HULL RIVER CROSSING

November 2014.
DRAFT BASIC ASSESSMENT

REF: 17/2/3/E-287

PROJECT:
Basic Environmental Assessment for the Replacement of a Causeway Crossing of the Klaserie River, Klaserie Game Reserve

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PROPERTY:
The farm Hull 92KU

Ref. No: 17/2/3/E-287

EMROSS
CONSULTING (PTY) LTD

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Department:
Economic Development, Environment and Tourism
MPUMALANGA PROVINCIAL GOVERNMENT

Basic assessment report in terms of the Environmental Impact Assessment Regulations, 2010, promulgated in terms of the National Environmental Management Act, 1998(Act No. 107 of 1998), as amended.

(For applicant / EAP to complete)

File Reference Number:	17/2/3/E-286
Project Title:	Basic Environmental Assessment for the replacement of a causeway crossing of the Klaserie River, Klaserie Private Nature Reserve
Name of Responsible Official:	Millicent Masango

(For official use only)

NEAS Reference Number:	
Date Received:	

Kindly note that:

1. Required information must be typed within the spaces provided in the form. The size of the spaces provided is not necessarily indicative of the amount of information to be provided. Tables can be extended as each space is filled with typing.
2. Where applicable **black out** the boxes that are not applicable in the form.
3. An incomplete report may be returned to the applicant for revision.
4. The use of "not applicable" in the report must be done with circumspection because if it is used in respect of material information that is required by the competent authority for assessing the application, it may result in the rejection of the application as provided for in the regulations.
5. All reports (draft and final) must be submitted to the Department at the address of the relevant **DISTRICT OFFICE** given below or by delivery thereof to the relevant **DISTRICT OFFICE**. Should the reports not be submitted at the relevant district office, they will not be considered.
6. No faxed or e-mailed reports will be accepted.
7. One copy of the draft version of this report must be submitted to the relevant district office. The case officer may request more than one copy in certain circumstances.
8. **Copies of the draft report must be submitted to the relevant State Departments / Organs of State for comment.** In order to give effect to Regulation 56(7), proof of submission/delivery of the draft documents to the State Departments / Organs of State must be attached to the draft version of this report.
9. Unless protected by law, all information in the report will become public information on receipt by the competent authority. Any interested and affected party should be provided with the information contained in this report on request, during any stage of the application process.
10. All specialist reports must be appended to this document, and all specialists must complete a declaration of independence, which is obtainable from the Department.

SECTION A: BACKGROUND INFORMATION

Project applicant:	Jessica Bridget Slack		
Trading name (if any):			
Contact person:	Sean Fairhead		
Physical address:	Remainder Portion of the Farm Hull 92KU, Klaserie Private Nature Reserve, Mpumalanga		
Postal address:	PO Box 123, Hoedspruit		
Postal code:	1380	**Cell:**	083 309 9546
Telephone:	015 793 1774	**Fax:**	015 793 1774
Email:	ntoma@telkomsa.net		

Environmental Assessment Practitioner:	Emross Consulting (Pty) Ltd		
Contact person:	Andrew Rossaak		
Postal address:	PO Box 507, White River		
Postal code:	1240	**Cell:**	082 3399 627
Telephone:	0137502782 / 0130070077	**Fax:**	086 675 4320
E-mail:	andrew@emross.co.za		
Qualifications:	M.Sc. Ecology and 15+ years of experience in environmental field		
Professional affiliations (if any):	SACNASP reg no: 400167/08; GSSA registered professional; IAIAsa		

SECTION B: DETAILED DESCRIPTION OF THE PROPOSED ACTIVITY

Describe the activity, which is being applied for, in detail. The description must include the size of the proposed activity (or in the case of linear activities, the length) and the size of the area that will be transformed by the activity.

The replacement of a causeway crossing of the Klaserie River, Klaserie Private Nature Reserve.

SECTION C: PROPERTY/SITE DESCRIPTION

Provide a full description of the preferred site alternative (farm name and number, portion number, registration division, erf number etc.):

Farm Hull 92KU

Indicate the position of the activity using the latitude and longitude of the centre point of the preferred site alternative. The co-ordinates should be in degrees and decimal minutes. The minutes should have at least three decimals to ensure adequate accuracy. The projection that must be used in all cases is the WGS84 spheroid in a national or local projection. The position of alternative sites must be indicated in Section B of this document.

Latitude (S):		**Longitude (E):**	
24°	16.621‘	31°	8.061‘

In the case of linear activities:

- Starting point of the activity
- Middle point of the activity
- End point of the activity

Latitude (S):		**Longitude (E):**	
°	‘	°	‘
°	‘	°	‘
°	‘	°	‘

SITE OR ROUTE PLAN

A detailed site or route plan(s) must be prepared for each alternative site or alternative activity. It must be attached as an appendix to this document.

The site or route plans must be at least A3 and must include the following:

6.1 a reference no / layout plan no., date, and a legend / land use table
6.2 the scale of the plan which must be at least a scale of 1:2000;
6.3 the current land use as well as the land use zoning of each of the properties adjoining the site or sites;
6.4 the exact position of each element of the application as well as any other structures on the site;
6.5 the position of services, including electricity supply cables (indicate above or underground), water supply pipelines, boreholes, street lights, sewage pipelines, storm water infrastructure and telecommunication infrastructure;
6.6 all indigenous trees taller than 1.8 metres and all vegetation of conservation concern (protected, endemic and/or red data species);
6.7 servitudes indicating the purpose of the servitude;
6.8 sensitive environmental elements within 100 metres of the site or sites including (but not limited thereto):
  a) watercourses and wetlands;
  b) the 1:100 year flood line;
  c) ridges;
  d) cultural and historical features;
6.9 10 metre contour intervals

SITE PHOTOGRAPHS

Colour photographs from the centre of the site must be taken in at least the eight major compass directions with a description of each photograph. Photographs must be attached as an appendix to this form**.**

FACILITY ILLUSTRATION

A detailed illustration of the activity must be provided at a scale of 1:200 as an appendix for activities that include structures. The illustrations must be to scale and must represent a realistic image of the planned activity. The illustration must give a representative view of the activity.

SECTION D: BASIC ASSESSMENT REPORT

Prepare a basic assessment report that complies with Regulation 22 of the Environmental Impact Assessment Regulations, 2010. The basic assessment report must be attached to this form and must contain all the information that is necessary for the competent authority to consider the application and to reach a decision contemplated in Regulation 25, and must include:

(Checklist for official use only)

1.	A description of the environment that may be affected by the proposed activity and the manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity.	
2.	An identification of all legislation and guidelines that have been considered in the preparation of the basic assessment report.	
3.	Details of the public participation process conducted in terms of Regulation 21(2)(a) in connection with the application, including – (i) the steps that were taken to notify potentially interested and affected parties of the proposed application; (ii) proof that notice boards, advertisements and notices notifying potentially interested and affected parties of the proposed application have been displayed, placed or given; (iii) a list of all persons, organisations and organs of state that were registered in terms of regulation **55** as interested and affected parties in relation to the application; and (iv) a summary of the issues raised by interested and affected parties, the date of receipt of and the response of the EAP to those issues;	

4.	A description of the need and desirability of the proposed activity;	
5.	A description of any identified alternatives to the proposed activity that are feasible and reasonable, including the advantages and disadvantages that the proposed activity or alternatives will have on the environment and on the community that may be affected by the activity;	
6.	A description and assessment of the significance of any environmental impacts, including— cumulative impacts, that may occur as a result of the undertaking of the activity or identified alternatives or as a result of any construction, erection or decommissioning associated with the undertaking of the activity; the nature of the impact; the extent and duration of the impact; the probability of the impact occurring; the degree to which the impact can be reversed; the degree to which the impact may cause irreplaceable loss of resources; and the degree to which the impact can be mitigated;	
7.	Any environmental management and mitigation measures proposed by the EAP;	
8.	Any inputs and recommendations made by specialists to the extent that may be necessary;	
9.	A draft environmental management programme containing the aspects contemplated in regulation 33;	
10.	A description of any assumptions, uncertainties and gaps in knowledge;	
11.	A reasoned opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation	
12.	Any representations, and comments received in connection with the application or the basic assessment report;	
13.	The minutes of any meetings held by the EAP with interested and affected parties and other role players which record the views of the participants;	
14.	Any responses by the EAP to those representations, comments and views;	
15.	Any specific information required by the competent authority; and	
16.	Any other matters required in terms of sections 24(4)(a) and (b) of the Act.	

The basic assessment report must take into account -

(a) any relevant guidelines; and

(b) any departmental policies, environmental management instruments and other decision making instruments that have been developed or adopted by the competent authority in respect of the kind of activity which is the subject of the application.

* In terms of Regulation 22(4), the EAP managing the application must provide the competent authority with detailed, written proof of an investigation as required by section 24(4)(b)(i) of the Act and motivation if no reasonable or feasible alternatives, as contemplated in subregulation 22(2)(h), exist.

Have reasonable and feasible alternatives been identified, described and assessed?	YES	NO

If NO, the motivation and investigation required in terms of Regulation 22(4) must be attached as an Appendix to this document		

SECTION E: CONSULTATION WITH OTHER STATE DEPARTMENTS

Provide a list of all State Departments / Organs of State that have been consulted and registered as interested and affected parties, and to whom draft reports have been submitted for comment. **Proof of submission / delivery of the draft report to all State Department / Organs of State must be attached to this document.**

Department:	Kruger National Park		
Contact person:	Tracy-Lee Petersen		
Postal address:	PO Box 394, SKUKUZA		
Postal code:	1350	**Cell:**	074 580 5583
Telephone:	013 735 4271	**Fax:**	013 735 4051
Email:	TracyP@sanparks.org		

Department:	Mpumalanga Parks and Tourism Agency		
Contact person:	Komilla Narasoo/ Frans Krige		
Postal address:	Private Bag X11338, NELSPRUIT		
Postal code:	1200	**Cell:**	084 232 2902
Telephone:	013 254 0279	**Fax:**	013 254 0279
Email:	franskrige@telkomsa.net		

Department:	Bushbuck Ridge Local Municipality		
Contact person:	Municipal Manager – Mr. Doctor Shabangu		
Postal address:	Private Bag X9308, Bushbuck Ridge		
Postal code:	1280	**Cell:**	
Telephone:	013 799 1851/7	**Fax:**	013 799 1865
Email:	shabangud@bushbuckridge.gov.za		

Department:	Sabi Sand Game Reserve		
Contact person:	Edwin Pierce – SSW Ecological Officer		
Postal address:			
Postal code:		**Cell:**	078 804 0347
Telephone:		**Fax:**	
Email:	ecologist@sabisand.co.za		

Department:	Department of Water Affairs		
Contact person:	Sampie Shabangu		
Postal address:			
Postal code:		**Cell:**	082 857 4275
Telephone:		**Fax:**	
Email:	shabangus2@dwa.gov.za		

Department:	Inkomati Usuthu Catchment Management Agency		
Contact person:	Thomas Gyedu-Ababio		
Postal address:			
Postal code:		**Cell:**	078 893 8924
Telephone:	013 753 9050	**Fax:**	
Email:	thomasga@inkomaticma.co.za		

SECTION E: APPENDICES

The following appendices must be attached to the basic assessment report as appropriate:

Site plan(s)

Photographs

Facility illustration(s)

Specialist reports

Comments and responses report

Other information

TABLE OF CONTENTS

APPENDICES:

1 INTRODUCTION

The Klaserie Private Nature Reserve (KPNR) is situated to the north-east of Hoedspruit and forms a part of the Associated Private Nature Reserves (APNR) network. As the KPNR forms a part of a larger network of reserves, it is vital that management personnel have full access to the reserve, allowing them to react rapidly to any situations which may have potential adverse effects on both the KPNR as well as the reserves with which it is associated.

Due to previous flooding events, an important causeway which provides access to various parts of the reserve and crosses the Klaserie River was washed away and requires replacement.

EMROSS Consulting (Pty) Ltd. has been appointed, as independent environmental consultants, by Ms. Slack to undertake the necessary actions required to apply for environmental authorisation from the Mpumalanga Provincial Government Department of Economic Development, Environment and Tourism (MDEDET, the decision-making authority) for the replacement of a causeway crossing the Klaserie River in the Klaserie Private Nature Reserve.

The new proposed development will be informed by essential environmental and engineering aspects which have been identified in the assessment. Any recommendations which are provided in this Basic Assessment Report have been generated by ecological, environmental and engineering specialists who recognize the importance of ecological integrity and optimal ecosystem functionality. Furthermore, the provided recommendations are aimed at reducing the impact which any developmental activities may have on the receiving environment and vice versa, and have been generated in accordance with the National Environmental Management Principles to ensure the mitigation of any possible impacts and promote sustainability.

The site of the proposed development is located along the Klaserie River (Figure 1) on the farm Hull 92KU within the Klaserie Private Nature Reserve; an area which has been declared “protected” in terms of NEMPAA.

The relevant legislation which is applicable to the proposed developmental activities is discussed in section 4 of this report.

Figure 1: Location of the proposed causeway crossing the Klaserie River, Klaserie Private Nature Reserve (Source: Google Earth 2014).

2 DESCRIPTION OF PROPOSED ACTIVITIES

The previously existing access causeway which crossed the Klaserie River at Hull was washed away in the 2012 floods. This has resulted in certain areas of the property being of limited access to the reserve's security and management personnel. The land owner wishes to replace the river crossing in order to improve accessibility to various areas of the property.

The preferred site for the proposed crossing (referred to as 'KCP' in the specialist reports in Appendix 4) is located approximately 370m further south (upstream) from the previously existing access causeway (Figure 2). The construction of the causeway at this site will place it in a relatively central location which is important for enabling reserve management and security personnel with rapid access to various areas of the reserve. Additionally, the causeway will be in closer proximity to the base of reserve management and security personnel.

There are two separate less defined gravel roads which run parallel to the left and right banks of the river and adjoin with more frequently utilised gravel roads that provide access to other areas of the reserve. These roads occur in sandy soils which would allow for moderate shaping; however, would require hardened side drainage to prevent erosion. The left bank approach would be in a minor cutting which would require armouring against erosion by flood water. The right bank approach road would be oblique to the river bank and would not need armouring.

The river channel was probed along the left bank and in the central and right elevated sand riverbed. It was revealed that a competent foundation could be established 1.2- 1.8m below the sand level (refer to page 6 of the engineering report in Appendix 4). This would allow both surface and sub-sand conduits to be placed in a causeway at a height equal to or just above the

low water level for part of the central river bed, preventing the obstruction of higher flows. Some minor rock trimming may have to occur, either by hand (hammer and chisel) or by closed space drilling, where an expansive material will be used in the holes to split the surface rock off. The design and engineering of the causeway will ensure minimal impact to the receiving environment, both directly and indirectly.

Figure 2 illustrates the locality of the alternatives that have been considered which are discussed in detail in section 7 of this report.

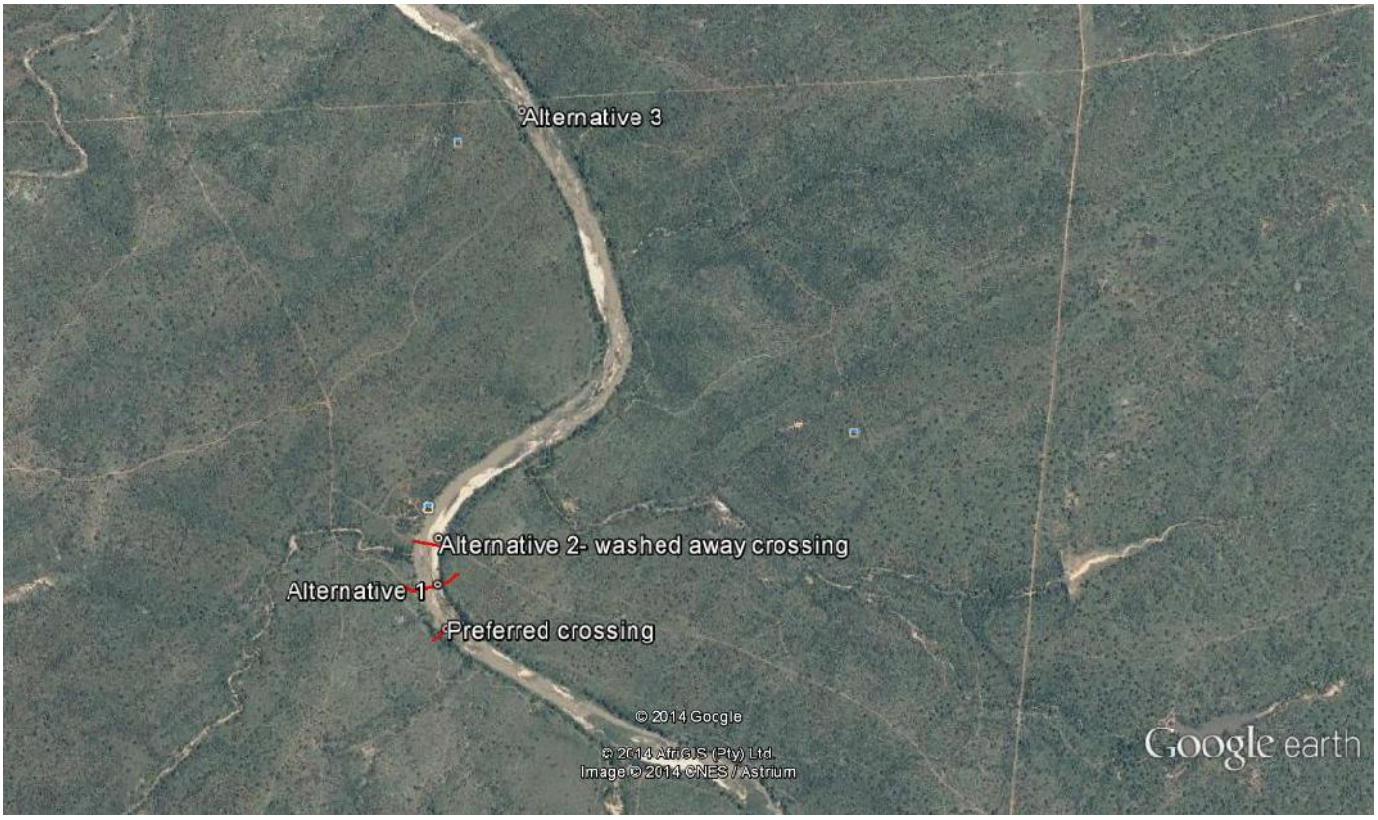


Figure 2: Location of the preferred and alternative sites for the proposed access causeway along the Klaserie River (Source: Google Earth 2014).

3 DESCRIPTION OF RECEIVING ENVIRONMENT

The natural vegetation occurring throughout the site is characteristic of the Granite Lowveld (SVI 3) vegetation type (Mucina & Rutherford 2006). The conservation status of SVI 3 is listed as "vulnerable" (Figure 3).

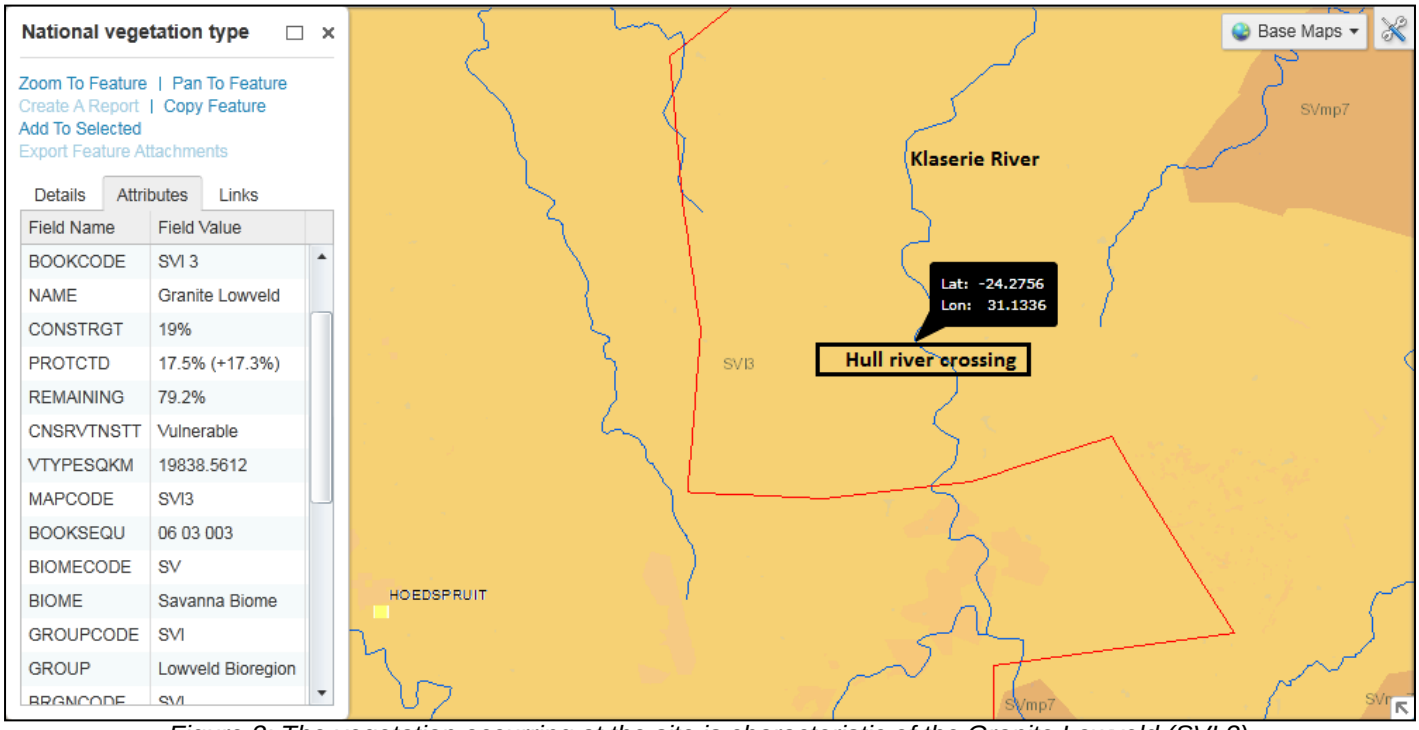


Figure 3: The vegetation occurring at the site is characteristic of the Granite Lowveld (SVI 3) vegetation type (Source: Biodiversity GIS 2007).

A large extent of the vegetation occurring at each of the proposed sites is associated with riverine habitats and is typically characteristic of the riparian zone.

PREFERRED SITE

The site is characterised by an exposed low level gneissic rock sill in the middle of the river, with a dolerite dyke intrusion forming a natural lower weir. This extends approximately 13m from the left bank and is covered by sand on the right central and bank area.

A solid platform of rock occurs approximately 1m below the water level along the left riverbed. The left bank consists of a narrow sand bank occurring below an incised sandy clay deposit which is approximately 2m deep. The right bank consists of a wide sand bank occurring well above the low water level, with rock present 1-1.2m below the surface. Both outer banks are comprised of sandy clay soils which sustain the growth of tall trees and open brush.

A desktop analysis of the site using Google Earth 2014 reveals that an existing gravel road runs parallel to the river at a distance approximately 50m from the western bank, while another gravel road runs parallel to the river at approximately 70m from the eastern bank. Refer to page 10 of the aquatic assessment and pages 5 and 6 in the engineering report (Appendix 4) for a comprehensive description of the receiving environment at the preferred site.

ALTERNATIVE 1

The river is characterised by a well-defined channel of approximately 80m in width at the site for alternative 1 (referred to as KCA1 in the engineering report and A1 in the aquatic assessment in Appendix 4). The left bank (western side) is short and steep with a well-developed riffle of roughly 100-120m in length which occurs along the edge of the bank. There is a well-developed point bar along the right bank which leads to a more gradual and broader non-marginal zone. There is a well-defined gravel road which runs parallel to the river approximately 70m to the west of the left bank, with no gravel road immediately to the east of the right bank. Refer to pages 34 and 35 of the aquatic assessment and page 9 of the engineering report in Appendix 4 for a comprehensive description of the receiving environment at the development site for alternative 1.

ALTERNATIVE 2

The site for alternative 2 (referred to as KCA2 in the engineering report and A2 in the aquatic assessment in Appendix 4) is characterised by a well-defined channel approximately 100m in width. The non-marginal zone along the left bank is short and steep while a well-developed point bar exists on the right bank (eastern side) which has resulted in a more gradual and broader non-marginal zone. Both the left and right banks have access to a gravel road as this is the site of the previously existing access causeway. Refer to pages 35 and 36 of the aquatic assessment and page 13 of the engineering report in Appendix 4 for a comprehensive description of the receiving environment at the development site for alternative 2.

ALTERNATIVE 3

The site for alternative 3 (referred to as KCA3 in the engineering report and A3 in the aquatic assessment in Appendix 4) is characterised by a well-defined channel of approximately 110m in width. The non-marginal zone along both the left and right bank is gradual. The development site for alternative 3 is the current crossing and occurs along a major gravel road which serves as a cutline and separates the adjoining properties and provides access and servitude across the KPNR in a west-east direction. Refer to page 37 of the aquatic assessment and page 15 of the engineering report in Appendix 4 for a comprehensive description of the receiving environment at the development site for alternative 3.

4 APPLICABLE LEGISLATION

In terms of the National Environmental Management Act (NEMA), the activities proposed are regarded as listed activities under schedule of activities as follows:

Government Notice Regulation 544:

Activity 11(xi): *"The construction of infrastructure or structures covering 50m² or more where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line."*

Activity 18(i): "*The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from a watercourse; but excluding where such infilling, depositing, dredging, excavation, removal or moving is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or* (ii) *occurs behind the development setback line."*

Government Notice Regulation 546:

Activity 16(iv)(a)ii(aa): *"The construction of infrastructure covering 10m2 or more where such construction occurs within a watercourse or within 32m of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line. In Mpumalanga: outside urban areas, in; a protected area identified in terms of NEMPAA, excluding conservancies."*

The following legislation may also be applicable to the proposed developments, in no particular order:

- Constitution of Republic of South Africa 108 0f 1996; (Constitution)
- National Environmental Management Act 107 of 1998; (NEMA)
- Conservation of Agricultural Resources Act 43 of 1983; (CARA)
- Environmental Conservation Act 73 of 1989; (ECA)
- Promotion of Administrative Justice Act 3 of 2000; (PAJA)
- Promotion of Access to Information Act 2 of 2000; (PAIA)
- National Veld and Forest Act 101 of 1998; (NVFA)
- National Forests Act 84 of 1998; (NFA)
- National Heritage Resources Act 25 of 1999; (NHRA)
- National Environmental Management Biodiversity Act 10 of 2004; (NEM-BA)
- Mpumalanga Nature Conservation Act 10 of 1998; (MNCA) and
- National Water Act 108 of 1997; (NWA)

The Constitution, The PAJA and PAIA deals with people's rights – the right to be heard, obtain information; have an environment that is not harmful and the right to receive fair treatment in the process. This is dealt with in the public participation process in section 5 below.

The NEMA, CARA, ECA and NVFA deals with people's responsibility to take due care of the environment. This is covered in various sections of this report, the environmental management plan (EMPr). Should it be necessary to damage protected trees, the appropriate applications will need to be submitted to Department of Agriculture Forestry and fisheries or MTPA.

The Heritage Act lists certain activities in section 38 of that act, which requires a heritage impact assessment.

"Section 38. (1) Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as—
(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;
(b) the construction of a bridge or similar structure exceeding 50 m in length;
(c) any development or other activity which will change the character of a site—
(i) exceeding 5 000 m^2 in extent; or
(ii) involving three or more existing erven or subdivisions thereof; or
(iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

(iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;
(d) the re-zoning of a site exceeding 10 000 m2 in extent; or
(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development."

It is assessed that a heritage impact assessment is not required for the proposed activity.

5 PUBLIC PARTICIPATION PROCESS

In accordance with the Constitution of the Republic of South Africa, it is the right of persons to have the environment in which they live protected in a responsible and sustainable manner. Every person also has the right of access to information and should be informed of any proposed scheduled activities. Therefore, an important aspect of the Environmental Impact Assessment is to identify potential Interested and Affected Parties (I&APs) and to provide accessible information regarding any proposed development to any I&APs, to which they may raise comments and voice any concerns associated with the proposed development.

REGULATORY PROCESS OF IDENTIFICATION, NOTIFICATION AND RESPONSE OF INTERESTED AND AFFECTED PARTIES

GNR 543, Section 54(2) prescribes that Interested and Affected Parties must be identified and notified through the following approach:

- By placing notice boards in relevant places;
- By directly notifying all land owners and occupants of affected properties;
- By directly notifying neighbours to affected properties;
- By directly notifying ward councillors, rate payers associations, municipality and any relevant organ of state;
- By advertisement in local newspaper; and
- Any other method found reasonable for reaching affected parties which may not be reached with the above mentioned methods.

In return the registered Interested and Affected Party is expected to:

- Submit all comments in writing to the consultant;
- Adhere to time frames given for commenting or submit a written motivation for why a longer commenting period is needed; and
- Disclose any direct business, financial, personal or other interest in the approval or refusal of the development.

APPLICATION OF THE REGULATORY PROCESS

Identification of Interested and Affected Parties

The relevant Interested and Affected Parties were identified and notified about the proposed developments through three distinct methods:

- Authority identification and contact.
- Direct contact of land owners and other potential Interested and Affected Parties.
- Notices and media advertising.

Authority identification and contact

Various authorities having jurisdiction were included in the EIA process and were provided with the necessary information regarding the proposed developments. Additionally, the following authorities were consulted with and requested for the provision of comment on any issues or concerns regarding the proposed developments:

- Bushbuck Ridge Local Municipality
- Mpumalanga Tourism and Parks Agency;
- Kruger National Park;
- The Department of Water and Sanitation
- The Inkomati Usuthu Catchment Management Agency.
- Klaserie Private Nature Reserve Management

As the development is in a reserve which belongs to a network of reserves bordering the Kruger National Park (KNP); the MTPA and KNP were informed about the proposed developments. Jurisdiction of the Klaserie Private Nature Reserve lies within the Bushbuck Ridge Local Municipality and as a result, the local municipality was informed about the proposed developments. As the development is in the vicinity of a water course, the Department of Water and Sanitation and the Inkomati Usuthu Catchment Management Agency was also informed of the proposed development.

Direct contact of land owners and other potential Interested and Affected Parties

All neighbouring landowners, along with the Klaserie Private Nature Reserve Management and other potential Interested and Affected Parties which surround the Klaserie Private Nature Reserve were contacted directly and notified about the proposed development at the Hull river crossing.

Notices and media advertising

An advert was placed in the advertising section of the local newspaper, the *Lowvelder*, providing information about the proposed developments on Friday 4th July. A site notice was also erected at Inchene Gate on the 31st of July 2014. A copy of both the newspaper advertisement and the notice at Inchene Gate is provided in Appendix 2 along with a complete list of all registered Interested and Affected Parties.

All comments and issues which have been raised by any Interested and Affected Parties pertaining to the proposed developments have been recorded as a means of identifying all key environmental issues (including project alternatives) regarding the proposed development.

SUMMARY OF COMMENTS AND RESPONSES

Up to draft phase the following responses have been received:

Two landowners had no objection. Another neighbour offered an additional alternative, which has been included as alternative 3 in the assessment process.

Water affairs responded indicating a water use licence would be required.

Copies of responses are contained in Appendix 2.

6 NEED AND DESIRABILITY

With consideration to the current rhino poaching crisis it is important that reserve management and security personnel have the ability to respond rapidly and effectively to any situation. The new causeway will provide improved access to various areas of the reserve for the ranger staff located in the camp in the immediate area. In addition, the ease of access to the main reserve access road is important for rapid deployment of the anti-poaching rangers and security teams. The access causeway should therefore be constructed close to the ranger picket to enable an efficient response.

The crossing utilised by the landowners was destroyed in the 2012 floods. This crossing was close to two camps on the property and also was located in the middle of the property. Accessing these camps from the east side of the property without a river crossing requires a considerable round trip. Replacing teh causeway would benefit both management ability and enjoyment of the private protected area. The desire is to have a sustainable, low impact causeway. The exact location of the past causeway is considered, but initial engineering assessments indicated it would not be the preferred option. The preferred option is thus located where there is reasonable rock to support the crossing.

7 ALTERNATIVE ACTIVITY AND SITES

The need to replace the access causeway which was washed away during the 2012 floods has resulted in the identification and reviewing of various alternative sites along the Klaserie River. These alternatives have been identified and considered based on their potential impact on the receiving environment, their suitability in an engineering context as well as their ease of accessibility based on existing roads which lead to a site or the presence of roads which can be extended to provide an accessible route to the causeway.

ALTERNATIVE 1

The site for alternative 1 is located approximately 180m downstream from the preferred site at an east-bending section of the river. This site was considered as an alternative as the riffle along the left bank provides a potential solid anchoring surface upon which the causeway can be constructed. As mentioned in section 3, there is a well-defined gravel road which runs parallel to the river approximately 70m to the west of the left bank while there is no road present immediately to the east of the right bank.

The engineering report (Appendix 4) illustrates the need to determine a balance between aesthetics, rock excavation and cost of the causeway. Development of the proposed activity at alternative site 1 would result in a causeway structure that would occur high above the low flow channel and would not blend in with the surrounding environment. The causeway would be relatively level with the right (eastern) bank sand beds and would be high above any sound foundation. This would render it vulnerable to being washed away with sand bank scouring and re-deposition under high flood.

ALTERNATIVE 2

The site for alternative 2 is that of the previously existing access causeway and is located approximately 370m downstream from the preferred site. Following the destruction of the previously existing access causeway, the initial plan was to reinstate this causeway at the same site. Upon further investigation this was considered an unviable option as it was apparent that the western bank was heavily eroded which would make it difficult to secure the causeway and ultimately put it at risk of being washed away in future flooding events. Furthermore, the lack of rock beneath the surface poses challenges in an engineering context as piling would need to take place in order to effectively anchor the causeway.

ALTERNATIVE 3

The development site for alternative 3 is located approximately 2.41km downstream from the preferred site at the present crossing, as described in section 3 of this report. Alternative 3 was received as part of the public participation process and was recommended by neighbouring landowners. The site is characterised by a massive exposed sheet rock occurring from bank to bank, making it a viable alternative for competent anchorage of the causeway.

Although construction would be easy on this site, the impact on river flow would be considerable. This impact can be mitigated by limiting the roadway to a concrete skim which is thick enough to accommodate anchor bars and reinforcement, with all flow going over the roadway. A small diameter low flow culvert would need to be provided. The approach roads would require moderate armouring against flood damage. Another important aspect to consider is that the site is located at the extremity of the property which could pose issues when rapid managerial intervention and security response is required.

8 POTENTIAL ENVIRONMENTAL IMPACTS

The proposed development could potentially have an impact on, or be impacted by, various components of the physical environment. Potential environmental impacts that should be considered when planning, designing and constructing the access causeway are discussed below.

Flooding could cause damage to infrastructure:

The ever-changing global climate has seen an increase in extreme local weather conditions in recent years, and there is a strong possibility of an increase in the regularity and intensity of flooding events in the future. Flooding has generally been infrequent in the past; however there have been flooding events over the past three years which have resulted in extremely high river flows.

The proposed access causeway will be at risk of being impacted on by potential future flooding events. The design and placement of the causeway must ensure that it is not impacted on by future flooding events.

Habitat loss as a result of the development footprint:
The footprint of any development has an impact on the natural landscape which it occupies as it reduces the area of the natural habitat available for dynamic ecosystem functioning.

The causeway will be designed in a way which serves to reduce its development footprint and ensure a limited impact on the surrounding environment through the use of strategic environmentally friendly engineering techniques.

