

FRESHWATER CONSTRAINTS AND OPPORTUNITIES REPORT FOR THE PROPOSED DEVELOPMENT OF NEW CULTIVATION AREAS ON FARM 38/129, UITNOOD, ROBERTSON

MAY 2021



Prepared By:

Ms Toni Belcher

Tel: 082 883 8055

E-mail: toni@bluescience.co.za

TABLE OF CONTENTS

1. SPECIALIST DETAILS, EXPERTISE AND DECLARATION	1
1.1. QUALIFICATIONS OF SPECIALIST CONSULTANT	1
1.2. DECLARATION OF INDEPENDENCE.....	2
2. INTRODUCTION.....	3
2.1. SCOPE OF STUDY	3
2.2. TERMS OF REFERENCE	4
2.3. METHODOLOGY AND LIMITATIONS OF THE STUDY	5
2.4. USE OF THIS REPORT	5
3. DESCRIPTION OF THE STUDY AREA.....	6
3.1 VISUAL CHARACTERISTICS AND TOPOGRAPHY	6
3.2. CLIMATE	6
3.3. GEOLOGY AND SOIL.....	7
3.4. FLORA	7
3.5. AQUATIC FEATURES.....	8
3.6. CONSERVATION VALUE OF THE FRESHWATER FEATURES.....	8
3.7. LAND USE.....	14
4. ASSESSMENT OF AQUATIC FEATURES	14
4.1. DESCRIPTION OF FRESHWATER FEATURES	16
4.2. PAST DEVELOPMENT OF THE SITE	17
4.3. WATERCOURSE CHARACTERISATION AND PRESENT ECOLOGICAL STATUS	18
4.4. PRESENT ECOLOGICAL STATUS OF THE WETLAND AREAS	19
4.4.1. Wetland Characterisation.....	19
4.4.2. Wetland Habitat Integrity.....	21
4.5. ECOLOGICAL IMPORTANCE AND SENSITIVITY AND ECOSYSTEM SERVICES	22
4.5.1. Ecological Importance and Sensitivity	22
4.5.2. Wetland Ecosystem services.....	23
4.5. OVERALL ECOSTATUS AND RECOMMENDED ECOLOGICAL MANAGEMENT CATEGORY	24
5. LEGISLATIVE REQUIREMENTS	24
5.1. NEMA AND ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS	25
5.2. NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998)	25
General Authorisation in terms of Section. 39 of the NWA	25
Regulations Requiring that a Water User be Registered, GN R.1352 (1999).....	26
6. AQUATIC ECOSYSTEM CONSTRAINTS	26
7. CONCLUSIONS AND RECOMMENDATIONS	27
8. REFERENCES	28
APPENDIX A: PRESENT ECOLOGICAL STATE OF THE KEISERS RIVER (DWAF, 2012)	30

1. SPECIALIST DETAILS, EXPERTISE AND DECLARATION

1.1. QUALIFICATIONS OF SPECIALIST CONSULTANT

Name: Antonia Belcher
Contact details: 53 Dummer St, Somerset West, 7130; Phone: 082 883 8055;
 Email: toni@bluescience.co.za
Profession: Aquatic Scientist (P. Sci. Nat. 400040/10)
Fields of Expertise: Specialist in freshwater assessments, monitoring and reporting
Years in Profession: 29+ years

Toni Belcher worked for the Department of Water Affairs and Forestry for more than 17 years. During this period she worked for the Directorate Water Quality Management, the Institute for Water Quality Studies and the Western Cape Regional Office and has built up a wide skills base on water resource management and water resource quality for rivers, estuaries and the coastal marine environment. Since leaving the Department in 2007, she has been working in her private capacity and was co-owner of BlueScience (Pty) Ltd, working in the field of water resource management and has been involved in more than 500 aquatic ecosystem assessments for environmental impact assessment and water use authorisation purposes. In 2006 she was awarded a Woman in Water award for Environmental Education and was a runner up for the Woman in Water prize for Water Research.

Professional Qualifications:

1984 Matriculation Lawson Brown High School
 1987 B.Sc. – Mathematics, Applied Mathematics University of Port Elizabeth
 1989 B.Sc. (Hons) – Oceanography University of Port Elizabeth
 1998 M.Sc. – Environmental Management (cum laude) Potchefstroom University

Key Skills: Areas of specialisation: Aquatic ecosystem assessments, Monitoring and evaluation of water resources, Water resource legislation and authorisations, River classification and Resource Quality Objectives, River Reserve determination and implementation, Water Quality Assessments, Biomonitoring, River and Wetland Rehabilitation Plans, Catchment management, River maintenance management, Water education.

Summary of Experience:

1987 – 1988	Part-time field researcher, Department of Oceanography, University of Port Elizabeth
1989 – 1990	Mathematics tutor and administrator, Master Maths, Randburg and Braamfontein Colleges, Johannesburg
1991 – 1995	Water Pollution Control Officer, Water Quality Management, Department of Water Affairs, Pretoria
1995 – 1999	Hydrologist and Assistant Director, Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria
1999 – 2007	Assistant and Deputy Director, Water Resource Protection, Western Cape Regional Office, Department of Water Affairs, Cape Town
2007 – 2012	Self-employed – Aquatic Specialist
2013 – 2020	Senior Aquatic Specialist and part-owner, BlueScience
2020 – present	Self-employed – Aquatic Specialist

1.2. DECLARATION OF INDEPENDENCE

I, **Antonia Belcher**, as the appointed specialist hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent:
 - other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or
 - ~~am not independent, but another specialist that meets the general requirements set out in Regulation 13 of GN No. 326 have been appointed to review my work (Note: a declaration by the review specialist must be submitted);~~
- in terms of the remainder of the general requirements for a specialist, am fully aware of and meet all of the requirements and that failure to comply with any the requirements may result in disqualification;
- have disclosed/will disclose, to the Applicant, the Department and registered interested and affected parties, all material information that have or may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application;
- have ensured/will ensure that information containing all relevant facts in respect of the application was/will be distributed or was/will be made available to interested and affected parties and the public and that participation was/will be facilitated in such a manner that all interested and affected parties were/will be provided with a reasonable opportunity to participate and to provide comments;
- have ensured/will ensure that the comments of all interested and affected parties were/will be considered, recorded and submitted to the Department in respect of the application; and
- am aware that a false declaration is an offence in terms of Regulation 48 of the NEMA EIA Regulations, 2014 (as amended).

Date: 29 May 2021

Name of company: -

Signature of the specialists:



2. INTRODUCTION

2.1. SCOPE OF STUDY

The development of new cultivation areas is proposed on Farm 38/129, Uitnood, near Robertson. The property is located about 4.5 km south of Robertson and 9 km north of McGregor (Figure 1). Several small ephemeral features are draining the proposed cultivation area. The ephemeral streams are minor tributaries of the Keisers River in the middle reaches of the Breede River System. This report assesses these features and the constraints which they pose towards the development of the site.

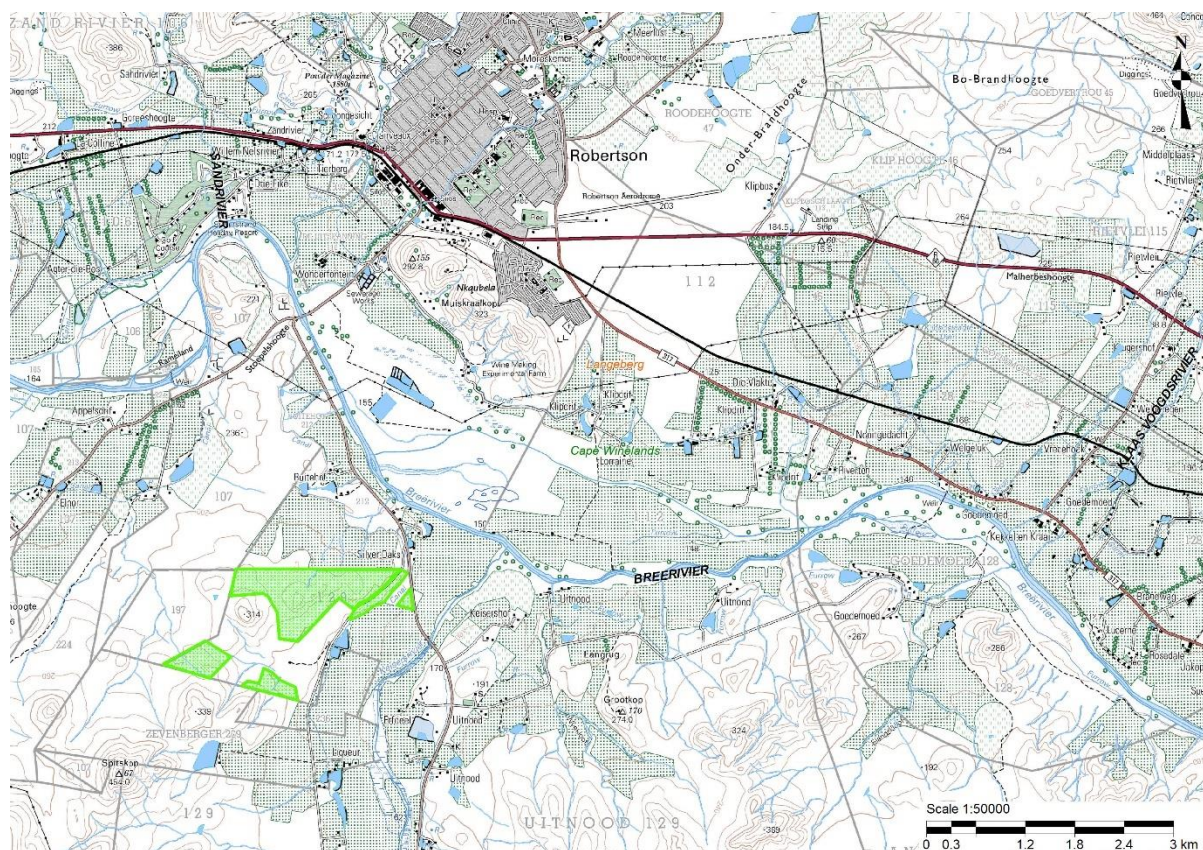


Figure 1. A topographical map of the study area, indicating the locality of the proposed cultivation areas (green polygons)

Table 1. Key information related to the water resources which may be impacted by the proposed activities

Descriptor	Name / details	Notes
Water Management Area	Breede Gourits WMA	
Catchment Area	Konings/Keisers Catchment	Mid Breede River Catchment
Quaternary Catchment	H40K	
Present Ecological State (PES)	Keisers River: D (largely modified)	DWAF 2012
Ecological Importance (EI) and Sensitivity (ES)	Keisers River: EI – Moderate; ES – Very High	DWAF 2012
Water resource component potentially impacted	Unnamed tributaries and associated wetlands of the Keisers River	
Latitude	33°51'23.87"S	Location of site
Longitude	19°51'44.01"E	

The study site lies within a wider area considered of Low Aquatic Biodiversity Combined Sensitivity (Figure 2). Only the downstream Keisers and Breede Rivers are mapped as being of Very High Aquatic Biodiversity Combined Sensitivity. The potential impact of the activities on the wetland areas at the site is assessed in this report.

