AQUATIC ECOLOGICAL ASSESSMENT AS PART OF THE WATER USE LICENSING PROCESS FOR THE CONSTRUCTION OF A POWERLINE FROM THE CASHAN SUB-STATION TO A NEW PROPOSED SUB-STATION.

Prepared for

SRK Consulting (Pty) Ltd

November 2014

SECTION C – Aquatic Assessment

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Report Reference: **SAS 213227**
Date: **November 2014**

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct an aquatic ecological assessment and wetland studies as part of the water use licensing process for the construction of a proposed powerline route from the Cashan sub-station to the new proposed sub-station. Two alternative lines were proposed for this study, one of which being the existing line which may be upgraded (alternative 1). The second alternative is to develop a new line (alternative 2). The alternative powerline 1 is located adjacent to the R560 Road. Alternative line 2 runs approximately parallel, at a distance of approximately 1km from the alternative powerline 1.

A single site visit and sampling round was conducted on the 28th of October 2014. Based on desktop research as well as observations in the field the Ecological Importance and Sensitivity of the systems was defined. During this site visit an aquatic ecological assessment was conducted in order to define the PES and Ecostatus of the aquatic ecosystems within the study area. An impact assessment on the aquatic resources of the study area was performed to determine the significance of the perceived impacts on the receiving environment. In addition, mitigatory measures were developed which aim to minimise the impacts, followed by an assessment of the significance of the impacts after mitigation, assuming that they are fully implemented.

This report, after consideration and the description of the ecological integrity of the study area, must guide the Environmental Assessment Practitioner (EAP), regulatory authorities and developing proponent, by means of the presentation of results and recommendations, as to the ecological viability of the proposed development activities.

1.2 Legislative requirements

1.2.1 National Environmental Management Act, 1998

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

Basic Assessment process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact.

1.2.2 National Water Act, 1998

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

2 METHOD OF ASSESSMENT

The sections below describe the methodology used to assess the aquatic ecological integrity of the various sites based on water quality, instream and riparian habitat condition and biological impacts and integrity.

The ecological category (EC) classification for each aspect of ecology and habitat analyses will be employed using the eco-status A to F continuum approach (Kleynhans and Louw 2007) where applicable. This approach allows for boundary categories denoted as B/C, C/D etc., as illustrated in Figure 1.

Figure 1: Ecological categories (EC) eco-status A to F continuum approach employed (Kleynhans and Louw 2007)

2.1 Visual Assessment

Each site was investigated in order to identify visible impacts on the site with specific reference to impacts from surrounding activities and any effects from the proposed discharge point. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the system were assessed by observing conditions and relating them to professional experience. Photographs of each site were taken to provide

visual indications of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area;
- Other life forms reliant on aquatic ecosystems and
- Signs of impact related to water quality.

2.2 Physico Chemical Water Quality Data

On-site testing of biota specific water quality variables took place. Parameters measured include pH, Electrical Conductivity and temperature. The results of on-site biota specific water quality analyses were used to aid in the interpretation of the data obtained by the bio-monitoring. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF 1996 vol. 7).

2.3 Habitat Integrity

It is important to assess the habitat of each site, in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the site should be discussed based on the application of the Intermediate Habitat Integrity Assessment for (Kemper; 1999). The Intermediate Habitat Integrity Assessment (IHIA) protocol, as described by Kemper (1999), should be used for site specific assessments. This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996). The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site should be scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The instream and riparian zones should be analysed separately, and the final assessment should be made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone are, however, primarily interpreted in terms of the potential impact on the instream component. The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data should be carried out by weighting each of the criteria according to

Kemper (1999). By calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the site. The method classifies Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

Table 1: Classification of Present State Classes in terms of Habitat Integrity [Based on Kemper 1999]

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

2.4 Habitat for Aquatic Macro-Invertebrates

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

- <65% inadequate for supporting a diverse aquatic macro-invertebrate community
- 65%-75% adequate for supporting a diverse aquatic macro-invertebrate community
- >75% highly suited for supporting a diverse aquatic macro-invertebrate community

2.5 Aquatic Macro-Invertebrates

Aquatic macro-invertebrate communities of the selected sites were investigated according to the method, which is specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter. The

assessment was undertaken according to the protocol as defined by Dickens & Graham (2001). All work was undertaken by an accredited SASS5 practitioner.

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score in conjunction with a low habitat score can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score together with a high habitat score would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

Classification of the system took place by comparing the present community status to reference conditions, which reflect the best conditions that can be expected in rivers and streams within a specific area and also reflect natural variation over time. The perceived reference state for the local streams was determined as a SASS5 score of 125 and an ASPT score of 5.5 based on general conditions of streams in the Western Bankenveld Eco-region. Interpretation of the results in relation to the reference scores was made according to the classification of SASS5 scores presented in the SASS5 methodologies published by both Dickens & Graham (2001) as well as Dallas (2007).

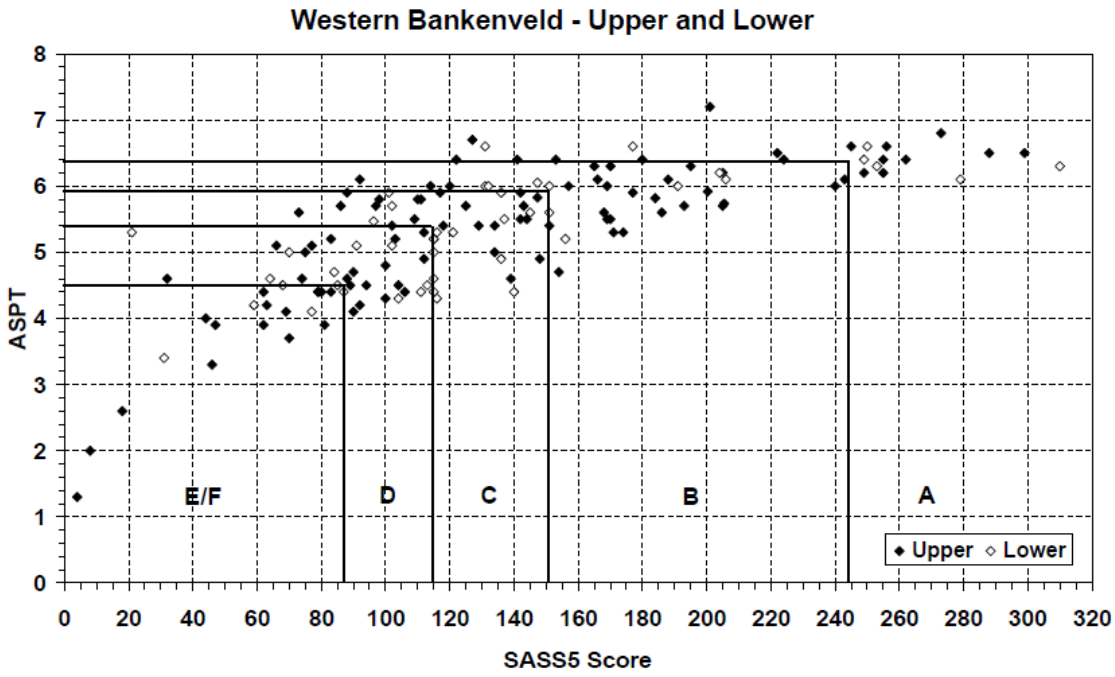

Figure 2: SASS5 Classification using biological bands calculated form percentiles for the Western Bankenveld Ecoregion, Dallas, 2007

