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FRESHWATER ECOLOGICAL ASSESSMENT FOR THE PROPOSED KLEINVLEI DAM ON PORTION 1 OF THE FARM KLEINVLEI 209, NEAR CERES, WESTERN CAPE PROVINCE

Prepared for

EnviroAfrica CC

February 2020

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Report reference: FEN 21-0001
Date: February 2020

EXECUTIVE SUMMARY

The proposed Kleinvlei Dam entails the construction of an earthfill dam wall between two ridges, through which an excavated channel is routed. Excavated channels act as waterways between the upgradient natural episodic drainage lines and the downgradient Houdenbek River. The excavated channels cannot be classified as watercourses from an ecological perspective due to the lack of saturated soils and wetland/riparian vegetation. However, based on the definition of a watercourse water flows regularly or intermittently within these excavated channels, conveying water from the limited upgradient catchment area - from the episodic drainage lines - into the downgradient Houdenbek River. As such, they can be considered as watercourses due to their importance for hydrological functioning as they do function as waterways and therefore enjoy protection in terms of the National Water Act, 1998 (Act No. 36 of 1998).The DWS Risk Assessment determined that the proposed Kleinvlei Dam development poses a low risk significance to the integrity of the watercourses downgradient of the proposed dam development provided that adherence to cogent, well-conceived and ecologically sensitive construction plans are implemented and the mitigation measures provided in this report as well as general good construction practice are adhered to.

MANAGEMENT SUMMARY

FEN Consulting was appointed to conduct a specialist freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Licence Application (WULA) processes for the proposed Kleinvlei Dam on Portion 1 of the farm Kleinvlei 209, near Ceres, hereafter referred to as the "study area". The project entails the following:

- The dam wall will be an earthfill embankment across two valley ridges (straight alignment) located in the western portion of the study area. Material excavated from the basin of the dam will be used to construct the dam wall;
- An open side channel spillway is proposed against the northern bank. This spillway will have a concrete sill at the right flank directing the flood water safely past and away from the embankment toe and back to the existing drainage excavated channel;
- A 250mm ø pipe outlet is proposed under the central embankment. The outlet pipe will be a single reinforced concrete pipe with a flanged sluice-gate control valve and manifold on the downstream side.

A desktop study was conducted in which possible watercourses were identified for on-site investigation, and relevant national and provincial databases were consulted. The results of the desktop study are contained in Section 4 of this report.

During the site assessment undertaken in January 2020. In accordance with Government Notice (GN) 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA), a 500m zone of investigation around the study area was used as a guide in which to assess possible sensitivities of the receiving freshwater environment. Several ephemeral drainage lines were identified in the eastern portion of the investigation area (conveying surface water into excavated channels located in the study area, which ultimately flow into the Houdenbek River (located approximately 510m west of the study area). Historically (prior to any land use transformation) these excavated channels were potentially functioning watercourses (as part of the upgradient drainage lines, in the eastern portion of the investigation area) which have become severely degraded (as a result of removal of all indigenous vegetation and straightening of the channels to optimise the study area for cultivation) to the point that they only function as waterways, through episodic conveyance of water from the limited upgradient catchment area into the downstream Houdenbek River. The upstream reaches of the episodic drainage lines associated with the surrounding mountainous area (upgradient from the proposed dam) are considered true watercourses. The excavated channels cannot be classified as watercourses from an ecological perspective due to the lack of saturated soils and wetland/riparian vegetation. However, based on the definition of a watercourse water flows regularly or intermittently within these excavated channels, conveying water from the limited upgradient catchment area - from the episodic drainage

lines - into the downgradient Houdenbek River. As such, they can be considered as watercourses due to their importance for hydrological functioning as they do function as waterways and therefore enjoy protection in terms of the National Water Act, 1998 (Act No. 36 of 1998).

Due to the lack of watercourse characteristics of the excavated channels, determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the excavated channels was not deemed applicable. Since the upgradient catchment area is limited to 1.8% of the Mean Annual Run-off (MAR) and hydrological inputs from the upgradient episodic drainage lines are relatively limited, the need to release water for the Ecological Water Requirements (EWR) is undetermined. A hydrological investigation would need to be conducted to determine the volume of water entering the Kleinvlei Dam from the upgradient catchment and the relevant releases (should this be required by the relevant authorities) determined from the dam. It must be noted that the determination of the EWR did not part of the scope of works for this report.

Since the excavated channels are important for retaining hydrological connectivity between the upgradient and downgradient natural watercourses, it was deemed relevant to undertake a risk assessment, albeit the quantum of risk is considered limited. The following summarises the risks associated with the proposed activities associated with the construction and operational phases:

Table A: Summary of the DWS Risk Assessment outcomes.

Phases	Activity	Risk Rating
Construction Phase	Site preparation prior to construction activities (applicable to all proposed project activities) • Removal of vegetation, including the large stand of poplar trees between the two ridges, leading to the exposure of soils; • Exposed soils can be transported into the excavated channel underneath the R303 road, causing sedimentation of the downstream Houdenbek River; • Any sheet runoff from the dam footprint area cleared of vegetation can cause erosion, resulting in a high sediment load entering the downstream excavated channel; • Proliferation of alien vegetation as a result of disturbances.	L
	Construction activities related to construction of the dam wall utilising excavated material from the basin of the proposed dam. • Runoff from stockpiled material or sediment laden runoff from the construction footprint area could enter the excavated channel between the proposed dam wall and the R303 road and increase its sediment load; • Disturbance to vegetation and soils due to edge effects.	L
	Construction of an open side channel spillway against the northern bank of the dam wall • Potential negative impact on the water quality (if present); • Potential erosion of excavated channel.	L
Operational Phase	Operation of the dam wall	L
	Maintenance of the dam.	L

Based on the findings of the risk assessment, several mitigation measures are recommended to minimise the impact on the hydrological linkage between the downstream excavated channel (specifically the excavated channel between the R303 road and the proposed locality of the dam wall) and the watercourse (Houdenbek River), as discussed in Section 7 and Appendix F of this report. Key mitigation and control measures include (but are not limited to):