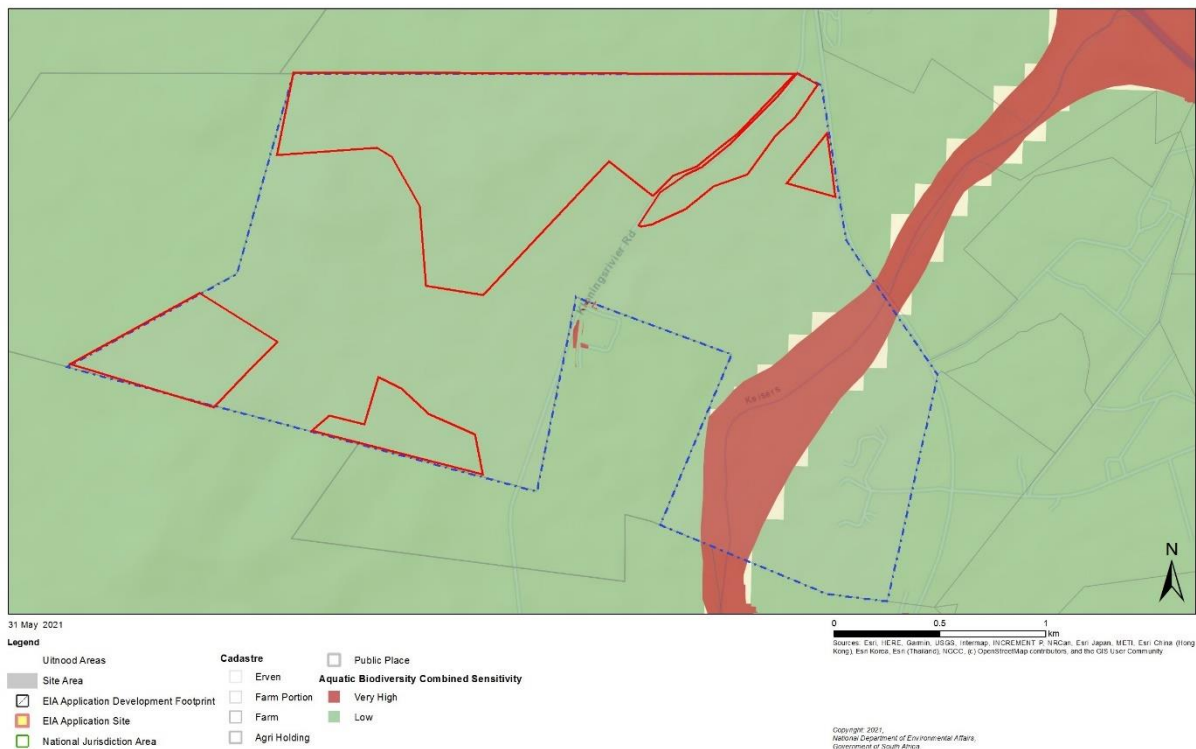


Figure 2. DEA Screening Tool Aquatic Biodiversity Combined Sensitivity mapping for the site

2.2. TERMS OF REFERENCE

The Terms of Reference for this specialist freshwater screening assessment is as follows:

- Describe the aquatic ecosystem present on/or adjacent to the site,
- Mapping of watercourses on the affected portion of the property,
- Familiarisation with available information regarding (inter alia) the watercourses, wetlands, groundwater, botanical aspects of the study area,
- Assessment of the present ecological status and importance of mapped watercourses,
- Assessment of the functional and other roles played by the watercourses,
- Identification and assessment of potential aquatic ecosystem impacts and any proposed alternatives.
- Recommendations concerning measures that can be undertaken to mitigate any potential impacts,
- Identify all relevant legislation, permits and standards that would apply to the development.

2.3. METHODOLOGY AND LIMITATIONS OF THE STUDY

Input into this report was informed by a combination of desktop assessments of existing freshwater ecosystem information for the study area and catchment, as well as a site visit in February 2021, at the end of the dry summer period. Considering the aquatic features at the site are ephemeral, the timing of the site visit was not considered a constraint. Wetland areas were still visible at the time of the assessment.

During the field visit, the characterisation and integrity assessments of the freshwater features were undertaken. Mapping of the freshwater features was undertaken using GPS Tracker and mapped in Google Earth Professional. Past imagery of the site was also consulted to determine past land use and modification activities that have taken place within the site.

The SANBI Biodiversity GIS and Cape Farm Mapper websites were consulted to identify any constraints in terms of fine-scale biodiversity conservation mapping as well as possible freshwater features mapped in the Freshwater Ecosystem Priority Areas maps. This information/data was used to inform the resource protection-related recommendations.

Limitations and uncertainties often exist within the various techniques adopted to assess the condition of ecosystems. The following techniques and methodology were utilized to undertake this study:

- Analysis of the freshwater ecosystems was undertaken at a rapid level and did not involve detailed habitat and biota assessments;
- The river health assessment was carried out using the South African Department of Water and Sanitation developed methodologies. River Health assessments were carried out to provide information on the ecological condition and ecological importance and sensitivity of the river systems impacted.
- The guideline document, “A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas” document, as published by DWAF (2005) was followed for the delineation of the riparian and wetland areas.
- The wetlands were subsequently classified according to their hydro-geomorphic determinants based on a classification system devised by Kotze *et al* (2004) and SANBI (2009). Notes were made on the levels of degradation in the wetlands based on field experience and a general understanding of the types of systems present.
- A Present Ecological State (PES) assessment was conducted for each hydro-geomorphic wetland unit identified and delineated within the study area.
- The functional wetland assessment technique, WET-EcoServices, developed by Kotze *et al* (2009) was used to indicate the ecological benefits and services provided by delineated wetland habitat. This technique consists of assessing a combination of desktop and infield criteria to identify the importance and level of functioning of the wetland units within the landscape.
- The ecological importance and sensitivity assessment was conducted according to the guidelines as developed by DWAF (1999).
- Recommendations are made with respect to the adoption of buffer zones within the development site, based on the wetlands/river's functioning and site characteristics as well as the use of the DWS riparian and wetland buffer determination tool.

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

2.4. USE OF THIS REPORT

This report reflects the professional judgment of its author. The full and unedited content of this should be presented to the client. Any summary of these findings should only be produced in consultation with the author.

3. DESCRIPTION OF THE STUDY AREA

3.1 VISUAL CHARACTERISTICS AND TOPOGRAPHY

The site is located on the south- and eastern slopes of the foothills of the Klipberg, extending down to the Keisers River approximately 3km upstream of where it joins the Breede River. The slopes of the foothills are relatively undisturbed however the valley floor is completely modified by cultivated areas (Figure 3). Several smaller streams drain the hillside that is in a similar state to the surrounding landscape, which is still largely natural in the upper reaches but significantly modified in the lower reaches.

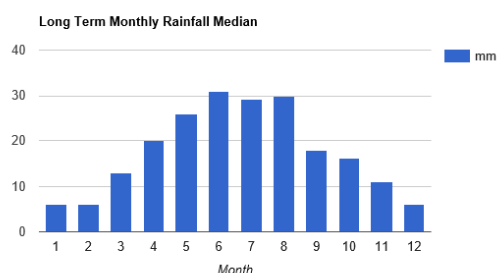


Figure 3. View of the study area as seen from the existing dam within the site, looking towards the east and the lower Keisers River Valley where it drains into the Breede River. The proposed cultivated areas lie on the left-hand side of the image, on the slopes of the low hills that still comprise natural vegetation.

3.2. CLIMATE

The study area has a Mediterranean climate and receives most of its rainfall during cold winters whilst its summers are hot and dry. The mean annual rainfall for the area is 280mm. The month of June receives an average rainfall of 31 mm and its average temperature is approximately 12°C. In contrast, December to February receives an average rainfall of 6mm and its average temperature between 21°C and 23°C (Figure 4). Surface water flow is therefore much higher during winter months with increased flows usually occurring from April to September and the highest flows in August (Figure 5). This is an important factor to consider in the timing of construction activities associated with wetlands, streams or rivers.

Long Term Climate Graph (1950 - 2000)



Long Term Climate Graph (1950 - 2000)

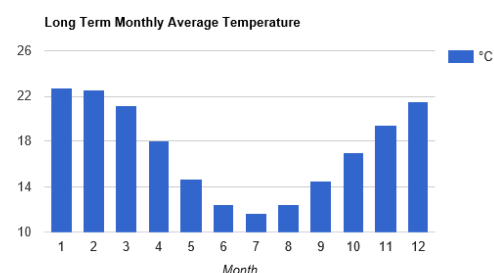


Figure 4. Climate graphs for the area (CapeFarmMapper). The graph on the right indicates the annual average of monthly median rainfall and the graph on the right the long term mean annual temperature, based on data for the period 1950-2000 (Source: SA Atlas of Climatology and Agrohydrology by R.E. Schulze,2009)

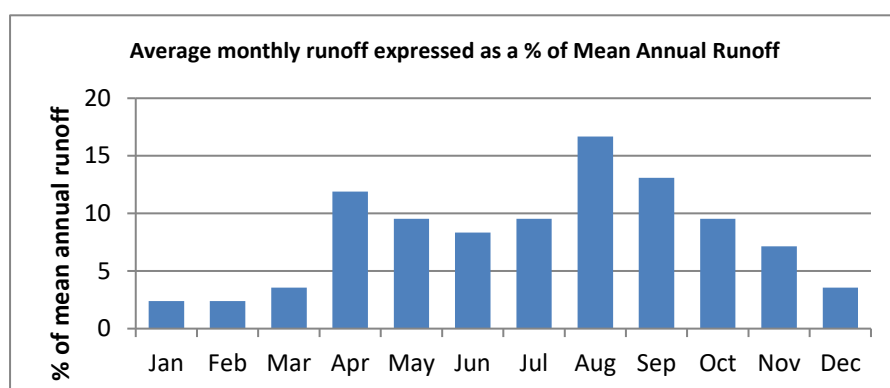


Figure 5. Average monthly flow distribution for the area expressed as a percentage of mean annual runoff of the surface water features (WR2012 flow data)

3.3. GEOLOGY AND SOIL

The geology of the area is underlain by feldspathic sandstone of the Rietvlei Formation, Table Mountain Group on the higher-lying slopes in the west and the east of the study area, shale and sandstone of the Bokkeveld Group, overlain by loam on foot slopes and alluvium in the valley bottoms. Glenrosa and Mispah soil forms are common in the area (Figure 6). Lime is generally present in this area. The soils are typically shallow with limited pedological development and moderately erodible.

