterinary Researcher" by former Intervet at their Malelane research facility. From 2003 to 2006 he also performed part-time fly fishing guiding services for the former Fly Fishing Outfitters (Nelspruit). He moved to Bloemfontein in 2007 where he was employed as "Assistant Manager: Endoparasitology" at ClinVet International (Pty) Ltd from 2007 to 2012. In 2009 he enrolled for a part-time PhD in Zoology (monogenean parasites of freshwater fish) at the University of Johannesburg and received his degree in 2013. As from 2013 he is employed as Associate Scientific Writing Manager at ClinVet and also performs scientific writing services for Scientific Aquatic Services. In the latter capacity he has participated in a number of studies relating to aquatic biomonitoring and toxicity testing.

Louise Zdanow (B.Sc. Hons UCT)

Louise Zdanow completed an undergraduate degree majoring in Botany and Zoology at the Nelson Mandela Metropolitan University. This degree was awarded with distinction in 2009. On completion of this degree, Louise undertook an honours course in Botany at the University of Cape Town (2011). During her honours year she completed two mini theses, both of which focused on plant ecophysiology. During her time at UCT Louise underwent training in the identification of fynbos species and communities. From her experience in the field, she has gained an understanding of the unique systems and processes found within fynbos vegetation.

Louise graduated from UCT at the end of 2011 and joined Scientific Aquatic Services at the beginning of 2012. Since joining the company Louise has gained experience in the Western Cape, the Northern Cape as well as the Eastern Cape Provinces and has completed work in Mozambique. She has been involved in both floral and wetland based ecological assessments, including the assessment of wind energy facilities in the Western Cape, the development of rescue and relocation plans for mining developments in the Western Cape, the Northern Cape, the Limpopo and Mpumalanga Provinces and the ecological assessment of residential, mining, agricultural and infrastructural developments. Louise is also a member of the Botanical Society of South Africa as well as the Western Cape Wetlands Forum.

1.3 Indemnity and Terms of Use of this Report

The findings, results, observations, conclusions and recommendations presented in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken.

SAS cc and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although SAS cc exercises due care and diligence in rendering services and preparing documents, SAS cc accepts no liability and the client, by receiving this document, indemnifies SAS cc and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages



and expensed arising from or in connection with services rendered, directly or indirectly by SAS cc and by the use of the information contained in this document.

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

1.4 Legislative Requirements

Minerals and petroleum Resource Development Act (MPRDA) (Act 28 of 2002)

The obtaining of a New Order Mining Right (NOMR) is governed by the MPRDA. The MPRDA requires the applicant to apply to the DMR for a NOMR which triggers a process of compliance with the various applicable sections of the MPRDA. The NOMR process requires environmental authorisation in terms of the MPRDA Regulations and specifically requires the preparation of a Scoping Report, an Environmental Impact Assessment (EIA) and Environmental Management Programme (EMP), and a Public Participation Process.

National Environmental Management Act (Act 107 of 1998)

- The National Environmental Management Act (Act 107 of 1998) and the associated Regulations (Listing No R. 544, No R. 545 and R. 546) as amended in June 2010, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact.

National Water Act (NWA; Act 36 of 1998)

- The NWA; Act 36 of 1998 recognises that the entire ecosystem and not just the water itself in any given water resource, constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water Affairs (DWA).
- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWA in terms of Section 21 of the NWA.

General Notice (GN) 1199 as published in the Government Gazette 32805 of 2009 as it relates to the NWA, 1998 (Act 36 of 1998)

- Wetlands are extremely sensitive environments and as such, the Section 21 (c) and (i) water use General Authorisation does not apply to any wetland or any water resource within a distance of 500 meters upstream or downstream from the boundary of any wetland.

GN 704 – Regulations on use of water for mining and related activities aimed at the protection of water resources, 1999

- These Regulations, forming part of the NWA, were put in place in order to prevent the pollution of water resources and protect water resources in areas where mining activity is taking place from impacts generally associated with mining.
- It is recommended that the proposed project complies with Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) which contains regulations on use of water for mining and related activities aimed at the protection of water resources. GN 704 states that:

No person in control of a mine or activity may:

- (a) *locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on waterlogged ground, or on ground likely to become waterlogged, undermined, unstable or cracked;*

According to the above, the activity footprint must fall outside of the 1:100 year floodline of the drainage feature or 100m from the edge of the feature, whichever distance is the greatest.



1.5 Assumptions and Limitations

- Access to the numerous farms, was not granted and therefore these farms were not ground truthed. However, the precautionary principle was applied and all features identified on a desktop level, included in the specialist study as well as sensitivity mapping as part of this report. As best as possible the observations made through the rest of the project area as well as other projects in the area were extrapolated to allow for characterisation of the riparian and wetland resources on the subject property;
- The wetland assessment is confined to the study area as well as the immediate adjacent areas of relevance and does not include the neighbouring and adjacent properties;
- Due to the extent of the areas that form part of the study area, use was made of aerial photographs, digital satellite imagery as well as provincial and national wetland databases to identify areas of interest prior to the field survey. Any additional wetland areas and drainage lines noted during the field survey were also assessed and added to the number of survey points. Although all possible measures were undertaken to ensure all wetland features, riparian zones and drainage lines were assessed and delineated, some smaller ephemeral drainage lines may have been overlooked. However, if the sensitivity map is consulted during the planning phases of the mine the majority of wetland habitat considered to be of increased EIS will be safeguarded;
- Due to the majority of drainage features being ephemeral within the region, very few areas were encountered that displayed more than one wetland characteristic as defined by the DWA (2005) method. As a result, identification of the outer boundary of temporary wetland zones and riparian zones proved difficult in some areas and in particular in the areas where wetland conditions and riparian zones are marginal. Therefore, the wetland delineation as presented in this report is regarded as a best estimate of the wetland boundary based on the site conditions present at the time of assessment;
- Wetlands and terrestrial areas form transitional areas where an ecotone is formed as vegetation species change from terrestrial species to facultative wetland species. Within this transition zone some variation of opinion on the wetland or riparian zone boundary and the occurrence of a true riparian zone may occur. However, if the DWA 2005 method is followed, all assessors should get largely similar results; and
- Aquatic, wetland and riparian ecosystems are dynamic and complex. Some aspects of the ecology of these systems, some of which may be important, may have been overlooked. The findings of this study were largely based on a single site visit undertaken late in the low flow season at a time when extremely low flows were being experienced. A more reliable assessment would have required that seasonal assessments take place with at least one assessment in the high flow season also undertaken. Some historical data for Mutamba River was available upstream of the proposed Generaal Project, from which limited additional inferences could be made about the drainage systems of the area in different seasons.

2 METHOD OF ASSESSMENT

2.1 Literature Review

A desktop study was compiled with all relevant information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (<http://bgis.sanbi.org>). Wetland specific information resources taken into consideration during the desktop assessment of the study area included:

- National Freshwater Ecosystem Priority Areas (NFEPAs, 2011)
 - NFEPa water management area (WMA)
 - NFEPa wetlands/National wetlands map
 - Wetland and estuary FEPA
 - FEPA (sub)WMA % area
 - Sub water catchment area FEPAs
 - Water management area FEPAs
 - Fish sanctuaries
 - Wetland ecosystem types
- Threatened Terrestrial Ecosystems for South Africa, 2009
- National Wetlands Inventory, 2006

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the EIS,



Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined, and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems.

Water resources are generally classified according to the degree of modification or level of impairment. The classes used by the South African River Health Program (RHP) are presented in the table below and will be used as the basis of classification of the systems in the study area.

Table 1: Classification of river health assessment classes in line with the RHP

Class	Description
A	Unmodified, natural.
B	Largely natural, with few modifications.
C	Moderately modified.
D	Largely modified.
E	Extensively modified.
F	Critically modified.

In addition the ecological category (EC) classification will be employed using the eco-status A to F continuum approach (Kleynhans and Louw 2007). This approach allows for boundary categories denoted as B/C, C/D etc., as illustrated in Figure 3.



Figure 3: Ecological categories (EC) eco-status A to F continuum approach employed (Kleynhans and Louw 2007)

2.2 Wetland Site Selection and Field Verification

Due to the extent of the areas that form part of the study area, use was made of aerial photographs, digital satellite imagery as well as provincial and national wetland databases to identify points of interest prior to the field survey. Points of interest were defined taking the following into consideration:

- Ensuring a geographic spread of points to ensure that conditions in all areas were addressed; and
- Ensuring that features displaying a diversity of digital signatures were identified in order to allow for field verification. In this regard specific mention is made of the following:
 - Riparian vegetation: a distinct increase in density as well as tree size near drainage lines;
 - Hue: with drainage lines and outcrops displaying soils of varying chroma created by varying vegetation cover and soil conditions identified; and
 - Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions being identified.

A site visit was undertaken during September 2013 to assess as many of the points of interest as possible which were identified during the desktop assessment phase. The presence of any wetland characteristics as defined by the DWA 2005 or riparian habitat as defined by the NWA (Act 36 of 1998) was noted at each river, drainage line, pan and artificial impoundment to determine if features can be considered to contain areas displaying wetland or riparian characteristics. Factors influencing the habitat integrity of each feature group identified during the field survey was noted, the functioning and the environmental and socio-cultural services provided by the various features was determined.



2.3 Aquatic Ecological Assessment sites and site selection

Aquatic ecological assessments were undertaken at one point on the Mutamba River a very long distance upstream of the proposed Generaal Project. No areas further down in the catchment were identified where sufficient surface water was present to allow aquatic ecological assessments to be undertaken. One point in the lower Mutamba River was identified with some surface water and an assessment of the water quality at this point was undertaken in order to compare to the upstream site. In addition historical information from several sites upstream of the Generaal project was available which was used to further aid in the characterization of the aquatic ecology of the Mutamba River. Two points were also assessed on the Nzelele River. Both these points were located in the lower areas of the project area and the data from these points serves to provide temporal reference data prior to mining taking place in the area. On assessment point was also identified on the Dolidoli River upstream of the mining area which was used to describe the system in lieu of the areas within the project area not being accessible at the time of sampling. One site (GSPG W1) represented wetland areas which were assessed in order to obtain an indication of the ecology of the small impoundments within the project area.

Table 2 below present geographic information with regards to the monitoring points on the Nzhelele River, Mutamba River and Dolidoli River systems as well as the wetland system assessed. Figure 4 visually presents the locations of the various points along the various river systems, assessed either in the current assessment or by accessing information available from the literature review and historical data collected.

Table 2: Location of the biomonitoring points with co-ordinates

Site	Detailed Site Description	GPS coordinates	
		South	East
Riverine assessment points			
GSP8	Mutamba River upstream of the project area. only historical data available	-22.9322	29.7499
GSP9	Mutamba River on upstream border of the project area	-22.8828	29.7964
GSP10	Mutamba River halfway between the R523 and the N1	-22.8374	29.8325
GSP11	Mutamba River halfway where it crosses the N1	-22.8053	29.8921
GSP12	Mutamba River in the lower areas to the west of the N1 where more dense riparian vegetation was observed	-22.6828	30.0806
GSP13	Mutamba River a short distance upstream of the confluence with the Nzelele River at a dirt road crossing	-22.6833	30.0943
GSP14	Nzhelele River in the vicinity of the proposed mining operations	-22.6833	30.0943
GSP15	Nzhelele River downstream of current citrus farming areas and proposed mining areas	-22.6605	30.0952
GSP16	Dolidoli River which runs through the eastern areas of the MRA	-22.6927	30.1801
Wetland/artificial impoundment assessment points			
GSPG W1	Artificial dam on the Schuitdrift Farm	-22.68489	29.076405

The sites assessed were all visually assessed. The Invertebrate Habitat Assessment System (IHAS), Intermediate Habitat Integrity Assessment (IHIA), fish Habitat Cover Ratings (HCR), the South African Scoring System version 5 (SASS5) and Macro-Invertebrate Risk Assessment Index (MIRAI) for the assessment of the macro-invertebrate community and the Fish Risk Assessment Index (FRAI) in order to assess the risks to the fish community were employed at sites GSP9 on the Mutamba River and sites GSP15 and GSP16 on the Nzhelele River in addition to the analyses of biota specific water quality. The aquatic macro-invertebrate community of the GSPC G1, an artificial dam on the Schuitdrift farm site was also assessed. The protocols of applying the indices were strictly adhered to and all work was carried out by a South African River Health Program (SA RHP) accredited assessor.



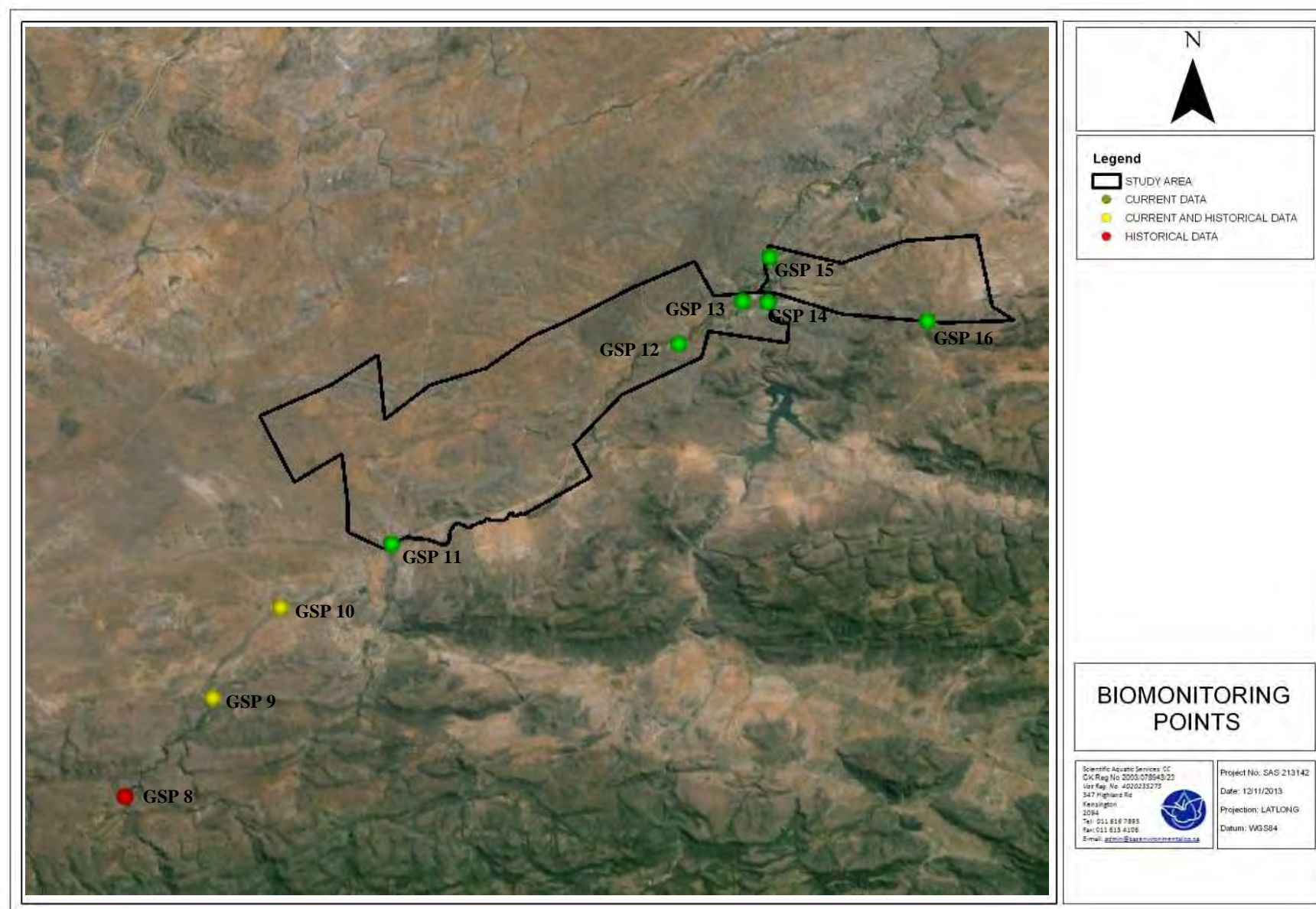


Figure 4: Aquatic ecological assessment points presented on a digital satellite image.



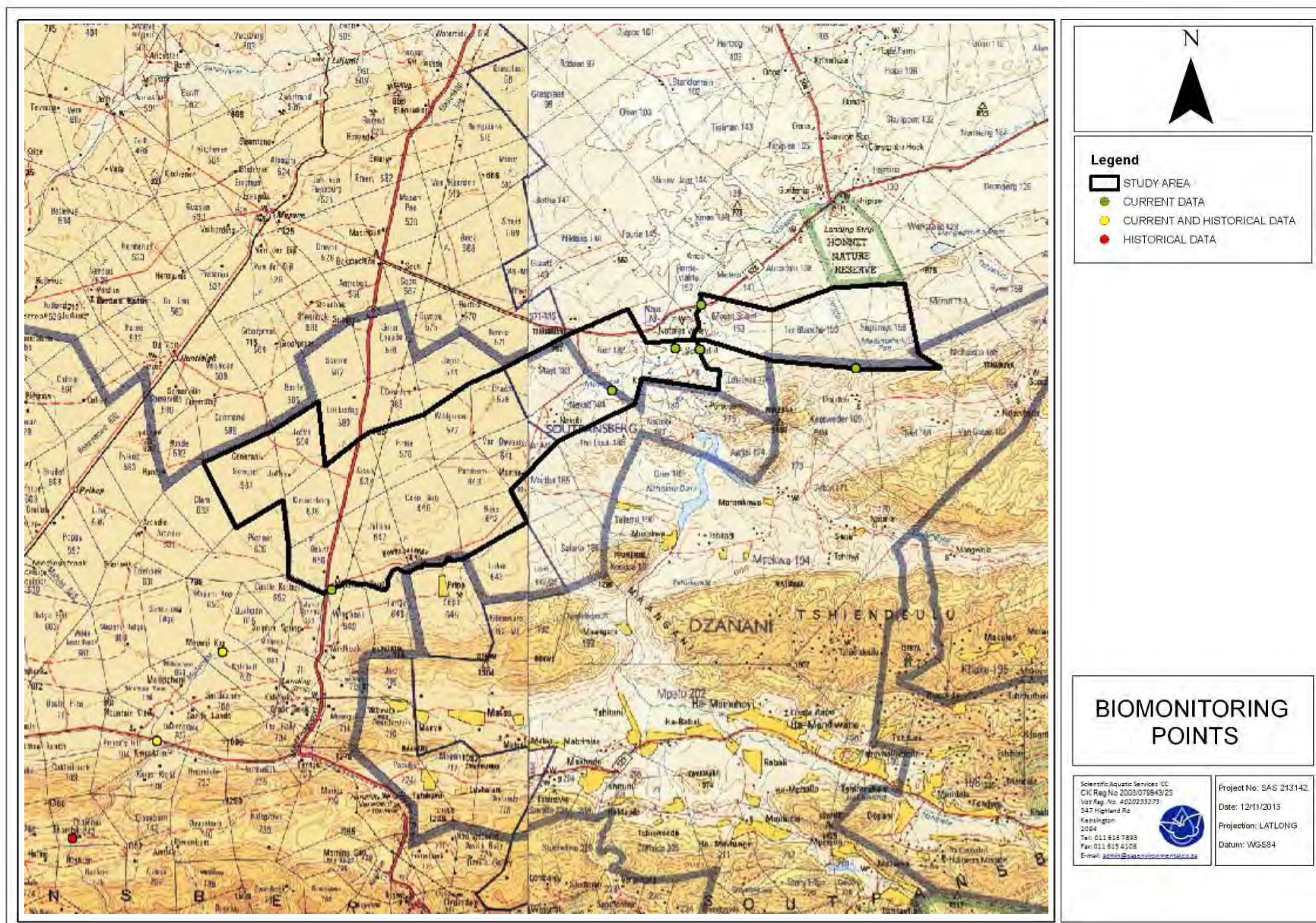


Figure 5: Riverine aquatic ecological assessment points presented on a 1:250 000 topographical map.



2.4 Classification System for Wetlands and other Aquatic Ecosystems in South Africa

All wetland features encountered within the study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al.*, 2013).

A summary of Levels 1 to 4 of the proposed Classification System for Inland Systems are presented in Table 3 and 4, below.

Table 3: Proposed classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions	Valley Floor
	OR	Slope
	NFEPA WetVeg Groups	Plain
	OR	Bench (Hilltop / Saddle / Shelf)
	Other special framework	

Table 4: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	B	C
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
Channelled valley-bottom wetland	Rejuvenated bedrock fall	Active channel
		Riparian zone
Unchannelled valley-bottom wetland	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
	(not applicable)	(not applicable)
	(not applicable)	(not applicable)



FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

2.4.1 Level 1: Inland Systems

For the proposed Classification System, Inland Systems are defined as ***an aquatic ecosystem that have no existing connection to the ocean¹*** (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but ***which are inundated or saturated with water, either permanently or periodically***. It is important to bear in mind, however, that certain Inland Systems may have had an historical connection to the ocean, which in some cases may have been relatively recent.

2.4.2 Level 2: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the proposed Classification System is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans et al., 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland (figure below). DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

¹ Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.



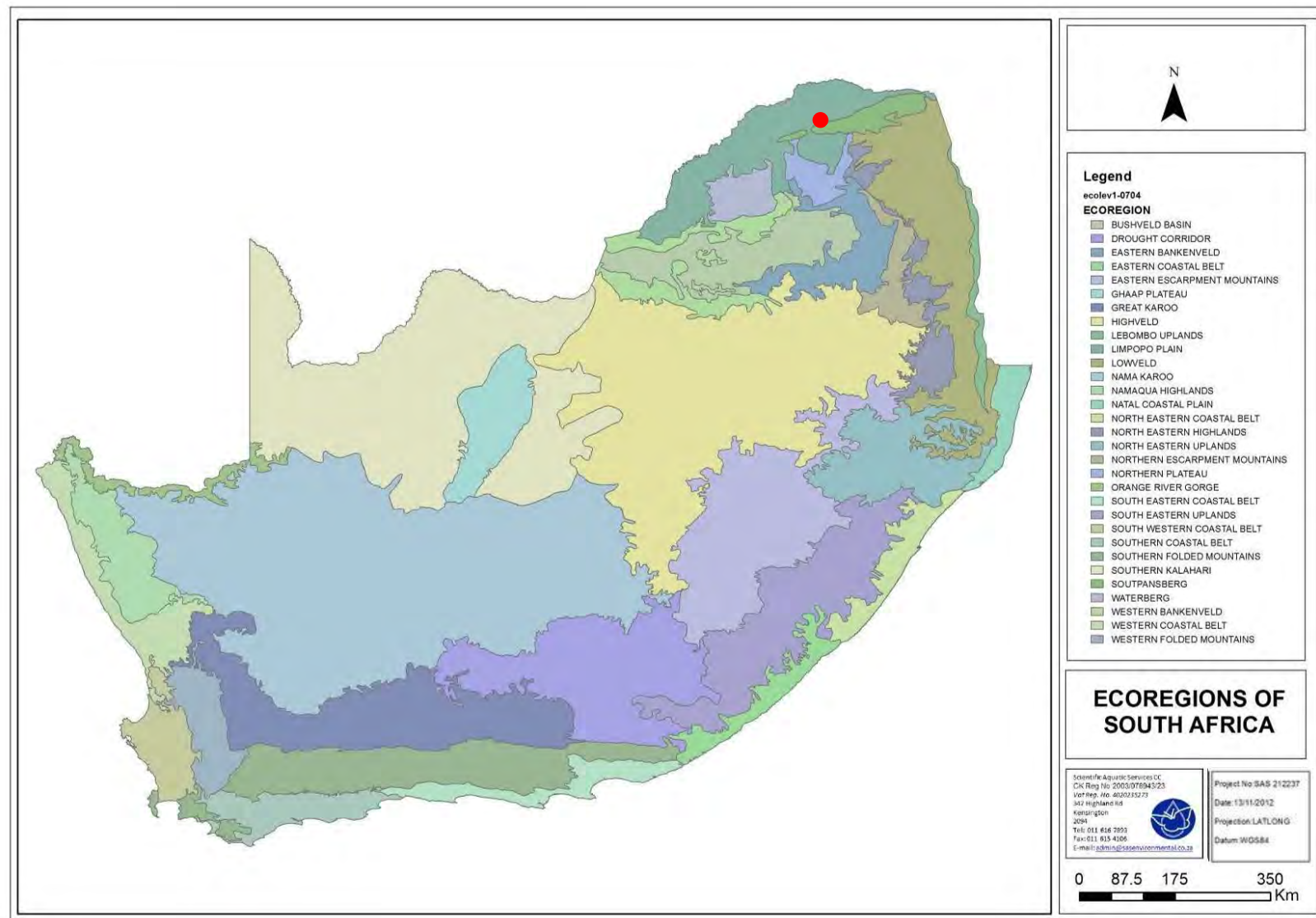


Figure 6: Map of Level 1 Ecoregions of South Africa, with the approximate position of the study area indicated in red.



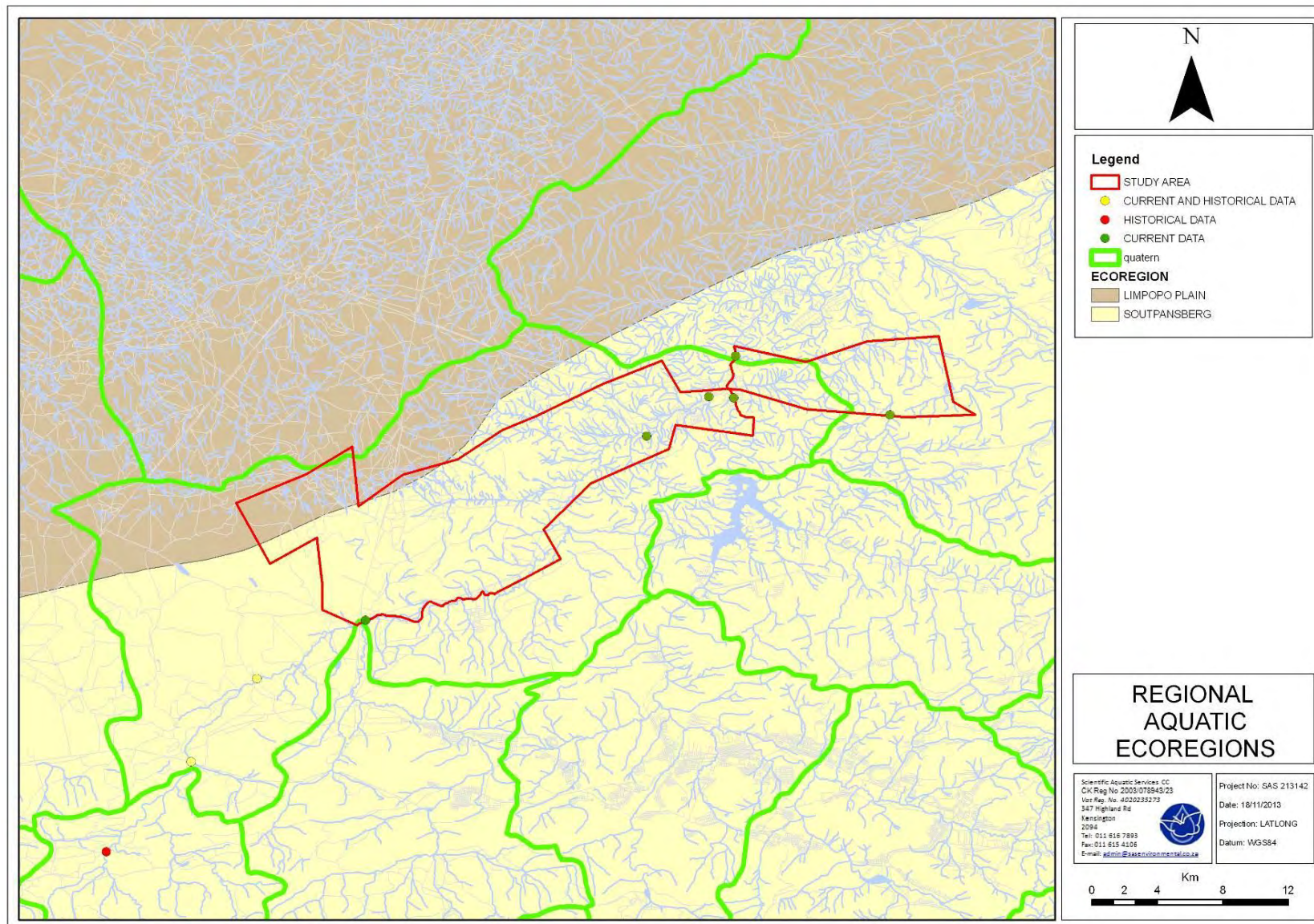


Figure 7: Map of Level 1 Ecoregions of South Africa, with the study area and aquatic ecological assessment points.



2.4.3 Level 2: NFEPA Wet Veg Groups

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel et al., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national and regional scale conservation planning and wetland management initiatives.

2.4.4 Level 3: Landscape Setting

At Level 3 of the proposed classification System, for Inland Systems, a distinction is made between four Landscape Units (Table 3) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis et al., 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes.
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

2.4.5 Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the proposed Classification System (Table 4), on the basis of hydrology and geomorphology (Ollis *et al.*, 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it.
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it.
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the Classification System to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane et al., 2008) and WET-EcoServices (Kotze et al., 2005).



2.5 WET-Health

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever changing landscape. The primary purpose of this assessment² is to evaluate the ecophysical health of wetlands, and in so doing promote their conservation and wise management.

2.5.1 Level of Evaluation

Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution;
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment; and
- Due to the extensive areas that were needed to be covered for this project this study was undertaken as a level 1 assessment.

2.5.2 Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

2.5.3 Units of Assessment

Central to WET-Health is the characterisation of hydrogeomorphic (HGM) units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the *Classification System for Wetlands and other Aquatic Ecosystems* in Section 2.2.

2.5.4 Quantification of Present State of a Wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial *extent* of impact of individual activities and then separately assessing the *intensity* of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores and Present State categories are provided in Table 5.

² Kleynhans et al., 2007



Table 5: Impact scores and categories of present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

2.5.5 Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or from within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (Table 6).

Table 6: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓



2.5.6 Overall Health of the Wetland

Once all HGM units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provides a summary of impacts, Present State, Trajectory of Change and Health for individual HGM units and for the entire wetland.

2.6 Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: „riparian habitat“ includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results³. Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Table 7: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

2.7 Wetland Function Assessment

“The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class”.⁴ The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al* (2005). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- · Flood attenuation
- · Stream flow regulation
- · Sediment trapping
- · Phosphate trapping
- · Nitrate removal
- · Toxicant removal
- · Erosion control

³ Kleynhans et al, 2007

⁴ DWA and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources*, 1999



- · Carbon storage
- · Maintenance of biodiversity
- · Water supply for human use
- · Natural resources
- · Cultivated foods
- · Cultural significance
- · Tourism and recreation
- · Education and research

The characteristics were used to quantitatively determine the value, and by extension also sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 8: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.5-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

2.8 Defining Ecological Importance and sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to assign the EIS category.

Table 9: Wetland EIS category definitions, (1999).

EIS Category	Range of Median	Recommended Ecological Management Class
<u>Very high</u> Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and ≤4	A
<u>High</u> Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and ≤3	B
<u>Moderate</u> Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and ≤2	C
<u>Low/marginal</u> Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and ≤1	D



2.9 Index of Habitat Integrity (IHI)

The WETLAND-IHI⁵ is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the RHP. The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (Table below), and provide a score of the PES of the habitat integrity of the wetland system being examined.

Table 10: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

Ecological Category	PES % Score	Description
A	90-100%	Unmodified, natural.
B	80-90%	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. E 20-40% Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E	20-40%	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

2.10 Recommended Ecological Category (REC)

“A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure.”⁶

The REC was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above). This was followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland may receive the same class for the PES, as the REC if the wetland is deemed to be in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the wetland feature.

⁵ DWA and Forestry Resource Quality Services, 2007

⁶ DWA and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999



2.11 Wetland Delineation

For the purposes of this investigation, a wetland habitat is defined in the NWA (Act 36 of 1998) as including the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

The wetland zone delineation of the rivers features took place according to the method presented in the final draft of “A practical field procedure for identification and delineation of wetlands and riparian areas” published by the DWA in February 2005. Based on these delineation principles the foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils and
- The presence of alluvial soils in stream systems.

By observing the evidence of these features, in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA 2005).

Riparian and wetland zones can be divided into three zones (DWA 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation.

The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

2.12 Visual Assessment of Aquatic Assessment Points

Each site was selected in order to identify current conditions, with specific reference to impacts from surrounding activities where applicable. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the systems identified, was identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual records of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- Upstream and downstream significance of each point, where applicable;
- Significance of the point in relation to the study area;
- stream morphology;
- instream and riparian habitat diversity;
- stream continuity;
- erosion potential;
- depth flow and substrate characteristics;
- signs of physical disturbance of the area; and
- other life forms reliant on aquatic ecosystems.

2.13 Physico-chemical Water Quality Data

On site testing of biota specific water quality variables took place on all sites where surface water was present. The results of on-site biota specific water quality analyses were used to aid in the interpretation



of the data obtained by the biomonitoring. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF, 1996 vol. 7).

2.14 Intermediate Habitat Integrity Assessment (IHIA)

It is important to assess the habitat of riverine systems in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the sites was assessed based on the application of the Intermediate Habitat Integrity Assessment for (Kemper; 1999). The Intermediate Habitat Integrity Assessment (IHIA) protocol, as described by Kemper (1999), was used using the site specific application protocols. This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996). The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site was scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The instream and riparian zones were analysed separately, and the final assessment was then made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone is, primarily interpreted in terms of the potential impact on the instream component. The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data was carried out by weighting each of the criteria according to Kemper (1999). By calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the sites. The method classifies Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

2.15 Invertebrate Habitat Suitability (Invertebrate Habitat Assessment: IHAS)

The Invertebrate Habitat Assessment System (IHAS) was applied to sites GSP1, GSP3, GSP4 and GSP6 according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates, as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index were interpreted according to the guidelines of McMillan (1998) as follows:

- <65%: habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community.
- 65%-75%: habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.
- >75%: habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community.

2.16 Aquatic Macro-Invertebrates: South African Scoring System (SASS5)

Aquatic macro-invertebrate communities of the accessible sites (GSP1, GSP3, GSP4 and GSP6) were investigated according to the method, which is specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter (1998). The assessment was undertaken according to the South African Scoring System (SASS) protocol as defined by Dickens and Graham (2001). All work was undertaken by an accredited South African Scoring System, version 5 (SASS5) practitioner.



Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do.

In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score in conjunction with a low habitat score can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score together with a high habitat score would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

The perceived reference state for the local streams was determined in consideration of the ecoregion conditions as well as local habitat conditions. Local conditions are extremely poorly suited for supporting aquatic macro-invertebrates and very low diversities and abundances of aquatic macro-invertebrates can be expected. Only more tolerant taxa and those with specific adaptations to the unstable sandy habitat are deemed likely to occur in the area. Reference scores were defined as a SASS5 score of 128 and an Average Score Per Taxon (ASPT) of 5.5. Interpretation of the results in relation to the reference scores was made according to the classification of SASS5 scores presented in the SASS5 methodology published by Dickens and Graham (2001) as well as according to Dallas (2007).

Table 11: Definition of Present State Classes in terms of SASS and ASPT scores as presented in Dickens and Graham (2001)

Class	Description	SASS Score%	ASPT%
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100	Variable
		80-89	>90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89	<75
		70-79	>90
		70-89	76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79	<60
		50-59	>75
		50-79	60-75
D	Largely impaired. Mostly tolerant taxa present.	50-59	<60
		40-49	Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

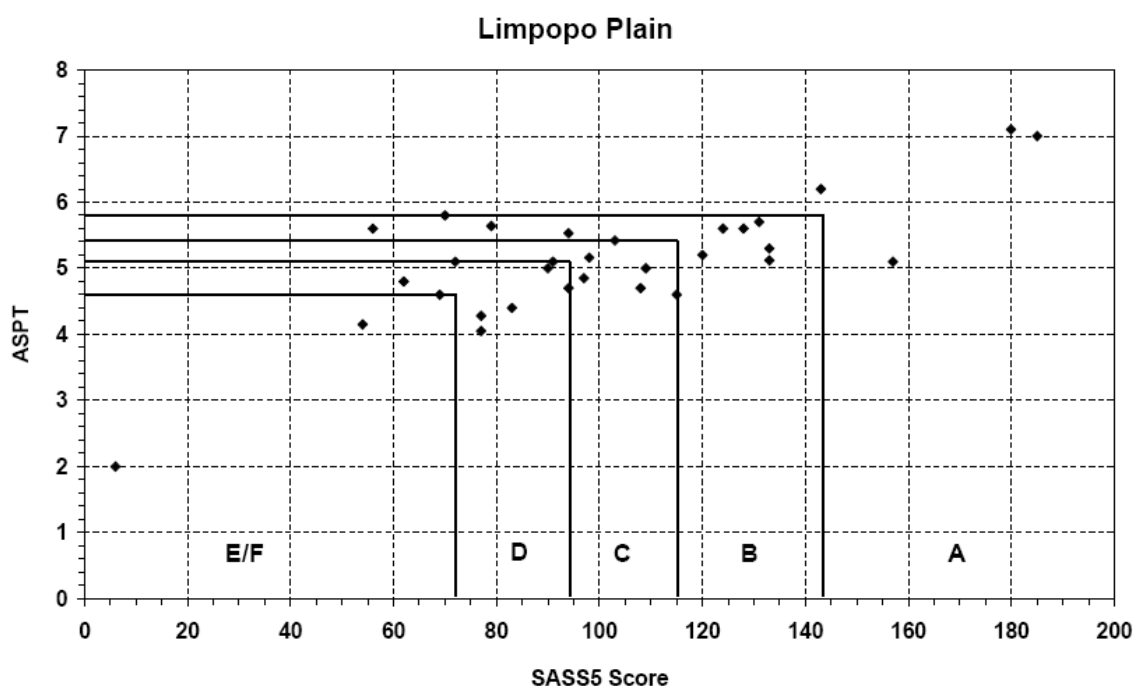


Figure 8: SASS5 Classification using biological bands calculated from percentiles for the Limpopo plain ecoregion, Dallas, 2007



2.17 Aquatic Macro-Invertebrates: Macro-invertebrate Response Assessment Index (MIRAI)

The four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs. An interplay between these factors (particularly habitat and availability of food sources) result in the discontinuous, patchy distribution pattern of aquatic macro-invertebrate populations. As such aquatic invertebrates shall respond to habitat changes (i.e. changes in driver conditions).