Lack of rehabilitation leading to loss of soil and alien plant establishment:
The absence or lack of sufficient management practises associated with the rehabilitation of areas following construction activities can lead to accelerated soil erosion as well as promote the successful establishment of alien plant species. These occurrences can have dramatic impacts and may hinder or even terminate vital ecological processes which are responsible for maintaining ecosystem health and integrity. Such effects must be avoided through enforcement of the appropriate soil management practises during the construction process, as well as implementation of the comprehensive KPNR management plan in order to avoid any potential impacts subsequent to the construction process.

Other possible impacts of the construction process and buildings on the receiving environment
The proposed development could potentially impact on the following components of the physical environment:

Soils
Soil erosion, loss of topsoil and deterioration of soil quality are the main potential impacts that could occur during the construction process. Once disturbed, soil becomes more susceptible to erosion. The resultant infrastructure may cause changes to natural drainage patterns and the diversion of storm-water may result in large volumes of water being concentrated in certain areas, thereby increasing the risk of erosion. Erosion of the soil surface greatly increases the risk of losing topsoil which impairs the soils ability to support vegetation growth. It may also provide sites for the establishment of alien plants.

During construction, hydrocarbons leaking from construction vehicles, refuelling depots and concrete mixing areas may result in the contamination of soils.

The sourcing of sand and gravel for the construction of the building may result in erosion and degradation of the soil. Sand and stone brought onto site may carry with it alien plants and other biota.

Surface and ground water

The risk of contamination of ground and surface water may increase during the construction process.

Elevation of sediment loads due to eroded soil particles which enter watercourses may affect the degree of sun penetration, water temperature and levels of oxygen available to aquatic species.

Temporary ablution facilities for the construction crew have the potential to impact on surface water in the form of chemicals, pathogens and nutrients.

Contamination of surface water with cement or concrete can be detrimental to aquatic organisms as it increases the alkalinity of the water.

Hydrocarbon spills from construction vehicles may have a detrimental impact on surface water.

Flora

Natural vegetation can be impacted by construction activities such as stock piling of materials and clearing of the development footprint. Flora may also be impacted on by increased access to a site, leading to harvest or disturbance of certain plants.

Fauna

Increased traffic and disturbance to a site during the construction process may have an impact on the wildlife occurring in an area as the presence of humans and noise may disturb animals, resulting in the animals dispersing from the area.

Fauna can also be directly impacted through the accidental or intentional killing of animals during the construction process.

Any flora which is impacted on during the construction process is likely to have an impact on various animals which rely on such vegetation for refuge or food.

Cultural – historical / socio – economic impacts

Construction activities may disturb archaeological or cultural artefacts, if any such are present. This is dealt with in the Environmental Management Programme.

Possible impacts of the development to the aesthetic nature of the area

Noise pollution

Activities carried out during the construction process can generate a large amount of noise pollution. The main sources of noise pollution are produced by construction vehicles and machinery, as well as the construction team carrying out the construction activities. Noise pollution can increase the stress levels of animals in the vicinity and may also detract from the experience of guests at nearby facilities.

Light pollution

No construction will be permitted outside of daylight hours.

Dust pollution

A large amount of dust may be produced during the construction process, especially if the construction process takes place predominantly during the dry season. The greatest occurrence of dust production will be primarily around the construction site.

Dust generated during the construction process will be limited to vehicle generated dust on the roads. This should be limited as most travels will be at a slow pace or on foot.

Visual impact

The visual aesthetics of a structure contribute largely to the 'sense of place' impression which is radiated to any person. It is important to provide guests and other persons with this 'sense of place' feeling, especially in an eco-tourism or game reserve context. Care should be taken throughout the planning and construction process whereby aesthetics should be considered as an important focus point of the development. Limiting the visual impact of a development requires considerations to be taken during site selection of the development right through to the level of designing the causeway. The sustainable utilisation of natural resources and cover will allow the causeway to blend in with its natural surroundings and reduce its visual impact.

Utilisation of resources

Water utilisation

Sustainable water utilisation should be practised by construction personnel during the construction process.

Sand utilisation

Sustainable sand collection from site for the development only may be undertaken by construction personnel during the construction process.

9 THE NATIONAL ENVIRONMENTAL MANAGEMENT PRINCIPLES

The primary objective of an environmental impact assessment is to determine the possible effects, both positive and negative, which any developmental activities may have on the receiving environment, and vice versa. An assessment of this sort also takes the relevant legislative framework into consideration and ensures that the proposed developmental activities are undertaken with the necessary authorisation as per in the National Environmental

Management Act. Additionally, ascertaining that the proposed developmental activities proceeds in adherence to the National Environmental Management Principles is important and compliments the entire decision-making process, where decisions will be made to optimise sustainability of the development at all levels and ultimately promote and maximise benefits on an economic, social and ecological scale.

Table 1 provides a checklist for the adherence of the proposed developmental activities to the National Environmental Management Principles.

Table 1: Checklist for adherence of the proposed developmental activities to the National Environmental Management Principles

Principle	Specification	√ / X	Notes
2. (1)	The principles set out in this section apply throughout the Republic to the actions of all organs of state that may significantly affect the environment and—		
(a)	shall apply alongside all other appropriate and relevant considerations, including the State's responsibility to respect, protect, promote and fulfil the 35 social and economic rights in Chapter 2 of the Constitution and in particular the basic needs of categories of persons disadvantaged by unfair discrimination;	√	In the process of determining the potential environmental, social and economic impacts that the proposed development may potentially have, the NEMA legislation was considered alongside other relevant legislation (see section 4) which addresses these issues.
(b)	serve as the general framework within which environmental management and implementation plans must be formulated;	√	The proposed developments have been planned to proceed in accordance with certain facets of the current KPNR Management Plan and will ensure the proposed developments are sustainable and environmentally-friendly (see Appendix 5).
(c)	serve as guidelines by reference to which any organ of state must exercise any function when taking any decision in terms of this Act or any statutory provision concerning the protection of the environment;	√	Information in this report has been provided to the consultant by the applicant and obtained from other reputable and approved sources and serves to aid in the decision-making process of the competent authority when considering the potential authorisation of the proposed developments.
(d)	serve as principles by reference to which a conciliator appointed under this Act must make recommendations; and	√	This Basic Assessment Report aims to provide the conciliator with all the necessary information regarding the proposed development, upon which balanced and informed decisions and recommendations can be made in association with any issues concerning environmental aspects as well as issues raised by interested and affected parties.
(e)	guide the interpretation, administration and implementation of this Act, and any other law concerned with the protection or management of the environment.	√	
(2)	Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably.	√	All interested and affected parties associated with the proposed development were contacted and provided with the opportunity to raise any issues and voice any concerns regarding the developmental activities. This report considers and addresses all identified environmental factors and social interests which may be of concern regarding the proposed developments. See section 5 and Appendix 2.
(3)	Development must be socially, environmentally and economically sustainable.	√	The preferred option of the developmental activities was carefully selected from a range of possible alternatives (see section 7) with the primary objective of addressing environmental, social and economic issues and achieving a balanced resolution for such issues (see section 10), ultimately promoting improved sustainability.
(4) *(a)*	Sustainable development requires the consideration of all relevant factors including the following:		
(i)	That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;	√	The preferred actions and developmental activities discussed in this report have been carefully assessed and selected based on their reduced impact on

			the receiving environment.
(ii)	that pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied;	√	The implementation of the management plan during the construction process will ensure that the risk of pollution and degradation of the environment will be minimised or avoided. The construction process will proceed in accordance with the recommendations provided in the KPNR Management Plan (see Appendix 5).
(iii)	that the disturbance of landscapes and sites that constitute the nation's cultural heritage is avoided, or where it cannot be altogether avoided, is minimised and remedied;	√	As the preferred site is currently undeveloped and in a natural state it will be difficult to fully avoid disturbance of the landscape. Such disturbance can however be minimised through implementation of the recommended mitigation measures (see section 10) along with the KPNR Management Plan (Appendix 5).
(iv)	that waste is avoided, or where it cannot be altogether avoided, minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner;	√	Any waste produced by the developmental activities will be managed and addressed in accordance with the Waste Act and the KPNR Management Plan (see Appendix 5).
(v)	that the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;	√	It will be ensured that all non-renewable resources; such as fuel, electricity and water, will be utilised during the construction process in a sustainable manner.
(vi)	that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised;	√	The utilisation and exploitation of renewable resources will proceed in a sustainable and environmentally-friendly manner. No natural resources from threatened and endangered environments will be exploited i.e. no protected trees will be harvested or impacted on during the construction process unless the appropriate licensing has been acquired.
(vii)	that a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions; and	√	The various options for the proposed developments have been carefully reviewed through the Environmental Impact Assessment process to determine all potential environmental risks associated with the development. The most viable options were selected to ensure the reduction of the impact and increased sustainability of the development.
(viii)	that negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied.	√	All potential impacts have been considered (see sections 8 and 12), the rights of interested and affected parties have been considered and any concerns and issues raised by interested and affected parties have been addressed (see Appendix 2), and the appropriate mitigation measures for any potential issues and impacts have been recommended (see section 10).
(b)	Environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must take into account the effects of decisions on all aspects of the environment and all people in the environment by pursuing the selection of the best practicable environmental option.	√	Each of the proposed developmental activities has been considered by ecological and environmental specialists with an understanding of the dynamics of ecosystem patterns and processes and recognizes the importance of ecosystem integrity and functionality.
(c)	Environmental justice must be pursued so that adverse environmental impacts shall not be distributed in such a manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons.	√	This has been achieved through the public participation process being open and balanced. Furthermore, the practicality and sustainability of any decisions made have been considered and assessed for potential impacts that they may

			have, both directly and indirectly, on interested and affected parties in the future.
(d)	Equitable access to environmental resources, benefits and services to meet basic human needs and ensure human well-being must be pursued and special measures may be taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination.	√	Due to the locality and scale of the proposed activities, it is regarded to be of low impact and has no potential to negatively impact surrounding communities.
(e)	Responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle.	√	Ensuring that the construction process proceeds under the approved management plan will ensure that this principle is achieved.
(f)	The participation of all interested and affected parties in environmental governance must be promoted, and all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation, and participation by vulnerable and disadvantaged persons must be ensured.	√	All neighbouring landowners and other interested and affected parties have been identified and contacted and the proposed activities have been advertised accordingly (see section 5 and Appendix 2). As independent consultants, we are receptive to any comments regarding issues of concern to interested and affected parties until the final report is issued (a period of approximately 4 months).
(g)	Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional and ordinary knowledge.	√	All comments have been noted and any issues and concerns raised by interested and affected parties have been considered and addressed (Appendix 2).
(h)	Community wellbeing and empowerment must be promoted through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means.	√	Due to the localised footprint and small scale of the project, it is difficult to satisfy this principle in the broader sense; however, construction personnel will be provided with environmental guidelines to follow during the construction process. The construction process will also proceed under the guidance and recommendations of an environmental control officer in order to ensure that any activities are correctly undertaken with minimal impact.
(i)	The social, economic and environmental impacts of activities, including disadvantages and benefits, must be considered, assessed and evaluated, and decisions must be appropriate in the light of such consideration and assessment.	√	All provided in this report.
(j)	The right of workers to refuse work that is harmful to human health or the environment and to be informed of dangers must be respected and protected.	√	The rights of workers and others are not infringed in any way through this assessment.
(k)	Decisions must be taken in an open and transparent manner, and access to information must be provided in accordance with the law.	√	This report attempts to provide all the relevant information in order to achieve transparent and open decision-making.
(l)	There must be intergovernmental co-ordination and harmonisation of policies, legislation and actions relating to the environment.		n/a
(m)	Actual or potential conflicts of interest between organs of state should be resolved through conflict resolution procedures.		n/a
(n)	Global and international responsibilities relating to the environment must be discharged in the national interest.		n/a
(o)	The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage.	√	The causeway will provide reserve management and security personnel with important access to various areas of the reserve, allowing them to intervene during relevant time of crises. The increased opportunity for management to intervene at the appropriate times and the increase in vigilance throughout the reserve will ensure both protection of the environment and service of the public

			interest (i.e. all interested and affected parties). Furthermore, the causeway is to be constructed in a sustainable manner whereby environmentally-friendly techniques will ensure a reduced impact footprint with extended longevity and low maintenance requirements.
(p)	The costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.	√	This has been accepted and guides the mitigation measures to a large extent (see section 10).
(q)	The vital role of women and youth in environmental management and development must be recognised and their full participation therein must be promoted.		The employment of women and youth in the construction of the causeway will be encouraged.
(r)	Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.	√	The proximity of the proposed development to the river system is the trigger for this assessment and all potential impacts of the development on and within the riparian zone have been considered.

10 POSSIBLE AND RECOMMENDED MITIGATION MEASURES

Mitigation means 'to reduce the severity of something'. This may be by implementation of practical measures to reduce, limit or eliminate adverse impacts or enhance project benefits and protect public and individual rights.

The potential environmental concerns for the proposed development have been considered (section 8) and investigated. Where appropriate, mitigation measures have been proposed. In many cases, the existing procedures are sound environmental impact prevention measures themselves, and little or no additional mitigation is necessary in many aspects.

The mitigation measures provided below cut across various potential impacts and should be considered as a suite of mitigation measures that may be implemented, especially during construction.

The following mitigation measures and procedures are recommended:

- Minimise the area of vegetation clearance and avoid exposing soils that are vulnerable to erosion.
- Areas susceptible to erosion must be protected by installing appropriate temporary or permanent drainage works and storm water energy dispersion structures.
- When excavating trenches or holes, top soil and sub soils should be kept separate in order to facilitate the soils being replaced in the right order following construction. Topsoil, the upper 5-10cm of soil, often contains the appropriate quantities of humus and plant seeds to assist with rapid and efficient rehabilitation of the trench.
- Rehabilitation of denuded areas once the construction is completed. The purchase of new topsoil or compost and seeds can be very costly, an expense which can be avoided by conserving and replacing topsoil. Importing topsoil is not the most viable option as it increases the risk of importing alien invasive plants.
- All materials to be trenched must be on site prior to excavating the trench in order to minimise the time period that the trench is open, thus reducing the risk of animals injuring themselves.
- Disturbed soil and vegetation provides ideal conditions for the establishment of pioneer plant species. Many alien invasive plants are considered to be pioneer plants and can rapidly colonise and establish themselves in disturbed areas. For this reason, sound and rapid rehabilitation is necessary in order to avoid the ecological impacts caused by alien plant species. Rehabilitation must be promoted and any alien plants must be physically removed or eradicated.
- Implement appropriate topsoil management practices (stripping, stockpiling and reuse during rehabilitation of disturbed areas).
- All materials for building must be sourced off site from sustainable and appropriately licensed sources (sand, stone etc.) and must be free from contaminants. Sand may be sourced from the build site.

- Areas which have been disturbed during the construction process, including spoil dumps and stockpile areas, should be rehabilitated as soon as possible after the disturbance has ceased.
- Ensure compliance with legislation such as the Conservation of Agricultural Resources Act, Hazardous Substances Act, and the Integrated Pollution and Waste Management Act.
- Ensure the appropriate handling of hazardous substances. Any hazardous substance must be stored in bunded containers in a locked area.
- Polluted soils should be remediated. This can be done *in situ* with an appropriate hydrocarbon-destroying microbe solution.
- Ensure correct waste management. Waste sorting and recycling should be carried out where possible.
- Waste management must be undertaken such that human-wildlife conflict will be avoided.
- Ensure that the placing of concrete batching plants and vehicle servicing areas etc. are such that they avoid areas susceptible to soil and water pollution, particularly drainage lines.
- It should be kept in mind that archaeological deposits often occur below the soil surface. Should artefacts or skeletal remains be discovered during the construction of the building, the project proponent must be notified in order for an investigation and evaluation of the find(s) by a qualified archaeologist or a specialist in the related field to take place according to the National Heritage Resources Act (Act 25, 1999).
- Working hours should be kept to normal working hours from 6am to 5pm or as per the reserve regulations.
- Suitable site toilet facilities should be installed. The connection to existing services or the use of evaporative or eco-loos is suggested rather than chemical toilets.
- Keep the building site orderly at all times and use screening, especially for unsightly areas such as temporary ablution facilities and storage areas.
- If dust becomes problematic, roadways should be dampened. Following construction, these areas should be vegetated.
- Water use must be continually monitored and all water must be clean.
- Water saving measures must be implemented wherever practical.

11 SUSTAINABILITY CONSIDERATIONS

Consideration and effort is being applied to sustainability measures in the design of the access causeway. These include the implementation of ‘green’ building techniques, reducing the environmental footprint, minimising disturbance and applying techniques which ensure the aesthetics of the development compliments the surroundings and location as far as possible. Furthermore, development of the access causeway has been planned with a focus primarily aimed at sustainability and the importance of maintaining ecological integrity so as not to disrupt the functioning of ecosystem patterns and processes.

Sustainability will be aided through the implementation of the construction EMP (Appendix 5) as well as the approved Klaserie Watercourse maintenance EMP which will direct the continued management and maintenance of the causeway.

12 ENVIRONMENTAL IMPACT EVALUATION

An 'environmental impact' considers the environmental consequences, whether positive or negative, that a proposed development is likely to have on the receiving environment. The significance of an environmental impact depends on its extent, intensity and duration, sensitivity of the receiving environment, the degree of change, and the probability that the proposed development will impact the receiving environment.

METHOD AND CRITERIA

Based on responses to issues identified for the proposed site, and adopting the precautionary principle in cases of uncertainty, potential impacts associated with each issue were subjectively classified according to the direction of impact viz. positive, negative or neutral. Negative impacts need to be addressed by management intervention, whereas positive and neutral impacts are considered to be accounted for.

Tables 2, 3, 4 and 5 identify the potential impacts which may be imposed on the receiving environment during the construction process of the access causeway. The potential impacts are described and assessed for significance. Significance is assessed by scoring each impact on the basis of four variables: its frequency, severity, duration and its spatial implications. The significance of the impact caused at each alternative site provides a framework for comparison whereby the most viable and environmentally-friendly option can be selected.

On the understanding that a significant impact is one which, either in isolation or in combination with other impacts, could have a material influence on the decision making process, including the specification of mitigating measures; significance in this study is scaled according to impact scores as follows:

Low (scoring less than 10)
Medium (scoring 10 – 15)
High (scoring more than 15)

The four variables with their score criteria are detailed below:

Frequency / Probability (FR)

The frequency or likelihood of activities having an impact on the environment:
1. Almost never / almost impossible.
2. Very seldom / highly unlikely.
3. Infrequent / unlikely / seldom.
4. Often / regularly / likely / possible.

5. Daily / highly likely / definitely.

Severity (SV)

The degree of change to the baseline environment in terms of reversibility of impact; sensitivity of receptor; duration of impact; controversy potential and precedent setting; threat to environmental and health standards:
1. Insignificant / non-harmful.
2. Small / potentially harmful.
3. Significant / slightly harmful.
4. Great / harmful.
5. Disastrous / extremely harmful.

Duration (DR)

The length of time over which activities will cause a change on the environment or vegetation:
1. One day to one month.
2. One month to one year.
3. One year to ten years.
4. Life of operation.
5. Post closure.

Spatial scope (SS)

The geographical coverage:
1. Activity specific.
2. Area specific.
3. Whole site.
4. Regional (neighbouring areas).
5. National.

The score is calculated for each aspect as the sum of the mitigated impacts to provide an impact value. Impact scores from the aquatic assessment were adapted and included. Additionally, the road length to connect existing roads and crossing length (m) are given as scores. These scores are summed together to provide a total score, where a lower impact score illustrates a reduced impact of development at the site.

The scores provided by the engineering report are the opposite, where the higher the score, the more sustainable and practical it is for development of the causeway at the respective sites.

ASSESSMENT OF POTENTIAL IMPACTS

The results of the impact assessment are summarised in the tables below. Although the proposed activities are similar in terms of the potential environmental impacts, they are grouped and assessed based on their locality so as to consider various aspects of potential impacts.

Preferred Site

Table 2: *Assessment of the potential impacts for development at the preferred site*

ISSUE	FREQUENCY		SEVERITY		DR	SS	IMPACT	SIGNIFICANCE
	Unmitigated	Mitigated	Unmitigated	Mitigated				
CONSTRUCTION OF CAUSEWAY AT PREFERRED SITE								
Loss of sense of place	3	2	2	1	2	2	7	Low
Loss of habitat	3	2	2	1	2	2	7	Low
Cumulative impact	2	1	2	1	2	2	6	Low
Loss of ecosystem services	3	2	3	1	2	2	7	Low
Visual impact	4	3	2	1	4	2	10	Medium
Impact on physical attributes and morphological units	4	3	2	1	4	1	9	Low
Impact on riparian vegetation	4	3	3	2	3	1	9	Low
Impact on macro-invertebrate assemblage and diversity	4	3	2	1	2	1	7	Low
Impact on fish assemblage and diversity	4	3	2	1	3	2	9	Low
Total							**71**	
Crossing length (m)*							9.0	
Road length to connect existing roads (m)							13.0	
Conservation impact: distance from field ranger camp **							38.0	
Total							**60**	
Engineering sustainability							**102**	

* Crossing length is an approximate value determined by a desktop analysis using Google Earth 2014, whereby the distance (m) is taken from the top of the west bank to the top of the east bank.

** Part of the motivation to re-establish the crossing is for conservation management, particularly anti-poaching. Distance from this is camp therefore included.

Conclusions:

The assessment results from Table 2 reveal an environmental total impact score of 71. This is considerably low and only one criteria is considered medium impact after mitigation. In terms of the engineering sustainability of the preferred site, it receives a total score of 102, the highest of the options considered by a reasonable margin.

Alternative 1

Table 3: *Assessment of the potential impacts for development at the site for Alternative 1*

ISSUE	FREQUENCY		SEVERITY		DR	SS	IMPACT	SIGNIFICANCE
	Unmitigated	Mitigated	Unmitigated	Mitigated				
CONSTRUCTION OF CAUSEWAY AT ALTERNATIVE 1								
Loss of sense of place	3	2	2	1	2	2	7	Low
Loss of habitat	3	2	2	1	2	2	7	Low
Cumulative impact	2	1	2	1	2	2	6	Low
Loss of ecosystem services	3	2	3	1	2	2	7	Low
Visual impact	4	3	2	1	4	2	10	Medium
Impact on physical attributes and morphological units	4	3	3	2	4	1	10	Medium
Impact on riparian vegetation	4	3	3	2	3	1	9	Low
Impact on macro-invertebrate assemblage and diversity	4	3	3	2	2	1	8	Low
Impact on fish assemblage and diversity	4	3	3	2	3	2	10	Medium
Total							**74**	
Crossing length (m)							8.1	
Road length to connect existing roads (m)							13.4	
Conservation impact: distance from field ranger camp							23.5	
Total							**45**	
Engineering sustainability							**86**	

Conclusions:

The assessment results from Table 3 reveal an environmental total impact score of 74. This is higher than that of the preferred site and three aspects are assessed to have a medium impact. In terms of the engineering sustainability of the site for alternative 1, it receives a total score of 86. This is the worst score and is considerably poorer than that of the preferred site.

Alternative 2

Table 4: *Assessment of the potential impacts for development at the site for Alternative 2*

ISSUE	FREQUENCY		SEVERITY		DR	SS	IMPACT	SIGNIFICANCE
	Unmitigated	Mitigated	Unmitigated	Mitigated				
CONSTRUCTION OF CAUSEWAY AT ALTERNATIVE 2								
Loss of sense of place	3	2	2	1	2	2	7	Low
Loss of habitat	3	2	2	1	2	2	7	Low
Cumulative impact	3	2	2	1	2	2	7	Low
Loss of ecosystem services	3	2	3	1	2	2	7	Low
Visual impact	4	3	2	2	4	2	11	Medium
Impact on physical attributes and morphological units	4	3	2	1	4	1	9	Low
Impact on riparian vegetation	4	3	3	2	3	1	9	Low
Impact on macro-invertebrate assemblage and diversity	4	3	2	1	2	1	7	Low
Impact on fish assemblage and diversity	4	3	2	1	3	2	9	Low
Total							**73**	
Crossing length (m)							9.2	
Road length to connect existing roads (m)							0	
Conservation impact: distance from field ranger camp							6.0	
Total							**15.2**	
Engineering sustainability							**88**	

Conclusions:

The assessment results from Table 4 reveal an environmental total impact score of 73. This impact score is slightly higher than the preferred site and is the next best from an environmental perspective. In terms of the engineering sustainability of the site for alternative 2, it receives a total score of 88. This is considerably poorer than that of the preferred site and similar to that of the site for alternative 1.

Alternative 3

Table 5: *Assessment of the potential impacts for development at the site for alternative 3*

ISSUE	FREQUENCY		SEVERITY		DR	SS	IMPACT	SIGNIFICANCE
	Unmitigated	Mitigated	Unmitigated	Mitigated				
CONSTRUCTION OF CAUSEWAY AT ALTERNATIVE 3								
Loss of sense of place	3	2	2	1	2	2	7	Low
Loss of habitat	3	2	2	1	2	2	7	Low
Cumulative impact	2	1	2	1	2	2	7	Low
Loss of ecosystem services	3	2	3	1	2	2	7	Low
Visual impact	4	3	2	1	4	2	10	Medium
Impact on physical attributes and morphological units	4	3	3	2	4	1	10	Medium
Impact on riparian vegetation	4	3	3	2	3	1	9	Low
Impact on macro-invertebrate assemblage and diversity	4	3	3	2	2	1	8	Low
Impact on fish assemblage and diversity	4	3	3	2	3	2	10	Medium
Total							**75**	
Crossing length (m)							8.6	
Road length to connect existing roads (m)							0	
Conservation impact: distance from field ranger camp							160.0	
Total							**168.6**	
Engineering sustainability							**95**	

Conclusions:

The assessment results from Table 5 reveal an environmental total impact score of 75. This impact score is the highest and least desirable from an environmental perspective. In terms of the engineering sustainability of the site for alternative 3, it receives a total score of 95, which is the second best, but still well below the preferred site score.

Table 5: *Summary of the impact scores for all sites*

Site	Eco-enviro score	Distances	Engineering score	Comments and rank
Preferred	71	60	102	1 – Most favourable environmental and engineering.
Alternative 1	74	45	86	3 – Least desirable engineering location and poor environmental location
Alternative 2	73	15.2	88	2 – Second best environmental option and lowest access routing
Alternative 3	75	168.6	95	4 – Least desirable environmental, however reasonable engineering option.

13 ECOLOGICAL CONSIDERATIONS

Construction of the causeway could have an impact on the quality of surface water both at the site and downstream of the preferred site. Such negative impacts can either be prevented or mitigated by utilising appropriate materials for the construction of the causeway. Avoiding negative impacts to surface water can further be achieved by ensuring that the design of the causeway allows for the through-flow of water during the low-flow months of the dry season. An adequate through-flow of water will also provide a channel which relevant migratory fish species can utilise.

No trees of significant ecological importance were found within the riparian zone at the preferred site. There were, however, a number of *Spirostachys africana* recorded in the lower and upper levels of the non-marginal zone along the right bank. These trees are protected under the National Forest Act (Act No. 84 of 1998) and should not be removed or impacted on in any way. Refer to pages 38-41 of the aquatic assessment (Appendix 4) for a comprehensive list of plant species which were recorded at the preferred site.

The practise of sustainability does not only apply to an ecological and environmental context but also to an economic and social context. Development of the causeway at the preferred site should be undertaken so as to optimise the financial feasibility and minimise the environmental footprint of the development.

14 DRAFT ENVIRONMENTAL MANAGEMENT PROGRAM

The Environmental Management Programme (EMP) provided in Appendix 5 is developed from extracts out of the existing KPNR watercourse crossing Management Plan, but is adapted for a new crossing. The EMP must be followed during the construction process so as to ensure that any impacts are minimised and potential effects are mitigated.

15 ASSUMPTIONS AND LIMITATIONS

This Basic Assessment Report has been prepared on the strengths of the information provided by the applicant, from our field surveys, specialist reports and other information provided by the applicant at the time of the assessment. The assessment was conducted as a desktop and field survey and numerous site visits were undertaken. Topographical and ecological maps were utilised. The assumptions made and constraints that were prevalent did not have any significant restrictive or negative implications on the study.

In undertaking this investigation and compiling the Basic Assessment Report, the following has been assumed:

- The information provided by the client is accurate;
- The scope of this investigation is limited to assessing the environmental impacts associated with the construction of the proposed infrastructure.

- Should the project be authorised the applicant will ensure the implementation of any recommendations and mitigation measures outlined in this assessment and adhere to the authorisation provided for the detailed design and construction contract specifications of the proposed project.

16 EAP RECOMMENDATIONS

Based on the information provided by the applicant, site inspections undertaken, and the consultation of specialist reports, it was assessed that the preferred site is the most viable option for the construction of the causeway crossing at Hull. All activities which will occur during the construction process should proceed in accordance with the recommendations provided in this Basic Assessment Report. The management personal at Klaserie Private Nature Reserve should ensure an understanding of the mitigation measures provided in this report for their possible implementation wherever and whenever necessary. Should management have an issue with the implementation of any mitigation measures, it is advised that EMROSS Consulting (Pty) Ltd. be contacted for assistance and specialist advice.

Based on the assessment and information gathered, the EAP recommends that the river crossing is authorised on the preferred site.

PREFERRED ALTERNATIVES

The proposed developmental activity discussed in this report (section 2) is the preferred option for the replacement of the access causeway.

NO-GO ALTERNATIVE

The no-go alternative would be to not proceed with the proposed developmental activities. There is no requirement to recommend the no-go alternative as the proposed developments will fulfil the various needs and requirements which have been identified by the relevant managerial parties concerned. Furthermore, the impacts which have been assessed are considered to be low and any potential impacts may be mitigated.

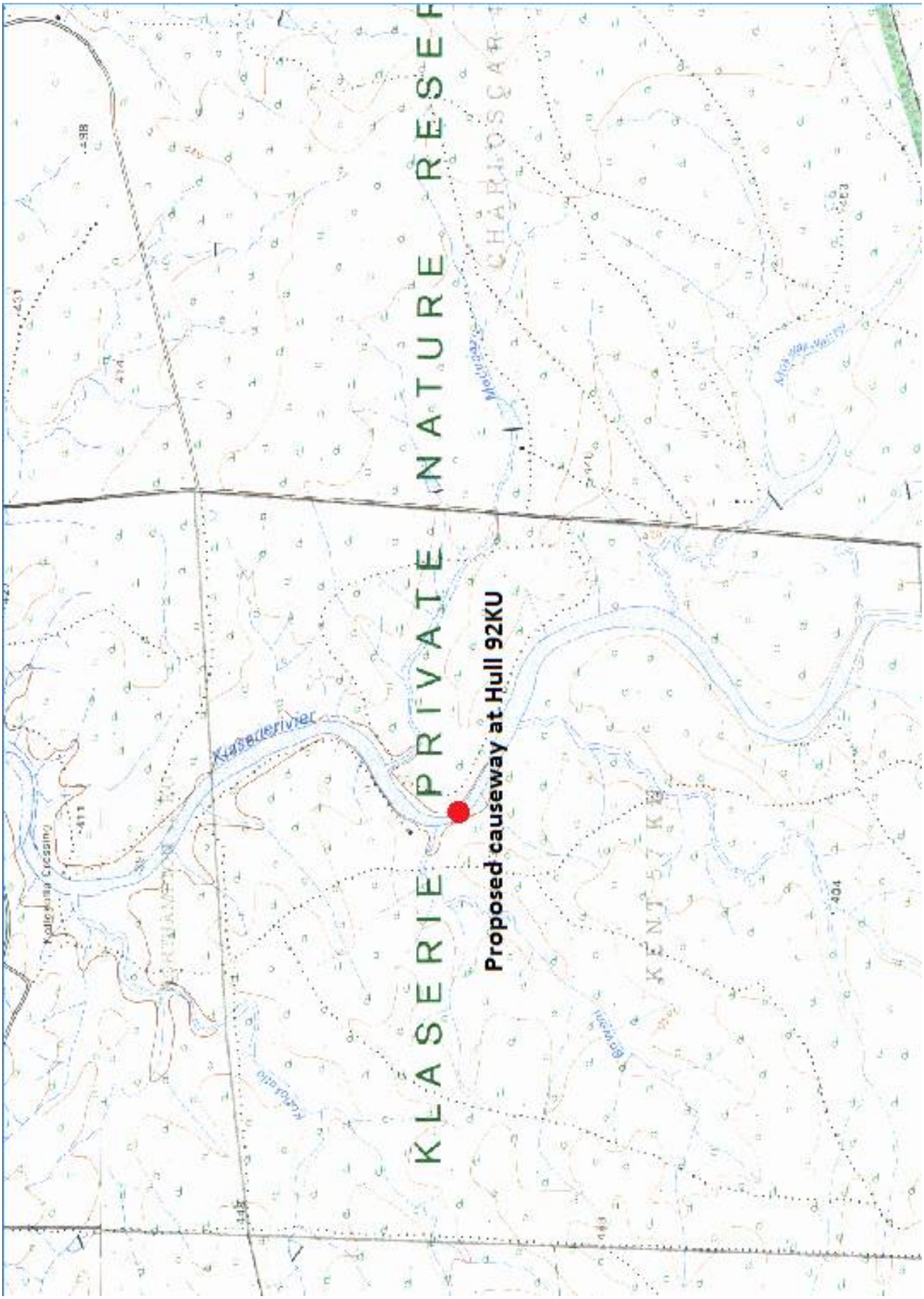
ADDITIONAL MITIGATION MEASURES

The environmental management programme (EMP) should form part of the contract between the construction company and the client. This will help ensure that the EMP is adhered to.

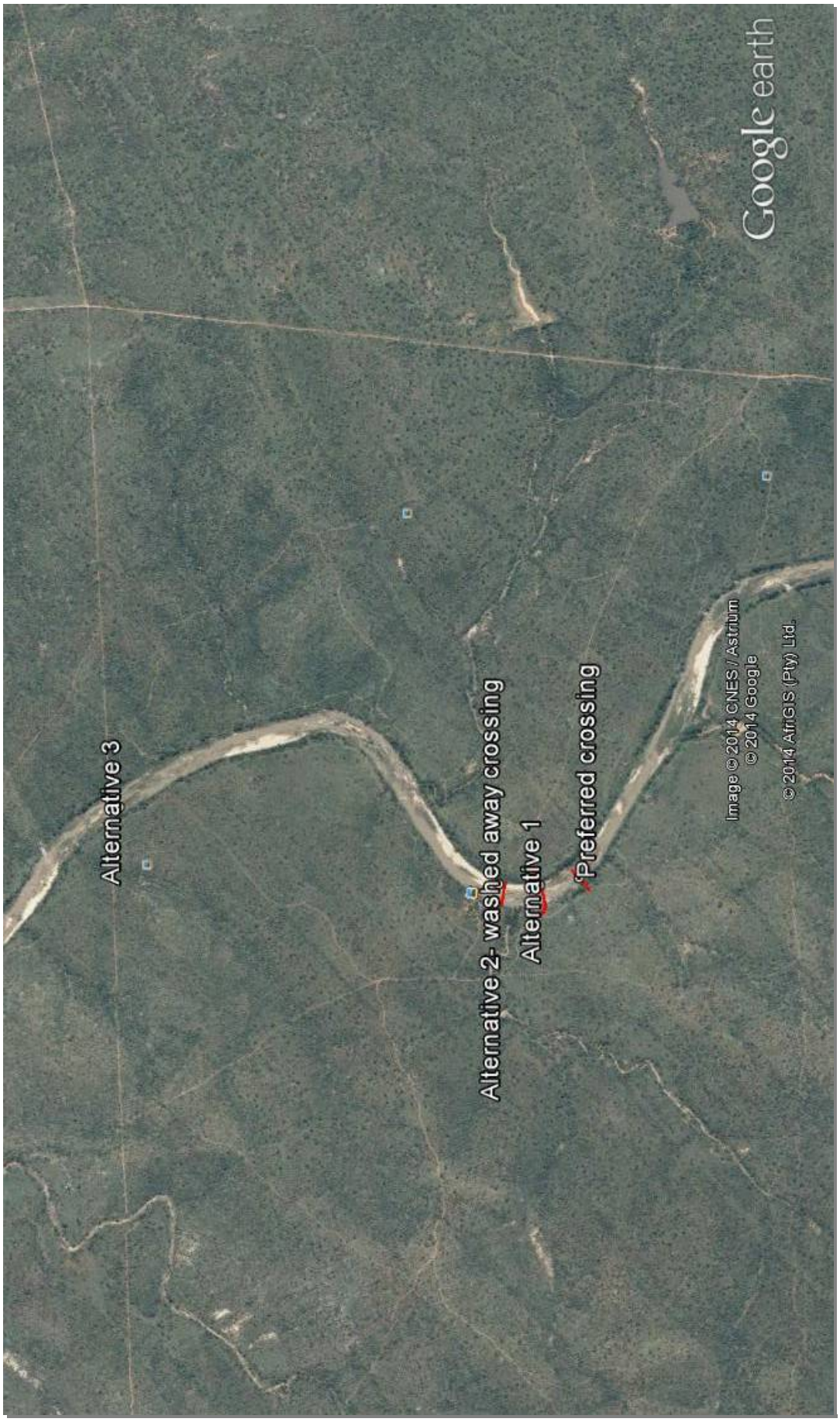
An Independent Environmental Control Officer (ECO) should be appointed to assist and provide the contractor with advice should any unforeseen issues arise during the process of construction. Furthermore, this will serve to provide a level of assurance and oversight to stakeholders that the site is being well managed. The ECO involvement should be limited to a pre-construction contractor induction and a final inspection at hand-over.