3.4. FLORA

The vegetation type mapped by Mucina & Rutherford (2006) as having naturally occurred within the area of the proposed activity comprises largely of Robertson Karoo (SKv 7, tan areas Figure 7) in the Succulent Karoo Biome. This vegetation is characterized by dwarf succulent shrubland and a succulent thicket of medium height. It is common on undulating flats and higher hills as seen in the study area. As these areas are less suitable for cultivation than the alluvial soils in the valley, 84% of this vegetation type's natural extent remains and it is considered Least Threatened.

The vegetation on the lower lying areas of the farm and areas containing deeper sand, is mapped as Breede Sand Fynbos (FRa 1, light purple in Figure 7 in the Fynbos Biome. This vegetation type comprises an open restioid shrubland on deep sands dominated by *Willdenowia incurvata*. This vegetation type is considered Vulnerable as much of its natural extent has been lost due to its occurrence upon fertile alluvial soils suitable for agriculture. Muscadel Riviere occurs in the very south-eastern extent of the study area and is associated with the floodplain of the Breede and Keisers River and is a Critically Endangered vegetation type due to its large-scale loss. A detailed Botanical Impact Assessment was conducted for the proposed cultivation areas. The aquatic features within the study area have little aquatic vegetation within their upper reaches but are dominated by terrestrial vegetation. Typical riparian vegetation along the watercourses includes *Carissa haematocarpa*, *Dodonaea angustifolia*, *Euclea undulata* and *Vachellia karroo*.

3.5. AQUATIC FEATURES

Aquatic features within the study area consist of several smaller ephemeral streams and drainage lines of the Konings / Keisers River System. The Keisers River, a tributary in the middle reaches of the Breede River. In the upper reaches, these features are still largely natural however in the lower reaches they have been significantly modified. Many of the streams no longer flow within their original channels but have been diverted into canals to facilitate the cultivation of the area. In the past, these lower-lying areas consisted of valley bottom wetland areas that have largely been lost to cultivated areas. The Keisers River near the site is mapped as a valley bottom wetland area but has been significantly modified by the surrounding cultivation activities. The dams within the area are mapped as artificial wetlands, some with natural wetland elements (Figure 8). The aquatic features detected on-site during the site visit are further described in Section 4.

3.6. CONSERVATION VALUE OF THE FRESHWATER FEATURES

Two sets of conservation mapping results are of relevance to the national and provincial identification of the ecological importance that has been attributed to the freshwater features in the study area. The National Freshwater Ecosystem Priority Areas (FEPA) map and the Western Cape Biodiversity Spatial Plan (WCBSP) map that was a product of the Provincial Fine Scale mapping process.

FEPAs are intended to provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. FEPAs were determined through a process of systematic biodiversity planning and were identified using a range of criteria for serving ecosystems and associated biodiversity of rivers, wetlands and estuaries. The river and wetland FEPAs are required to be maintained in a largely natural ecological state while fish support areas should not be allowed to degrade from their existing ecological condition. The upper Konings and Keisers Rivers are mapped as FEPA Rivers but not the lower river of the Keisers River. The nearby farm dams and the wider Keisers and Breede River corridors are mapped as FEPA wetlands (Figure 9). The proposed activities are located away from any mapped FEPA features.

The WCBSP for the Langeberg Municipality aims to guide sustainable development by providing a synthesis of biodiversity information to decision-makers. The main CBA Map categories are the CBAs (Terrestrial and Aquatic), Ecological Support Areas (ESAs) (Critical and Other), Other Natural Remaining Areas and No Natural Remaining Areas. The first two mentioned categories represent the biodiversity priority areas that should be maintained in a natural to near-natural state. The last two mentioned categories are not considered as priority areas and a loss of biodiversity within these areas may be acceptable. The valley bottom wetland associated with the Keisers River is mapped as an aquatic CBA. The small streams/drainage features crossing the various cultivation areas are mapped as aquatic ESAs that play an important role in delivering ecosystem services (Figure 10). **Error! Reference source not found.**

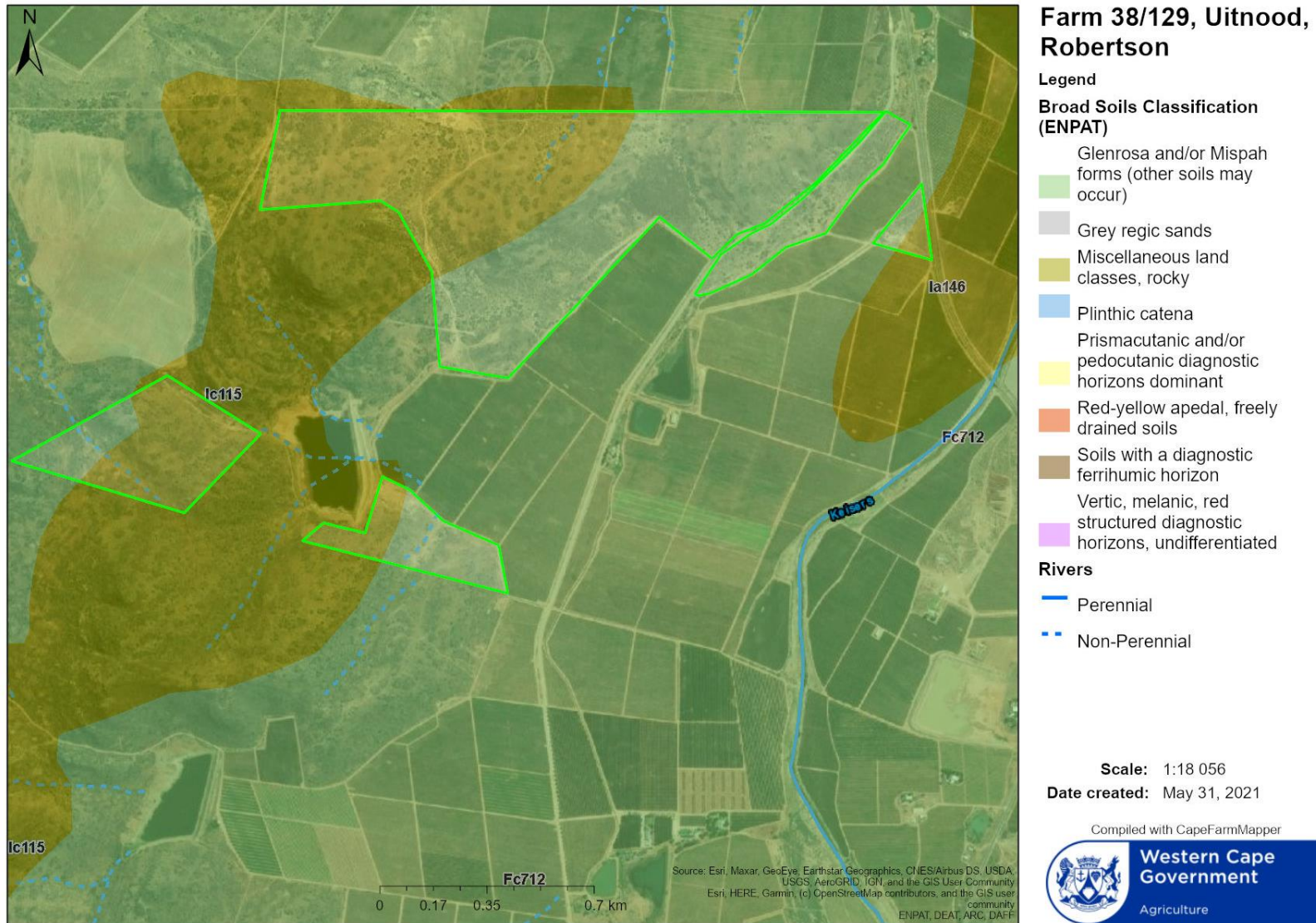


Figure 6. Soil Classification map for the site, the green polygons represent the proposed cultivation areas (ENPAT data obtained from CapeFarmMapper in May 2021)

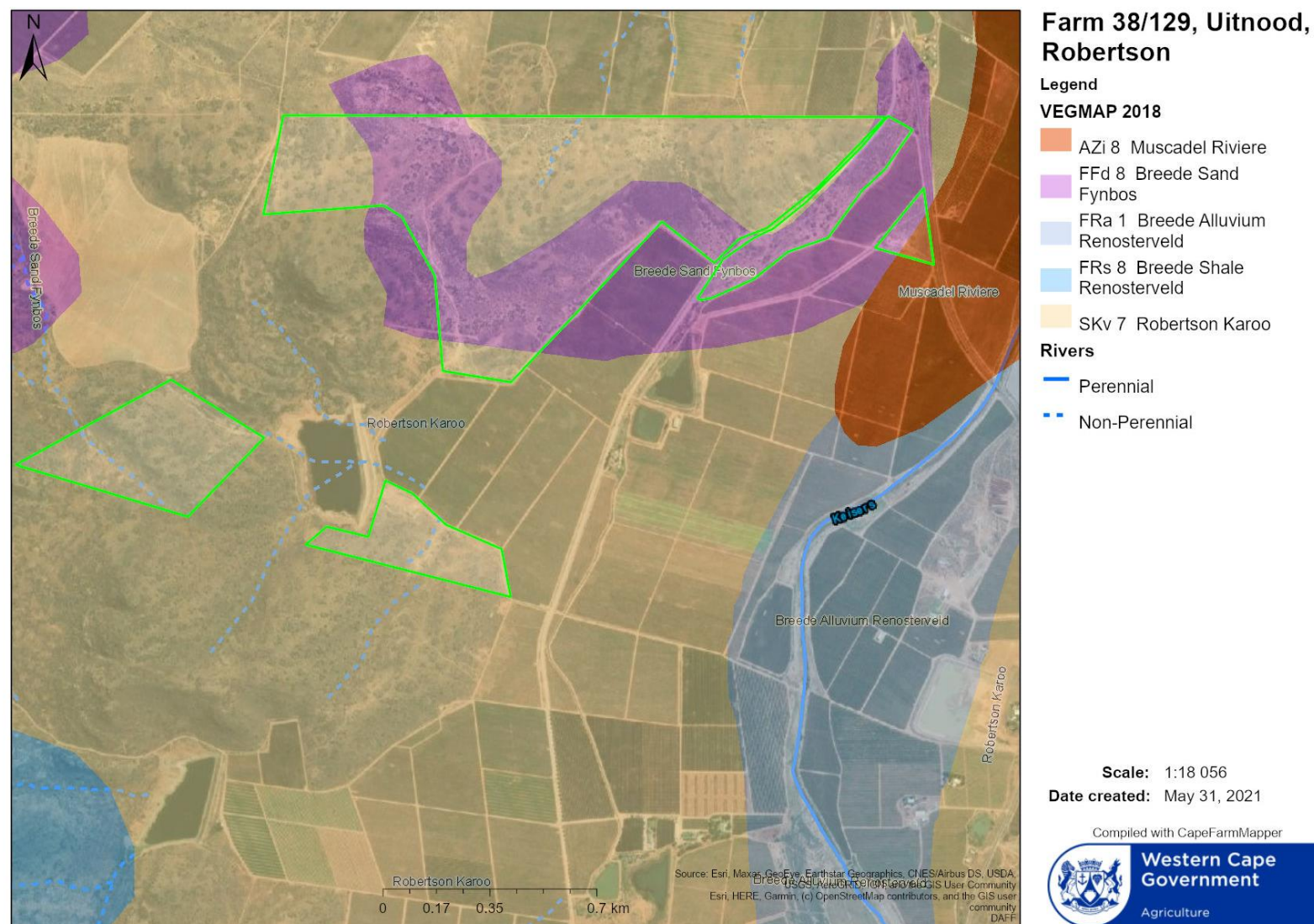


Figure 7. Vegetation map for the site, green polygons indicate the proposed cultivated areas (South African National Biodiversity Institute. 2018 Vegetation Map App [Vector] obtained from CapeFarmMapper in May 2021)