Table 2: Definition of Present State Classes in terms of SASS scores as presented in Dickens & Graham (2001)

Class	Description	SASS5 Score%	ASPT
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100 80-89	Variable >90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89 70-79 70-89	<75 >90 76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79 50-59 50-79	<60 >75 60-75
D	Largely impaired. Mostly tolerant taxa present.	50 – 59 40-49	<60 Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

Table 3: Description of the discussion points used for the discussion of data for each site

ASPECT	DEFINITION
Biotopes sampled	Refers to the various biotopes sampled for aquatic macro-invertebrates during the collection of the SASS5 samples.
Sensitive taxa present	A list of the taxa that were captured during SASS5 sampling regarded as being sensitive taxa relevant to the conditions in the area.
Sensitive taxa absent	A list of the taxa that were not captured during SASS5 sampling of the site but that were captured at other sites in the program and regarded as sensitive taxa.
Adjusted SASS5 score	The adjusted SASS5 value based on the adjustment figure in the IHAS index for variances in habitat conditions.
SASS5 % of reference score	The result compared to the reference SASS5 score of (125).
ASPT % of reference score	The result for the site compared to the reference ASPT score of (5.5)
Dallas; 2007 classification	The classification of the site as excellent, into ecological bands/categories based on data from the Eastern Escarpment Mountains (Upper zone).

ASPECT	DEFINITION
Dickens and Graham, 2001 SASS5 classification	The classification of each site into one of five classes, based on the degree of impairment observed in the aquatic macro-invertebrate community.
McMillan, 1998 IHAS description	Description of the adequacy of habitat according to the guidelines of McMillan 1998
IHAS stones biotopes results	Discussion of the suitability of the stones biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS vegetation biotopes results	Discussion of the suitability of the vegetation biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS other biotopes results	Discussion of the suitability of the gravel, sand and mud biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS general stream characteristics	A summary of the notes made from the general stream characteristics section of the IHAS index.
Previous assessment IHAS score	The IHAS score obtained in the previous assessment.
Current IHAS score	The current score.
Current IHAS Adjustment score	The adjustment score from the IHAS index based on stream conditions.

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

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

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

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

2.7 Fish Response Assessment Index (FRAI)

No fish species was observed or caught during the site assessment. In addition no threatened fish species are highlighted within the Quaternary catchment A21F (Kleynhans et al., 2007). For these reasons the FRAI ecostatus tool was not applied to the two sites.

2.8 Aquatic EIS assessment

The EIS method considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale (Table 4). The median of the resultant score is calculated to derive the EIS category.

Table 4: Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General Description	Range of median
Very high	Quaternaries/delineations that are considered to be unique on a national and international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3-4
High	Quaternaries/delineations that are considered to be unique on a national scale based on their biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases may have substantial capacity for use.	>2-≤3
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are not usually very sensitive to flow modifications and often have substantial capacity for use.	>1-≤2
Low/ marginal	Quaternaries/delineations that is not unique on any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have substantial capacity for use.	≤1

2.9 Impact Assessment

The anticipated impacts associated with the proposed project have been assessed according to SRK's standardised impact assessment methodology which is presented below. This methodology has been utilised for the assessment of environmental impacts where the consequence (severity of impact, spatial scope of impact and duration of impact) and likelihood (frequency of activity and frequency of impact) have been considered in parallel to provide an impact rating and hence an interpretation in terms of the level of environmental management required for each impact.

The first stage of any impact assessment is the identification of potential environmental activities[1], aspects[2] and impacts which may occur during the commencement and

implementation of a project. This is supported by the identification of receptors[3] and resources[4], which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. Environmental impacts[5] (social and biophysical) are then identified based on the potential interaction between the aspects and the receptors/resources.

The significance (degree to which the impact may cause irreplaceable loss of resources) of the impact is then assessed by rating each variable numerically according to defined criteria as outlined in Table 1. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity[6], spatial scope[7] and duration[8] of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity[9] and the frequency of the impact[10] together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix table as shown in Table 5.

This matrix thus provides a rating on a scale of 1 to 150 (low, medium low, medium high or high) based on the consequence and likelihood of an environmental impact occurring.
Natural and existing mitigation measures, including built-in engineering designs, are included in the pre-mitigation assessment of significance. Measures such as demolishing of infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

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[1]An ***activity*** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or pieces of infrastructure that are possessed by an organisation.

[2]An ***environmental aspect*** is an 'element of an organisations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an impact.

[3]***Receptors*** comprise, but are not limited to people or man-made structures.

[4]***Resources*** include components of the biophysical environment.

[5]***Environmental impacts*** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. Receptors can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as aquifers, flora and palaeontology. In the case where the impact is on human health or well-being, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.

[6]***Severity*** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.

[7]***Spatial scope*** refers to the geographical scale of the impact.

[8]***Duration*** refers to the length of time over which the stressor will cause a change in the resource or receptor.

[9]***Frequency of activity*** refers to how often the proposed activity will take place.

[10]***Frequency of impact*** refers to the frequency with which a stressor (aspect) will impact on the receptor.