To relate drivers to such changes in habitat and aquatic invertebrate condition, two key elements are required. Firstly habitat preferences and requirements for each taxa present should be obtained. As such reference conditions can be established against which any response to drivers can be measured. Secondly habitat features should be evaluated in terms of suitability and the requirements mentioned in the first point. As a result expected and actual patterns can be evaluated to achieve an Ecstatus Category (EC) rating.

Based on the three key requirements, the MIRAI provides an approach to deriving and interpreting aquatic invertebrate response to driver changes. The index has been applied to sites GSP1, GSP3, GSP4 and GSP6 following methodology described by Thirion (2007). Aquatic macro-invertebrates expected at each point were derived both from previous studies of rivers near the area as well as habitat, flow and water parameters (Thirion 2007).

2.18 Fish biota: Habitat Cover Rating (HCR) and Fish Habitat Assessment (FHA)

This approach was developed to assess habitats according to different attributes that are surmised to satisfy the habitat requirements of various fish species. At each site, the following depth-flow (df) classes are identified, namely:

- Slow (<0.3m/s), shallow (<0.5m) - Shallow pools and backwaters.
- Slow, deep (>0.5m) - Deep pools and backwaters.
- Fast (>0.3m/s), shallow - Riffles, rapids and runs.
- Fast, deep - Usually rapids and runs.

The relative contribution of each of the above mentioned classes at a site was estimated and indicated as:

- 0 = Absent
- 1 = Rare (<5%)
- 2 = Sparse (5-25%)
- 3 = Moderate (25-75%)
- 4 = Extensive (>75%)

For each depth-flow class, the following cover features (cf) -considered to provide fish with the necessary cover to utilise a particular flow and depth class- were investigated:

- Overhanging vegetation
- Undercut banks and root wads
- Stream substrate
- Aquatic macrophytes

The amount of cover present at each of these cover features (cf) was noted as:

- 0 = absent
- 1 = Rare/very poor (<5%)
- 2 = Sparse/poor (5-25%)
- 3 = Moderate/good (25-75%)
- 4 = Extensive/excellent (>75%)



The fish habitat cover rating (HCR) was calculated as follows:

- The contribution of each depth-flow class at the site was calculated ($df/\Sigma df$).
- For each depth-flow class, the fish cover features (cf) were summed (Σcf).

$$HCR = df/\Sigma df \times \Sigma cf.$$

The amount and diversity of cover available for the fish community at the selected sites was graphically expressed as habitat cover ratings (HCR) for different flow-depth classes as a stacked bar chart.

2.19 Fish biota: Fish Response Assessment Index (FRAI)

The FRAI (Kleynhans 2008) is based on the premise that “drivers” (environmental conditions) may cause fish stress which shall then manifest as changes in fish species assemblage. The index employs preferences and intolerances of the reference fish assemblage, as well as the response of the actual (present) fish assemblage to particular drivers to indicate a change from reference conditions. Intolerances and preferences are divided into metric groups relating to preferences and requirements of individual species. This allows cause-effect relationships to be understood, i.e. between drivers and responses of the fish assemblage to changes in drivers. These metric groups are subsequently ranked, rated and finally integrated as a fish Ecological Category (EC) shown previously in Figure 3. Fish expected to occur in the system is summarised in Table 12.

Table 12: Intolerance ratings for naturally occurring indigenous fish species with natural ranges included in the Mutamba and Nzhelele Rivers⁴ (Limpopo River system) of the study area (Skelton, 2001; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).

SPECIES NAME	COMMON NAME	INTOLERANCE RATING ³	COMMENTS
<i>Amphilius uranoscopus</i> ²	Stargazer (mountain catfish)	4.8	Okovango and Zambezi systems, east coast rivers south to Mkuze in northern Kwa-Zulu Natal
<i>Barbus eutaenia</i> ²	Orange-fin barb	4.3	Cunene, Okovango and Zambezi, east coast systems south to the Phongolo
<i>Barbus paludinosus</i> ¹	Straightfin barb	1.8	Widespread
<i>Barbus trimaculatus</i> ²	Threespot barb	2.2	Common in many river systems of southern Africa
<i>Barbus unitaeniatus</i> ¹	Longbeard barb	1.7	Widely distributed in southern Africa
<i>Barbus viviparus</i> ¹	Bowstripe barb	2.4	East coastal rivers from the Ruvuma south to Vungu in KwaZulu-Natal.
<i>Chiloglanis pretoriae</i> ¹	Shortspine Suckermouth or Rock catlet	4.6	Widespread (Incomati, Limpopo & Zambezi)
<i>Chiloglanis paratus</i> ¹	Sawfin Suckermouth or Sawfin rock catlet	3.5	Incomati, Limpopo & Phongolo River systems
<i>Clarias gariepinus</i> ¹	Sharptooth Catfish	1.2	Most widely distributed fish in Africa.
<i>Gambusia affinis</i>	Mosquito fish	2.0	Widespread
<i>Labeo cylindricus</i> ¹	Redeye labeo	3.1	Widespread East-African rivers down to Phongolo system in KwaZulu-Natal
<i>Labeo molybdinus</i> ¹	Leaden labeo	3.2	Middle and lower Zambezi down to Tugela system in KwaZulu-Natal
<i>Labeo rosae</i> ¹	Rednose labeo	2.4	Lowveld region of the Limpopo, Incomati and Phongolo systems
<i>Mesobola brevianalis</i> ¹	River sardine	2.3	East coastal rivers from Limpopo to Umfolozi in KwaZulu-Natal
<i>Micralestes acutidens</i> ¹	Silver robbers	2.3	Cunene, Okavango, Zambezi and east coast rivers south to Phongolo.



SPECIES NAME	COMMON NAME	INTOLERANCE RATING ³	COMMENTS
<i>Oreochromis mossambicus</i> ¹	Blue Kurper	1.3	Widespread
<i>Pseudocrenilabrus philander</i> ¹	Southern mouthbrooder	1.3	Widespread
<i>Tilapia sparrmanii</i> ¹	Banded Tilapia	1.3	Widespread
<i>Tilapia rendalli</i> ¹	Redbreast tilapia	1.8	Cunene, Okavango, Zambezi and east coast rivers south to Phongolo.
<i>Schilbe intermedius</i> ¹	Silver catfish	1.7	Cunene, Okavango, Zambezi and east coast rivers south to Phongolo.

Tolerant: 1-2; Moderately tolerant :> 2-3; Moderately Intolerant: >3-4; Intolerant: >4

⁴ Note: The Mutamba River is a main tributary of the Nzhelele River. No FROC data are available for the Mutamba River so available data for the Nzhelele River was used instead as described below:

¹ Fish species previously encountered below the Nzhelele Dam (catchment A80G) for which FROC (reference frequency of occurrence) values are listed (Kleynhans *et al.* 2007).

² Fish species previously encountered above the Nzhelele Dam (catchment A80B) for which FROC (reference frequency of occurrence) values are listed (Kleynhans *et al.* 2007). Given the position of the assessment sites these species are unlikely to occur. However, as they do occur in the same river system, they have been included in the list.

Based on known distribution (Limpopo River system) and habitat preference (e.g. Skelton 2001) the other species listed may, however, also occur in the area. For details of actual collection data and FROC values employed refer to Results section.

³ Average overall intolerance rating as per Kleynhans (1999).

2.20 Impact Assessment Report

In order for the Environmental Assessment Practitioner (EAP) to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An **environmental aspect** is an „element of an organizations activities, products and services which can interact with the environment“⁷. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.

⁷ The definition has been aligned with that used in the ISO 14001 Standard.



- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria. Refer to the table below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary⁸.

The assessment of significance is undertaken twice. Initially, significance is based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment takes into account the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

Table 13: Criteria for assessing significance of impacts

LIKELIHOOD DESCRIPTORS

Probability of impact	RATING
Highly unlikely	1
Possible	2
Likely	3
Highly likely	4
Definite	5
Sensitivity of receiving environment	RATING
Ecology not sensitive/important	1
Ecology with limited sensitivity/importance	2
Ecology moderately sensitive/important	3
Ecology highly sensitive/important	4
Ecology critically sensitive/important	5

⁸ Some risks/impacts that have low significance will however still require mitigation



CONSEQUENCE DESCRIPTORS

Severity of impact	RATING
Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function Largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	RATING
Activity specific/ < 5 ha impacted / Linear features affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / Linear features affected < 100m	2
Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m	3
Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m	4
Entire habitat unit / Entire system/ > 2000ha impacted / Linear features affected > 3000m	5
Duration of impact	RATING
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5



Table 14: Significance rating matrix

LIKELIHOOD (Frequency of activity + Frequency of impact)	CONSEQUENCE (Severity + Spatial Scope + Duration)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 15: Positive/Negative Mitigation Ratings

Significance Rating	Value	Negative Impact management recommendation	Positive Impact management recommendation
Very High	126 - 150	Consider the viability of the project. Very strict measures to be implemented to mitigate impacts according to the impact mitigation hierarchy	Actively promote the project
High	101 - 125	Consider alternatives in terms of project execution and location. Ensure designs take environmental sensitivities into account and Ensure management and housekeeping is maintained and attention to impact minimisation is paid according to the impact mitigation hierarchy	Promote the project and monitor ecological performance
Medium High	76 – 100	Consider alternatives in terms of project execution and Ensure management and housekeeping is maintained and attention to impact minimisation is paid according to the impact mitigation hierarchy	Implement measures to enhance the ecologically positive aspects of the project while managing any negative impacts
Medium Low	51 - 75	Ensure management and housekeeping is maintained and attention to impact minimisation is paid	Implement measures to enhance the ecologically positive aspects of the project while actively managing any negative impacts
Low	26 - 50	Promote the project and ensure management and housekeeping is maintained	Monitor ecological performance and pay extensive attention to minimising potential negative environmental impacts
Low Very	1 - 25	Promote the project	Actively seek measures to implement impact minimisation according to the impact mitigation hierarchy and identify positive ecological aspects to be promoted

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:



- Primary project site and related facilities that the client and its contractors develops or controls;
 - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
 - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for all stages of the project cycle including:
- Pre-construction
 - Construction and;
 - Operation.
 - Decommissioning and closure
- If applicable, transboundary or global effects were assessed;
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status were assessed.
- Particular attention was paid to describing any residual impacts that will occur after rehabilitation.

2.20.1 Mitigation Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed construction.

- *Mitigation and performance improvement measures* and actions that address the risks and impacts⁹ are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
- Avoidance or prevention of impact
 - Minimisation of impact
 - Rehabilitation
 - Offsetting
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation.
- Desired outcomes are defined, and have been developed in such a way as to be *measurable events with performance indicators, targets and acceptable criteria* that can be tracked over *defined periods*, wherever possible.

2.20.2 Recommendations possible

Recommendations were developed to address and mitigate potential impacts on the wetland ecology associated with the Greater Soutpansberg Generaal project. These recommendations also include specific management measures applicable to individual Wetland Management Units as well as general management measures which apply to the mine area as a whole.

3 RESULTS OF LITERATURE REVIEW

3.1 Conservation Importance of the Study Area with Regards to Wetlands

3.1.1 Ecoregion

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the area is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment, which aids in guiding the assessment.

⁹ Mitigation measures should address both positive and negative impacts



The Generaal Project Area falls within the Limpopo Plain Ecoregion and is located within the A71K, A80F and A80G quaternary catchments although the area within the A71K quaternary catchment is very limited. The tables below indicate the aquatic ecoregions and quaternary catchment of the Generaal Project Area.

Table 16: Summary of the ecological status of the Limpopo Plains Region.

MAIN ATTRIBUTES	LIMPOPO PLAIN
Terrain Morphology: Broad division (dominant types in bold) (Primary)	Plains; Low Relief; Plains Moderate Relief; Lowlands; Hills and Mountains; Moderate and High Relief; Closed Hills; Mountains; Moderate and High Relief (limited)
Vegetation types (dominant types in bold) (Primary)	Mopane Bushveld; Sweet Bushveld; Mixed Bushveld Waterberg Moist Mountain Bushveld; Clay hills; Mountains; Kalahari Plains Thorn Bushveld
Altitude (m a.m.s.l) (modifying)	300-1100 (1100-1300 limited)
MAP (mm) (Secondary)	200 to 600
Coefficient of Variation (% of annual precipitation)	25 to 40
Rainfall concentration index	60 to >65
Rainfall seasonality	Early to mid-summer
Mean annual temp. (°C)	18 to >22
Mean daily max. temp. (°C): February	26 to 32
Mean daily max. temp. (°C): July	20 to >24
Mean daily min. temp. (°C): February	16 to >20
Mean daily min temp. (°C): July	2 to >10
Median annual simulated runoff (mm) for quaternary catchment	<5 to 60 (60-100 limited)

3.1.2 Ecstatus Classification

Water resources are generally classified according to the degree of modification or level of impairment. The classes, used by the South African River Health Program (RHP), are presented in the table below and will be used as the basis of classification of the systems in future field studies.

Table 17: Classification of river health assessment classes in line with the RHP

Class	Description
A	Unmodified, natural.
B	Largely natural, with few modifications.
C	Moderately modified.
D	Largely modified.
E	Extensively modified.
F	Critically modified.

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the Ecological Importance and Sensitivity (EIS), Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems, prior to assessment or as part of a desktop assessment.

This database was searched for the catchment of concern in order to define the EIS, PEMC and DEMC. The results of the assessment are summarised in the table below.



Table 18: Summary of the ecological status of quaternary catchments A71L, A80F and A80G based on Kleynhans (1999)

Catchment	Resource	EIS	PESC	DEMC
A80F	Nzhelele River	High	Class D	B: Sensitive system
A80G	Nzhelele River	Moderate	Class D	C: Moderately sensitive system

A80F

According to the ecological importance classification for the quaternary catchment, the system can be classified as a *Sensitive* system which, in its present state, can be considered a Class D (largely modified) stream.

The points below summarise the impacts on the aquatic resources in the A80F quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been marginally affected by scouring of the system.
- Flow modification within the catchment is considered very high due to the control of flow by a dam upstream.
- Marginal impacts from inundation of the system occur.
- Riparian zones and stream bank conditions are considered to be moderately impacted by erosion.
- A low impact occurs as a result of the introduction of instream biota with special mention of *Azolla* sp. (Water Fern) and *Cyprinus carpio*. (Carp).
- Impacts on water quality in the system are considered high as water released by the dam has a modified temperature and quality.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in this catchment:

- The riverine systems in this catchment have a high diversity of habitat types.
- The site has a moderate importance in terms of conservation with special mention of a gorge in the system.
- The riverine resources in this system have a moderate intolerance to flow and flow related water quality changes.
- The aquatic resources in the area have a high importance in terms of migration of species and form a transition zone between mountain and lowveld. Special mention is made of the migration of eels, fish and birds.
- The system is considered to be of high importance in terms of rare and endemic species conservation. Some species may occur upstream of Nzhelele Dam.
- The aquatic resources in this catchment are moderately important in terms of the provision of refuge areas.
- The riverine resources in this system have a moderate sensitivity to changes in water quality and flow. The gorge area is particularly sensitive to changes in flow.
- The aquatic resources in this area are of high importance in terms of Species/Taxon richness with up to 16 different species present.
- The system is of high importance with regards to unique or endemic species with special mention of *Barbus euteneus* (Orange-fin Barb), *Barbus lineamaculatus* (Line-spotted Barb).

A80G

According to the ecological importance classification for the quaternary catchment, the system can be classified as a *Sensitive* system which, in its present state, can be considered a Class D (largely modified) stream.

The points below summarise the impacts on the aquatic resources in the A80G quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been moderately affected by the possible deposition of ferric oxide into the system.
- Flow modification within the catchment is considered very high.



- Marginal impacts from inundation occur as a result of weirs in the system.
- Riparian zones and stream bank conditions are considered to be highly impacted by agriculture, overgrazing and cultivation.
- A marginal impact occurs as a result of the introduction of instream biota.
- Impacts on water quality in the system are high. These impacts are a result of agricultural runoff into the system, sewage point sources and high pressure water released into the system.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in this catchment:

- The riverine systems in this catchment have a moderate diversity of habitat types.
- The site has a moderate importance in terms of conservation.
- The riverine resources in this system have a moderate intolerance to flow and flow related water quality changes.
- The aquatic resources in the area have a high importance in terms of migration of species. Special mention is made of the migration of eels, fish and birds.
- The system is considered to be of high importance in terms of rare and endemic species conservation. Some species may occur upstream of Nzhelele Dam.
- The aquatic resources in this catchment are moderately important in terms of the provision of refuge areas.
- The riverine resources in this system have a moderate sensitivity to changes in water quality and flow.
- The aquatic resources in this area are of high importance in terms of Species/Taxon richness with up to 16 different species present.
- The system is of high importance with regards to unique or endemic species with special mention of *Barbus euteneus* (Orange-fin Barb), *Barbus lineamaculatus* (Line-spotted Barb).

3.1.3 Importance according to the RSA wetland types database (2010) and the National Freshwater Ecosystem Priority Areas (2011) database

The RSA Wetland Types (2010) and National Freshwater Ecosystem Priority Areas (NFEPA) (2011) databases were consulted to define the ecology of the wetland or river systems within the Generaal Project Area that may be of ecological importance. Aspects applicable to the Generaal Project Area and surroundings are discussed below:

- The Generaal Project Area falls within the Limpopo Water Management Area (WMA). Each Water Management Area is divided into several sub-Water Management Areas (subWMA), where catchment or watershed is defined as a topographically defined area which is drained by a stream or river network. The subWMA indicated for the Generaal Project Area is the Sand subWMA.
- The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors.
- The subWMA is not considered important in terms of translocation and relocation zones for fish.
- The subWMA is not listed as a fish Freshwater Ecosystem Priority Area.
- The Mutamba River, Nzhelele River and tributaries of the Sand River extend through the Generaal Project Area (Figure 2).
- Both the Mutamba and Nzhelele Rivers are perennial systems classified as Class D (largely modified) rivers and are not indicated as free flowing, flagship or as FEPA Rivers.
- The Sand River is a perennial system classified as a Class B (largely natural) river and is not indicated as a free flowing or flagship river. However, the Sand River is indicated as a FEPA river (Figure 2).
- River FEPAs achieve biodiversity targets for river ecosystems and threatened fish species, and were identified in rivers that are currently in a good condition (A or B ecological category). Their FEPA status indicates that they should remain in a good condition in order to contribute to national biodiversity goals and support sustainable use of water resources. Although FEPA status applies to the actual river reach within such a sub-quaternary catchment. The shading of the whole sub-quaternary catchment indicates that the surrounding land and smaller stream network need to be managed in a way that maintains the good condition (A or B ecological category) of the river reach.



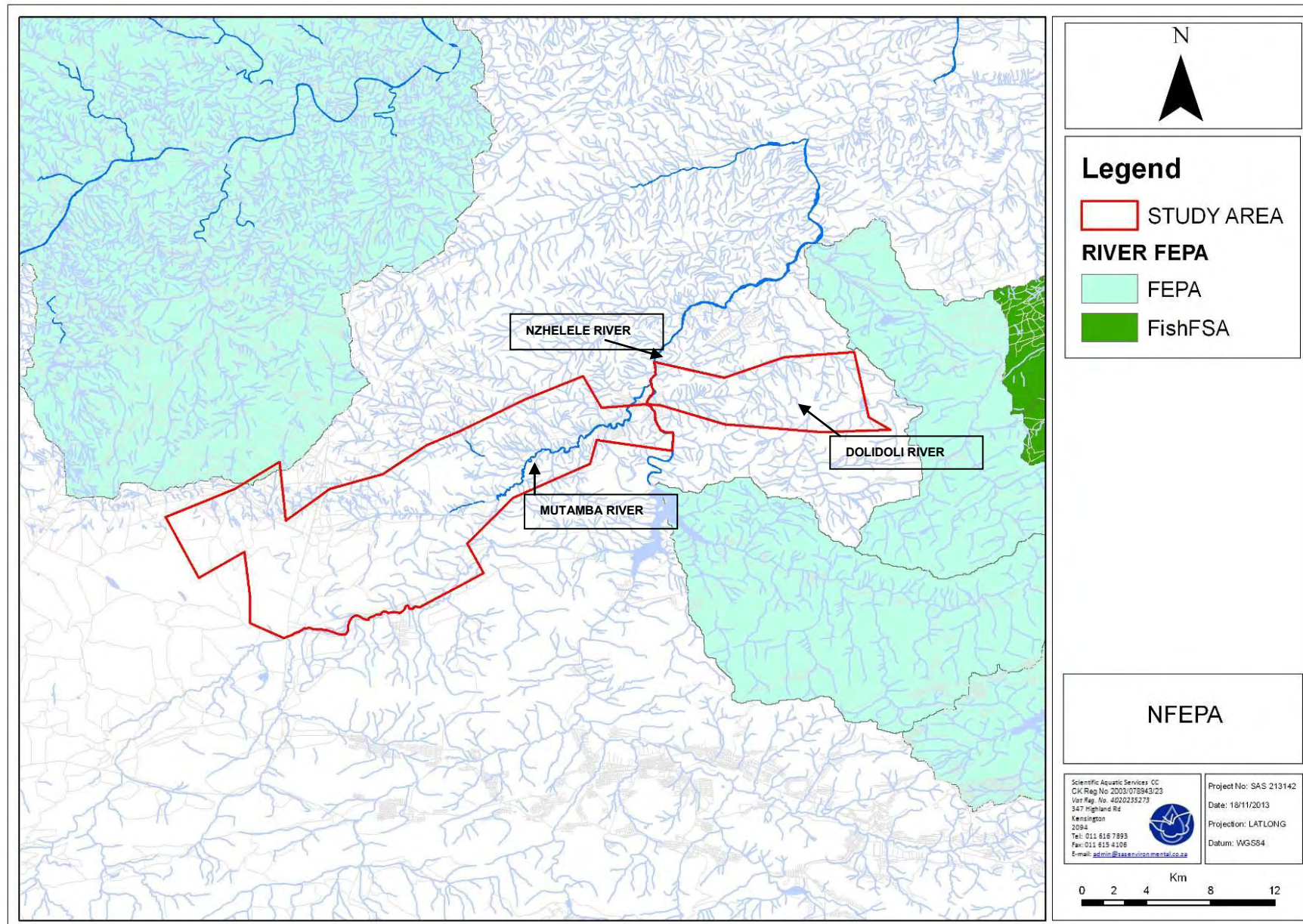


Figure 9: Map depicting the rivers located within the study area.



-
- Numerous wetland features are located within the Generaal Area, these include bench slope and valley floor wetland features. (Figure 10).
 - Both natural and artificial wetland features occur within the Generaal Area, two wetland features are considered natural while five are considered artificial (Figure 11).
 - The Generaal Area contains wetlands in Z1 and Z3 condition (Figure 12):
 - Category Z1 – Wetland overlaps with a 1: 50 000 “artificial” inland water body from the Department of Land Affairs: Chief Directorate of Surveys and Mapping (2005 – 2007);
 - Category Z3 - Percentage natural land cover less than 25%;
 - Wetlands within the Generaal Area were ranked according to general importance. All wetland features were ranked as Rank 6 with No importance indicated.
 - No wetland features within the Generaal Project Area are considered important with regards to the conservation of biodiversity.
 - No wetland features within the Generaal Project Area are indicated as FEPA wetlands.
 - Wetlands located within the Generaal Project Area are not shown to have sighting or breeding areas for cranes.
 - No RAMSAR wetlands are located within or close to the Generaal Project Area.
 - No wetlands are indicated to fall within 500m of an IUCN threatened frog point locality.

According to the NFEPA database (2011), none of the wetland features within the Generaal Project Area are considered of significant biodiversity importance. All wetland features are indicated to be in a heavily to critically modified condition and are not considered important with regards to the conservation of biodiversity in the area.



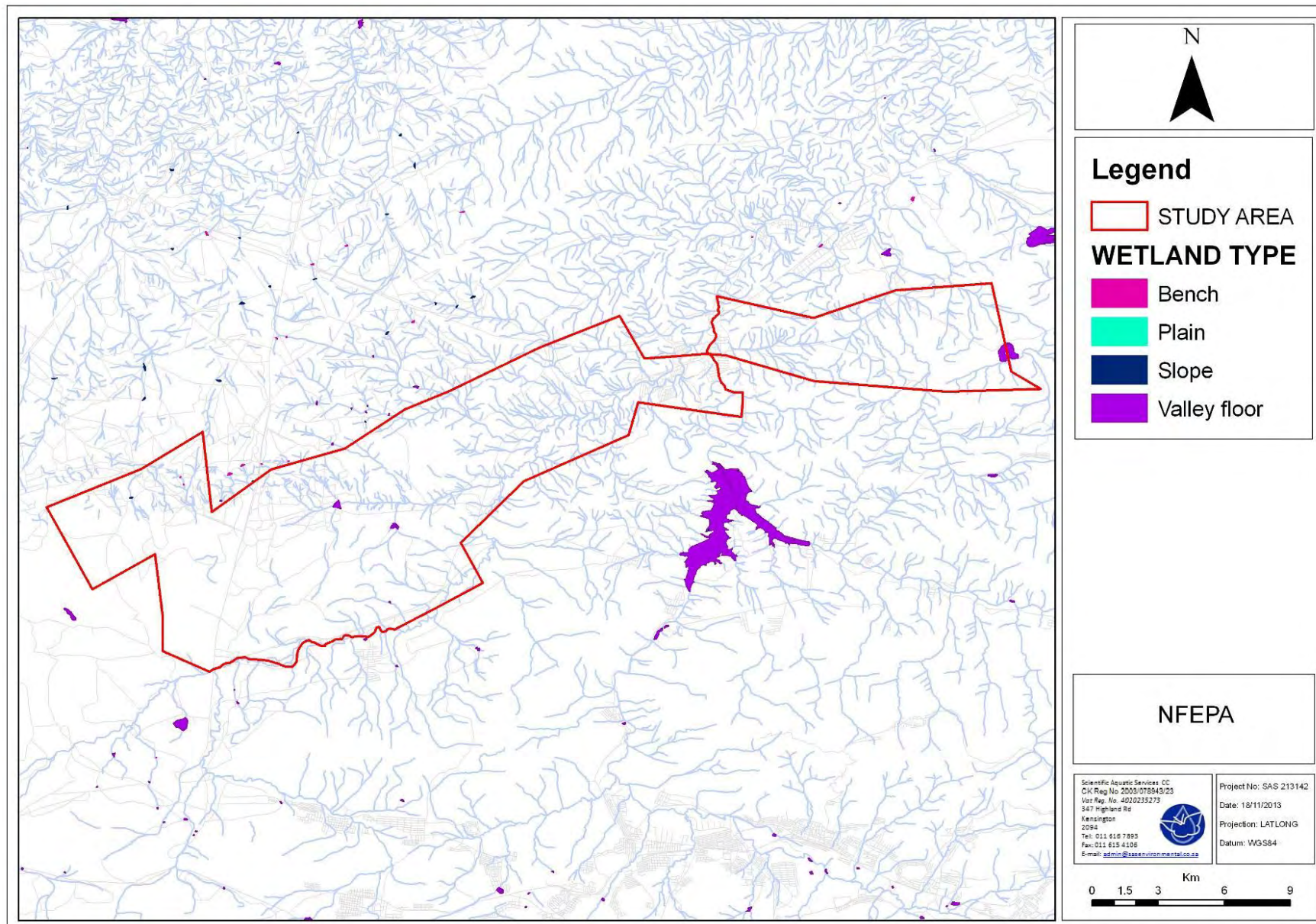


Figure 10: NFEPA wetland types within the Generaal Area.



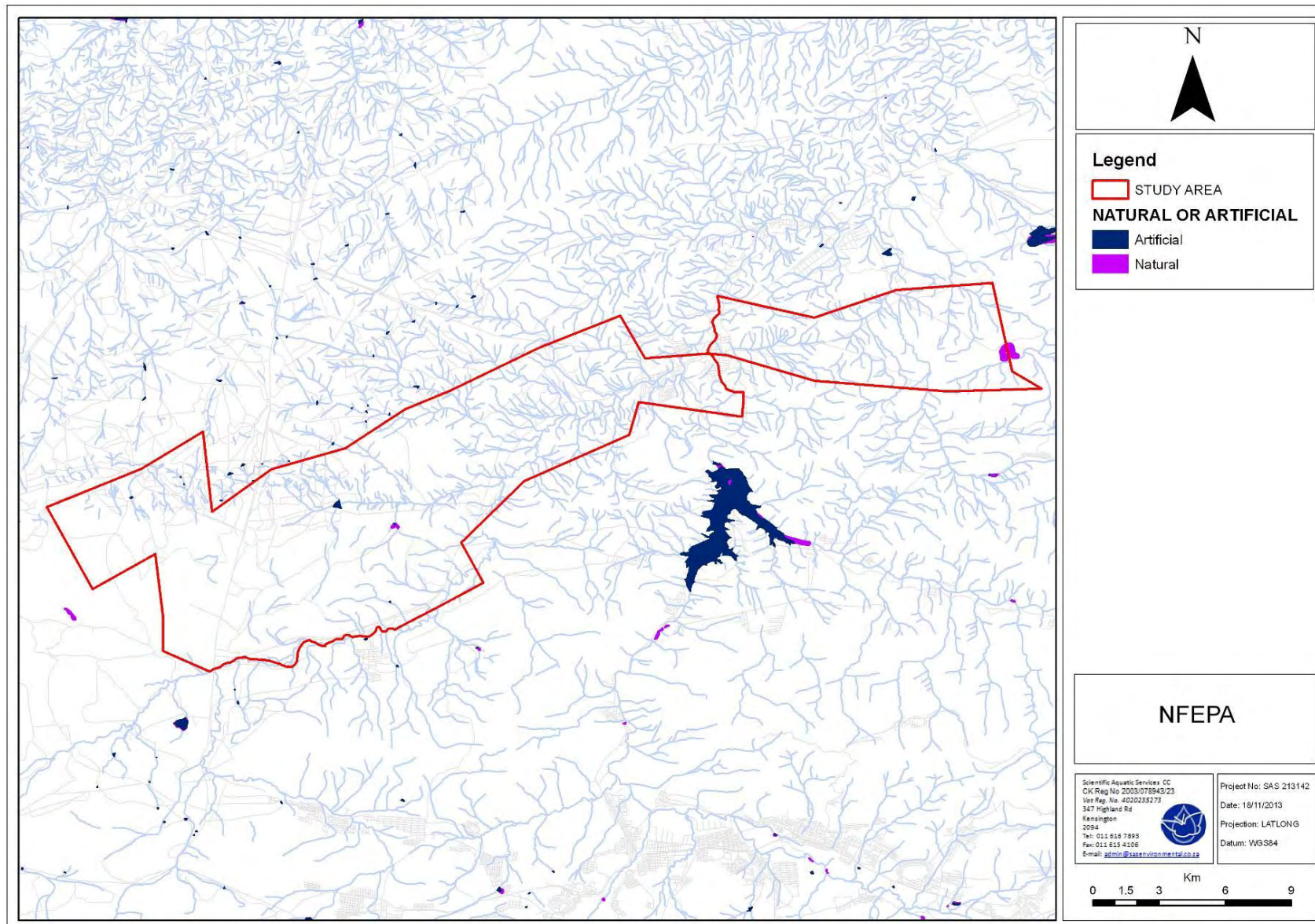


Figure 11: Natural and Artificial wetlands within the General Area.



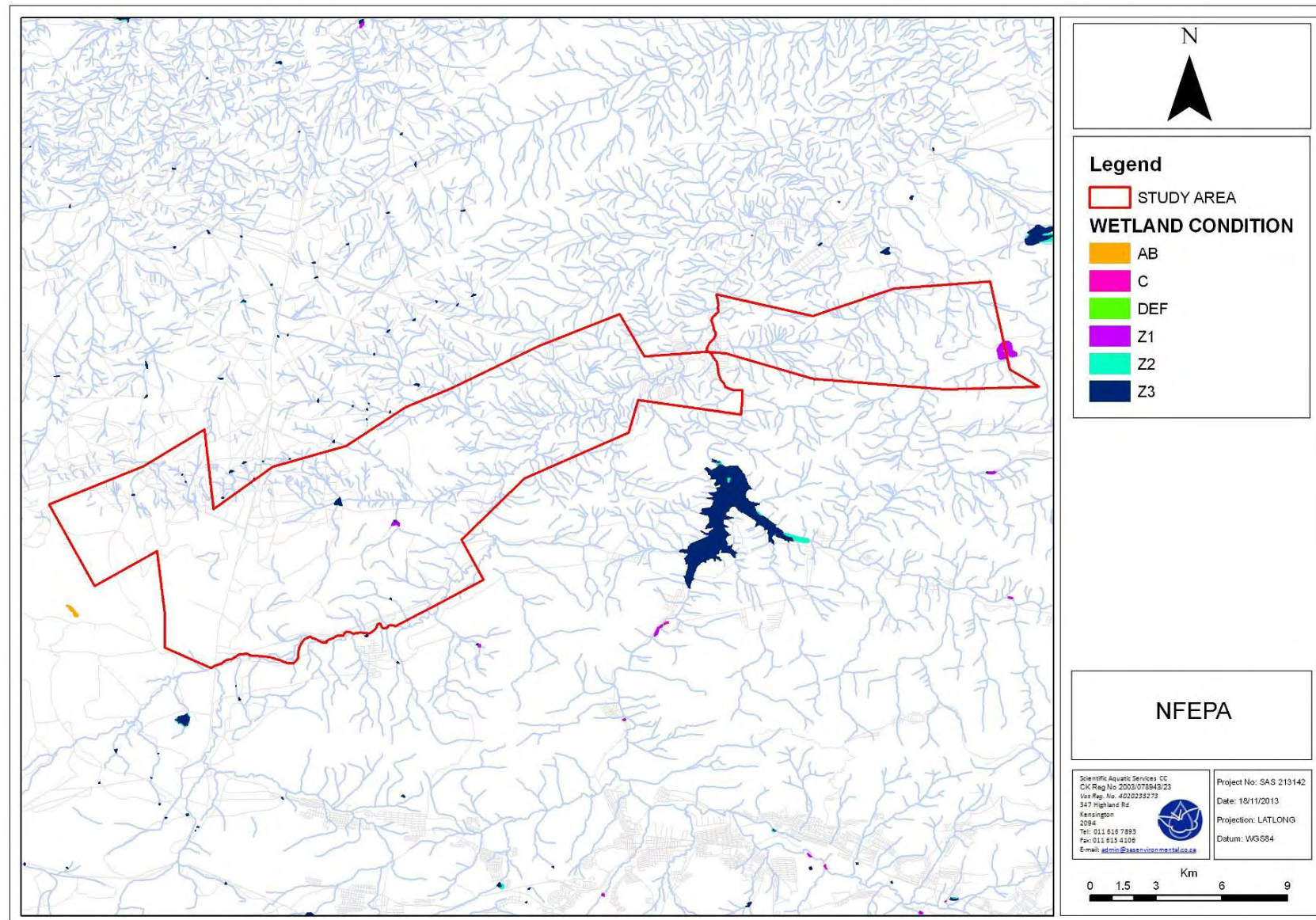


Figure 12: NFEPA wetland conditions within the General Area.



4 WETLAND ASSESSMENT SITE SELECTION RESULTS

Due to the extent of the study area as well as restricted access to many farms, sites were selected considered to be representative of the characteristics of the features within the study area. Selection of areas representative of the different feature groups, took place with the use of desktop methods (contours, flood lines, digital satellite imagery and topographical maps indicating depressions or drainage lines) after which selected points of interest were identified which are representative of the various systems. Each point of interest was assessed during the field survey to distinguish between true wetland and non-wetland as well as true riparian and non-riparian habitat. For the purposes of this investigation, use was made of distinguishing factors as either defined by DWA (2005) for „wetland habitat“ or defined in the NWA (Act No 36 of 1998) for „riparian habitat“, as discussed below.