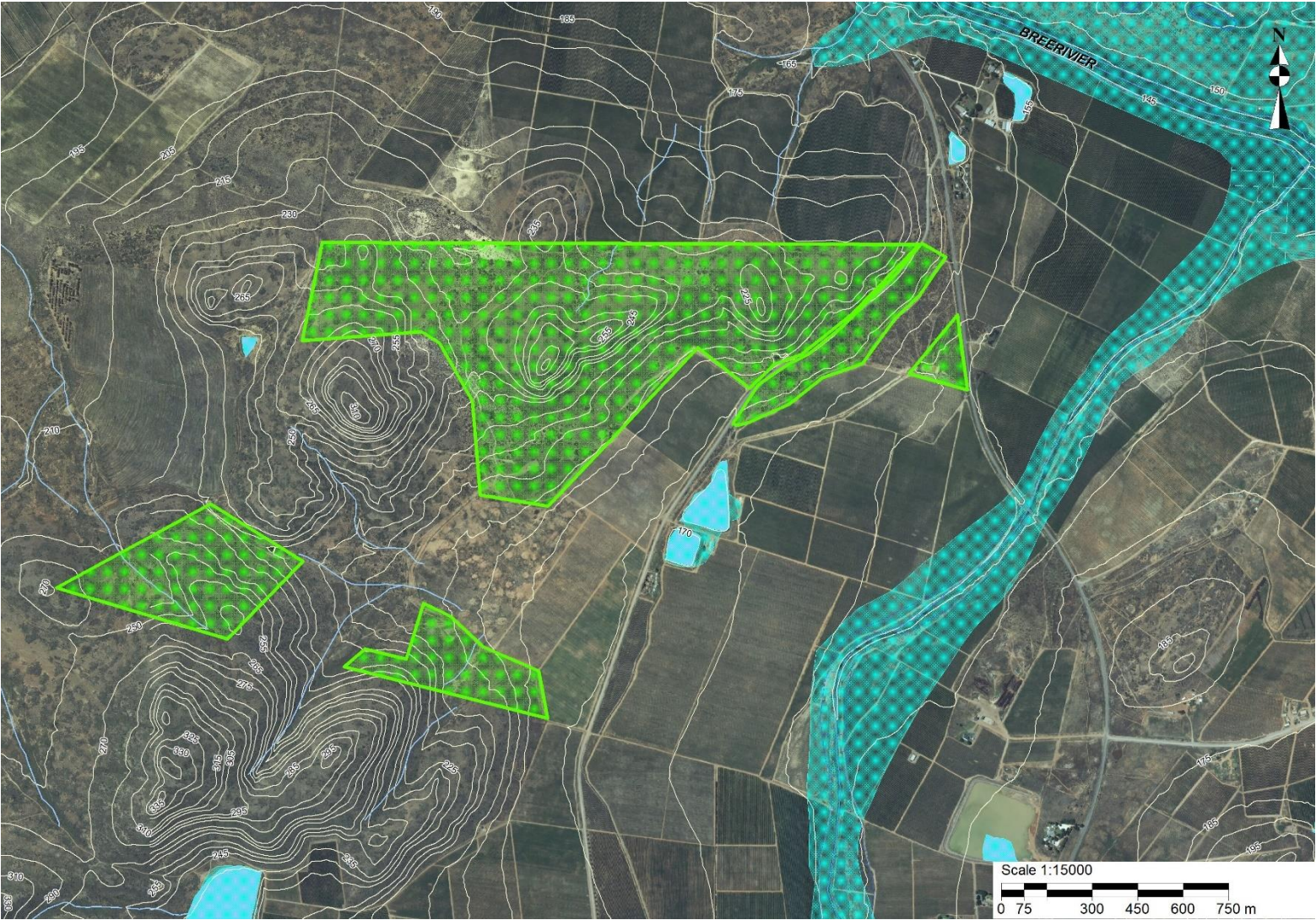


Figure 8. Orthophotograph of the site (green polygon) showing the watercourse and Freshwater Ecosystem Priority Areas wetland mapping in the area

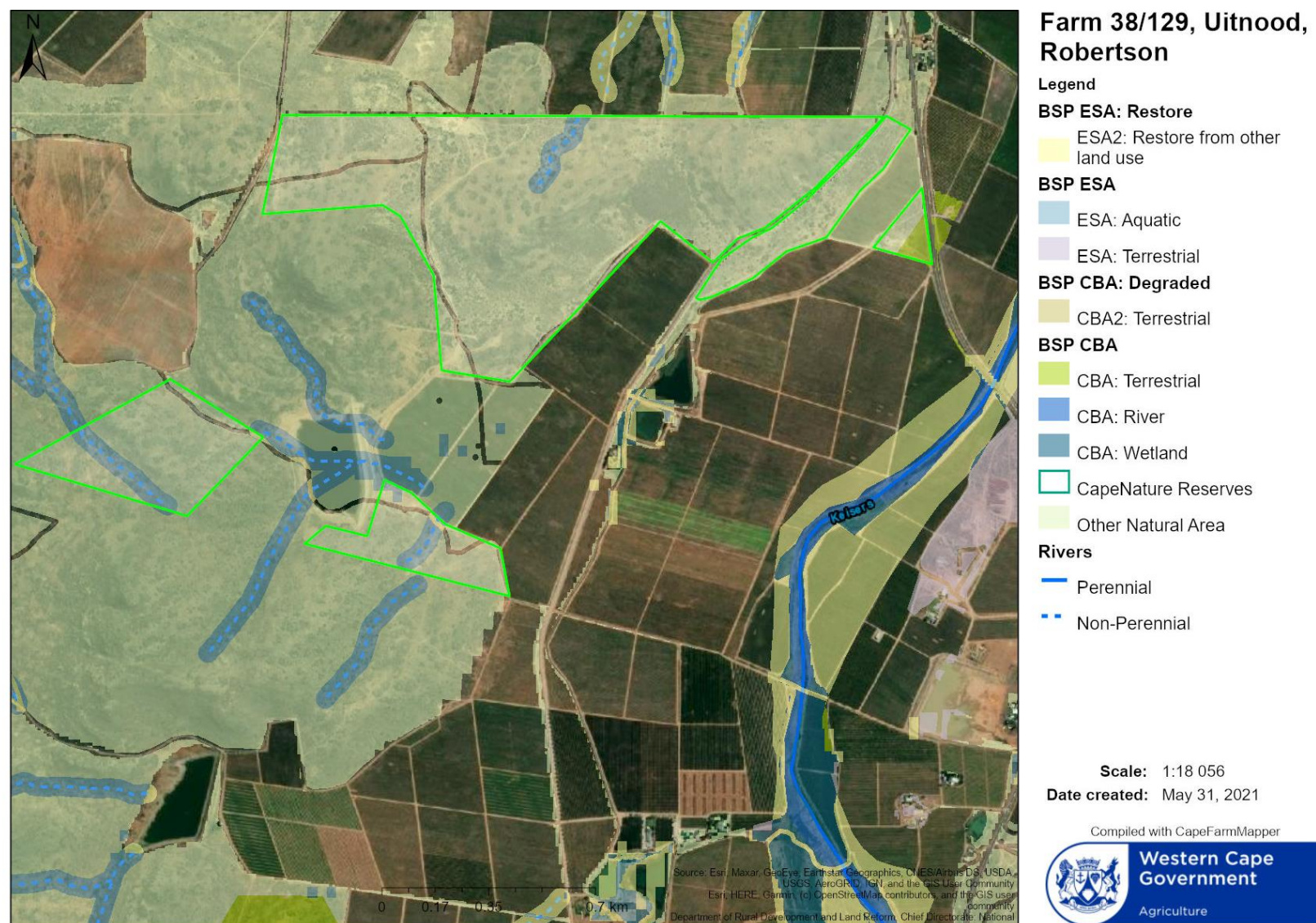


Figure 9. The Western Cape Biodiversity Spatial Plan mapping in the vicinity of the site (green polygons) (CapeFarmMapper, May 2021)