- It is imperative that all construction works be undertaken during the dry, summer months as it is expected that surface runoff collected in the excavated channels at that time will be minimal and no diversion of flow would be necessary, and would limit any edge effects impacting on the downstream Houdenbek River;
- The removal of the blue gum trees (at the dam wall footprint along the downstream excavated channel) may potentially result in an increase of dust and sediments in the downstream excavated channel. Thus, sediment control devices (such as silt traps) should be constructed prior to any vegetation clearing. This will prevent any blockages of the excavated channel before the R303 road crossing;
- The slope of the dam wall may not exceed the maximum slope ratio of 3:1, and must be stabilised (on the western embankment of the dam wall) during the construction phase with the use of a geotextile product such as hessian or Geojute, which is to be staked to the surface of the dam wall slope while revegetation of the dam wall occurs;
- The dam wall must be revegetated after the construction activities, to stabilize the soils and prevent erosion of the dam wall. A graminoid seed mixture (such as the MayFord Fynbos Biomosome seed mixture) can be used for this purpose, as it will allow for quick establishment of vegetation;
- The inlet and outlet of the proposed spillway must be of equal width to allow water to enter the spillway and diffusely flow through the spillway and into the downstream excavated channel, without the flow being concentrated which may cause scouring;
- The dam and spillway should regularly be inspected for erosion, especially after heavy rainfall events when overflow from the dam is expected and the flow velocity is increased. If erosion is noted, this should be rectified, preferably reinstating vegetation in the eroded areas in the excavated channel. If erosion is pronounced, erosion control devices such as reno mattresses should be considered, in consultation with a watercourse ecological specialist.

Based on the findings of the watercourse assessment and the results of the impact assessment, it is the opinion of the ecologist that the proposed Kleinvlei Dam poses a **low risk to the integrity of the watercourses downgradient of the proposed dam development** provided that adherence to cogent, well-conceived and ecologically sensitive construction plans are implemented and the mitigation measures provided in this report as well as general good construction practice are adhered to.

DOCUMENT GUIDE

The following table indicates the requirements for Specialist Studies as per Appendix 6 of Government Notice 326 of 2017, amendments to the Environmental Impact Assessment (EIA) Regulations, 2014 as it relates to the National Environmental Management Act, 1998 (Act No. 107 of 1998), promulgated in Government Notice 40772 of 2017.

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix G
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix G
b)	A declaration that the specialist is independent	Appendix G
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1 and Section 2
cA)	An indication of the quality and age of base data used for the specialist report	Section 3.1
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 7
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 5
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3 and Appendix C and Appendix D
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives.	Section 2 and Section 5
g)	An identification of any areas to be avoided, including buffers.	Section 6
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 5 and Section 6
i)	A description of any assumption made and any uncertainties or gaps in knowledge.	Section 1.3
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities.	Section 7
k)	Any mitigation measures for inclusion in the EMPr.	Section 7 and Appendix F
l)	Any conditions for inclusion in the environmental authorisation.	Section 7
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 7
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised.	Section 8
(iA)	Regarding the acceptability of the proposed activity or activities.	Section 8
(ii)	If the opinion is that the proposed activity, activities 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	Section 8
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q)	Any other information requested by the competent authority	N/A

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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydromorphy:	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Perennial:	Flows all year round.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status.
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	The outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year.
Watercourse:	In terms of the definition contained within the National Water Act, 1998 (Act No. 36 of 1998) a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks.
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

°C	Degrees Celsius
BAR	Basic Assessment Report
BGIS	Biodiversity Geographic Information Systems
CBA	Critical Biodiversity Area
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (use to be defined in relevant sections)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMP	Environmental Management Program
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Areas
GA	General Authorisation
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
IHI	Index of Habitat Integrity
m	Meter
MAP	Mean Annual Precipitation
MC	Management Classes
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NBA	National Biodiversity Assessment
NEMA	The National Environmental Management Act, 1998 (Act No. 107 of 1998)
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act, 1998 (Act No. 36 of 1998)
NWCS	National Wetland Classification System
PEMC	Present Ecological Management Class
PES	Present Ecological State
REC	Recommended Ecological Category
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
subWMA	Sub-Water Management Area
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WRC	Water Research Commission

1 INTRODUCTION

1.1 *Background*

FEN Consulting was appointed to conduct a specialist freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Licence Application (WULA) processes for the proposed Kleinvlei Dam on Portion 1 of the farm Kleinvlei 209, near Ceres, Western Cape Province, hereafter referred to as the "study area" (please refer to Section 2 for the project description). In order to identify all watercourses that may potentially be impacted by the proposed dam development, a 500m "zone of investigation" around the study area, in accordance with Government Notice (GN) 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA), was used as a guide in which to assess possible sensitivities of the receiving freshwater environment. This area – i.e. the 500m zone of investigation around the study area - will henceforth be referred to as the "investigation area".

The purpose of this report is to define the ecology of the watercourse associated with the study area in terms of the watercourse characteristics, including mapping of the watercourse, defining areas of increased Ecological Importance and Sensitivity (EIS), and defining the Present Ecological State (PES) of the watercourses associated with the study area. The Department of Water and Sanitation (DWS) Risk Assessment Matrix as promulgated in Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) was applied to determine the significance of the impacts associated with the proposed dam development and mitigatory measures were identified which aim to minimise the potential impacts.

This study further aims to provide detailed information to guide the proposed dam development in the vicinity of the watercourse, to ensure the ongoing functioning of the ecosystems, such that local and regional conservation requirements and the provision of ecological services in the local area are supported while considering the need for sustainable economic development. This report, after consideration of the above, must guide the Environmental Assessment Practitioner (EAP), by means of a reasoned opinion and recommendations, as to the viability of the proposed dam development from a watercourse management perspective.

1.2 *Structure of this report*

This report investigates the impact significance of the proposed dam development, as explained in Section 2 below, in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) as well as the National Water Act, 1998 (Act No. 36 of 1998) (NWA) by means of the DWS Risk Assessment Matrix. The following structure is applicable to this report:

Section 1: Introduction
Provides an introduction, the structure of this report and the assumptions and limitations.

Section 2: Project Description
Provides the location of the study area as well as a brief summary of the proposed activities associated with the proposed dam development.

Section 3: Assessment Approach
Provides the relevant methodology and definitions applicable to this report, a description of the sensitivity mapping and the risk assessment approach.

Section 4: Desktop Assessment Results
Reports on the findings from the relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas [NFEPA], 2011 database; the DWS Resource Quality Information System (RQIS) PES/ EIS, 2014 database and the Western Cape Biodiversity Spatial Plan (2017)) was undertaken to aid in defining the PES and EIS of the watercourse.

Section 5: Site Based Watercourse Assessment Results
This section reports the following:

- A description and delineation of the watercourse associated with the study area according to "Department of Water Affairs and Forestry (DWAF)[1] (2008): A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". All features are mapped according to their ecological sensitivity;
- Delineation of all watercourses (using desktop methods) within 500m of the study area in accordance with Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to activities as stipulated in Section 21(c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998);
- The classification of the watercourse according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);

Section 6: Legislative Requirements
Provides the applicable legislative requirements based on the findings from Section 5 and indicates any applicable zones of regulation that may trigger various enviro-legal authorisation requirements.