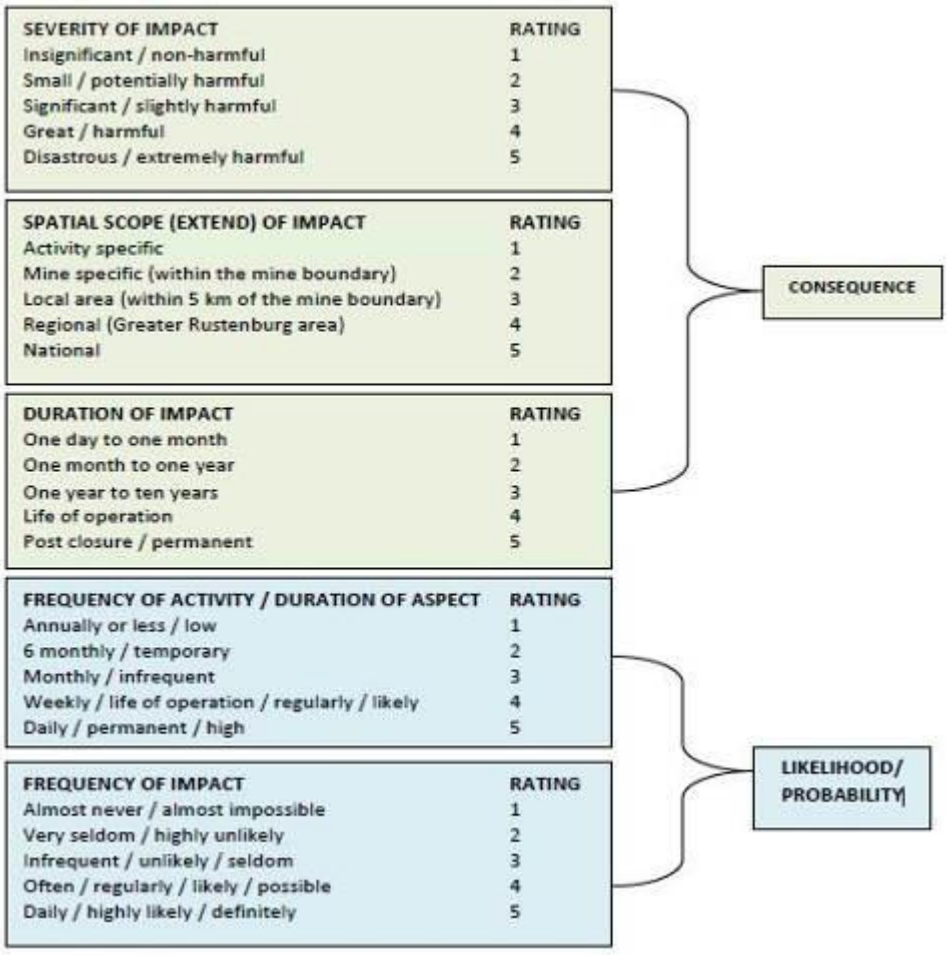

Figure 3: The Ecoregion and Quaternary Catchment applicable to the study area

Table 5: Interpretation of Impact Rating

Consequence

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

	High	76 to 150	Improve current management
	Medium High	40 to 75	Maintain current management
	Medium Low	26 to 39	
	Low	1 to 25	No management required

SIGNIFICANCE = CONSEQUENCE x LIKELIHOOD

2.10 Assumptions and limitations

The following points serve to indicate the assumptions and limitations of this study.

- ***Reference conditions are unknown:*** The composition of aquatic biota in the study area, prior to major disturbance, is unknown. For this reason, reference conditions are hypothetical, and are based on professional judgement and/or inferred from limited data available.
- ***Temporal variability:*** The data presented in this report are based on one site visit. The effects of natural seasonal and long term variation in the ecological conditions and aquatic biota found in the streams are, therefore, unknown. Ideally aquatic assessments should be undertaken, as a minimum in the summer/high flow and winter/low flow seasons to account for and define seasonal variability.
- ***Ecological assessment timing:*** *A*quatic and terrestrial ecosystems are dynamic and complex. It is possible that aspects, some of which may be important, could have been overlooked. A more reliable assessment of the biota would require seasonal sampling, with sampling being undertaken under both low flow and high flow conditions. Due to the impacted nature of the Magalies River, the observations made in this study are deemed adequate to provide the information required to define the risk to the aquatic ecosystem and to ensure that sufficient insight into management and mitigation measures is provided to adequately protect the system and to maintain the PES of the system.

3 GENERAL IMPORTANCE OF THE STUDY AREA

3.1 Ecoregions

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

The study area falls within the Western Bankenveld Aquatic Ecoregion. According to the ecological importance classification for the A21F quaternary catchment, the systems in the area can be classified as moderately sensitive in terms of ecological importance and sensitivity in their present state, and can be considered to be Class B (largely natural) stream and as Class C (moderately modified) stream based on the certainty of desktop methods.

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

Table 6: Summary of the ecological status of quaternary catchments in the study area based on Kleynhans 1999

Catchment	Resource	EISC	PESC	DEMC
A21F	Magalies River	Moderate	CLASS B: Largely natural systems	CLASS C: Moderately modified systems

The points below summarise the impacts on the aquatic resources in the A21F quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been highly affected by bed modification.
- High impacts from flow modifications have taken place.
- Moderate impacts from the introduced fish species, *Cyprinus carpio* and *Oncorhynchus mykiss* is likely.
- A high impact from inundation has taken place on the system.
- Riparian zones and stream bank conditions are considered to be moderately impacted due to agriculture in this area.
- A high impact on water quality has occurred in the area.

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

- The riverine systems have a low diversity of habitat types, decreasing their ecological importance and sensitivity.
- The site has a very low importance in terms of conservation.
- The riverine resources have a high sensitivity to flow requirements and changes in water quality as they provide breeding habitat for species such as *Chiloglanis pretoriae* and *Amphilius uranoscopus.*
- The area has a very low importance in terms of migration of aquatic species.
- The area has no importance in terms of rare and endemic species conservation.
- The ecology of the area is considered to be moderately sensitive to changes in water quality.
- The area has moderate importance as a source of refugia for aquatic species.