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: „riparian habitat“ includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

Wetland habitat was defined as a feature with the following distinguishing factors as advocated by DWA (2005):

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

Areas of interest were defined taking the following into consideration:

- Ensuring a geographic spread of points to ensure that conditions in all areas were addressed; and
- Ensuring that features displaying a diversity of digital signatures were identified in order to allow for field verification. In this regard specific mention is made of the following:
 - Riparian vegetation: a distinct increase in density as well as tree size near drainage lines;
 - Hue: with drainage lines and outcrops displaying soils of varying chroma created by varying vegetation cover and soil conditions identified;
 - Surface water: to aid with the identification of artificial impoundments that may sustain wetland habitat the presence of surface water were considered informative; and
 - Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions being identified.



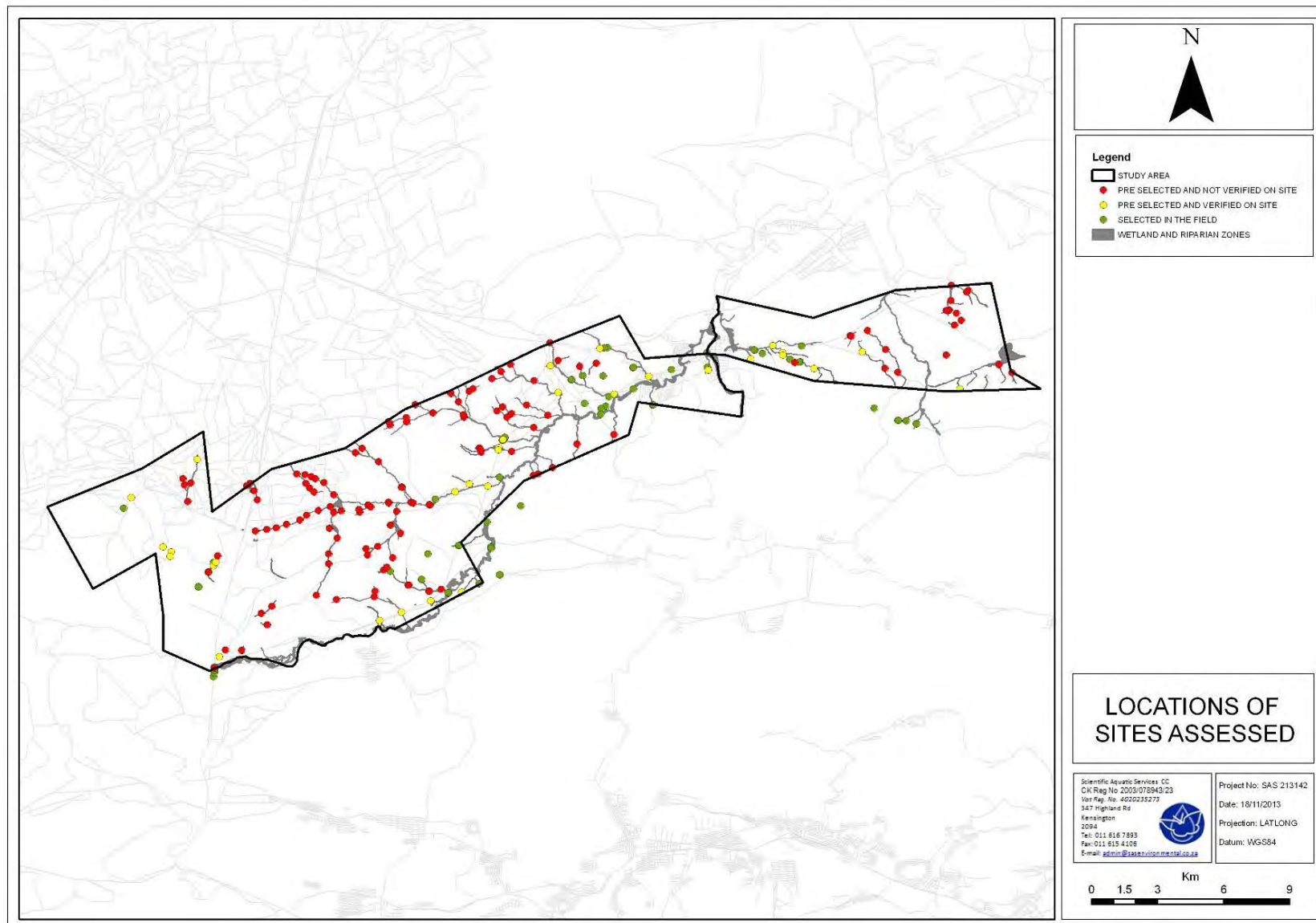


Figure 13: Areas of interest selected for assessment during the field survey.



5 CLASSIFICATION SYSTEM FOR WETLANDS AND OTHER AQUATIC ECOSYSTEMS IN SOUTH AFRICA

Features within the study area were categorised with the use of the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis *et al.*, 2013). After the field assessment it can be concluded that three main feature groups are present within the study area, namely depressions (smaller pans), rivers (Mutamba River, Nzelele River and Dolidoli River) and smaller drainage lines. Within the area several artificial earth dams were also observed, most of which do not hold surface water for periods long enough for the formation of hydromorphic soil that would support vegetation adapted to life in saturated soils. The results of the classification of the systems are illustrated in the tables below.

Table 19: Classification for smaller pans (SANBI 2013).

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform / Inflow drainage
An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The study area falls within the Limpopo Plain Ecoregion and Mopane Group 1 and 2 wetland vegetation groups (NFEPA WetVeg).	Plain: An extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.	Depression: A landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.	Endorheic.

Table 20: Classification for the Rivers (SANBI 2013).

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform / Inflow drainage
An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The study area falls within the Limpopo Plain Ecoregion and Mopane Group 1 and 2 wetland vegetation groups (NFEPA WetVeg).	Valley floor: The base of a valley, situated between two distinct valley side slopes, where alluvial or fluvial processes typically dominate.	Channelled valley bottom wetland: a valley bottom wetland with a river channel running through it.	N/A

Table 21: Classification for the drainage lines (SANBI 2013).

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform / Inflow drainage
An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The study area falls within the Limpopo Plain Ecoregion and Mopane Group 1 and 2 wetland vegetation groups (NFEPA WetVeg).	Plain: An extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.	Channelled valley bottom wetland: a valley bottom wetland with a river channel running through it.	N/A



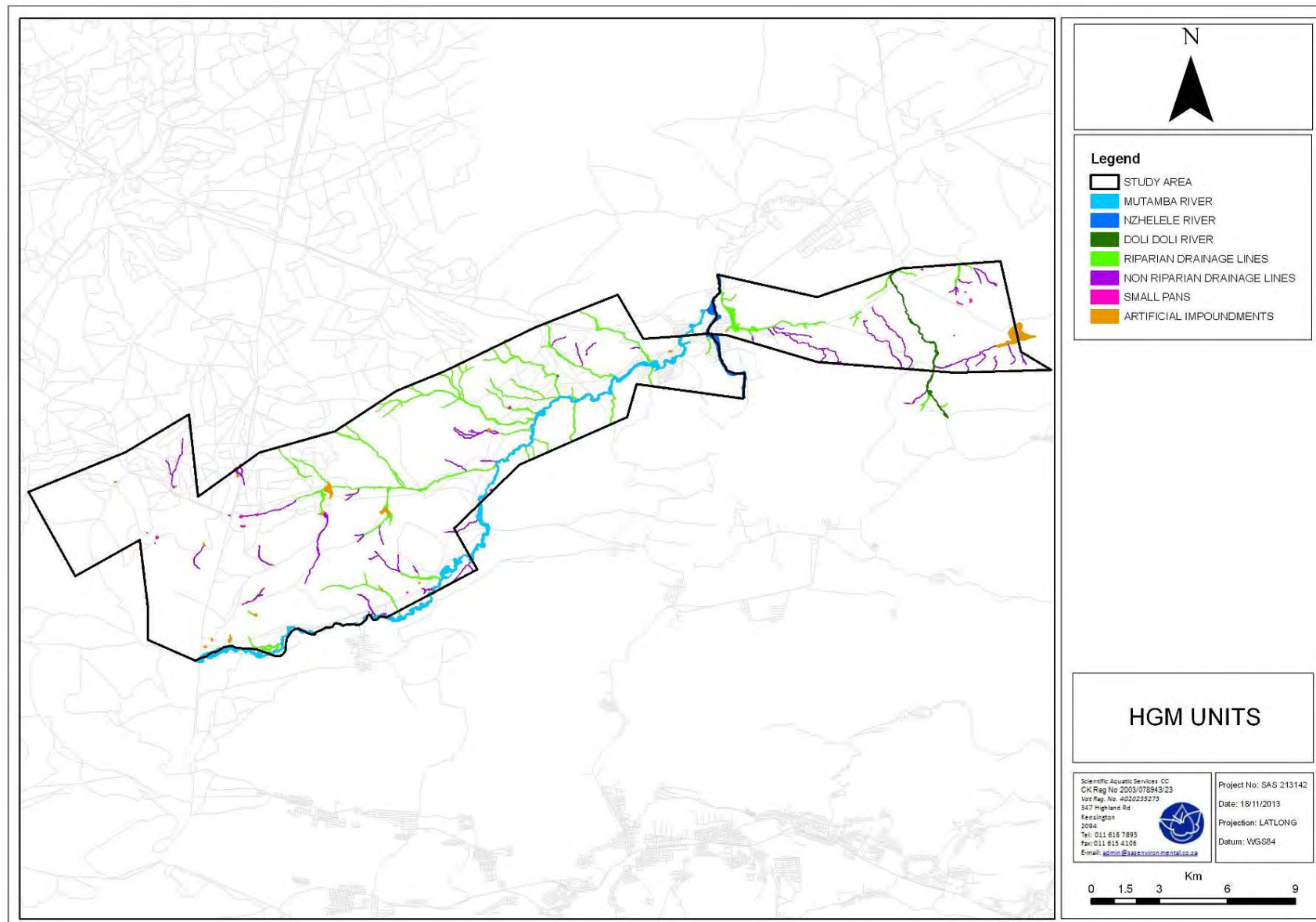


Figure 14: Locations of the wetland types in relation to the study area.



With the use of *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis *et al*, 2013) all features within the study area could be divided into three main groups namely rivers, smaller drainage lines and depressions. The features identified during the assessment were further divided into either wetland or riparian habitat based on the characteristics as defined by the NWA No 36 of 1998, provided below.

Wetland habitat – land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil (NWA; Act No. 36 of 1998).

Riparian habitat - includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure **distinct** from those of adjacent land areas.

The rivers assessed (Mutamba River, Nzhelele River and Dolidoli River) were defined as systems containing riparian habitat due to the presence of alluvial soil as well as the presence of vegetation, with a composition and physical structure, distinct from adjacent areas. Many smaller drainage lines within the study area also display these characteristics and were therefore also defined as systems with riparian habitat. The catchment of some of the drainage lines are however smaller and did not allow for the establishment of the defined riparian habitat characteristics and were therefore considered non-riparian ephemeral drainage lines.

Artificial impoundments were encountered within smaller drainage lines, most likely created as an effort to retain water for as long as possible. Most of these artificial impoundments hold water for periods long enough that could have resulted in the formation of wetland characteristics as defined by the NWA (1998) and therefore were not considered wetland habitat.

In summary, the rivers and smaller drainage lines were subdivided into riparian or non-riparian habitat. All pan features encountered could be defined as wetland habitat based on the presence of gleyed soil as well as degree of soil saturation noted within soil samples. In the sections that follow riparian habitat was assessed with use of the VEGRAI, Wetland Function Assessment, Wet-Health, and Wetland IHI. Wetland habitat was assessed with the use of Wet-Health and the Wetland Function Assessment. Refer to section 2 for the method of assessment.

5.1 Rivers

Three main river systems namely the Mutamba River, Nzhelele River and Dolidoli River flow through the study area with numerous tributaries and drainage lines also identified throughout the study area.

The terrain units and soil were considered largely similar when the different rivers were compared and therefore dominant characteristics were discussed together in the sections that follow. The extent of surface water as well as vegetation communities were considered to be different to some degree and were therefore discussed separately.





Figure 15: Mutamba River.

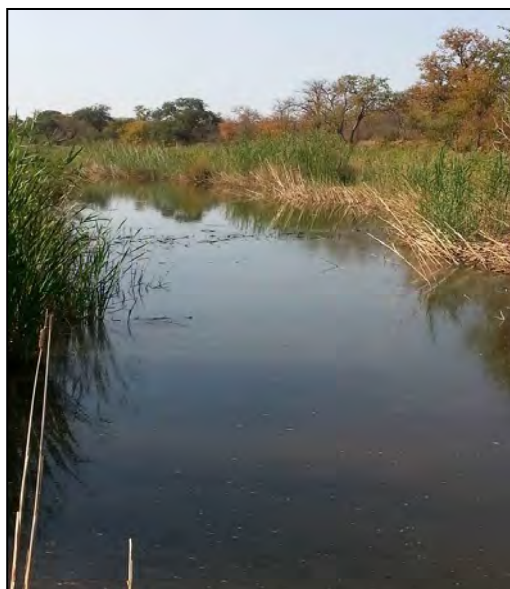


Figure 16: Nzhelele River.



Figure 17: Dolidoli River.

5.1.1 Terrain Units

The sandy nature of the soil within the region, make water courses prone to erosion and has resulted in incised river features within the study area. The degree of incision of the various riverine features formed a clear continuum. Smaller drainage features showed very limited levels of incision while larger drainage features were more incised. The largest rivers within the study area such as the Mutamba River and Nzhelele River showed significant incision and obvious stream banks.

5.1.2 Soil



Figure 18: Alluvial soil within the active channel of rivers.

The active channel of all rivers mainly constituted of alluvial soil and larger boulders and cobbles in certain areas as well as isolated areas of bedrock. The coarse alluvial sands showed clear indications of surface water movement from time to time with the degree of development characterised by the size of the system and the runoff received by the system. Water movement for prolonged periods has resulted in leaching of soil components such as iron and manganese from the soil resulting in alluvial sands with a low chroma. A distinct increase in chroma and decrease in particle size is evident on the banks where significantly less leaching has taken place and where soil material is more related to the local parent material and less associated with alluvium washed in from areas further upstream.

5.1.3 Vegetation

The larger drainage features are considered characteristic of the Subtropical Alluvial vegetation type characterised by flat alluvial riverine terraces supporting an intricate complex of macorphytic vegetation, marginal reed belts (in sheltered oxbows and along very slow flowing water courses) as well as riverine thickets (Mucina and Rutherford, 2006).



Abundance and diversity of vegetation were assessed at each site selected for a river system giving attention to zonation of the wetland assessment. A distinctive change in vegetation abundance as well as diversity was noted in the lower and upper zones compared to the surrounding terrestrial zones. Although the width of the active channel of the different rivers varied, the dominant riparian vegetation communities within the lower and upper zones were considered uniform. The most distinct difference between the different rivers assessed was identified in the vegetation structure of the marginal zone. The Nzhelele River and Mutamba River hosted *Cyperus spp.*, *Phragmites australis* (common reed) and *Typha capensis* (bulrush) not identified within any of the marginal zones of the other smaller river systems. Both these taxa are obligate wetland/riparian floral species and are therefore adapted to the anaerobic soil conditions found within the active channel of larger river systems. Therefore their presence are directly related to the availability of baseflow within a system for the largest part of the year. The additional permanent and seasonal habitat provided by the Nzhelele River and Mutamba River do increase both systems importance in terms of wetland biodiversity and it is deemed likely that with the continuation and possible increase in the volume of water abstracted from these systems that a decline in obligate/facultative floral species habitat may occur. It should further be noted that larger tree species located within the lower and upper zones would most likely also be impacted upon by a decrease in the water table resulting from ongoing and/or increased water abstraction.

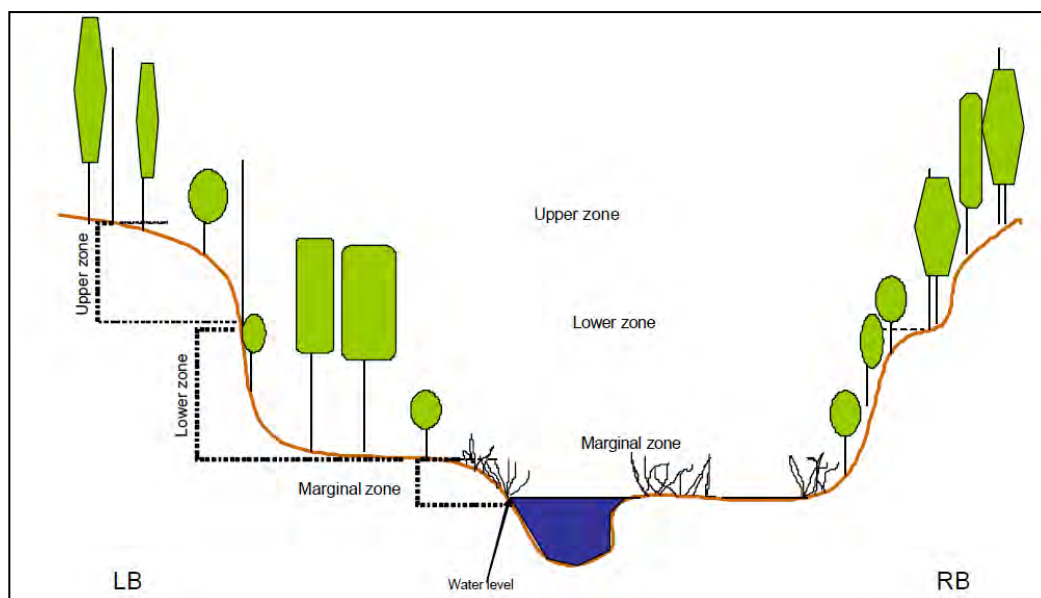


Figure 19: Cross sectional sketch¹⁰ of a river system and associated riparian zone.

The table below lists the dominant floral species identified during the assessment of all the rivers, the dominant species listed for the marginal zone are only applicable to the Nzhelele River and Mutamba River.

Table 22: Dominant floral species identified during the assessment of the rivers.

Upper zone	Lower zone	Marginal zone
<i>Colophospermum mopane</i> (Mopane)	<i>Faidherbia albida</i> (Ana tree)	<i>Phragmites australis</i> (Common reed)
<i>Combretum apiculatum</i> (Red bushwillow)	<i>Grewia flava</i> (Velvet raisin)	<i>Cyperus compressus</i>
<i>Dichrostachys cinerea</i> (Sickle bush)	<i>Cyperus fastigiatus</i>	<i>Cyperus fastigiatus</i>
<i>Acacia karroo</i> (Sweet thorn)	<i>Cynodon dactylon</i> (Couch grass)	<i>Cyperus distans</i>

¹⁰ Kleynhans et al., 2007



Upper zone	Lower zone	Marginal zone
<i>Acacia nigrescens</i> (Knob thorn)	<i>Panicum maximum</i> (Guinea grass)	<i>Ammannia baccifera</i> (Waterbessiekruid)
<i>Terminalia prunioides</i> (Lowveld cluster-leaf)	<i>Heliotropium</i> sp.	<i>Typha capensis</i> (Bulrush)
<i>Ziziphus mucronata</i> (Buffalo-thorn)		
<i>Sclerocarya birrea</i> subsp. <i>caffra</i> (Marula)		
<i>Euclea undulata</i> (Common guarri)		
<i>Grewia bicolor</i> (White raisin)		
<i>Gymnosporia senegalensis</i> (Red spike thorn)		
<i>Combretum imberbe</i> (Leadwood)		
<i>Xanthocercis zambesiaca</i> (Nyala tree)		
<i>Acacia robusta</i> (River thorn)		
<i>Schotia brachypetala</i> (Weeping boerbean)		
<i>Combretum molle</i> (Velvet bushwillow)		
<i>Spirostachys Africana</i> (Tamboti)		

5.1.3.1 Riparian Vegetation Response Assessment Index (VEGRAI)

Where access was allowed onto farms, up and downstream areas of each river system were assessed during the field survey. In order to get an overall VEGRAI rating, VEGRAI was applied to all points assessed and a mean score calculated for each system.

5.1.3.1.1 Mutamba River



Figure 20: Representative points on the Mutamba River.

Table 23: VEGRAI Ecological Category Description Scores for the Mutamba River.

Name	VEGRAI %	EC	Definition
GSP 9	87%	A/B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
GSP 10	86%	B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
GSP 11	86%	B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
GSP 12	88%	A/B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
GSP 13	69%	C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.
Mean	83%	B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.

It is evident from the results above that the riparian ecosystem has remained largely intact, with limited change of cover, abundance and species composition when compared to the reference condition in both the marginal as well as non-marginal zones.

The lower score calculated at GSP 13 is as a result of agriculture in the immediate surroundings, that resulted in an increase in non woody species and a significant loss of tree diversity within the riparian zone and the presence of some alien forbes. It is also considered highly likely that the water abstracted from along the river for agricultural purposes, leads to increasing stress on the riparian zone in a downstream direction.

5.1.3.1.2 Nzhelele River and Dolidoli River

Two points were assessed along the Nzhelele River. The portion of the Nzhelele River flowing through the study area are located within an area presently utilised for extensive agriculture.

Table 24: VEGRAI Ecological Category Description Scores for the Nzhelele River.

Point	VEGRAI %	EC	Definition
GSP 13	67%	C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.
GSP 14	66%	C	
Mean	66%	C	

The mean percentage calculated indicates the Nzhelele River as a class C (moderately modified) system considered representative of the degree of impact that resulted due to agricultural activities near the system. It is expected that transformation of the riparian community associated with the Nzhelele River will continue, due to alien vegetation proliferation and ongoing abstraction from the river under current conditions.

Restricted access resulted in the assessment of only one point along the Dolidoli River. The point assessed was located within an area that has been impacted upon by anthropogenic activity, however it should be noted that the portion of the Dolidoli River within the study area has remained largely undisturbed and therefore will most likely fall within a higher VEGRAI Ecological Category. Based on the conditions in the Doli Village the riparian vegetation is best described as being Largely Modified (Class D).

Table 25: VEGRAI Ecological Category Description Scores for the Dolidoli River.

Point	VEGRAI %	EC	Definition
GSP 16	52%	D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.





Figure 21: Representative points on the Nzhelele River.



Figure 22: Representative points on the Dolidoli River.

5.1.4 Surface Water

The field assessment was undertaken during early spring, as a result surface water was only encountered within isolated small depressions of the Mutamba River within proposed Generaal Project Area. Evidence of faunal species burrowing for water was also encountered and indicates substantial sub-surface flow within the Mutamba River during the drier months increasing the importance of rivers in terms of water provision for faunal species during the winter season when surface water is scarce. Surface water with the Nzhelele River consisted of slowly flowing glides and large pools of varying depth and thereby supporting a marginal zone consisting of abundant stands of obligate wetland species such as *typha capensis*.

Although very little surface water was observed within the Dolidoli River, this system and similar systems are still considered important in terms of water provision for fauna and do also support a functional riparian zone with ecology that is distinct from the surrounding terrestrial areas.

5.1.5 Biodiversity

The study area is located within a water stressed region and as a result available wetland and riparian habitat are considered to be of increased ecological conservation importance in terms of wetland dependent floral and faunal species. Even though surface water was only encountered within the Mutamba River and Nzhelele River, other riparian zones will still be used for shelter and migratory connectivity by both wetland dependent as well as terrestrial faunal species. The riparian habitat associated with these features is therefore considered worth a conservation effort.

Charismatic as well as species of concern were also documented during prior studies done in the area. Two tree species namely *Combretum imberbe* (Leadwood) and *Sclerocarya birrea* (Marula) are protected in accordance to the National Forests Act (Act No 84 of 1998 as amended September 2008) and was identified within riparian zones of the larger rivers. Aquatic species such as crocodiles are known to utilise the nearby Sand River and therefore it is considered possible to find these species within the Nzhelele River after sufficient rainfall. Endangered avifaunal species also expected to utilise the river resources within the study area include *Ephippiorhynchus senegalensis* (Saddle billed stork: endangered) and *Mycteria ibis* (Yellow billed stork: Near threatened)¹¹. Furthermore, *Pyxicephalus adspersus* (Giant Bullfrog), listed as near threatened¹², have been identified within seasonally rain filled depressions within wetlands of neighbouring properties and it is therefore considered likely to also be found within the study area.

The Dolidoli River has remained largely undisturbed within the project area, although increased levels of disturbance near to human settlements is observed. Although the system is ephemeral, the increase in vegetation cover within the riparian zone will provide migratory connectivity, increasing the systems importance in terms of biodiversity. Furthermore, the distinct riparian zone also indicates perennial baseflow that will also support larger tree species such as *Combretum imberbe* (Leadwood) and *Xanthocercis zambesiaca* (Nyala) with more extensive root systems. Occasional ponding after sufficient rainfall is also likely to provide habitat for breeding amphibians and invertebrates with shorter live cycles.

5.1.6 Wetland Function Assessment

The function and service provision was calculated for the Mutamba River, Nzhelele River and the Dolidoli River according to characteristics discussed in the previous sections. The average scores are presented in the following table as well as the radar plot in the figure that follow the table.

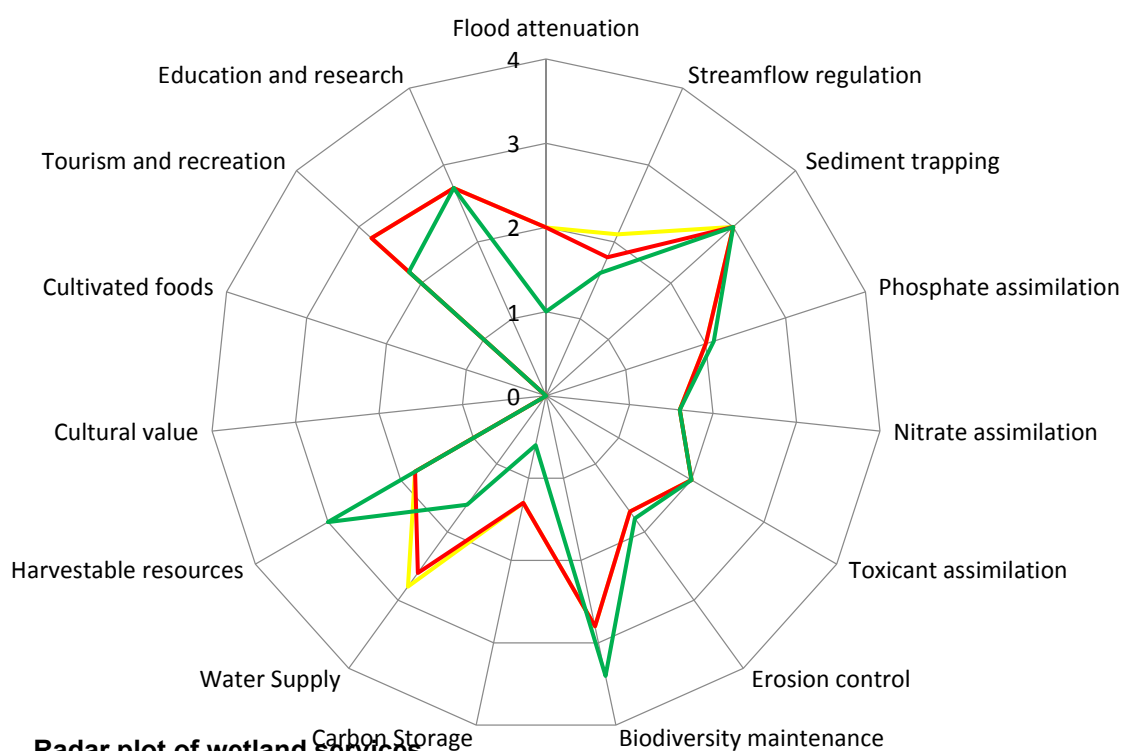
¹¹SRK Consulting, 2009

¹² Du Preez and Carruthers, 2009



Table 26: Wetland service and function assessment.

Ecosystem service	Nzhelele River	Mutamba River	Dolidoli River
Flood attenuation	1.6	2	1.6
Streamflow regulation	1.5	1.5	1.2
Sediment trapping	3	3	3
Phosphate assimilation	2.6	2.6	2.2
Nitrate assimilation	2.3	2.3	1.7
Toxicant assimilation	2.9	2.6	1.9
Erosion control	2	1.9	1.9
Biodiversity maintenance	2.6	2.6	2.8
Carbon Storage	1.3	1.3	0.6
Water Supply	2.6	2.6	1.5
Harvestable resources	2.2	2.2	2.6
Cultural value	0	0	0
Cultivated foods	2.2	2.2	1.4
Tourism and recreation	2	2.4	1.5
Education and research	0.8	1.8	1
SUM	29.6	31.0	24.9
Average score	2.0	2.1	1.7

**Figure 23: Radar plot of wetland services.**

All the features are considered to be of intermediate importance in terms of wetland function and service provision. The Mutamba and Nzhelele rivers calculated the highest scores for sediment trapping and water supply due to the primary land use being agriculture within surrounding areas. These river systems are also considered of importance in terms of biodiversity, due to persisting surface water providing habitat for various faunal and floral species within a water stressed region.

The Dolidoli River calculated lower scores in terms of water supply, however its isolation and distance from present agricultural activities did increase its importance in terms of biodiversity maintenance.

5.1.7 Index of Habitat Integrity (IHI)

The Wetland IHI index was applied to the various riverine resources in order to assist in defining the EC of these systems. The sections below present the summaries of the calculations undertaken as well as discussions of the results.

5.1.7.1 Mutamba River

Table 27: GSP 8

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		100	0.3		
Hydrology	1	100	0.4	2.7	A
Geomorphology	2	80	0.4	2.9	A/B
Water Quality	3	30	0.0	3.9	A
WETLAND LANDUSE ACTIVITIES:		80	0.2	3.1	
Vegetation Alteration Score	1	100	0.2	3.1	A
OVERALL SCORE:			0.3	Confidence Rating	
PES %			94.6		
PES Category:			A		1.4

Table 28: GSP 9

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		100	0.8		
Hydrology	1	100	1.3	2.7	C
Geomorphology	2	80	0.4	2.9	A/B
Water Quality	3	30	0.1	3.9	A
WETLAND LANDUSE ACTIVITIES:		80	0.2	3.1	
Vegetation Alteration Score	1	100	0.2	3.1	A
OVERALL SCORE:			0.5	Confidence Rating	
PES %			89.3		
PES Category:			A/B		1.4



Table 29: GSP 10

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		100	0.8		
Hydrology	1	100	0.6	2.8	A/B
Geomorphology	2	80	1.4	2.9	C
Water Quality	3	30	0.1	3.9	A
WETLAND LANDUSE ACTIVITIES:		80	0.2	3.1	
Vegetation Alteration Score	1	100	0.2	3.1	A
OVERALL SCORE:			0.6	Confidence Rating	
PES %			88.6		
PES Category:			A/B		1.4

Table 30: GSP 11

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		100	0.5		
Hydrology	1	100	0.7	2.7	B
Geomorphology	2	80	0.4	2.9	A/B
Water Quality	3	30	0.0	3.9	A
WETLAND LANDUSE ACTIVITIES:		80	0.0	3.0	
Vegetation Alteration Score	1	100	0.0	3.0	A
OVERALL SCORE:			0.3	Confidence Rating	
PES %			94.2		
PES Category:			A		1.3

Table 31: GSP 12

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		100	0.8		
Hydrology	1	100	0.6	2.8	A/B
Geomorphology	2	80	1.4	2.9	C
Water Quality	3	30	0.1	3.9	A
WETLAND LANDUSE ACTIVITIES:		80	0.9	3.3	
Vegetation Alteration Score	1	100	0.9	3.3	B
OVERALL SCORE:			0.8	Confidence Rating	
PES %			83.1		
PES Category:			B		1.5

The average score calculated for the Mutamba River with the use of the Wetland IHI, indicates that the feature can be considered to fall within PES Category A (Unmodified). A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. Water is also abstracted



from the Mutamba River that resulted in a lowered PES Category for hydrology, however water quality and geomorphology as well as riparian vegetation condition has remained largely unchanged. It is also notable that there is a general decreasing trend in wetland habitat integrity in a downstream direction largely as a result of increased water abstraction. This results in slightly lower ecological scores in the area of the Generaal project in relation to the upstream areas although the habitat integrity at this point can still be considered largely natural with few modifications (Class B).

5.1.7.2 Nzhelele River

Table 32: Overall PES of the Nzhelele River in the Vicinity of the Generaal mining project

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		100	1.8		
Hydrology	1	100	2.4	3.2	D
Geomorphology	2	80	1.6	2.9	C
Water Quality	3	30	0.2	3.9	A
WETLAND LANDUSE ACTIVITIES:		80	1.2	3.8	
Vegetation Alteration Score	1	100	1.2	3.8	C
OVERALL SCORE:			1.5	Confidence Rating	
PES %			70.0		
PES Category:			C		1.7

The score calculated for the Nzhelele River with the use of the wetland IHI, indicates that the feature can be considered to fall within PES Category B indicating largely natural conditions with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. However, some hydrological and geomorphological changes have occurred within the system, mainly as a result of agriculture, that resulted in a decrease of the overall PES Category.

5.1.7.3 Dolidoli River

Table 33: GSP 15

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		100	0.2		
Hydrology	1	100	0.1	3.4	A
Geomorphology	2	80	0.4	3.4	A/B
Water Quality	3	30	0.1	3.9	A
WETLAND LANDUSE ACTIVITIES:		80	1.5	3.9	
Vegetation Alteration Score	1	100	1.5	3.9	C
OVERALL SCORE:			0.8	Confidence Rating	
PES %			83.9		
PES Category:			B		1.7



The average score calculated for the Dolidoli River with the use of the Wetland IHI, indicates that the feature can be considered to fall within PES Category B (Largely natural with few modifications). This is considered representative of a system that has remained largely undisturbed and in which ecosystem function remained largely natural. It is however notable that in the vicinity of the local villages a significant reduction in wetland habitat integrity is evident.

5.1.8 Conclusion

After the assessment it can be concluded that the river resources are of importance in terms of function and service provision with special mention of biodiversity as well as water provision for farmers within a water stressed region. Game farming is also the present land use of the majority of the farms investigated with limited areas utilised for crop cultivation, consequently the river systems have remained largely undisturbed and are therefore important in terms of biodiversity value. The Mutamba River and Nzhelele River have significant downstream importance for socio-cultural purposes with special mention of water supply as well as biodiversity maintenance and other basic ecosystem services. Measures to ensure the ongoing functioning of these rivers in the area are therefore considered of high importance.

Mining related activities and infrastructure as proposed by the present layout provided by the proponent have the potential to impact on the tributaries of the Mutamba and Doli Doli Rivers which in turn could impact on the Nzhelele River. Should mining activity encroach onto the allocated 100m buffer zones, effective mitigation of impacts would be unlikely to minimize the impacts on these smaller systems, however with mitigation the impact on the major drainage lines in the area can be significantly limited.

It should be noted that the region in the vicinity of the study area is significantly water stressed and as a result farmers depend on water from the rivers for general water provision for agriculture as well as livestock and game farming with specific reference to the Nzhelele River and Mutamba River. Furthermore, it would be difficult if not impossible to substitute the water supply from rivers with alternative water sources except for possible groundwater use. If the proposed mining activity results in a substantial decrease in available water volumes in the aquifers associated with these water courses or result in the formation of a cone dewatering, there is the potential that farmers within the study area as well as downstream areas would be affected in addition to the ecology of the area. The Nzhelele and Mutamba Rivers are also considered to be of increased significance with regards to biodiversity maintenance due to the presence of fish as well as crocodiles that would be restricted to river corridors and refugia formed during the winter months. Therefore, reduced water volumes or impaired water quality will directly impact on the survival as well as migratory corridors of aquatic species. Any reduction of streamflow that leads to the loss of refugia for aquatic species or the significant loss of downstream water supply or impaired water quality is be considered potential impact on the lower reaches of the Mutamba River and to a lesser degree the Nzhelele River and Dolidoli river systems.

It is recommended that all requirements in terms of GN 704, Section 21 of the NWA as well as General Notice no. 1199 of 2009 as it relates to the NWA, be adhered to for any proposed activities associated with mining in these areas. In this regard specific mention is made of obtaining authorisation in terms of Section 21 c and i of the NWA for all activities which would affect these water courses.

5.2 Smaller Drainage Lines

The Generaal Project area had a low drainage density in relation to areas further to the north of the Soutpansberg mountain range. However, numerous ephemeral drainage lines with poorly defined riparian zones were identified throughout the study area. As a result, many of these features could not be considered as either wetland or riparian habitat due to the lack of characteristics as defined by the NWA (Act 36 of 1998) and DWA (2005). Consequently, the digital signatures identified on a desktop level and verified during the field survey were used to distinguish between drainage lines with riparian zones and drainage lines without riparian zones within the remainder of the study area delineated on a desktop level. It should also be noted that several artificial impoundments were also encountered within the drainage lines most likely due to farmers trying to retain water for as long as possible for watering of livestock and game. Within the Generaal project area, however most of these features cannot be defined as wetland features.



Features resembling drainage lines were also encountered, however many of these features were considered to be mainly as a result of roads or other anthropogenic activity that canalised streamflow and consequently resulted in erosion canals being formed and cannot be defined as true wetland or riparian features.



Figure 24: Example of a drainage line within the study area.