17 CONCLUSION

Based on the information supplied in this report, it is the view of the environmental assessment practitioner that the construction of the proposed developments may be undertaken at the preferred sites, given that the Environmental Management Programme and all mitigation measures are adhered to during the construction process.



Topographic map 2431 AC



Source: Google Earth 2014

CORRESPONDENCE WITH INTERESTED AND AFFECTED PARTIES

The various authorities and neighbours were contacted via e-mail on 1 August 2014, with information of the proposed development.

Correspondence is included in the following pages.

Identified Interested and Affected Parties:

Contact person	Title	Connection / interest
David Crookes	Neighbour	Matamani Lodge
John Gillatt	Neighbour	
Bill de Bruin	Neighbour	Charlosca Farms
Eddie Haumann	Neighbour	Cedar Point
Niel Anderson	Neighbour	Hull Beleggings
John Sayers	Neighbour	Copenhagen Prop Trust
Colin Rowles	Manager	Klaserie PNR
Sampie Shabangu	Control Biodiversity Officer	DWS
Thomas Gyedu-Ababio	Chief Operations Officer	Inkomati CMA
Tracy-Lee Ann Petersen	Tracy-Lee Petersen	KNP
Frans Krige	Frans Krige	MTPA
Municipal Manager	Municipal Manager	Bushbuck Ridge LM

The environmental assessment process was advertised in the Lowvelder Local Newspaper on 4 July 2014.

A Site Notice was erected at the Incheni Gate to the Klaserie Private Nature Reserve on 30 July 2014.

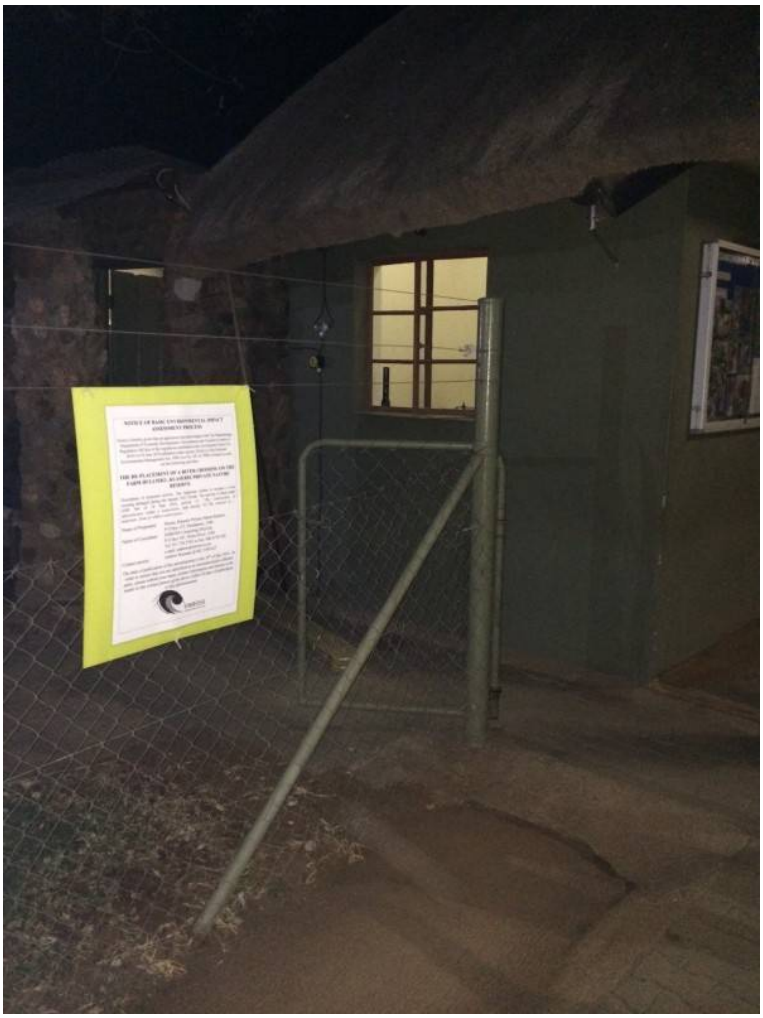
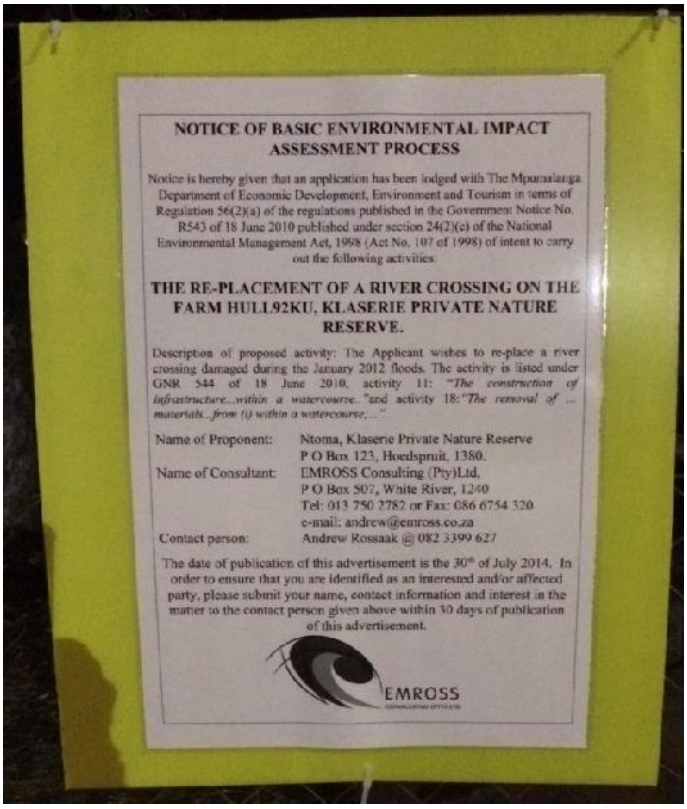


Photo: Site notice at Incheni Gate



NOTICE OF BASIC ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

Notice is hereby given that an application has been lodged with The Mpumalanga Department of Economic Development, Environment and Tourism in terms of Regulation 56(2)(a) of the regulations published in the Government Notice No. R543 of 18 June 2010 published under section 24(2)(c) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) of intent to carry out the following activities.

THE RE-PLACEMENT OF A RIVER CROSSING ON THE FARM HULL92KU, KLASERIE PRIVATE NATURE RESERVE.

Description of proposed activity: The Applicant wishes to re-place a river crossing damaged during the January 2012 floods. The activity is listed under GNR 544 of 18 June 2010, activity 11: *"The construction of infrastructure...within a watercourse.."*and activity 18:*"The removal of ... materials...from (i) within a watercourse;..."*

Name of Proponent: Ntoma, Klaserie Private Nature Reserve
P O Box 123, Hoedspruit, 1380.
Name of Consultant: EMROSS Consulting (Pty)Ltd.
P O Box 507, White River, 1240
Tel: 013 750 2782 or Fax: 086 6754 320
e-mail: andrew@emross.co.za
Contact person: Andrew Rossaak @ 082 3399 627

The date of publication of this advertisement is the 30th of July 2014. In order to ensure that you are identified as an interested and/or affected party, please submit your name, contact information and interest in the matter to the contact person given above within 30 days of publication of this advertisement.

EMROSS

Classifieds

NOTICE OF BASIC ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

Notice is hereby given that an application has been lodged with The Mpumalanga Department of Economic Development, Environment and Tourism in terms of Regulation 56(2)(a) of the regulations published in the Government Notice No. R543 of 18 June 2010 published under section 24(2)(c) of the National Environmental Management Act, 1998 (Act 107 of 1998) of intent to carry out the following activity:
THE CONSTRUCTION OF A WATERCOURSE CROSSING ON THE FARM HULL IN THE KLASERIE PRIVATE GAME RESERVE
MDEDET Ref. No. 17/2/3/E-287

Description of proposed activity: The proponent wishes to construct a new water course crossing to replace a crossing destroyed in the 2012 floods. This activity is listed under GNR 544 of 18 June 2010, activity 11 and 18, as requiring the undertaking of a basic assessment. The site I located on remainder portion of the farm Hull, in the Klaserie Private Nature reserve, Bushbuckridge Local Municipality, Mpumalanga Province.

Name of Proponent: Jessica Bridget Slack
PO Box 123, Hoedspruit, 1380
Name of Consultant: Emross Consulting (Pty) Ltd
PO Box 507, White River, 1240
Tel: 013-750-2782 or
E-mail: andrew@emross.co.za
Contact person: Andrew Rossaak @ 082-339-9627

The date of publication of this advertisement is Friday the 4th of July 2014. In order to ensure that you are identified as an interested and/or affected party, if you so wish, please submit your name, contact information and interest in the above mentioned project to the contact person given above within 30 days of publication of this advertisement.

AC6426

AUCTION! / VEILING!

C&C Rademeyer Auctioneers

5 July 2014 9:00am

- **VEHICLES:** MB 1113; Ford Explorer; MB 1114 tipper 6m² (1991); VW Beetle (with R7000.00 sound system); Boat trailer; Alfa Romeo (spares)

- **REPOSSESSED and NEW FURNITURE:** Lounge suites; base sets; kitchen schemes; surround sound systems and hifi's; flat screen TV's; robes; fridges; deep freezers; bedroom suites; Sleeper-wood table

Invitation to an information sharing session

Invitation to an information sharing session for civil works for Eskom substations

Eskom Holdings SOC Limited invites you to attend an information sharing session for the potential formation of provincial contractor panels for the execution of substation civil works at Eskom Transmission and Power Delivery Project sites.

The information sharing sessions will be held as follows:

Province	*Venue*	*Information sharing date*	*E-mail enquiries to:*
Free State	**Ilanga Estate** Lucas Steyn Street Plot 9, Heuwelsig	July 11, 2014	pdp11com@eskom.co.za
Western Cape	**University of The Western Cape** Robert Sobukwe Road, Bellville	July 11, 2014	pdp18com@eskom.co.za
KwaZulu-Natal	**Sinodale Centre** 345 Burger Street, Pietermaritzburg	July 14, 2014	pdp13com@eskom.co.za
Gauteng	**Franklin Auditorium** Eskom Megawatt Park, 2 Maxwell Drive, Sunninghill	July 16, 2014	pdp12com@eskom.co.za
Eastern Cape	**East Cape Training Centre** Spondo Street, Struandale, Port Elizabeth	July 17, 2014	pdp10com@eskom.co.za
Limpopo	**Polokwane Royal** Cnr Jorissen & Dorp Street,	July 17, 2014	pdp14com@eskom.co.za
North West	**Rustenburg Civic Centre** 1 Kloof Street, Rustenburg	July 21, 2014	pdp17com@esk om.co.za
Mpumalanga	**Witbank Civic Centre** Mandela Street, eMalahleni (Witbank)	July 22, 2014	pdp15com@eskom.co.za
		July 23, 2014	pdp16com@eskom.co.za

Subject: Hull Farm River Crossing, Application for Environmental Authorisation
From: Mette Rossaak <mette@emross.co.za>
Date: 2014/08/01 11:34 AM
To: david@finningley.co.za, jhnglltt@iafrica.com, quentin@ntelecom.co.za, mhaumann@mweb.co.za, naanderson@mweb.co.za, meyrick@global.co.za, Klaserie Management <manager@klaseriereserve.co.za>, Sean Fairhead <ntoma@telkomsa.net>, Frans Kriege <franskrige@telkomsa.net>, "Shabangu Sampie Howard (NSP)" <ShabanguS2@dwa.gov.za>, Tracy-Lee Petersen <TracyP@sanparks.org>, Doctor Shabangu <shabangud@bushbuckridge.gov.za>

Dear Sir,

Please be informed that Ms. Jessica Slack, of the remainder portion of the Farm Hull, is applying to the Mpumalanga Department of Economic Development, Environment and Tourism for environmental authorisation for the replacement of a low level crossing of the Klaserie River.

Emross Consulting has been appointed as independent environmental consultants to apply for this authorisation, and in that connection investigate the potential environmental risks in connection with the construction and to propose mitigation measures where possible.

An important part of this process is the participation of interested and potentially affected parties. You have been identified as an interested and affected party as your property is neighbouring to the Hull property, or because you represent an authority with jurisdiction, and as such we would value any comments you may have.

I have attached, for your information, a background document that outlines the proposal for the river crossing. We have identified some studies that need to be undertaken in the evaluation of the various proposed sites, and the information provided is what we have at present.

If you wish to register as an interested and/or affected party you can use the online form on the downloads page of our website (www.emross.co.za) or simply reply to this email.

We are available to meet with you, or your representative in the Klaserie, to discuss the proposal, and hear and document your concerns or comments. Please let us know if you wish to have a face-to-face meeting so that we can make an arrangement.

If you have no comments or concerns at this stage, that is fine (and common) – please just let us know. You will still have an opportunity to view the draft and the final reports prior to submission to the authorities.

Should you **not** wish to receive further correspondence regarding the assessment and application, please inform us to that effect by replying to this email.

If you have any questions, please feel free to contact me.

Many thanks for your time, and kind regards
--
Mette Rossaak
Certified Environmental Assessment Practitioner

Emross Consulting (Pty) Ltd.
Tel 013 750 2782
Cell 082 3399 627
Fax 086 675 4320

Attachments:

BID Hull River Crossing.pdf 569 KB

BACK GROUND INFORMATION DOCUMENT

July 2014. DRAFT

PROJECT:
Basic Environmental Assessment for the Replacement of a Causeway Crossing of the Klaserie River, Klaserie Game Reserve

CONSULTANT:
EMROSS Consulting
P.O. Box 507
White River
1240
Phone: 013 750 2782
Cell: 082 3399 627
Fax: 086 675 4320
Email: andrew@emross.co.za

APPLICANT:
Jessica Bridget Slack
Contact: Sean Fairhead
Postal address: PO Box 123
Hoedspruit
1380
Phone: 015 793 1774
Fax: 015 793 1774
Email: ntoma@telkomsa.net

PROPERTY:
The farm Hull 92KU

Ref. No: 17/2/3/E-287

1 INTRODUCTION

Emross Consulting was appointed by Ms. Slack (the applicant), as independent environmental consultants, to undertake the required actions to apply for environmental authorisation to be obtained from the Mpumalanga Provincial Department of Economic Development, Environment and Tourism (MDEDET, the decision-making authority) for the proposed replacement of a river crossing, on the farm Hull, in the Klaserie Game Reserve.

Government notices no. R 544-546 stipulates activities which require authorisation, in terms of the National Environmental Management Act (Act 107 of 1998). Government notice 543 prescribes the manner in which the assessment must be undertaken.

2 PROPOSED DEVELOPMENT

The previously existing access causeway which crossed the Klaserie River at Hull was washed away in the 2012 floods. Since the flooding event, there has been limited access to certain areas of the property for management personnel and reserve security personnel. The land owner wishes to replace the river crossing to improve accessibility to various areas of the property.

The proposed development is the construction of a causeway across the Klaserie River in order to replace the structure that was destroyed in the 2012 floods. It is proposed that the crossing be moved further south, in order to reduce the potential impact of future floods (*Figure 1*).

Figure 1: Satellite image indicating the location of the area investigated for location of the proposed crossing.

3 LEGISLATIVE CONTEXT

In terms of the National Environmental Management Act (NEMA), the activity proposed is regarded as a listed activity under schedule of activities as follows:

GNR 546:

Activity 16(iv)(a)ii(aa): "*The construction of infrastructure covering 10 m^2 or more where such construction occurs within a watercourse …, in Mpumalanga, outside urban areas, in a protected area identified in terms of NEMPAA, ..."* and

GNR 544:

Activity #11; *"The construction of (xi) infrastructure or structures covering 50m^2 or more, where such construction occurs within a watercourse ...."* and

Activity #18: *"The infilling or depositing of any material of more than 5m^3 into, or the dredging, excavation, removal or moving of soil, sand, …..or rock from or within (i) a watercourse; ...".*

This means that the proposed development requires a Basic Environmental Assessment to be conducted in order to obtain environmental authorisation.

The proposed development may also be subject to regulations contained in other legislation, such as the:

- National Heritage Resources Act 25 of 1999 (Section 38)
- Conservation of Agricultural Resources Act (.
- National Water Act 1998 (act 36 of 1998)
- National Environmental Management Act (act 107 of 1998)
- Constitution of the Republic of South Africa (act 108 of 1996)
- Promotion of Access to Information Act (act 2 of 2000)
- Mpumalanga Nature Conservation Act (No 10 of 1989).

These will be considered in the assessment and reporting.

4 THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

The legislation calls for a basic assessment to be conducted , in order to establish potential environmental and social impacts of a proposed development. This in order to find a way of avoiding or minimising environmental damage and to promote sustainable development.

The assessment process comprises of a planning stage. During this stage;

- An application is lodged with the decision making authority, in this case the Mpumalanga Department of Economic Development, Environment and Tourism.
- Site visits by specialists are undertaken to asses the site and potential impacts that could be caused by the proposed development, and
- Potential interested and affected parties to the development are identified.

This stage is followed by a participation stage. During this stage;

- A site visit is conducted with the decision making authority, and
- Notices and advertisements are publicised and identified interested and affected parties are consulted.

Once property information and public comment has been obtained a report is compiled, assessing the proposed development in context of the site and using specialist inputs. This report is made available for comment and finally submitted, with comments received, to the lead authority for decision making.

5 PUBLIC PARTICIPATION PROCESS

According to the Constitution of the Republic of South Africa everybody has the right to have the environment protected, amongst others through sustainable development. Everybody also have the right to be informed and to access information.

Therefore a very important part of the Environmental Impact Assessment is to identify and hear the interested and affected parties to the proposed development.

This is done by contacting neighbouring landowners, by advertising the process in the newspaper (The Lowvelder), by erecting notices on site (Klaserie Access Gate), and also by contacting special affected parties directly.

Registered interested and affected parties have the right to comment on reports regarding the development submitted by the consultant to the department.

In return the registered interested and affected party is expected to:

- Submit all comments in writing to the consultant;
- Adhere to time frames given for commenting or submit a written motivation for why a longer commenting period is needed; and
- Disclose any direct business, financial, personal or any other interest in the proposed development and approval or refusal thereof.

6 ENVIRONMENTAL CONSIDERATIONS

Due to the severity of the January 2012 floods, some of the river crossings which were washed away, are not easily re-established as the river bed and banks have been altered. This means that those crossings may be required to be replaced at a slightly different location, in order to find new footing and reasonable access, crossing and exit from the riverbed.

One of the aims is to facilitate a minimum of construction and to try to ensure that the crossings are better secured from future floods and general erosion impact.
During the floods a lot of material was shifted and deposited in new places within the watercourse. It is proposed that some of these materials, especially sand and rocks, are able to be moved to prevent future erosion, structural or ecological damage. Examples of proposed maintenance applications are the collection of rocks to be used in the construction of gabion structures. It is proposed that sand may be needed to be moved, especially from around the new crossing. This sand may also be required in any construction of the crossing.

Another aim is to ensure that the river ecology and health is not adversely impacted by the new river crossing – either during construction or thereafter. This achieved through specialist inputs that will look at aspects of water quality, flow and aquatic species requirements.

7 POSSIBLE CONCERNS

Consideration / concern	*Reply*	*Impact / Significance*
What environmental aspects are considered?	The proposed river crossing is to reconnect existing roads. Some limited impact may be caused to indigenous riverine vegetation.	Low
Who will be allowed to move or remove materials from the riverbeds?	Only the employees of the landowner. The materials will need to remain on the Property.	
Will there be a lasting impact following the causeway construction?	A lasting impact is expected, this includes visual impact. Mitigation measures will be proposed and these will be covered in detail in the report.	Low
How long will it take?	It is envisaged that the construction of the new river crossings will commence as soon as authorisation is obtained. The construction should be completed in 2 – 3 months depending on seasonal restraints. The maintenance will be an ongoing activity on an as and when needed basis.	
What about alternatives?	Alternatives will be identified and assessed in the report.	
What happens now that you have been informed about the proposed development ? Do you need to do anything?	You are welcome to register as an Interested and Affected Party (I & AP) and submit any comments to the proposed development to the consultants. These comments are welcomed and will be included in the report submitted to the Mpumalanga Department of Environment for decision making. If this proposal does not concern you, and you wish not to be an I & AP please inform the consultant to this effect. You don't need to comment to be an I & AP. All I &AP's will receive further information regarding the application.	
What happens next?	The consultants will develop a draft basic assessment report. You are welcome to review the draft report and provide comments within the time frames provided (30 days). A final report is then submitted to the Mpumalanga Department of Environment. You will be given an opportunity to comment on this too. The department will provide a Record of Decision (RoD) of Environmental Authorisation based on their findings, which is legally binding for the applicant. You (and the applicant) will have the opportunity to view and appeal the RoD. Details of the public participation time frames are attached to this document.	

8 WHO TO CONTACT

Should you wish to register as an interested and affected party to this scoping process and should you have any special concerns that you wish to be addressed during the scoping process please send your name and contact details and issues to be addressed to:

Emross Consulting Pty Ltd.
Andrew Rossaak
PO Box 507
White River
1240
Tel: 013 750 2782
Cell: 082 3399 627
Fax: 086 675 4320
E-mail: andrew@emross.co.za

Notice in the Lowvelder is published on the 4th of July 2014 and a site notice erected at the Klaserie Access gate on the 10th of July. Interested and affected parties have 30 days to register.

Subject: Re: Hull Farm River Crossing, Application for Environmental Authorisation
From: "Finningley Estates" <admin@finningley.co.za>
Date: 2014/08/04 10:05 AM
To: "Mette Rossaak" <mette@emross.co.za>
CC: "David Crookes" <david@finningley.co.za>

Mette Rossaak
re: Low level crossing at Hull
We have no objection to the proposed crossing. It can only be of benefit to Management and Security
Regards
David Crookes

Subject: RE: Hull Farm River Crossing, Application for Environmental Authorisation
From: "Shabangu Sampie (NSP)" <ShabanguH@dwa.gov.za>
Date: 2014/08/04 10:42 AM
To: "mette@emross.co.za" <mette@emross.co.za>

Register DWS as an interested party and please be advised that such an activity triggers section 21 water uses which will require an authorisation by DWS.

Kind Regards

Mr. Sampie Howard Shabangu
Control Biodiversity Officer
Department Of Water Affairs
Private Bag X 11259
NELSPRUIT,1200

35 BROWN STREET
PROROM BUILDING
2ND FLOOR, ROOM 199
NELSPRUIT
MPUMALANGA PROVINCE
SOUTH AFRICA
Tel:0137597300/7636
Cel: 0837910876
eMail: shabanguh@dwa.gov.za

Subject: RE: Hull Farm River Crossing, Application for Environmental Authorisation
From: "Quentin de Bruyn" <quentin@ntelecom.co.za>
Date: 2014/08/05 08:20 PM
To: <mette@emross.co.za>

Hi

Our family are the owners of Charloscar (TD de Bruyn). We have no objections to such a river crossing. Please keep us informed should you feel we would be adversely affected.

Regards

Quentin de Bruyn
Vastrap Farm, P.O. Box 63, Ladybrand, 9745
Home: (051) 924-2424 / Cell: 084 5924 245
www.vastrapboran.com

Subject: RE: Hull Farm River Crossing, Application for Environmental Authorisation
From: <naanderson@mweb.co.za>
Date: 2014/08/11 08:05 AM
To: <mette@emross.co.za>

Dear Sir

We would like to be registered as an interested and affected party and would like to make a suggestion.

If the river crossing was upgraded on the northern boundary it would make it easier for the Klaserie teams to cross the river at any time, without having to go through the middle of the property.

Regards

Neil Anderson
Cell: 082 4133211
Tel: 012 3482456

Subject: Re: Hull Farm River Crossing, Application for Environmental Authorisation
From: Mette - EMROSS <mette@emross.co.za>
Date: 2014/08/11 09:06 AM
To: naanderson@mweb.co.za

Dear Mr Anderson,

Thank you for your reply. We will keep you informed and will look at your suggestion.

Kind regards

Mette Rossaak
Certified Environmental Assessment Practitioner

Emross Consulting (Pty) Ltd.
Tel 013 750 2782 / 013 007 0077
Cell 082 3399 627
Fax 086 675 4320

Hull River Crossing – Old crossing Site:

Hull River Crossing - Preferred Site:

Hull River Crossing – Preferred site cardinals:

North

North East

East

South East

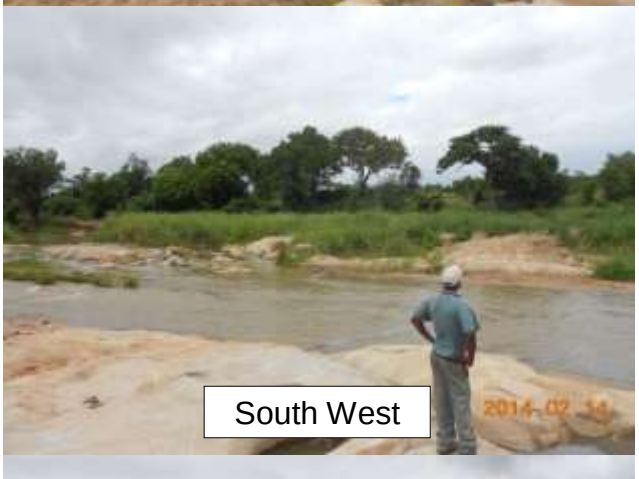
South

South West

West

North West

Hull River Crossing - Alternative 1 Site:



Hull River Crossing - Alternative 2 Site:

AQUATICS ASSESSMENT

leadership through nature

TAYLOR ENVIRONMENTAL

aquatic sciences. education. trails

White River Office
Business Park Annexe
Macadamia Medical Centre
Impala Str
WHITE RIVER
1240
P O Box 4670
WHITE RIVER
1240
Cell 076 413 9566 / 083 259 4568
llewtaylorsa@gmail.com
www.taylorenvironmental.co.za

23/08/2014

A healthy pool-riffle sequence immediately downstream of the preferred site for the proposed causeway

An Aquatic Assessment of the Klaserie River for a proposed causeway (24°16.634'S, 31°08.067'E) on the Remaining Portion of the Farm Hull 92KU, Klaserie Private Nature Reserve, Limpopo, RSA.

Prepared by:

Dr LR Taylor *PrSciNat*

CONTENTS

Specialist Investigator

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Declaration of Independence

I, Dr LR Taylor, hereby declare that,

(1) I act as an independent investigator and do not have an interest in the development for which this work has been undertaken, other than for financial compensation for work completed on the project in the capacity as investigator.

(2) I do not object to or endorse the development, and will present facts and recommendations based on sound scientific data and professional experience.

Limitations of this Investigation

The report is based on an investigation within the area encompassed by the proposed causeway and does not include any long-term consideration of the biophysical attributes. Should additional information come to light subsequent to this report, such information may not be reflected in this report and hence Taylor Environmental reserves the right to amend the report, recommendations or conclusions at any stage of the project should such information become available.

Acknowledgements

Mr S Fairhead is thanked for his assistance with respect to historical information relevant to the project, assistance during the sampling for riparian vegetation, macro-invertebrates and fish and for providing accommodation. In addition, Mr L Fairhead is thanked for his youthful enthusiasm and assistance during the fish survey.

Mr J Matibula and Mr A Ntimane are thanked for their valued support and assistance in the field throughout the survey period.

Report prepared for

Emross Consulting (Pty) Ltd
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Executive Summary

The client, Emross Consulting (Pty) Ltd, required that an Aquatic Assessment be undertaken in the Klaserie River System (KRS) at 24°16.634'S and 31°08.067'E (site KCP), given that the construction of a low water causeway is planned for the locality. Three alternatives considered included (1) a site 180m downstream of KCP, A1 (24°16.549'S, 31°08.038'E), (2) a site 370m downstream of KCP and close to the northern infrastructure of the property along the Left bank (LB), A2 (24°16.451'S, 31°08.031'E) and (3) the present access across the river 2.41km downstream of KCP, (24°15.561'S, 31°08.198'E).

In a literature review for the KRS, generally in Eco-region 5.02, which includes most of the KPNR, the rivers were found to be in a fair state, with riparian vegetation, fish and invertebrates occasionally reflecting poor conditions. Overgrazing and industrial and mining activities have led to significant deposition of soils and heavy metals and chlorides into streams and rivers, with concomitant deleterious effects on habitats and biota. The ecological importance of the riparian zone was considered to be medium and the in-stream habitat integrity was in a B/C category (78.4%) (moderately modified but very close to being largely natural) and the riparian zone integrity in a B category (82.6%) (largely natural with few modifications). The ecological importance of the habitat was found to be low and the ecological importance of the macro-invertebrate assemblage to be fair. It was calculated that the macro-invertebrate Ecological Category at site OLI-EWR7 was a C (75.8%), implying that the river is in a moderately modified ecological condition, with loss and change of natural habitat and biota having occurred and basic ecological functions predominantly unchanged. Results for fish indicated that they are in a PES of Category B/C (79.9%), which implies that the site may be classified as moderately modified but lies very close to being largely natural. There has been a change, possibly small, in natural habitats and biota. The ecosystem functions are still unchanged.

The total water resource requirement for use in the Lower Olifants system was found to be 164 Mm^3a^{-1}, giving a deficit on its water resources and demand balance of 63 Mm^3a^{-1}. The failure of the Lower Olifants to meet the Environmental Water Requirements (EWR), at a site (EWR16), occurred for 45% of the time during the period 1987 to 2000 and 47% of the time during the period 2001 to 2008. The consensus reached by ecologists was that the water depths and velocities at the critical riffle habitat, recommended during the critical low flow month of September, was not adequate to maintain the system in a B category. The maintenance low flows for September were adjusted from 0.079m^3s^{-1} to 0.101m^3s^{-1} to provide the necessary depths and velocities for fish and macro-invertebrates.

In terms of water quality, the TDS values for the Klaserie River System (KRS) at B7H004 are within acceptable limits, and an examination of the values for EC over the two-year period, have not yielded any outliers. The values for the BKD are marginally higher than for the river at B7H004. Although the peaks for NO_x occurred in the summer months, possibly due to a discharge of nitrogen-rich water into the KRS from anthropogenic activity, peaks in the dry period are expected due to the low volumes and discharge rates and high numbers of hippopotami in pools in the KRS. In the absence of values for NH_3, the values for NH_4 would suggest that there is sufficient N in the KRS to support mildly eutrophic conditions. Nitrate is not normally toxic, but levels above 0.1mgl^{-1} in natural surface waters are indicative of their introduction into water from fertilizers and agricultural runoff. It is likely that the peaks for the inorganic PO_4^{3-} in the KRS are due to sewage or leaching and runoff from cultivated land, or from the release of adsorbed P from sediments during high flow events. The pH levels for both sites B7H004 (average 7.66) and the BKD (average 7.83) vary between 7.09 and 8.09 and are acceptable and stable in terms of the geo-hydrological environment in which the KRS exists. Generally, though, pH values should not be allowed to vary from the range of the background pH by more than 0.5 of a H unit. This is not met for June 2013 at the BKD site.

The investigation for the alternative sites A1, A2 and A3 was restricted to a desktop study of each site, focusing on the river reach, channel and morphological units, the reference and present extent of the riparian zone, the biotopes for macro-invertebrates and flow-depth habitats for fish and the anthropogenic activity. The riparian vegetation was assessed at site KCP on 8 August 2014 using the VEGRAI technique. The macro-invertebrate fauna was sampled in a pool and riffle sequence 70m downstream of site KCP_m on 6 August 2014 using standard procedures, and additions or modifications to, where appropriate, including SASS5 and IHAS. The Fish

Assemblage Integrity Index (FAII) technique was used to assess the fish fauna and included the fish species collected between 6 and 8th August 2014 within the biological segments (fish habitats) of KRS at sites KCPm, KCP and KU as well as for information from the Reference Frequency of Occurrence (FROC) Sites 40F81 and 40F73. The ecological sensitivity of the area is based on available data and the results obtained in the field during the site visit from 6 to 8th August 2014. Potential environmental impacts were identified and assessed for their significance. For each impact, the extent (spatial scale), magnitude and duration (time scale) are described. These criteria are used to ascertain the significance of the impact.

In terms of river reach, channel and morphological units, alternative site A1 is characterized by a well-defined braided channel 80m in width with a well-developed riffle of 100 to 120m in length. A well-developed point bar exists in the marginal zone. In terms of the reference and present extent of the riparian zone, the river channel has been significantly scoured, broadening the channel and resulting in a reduction in cover of marginal non-woody vegetation from approximately 40 to 10%. There has also been a decrease in woody vegetation along the non-marginal zone. In terms of the biotopes for macro-invertebrates and flow-depth habitat classes for fish, site A1 appears to have a high diversity of habitats, including SIC, SOOC, MVEG and GSM macro-invertebrate biotopes and deep and slow, shallow and slow, deep and fast and deep and slow flow-depth habitats for fish species. In terms of anthropogenic activity, there is a well-defined gravel road parallel to the river approximately 70m to the west of the LB.

In terms of river reach, channel and morphological units, alternative site A2 is an old river crossing and has a well-defined channel 100m in width in the form of a braided, alluvial channel along the base of the LB. A well-developed point bar exists in the marginal zone. In terms of the reference and present extent of the riparian zone, the river channel has been significantly scoured, broadening the channel and resulting in a reduction in cover of marginal non-woody vegetation from approximately 80 to less than 10%. There has been no noticeable change in woody cover either along the LB or RB. In terms of the biotopes for macro-invertebrates and flow-depth habitat classes for fish, site A2 appears to have a lower diversity of habitats, including only MVEG and GSM macro-invertebrate biotopes, with a lack of riffles (SIC, SOOC). It is likely that only two of the four flow-depth habitat classes for fish exist at the site, namely deep and slow and shallow and slow. In terms of anthropogenic activity, the site is immediately upstream of the northern infrastructure along the LB and there is direct access to the site along a gravel road along both the LB and RB.