- The catchment can be considered to be moderately important in terms of species and taxon richness with special mention of *Chiloglanis pretoriae* and *Amphilius uranoscopus.*

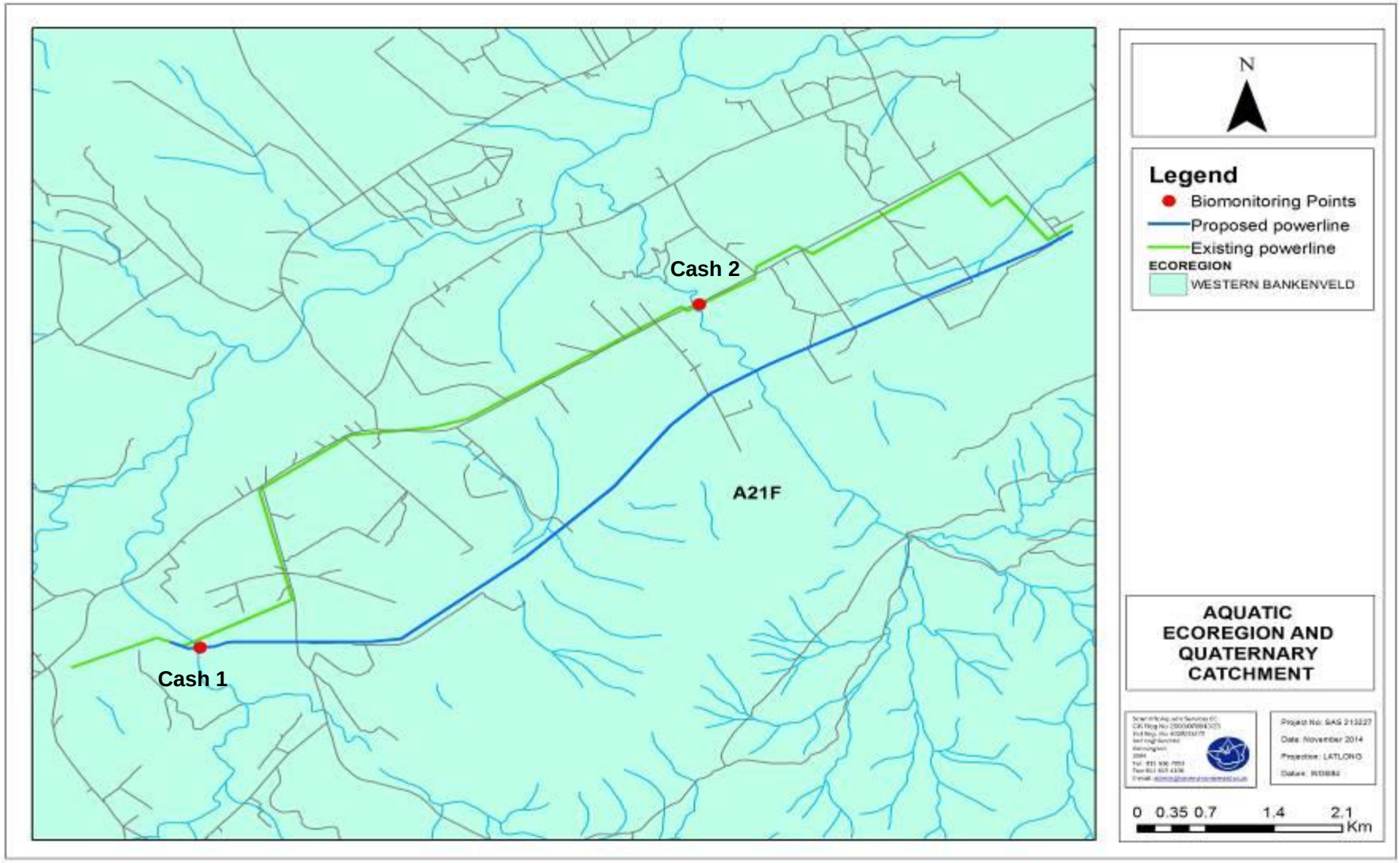

Figure 4: **The Ecoregion and Quaternary Catchment applicable to the study area**

4 RESULTS

Two aquatic ecological assessment points were assessed on the 28th of October 2014.

4.1 Visual Assessment

A photographic record of each site was made in order to provide a visual record of the condition of each assessment site as observed during the field assessment. The photographs taken at each site are presented in the sections below. The tables in each section summarise the observations for the various criteria made during the visual assessment undertaken at each site.

Figure 5: Upstream view of the Cash1 site on the Magalies River.

Figure 6: Downstream view of the Cash1 site on the Magalies River.

Figure 7: Upstream view of the Cash2 site located on an unnamed tributary of the Magalies River.

Figure 8: Downstream view of the Cash2 site located on an unnamed tributary of the Magalies River.

Table 7: Description of the assessment sites located on the Magalies River and the unnamed tributary.

SITE	Cash1	Cash2
Upstream features	This point is located on the Magalies River upstream of the existing powerline.	This point is located on the unnamed tributary of the Magalies River downstream of the proposed powerline.
Downstream significance	The assessment site is surrounded by agricultural activities.	The site is located at a bridge crossing on the R560 and is surrounded by agricultural activities.
Riparian zone characteristics	The riparian zone is relatively narrow due to the incised nature of the active-channel. The riparian zone is dominated by a mix of grasses and trees. Little inundated bankside vegetation was present.	The riparian zone is relatively narrow. The riparian zone is dominated by grass. Inundated bankside vegetation was present at the time of the assessment.
Algal presence	Algal proliferation was evident at the time of the assessment.	Algal proliferation was evident at the time of the assessment.
Visual indication of and impact on aquatic fauna	No visual indication of an impact on aquatic fauna, due to alterations in water quality was evident at the time of the assessment.	No visual indication of an impact on aquatic fauna, due to alterations in water quality was evident at the time of the assessment.
Depth characteristics	The system at this point was dominated by shallow runs and riffles the time of the assessment.	The system at this point was dominated by shallow pools, with a loss of connectivity in the system at the time of the assessment.
Flow condition	There was a low diversity of flow; the water can be considered as slow flowing. This will limit the diversity and sensitivity of the aquatic community to some degree.	There is a low diversity of flow; the water can be considered as still with a loss of connectivity in the system. This will limit the diversity and sensitivity of the aquatic community significantly.
Water clarity	Water was clear at the time of the assessment.	Water was clear at the time of the assessment.
Water odour	No odors were evident.	No odors were evident.
Erosion potential	There is potential for erosion due to the incised and eroded riverbanks.	There is a low potential for erosion due to the presence of incised riverbanks.

4.2 Biota Specific Water Quality

Table 8 below records the biota specific water quality of the assessment sites.

Table 8: Biota specific water quality variables

Site	Cond ms/m	pH	DO mg/l	Temp °C
Cash1	30.2	7.14	7.18	20.7
Cash2	32.1	6.78	5.02	20.4

- The water quality data indicates that both sites on the Magalies River and unnamed tributary have slightly elevated salt concentrations from those expected under natural conditions.
- The electrical conductivity (EC) at the Cash2 site on the unnamed tributary of the Magalies River is slightly higher than the Cash1 site. This is likely due to the location of the site in close proximity to the bridge crossing.
- The pH value at the Cash1 site can be considered as largely neutral while the pH at the Cash2 site can be regarded as slightly acidic at the time of the assessment but still within levels considered suitable for supporting a diverse and sensitive aquatic community.