5.2.1 Terrain Units

Terrain units associated with drainage lines were considered uniform throughout the study area. All features assessed had a distinct active channel consisting of leached alluvial soil and incised banks. The incision of banks results from the sandy nature of the soil that is prone to erosion during rainfall events.

5.2.2 Soil

Soil within the drainage lines without riparian zones had a higher chroma and finer texture when compared to soil from drainage lines with riparian zones. This is considered to be a result of more volumes of water conveyed by the drainage lines with riparian zones that resulted in the leaching of minerals and the transport of smaller soil particles downstream. Soils in riparian systems had a characteristically clear alluvial substrates.

5.2.3 Vegetation

Due to the sandy nature of the soil, surface water within smaller drainage lines is only expected during a couple of days after sufficient rainfall and therefore saturated soil will not be present long enough within the majority of drainage lines to support floral species which are representative of riparian zones of small drainage lines. As a result the smaller drainage lines were divided based on the presence or absence of distinctive riparian vegetation. The dominant floral species of the riparian community is considered similar to the river systems as assessed in section 5.1.3, with a slight decrease in tree species diversity. The drainage lines with riparian zones do however capture enough water to support larger tree species such as *Combretum imberbe* (leadwood) (protected in accordance to the National Forests Act (Act No 84 of 1998 as amended September 2008))



The dominant floral species identified during the field survey are listed in the table below. All the drainage lines are considered ephemeral and therefore no facultative or obligate floral species were encountered that could be considered indicative of a marginal wetland/riparian zone.

Table 34: Dominant floral species identified during the assessment of the smaller drainage lines.

Upper zone	Lower zone
<i>Colophospermum mopane</i> (Mopane)	<i>Setaria verticillata</i> (Bur Bristle grass)
<i>Combretum apiculatum</i> (Red bushwillow)	<i>Cynodon dactylon</i> (Couch grass)
<i>Terminalia prunioides</i> (Lowveld clusterleaf)	<i>Panicum maximum</i> (Guinea grass)
<i>Sclerocarya birrea</i> subsp. <i>Caffra</i> (Marula)	
<i>Acacia karroo</i> (Sweet thorn)	
<i>Ziziphus mucronata</i> (Buffalothorn)	
<i>Combretum mossambicensis</i> (Kobbly creeper)	
<i>Euclea undulate</i> (Common guarri)	
<i>Grewia bicolor</i> (White raisin)	
<i>Gymnosporia senegalensis</i> (Red spike thorn)	
<i>Combretum imberbe</i> (Leadwood)	

5.2.3.1 VEGRAI

Numerous drainage lines were assessed within the study area to determine the characteristics of the riparian communities. When results were compared it was evident that the riparian abundances as well as diversity at the different drainage lines were very similar. One VEGRAI assessment was therefore undertaken as representative of all smaller drainage lines.

The majority of the drainage lines are located within less disturbed areas of game farms, with the only impact noted being the crossing of tracks resulting in erosion within the immediate vicinity of the features. Within some features less woody species and more non woody species with special mention of graminoids were noted that decreased the overall score to some degree. However, the EC class B (largely natural) is considered representative of the majority of the drainage lines located within the study area.

Table 35: VEGRAI Ecological Category Description Scores for the drainage lines with riparian zones.

Name	VEGRAI %	EC	Definition
Drainage lines with riparian zones	82	B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.

5.2.4 Surface Water

The field assessment was undertaken during early spring. As a result no surface water was present within any of the drainage lines assessed. It is also considered highly unlikely that surface water would remain



present for extended time periods, even after significant rainfall events, due to the high permeability of the soil.

5.2.5 Biodiversity

It is regarded unlikely that any of the drainage lines will retain water long enough to provide breeding and foraging habitat for aquatic macro-invertebrates, amphibians as well as avifaunal species. However, the drainage lines with riparian zones may provide migratory connectivity as well as sheltered nesting habitat for terrestrial avifaunal species. Amphibians and waterfowl may however opportunistically utilise these systems in times of increased rainfall.

Furthermore, these features provide an important habitat type due to the longitudinal connectivity of the habitat offered by the riparian zones. The vegetation cover within riparian zones is often denser and therefore offers better habitat cover for many faunal species for longer periods of the season. This aspect consequently leads to a higher predator species component that not only relies on the better habitat cover, but also the more reliable prey source. This complex habitat type therefore often has relatively high species diversity. Localised terrestrial (or aquatic) negative impacts invariably have negative impacts on the system as a whole.

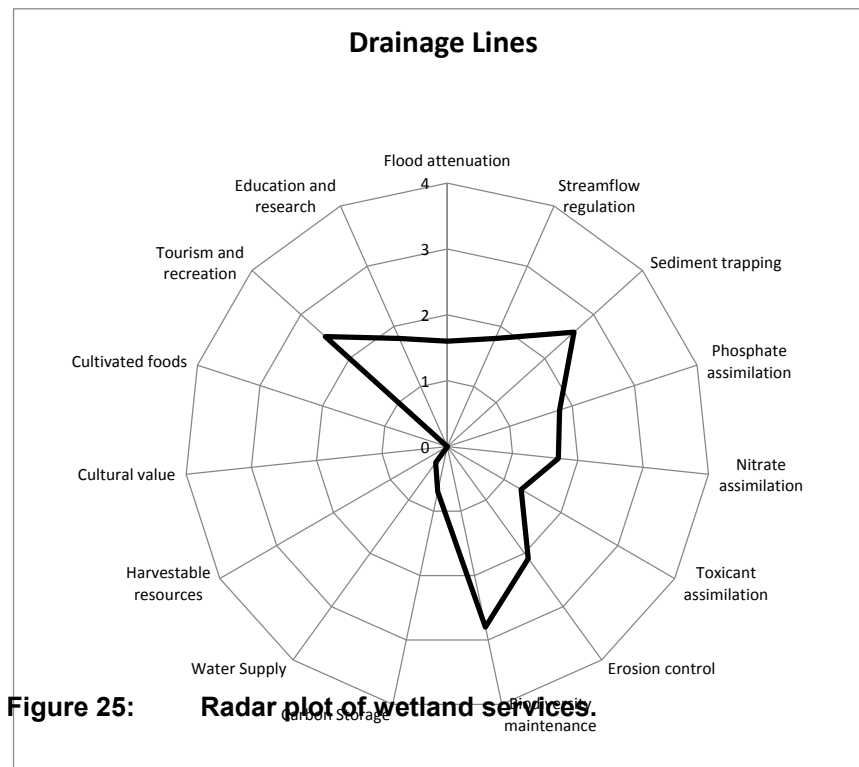
5.2.6 Wetland Function Assessment

The function and service provision was calculated for the drainage lines according to characteristics discussed in the previous sections. The average score is presented in the following table as well as the radar plot in the figure that follow the table.

Table 36: Wetland service and function assessment.

Ecosystem service	Drainage Lines
Flood attenuation	1.6
Streamflow regulation	1.8
Sediment trapping	2.6
Phosphate assimilation	1.8
Nitrate assimilation	1.7
Toxicant assimilation	1.3
Erosion control	2.1
Biodiversity maintenance	2.8
Carbon Storage	0.7
Water Supply	0.3
Harvestable resources	0
Cultural value	0
Cultivated foods	0
Tourism and recreation	2.5
Education and research	1.8
SUM	21.0
Average score	1.4





From the results of the assessment, it is evident that the smaller drainage lines encountered within the study area are not regarded to be of exceptional importance in terms of function and service provision. This is mainly as a result of lack of surface water for extended periods of time limiting the ability to support any aquatic ecological communities, or the formation of seasonal and permanent wetland zones that could support a more diverse riparian floral community.

The drainage lines cannot be considered important in terms of harvestable resources or cultivated foods due to lack of sufficient water that would support such activities. However, drainage lines are still considered important in terms of biodiversity maintenance, tourism and recreation as well as sediment trapping.

5.2.7 Index of Habitat Integrity (IHI)

Table 37: Smaller Drainage Lines IHI.

OVERALL PES (PES) SCORE					
	Ranking	Weighting	Score	Confidence Rating	PES Category
DRIVING PROCESSES:		100	0.5		
Hydrology	1	100	0.7	2.9	B
Geomorphology	2	80	0.4	2.9	A/B
Water Quality	3	30	0.1	3.9	A
WETLAND LANDUSE ACTIVITIES:		80	0.1	3.2	
Vegetation Alteration Score	1	100	0.1	3.2	A
OVERALL SCORE:			0.3	Confidence Rating	
PES %			93.7		
PES Category:			A		



The average score calculated for the smaller drainage lines with the use of the IHI, indicates that the features can be considered to fall within PES Category A (Unmodified/Natural). Smaller drainage lines have been left largely undisturbed with marginal change for hydrology and geomorphology identified.

5.2.8 Conclusion

Characteristics of smaller drainage lines with riparian zones are considered to be largely uniform throughout the study area. The majority of the features are located within more isolated areas further from agriculturally related activities and the lack of water for extensive periods of the year does not make it feasible for abstraction. All these aspects have resulted in drainage features with limited levels of present impact, which can be considered important in terms of biodiversity conservation.

Due to the ephemeral nature of the drainage lines, not all drainage lines could be considered riparian habitat as defined by NWA No 36 of 1998. Therefore, distinction was made between drainage lines with riparian zones and drainage lines without riparian zones. Smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year flood lines exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA will also apply and therefore a Water Use License will be required.

Smaller drainage lines *without* riparian zones are not considered wetlands but are still defined as watercourses. If any activities are to take place with the 1:100 year flood line exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained, however Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA does not apply and therefore no Water Use License will be required.

5.3 Depressions and artificial impoundments

Several artificial depressions were identified, mostly as a result of artificially created impoundments within drainage lines. By considering the distinguishing factors of wetland habitat as defined by DWA (2005), namely presence of surface water, hydromorphic soil and vegetation adapted to saturated soil, most of the depressions encountered, could not be considered true wetland habitat and therefore were not investigated as part of the wetland assessment. Several smaller pans where hydromorphic soil formation were identified during the assessment are discussed in detail below.

5.3.1 Terrain Units

Smaller pans can be considered most representative of endorheic depressions. Due to the presence of closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.

5.3.2 Soil

The smaller pans hold water long enough for hydromorphic soil formation. Furthermore, soil within the temporary zone had a low chroma compared to surrounding terrestrial zones. A sign of anaerobic conditions under which minerals such as iron becomes soluble and leaches from soil, a characteristic known as gleying.

5.3.3 Vegetation

Smaller pans lacked a vegetation layer completely except for the edges of the feature where grasses dominated followed by mopane veld higher up the in the sequence. As a result, no obligate or facultative floral species associated within the seasonal and permanent zones of wetlands were identified. This characterisation is presented in Table 38 below, and includes the terrestrial species identified near the temporary zones.



Table 38: Dominant floral species identified during the assessment of smaller pans.

Terrestrial species	Temporary species
<i>Colophospermum mopane</i> (Mopane)	<i>Cynodon dactylon</i> (Couch grass)
<i>Acacia karroo</i> (Sweet thorn)	
<i>Dichrostachys cinerea</i> (Sickle bush)	

5.4.4 Surface Water

The field assessment was undertaken during winter, therefore none of the pans had surface water. The natural pans in the area are expected to have seasonally saturated soils.

5.3.5 Biodiversity

Wetland depressions are considered to be of increased sensitivity due to their ability to retain water for longer periods of time that would provide habitat for wetland dependent floral and faunal species for longer periods within a region with very limited surface water present year round. Although the terrestrial depressions only retain water seasonally, these features will still provide habitat for amphibian and avifaunal species during the rainy season. The pans are generally devoid of vegetation cover in the seasonally inundated areas. The lack of vegetation reduces the ecological significance of these features. The lack of cover within the features also reduces the significance in terms of faunal conservation.

5.3.6 Wetland Function Assessment

The function and service provision was calculated for smaller pans according to characteristics discussed in the previous sections. The average scores are presented in the following table as well as the radar plot in the figure that follows the table.

Table 39: Wetland service and function assessment.

Ecosystem service	Smaller Pans
Flood attenuation	0.8
Streamflow regulation	0
Sediment trapping	0.2
Phosphate assimilation	1.5
Nitrate assimilation	1.6
Toxicant assimilation	1.3
Erosion control	1.5
Biodiversity maintenance	1.5
Carbon Storage	1
Water Supply	0
Harvestable resources	0
Cultural value	0
Cultivated foods	0
Tourism and recreation	0
Education and research	0
SUM	9.4
Average score	0.6



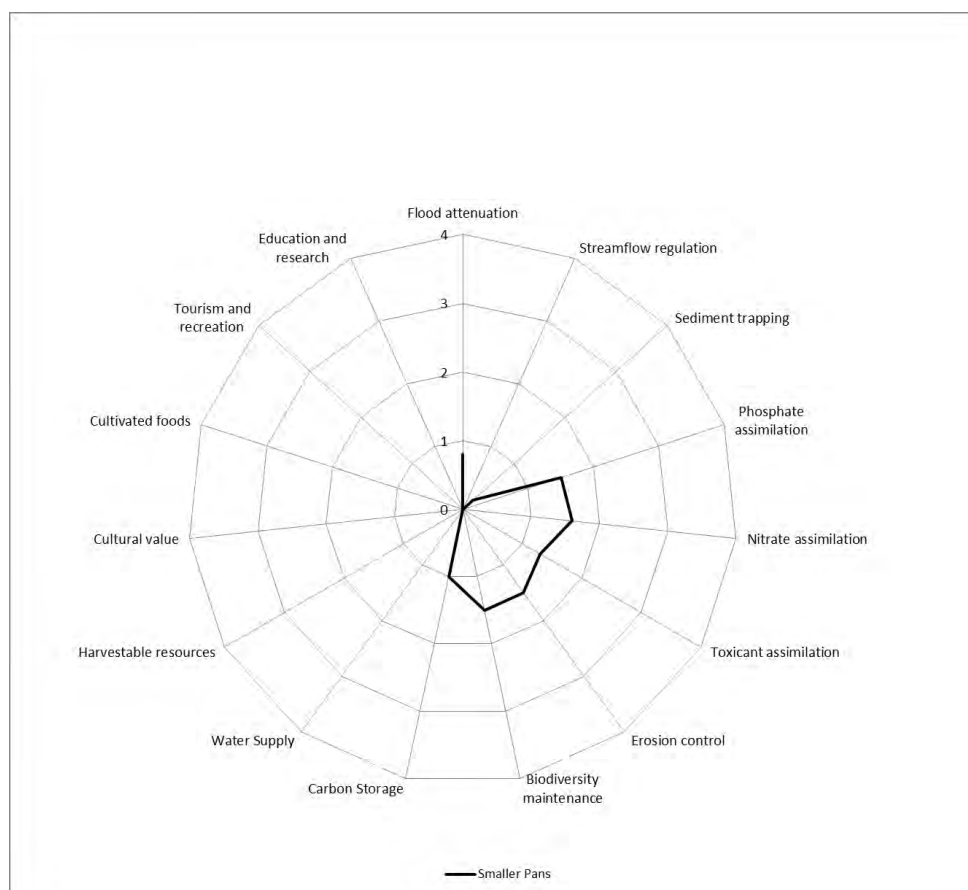


Figure 26: Radar plot of wetland services.

When considering the average score it is evident that the smaller pans within the study area can be considered of moderately low importance in terms of service and function provision. Due to lack of year round surface water smaller pans are not expected to be of any importance in terms of water supply or crop cultivation. None of the features are located within a rural communal area and therefore service provision in terms of harvestable resources, cultural value and cultivated food are considered to be insignificant.

5.3.7 Wet-Health

The geomorphological module focusses on wetlands that are connected to a drainage network, as a result, present geomorphic state was not assessed for smaller pans.

Table 40: Summary of the overall health of the features based on impact score and change score.

Feature type	Hydrology		Vegetation	
	Impact Score	Change Score	Impact Score	Change Score
Smaller Pans	A	→	A	→

The limited amount of anthropogenic activity noted during the assessment within the immediate vicinity of the smaller pans resulted in the pans still being in a very high PES (unmodified, natural). If mining activity remains outside the allocated buffer zones no change is expected within the next 5 years.



5.3.8 Conclusion

Smaller pans showed characteristics of a wetland habitat in which soil is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils. These depressions are considered to be of increased EIS for aquatic and terrestrial species which rely on these systems for parts of their life cycles as well as drinking water during winter months. It is for this reason that these systems should be conserved wherever possible and that as far as possible connectivity between these areas and surrounding open areas should be maintained in order to support the biodiversity maintenance services that these systems provide.

Pans are depressions without in or outflow, therefore dependent on the surrounding catchment for water. Any activity that would result in a reduction in size of the catchment would impact on the volume of water reaching the pans in turn impacting wetland habitat presently considered to be important in terms of ecological function and service provision.

Several artificial depressions were identified, mostly as a result of artificially created impoundments within drainage lines. However, the artificial dams can be divided into wetland dams and ephemeral terrestrial dams depending on permeability of the base and the extent of the drainage catchment of the dam and consequent ability to retain water long enough for the formation of hydromorphic soil that would support facultative or obligate wetland floral species.



Figure 27: Terrestrial artificial dam (left) and a dam with artificial wetland conditions (right) observed during the field survey.

At the time of the assessment various avifaunal species were encountered near wetland depressions. *Pelomedusa subrufa* (Marsh Terrapin), although considered common for the region were also observed in some artificial impoundments in the region. It is therefore considered important that as far as possible wetland depressions and pans remain undisturbed during the proposed mining activities as they provide valuable wetland habitat in the region.

5.4 Synthesis

Sites selected with the use of desktop methods, were investigated during the field survey undertaken in August 2013. For the purposes of this investigation, use was made of distinguishing factors as either defined by DWA (2005) for „wetland habitat“ or defined in the Water Act (Act No 36 of 1998) for „riparian habitat“. After the field assessment it can be concluded that four groups representing true wetland or riparian characteristics are present within the study area namely rivers, smaller drainage lines, pans and wetland depressions. These

four groups were then assessed to determine importance in terms of function and service provision as well as PES, discussed in the sections above. The bullets below summarise the key findings:

- The results obtained for the function and service provision indicated the Mutamba River, Nzhelele River and Dolidoli River to be of similar importance in terms of function and service provision, with the highest scores calculated for water supply, biodiversity and tourism and recreation. The smaller pans as well as drainage lines calculated scores that fall within a moderately low class and therefore cannot be considered of exceptional importance in terms of function and service provision despite the drainage lines being in a largely unmodified state;
- Wet-Health was used to determine the PES of the smaller pans within the study area. The pans have been largely undisturbed and therefore can still generally be considered to be in good condition and are considered to be relatively important in terms of biodiversity support in the area although overall functional importance is limited. The wetland Pans were defined as being moderately important (class B systems); and
- VEGRAI was used to assess the response of riparian vegetation to impacts within rivers as well as smaller drainage lines. The mean average scores calculated for the drainage lines and Mutamba River both fall within Class B (largely natural) and mean average scores calculated for the Nzhelele River and Dolidoli River fall within Class C (moderately modified).

5.5 Ecological Importance and Sensitivity

Table 41: EIS determination for the various river systems within the study area.

System	Mutamba River		Nzhelele River		Dolidoli River		Smaller drainage lines	
Determinant	Score	Conf	Score	Conf	Score	Conf	Score	Conf
PRIMARY DETERMINANTS								
1. Rare & Endangered Species	3	2	2	2	3	2	2	2
2. Populations of Unique Species	3	3	3	2	2	3	1	2
3. Species/taxon Richness	3	2	2	2	2	2	2	2
4. Diversity of Habitat Types or Features	2	3	3	3	1	3	1	3
5. Migration route/breeding and feeding site for wetland species	3	3	3	3	2	3	1	3
6. PES as determined by WET-Health assessment*	3	3	2	3	3	3	4	3
7. Importance in terms of function and service provision	3	3	3	3	2	3	2	3
MODIFYING DETERMINANTS								
8. Protected Status according to NFEPA Wetveg	3	4	4	4	4	4	4	3
9. Ecological Integrity	3	3	3	3	4	3	3	2
TOTAL	26	26	25	25	23	26	20	23
MEDIAN	2.9	2.9	2.8	2.8	2.6	2.9	2.2	2.6
OVERALL EIS	B		B		B		B	

*WET IHI used in Place of WET Health

Based on the findings of the study it is evident that from a wetland point of view, the EIS of the river systems are largely similar. All the systems can be defined as Class B systems indicating a high EIS. Drainage lines also calculated an overall EIS score of B. The smaller pans calculated an EIS score included within a high EIS Class (Class B).



Table 42: EIS determination for the smaller pans within the study area.

System Determinant	Smaller pans	
	Score	Conf
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	1	3
2. Populations of Unique Species	0	2
3. Species/taxon Richness	0	2
4. Diversity of Habitat Types or Features	1	3
5. Migration route/breeding and feeding site for wetland species	1	1
6. PES as determined by WET-Health assessment	4	2
7. Importance in terms of function and service provision	2	3
MODIFYING DETERMINANTS		
8. Protected Status according to NFEPA Wetveg	4	3
9. Ecological Integrity	4	2
TOTAL	17	21
MEDIAN	1.9	2.3
OVERALL EIS	C	

5.6 GIS Mapping

Due to time constraints, the vast number of wetland and riparian features within the study area, as well as restricted access to some of the farms within the study area, digital signatures were identified during the initial desktop assessment that were ground truthed during the assessment of each site that was selected. These digital signatures were then used to determine if wetland or riparian habitat is present within a feature. The following digital signatures were considered:

- Riparian vegetation: a distinct increase in density as well as tree size near drainage lines;
- Hue: with drainage lines and outcrops displaying soils of varying chroma created by varying vegetation cover and soil conditions identified;
- Surface water: to aid with the identification of artificial impoundments that may sustain wetland habitat the presence of surface water were considered informative; and
- Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions being identified.

5.7 Delineation and Sensitivity Mapping

All features were delineated on a desktop level with the use of aerial photographs, digital satellite imagery and topographical maps. Portions of the features were verified during the field survey according to the guidelines advocated by DWA (2005) and the wetland/riparian delineations as presented in this report are regarded as a best estimate of the temporary and riparian zone boundaries based on the site conditions present at the time of assessment.

The following indicators were used during the verification of riparian and wetland zones:

- Terrain units were used as the primary indicator for both riparian as well as wetland zones;





Figure 28: Terrain unit used as primary indicator and vegetation as the secondary indicator



Figure 29: Gleying evident within the soil profile of the smaller drainage lines with riparian zones (left); gleyed soils within the permanent zone of pans (right).

- Vegetation was also considered informative at all features.
 - A riparian zone is defined as an area that supports vegetation with a composition and physical structure distinct from the adjacent terrestrial zones. Vegetation could therefore be used as secondary indicator for rivers and smaller drainage lines;
 - Facultative and obligate wetland floral species were encountered at all wetland depressions, with a distinct increase of *Colophospermum mopane* (Mopane tree) density and tree size within terrestrial areas; and
 - Pans lacked vegetation completely within permanent and seasonal zones, with an increase in abundance of terrestrial species within the temporary and seasonal zones.
- Soil form as indicator was used within areas where vegetation and landscape transformation have taken place.
 - For the soil form indicator at wetland depressions and pans, the presence of gleyed soils (most of the iron has been leached out of the soil leading to a greyish/greenish/bluish colour) and mottling (created by a fluctuating water table) were investigated; and
 - For the soil form indicator at rivers and smaller drainage lines, the presence of leached alluvial soils were investigated.
- The field assessment was undertaken during the early spring, as a result no surface water was present in most systems except for the Nzhelele River, Mutamba River, Dolidoli River and some of the artificial impoundments.

5.7.1 Legislative requirements

Legislative requirements were used to determine the extent of buffer zone required for each group depending on whether a group is considered wetland/riparian habitat or not. The Mutamba River, Nzhelele River and Dolidoli River as well as smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year flood lines exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA will also apply and therefore a Water Use License will be required.

Smaller drainage lines *without* riparian zones are not considered wetlands but are still defined as watercourses. If any activities are to take place with the 1:100 year flood line exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained, however Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA does not apply and therefore no Water Use Licence will be required.

Smaller pans are considered wetland habitat, therefore a Water Use Licence in terms of section 21 c and i of the NWA will be required, and the 500 m zone of applicability of General Notice no. 1199 of 2009 as it relates to the NWA will also apply.

5.7.2 Buffer Allocations

During the field survey it became evident that the majority of features has remained largely undisturbed and can still be regarded to be in a high PES. Furthermore, features with surface water throughout the year play a vital role in the provision of water for both wildlife as well as agricultural activities. To comply with legislative requirements as defined above as well as to aid with conservation of habitat within the study area, during the proposed mining activities, 100m buffer zones are recommended for all features. The location of the features in relation to the study area is conceptually depicted in the figures below. Subsequently, the activities will fall within the 500m zone of applicability of General Notice no. 1199 of 2009 as it relates to the NWA, therefore a risk assessment might have to be undertaken. It is recommended that the mining proponent liaises with DWA in order to ensure that all legislative requirements are adhered too in terms of General Notice no. 1199.



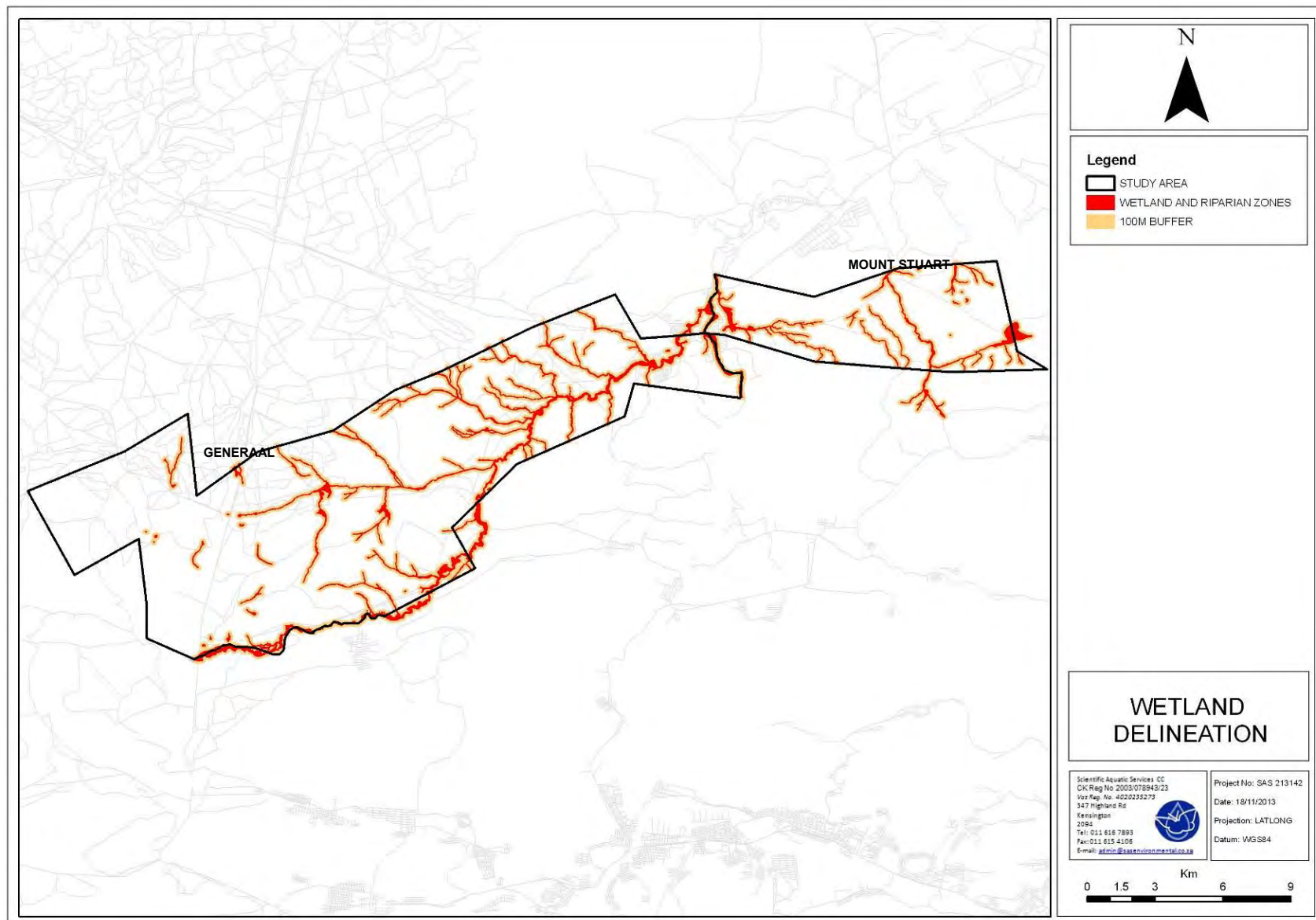


Figure 30: Allocated 100m buffer zones in relation to the study area (Divided into the Generala and Mount Stuart sections below).



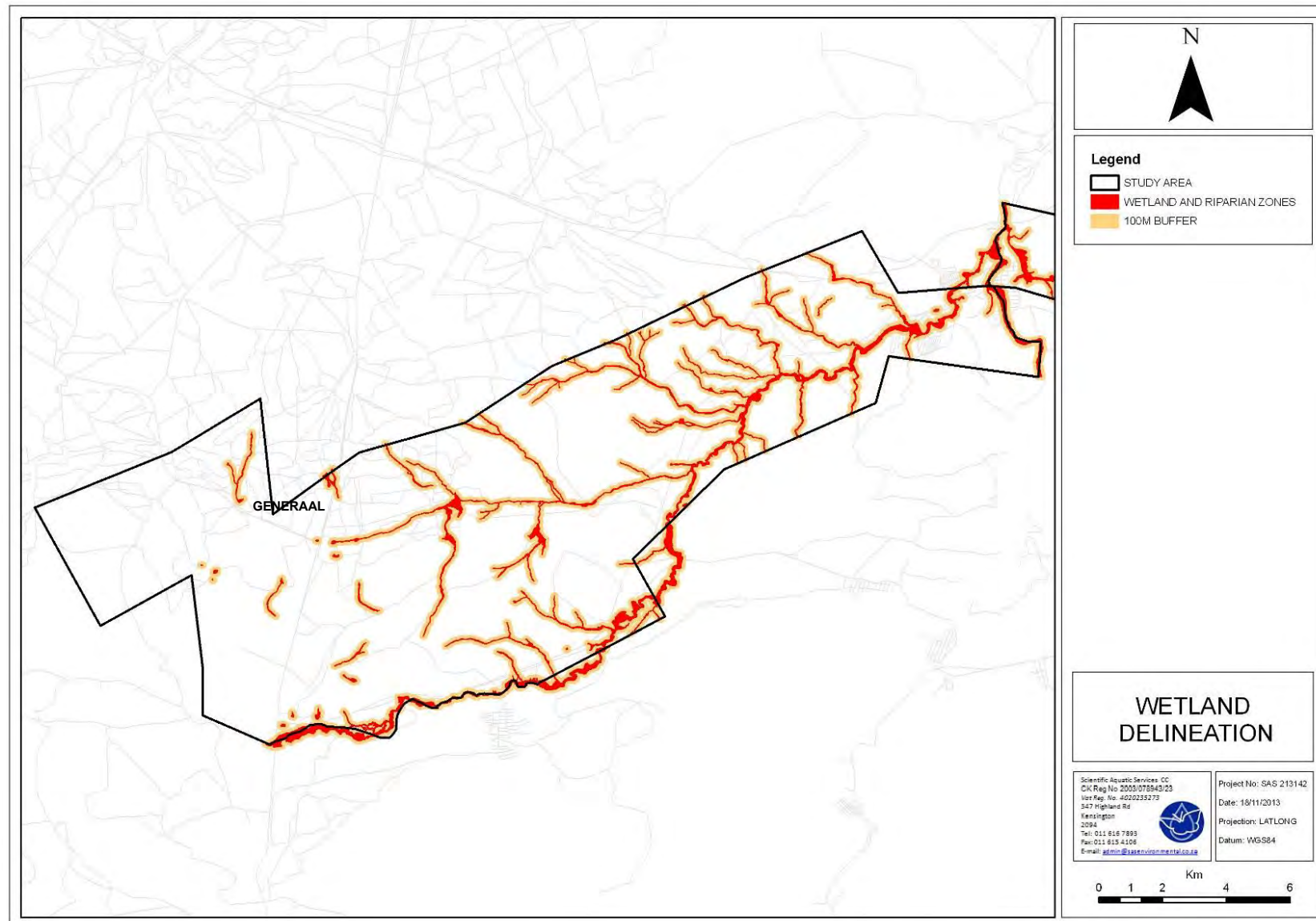


Figure 31: Allocated 100m buffer zones in relation to the General section



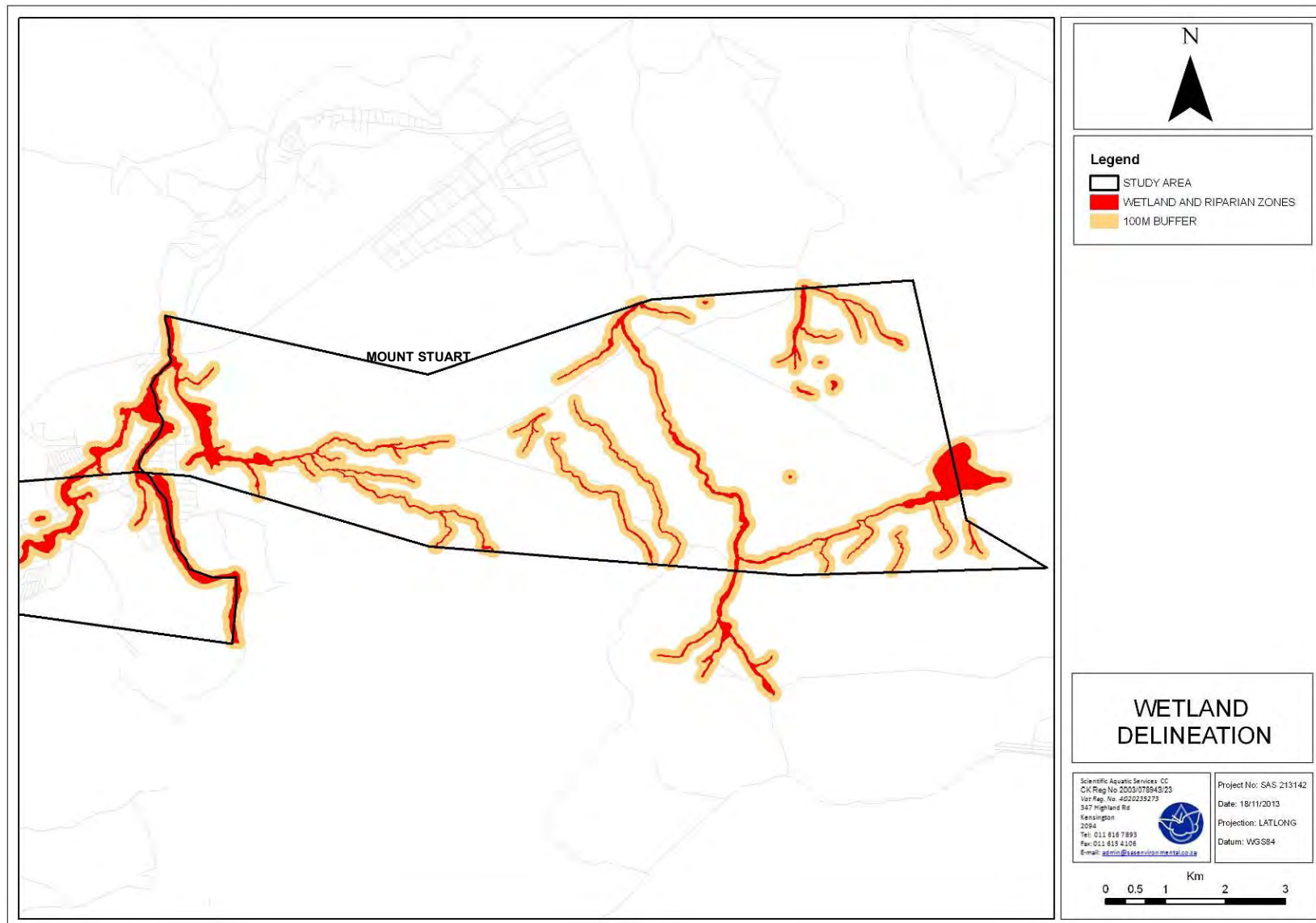


Figure 32: Allocated 100m buffer zones in relation to the Mount Stuart section.



