ECOLOGICAL IMPACT ASSESSMENT (TERRESTRIAL AND AQUATIC)

PROPOSED DAM ON ARBEIDSGENOT FARM, MOORREESBURG REMAINDER OF FARM BAKOVEND 403, GOUDA DISTRICT

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COMPLIANCE WITH THE APPENDIX 6 OF THE AMENDED 2014 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REGULATIONS

REQUIREMENTS OF APPENDIX 6 – GN 326	**ADDRESSED IN SPECIALIST REPORT**
1. (1) A specialist report prepared in terms of these Regulations must contain - a) details of: i) the specialist who prepared the report; and ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Chapter 1 and Appendix A
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Original attached to formal application to DEA&DP. Included in beginning of report
c) an indication of the scope of, and the purpose for which, the report was prepared;	Chapter 1
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Chapter 3.12
e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	Chapter 3.
f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Chapter 5
g) an identification of any areas to be avoided, including buffers;	Chapter 6
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figures 2 and 3
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Chapter 3.12
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Chapter 7
k) any mitigation measures for inclusion in the EMPr;	Chapter 7
l) any conditions for inclusion in the environmental authorisation;	Chapter 7
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Chapter 7
n) a reasoned opinion - i) as to whether the proposed activity or portions thereof should be authorised; and ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Chapter 7
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	BAR Comments and Response Report
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	BAR Comments and Response Report
q) any other information requested by the competent authority.	N/A

1. INTRODUCTION AND BACKGROUND

Eco Impact Legal Consulting (Pty) Ltd was appointed by Mr. Marius Hanekom to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the freshwater and riparian resources as part of the Water Use Authorization application.

The property and proposed dam site are situated west of the Berg River east of the Moorreesburg to Gouda gravel road approximately 23km east of Moorreesburg. The dam's 0.2 km^2 catchment is located in the quaternary catchment G10J. The proposed dam will have a storage capacity of 324 000m^3, dam wall height of 13.5m and a surface area of 6.2ha. The dam wall will be constructed using a cut and fill process. Soil and clay will be cut from the dam basin and dam wall area that will also help to increase the depth of the dam and decrease the catchment basin that will lower water evaporation as the surface of the dam is smaller. The cut material will be used to fill and construct the dam wall. No other material is needed to construct the dam wall.

The overall area is characterised by ploughed and planted lands used for agriculture. The dam will impact on a disturbed tributary of the Berg River which has been classified as an ecological support area. Take note that the tributary has no ecological functioning left other than the transport of water from the agricultural lands.

Associated infrastructure
The farm has two existing abstraction points on the Berg River south and north-east of the farmhouse. The existing pipelines (125 & 165mm dia) from these abstraction points will be upgraded to 250mm dia each to fill the proposed dam. An additional abstraction point with a 250mm dia pipeline (130m long) is proposed just below (to the north) of the proposed dam, which will be the shortest route to fill the dam.

A new power line will be required from the north-eastern abstraction point to the new point. All areas to be irrigated from the new dam will be located within existing cultivated lands. A raft abstraction pump from the dam basin will be used for bulk conveyance to the areas.

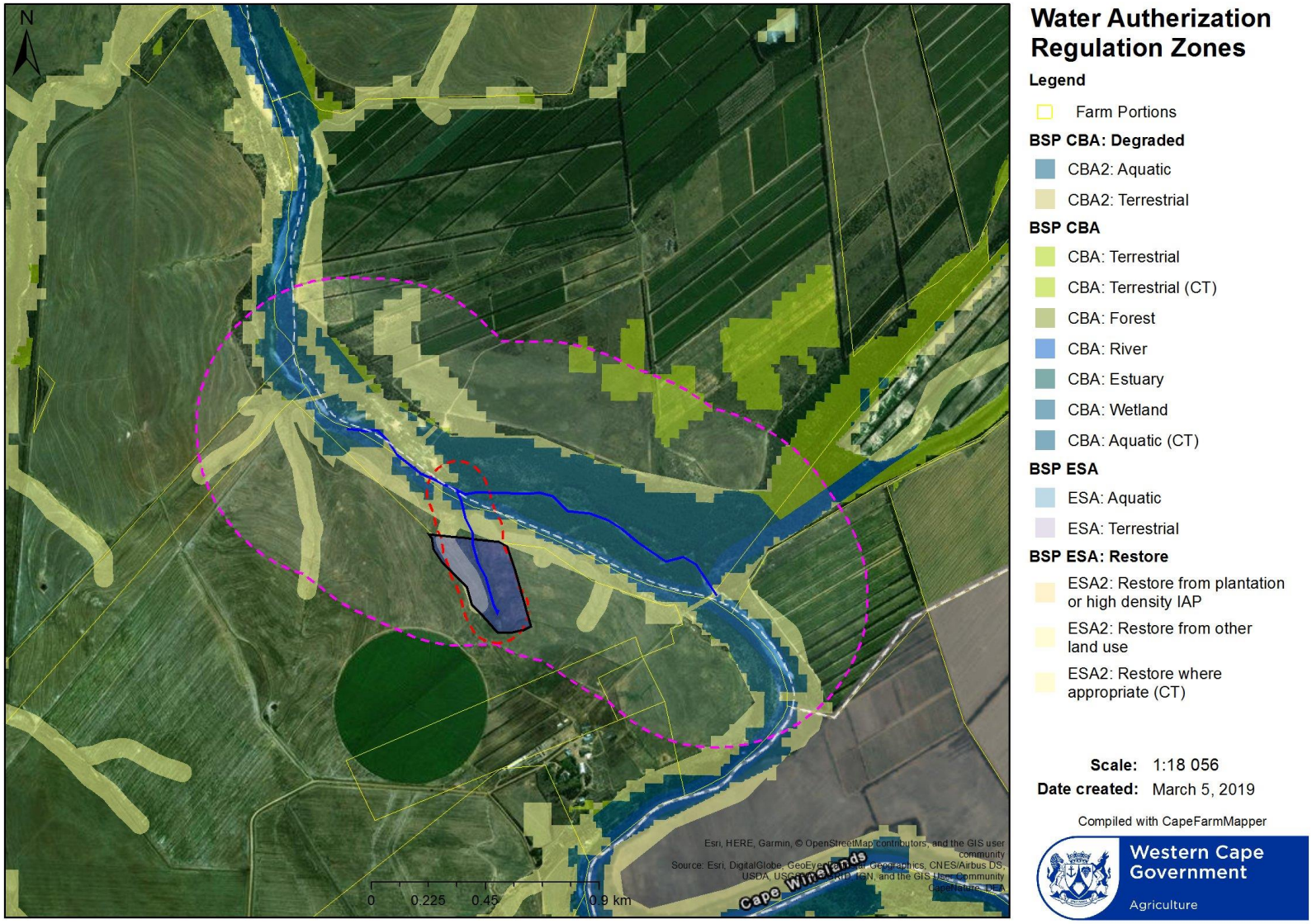

Figure 1: The water uses falling within the regulated zones that require authorization in terms of the National Water Act.

2. LEGISLATIVE REQUIREMENTS

Some of the pertinent environmental legislation that has possible bearing on the proposed development are as follows:

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

The National Water Act (NWA) guides the management of water in South Africa. The Act aims to regulate the use of water and activities that may impact on water resources through the categorisation of "listed water uses" encompassing water extraction and flow attenuation within catchments as well as the potential contamination of water resources, where the Department of Water and Sanitation (DWS) is the administering body in this regard. In terms of the proposed development and its nature, a specialist assessment is needed to provide DWS with the necessary information related to the proposed project's water uses and the potential impacts on the water resources of the area. It is the client's intention to register and license all water uses related to this project.

The National Environmental Management Act, 1998 (Act 107 Of 1998)

The activities in accordance with the requirements of the National Environmental Management Act, 1998 (Act 107 of 1998) for which Environmental Authorization is required applicable to this Ecological Impact assessment is:

- Activity 12 of Listing Notice 1 (GN 327) of the National Environmental Management Act (NEMA) EIA regulations, 2014 (as amended) states that: **The development of— (i) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 100 square metres; where such development occurs- (a) within a watercourse;**
- Activity 19 of Listing Notice 1 (GN 327) of the NEMA EIA regulations, 2014 (as amended) states: **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 of more than 5 cubic metres from- (i) a watercourse;**

The expansion of the dam triggers the above listed activities for which Environmental Authorization is required.

3. METHOD OF ASSESSMENT, ASSUMPTIONS AND LIMITATIONS OF THE STUDY

Input into the overall project was driven by the following Terms of Reference (ToR), which required the specialist to:

- Identify and describe freshwater ecosystems in the study area based on existing data and an onsite survey;
- Place freshwater ecosystems in a regional context and describe freshwater ecosystem-dependent fauna and flora species present;
- Classify, describe and map freshwater ecosystems in terms of their ecological sensitivity and functional value;
- Comment on and map freshwater ecosystem sensitivity in terms of ecologically important habitats, ecological corridors and linkages with other ecological systems;
- Identify potential impacts of the proposed project on freshwater ecosystems;
- Conduct a specialist assessment in line with NEMA (Act no. 107 of 1998) minimum specialist report requirements, which are presented within Appendix 6 of the NEMA: EIA Regulations (2014, as amended);
- Assess the direct, indirect and cumulative impacts (pre and post-mitigation) of the final location of infrastructure (and alternatives, if applicable) on freshwater ecosystems in the study area using the prescribed impact assessment methodology;
- Recommend practicable mitigation measures to avoid and/or minimise/reduce impacts and enhance benefits;

- Investigate an area of 500m from the proposed development area to determine if any wetlands occur within this area which would potentially trigger GN509 as promulgated in 2016;

All watercourses and wetlands directly impacted upon by the project will need to be delineated and assessed (i.e. functionally and health assessment). Whilst distinction shall be made between wetlands that occur as a result of natural land topography and features separate from those that occur because of artificial causes such as leaking water lines and raised culvert inverts relative to the surrounding natural ground; artificially created wetlands will require the same level of assessment as natural wetlands and EAP shall address them in the study and Environmental Management Programme (EMPr) to be submitted for approval. Specific reference shall be made to the distinction and no onus is to be placed on the contractor in the EMPr to preserve those identified as being futile to perpetuate.