Section 7: Risk Assessment
Provides the outcomes from the DWS Risk Assessment Matrix which highlights all potential impacts and that may affect the watercourse. Management and mitigation measures are provided which should be implemented during the various dam development activities (planning, construction and operational phases) in order to assist in minimising the impact on the receiving environment.

Section 8: Conclusion
Summarises the key findings and recommendations based on the risk assessment outcomes and legislative requirements.

1.3 *Assumptions and Limitations*

- The ground-truthing and delineation of the watercourse boundaries and the assessment thereof are confined to a site visit undertaken in January 2020 of the study area. All watercourses identified within the investigation area were delineated in fulfilment of Government Notice 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) using various desktop methods including the use of topographic maps, historical and current digital satellite imagery and aerial photographs. These watercourses (i.e. those within 500m of the study area) were not ground-truthed, however, the general surroundings were considered during the desktop assessment;
- Most areas surrounding the study area have undergone significant anthropogenic changes as a result of surrounding agricultural activities, including the diversion of catchment runoff into excavated channels. Nevertheless, the watercourse delineation as presented in this report is regarded as a best estimate of the boundaries based on the site conditions present, as observed during the site assessment. The results obtained are, however, considered sufficiently accurate to allow informed planning and decision making to take place;

[1] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.

- Determination of any watercourse Ecological Water Requirements (EWR) to sustain the downstream ecological conditions did not form part of the scope of work for this report as it is not clear if any provision for water releases from the new Kleinvlei Dam would be made or if it is required (to be confirmed by the relevant authorities). This report considered the watercourse characteristics only and provided mitigation measures accordingly;
- Additionally, no instream or riparian assessment of the Houdenbek River (located approximately 510m west of the study area) was undertaken by the watercourse ecologist, as it did not form part of the scope of work for this investigation;
- Global Positioning System (GPS) technology is inherently somewhat inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. However, the delineations as provided in this report are deemed accurate enough to fulfil the environmental authorisation requirements as well as the implementation of the mitigation measures provided;
- Watercourses 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 watercourse boundaries may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results; and
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. However, it is expected that the watercourse has been accurately assessed and considered, based on the field observations and monitoring data in terms of riparian and wetland ecology.

2 PROJECT DESCRIPTION

The study area (Portion 1 of the farm Kleinvlei 209) is located approximately 32km north of Ceres and 5km south of Op-die-Berg (Figures 1 and 2). The R303 road forms the western boundary of the study area. The study area is surrounded by mountainous areas, with the Skurweberge to the west and the Sandberg to the east. Cultivation is the dominant land use in the study area.

The proposed Kleinvlei Dam will have a total storage capacity of approximately 235 000m³ and will exclusively be filled with water abstracted from the Houdenbek River (during the winter period), located approximately 510m west of the study area. The abstraction of water from the Houdenbek River is in accordance with existing lawful rights which is used for summer irrigation (Sarel Bester Ingenieurs, 2019). The proposed Kleinvlei Dam will be used for the storing of water during the winter period, for subsequent use for summer irrigation during times when the Houdenbek River nearly runs dry. The section below describes the proposed dam wall design, as depicted in Figure 3:

- The dam wall will be an earthfill embankment across two natural valley outcrop ridges (straight alignment) located in the western portion of the study area. A large stand of poplar trees are currently located in between the ridges. The proposed maximum wall height is approximately 8.5m with the inside slope provisionally set at a slope of 1:3, the outside slope at 1:2 and the crest width at approximately 4m. The dam wall will have a crest length of approximately 155m. Material excavated from the basin of the dam will be used to construct the dam wall;
- An open side channel spillway is proposed against the northern bank. This spillway will have a concrete sill at the right flank directing the flood water safely past and away from the embankment toe and back to the existing excavated channel, which flows through the R303 road culvert;
- A 250mm ø pipe outlet is proposed under the central embankment. The outlet pipe will be a single reinforced concrete pipe with a flanged sluice-gate control valve and manifold on the downstream side. This will be sufficient for irrigation purposes as well as for emptying the dam or lowering the water level in case of an emergency.