In terms of river reach, channel and morphological units, alternative site A3 is characterized by a well-defined channel 110m in width and the base-flow is in the form of a braided to anastomosing channel, well represented by riffle-pool sequences for a distance of 500m upstream and a distance of nearly 1.0km downstream of the site. In terms of the reference and present extent of the riparian zone, there has been a change in non-woody cover in the marginal zone from approximately 90% to 60 to 80%. There appears to have been a slight increase in woody cover along both the LB and RB. In terms of the biotopes for macro-invertebrates and flow-depth habitat classes for fish, site A3 appears to have a very high diversity of habitats, including SIC, SOOC, MVEG and GSM macro-invertebrate biotopes and deep and slow, shallow and slow, deep and fast and deep and slow flow-depth habitats for fish species, both immediately upstream and downstream of the crossing. In terms of anthropogenic activity, alternative site A3 is the presently existing river crossing along a major gravel road. There is also a well-defined gravel road parallel to and 35m from the LB, upstream of the crossing.

A total of 39 species of plants were collected at site KCP (Appendix A), including four alien species (Kikuyu, White Potato Creeper, Large Cocklebur and Persicaria). Species of plants collected in the marginal zone included Flueggea virosa, Phragmites mauritianus, Plumbago auriculata, Leonotis ocymifolia, Pennisetum clandestinum (A), Xanthium strumarium (A), Spirostachys africana, Combretum hereroense, Cyperus sp., Sida cordifolia, Sida dregei, Dichrostachys cinerea, Gymnosporia senegalensis, Solanum seaforthianum and Euclea natalensis, amongst others. Species of plants collected in the non-marginal zone included Phyllanthus reticulates, Gymnosporia senegalensis, Phragmites mauritianus, Diospyros mespiliformis, Combretum imberbe, Grewia flavescens, Schotia brachypetala, Euclea natalensis, Sida cordifolia, Sida dregei, Leonotis ocymifolia, Philenoptera violacea, Sphaeranthus flexuosus, C. apiculatrum, Peltophorum africanum, Euclea divinorum and Spirostachys africana, amongst others. In the marginal zone the climax vegetation may be considered to be dominated by stands of non-woody Phragmites mauritianum, with both abundance and cover high, over most of the channel. The present state, however, includes significantly more and extensive areas of exposed

sediment in the form of various bars across the channel. The loss of abundance and cover may be as much as 50%. Although this may be deemed natural, the increase in sedimentation in the river is due to anthropogenic activity in the catchment. The apparent increase in significant flood events has also resulted in an almost permanent state of secondary succession in the river, without the progression in time to a state of climax vegetation. If the effect of catchment-wide influences on vegetation removal is considered then a conservative estimate for vegetation removal (cover and abundance) in terms of non-woody species may be considered to be 20 to 40% and in terms of woody species 10 to 20%. In the non-marginal zone the climax vegetation may be considered to be dominated by woody species including Spirostachys africana, Diospyros mespiliformis, Combretum imberbe, Schotia brachypetala, Gymnosporia senegalensis, Euclea natalensis, Philenoptera violacea, and others. The percentage cover would be significantly high. The present state, however, includes a high proportion of coppiced woody vegetation due to (1) frequent high flood events resulting in scouring of the river channel and the loss and re-deposition of woody vegetation and (2) herbivory by mega-herbivores. Hence, as is the case with the marginal zone, there has been a loss of both cover and abundance of both woody and non-woody vegetation, should catchment-wide influences be considered. The magnitude of the loss along the LB may be estimated to be in the region of less than 10% for abundance and 10 to 20 % for cover. In the case of the RB the magnitude would be lower as the area represents the inside of the riverbend and may be estimated to be less than 10% for both abundance and cover. Finally, it has been observed that there are a number of terrestrial non-woody and woody plants in the marginal and non-marginal zones, including Grewia flavescens, Sida cordifolia, Flueggea virosa, Plumbago auriculata, Combretum hereroense, C. apiculatum, Dichrostachys cinerea and Euclea divinorum, amongst others. This is probably due to displacement during flood events and seed dispersal. The VEGRAI score calculated for the riverine and riparian vegetation at the KCP site was calculated to be 81.2%, with a 20% change in marginal vegetation and a 17 % change in non-marginal vegetation. Hence, the Ecological Category and PES for the site is a B (Table 4), where the riverine and riparian vegetation can be described as Largely Natural with few modifications, with a small change in habitats and biota having taken place, with ecosystem function essentially unchanged.

A total of 28 macro-invertebrate taxa (65% of the taxa expected at the site) were collected at KCP_m ($24^o16.641'S$, $31^o08.057'E$), including Oligochaeta, Potamonautidae, Hydracarina, Baetidae (> 2sp), Caenidae, Heptageniidae, Leptophlebiidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Belostomatidae, Gerridae, Naucoridae, Notonectidae, Vellidae, Hydropsychidae (1sp), Leptoceridae, Hydraenidae, Ceratopogonidae, Chironomidae, Culicidae, Psychodidae, Simuliidae, Tabanidae, Corbiculidae and Unionidae. The SASS5 score was calculated to be 153 with an ASPT score of 5.5. The Ecological Category, using the Biological bands for the Lower Lowveld was found to be B, which may be described as unmodified, natural. A total of 304 fish from 22 species was collected at sites KCP_m, KCP and KU, including Marcusenius macrolepidotus, Petrocephalus catostoma, Barbus annectens, B. lineomaculatus, B. unitaeniatus, B. viviparus, B. trimaculatus, B. eutania, B. paludinosus, Labeobarbus marequensis, Labeo rosae, L. ruddi, L. cylindricus, L. molybdinus, Brycinus imberi, Clarias gariepinus, Chiloglanis paratus, C. pretoriae, Pseudocrenilabrus philander, Tilapia sparrmanii, T. rendalli and Oreochromis mossambicus. Of the 273 fish collected at site KCP, 25 (9%) were health impaired and of the 109 fish collected at site KU, 22 (20%) were health impaired. The relative FAII calculated for the fish at site KCP_m, KCP and KU, in conjunction with data from FROC sites 40F81 and 40F73 was 81.0% (Ecological Category B) which may be described as Largely Natural with few modifications. Changes in community characteristic may be present and species richness and the presence of intolerant species indicate little modification. The presence of water flow and water quality intolerant species, including B. eutania and C. pretoriae supports the view that the Klaserie River at the KCP_m, KCP and KU sites may be considered to be largely natural with few modifications.

The riparian vegetation at site KCP, the macro-invertebrates at site KCP_m, and the fish fauna in the macro-reach at sites KCP_m, KCP and KU as well as in the region, all generally reflect an aquatic environment that may be placed in the Ecological Category B, where the ecosystems are in a PES described as largely natural with few modifications. For this reason, the ecological sensitivity of the preferred site KCP may be classified as being characterized by a high Ecological sensitivity. The KCP site does not, however, possess a high diversity of in-stream habitats and should be classified as medium-high to high ecological sensitivity. Site A1 is very similar to site KCP_m, and should thus be classified as of high ecological sensitivity. Site A2, however, may be classified as medium ecological sensitivity as it has been previously impacted given that it is the causeway site that was recently destroyed and also is within an area of the macro-reach where there is a low diversity of in-stream

habitats. Site A3 should be classified as high to very high ecological sensitivity in that it is not only similar to site KCP_m and KCP, but the site is characterized by pool-riffle sequences over a distance along the in-stream channel of 1.5km.

The significance of potential impacts on the aquatic environment was found to vary between very low (macro-invertebrate fauna) and medium (riparian vegetation) at preferred site KCP (medium-high to high ecological sensitivity), medium significance at alternative sites A1 (high ecological sensitivity) and A3 (very high ecological sensitivity) and low significance at alternative site A2 (medium ecological sensitivity). Although site A2 would thus be the best choice for the location of the causeway in terms of biotic considerations, and important aspect to consider is that the site is alluvial in nature and there is no dyke or rock on which to secure the causeway and construct a sound structure. Hence, the likelihood is that the causeway would be significantly damaged or destroyed in a flood event. The destruction by flooding of causeways and the concomitant desire to construct new ones must be avoided as far as possible. As stated in Section 1.1, a total of 16 river crossings (sand, rock or concrete) were discernible from Google 2008 images (Google™, 2014) over a distance of 45km (one crossing every 2.8km). Hence, as the next alternative to site A2, site KCP would be the best choice for the location of the causeway. The site includes a dyke and rock bar for proper anchoring of the causeway and is low enough to be constructed at base flow level, hence obviating the necessity of extreme intervention, for example, blasting, and allowing for the most efficient use of construction materials, the limitation of visual impact and the construction of flow through structures to allow for meeting EWR requirements. It will be important, though, to strongly mitigate any impact on the riparian vegetation at the site.

Mitigation measures and/or recommendations are provided for the construction and operational phases.

1. Introduction

1.1. Project description, site locality and the Klaserie River System

The client, Emross Consulting (Pty) Ltd, requires that an Aquatic Assessment be undertaken in the Klaserie River System (KRS) at 24°16.634'S and 31°08.067'E (site KCP) (Figure 1), given that the construction of a low water causeway is planned for the locality.

Figure 1. The preferred site (KCP) for the causeway over the Klaserie River, facing upstream.

The site KCP is the preferred one for the construction. Three alternatives under consideration include (1) a site 180m downstream of KCP, designated A1 (24°16.549'S, 31°08.038'E), (2) a site 370m downstream of KCP and close to the northern infrastructure of the property along the Left bank (LB), designated A2 (24°16.451'S, 31°08.031'E) and (3) the present access across the river 2.41km downstream of KCP, designated A3 (24°15.561'S, 31°08.198'E).

The information available on the KCP site to date includes:

(1) The causeway will be sited on a rock bar at or just above low water level for part of the central riverbed. The left riverbed has apparent rock about 1m below water level. The right bank is a wide sand bank well above low water, again with apparent rock at 1,0 to 1,2m below. The left bank is a narrow sand bank below an incised sandy clay deposit, about 2m deep. On both outer banks there is sandy clay with open brush and tall trees (R. Clanahan, *pers. comm.*).

(2) A series of seven photographs of the site (R. Clanahan, *pers. comm.*).

The KRS has its source (approximate co-ordinates 24°36.186'S, 30°52.471'E) in the mountainous region on the eastern portion of the Blyde River and Motlatse Canyon Provincial Nature Reserves. Two prominent upstream first-order tributaries leave the protected area and flow in a northeasterly direction and become confluent approximately 17km downstream of the source (24°34.338'S and 30°59.920'E), south of the Madrid and Selati Game Reserves (Taylor Environmental, 2014).

The river enters the Kapama and Phelwana Game Reserves and then flows in a northerly direction into the Klaserie (Jan Wassenaar) Dam (24°32.238'S, 31°02.811'E). The river further skirts the eastern borders of a number of protected areas until entering (24°19.253'S, 31°08.340'E) the Klaserie Private Nature Reserve (KPNR). The confluence with the Olifants River (24°04.906'S, 31°14.933'E) lies approximately 45km to the north along the northern border of the KPNR.

Although there are numerous drainage lines and less prominent ephemeral streams that enter the KRS, approximately 28 prominent 1° and 2° streams or tributaries entering the river, along both banks, between the entry point into the KPNR in the west and the confluence with the Olifants River in the northeast. In addition, Google 2009 images (Google™, 2014) indicate the presence of at least 19 dwellings and/or lodges along the left and right banks, as well as 16 active or inactive road crossings over the river.

The KRS forms part of the Lower Olifants sub-area of the Olifants Water Management Area (OWMA). The Olifants River System, in turn, forms part of the greater Limpopo River Basin. The KRS drains the B73A (165km^2) and B73B (688km^2) Quaternary Drainage Regions. The MAP for the former is 957mm and for the latter 491mm.

1.2. Terms of Reference for the present study

The Terms of Reference (ToR) for the Aquatic Assessment include:

(1) A literature review of the present ecological status (PES) of the Klaserie River and/or catchment environs. The literature review includes consideration of Environmental Flow Requirements (EFR) and surface water quality.
(2) Consideration of the preferred site for the proposed causeway as well as for three alternative sites.
(2) A physical description (morphological units) of the macro-reach (> 100m) in which the four sites lie.
(3) Assessment of the riparian vegetation and associated PES (VEGRAI) at the preferred site.
(4) Assessment of the macro-invertebrate fauna and associated PES (SASS) at the preferred site and/or in the macro-reach.
(5) Assessment of the fish fauna and associated PES (FAII) at the preferred site and/or in the macro-reach and further afield.
(6) Description of the amphibia and river-associated reptilia, mammals and birds encountered on site.
(7) Ecological sensitivity analysis, impact assessment, mitigation measures and recommendations for the preferred site, as well as the alternative sites, where appropriate.

2. Literature Review

2.1. Introduction

The KRS has its source and upper and middle reaches in Eco-regions 5.05 and 5.06 (5 – Lowveld; 02 and 06 – subdivisions of 5) and the lower reaches in Eco-region 5.02 (Figure 2).

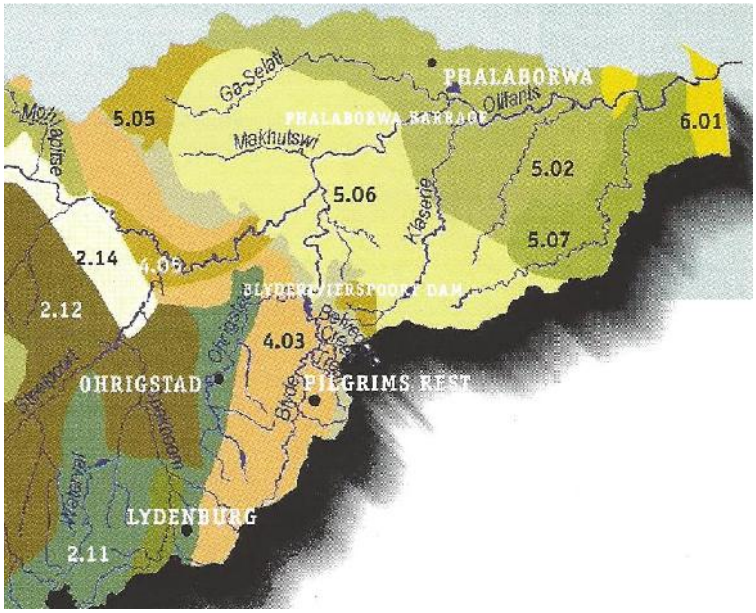


Figure 2. Eco-regions 5.02, 5.05 and 5.06 in the Lower Olifants catchment area [After River Health Programme (RHP), 2001].

In Eco-region 5.05, the in-stream and riparian habitats and fish population for the KRS are considered to be in a good ecological state. The invertebrates and riparian vegetation reflect a fair state. The drivers of ecological change in terms of land-use activities for Eco-region 5.05 are both agricultural (citrus, forestry) and protective (conservation) in nature, with the former significantly responsible for in-stream sedimentation.

In Eco-region 5.06, the KRS is also in a good state, with the fish and invertebrates occasionally reflecting natural health. Here the drivers of ecological change include timeshare developments built in the riparian zone, which requires the clearing of vegetation and leads to the increased risk of soil erosion, and fruit orchards, which results in little ground cover and flourish.

Generally in Eco-region 5.02, which includes most of the KPNR, the rivers are in a fair state, with riparian vegetation, fish and invertebrates occasionally reflecting poor conditions (River Health Programme, 2001). Overgrazing and industrial and mining activities have led to significant deposition of soils and heavy metals and chlorides into streams and rivers of the KRS, with concomitant deleterious effects on habitats and biota.

In addition, a major problem is the impact on habitats and communities derived from the insensitive releases of irrigation water from major in-stream impoundments.

2.2. Riparian vegetation

Hill, Vos, Moolman and Siberbauer (2001) state that the average width of the riparian zone in the KRS is 75m and that the dominant vegetation is grass and trees, with *Combretum erythrophyllum*, *Salix mucronata*, *Dombeya rotundifolia* and *Mytenus heterophylla* dominant amongst the latter.

The ecological importance of the riparian zone is considered to be medium.

In determining the habitat integrity for the KRS, Moodley (2011) utilized the procedure described by Kleynhans (1996) and the habitat integrity was evaluated taking into consideration the flow and water quality related impacts of the upstream catchment.

The in-stream habitat integrity was in a B/C category (78.4%) (moderately modified but very close to being largely natural) and the riparian zone integrity in a B category (82.6%) (largely natural with few modifications).

The main impacts on the habitat integrity of the system are impacts on water quantity due to upstream afforestation (reduced low flows), vegetation clearing (sediments) and settlements (nutrients). The presence of alien vegetation (Mauritius thorn, guava and jacaranda) impacts on the riparian zone of the KRS.

Moodley (2011) suggests that the Ecological Importance and Sensitivity (EIS) of the KRS is high.

The authors justify the statement, amongst others, by indicating, (1) the diversity of habitat type including chutes, bedrock, riffles, runs, stones-in-current (SIC), stones-out-of-current (SOOC), marginal vegetation (MVEG) and gravel, sand and mud (GSM), (2) the KRS as a small system that is intolerant to flow and flow related changes and (3) the river running through part of the Kruger to Canyon conservation area.

2.3. Aquatic macro-invertebrates

The closest River Health Programme (RHP) bio-monitoring site (K2, B7KLAS-GUERN, 24°29.8200'S, 31°05.2799'E) to the KPNR lies 40km upstream of KCP. Hill *et al* (2001) sampled all four biotopes [SIC, SOOC, MVEG, GSM] at this point (K2, B7KLAS-GUERN) and found the condition thereof to be poor.

The ecological importance of the habitat was found to be low and the ecological importance of the macro-invertebrate assemblage to be fair.

The taxa most likely to be encountered will be those found in shallow, slow-flowing alluvial environments with occasional, weakly-developed riffles. It is also likely that the taxa will be dominated by those that score between 1 and 10 on the sensitivity scale (where 1 represents a taxon that is tolerant to pollution and 15 represents a taxon that is extremely intolerant to pollution). The taxa likely to be present include mayflies (Baetidae, Caenidae), caddisflies (Hydropsychidae, Ecnomidae, Leptoceridae), beetles (Dytiscidae, Gyrinidae, Hydrophilidae), bugs (Belostomatidae, Corixidae, Gerridae, Nepidae, Naucoridae, Notonectidae), dragonflies and damselflies (Aeshnidae, Gomphidae, Libellulidae, Coenagrionidae), flies, mosquitoes and midges (Ceratopogonidae, Chironomidae, Culicidae Simuliidae, Tabanidae, Tipulidae), crabs (Potamonautidae), aquatic earthworms (Oligochaeta), leeches (Hirudinidae), snails (Lymnaeidae, Physidae, Thiaridae) and mussels (Unionidae). Should one conduct the Stream Assessment Scoring System technique, version 5 (SASS5) (Dickens and Graham, 2002, Dallas, 2007) for all the potential biotopes at any one time, it is probable that up to approximately 20 of the taxa stated here may be found.

Moodley (2011) *expected* the list of macro-invertebrates for the site OLI-EWR7 (24°32.540'S, 31°02.093'E, approximately 48km upstream of KCP) to include the Hydracarina, Perlidae, Baetidae (>2spp), Oligoneuridae, Polymitarcyidae, Tricorythidae, Aeshnidae, Corduliidae, Gomphidae, Corixidae, Notonectidae, Ecnomidae, Hydropsychidae (>2spp), Leptoceridae, Elmidae, Gyrinidae, Ceratopogonidae, Simuliidae, Ancylidae and Corbiculidae, with a SASS5 score of 200 and Average Score per Taxon (ASPT) score of 7, which would be classified as Category A and described as unmodified, natural.

Once again, Moodley (2011) suggests that the Ecological Importance and Sensitivity (EIS) of the KRS is high and justifies the statement by indicating that 25 macro-invertebrate taxa are present, significantly including the Perlidae, Heptageniidae and Hydropsychidae.

In using the MIRAI (Macro-invertebrate Rapid Assessment Index) (Thirion, 2008), the three modification metrics, namely flow modification, habitat and water quality, were each ranked and weighted and then rated according to change from the natural or unmodified condition (Moodley, 2011). The Ecological Category for site OLI-EWR7 was then derived using the model.

It was calculated that the macro-invertebrate Ecological Category at site OLI-EWR7 was a C (75.8%), implying that the river is in a moderately modified ecological condition, with loss and change of natural habitat and biota having occurred and basic ecological functions predominantly unchanged.

The most impacted driver metric is that of water quality at 74.1%, followed closely by in-stream habitat at 76.6%, with the least impacted driver metric being flow modification, at 77.0%. Taxa that characterised the site include the Porifera, Hydracarina, Baetidae (>2spp), Heptageniidae, Leptophlebidae, Hydropsychidae (>2spp), Leptoceridae, Simuliidae and Corbiculidae.

Further to this, the results indicated that the presence and frequency of occurrence of taxa with a preference for moderately fast flowing water was ranked the most important and those with a preference for standing water the least important. The presence of taxa with a preference for very fast flowing water, vegetation and loose cobbles have been impacted the most from the natural or unmodified condition. The occurrence, abundance and frequency of occurrence of loose cobbles were ranked as the most important in-stream habitat for the site and the water column the least important. Taxa with a moderate requirement for unmodified physico-chemical conditions were impacted the most.

However, in a SASS5 assessment conducted at site BARN01 (24°07.111'S, 31°11.360'E, 27.1km downstream of KCP), 75.7km downstream of OLI-EWR7 and in the KPNR, on 24 March 2014, the SASS5 score was found to be 65, with 13 taxa collected, giving an ASPT score of 5.0 (Taylor Environmental, 2014). Using the Biological Bands

for the Lower Lowveld (Dallas, 2007), site BARN01 may be described as Category D/E, largely to seriously modified. The taxa collected at the site included the Baetidae (3 spp), Gomphidae, Libellulidae, Naucoridae, Notonectidae, Veliidae, Hydropsychidae (2 spp), Leptoceridae, Chironomidae, Culicidae, Simuliidae, Thiaridae and Corbiculidae. Using McMillan (1998), it was estimated that the Invertebrate Habitat Assessment score was 60%. The value obtained for the biotope suitability at BARN01 during the SASS5 assessment was estimated to be 49%.

In summary, although cognizant of the fact that the sampling stations were far apart, and contrary to the expected ecological conditions of unmodified and natural, previous studies have classified the KRS as fair or moderately modified in terms of ecological functioning in general.

The result obtained at site BARN01 of largely to seriously modified ecological conditions may be due (1) to the fact that the flow during sampling was relatively high compared to conditions when other sampling efforts were conducted, (2) invertebrate drift due to flood events and a recent spate had resulted in lower than normal macro-invertebrate population densities or (3) there has been a further decrease in the ecological health of the KRS. Importantly, although the ecological importance of the habitats in general has been documented as low, there is an increase in importance in terms of impact from flow modification, to in-stream habitat to water quality and from standing to moderately flowing water. Loose cobbles are more important in the in-stream environment than the water column. When considering priority areas in the management of the KRS, it is important to take these results from previous studies into consideration.

2.4. The fish fauna

Eighteen indigenous species of fish were collected at site B7KLAS-GUERN (K2) by Hill *et al* (2001), using an electro-shocker in fast, shallow water and a seine net in slow, deep water. The abundance, overhanging vegetation, undercut banks and root wads and substrate, of the four habitats (fast, deep; fast, shallow; slow, deep; slow, shallow), was found to vary in condition between poor and fair.

Klenynhans et al (2008) report 15 species of fish for the Frequency of Occurrence site (FROC) 40F81 (24°33.00'S, 31°01.9998'E, 47.6km upstream of KCP) and 30 species at FROC site 40F73 (24°27.942'S, 31°06.60'E, 34.6km upstream of KCP) (Table 1).

Table 1. The fish species recorded for FROC sites 40F81 and 40F73 in the Klaserie River.

Fish species	Presence (+) at FROC Site		Preferred habitat
	40F81	40F73	
Anguilla mossambica	+	+	Flowing river stretches (juveniles) and pools (adults).
A. bengalensis		+	Flowing river stretches (juveniles) and pools (adults).
A. marmorata		+	Flowing river stretches (juveniles) and pools (adults).
Amphilius uranoscopus	+		Clear, flowing water, rocky areas.
Barbus eutaenia	+	+	Clear, flowing water, rocky areas, headwaters.
Barbus marequensis	+	+	Flowing, perennial waters.
B. neefi	+		
B. lineomaculatus		+	Wide variety.
B. paludinosus	+	+	Quiet, well-vegetated waters.
B. trimaculatus	+	+	Wide variety.
B. unitaeniatus		+	Wide variety.
B. viviparus	+	+	Vegetated pools, lake margins.
Brycinus imberi		+	Wide variety.
Cyprinus carpio (A)		+	Wide variety.
Clarias gariepinus	+	+	Wide variety.
Chiloglanis paratus		+	Rocky riffles, rapids and rocky pools.
C. pretoriae	+	+	Shallow rocky reaches, riffles and rapids of permanent waters.
Glossogobius callidus (?)		+	Pools, between cobbles and vegetation.
Hydrocynus vittatus		+	Warm, well-oxygenated water in large rivers.
Labeo cylindricus	+	+	Clear, running water, rocky areas.
L. molybdinus	+	+	Deep pools, occasionally rapids.
L. rosae		+	Sandy stretches.
L. ruddi		+	Quiet, standing waters.
Micralestes acutidens		+	Shoals in clear, flowing or standing water.
Mesobola brevianalis		+	Shoals, well aerated, open water, flowing rivers.
Marcusenius macrolepidotus		+	Well-vegetated, muddy bottomed marginal areas.
Oreochromis mossambicus	+	+	Wide variety, thrives in standing water.
Petrocephalus catostomata		+	Shoals, quiet reaches.
Pseudocrenilabrus philander	+	+	Wide variety.
Schilbe intermedius		+	Shoals, open, standing water with emergent or submerged vegetation.
Synodontis zambezensis		+	Pools, slow-flowing reaches.
Tilapia rendalli		+	Quiet, well-vegetated water, littoral and backwater areas.
T. sparrmanii	+		Wide variety, prefers quiet, standing water, vegetation.

Key: A – alien species; ? – unlikely to be present.
Note: Wide variety implies presence in standing and flowing water and open or vegetated habitats.

Moodley (2011) expected the list of fish species (reference conditions) to include *Amphilius uranoscopus, Barbus eutaenia, Barbus lineomaculatus, Barbus paludinosus, Barbus trimaculatus, Barbus unitaeniatus, Chiloglanis pretoriae, Clarias gariepinus, Labeobarbus marequensis, Marcusenius macrolepidotus, Petrocephalus wesselsi, Pseudocrenilabrus philander* and *Tilapia sparrmanii*.

Moodley (2011) suggests that the Ecological Importance and Sensitivity (EIS) of the KRS is high and justifies the statement, amongst others, by indicating that there is the presence of intolerant flow and water quality species (*Amphilius uranoscopus, Barbus eutania, Chiloglanis pretoriae*).

During the August 2011 survey (Moodley, 2011), *Barbus eutaenia, Barbus trimaculatus, Chiloglanis pretoriae, Clarias gariepinus, Labeobarbus marequensis, Marcusenius*

macrolepidotus and *Pseudocrenilabrus philander* was collected. Based on these results, the PES (Present Ecological State) was determined using the Fish Response Assessment Index (FRAI) (Kleynhans, 2008).

The results indicated that the fish are in a PES of Category B/C (79.9%), which implies that the site may be classified as moderately modified but lies very close to being largely natural. There has been a change, possibly small, in natural habitats and biota. The ecosystem functions are still unchanged.

There are increased sediments and reduced water quality at the EWR site. The absence of *Amphilius uranoscopus* during the survey is indicative of reduced water quality.

During the study at site BARN01, although a fish survey was not intended, *Chiloglanis pretoriae* and *Labeo molybdinus* was captured during the SASS5 assessment.

2.5. Environmental water requirements.

In the Lower Olifants region, the total local yield of water is 100Mm^3a^{-1} with additional 1.0 Mm^3a^{-1} from transfers of water into the region.

The total water resource requirement for use is 164 Mm^3a^{-1}, giving a deficit on its water resources and demand balance of 63 Mm^3a^{-1}.

Irrigation claims 66% of the volume and mining and industrial concerns 26% (Pollard and Du Toit, 2010).

In a study by Pollard, Mallory, Riddell and Sawunyama (2010), it was found that the failure of the Lower Olifants to meet the Environmental Water Requirements (EWR), or otherwise referred to as the Ecological Reserve (ER), at a site (EWR16), occurred for 45% of the time during the period 1987 to 2000 and 47% of the time during the period 2001 to 2008.

Conditions are worse in the dry season (67% failure for both periods) and less so in the wet season (28 and 25%, respectively). The position appears to have worsened during the period 2003 to 2010, with average failure of 56% (67% for the dry season and 46% for the

wet season). The Lower Olifants actually ceased flowing completely for 33 days during the two driest months (September and October) in 2005.

In a study of the EWR for the Olifants catchment, Moodley (2011) used the Desktop Reserve Model (DRM) (SPATSIM, version 2.12) to calculate the EWR for a recommended Ecological Category (EC) of B (largely natural with few modifications, where a small change in natural habitats and biota may have taken place but ecosystems remain predominantly unchanged) for the Klaserie River at the EWR site OLI-EWR7. The EWR flow data was converted to hydraulic conditions at the EWR site (i.e. depths and flow velocities at discharges measured in m^3s^{-1}) using a hydraulic model. Maintenance flows were examined for September (discharge of $0.101m^3s^{-1}$, maximum depth of 0.28m, average depth of 0.13m, average velocity of $0.12ms^{-1}$) and February (discharge of $0.452m^3s^{-1}$, maximum depth of 0.40m, average depth of 0.16m, average velocity of $0.24ms^{-1}$). September is the lowest flow month and February the highest flow month based on the natural time series. The water level in the KRS during the site visit on 10 August 2011 (discharge of $0.112m^3s^{-1}$, maximum depth of 0.29m, average depth of 0.13m, average velocity of $0.13ms^{-1}$) was used as a datum. The hydraulic model and the water levels proposed by the Desktop Reserve Model (DRM) for maintaining low flows were assessed in terms of habitat and biotic requirements.

The site-specific flow requirements were based mainly on the depths required for fish passage, as well as the velocity requirements of flow-sensitive aquatic macro-invertebrates.

The consensus reached by the ecologists was that the water depths and velocities at the critical riffle habitat, recommended by the DRM during the critical low flow month of September was not adequate to maintain the system in a B category. The maintenance low flows for September were adjusted from $0.079m^3s^{-1}$ to $0.101m^3s^{-1}$ to provide the necessary depths and velocities for fish and macro-invertebrates.

Clearly, the Lower Olifants region of the OWMA is a severely stressed catchment in serious need of integrated planning and management and currently has weak Integrated Water Resource Management (IWRM).

2.6. Surface water quality

Surface water quality results were obtained from data held by the Department of Water Affairs and Forestry (DWAF) for monitoring sites B7H004 (24°33.3168'S, 31°01.9332'E,

50km upstream from KCP) and the Barrage at Klaserie Dam (BKD) (24°31.452'S, 31°04.224'E, 32.6km upstream of KCP), for the periods January 2012 to March 2014 and March 2012 to September 2013, respectively. Water quality parameters measured included Ca, Cl, DMS (dimethylsulphide), EC (electrical conductance), F, K, Mg, Na, NH_4, NO_3+NO_2 (NO_x), pH, PO_4, Si, SO_4, Kjeldahl-N and P (Tables 2 and 3). Although the surface water quality data is for sites 32 to 50km upstream of the site KCP, it is plausible to use the data to indicate what surface water quality conditions are likely to be at site KCP and the alternative sites A1, A2 and A3.

Water quality parameters that are important to consider in terms of the effect on in-stream biota include EC, nitrogen, phosphorus and pH. The average value for EC was 10.27mSm^{-1}, with the range between 7.95 and 14.07mSm^{-1} at site B7H004, and 12.52mSm^{-1} at BKD, with the range between 9.49 and 17.09mSm^{-1}. EC is a measure of the number of ions in water and can be converted to TDS (Total Dissolved Solids) by using the formula TDS (mgl^{-1}) = EC (mSm^{-1}) x 6.6 (Dallas and Day, 2004). The estimated average TDS for the surface water quality at B7H004 would thus be 67.78mgl^{-1} with the range between 52.47 and 92.86mgl^{-1}, and 82.6mgl^{-1} at BKD, with a range of 62.6 to 112.8mgl^{-1}. The lowest recorded values in South Africa are in the range of 10 to 27mgl-1 (Britton, 1991, in Dallas and Day, 2004) and it is generally accepted that most rivers worldwide have a TDS of less than 100mgl^{-1}.

The TDS values for the Klaserie River are therefore within acceptable limits, and an examination of the values for EC over the two-year period, have not yielded any outliers. The values for the BKD are marginally higher than for the river at the hydrological monitoring site.

The average values and ranges for nitrogen in the form of NH_4 and NO_3 + NO_2 (NO_x) were 0.03mgl^{-1} (0.03 to 0796) and 0.11mgl^{-1} (0.03 to 0.3), respectively, for site B7H004. Peaks in values for NO_x occurred during July and August 2012 (0.125 and 0.134mgl^{-1}, respectively), March to May 2013 (0.219, 0.176 and 0.145mgl^{-1}, respectively) and February and March 2014 (0.116 and 0.158, respectively).

Although the peaks for NO_x occurred in the summer months, possibly due to a discharge of nitrogen-rich water into the KRS from anthropogenic activity, peaks in the dry period are expected due to the low volumes and discharge rates and high numbers of hippopotami, for example, in pools in the KRS.

At the BKD the NH_4 average and range was 0.28mgl^{-1} (0.03 to 3.25) and the NO_x average and range was 0.21mgl^{-1} (0.03 to 0.96). As expected peaks occurred in the dry months for both NH_4 (0.145 and 0.164mgl^{-1} for May and June, 2013) and NO_x (0.218, 0.219, 0.238 and 0.192mgl^{-1} in May, twice in June, and August, 2012, respectively and 0.96mgl^{-1} in June 2013). The value for NH_4 was significantly higher (3.252mgl^{-1}) at the BKD in January 2013. Although NH_4 is not toxic and only contributes to eutrophication, a better measure is un-ionized ammonia (NH_3) in that toxicity for this chemical species is directly related to concentration. The target water quality range (TWQR) for NH_3 in aquatic ecosystems in South Africa is less than 0.007mgl^{-1}, with the chronic effect value (CEV) 0.015mgl^{-1} and acute effect value 0.1mgl^{-1}.

Thus, in the absence of values for NH_3, the values for NH_4 would suggest that there is sufficient N in the KRS to support mildly eutrophic conditions, as opposed to the more oligotrophic condition that one would expect in the KRS if considered natural and unmodified. Nitrate is not normally toxic, but levels above 0.1mgl^{-1} in natural surface waters are indicative of their introduction into water from fertilizers and agricultural runoff.

Nitrite, on the other hand, an intermediate product of the conversion of NH_3 to NO_3, is introduced into water from anthropogenic activity including industry, sewage effluents and even aquaculture. Nitrite toxicity is linked to and modified by the influence of other chemical species in water, including the anions Cl^- and HCO_3^-.

The inorganic PO_4^{3-} values peak at the B7H004 site in August, September and November 2012 (0.011, 0.038, 0.027 mgl^{-1}), as well as in April 2013 (0.011mgl^{-1}). At the BKD site the values peak in December 2012 (0.047mgl^{-1}) and January 2013 (0.189mgl^{-1}), with the latter reflecting a significantly higher value relative to the background level.

It is likely that the peaks for the inorganic PO_4^{3-} in the KRS are due to sewage, leaching and runoff from cultivated land, or from the release of adsorbed P from sediments during high flow events.

The pH levels for both sites B7H004 (average 7.66) and the BKD (average 7.83) vary between 7.09 and 8.09 and are acceptable and stable in terms of the geo-hydrological environment in which the KRS exists. Generally, though, pH values should not be allowed to vary from the range of the background pH by more than 0.5 of a H unit. This is not met for June 2013 at the BKD site.