- The water quality guideline for aquatic ecosystems (DWAF, 1996) states that dissolved oxygen concentrations should range between 80% and 120% of saturation.
- Saturation (i.e. maximum dissolved oxygen concentrations) shall in turn depend on the temperature of the water sampled (USA EPA website accessed November 2014). The current readings were expressed as a percentage of the potential maximum (Table 9).

Table 9: Oxygen measured expressed as a percentage of maximum concentration at the temperature measured.

Site	Oxygen (mg/L)	Temperature when measured (°C)	Maximum oxygen at that temperature (mg/L)	Oxygen measured expressed as percentage of maximum
Cash1	7.18	20.7	9.07	79.2
Cash2	5.02	20.4	9.07	55.3

- The DO concentrations at both sites fall below the recommended saturation. The low DO at the Cash2 site may be related to impacts from the surrounding agricultural activates.
- Temperatures can be regarded as normal for the time of year when sampling took place.

4.3 Habitat Assessment

- From the results of the application of the IHIA to the Cash1 assessment site, it is evident that there are some impacts at the present time.
- Instream impacts included large impacts from flow modification, channel modification, bed modification and water quality modification. Overall, the site achieved a 59.1% score for instream integrity.
- The largest riparian zone impacts included bank erosion and flow modification. The site achieved a 65.6% score for riparian zone integrity.
- The site obtained an overall IHIA rating of 62.3%, which indicates moderately modified (Class C conditions). The site, therefore, falls within the DEMC for the quaternary catchment in terms of habitat integrity.
- From the results of the application of the IHIA to the Cash2 assessment site, it was observed that instream impacts included large impacts from flow modification, channel modification, bed modification and water quality modification. Overall, the site achieved a 58.1% score for instream integrity.

- The largest riparian zone impacts included flow modification, exotic vegetation encroachment and channel modification. The site achieved a 66.7% score for riparian integrity.
- The site obtained an overall IHIA rating of 62.4%, which indicates moderately modified (Class C conditions). The site, therefore, falls within the DEMC for the quaternary catchment in terms of habitat integrity.

Table 10 provides a summary of the results obtained from the application of the IHAS Index to the four assessment sites. This index determines habitat suitability with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in interpreting the SASS data.

Table 10: A summary of the results obtained from the application of an IHAS index to the assessment sites

Type of Result	Site Cash1	Site Cash2
McMillan, 1998 IHAS description	Habitat structure and diversity was highly suited for supporting a diverse aquatic macro-invertebrate community.	Habitat structure and diversity was adequate for supporting a diverse aquatic macro-invertebrate community.
IHAS stones biotopes results	There was good rocky substrate available at this point.	There was adequate rocky substrate available at this point.
IHAS vegetation biotopes results	Adequate aquatic vegetation was present to provide habitat for aquatic macro-invertebrates.	Marginal vegetation was present to provide habitat for aquatic macro-invertebrates.
IHAS other biotopes results	Adequate gravel, sand and mud deposits were present at this point.	Adequate gravel, sand and mud deposits were present at this point.
IHAS general stream characteristics	A relatively wide, shallow run at the time of the assessment. The stream is clear at this point.	The stream consisted of a narrow, shallow pool at the time of the assessment.
IHAS score	75%	70%
Current IHAS Adjustment score	+10	+11

- The habitat structure and diversity was highly suited for supporting a diverse aquatic macro-invertebrate community at the Cash1 site located on the Magalies River.
- The habitat structure and diversity was adequate for supporting a diverse aquatic macro-invertebrate community at the Cash 2 site located on the unnamed tributary of the Magalies River.

4.4 Aquatic macro-invertebrate community assessment

Tables 11 and 12 provide a summary of the results obtained from the application of the SASS5 and IHAS indices to the sites.

Table 11: Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites

PARAMETER		STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	Cash1	43	49	34	67
	Cash2	49	39	38	58
Taxa	Cash1	8	10	6	14
	Cash2	10	8	8	12
ASPT	Cash1	5.4	4.9	5.7	4.8
	Cash2	4.9	4.9	4.8	4.8

Table 12: A summary of the results obtained from the application of the SASS5 and IHAS indices to the assessment sites

Type of Result	Site Cash1	Site Cash2
Biotopes sampled	Stones in and out of current, gravel, sand, mud and marginal vegetation.	Stones in and out of current, gravel, sand, mud and marginal vegetation.
Sensitive taxa present	*Caenidae; Gomphidae*	*Gomphidae; Naucoridae*
Sensitive taxa absent	*Chlorolestidae; Dipseudopsidae; Hydrometridae; Lestidae; Leptophlebidae; Dixidae; Hydracarina; Hydraenidae; Neucoridae*	*Chlorolestidae; Dipseudopsidae; Hydrometridae; Lestidae; Caenidae; Leptophlebidae; Dixidae; Hydracarina*
Adjusted SASS5 score	77	69
SASS5 % of reference score	53.6%	46.4%
ASPT % of reference score	87.3%	87.3%
Dallas, 2007 classification	Class C	Class D
Dickens and Graham, 2001 SASS5 classification	Class D (Largely impaired)	Class D (Largely impaired)

- The sites may be considered to be in a Class C (moderately impaired) condition at the Cash1 site while the Cash2 site may be considered a Class D (largely impaired) according to the Dallas (2007) classification system. Both the sites can be classified as a Class D (largely impaired) condition according to the Dickens & Graham (2001) classification system.

4.5 Aquatic Macro-Invertebrates: MIRAI

The results obtained after employing the MIRAI are summarised below. For ease of comparison the classifications obtained using SASS5 are also presented in this section.

Table 13: Summary of the results (ecological categories) obtained from the application of the MIRAI to the assessment sites, compared to classes awarded using SASS5.

Variable / Index	Cash1	Cash2
Ecological category (MIRAI)	D	D
Dickens and Graham (SASS5)	D	D
Dallas (SASS5)	C	D

From the table above it is clear that the MIRAI results in terms of (Ecological Category classification) follow the same trends as that obtained using the SASS class classifications. The general deterioration from the expected natural condition in terms of macro-invertebrate community integrity is clearly evident. This is due to the modified flow conditions and decreased water quality at the time of the assessment.