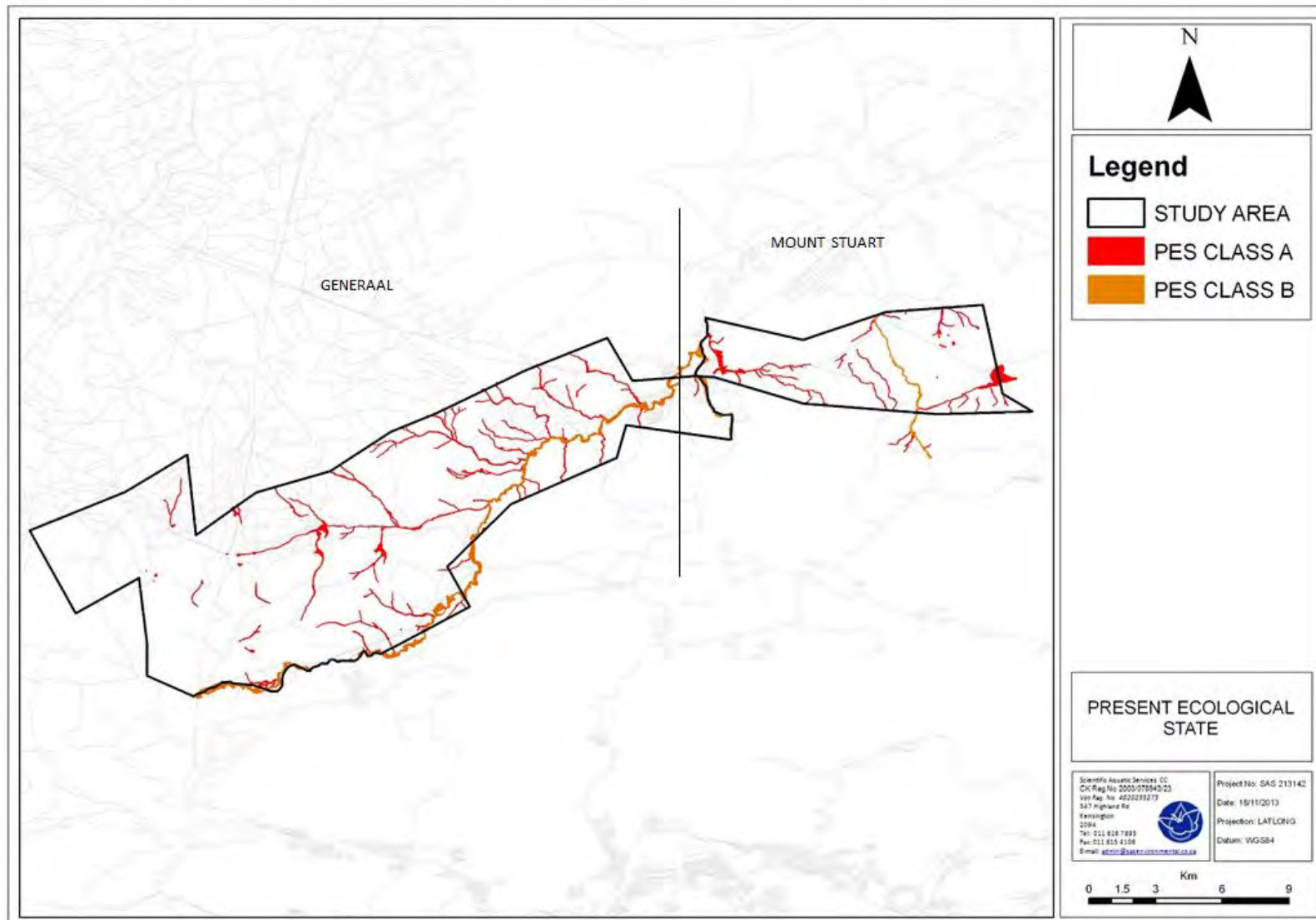


Figure 33: PES Maps based on the same principle as above (divided into Generaal and Mount Stuart sections)



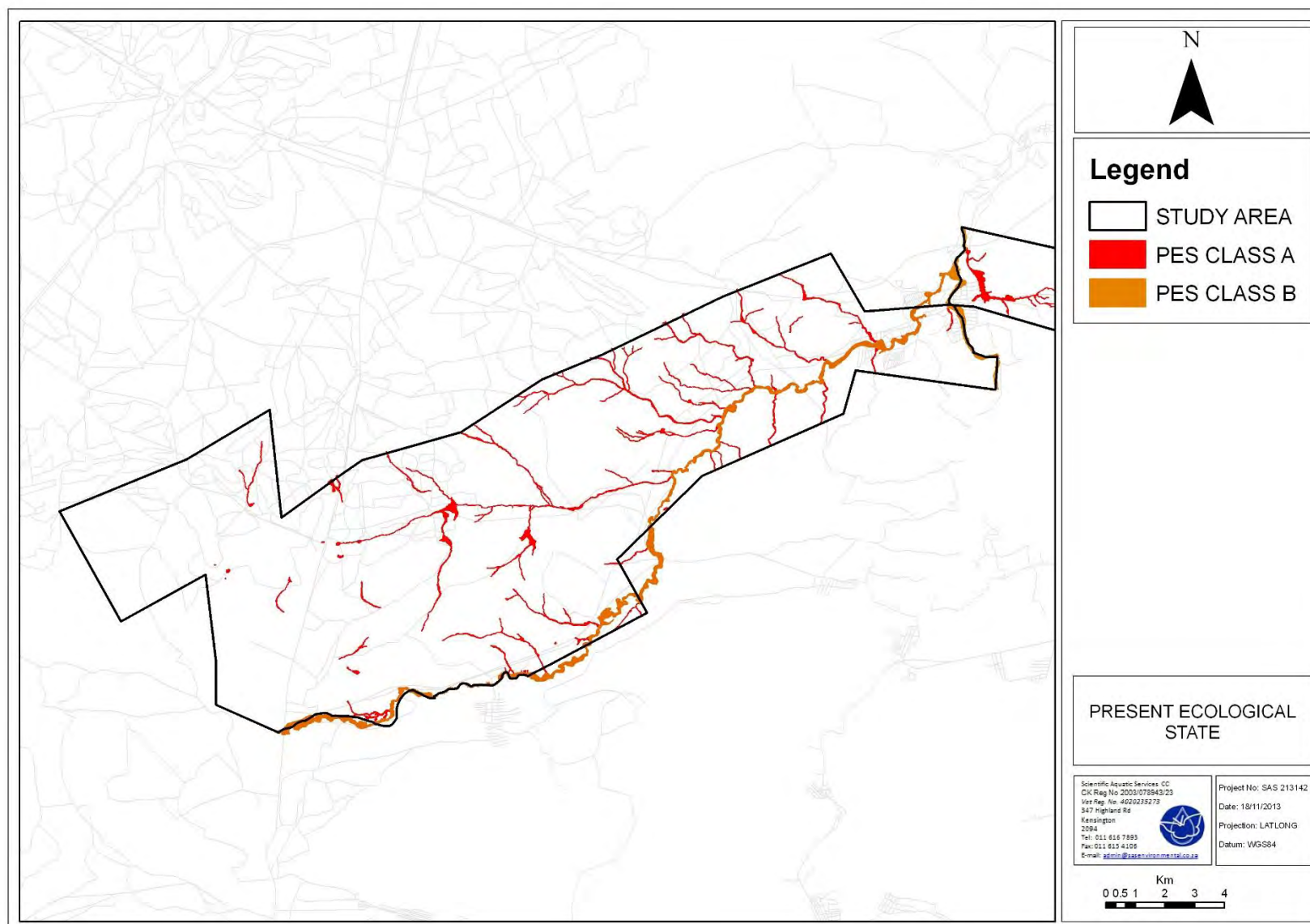


Figure 34: PES Map (Generaal section)



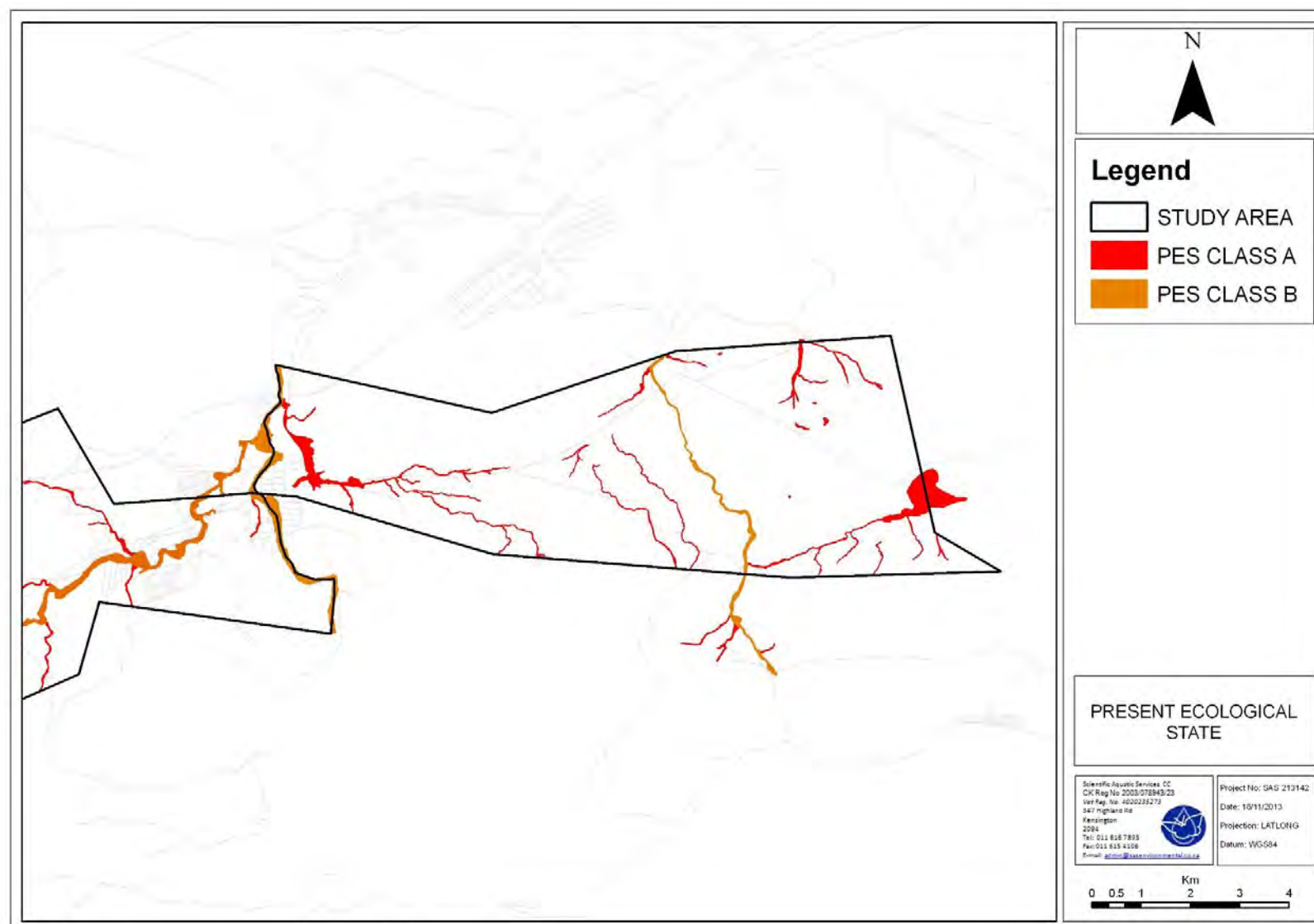


Figure 35: PES Map (Mount Stuart section)



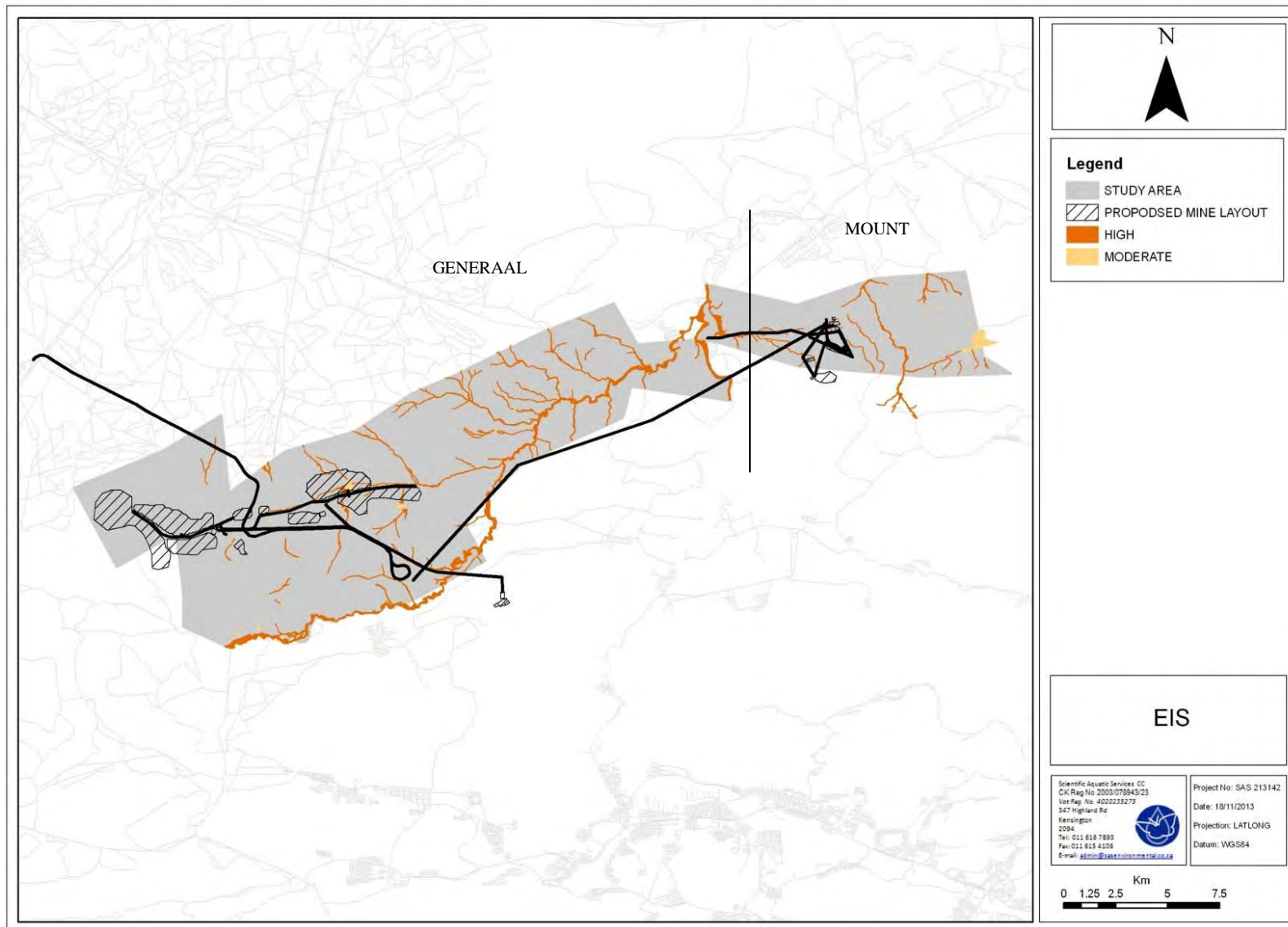


Figure 36: EIS Maps based on the same principle as above (divided into Generala and Mount Stuart sections)



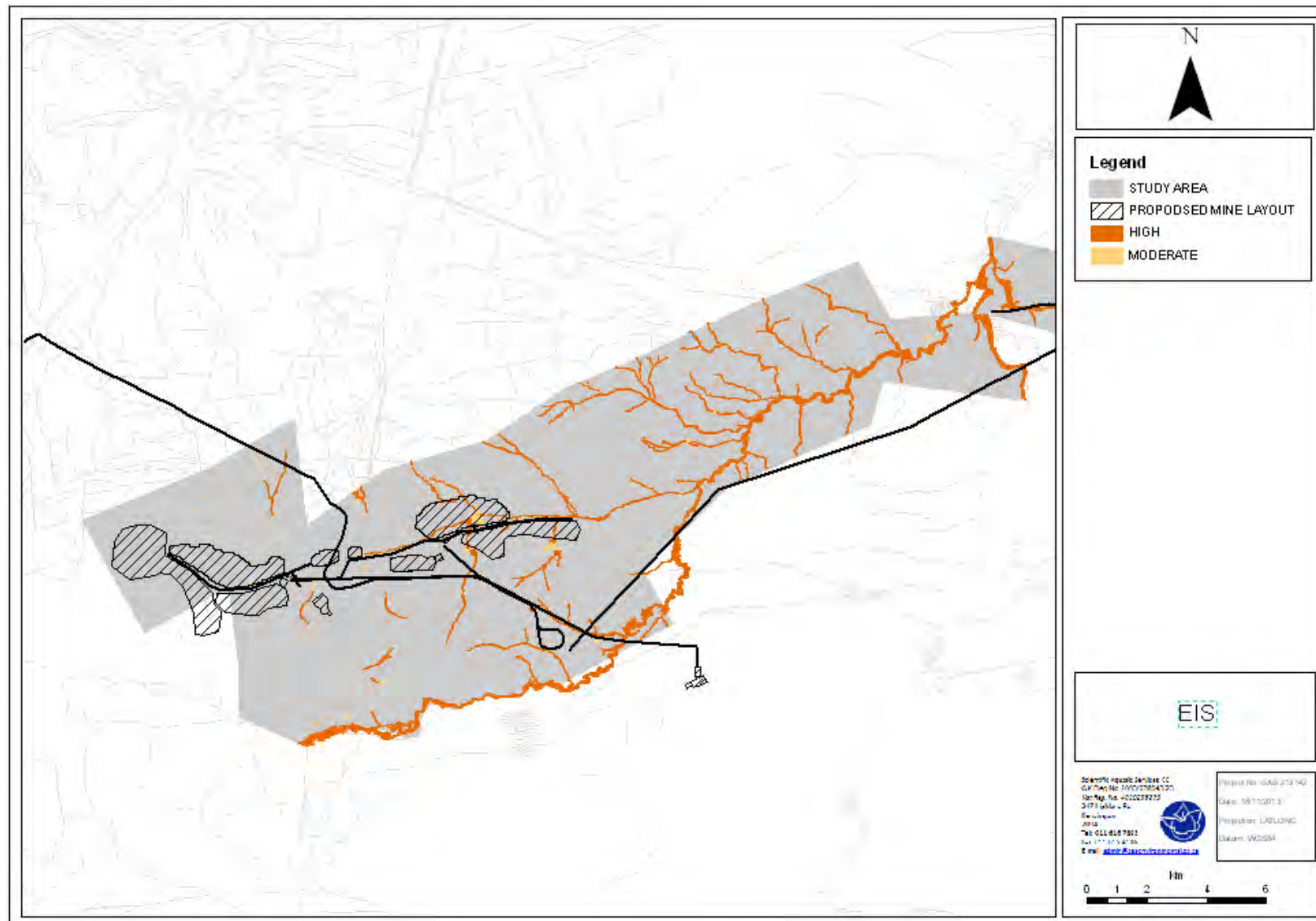


Figure 37: EIS Map (General section)



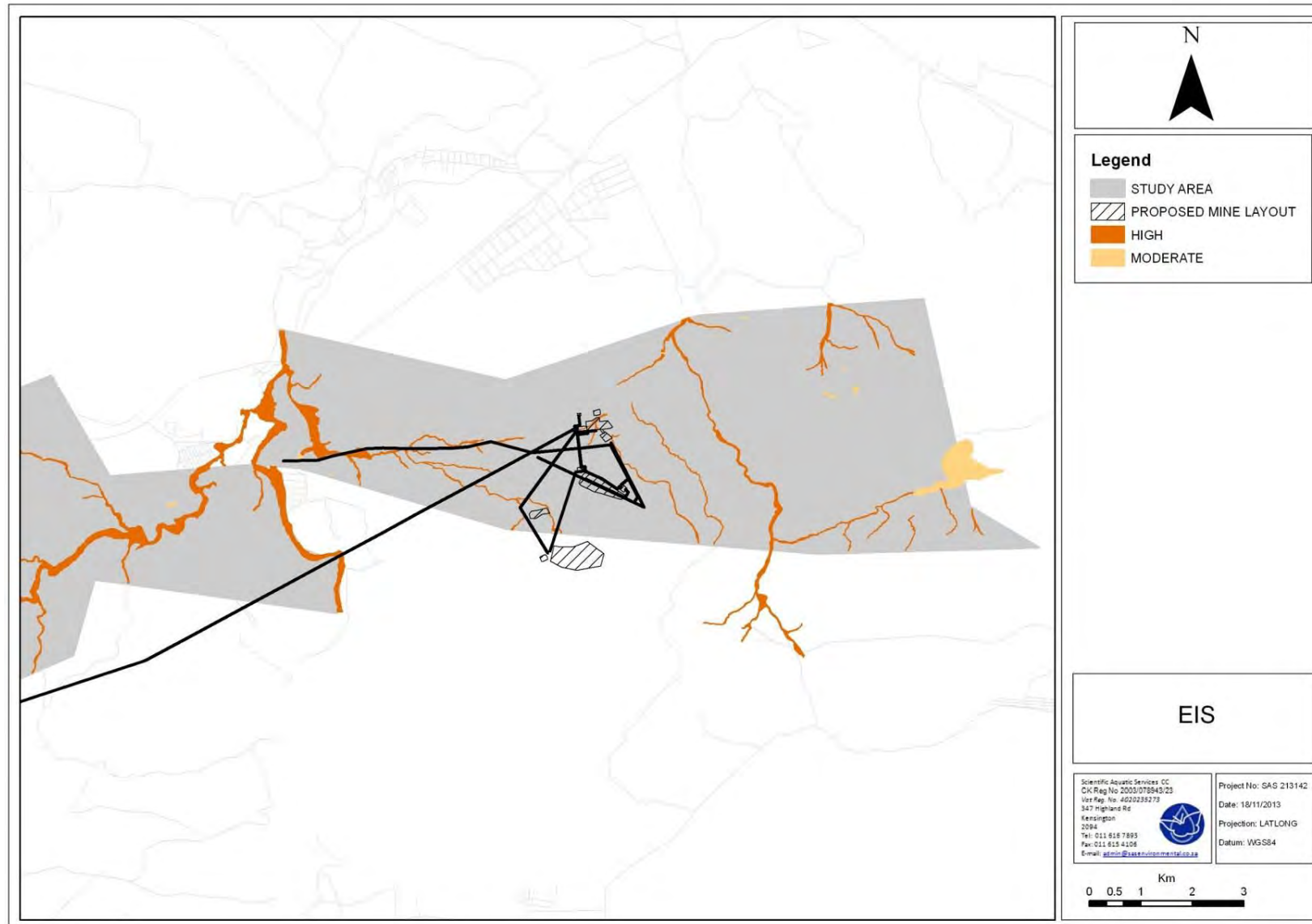


Figure 38: EIS Map (Mount Stuart section)



5.8 Recommended Ecological Class

According to the resource directed measures for protection of water resources¹³ a wetland or river may receive the same class for the PES, as the REC, if the habitat is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the feature. The results obtained from the assessments indicate a relatively low level of transformation on all levels of ecology. It is therefore recommended that the features be assigned the same REC as the PES Class calculated. The EIS and REC values are presented in the table below:

Table 43: Assigned REC Classes.

Feature	VEGRAI Ecstatus	Wetland PES Classes	EIS Class	REC Class
Mutamba River	B	B	B	B
Nzhelele River	C	C	B	B
Dolidoli River	D	B	B	B
Smaller drainage lines	A	A	B	B
Smaller pans	*	A	B	B

* = not applicable

6 AQUATIC ECOLOGICAL ASSESSMENT RESULTS

6.1 The Mutamba River

6.1.1 Visual Assessment



Figure 39: Upstream view of the GSP8 site on the Mutamba River showing the very limited flow at the time of assessment.



Figure 40: Downstream view of the GSP8 site showing the excellent rocky substrate present.

¹³ DWA and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999





Figure 41: A general view of the Mutamba River (GSP11) where the River enters the Generaal Project Area.



Figure 42: A general view of the middle section of the Mutamba River (GSP12) showing the well-developed riparian zone of the system.



Figure 43: Upstream view of the GSP13 site on the Mutamba River showing the dense reed growth.



Figure 44: Downstream view of the GSP13 site showing the small pool below the bridge.



Table 44: Visual description of the sites selected on the Mutamba River

ASPECT	GSP9	GSP10	GSP13
Significance of the point	This site serves as a future spatial reference point for all sites further downstream in the catchment. The point also serves to indicate the condition of the Mutamba River prior to any effects as a result of the activities of the proposed Chapudi and Generaal mining projects.	Photographs are representative of the middle reaches of the system and can be considered representative of the GSP 9 GSP11 and GSP 12 points too.	The site is situated on the lower reaches of the Mutamba River near to the confluence with the Nzhelele River. Future data for this point can be spatially compared to the results obtained at site GSP8 in order to identify any impacts on the aquatic ecology of the system occurring between the two points.
Surrounding features	This section of the river is located in an area dominated by game farming and winter vegetable production. The surrounding landscape is largely intact as the river flows through a remote gorge where little human activity occurs.	This section of the river is located in an area dominated by game farming. The surrounding landscape limited levels of transformation although some impact from water abstraction may occur.	This section of the river is located in an area dominated by game farming upstream of the point and citrus production in the vicinity of the point. The surrounding landscape shows varying degrees of transformation based on the intensity an extent of agricultural activities on each farm portion.
Riparian zone characteristics	The riparian zone along the length of this section of the Mutamba River is steep and narrow due to topography of the area. Some vegetation removal has occurred in the vicinity of the bridge. The riparian zone at this point may be affected by alien vegetation encroachment to a small degree.	The riparian zone along the length of this section of the Mutamba River is relatively broad with a well-developed riparian zone with trees associated with water courses dominating the riparian zone.	The riparian zone along the length of this section of the Mutamba River is relatively broad due to the wide floodplain of the system. The riparian vegetation is dense and consists mostly of <i>phragmites mauritianum</i> .
Depth and flow characteristics	The Mutamba River was flowing at this point and displayed some slow flowing sections. No fast flowing water was present. The river consisted mostly of shallow freestone runs and isolated deep sections in the larger pools.	The Mutamba River was dry along most of its course with only subterranean flow through the alluvium present along extensive lengths of the system.	The Mutamba River was dry along most of its course with only subterranean flow present along extensive lengths of the system. At the GSP12 point the site consisted of a pool among the dense vegetation.
Water clarity	Water was very clear.	River segment was dry at the time of assessment	Water was clear although biological activity leads to some increase in turbidity.
Impacts and signs of pollution	At the time of assessment no significant impacts on the instream ecology were visually evident.	At the time of assessment no significant impacts on the instream ecology were visually evident although some impact from water abstraction may occur	At the time of assessment limited impacts on the instream ecology were visually evident although some impact due to water abstraction from the system leading to reduced instream flow and loss of refuge pools is considered highly likely to be occurring. Some impact on water quality was also deemed possible.



6.1.2 Physico-Chemical Water Quality

Water quality variables were measured at two points on the Mutamba River where surface water was present. GSP9 represents the upstream point on the system on the upper boundary of the project area and GSP 13 represents a downstream point on the system at a point just before the confluence of the Mutamba River with the Nzhelele River.

Table 45: Biota specific water quality data for the assessed river assessment sites

Site	Description	pH (pH units)	Conductivity (mS/m)	DO (mg/L)	Temp (°C)
GSP9	Mutamba River – Spatial reference point	7.35	18.4	7.51	25.9
GSP13	Mutamba River – Point to assess potential impact	6.32	116.4	5.60	22.8

The following key points on the water quality of the Mutamba River system both upstream and in the vicinity of the proposed Generaal project were observed:

- Increased concentrations of dissolved salts were observed in a downstream direction;
- This was due to lower flow conditions (further compounded by water abstraction from the system for agricultural purposes) and associated high evaporation rates in the area leading to the concentrating of salts in the system;
- Spatially there was an increase in conductivity in a downstream direction, with EC being 6.3 times higher at site GSP13 compared to GSP9;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that: 1) Total dissolved salts (TDS) concentrations (i.e. as indicated by the EC measurements) should not be changed by > 15 % from the normal cycles of the water body under unimpacted conditions at any time of the year; and 2) the amplitude and frequency of natural cycles in TDS concentrations should not be changed;
- When viewing upstream site GSP9 as reference site, the spatial change downstream thus exceeds the above recommendation although it must be noted that natural salinization of the system is deemed likely in the local area;
- From a temporal perspective, EC increased by 38.3% at site GSP9 from 2009 to 2013. Once again this change exceeds the recommendation;
- Comparing current GSP9 readings to that obtained at an upstream site (GSP8 historically called M0) in 2009, EC was 89.5% higher at GSP9;
- Comparing current GSP9 readings to that obtained at a downstream site (historically called M2) in 2009, EC was 21.6% higher at GSP9;
- The temporal changes in EC at site GSP9 exceed the DWA (2007) guideline recommendation for aquatic ecosystems. The Mutamba River is likely to display a naturally high level of variability in dissolved salt concentration linked to seasonality of flow. Close monitoring of these trends will be required in future;
- Spatially there was a 14.0% decrease in pH value in a downstream direction between sites GSP9 and GSP13;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that pH values should not be allowed to vary from the range of the background pH values for a specific site by > 5 %;
- If the upstream site GSP9 pH value is considered a reference value for the downstream site GSP13, the observed changes in pH value exceed the recommended percentage change range from a spatial perspective;
- From a temporal perspective pH value decreased by 1.1% at GSP9 from 2009 to 2013. This change falls well within the recommended guideline and the observed variations can be attributed to natural temporal variation;
- Comparing the historical M0 (GSP8) and M2 to GSP9 (also from a temporal perspective), the percentage decrease in pH value of 0.7% and 3.5% respectively also falls within the recommended guideline;
- Dissolved oxygen (DO) concentration decreased by 25.4% in a downstream direction between sites GSP9 and GSP13;



- The water quality guideline for aquatic ecosystems (DWA 1997) states that dissolved oxygen concentrations should range between 80% and 120% of saturation. Saturation (i.e. maximum dissolved oxygen concentrations) shall in turn depend on the temperature of the water sampled (USA EPA website accessed 18 May 2013). The current readings can then be expressed as a percentage of the potential maximum as tabulated below.

Table 46: Oxygen measured expressed as a percentage of maximum at the temperature measured.

Site	Oxygen (mg/L)	Temperature when measured (°C)	Maximum oxygen at that temperature (mg/L)	Oxygen measured expressed as percentage of maximum
GSP8	7.51	25.9	8.09	92.83%
GSP12	5.60	22.8	8.56	65.42%

- Dissolved oxygen concentration at upstream site GSP9 falls well within the recommended range, whilst that at the downstream site (GSP13) is below the recommended range;
- When comparing current results to historical (2009) data, oxygen concentration increased by 4.5% (from 7.19 to 7.51 mg/mL) at site GSP9;
- Furthermore, from a temporal perspective, when considering the historical data, oxygen concentration at sites M0 (GSP8) and M2 (2009) were 25.4% and 9.6% respectively higher at GSP9 (2013);
- The observed variation in dissolved oxygen concentration is likely to be attributed largely to natural variation with biological activity within the system at each point considered to be a significant driver of the variation in the system;
- The temperatures observed at each of the points are deemed natural for the time of year and the nature of the systems. The observed variations can again be attributed to diurnal variation between sampling times and the variation in the volume of water in the water bodies sampled and some level of seasonal variation in sampling times.

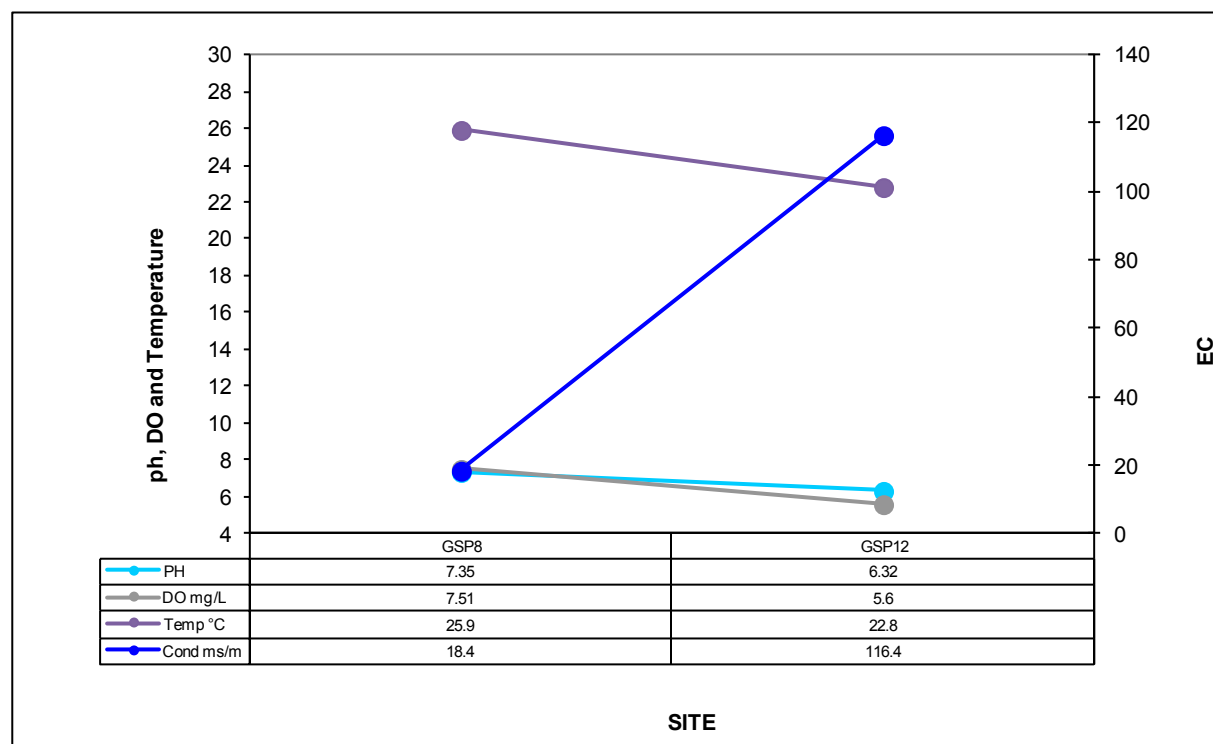


Figure 45: Physico-chemical water quality showing spatial trends



6.1.3 Intermediate Habitat Integrity Assessment (IHIA)

Assessment site GSP9 was on the Mutamba River and is considered the most suitable reference site for the Generaal project (most upstream site during current assessment). It must however be considered that the habitat conditions at this point are significantly different from areas further downstream in the system and therefore significant differences in the aquatic community structure can be expected in the Generaal Project area in relation to the GSP9 point

For site GSP9, only small and moderate impacts were recorded for both instream and riparian zones habitat. The former relates to bed modification, channel modification, water quality and solid waste disposal, of which only channel modification was moderately impacted. Site GSP9 obtained an "A" ("Unmodified / Natural") classification with regard to instream habitat integrity.

The most significant riparian zone impacts at site GSP9 were alien encroachment and bank erosion (both moderately impacted). Site GSP9 obtained an "A" ("Unmodified / Natural") classification with regard to riparian habitat integrity.

An overall score of 86.7% (GSP9) was calculated, placing site GSP9 in class A (unmodified/natural).

6.1.4 Invertebrate Habitat Assessment System (IHAS)

Table 47 is a summary of the results obtained from the application of the Invertebrate Habitat Integrity Assessment (IHAS) Index to one river assessment site on the Mutamba River (GSP9). This index determines habitat suitability, with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in interpreting the SASS5 results. IHAS scores (McMillan, 1998) are presented in Appendix 2.

- The GSP9 site on the Mutamba River were dominated by pools and runs;
- Water was clear at the time of assessment;
- Water flow was mixed but generally slow;
- Fringing vegetation was absent but rocks provided very good bank cover. Bank/riparian vegetation (mix of reeds and shrubs) were present;
- Suitable rocky substrate was present at the GSP9 site, increasing the ability to support a diverse and sensitive aquatic community at this point significantly;
- The other habitat types noted were sand and gravel substrate;
- Habitat diversity and structure was considered highly suitable for supporting a diverse and sensitive aquatic macro-invertebrate community.

Table 47: A summary of the results obtained from the application of and IHAS indices to the assessment site on the Mutamba River

SITE	GSP9
IHAS score	73
IHAS Adjustment score (illustrative purposes only)	+22
McMillan, 1998 IHAS description	Habitat diversity and structure is highly suited to supporting a diverse aquatic macro-invertebrate community under the current flow conditions.
Stones habitat characteristics	Adequate loose cobbles and rocks in current present. Stones out of current present.
Vegetation habitat characteristics	Bank/riparian vegetation (mix of reeds and shrubs) was present. No fringing vegetation were, however, present or sampled. Aquatic vegetation was also absent.
Other habitat characteristics	Sand (and gravel habitats available. No mud or bedrock substrate present. No algae present.
IHAS general stream characteristics	The stream at this point has a fair diversity of flow, is fairly wide and of average depth under the current conditions. Water is clear and bank cover is good, thus limiting the potential for erosion at this point.



6.1.5 Aquatic Macro-Invertebrates:

6.1.5.1 SASS5

Table 48 indicates the results obtained per biotope sampled whilst SASS5 scores are tabulated in Table 49. SASS5 and ASPT scores (Dickens and Graham, 2001) are presented in Appendix 3.