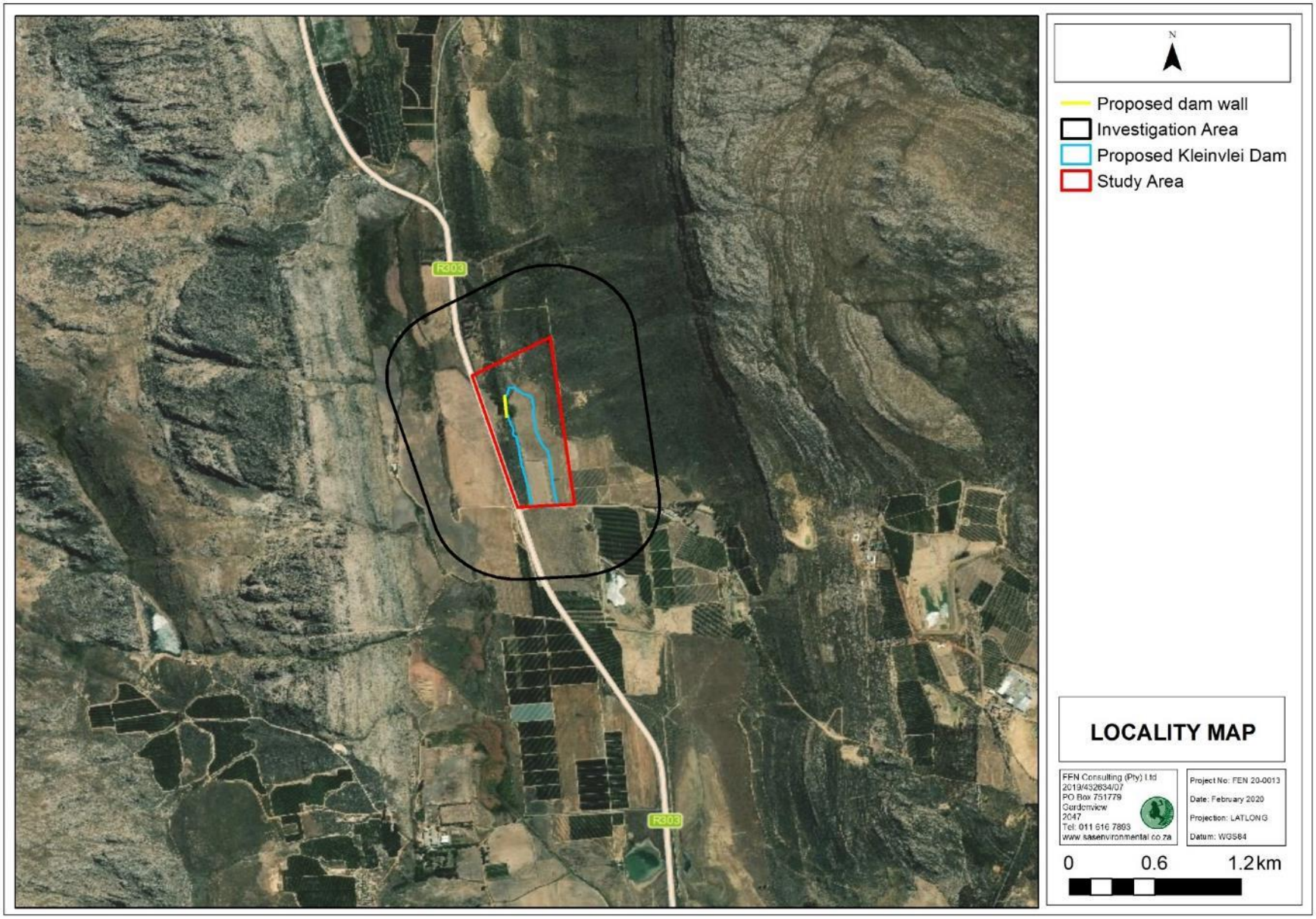


Figure 1: Digital satellite image depicting the study and investigation areas in relation to the surroundings.

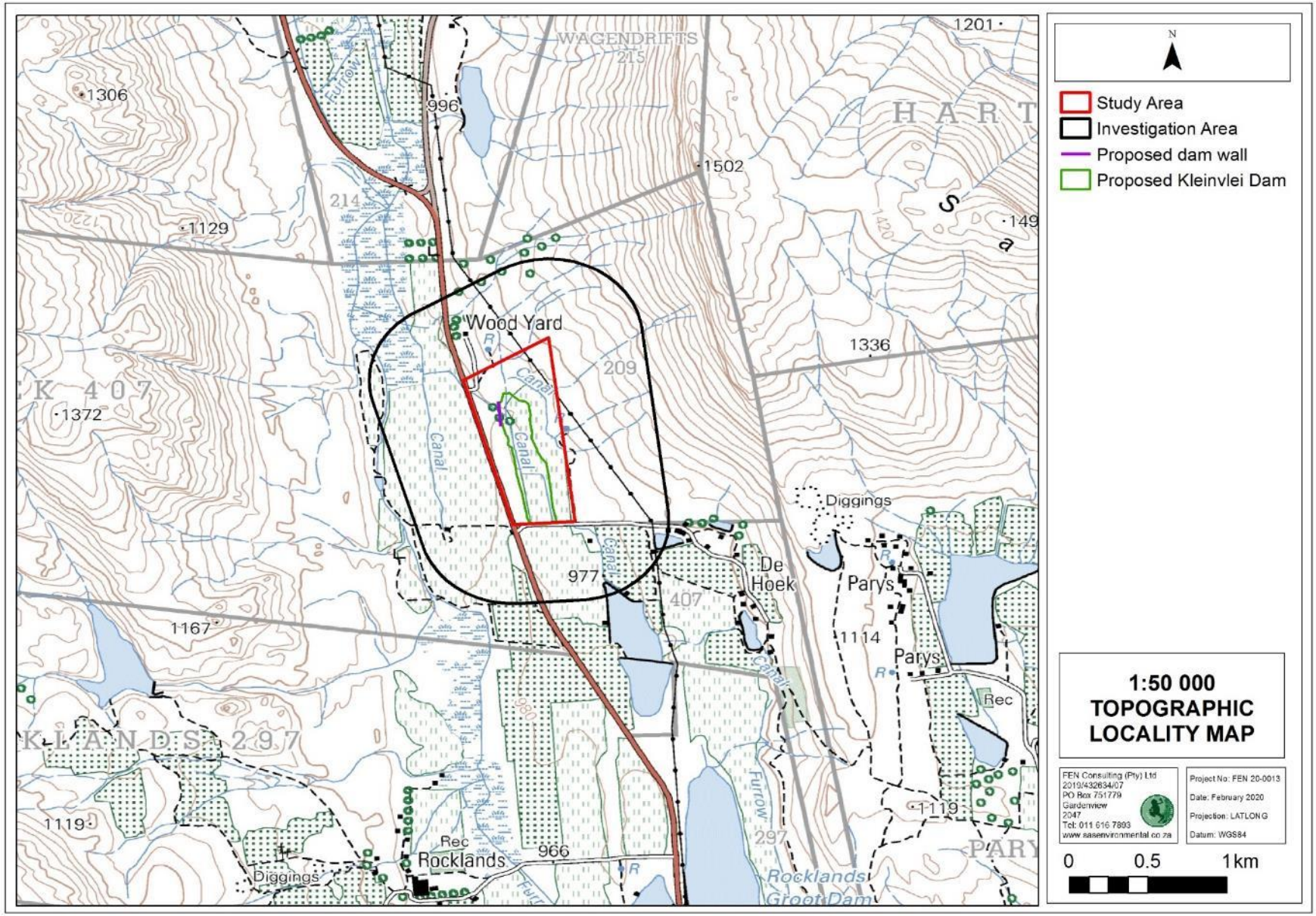


Figure 2: Location of the study and investigation areas depicted on a 1:50 000 topographical map in relation to surrounding areas.