Table 2. Surface water quality results for hydrological site B7H004, Klaserie River, from January 2012 to March 2014 (DWAF, undated)

Date	Water quality parameters (in mg/l unless otherwise stated)														
	Ca	Cl	DMS	EC	F	K	Mg	Na	NH4	NO3 + NO2	pH	PO4	Si	SO4	TAL
Jan-12	3.728	10.409	76.075	11.31	0.167	2.428	2.593	14.34	0.025	0.025	7.855	0.012	6.695	1.5	33.406
February	2.902	7.335	61.263	9.14	0.31	2.206	2.972	8.869	0.025	0.084	7.525	0.005	9.253	1.5	28.501
March	5.079	7.44	88.863	10.01	0.477	2.76	2.601	10.311	0.07	0.12	7.553	0.005	9.904	1.5	47.618
April	4.577	6.942	65.037	12.52	0.167	2.391	0.75	9.673	0.025	0.025	7.352	0.005	10.495	1.5	31.887
May	4.603	6.407	62.296	11.08	0.025	2.285	1.887	8.773	0.025	0.025	7.563	0.005	10.754	1.5	30.066
June	3.936	7.388	64.424	11.44	0.025	2.74	1.765	10.665	0.025	0.025	7.709	0.005	13.397	1.5	29.729
July	3.96	8.485	73.485	9.48	0.096	2.209	1.832	10.863	0.025	0.125	7.687	0.005	11.805	7.186	31.374
August	3.611	8.539	70.455	10.08	0.055	2.31	1.944	12.893	0.025	0.134	7.64	0.011	12.188	1.5	31.941
September	4.289	8.776		11.28	0.134	2.342	2.377	9.547	0.025	0.025	7.866	0.038	11.9	1.5	
October	4.384	8.204	71.239	11.14	0.155	2.288	0.75	9.41	0.025	0.025	7.815	0.005	11.797	1.5	36.407
November	2.692	6.367	59.974	9.47	0.198	2.074	2.141	9.804	0.025	0.025	7.442	0.027	10.994	1.5	28.683
Mar-13	3.892	7.602	58.491	8.91	0.025	1	1.57	9.239	0.025	0.219	7.761	0.005	9.608	1.5	26.775
April	4.959	7.222	60.947	8.44	0.071	2.592	1.525	8.901	0.025	0.176	7.515	0.011	9.324	1.5	27.338
May	2.515	8.23	51.783	9.48	0.146	1	2.061	8.475	0.025	0.145	7.79	0.005	9.753	1.5	22.281
June	3.96	8.036	58.462	10.44	0.128	2.627	1.58	9.869	0.025	0.096	7.608	0.005	11.035	1.5	24.843
July	4.092	7.555	63.773	10.43	0.154	2.327	1.925	9.442	0.025	0.3	7.791	0.005	11.145	1.5	29.036
August	4.386	7.888	68.88	11.93	0.512	2.058	0.75	11.019	0.025	0.147	7.581	0.005	11.762	1.5	32.863
October	3.926	8.404	71.706	9.632	0.249	2.192	2.485	12.715	0.025	0.213	7.437	0.005	11.666	1.5	32.187
November	4.104	7.561	65.978	14.07	0.139	1	3.767	10.519	0.025	0.06	8.027	0.005	10.694	1.5	30.408
December	5.307	5.879	60.673	8.1	0.078	2.011	1.627	6.973	0.025	0.054	7.752	0.011	8.564	1.5	30.341
Feb-14	3.625	8.199		7.949	0.096		2.072		0.025	0.116	7.748	0.005	8.432	1.5	16.93
March	3.364	8.274		9.521	0.075		0.75		0.025	0.158	7.54	0.005	8.165	1.5	37.885
Mean	4	7.78	65.99	10.27	0.16	2.14	1.9	10.12	0.03	0.11	7.66	0.01	10.42	1.76	30.50
N	22	22	19	22	22	20	22	20	22	22	22	22	22	22	21
Maximum	5.31	10.41	88.86	14.07	0.51	2.76	3.77	14.34	0.07	0.3	8.03	0.04	13.4	7.19	47.618
Minimum	2.52	5.88	51.78	7.95	0.03	1	0.75	6.97	0.03	0.03	7.35	0.01	6.7	1.5	16.93
STDEV	0.7207	0.9771	8.2276	1.519	0.1318	0.534	0.7299	1.6857	0.0098	0.0783	0.1678	0.0084	1.5446	1.2408	5.9146
Key: DMS, dimethylsulphide in nM/l; EC, Electrical Conductance in mS/m; TAL, Total Alkalinity, STDEV, Standard Deviation.															

Table 3. Surface water quality results for the Klaserie Dam Barrage, Klaserie River, from April 2012 to September 2013 (DWAF, undated)

Date	Water quality parameters (in mg/l unless otherwise stated)																
	Ca	Cl	DMS	EC	F	K	Mg	Na	NH4	NO3 + NO2	pH	PO4	Si	SO4	TAL	Kjeldahl -N	P
Apr-12	5.061	7.754	71.34	17.09	0.025	1	3.27	8.948	0.089	0.126	7.961	0.005	8.579	1.5	35.345	0.823	0.08
May	5.712	8.56	70.67	14.95	0.053	2.141	2.636	9.131	0.053	0.218	7.956	0.005	8.862	1.5	32.715		
05-Jun	6.653	8.128	76.243	13.15	0.025	2.561	2.386	8.428	0.063	0.219	7.956	0.005	8.722	1.5	37.315		
27-Jun	6.448	8.427	76.941	13.44	0.459	2.261	2.238	8.491	0.025	0.238	7.908	0.005	8.807	1.5	37.741		
August	6.44	11.453	80.116	12.85	0.201	1	2.133	9.333	0.025	0.192	7.999	0.005	9.274	1.5	38.678		
02-Oct	4.549	10.192	75.814	11.99	0.025	2.212	0.75	10.099	0.025	0.127	7.741	0.015	8.636	1.5	37.602		
29-Oct	5.194	10.385	76.568	12.5	0.235	2.502	0.75	11.202	0.025	0.16	7.974	0.005	8.718	1.5	36.124		
November	5.527	8.984	73.813	12.22	0.278	2.05	0.75	9.683	0.025	0.076	7.903	0.016	7.863	1.5	36.599		
December	5.037	8.621		11.22	0.025	2.272	0.75	9.789	0.025	0.102	7.919	0.047	8.056	1.5			
Jan-13	3.965	9.798	74.11	11.63	0.131	2.612	0.75	8.018	3.252	0.194	7.702	0.189	6.727	1.5	34.209		
May	7.708	8.325	67.613	10.08	0.246	2.153	0.75	10.637	0.145	0.117	7.763	0.019	7.98	1.5	29.142		
June	5.273	8.376	72.947	9.492	0.184	1	2.026	9.625	0.164	0.96	7.19	0.015	8.406	1.5	33.181	0.343	0.031
August	9.26	7.471	93.679	14.04	0.401	2.422	2.652	9.404	0.025	0.025	7.555	0.035	7.964	1.5	49.472		
September	5.631	8.613	65.639	10.68	0.112	1	2.022	9.709	0.025	0.121	8.089	0.005	7.454	1.5	29.911		
Mean	5.89	8.93	75.04	12.52	0.17	1.94	1.7	9.46	0.28	0.21	7.83	0.03	8.29	1.5	36	0.58	0.06
N	14	14	13	14	14	14	14	14	14	14	14	14	14	14	13	2	2
Maximum	9.26	11.45	93.68	17.09	0.46	2.61	3.27	11.2	3.25	0.96	8.09	0.19	9.27	1.5	49.47	0.82	0.08
Minimum	3.97	7.47	65.64	9.49	0.03	1	0.75	8.02	0.03	0.03	7.19	0.01	6.73	1.5	29.14	0.34	0.03
STDEV	1.355	1.118	6.857	1.996	0.142	0.639	0.912	0.857	0.856	0.225	0.232	0.048	0.664	0	5.024	0.339	0.035

3. Methods and materials for the aquatic assessment

3.1. Introduction

The investigation for the alternative sites A1, A2 and A3 was restricted to a desktop study of each site, focusing on (1) river reach, channel and morphological units, (2) the reference and present extent of the riparian zone (2008 to 2014), (3) the biotopes for macro-invertebrates and flow-depth habitat classes for fish and (4) anthropogenic activity. Given that the riparian vegetation was examined at site KCP, the macro-invertebrates examined at site KCP_m (24°16.641'S, 31°08.057', 70m downstream from site KCP) and the fish fauna at sites KCP_m, KCP and KU (24°16.879'S, 31°08.642'E, 1.08km upstream of KCP), the localities of which are all within 3.5km of alternatives sites A1, A2 and A3, it was deemed plausible that the results for A1, A2 and A3 and would be similar on condition the diversity of habitats was comparable.

3.2. The riparian vegetation

The riverine and riparian vegetation was assessed at site KCP on 8 August 2014. The VEGRAI technique (Kleynhans, Mackenzie and Louw, 2007) is composed of a number of metrics (cover, abundance and species composition) and metric groups (marginal and non-marginal zone), which are rated in the field. The status of indigenous riparian vegetation (woody and non-woody) in the reference and current states is described for each metric. Differences between the two states are then compared as a measure of vegetation response to an impact zone. Exotic vegetation is also assessed separately.

The metrics are rated and weighted and an Ecological Category (EC) for the riparian vegetation state determined, between A and F (Table 4). The rating system comprises a six-point scoring system, where 0 represents no discernable change from reference conditions to 6 representing extreme modifications from reference. The vegetation component (woody and non-woody) in each vegetation zone is considered in terms of its importance in maintaining the condition of the vegetation zone under reference conditions. The vegetation component considered the most important in influencing the EC of the vegetation zone if it changed is ranked 1 and awarded a weight of 100%, and the next most important component is ranked 2 and awarded a rating proportionately less than 100%, and so on. The weighting of metric groups (vegetation zones) follows a similar approach (Kleynhans, MacKenzie and Louw, 2007).

A field form was completed for VEGRAI determination at site KCP (Appendix A) and photographs were taken to provide additional information.

Table 4. Ecological Categories for EcoStatus determination of riverine and riparian vegetation

Ecological Category	Description	Score (% of total)
A	**Unmodified, Natural**	90 – 100
B	**Largely Natural with few modifications**. A small change in habitats and biota has taken place, with ecosystem function essentially unchanged.	80 – 89
C	**Moderately Modified**. Loss and change in habitats and biota has occurred, with basic ecosystem functions predominantly unchanged.	60 – 79
D	**Largely Modified**. A large loss of habitats, biota and basic ecosystem function has occurred.	40 – 59
E	**Seriously Modified**. There is extensive loss of habitats, biota and ecosystem function.	20 – 39
F	**Critically Modified**. Almost complete loss of habitat and biota. In the worst case scenario, basic ecosystems function has been destroyed and the changes are irreversible.	0 - 19

(After Kleynhans *et al*, 2007, modified from Kleynhans, 1996 and Kleynhans, 1999).

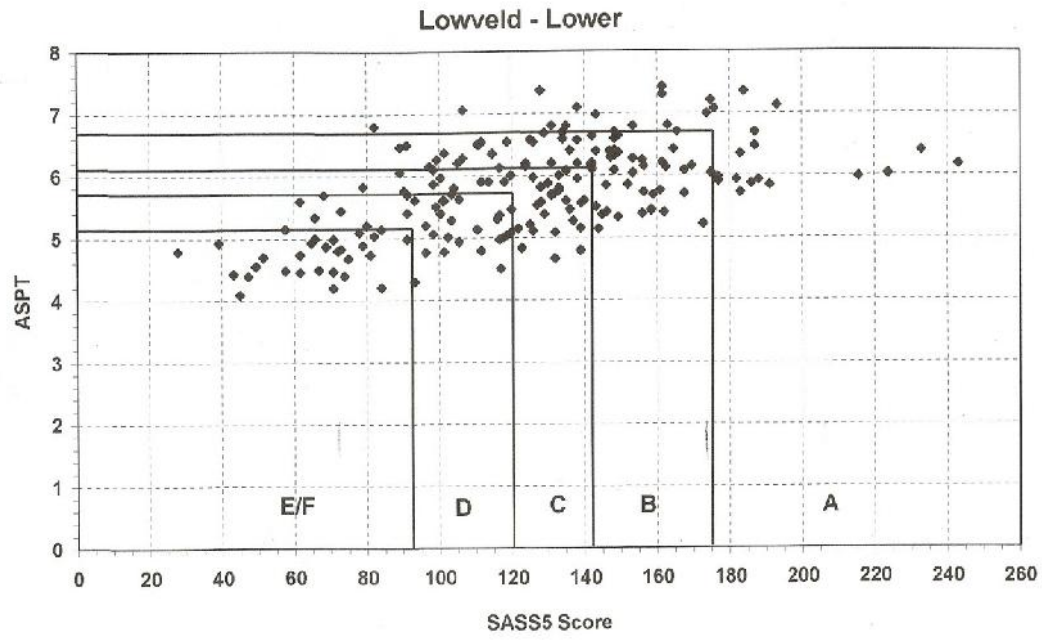
3.3. The aquatic macro-invertebrates

The macro-invertebrate fauna was sampled in a pool and riffle sequence (site KCP_m) on 6 August 2014 using standard procedures, and additions or modifications to, where appropriate, including SASS5 (Chutter, 1998; Dickens & Graham, 2002, Dallas, 2007) and IHAS (McMillan, 1998). The physico-chemical parameters determined for the river water at site KCP included, flow rate, clarity, turbidity and colour. Biotic parameters measured included macro-invertebrate biodiversity in stones in current (SIC), stones out of current (SOOC), bedrock, aquatic vegetation, marginal vegetation in current, marginal vegetation out of current (MVEG) and gravel, sand and mud (GSM) habitats. Total SASS5 and ASPT scores were determined, the IHAS and overall biotope suitability (SASS5) was estimated and an Ecological Category (EC) assigned to site KCP. The determination of ECs was according to Dallas (2007), across six bands for the Lower Lowveld, where Band A reflects unmodified natural conditions, through to F, the latter reflecting a critically or extremely modified status (Table 5, Figure 4). A standard form was used to record the data at site KCP_m (Appendix B).

Table 5. The Biological Bands and Ecological Categories for the interpretation of SASS5 data.

Biological Band / Category	Ecological Category Name	Description	Colour
A	Natural	Unmodified, natural.	Blue
B	Good	Largely natural with few modifications.	Green
C	Fair	Moderately modified.	Yellow
D	Poor	Largely modified.	Red
E	Seriously Modified	Seriously modified.	Purple
F	Critically Modified	Critically modified.	Black

(After Dallas, 2007).



(After Dallas, 2007)

Figure 4. The Biological Bands for the Lowveld, Lower Zone.

3.4. The fish fauna

The Fish Assemblage Integrity Index (FAII) technique (Kleynhans, or used to assess the fish fauna. This included the fish species collected between 6 and 8th August 2014 within the

biological segments (fish habitats) of KRS at sites KCP_m, KCP and KU as well as information for the Reference Frequency of Occurrence (FROC) Sites 40F81 and 40F73. Fish were collected using a SAMUS 725 electro-fishing apparatus, as well as with baited traps. Electro-fishing was conducted for 10 to 20mins in each of slow and deep, slow and shallow, fast and deep and fast and shallow flow-depth habitats. Eight traps were baited with bait balls comprising a mixture of fishmeal, maize meal and gelatine. The traps were submerged in the river overnight for a period of at least 16h.

The fish were categorized according to an intolerance index which takes into account trophic preferences and specialization, flowing water requirements during different life stages and association with habitats with unmodified water quality. The intolerance index (IT), the expected frequency of occurrence (F) and expected health (H) of the fish species at the localities was used to formulate an index for the situation expected under minimally impaired conditions and compared with the observed conditions following sampling. An IT value was determined at the sites for each expected species of fish, using habitat preference and present general aquatic conditions at the respective station as guidelines, and an average IT value was calculated for the species across all four stations. The average IT value was used in FAII determination. The values obtained were compared against values used by Kayde (2008) for fish species in the Nyagui River, Zimbabwe. The expected F value for each species at the stations was determined taking habitat preference and regional distribution (Skelton, 1993) into consideration. In the case of the reference sites, 40F81 and 40F73, a value of 3 was used for species, except in cases where the species is known to be hardy and encountered in a variety of habitats, where a value of 1 was used. The observed situation is expressed as a fraction of the expected situation, deriving a FAII value, described in the form of an EC (Kleynhans, 1999) (Table 6), where,

$FAII_{expected} = \sum IT_{expected} [(F_{expected} + H_{expected})/2]$,

$FAII_{observed} = \sum IT_{observed} [(F_{observe}d + H_{observed})/2]$, and,

$FAII_{relative} = [FAII_{observed} / FAII_{expected}] \times 100\%$.

The expected H for all species of fish expected to be found was fixed at a value of 5, the latter representing the fact that the frequency of fish for a species affected by externally evident disease or other anomalies (health impairment) is <2% (Kleynhans, 1999). Observed values for the fish collected were determined after examination of each individual fish. The

expected and observed values for the fish as recorded for the FROC sites was fixed, with the assumption that no evidence of impaired health occurred.

Table 6. The FAII Integrity Classes, their description and relative score.

Integrity Class rating	Description of conditions expected for the associated Integrity Class	Relative FAII score (% of the expected)
A	**Unmodified, Natural** conditions approximated.	90 to 100
B	**Largely Natural**, few modifications. Change in community characteristic may be present, species richness and presence of intolerant species indicate little modification.	80 to 89
C	**Moderately Modified**. Lower than expected species richness, presence of most intolerant species. Some impairment of health of the ecosystems, at lower limit.	60 to 79
D	**Largely Modified**. Lower than expected species richness, absence or lowered presence of intolerant species. Impairment of health more evident at lower limit.	40 to 59
E	**Seriously Modified**. Strikingly lower than expected species richness and absence of intolerant species. Impairment of health very evident.	20 to 39
F	**Critically Modified**. Extremely lowered species richness and absence of intolerant species. Complete loss of species in the lower limit. Impairment of health very evident.	0 to 19

(After Kleynhans, 1999).

3.5. Biophysical sensitivity analysis

The ecological sensitivity of the area is based on available data and the results obtained in the field during the site visit from 6 to 8th August 2014. The sensitivity is determined on a descriptive scale from **Very Low to High** (Table 7), where **Very Low** reflects a **highly transformed** natural environment with little or no ecological sensitivity, typically represented where there is existing infrastructure, to **High,** which may be described as **Natural and Unmodified.**

Table 7. The classification system used to describe the ecological sensitivity of the site.

Description of sensitivity	Comment
Very Low	No ecological significance. Highly transformed, dominated by infrastructure development. Ecological functions may be considered nearly irreversibly impaired.
Low	Low ecological significance. Highly transformed, dominated by agriculture development. Ecological functions seriously modified.
Medium-Low	Low to medium ecological significance. Ecological functions largely modified.
Medium	Medium ecological significance. Ecological functions moderately modified.
Medium-High	Medium to high ecological significance. Ecological functions with few modifications.
High	High ecological significance. Ecological functions unmodified.

Note: Classification partly based on that represented for EcoClassification determination as stated in Kleynhans and Louw (2008).

3.6. Impact Assessment and Mitigation

3.6.1. Assessment Methodology

This section outlines the methodology used to assess the significance of the potential environments impacts. For each impact, the extent (spatial scale), magnitude and duration (time scale) are described (Table 8). These criteria are used to ascertain the significance of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place. The mitigation described represents the full range of plausible and pragmatic measures and does not imply that they would or should be implemented. The tables below show the scale used to assess these variables, and define each of the rating categories.

Table 8. Assessment criteria for the evaluation of impacts

CRITERIA	CATEGORY	DESCRIPTION
Extent or spatial influence of impact	**Regional**	Beyond 5 km of the proposed activity.
	Local	Within 5 km of the proposed activity.
	Site specific	On site or within 100 m of the site boundary.
Magnitude of impact (at the indicated spatial scale)	**High**	Natural and/ or social functions and/ or processes are *severely* altered.
	Medium	Natural and/ or social functions and/ or processes are *notably* altered.
	Low	Natural and/ or social functions and/ or processes are *slightly* altered.
	Very Low	Natural and/ or social functions and/ or processes are *negligibly* altered.
	Zero	Natural and/ or social functions and/ or processes remain *unaltered.*
Duration of impact	**Construction**	Up to 2 years.
	Short Term	0-5 years (after construction).
	Medium Term	5-15 years (after construction).
	Long Term	More than 15 years (after construction).

The significance of an impact is derived by taking into account the temporal and spatial scales and magnitude. The means of arriving at the different significance ratings is explained in Table 9.

Table 9. Definition of significance ratings

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED
High	• High magnitude with a regional extent and long term duration. • High magnitude with either a regional extent and medium term duration or a local extent and long term duration. • Medium magnitude with a regional extent and long term duration.
Medium	• High magnitude with a local extent and medium term duration. • High magnitude with a regional extent and short term duration or a site specific extent and long term duration. • High magnitude with either a local extent and short term duration or a site specific extent and medium term duration. • Medium magnitude with any combination of extent and duration except site specific and short term or regional and long term. • Low magnitude with a regional extent and long term duration.
Low	• High magnitude with a site specific extent and short term duration. • Medium magnitude with a site specific extent and short term duration. • Low magnitude with any combination of extent and duration except site specific and short term. • Very low magnitude with a regional extent and long term duration.
Very low	• Low magnitude with a site specific extent and short term duration. • Very low magnitude with any combination of extent and duration except regional and long term.
Neutral	• Zero magnitude with any combination of extent and duration.

Once the significance of an impact has been determined, the probability of this impact occurring as well as the confidence in the assessment of the impact, are estimated using the rating systems outlined in Tables 10 and 11, respectively. It is important to note that the significance of an impact should always be considered in concert with the probability of that impact occurring. Lastly the reversibility is estimated using the rating system outlined in Table 12.

Table 10. Definition of probability ratings

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95 % chance of the impact occurring.
Highly probable	Estimated 80 to 95 % chance of the impact occurring.
Probable	Estimated 20 to 80 % chance of the impact occurring.
Possible	Estimated 5 to 20 % chance of the impact occurring.
Unlikely	Estimated less than 5 % chance of the impact occurring.

Table 11. Definition of confidence ratings

CONFIDENCE RATINGS	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 12. Definition of reversibility ratings

REVERSIBILITY RATINGS	CRITERIA
Irreversible	The activity will lead to an impact that is permanent.
Long Term	The impact is reversible within 2 to 10 years after construction.
Short Term	The impact is reversible within the 2 years of construction.

3.6.2. Subjectivity in Assigning Significance

To facilitate informed decision-making, EIA's must endeavour to come to terms with the significance of the potential environmental impacts associated with particular development activities. Despite their attempts at providing a completely objective and impartial assessment of the environmental implications of development activities, EIA processes can never completely escape the subjectivity inherent in attempting to define significance. Recognising this, there is an attempt here to address potential subjectivity in the current process as follows:

(1) Being explicit about the difficulty of being completely objective in the determination of significance, as outlined above.

(2) Developing an explicit methodology for assigning significance to impacts and outlining this methodology. Having an explicit methodology not only forces the assessor to come to terms with the various facets contributing toward determination of significance, thereby avoiding arbitrary assignment, but also provides the reader with a clear summary of how the assessor derived the assigned significance.

(3) Wherever possible, differentiating between the likely significance of potential environmental impacts as experienced by the various affected parties.

Although these measures may not totally eliminate subjectivity, they provide an explicit context within which to review the assessment of impacts.

3.6.3. Consideration of Cumulative Impacts

Section 24(4) of the National Environmental Management Act requires the consideration of cumulative impacts as part of any environmental assessment process. EIA's have traditionally, however, failed to come to terms with such impacts, largely as a result of the following considerations:

(1) Cumulative effects may be local, regional or global in scale and dealing with such impacts requires co-ordinated institutional arrangements; and

(2) EIA's are typically carried out on specific developments, whereas cumulative impacts may result from broader biophysical, social and economic considerations, which typically cannot be addressed at the project level.

4. Results and Discussion

4.1. Description of the alternative sites A1, A2 and A3

4.1.1. Alternative site A1

In terms of *river reach, channel and morphological units*, alternative site A1 is characterized by a well-defined channel (15/3/2014) approximately 80m in width (Figure 5). The examination of an image from November 2013 indicated that the base-flow is in the form of a braided channel, with a well-developed riffle of 100 to 120m in length, along the edge of the left bank (LB). The non-marginal zone along the LB (western side) is thus short and steep and reflects the incised nature of the channel and bank here given that the river turns to the east in the area. A well-developed point bar exists in the marginal zone on the eastern side

of the channel and leads to a more gradual and broader non-marginal zone along the right bank (RB). A tributary enters the river approximately 130m downstream of the site. *In terms of the reference and present extent of the riparian zone (2008 to 2014)*, a comparison of the images for 2013 and 2014 with that for January 2008 clearly shows that the river channel has been significantly scoured, broadening the channel and resulting in a reduction in cover of marginal non-woody vegetation from approximately 40 to 10%. There has also been a decrease in woody vegetation along the non-marginal zone, especially along the LB. In terms of *the biotopes for macro-invertebrates and flow-depth habitat classes for fish*, site A1 appears to have a high diversity of habitats, including SIC, SOOC, MVEG and GSM macro-invertebrate biotopes and deep and slow, shallow and slow, deep and fast and deep and slow water environments for fish species. In terms of *anthropogenic activity*, there is a well-defined gravel road parallel to the river approximately 70m to the west of the LB. There are no gravel roads immediately to the east of the RB. There is no direct, existing gravel road access to the river channel from either the LB or RB.

Figure 5. The Klaserie River at alternative site A1 (Google Earth™, 2014).

4.1.2. Alternative site A2

In terms of *river reach, channel and morphological units*, alternative site A2 is the old river crossing that existed before it was destroyed by a recent flood event. Alternative site A2 is characterized by a well-defined channel (15/3/2014) approximately 100m in width (Figure 6).

The examination of an image from November 2013 indicated that the base-flow is in the form of a braided, alluvial channel along the base of the LB. The non-marginal zone along the LB (western side) is short and steep. A well-developed point bar exists in the marginal zone on the eastern side of the channel and leads to a more gradual and broader non-marginal zone along the RB. *In terms of the reference and present extent of the riparian zone (2008 to 2014)*, a comparison of the images for 2013 and 2014 with that for January 2008 clearly shows that the river channel has been significantly scoured, broadening the channel and resulting in a reduction in cover of marginal non-woody vegetation from approximately 80 to less than 10% of the marginal zone. There has been no noticeable change in woody cover either along the LB or RB. In terms of *the biotopes for macro-invertebrates and flow-depth habitat classes for fish*, site A2 appears to have a lower diversity of habitats, including only MVEG and GSM macro-invertebrate biotopes, with a lack of riffles (SIC, SOOC). It is likely that only two of the four flow-depth habitat classes for fish exist at the site, namely deep and slow and shallow and slow. In terms of *anthropogenic activity*, the site is immediately upstream of the northern infrastructure along the LB. There is direct access to the site along a gravel road along both the LB and RB.

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Figure 6. The Klaserie River at alternative site A2 (Google Earth™, 2014).

4.1.3. Alternative site A3

In terms of *river reach, channel and morphological units*, alternative site A3 is characterized by a well-defined channel (15/3/2014) approximately 110m in width (Figure 7). The examination of an image from November 2013 indicated that the base-flow is in the form of a braided to anastomosing channel, well represented by riffle-pool sequences for a distance of 500m upstream and a distance of nearly 1.0km downstream of the site. The non-marginal zone along both the LB and RB is gradual. A comparison of the images for 2013 and 2014 with that for January 2008 clearly shows that the river channel has changed from a single straight channel to a more diverse one, with base flow changing from mid-channel to a position along the base of the RB. In terms of *the reference and present extent of the riparian zone (2008 to 2014)*, there has been a change in non-woody cover in the marginal zone from approximately 90% to 60 to 80%. There appears to have been a slight increase in woody cover along both the LB and RB. In terms of *the biotopes for macro-invertebrates and flow-depth habitat classes for fish*, site A3 appears to have a very high diversity of habitats, including SIC, SOOC, MVEG and GSM macro-invertebrate biotopes and deep and slow, shallow and slow, deep and fast and deep and slow water environments for fish species, both immediately upstream and downstream of the crossing. In terms of *anthropogenic activity*, alternative site A3 is the presently existing river crossing along a major gravel road ("cutline") that separates adjoining properties and serves as an access and servitude across the KPNR in a west-east direction. There is also a well-defined gravel road parallel to and 35m from the LB, upstream of the crossing.

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Figure 7. The Klaserie River at alternative site A3 (Google Earth™, 2014).

4.2. Riparian vegetation at site KCP

The riparian vegetation was surveyed and assessed using the VEGRAI technique at the preferred site, KCP, along a transect that follows the footprint of the proposed causeway, from the LB to the RB (Figures 8 and 9), with coordinates from the Left Bank (LB) to the Right Bank (RB), including (1) 24°16.648'S, 31°08.059'E, (2) (KCP) 24°16.634'S, 31°08.067'E, (3) 24°16.624'S, 31°08.073'E, (4) 24°16.619'S, 31°08.082'E, (5) 24°16.619'S, 31°08.089'E, (6) 24°16.607'S, 31°08.095'E and (7) 24°16.604'S, 31°08.095'E.

Less defined gravel roads are found parallel to the river along both the Left Bank (LB) and Right Bank (RB). More prominent gravel roads serve as access to these as well as to other parts of the reserve. An unimproved sand crossing across the river (site A3) is located approximately 2.41km downstream of the preferred causeway development site (KCP). The main causeway across the Klaserie River is located 11.24km downstream (24°12.128'S, 31°08.785'E) of site KCP. Infrastructure (northern) undergoing upgrading exists along the LB 440m downstream of site KCP, as well as 800m upstream of the site (southern infrastructure). Two tributaries (dry alluvial riverbeds) enter the Klaserie River along the LB between site KCP and the northern infrastructure (24°16.480'S, 31°07.985'E) and at the

southern infrastructure (24°16.854'S, 31°08.429'E). Two smaller tributaries enter the river along the RB at 24°15.857'S, 31°08.410'E and 24°16.260'S, 31°08.282'E.

Figure 8. The transect across the Klaserie River along which the VEGRAI assessment was conducted (Image, 2014; Google Earth™, 2014).

A total of 39 species of plants were collected at site KCP (Appendix A) in the marginal and non-marginal zones, including four alien species (Kikuyu, White Potato Creeper, Large Cocklebur and Persicaria). Species of plants collected in the marginal zone included *Flueggea virosa, Phragmites mauritianus, Plumbago auriculata, Leonotis ocymifolia, Pennisetum clandestinum* (A), *Xanthium strumarium* (A), *Spirostachys africana, Combretum hereroense, Cyperus sp., Sida cordifolia, Sida dregei, Dichrostachys cinerea, Gymnosporia senegalensis, Solanum seaforthianum* and *Euclea natalensis,* amongst others. Species of plants collected in the non-marginal zone included *Phyllanthus reticulates, Gymnosporia senegalensis, Phragmites mauritianus, Diospyros mespiliformis, Combretum imberbe, Grewia flavescens, Schotia brachypetala, Euclea natalensis, Sida cordifolia, Sida dregei, Leonotis ocymifolia, Philenoptera violacea, Sphaeranthus flexuosus, C. apiculatrum, Peltophorum africanum, Euclea divinorum* and *Spirostachys africana,* amongst others. Eight species of terrestrial woody and non-woody plant species were collected, including *Grewia flavescens, Sida cordifolia, Flueggea virosa, Plumbago auriculata, Combretum hereroense, C. apiculatum, Dichrostachys cinerea* and *Euclea divinorum*, amongst others. The latter

were probably displaced during flood events or spread along the riparian zone as a result of seed dispersal. No species of conservation importance were found (SANBI, 2014)

Figure 9. The in-stream area of the KCP site, facing across and upstream.

In the marginal zone of the KCP site the climax vegetation may be considered to be dominated by stands of non-woody *Phragmites mauritianus*, with both abundance and cover high, over most of the channel. There would be a significant proportion of riparian woody species too. The only areas not covered by these stands would be the primary active channel comprising pool – riffle sequences and over bedrock of the dykes and sills crossing the riverbed. Other areas that may not be covered by these stands would be where point and lateral bars have been formed due to a sharp change in riverbed channel direction at bends in the river. The present state, however, includes significantly more and extensive areas of exposed sediment in the form of various bars across the channel. The loss of abundance and cover may be as much as 50%. Although this may be deemed natural, the increase in sedimentation in the river is due to anthropogenic activity in the catchment. The apparent increase in significant flood events has also resulted in an almost permanent state of secondary succession in the river, without the progression in time to a state of climax vegetation. Vegetation removal in the marginal zone, thus, in terms of anthropogenic activity on site, is negligible, and may thus be considered to be lower than 10% (cover and abundance) for both woody and non-woody vegetation. If the effect of catchment-wide

influences on vegetation removal is considered then a conservative estimate for vegetation removal (cover and abundance) in terms of non-woody species may be considered to be 20 to 40% and in terms of woody species 10 to 20%. The latter values are considered in the calculation of the EC.

In the non-marginal zone the climax vegetation may be considered to be dominated by woody species and in the area of the KCP site would include *Spirostachys africana, Diospyros mespiliformis, Combretum imberbe, Schotia brachypetala, Gymnosporia senegalensis, Euclea natalensis, Philenoptera violacea*, and others. The percentage cover would be significantly high. The present state, however, includes a high proportion of coppiced woody vegetation due to (1) frequent high flood events resulting in scouring of the river channel and the loss and re-deposition of woody vegetation and (2) herbivory by mega-herbivores. Hence, as is the case with the marginal zone, there has been a loss of both cover and abundance of both woody and non-woody vegetation, should catchment-wide influences be considered. The magnitude of the loss along the LB may be estimated to be in the region of less than 10% for abundance and 10 to 20 % for cover. In the case of the RB the magnitude would be lower as the area represents the inside of the riverbend and may be estimated to be less than 10% for both abundance and cover. Vegetation removal in the non-marginal zone, thus, in terms of anthropogenic activity on site, is negligible, and may thus be considered to be lower than 10% (cover and abundance) for both woody and non-woody vegetation. The former values were used in the calculation of the EC.

The VEGRAI score calculated for the riparian vegetation at the KCP site was calculated to be 81.2%, with a 20% change in marginal vegetation and a 17 % change in non-marginal vegetation. Hence, the Ecological Category and PES for the site is a B (Table 4), where the riparian vegetation can be described as Largely Natural with few modifications, with a small change in habitats and biota having taken place, with ecosystem function essentially unchanged.

4.3. The aquatic macro-invertebrates at site KCP_m

A total of 28 macro-invertebrate taxa (65% of the taxa expected at the site) were collected at a sampling site KCP_m (24°16.641'S, 31°08.057'E) 70m downstream of site KCP (Figure 10), including Oligochaeta, Potamonautidae, Hydracarina, Baetidae (> 2sp), Caenidae, Heptageniidae, Leptophlebiidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Belostomatidae, Gerridae, Naucoridae, Notonectidae, Vellidae, Hydropsychidae

(1sp), Leptoceridae, Hydraenidae, Ceratopogonidae, Chironomidae, Culicidae, Psychodidae, Simuliidae, Tabanidae, Corbiculidae and Unionidae. One taxon not expected at the site, namely the minute moss beetle, was collected. A Belostomatid male with eggs over the dorsal surface was collected. Only one taxon with a sensitivity score of greater than 10 was collected (Heptageniidae). The biotope suitability score was 53% and the IHAS score was estimated to be 72%. The flow rate was low, the turbidity medium, the clarity approximately 20cm and the water colour grey (Appendix B).

The SASS5 score at the KCP_m site was calculated to be 153 with an ASPT score of 5.5. The Ecological Category (Table 5), using the Biological bands for the Lower Lowveld (Figure 4) was found to be a B, which may be described as unmodified, natural.