3.1. Freshwater Ecological Assessment sites and site selection

The sites were visually assessed. Several methods (refer to below) was used to assess the risks to the freshwater ecology at the project area.
The objective is to demarcate and delineate river reaches[1] following a hierarchical approach according to the following considerations:

- **Broad natural physical reaches** that constitute the river from its source downstream. These reaches are the result of the various drivers of the system under reference conditions, viz. Hydrology, Geomorphology and Physico-chemical attributes. It follows that the biota responded and adapted to these reference conditions (i.e., the broad natural habitat template) in a dynamic way depending on natural climatic variation. The boundaries between different broad natural reaches are not necessarily crisp and clear. However, where marked and rapid changes occur due to geology (e.g. geomorphology and physico-chemical changes) and hydrology (e.g. large tributaries or a change in climate) these boundaries may be easy to identify.
- **Smaller natural reaches** may be distinguished within these large reaches. Depending on the characteristics of the biological group and taxa considered, the distribution of biota will broadly coincide with the demarcation of the natural reaches. However, depending on the attributes (e.g. preferences and intolerances) of the biota they may be limited to smaller natural reaches within the broad natural physical reaches. These will result in so-called biological habitat segments (e.g. fish habitat segments, Kleynhans 1999).
- Superimposed on these natural reaches are the changes brought about by anthropogenic activities. These activities may result in a homogenous impact throughout the length of a broad natural reach or their impact may be heterogeneous and result in smaller distinguishable sub-reaches. Physical driver changes as well as biological change agents (e.g. alien biota) may be involved.

Reference conditions (in terms of natural reaches, drivers and biota) need to be considered as these provide the natural evolutionary setting that indicates the resilience of the system to various forms of modification and stress. However, pragmatic considerations that come into the picture include anthropogenic changes to the system that are within the medium and long term not likely to change. These may include modifications to the system such as impoundments, agricultural, urbanization and forestry. Such modifications brings about changes in the natural reach characteristics in terms of the system drivers and biota and indicates changed reaches that needs particular consideration in order to manage them accordingly inter alia, ecological importance and sensitivity, Present Ecological State (PES), the recommended category and sustainability. This rationale also therefore enables the setting of resource quality objectives, ecological specifications and monitoring objectives and

[1] For the purpose of this document, "reach" is broadly defined as "a specified segment of a stream's path" (www.wwnorton.com/college/geo/earth2/glossary/r.htm).

specifications.

The freshwater delineations as presented in this report are regarded as the best based on the site conditions present at the time of the assessment.

3.2. Visual Assessment of Aquatic Assessment Points

Each site was selected in order to identify current conditions, with specific reference to impacts from surrounding activities where applicable. The following activities were conducted arriving at the site:

- Note whether site assessment is relative to natural state or previous site survey.
- Note land-use at the site that may impact on water quality, e.g. industrial site, urban, peri-urban, informal housing, subsistence and commercial farming.
- Note flow e.g. slow, medium or fast.
- Take fixed-point photographs of areas of concern, for comparison during later surveys.
- Complete the rating table in the field form for the following water quality indicators for metrics and individual rating tables:
    - Anthropogenic activities at the site that result in impaired in-stream water quality.
    - Odours that may suggest poor water quality.
    - Water column colour, e.g. green may indicate eutrophication.
    - Water clarity as an indicator of suspended sediment loads. This measure may be used as a surrogate for turbidity measurements, e.g. using a Secchi disk or turbidity tube.
    - Water surface, riparian bank and vegetation indicators of potential water quality impacts, e.g. visible scum or purple sheen on the surface, or salt deposits on the bank or riparian vegetation.
    - Extent of algal growth on rocks, i.e. periphyton (note there is a link to the habitat assessment method developed for the biological monitoring programme).
    - Visible biotic responses, e.g. fish kills.

3.3. Riparian Vegetation Response Assessment Index (VEGRAI)

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

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results (Kleynhans *et al*, 2007). Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category) (Table 1).

Table 1: Descriptions of the A-F ecological categories

Ecological Category	**Description**	**Score (% of total)**
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the 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	40-59

Ecological Category	Description	Score (% of total)
	and basic ecosystem functions has occurred.	
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with almost complete loss of natural habitat and biota. In worst instances basic ecosystem functions have been destroyed and changes are irreversible.	0-19

The level of aquatic assessment undertaken was considered to be adequate for this study.

3.4. Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) of riparian areas is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on a local scale to a more broader scale; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). The list of the EIS categories and rating scheme used in the assessment tool are shown in Table 2 and Table 3 respectively.

Table 2: List of the EIS categories used in the assessment tool (Kleynhans & Louw, 2007)

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 which are 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

Table 3: Rating scheme used for the assessment of riparian EIS (Kleynhans & Louw, 2007)

Score	Channel Type	Conservation context			Vegetation and Habitat Integrity	Connectivity	Threat status of Vegetation Type
0	Ephemeral Stream	Non-FEPA river	No status	None/ Excluded	No natural remaining	None	No Status
1	Stream non-perennial		Upstream management area	Available	Very poor	Very poor	Least threatened

2	Stream-perennial flow		Rehab FEPA		Poor	Low	Vulnerable
3	Minor river- non-perennial flow		Fish corridor	Earmarked for conservation	Moderately modified	Moderate	Near Threatened
4	Minor river-perennial flow		Fish support area		Largely natural	High	Endangered
5	Major river-perennial flow	FEPA river	River FEPA	Protected	Unmodified / natural habitat	Very high	Critically Endangered

3.4. National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

The National Freshwater Ecosystem Priority Areas (NFEPA) project was a partnership and collaborative process led by the CSIR with the South African National Biodiversity Institute (SANBI), Department of Water Affairs (DWA), the Water Research Commission (WRC), WWF South Africa, as well as expertise from South African National Parks (SANParks), the South African Institute for Aquatic Biodiversity (SAIAB) and Department of Environmental Affairs and Tourism (DEAT). The project was originally conceived in 2006 and the project proposal was submitted to the WRC in July 2007. An inception meeting took place in August 2008 to introduce the aims of the project to relevant stakeholders from the freshwater science, governance and management sectors. The NFEPA project aimed to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation.

NFEPA takes forward the implementation of the Cross-Sector Policy Objectives for Inland Water Conservation. It also builds on the river component of the National Spatial Biodiversity Assessment (NSBA) 2004, and will feed directly into the NBA (National Biodiversity Assessment) 2010.

The NFEPA database was searched in terms of conservation status of rivers, wetland habitat and wetland features present in the vicinity of the proposed development.

3.5. Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS), Present Ecological State / Ecological Importance and Sensitivity (PES/EIS) Database (2014)

The information obtained from these assessments/databases was used as first level desktop assessments for purposes of ecological reserve determination and for Ecological Water Resource Monitoring (EWRM).

3.6. Rapid Habitat Assessment

The Rapid Habitat Assessment Method (RHAM) is a simplified approach to measure and estimate habitat conditions according to cross sections through broadly defined morphological units (Kleynhans & Louw, 2009). The RHAM methodology consists of a series of steps. The methodology allows for a set cross sections of various Geomorphic Habitat Unit (GHU) to be monitored temporally, and for the biotic results to be interpreted more specifically with regards to habitat potential and availability in the GHUs of the reach.

DATA INTERPRETATION AND THRESHOLDS OF PROBABLE CONCERN (TPC)

For each of the water quality indicators (other than visible biotic response), the following rating system is used:

- 0 = natural / no impact
- 1 = small impact
- 2 = moderate impact
- 3 = large impact
- 4 = serious impact
- 5 = extreme impact

TPCs are set according to the Ecological Importance and Sensitivity (EIS) of the site. If a TPC is exceeded, a management intervention is required. The management action to be undertaken is determined by the indicator exceeded and its significance to the water quality impact on the ecological state of the site.

Low or Moderate EIS: Should any indicator be 2 and lower, i.e. a no impact, small or moderate impact, no management intervention should be initiated.

High EIS: Should any indicator exceed 2, i.e. a large to extreme impact, a management intervention should be initiated, e.g. move up to the next level of monitoring, more frequent biomonitoring, more frequent assessments of that site, or identification of the cause.

3.8. Assumptions and Limitations

The ground-truthing and delineation of the freshwater resource assessment thereof are confined to a single site visit undertaken in November 2018 which considered the freshwater resources associated with the development, as identified within the EIA application. All freshwater resources identified within the investigation area were delineated in fulfilment of Regulation GN509 of the National Water Act, 1998 (Act 36 of 1998) using desktop methods described above, including the use of topographic maps, historical and current digital satellite imagery and aerial photographs and were ground-truthed.

All areas surrounding the development have undergone significant changes (such as infilling, constructed stormwater dams, agricultural activities, road crossings and channelization at places) which have altered the geomorphic characteristics, hydrological regime and vegetation composition. The freshwater resource delineations as presented in this report are regarded as the best based on the site conditions present, as observed during the site assessment. The results obtained are, however, considered sufficiently accurate to allow planning and decision making to take place.

Freshwater resources and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater resource boundaries may occur. However, if the best practice and latest methods are followed, all assessors should get largely similar results. With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. However, the delineations as provided in this report are deemed appropriately accurate to guide any future development plans.

4. RESULTS OF THE LITERATURE REVIEW

The site is located in the Berg River catchment (DWS Primary Drainage Region G)[2]. The proposed water uses would pass through sections of the G10F quaternary catchment which is drained primarily by the Berg, Diep and Steenbras rivers. The tributary in which the proposed water uses is planned flow into the Berg river. The natural vegetation on site used to be Swartland Shale renosterveld (Critically Endangered conservation status), (Refer to figure 2 below). The impacted and surrounding area is however mostly transformed and disturbed as a result of previous agricultural activities.