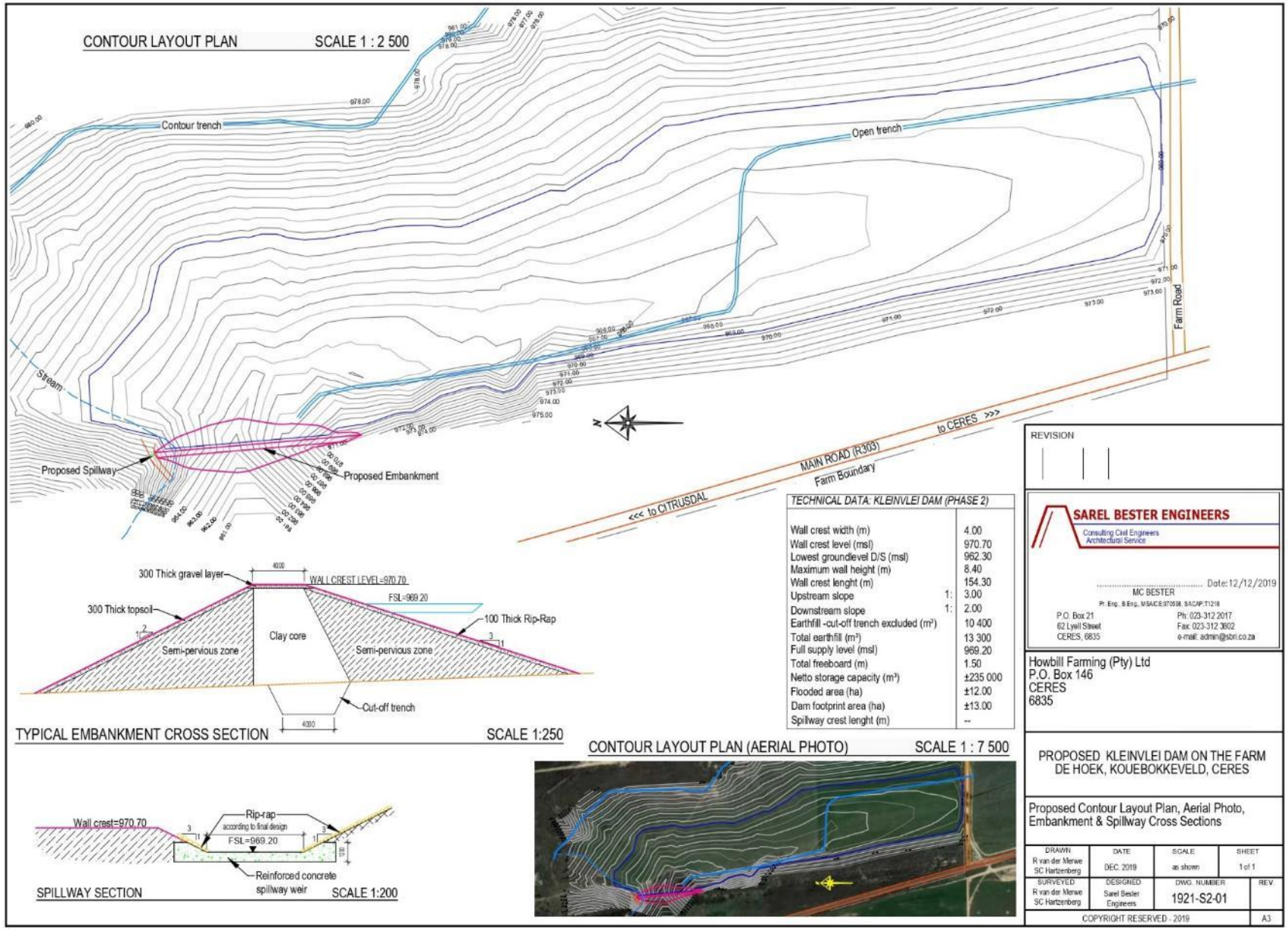


Figure 3: Proposed design of the Kleinvlei Dam (Sarel Bester Engineers, 2019).

3 ASSESSMENT APPROACH

3.1 *Watercourse Field Verification*

As part of this assessment, the following definitions, as per the National Water Act, 1998 (Act No. 36 of 1998) are of relevance:

Watercourse means-

(a) A river or spring;
(b) A natural channel in which water flows regularly or intermittently;
(c) A wetland, lake or dam into which, or from which water flows; and
(d) Any collection of water, which the Minister may, by notice of the Gazette, declare a watercourse.

Wetland habitat is "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."

Riparian habitat includes the physical structure and associated vegetation of 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**.**

A field verification was undertaken on the 16th of January 2020, during which the presence of any watercourse characteristics as defined by DWAF (2008) or wetlands or riparian habitat as defined by the National Water Act, 1998 (Act No. 36 of 1998) were noted (please refer to Sections 4 and 5 of this report). In addition to the delineation process, detailed assessment of the delineated watercourse was undertaken, at which time factors affecting the integrity of the watercourse were taken into consideration and aided in the determination of the functioning and the ecological and socio-cultural services provided by the watercourse. A detailed explanation of the methods of assessment undertaken is provided in **Appendix C** of this report.

3.2 *Sensitivity Mapping*

The watercourse associated with the study area were delineated with the use of a Global Positioning System (GPS). Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map presented in Section 6 should guide the design, layout and management of the proposed dam development.

3.3 *Risk Assessment and Recommendations*

Following the completion of the assessment, a risk assessment was conducted (please refer to **Appendix D** for the method of approach) and recommendations were developed to address and mitigate impacts associated with the proposed dam development. These recommendations also include general management measures, which apply to the proposed construction and operational/maintenance activities. The detailed mitigation measures are outlined in Section 7 of this report, while the general management measures which are considered best practice mitigation applicable to this project, are outlined in **Appendix F**.

4 DESKTOP ASSESSMENT RESULTS

4.1 *National and Provincial Datasets*

The following section contains data accessed as part of the desktop assessment and presented as a "dashboard-style" report below (Table 1). The dashboard report aims to present concise summaries of the data on as few pages as possible in order to allow for integration of results by the reader to take place. Where required, further discussion and interpretation are provided.

It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the actual site characteristics associated with the study area at the scale required to inform the environmental authorisation and/or water use authorisation processes. Given these limitations, this information is considered useful as background information to the study, is important in legislative contextualisation of the risks and impacts, and was thus used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance during the field survey. It must however be noted that site verification of key areas may potentially contradict the information contained in the relevant databases, in which case the site verified information must carry more weight in the decision making process.

Table 1: Desktop data (from desktop databases only) relating to the characteristics of the associated with the study area.