Table 48: Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites

PARAMETER	SITE	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	GSP9	76	0	22	79
Number of taxa		12	0	5	13
ASPT		6.3	0	4	6.1

Table 49: Summary of the results obtained from the application of the SASS5 index to the assessment site on the Matumba River

Type of Result	GSP9
Biotores sampled	Sand, gravel, stones in current, stones out of current.
Sensitive taxa present	<i>Atyidae; Caenidae; Leptophlebiidae; Chlorocyphidae; Gomphidae</i>
Sensitive taxa absent	<i>Philopotamidae; Hydracarina; Corduliidae</i>
SASS5 score	79
Adjusted SASS5 score	101
SASS5 % of theoretical reference score*	54.5
ASPT % of theoretical reference score**	101.7
Dickens & Graham, 2001 SASS5 classification	Class C
Dallas 2007 Classification	Class A

*SASS5 reference score = 145; **ASPT reference score = 6

- Habitat limitations are likely to limit the diversity, abundance and sensitivity of the aquatic community to some degree;
- Suitable habitat in the form of ample rocky substrate indicates suitable macro-invertebrate habitat conditions at this point. The absence of vegetation biotopes, however, is the most likely reason for the lower than expected SASS score obtained at site GSP9;
- Taxa dependent on faster flow conditions are also likely to be largely absent;
- Water quality is likely to be an additional limiting factor shaping the aquatic community in the lower reaches of the system. As more data on the system is collected, better inferences on the ecological condition of the community will be possible;



- At site GSP9, the stream may be considered to be in a class C (moderately impaired) condition according the Dickens & Graham (2001) classification system. According to the Dallas (2007) classification system, the site can be classified as class A (Natural);
- This apparent discrepancy can be explained by the high ASPT score that exceeded 6, resulting in a much higher classification on the reference graph compiled by Dallas (2007);
- The Dallas (2007) classification is considered to be a more accurate representation of the conditions at this point;
- The ephemeral nature of the Mutamba River in the vicinity of the Generaal Project reduces the EIS of the system in this area significantly;
- The Mutamba River system is expected to exhibit broad variability in aquatic community integrity on a temporal scale due to variations in flow and habitat availability in the system. As more data on the system is collected, better inferences on the ecological condition of the community will be possible;
- Due to the degree of sensitivity of the system to habitat changes and loss of instream flow careful design and operational procedures will be required to limit the impact on the Mutamba River.

6.1.5.2 Aquatic Macro-Invertebrates: MIRAI

Table 50: Summary of the results (ecological categories) obtained from the application of the MIRAI to the GSP9 assessment site on the Mutamba River, compared to classes awarded using SASS5.

Variable / Index	GSP9
Ecological category (MIRAI)	C
Dickens and Graham (SASS5)	C
Dallas (SASS5)	A

In terms of general ecological category classification, the values obtained are in congruence with previous studies performed in the same system. A faunal assessment for the Chapudi Project (compiled by Natural Scientific Services CC) previously reported on ecological categories between six sites. For five of these sites classifications varied between D and E with only one site achieving a C ecological classification. For site GSP8 (M1 historically) specifically, an ecological classification of D was achieved (compared to C obtained in the current assessment).

6.1.6 Fish Community Assessment

The HCR (Habitat Cover Rating) results for the GSP8 site assessed on the Mutamba River are provided in Figure 66. With regard to application of the FRAI, fish collected and scores employed are provided in Table 51.



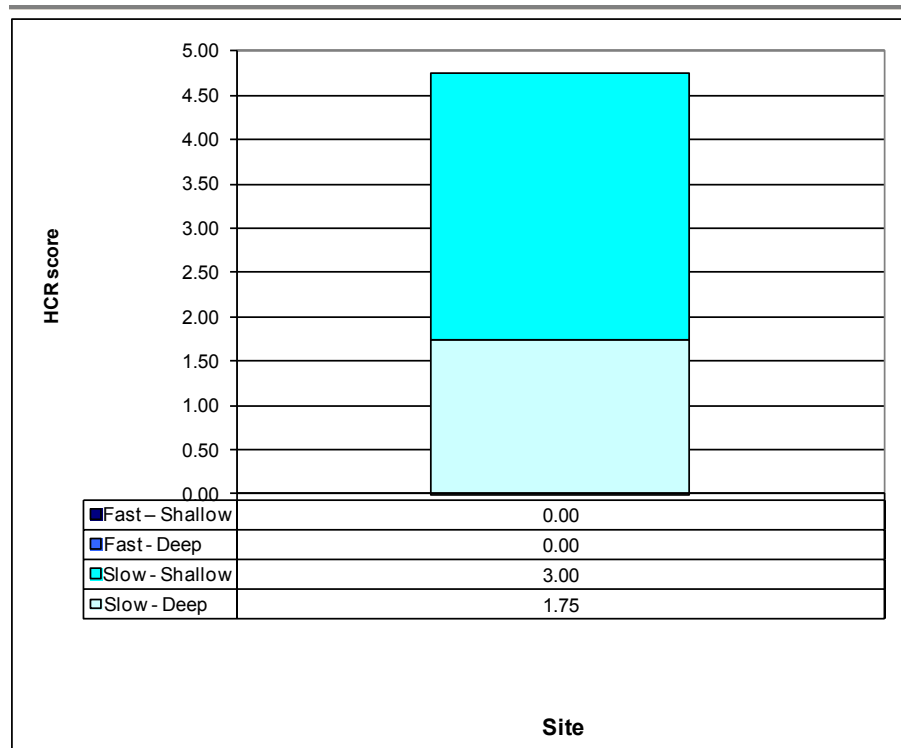


Figure 46: HCR scores for the GSP9 site assessed on the Mutamba River

Table 51: Intolerance ratings for naturally occurring indigenous fish species with natural ranges included in the Mutamba River⁴ (Limpopo River system) of the study area (Skelton, 2001; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).

SPECIES NAME	COMMON NAME	INTOLERANCE RATING ³	COMMENTS
<i>Amphilius uranoscopus</i> ²	Stargazer (mountain catfish)	4.8	Okovango and Zambezi systems, east coast rivers south to Mkuze in northern Kwa-Zulu Natal
<i>Barbus eutaenia</i> ²	Orange-fin barb	4.3	Cunene, Okovango and Zambezi, east coast systems south to the Phongolo
<i>Barbus paludinosus</i> ¹	Straightfin barb	1.8	Widespread
<i>Barbus trimaculatus</i> ²	Threespot barb	2.2	Common in many river systems of southern Africa
<i>Barbus unitaeniatus</i> ¹	Longbeard barb	1.7	Widely distributed in southern Africa
<i>Barbus viviparus</i> ¹	Bowstripe barb	2.4	East coastal rivers from the Ruvuma south to Vungu in KwaZulu-Natal.
<i>Chiloglanis pretoriae</i> ¹	Shortspine Suckermouth or Rock catlet	4.6	Widespread (Incomati, Limpopo & Zambezi)
<i>Chiloglanis paratus</i> ¹	Sawfin Suckermouth or Sawfin rock catlet	3.5	Incomati, Limpopo & Phongolo River systems
<i>Clarias gariepinus</i> ¹	Sharptooth Catfish	1.2	Most widely distributed fish in Africa.
<i>Gambusia affinis</i>	Mosquito fish	2.0	Widespread
<i>Labeo cylindricus</i> ¹	Redeye labeo	3.1	Widespread East-African rivers down to Phongolo system in KwaZulu-Natal
<i>Labeo molybdinus</i> ¹	Leaden labeo	3.2	Middle and lower Zambezi down to Tugela system in KwaZulu-Natal



SPECIES NAME	COMMON NAME	INTOLERANCE RATING ³	COMMENTS
<i>Labeo rosae</i> ¹	Rednose labeo	2.4	Lowveld region of the Limpopo, Incomati and Phongolo systems
<i>Mesobola brevianelis</i> ¹	River sardine	2.3	East coastal rivers from Limpopo to Umfolozi in KwaZulu-Natal
<i>Micralestes acutidens</i> ¹	Silver robbers	2.3	Cunene, Okavango, Zambezi and east coast rivers south to Phongolo.
<i>Oreochromis mossambicus</i> ¹	Blue Kurper	1.3	Widespread
<i>Pseudocrenilabrus philander</i> ¹	Southern mouthbrooder	1.3	Widespread
<i>Tilapia sparrmanii</i> ¹	Banded Tilapia	1.3	Widespread
<i>Tilapia rendalli</i> ¹	Redbreast tilapia	1.8	Cunene, Okavango, Zambezi and east coast rivers south to Phongolo.
<i>Schilbe intermedius</i> ¹	Silver catfish	1.7	Cunene, Okavango, Zambezi and east coast rivers south to Phongolo.

Tolerant: 1-2; Moderately tolerant :> 2-3; Moderately Intolerant: >3-4; Intolerant: >4

⁴ Note: The Mutamba River is a main tributary of the Nzhelele River. No FROC data are available for the Mutamba River so available data for the Nzhelele River was used instead as described below:

¹ Fish species previously encountered below the Nzhelele Dam (catchment A80G) for which FROC (reference frequency of occurrence) values are listed (Kleynhans *et al.* 2007).

² Fish species previously encountered above the Nzhelele Dam (catchment A80B) for which FROC (reference frequency of occurrence) values are listed (Kleynhans *et al.* 2007). Given the position of the assessment sites these species are unlikely to occur. However, as they do occur in the same river system, they have been included in the list. Based on known distribution (Limpopo River system) and habitat preference (e.g. Skelton 2001) the other species listed may, however, also occur in the area. For details of actual collection data and FROC values employed refer to Results section. ³ Average overall intolerance rating as per Kleynhans (1999).

Table 52: Fish species collected at the various sites indicating abundance (i.e. numbers collected used for site score evaluation in the FRAI assessment) with natural ranges included in the Mutamba River (Limpopo River system) of the study area (Skelton, 2001; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).

SPECIES NAME	Number of fish collected at site GSP9	Abundance score (AS)	FROC ¹ score (below Nzhelele Dam)
<i>Barbus trimaculatus</i>	18	3	1 ²
<i>Barbus paludinosus</i>	24	3	1
<i>Barbus unitaeniatus</i>	11	2	1
<i>Barbus viviparus</i>	2	1	1
<i>Labeo cylindricus</i>	1	1	1
<i>Pseudocrenilabrus philander</i>	2	1	1
<i>Tilapia sparrmanii</i>	4	1	1

¹ Fish species previously encountered below the Nzhelele Dam (catchment A80G) for which FROC (reference frequency of occurrence) values are listed (Kleynhans *et al.* 2007). Where fish species were collected that were not previously listed, the FROC scores employed were derived as described in the respective footnotes. Only these species (i.e. previously encountered plus actually encountered but not previously listed) were used for application of the FRAI assessment for the Mutamba River.

² FROC score from above Nzhelele Dam catchment A80B (fish species FROC score not listed below dam in catchment A80G).

⁴ AS = Abundance score. For site specific analyses abundance scores were determined for each site and used as FROC scores in the FRAI assessment. Abundance scores (AS) were classified as follows:

1 to 5 fish = 1
6 to 15 fish = 2
16 to 30 = 3
31 to 60 = 4
61 to 120 = 5



The table below summarises the EC obtained using the FRAI. For ease of comparison the EC values obtained by using the MIRAI have again been included.

Table 53: Summary of the results (ecological categories) obtained from the application of the FRAI to the GSP9 assessment site on the one site on the Mutamba River, compared to that obtained using MIRAI.

River assessed	Matumba
Variable / Index	GSP9
Automated FRAI (%)	35.3
Automated EC (FRAI)	E
Refined EC (FRAI)	D/E
Ecological category (EC) (MIRAI)	C

EC = Ecological category

From the above it is clear that the EC calculated for the FRAI largely corresponds to that obtained for the MIRAI. In terms of general ecological category classification, the FRAI EC's obtained are lower compared to previous studies performed in the same system. A faunal assessment for the Chapudi Project (compiled by Natural Scientific Services CC) previously reported ecological categories ranging between B and C. The variation in results may be attributed to the low flows at the time of assessment and potential migratory movement of fish in the system. The EC values calculated during the current assessment are, however, in congruence with results obtained using macro-invertebrate indices (MIRAI and SASS5).



6.2 The Nzhelelele River and Dolidoli River

6.2.1 Visual Assessment

A photographic record of each site was made in order to provide a visual record of the condition of each assessment site as observed during the field assessment. The photographs taken are presented, followed by a table summarising the observations for the various criteria made during the visual assessment undertaken at each point.



Figure 47: Upstream view of the GSP16 site on the Dolidoli River showing the very limited flow at the time of assessment.



Figure 48: Downstream view of the GSP16 site showing the sparse nature of the riparian zone.



Figure 49: Upstream view of the GSP14 site on the Nzelele River showing the dense reed growth on the banks.



Figure 50: Downstream view of the GSP14 site on the Nzhelele River showing the slow flowing nature of the water at this point.





Figure 51: Upstream view of the GSP15 site on the Nzhelele River indicating the presence of some shallows in the area and dense algal growth on the rocky substrate.



Figure 52: Downstream view of the GSP15 site showing the deeper pool and bulrush lined banks.

Table 54: Visual description of the sites selected on the Dolidoli and Nzhelele River systems

ASPECT	GSP14	GSP15	GSP16
Significance of the point	This site serves as a future monitoring point and the current data serves to present temporal data prior to any effects as a result of the activities of the proposed Generaal mining project and serves as a reference point for all sites further downstream in the catchment.	The site is situated on the lower limit of the Generaal project area on the Nzhelele River. Future data for this point can be spatially compared to the results obtained at site GSP10 in order to identify any impacts on the aquatic ecology of the system occurring between the two points.	Photographs are representative of the upper reaches of the Dolidoli river system upstream of the Generaal Project area.
Surrounding features	This section of the river is located in an area dominated citrus production. The site is also located downstream of the Nzhelele Dam which is likely to affect the system significantly through streamflow regulation.	This section of the river is located in an area dominated citrus production. The site is also located downstream of the Nzhelele Dam which is likely to affect the system significantly through streamflow regulation.	This section of the river is located in the vicinity of the Doli Doli Village and has seen some impact from livestock grazing and watering and the removal of riparian vegetation.
Riparian zone characteristics	The riparian zone along the length of this section of the Nzhelele River is steep but the system has a relatively wide floodplain. Some vegetation removal has occurred in the vicinity of the bridge. The riparian zone at this point is affected by alien vegetation encroachment and erosion.	The riparian zone along the length of this section of the Nzhelele River is steep but the system has a relatively wide floodplain. Some vegetation removal has occurred in the vicinity of the bridge. The riparian zone at this point is affected by alien vegetation encroachment.	The riparian zone along the length of this section of the Dolidoli River is relatively narrow although a well-developed riparian zone with trees associated with water courses dominate the riparian zone. Ground cover has however been affected by livestock grazing
Depth and flow characteristics	The Nzhelele River was flowing at this point and displayed some slow flowing sections. No fast flowing water was present. The river consisted mostly of	The Nzhelele River was flowing at this point and displayed some slow flowing sections. No fast flowing water was present. The river consisted	The Dolidoli River had very little surface flow at this point in the system with only very shallow water moving down the active



ASPECT	GSP14	GSP15	GSP16
	deep glides over sandy substrate.	mostly of deep glides over sandy substrate.	stream channel
Water clarity	Water was slightly discoloured, most likely as a result of algal proliferation.	Water was slightly discoloured, most likely as a result of algal proliferation.	Water was relatively clear
Impacts and signs of pollution	At the time of assessment no significant impacts on the instream ecology were visually evident although the discolouration of the water serves as a potential indication of eutrophication of the system.	At the time of assessment no significant impacts on the instream ecology were visually evident although the discolouration of the water serves as a potential indication of eutrophication of the system.	At the time of assessment the most significant impact on the system observed was riparian vegetation removal. Some impact on water quality may be present leading to algal proliferation

6.2.2 Physico-Chemical Water Quality

Water quality variables were measured at two points on the Nzhelele River where surface water was present. Water quality variables were also measured at one point on the Dolidoli River.

Table 55: Biota specific water quality data for the assessed Nzhelele and Dolidoli Rivers assessment sites

Site	Description	Conductivity (mS/m)	pH (pH units)	DO (mg/L)	Temp (°C)
GSP15	Nzhelele River – Spatial reference point	88.0	8.72	9.3	25.3
GSP16	Nzhelele River – Point to assess potential impact	97.7	8.35	8.56	24.2
GSP17	Dolidoli River (tributary of the Nzhelele)	165.4	8.14	6.78	28.5

The following key points on the water quality of the Nzhelele River system both downstream and in the vicinity of the proposed Generaal Project were observed:

- Both the Nzhelele River and the Dolidoli River have elevated salt concentrations evident prior to mining taking place indicating that the systems naturally carry a relatively high concentration of dissolved salts;
- Increased concentrations of dissolved salts were observed in a downstream direction. The change was, however, much less pronounced than that observed for the Mutamba River;
- Increase in EC was due to lower flow volumes conditions (further compounded by water abstraction from the system for agricultural purposes) and associated high evaporation rates in the area leading to the concentrating of salts in the system;
- Compared to GSP15, EC increased by 11.0% at site GSP16;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that: 1) Total dissolved salts (TDS) concentrations (i.e. as indicated by the EC measurements) should not be changed by > 15 % from the normal cycles of the water body under unimpacted conditions at any time of the year; and 2) the amplitude and frequency of natural cycles in TDS concentrations should not be changed;
- The spatial change downstream thus falls within the above recommendation;
- Compared to the Nzhelele River, EC in the Dolidoli River (GSP17) was much higher (69.3% compared to GSP15 and 88.0% compared to GSP16);
- Spatially there was a 4.2% decrease in pH value in a downstream direction between sites GSP15 and GSP16;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that pH values should not be allowed to vary from the range of the background pH values for a specific site by > 5 %;
- The observed changes in pH value thus fall within the recommended percentage change range from a spatial perspective;
- The pH, observed in the Dolidoli River was more neutral than that of the Nzhelele River system;



- Dissolved oxygen (DO) concentration decreased by 8.0% in a downstream direction between sites GSP16 and GSP17;
- The water quality guideline for aquatic ecosystems (DWA 1997) states that dissolved oxygen concentrations should range between 80% and 120% of saturation.
- Saturation (i.e. maximum dissolved oxygen concentrations) shall in turn depend on the temperature of the water sampled (USA EPA website accessed 18 May 2013). The current readings can then be expressed as a percentage of the potential maximum as tabulated below.

Table 56: Oxygen measured expressed as a percentage of maximum at the temperature measured.

Site	Oxygen (mg/L)	Temperature when measured (°C)	Maximum oxygen at that temperature (mg/L)	Oxygen measured expressed as percentage of maximum
GSP15	9.30	25.30	8.24	113%
GSP16	8.56	24.20	8.40	102%
GSP17	6.78	28.50	7.81	87%

- Dissolved oxygen concentration at all the sites falls well within the recommended range;
- The observed variation in dissolved oxygen concentration is likely to be attributed largely to natural variation in biological activity within the system at each point;
- It is evident that dissolved oxygen saturation was significantly lower in the Dolidoli River than in the Nzhelele River which will limit the ability to support more sensitive aquatic taxa.
- The temperatures observed at each of the points are deemed natural for the time of year and the nature of the systems. The observed variations can again be attributed to diurnal variation between sampling times and the variation in the volume of water in the water bodies sampled and some level of seasonal variation in sampling times.

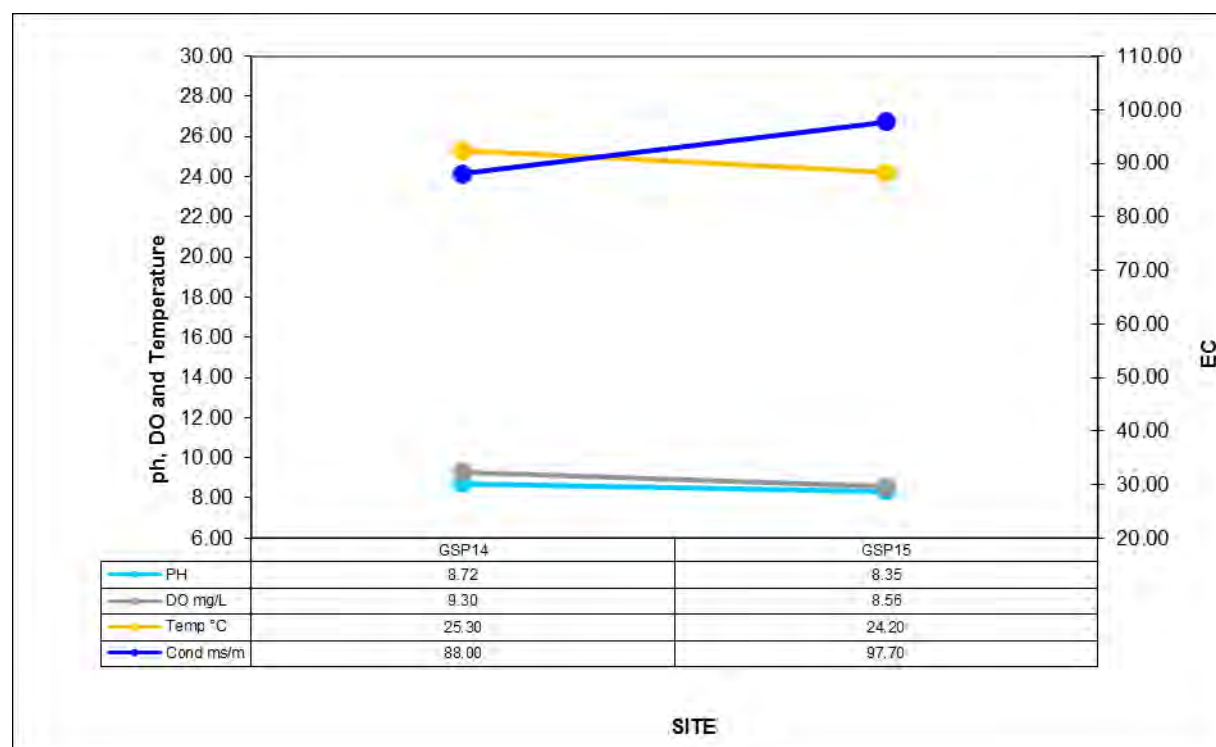


Figure 53: Physico-chemical water quality showing spatial trends on the Nzhelele River



6.2.3 Invertebrate Habitat Integrity Assessment (IHIA)

For both sites small, moderate and large impacts were recorded for both instream and riparian zones habitat.

For both sites GSP15 and GSP16 large impacts on instream integrity were recorded for water abstraction and flow modification. Other impacted (small to moderate) variables included bed and channel modification, water quality exotic macrophytes and solid waste disposal. With regard to instream habitat integrity, site GSP15 obtained a “C” (“Moderately modified”) classification whilst site GSP16 obtained a “D” (“Largely modified”) classification.

The most significant riparian zone impacts at both sites were vegetation removal, alien encroachment, bank erosion, water abstraction, flow modification, channel modification and water quality. For the latter, impact was regarded as small. The impact of alien encroachment recorded at site GSP15 was considered to be large. All other impacts were considered moderate. Both sites obtained a “C” (“Moderately modified”) classification with regard to riparian habitat integrity.

An overall score of 65.3% was calculated for GSP15 (class “C” and hence considered “Moderately modified”). For GSP16 an average score of 54.6% was calculated, placing this site in class “D” (“Largely modified”).

6.2.4 Invertebrate Habitat Assessment System (IHAS)

Table 57 is a summary of the results obtained from the application of the Invertebrate Habitat Integrity Assessment (IHAS) Index to one river assessment sites on the Nzhelele River (GSP15 and GSP16). This index determines habitat suitability, with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in interpreting the SASS5 results. IHAS scores (McMillan, 1998) are presented in Appendix 2.

- The GSP14 site on the Nzhelele River was represented by pool habitat only, whilst site GSP15 on the same river was characterized by a mix of pools, rapids and runs;
- Water was discoloured at both sites at the time of assessment;
- Fringing vegetation was present and provided good bank cover. Bank/riparian vegetation (mix of reeds and shrubs) were present and cover at site GSP15 was better compared to GSP14. Aquatic vegetation was also present at both sites;
- Suitable rocky substrate (stones in and out of current) was present at site GSP15, increasing the ability to support a diverse and sensitive aquatic community at this point. No rocky habitat was present at GSP14;
- The other habitat types noted at both sites were sand and algae (isolated patches at GSP14 and on rocks at GSP15). Gravel substrate was also present at GSP15. This, together with rocky habitat already mentioned, further increases the ability of this site (GSP15) to support a diverse and sensitive aquatic community;
- Habitat diversity and structure at site GSP15 was considered highly suitable for supporting a diverse and sensitive aquatic macro-invertebrate community;
- In comparison habitat diversity and structure at site GSP14 was considered inadequate for supporting a diverse and sensitive aquatic macro-invertebrate community.



Table 57: A summary of the results obtained from the application of and IHAS indices to the assessment site on the Nzhelele River

SITE	GSP14	GSP15
IHAS score	42	73
IHAS Adjustment score (illustrative purposes only)	+34	+15
McMillan, 1998 IHAS description	Habitat diversity and structure is inadequate to support a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is adequate to support a diverse aquatic macro-invertebrate community under the current flow conditions.
Stones habitat characteristics	No stone habitat present in or out of current.	Adequate loose cobbles and rocks in current present. Stones out of current present.
Vegetation habitat characteristics	Bank/riparian vegetation (mix of reeds and shrubs) was present. Fringing vegetation was sampled around a pool. Aquatic vegetation was absent.	Bank/riparian vegetation (mix of reeds and shrubs) was present. Fringing vegetation was sampled around a pool. Aquatic vegetation was present and sampled.
Other habitat characteristics	Sand and isolated patches of algae were present.	Sand, gravel and algae on rocks were present.
IHAS general stream characteristics	The stream at this point consists of pools, is wide (>10 m) and of average depth (0.5 m) under the current conditions. Water is discolored and bank cover is fair (>50 %), thus limiting the potential for erosion to some extent at this point.	The stream at this point exhibits a fair diversity of flow (pools, runs and rapids), is fairly wide (>5 to 10 m) and shallow (<0.75 to 0.25 m) under the current conditions. Water is discolored and bank cover is very good (>95 %), thus limiting the potential for erosion at this point.

6.2.5 Aquatic Macro-Invertebrates:

6.2.5.1 SASS5

Table 58 indicates the results obtained per biotope sampled whilst SASS5 scores are tabulated in Table 59. SASS5 and ASPT scores (Dickens and Graham, 2001) are presented in Appendix 3.



Table 58: Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites

PARAMETER	SITE	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	GSP15	0	34	13	42
Number of taxa		0	8	3	9
ASPT		0	4.3	4.3	4.7
SASS5 Score	GSP16	35	18	0	53
Number of taxa		6	4	0	10
ASPT		5.8	4.5	0	5.3

Table 59: Summary of the results obtained from the application of the SASS5 index to the two Nzhelele River assessment sites

Type of Result	GSP15	GSP16
Biotores sampled	Sand.	Sand, gravel, stones in current, stones out of current.
Sensitive taxa present	<i>Atyidae, Gomphidae</i>	<i>Caenidae; Leptophlebiae; Ecnomidae; Unionidae.</i>
Sensitive taxa absent	<i>Caenidae; Leptophlebiae; Ecnomidae; Unionidae.</i>	<i>Atyidae, Gomphidae</i>
SASS5 score	42	53
Adjusted SASS5 score	76	68
SASS5 % of theoretical reference score*	28.97%	36.55%
ASPT % of theoretical reference score**	78.33%	88.33%
Dickens & Graham, 2001 SASS5 classification	Class E	Class E
Dallas 2007 Classification	Class D	Class C

*SASS5 reference score = 145; **ASPT reference score = 6

- As for the Mutamba River, habitat limitations are likely to limit the diversity, abundance and sensitivity of the aquatic community to some degree on the Nzhelele river system;
- Suitable habitat in the form of ample rocky substrate indicates suitable macro-invertebrate habitat conditions at site GSP16. The absence of such biotores may have contributed to the lower SASS score obtained as GSP14 compared to GSP15;
- Taxa dependent on faster flow conditions are also likely to be largely absent;
- Water quality is likely to be an additional limiting factor shaping the aquatic community. As more data on the system is collected, better inferences on the ecological condition of the community will be possible;



- At site GSP14, the stream may be considered to be in a class E (severely impaired) condition according to the Dickens & Graham (2001) classification system. According to the Dallas (2007) classification system, the site can be classified as class D;
- Stream conditions at site GSP15 may also be considered to be in a class E (severely impaired) condition according to the Dickens & Graham (2001) classification system. However, according to the Dallas (2007) classification system, the site can be classified as class C;
- The latter classification is in agreement with the IHAS assessment, where habitat conditions at GSP15 appear more suited to supporting a diverse and sensitive aquatic macro-invertebrate community when compared to GSP14;
- This higher classification can be attributed to the higher ASPT score obtained at GSP15, resulting in a higher classification on the reference system compiled by Dallas (2007);
- As for the Mutamba River, the system is expected to exhibit broad variability in aquatic community integrity on a temporal scale due to variations in flow and habitat availability within the system. As more data on the system is collected, better inferences on the ecological condition of the community will be possible;
- Any reductions in SASS5 and ASPT in future monitoring should be noted and the causal factors identified in conjunction with application of the IHIA index. Close monitoring of such trends must take place;
- Due to the degree of sensitivity of the system to habitat changes and loss of instream flow, careful design and operational procedures will be required to limit the impact on the Nzhelele River.

6.2.5.2 Aquatic Macro-Invertebrates: MIRAI

Table 60: Summary of the results (ecological categories) obtained from the application of the MIRAI ecostatus tool to the GSP14 and GSP15 assessment sites on the Nzhelele River, compared to classes awarded using SASS5.

Variable / Index	GSP14	GSP15
Ecological category (MIRAI)	D	D
Dickens and Graham (SASS5)	E	E
Dallas (SASS5)	D	C

From the table above it is clear that the MIRAI results in terms of (ecological category classification) largely follow the same trends as that obtained using the SASS class classifications with both sites having an ecostatus score of Class D indicating largely modified conditions.

6.2.6 Fish Community Assessment

The HCR (Habitat Cover Rating) results for the GSP14 and GSP15 sites assessed on the Nzhelele River are provided in Figure 54. With regard to application of the FRAI, fish collected and scores employed are provided in Table 61.



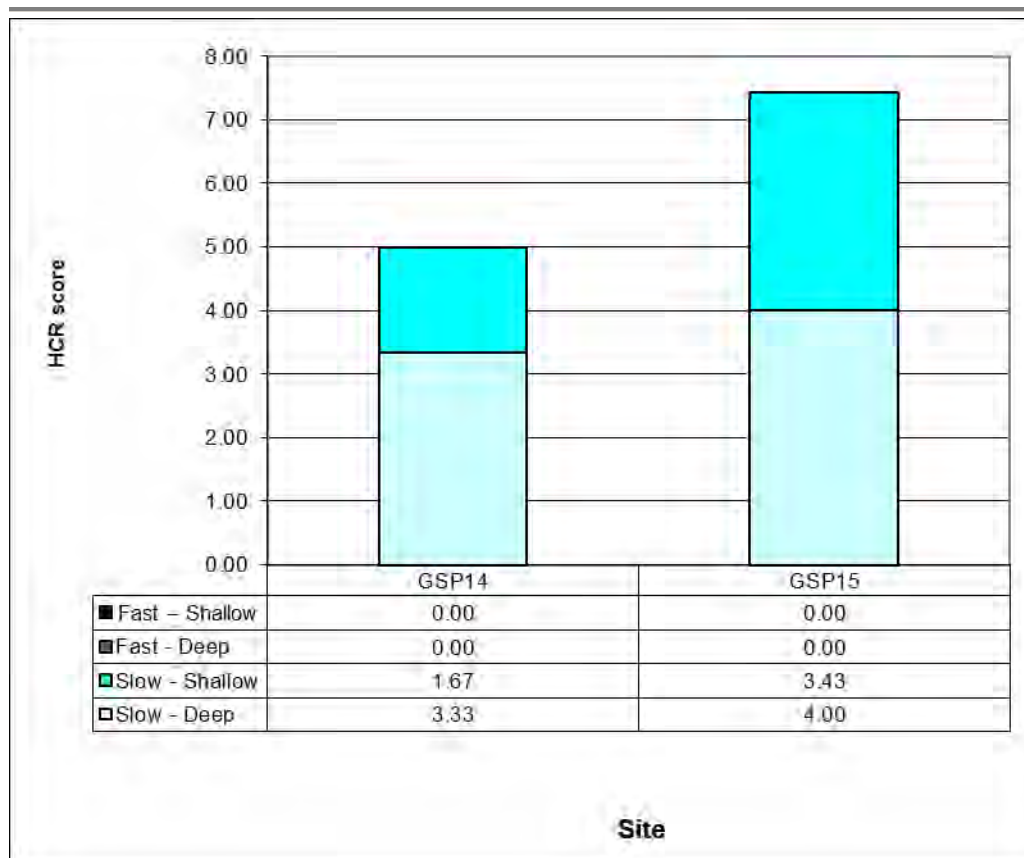


Figure 54: HCR scores for the two sites assessed on the Nzhelele River

Table 61: Fish species collected at the various sites indicating abundance (i.e. numbers collected used for site score evaluation in the FRAI assessment) with natural ranges included in the Nzhelele River (Limpopo River system) of the study area (Skelton, 2001; Kleynhans, 2003; Kleynhans, Louw and Moolman, 2007).

SPECIES NAME	Number of fish collected at site GSP15	Abundance score (AS)	Number of fish collected at site GSP16	Abundance score (AS)	FROC ¹ score (below Nzhelele Dam)
<i>Barbus trimaculatus</i>	21	3	31	4	1 ²
<i>Barbus paludinosus</i>	17	3	42	4	1
<i>Barbus unitaeniatus</i>	14	2	7	2	1
<i>Labeo cylindricus</i>	1	1	3	1	1
<i>Labeobarbus marequensis</i>	0	0	2	1	1
<i>Mesobola brevianelis</i>	16	3	23	3	1
<i>Micralestes acutidens</i>	0	0	19	3	1
<i>Oreochromis mossambicus</i>	32	4	8	2	1

¹ Fish species previously encountered below the Nzhelele Dam (catchment A80G) for which FROC (reference frequency of occurrence) values are listed (Kleynhans *et al.* 2007). Where fish species were collected that were not previously listed, the FROC scores employed were derived as described in the respective footnotes. Only these species (i.e. previously encountered plus actually encountered but not previously listed) were used for application of the FRAI assessment for the Nzhelele River.

² FROC score from above Nzhelele Dam catchment A80B (fish species FROC score not listed below dam in catchment A80G).

⁴ AS = Abundance score. For site specific analyses abundance scores were determined for each site and used as FROC scores in the FRAI assessment. Abundance scores (AS) were classified as follows:

1 to 5 fish = 1; 6 to 15 fish = 2; 16 to 30 = 3; 31 to 60 = 4; 61 to 120 = 5.



The table below summarises the EC obtained using the FRAI. For ease of comparison the EC values obtained by using the MIRAI have again been included.

Table 62: Summary of the results (ecological categories) obtained from the application of the FRAI to two assessment sites on the Nzhelele River, compared to that obtained using MIRAI.

River assessed	Nzhelele	
	GSP15	GSP16
Automated FRAI (%)	33.7	41.5
Automated EC (FRAI)	E	D/E
Refined EC (FRAI)	D	D
Ecological category (EC) (MIRAI)	D	D

EC = Ecological category

From the above it is clear that the EC calculated for the FRAI largely corresponds to that obtained for the MIRAI. Because the habitat (and hence potential drivers) was fairly homogenous between the sites, the refined EC was also similar. The EC for the system indicates that some loss of fish community integrity of the system has occurred, however there is still a significant diversity and abundance of fish present in the system. The EC values calculated during the current assessment are, however, in congruence with results obtained using macro-invertebrate indices (MIRAI and SASS5).

6.3 Synthesis

Based on the findings of the aquatic study the Mutamba River is seen to be a water stressed system with the degree of water stress increasing in a downstream direction. Some recovery of the system does however occur in the lower reaches but impacts on the aquatic ecology of the lower reaches of the system are still considered to be likely. The Mutamba River can be considered to be a system of reduced Ecological Importance and Sensitivity in relation to the Nzhelele River due to the limited provision of refugia and in the local area and the limited support it provides to the aquatic ecology of the area. The system is however deemed important in terms of the provision of services to the terrestrial fauna of the area as well as fair significance from a socio-cultural point of view. It is deemed essential that all effort is made to ensure that impacts on the Mutamba River as a result of the proposed Generaal Project are minimised.

Based on the findings of the aquatic study the Nzhelele River is seen to be a water stressed system. Whilst some of the indices indicate an improvement in the ecostatus in a downstream direction, this apparent trend most probably results from differences in habitat suitability at the sites assessed (GSP15 has more biotypes available compared to GSP14). The Nzhelele River can be considered to be a system of high aquatic Ecological Importance and Sensitivity due to the provision of refugia and in the local area and the support it provides to the aquatic ecology of the area. The system is also deemed important in terms of the provision of services to the terrestrial fauna, such as the provision of drinking water of the area as well as a high significance from a socio-cultural point of view, with special mention of water provision for agriculture. It is deemed essential that all effort is made to ensure that impacts on the Nzhelele River as a result of the proposed Generaal Project are minimised.



7 IMPACT ASSESSMENT

The proposed Generaal Mining project can be defined as consisting of two major “blocks”. The degree of impact on the aquatic ecology between the various blocks varies significantly. For this reason the impact assessment was divided into two sections as follows:

- Impact assessment for the Generaal Section; and
- Impact assessment for the Mount Stewart sections.