Figure 10. The stones-in-current biotope at the SASS5 sampling site.

4.4. The fish fauna at sites KCP_m, KCP and KU

The fish fauna was surveyed for at sites KCP_m and KCP (data pooled), as well as at site KU (Figure 11), 1.08km upstream of site KCP, in shallow and slow, deep and slow, shallow and fast and deep and fast biotopes. A total of 304 fish from 22 species was collected (Table 13), including *Marcusenius macrolepidotus, Petrocephalus catostoma, barbus annectens, B. lineomaculatus, B. unitaeniatus, B. viviparus, B. trimaculatus, B. eutania, B. paludinosus,*

Labeobarbus marequensis, Labeo rosae, L. ruddi, L. cylindricus, L. molybdinus, Brycinus imberi, Clarias gariepinus, Chiloglanis paratus, C. pretoriae, Pseudocrenilabrus philander, Tilapia sparrmanii, T. rendalli and *Oreochromis mossambicus* (Appendix C). No species of conservation importance were found (IUCNI, 2014)

Figure 11. A section of the upstream site, KU, used for sampling fish and for the FAII analysis.

Table 13. The fish species collected at sites KCP_m, KCP and KU in the Klaserie River, 6 to 8th August 2014.

Species	Number of Fish					Description of health impairment
	Sites KCP_m and KCP		Site KU		Total	
	EF	TR	EF	TR		
Marcusenius macrolepidotus	1	1	4		**6**	
Petrocephalus catastoma			8(2)		**8(2)**	Caudal fin lower lobe swollen, yellowish.
Barbus annectens	1	2	10		**13**	
B. lineomaculatus	1				**1**	
B. unitaeniatus	8				**8**	
B. viviparus	1				**1**	
B. trimaculatus	15	14(2)			**29(2)**	Secondary infection on fin.
B. eutania	5				**5**	
B. paludinosus	1				**1**	
Labeobarbus marequensis	47(2)		11		**58(2)**	Vasculitis on fin.
Labeo rosae	2				**2**	
L.ruddi	3		8	3	**14**	
L.cylindricus	35	1	11	3	**50**	
L. molybdinus	26(8)				**26(8)**	Cutaneous vasculitis below scales. Distorted caudal fin.
Brycinus imberi	4		6	1	**11**	
Clarias gariepinus	2		2(2)		**4(2)**	Pre-orbital skin lesion. Severe injury on area of caudal peduncle, cutaneous necrosis, skeletal muscle exposed
Chiloglanis paratus	1				**1**	
C. pretoriae	11(4)	1			**12(4)**	Not recorded
Pseudocrenilabrus philander	1		8	4(2)	**13(2)**	White cartilaginous deformity on caudal fin. Vasculitis on caudal fin.
Tilapia sparrmanii	1		1		**2**	
T. rendalli			11	1	**12**	
Oreochromis mossambicus	10(9)		17(16)		**27(25)**	Black spot disease common in the fish.
Total	**176(23)**	**19(2)**	**97(20)**	**12(2)**	**304(47)**	

Key: EF, electrofishing; Tr, trapping; (x), number of fish health impaired.

A total of 80mins electrofishing was undertaken at sites KCP_m and KCP and 40mins at site KU. The 8 baited traps were left overnight in the river at sites KCP_m and KCP for 16.25h and at site KU for 16.00h. The catch per unit effort (CPUE) for electrofishing at site KCP_m and KCP was 146.25 fish h^{-1} and at site KU 160 fish h^{-1}. The CPUE for the trapping of fish was 0.15 fish per trap h^{-1} at site KCP_m and KCP and at site KU 0.09 fish per trap h^{-1}. Of the 273 fish collected at site KCP_m and KCP, 25 (9%) were health impaired and of the 109 fish collected at site KU, 22 (20%) were health impaired.

The relative FAII calculated for the fish at site KCP_m, KCP and KU, in conjunction with data from FROC sites 40F81 and 40F73, was 81.0% (Ecological Category B) which may be described as Largely Natural with few modifications. Changes in community characteristic may be present and species richness and the presence of intolerant species indicate little modification.

The presence of water flow and water quality intolerant species, including *B. eutania* and *C. pretoriae* (Moodley, 2011) supports the view that the Klaserie River at the KCP_m and KCP and KU sites may be considered to be largely natural with few modifications.

4.5. Other taxa

Although a dedicated survey of other biota was not specifically carried out at the KCP site or alternative sites A1, A2 and A3, there was evidence at KCP of the presence of the Cape Clawless Otter, *Aonyx capensis*. As expected, there were hippopotami and crocodiles present in the Klaserie River.

4.6. Biophysical sensitivity analysis

Based on available information, the literature review in Section 2 and the results obtained in Section 4, the preferred site KCP and the alternative sites A1, A2 and A3, were subjected to an ecological sensitivity analysis as described in Section 3.5.

The riparian vegetation at site KCP, the macro-invertebrates at site KCP_m, and the fish fauna in the macro-reach at sites KCP_m, KCP and KU as well as in the region, all generally reflect an aquatic environment that may be placed in the Ecological Category (EC) B, where the ecosystems are in a Present Ecological State (PES) described as largely natural with few modifications. For this reason, the Ecological Sensitivity of the preferred site KCP may be classified as being characterized by a high Ecological sensitivity (Table 14). Although the

KCP site however does not possess a high diversity of in-stream habitats and thus should be classified as medium-high to high ecological sensitivity. Site A1 is very similar to site KCP_m, and should thus be classified as of high ecological sensitivity. Site A2, however, may be classified as medium ecological sensitivity as it has been previously impacted given that it is the causeway site that was recently destroyed and also is within an area of the macro-reach where there is a low diversity of in-stream habitats. Site A3 should be classified as high to very high ecological sensitivity in that it is not only similar to site KCP_m and KCP, but the site is characterized by pool-riffle sequences over a distance along the in-stream channel of 1.5km.

Table 14. The ecological sensitivity analysis for the preferred KCP and alternative A1, A2 and A3 sites.

Proposed localities for the causeway	Ecological sensitivity	Description	Comment
Site KCP	Medium-High to High	Medium to High ecological significance. Ecological functions with few modifications.	The KCP site, in terms of the actual footprint of the proposed causeway, does not possess a high diversity of in-stream habitats. The presence of site KCP_m 70m downstream of the KCP site, would suggest, however, that the choice of the site must be considered with caution, as the river along the macro-reach in the area may be classified as largely natural, with few modifications: (1) VEGRAI Assessment for riparian vegetation: EC = B. Largely Natural with few modifications. A small change in habitats and biota has taken place, with ecosystem function essentially unchanged. (2) SASS5 Assessment for macro-invertebrates. Largely natural with few modifications. (3) FAII Assessment. Largely Natural, few modifications. Change in community characteristic may be present, species richness and presence of intolerant species indicate little modification. Advantages in the choice of the site in terms of construction include the fact that the rock bar and dyke across the river at the site is at an appropriate height for the construction of a low causeway with significant foundation support. Thus the construction will not require significant intervention, for example removal of rock by blasting, and will be sufficiently stable to avoid loss during flood events.
Site A1	High	High ecological significance.	As the river at site A1 is similar to site KCP_m in types and diversity of habitat, the site may be classified as largely natural with few modifications: (1) VEGRAI Assessment for riparian vegetation: EC = B. Largely Natural with few modifications. A small change in habitats and biota has taken place, with ecosystem function essentially unchanged. (2) SASS5 Assessment for macro-invertebrates. EC = B. Largely natural with few modifications. (3) FAII Assessment. EC = B. Largely Natural, few modifications. Change in community characteristic may be present and species richness and presence of intolerant

		Ecological functions unmodified.	species indicate little modification. The A1 site is characterized by a well-developed pool-riffle sequence flowing between prominent bedrock and boulder-bed sections of a pronounced dyke across the river. The site must therefore not be disturbed as it serves the same important function as the pool-riffle sequence at site KCP_m, that is, by providing diverse habitat as refuge for a high diversity of biota, especially in low flow conditions in the dry months. However, in terms of construction, the bedrock across the river at the site would need significant intervention, for example removal of rock by blasting. This must be avoided. The bedrock would create a stable foundation for a causeway, though.
Site A2	Medium	Medium significance. Ecological functions moderately modified.	Based on the fact that the site is characterized by single alluvial channel with a low diversity of habitats, as well as the fact that it has served as a river crossing historically, it is expected that the biota at the site would reflect moderately modified ecological functions. In addition, given that site A2 is a sand crossing with an inadequate rock base, it would be inadvisable to construct a permanent causeway at the site as there would not be sufficient foundation stability during flood events. An advantage in terms of the use of the site is that there is direct gravel road access to the site presently.
Site A3	(Very) High	High ecological significance. Ecological functions unmodified.	As the river at site A3 is similar to site KCP_m in types and diversity of habitat, the site may be classified as largely natural with few modifications: (1) VEGRAI Assessment for riparian vegetation: EC = B. Largely Natural with few modifications. A small change in habitats and biota has taken place, with ecosystem function essentially unchanged. (2) SASS5 Assessment for macro-invertebrates. Largely natural with few modifications. (3) FAII Assessment. Largely Natural, few modifications. Change in community characteristic may be present, species richness and presence of intolerant species indicate little modification. In addition, however, given that the macro-reach both upstream and downstream of the crossing is represented by well-developed pool-riffle sequences for a total distance of 1.5km, it is thus strongly advised that this macro-reach be conserved with as little impact across the river at the reach as possible. The A3 site has been impacted by the fact that it presently serves as a main route across the Klaserie River for access to properties across the east-west axis of the KPNR.

5. Impact Assessment and Mitigation Measures

5.1. Impact Assessment

5.1.1. Introduction

The potential impact of the construction of a proposed causeway in the Klaserie River on all four sites as a whole in terms of surface water quality and EFR is considered first. This is followed by the impact of a proposed causeway on the physical attributes and morphological

units of the in-stream zone, riparian vegetation, macro-invertebrate assemblage and diversity and fish assemblage and diversity at the preferred site KCP and alternative sites A1, A2 and A3, respectively.

5.1.2. Impact of construction on surface water quality and the EWR at sites KCP, A1, A2 and A3.

The literature review on the surface water quality (Section 2.6) in the Klaserie River would suggest that receiving waters in the region of the macro-reach, which includes all four sites, is characterized by acceptable levels of electrical conductance, total dissolved solids and pH for aquatic ecosystems. Values for $NH4^{+}$, NO_x and PO_4^{3-} indicate that there are sufficient concentrations of nutrients in the water to support mesotrophic to mildly eutrophic conditions. On condition that the causeway is constructed from appropriate materials and there is sufficient through-flow of water at the proposed causeway during low flow months in the dry season when the river is not subject to ephemeral conditions, the negative impact of the causeway on site-specific surface water quality will be negligible.

It is very likely that the Lower Olifants River System, which includes the Klaserie River, continues to fail to meet Environmental Water Requirements today, as was the case for significant parts of the periods 1987 to 2000 and 2001 to 2008 (Section 2.5). The recommendation is that the flow rate in the most critical months, for example, September, must be a minimum of $0.101 m^3 s^{-1}$ to provide the necessary depths and velocities for macro-invertebrates and fish. Riffles, in particular, are very sensitive to these requirements because given their nature they often exist at a slightly higher elevation than surrounding standing water environments. Should these requirements be met at the causeway when possible (depending on the volume and discharge rate of receiving waters), the negative impact thereof on EWR should be negligible.

Hence, the negative impact of the causeway on surface water quality and EWR will be site-specific in extent, of low magnitude, short-term duration and very low significance (Table 15).

Table 15. The extent, magnitude, duration and significance of the impact of the proposed causeway on the surface water quality and EWR at sites KCP, A1, A2 and A3.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on surface water quality and EWR	Site Specific	Low	Short-term	Very low	Probable	Sure	Long-term

5.1.3. Preferred site KCP

The in-stream zone at the KCP site is characterized by a low diversity of morphological units, with the presence of significant sedimentation around the rock bar and dyke across the footprint for the proposed causeway. **The potential impact of the proposed causeway on destruction of the physical attributes and morphological units of site KCP may be considered to be site-specific in extent, low magnitude, long-term duration and low significance** (Table 16).

None of the 39 plant species found in the riparian vegetation are of conservation importance. Four species of alien plants were identified and it was found that eight species of terrestrial species were present in the marginal and non-marginal zones. The presence, however, of Tamboti trees, *Spirostachys africana*, especially in the lower and upper levels of the non-marginal zone along the RB, must be taken cognizance of and these trees must be avoided as far as possible during construction. The PES for the riparian vegetation was found to be largely natural with few modifications, and although the composition and the dynamics of the riparian vegetation may change at the site due to the effect of flood events, the PES must be maintained at the site. **The potential impact of the proposed causeway on the composition and diversity of the riparian zone may be considered to be site-specific in extent, medium in magnitude, of long-term duration and medium significance** (Table 16).

The site does not possess all the biotopes to support a diverse macro-invertebrate fauna, especially SIC, SOOC and bedrock types. Therefore, although KCP_m immediately downstream of the site included all the biotopes (SIC, SOOC, bedrock, MVEG and GSM) and was found to be largely natural with few modifications, the impact of the proposed causeway on the macro-invertebrate fauna is not expected to be significant because the diversity is expected to be low with a lower SASS5 score. **Hence, the potential impact of the proposed causeway on the composition and diversity of the macro-invertebrate fauna may be considered to be site-specific in extent, low in magnitude, of short-term**

duration and very low in significance (Table 16). The causeway construction, on the contrary, will create additional artificial habitats, for example solid surfaces and cobbled "riffles" for the macro-invertebrate fauna that inhabit SIC, SOOC and bedrock

Although the FAII for the fish species in the macro-reach that includes all four sites was determined to be largely natural with few modifications (Section 4.4), site KCP does not include an important fish flow-depth class, namely fast and shallow water. This depth-class is expected to have a diversity of fish species, especially sexually mature adults. Hence, the impact of the proposed causeway on the fish fauna is not expected to be significant because the diversity is expected to be lower with a potentially lower FAII score. Given that nine of the 22 fish species (41%) recorded for the macro-reach in which all four sites are located undergo some form of migration during their life history, it is essential that to limit negative impacts on the fish, the causeway must include an adequate throughput of water to allow for this migration. Site KCP is classified as medium-high to high ecological sensitivity

Hence, the potential impact of the proposed causeway on the composition and diversity of the fish fauna may be considered to be local in extent, low in magnitude, of long-term duration and low in significance (Table 16).

Table 16. The extent, magnitude, duration and significance of the impact of the proposed causeway on the aquatic environment at preferred site KCP.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on physical attributes and morphological units.	Site Specific	Low	Long-term	Low	Probable	Sure	Long-term
Impact on riparian vegetation	Site Specific	Medium	Long-term	Medium	Probable	Sure	Long-term
Impact on macro-invertebrate assemblage and diversity	Site-specific	Low	Short-term	Very low	Probable	Sure	Short-term
Impact on fish assemblage and diversity	Local	Low	Long-term	Low	Probable	Sure	Short-term

5.1.4. Alternative site A1

Given that alternative site A1 was not included specifically in the VEGRAI. SASS5 and FAII analyses, the impact assessment here is based only on the description for the site (Section

4.1.1) and is expressed broadly in terms of the impact of the causeway on the site in general (Figure 17).

The base-flow at site A1 is in the form of a braided channel, with a well-developed riffle of 100 to 120m in length and has a high diversity of habitats, including SIC, SOOC, MVEG and GSM macro-invertebrate biotopes and deep and slow, shallow and slow, deep and fast and deep and slow water environments for fish species. This would suggest that the site has a high diversity of both macro-invertebrate and fish species and in all likelihood may be described as largely natural with few modifications. The impact of the construction of a causeway over the riffle would thus be significant. In addition, the ecological sensitivity of the site is high. Further to this, although there has been a reduction in cover of marginal non-woody vegetation from approximately 40 to 10% of the marginal zone and a decrease in woody vegetation along the non-marginal zone, the construction of an access route to the site from both banks would have a negative impact on the riparian vegetation. Site A1 has been classified as of high ecological sensitivity.

Hence, the potential impact of the proposed causeway on the riparian, macro-invertebrate and fish fauna at site A1 may be considered to be site-specific in extent, medium in magnitude, of long-term duration and medium in significance (Table 17).

Table 17. The extent, magnitude, duration and significance of the impact of the proposed causeway on the riparian vegetation and macro-invertebrate and fish fauna at alternative site A1.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on the riparian vegetation and macro-invertebrate and fish fauna	Site-specific	Medium	Long-term	Medium	Probable	Sure	Irreversible

5.1.5. Alternative site A2

Alternative site A2 is the old river crossing that existed before it was destroyed by a recent flood event and thus represents a historically negatively impacted area. The river channel has been significantly scoured, broadening the channel and resulting in a reduction in cover of marginal non-woody vegetation from approximately 80 to less than 10% of the marginal zone. There has been no noticeable change in woody cover either along the banks. Site A2 appears to have a lower diversity of habitats, including only MVEG and GSM macro-

invertebrate biotopes, with a lack of riffles (SIC, SOOC). It is likely that only two of the flow-depth habitat classes for fish, namely deep and slow and shallow and slow are present at the site. There is direct access to the site along a gravel road along both the LB and RB. The site is classified as of medium ecological sensitivity.

Hence, the potential impact of the proposed causeway on the riparian, macro-invertebrate and fish fauna at site A2 may be considered to be site-specific in extent, medium in magnitude, of long-term duration and low in significance (Table 18).

Table 18. The extent, magnitude, duration and significance of the impact of the proposed causeway on the riparian vegetation and macro-invertebrate and fish fauna at alternative site A2.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on the riparian vegetation and macro-invertebrate and fish fauna	Site-specific	Low	Long-term	Low	Probable	Sure	Long-term

5.1.6. Alternative site A3

Alternative site A3 is characterized by a well-defined channel 110m in width with the base-flow in the form of a braided to anastomosing channel, well represented by riffle-pool sequences for a distance of 500m upstream and a distance of nearly 1.0km downstream of the site. There has been a change in non-woody cover in the marginal zone from approximately 90% to 60 to 80%, with a slight increase in woody cover along both the banks. Site A3 appears to have a very high diversity of habitats, including SIC, SOOC, MVEG and GSM macro-invertebrate biotopes and deep and slow, shallow and slow, deep and fast and deep and slow water environments for fish species, both immediately upstream and downstream of the crossing. In addition, the A3 is the presently existing river crossing along a major gravel road. The site has very high ecological sensitivity.

Hence, the potential impact of the proposed causeway on the riparian, macro-invertebrate and fish fauna at site A3 may be considered to be site-specific in extent, medium in magnitude, of long-term duration and medium in significance (Table 19).

Table 19. The extent, magnitude, duration and significance of the impact of the proposed causeway on the aquatic environment at alternative site A3.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on the riparian vegetation and macro-invertebrate and fish fauna	Local	Medium	Long-term	Medium	Probable	Sure	Irreversible

5.1.7. Cumulative impacts

Clearly as alluded to in Section 3.6.3, there are limitations in considering cumulative impacts of a development relative to other associated impacts. This is particularly relevant to river systems that are characterized by their longitudinal dimension, affording a potential link to natural and anthropogenic events at local, regional and global scales. In the context of the impact of the construction and operation of a causeway of the type as envisaged for the Remaining Portion of the Farm Hull 92KU in the KRS, the impacts upstream of the causeway at one of the the KCP, A1, A2 and A3 sites that may be considered to be cumulative with these are (1) the impact on water quality and (2) the impact on the longitudinal, lateral and vertical components of the river water column and EWR. In terms of the former, water quality impacts occur outside of the KPNR over 6.7km upstream and in terms of the latter, the closest properly constructed causeway is 11.24km downstream. Given the results and impact assessment recorded in this report and the inherent resilience of river systems, it is very unlikely that the construction of a causeway at any one of the sites will contribute to a significant cumulative effect with other local or regional impacts in the KRS.

5.1.8. Summary

the negative impact of the causeway on surface water quality and EWR will be of very low significance.

The significance of potential impacts on the aquatic environment was found to vary between very low (macro-invertebrate fauna) and medium (riparian vegetation) at preferred site KCP (medium-high to high ecological sensitivity), medium significance at alternative sites A1 (high ecological sensitivity) and A3 (very high ecological sensitivity) and low significance at alternative site A2 (medium ecological sensitivity). Although site A2 would thus be the best choice for the location of the causeway in terms of biotic considerations, and important aspect to consider is that the site is alluvial in nature and there is no dyke or rock on which to secure the causeway and construct a sound structure. Hence, the likelihood is that the

causeway would be significantly damaged or destroyed in a flood event. The destruction by flooding of causeways and the concomitant desire to construct new ones must be avoided as far as possible. As stated in Section 1.1, a total of 16 river crossings (sand, rock or concrete) were discernible from Google 2008 images (Google^{TM}, 2014) over a distance of 45km (one crossing every 2.8km). Hence, as the next alternative to site A2, site KCP would be the best choice for the location of the causeway. The site includes a dyke and rock bar for proper anchoring of the causeway and is low enough to be constructed at base flow level, hence obviating the necessity of extreme intervention, for example, blasting, and allowing for the most efficient use of construction materials, the limitation of visual impact and the construction of flow through structures to allow for meeting EWR requirements. It will be important, though, to strongly mitigate any impact on the riparian vegetation at the site.

5.2. Mitigation measures and/or recommendations

5.2.1. Construction Phase

5.2.1.1. Causeway design and construction

The design of the causeway, its access roads and the chosen footprint will play an important role in ensuring that the development has a limited impact on the aquatic environment. The goal must be to,

(1) Minimize clearing in the non-marginal zone, especially of large indigenous trees or conservation important trees,

(2) Optimize the approach road cutting to the causeway by a combination of the minimization of angle of slope (longitudinally and laterally), minimization of a breach in the longitudinal connectivity of the riparian zone and the employment of erosion control measures,

(3) Minimize the destruction of marginal zone and in-stream habitat diversity by avoiding construction over prominent riffles, minimize the influence of the position of the causeway on upstream and downstream riffles, allow for a discharge of water through the causeway during low flow conditions of at least $0.101 m^3 s^{-1}$, where possible, and by applying measures to minimize the deposition of excess sediment on the upstream side of the causeway, and,

(4) Prevent scouring of the sediment immediately below the causeway.

Measures to achieve these goals include,

(1) Avoiding the Tamboti trees in the upper part of the non-marginal zone along the RB at the preferred site KCP should this site be chosen,

(2) Employing sound engineering and the application of river rehabilitation techniques, for example those recommended in Russell, W. (2009) WET-RehabMethods: National guidelines and methods for wetland rehabilitation. Wetland Management Series. WRC Report No. TT341/09. Water Research Commission, Pretoria.

(3) Placing pipes low enough through the base of the body of the causeway to allow for water to pass through during low flow conditions. This will allow the minimum EWR of $0.101 m^3 s^{-1}$ to be met should there be sufficient receiving water upstream of the causeway. The pipes should also be placed in a position along the length of the causeway where the likelihood is the greatest for the active channel to pass through during low flow conditions. In the case of the site KCP, this position is clearly directly adjacent to the LB. An examination of Google Earth™ (2014) images for the period 2008 to 2014 indicates that the path for the active channel during low conditions has been stable for this period.

(4) Constructing a cobbled "slipway" over the top of the causeway for a short distance in one or more positions across its length to promote riffle functions, including an increase in habitat diversity, the "purification of the water" and oxygenation of the water. The best position for such a cobbled area on the proposed causeway for the KCP site would be towards the RB end of the structure, where the river is likely to flow over the causeway when the flow increases.

(5) Ensuring that when the river is diverted to allow for construction of the causeway, the diversion is such that the path of the river downstream of the causeway is not significantly altered, especially to the extent where the downstream base flow is also diverted from passing over the pool-riffle sequence at site KCP_m.

5.2.1.2. Materials use and handling

Soil used for the production of concrete for the causeway must be utilized from the river channel and riparian zone as close to the site as possible. The excavation of the soil from the site must be such that the base flow is not altered from its present course as far as possible.

The importation and use of foreign and hazardous substances, for example, petrol, oil and lubricants, on the construction site must be governed by acceptable practices and specified as such in an EMPr.

5.2.2. Operations Phase

5.2.2.1. Maintenance of the causeway

Maintenance of the causeway must be undertaken immediately when required and must also be thoroughly checked on an annual basis. Sediment and debris deposition immediately upstream of the causeway, and against roadway guiding posts, must be taken cognizance of on a regular basis and the efficient operation of the causeway, for example the prevention and clearing of sediment and debris buildup and blocking up of the throughput pipes, must be done regularly. This will ensure that the low flow active channel remains as is and does not change course. The disturbance of the alluvial bed of the river on site must be avoided as far as possible, though.

The roadway across the causeway should be covered with a thin layer of river sediment when exposed to reduce the visual impact.

5.2.2.2. Validation of impacts on biota

In order to validate the impacts of the causeway on the aquatic environment in the Klaserie River, it is recommended that a short-term bio-monitoring program be conducted to determine the PES for the macro-invertebrates and fish fauna at site KCP_m. The results obtained in this study may be used as a baseline data set and the program can be conducted once a year for three years, post-construction. Should any trends of concern or anomalies be discovered during the process, appropriate intervention may be considered in conjunction with the management component of the KPNR.

This will ensure that measures are taken to maintain the overall PES for the aquatic environment in the macro-reach as unmodified natural with few modifications, and also provide an indication of post-mitigation impact significance in the river.

Finally, it is strongly recommended that the management component on the property engage with the authorities in charge of the OWMA in order that the IWRM of the Klaserie River and Lower Olifants River System can be supported and improved on.

6. Conclusion

The VEGRAI score calculated for the riparian vegetation at the KCP site was calculated to be 81.2%, with a 20% change in marginal vegetation and a 17 % change in non-marginal vegetation. The Ecological Category and PES for the site is a B, where the riparian vegetation can be described as Largely Natural with few modifications, with a small change in habitats and biota having taken place, with ecosystem function essentially unchanged. The SASS5 score at the KCP_m site was calculated to be 153 with an ASPT score of 5.5. The Ecological Category was found to be a B, which may also be described as unmodified and natural. The relative FAII calculated for the fish at site KCP_m, KCP and KU, in conjunction with data from FROC sites 40F81 and 40F73, was 81.0% (Ecological Category B) which may be described as Largely Natural with few modifications. Changes in community characteristic may be present and species richness and the presence of intolerant species indicate little modification.

The Ecological Sensitivity of the preferred site KCP may be classified as being characterized by a Medium-high to High ecological sensitivity. Alternative site A1 may be classified as of High ecological sensitivity, site A2 as of medium ecological sensitivity and site A3 High to Very high ecological sensitivity.

The significance of potential impacts on the aquatic environment was found to vary between very low (macro-invertebrate fauna) and medium (riparian vegetation) at preferred site KCP, medium significance at sites A1 and A3 and low significance at site A2. However, since site A2 does not include a rock bar and dyke for securing the causeway and providing for a structure that can withstand floods, site KCP would be the best choice for the location of the causeway. The site includes a dyke and rock bar for proper anchoring of the causeway and is low enough to be constructed at base flow level, hence obviating the necessity of extreme intervention.

Mitigation measures and recommendations for the construction and operation phases are provided.

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Appendix A
VEGRAI ASSESSMENT
PROPOSED CAUSEWAY HULL PROPERTY
KLASERIE RIVER, APNR

Assessors: Dr LR Taylor, Mr J Matibula, Mr A Ntimane
River: Klaserie River
Coordinates: 24°16.634'S, 31°08.067'E
Quaternary Catchment: Eco-region 3.07, QDB B73B
Date: **08**/08/2014

Longitudinal boundary of site

Description:

Less defined gravel roads are found parallel to the Klaserie River (KR) along both the Left Bank (LB) and Right Bank (RB). More prominent gravel roads serve as access to these as well as to other parts of the reserve. An unimproved sand crossing across the river (KWC) is located approximately 2.41km downstream of the preferred causeway development site (KCP). Infrastructure undergoing upgrading exists along the LB 440m downstream (staff housing) of KCP and 800m upstream (lodge) of the site.

Two tributaries (dry alluvial riverbeds) enter the KR along the LB between KCP and the staff housing (24°16.480'S, 31°07.985'E) and at the lodge (24°16.854'S, 31o08.429'E). Two smaller tributaries enter the river along the RB at 24°15.857'S, 31°08.410'E and 24°16.260'S, 31°08.282'E.

The main causeway across the Klaserie River is located 11.24km downstream (24°12.128'S, 31°08.785'E of KCP.

RIPARIAN VEGETATION ZONES: MARGINAL

The marginal riparian vegetation has altered in structure since 2008 (1 January 2008, earliest images available on open Google Earth™) to the present 2014 (15 March, latest images available on open Google Earth™), from a non-woody *Phragmites mauritianus* dominated state with significant cover over the bank to bank channel, to a mixed state of *Phragmites mauritianus* stands and alluvial lateral bar sediments deposits. This is due to the dynamic changes brought about by a flood event in 2012, effectively transforming the ecological state of the riparian area into repeated states of secondary succession, without achieving a climax state. Species of plants collected in the marginal zone included *Flueggea virosa, Phragmites mauritianus, Plumbago auriculata, Leonotis ocymifolia, Pennisetum clandestinum* (A)*, Xanthium strumarium* (A), *Spirostachys africana, Combretum hereroense, Cyperus sp., Sida cordifolia, Sida dregei, Dichrostachys cinerea, Gymnosporia senegalensis, Solanum seaforthianum* and *Euclea natalensis,* amongst others.

An examination of the active channel at base level for 2008, 2013 (13 November) and 2014 shows that the channel passes from its path along the RB immediately upstream of KCP, across the site to the RB and then gradually back to the LB immediately downstream of the site. The river channel as a whole turns away to the right 350m downstream of the site. The outer bend of the channel along the LB has left the latter heavily incised, with the deposition of alluvial deposits along the RB and the development of a point bar.

RIPARIAN VEGETATION ZONES: NON MARGINAL (split into **lower** and **upper** for level 4)

The non-marginal riparian vegetation is limited to a very narrow and steep zone along the LB and a less steep zone along the RB, the latter of which may be divisible into upper and lower zones. The vegetation along the zone along of banks is dominated by large woody species. Species of plants collected in the non-marginal zone included *Phyllanthus reticulates, Gymnosporia senegalensis, Phragmites mauritianus, Diospyros mespiliformis, Combretum imberbe, Grewia flavescens, Schotia brachypetala, Euclea natalensis, Sida cordifolia, Sida dregei, Leonotis ocymifolia, Philenoptera violacea, Sphaeranthus flexuosus, C. apiculatrum, Peltophorum africanum, Euclea divinorum* and *Spirostachys africana,* amongst others.

PHOTOGRAPHS OF THE MARGINAL AND NON-MARGINAL ZONES

a) An image of the KCP site taken on 15 March 2014 (Google Earth™, 2014).

b) The in-stream area of the KCP site, facing across and upstream.

c) LB riparian vegetation and causeway exit point.

d) RB riparian vegetation immediately to the north of the causeway exit point.

SPECIES LIST

L = Lower, U = Upper, W = woody, NW = Non-woody

SPECIES	Common name	MARGINAL		NON MARGINAL			
		W	NW	L: W	L: NW	U: W	U: NW
						NM	NM
Non-marginal Zone LB	**24°16.648'S, 31°08.059'E**						
1. Potato Bush	*Phyllanthus reticulatus*			x			
2. Red Spikethorn	*Gymnosporia senegalensis*			X			
3. Lowveld Reed	*Phragmites mauritianus*				x		
4. Jackalberry	*Diospyros mespiliformis*			x			
5. Leadwood	*Combretum imberbe*			x			
6. Sandpaper Raisin	*Grewia flavescens*			x			
7. Weeping Boerbean	*Schotia brachypetala*			x			
8. Potamogeton sp (?)					x		
9. Hairy Guarri	*Euclea natalensis*			x			
10. Heart-leaf Sida (flannel weed)	*Sida cordifolia*			x			
11. Spider-leg	*Sida dregei*			x			
12. Broad-leaved Minaret Flower	*Leonotis ocymifolia*				x		
13. Apple-leaf	*Philenoptera violacea*			x			
14. (Small reddish flower)	*Sphaeranthus flexuosus*				x		
Marginal Zone	**24°16.634'S, 31°08.067'E**						
15. Kikuyu (A)	*Pennisetum clandestinum*		x				
(3)							
16. White Berry-bush	*Flueggea virosa*	x					
(3)							
17. White Potato Creeper (A)	*Solanum seaforthianum*		x				
18. Blousyselbos	*Plumbago auriculata*		x				
(12), (15)							
19. Large Cocklebur (A)	*Xanthium strumarium*		x				
(17)							
20. Tamboti	*Spirostachys africana*	x					
21. Russett Bushwillow	*Combretum hereroense*	x					
22. Sedge	*Cyperus sp.*		x				
(10), (11), (16)							
23. Sicklebush	*Dichrostachys cinerea*	x					
(2), (9)							
Non-marginal Zone RB	**24°16.604'S, 31°08.095'E**						
24. Red Bushwillow	*C. apiculatrum*	x					
25. African-wattle	*Peltophorum africanum*	x					
(6), (20), (7), (9)							
26. Magic Guarri	*Euclea divinorum*	x					
Other species							
27. Bushveld Gardenia	*Gardenia volkensii*			x			
28. Porcupine Bush	*Pyrostria hystrix*			x			

29. Eastern Blue Bush	*Diospyros lycioides sericea*			x			
30. Fluted Abutilon	*Abutilon angulatum*			x			
31. Feverberry	*Croton megalobotrys*			x			
32. Conyza	*Conyza* sp.				x		
33. Ivy-vine	*Cissampelos mucronata*				x		
34. Persicaria (A)	*Persicaria mucronata*				x		
35. Koko Tree (?)	*Maytenus undata*			x			
36. Sleepy Morning	*Waltheria indica*						
37. Bitter Apple	*Solanum panduriforme*				x		
38. Hermannia	*Hermannia* sp.						
39. Marsh Fern	*Thelypteris confluens*				x		

LANDUSE AND IMPACT EVALUATION

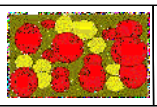
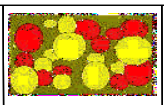
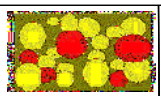
MARGINAL ZONE: SURROUNDING AND UPSTREAM LAND USE
(any land use that causes an impact on the VEGRAI site)

LANDUSE	IMPACTS					
	Rating: 0 (no impact) - 5 (severe impact)					
	REMOVAL		QUANTITY		QUALITY	
	INT	EXT	INT	EXT	INT	EXT
Nature reserve, game farming, natural areas	1	1	0	0	1	1
Picnic site/recreational area	0	0	0	0	0	0
Subsistence (rural) farming (not stock)	0	0	0	0	0	0
Stock farming	0	0	0	0	0	0
Firewood, reed, medicinal plant utilisation	1	1	0	0	1	1
Forestry	0	0	0	0	0	0
Irrigation farming (formal) crops	0	0	0	0	0	0
Residential, urban	0	0	0	0	0	0
Residential, rural	0	0	0	0	0	0
Large dams	0	0	0	0	0	0
Weirs and farm dams	0	0	0	0	0	0
Mining, quarrying (including obsolete)	0	0	0	0	0	0
Sewerage treatment and releases	0	0	0	0	0	0
Infrastructure (formal roads)	1	1	0	0	1	1
Infrastructure (vehicle tracks)	1	1	0	0	1	1
Infrastructure (rails)	0	0	0	0	0	0
Infrastructure (foot- and livestock paths)	0	0	0	0	0	0
Rubbish Dumping	0	0	0	0	0	0
Industrial	0	0	0	0	0	0
Other: Specify						
OVERALL RATING (representative of the maximum rating above)	**1**	**1**	**0**	**0**	**1**	**1**
CONFIDENCE	**4**	**4**	**4**	**4**	**4**	**4**

NON-MARGINAL OR LOWER ZONE: SURROUNDING AND UPSTREAM LAND USE (any land use that is causes an impact on the VEGRAI site)						
LANDUSE	**IMPACTS**					
	Rating: 0 (no impact) - 5 (severe impact)					
	REMOVAL		**QUANTITY**		**QUALITY**	
	INT	**EXT**	**INT**	**EXT**	**INT**	**EXT**
Nature reserve, game farming	1	1	0	0	1	1
Natural areas	1	1	0	0	1	1
Picnic site/recreational area	0	0	0	0	0	0
Subsistence (rural) farming	0	0	0	0	0	0
Stock farming	0	0	0	0	0	0
Forestry	0	0	0	0	0	0
Irrigation farming (formal) crops	0	0	0	0	0	0
Residential, urban	0	0	0	0	0	0
Residential, rural	1	1	1	1	1	1
Large dams	0	0	0	0	0	0
Weirs and farm dams	0	0	0	0	0	0
Mining, quarrying (including obsolete)	0	0	0	0	0	0
Sewerage treatment and releases	1	1	0	0	1	1
Infrastructure (formal roads)	1	1	0	0	1	1
Infrastructure (vehicle tracks)	2	2	0	0	2	2
Infrastructure (rails)	0	0	0	0	0	0
Infrastructure (foot- and livestock paths)	0	0	0	0	0	0
Rubbish Dumping	0	0	0	0	0	0
Industrial	0	0	0	0	0	0
Other: Specify						
OVERALL RATING (representative of the maximum rating above)	**2**	**2**	**1**	**1**	**2**	**2**
CONFIDENCE	**4**	**4**	**4**	**4**	**4**	**4**

EXOTIC INVASION

Use COVER of alien vegetation compared to indigenous vegetation to provide an *estimate of the proportional invasion as a percentage according to the range below.*

INVASION BY EXOTICS						
Red/dark grey circles representing aliens						
COVER of aliens	100-80%	80 - 60%	60-40%	40-20%	20-10%	<10%
Indicate (X)						

EXOTIC VEGETATION	Marginal	Non-marginal	
		Lower	Upper
(indicate with a tick)			
Species:			
15. Kikuyu	x		
17. White Potato Creeper	x		
19. Large Cocklebur	x		
34. Persicaria		x	

	Int	Ext	Int	Ext	Int	Ext
EXOTIC VEGETATION: OVERALL RATING (Use rating in figures above for Intensity)	1	1	1	1		

MARGINAL					
80 - 100	**60 – 80**	**40 – 60**	**20 – 40**	**10 - 20**	**<10**
					x
NON-MARGINAL					
80 - 100	**60 - 80**	**40 - 60**	**20 - 40**	**10 - 20**	**<10**
					x

User information compiled on exotic vegetation to derive the potential impact on species composition. Provide a rating of 0 – 5 in the Marginal and Non – Marginal columns and provide a motivation in the comments block.