4.6 Fish Community Assessment

The fish community in this section of the Magalies River and its tributary has suffered an overall loss in integrity. The limited diversity of fish in the system is indicative of long-term impacts on the Magalies River system; this is likely due to the surrounding long-term agricultural activities of the area as well as loss of spawning habitat and upstream and downstream migration barriers. Seasonal variation in species distribution may also play a role in the absence of fish from the assessment sites at the time of the assessment.

The potential environmental impact from the powerline on the migratory routes of fish and other species may occur although the risk of these impacts is deemed unlikely and largely limited to the construction phase. Suitable mitigation and management measures should be applied.

4.7 Aquatic EIS determination

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

Table 14: Aquatic EIS determination for the Magalies River

Biotic Determinants	**Magalies River**
Rare and endangered biota	0
Unique biota	3
Intolerant biota	4
Species/taxon richness	2
Aquatic Habitat Determinants	
Diversity of aquatic habitat types or features	2
Refuge value of habitat type	3
Sensitivity of habitat to flow changes	3
Sensitivity of flow-related water quality changes	2
Migration route/corridor for instream and riparian biota	1
Nature Reserves, Natural Heritage sites, Natural areas, PNEs	1
RATING AVERAGE	**2.1**
EIS CATEGORY	**High**

Based on the findings of the assessment it is evident that aquatic features associated with the Magalies River have an EIS which can be considered high. The Magalies River system can therefore be defined as unique on a national scale based on their biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases may have substantial capacity for use.

5 IMPACT ASSESSMENT

5.1 General Management and Good Housekeeping Practices

The following essential mitigation measures are considered to be standard best practice measures applicable to a development of this nature, and must be implemented during all phases of the proposed powerline development, in conjunction with those stipulated in the individual tables pertaining to specific impacts in the following sections which define the mitigatory measures specific to the minimisation of impacts on aquatic resources.

Development and construction footprint

- Sensitivity maps should be considered during all phases of the development to aid in the conservation of aquatic habitat and resources within the study area;
- All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive areas with specific mention of wetland resources. It must be ensured that the riparian and drainage line systems, and their associated buffer zones are off-limits to construction vehicles and personnel; and
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration.

Vehicle access

- Planning of temporary roads and access routes should take the site sensitivity plan into consideration;
- No washing of construction equipment and vehicles on site; and
- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil. All spills should they occur, should be immediately cleaned up and treated accordingly.

Alien plant species

- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas that will have an impact on future rehabilitation has to be controlled;
- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the operational and rehabilitation/maintenance phases;
- For species specific and area specific eradication, care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used, and footprint areas should be kept as small as possible when removing alien plant species; and
- No vehicles should be allowed to drive through designated sensitive drainage line and riparian areas during the eradication of alien and weed species.

Riparian and drainage line habitat

- Any damage to the drainage lines necessary to complete the work must be limited in extent;
- No rocks from any water resource may be used as erosion or sedimentation control;
- Permit only essential construction personnel within 32m of the riparian habitat, if absolutely necessary that they enter the buffer zone;
- Implement effective waste management in order to prevent construction related waste from entering the drainage line and riparian environments; and
- The fishing or capturing of any biota should be prohibited.

Soils

- All areas should be monitored for erosion and incision. Specific mention is made of sedimentation of riparian areas;
- To prevent the erosion of topsoils, management measures to minimise erosion should include installation of berms, silt traps, hessian curtains at erodible areas and stormwater diversion away from areas susceptible to erosion;
- Berms every 50m should be installed where any disturbed soils have a slope of less than 2%, every 25m where the track slopes between 2% and 10%, every 20m where the track slopes between 10% and 15% and every 10m where the track slope is greater than 15% to prevent gully formation;
- Sheet runoff from access roads should be slowed down by the strategic placement of berms; and
- All soils compacted as a result of activities falling outside of project footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all operational and rehabilitation phases to prevent loss of floral habitat.

Waste Management

- Implement effective waste management in order to prevent construction-related waste from entering the drainage line and riparian environments;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage;
- All spills, should they occur, should be immediately cleaned up and treated accordingly;
- Appropriate sanitary facilities must be provided for the life of the construction activity and all waste removed to an appropriate waste facility;
- No camp fires should be permitted in or near the riparian area; and

- Ensure that litter does not affect the riparian areas and associated buffer zones.

Rehabilitation

- All soils compacted as a result of activities falling outside of project footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all operational and rehabilitation phases to prevent loss of floral habitat;
- Rehabilitate all drainage line and riparian habitat areas if required, in order to ensure that the ecology of these areas is re-instated during all phases;
- Edge effects of activities including erosion and alien/weed control need to be strictly managed in these areas;
- All reseeding activities must be undertaken at the end of the dry season to ensure optimal conditions for germination and rapid vegetation establishment;
- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils; and
- All alien vegetation should be removed during the rehabilitation phase and reseeded with indigenous grasses as as specified by a suitably qualified specialist (ecologist).

5.1.1 Impact 1: Changes to instream flow

Potential activities leading to impact

Pre-Construction	Construction	Operational
Poor planning leading to the placement of support towers in the active channels of the river may cause local changes to instream flow patterns.	Vehicles accessing area through riparian area and area of natural bankside vegetation leading to altered streamflow patterns.	Placement of support towers in the active channels of the river may cause local changes to instream flow patterns.
	Placement of support towers in the active channels of the river may cause local changes to instream flow patterns.	
	Incorrect rehabilitation and reshaping of the stream bed and banks	

Aspects of aquatic habitat affected

Construction	Operational
Altered streamflow characteristics and runoff patterns.	Altered streamflow characteristics.
Direct impact on instream habitat.	Increased erosion leading to sediment deposition in the aquatic resources and loss of instream habitat

Construction	Operational
Compaction of riparian soils promoting runoff.	
Altered structure of the riparian area leading to encroachment of alien vegetation.	

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	
Placement of support towers in the active channels of the river may cause local changes to instream flow patterns.	2	2	4	4	2	**48**	**MH Maintain Current Management**	1	1	1	4	1	**15**	**L No Management Required**	C
RECOMMENDED MITIGATION MEASURES															
No support structures should be constructed within the riparian areas or within the active stream channel. If at all possible all support structures should be developed above the 1: 100 year flood line and above the 1:50 year flood line as a minimum; During construction all building materials should be kept out of the riparian areas as well as the active stream channels; All waste and remaining building materials should be removed from site on completion of the project; and No vehicles should be allowed to indiscriminately drive through the riparian areas or within the active stream channels.															