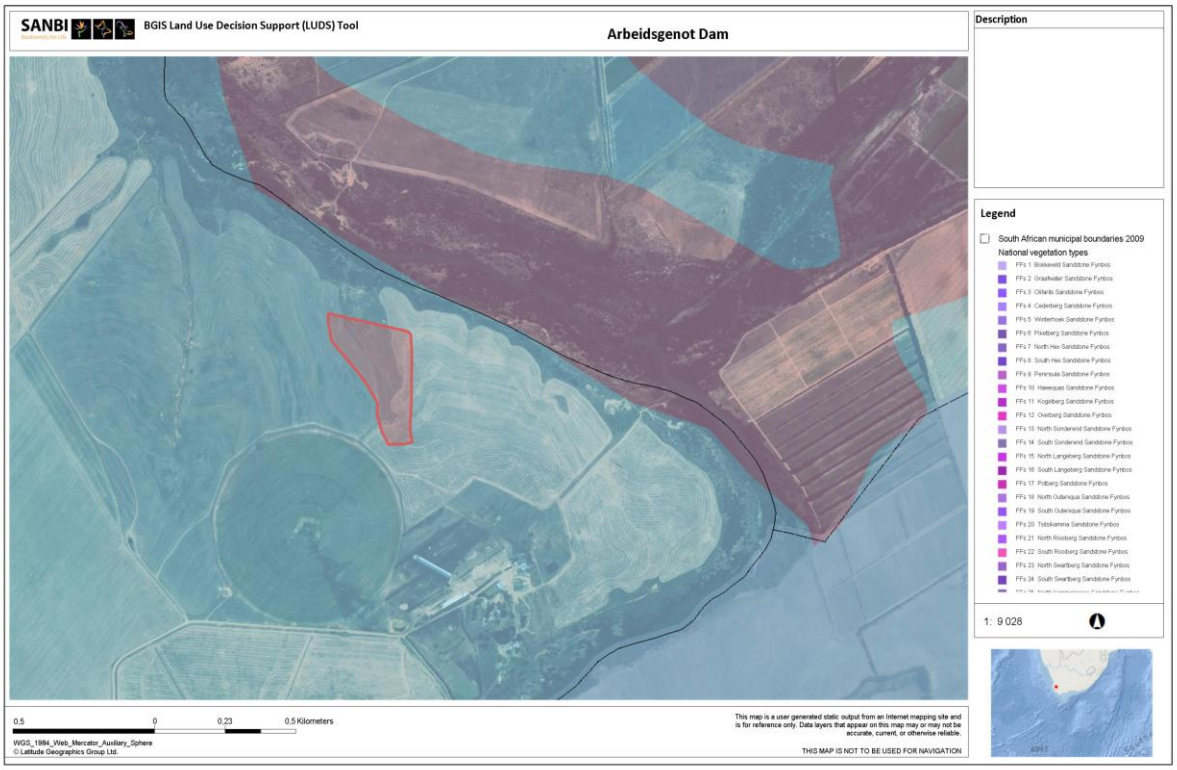

Figure 2: Map of vegetation type and conservation status.

Two biodiversity conservation mapping initiatives are of relevance to the freshwater ecosystems within the study area; namely the Western Cape Biodiversity Spatial Plan mapping initiatives that were undertaken on a regional basis and the NFEPA mapping initiative. The Berg River adjacent to the proposed dam is the only identified NFEPA features within the regulated zone (Refer to Figure 3).

[2] Department of Water and Sanitation, South Africa. January 2017. Determination of Water Resources Classes and Resource Quality Objectives in the Berg Catchment: Evaluation of Scenarios Report. Report No: RDM/WMA9/00/CON/CLA/0417.

Figure 3: FEPA Map.

The non-perennial river in which the proposed dam is planned was identified as Ecological Support Areas (ESAs) in the latest Western Cape Biodiversity Spatial Plan (2017) (Figure 1). ESA's are supporting zones required to prevent the degradation of Critical Biodiversity Areas (CBAs) and Protected Areas. The Berg River adjacent and downs stream to the dam expansion site was identified as an Aquatic CBA and its buffer areas as an ESA. The proposed dam are however outside the CBA areas identified. The dam wall and catchment of the dam will be outside the Berg River flood plain and buffer areas.

The information from PES/EIS database, as developed by the DWS RQIS department, is based on information at a sub-quaternary catchment reach (SQR) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS. No data was available for the non-perennial river in which the proposed dam is planned. The Berg River next to the proposed dam site according to the database has the following:

- Present Ecological State (PES) -Class D,
- mean Ecological Integrity (EI) – moderate,
- mean Ecological Sensitivity – high and
- default Ecological Category (EC) (based on median PES and highest of EI or ES - Class B.

The State of Rivers Report: Rivers of the Berg River System[3] reported that the Berg River had a fair to poor Index of habitat integrity, fair geomorphology index, fair riparian vegetation index, fair SASS index and poor fish index.

5. FRESHWATER ECOLOGICAL ASSESSMENT RESULTS

A photographic record of the impacted area was taken in order to provide a visual record of

[3] River Health Programme (2004). State-of-Rivers Report: Berg River System. Department of Water Affairs and Forestry Pretoria ISBN No: 0-620-32075-3

the condition of the assessment site as observed during the field assessment. The photographs taken are presented (Photos 1-5), followed by a table (Table 4) summarising the observations for the various criteria made during the visual assessment undertaken at each point.

The non-perennial river in which the dam is proposed is a tributary of the Berg River. Flow within the minor tributary would only occur for a short period of time in winter. The dam's catchment of 0.2 km^2 is located in the quaternary catchment G10J. The Water Research Commission MAP indicate a rainfall of 471 mm. The Mean Annual Runoff (MAR) from the catchment is estimated at less than 10 000 m^3 (little runoff from sandy overburden soils) and therefore neglible.The non-perrenial river is fully located in an agricultural ploughed land and surrounded by cultivated lands.

Photo 1: Upstream channelled non-perennial river.

Photo 2: View of non-perennial river downstream of proposed dam

Photo 3: Non-perennial river downstream of dam before flowing into the Berg River

Photo 4: View of dam catchment area

Photo 5: View of Berg river floodplain downstream of the proposed dam

The non- perennial river (proposed dam area) consists of area impacted by the existing agricutural activities that resulted in the degradation of the non-perennial rivers PES. The PES for this section of the river and where the dam is proposed was assessed to have a poor PES status. The riparian system falls into the category E. This indicates that the loss of natural habitat, biota and basic ecosystem functions is extensive.

Table 4: Descriptions of the location of dam in relation to mapped non-perennial river

Characteristics	Dam site	Upstream area	Downstream area
Significance of the point	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.
Surrounding anthropogenic activities	The site is situated at the area where the dam will impact on the non-perennial river.	The site is situated upstream where the dam will impact the non-perennial river.	The site is situated downstream where the dam will impact the non-perennial river.
Riparian zone characteristics	No riparian at this point and it is characterised by alien grasses (*Avena sativa*) as a result of the current and past agricultural activities in the area.	No riparian at this point and it is characterised by alien grasses (*Avena sativa*) as a result of the current and past agricultural activities in the area.	Limited riparian at this point. The Berg River in the area are typically dominated by the common reed *Phragmites australis* in the instream zone and invasive alien trees such as River gums (*Eucalyptus camaldulensis*) and Port Jackson willows (*Acacia saligna*) dominating the riparian zones.

5.1. Riparian Vegetation Response Assessment Index (VEGRAI)

The results of the VEGRAI are indicated in Table 5 below.

Table 5: The overall VEGRAI score of the impacted area

LEVEL 3 ASSESSMENT					
METRIC GROUP	CALCULATED RATING	WEIGHTED RATING	CONFIDENCE	RANK	% WEIGHT
MARGINAL	10.0	3.8	2.7	2.0	60,0
NON MARGINAL	41.7	26.0	2.7	1.0	100,0
2.0					160,0
LEVEL 3 VEGRAI (%)				29.8	
VEGRAI EC				**E**	
AVERAGE CONFIDENCE				2.7	

The score attained for the VEGRAI indicated that the riparian system falls into the category E and this indicates that the loss of natural habitat, biota and basic ecosystem functions is extensive.

5.2. Ecological Importance and Sensitivity (EIS)

The results of the EIS are indicated in Table 6 below.

Table 6: Results of the EIS assessment for the affected watercourse

Component	Score	Confidence	Comments/description
Channel type	1	4	Channelled non-perennial river.
Conservation context	0	4	No Status
Vegetation and habitat Integrity	1	4	Largely modified
Connectivity	1	4	Not connected. Downstream connection is lost.
Threat Status of Vegetation Type	1	4	Critically Endangered Vegetation at the dam impact site has a low botanical conservation value
EIS Category	**0.8**		**Low to marginal**

EIS 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. The median of the resultant score is calculated to derive the EIS category.

The non-perennial river is considered to be of low/marginal ecological importance. The non-perennial river and proposed dam areas were also not identified as a Critical Biodiversity Area or important area from a terrestrial ecology and botanical perspective.

The non-perennial river was classified according to the Classification System[4] as an Inland System, located within the Southern Coastal Belt Ecoregion.

5.3. Rapid Habitat Assessment

Description of the site

Geomorphic zone
The South Western Coastal Belt is typified by renosterveld-covered plains

Geomorphic Habitat Unit (GHU) characterisation
Alluvial run

Valley shape
U Shape

Channel shape
Broad valley

[4] Kleynhans, CJ, Thirion, C and Moolman, J (2005). A Level I River Ecoregion classification System for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Longitudinal connectivity at low flows (time of survey)
Unrestricted passage

Types of bars present
Bars absent

Bank shape
Concave

Bank slope
Flat

Bed compaction
Low compaction (2).

Sediment matrix
Matrix dominated

Local Disturbances at the site

The information relates to the Index of Habitat Integrity (IHI) information that is collated to derive the IHI ratings (Kleynhans *et al.* 2008). However, the IHI evaluations of impacts are applicable to the Management Resource Unit (MRU) and not to the site per se. This information required here is applicable to the site and only serves as a record to identify any additional local disturbances or changes. The IHI for the MRU is a requirement as part of the baseline for Ecological Water Resources Monitoring (EWRM) and therefore does not have to be addressed here.

Table 7 identify the disturbance, to provide a comment regarding the disturbance, and to provide a rating (1 – 5). The rating is an evaluation of the extent and severity of the disturbance with 5 relating to a severe disturbance applicable to most of the site. The focus area is the channel condition and the riparian zone as well as any disturbances immediately outside of the riparian zone which impacts on the site.

MODIFICATION	COMMENT	RATING
Abstraction (run of river)	None.	1
Animal farming	Area use for grazing of livestock.	5
Artificial covering	Vegetation extremely disturbed as a result of farming activities	5
Bed: material disturbance/removal	Historical agricultural disturbances.	4
Bed: stabilization (e.g. concrete)	None	NA
Buildings	None	NA
Channel Straightening	Historical agricultural disturbances.	4
Construction activities	None	NA
Crossings low water (immediately upstream or downstream)	None	NA
Dams (immediately upstream or downstream)	None	NA
Dry land farming	Ploughed and planted wheat fields	4
Erosion	Minimal	1
Forestry	None	NA

MODIFICATION	COMMENT	RATING
Invasive alien vegetation	*Avena sativa* as a result of the current and past agricultural activities in the area.	5
Irrigation	None	NA
Mining	None	NA
Off-channel dams	None	NA
Recreation	None	NA
Riparian vegetation removal	*Avena sativa* as a result of the current and past agricultural activities in the area.	5
Roads	None	NA
Rubbish dumping	None	NA
Runoff/effluent	None	NA
Trampling	Area use for grazing of livestock.	5
Weirs (immediately upstream or downstream)	None	NA

Geomorphic Habitat Unit (GHU)
Run (RN): Water moving with a relatively smooth, unbroken surface. Low turbulence. (FAST SHALLOW AND OR FAST DEEP). Similar to a glide

Depth
Approximately 0.5m

Velocity
The velocity is judged to be slow considering the characteristics of the bed and banks.