Species Composition			
Vegetation Components	**Marginal rating**	**Non Marginal rating**	**Comment**
Woody	0	1	
Non Woody	1	1	

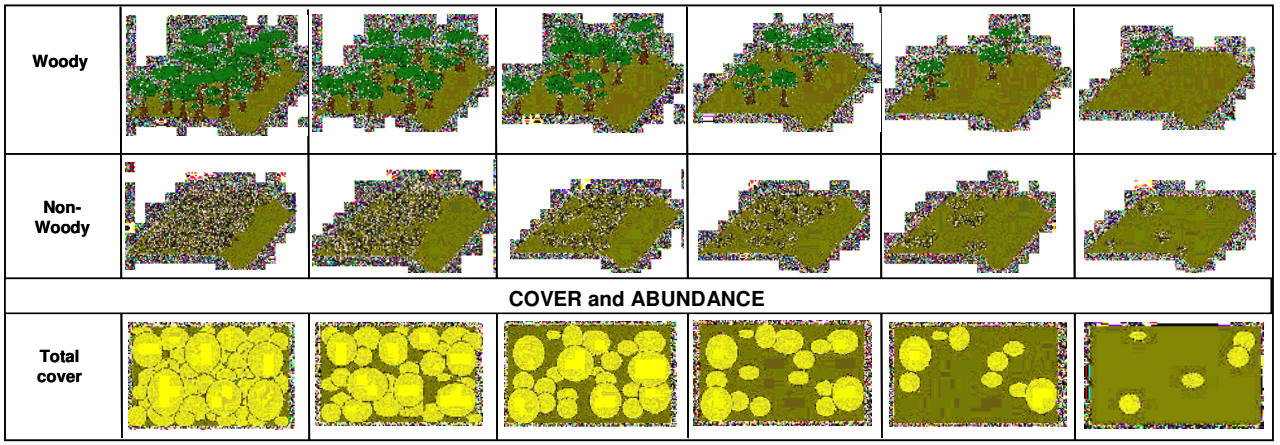
REFERENCE CONDITIONS

IMPACTS TO REMOVE	RESPONSE METRIC	DESCRIPTION OF STATE CHANGE
Vegetation removal	Cover Abundance	In the marginal zone of the KCP site the climax vegetation may be considered to be dominated by stands of non-woody *Phragmites mauritianum*, with both abundance and cover high, over most of the channel. There would be a significant proportion of riparian woody species too. The only areas not covered by these stands would be the primary active channel comprising pool – riffle sequences and over bedrock of the dykes and sills crossing the riverbed. Other areas that may not be covered by these stands would be where point and lateral bars have been formed due to a sharp change in riverbed channel direction at bends in the river. The present state, however, includes significantly more and extensive areas of exposed sediment in the form of various bars across the channel. The loss of abundance and cover may be as much as 50%. Although this may be deemed natural, the increase in sedimentation in the river is due to anthropogenic activity in the catchment. The apparent increase in significant flood events has also resulted in an almost permanent state of secondary succession in the river, without the progression in time to a state of climax vegetation. Vegetation removal in the marginal zone, thus, in terms of anthropogenic activity on site, is negligible, and may thus be considered to be lower than 10% (cover and abundance) for both woody and non-woody vegetation. If the effect of catchment-wide influences on vegetation removal is considered then a conservative estimate for vegetation removal (cover and abundance) in terms of non-woody species may be considered to be 20 to 40% and in terms of woody species 10 to 20%. Both scenarios will be fed into the Excel spreadsheet for the determination of Ecological Category. In the non-marginal zone the climax vegetation may be considered to be dominated by woody species and in the area of the KCP site would include *Spirostachys africana, Diospyros mespiliformis, Combretum imberbe, Schotia brachypetala, Gymnosporia senegalensis, Euclea natalensis, Philenoptera violacea*, and others. The percentage cover would be significantly high. The present state, however, includes a high proportion of coppiced woody vegetation due to (1) frequent high flood events resulting in scouring of the river channel and the loss and re-deposition of woody vegetation and (2) herbivory by mega-herbivores. Hence, as is the case with the marginal zone, there has been a loss of both cover and abundance of both woody and non-woody vegetation, should catchment-wide influences be be considered. The magnitude of the loss along the LB may be estimated to be in the region of less than 10% for abundance and 10 to 20 % for cover. In the case of the RB the magnitude would be lower as the area represents the inside of the riverbend and may be estimated to be less than 10% for both abundance and cover. Vegetation removal in the non-marginal zone, thus, in terms of anthropogenic activity on site, is negligible, and may thus be considered to be lower than 10% (cover and abundance) for both woody and non-woody vegetation. Finally, it has been observed that there are a number of terrestrial

		non-woody and woody plants in the marginal and non-marginal zones, including *Grewia flavescens, Sida cordifolia, Flueggea virosa, Plumbago auriculata, Combretum hereroense, C. apiculatum, Dichrostachys cinerea* and *Euclea divinorum*, amongst others. This is probably due to displacement during flood events and seed dispersal.
Exotic invasion	Cover Abundance	The extent of alien vegetation presently, as opposed to the reference state, is low given that the river is in a protected area which has been in existence for some time. The risk of the introduction of alien and invasive plants is ever-present given that the river within the KPNR represents the lower reaches of the system and there is significant and diverse anthropogenic activity upstream of the reserve in most of the catchment of the river. The extent of the loss of abundance and cover from the reference state for both the non-woody and woody vegetation in both the marginal and non-marginal zones is well below 10%. The presence of the cockle-bur, *Xanthium strumarium,* must be closely monitored and managed as this alien has the capacity to become a very significant threat to the well-being and functionality of the aquatic ecosystem.
Water quantity	Cover Abundance	Relative to a perceived reference state, the water quantity at the KCP site has in all likelihood been significantly and negatively affected by the presence of major impoundments in the upstream reaches of the Klaserie River, including the Klaserie (Jan Wassenaar) Dam, approximately 44km upstream of the KCP site. Although flood events would reduce cover and abundance of both non-woody and woody vegetation in the marginal and non-marginal zones, the present-day condition where there has been a significant change to the natural water regime exacerbates this position.
Water quality	Cover Abundance	Relative to the perceived reference state and notwithstanding the fact that anthropogenic activities upstream of the KCP site significantly affect the concentrations of chemical species in the river, the influence of water quality on cover and abundance of marginal and non-marginal zone woody and non-woody vegetation would be very low. The most significant change in water quality would be physical, with an increase in turbidity and TDS, for example.

ABUNDANCE AND COVER:

Use the top two rows (woody and non-woody) to assess abundance and the third row (circles) to assess cover Tick the appropriate cell for present condition of INDIGENOUS VEGETATION. If possible, indicate the percentage in the range where you think it lies. Then, derive reference conditions using the reference conditions guide at the end of the forms and indicate which percentage range represents reference condition. Using the rating table at the end of the document, determine the appropriate rating to populate the model. ((Figure Supplied by Douglas Macflardane)



WOODY

		80 – 100%		60 – 80%		40 – 60 %		20 – 40%		10 -20%		<10%	
		Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance
Marginal	Present									**(x)**	**(x)**	**x**	**x**
	Reference									**x**	**x**		
Non-marginal	Present					**(x)**	**x (x)**	**x**					
	Reference					**x**	**x**						

NON-WOODY

		80 – 100%		60 – 80%		40 – 60 %		20 – 40%		10 -20%		<10%	
		Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance	Cover	Abundance
Marginal	Present			**(x)**	**(x)**	**x**	**x**						
	Reference			**x**	**x**								
Non-marginal	Present							**(x)**	**(x)**	**x**	**x**		
	Reference							**x**	**x**				

Key: (X) denotes decision based on the exclusion of external anthropogenic activities.

Appendix B

SASS Version 5 Score Sheet

Version date: Apr 2008

Date (dd:mm:yr):	6/8/2014		(dd.ddddd)
Site Code:	KCP (m)	Grid reference (dd mm ss.s) Lat: S	24deg16.641	#VALUE!
Collector/Sampler:	Dr LR Taylor, Mr S Fairhead, Mr J Matibula, Mr A Ntimane	Long: E	31deg08.057	#VALUE!
River:	Klaserie River, KPNR	Datum (WGS84/Cape):	WGS
Level 1 Ecoregion:	3: LOWVELD	Altitude (m):	406
Quaternary Catchment:	B73B	Zonation:	F: Lowland River

Temp (°C):	NM	**Routine or Project? (circle one)**	Flow:	Low
pH:	NM	Project Name:	Clarity (cm):	20cm
DO (mg/L):	NM	KPNR Hull Property proposed causeway.	Turbidity:	Medium
Cond (mS/m):	NM		Colour:	Grey
Riparian Disturbance:	No anthropogenic disturbances.			
Instream Disturbance:	No anthropogenic disturbances.			

Site Description:
70m upstream of KCP. Well developed riffle - pool sequence with bedrock, SIC, SOOC, marginal vegetation in and out of current and GSM. Deep and shallow alluvial pools, fast-flowing and slow-flowing.

Biotopes Sampled (tick & rate)	Rating	Weight		Time (min)
Stones In Current (SIC)	4	3.0		11:00
Stones Out Of Current (SOOC)	2	3.0		14:00
Bedrock	4	1.0		180mins
Aquatic Veg	2	2.5		
MargVeg In Current	4	2.0		
MargVeg Out Of Current	2	2.0		
Gravel	4	0.5		
Sand	2	4.0		
Mud	2	1.5		
Hand picking/Visual observation			10.4	Category
OVERALL BIOTOPE SUITABILITY		0.0	53%	C

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1	1			1
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3	1			1
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8		1		1
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6	C		A	
Baetidae > 2 sp	12		C		C
Caenidae (Squaregills/Cainfles)	6	1		1	A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13		A		A
Leptophlebiidae (Prongills)	9	1	A		A
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9				
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10				
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		B		B
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8	1			1
Corduliidae (Cruisers)	8			A	A
Gomphidae (Clubtails)	6	A	1		A
Libellulidae (Darters/Skimmers)	4	A	1		A
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3		A		A
Corixidae* (Water boatmen)	3				
Gerridae* (Pond skaters/Water striders)	5		1		1
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7		1	1	A
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3	1	1		A
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5	A	A		B
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4	A		1	A
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6	1	B	1	B
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5				
Haliplidae* (Crawling water beetles)	5				
Helodidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8		1		1
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving Beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10				
Blepharoceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5	A	1	A	B
Chironomidae (Midges)	2	B		A	B
Culicidae* (Mosquitoes)	1		1		1
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1	1			1
Simuliidae (Blackflies)	5	B			B
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5	B			B
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5	A			A
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6	1			1
SASS Score		90	107	44	153
No. of Taxa		19	16	8	28
ASPT		4.7	6.7	5.5	5.5

Other biota:
One *Amieta senegalenis* tadpole caught.
One sawfin suckermouth caught.
Two redeye labeos caught.

Comments/Observations:
Belostomatid male with eggs caught. IHAS score = 72%, Ecological Category = B

Procedure:
Kick SIC & bedrock for 2 mins, max. 5 mins. Kick SOOC & bedrock for 1 min. Sweep marginal vegetation (IC & OOC) for 2m total and aquatic veg 1m². Stir & sweep gravel, sand, mud for 1 min total. * = airbreathers
Hand picking & visual observation for 1 min - record in biotope where found (by circling estimated abundance on score sheet). Score for 15 mins/biotope but stop if no new taxa seen after 5 mins.
Estimate abundances: 1 = 1, A = 2-10, B = 10-100, C = 100-1000, D = >1000 S = Stone, rock & solid objects; Veg = All vegetation; GSM = Gravel, sand, mud SWC = South Western Cape, T = Tropical, ST = Sub-tropical
Rate each biotope sampled: 1=very poor (i.e. limited diversity), 5=highly suitable (i.e. wide diversity) Rate turbidity: V low, Low, Medium, High, Very High
Rate flows: Zero, trickle, low, medium, high, flood Rate colour: transparent, tea brown, light brown, dark brown, light green, dark green, yellow, red, grey, milky white, black

APPENDIX C: FAII Assessment														
Common Name	**Species Name**	**Habitat**	**REF IT**	**IT**	**40F81***	**40F73***	**KC**	**KU**	**FROC**	**40F81***	**40F73***	**KC**	**KU**	**HEALTH**
LUNGFISH	*Protopterus annectens*	Vleis, pand and swamps		1.5	0	0	0	0	1(0)	0	0	0	0	5(5)
BULLDOG**	*Marcusenius macrolepidotus*	Well-vegetated, muddy, botomed and marginal, rivers, floodplains	2.5	2.5	0	1	2	4	5(5)	0	0	0	0	5(5)
CHURCHILL*	*Petrocephalus catastoma*	Quiet reaches, rivers and floodplains		3.0	0	1	0	8	5(3)	0	0	0	2	5(1)
LONGFIN EEL***	*Anguilla mossambica*	Pool or river stretch	3.0	3.1	3	3	0	0	5(3)	0	0	0	0	5(5)
AFRICAN MOTTLED EEL ***	*A. benegalensis*	Pool or river stretch	3.0	3.1	0	3	0	0	3(1)	0	0	0	0	5(5)
MADAGASCAR MOTTLED EEL ***	*A. marmorata*	Deep rocky pools, nocturnal		3.1	0	3	0	0	3(1)	0	0	0	0	5(5)
RIVER SARDINE	*Mesobola brevianalis*	Well-aerated, open river water, attracted to ligh at night		3.3	0	1	0	0	3(1)	0	0	0	0	5(5)
BROADSTRIPED BARB	*Barbus annectens*	Slow flowing streams with vegetation		2.0	0	0	3	10	3(3)	0	0	0	0	5(5)
LINE-SPOTTED BARB	*B. lineomaculatus*	Wide range habitats, small streams to large rivers		3.0	0	1	1	0	5(3)	0	0	0	0	5(5)
BARRED MINNOW	*Opsaridium zambezense*	Clear, flowing water, pools below rocky rapids		4.1	0	0	0	0	3(0)	0	0	0	0	5(5)
SIDESPOT BARB	*B. neefi*			3.0	1	0	0	0	1(1)	0	0	0	0	5(5)
LONGBEARD BARB	*B. unitaeniatus*	Wide variety, flowing and standing waters, dams and lakes	2.0	1.5	0	1	8	0	5(3)	0	0	0	0	5(5)
BOWSTRIPE BARB	*B. viviparus*	Vegetated poolsof streams, rivers, lake edges	3.0	2.0	3	1	1	0	5(5)	0	0	0	0	5(5)
BEIRA BARB	*B. radiatus*	Marshes and marginal vegetation of streams, rivers and lakes		3.0	0	0	0	0	3(0)	0	0	0	0	5(5)
THREESPOT BARB *	*B. trimaculatus*	Wide variety, hardy, especially vegetation	2.0	2.0	1	1	29	0	5(5)	0	0	2	0	5(1)
ORANGEFIN BARB	*B. eutania*	Clear-flowing, headwaters, rocky habitats	4.5	3.5	1	1	5	0	1(5)	0	0	0	0	5(5)
STRAIGHTFIN BARB	*B. paludinosus*	Hardy, quiet, well-vegetated waters, lakes, swamps, marshes, rivers		1.0	1	3	1	0	5(5)	0	0	0	0	5(5)
PAPERMOUTH	*B mattozi*	Large pools of cooler, perennial rivers, thrives in man=made impoundments		3.5	0	0	0	0	1(0)	0	0	0	0	5(5)
LARGESCALE YELLOWFISH	*Labeobarbus marequensis*	Flowing, perennial waters	1.5	3.1	1	1	47	11	5(5)	0	0	2	0	5(1)
REDNOSE LABEO ***	*Labeo rosae*	Sandy areas, large ivers		2.5	1	3	2	0	5(5)	0	0	0	0	5(5)
SILVER LABEO ***	*L. ruddi*	Quiet, deep, muddy standing waters		3.0	0	3	3	11	5(5)	0	0	0	0	5(5)
PURPLE LABEO ***	*L. congoro*	Strong-flowing, rocky reaches of large, perennial rivers		3.1	0	0	0	0	3(0)	0	0	0	0	5(5)
REDEYE LABEO ***	*L. cylindricus*	Clear, flowing water, pools below rocky rapids	3.5	3.1	3	1	35	14	5(5)	0	0	0	0	5(5)
LEADEN LABEO ***	*L. molybdinus*	Deep pools	3.5	3.0	1	1	26	0	3(5)	0	0	8	0	5(1)
IMBERI **	*Brycinus imberi*	Wide variety, rivers, floodplain pans, lagoons		2.0	11	3	4	7	3(5)	0	0	0	0	5(5)
SILVER ROBBER **	*Micralestes acutidens*	Clear, flowing or standing open water		2.5	0	1	0	0	3(1)	0	0	0	0	5(5)
TIGERFISH	*Hydrocynus vittatus*	Warm well-oxygenated water, mainly large rivers aand lakes		4.1	0	3	0	0	1(1)	0	0	0	0	5(5)
COMMON MOUNTAIN CATFISH	*Amphilius uranoscopus*	Clear, flowing water, rocky		3.1	1	0	0	0	5(1)	0	0	0	0	5(5)
SILVER CATFISH	*Schilbe intermedius*	Standing or slow-flowing open water, vegetation, nocturnal		2.0	0	1	0	0	5(1)	0	0	0	0	5(5)
SHARPTOOTH CATFISH	*Clarias gariepinus*	Any, favours floodplains, large sluggish rivers, lakes, dams	1.5	1.5	1	1	2	2	5(5)	0	0	0	2	5(1)
SAWFIN SUCKERMOUTH **	*C. paratus*	Rocky riffles and rapids, sometimes low-flow rocky pools		3.1	1	3	1	0	5(5)	0	0	0	0	5(5)
SHORTSPINE SUCKERMOUTH	*C. pretoriae*	Shallow rocky reaches, riffles and rapids	5.0	3.1	1	1	12	0	5(5)	0	0	4	0	5(1)
LOWVELD SUCKERMOUTH	*C. swierstrai*	Sandy stretches of flowing rivers, burrows into sand		2.5	0	1	0	0	1(1)	0	0	0	0	5(5)
BROWN SQUEAKER	*Synodontis zambezensis*	Pools and slow-flowing reches, nocturnal		2.0	0	1	0	0	5(1)	0	0	0	0	5(5)
SOUTHERN MOUTHBROODER	*Pseudocrenilabrus philander*	Wide variety, usually vegetated	1.0	1.0	1	1	1	12	5(5)	0	0	0	2	5(1)
BANDED TILAPIA	*Tilapia sparrmanii*	Wide variety, prefers, quiet, standing water, vegetation	1.0	1.0	3	0	1	1	5(5)	0	0	0	0	5(5)
REDBREAST TILAPIA	*T. rendalli*	Quiet, well-vegetated water, littorals, backwaters, floodplains, swamps		1.0	0	1	0	12	5(3)	0	0	0	0	5(5)
MOZAMBIQUE TILAPIA	*Oreochromis mossambicus*	Thrives in standing waters, wide temperature, salinity tolerances	1.0	1.0	3	1	10	17	5(5)	0	0	9	16	5(1)
TANK GOBY	*G. giurus*	Quiet sandy zones streams, backwaters, floodpalin pans		2.5	0	0	0	0	1(0)	0	0	0	0	5(5)
TOTAL				**98.4**			**194**	**109**	**147(113)**			**25**	**22**	**200(168)**
FAII Score:	**81.00%**	**Largely natural with few modifications**												

Key: IT, Intolerance rating; 40F81 and 40F73, Frequency of Occurrence sites; KC, Klaserie causeway site; KU, Klaserie upstream site. FROC, frequency of occurrence; 5(0), Expected rating (Observed rating).

*Values are frequency of occurrence values, not number of fish collected. Values for KC and KU reflect number of fish collected.

Addendum Document
Hull Property Project, Klaserie River, KPNR

This document serves as additional information for the Section in the BA document that relates to the *Assessment of Potential Impacts* for Alternative Sites 1, 2 and 3.

Table 16. The extent, magnitude, duration and significance of the impact of the proposed causeway on the aquatic environment at preferred site KCP.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on physical attributes and morphological units.	Site Specific	Low	Long-term	Low	Probable	Sure	Long-term
Impact on riparian vegetation	Site Specific	Medium	Long-term	Medium	Probable	Sure	Long-term
Impact on macro-invertebrate assemblage and diversity	Site-specific	Low	Short-term	Very low	Probable	Sure	Short-term
Impact on fish assemblage and diversity	Local	Low	Long-term	Low	Probable	Sure	Short-term

Modified Table 17. The extent, magnitude, duration and significance of the impact of the proposed causeway on the riparian vegetation, macro-invertebrates and fish fauna at Alternative Site A1.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on physical attributes and morphological units.	Site Specific	Medium	Long-term	Medium	Probable	Sure	Long-term
Impact on riparian vegetation	Site Specific	Medium	Long-term	Medium	Probable	Sure	Long-term
Impact on macro-invertebrate assemblage and diversity	Site Specific	Medium	Short-term	Low	Probable	Sure	Short-term
Impact on fish assemblage and diversity	Local	Medium	Long-term	Medium	Probable	Sure	Short-term

Modified Table 18. The extent, magnitude, duration and significance of the impact of the proposed causeway on the riparian vegetation, macro-invertebrates and fish fauna at Alternative Site A2.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on physical attributes and morphological units.	Site Specific	Low	Long-term	Low	Probable	Sure	Long-term
Impact on riparian vegetation	Site Specific	Medium	Long-term	Medium	Probable	Sure	Long-term
Impact on macro-invertebrate assemblage and diversity	Site-specific	Low	Short-term	Very low	Probable	Sure	Short-term
Impact on fish assemblage and diversity	Local	Low	Long-term	Low	Probable	Sure	Short-term

Modified Table 19. The extent, magnitude, duration and significance of the impact of the proposed causeway on the riparian vegetation, macro-invertebrates and fish fauna at Alternative Site A3.

Criterion	Extent	Magnitude	Duration	Significance	Probability	Confidence	Reversibility
Impact on physical attributes and morphological units.	Site Specific	Medium	Long-term	Medium	Probable	Sure	Long-term
Impact on riparian vegetation	Site Specific	Medium	Long-term	Medium	Probable	Sure	Long-term
Impact on macro-invertebrate assemblage and diversity	Site-specific	Medium	Short-term	Low	Probable	Sure	Short-term
Impact on fish assemblage and diversity	Local	Medium	Long-term	Medium	Probable	Sure	Short-term

ENGINEERING ASSESSMENT

Contents

Table of Figures

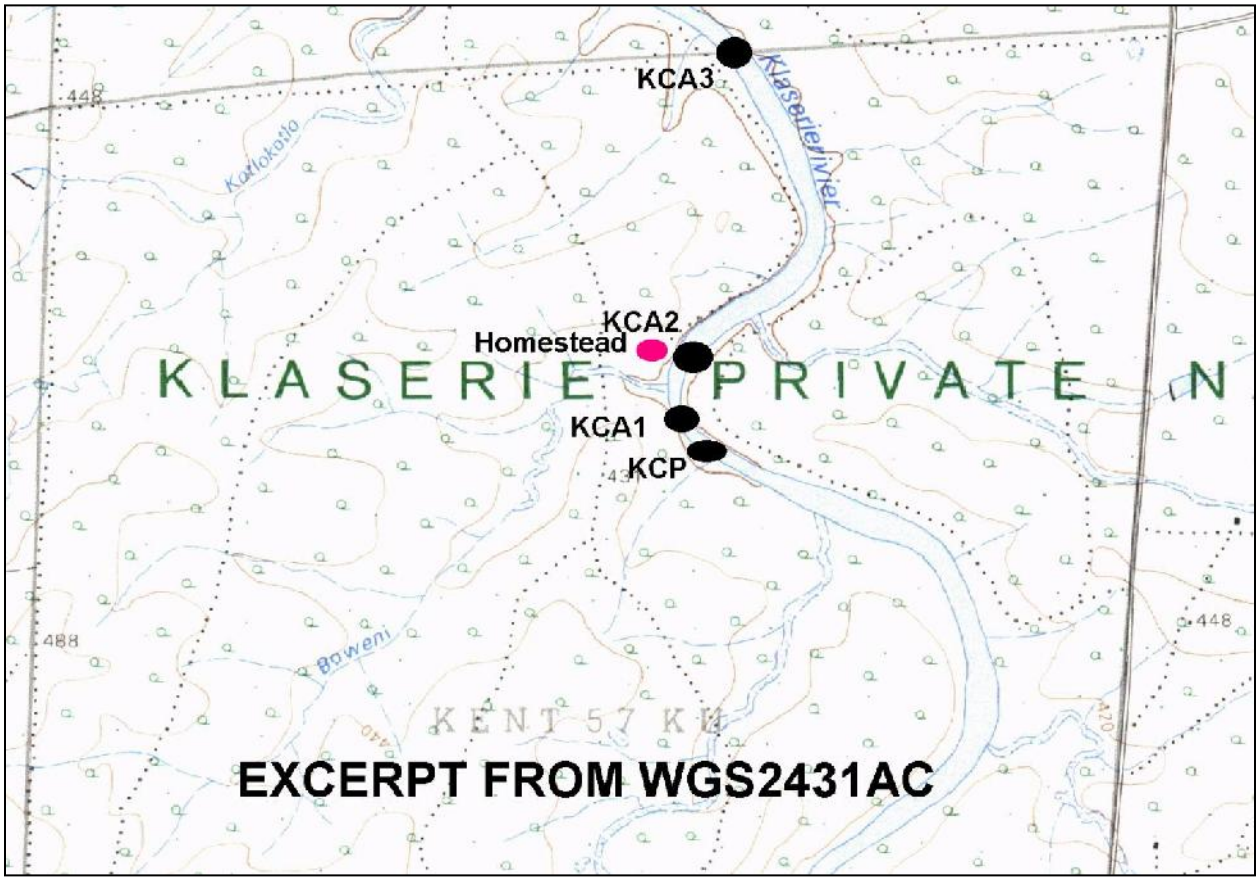
Table of Tables

EXECUTIVE SUMMARY

Emross Consulting were approached to develop a causeway across the Klaserie River from the west bank Homestead on the remaining Portion of Hull 92KU. This is required to provide access to the other bank, principally for security and firefighting. The more southern section of the of the east bank property is particularly distant from management and control. The potential river crossings are shown in juxtaposition with the farm extent and boundaries in Figure 0-1, below.

Four sites were evaluated for environmental and engineering suitability and subjectively ranked on a number of criteria or desiderata. The downstream site is preferred, with the furthest north being the next best site, but not fulfilling the requirement for rapid access to the more southern portions of the property. The southern site has been surveyed and has been investigated further. Preliminary design sketches for the engineering works are given below.

Figure 0-1 : Excerpt of 1:50 000 mapping showing the extent of farm boundaries and positions of possible causeway sites on the Klaserie River.



1. TERMS OF REFERENCE

1.1 Task

The undersigned was requested by Emross Consulting (Pty) Ltd to assist in the location of a causeway across the Klaserie river on the Remaining Portion of the Farm Hull 92KU, Klaserie Private Nature Reserve, Limpopo, RSA. This was expanded to providing the engineering assessment, which incorporates a preliminary design of the preferred alignment and commentary on alternative sites.

1.2 Expertise

The undersigned C,R,H, Clanahan is a Registered Professional Engineer, Chartered Civil Engineer and Chartered Water and Environmental Manager, with a BSc in Civil Engineering (1961) and MPhil in Environmental Management (2003).

1.3 Independence

I certify that I have no financial interest in the development investigated, other than payment for services rendered.

2. PREFERRED SITE AND ALTERNATIVES

2.1 Required Characteristics

The site should :

a) provide a sound foundation for the river crossing;
b) require no rock excavation (blasting) or as little as possible, which could be effected by expansion agent splitting;
c) provide a causeway at or near sand bed level, with no restriction on low flow passage;
d) be on a reach of river that is stable;
e) have approach roads at reasonable gradients and good visibility;
f) require the removal of no large trees and as little other flora as possible;
g) roads do not impact of water holes or mud wallows;
h) be close to the homestead on the property on the left bank of the river, to allow rapid deployment of security staff to the right bank in the event of fire or poaching.
i) minimum aesthetic impact;
j) minimum input of imported materials (pipes, cement, aggregate etc)

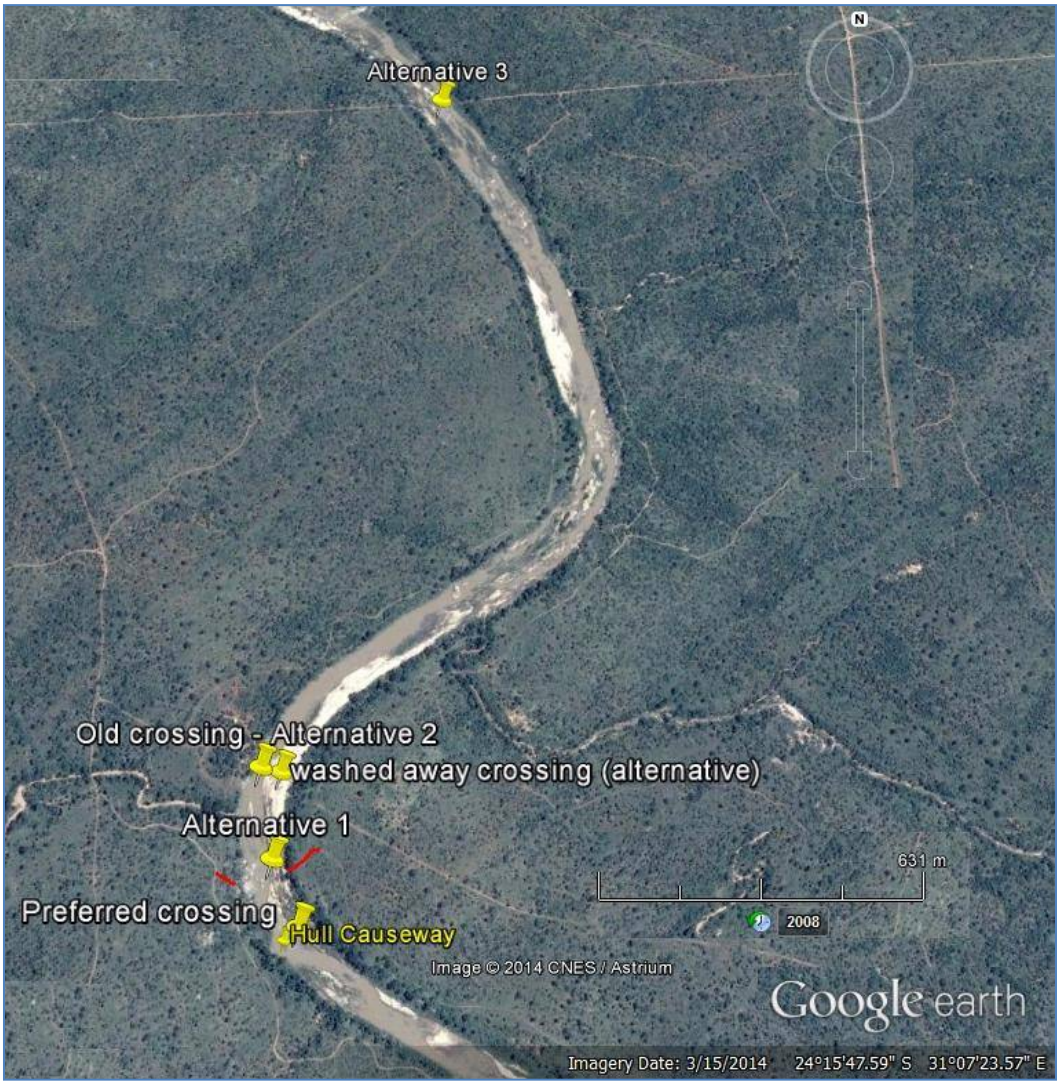
2.2 Identified Sites

Three sites were identified by walking the stretch of the river in the vicinity of the homestead. The fourth site was suggested by other interested parties to the north and north west of the property on the east-west cut line road..
The Preferred Site (Klaserie Crossing Preferred – KCP) and feasible alternative sites (Klaserie Crossing Alt 1,2 and 3 – KCA1, KCA2, KCA3) are shown on the Google image
,

Table 2-1 : Coordinates of the sites

Site	Latitude	Longitude	River Width (Google) (m)	Distance from Homestead by road (km)
Preferred site	24° 16' 37.29"'S	31° 08' 03.71"E	90	1.12
Alternative 1	24° 16' 32.97"S	31° 08' 01.52"E	81	0.98
Alternative 2	24° 16' 26.63"S	31° 08' 00.48"E	92	0.22
Alternative 3	24° 15' 33.76"S	31° 08' 12.40"E	86	2.24

Figure 2-1 : All addressed sites



2.3 Preferred Site (KCP)

The site has an exposed low level gneissic rock sill in the middle of the river, with a dolerite dyke intrusion, which forms a natural low weir. This extends to about 13m from the left bank and is covered by sand on the right central and bank area.