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	
Placement of support towers in the active channels of the river may cause local changes to instream flow patterns.	2	2	4	4	2	**48**	**MH Maintain Current Management**	1	1	1	4	1	**15**	**L No Management Required**	O
RECOMMENDED MITIGATION MEASURES															
If it is inevitable that support towers are to be developed within the active channels measures to ensure that the structures will cause limited turbulence must be ensured; and The bed profile should be re-instated in such a way as to prevent incision and erosion in all areas that may be disturbed.															

5.1.2 Impact 2: Impacts due to sedimentation and increased turbidity

Potential activities leading to impact

Pre-Construction	Construction	Operational
Inadequate design of access roads as well as tower footprints.	Disturbance of soils resulting in erosion.	Erosion caused by altered flow around the tower base.
Inadequate planning of rehabilitation.	Removal of riparian vegetation.	Obstacles in the riparian zone obstructing flow and causing a build-up of sediment.
	Obstacles in the riparian zone obstructing flow and causing a build-up of sediment.	
	Inadequate rehabilitation of the riparian zone.	

Aspects of aquatic ecology affected

Construction	Operational
Disturbance and displacement of instream biota.	Deterioration of health of the instream biota.
Deterioration of health of the instream biota.	Loss of instream biota.
Loss of instream biota.	Loss of biodiversity.
Loss of biodiversity.	Loss of more sensitive aquatic taxa.
Loss of more sensitive aquatic taxa.	

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	
Increased sedimentation and turbidity.	2	2	2	4	2	**36**	**ML Maintain Current Management**	1	1	1	3	2	**15**	**L No Management Required**	C
RECOMMENDED MITIGATION MEASURES															
As far as possible no activities, with special mention of access roads, should occur within the riparian zones of stream channels as well as the stream channels themselves; The duration in which soils are exposed during construction activities should remain as short as possible; Concurrent rehabilitation is to take place as far as possible and footprint areas should be minimised as far as possible; All areas affected by construction should be rehabilitated upon completion of the construction phase of the development; River banks must be appropriately re-profiled and re-vegetated with indigenous grasses and trees. Steep banks should be stabilised with hessian sheets; Adequate stormwater management must be incorporated into the design of the proposed upgrade in order to prevent erosion and the associated sedimentation of the riparian and instream areas, as these systems have aquatic communities which rely on stream substrates clear of sediment and on, fast flowing water over rocky substrates. During the construction and operational phases of the proposed development, erosion berms should be installed to prevent gully formation and siltation of the riparian resources. The following points should serve to guide the placement of erosion berms: Where the track has slope of less than 2%, berms every 50m should be installed. Where the track slopes between 2% and 10%, berms every 25m should be installed. Where the track slopes between 10%-15%, berms every 20m should be installed. Where the track has slope greater than 15%, berms every 10m should be installed.															

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	
Increased sedimentation and turbidity.	2	2	2	3	2	**30**	**ML Maintain Current Management**	1	1	1	2	2	**12**	**L No Management Required**	O
RECOMMENDED MITIGATION MEASURES															
All areas affected by construction should be rehabilitated upon completion of the construction phase of the development; River banks must be appropriately re-profiled and re-vegetated with indigenous grasses and trees. Steep banks should be stabilised with hessian sheets; Adequate stormwater management must be incorporated into the design of the proposed development in order to prevent erosion and the associated sedimentation of the riparian and instream areas, as these systems have aquatic communities which rely on stream substrates clear of sediment and on, fast flowing water over rocky substrates. During the construction and operational phases of the proposed development, erosion berms should be installed to prevent gully formation and siltation of the riparian resources. The following points should serve to guide the placement of erosion berms: Where the track has slope of less than 2%, berms every 50m should be installed. Where the track slopes between 2% and 10%, berms every 25m should be installed. Where the track slopes between 10%-15%, berms every 20m should be installed. Where the track has slope greater than 15%, berms every 10m should be installed.															

5.1.3 Impact 3: Impacts on aquatic migratory corridors

Potential activities leading to impact

Pre-Construction	Construction	Operational
Inadequate design of support towers and their placement within areas which are regularly inundated.	Stream bed modifications due to construction of temporary construction access roads	Stream bed modifications due to ongoing use of temporary construction access roads.

Aspects of aquatic ecology affected

Construction	Operational
Disturbance and displacement of instream biota.	Deterioration of health of the instream biota.

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	
Impact on aquatic migratory corridors due to inadequate design of support towers and their placement within areas which are regularly inundated.	2	2	2	4	2	**36**	**ML Maintain Current Management**	1	1	1	3	1	**12**	**L No Management Required**	C
RECOMMENDED MITIGATION MEASURES															
Disturbance of the riparian areas should be avoided as far as possible. No support structures should be constructed within the riparian areas or river channels.															

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	
Impact on aquatic migratory corridors due to inadequate design of support towers and their placement within areas which are regularly inundated.	2	2	2	4	2	**36**	**ML Maintain Current Management**	1	1	1	3	1	**12**	**L No Management Required**	O
RECOMMENDED MITIGATION MEASURES															
Disturbance of the riparian areas should be avoided as far as possible. No support structures should be constructed within the riparian areas or river channels.															

5.1.4 Impact 4: Impacts on taxa sensitive to changes in water quality

Potential activities leading to impact

Pre-Construction	Construction	Operational
Inappropriate positioning of support towers.	Direct impact on instream habitat due to access road construction and placement of support towers	Ongoing use of access roads for maintenance activities.
Poor design and positioning of construction access roads.	Vegetation clearing and soil disturbance.	
	Pollution such as litter and any spills (both chemical and organic) may occur during the construction phase.	

Aspects of aquatic ecology affected

Construction	Operational
Deterioration of health of the instream biota.	Deterioration of health of the instream biota.
Loss of instream biota.	Loss of instream biota.
Loss of biodiversity.	Loss of biodiversity.
Loss of more sensitive aquatic taxa.	Loss of more sensitive aquatic taxa.

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	
Impacts on taxa sensitive to changes in water quality	3	3	4	4	3	**70**	**MH Maintain Current Management**	2	1	2	1	1	**10**	**L No Management Required**	C
RECOMMENDED MITIGATION MEASURES															
The time in which soils are exposed during construction activities should remain as short as possible; As small an area should be disturbed as possible.; No unnecessary support structures should be constructed within the riparian zones or active stream channels; During construction all construction materials should be kept out of the riparian or wetland zones; All waste and remaining building materials should be removed from site on completion of the project; No dumping should take place in or near the construction site; All spills should be immediately cleaned up and treated accordingly; No fires should be permitted on site; and Appropriate sanitary facilities must be provided for the duration of the proposed development and all waste removed to an appropriate waste facility.															

POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	Se	Sp	Du	Fa	Fi	TOTAL	SRK Guideline	
Impacts on taxa sensitive to changes in water quality	2	2	4	2	2	**32**	**ML Maintain Current Management**	1	1	2	1	1	**8**	**L No Management Required**	O
RECOMMENDED MITIGATION MEASURES															
No unnecessary support structures should be constructed within the riparian zones or active stream channels; All waste and remaining building materials should be removed from site on completion of the project; and No dumping should take place in or near the construction site.															

5.1.5 Impact Assessment Conclusion

Based on the above assessment it is evident that there are four possible impacts that may have an effect on the overall aquatic integrity of the Magalies River and its tributary. The table below summarises the findings indicating the significance of the impacts before mitigation takes place as well as the significance of the impacts if appropriate management and mitigation takes place. In the consideration of mitigation it is assumed that a high level of mitigation takes place but which does not lead to prohibitive costs.

Table 15: A summary of the impact significance of the construction phase on the Magalies River and its tributary.

Impact	Unmanaged	Managed
1: Changes to instream flow	Medium - High	Low
2: Impacts due to sedimentation and increased turbidity	Medium - Low	Low
3: Impacts on aquatic migratory corridors	Medium - Low	Low
4: Impacts on taxa sensitive to change in water quality	Medium - High	Low

Table 16: A summary of the impact significance of the operational phase on the Magalies River and its tributary.

Impact	Unmanaged	Managed
1: Changes to instream flow	Medium - High	Low
2: Impacts due to sedimentation and increased turbidity	Medium - Low	Low
3: Impacts on aquatic migratory corridors	Medium - Low	Low
4: Impacts on taxa sensitive to change in water quality	Medium - Low	Low

From the tables it is evident that prior to mitigation, the impact on the instream flow of the Magalies River and its tributary can be considered as Medium-High impacts during both the construction and operational phases. Should mitigatory measures be implemented as recommended, impacts will be reduced to Low level impacts. The impact on the aquatic resources due to sedimentation and turbidity as well as the impact on migratory corridors during both the construction and operational phases can be considered as Medium-Low impacts before the implementation of mitigatory measures. After implementation, these impacts will be reduced to Low level impacts. While the impact on the aquatic biodiversity and sensitive taxa of the Magalies River and its tributary during the construction phase can be considered as a Medium-High impact and as a Medium-Low impact during the operational phase before the implementation of mitigatory measures, the impact will be reduced to a Low level impact with the implementation of mitigation measures.

6 CONCLUSION

Based on the findings of this study, it can be concluded that the study area has low level of ecological importance and sensitivity; and the proposed powerline development is therefore likely to result in a moderate transformation of important habitats and systems, and the loss of biodiversity should impact minimisation measures not be implemented adequately. Adherence to the recommended mitigation measures will assist in reducing the impact on the aquatic resources on the subject property to an overall low level.

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APPENDIX 1: SASS5 Scoresheets

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 28/10/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E:°	**TURBELLARIA**	3					Corixidae*	3	**1**	**B**		**B**	Blepharoceridae	15				
SITE CODE: CASH 1	**ANNELIDA:**						Gerridae*	5		**B**		**B**	Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	**B**	**B**	**B**	**B**
SITE DESCRIPTION:	Leeches	3			**1**	**1**	Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 20.7 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.14	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 7.18 mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 30.2 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5	**A**			**A**
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
MVEGIC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4	**A**			**A**	Ancylidae	6				
MVEGOOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12	**B**	**B**	**B**	**B**	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6	**B**	**B**	**B**	**B**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3		**A**		**A**
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		43	49	34	67
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		8	10	6	14
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		5.38	4.90	5.67	4.79
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	75%				
	Coenagrionidae	4		**B**		**B**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5		**B**	**B**	**B**	**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5	**A**	**1**		**A**	SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**A**		**A**	**A**	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4		**A**		**A**	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 28/10/2014	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E:°	**TURBELLARIA**	3					Corixidae*	3	**A**	**B**	**A**	**B**	Blepharoceridae	15				
SITE CODE: CASH 2	**ANNELIDA:**						Gerridae*	5		**B**		**B**	Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	**B**		**A**	**B**
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7	**1**			**1**	Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 20.4 °C	Amphipoda	13					Notonectidae*	3	**1**	**B**	**1**	**B**	Empididae	6				
Ph: 6.78	Potamonautidae*	3					Pleidae*	4	**1**			**1**	Ephydridae	3				
DO: 5.02 mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 32.1 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
MVEGIC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
MVEGOOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12	**B**	**B**	**B**	**B**	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3	**A**	**B**	**1**	**B**
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		49	39	38	58
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		10	8	8	12
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		4.90	4.88	4.75	4.83
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	70%				
	Coenagrionidae	4		**A**		**A**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5	**B**	**A**	**A**	**B**	**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	**A**		**A**	**B**	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4	**A**	**B**	**A**	**B**	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

APPENDIX 2: IHAS Scoresheets

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name:
Site Name: Cash1 **Date**: 28/10/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):				**18**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):					**13**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):					**14**	
HABITAT TOTAL (MAX 55):					**45**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX						**30**
TOTAL IHAS SCORE (%):					**75**	

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name:
Site Name: Cash2 **Date**: 28/10/2014

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):				**15**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):					**14**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):					**15**	
HABITAT TOTAL (MAX 55):					**44**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX						**26**
TOTAL IHAS SCORE (%):					**70**	

APPENDIX 3: IHIA Scoresheets

Instream Habitat Integrity

Weights	14	13	13	13	14	10	9	8	6		
SITE	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
Cash1	8	12	10	10	12	3	3	0	1	59.1	D Largely modified
Cash2	8	14	10	10	12	3	3	0	1	58.1	D Largely modified
None (0)	Small (1-5)		Moderate (6 – 10)			Large (11 – 15)			Serious (16 – 20)		Critical (21 – 25)

Riparian Zone Habitat Integrity

Weights	13	12	14	12	13	11	12	13		
SITE	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
Cash1	8	8	10	4	12	8	8	2	65.6	C Moderately modified
Cash2	8	8	8	4	12	8	8	2	66.7	C Moderately modified
None (0)	Small (1-5)		Moderate (6 – 10)			Large (11 – 15)			Serious (16 – 20)	Critical (21 – 25)

Combined Habitat Integrity (Kemper, 1999)

SITE	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHI SCORE*	*CLASS*
Cash1	59.1	65.6	62.3	C Moderately modified
Cash2	58.1	66.7	62.4	C Moderately modified