Aquatic ecoregion and sub-regions in which the study area is located		Detail of the study area in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database	
Ecoregion	Western Folded Mountains	FEPACODE	The study area is located in an area indicated to be an upstream management catchment by the NFEPA Database (2011). These catchments are required to prevent any downstream degradation of Freshwater Ecosystem Priority Areas (FEPAs) and fish support areas.
Catchment	Olifants - Cape		
Quaternary Catchment	E12D		
WMA	Olifants/Doorn		
subWMA	Koue Bokkeveld		
Dominant characteristics of the Western Folded Mountains Ecoregion Level II (23.03) (Kleynhans *et al.,* 2007)			
Level II Code	23.03	NFEPA Wetlands (Figure 4)	According to the NFEPA database, no wetlands are located in the study area. Two natural channelled valley bottom wetlands are indicated on the western boundary of the investigation area, which are associated with the Houdenbek River. An artificial channelled valley bottom is indicated on the southern boundary. This was identified as an artificial impoundment on digital satellite imagery.
Dominant primary terrain morphology	High Mountains, Slightly Undulating Plains, Low Mountains, Moderately Undulating Plains.		
Dominant primary vegetation types	Mountain Fynbos, south And South-west Coastal Renosterveld, Central Mountain Renosterveld, West Coast Renosterveld.		
Altitude (m a.m.s.l)	300 - 1500		
MAP (mm)	500 - 1500		
Coefficient of Variation (% of MAP)	<20 - 25		
Rainfall concentration index	30 - 55	Wetland Vegetation Type	The study area is located in the Northwest Shale Fynbos vegetation group (Critically Endangered). The threat status is provided by Mbona *et al* (2015).
Rainfall seasonality	Winter		
Mean annual temp. (°C)	14 - 18		
Winter temperature (July)	2 - 16		
Summer temperature (Feb)	10 - 30	NFEPA Rivers (Figure 4)	As per the NFEPA database, the Houdenbek River is located approximately 600m west (and downgradient) of the study area. This river is considered to be seriously to critically modified (RIVCON = EF).
Median annual simulated runoff (mm)	150 - > 250		
Default Ecological Class (based on median PES and highest EI or ES mean)	A (Very High)		
Importance of the study area according to the Western Cape Biodiversity Spatial Plan (2017) (Figure 5)			
Critical Biodiversity Area	The north eastern corner of the study area is indicated to be a CBA 1 of terrestrial importance. Critical Biodiversity Areas (CBA) are areas of high biodiversity and ecological value and need to be kept in a natural or near natural state, with no further loss of habitat or species. A distinction is made between CBAs that are likely to be in a natural condition (CBA 1) and those that are potentially degraded or represent secondary vegetation (CBA 2).		
Ecological Support Area	A small area in the north western portion of the study area is indicated to be an ESA 1 of terrestrial importance. Small areas associated with the ESA 1s is indicated to be ESA 2s of watercourse importance. Ecological Support Areas (ESAs) are areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of protected areas (PAs) or CBAs and are often vital for delivering system services. A distinction is made between ESAs that are still likely to be functional (ESA 1) or areas that are severely degraded or have no natural cover remaining and therefore require restoration (ESA 2).		

CBA = Critical Biodiversity Area; CESA = Critical Ecological Support Area; CR = Critically Endangered; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; EN = Endangered; m.a.m.s.l = Metres above mean sea level; MAP = Mean Annual Precipitation; NFEPA = National Freshwater Ecosystem Priority Area; OESA = Other Ecological Support Area; PES = Present Ecological State; WMA = Water Management Area.

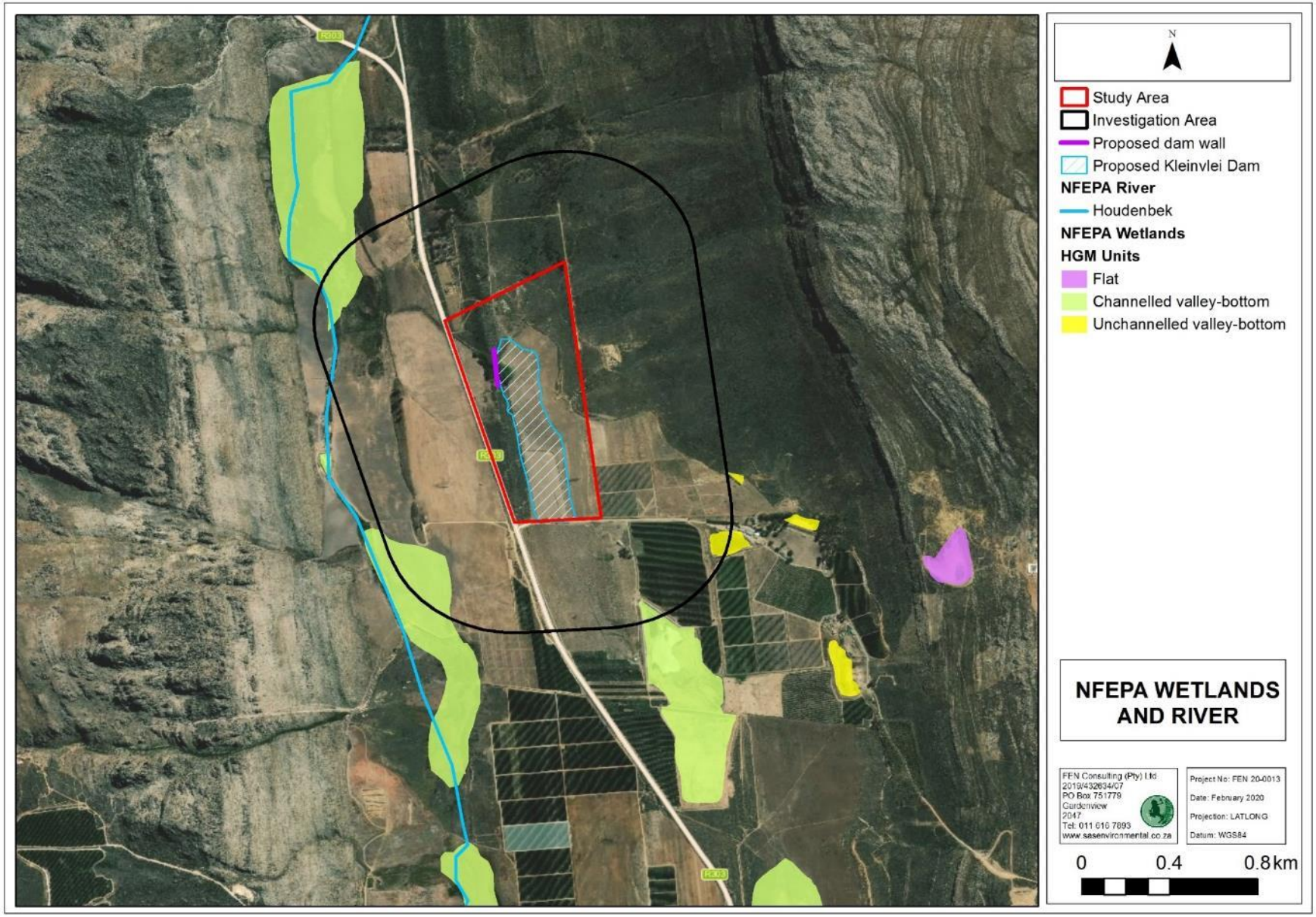


Figure 4: NFEPA identified HGM units associated with the study area, according to the NFEPA database (2011). The Houdenbek River is located to the west of the study area.