Substrate
Sediment. Low compaction (2).

Cover
Grasses (*Avena sativa*) as a result of the current and past agricultural activities in the area.

Anthropogenic activities
Anthropogenic activities have impacts on in-stream water quality and obvious sources of activities that can result in impaired in-stream water quality (Table 8).

Table 8: Non-perennial river anthropogenic activities recorded for the river reach affected

ANTHROPOGENIC ACTIVITIES	RATING					
	0	1	2	3	4	5
Ploughing along banks						x
Sand-mining	x					
Cattle watering or crossing point						x
Abstraction point	x					
Discharge point	x					
Chemical spill, e.g. abandoned pesticide containers, spillage from pumps, vehicle accidents	x					
Car washing	x					
Laundry washing	x					
In-stream building activities	x					
Litter	x					
Dump site	x					
Other (List, e.g. weir immediately upstream).	x					

Odour
The type of odour that is present at the site, if any (Table 9). NOTE WHETHER ODOURS ARE ASSOCIATED WITH THE SEDIMENT IN THE RIPARIAN ZONE. The following odours have been identified: a. Sewage, b. Cattle, e.g. cattle-watering point, c. Chemical, e.g. chlorine or pesticides, d. Anaerobic, e.g. hydrogen sulphide (or "rotten egg" smell normally associated with sediments) and e. Other: describe if possible

Table 9: Non-perennial river water quality indicator recorded for the river reach affected

WATER QUALITY INDICATOR	RATING						
	NA	0	1	2	3	4	5
Odour type 1 – sewage	x						
Odour type 2 – cattle	x						
Odour type 3 – chemical	x						
Odour type 4 – anaerobic	x						
Odour type 5 – other	x						

Colour
The colour of the water column at the site, if discoloured (Table 10). The following colours can be identified: a. Brown-black, indicating humics or low pH. DO NOT SCORE IF NATURAL, E.G. WESTERN CAPE STREAMS, b. Milky, indicating possible chemical pollution, c. Green, indicating algal growth in the water column and probable eutrophication, d. Orange, indicating presence of iron-oxidizing bacteria or acid mine drainage. NOTE THAT THIS IS NOT TURBIDITY and e. Other: describe if possible

Table 10: Non-perennial river water quality indicator (colour) recorded for the river reach affected

WATER QUALITY INDICATOR	RATING						
	NA	0	1	2	3	4	5
Colour type 1 – brown-black	x						
Colour type 2 – milky	x						
Colour type 3 – green	x						
Colour type 4 – orange	x						
Colour type 5 – other	x						

Clarity
Turbidity can be described as the following levels of clarity (Table 11) if a turbidity meter, turbidity tube or Secchi disk is not available to conduct a quantitative measurement.

Table 11: Non-perennial river water quality indicator (clarity) recorded for the river reach affected

WATER QUALITY INDICATOR	RATING					
	0	1	2	3	4	5
Clarity						

Clarity could not be recorded. No water flow at time of site visit.

0: no turbidity in the water column, 1: slightly turbid, 2: moderately turbid,3: largely turbid,4: seriously turbid and 5: extremely turbid or opaque throughout the site

Water surface and riparian bank and vegetation clues

The presence of deposits on the surface of the water and riparian banks or vegetation may be indicative of potential water quality impairment (Table 12).

Table 12: Non-perennial river surface water quality indicator recorded for the river reach affected

SURFACE WATER QUALITY INDICATOR	RATING						
	NA	0	1	2	3	4	5
Scum (e.g. from elevated organics)	x						
Foam (e.g. detergent use)	x						
Purple / oily sheen (e.g. diesel + oils)	x						
Visible salt deposits on banks and vegetation	x						
Other							

Extent of algal growth on rocks

The presence of algal growth on rocks, i.e. periphyton, may indicate eutrophication or elevated nutrients in the water column (Table 13). It is important to compare these indicators to the natural state as some rivers may have naturally high nutrient levels due to geological and other factors.

Table 13: Extent of algal growth on rocks recorded for the river reach affected

WATER QUALITY INDICATOR	RATING					
	0	1	2	3	4	5
Extent of algal growth on rocks	x					

0: no periphyton growth on rocks, 1: slight periphyton growth, 2: moderate growth, 3: large periphyton growth, 4: serious periphyton growth and 5: extreme coverage of rocks.

Visible biotic response

Any visible biotic responses displayed by megafauna, e.g. fish kills, should be noted and will require an immediate management action (Table 14). A more detailed water quality assessment will need to be conducted immediately, including toxicity testing of in-stream water.

Table 14: Visible biotic response recorded for the river reach affected

VISIBLE BIOTIC RESPONSE	RATING						
	NA	0	1	2	3	4	5
Visible fish kill	x						
Visible other species (note species)	x						

The overall Ecological and Importance of the non-perennial river where the proposed dam expansion is planned is assessed to be Low.

This confirm the assessment results of the NFEPA study and State of the River report findings.

6. HYDROLOGY AND ENVIRONMENTAL WATER REQUIREMENTS

The proposal is to store 320 000 cubic meters of allocated water from the Berg River in a newly constructed dam that would be constructed within a minor tributary of the Berg. Flow within the minor tributary would only occur for a short period of time in winter. The dam's catchment of 0.2 km^2 is located in the quaternary catchment G10J. The Water Research Commission MAP indicate a rainfall of 471 mm. The Mean Annual Runoff (MAR) from the catchment is estimated at less than 10 000 m^3 (little runoff from sandy overburden soils) and therefore neglible.[5]

No Reserve or environmental water requirement determination was undertaken due to the fact that the water utilized to fill the proposed dam would be from already allocated water from the

[5] Mbenga, J & Hagen. D.J. 03 April 2017. Ingerop Engineers. Proposed Elohim Dam, Moorreesburg.

Berg River. Although the proposed dam would be placed within a minor tributary, the runoff from the streams is small. The abstraction from Berg River should be reduced by the amount impeded from the stream by the dam.

There is only likely to be surface water runoff from the catchment of the minor tributaries between the months of April/May to October. The Environmental Water Requirement of the watercourses within the study area for the recommended ecological category for these streams of an E category (largely modified) would be approximately 20% of the Mean Annual Runoff (MAR) of the watercourses. This would equate to an environmental flow requirement of approximately 2 000 m^3. There is however only a very short stretch of the watercourse (about 30m) downstream of the proposed dam that would benefit from any environmental flow release. The significant section of the non-perennial river that requires water for ecological functioning is flooded from time to time during winter when the Berg River flow is high.

7. TERRESTRIAL ECOLOGICAL ASSESSMENT RESULTS

The study area according to Mucina and Rutherford (2006) lies within the Fynbos Biome and would have consisted largely of Swartland Shale Renosterveld (Critically endangered). Much of this natural vegetation has been replaced by cultivated crops with remnants only remaining within the non-perennial river and its floodplain areas. The Berg River in the area are typically dominated by the Common reed *Phragmites australis* in the instream zone and invasive alien trees such as River gums *Eucalyptus camaldulensis* dominating the riparian zones. The natural Fynbos Riparian Vegetation associated with the Berg River is virtually non-existent in the current project area as a result of its destruction through farming activities and the clearing of the consequent invasion by exotic (alien) invader species such as *Eucalyptus camaldulendsis*, *Salix babylonica* and European annual grasses, such as *Avena sativa*.

No riparian vegetation was recorded on the area that will be impacted by the dam wall and catchment basin as a result of the onsite agricultural activities and upstream impacts.

The area that will be impacted by the dam was classified having a poor ecological status.

8. IMPACT ASSESSMENT OF THE ACTIVITIES

You need to explain what extent, duration, magnitude, probability, significance mean etc

Alternative Site 1(Preferred alternative)

Dam Construction	**Geographical and Physical Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Disturbance to soil which is caused during the construction of the dam wall may lead to erosion of the site and surrounds.**
Extent and duration of impact:	**Extent 1 (footprint) & Duration 1**
Magnitude:	**2**
Consequence of impact or risk:	**Clearing and excavation activities can result in erosion and dust.**
Probability of occurrence:	**2 (I)**
Degree to which the impact may cause irreplaceable loss of resources:	**2 (PR)**
Degree to which the impact can be reversed:	**PR**

Indirect impacts:	**Disturbance to surface area can result in erosion and dust generation**
Cumulative impact prior to mitigation:	**Exposing soil may lead to erosion and dust generation if not mitigated.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**8 - Low**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**1 (CM)**
Proposed mitigation:	• **Access to roads and other areas must be controlled to avoid disturbance of areas outside the development footprint. Personnel should be restricted to the immediate construction areas only.** • **Monitor construction areas frequently for signs of erosion and if signs of erosion are detected implement repair and preventative measures immediately.** • **Strict compliance with the EMPr and MMP.**
Residual impacts:	**It is not anticipated that the impact will be high if the mitigation measures are adhered to.**
Cumulative impact post mitigation:	**It is not anticipated that the impact will be high if the mitigation measures are adhered to.**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low**
OPERATIONAL PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Similar to that in the development phase.**

Alternative Site 1. Preferred Alternative

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, thereby reducing biodiversity. Modification of habitats for agriculture as well as surface mining and urban development are the main causes of habitat destruction in this case. Additional causes of habitat destruction include water pollution, introduction of alien**

	species and overgrazing. The non-perennial riverine systems have very low flows as part of their annual hydrological cycles and are particularly susceptible to changes in habitat condition. The proposed development project has the potential to lead to habitat loss and/or alteration of the aquatic and riparian resources on the study area. It is however important to note that the freshwater ecology, and especially aquatic habitats of most of the systems has been impaired or impacted already as a result of existing dams, road crossings, channelization upstream and historical agricultural impacts and as such the risk to the receiving environment as a result of the proposed project is reduced to some degree.
Extent and duration of impact:	**Extent 2 & Duration 5**
Magnitude:	**2**
Consequence of impact or risk:	**Loss of freshwater ecological habitat**
Probability of occurrence:	**4**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Irreversible (IR)**
Indirect impacts:	**Loss of freshwater ecological habitat**
Cumulative impact prior to mitigation:	***Riparian zone*** **Earthworks in the vicinity of drainage systems leading to increased runoff and erosion and altered runoff patterns.** **Construction of the dam wall.** **Alien invasive vegetation encroachment.** ***Instream zone*** **Loss of aquatic refugia.** **Altered substrate conditions due to the deposition of silt.** **Altered depth and flow regimes in the non-perennial river.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**36 - Medium**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**
Proposed mitigation:	**Essential mitigation measures:** • **Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of aquatic habitats in the area.** • **Keep all demarcated sensitive zones outside of the construction area off limits during the construction**

	phase of the project. The non-impacted areas of the non-perennial river, its riparian zones and 32m buffer areas is regarded as no-go and no impact areas. • **On-going aquatic ecological monitoring must take place as per the water use authorization by a suitably qualified assessor.** • **Contractor laydown areas and stockpiles to be established outside of the 100m Zone of Regulation implemented around the watercourses.** • **Vehicles to be serviced at the contractor laydown area and all re-fuelling is to take place outside of all relevant zones of regulation.** • **Care must be taken to ensure that all concrete mixing is done on batter boards or within suitably bunded areas and no cement laden run-off may enter into the preferential surface flow pathway or the downstream ephemeral stream.** **Recommended mitigation measures** • **Permit only essential construction personnel within 32m of all riparian systems;** • **Restrict construction activities to the drier summer months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development and aim for completion in early spring at which time revegetation should take place allowing for a full summer growing season to become established.**
Residual impacts:	**Loss of freshwater ecological habitat**
Cumulative impact post mitigation:	**Loss of freshwater ecological habitat**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**16 - Low**
OPERATIONAL PHASE	
Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Not Applicable.**