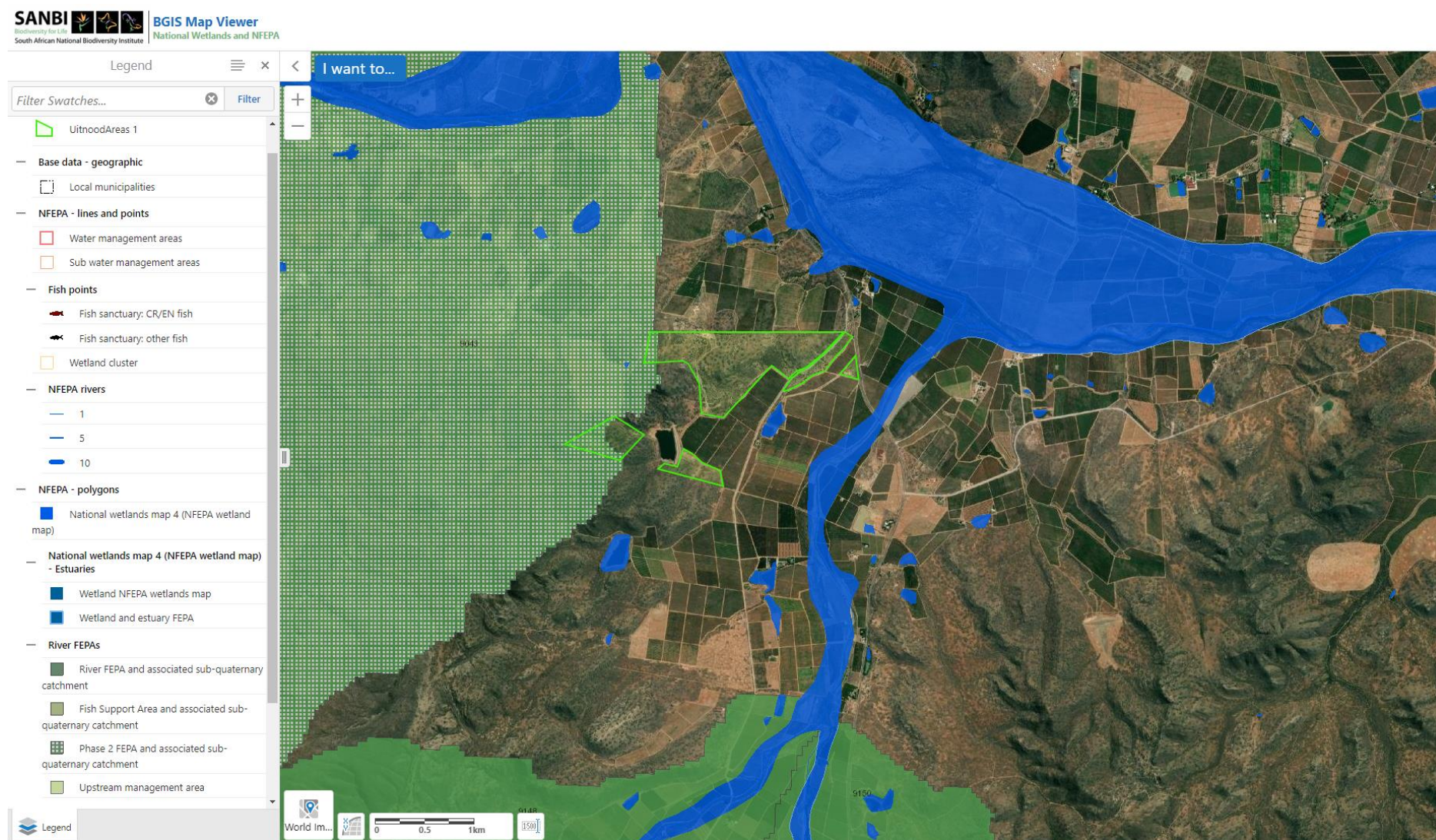


Figure 10. Freshwater Ecosystem Priority Areas Rivers and Wetlands within the wider vicinity of the site (green polygons) (CSIR NFEPA rivers 2011 obtained from SANBI BiodiversityGIS, May 2021))

3.7. LAND USE

The land cover at the sites of the proposed activities is a mixture of succulent karoo shrubland and natural grassland vegetation. Cultivated vineyards (maroon in Figure 11). The closest urban areas are McGregor approximately 10 km to the south and Robertson approximately 7 km to the north. The formally protected Vrolijkheid Nature Reserve is located approximately 7 km to the south-east of the site and the informal conservation area Skuilkrans Private Nature Reserve is about 10 km to the south-west.



Figure 11. Landcover map showing the land cover in and adjacent to the site (DEA, 2018 downloaded from CapeFarmMapper, May 2021)

4. ASSESSMENT OF AQUATIC FEATURES

A freshwater assessment was only undertaken of the smaller watercourses within the proposed cultivated areas. A wetland area is also located within the easternmost cultivation area. This wetland area is located at the foot of the hillslope and is likely to have been associated with the small streams upslope of it, where these streams drained into the historic wider floodplain of the Keisers River. A small dam has been constructed in the channel upstream of it and a patch of wetland habitat occurs downslope of it, on the opposite side of the road to Mc Gregor. The surrounding areas are however cultivated with little remaining of the lower reaches of the original watercourses draining the hillslope.

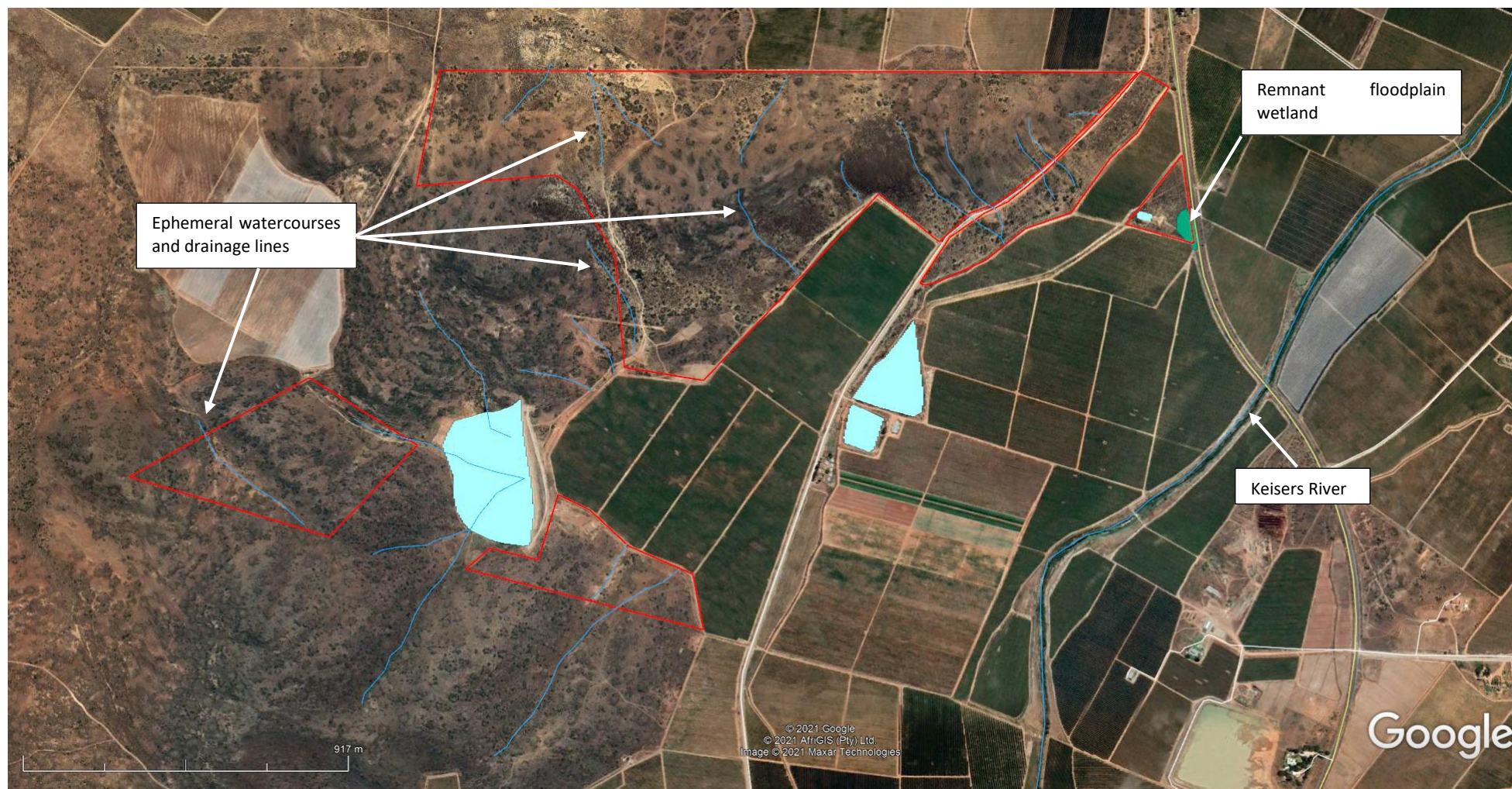


Figure 12. Google Earth image with the mapped aquatic features within the study area

4.1. DESCRIPTION OF FRESHWATER FEATURES

KEISERS TRIBUTARIES

The tributaries within the proposed cultivation areas can be categorised as relatively small episodic foothill tributaries of the Keisers River. In their upper reaches, the tributaries comprise several smaller tributaries and drainage lines that drain the hillslope. The upper reaches of these streams are still in a largely natural state. The stream channels within the tributary are currently vegetated primarily with natural vegetation but have a high potential for erosion because the substrate is predominantly shallow alluvium, interspersed with gravel. The lower reaches of all the streams have mostly been lost to cultivation activities.



Figure 13. A view of the typical ephemeral stream/drainage line within the site – the blue arrow denotes the watercourse channel and flow direction.

The wetland area in the south-eastern extent of the study area comprises a mix of *Juncus kraussii*, *Juncus capensis*, *Ficinia nodosa*, *Eleocharis limosa* and *Senecio halimifolium* with *Willdenowia incurvata* (Figure 14). The wetland lies on the lower slope of the hillslope that is drained by two small ephemeral streams. A small dam was constructed upslope of the wetland. Downslope of the wetland is the road between Robertson and McGregor. On the downslope of the road is further wetland habitat that is dominated by *Phragmites australis*, *Juncus capensis* and *Senecio halimifolium*.



Figure 14. View of the wetland area in the south-eastern extent of the study area

4.2. PAST DEVELOPMENT OF THE SITE

The earliest available aerial photograph taken of the area was taken in 1949, more than 70 years ago (Figure 15). In 1949, the cultivated areas were restricted to along the Keisers River Wetland areas are visible along the Keisers River, particularly where the Keisers River joins the Breede River. The Keisers River was also more braided at that time. Most of the watercourses still follow their original courses and were naturally poorly defined in their lower reaches.