The tables in the subsections below serve to summarise the activities which will lead to impacts on the aquatic ecology of the Nzhelele and Mutamba River systems as well as their associated tributaries as well as the significance of perceived impacts on the wetland biodiversity of the study area and indicate the impact significance on aquatic resources. Each impact significance was assessed separately for the pre-construction, construction operational and decommissioning and closure phases of the proposed project.

7.1 IMPACT 1: Loss of Instream Flow, Aquatic Refugia and Flow Dependent Taxa

7.1.1 Discussion

The Nzhelele River, Mutamba River, Dolidoli River and to a lesser degree the other systems in the vicinity of the Proposed Generaal Project are water stressed. The Nzhelele River, Mutamba River systems are extensively utilised for the abstraction of water for the production of citrus and vegetable crops. These water uses lead to the lower sections of the Mutamba Rivers being dry along most of its length and few refuge pools for aquatic biota occur in these lower areas. Any impact on instream flow will therefore be significant and can have a significant impact on the Nzhelele and Mutamba River Ecology. In addition many of the drainage lines in the area have well established riparian zones. In particular mention is made of the Dolidoli River as well as some smaller systems.

In terms of aquatic and riparian zone ecology in the vicinity of the project area the Nzhelele and Mutamba Rivers are the most significant and require the most attention when considering impacts on reduced instream flow and aquatic refugia and the loss of flow dependent taxa.

The remainder of the project area is very dry and no other systems were identified in which aquatic biota occurred except in artificial impoundments where a more permanent supply of surface water occurs. The artificial impoundments support low abundances of tolerant aquatic taxa and wetland vegetation.

According to Jacana cc (2013) Mean annual runoff (MAR) from the Project site into the water courses of the area are anticipated to be primarily affected by the following:

- Direct rainfall in the opencast pits. Rain falling directly into the pits will collect in a sump at the bottom of the pit/s and thus be polluted. This water may be recycled for use, or evaporated in dirty water dams, thereby decreasing the MAR reaching the surrounding river systems;
- Runoff from stockpiles. Rain falling directly onto the „dirty“ stockpiles will either seep into the stockpile or runoff the sides of the stockpile. Any runoff or horizontal seepage from the stockpile will be captured in control dams or a leaching system for water quality control reasons, and thus subsequently be prevented to discharge to tributaries and into the surrounding larger river systems;
- Concentration of flow when runoff is intercepted by canals. The canal system will intercept runoff that would otherwise have flowed naturally over the ground surface until reaching a defined watercourse. Vegetation and surface topography, particularly in flatter areas, would in the natural state have encouraged interception and infiltration. Once water has been intercepted by a canal however, no further interception or infiltration is likely until the canal discharges the flow into a surrounding river systems), the concentration of flow would still discourage interception and infiltration. There is thus likely to be a marginal increase in MAR resulting from the construction of the canal system. Streamflow regulation and recharge and a change in flow rates will however occur.



According to (Jacanacc 2013) a substantial increase to the peak flow of flood events in the Matumba River could cause erosion and change in channel character and dimensions, destroy riverine vegetation, alter bed roughness and cause eroded sediment to be deposited downstream.

It is expected that Project activities will cause a change to peak flows in the river system downstream of the Project site, due to the following factors:

- Change in surface coverage. Development of the Project area will change the surface coverage in some areas from vegetated soil to buildings, hardened gravel roads, paved areas (parking), and compacted earth. These new surface types will allow considerably less infiltration into the ground (typically 0-20%) as compared to the natural surface (typically 60-70%), resulting in more surface runoff following storms and consequently higher peak flow rates.
- Capture of runoff and capture of rainfall in the „dirty“ area would lower instream flow in the receiving environment.
- Canalisation of runoff. Intercepting runoff from the hillslopes above the opencast pits and canalising the flow could reduce the amount of time that water would take to reach the surrounding river systems. This is due to the decreased friction on the water associated with concentrated flow in a concrete lined canal as opposed to sheet flow on the hill slopes, and the consequently lower flow velocities.

In technical terms, the time of concentration would be reduced, reducing the time of concentration results in higher peak flow rates. This effect is dependent on the design of the canalisation system, as increasing the length of flow paths, and implementing other detention measures, could negate this effect.

According to Jacana cc (2013) A cut off canal system is required to separate unpolluted („clean“) and polluted („dirty“) water, which is a positive intervention. However, intercepting the tributaries that flow from the water divide across the mining areas, and redirecting them via canals around the pits, will starve those same water courses of water along their reach between the point of interception and the surrounding larger river systems.

Furthermore, if the canals only extend as far as to route water around the outer edge of the opencast pits, then concentrated volumes of water will be discharged at point locations on the hill slopes. Leading to altered surface and subterranean hydrology.

All the above factors are likely to lead to altered riverine recharge flood peaks and a general loss of runoff volumes successfully reaching the surrounding larger river systems as well as the other major drainage systems in the area which in turn lead to the loss of aquatic biota such as fish and aquatic macro-invertebrates which rely on the presence of surface water as well as the riparian zone which relies on base flows as well as recharge by larger rainfall events.

Activities potentially leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning leading extensive dirty water areas which need to be managed and reducing the MAR to the drainage systems in the area	Construction and mining over the unnamed tributary of the Mutamba River and small stream diversions	Loss of MAR from dirty water areas	Loss of MAR from latent dirty water areas
Inadequate design of ephemeral stream diversions leading to loss of recharge of the larger systems	Construction of clean and dirty water separation structures for pollution control purposes.	Loss of water through clean and dirty water separation as well as stream diversion systems	Loss of water to inadequately rehabilitated areas such as discard dumps and open pits



Encroachment of open pits into drainage features such as the unnamed tributary of the Mutamba River leading to reduced instream flow in downstream areas and potentially the Nzhelele River	Clearing of areas for the initiation of the production pits	The formation of a cone of dewatering created by open pits	The formation of a cone of dewatering created by final voids
The open pits in the being too near to drainage features leading to loss of stream flow and base flow due to the formation of a cone of dewatering in the aquifer to the open pits	Use of surface water runoff and groundwater as a water supply during construction	Use of surface water runoff and groundwater as a water supply during the operational phase of the mine	Use of surface water runoff and groundwater as a water supply during the closure phase of the mine
Design of canals leading to rapid release of water which in turn will lead to a loss of streamflow regulation capabilities in the area	Impact on natural streamflow regulation and stream recharge due to altered hydrology in the area	Impact on natural streamflow regulation and stream recharge due to altered hydrology in the area	Impact on natural streamflow regulation and stream recharge due to altered hydrology in the area

Aspects of instream habitat and flow affected

Construction	Operational	Decommissioning & Closure
Loss of instream surface and base flow	Loss of instream surface and base flow	Loss of instream surface and base flow
The drying out of aquatic refugia in the Mutamba River and potentially the Nzhelele River	The drying out of aquatic refugia in the Nzhelele and Mutamba River	The drying out of aquatic refugia in the Nzhelele and Mutamba River
Loss of streamflow regulation and stream recharge	Loss of streamflow regulation and stream recharge	Loss of streamflow regulation and stream recharge
Loss of aquatic habitats for aquatic macro-invertebrates and fish	Loss of aquatic habitats for aquatic macro-invertebrates and fish	Loss of aquatic habitats for aquatic macro-invertebrates and fish
Increased moisture stress on riparian vegetation	Increased moisture stress on riparian vegetation	Increased moisture stress on riparian vegetation



Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	3	3	4	5	5	6	14	84 (Medium high)
Mount Stewart Section	2	2	2	3	4	6	9	54 (Low)

Essential mitigation measures:

- Ensure that as far as possible all infrastructure is placed outside of wetland areas and streams. In particular mention is made of the need to minimize the impact on the unnamed tributary of the Mutamba River in the vicinity of the Generaal mining section and a minimum buffer of 100m around all wetland and riparian systems should be maintained in line with the requirements of regulation GN704 of the national Water Act wherever resource independent structures are to be developed;
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas and the concomitant recharge of streams in the area.
- No use of clean surface water or any groundwater which potentially recharges the watercourses in the area should take place. In this regard specific mention is made of any water use which will affect the instream flow in the Mutamba River and the baseflow in the unnamed tributary of the Mutamba river in the vicinity of the Generaal mining section;
- Very strict control of water consumption must take place and detailed monitoring must take place. All water usage must continuously be optimised;
- Upstream dewatering boreholes should be utilised to minimise the creation of dirty water and this clean water should be used to recharge the natural systems downstream/downgradient of the mining footprint areas;
- Pollution control dams should be off stream structures and not within the natural drainage system of the area, thereby minimising impacts loss of instream flow and downstream recharge;
- Permit only essential construction personnel within 32m of all riparian systems;
- Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the development;
- Implement alien vegetation control program within wetland areas with special mention of water loving tree species;
- Monitor all affected riparian systems for moisture stress;
- Monitor all potentially affected riparian zones for changes in riparian vegetation structure;
- Ongoing aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor;

Recommended mitigation measures

- Infrastructure near to the Mutamba as well as the unnamed tributary of the Mutamba River near the Generaal mining section must be kept to an absolute minimum and must be placed as far from these water courses as possible
- No infrastructure or open pits should encroach into any major drainage lines

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	3	3	4	4	4	6	12	72 (Medium low)
Mount Stewart Section	2	2	2	3	4	6	9	54 (Low)

Probable latent impacts

- Reduced recharge of the Mutamba and possibly the Nzhelele Rivers and other riparian systems affected by upstream and adjacent mining;
- Altered riparian vegetation structures and increased moisture stress on riparian vegetation communities.



7.2 IMPACT 2: Impacts on Water Quality Affecting Aquatic Ecology

7.2.1 Introductory discussion and Rationale

The philosophy supporting the following section of the report is that if all constituents in the cumulative discharge from the Project site are within the applicable target water quality ranges, then the Project activities will not contribute significantly to an unacceptable cumulative impact. This is the objective for the project as defined in the scoping report for the Generaal Project (Jacana; 2013).

The converse of this statement is not necessarily true, as different activities within the catchment may discharge different pollutants at different concentrations, and the dilution effect may mean that a constituent that is out of the target water quality range in the cumulative discharge from the Project site is within the target water quality range when the discharge is combined with the flow in the receiving environment itself. It must however be noted that the natural flow in these rivers is very limited.

However the Precautionary Principle requires that a conservative approach be taken, in this case to account for possible discharge of pollutants by future activities in the river catchment, and therefore the dilution effect of the surrounding larger river systems cannot be relied upon. It must further be noted that the analyses of biota specific water quality indicated elevated salt loads in the low flow season in the larger river systems and therefore very limited dilution capacity of salts in the system is deemed likely and any addition of salts to the system is likely to be harmful to the system. The discussions on water quality risks presented below are based on the scoping report of the project (Jacana cc 2013)

7.2.2 Increased sediment load in larger rivers

In the natural state of the project site, vegetation cover causes friction to rainfall runoff, that reduces flow velocities and consequently shear forces between the water and the ground surface, resulting in the ground surface remaining intact and not being eroded away. If for any reason flow velocities are increased, there is potential for increased erosion to occur.

Increased erosion of disturbed surfaces means that the runoff contains a higher silt or sediment load, which is discharged to the surrounding river systems. A component of this sediment load is particles fine enough to remain in suspension, „clouding“ or „muddying“ the water.

The extent of this effect can be quantified by measuring a water quality parameter, suspended solids. If there are too many suspended solids in the water this can negatively affect biological life. In addition, a changed sediment load could have similar morphological effects to the river as changing peak flow rates, such as changes in channel character or dimensions and changes to bed roughness (Jacana; 2013). Severe sediment deposition in the surrounding river systems could lead to reduced surface flows in the system with a larger volume of water moving through a thickened sand layer. All of these changes could potentially affect biological life.

The following activities are likely to cause an increase in flow velocities, or directly increase erosion:

- Stripping (vegetation clearance) of mining areas prior to excavation of pits;
- Construction of hard standing areas that increase runoff volumes, including roads, buildings and paved areas;
- Canalisation of runoff, particularly if canals do not discharge directly into the a major watercourse; and
- Construction activities that loosen the ground surface.

Furthermore, if runoff from the stockpiles is uncontrolled, such runoff would likely contain a high sediment load due to the fine particles in the waste product resulting from the ore crushing process. It can thus be stated that without any mitigation measures, the sediment load in the larger watercourses in the project area will increase as a result of mining activities associated with this Project.



7.2.3 Impaired water quality due to pollutants discharged from processing plant

Wastewater from the coal ore beneficiation process would contain pollutants in excess of the target water quality ranges for the water uses of the receiving water body and discharge of this would impact negatively on the surface water quality. A further consideration is the runoff of pollutants from the process plant area following rainfall, due to the activities within that area.

7.2.4 Impaired water quality due to pollutants in runoff from stockpiles

It is likely that runoff from the stockpiles will have a different chemical composition to natural runoff. In this event it is best practice to keep „dirty“ water from stockpile runoff separate from „clean“ water from natural runoff.

7.2.5 Impaired water quality due to pollutants in water discharged from opencast pits

Overflow of water (decant), whether surface or ground, from the pits could release pollutants to the surface water environment if geochemical testing indicates a possible acid mine drainage or other water quality issue.

7.2.6 Impaired water quality due to petrochemical spills

Fuel or oil spills from vehicles could contaminate surface water resources. Leakages, spills or runoff from vehicle wash bays, workshop facilities, fuel depots or storage facilities of potentially polluting substances could contaminate surface water resources.

7.2.7 Heavy metal contamination

Increase in metal concentrations is commonly associated with tillage and blasting of the upper crust of the earth's surface. This releases metals into the associated surface and ground water systems (NSS, 2009). Under alkaline conditions, most of the metals remain biologically unavailable, however in the presence of acid mine drainage the metal-speciation changes and they become available (Bonta et al., 1993). This may alter the species composition of the aquatic biota inhabiting the river, in the vicinity of and downstream of the proposed development.

Activities potentially leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning leading to extensive and complex dirty water areas which need to be managed.	Major earthworks and construction activities.	Mining and the creation of mining waste which needs to be managed to prevent pollution.	Inadequate closure and rehabilitation leading to ongoing pollution from contaminating sources such as discard dumps.
Poor planning leading to placement of polluting structures in drainage lines and/or wetlands which would increase mobility of pollutants.	Clean and dirty water systems not being constructed to the required specifications to prevent contamination of clean water areas.	Clean and dirty water systems not being maintained to the required specifications to prevent contamination of clean water areas.	Clean and dirty water systems not being maintained to the required specifications to prevent contamination of clean water areas.



Inadequate planning of the separation of clean and dirty water areas leading to contaminated water leaving the defined dirty water area	Poor housekeeping and management	Poor housekeeping and management	Poor housekeeping and management
Clean and dirty water systems not being designed adequately to ensure protection of the water resources.	Spills and other unplanned events	Spills and other unplanned events	Spills and other unplanned events

Aspects of Aquatic ecology affected

Construction	Operational	Decommissioning & Closure
Loss of sensitive fish and aquatic macro-invertebrate species	Loss of sensitive fish and aquatic macro-invertebrate species	Loss of sensitive fish and aquatic macro-invertebrate species due to chronic water quality impacts
Impact on riparian vegetation structures due to impaired water quality with special mention of changes to sediment balances	Impact on riparian vegetation structures due to impaired water quality with special mention of changes to pH and increased salt loading	Impact on riparian vegetation structures due to impaired water quality with special mention of changes to pH and increased salt loading
Build-up of contaminants in sediments leading to the creation of a sediment sink and chronic source of potential water contamination	Build-up of contaminants in sediments leading to the creation of a sediment sink and chronic source of potential water contamination	Latent release of contaminants in sediments leading to the formation of an ongoing source of potential water contamination
	Impacts on groundwater quality which could manifest in surface water sources	Impacts on groundwater quality which could manifest in surface water sources

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	3	4	2	4	5	7	11	77 (Medium high)
Mount Stewart Section	2	2	1	3	4	4	8	32 (Low)

Essential mitigation measures:

- Ensure that as far as possible all infrastructure is placed outside of wetland areas and streams. In particular mention is made of the need to not encroach on the unnamed tributary of the Mutamba River in the vicinity of the Generaal mining section and a minimum buffer of 100m around all wetland and riparian systems should be maintained in line with the requirements of regulation GN704 of the national Water Act wherever non resource dependent infrastructure is planned;
- Very clear and well managed clean and dirty water separation must take place in line with the requirements of regulation GN704 of the national Water Act;
- Pollution control dams must be adequately designed to contain a 1:50 24 hour storm water event;
- All pollution control facilities must be managed in such a way as to ensure that storage and surge capacity is available if a rainfall event



occurs;

- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas and the concomitant recharge of streams in the area.
- Permit only essential construction personnel within 32m of all riparian systems;
- All linear features should cross watercourses at 90 degree angles to minimise the extent of disturbance within the watercourse;
- Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the development;
- All hazardous chemicals must be stored on bunded surfaces
- Ensure that all spills are immediately cleaned up;
- Monitor all pollution control facilities using toxicological screening methods and implement the calculation of discharge dilution factors by means of the Direct Estimation of Ecological Effect Potential (DEEEP) protocol;
- Ongoing aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor.

Recommended mitigation measures

- Infrastructure near to the unnamed tributary of the Mutamba River in the vicinity of the Generaal mining section must be minimised and must be placed as far from these water courses as possible;

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	3	4	2	4	4	7	10	70 (Medium low)
Mount Stewart Section	2	2	1	3	4	4	8	32 (Low)

Probable latent impacts

- Ongoing salinisation of the water courses in the area;
- Impacts on pH
- Impacts on dissolved oxygen concentration and saturation
- Loss of aquatic taxa intolerant to poor quality water;
- Altered riparian vegetation structures.

7.3 IMPACT 3: Loss of Aquatic Habitat

Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, reducing biodiversity. Globally modification of habitats for agriculture is the chief cause of such habitat loss. Other causes of habitat destruction include surface mining, deforestation, slash and burn practices and urban development. Habitat destruction is presently ranked as the most significant cause of species extinction worldwide. Additional causes of habitat destruction include water pollution, introduction of alien species, overgrazing and overfishing.

Riverine systems and particularly ephemeral riverine systems or river systems that have very low flows as part of their annual hydrological cycles are particularly susceptible to changes in habitat condition. The proposed mining activity of the Generaal project has significant potential to lead to habitat loss and/or alteration of the aquatic and riparian resources on the study area.



Activities leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning leading to the placement of infrastructure within riverine features with special mention of the waste stockpile areas and the open pit areas themselves as well as road crossings, conveyor crossings and bridges	Site clearing and the removal of vegetation leading to increased runoff and erosion	Ongoing disturbance of soils with general operational activities	Disturbance of soils as part of demolition activities
Inadequate design of infrastructure leading to changes to instream habitat with special mention of road and conveyor crossings	Site clearing and road construction and the disturbance of soils leading to increased erosion	Inadequate separation of clean and dirty water areas	Inadequate separation of clean and dirty water areas
Inadequate design of infrastructure leading to changes to system hydrology with special mention of road and conveyor crossings	Earthworks in the vicinity of drainage systems leading to increased runoff and erosion and altered runoff patterns	Mining leading to increased disturbance of soils and drainage lines	Ongoing pollution from inappropriately decommissioned structures
Inadequate separation of clean and dirty areas and the prevention of the release of sediment rich water into the receiving environment	Construction of bridge crossings altering streamflow patterns and water velocities	Any activities which lead to the reduction in flow in the system with special mention of the open pits and the use of surface and groundwater sources for production water	Alien vegetation encroachment
	Alien vegetation encroachment	Alien vegetation encroachment	

Aspects of instream habitat affected

Construction	Operational	Decommissioning & Closure
Erosion and incision of riparian zone	Erosion and incision of riparian zone	Erosion and incision of riparian zone
Altered wetting patterns leading to impacts on riparian zone continuity	Altered wetting patterns leading to impacts on riparian zone continuity	Altered wetting patterns leading to impacts on riparian zone continuity
Loss of low flow refugia	Loss of low flow refugia	Loss of low flow refugia
Altered substrate conditions from sandy conditions to more muddy conditions	Altered substrate conditions from sandy conditions to more muddy conditions	Altered substrate conditions from sandy conditions to more muddy conditions
Altered depth and flow regimes in the major drainage systems	Altered depth and flow regimes in the major drainage systems	Alien vegetation proliferation
Alien vegetation proliferation	Alien vegetation proliferation	



Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	5	3	3	5	5	8	13	104 (High)
Mount Stewart Section	2	2	2	2	4	4	8	32 (Low)

- Ensure that as far as possible all infrastructure is placed outside of wetland areas and drainage lines. In particular mention is made of the need to not encroach on the unnamed tributary of the Mutamba River in the vicinity of the Generaal mining section and a minimum buffer of 100m around all wetland and riparian systems should be maintained in line with the requirements of regulation GN704 of the national Water Act for all non resource dependent infrastructure;
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas and the concomitant recharge of streams in the area;
- Ensure that all stockpiles are well managed and have measures such as berms and hessian sheets implemented to prevent erosion and sedimentation;
- No use of clean surface water or any groundwater which potentially recharges the watercourses in the area should take place. In this regard specific mention is made of any water use which will affect the instream flow in the Mutamba River;
- Pollution control dams should be off stream structures and not within the natural drainage system of the area, thereby minimising impacts loss of instream flow and downstream recharge;
- Permit only essential construction personnel within 100m of all riparian systems;
- Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the development;
- Implement alien vegetation control program within wetland areas with special mention of water loving tree species;
- Ongoing aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor;

Recommended mitigation measures

- No infrastructure or open pits should encroach into any major drainage lines
- Revegetate all disturbed areas with indigenous tree species and make use of indigenous species with an affinity for riparian zones such as *Combretum imberbe*, *Faederherbia albida*, *Ficus*, *sp.* and *Xanthocercis zambesiaca*;

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	4	3	3	4	4	7	11	77 (Medium low)
Mount Stewart Section	2	2	2	2	3	4	7	28 (Low)

Probable latent impacts

- Sedimentation of the systems may occur for long after mining is completed;
- Eroded and incised streams are unlikely to be rehabilitated.
- Silted up refuge pools are unlikely to be naturally rehabilitated and are unlikely to be rehabilitated by the mine
- Ongoing loss of instream flow leading to a loss of low flow refugia

7.4 IMPACT 4: Loss of Aquatic Biodiversity and Sensitive Taxa

Aquatic resources in the area can be considered scarce and in addition to being scarce are generally exposed to significant water stress. The aquatic resources in the direct vicinity of the project area are of limited importance to instream biodiversity. There is however the potential for the mining operations to affect the Nzhelele River which supports a diverse aquatic macro-invertebrate community and a well-established fish community. On a national scale the system is also considered to be of importance since the lower sections of the Sand River are considered a FEPA system and a Fish FEPA support system and the Nzhelele River and associated drainage systems form part of this catchment.



The aquatic ecology of the area can potentially be impacted by further reductions in instream flow, altered water quality and habitat loss.

Activities potentially leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning leading to the placement of infrastructure within riverine features with special mention of the overburden stockpile areas as well as the open pits themselves as well as road crossings and bridges	Site clearing and the removal of vegetation	Ongoing disturbance of soils with general operational activities	Disturbance of soils as part of demolition activities
Inadequate design of infrastructure leading to changes to instream habitat	Site clearing and road construction	Inadequate separation of clean and dirty water areas	Inadequate separation of clean and dirty water areas
Inadequate design of infrastructure leading to changes to system hydrology	Earthworks in the vicinity of wetland areas	Loss of instream flow due to abstraction for water for production and the formation of a cone of dewatering from open pits	Seepage from any latent discard dumps and dirty water areas
Inadequate design of infrastructure leading to contamination of water and sediments in the streams	Construction of bridge crossings altering streamflow patterns and water velocities	Seepage from the discard dumps and overburden stockpiles	Inadequate closure leading to post closure impacts on water quality
	placement of infrastructure within riverine features with special mention of the overburden stockpile areas as well as the open pits themselves as well as road crossings and bridges	Discharge from the mine process water system with special mention of the RWD and any PCD's	Ongoing erosion of disturbed areas that have not been adequately rehabilitated
	Inadequate separation of clean and dirty water areas	Sewage discharge from mine offices and camps	
		Nitrates from blasting leading to eutrophication of the receiving environment	



Aspects of biotic integrity affected

Construction	Operational	Decommissioning & Closure
Sedimentation and loss of natural substrates	Sedimentation and loss of natural substrates	Sedimentation and loss of natural substrates
Altered stream channel forms	Altered stream channel forms	Altered stream channel forms
Increased turbidity of water	Increased turbidity of water	Loss of refugia
Loss of refugia	Loss of refugia	Deterioration in water quality with special mention of impacts from cyanide, heavy metals, AMD And salinisation
Deterioration in water quality	Deterioration in water quality with special mention of impacts from cyanide, heavy metals, AMD And salinisation	Eutrophication of the aquatic ecosystems
Loss of flow sensitive macro-invertebrates and fish	Eutrophication of the aquatic ecosystems	Loss of flow sensitive macro-invertebrates and fish
Loss of water quality sensitive macro-invertebrates and fish	Loss of flow sensitive macro-invertebrates and fish	Loss of water quality sensitive macro-invertebrates and fish
Loss of riparian vegetation species	Loss of water quality sensitive macro-invertebrates and fish	Loss of riparian vegetation species
	Loss of riparian vegetation species	

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	2	2	4	5	5	4	14	56 (Medium low)
Mount Stewart Section	2	2	2	4	4	4	10	40 (Low)

Essential mitigation measures:

- Ensure that as far as possible all infrastructure is placed outside of wetland areas and drainage lines. In particular mention is made of the need to not encroach on the unnamed tributary of the Mutamba River in the vicinity of the Generaal mining section and a minimum buffer of 100m around all wetland and riparian systems should be maintained in line with the requirements of regulation GN704 of the national Water Act for all non resource dependent infrastructure;
- Pollution control dams should be off stream structures and not within the natural drainage system of the area, thereby minimising impacts from inundation and siltation;
- Permit only essential construction personnel within 100m of the wetland habitat;
- Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the development;
- Use of water must be minimised as far as possible in order to minimise the loss of recharge of the Nzhelele and Mutamba River systems;
- Limit the footprint area of the construction activity to what is absolutely essential in order to disturbance of soils leading to runoff, erosion and sedimentation and loss of instream flow and stream recharge;
- Prevent runoff from dirty water areas entering stream systems through ensuring clear separation of clean and dirty water areas;
- Ensure that the mine process water system is managed in such a way as to prevent discharge to the receiving environment and to prevent



discharge of dirty water;

- Implement measures to contain seepage as far as possible to prevent contamination of the groundwater regime;
- Implement alien vegetation control program within wetland areas;
- Monitor all systems for erosion and incision;
- Any areas where active erosion is observed must be rehabilitated and berms utilised to slow movement of water;
- Ongoing aquatic biomonitoring should take place in order to identify any emerging issues in the receiving aquatic environment;
- Toxicological monitoring of the receiving and process water systems on a quarterly basis.

Recommended mitigation measures

- No infrastructure or open pits should encroach into any major drainage lines;
- Monitoring of sediment heavy metal concentrations;

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
General Section	2	2	3	4	4	4	11	44 (Low)
Mount Stewart Section	1	2	1	3	3	3	7	21 (Very low)

Probable latent impacts

- Loss of some flow dependent species is possible;
- Loss of some species less tolerant of water quality changes is possible;
- Loss of some low flow refugia in the Nzhelele and Mutamba Rivers is possible;

7.5 IMPACT 5: Loss of Wetland and Riparian Habitat

The main land use constitutes game farming and to a lesser extent crop cultivation. As a result, overall landscape and vegetation transformation in the vicinity of water courses and depressions, within the study area, are considered to be low. Consequently, all features presently provide niche habitat for wetland and aquatic faunal and floral species within a water stressed region.

The ephemeral nature of smaller drainage lines does limit the ability for these features to provide optimum conditions for the formation of an extensive riparian zone. Therefore, larger tree species with root systems that can subtract water from deeper within the soil during winter months such as *Faedherbia albida* and *Xanthocercis zambesiaca* (Nyala) and fig species were restricted to river systems such as the Mutamba River as well as the Nzhelele River as well as some of the larger ephemeral drainage lines in the area. None the less, the smaller drainage lines do provide habitat for species such as *Combretum imberbe* (leadwood) (protected in accordance to the National Forests Act (Act No 84 of 1998 as amended September 2008).

Surface water that would provide habitat for aquatic species as well as drinking water for terrestrial wildlife, was also concentrated on the Nzhelele and Mutamba Rivers. Some of the more ephemeral pans in the area are also likely to be of some importance in surface water provision to the faunal communities of the area.

Loss or impact on wetland and riparian habitat would result in loss of niche habitat for various faunal and floral species within a water stressed region. Due to the sandy nature of the soil it is deemed likely that it would be difficult to rehabilitate wetland and riparian habitat to resemble these unique habitat units presently within the study area.



Activities leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning leading to the placement of infrastructure within riverine features with special mention of the overburden stockpile areas as well as the open pits themselves as well as road crossings and bridges	Site clearing and the removal of wetland and riparian vegetation	Ongoing disturbance of soils with general operational activities	Disturbance of soils as part of demolition activities
Inadequate design of infrastructure leading to changes to instream habitat	Site clearing and road construction	Inadequate separation of clean and dirty water areas	Seepage from any latent discard dumps and dirty water areas
Inadequate design of infrastructure leading to changes to system hydrology	Earthworks in the vicinity of wetland and riparian areas	Loss of instream flow due to abstraction for water for production and the formation of a cone of dewatering from open pits	Ongoing erosion of disturbed areas that have not been adequately rehabilitated
Inadequate design of infrastructure leading to contamination of water and sediments in the streams	Construction of bridge crossings altering streamflow patterns and water velocities	Seepage from the discard dumps and overburden stockpiles	Ineffective rehabilitation of riparian areas could cause siltation and changes in the hydrological functioning of these areas
Vehicles may impact upon sensitive riparian and wetland areas resulting in a loss of habitat	Placement of infrastructure within riverine features with special mention of the overburden stockpile areas as well as the open pits themselves as well as road crossings and bridges	Earthworks in the vicinity of wetland areas may lead to increased runoff and erosion and altered runoff patterns	Vehicles may impact upon sensitive riparian and wetland areas resulting in a loss of habitat
	Earthworks within and in the vicinity of wetland areas may lead to increased runoff and erosion and altered runoff patterns	Topsoil stockpiling adjacent to wetlands and runoff from stockpiles may contaminate wetland features	



Pre-Construction	Construction	Operational	Decommissioning & Closure
	Dumping of hazardous and non-hazardous waste into the wetland areas may result in a loss of wetland habitat and ecological structure	Seepage from mining facilities, general dirty water areas as well as spillages of hydrocarbons, has the potential to contaminate the groundwater environment which in turn can affect water quality in surface water sources in the area	
	Vehicles may impact upon sensitive riparian and wetland areas resulting in a loss of habitat	Dumping of hazardous and non-hazardous waste into the wetland areas may result in a loss of wetland habitat and ecological structure	
		Vehicles may impact upon sensitive riparian and wetland areas resulting in a loss of habitat	

Aspects of wetland and riparian habitat affected

Construction	Operational	Decommissioning & Closure
Direct loss of habitat during construction related activities	Direct loss of habitat during operational related activities	Direct loss of habitat during decommissioning and closure activities
Indirect loss through sedimentation and erosion	Indirect loss through sedimentation and erosion	Indirect loss through sedimentation and erosion due to ineffective rehabilitation
Loss of riparian and wetland vegetation species diversity	Indirect loss through cone of dewatering	Loss of riparian and wetland vegetation species diversity
Loss of endangered and charismatic wetland dependent faunal and floral species	Loss of riparian and wetland vegetation species diversity	Loss of endangered and charismatic wetland dependent faunal and floral species
Contamination of soils and surface water impacting foraging and breeding habitat for wetland/riverine species	Loss of endangered and charismatic wetland dependent faunal and floral species	Contamination of soils and surface water impacting foraging and breeding habitat for wetland/riverine species
Changes to the wetland community due to alien vegetation proliferation within disturbed areas	Contamination of soils and surface water impacting foraging and breeding habitat for wetland/riverine species	Changes to the wetland community due to ineffective alien vegetation control during decommissioning and closure



Construction	Operational	Decommissioning & Closure
	Changes to the wetland community due to alien vegetation proliferation within disturbed areas	

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	5	3	5	5	5	8	15	120 (High)
Mount Stewart Section	2	2	2	4	4	4	10	40 (Low)

Essential mitigation measures:

- Ensure that as far as possible all infrastructure is placed outside of wetland areas and drainage lines. In particular mention is made of the need to not encroach on the unnamed tributary of the Mutamba River in the vicinity of the Generaal mining section and a minimum buffer of 100m around all wetland and riparian systems should be maintained in line with the requirements of regulation GN704 of the national Water Act for all non resource dependent infrastructure;
- A sensitivity map has been developed for the study area, indicating the various wetland and river features which are considered to be of increased EIS. It is recommended that this sensitivity map be considered during the planning of the proposed mining activities to aid in the conservation of wetland and riparian ecology within the study area;
- The mining footprint area must be limited to what is absolutely essential in order to minimise environmental damage and to minimise impacts on catchment yield;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Impacts on the affected wetland features should be managed to minimise impacts on wetland areas not directly affected by or falling within the proposed development;
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas;
- Access into wetland areas not directly affected by or falling within the proposed development footprint, particularly by vehicles, is to be strictly controlled;
- All vehicles should remain on designated roads with no indiscriminate driving through adjacent wetland areas;
- Ensure that all stockpiles are well managed and have measures such as berms and hessian curtains implemented to prevent erosion and sedimentation;
- No use of clean surface water or any groundwater which potentially recharges the watercourses in the area should take place. In this regard specific mention is made of any water use which will affect the instream flow in the Nzhelele and Mutamba Rivers and the associated larger tributaries;
- Pollution control dams should be off stream structures and not within the natural drainage system of the area, thereby minimising impacts loss of instream flow and downstream recharge;
- Implement alien vegetation control program within wetland areas with special mention of water loving tree species; and
- All spills should be immediately cleaned up and treated accordingly.

Recommended mitigation measures

- Infrastructure near to the Nzhelele and Mutamba Rivers must be kept to an absolute minimum and must be placed as far from these water courses as possible;
- No infrastructure or open pits, except for bridge crossings should encroach into any major drainage lines and the associated riparian zones; and
- Revegetate all disturbed areas with indigenous tree species and make use of indigenous species with an affinity for riparian zones such as *Combretum imberbe* (leadwood), *Faederbia albida* (Ana tree) and *Xanthocercis zambesiaca* (Nyala) as well as fig species.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	4	3	4	4	4	7	12	84 (Medium-high)
Mount Stewart Section	2	2	2	3	3	4	8	32 (Low)



Probable latent impacts

- Wetland and riparian habitat within the study area, may be permanently altered or lost if mining activities are undertaken within the features and inadequate rehabilitation takes place;
- Sedimentation of the systems may occur for long after mining is completed;
- Eroded and incised streams are unlikely to be rehabilitated; and
- Silted up refuge pools are unlikely to be naturally rehabilitated and are unlikely to be rehabilitated by the mine.

7.6 IMPACT 6: Changes to Wetland Ecological and Socio-cultural Service Provision

To determine feature specific importance in terms of function and service provision, the Nzhelele River, Mutamba River, smaller drainage lines as well as pans and wetland depressions were assessed separately. Following the assessment, all features are considered of intermediate importance in terms of function and service provision, with the highest scores calculated for water provision biodiversity, tourism and recreation.

Loss or impact on wetland and riparian habitat would reduce a features importance in terms of function and service provision. Although deemed possible to reduce impact in terms of changes to ecological and sociocultural service provision it is doubtful that the level of importance could be reinstated after mine closure, unless all allocated 100m buffer zones are kept strictly off limits to any mining related activity, including general infrastructure and that water abstraction are kept to a minimum and there is no formation of a cone of dewatering which may be created through the opencast mining methods which affects the baseflows in the aquifers of the Nzhelele and Mutamba River systems.