Alternative Site 1. Preferred Alternative

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**

Nature of impact:	**A localised loss of riparian habitat and modification of the stream bed or banks of the watercourse at the dam site and immediately downstream is likely to occur as a result of the dam construction as well as the pipeline construction. This impact is however likely to be small due to the fact that the habitat within the watercourse for the preferred dam site as well as the watercourse and dam basin catchment that will be impacted by the dam are already largely modified.** **Special precaution is to be taken during the construction of the infrastructure that falls within the regulated area as determined in the NWA. Construction activities must be controlled to ensure that the river and its buffer areas are not negatively impacted.**
Extent and duration of impact:	**Extent 3 & Duration 2**
Magnitude:	**4**
Consequence of impact or risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Probability of occurrence:	**4**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Partly Reversible (PR)**
Indirect impacts:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Cumulative impact prior to mitigation:	**None as a result of the degraded habitat at the proposed dam impact area.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**36 - Medium**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**
Proposed mitigation:	• **Undertake construction activities only in identified and specifically demarcated areas.** • **Invasive vegetation to be removed during construction to be disposed of at landfill site if not use for fire wood, in such a manner that seeds must not be able to spread from the disposal site or during transportation.** • **At no point may construction equipment stand unauthorised within or near the river.** • **All excess sediment removed from the watercourses must be utilised as part of the building activities or be removed from site. At no point may this material**

	be dumped on site or within any of the other freshwater features identified within the surrounding area. Topsoil will have a high density of alien invasive seeds which will need to be controlled into the operational phase. • **Soil surrounding the wingwalls must be suitably backfilled and sloped (minimum of a 1:3 ratio) and concrete aprons as well as gabion mattresses should be installed both up and downstream for energy dissipation and sediment trapping.**
Residual impacts:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Cumulative impact post mitigation:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**10 - Low**
OPERATIONAL PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Nature of impact:	**Not Applicable.**

Alternative Site 1. Preferred Alternative

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Flow modification**
Nature of impact:	**Not Applicable**
OPERATIONAL PHASE	
Potential impact and risk:	**Flow modification**
Nature of impact:	**The proposal is to store 320 000 cubic meters of allocated water from the Berg River in a newly constructed dam that would be constructed within a minor tributary of the Berg. Flow within the minor tributary would only occur for a short period of time in winter. The dam's catchment of 0.2 km^2 is located in the quaternary catchment G10J. The Water Research Commission MAP indicate a rainfall of 471 mm. The Mean Annual Runoff (MAR) from the catchment is estimated at less than 10 000 m^3 (little runoff from sandy overburden soils) and therefore neglible.**
Extent and duration of impact:	**Extent 1 & Duration 5**
Magnitude:	**2**
Consequence of impact or risk:	**Flow modification**
Probability of occurrence:	**2**

Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Irreversible (IR)**
Indirect impacts:	**Loss of significantly impacted upon habitat and bed/bank modification.**
Cumulative impact prior to mitigation:	**There is only likely to be surface water runoff from the catchment of the minor tributaries between the months of April/May to October. The Environmental Water Requirement of the watercourses within the study area for the recommended ecological category for these streams of an E category (largely modified) would be approximately 20% of the Mean Annual Runoff (MAR) of the watercourses. This would equate to an environmental flow requirement of approximately 2 000 m^3. There is however only a very short stretch of the watercourse (about 30m) downstream of the proposed dam that would benefit from any environmental flow release.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**16 - Low**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**
Proposed mitigation:	**The tributary in which the dam is proposed as well as that associated with the pump station and pipeline still contains some indigenous vegetation within the watercourse but also contains invasive alien plants. It is important that the disturbed area is rehabilitated and that ongoing monitoring and management of invasive alien plants with the watercourses are undertaken. Follow up work should be carried out after rehabilitation to ensure that no invasive alien plants establish themselves within the watercourse adjacent to the dam as well as downstream of the dam.** **All of the above recommendations should be included in a River Management Maintenance Plan (MMP) for the project that would form part of the Environmental Management Plan.**
Residual impacts:	**Flow modification**
Cumulative impact post mitigation:	**Flow modification**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**10 - Low**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Impact on sensitive environments (rivers, wetlands etc.)**

Nature of impact:	**Similar to that in the development phase.**

Alternative Site 1. Preferred Alternative

Dam Construction	**Socio-Economic Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Temporary jobs will be created for the construction of the dam wall.**
Extent and duration of impact:	**Extent 2 (On site or within 100 m of the site) & Duration 1 (0 – 1 years)**
Consequence of impact or risk:	**Influx of contract workers due to lack of skills.** **Influx of job seekers due to jobs created.** **Littering.**
Probability of occurrence:	**4 (most likely)**
Degree to which the impact may cause irreplaceable loss of resources:	**NA – Positive**
Degree to which the impact can be reversed:	**NA – Positive**
Indirect impacts:	**NA – Positive**
Cumulative impact prior to mitigation:	**NA – Positive**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**8 – Low (positive)**
Degree to which the impact can be avoided:	**NA – Positive**
Degree to which the impact can be managed:	**NA – Positive**
Degree to which the impact can be mitigated:	**NA – Positive**
Proposed mitigation:	**Local contractors, employing or seeking to employ local (historically disadvantaged individuals (HDIs) from the region who are suitably qualified, should get preference.** **The municipality, local community and local community organizations should be informed of the project and potential job opportunities by the developer.**
Residual impacts:	**NA – Positive**
Cumulative impact post mitigation:	**NA – Positive**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low (positive)**
OPERATIONAL PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Similar to that in the development phase.**

Alternative Site 1. Preferred Alternative

Dam Construction	Cultural-Historical Impacts
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains**
Extent and duration of impact:	**Extent 1 (Footprint) & Duration 5 (Will not cease)**
Magnitude:	**2**
Consequence of impact or risk:	**The proposed development, related facilities and infrastructure will have no impact on the cultural-historical aspects.**
Probability of occurrence:	**2 (some possibility, but low likelihood)**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Partly reversible (PR)**
Indirect impacts:	**The proposed development, related facilities and infrastructure will have no impact on the cultural-historical aspects.**
Cumulative impact prior to mitigation:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**16 – Low**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2-Partly mitigatable (PM)**
Proposed mitigation:	**Should any burials, fossils or other historical material be encountered during construction, work must cease immediately and HWC must be contacted.**
Residual impacts:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Cumulative impact post mitigation:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low**

OPERATIONAL PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**Not Applicable.**

Alternative Site 2, upstream (Alternative)

Dam Construction	**Geographical and Physical Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Disturbance to soil which is caused during the construction of the dam wall may lead to erosion of the site and surrounds.**
Extent and duration of impact:	**Extent 1 (footprint) & Duration 1**
Magnitude:	**2**
Consequence of impact or risk:	**Clearing and excavation activities can result in erosion and dust.**
Probability of occurrence:	**2 (I)**
Degree to which the impact may cause irreplaceable loss of resources:	**2 (PR)**
Degree to which the impact can be reversed:	**PR**
Indirect impacts:	**Disturbance to surface area can result in erosion and dust generation**
Cumulative impact prior to mitigation:	**Exposing soil may lead to erosion and dust generation if not mitigated.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**8 - Low**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**1 (CM)**
Proposed mitigation:	• **Access to roads and other areas must be controlled to avoid disturbance of areas outside the development footprint. Personnel should be restricted to the immediate construction areas only.** • **Monitor construction areas frequently for signs of erosion and if signs of erosion are detected implement repair and preventative measures immediately.** • **Strict compliance with the EMPr and MMP.**

Residual impacts:	**It is not anticipated that the impact will be high if the mitigation measures are adhered to.**
Cumulative impact post mitigation:	**It is not anticipated that the impact will be high if the mitigation measures are adhered to.**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low**
OPERATIONAL PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Similar to that in the development phase.**

Alternative Site 2, upstream (Alternative)

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, thereby reducing biodiversity. Modification of habitats for agriculture as well as surface mining and urban development are the main causes of habitat destruction in this case. Additional causes of habitat destruction include water pollution, introduction of alien species and overgrazing. The non-perennial riverine systems have very low flows as part of their annual hydrological cycles and are particularly susceptible to changes in habitat condition. The proposed development project has the potential to lead to habitat loss and/or alteration of the aquatic and riparian resources on the study area. It is however important to note that the freshwater ecology, and especially aquatic habitats of most of the systems has been impaired or impacted already as a result of existing dams, road crossings, channelization upstream and historical agricultural impacts and as such the risk to the receiving environment as a result of the proposed project is reduced to some degree.**
Extent and duration of impact:	**Extent 2 & Duration 5**
Magnitude:	**2**
Consequence of impact or risk:	**Loss of freshwater ecological habitat**
Probability of occurrence:	**4**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Irreversible (IR)**

Indirect impacts:	**Loss of freshwater ecological habitat**
Cumulative impact prior to mitigation:	***Riparian zone*** **Earthworks in the vicinity of drainage systems leading to increased runoff and erosion and altered runoff patterns.** **Construction of the dam wall.** **Alien invasive vegetation encroachment.** ***Instream zone*** **Loss of aquatic refugia.** **Altered substrate conditions due to the deposition of silt.** **Altered depth and flow regimes in the non-perennial river.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**36 - Medium**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**
Proposed mitigation:	**Essential mitigation measures:** • **Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of aquatic habitats in the area.** • **Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the project. The non-impacted areas of the non-perennial river, its riparian zones and 32m buffer areas is regarded as no-go and no impact areas.** • **On-going aquatic ecological monitoring must take place as per the water use authorization by a suitably qualified assessor.** • **Contractor laydown areas and stockpiles to be established outside of the 100m Zone of Regulation implemented around the watercourses.** • **Vehicles to be serviced at the contractor laydown area and all re-fuelling is to take place outside of all relevant zones of regulation.** • **Care must be taken to ensure that all concrete mixing is done on batter boards or within suitably bunded areas and no cement laden run-off may enter into the preferential surface flow pathway or the downstream ephemeral stream.** **Recommended mitigation measures**