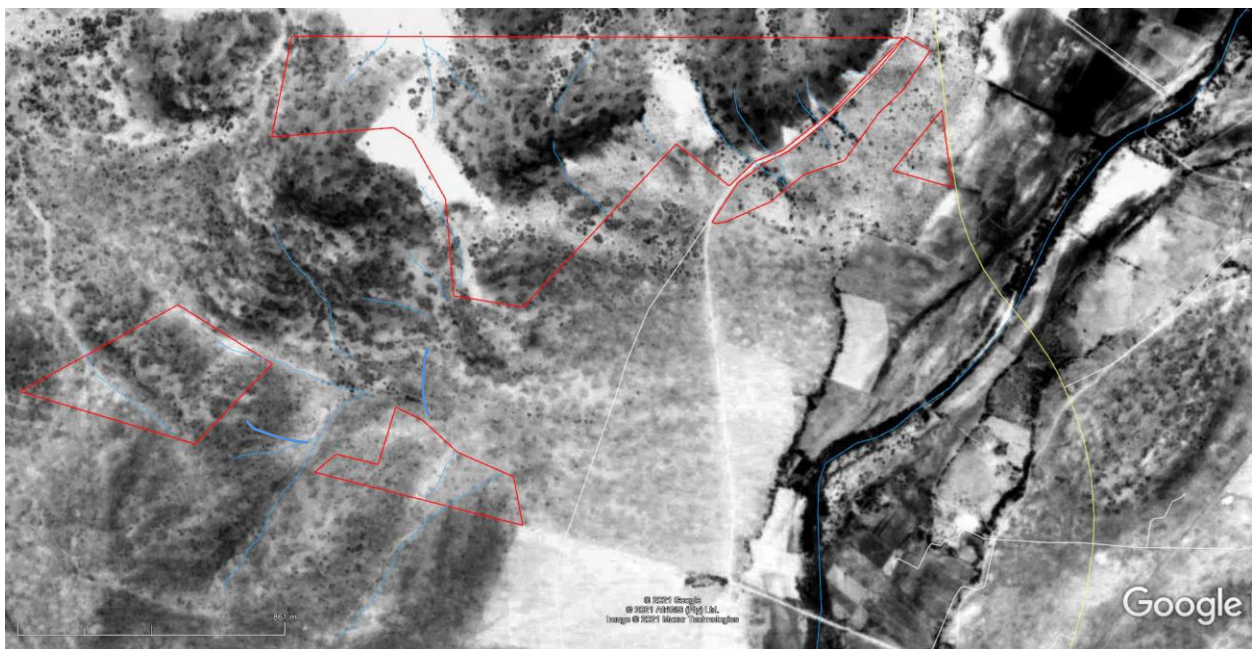


Figure 15. Aerial photograph taken in 1949 shown together with the mapped present day aquatic features and the proposed cultivation areas.

4.3. WATERCOURSE CHARACTERISATION AND PRESENT ECOLOGICAL STATUS

To assess the condition and ecological importance and sensitivity of the rivers or streams, it is necessary to understand how the rivers/streams might have appeared under unimpacted conditions. This is achieved through classifying rivers according to their ecological characteristics so that they can be compared to ecologically similar rivers. River typing or classification involves the hierarchical grouping of rivers into ecologically similar units so that inter-and intra-river variation in factors that influence water chemistry, channel type, substratum composition and hydrology are best accounted for. Any comparative assessment of river condition should only be done between rivers that share similar physical and biological characteristics under natural conditions. Thus, the classification of rivers provides the basis for assessing river condition to allow comparison between similar river types. The primary classification of rivers is a division into Ecoregions. Rivers within an ecoregion are further divided into sub-regions.

Ecoregions: groups of rivers within South Africa, which share similar physiography, climate, geology, soils and potential natural vegetation. For this study, the ecoregional classification presented in DWAF (1999), which divides the country's rivers into ecoregions, was used. The area assessed lies within the Southern Folded Mountains Ecoregion, the typical characteristics of which are described in the table below:

Table 2. Characteristics of the Southern Folded Mountains Ecoregion

Main Attributes	Characteristics (dominant types in bold)
Terrain Morphology	Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to High Relief; Closed Hills; Mountains; Moderate and High Relief
Vegetation	Patches Afromontane Forest; Spekboom Succulent Thicket; Grassy Fynbos; Mountain Fynbos; South and South West Coast Renosterveld; Central Mountain Renosterveld; Eastern Mixed Nama Karoo; Central Nama Karoo; Great Nama Karoo
Altitude (m a.m.s.l)	0-300 limited; 300-900
MAP (mm)	200 to 1500
Rainfall seasonality	Very late summer to winter to all year
Mean annual temp. (°C)	10 to 20
Median annual simulated runoff (mm) for quaternary catchment	<5 to >250

Sub-regions: sub-regions (or geomorphological zones) are groups of rivers or segments of rivers, within an ecoregion, which share similar geomorphological features, of which gradient is the most important. The use of geomorphological features is based on the assumption that these are a major factor in the determination of the distribution of the biota. From the Site Characterisation assessment, the geomorphological and physical characteristics of the two tributaries that were assessed can be classified as follows:

Table 3: Geomorphological and Physical features

River	Tributaries of the Keisers River (upper reaches)	Tributaries of the Keisers River (lower reaches)
Valley Form	Foothill streams	Lowland/floodplain
Lateral mobility or entrenchment	Moderately confined	Largely Unconfined
Channel form	Poorly defined with multiple channels	Multiple channels historically, today largely confined to a single channel or lost due to cultivation
Channel pattern	Multiple thread: low sinuosity	
Channel type	Gravel bed	Alluvial
Hydrology	Episodic	Episodic/seasonal

The watercourses have been significantly modified in their lower reaches as a result of agricultural-related disturbance activities (channel modification and cultivation within the riparian zone).

Evaluation of Index of Habitat Integrity (IHI) provides a measure of the degree to which a river or stream has been modified from its natural state. This assessment was undertaken for the tributaries of the Keisers River at the site. The results are provided in Table 5.

The methodology (DWAF, 1999) involves a qualitative assessment of the number and severity of anthropogenic perturbations on a river and the damage they potentially inflict upon the system. These disturbances include both abiotic and biotic factors, which are regarded as the primary causes of the degradation of a river. The severity of each impact is ranked using a six-point scale with 0 (no impact) to 25 (critical impact). The IHI assessment is based on an evaluation of the impacts of two components of the river, the riparian zone and the in-stream habitat. The total scores for the in-stream and riparian zone components are then used to place the habitat integrity of both in a specific habitat category (Table 4).

Table 4: Habitat Integrity categories (From DWAF, 1999)

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 and basic ecosystem functions has occurred.	40-59
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 an almost complete loss of natural habitat and biota. In worst instances, basic ecosystem functions have been destroyed and changes are irreversible.	0

Table 5: Index of Habitat Integrity Assessment results and criteria assessed

Instream Habitat Integrity	Ephemeral tributaries of the Keisers River	Riparian Zone Habitat Integrity	Ephemeral tributaries of the Keisers River
Water Abstraction	3	Vegetation Removal	7
Flow Modification	4	Exotic Vegetation	4
Bed Modification	5	Bank Erosion	14
Channel Modification	4	Channel Modification	4
Water Quality	4	Water Abstraction	3
Inundation	5	Inundation	5
Exotic Macrophytes	2	Flow Modification	3
Exotic Fauna	2	Water Quality	3
Rubbish Dumping	3		
INTEGRITY CLASS	B	INTEGRITY CLASS	C

The upper reaches of the tributaries within the site are in a largely natural ecological condition but the watercourses degrade significantly in their lower reaches, with most being lost to cultivation.

4.4. PRESENT ECOLOGICAL STATUS OF THE WETLAND AREAS

4.4.1. WETLAND CHARACTERISATION

In South Africa, wetlands are defined as “...land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil” (National Water Act, Act No. 36 of 1998, (NWA) and Environmental Impact Assessment

Regulations: Listing Notice 1 OF 2014 Government Notice R983 in Government Gazette 38282 dated 4 December 2014, as amended by Government Notice 327 in Government Gazette 40772 dated 7 April 2017). Wetlands are also included in the definition of a watercourse within the NWA, which implies that whatever legislation refers to watercourses will also apply to wetlands.

Only the remnant floodplain wetland has been assessed within the site. The wetland can be classified according to the wetland types described in Table 6. The classification of the wetland is provided in Table 7.

Table 6: Wetland hydro-geomorphic types typically supporting inland wetlands in South Africa

Hydro-geomorphic types	Description	Source of water ¹	
		Surface	Sub-surface
Floodplain 	Valley bottom areas with a well-defined channel, gently sloped, characterized by floodplain features and alluvial transport or sediment deposition, usually lead to net sediment accumulation. Water input from channel and adjacent slopes.	***	*
Valley bottom with a channel 	Valley bottom areas with a well-defined channel but lacking characteristic floodplain features. May be gently sloped, characterized by net accumulation of alluvial deposits or may have steeper slopes, characterized by a net loss of sediment. Water inputs from main channel and from adjacent slopes.	***	*/ ***
Valley bottom without a channel 	Valley bottom areas with no clear channel, gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
Hillslope seepage linked to a stream channel 	Slopes on hillsides, which are characterized by the colluvial movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
Isolated Hillslope seepage 	Slopes on hillsides, characterized by colluvial material movement. Water input mainly sub-surface flow and very limited outflow or through diffuse sub-surface / surface flow with no direct surface water connection to a stream channel.	*	***
Depression (includes Pans) 	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water. It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.	*/ ***	*/ ***

¹ Precipitation is an important water source and evapotranspiration an important

Water source: * Contribution usually small or *** Contribution usually large
*/ *** Contribution may be small or important depending on the local circumstances



Wetland

Table 7: Classification of wetland area within the study area

Name	Remnant floodplain wetland
System	Inland
Ecoregion	Southern Folded Mountains Ecoregion
Landscape setting	Floodplain wetlands (associated with the Keisers River and its tributary)
Drainage	Some surface and subsurface drainage
Seasonality	Seasonal
Anthropogenic influence	The wetland has been significantly modified by cultivation and flow modification.
Geology	Mainly alluvium overlying shale, siltstone and sandstone of the Witteberg Group
Terrestrial Vegetation	Muscadel Riviere
Dominant wetland vegetation	<i>Juncus kraussii</i> , <i>Juncus capensis</i> , <i>Ficinia nodosa</i> , <i>Eleocharis limosa</i> and <i>Senecio halimifolium</i> with <i>Willdenowia incurvata</i>
Substrate	sandy soils
Salinity	Fresh

4.4.2. WETLAND HABITAT INTEGRITY

The Present Ecological Status (PES) Method (DWAF 2005) was used to establish the integrity of the wetlands in the study area and was based on the modified Habitat Integrity approach developed by Kleynhans (DWAF, 1999; Dickens *et al*, 2003). Table 8 displays the criteria and results from the assessment of the habitat integrity of the wetlands. These criteria were selected based on the assumption that anthropogenic modification of the criteria and attributes listed under each selected criterion can generally be regarded as the primary causes of the ecological integrity of a wetland.