Activities potentially leading to impact

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning leading to the placement of infrastructure within wetland and riparian features presently considered important in terms of biodiversity, tourism and recreation	Construction of infrastructure within wetland and riparian features presently considered important in terms of biodiversity, tourism and recreation	Operational activities within wetland and riparian features presently considered important in terms of biodiversity, tourism and recreation	Closure related activities within wetland and riparian features presently considered important in terms of biodiversity, tourism and recreation
Poor planning leading to the placement of infrastructure within wetland and riparian features leading to loss in ecological and sociocultural services dependent on abundance of vegetation present and surface roughness	Site clearing and the removal of vegetation leading to loss in ecological and sociocultural services dependent on abundance of vegetation present and surface roughness	Ongoing disturbance leading to loss in ecological and sociocultural services dependent on abundance of vegetation present and surface roughness	Site clearing and the removal of vegetation leading to loss in ecological and sociocultural services dependent on abundance of vegetation present and surface roughness
Inadequate design of infrastructure leading to changes to instream habitat that would reduce assimilation capability	Construction of infrastructure leading to changes to instream habitat that would reduce assimilation capability	Loss of water volumes for abstraction by farmers due to abstraction for water for production and the loss of base flow in the riverine resources in the area	Seepage from any latent discard dumps and dirty water areas leading to a loss in ecological and sociocultural services



Pre-Construction	Construction	Operational	Decommissioning & Closure
	Construction related activities resulting in changes to riparian and instream characteristics that are important in terms of flood attenuation, streamflow regulation and sediment trapping	Operation related activities resulting in changes to riparian and instream characteristics that are important in terms of flood attenuation, streamflow regulation and sediment trapping	Decommissioning and closure related activities resulting in changes to riparian and instream characteristics that are important in terms of flood attenuation, streamflow regulation and sediment trapping

Aspects of Wetland Ecological and Sociocultural Service Provision affected

Construction	Operational	Decommissioning & Closure
Direct loss of biodiversity, tourism and recreational value	Direct loss of biodiversity, tourism and recreational value	Direct loss of biodiversity, tourism and recreational value
Loss of phosphate, nitrate and toxicant removal abilities	Loss of phosphate, nitrate and toxicant removal abilities	Loss of phosphate, nitrate and toxicant removal abilities
Loss of flood attenuation, streamflow regulation and erosion control abilities	Loss of flood attenuation, streamflow regulation and erosion control abilities	Loss of flood attenuation, streamflow regulation and erosion control abilities

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	5	3	4	4	5	8	14	112 (High)
Mount Stewart Section	2	2	3	2	3	4	8	32 (Low)

Essential mitigation measures:

- Ensure that as far as possible all infrastructure is placed outside of wetland areas and drainage lines. In particular mention is made of the need to not encroach on the unnamed tributary of the Mutamba River in the vicinity of the Generaal mining section and a minimum buffer of 100m around all wetland and riparian systems should be maintained in line with the requirements of regulation GN704 of the national Water Act for all non resource dependent infrastructure;
- A sensitivity map has been developed for the study area, indicating the various wetland and river features which are considered to be of increased EIS. It is recommended that this sensitivity map be considered during the planning of the proposed mining activities to aid in the conservation of wetland and riparian ecology within the study area;
- The mining footprint area must be limited to what is absolutely essential in order to minimise environmental damage;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Impacts on the affected wetland features should be managed to minimise impacts on wetland areas not directly affected by or falling within the proposed development;
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas;
- Access into wetland areas not directly affected by or falling within the proposed development footprint, particularly by vehicles, is to be strictly controlled;
- All vehicles should remain on designated roads with no indiscriminate driving through adjacent wetland areas;
- Ensure that all stockpiles are well managed and have measures such as berms and hessian curtains implemented to prevent erosion and sedimentation;



- No use of clean surface water or any groundwater which potentially recharges the watercourses in the area should take place. In this regard specific mention is made of any water use which will affect the instream flow in the Nzhelele and Mutamba Rivers and the associated larger tributaries;
- Pollution control dams should be off stream structures and not within the natural drainage system of the area, thereby minimising impacts loss of instream flow and downstream recharge;
- Implement alien vegetation control program within wetland areas with special mention of water loving tree species; and
- All spills should be immediately cleaned up and treated accordingly.

Recommended mitigation measures

- No infrastructure or open pits should encroach into any major drainage lines; and
- Revegetate all disturbed areas with indigenous tree species and make use of indigenous species with an affinity for riparian zones such as *Combretum imberbe*, *Faederherbia albida* and *Xanthocercis zambesiaca* as well as fig species.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Generaal Section	4	3	3	3	4	7	10	70 (Medium low)
Mount Stewart Section	2	2	3	2	3	4	8	32 (Low)

Probable latent impacts

- Ability for features to provide ecological and sociocultural services may be permanently lost or reduced if mining activities are undertaken within 100 meter of the features and inadequate rehabilitation takes place

7.7 SUMMARY OF AQUATIC AND WETLAND ECOLOGICAL IMPACTS

7.7.1 Impact assessment summary

Based on the above assessment it is evident that there are 4 major impacts on the aquatic ecology of the project area and 2 major impacts on wetland and riparian ecology of the project area. The tables below summarise the findings indicating the significance of the impact before mitigation takes place and the likely impact if management and mitigation takes place table 63 indicates the impact summary for the Generaal Section and Table 64 the impact summary for the Mount Stewart Section. In the consideration of mitigation it is assumed that a high level of mitigation takes place but which does not lead to prohibitive costs.

Table 63: A summary of the results obtained from the assessment of aquatic ecological impacts for the Generaal section

Impact level	Prior to mitigation	Post mitigation
IMPACT 1: Loss of instream flow, aquatic refugia and flow dependent taxa	Medium high	Medium low
IMPACT 2: Impacts on water quality affecting aquatic ecology	Medium high	Medium low
IMPACT 3: Loss of Aquatic habitat	High	Medium low
IMPACT 4: Loss of Aquatic Biodiversity and sensitive taxa	Medium low	Low
IMPACT 5: Loss of wetland and riparian habitat	High	Medium high
IMPACT 6: Loss of wetland ecoservices	High	Medium low
SUMMARY	High	Medium low

From the table it is evident that prior to mitigation the impact on instream flow and water quality is moderately high. Impacts due to a loss of aquatic habitat are considered high while the loss of aquatic biodiversity and less tolerant taxa is deemed moderately low. The impact on riparian vegetation and the loss of wetland ecoservices is considered to be high prior to mitigation. Overall the impact of the proposed Generaal section of the Generaal Project is considered to be high. If mitigation takes place all impacts can be considered to be moderately low level impacts except for the loss of aquatic biodiversity will be a low level impact while the loss of wetland and riparian habitat will remain moderately high. With mitigation the overall impact is considered to be a medium low level impact.



Table 64: A summary of the results obtained from the assessment of aquatic ecological impacts for the Mount Stewart section

Impact level	Prior to mitigation	Post mitigation
IMPACT 1: Loss of instream flow, aquatic refugia and flow dependent taxa	Low	Low
IMPACT 2: Impacts on water quality affecting aquatic ecology	Low	Low
IMPACT 3: Loss of Aquatic habitat	Low	Low
IMPACT 4: Loss of Aquatic Biodiversity and sensitive taxa	Low	Very Low
IMPACT 5: Loss of wetland and riparian habitat	Low	Low
IMPACT 6: Loss of wetland ecoservices	Low	Low
SUMMARY	Low	Low

From the table it is evident that prior to mitigation all impacts are low level impacts in the Mount Stewart section of the project. Overall the impact of the proposed Mount Stewart section of the Generaal Project is considered to be low prior to mitigation. If mitigation takes place all impacts except loss of aquatic biodiversity and sensitive taxa can be considered to be low while latter impacts can be considered very low. With mitigation the overall impact is considered to be a low level impact.

7.7.2 Cumulative impacts

The Nzhelele River and to a lesser degree the Mutamba are extremely important systems with these systems providing potable water as well as large volumes of water for the irrigation of crops to the north of the Soutpansberg mountain range. The irrigation of the crops is critical to their success and the crops produced can be considered to be of high significance as the crops are produced in winter when areas further to the south cannot produce food for the South African consumer. Prior to any large scale mining in the area both these systems can already be considered to be stressed from a water supply point of view. According to DWA (2004), the Nzhelele River is a water stressed region and therefore, the implementation of the ecological Reserve may require compulsory licensing to deal with the over-allocation to the irrigation sector.

The Sand River system has been identified as a FEPA river system and an upstream support area for a fish FEPA and is therefore considered important in fish conservation. For these reasons extreme caution must be used in decision making in the area with regards to any activity which may affect water supply in the Nzhelele and Mutamba River systems which are major tributaries of this system.

As part of the Greater Soutpansberg Project three very large scale mining operations are proposed which include the Mopane Project, the Chapudi project and the Generaal project. The activities of the Chapudi and Generaal projects are likely to contribute to the cumulative impact on the Mutamba River as well as the cumulative impact on the Nzhelele River.

There will also be a significant cumulative impact on the Sand River system from both the Chapudi and the Mopane projects with both systems likely to have similar types of impacts on the Sand River system. The combined impact of both these projects along with the Generaal project is likely to significantly affect the water supply and possibly the water quality in the lower reaches of the Sand River which in turn will affect the habitat available in the system as well as the availability of refuge pools in periods of low flow and an impact on aquatic and riparian community diversity sensitivity and abundance is likely to occur..

For these reasons extreme caution and care should take place throughout the entire life cycle of these three projects, should they proceed, in order to ensure that the impact on the Sand River system as well as the Nzhelele River system with special mention of the Mutamba River and other ephemeral systems in the area with riparian vegetation is minimised to levels which would ensure an ongoing acceptable level of functioning and biodiversity in these systems and ensure the implementation of the ecological reserve. In each phase of the GSP projects specific mention is made of the following:



- **Pre-construction:** ensure that the design of all infrastructure is optimal to minimise impacts on the aquatic and wetland areas within this already water scarce area and within the water stressed systems of the area;
- **Construction:** ensure that the design of all infrastructure is adhered to and ensure that very good housekeeping takes place to prevent impacts on the receiving aquatic and riparian environments;
- **Operation:** ensure that mine planning and original designs are adhered to and ensure that very good housekeeping takes place to prevent impacts on the receiving aquatic and riparian environments. In addition specific attention must be given to keep all streamflow reduction activities to the absolute minimum;
- **Closure:** ensure that long in advance prior to closure that detailed investigations are undertaken and a detailed closure plan is developed in order to ensure that latent impacts are minimised to ensure that an ongoing acceptable level of functioning and biodiversity occurs in the area. It should also be ensured that a suitably qualified team of ecologists are involved in the project to ensure that closure takes place in such a way as to ensure that post closure sustainability is reached.

8 CONCLUSION

Scientific Aquatic Services (SAS) was appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the wetland, aquatic and riparian resources as part of the environmental assessment and authorisation process for the proposed Greater Soutpansberg Generaal project, located approximately 70km to the south of Musina within the Limpopo Province.

The following general conclusions were drawn upon completion of the literature review:

The Generaal Project Area falls within the Limpopo Plain Ecoregion and is located within the A71K, A80F and A80G quaternary catchments although the area within the A71K quaternary catchment is very limited. According to the ecological importance classification for the A80 quaternary catchments, the system can be classified as a *Sensitive* system which, in its present state, can be considered a Class D (largely modified) stream. The most significant riverine resource within the Generaal Project area within the A80F quaternary catchment is the Mutamba River, a major tributary of the Nzhelele River and the Nzhelele River itself. The Dolidoli River was the only other system observed with surface water at the time of assessment. These systems all form part of the Sand River catchment which in turn is a large tributary of the Limpopo River. The RSA Wetland Types (2010) and National Freshwater Ecosystem Priority Areas (NFEPA) (2011) databases were consulted to define the ecology of the wetland or river systems within the Generaal Project Area that may be of ecological importance. Aspects applicable to the Generaal Project Area and surroundings are discussed below:

- The Generaal Project Area falls within the Limpopo Water Management Area (WMA). The subWMA indicated for the Generaal Project Area is the Sand subWMA.
- The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors.
- The subWMA is not listed as a fish Freshwater Ecosystem Priority Area.
- Both the Mutamba and Nzhelele Rivers are perennial systems classified as Class D (largely modified) rivers and are not indicated as free flowing, flagship or as FEPA Rivers.
- The Sand River is a perennial system classified as a Class B (largely natural) river and is not indicated as a free flowing or flagship river. However, the Sand River is indicated as a FEPA river.
- Numerous wetland features are located within the Generaal Area, these include bench slope and valley floor wetland features.
- Both natural and artificial wetland features occur within the Generaal Area, two wetland features are considered natural while five are considered artificial (Figure 11).
- Wetlands within the Generaal Area were ranked according to general importance. All wetland features were ranked as Rank 6 with no importance indicated.
- No wetland features within the Generaal Project Area are considered important with regards to the conservation of biodiversity.
- No wetland features within the Generaal Project Area are indicated as FEPA wetlands.
- No RAMSAR wetlands are located within or close to the Generaal Project Area.
- No wetlands are indicated to fall within 500m of an IUCN threatened frog point locality.
- According to the NFEPA database (2011), none of the wetland features within the Generaal Project Area are considered of significant biodiversity importance. All wetland features are indicated to be in a



heavily to critically modified condition and are not considered important with regards to the conservation of biodiversity in the area.

The following general conclusions were drawn upon completion of the wetland assessment:

- Features within the study area were categorised with the use of the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis, 2013). Three main feature groups are present within the study area, namely depressions (small pans), rivers (Nzhelele River, Mutamba River and Dolidoli River) and smaller drainage lines. Within the area several artificial earth dams were also observed, some of which are perennial with others that only seasonally or ephemerally hold surface water and support vegetation adapted to life in saturated soils. These four groups were then assessed to determine importance in terms of function and service provision as well as PES, and EIS of the systems. The bullets below summarise the key findings:
- The average score calculated for the Mutamba River with the use of the Wetland IHI, indicates that the feature can be considered to fall within PES Category A (Unmodified). A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. It is also notable that there is a general decreasing trend in wetland habitat integrity in a downstream direction largely as a result of increased water abstraction. This results in slightly lower ecological scores in the area of the Generaal project in relation to the upstream areas although the habitat integrity at this point can still be considered largely natural with few modifications (Class B).
- The score calculated for the Nzhelele and Dolidoli Rivers with the use of the wetland IHI, indicates that these features can be considered to fall within PES Category B indicating largely natural conditions with few modifications. It is however notable that in the vicinity of the local villages a significant reduction in wetland habitat integrity is evident. The average score calculated for the smaller drainage lines with the use of the IHI, indicates that the features can be considered to fall within PES Category A (Unmodified/Natural). Smaller drainage lines have been left largely undisturbed with limited change for hydrology and geomorphology identified.
- The results obtained for the function and service provision indicated the Mutamba River, Nzhelele River and Dolidoli River to be of similar importance in terms of function and service provision, with the highest scores calculated for water supply, biodiversity and tourism and recreation. The smaller pans as well as drainage lines calculated scores that fall within a moderately low class and therefore cannot be considered of exceptional importance in terms of function and service provision despite the drainage lines being in a largely unmodified state;
- Wet-Health was used to determine the PES of the smaller pans within the study area. The pans have been largely undisturbed and therefore can still generally be considered to be in good condition and are considered to be relatively important in terms of biodiversity support in the area although overall functional importance is limited. The wetland Pans were defined as being moderately important (class B systems); and
- VEGRAI was used to assess the response of riparian vegetation to impacts within rivers as well as smaller drainage lines. The mean scores calculated for the drainage lines and Mutamba River both fall within Class B (largely natural) and mean average scores calculated for the Nzhelele River and Dolidoli River fall within Class C (moderately modified). Based on the findings of the study it is evident that from a wetland point of view, the EIS of the river systems are largely similar. All the larger riverine systems along with the smaller drainage lines can be defined as Class B systems indicating a high EIS. The small pans identified on site also calculated an EIS score included within a high EIS Class (Class B).
- Mining related activities and infrastructure as proposed by the present layout provided by the proponent would most likely significantly impact on the unnamed tributary of the Mutamba River in the vicinity of the proposed Generaal Mining section. Should mining activity encroach onto the allocated 100m buffer zones, effective mitigation of impacts would be unlikely;
- It should be noted that the region in the vicinity of the study area is significantly water stressed and as a result farmers depend on water from the rivers for general water provision for agriculture as well as livestock and game farming with specific reference to the Nzhelele River and Mutamba River. Furthermore, it would be difficult if not impossible to substitute the water supply from rivers with alternative water sources except for possible groundwater use. If the proposed mining activity results in a decrease in available water volumes in the aquifers associated with these water courses, or result in the formation of a cone dewatering, many farmers within the study area as well as downstream areas would be significantly affected in addition to adverse impacts on the ecology of the area.



- The Nzhelele River is also considered to be of increased significance with regards to biodiversity maintenance due to the presence of fish that would be restricted to river corridors and refugia formed during the winter months. Therefore, reduced water volumes will directly impact on the survival as well as migratory corridors of aquatic species. Any reduction of streamflow, as a result of the project that leads to the loss of refugia for aquatic species or the significant loss of downstream water supply, should be considered an high risk on the Nzhelele River.
- Due to the ephemeral nature of the drainage lines, not all drainage lines could be considered riparian habitat as defined by NWA No 36 of 1998. Therefore, distinction was made between drainage lines with riparian zones and drainage lines without riparian zones. Smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year flood lines exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA will also apply and therefore a Water Use License will be required;
- Smaller drainage lines *without* riparian zones are not considered wetlands but are still defined as watercourses. If any activities are to take place with the 1:100 year flood line exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained, however Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA does not apply and therefore no Water Use Licence will be required.

The following general conclusions were drawn upon completion of the aquatic assessment:

- Increased concentrations of dissolved salts were observed in a downstream direction on the Matumba river with the EC being 6.3 times higher at site GSP13 site compared to the GSP9 site at the most upstream point;
- The Mutamba River is likely to display a naturally high level of variability in dissolved salt concentration linked to seasonality of flow. Close monitoring of these trends will be required in future;
- Spatially there was a 14.0% decrease in pH value in a downstream direction between sites GSP9 and GSP13;
- From a temporal perspective pH value decreased by 1.1% at GSP9 from 2009 to 2013. The observed variations can be attributed to natural temporal variation;
- Dissolved oxygen (DO) concentration decreased by 25.4% in a downstream direction between sites GSP9 and GSP13;
- Dissolved oxygen concentration at upstream site GSP9 falls well within the recommended range, whilst that at the downstream site (GSP13) is below the recommended range indicating that some limitations on the aquatic community in the lower sections of the Mutamba River in the vicinity of the Generaal project will occur;
- There is significant variation in dissolved oxygen over time. The observed variation in dissolved oxygen concentration is likely to be attributed largely to natural variation with biological activity within the system at each point considered to be a significant driver of the variation in the system;
- The temperatures observed at each of the points are deemed natural for the time of year and the nature of the systems.
- Both the Nzhelele River and the Dolidoli River have elevated salt concentrations evident prior to mining taking place indicating that the systems naturally carry a relatively high concentration of dissolved salts;
- Increased concentrations of dissolved salts were observed in a downstream direction. The change was, however, much less pronounced than that observed for the Mutamba River;
- Compared to the Nzhelele River, EC in the Dolidoli River (GSP17) was much higher (69.3% compared to GSP15 and 88.0% compared to GSP16);
- Spatially there was a 4.2% decrease in pH value in a downstream direction between sites GSP15 and GSP16. The observed changes in pH value thus fall within the recommended percentage change range from a spatial perspective. The pH, observed in the Dolidoli River was more neutral than that of the Nzhelele River system;
- Dissolved oxygen (DO) concentration decreased by 8.0% in a downstream direction between sites GSP16 and GSP17. Dissolved oxygen concentration at all the sites on the Nzhelele River and Dolidoli river fall well within the recommended range; The observed variation in dissolved oxygen concentration is likely to be attributed largely to natural variation in biological activity within the system at each point;
- It is evident that dissolved oxygen saturation was significantly lower in the Dolidoli River than in the Nzhelele River which will limit the ability to support more sensitive aquatic taxa.



-
- The temperatures observed at each of the points are deemed natural for the time of year and the nature of the systems.
 - Based on the IHIA index an overall score of 65.3% was calculated for GSP14 (class “C” and hence considered “Moderately modified”). For GSP15 an average score of 54.6% was calculated, placing this site in class “D” (“Largely modified”).
 - Habitat diversity and structure at site GSP15 was considered highly suitable for supporting a diverse and sensitive aquatic macro-invertebrate community. In comparison habitat diversity and structure at site GSP14 was considered inadequate for supporting a diverse and sensitive aquatic macro-invertebrate community.
 - As for the Mutamba River, habitat limitations are likely to limit the diversity, abundance and sensitivity of the aquatic community significantly due to the ephemeral nature of the system;
 - At site GSP14, the Nzhelele River may be considered to be in a class E (severely impaired) condition according to the Dickens & Graham (2001) classification system. According to the Dallas (2007) classification system, the site can be classified as class D;
 - Stream conditions at site GSP15 may also be considered to be in a class E (severely impaired) condition according to the Dickens & Graham (2001) classification system. However, according to the Dallas (2007) classification system, the site can be classified as class C;
 - The latter classification is in agreement with the IHAS assessment, where habitat conditions at GSP15 appear more suited to supporting a diverse and sensitive aquatic macro-invertebrate community when compared to GSP14;
 - Due to the degree of sensitivity of the system to habitat changes and loss of instream flow, careful design and operational procedures will be required to limit the impact on the Nzhelele River.
 - The MIRAI results in terms of (ecological category classification) largely follow the same trends as that obtained using the SASS class classifications with both sites having an ecostatus score of Class D indicating largely modified conditions.
 - The FRAI largely corresponds to that obtained for the MIRAI. Because the habitat (and hence potential drivers) was fairly homogenous between the sites, the refined EC was also similar. The EC for the system indicates that some loss of fish community integrity of the system has occurred, however there is still a significant diversity and abundance of fish present in the system. The EC values calculated during the current assessment are, however, in congruence with results obtained using macro-invertebrate indices (MIRAI and SASS5);
 - Both the Nzhelele River and the Mutamba River, are expected to exhibit broad variability in aquatic community integrity on a temporal scale due to variations in flow and habitat availability within the system. As more data on the system is collected, better inferences on the ecological condition of the community will be possible;

Based on the findings of the aquatic study the Mutamba River is seen to be a water stressed system with the degree of water stress increasing in a downstream direction. Some recovery of the system does however occur in the lower reaches but impacts on the aquatic ecology of the lower reaches of the system are still considered to be likely. The Mutamba River can be considered to be a system of reduced Ecological Importance and Sensitivity in relation to the Nzhelele River due to the limited provision of refugia and in the local area and the limited support it provides to the aquatic ecology of the area. The system is however deemed important in terms of the provision of services to the terrestrial fauna of the area as well as fair significance from a socio-cultural point of view. It is deemed essential that all effort is made to ensure that impacts on the Mutamba River as a result of the proposed Generaal Project are minimised.

The Nzhelele River can be considered to be a system of high aquatic Ecological Importance and Sensitivity due to the provision of refugia and in the local area and the support it provides to the aquatic ecology of the area. The system is also deemed important in terms of the provision of services to the terrestrial fauna, such as the provision of drinking water of the area as well as a high significance from a socio-cultural point of view, with special mention of water provision for agriculture. It is deemed essential that all effort is made to ensure that impacts on the Nzhelele River as a result of the proposed Generaal Project are minimised.



The proposed Generaal Mining project can be defined as consisting of two major “blocks”. The degree of impact on the aquatic ecology between the various blocks varies significantly. For this reason the impact assessment was divided into two sections as follows addressing the Generaal Section and the Mount Stewart section:

- From the Impact assessment for the Generaal Section it is evident that prior to mitigation the impact on instream flow and water quality is moderately high. Impacts due to a loss of aquatic habitat are considered high while the loss of aquatic biodiversity and less tolerant taxa is deemed moderately low. The impact on riparian vegetation and the loss of wetland ecoservices is considered to be high prior to mitigation. Overall the impact of the proposed Generaal section of the Generaal Project is considered to be high. If mitigation takes place all impacts can be considered to be moderately low level impacts except for the loss of aquatic biodiversity will be a low level impact while the loss of wetland and riparian habitat will remain moderately high. With mitigation the overall impact is considered to be a medium low level impact.
- From the impact assessment results for the Mount Stewart Section it is evident that prior to mitigation all impacts are low level impacts in the Mount Stewart section of the project. Overall the impact of the proposed Mount Stewart section of the Generaal Project is considered to be low prior to mitigation. If mitigation takes place all impacts except loss of aquatic biodiversity and sensitive taxa can be considered to be low while latter impacts can be considered very low. With mitigation the overall impact is considered to be a low level impact.
- The Nzhelele River and to a lesser degree the Mutamba are extremely important systems with these systems providing potable water as well as large volumes of water for the irrigation of crops to the north of the Soutpansberg mountain range. The irrigation of the crops is critical to their success and the crops produced can be considered to be of high significance as the crops are produced in winter when areas further to the south cannot produce food for the South African consumer. Prior to any large scale mining in the area both these systems can already be considered to be stressed from a water supply point of view.
- It is also important to note that no reserve determination has been undertaken for the Sand River. According to DWA (2004), the Nzhelele River is a water stressed region and therefore, the implementation of the ecological Reserve may require compulsory licensing to deal with the over-allocation to the irrigation sector.
- The Sand River system has been identified as a FEPA river system and an upstream support area for a fish FEPA and is therefore considered important in fish conservation. For these reasons extreme caution must be used in decision making in the area with regards to any activity which may affect water supply in the Sand system of which the Mutamba River and Nzhelele River form major tributaries.
- As part of the Greater Soutpansberg Project three very large scale mining operations are proposed which include the Mopane Project, the Chapudi project and the Generaal project. The activities of the Chapudi and Generaal projects are likely to contribute to the cumulative impact on the Mutamba River as well as the cumulative impact on the Nzhelele River although some very small impacts on the Limpopo River system may occur.
- For these reasons extreme caution and care should take place throughout the entire life cycle of these three projects, should they proceed, in order to ensure that the impact on the Sand River system as well as the Nzhelele River system with special mention of the Mutamba River and associated tributaries and other ephemeral systems in the area with riparian vegetation is minimised to levels which would ensure an ongoing acceptable level of functioning and biodiversity in these systems and ensure the implementation of the ecological reserve.



9 REFERENCES

Bromilow, C. 2010. Second Edition, Second Impression. *Problem Plants of South Africa*. Briza Publications, Pretoria, RSA.

Dada R., Kotze D., Ellery W. and Uys M. 2007. *WET RoadMap: A Guide to the Wetland Management Series*. WRC Report No. TT 321/07. Water Research Commission, Pretoria.

DWA, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources*, 1999. [Appendix W3].

De Villiers, C., Driver, A., Clark, B., Euston-Brown, D., Day, L., Job, N., Helme, N., Van Ginkel, CE., Glen, RP., Gordon-Gray, KD., Cilliers, CJ., Muasya, M and van Deventer, PP. 2011. *Easy identification of some South African Wetland Plants*. WRC Report No TT 479/10.

DWA and Forestry (2005). A practical field procedure of identification and delineation of wetlands and riparian areas. **DWA, Pretoria.**

DWAF. 2007. *Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types* by M. Rountree (ed); C.P. Todd, C. J. Kleynhans, A. L. Batchelor, M. D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. and G.C. Marneweck. Report no. N/0000/00/WEI/0407. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Du Preez, L and Carruthers, V. 2008. A complete guide to the frogs of Southern Africa. Stuiker Nature, - Random house, Cape Town, South Africa

Kleynhans C.J. 1999. *A procedure for the determination of the ecological reserve for the purposes of the national water balance model for South African River*. Institute of Water Quality Studies, Department of Water Affairs & Forestry, Pretoria.

Kleynhans CJ, Mackenzie J, Louw MD. 2007. Module F: *Riparian Vegetation Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination* (version 2). Joint Water Research Commission and DWA and Forestry report. WRC Report No.

Kleynhans C.J., Thirion C. and Moolman J. 2005. *A Level 1 Ecoregion Classification System for South Africa, Lesotho and Swaziland*. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria

Kotze D.C., Marneweck G.C., Batchelor A.L., Lindley D.S., Collins. N.B., 2005 *Wet Eco-services. A technique for rapidly assessing ecosystem services supplied by wetlands.*

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D., Koopman V., Goodman P. and Goge C. 2008. *WET-Health: A technique for rapidly assessing wetland health*. WRC Report No. TT 340/08. Water Research, Commission, Pretoria.

Mucina, L. & Rutherford, M.C. (Eds). 2006. *The Vegetation of South Africa, Lesotho and Swaziland*. Strelitzia 19. South African National Biodiversity Institute, Pretoria, RSA.



Nel, J.L., Driver, A., Strydom W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., Van Deventer, H., Swartz, E. & Smith, Adao, L.B. 2011a. *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources*. Water Research Commission Report No. TT 500/11, Water Research Commission, Pretoria.

Ollis, D.J.; Snaddon, C.D.; Job, N.M. & Mbona, N. 2013. *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems*. SANBI Biodiversity Series 22. South African Biodiversity Institute, Pretoria.

Onderstall, J. 1984. *Transvaalse Laeveld en Platorand insluitende Die Nasionale Krugerwildtuin. Veldblomgids van Suid-Afrika*. Botaniese Vereeniging van Suid-Afrika, Kaapstad, RSA.

Rowntree K.M. and Wadeson R.A. 2000. An Index of Stream Geomorphology for the Assessment of River Health. *Field Manual for Channel Classification and Condition Assessment*. NAEBP Report Series No. 13, Institute of Water Quality Studies, Department of Water Affairs and Forestry, Pretoria. Available: <http://www.csir.co.za/rhp/reports/reportseries13.html>.

Sinclair, I. and Ryan, P. 2010. *Birds of Africa south of the Sahara*. Struik Nature, Cape town, RSA.

Smit, N. 2008. *Field Guide to the Acacias of South Africa*. Briza Publications, Pretoria, RSA.

The South African National Biodiversity Institute - Biodiversity GIS (BGIS) [online]. URL: <http://bgis.sanbi.org>

SRK Consulting & Natural Scientific Services cc 2010 Faunal Assessment for the proposed Chapudi Coal Project near Waterpoort, Limpopo Province

The South African National Biodiversity Institute Biodiversity GIS (BGIS) [online]. Retrieved 2011/12/21 URL: <http://bgis.sanbi.org>

Van Ginkel C.E., Glen R.P., Gordon-Gray K.D., Cilliers C.J., Muasya M., Van Deventer P.P. 2011. Wetland Plants. WRC Report No TT 479/10.

Van Oudtshoorn, F. 2004. Second Edition, Third Print. *Guide to Grasses of South Africa*. Briza Publications, Pretoria, RSA.

Van Rooyen, N. 2001. Flowering plants of the Kalahari Dunes. Ecotrust cc, RSA.

Zietsman P.C. & Zietsman, L.E. 2010. Department of Botany, National Museum. Bloemfontein Centre for Environmental Management, University of the Free State, Bloemfontein.

Van Wyk, B. and van Wyk, P. 1997. *Field Guide to Trees of Southern Africa*. Struik Publishers, Cape Town, RSA.

Van Wyk, B., van Wyk, P. and van Wyk B.E. 2011. *Photo Guide to Trees of Southern Africa*. Briza Publications, Pretoria, RSA.



Appendix 1: IHIA data



Mutamba River

Instream Zone Habitat Integrity

Weights		14	13	13	13	14	10	9	8	6		
Reach	ASSESSMENT DATE	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
GSP9	September 2013	0	0	4	6	2	0	0	0	3	93.0	A: Unmodified
None		Small		Moderate		Large		Serious		Critical		

Riparian Zone Habitat Integrity

Weights		13	12	14	12	13	11	12	13		
Reach	ASSESSMENT DATE	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
GSP9	September 2013	3	7	7	2	2	2	0	0	80.4	A: Unmodified
None		Small		Moderate		Large		Serious		Critical	

REACH	ASSESSMENT DATE	INSTREAM HABITAT	RIPARIAN ZONE	IHI SCORE	CLASS
GSP9	September 2013	93.0	80.4	86.7	A: Unmodified



Nzhelele River

Instream Zone Habitat Integrity

Weights		14	13	13	13	14	10	9	8	6		
Reach	ASSESSMENT DATE	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
GSP16	September 2013	14	17	6	8	9	0	2	0	2	47.7	D: Largely modified
GSP14 15	September 2013	13	16	4	8	7	0	2	0	2	59.8	C: Moderately modified
None		Small		Moderate		Large		Serious		Critical		

Riparian Zone Habitat Integrity

Weights		13	12	14	12	13	11	12	13		
Reach	ASSESSMENT DATE	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
GSP16	September 2013	9	9	6	8	9	8	4	0	61.5	C: Moderately modified
GSP14 15	September 2013	7	11	8	7	8	7	4	0	70.7	C: Moderately modified
None		Small		Moderate		Large		Serious		Critical	

REACH	ASSESSMENT DATE	INSTREAM HABITAT	RIPARIAN ZONE	IHI SCORE	CLASS
GSP16	Sep 2013	47.4	61.5	54.6	D: Largely modified
GSP 14 15	Sep 2013	59.8	70.7	65.3	C: Moderately modified



Appendix 2: IHAS Score sheets September 2013



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: MATUMBA RIVER						
Site Name: GSP8	Date: SEPTEMBER 2013					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
			SIC Score (max 20): 19			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
			Vegetation Score (max 15): 0			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time) (** NOTE: you must still fill in the SIC section)		under		corr		over
			Other Habitat Score (max 20): 14			
			HABITAT TOTAL (MAX 55): 33			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
			STREAM CONDITIONS TOTAL (MAX 45) 40			
			TOTAL IHAS SCORE (%): 73			



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: NZHELELE						
Site Name: GSP15	Date: SEPTEMBER 2013					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):						0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):						9
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time) (** NOTE: you must still fill in the SIC section)		under		corr		over
Other Habitat Score (max 20):						12
HABITAT TOTAL (MAX 55):						21
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(***) NOTE: if more than one option, choose the lowest						
STREAM CONDITIONS TOTAL (MAX 45):						21
TOTAL IHAS SCORE (%):						42



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: NZHELELE						
Site Name: GSP16	Date: SEPTEMBER 2013					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):				18		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):				12		
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time) (** NOTE: you must still fill in the SIC section)		under		corr		over
Other Habitat Score (max 20):				10		
HABITAT TOTAL (MAX 55):				40		
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fldr' = flood or drought)***	fldr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45) 33						
TOTAL IHAS SCORE (%):				73		



Appendix 3: SASS5 Score sheets September 2013



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : September 2013	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE :	PORIFERA	5					HEMIPTERA :						DIPTERA :					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3			A	A	Blepharoceridae	15				
SITE CODE: GSP8	ANNELIDA :						Gerridae*	5	A			A	Ceratopogonidae	5				
RIVER: MATUMBA RIVER	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	A		A	B
SITE DESCRIPTION: UPSTREAM PROJECT	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: WARM DRY/LOW FLOW	CRUSTACEA :						Nepidae*	3					Dixidae*	10				
TEMP: 25.9 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.35	Potamonautidae*	3					Pleidae*	4					Ephyridae	3				
DO: 7.51 mg/l	Atyidae	8	A			A	Velidae/M...velidae*	5					Muscidae	1				
Cond: 18.4 mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordulidae	8					Simuliidae	5				
SIC: 5 TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC: 5	Notonemouridae	14					TRICHOPTERA						Tabanidae	5	1		1	A
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4	1			1	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	B			B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL: 2	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 3	Caenidae	6	A		A	B	Philopotamidae	10	1			1	Lymnaeidae*	3				
MUD:	Ephemerae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocent.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9	B			B	CASED CADDIS:						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosoptomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		76	0	22	79
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		12	0	5	13
	Chlorocyphidae	10	A			A	Petrothrincidae SWC	11					ASPT:		6.3	0.0	4	6.1
	Chlorolestidae	8					Pisuliidae	10					IHAS:		73%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :						COMMENTS :					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					* = airbreathers					
	Protoneuridae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5	A			A	T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Hemididae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6	A		B	B	Hydraenidae*	8					VG = all vegetation					
	Libellulidae	4					Hydrophilidae*	5					GSM = gravel, sand & mud					
	LEPIDOPTERA :						Limnichidae	10					≠1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: SEPTEMBER 2013	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3		A	A	B	Blepharoceridae	15				
SITE CODE: GSP15	ANNELIDA:						Gerridae*	5		1		1	Ceratopogonidae	5				
RIVER: NZHELELE	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		A		A
SITE DESCRIPTION: DIS MINING	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: HOT DRY/LOW FLOW	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 25.3 °C	Amphipoda	13					Notonectidae*	3		1		1	Empididae	6				
Ph: 8.72	Potamonautidae*	3					Pleidae*	4					Ephyridae	3				
DO: 9.30 mg/l	Atyidae	8		A		A	Veliidae/M. velidae*	5		A		A	Muscidae	1				
Cond: 88 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4		A	A		Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: 2 DOM SP:	Baetidae 2 sp	6				B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 4	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocn.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY: LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	34	13	42
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	8	3	9
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0	4.3	4.3	4.7
	Chlorolestidae	8					Pisuliidae	10					IHAS:		42%			
	Coenagrionidae	4		1		1	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6			A	A	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					±1, A=2-10, B=10-100, C=100-1000, D=>1000					



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE:	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3		A		A	Blepharoceridae	15				
SITE CODE: GSP16	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER: NZHELELE	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION: D/S ALL FARMS	Leeches	3	A			A	Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION: WARM DRY/LOW FL	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 24.2 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 8.35	Potamonautidae*	3					Pleidae*	4					Ephyridae	3				
DO: 8.56 mg/l	Atyidae	8					Veliidae/M. veliidae*	5					Muscidae	1				
Cond: 97.7 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: 3 TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC: 2	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8	1			1	GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: 3 DOM SP:	Baetidae 2 sp	6		B		B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 2	Caenidae	6	B			B	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: YES	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9	C			C	CASED CADDIS:						Thiaridae*	3	1			1
TURBIDITY: LOW	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6	1			1
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		35	18	0	53
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		6	4	0	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		5.8	0.0	0	5.3
	Chlorolestidae	8					Pisuliidae	10					IHAS:		73%			
	Coenagrionidae	4		A		A	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					* = airbreathers					
	Protoneuridae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5		A		A	T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					VG = all vegetation					
	Libellulidae	4					Hydrophilidae*	5					GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										