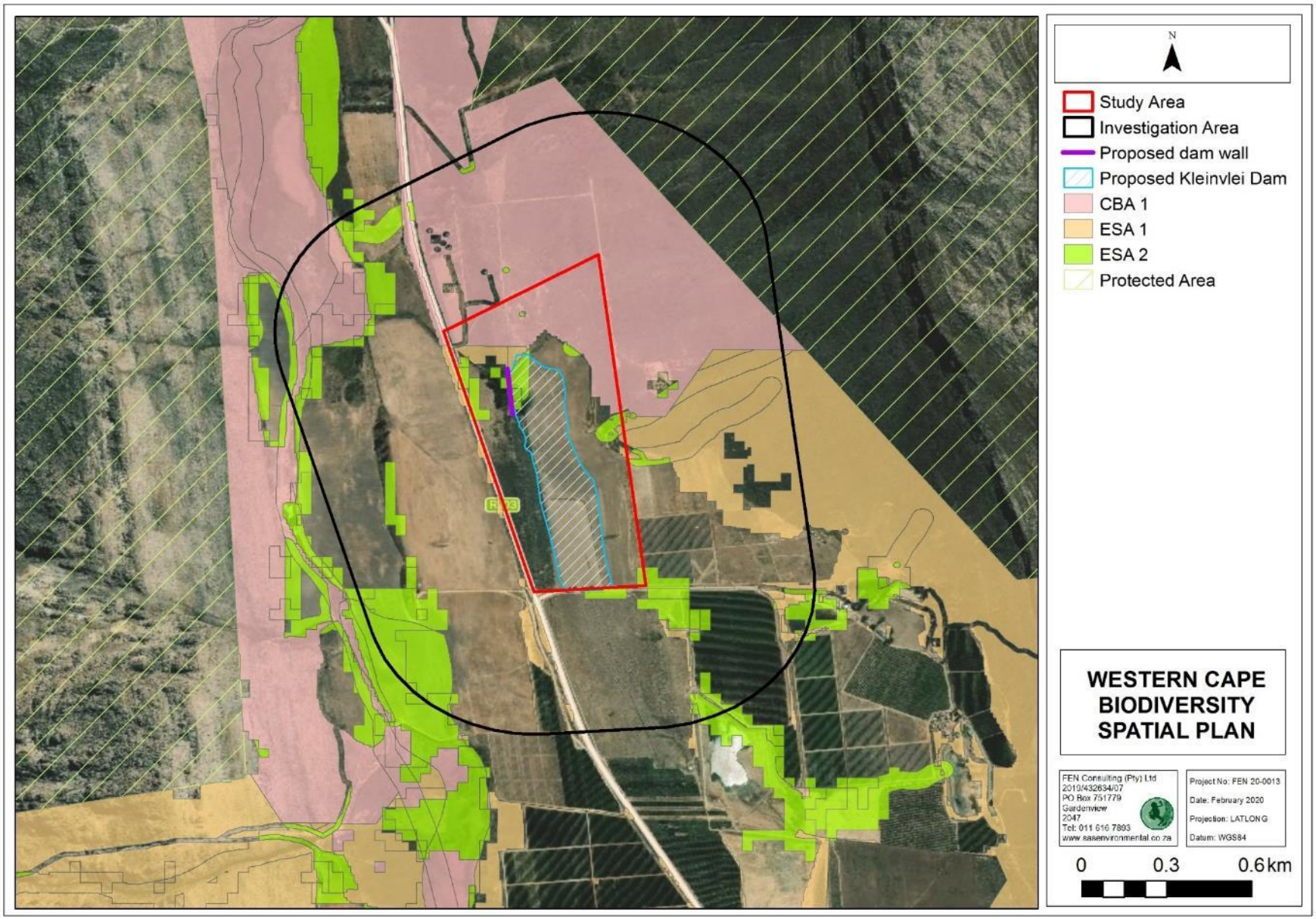


Figure 5: The areas of biodiversity importance identified to be associated with the study area, according to the Western Cape Biodiversity Spatial Plan (2017).

5 RESULTS: WATERCOURSE ASSESSMENT

In preparation for the field assessment, aerial photographs, digital satellite imagery and provincial and national watercourse databases (as outlined in Section 4 of this report) were used to identify points of interest in the surrounding area at a desktop level. Based on the historical aerial photograph (Figure 6), a diversity of signatures are identifiable that correspond with watercourses. In this regard, specific mention is made of the following:

- Linear features: since water flows/moves through the landscape, watercourses often have a distinct linear element to their signature which makes them discernible on aerial photography or satellite imagery;
- Vegetation associated with watercourses: a distinct increase in density as well as shrub size near flow paths;
- Hue: with water flow paths often show as white/grey or black and outcrops or bare soils displaying varying chroma created by varying vegetation cover, geology and soil conditions. Changes in the hue of vegetation with watercourse vegetation often indicated on black and white images as areas of darker hue (dark grey and black). In colour imagery these areas mostly show up as darker green and olive colours or brighter green colours in relation to adjacent areas where there is less soil moisture or surface water present; and
- Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions.

On review of the historical imagery dating back to 1949, a distinct drainage network can be identified east of the study area (Figure 6) flowing from the mountainous area (Sandberg) towards the Houdenbek River west of the study area. Due to the existing cultivation activities is the study area in 1949, as visible in Figure 6, it is expected that these episodic drainage lines were already altered to optimise the available area for cultivation practices.