Table 8. Habitat integrity assessment criteria for palustrine wetlands (Dickens *et al*, 2003)

Criteria & Attributes	Relevance
Hydrologic	
Flow Modification	Changes in flow regime, volumes, velocity which affect inundation of habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to wetland.
Inundation	Impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.
Water Quality	
Water Quality Modification	From point or diffuse sources such as from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.
Sediment Load Modification	Reduction due to entrapment by impoundments or increase due to land use practices. Cause of unnatural rates of erosion, accretion, infilling of wetlands and habitat change.
Hydraulic/Geomorphic	
Canalisation	Desiccation / change to inundation of wetland and habitat change. River diversions or drainage.
Topographic Alteration	Consequence of infilling, ploughing, trampling, bridges, roads, railway lines and other substrate disruptive activities that reduce or change wetland habitat directly in inundation patterns.
Biota	
Terrestrial Encroachment	Desiccation of wetland and encroachment of terrestrial plants due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.
Indigenous Vegetation Removal	Direct destruction of habitat through farming or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.
Invasive Plants	Affects habitat through changes in community structure and water quality changes.
Alien Fauna	Presence of alien fauna affecting faunal community structure.
Over utilization	Overgrazing, over fishing, etc.

Table 9. Wetland habitat integrity assessment (score of 0=critically modified to 5=unmodified)

Criteria & Attributes	Remnant floodplain wetland
Hydrological	
Flow Modification	2
Permanent Inundation	2
Water Quality	
Water Quality Modification	2.5
Sediment Load Modification	2
Hydraulic/Geomorphic	
Canalisation	2
Topographic Alteration	2.5
Biota	
Terrestrial Encroachment	2
Indigenous Vegetation Removal	2.5
Invasive Plant Encroachment	2.5
Alien Fauna	3
Over utilization of Biota	2.5
Category	D

The remnant floodplain wetland area is considered to be largely modified as a result of modifications that have taken place within the site as well as downstream of the site.

Table 10. Relation between scores given and ecological categories

Scoring Guidelines	Interpretation of Scores for all Attributes: Rating of Present Ecological Status Category (PESC)
Natural, unmodified – score=5.	CATEGORY A >4; Unmodified, or approximates natural condition.
Largely natural – score=4.	CATEGORY B >3 and ≤4; Largely natural with few modifications, but with some loss of natural habitats.
Moderately modified – score=3.	CATEGORY C >2 and ≤3; moderately modified, but with some loss of natural habitats.
Largely modified – score=2.	CATEGORY D ≤2; largely modified. Large loss of natural habitat & basic ecosystem function has occurred. OUTSIDE GENERALLY ACCEPTABLE RANGE
Seriously modified – rating=1.	CATEGORY E >0 and <2; seriously modified. Extensive loss of natural habitat & basic ecosystem function.
Critically modified – rating=0.	CLASS F 0; critically modified. Modification reached critical levels with system completely modified.

4.5. ECOLOGICAL IMPORTANCE AND SENSITIVITY AND ECOSYSTEM SERVICES

4.5.1. ECOLOGICAL IMPORTANCE AND SENSITIVITY

The EIS assessment considers several biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale (Table 11). The median of the resultant score is calculated to derive the EIS category (EISC in Table 12). Because the characteristics and condition of these three streams are very similar and they are located adjacent to one another, one EIS was done for all three streams.

Table 11: Scale used to assess biotic and habitat determinants for either importance or sensitivity

Scale	Definition
1	One species/taxon judged as rare or endangered at a local scale.
2	More than one species/taxon judged to be rare or endangered on a local scale.
3	One or more species/taxon judged to be rare or endangered on a Provincial/regional scale.
4	One or more species/taxon judged as rare or endangered on a National scale (i.e. SA Red Data Books)

Table 12: Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General description	Range of median
Very high	Quaternaries/delineations 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 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 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 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 13: Results of the EIS assessment for the tributaries assessed

Biotic Determinants	Ephemeral tributaries of the Keisers River
Rare and endangered biota	1
Unique biota	1
Intolerant biota	1
Species/taxon richness	0.5
Aquatic Habitat Determinants	
Diversity of aquatic habitat types or features	0.5
Refuge value of habitat type	1.5
Sensitivity of habitat to flow changes	1
Sensitivity of flow related water quality changes	1
Migration route/corridor for in-stream and riparian biota	1
National parks, wilderness areas, Nature Reserves, Natural Heritage sites, Natural areas, PNEs	0.5
EIS CATEGORY	Low

The tributaries are considered to be of a low ecological importance and sensitivity.

The Ecological Importance and Sensitivity Assessment for the wetland areas consider the same biotic and habitat determinants as evaluated for the assessment of the river.

Table 14: Results of the EIS assessment for the wetland areas

Biotic Determinants	Remnant floodplain wetland
Rare and endangered biota	0.5
Unique biota	1
Intolerant biota	1.5
Species/taxon richness	1
Aquatic Habitat Determinants	
Diversity of aquatic habitat types or features	1
Refuge value of habitat type	1.5
Sensitivity of habitat to flow changes	2.0
Sensitivity of flow related water quality changes	1.5
Migration route for instream and riparian biota	1
National parks, Nature Reserves, Natural Heritage sites, PNEs	0.5
EIS CATEGORY	Moderate/Low

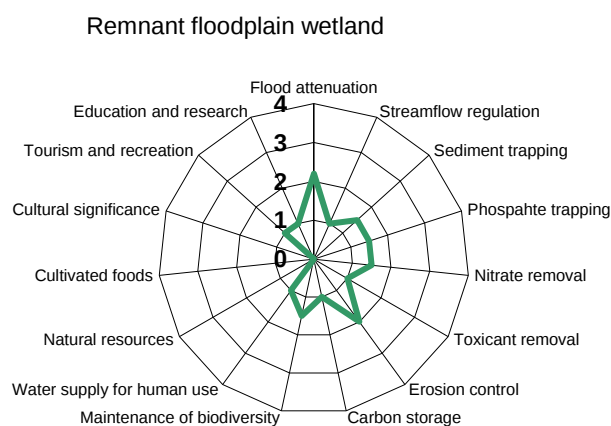
The degree of modification that has taken place within the floodplain wetland within the site has resulted in a loss of sensitive elements and a reduction of diversity and species richness. It is considered to be of moderate to low ecological sensitivity and importance.

4.5.2. WETLAND ECOSYSTEM SERVICES

The assessment of the ecosystem services supplied by the wetland areas was conducted according to the guidelines as described by Kotze *et al* (2005). An assessment was undertaken that examines and rates the services listed in Table 15. The characteristics were scored according to the general levels of services provided.

Table 15: Goods and services assessment results for wetlands (low=0 and high=4)

Goods and services	Remnant floodplain wetland	Goods and services	Remnant floodplain wetland
Flood attenuation	2.2	Biodiversity Maintenance	1.5
Stream flow regulation	1.0	Water supply	1.0
Sediment trapping	1.5	Natural resources	0.0
Phosphate trapping	1.5	Cultivated foods	0.0
Nitrate removal	1.5	Cultural significance	0.0
Toxicant removal	1.0	Tourism and recreation	1.0
Erosion control	2.0	Education and research	1.0
Carbon storage	1.0		

**Figure 16: Ecosystem services provided by the wetland area**

The remnant wetland area on the site offers limited goods and services due to its modified condition as well as the transformed landscape surrounding it.

4.5. OVERALL ECOSTATUS AND RECOMMENDED ECOLOGICAL MANAGEMENT CATEGORY

According to the draft Water Resource Classes and Resource Quality Objectives for quaternary catchment H40K, the target ecological category for the Keisers River is a D (Largely modified). The overall ecostatus of the tributaries in this assessment varies slightly from the Desktop Categories since the Desktop Categories are for the larger rivers and streams in the H40K quaternary, while the assessment is for minor tributaries of the Keisers River. It is however recommended that the target ecological category for the tributaries on the hillslopes is a B/C category. The wetland area within the site should at least be retained in its current ecological condition or improved if possible.

5. LEGISLATIVE REQUIREMENTS

The proposed development of the site needs to take cognisance of the legislative requirements, policies, strategies, guidelines and principles of the relevant regulatory documents of the Langeberg Local Municipality and the Cape Winelands District Municipality, as well as the National Water Act (NWA) and the National Environmental Management Act (NEMA).

5.1. NEMA AND ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS

NEMA is the overarching piece of legislation for environmental management in South Africa and includes provisions that must be considered to give effect to the general objectives of integrated environmental management. These provisions are contained in Section 24 (4)(a)(b) of the Act, and will be considered during the EIA process. Activities listed in terms of Chapter 5 of NEMA in Government Notice No. R. 983, 984 and 985, dated 4 December 2014, as amended, trigger a mandatory Basic Assessment, or even a full scoping EIA process, before development. Many of the listed activities relate to activities within or adjacent to aquatic ecosystems. This report is intended to provide input into the scoping phase of the environmental impact assessment process being undertaken by Cornerstone Environmental Consultants for the proposed development of the site.

5.2. NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998)

The purpose of the National Water Act, 1998 (NWA) is to provide a framework for the equitable allocation and sustainable management of water resources. Both surface and groundwater sources are redefined by the Act as national resources which cannot be owned by any individual, and rights to which are not automatically coupled to land rights, but for which prospective users must apply for authorisation and register as users. The NWA also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources.

The Act aims to regulate the use of water and activities (as defined in Part 4, Section 21 of the NWA), which may impact water resources through the categorisation of 'listed water uses' encompassing water abstraction and flow attenuation within catchments as well as the potential contamination of water resources, where the DWS is the administering body in this regard. The water uses most likely to be associated with the proposed activities are as follows:

Reference in the NWA	Description	Comment
Section 21(c)	Impeding or diverting flow of water in a watercourse	Works within the watercourses/wetlands is likely to trigger this water use
Section 21(i)	Altering the bed, banks, course or characteristics of a watercourse	Any works within or adjacent to any of the mapped aquatic features is likely to trigger this water use

Defined water use activities require the approval of DWS or the BGCMA in the form of a General Authorisation or Water Use Licence authorisation if not considered an existing lawful use (a water use that was lawful 2 years before the promulgation of the NWA in 1998) and a Schedule 1 use (small-scale/non-commercial level use). There are restrictions on the extent and scale of listed activities for which General Authorisations apply.

Section 22(3) of the National Water Act allows for a responsible authority (DWS) to dispense with the requirement for a Water Use Licence if it is satisfied that the purpose of the Act will be met by the grant of a licence, permit or authorisation under any other law.

GENERAL AUTHORISATION IN TERMS OF SECTION. 39 OF THE NWA

According to the preamble to Part 6 of the NWA, *"This Part established a procedure to enable a responsible authority, after public consultation, to permit the use of water by publishing general authorisations in the Gazette..."* *"The use of water under a general authorisation does not require a licence until the general authorisation is revoked, in which case licensing will be necessary..."*

The General Authorisations for Section 21 (c) and (i) water uses (impeding or diverting flow or changing the bed, banks or characteristics of a watercourse) as defined under the NWA were last revised in 2016 (Government

Notice R509 of 2016). The proposed works within or adjacent to the wetland areas and river channels are likely to change the characteristics of the associated freshwater ecosystems and may therefore require authorization. Determining if a water use licence is required for these water uses is now associated with the risk of degrading the ecological status of a watercourse. A low risk of impact could be authorised in terms of a General Authorisations (GA). A risk assessment for the proposed project would need to be undertaken once the detail of the proposed development has been finalised.