	• **Permit only essential construction personnel within 32m of all riparian systems;** • **Restrict construction activities to the drier summer months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development and aim for completion in early spring at which time revegetation should take place allowing for a full summer growing season to become established.**
Residual impacts:	**Loss of freshwater ecological habitat**
Cumulative impact post mitigation:	**Loss of freshwater ecological habitat**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**16 - Low**
OPERATIONAL PHASE	
Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Not Applicable.**

Alternative Site 2, upstream (Alternative)

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Nature of impact:	**A localised loss of riparian habitat and modification of the stream bed or banks of the watercourse at the dam site and immediately downstream is likely to occur as a result of the dam construction as well as the pipeline construction. This impact is however likely to be small due to the fact that the habitat within the watercourse for the preferred dam site as well as the watercourse and dam basin catchment that will be impacted by the dam are already largely modified.** **Special precaution is to be taken during the construction of the infrastructure that falls within the regulated area as determined in the NWA. Construction activities must be controlled to ensure that the river and its buffer areas are not negatively impacted.**
Extent and duration of impact:	**Extent 3 & Duration 2**
Magnitude:	**4**
Consequence of impact or risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Probability of occurrence:	**4**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**

Degree to which the impact can be reversed:	**Partly Reversible (PR)**
Indirect impacts:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Cumulative impact prior to mitigation:	**None as a result of the degraded habitat at the proposed dam impact area.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**36 - Medium**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**
Proposed mitigation:	• **Undertake construction activities only in identified and specifically demarcated areas.** • **Invasive vegetation to be removed during construction to be disposed of at landfill site if not use for fire wood, in such a manner that seeds must not be able to spread from the disposal site or during transportation.** • **At no point may construction equipment stand unauthorised within or near the river.** • **All excess sediment removed from the watercourses must be utilised as part of the building activities or be removed from site. At no point may this material be dumped on site or within any of the other freshwater features identified within the surrounding area. Topsoil will have a high density of alien invasive seeds which will need to be controlled into the operational phase.** • **Soil surrounding the wingwalls must be suitably backfilled and sloped (minimum of a 1:3 ratio) and concrete aprons as well as gabion mattresses should be installed both up and downstream for energy dissipation and sediment trapping.**
Residual impacts:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Cumulative impact post mitigation:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**10 - Low**
OPERATIONAL PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**

Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Nature of impact:	**Not Applicable.**

Alternative Site 2, upstream (Alternative)

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Flow modification**
Nature of impact:	**Not Applicable**
OPERATIONAL PHASE	
Potential impact and risk:	**Flow modification**
Nature of impact:	**The proposal is to store 320 000 cubic meters of allocated water from the Berg River in a newly constructed dam that would be constructed within a minor tributary of the Berg. Flow within the minor tributary would only occur for a short period of time in winter. The dam's catchment of 0.2 km^2 is located in the quaternary catchment G10J. The Water Research Commission MAP indicate a rainfall of 471 mm. The Mean Annual Runoff (MAR) from the catchment is estimated at less than 10 000 m^3 (little runoff from sandy overburden soils) and therefore neglible.**
Extent and duration of impact:	**Extent 1 & Duration 5**
Magnitude:	**2**
Consequence of impact or risk:	**Flow modification**
Probability of occurrence:	**2**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Irreversible (IR)**
Indirect impacts:	**Loss of significantly impacted upon habitat and bed/bank modification.**
Cumulative impact prior to mitigation:	**There is only likely to be surface water runoff from the catchment of the minor tributaries between the months of April/May to October. The Environmental Water Requirement of the watercourses within the study area for the recommended ecological category for these streams of an E category (largely modified) would be approximately 20% of the Mean Annual Runoff (MAR) of the watercourses. This would equate to an environmental flow requirement of approximately 2 000 m^3. There is however only a very short stretch of the watercourse (about 30m) downstream of the proposed dam that would benefit from any environmental flow release.**
Significance rating of impact prior to mitigation	**16 - Low**

(e.g. Low, Medium, Medium-High, High, or Very-High)	
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**
Proposed mitigation:	**The tributary in which the dam is proposed as well as that associated with the pump station and pipeline still contains some indigenous vegetation within the watercourse but also contains invasive alien plants. It is important that the disturbed area is rehabilitated and that ongoing monitoring and management of invasive alien plants with the watercourses are undertaken. Follow up work should be carried out after rehabilitation to ensure that no invasive alien plants establish themselves within the watercourse adjacent to the dam as well as downstream of the dam.** **All of the above recommendations should be included in a River Management Maintenance Plan (MMP) for the project that would form part of the Environmental Management Plan.**
Residual impacts:	**Flow modification**
Cumulative impact post mitigation:	**Flow modification**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**10 - Low**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Impact on sensitive environments (rivers, wetlands etc.)**
Nature of impact:	**Similar to that in the development phase.**

Alternative Site 2, upstream (Alternative)

Dam Construction	**Socio-Economic Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Temporary jobs will be created for the construction of the dam wall.**
Extent and duration of impact:	**Extent 2 (On site or within 100 m of the site) & Duration 1 (0 – 1 years)**
Consequence of impact or risk:	**Influx of contract workers due to lack of skills.** **Influx of job seekers due to jobs created.** **Littering.**
Probability of occurrence:	**4 (most likely)**
Degree to which the impact may cause irreplaceable loss of resources:	**NA – Positive**
Degree to which the impact can be reversed:	**NA – Positive**
Indirect impacts:	**NA – Positive**

Cumulative impact prior to mitigation:	**NA – Positive**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**8 – Low (positive)**
Degree to which the impact can be avoided:	**NA – Positive**
Degree to which the impact can be managed:	**NA – Positive**
Degree to which the impact can be mitigated:	**NA – Positive**
Proposed mitigation:	**Local contractors, employing or seeking to employ local (historically disadvantaged individuals (HDIs) from the region who are suitably qualified, should get preference.** **The municipality, local community and local community organizations should be informed of the project and potential job opportunities by the developer.**
Residual impacts:	**NA – Positive**
Cumulative impact post mitigation:	**NA – Positive**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low (positive)**
OPERATIONAL PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Similar to that in the development phase.**

Alternative Site 2, upstream (Alternative)

Dam Construction	**Cultural-Historical Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains**
Extent and duration of impact:	**Extent 1 (Footprint) & Duration 5 (Will not cease)**
Magnitude:	**2**
Consequence of impact or risk:	**The proposed development, related facilities and infrastructure will have no impact on the cultural-historical aspects.**
Probability of occurrence:	**2 (some possibility, but low likelihood)**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Partly reversible (PR)**

Indirect impacts:	**The proposed development, related facilities and infrastructure will have no impact on the cultural-historical aspects.**
Cumulative impact prior to mitigation:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**16 – Low**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2-Partly mitigatable (PM)**
Proposed mitigation:	**Should any burials, fossils or other historical material be encountered during construction, work must cease immediately and HWC must be contacted.**
Residual impacts:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Cumulative impact post mitigation:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low**
OPERATIONAL PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**Not Applicable.**

Alternative Site 2, downstream (Alternative)

Dam Construction	**Geographical and Physical Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Disturbance to soil which is caused during the construction of the dam wall may lead to erosion of the site and surrounds.**
Extent and duration of impact:	**Extent 1 (footprint) & Duration 1**

Magnitude:	**2**
Consequence of impact or risk:	**Clearing and excavation activities can result in erosion and dust.**
Probability of occurrence:	**2 (I)**
Degree to which the impact may cause irreplaceable loss of resources:	**2 (PR)**
Degree to which the impact can be reversed:	**PR**
Indirect impacts:	**Disturbance to surface area can result in erosion and dust generation**
Cumulative impact prior to mitigation:	**Exposing soil may lead to erosion and dust generation if not mitigated.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**8 - Low**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**1 (CM)**
Proposed mitigation:	• **Access to roads and other areas must be controlled to avoid disturbance of areas outside the development footprint. Personnel should be restricted to the immediate construction areas only.** • **Monitor construction areas frequently for signs of erosion and if signs of erosion are detected implement repair and preventative measures immediately.** • **Strict compliance with the EMPr and MMP.**
Residual impacts:	**It is not anticipated that the impact will be high if the mitigation measures are adhered to.**
Cumulative impact post mitigation:	**It is not anticipated that the impact will be high if the mitigation measures are adhered to.**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low**
OPERATIONAL PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Soil erosion and dust**
Nature of impact:	**Similar to that in the development phase.**

Alternative Site 2, downstream (Alternative)

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	

Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, thereby reducing biodiversity. Modification of habitats for agriculture as well as surface mining and urban development are the main causes of habitat destruction in this case. Additional causes of habitat destruction include water pollution, introduction of alien species and overgrazing. The non-perennial riverine systems have very low flows as part of their annual hydrological cycles and are particularly susceptible to changes in habitat condition. The proposed development project has the potential to lead to habitat loss and/or alteration of the aquatic and riparian resources on the study area. It is however important to note that the freshwater ecology, and especially aquatic habitats of most of the systems has been impaired or impacted already as a result of existing dams, road crossings, channelization upstream and historical agricultural impacts and as such the risk to the receiving environment as a result of the proposed project is reduced to some degree.**
Extent and duration of impact:	**Extent 2 & Duration 5**
Magnitude:	**2**
Consequence of impact or risk:	**Loss of freshwater ecological habitat**
Probability of occurrence:	**4**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Irreversible (IR)**
Indirect impacts:	**Loss of freshwater ecological habitat**
Cumulative impact prior to mitigation:	***Riparian zone*** **Earthworks in the vicinity of drainage systems leading to increased runoff and erosion and altered runoff patterns.** **Construction of the dam wall.** **Alien invasive vegetation encroachment.** ***Instream zone*** **Loss of aquatic refugia.** **Altered substrate conditions due to the deposition of silt.** **Altered depth and flow regimes in the non-perennial river.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**36 - Medium**
Degree to which the impact can be avoided:	**High**

Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**
Proposed mitigation:	**Essential mitigation measures:** • **Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of aquatic habitats in the area.** • **Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the project. The non-impacted areas of the non-perennial river, its riparian zones and 32m buffer areas is regarded as no-go and no impact areas.** • **On-going aquatic ecological monitoring must take place as per the water use authorization by a suitably qualified assessor.** • **Contractor laydown areas and stockpiles to be established outside of the 100m Zone of Regulation implemented around the watercourses.** • **Vehicles to be serviced at the contractor laydown area and all re-fuelling is to take place outside of all relevant zones of regulation.** • **Care must be taken to ensure that all concrete mixing is done on batter boards or within suitably bunded areas and no cement laden run-off may enter into the preferential surface flow pathway or the downstream ephemeral stream.** **Recommended mitigation measures** • **Permit only essential construction personnel within 32m of all riparian systems;** • **Restrict construction activities to the drier summer months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development and aim for completion in early spring at which time revegetation should take place allowing for a full summer growing season to become established.**
Residual impacts:	**Loss of freshwater ecological habitat**
Cumulative impact post mitigation:	**Loss of freshwater ecological habitat**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**16 - Low**

OPERATIONAL PHASE	
Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Loss of freshwater ecological habitat**
Nature of impact:	**Not Applicable.**

Alternative Site 2, downstream (Alternative)

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Nature of impact:	**A localised loss of riparian habitat and modification of the stream bed or banks of the watercourse at the dam site and immediately downstream is likely to occur as a result of the dam construction as well as the pipeline construction. This impact is however likely to be small due to the fact that the habitat within the watercourse for the preferred dam site as well as the watercourse and dam basin catchment that will be impacted by the dam are already largely modified.** **Special precaution is to be taken during the construction of the infrastructure that falls within the regulated area as determined in the NWA. Construction activities must be controlled to ensure that the river and its buffer areas are not negatively impacted.**
Extent and duration of impact:	**Extent 3 & Duration 2**
Magnitude:	**4**
Consequence of impact or risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Probability of occurrence:	**4**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Partly Reversible (PR)**
Indirect impacts:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Cumulative impact prior to mitigation:	**None as a result of the degraded habitat at the proposed dam impact area.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**36 - Medium**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**

Proposed mitigation:	• **Undertake construction activities only in identified and specifically demarcated areas.** • **Invasive vegetation to be removed during construction to be disposed of at landfill site if not use for fire wood, in such a manner that seeds must not be able to spread from the disposal site or during transportation.** • **At no point may construction equipment stand unauthorised within or near the river.** • **All excess sediment removed from the watercourses must be utilised as part of the building activities or be removed from site. At no point may this material be dumped on site or within any of the other freshwater features identified within the surrounding area. Topsoil will have a high density of alien invasive seeds which will need to be controlled into the operational phase.** • **Soil surrounding the wingwalls must be suitably backfilled and sloped (minimum of a 1:3 ratio) and concrete aprons as well as gabion mattresses should be installed both up and downstream for energy dissipation and sediment trapping.**
Residual impacts:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Cumulative impact post mitigation:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**10 - Low**
OPERATIONAL PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Degradation / loss of naturally occurring / indigenous flora and habitats**
Nature of impact:	**Not Applicable.**

Alternative Site 2, downstream (Alternative)

Dam Construction	**Biological Aspect Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Flow modification**
Nature of impact:	**Not Applicable**
OPERATIONAL PHASE	
Potential impact and risk:	**Flow modification**
Nature of impact:	**The proposal is to store 320 000 cubic meters of allocated water from the Berg River in a newly**

	constructed dam that would be constructed within a minor tributary of the Berg. Flow within the minor tributary would only occur for a short period of time in winter. The dam's catchment of 0.2 km^2 is located in the quaternary catchment G10J. The Water Research Commission MAP indicate a rainfall of 471 mm. The Mean Annual Runoff (MAR) from the catchment is estimated at less than 10 000 m3 (little runoff from sandy overburden soils) and therefore neglible.
Extent and duration of impact:	**Extent 1 & Duration 5**
Magnitude:	**2**
Consequence of impact or risk:	**Flow modification**
Probability of occurrence:	**2**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Irreversible (IR)**
Indirect impacts:	**Loss of significantly impacted upon habitat and bed/bank modification.**
Cumulative impact prior to mitigation:	**There is only likely to be surface water runoff from the catchment of the minor tributaries between the months of April/May to October. The Environmental Water Requirement of the watercourses within the study area for the recommended ecological category for these streams of an E category (largely modified) would be approximately 20% of the Mean Annual Runoff (MAR) of the watercourses. This would equate to an environmental flow requirement of approximately 2 000 m^3. There is however only a very short stretch of the watercourse (about 30m) downstream of the proposed dam that would benefit from any environmental flow release.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**16 - Low**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**
Degree to which the impact can be mitigated:	**2 - Partly mitigatable (PM)**
Proposed mitigation:	**The tributary in which the dam is proposed as well as that associated with the pump station and pipeline still contains some indigenous vegetation within the watercourse but also contains invasive alien plants. It is important that the disturbed area is rehabilitated and that ongoing monitoring and management of invasive alien plants with the watercourses are undertaken. Follow up work should be carried out after rehabilitation to ensure that no invasive alien plants establish themselves within**

	the watercourse adjacent to the dam as well as downstream of the dam. **All of the above recommendations should be included in a River Management Maintenance Plan (MMP) for the project that would form part of the Environmental Management Plan.**
Residual impacts:	**Flow modification**
Cumulative impact post mitigation:	**Flow modification**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**10 - Low**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Impact on sensitive environments (rivers, wetlands etc.)**
Nature of impact:	**Similar to that in the development phase.**

Alternative Site 2, downstream (Alternative)

Dam Construction	**Socio-Economic Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Temporary jobs will be created for the construction of the dam wall.**
Extent and duration of impact:	**Extent 2 (On site or within 100 m of the site) & Duration 1 (0 – 1 years)**
Consequence of impact or risk:	**Influx of contract workers due to lack of skills.** **Influx of job seekers due to jobs created.** **Littering.**
Probability of occurrence:	**4 (most likely)**
Degree to which the impact may cause irreplaceable loss of resources:	**NA – Positive**
Degree to which the impact can be reversed:	**NA – Positive**
Indirect impacts:	**NA – Positive**
Cumulative impact prior to mitigation:	**NA – Positive**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**8 – Low (positive)**
Degree to which the impact can be avoided:	**NA – Positive**
Degree to which the impact can be managed:	**NA – Positive**
Degree to which the impact can be mitigated:	**NA – Positive**
Proposed mitigation:	**Local contractors, employing or seeking to employ local (historically disadvantaged individuals (HDIs) from the region who are suitably qualified, should get preference.**

	The municipality, local community and local community organizations should be informed of the project and potential job opportunities by the developer.
Residual impacts:	**NA – Positive**
Cumulative impact post mitigation:	**NA – Positive**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low (positive)**
OPERATIONAL PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**Increased jobs**
Nature of impact:	**Similar to that in the development phase.**

Alternative Site 2, downstream (Alternative)

Dam Construction	**Cultural-Historical Impacts**
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains**
Extent and duration of impact:	**Extent 1 (Footprint) & Duration 5 (Will not cease)**
Magnitude:	**2**
Consequence of impact or risk:	**The proposed development, related facilities and infrastructure will have no impact on the cultural-historical aspects.**
Probability of occurrence:	**2 (some possibility, but low likelihood)**
Degree to which the impact may cause irreplaceable loss of resources:	**2-Resource may be partly destroyed (PR)**
Degree to which the impact can be reversed:	**Partly reversible (PR)**
Indirect impacts:	**The proposed development, related facilities and infrastructure will have no impact on the cultural-historical aspects.**
Cumulative impact prior to mitigation:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**16 – Low**
Degree to which the impact can be avoided:	**High**
Degree to which the impact can be managed:	**High**

Degree to which the impact can be mitigated:	**2-Partly mitigatable (PM)**
Proposed mitigation:	**Should any burials, fossils or other historical material be encountered during construction, work must cease immediately and HWC must be contacted.**
Residual impacts:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Cumulative impact post mitigation:	**Destruction of cultural-historical features at the site will contribute to the loss of such features in the general area due to other non-related activities. This can at all times be mitigated to prevent/ minimise the loss of such features.**
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	**Low**
OPERATIONAL PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**Not Applicable.**
DECOMMISSIONING AND CLOSURE PHASE	
Potential impact and risk:	**The potential impact of the proposed development on archaeological, paleontological and heritage remains.**
Nature of impact:	**Not Applicable.**

9. CONCLUSION

Eco Impact Legal Consulting (Pty) Ltd was appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the freshwater and riparian resources as part of the Water Use Authorization application.

The main water features within the study area comprise of the Berg River and its minor tributary.

There are no significant wetland habitats within the study area. Those that do occur are closely associated with the watercourses in which they occur. The following comments are made with regards to the wetland habitats in the area:

- The Berg River approximately 50m downstream of the site consists largely of valley bottom wetland habitat. This wetland habitat is closely associated with the Berg River and the proposed dam will not have any impact on it.

The watercourses within the study area have already been subjected to modification as a result of the surrounding agricultural activities. All three proposed dam locations will have the same impact on freshwater ecology. These impacts relate largely to the loss of the indigenous vegetation within the riparian zones and the associated growth of invasive alien plants. The proposed dam will result largely in a localized loss or modification of some habitat within the basin of the proposed dam.

The farm has two existing abstraction points on the Berg River south and north-east of the farmhouse. The existing pipelines (125 & 165mm dia) from these abstraction points will be upgraded to 250mm dia each to fill the proposed dam. An additional abstraction point with a

250mm dia pipeline (130m long) is proposed just below (to the north) of the proposed dam, which will be the shortest route to fill the dam. All pipes to be upgraded is on disturbed areas and will not impact on any vegetation or freshwater ecology features.

A new power cable of up to 600 volts will be installed on poles above ground from the north-eastern abstraction point to the new point. This power cable will not result in the clearing of any vegetation or impact on any freshwater ecology features and will be constructed on disturbed areas outside the 1 in 100 year flood line area of the Berg River. No formal structures (pump house) will be constructed. A movable pump, submersible abstraction pipe into the Berg River and pipelines will be used that will be connected to a fix pipe coupling at the dam.

All areas to be irrigated from the new dam will be located within existing cultivated lands. A raft abstraction pump from the dam basin will be used for bulk conveyance to the areas.

Most of the impacts would be during the construction phase. With effective implementation of the recommended mitigation measures, including the environmental water requirements and implementation of an approved River MMP, the condition of the streams could be maintained at the desired level of ecosystem functioning.

The proposed new abstraction point impact on the Berg River is of low significance as long as the management and mitigation measures included in the EMPr and MMP are adhered to. No vegetation may be cleared.