Probing the sand areas in the river channel along the left bank and in the central and right elevated sand riverbed showed that a competent foundation could be established 1.2 to 1.8m below sand level. This would allow both surface and sub-sand conduits to be placed in a causeway and still have the roadway level low enough to not obstruct higher surface flows. Some very minor rock trimming may have to be done, either by hand (hammer and chisel) or by close spaced drilling and using an expansive material in the holes to split the surface rock off.

The right bank is a wide sand bank well above low water, again with apparent rock at 1,0 to 1,2m below. The left bank is a narrow sand bank below an incised sandy clay deposit, about 2m deep. On both outer banks there is sandy clay with open brush and tall trees

Figure 2-2 : KCP route, with local levels (Google images Nov 2013 / Jan 2009)

There had been considerable scour and re-deposition of sand between dates of images, with a significant loss of larger flora and a marked change in the riverbed except at the preferred site. The animal track is also very similar !
Approach roads would be in clayey sandy soils, which would allow moderate shaping, but require hardened side drainage to prevent erosion. The left bank approach would be in a minor cutting, which would require armouring against erosion by flood water. The right bank approach road would be oblique to the river bank and would not need armouring, more than the road fill retaining blocks.

Figure 2-3 : KCP Central rock sill with dolerite dyke – looking at left bank

Figure 2-4 : KCP View from left bank end of rock sill to right bank.

Figure 2-5 : KCP left bank at the access route

Figure 2-6 L KCP left bank characteristic

2.4 Alternative Site 1 (KCA1)

The site is over a short reach of river, which is characterized by steep left (western) bank approach in outcropping rock to incised braided channels with whaleback rock outcrop in between channels (Figure 2-10 and Figure 2-11). The right bank is deep sand, which was not probed for foundation because it was evidently more than 1.80n down, which was the limit of the hand probe.

Comparing the December 2008 and November 2013 Google images (Figure 2-8 and Figure 2-9) the very low and low flow conditions are informative in the doubling up of most streams. The site would be located on one of two single low flow stream positions.

A balance would have to be drawn between aesthetics, rock excavation and cost of the causeway. The causeway structure would be high above the low flow channel and would not blend in with the surrounds. The causeway would be relatively level with the right (east) bank sand beds and would be high above any sound foundation. This would make it vulnerable to being washed away with sand bank scouring and re-deposition under high flood.

Figure 2-7 : Options on Alternative 1

Figure 2-8 : KCA1 – Google images – December 2008 and November 2013

Figure 2-9 : KCA1 – Google images – November 2013 and March 2014

Figure 2-10 : KCA1 – approximate line of southern crossing.

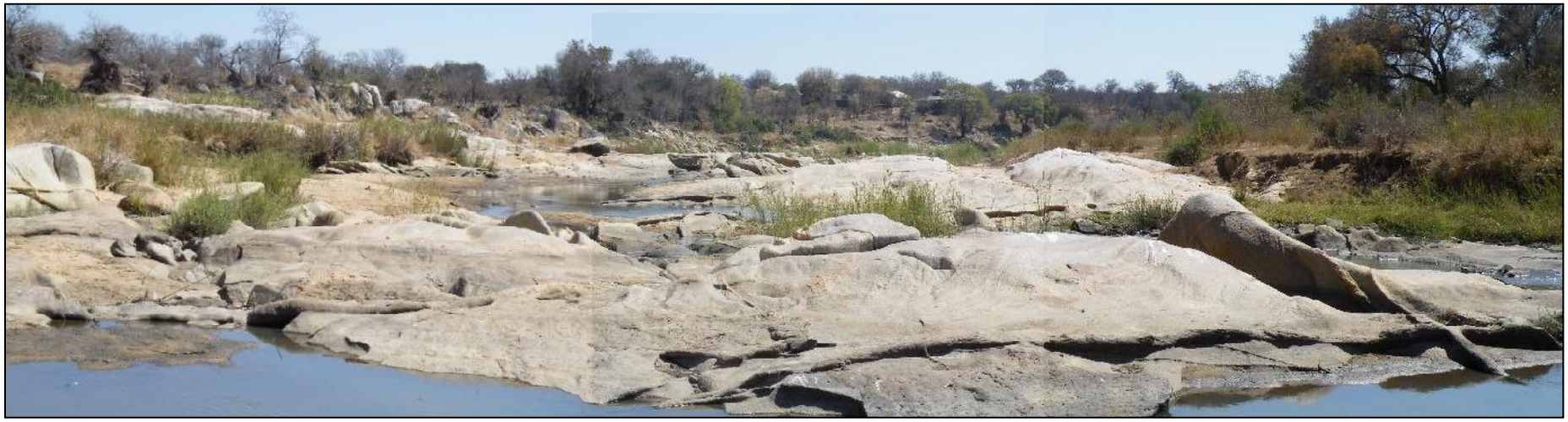


Figure 2-11 : KCA1 – approximate line of nothern crossing.

2.5 Alternative Site 2 (KCA2)

This site is again over a short reach of river, which is characterized by steep left (western) bank approach in outcropping rock and sand bed on the right (eastern) bank. The depth of the east sand bed was not probed. No rock can be seen in Google images for low flow periods in January 2008 or November 2013 (Figure 2-14). The construction of a causeway at this site would require considerable work in the riverbed and build up of the causeway foundation.

Figure 2-12 : KCL2 - Old Homestead crossing – view to left bank

Figure 2-13 : KCA2 – North of Old Homestead crossing – view to left bank

Figure 2-14 : KCA2 – Comparison of Google images January 2008 and November 2013 – no visible rock foundation for cross channel causeway.

2.6 Alternative Site 3 (KCA3)

This site is essentially exposed massive sheet rock from bank to bank, with small undulations. While construction on this site would be easy, the impact on river flow would be considerable, unless the roadway wa limited to a concrete skim thick enough to accommodate anchor bars and reinforcement, with all flow going over the roadway. The provision of a small diameter low flow culvert would be possible. The approach roads would need moderate armouring against flood damage.

Figure 2-15 : KCA3 – Rock outcrop – possible route for permanent causeway

Figure 2-16 : KCA3 – Current route for crossing through reed beds and sand banks.

2.7 Scored Comparison of All Four Sites

A subjective scored comparison of all four sites has been attempted, as set out below, which scores the preferred site KCP highest, being higher than KCA3 by virtue of being closer to the Homestead.

Table 2-2: Scored comparison of Sites

Parameter	Max Score	Site			
		KCP	KCA1	KCA2	KCA3
a) Sound foundation for crossing	20	16	12	12	18
b) No rock blasting or cutting	5	5	2	2	5
c) Causeway at sand bed level	20	18	8	12	12
d) Stable reach of river	20	18	16	10	20
e) Approach road gradients and visibility	10	8	9	8	8
f) Removal of no large trees / flora	10	9	8	9	8
g) Do not impact on waterholes / wallows	10	8	10	10	8
h) Close to homestead (need and desirability)	20	11	12	18	2
i) Minimum aesthetic impact	20	16	8	6	12
j) Minimum imports	5	3	1	1	2
Total Score	**140**	**102**	**86**	**88**	**95**

Maximum scores – Long term impact 20
Medium term impact 10
Short term impact 5

3. PRELIMINARY ENGINEERING INVESTIGATION AND DESIGN

3.1 Investigations

A seismic / resistivity survey was carried out, by a team that was in the area for other works. This has confirmed the levels of rock across the riverbed and into the banks. The graphic of the survey and explanation are shown in Figure 3-1, below. The gneissic and dolerite rock are similar too granite and basalt, respectively.

3.2 Preliminary design

Preliminary design proposals show the proposed culverts at riverbed level and – if feasible – additional through passage sub-surface. These are intended to accommodate typical sub-surface flow in sand beds of rivers and would be used, in the first instance, as a diversion channel during constriction.

Coffer damming may not be necessary, experience has shown that wet sand will retain a slope of 1:4 and dewatering can be done by a diesel driven pump to downstream of the excavation. Work in the riverbed should be completed in one week.

2014-10-09

C.R.H. Clanahan Pr Eng. MPhil

Figure 3-1 : KCP – Resistivity survey – showing hard rock (orange to purple) across the causeway site

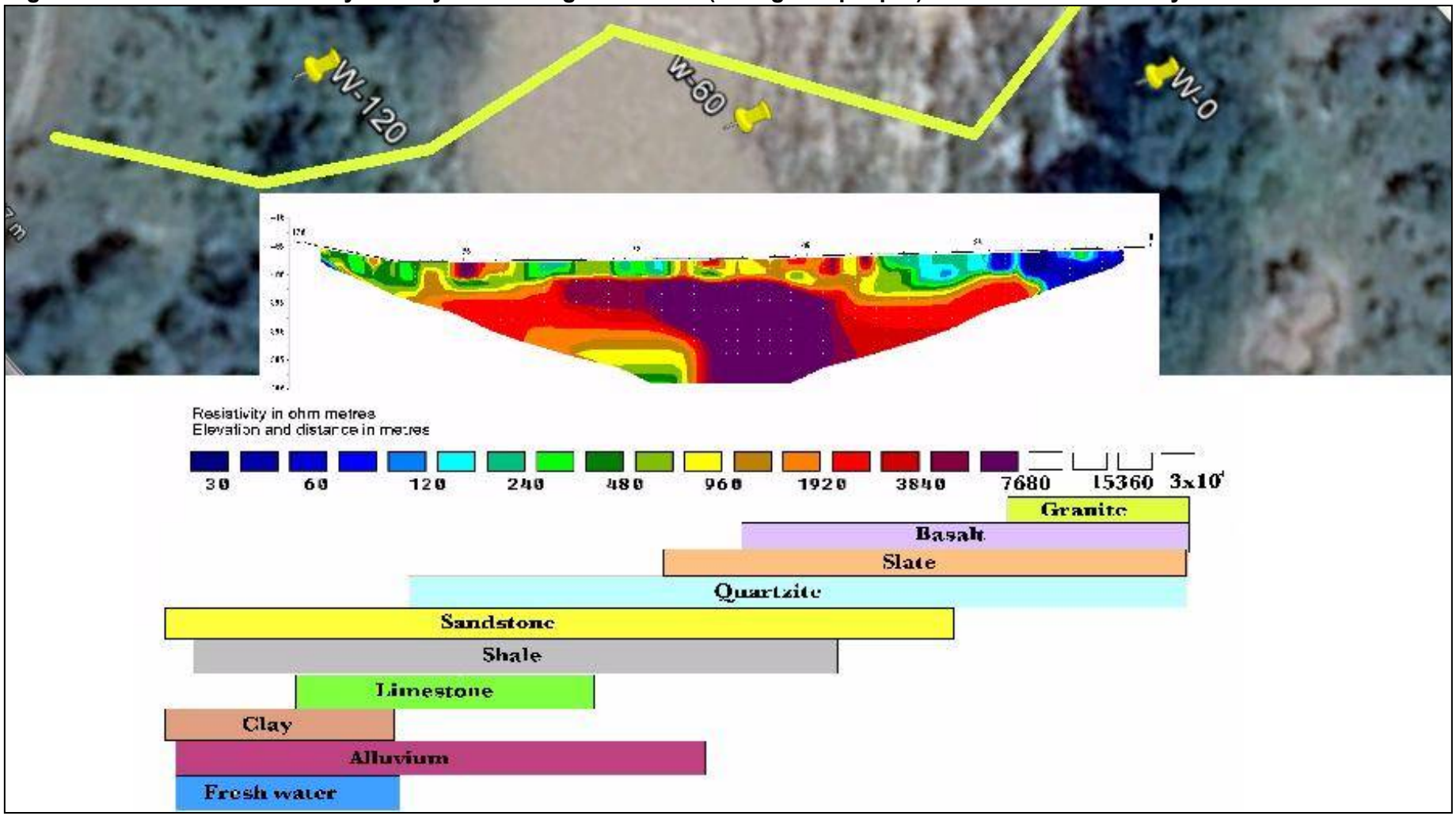


Figure 3-2 : KCP – Crossing at river low flow section (flow from right to left)

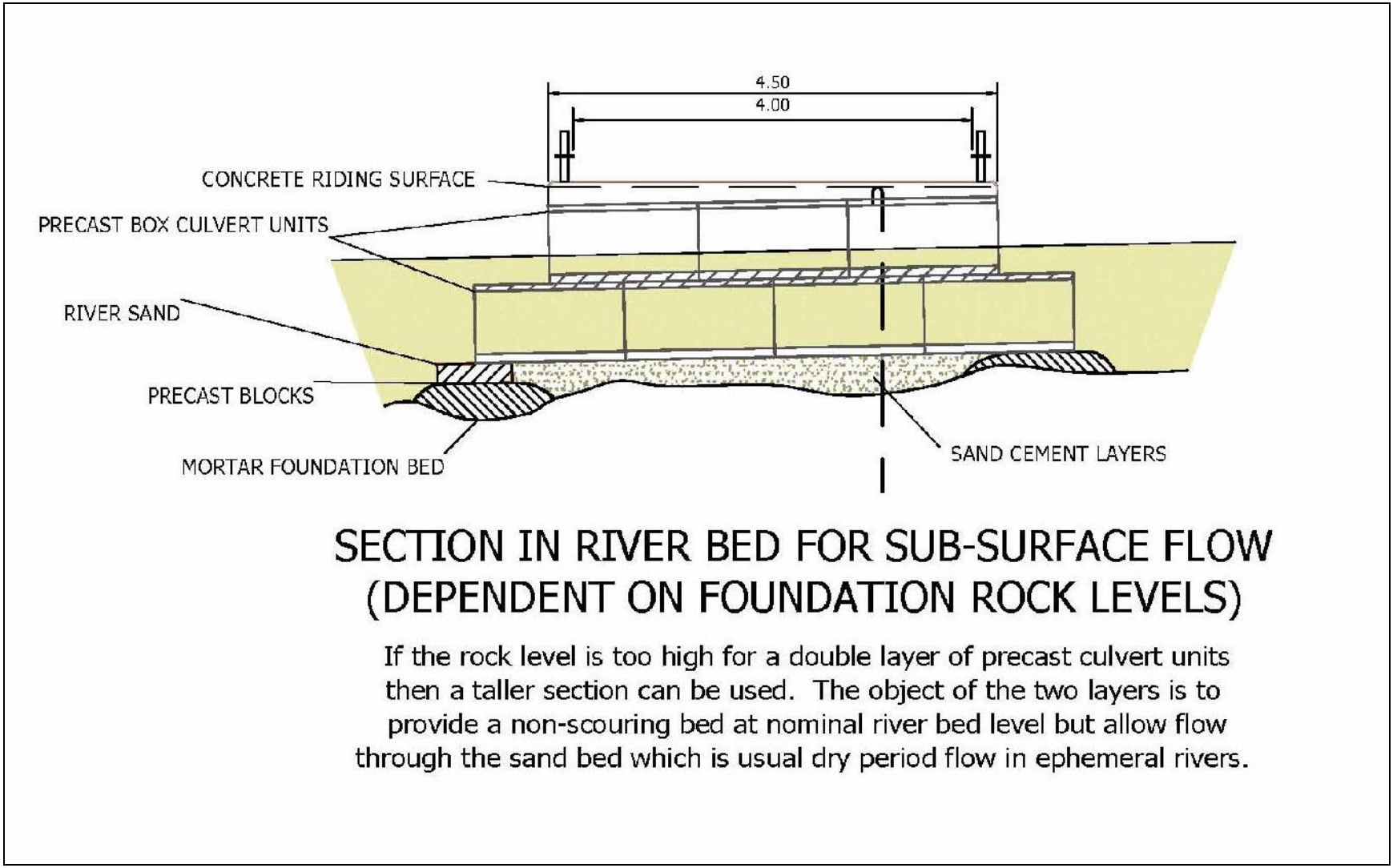


Figure 3-3 : KCP – Causeway adjacent to rock bar (flow from right to left)

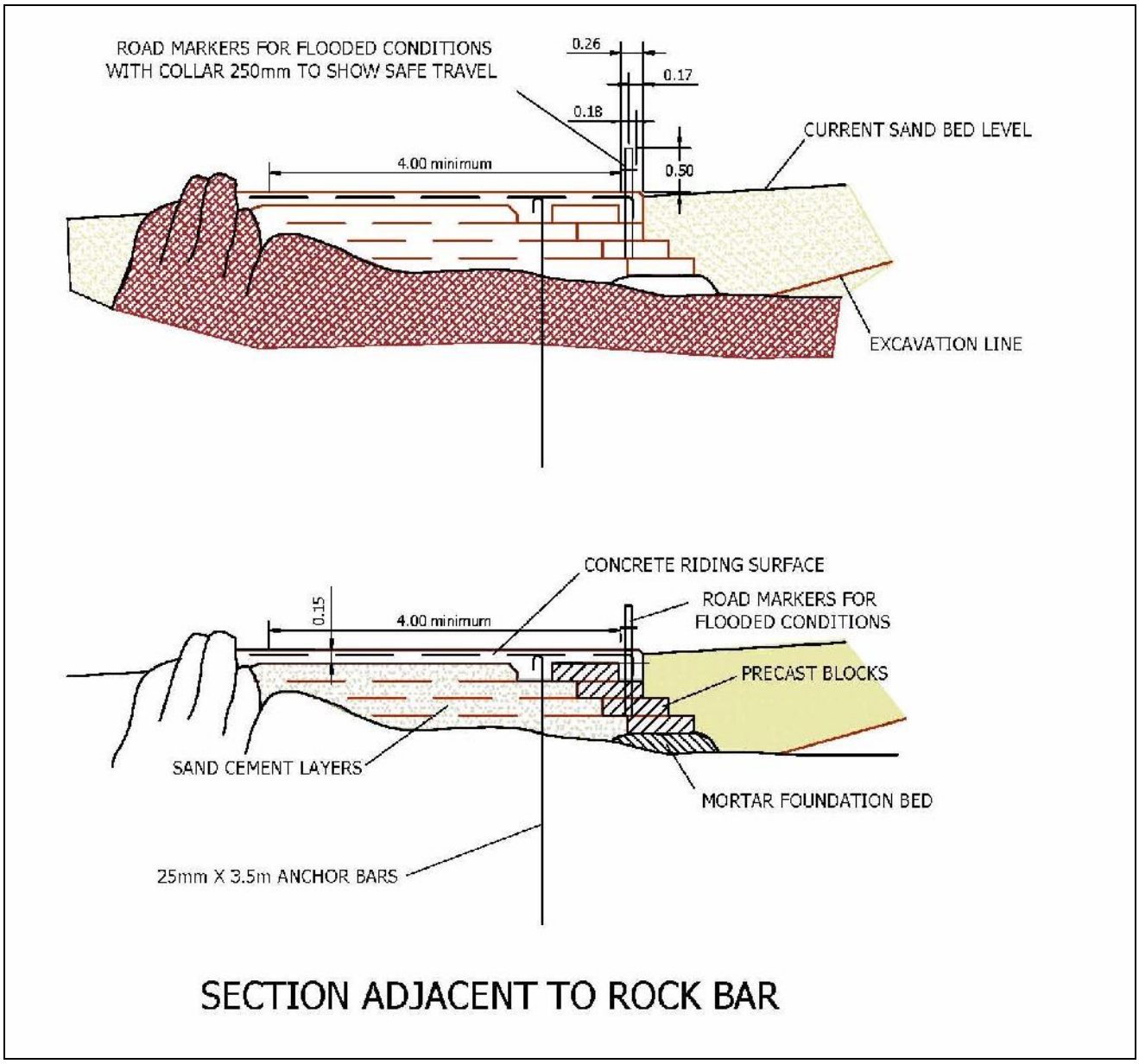
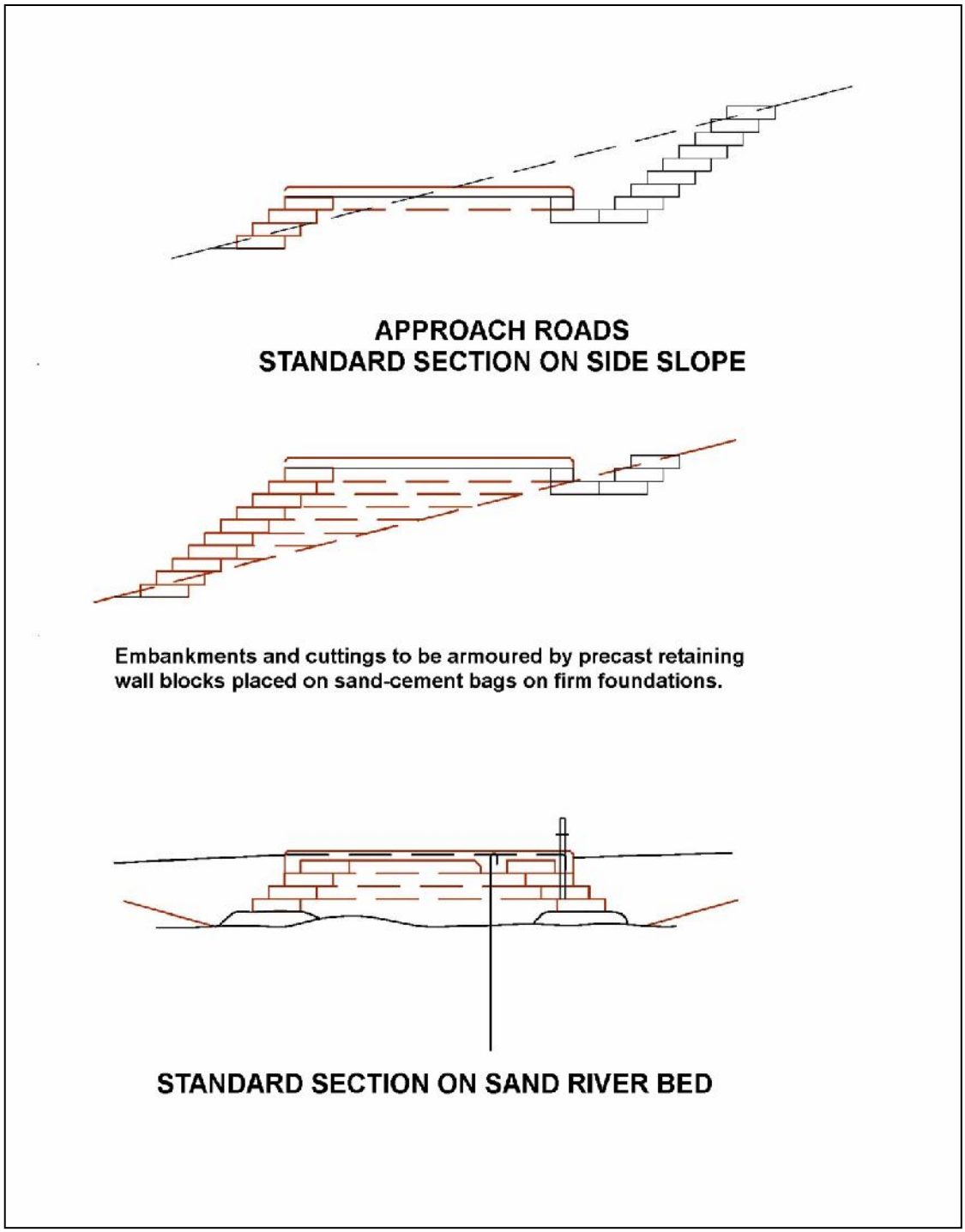


Figure 3-4 : KCP – Proposed standard sections.



ENVIRONMENTAL MANAGEMENT PROGRAMME

ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE CONSTRUCTION OF A RIVER COSSING AT HULL.

Ref.No. 17/2/3/E-287

EMPr

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INDEX

1 SCOPE

The Environmental Management Programme provides guidance and proposes viable and suitable mitigation measures for assessed impacts.

The document is a 'living' document in order that it can be adapted to specific environmental concerns and issues as they arise. Changes to the EMP must be in accordance with the conditions stipulated in the ROD.

The EMP must be finalised only after the ROD has been issues so that it can take into account any particular requirements of the ROD.

Copies of the EMP document, the ROD and all ECO and audit reports must be available on site at all times.

2 AGREEMENT

It is important to note that the acceptance of the EMP by the relevant environmental authority and the client are governed by legislation and are to be read as a contract between the implementing agent (Contractor), the Client and the environmental authority (MDALA). It is therefore crucial that the contractor, any sub-contractor and developer adhere to its requirements, failure to do so can lead to penalties levied against the contractor, sub-contractor and the developer.

The project manager / applicant must institute contractual measurements to ensure that the contractors and any sub-contractors adhere to the environmental obligations agreed upon.

3 RESPONSIBLE PERSON

An Environmental Control Officer (ECO) should be appointed to ensure full compliance with the requirements of the Environmental Management Programme during construction. The applicant, however, remains responsible for any environmental damage.

4 INCIDENT REGISTERS AND REPORTING

An incident register must be kept on site at all times. This register must be maintained and any environmental incidents must be recorded in this register. The register must be made available for inspection by the authority. The contractor and reserve manager will be responsible to ensure that the register is kept up to date. All environmental incidents must be reported in the register along with remedial action (if any) taken. The register must contain the date, time and place of the incident that took place.

5 DEFINITIONS

Construction	means the building, erection or establishment of a facility, structure or infrastructure that is necessary for the undertaking of a listed or specified activity but excludes any modification, alteration or expansion of such a facility, structure or infrastructure and excluding the reconstruction of the same facility in the same location, with the same capacity and footprint;

Expansion	means the modification, extension, alteration or upgrading of a facility, structure or infrastructure at which an activity takes place in such a manner that the capacity of the facility or the footprint of the activity is increased
Indigenous vegetation	refers to vegetation consisting of indigenous plant species occurring naturally in an area, regardless the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding ten years
Riparian Habitat	The vegetation zone along a watercourse which is adapted to the permanent or intermittent presence of water, either in the form of surface or below surface water.
Watercourse	means – (a) a river or spring; (b) a natural depression in which water flows regularly or intermittently; (c) a wetland, lake or dam into which, or from which, water flows; and (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks
Wetland	means 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.
Severe Flood	The result of a local or catchment based rainfall event that leads to increased river flow, to the extent that it surpasses the 1:50 year flood line.
Diverting the flow (temporarily)	Means a temporary structure causing the flow of water to be routes in a watercourse for any purpose
Impeding the flow (temporarily)	Means the temporary obstruction or hindrance to the flow of water in a watercourse by a structure built either fully or partially across a watercourse

Maintenance	The act of keeping in good condition by checking or repairing it regularly

6 SITE IMPACTS AND MITIGATION

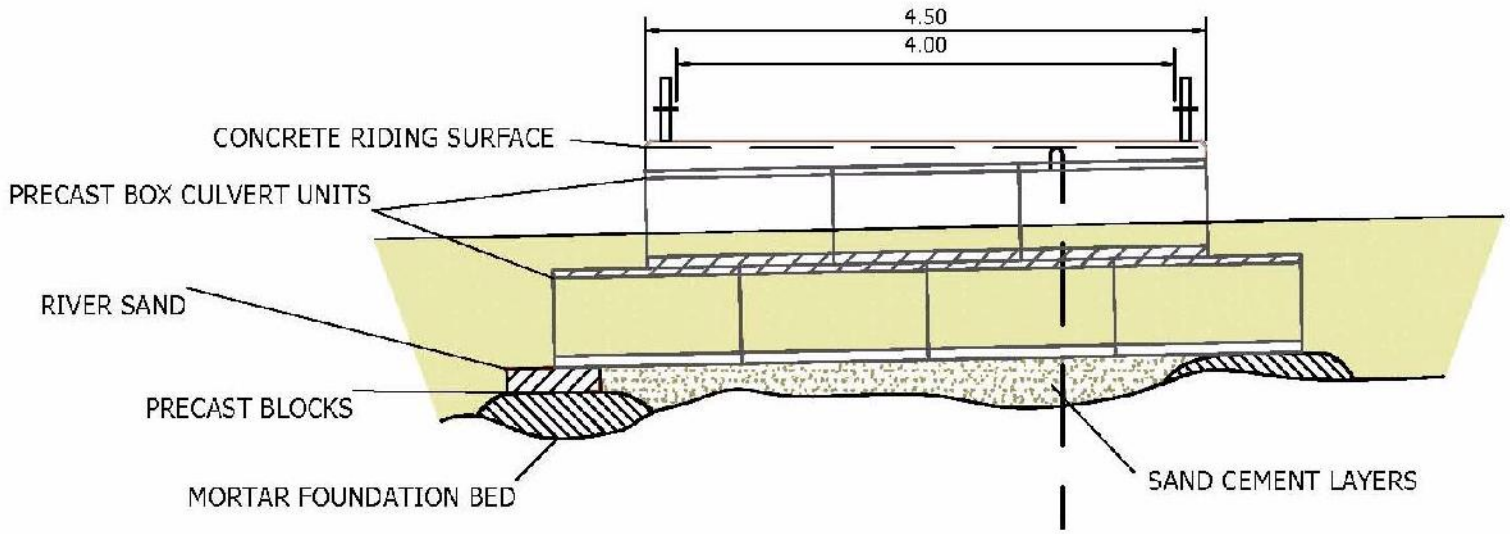
Element	General environmental controls
Vehicle access	Vehicle access to KPNR will be through the Incheni Gate. No new site access roads are permitted without express permission of the applicant. Applications for such consent shall be submitted in writing and conclusively detailed including GPS location points for reference purposes. The contractor and reserve manager will be responsible for clearly marking any roads that are required to be closed to traffic for the maintenance activity. There will be no off-road driving. All vehicles are to comply with the South African traffic ordinance. All drivers and vehicles shall be licensed and shall be in a road worthy condition and shall be well maintained. Vehicles are to be insured against accidents and third party liability. All vehicles must undergo regular checks to ensure they are roadworthy and free of oil or other lubricant leaks. Vehicles may not be washed on or near the site. Contractors and sub-contractors are to use the shortest possible route between the place of entry and the construction site at all times. Unauthorised driving through the reserve for purposes other than the contract is not permitted. Night driving by contractors in not permitted. Road closures necessary for works must be adequately marked.

Protection of fauna and flora	No tree of a trunk diameter exceeding 100mm (300 mm from the ground) should be removed without the written permission of the warden or the ECO. No 'listed' trees (Act 84 of 1998) requiring a permit may be removed or damaged without a permit. Contractors should clearly understand that they are working within a nature reserve. Contravention of any conservation and environmental legislation may result in prosecution. The Contractor is responsible for any illegal action by his/her staff, e.g. illegal hunting, setting of snares, fishing etc. The warden, reserve manager and ECO shall monitor that there is no introduction of alien invasive species to the construction site. Should any such species be identified, immediate and appropriate control measures are to be implemented. The area is an open system Big 5 reserve. Dangerous wild animals exist in the area and suitable precautions should be undertaken so as not to increase the risk to site personnel. It is also a malaria area. No foreign materials may be nailed or attached to any trees.
Prevention of cement pollution	Stockpiles and equipment may not be stored or parked within the 1:50 year flood line. Cement mixing is to take place on an impermeable layer and out of the watercourse and 1:50 year flood line. Cement is toxic to aquatic species. Shutter boards, steel plates, trailers and the like are useful impermeable surfaces on which to mix the cement. Any 'wash' or potential storm water contamination must be avoided and controlled. Storm water should be channeled away from the cement mixing area during construction. Waste water must be contained in the cement mixing area. Wheelbarrows should not be overfilled to reduce risk of spilling cement. Cement washings (from cement tool cleaning etc) must be prevented from entering the watercourse. Tools may not be washed or cleaned in the watercourse or natural pools or within the 1:50 year flood line. (a useful strategy is to wash tools in a dedicated drum and the water used for cement re-wetting). All used cement bags are immediately to be disposed of into the solid waste system. These bags are not to be used for other on site applications. Excess or waste cement should be allowed to dry on an impermeable surface and discarded with waste building rubble.
Ablution facilities and waste disposal	Contractors are requested to use existing toilets or erect appropriate site toilet (not pit latrines) No refuse or litter may be allowed to be left on site overnight. Any building rubble and any other non-compactable rubble should be safely stored out of the 1:50 year flood line or watercourse to be transported at a later stage, but prior to project completion. Building rubble must be removed from the reserve.
Provision of water	Water may need to be transported to the construction site. Filling of water tankers and similar must be arranged with the reserve manager.

Air pollution	No significant air pollution is anticipated, however, dust suppression may be necessary. This should be undertaken as required.
Noise	Unnecessary noise will not be tolerated. Contractors will not be permitted to shout on site. The use of megaphones is prohibited. Music and public radio is not permitted on site. Selection of machinery should include noise considerations.
Vehicle and equipment fuelling and maintenance	All vehicle fuelling and maintenance is to occur in areas specifically maintained for these activities such as the workshop / fuel station. The servicing and repair of equipment is to take place in a workshop or off site in areas specifically designed and designated for this. In the event of an on-site emergency repair, the contractor must ensure that all work is conducted over an impervious layer preventing spillage of oils and fuels into the environment. Sufficient absorbent materials and spill kits must be available to assist with clean-up operations. (geyser drip trays can be useful to achieve this).
Soil contamination and response	Should any soil contamination occur during construction, such contamination is to be immediately reported to the reserve manager. The contaminated soil shall be removed and stored in an area determined by the reserve manager and shall be labelled as to the form of contamination to prevent its future use. After consultation with an environmental specialist, the contaminated soil must be treated or disposed of, in accordance with legislation. It is essential that topsoil is separated from Overburden. In most cases the topsoil is clearly defined from the overburden by a colour change. If in doubt, the top 150mm may be considered as topsoil. Removed topsoil must be stored in stockpiles not higher than 1.5 meters. This is to prevent anoxic conditions from occurring. The stock piles should be wetted occasionally, particularly during periods of no rain in order to maintain the micro-organisms. The topsoil should be used as a primary rehabilitation measure as it contains the seedbank and micro- organisms related to the site. The topsoil, in rehabilitation, should be at least 50mm deep and careful watering as well as physical weed control should be implemented.
Borrow pits and quarries	Any imported gravel or sand shall be free of weeds, litter and contaminants. No sand may be harvested from non-approved source sites.
Fire prevention	No open fires will be allowed on the construction site or in the veld under any circumstances. Contractors must be aware of, and be able to raise the alarm if a fire is discovered.
Storm water management	No obstructions of any storm water system will be allowed and the dumping of water used for the cleaning of equipment will also not be permissible. Only level areas are to be used for stockpile zones and care is to be taken to prevent the stockpiling of materials in drainage lines.

Rehabilitation	On completion of construction, the development will be rehabilitated, by the contractor, through the removal of all construction facilities introduced, removal of waste and any other feature constructed or established during the use of the site. River banks will be re-contoured to match the surrounding landscape. Topsoil from the site must be used in the rehabilitation. Hydro-seeding and the import of compost is not recommended.
Communication	It is essential that good communication channels between the Contractor, landowner, reserve manager and Warden be maintained. This is particularly important with regard to road closures and wildlife safety.
Signage	Appropriate traffic signage should be erected where appropriate advising road users of closures and of maintenance.
Medical disaster	The site is not in close proximity to medical care for injuries on duty and evacuation in the case of serious illness may be required. The contractor must develop and maintain a medical disaster management procedure that will be communicated to all staff. These procedures will, as a minimum, have evacuation protocols, medical attention detail and a list of necessary contact numbers / persons included. Contractors will be required to have a first aid kit available on site at all times.

KCP – Crossing at river low flow section (flow from right to left)



SECTION IN RIVER BED FOR SUB-SURFACE FLOW (DEPENDENT ON FOUNDATION ROCK LEVELS)

If the rock level is too high for a double layer of precast culvert units then a taller section can be used. The object of the two layers is to provide a non-scouring bed at nominal river bed level but allow flow through the sand bed which is usual dry period flow in ephemeral rivers.

KCP – Causeway adjacent to rock bar (flow from right to left)