REGULATIONS REQUIRING THAT A WATER USER BE REGISTERED, GN R.1352 (1999)

Regulations requiring the registration of water users were promulgated by the Minister of DWA in terms of provision made in section 26(1)(c), read together with section 69 of the National Water Act, 1998. Section 26(1)(c) of the Act allows for registration of all water uses including existing lawful water use in terms of section 34(2). Section 29(1)(b)(vi) also states that in the case of a general authorisation, the responsible authority may attach a condition requiring the registration of such water use. The Regulations (Art. 3) oblige any water user as defined under section 21 of the Act to register such use with the responsible authority and effectively to apply for a Registration Certificate as contemplated under Art.7(1) of the Regulations.

6. AQUATIC ECOSYSTEM CONSTRAINTS

The aquatic constraints to the proposed cultivated areas comprise several smaller ephemeral watercourses that are tributaries of the Keisers River, a tributary in the middle reaches of the Breede River System. Many of these watercourses are minor drainage features rather than streams that contain distinct riparian and aquatic vegetation or provide any significant aquatic ecological functionality such that they can be considered as significant aquatic features. For this reason, although all the ephemeral streams and drainage features within the study area have been mapped, it is felt that only the significant aquatic features should be retained within the landscape and protected with a suitable buffer area of 15m. It is also recommended that the wetland area be retained and that it be protected with a buffer of approximately 20m.



Figure 17. Google Earth image showing the mapped aquatic features within the site and the recommended buffer areas

7. CONCLUSIONS AND RECOMMENDATIONS

The aquatic constraints to the proposed cultivated areas comprise several smaller ephemeral watercourses that are tributaries of the Keisers River, a tributary in the middle reaches of the Breede River System. There is also a wetland area in the south-eastern extent of the study area that is a remnant floodplain wetland associated with the lower reaches of the tributaries and the Keisers River. Nearly all of the surrounding floodplain wetland has since been lost.

The upper reaches of the tributaries within the site are in a largely natural ecological condition but the watercourses degrade significantly in their lower reaches, with most being lost to cultivation. The tributaries are considered to be of a low ecological importance and sensitivity. The small streams/drainage features crossing the various cultivation areas are mapped as aquatic ESAs that play an important role in delivering ecosystem services.

The remnant floodplain wetland area is considered to be largely modified as a result of modifications that have taken place within the site as well as downstream of the site. It is of moderate to low ecological sensitivity and importance. The remaining floodplain wetland along the Keisers River is mapped as FEPA Wetland and an aquatic CBA however that is some distance (about 280 m) from the remnant wetland on the site.

The best mitigation for the aquatic ecosystems within these areas is to set the cultivated land back from the more significant aquatic features and to maintain the recommended buffers as areas that comprise suitable indigenous vegetation which is kept free of invasive alien plants and is not utilized for farming activities such as stockpiling of materials, nor for use as informal access paths.

While all of the ephemeral streams and drainage lines have been mapped within the site not all of these features are considered significant watercourses. It is recommended that only the significant aquatic features should be retained within the landscape and protected with a suitable buffer area of 15m. It is also recommended that the wetland area be retained and that it be protected with a buffer of approximately 20m.

To reduce the potential for sedimentation and erosion of the wetlands and streams during the operation phase, it is important that any disturbed aquatic habitats associated with the proposed works within the buffer areas be properly maintained in a well-vegetated (indigenous vegetation) state that is free of alien vegetation.

During the establishment and operation of the farming activities, the disturbance within the buffer areas, riparian zones of the aquatic features and wetland area should be kept to a minimum. Where necessary, cleared areas should re-vegetated with suitable vegetation to reduce the risk of erosion in the streams and wetland. Follow-up work should be carried out after rehabilitation to ensure that no invasive alien plants establish themselves within the riparian zones, seeps and buffer areas.

Access roads to the cultivated areas should avoid crossing the watercourses and the wetland as much as possible. The road crossings through the watercourses should comprise only of low water crossings or have sufficient pipe culverts so as not to restrict or confine flow in the watercourses that is likely to result in erosion of the downstream stream channels.

It is recommended that some flow mitigation measures be undertaken at any stormwater discharge points into the channels or the wetland area to reduce the erosion and sedimentation potential at the discharge points.

With regards to the other mapped drainage features, these features should be considered and mitigated within the cultivated areas because they do periodically convey some runoff water within the landscape and as such, there is increased erosion potential associated with these features.

8. REFERENCES

- Breede Overberg Catchment Management Agency, 2010. Breede Overberg Catchment Management Strategy
Cape Farm Mapper. <http://gis.elsenburg.com/apps/cfm/>.
- Department of Water Affairs and Forestry. (1998). *National Water Act*. Act 36. South Africa.
- Department of Water Affairs and Forestry. (1999). *Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version 1.0*. Resource Directed Measures for Protection of Water Resources, Pretoria, South Africa.
- Department of Water Affairs and Forestry. (2005). *A practical field procedure for identification and delineation of wetland and riparian areas*. DWAF, Pretoria.
- Department of Water Affairs and Forestry. (2007). *River Ecoclassification: Manual for EcoStatus Determination (Version 2)*. Water Research Commission Report Number KV 168/05. Pretoria.
- Driver, Nel, Snaddon, Murray, Roux, Hill. (2011). Implementation Manual for Freshwater Ecosystem Priority Areas. Draft Report for the Water Research Commission.
- Government Notice 509 of 2016, Department of Water and Sanitation, National Water Act, 1998 (Act No.36 Of 1998), *General Authorisation in terms of Section 39 of the National Water Act, 1998 (Act no. 36 of 1998) for water uses as defined in Section 21(c) or section 21(i)*. Government Gazette Notice 40229 dated 26 August 2016.
- Kleynhans CJ (1996). *A qualitative procedure for the assessment of the Habitat Integrity status of the Luvuvhu River* (Limpopo system, South Africa). Journal of Aquatic Ecosystem Health 5: 41-54.
- 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.
- Kleynhans CJ, Louw MD, Graham M. (2008). Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical manual) Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08
- Kotze, D., Marneweck, G.C., Batchelor, A.L., Lindley, D.S. And Collins, N.B. (2005). *WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands*. Dept. Tourism, Environmental and Economic Affairs, Free State.
- Macfarlane, D. M., Kotze, D. C., Ellery, W. N., Walters, D., Koopman, V., Goodman, P., et al. (2008). *WETHealth: A technique for rapidly assessing wetland health*. WRC report TT340/08. South Africa: WRC.
- Marneweck, G.C. and Batchelor, A. 2002. *Wetland inventory and classification*. In: Ecological and economic evaluation of wetlands in the upper Olifants River catchment. (Palmer, R.W., Turpie, J., Marneweck, G.C and Batchelor (eds.). Water Research Commission Report No. 1162/1/02.
- Middleton, B.J., Midgley, D.C and Pitman, W.V., (1990). *Surface Water Resources of South Africa*. WRC Report No 298/1.2/94.
- Mucina, L. and Rutherford, M. C. (eds.) (2004) Vegetation map of South Africa, Lesotho and Swaziland. Strelitzia 18. South African National Biodiversity Institute, Pretoria.

River Health Programme. 2010. State of Rivers Report for the Breede Water Management Area.

SANBI Biodiversity GIS <http://bgis.sanbi.org/>

SANBI (2009). *Further Development of a Proposed National Wetland Classification System for South Africa*. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI). SANBI Biodiversity GIS 2012. <http://bgis.sanbi.org/capetown/bionetwork.asp>

WRC. (2011). *Atlas for Freshwater Ecosystem Priority Areas* – Maps to support sustainable development of water resources (WRC Report No. TT 500/11).

APPENDIX A: PRESENT ECOLOGICAL STATE OF THE KEISERS RIVER (DWAF, 2012)

SELECT SQ REACH	SQR NAME	LENGTH km	STREAM ORDER	PES ASSESSED BY EXPERTS? (IF TRUE="Y")	REASONS NOT ASSESSED	PES CATEGORY DESCRIPTION	PES CATEGORY BASED ON MEDIAN OF METRICS
H40K-09118	Keisers	19,50	2	Y		LARGELY MODIFIED	D
MEAN EI CLASS	MEAN ES CLASS	DEFAULT ECOLOGICAL CATEGORY (EC)	RECOMMENDED ECOLOGICAL CATEGORY				
MODERATE	VERY HIGH	A	#NUM!				
PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE			ECOLOGICAL SENSITIVITY		
INSTREAM HABITAT CONTINUITY MOD	LARGE	FISH SPP/SQ	3,00	INVERT TAXA/SQ	12,00	FISH PHYS-CHEM SENS DESCRIPTION	VERY HIGH
RIP/WETLAND ZONE CONTINUITY MOD	LARGE	FISH: AVERAGE CONFIDENCE	5,00	INVERT AVERAGE CONFIDENCE	1,33	FISH NO-FLOW SENSITIVITY DESCRIPTION	VERY HIGH
POTENTIAL INSTREAM HABITAT MOD ACT.	LARGE	FISH REPRESENTIVITY PER SECONDARY: CLASS	HIGH	INVERT REPRESENTIVITY PER SECONDARY, CLASS	LOW	INVERT PHYS-CHEM SENS DESCRIPTION	VERY HIGH
RIPARIAN-WETLAND ZONE MOD	SERIOUS	FISH REPRESENTIVITY PER SECONDARY: CLASS	HIGH	INVERT RARITY PER SECONDARY: CLASS	VERY HIGH	INVERTS VELOCITY SENSITIVITY	HIGH
POTENTIAL FLOW MOD ACT.	LARGE	FISH RARITY PER SECONDARY: CLASS	MODERATE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	HIGH	RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	LARGE	ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING	HIGH	HABITAT DIVERSITY CLASS	LOW	STREAM SIZE SENSITIVITY TO MODIFIED FLOW/WATER LEVEL CHANGES DESCRIPTION	VERY HIGH
		RIPARIAN-WETLAND NATURAL VEG RATING BASED ON % NATURAL VEG IN 500m (100%=5)	MODERATE	HABITAT SIZE (LENGTH) CLASS	HIGH	RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION	HIGH
		RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	HIGH	INSTREAM MIGRATION LINK CLASS	MODERATE		
				RIPARIAN-WETLAND ZONE MIGRATION LINK	MODERATE		
				RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	LOW		
				INSTREAM HABITAT INTEGRITY CLASS	MODERATE		