From the assessment of freshwater features within the study area, it can be concluded that there are no significant freshwater features that would potentially be impacted by the proposed dam and infrastructure upgrades. The valley bottom wetland downstream of dam site associated with the Beg River will not be impacted. No water will be required to be released from the dam to maintain the downstream channel. The Berg River, when flowing in winter, will push water upstream into the non-perennial river towards the dam wall to maintain the relevant downstream river ecological functioning.

The Department of Water and Sanitation, Western Cape Regional Office should be approached for approval of the water use aspects of the proposed activities.

Riparian Vegetation Response Assessment Index (VEGRAI)

The score attained for the VEGRAI indicated that the riparian system impacted by the proposed dam falls into the category E and this indicates that the loss of natural habitat, biota and basic ecosystem functions is extensive.

Ecological Importance and Sensitivity (EIS)

EIS 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. The median of the resultant score is calculated to derive the EIS category.

The non-perennial river is considered to be of low ecological importance. The non-perennial river and proposed dam areas was also not identified as a Critical Biodiversity area or important area from a terrestrial ecology and botanical perspective.

The overall Ecological and Importance of the non-perennial river where the proposed dam expansion is planned is assessed to be Low.

This confirms the assessment results of the NFEPA study and State of the River report findings.

Mitigation measures for inclusion in the EMPr

Essential mitigation measures:

- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of aquatic habitats in the area.
- Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the project. The non-impacted areas of the water courses and wetlands, its riparian zones and 32m buffer areas is regarded as no go and no impact areas.
- Contractor laydown areas and stockpiles to be established outside of the 100m Zone of Regulation implemented around the water courses and wetlands.
- Vehicles to be serviced at the contractor laydown area and all re-fuelling is to take place outside of all relevant zones of regulation
- Care must be taken to ensure that all concrete mixing is done on batter boards or within suitably bunded areas and no cement laden run-off may enter into the preferential surface flow pathway or the downstream ephemeral stream
- Allow only essential construction personnel within 32m of all riparian systems;
- Restrict construction activities to the drier summer months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development.
- Invasive vegetation to be removed during construction (the material that cannot be used for fire wood) to be disposed of at landfill site in such a manner that seeds must not be able to spread from the disposal site or during transportation.
- At no point may construction equipment stand unauthorised within or near the river.
- All excess sediment removed from the watercourses must be utilised as part of the building activities or be removed from site. At no point may this material be dumped on site or within any of the other freshwater features identified within the surrounding area. Topsoil will have a high density of alien invasive seeds which will need to be controlled into the operational phase.
- Soil surrounding the wingwalls must be suitably backfilled and sloped (minimum of a 1:3 ratio) and concrete aprons as well as gabion mattresses should be installed both up and downstream for energy dissipation and sediment trapping.

Operational Phase

- The amount abstracted from the Berg River should be reduced by the amount impeded from the catchment.
- Monitoring of the volume abstracted from the Berg River and that stored within the dam should be undertaken.

Conditions for inclusion in the environmental authorisation

- Appointment of Environmental Control Officer during construction phase.

Monitoring requirements for inclusion in the EMPr or Environmental Authorisation

- On-going aquatic ecological monitoring must take place by a suitably qualified assessor as per the conditions of the Water Use Authorization.

10. REFERENCES

CapeNature. 2017 WCBSP Stellenbosch [Vector] 2017. Available from the Biodiversity GIS website.

Driver, Nel, Snaddon, Murray, Roux, Hill (2011). Implementation Manual for Freshwater Ecosystem Priority Areas. Draft Report for the Water Research Commission.

DWAF, 2009. Rapid Habitat Assessment Model Manual. Report no RDM/ Nat/00/CON/0707. Authors: D Louw & CJ Kleynhans Submitted by Water for Africa.

KEMPER, N. 1999: Intermediate habitat integrity assessment for use in the rapid and intermediate assessments. IWR Environmental.

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

Kleynhans CJ, Louw MD. 2007. Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No.

Kleynhans CJ, Mackenzie J, Louw MD. 2007. Module F: Riparian Vegetation Response Assessment Index in River Eco Classification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and DWA and Forestry report.

Mucina L and Rutherford M. C (eds.) (2004) Vegetation map of South Africa, Lesotho and Swaziland. Strelitzia 18. South African National Biodiversity Institute, Pretoria.

SANBI Biodiversity GIS 2016. http://bgis.sanbi.org/WCBF14/additional.asp

APPENDIX A: ABBREVIATED CURRICULUM VITAE AND DECLARATION OF INDEPENDENCE OF FRESHWATER SPECIALIST

Name:	Nicolaas Willem Hanekom (Pri.Sci.Nat)
Profession:	Ecological Scientist
Nationality:	South African
Years experience	26 Years
Academic Qualifications	• National Diploma, Nature Conservation (Cape Technikon) • B. Tech Degree in Nature Conservation (Cape Technikon) • M.Tech in Nature Conservation (Cape Peninsula University of Technology) • Completed various Environmental Management Courses • Qualified Environmental Management System ISO 14001: 2004 Audit: Internal Auditor Course Based on ISO 19011:2002 (Centre for Environmental Management North West University)
Areas of specialisation:	• Ecosystem (terrestrial and aquatic) monitoring and assessments • Design of monitoring programmes for ecosystems (terrestrial and aquatic) • Environmental Impact Assessments • River classification and environmental water requirements • Wetlands Delineation • River and Wetlands management • Water Use Authorization Applications • Water quality management • River Health Assessments
Countries of Work Experience:	South Africa (Northern Cape, Western Cape, Free State, Mpumalanga, Gauteng)
Employment Record	• Student at Bontebok National Park (1992) • Assistant Reserve Manager at Gariep Dam Nature Reserve, Free State (1993 - 1998) • Reserve Manager, Conservation Services Manager for Western Cape Nature Conservation Board (1998 - 2006) • External Lecturer at Cape Peninsula University of Technology (2003 - 2005) • Director: Environmental Management at Cape Lowlands Environmental Services (2006 – 2010) • Director, Environmental Management and lead Environmental Impact Assessment Practitioner at Eco Impact (Pty) Ltd (2010 – to date)
Professional membership, accreditations and courses	• South African Council for Natural Scientists Professions Pri.Sci.Nat (Ecological Science) • Riparian vegetation identification and health assessment. Internal Western Cape Nature Conservation short course presented by Dr C Boucher (Stellenbosch University) in 2000. • SASS5 Aquatic Biomonitoring Training Course. 2 to 5 September 2013. Ground Truth Water and Environmental Engineering consultancy in partnership with the Department of Water Affairs. • Workshop on “Section 21(c) and (i) Water Use Training: Understanding Watercourses and Managing Impacts to their Characteristics”. 10 May 2017. Presented by Dr Wietsche Roets of the Department of Water and Sanitation (Sub-Directorate: Instream Water Use).

Summary of experience	1992: South African National Parks. Student at Bontebok National Park with management and monitoring actions related to the Breede River. 1993 -1998: Free State Nature Conservation. Ecological management and monitoring actions related to the Gariep Dam, Orange and Caledon Rivers. 1998 -2006: CapeNature. Ecological management and monitoring actions related to the Berg River Estuary, Verlorenvlei, Lamberts bay's Jackalsvlei, Wadrift Soutpanne, Oliphant's River mouth, Rocherpan Nature Reserve, etc. Review and assessment of EIA applications, inclusive of Freshwater ecology. Did some site visits with Department of Water Affairs and Forestry (Hester Lyons) to confirm the presence of aquatic ecological features during EIA water use registration applications. 2006 to date: Cape Lowland Environmental Services and Eco Impact Legal Consultant. Ecological (Freshwater and aquatic) Specialist input, assessment, monitoring and reports.
Publications and assessment reports	Just to name a few. Was involved in many Ecological Assessments, monitoring and inputs in EIA applications. • Elandskloof Farm 475 Citrusdal Biodiversity Baseline Survey. August 2010. This Biodiversity Assessment Covering Terrestrial and Aquatic Aspects to Inform Decisions Regarding The Proposed Elandskloof Weir Flood Damage Project On Farm 475, In The Citrusdal Area. • Cape Solar Energy Electricity Generation Facility. Farm 187/3 & 187/13 Kenhardt. Biodiversity And Ecological Baseline Survey. January 2011. (Included Terrestrial and aquatic ecological assessments and water use authorization applications) • Prieska Photvoltaic Power Generation Project. Prieska Commonage Northern Cape. Biodiversity And Ecological Baseline Survey. July 2011. (Included Terrestrial and aquatic ecological assessments and water use authorization applications) • Witteklip Erf 123 Extension, Vredenburg. Biodiversity Baseline Survey. Updated - October 2012 (Included Terrestrial and aquatic ecological assessments and water use authorization applications) • Baseline Biodiversity Survey And Wetland Delineation for ECCA Holdings: Cape Bentonite Mine on Erf 1412 Near Heidelberg. Prepared for: Shangoni Management Services Pry (Ltd). October 2014. • Freshwater Impact Assessment Laingsburg Flood Damage Repairs & Storm Water Infrastructure. 18 February 2016. • Ecological Assessment for Swartland Municipality - Upgrades To Voortrekker/Bokomo Road And Voortrekker/Rozenburg Road Intersections and Upgrade to the Diep River Bridge, Malmesbury on A Portion Of Erf 327, Malmesbury (Road) Erf 1530, Diep River Bridge Crossing, and Erf 1528, Property South of Diep River where Road Widening and Turning Circle Will Be Constructed. March 2016. (Freshwater Ecology Inputs and Water Use Registration) • Freshwater Impact Assessment. McGregor Bridge, Robertson Bridge and Willem Nels River Maintenance Management Plan. 24 June 2016. (Freshwater Ecology assessment and input as well as Water Use Registration)

	• Water Use Authorization Application Risk Matrix. Orange Grove Trust Vegetation Clearing and Agricultural Development on Portion 4 of Farm Glen Heatlie No 316, Worcester. 12 June 2017. (Freshwater ecological inputs in EIA process and Water Use Registration). • Water Use Authorization Application Risk Matrix Prepared For: Witzenberg Municipality Sand Mine Farm 1 Prince Alfred Hamlet. 28 March 2017. (Freshwater ecological inputs in EIA process and Water Use Registration). • Proposed Hartmanshoop Agri Vegetation Clearing Project and Irrigation on Erf 686, Laingsburg. 12 August 2017. (Freshwater ecological inputs in Water Use Registration). • County Fair: Hocraft Abattoir And Rendering Facility Waste Water Treatment Works "CF Hocraft WWTW" Mosselbank River Second Quarter 2018 Biomonitoring Report. June 2018. (Done quarterly biomonitoring for the last three years).