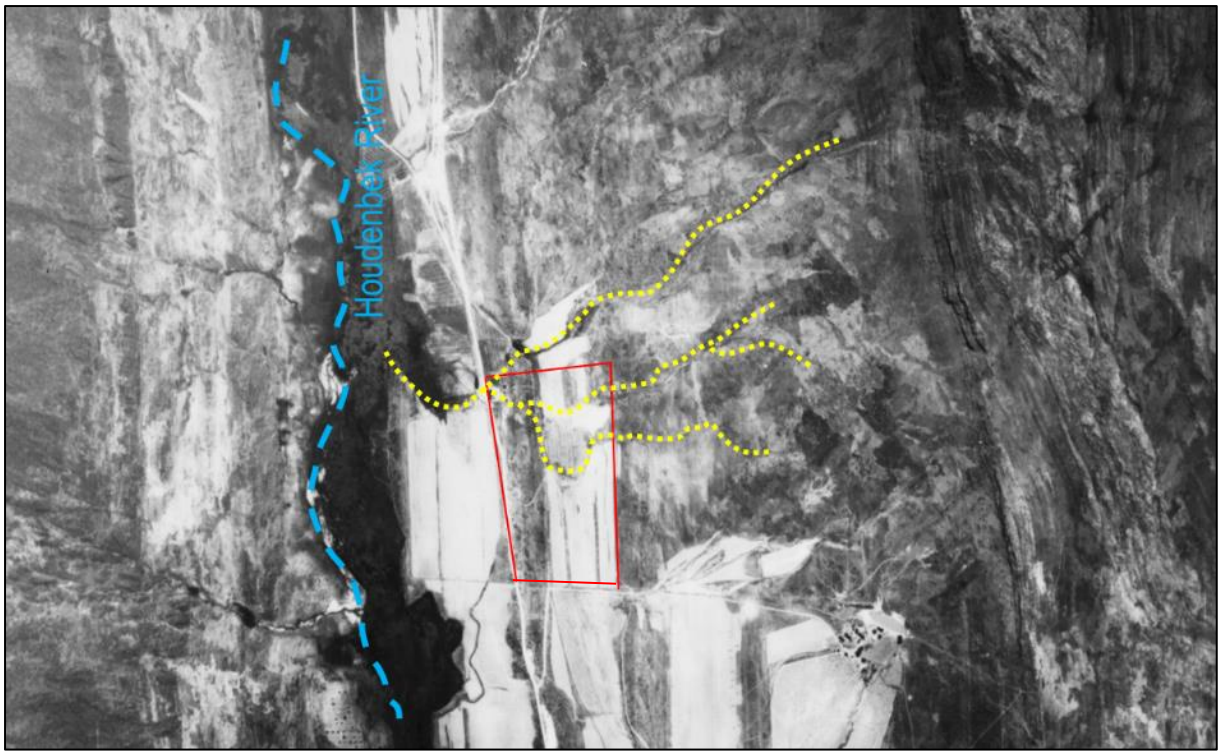


Figure 6: Historical imagery (1949) of the approximate footprint area of the study area (red outline) relative to the location of the episodic drainage lines (yellow dashed lines) (Job 226 Flight Plan 05359).

On review of the digital satellite imagery, circa 2019 (Figure 7), it is apparent that several channels have been constructed in the study area. These excavated channels were likely constructed to divert surface runoff from the mountainous area (west of the study area) around cultivated fields to prevent annual flooding of crops, through two ridges hosting poplar trees into the downgradient Houdenbek River (*Pers comm.* Mr. Theo van Rooyen, 2020 (proponent)).

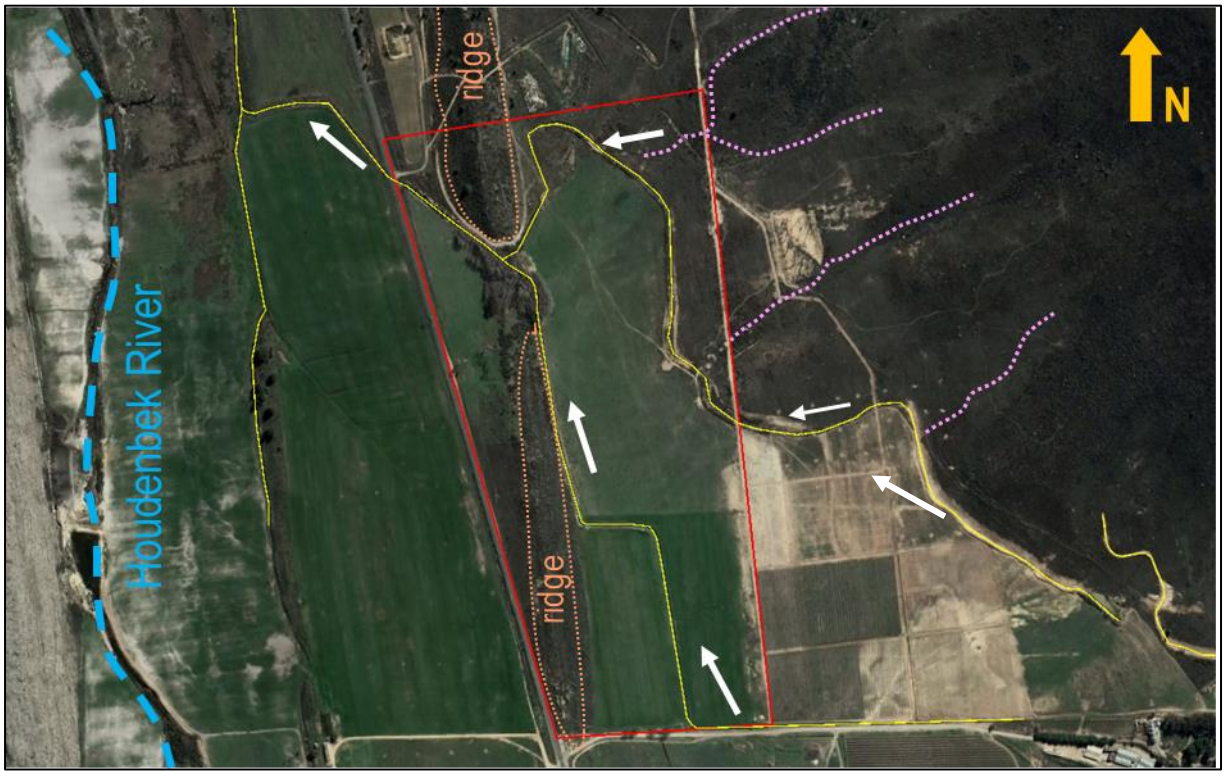


Figure 7: Digital satellite imagery (2019) of the locality of the excavated channels (yellow lines) in the study area (red outline). The purple dashed lines depict episodic drainage lines conveying surface runoff from the mountainous area into the excavated channels.

Considering the locality of the study area at the top of the E12D quaternary catchment (Figure 8), a limited volume of water would flow annually through the study area as per the information provided by the preliminary design report (Sarel Bester Ingenieurs, 2019), which was obtained from the Water Research Commission (WRC) Water Resources of South Africa study (2012) (Table 2).

Table 2: Characteristics of the E21D quaternary catchment relative to the local catchment of the proposed Kleinvlei Dam (Sarel Bester Ingenieurs, 2019).

	E21D Quaternary Catchment	Local catchment of the proposed Kleinvlei Dam
Area (km^2)	242	4.5
Mean Annual Rainfall (MAP) [mm]	627	627
Mean Annual Run-off (MAR) [mm]	193	193
Gross average run-off (MAR)[x 10^6 m^3]	46.71	0.87

Based on the historical photograph (Figure 6) and digital satellite imagery (Figure 7) and considering the hydrological characteristics of the study area as per Table 2 and Figure 8 below, it can be concluded that the volume of water flowing through the study area (historically through ephemeral drainage lines as shown in Figure 6, but currently diverted within the excavated channels that will remain unimpacted

by the proposed dam (Figure 7)), only contributes 1.8%[2] to the MAR of the downstream Houdenbek River and thus the loss of recharge that will be experienced is limited.

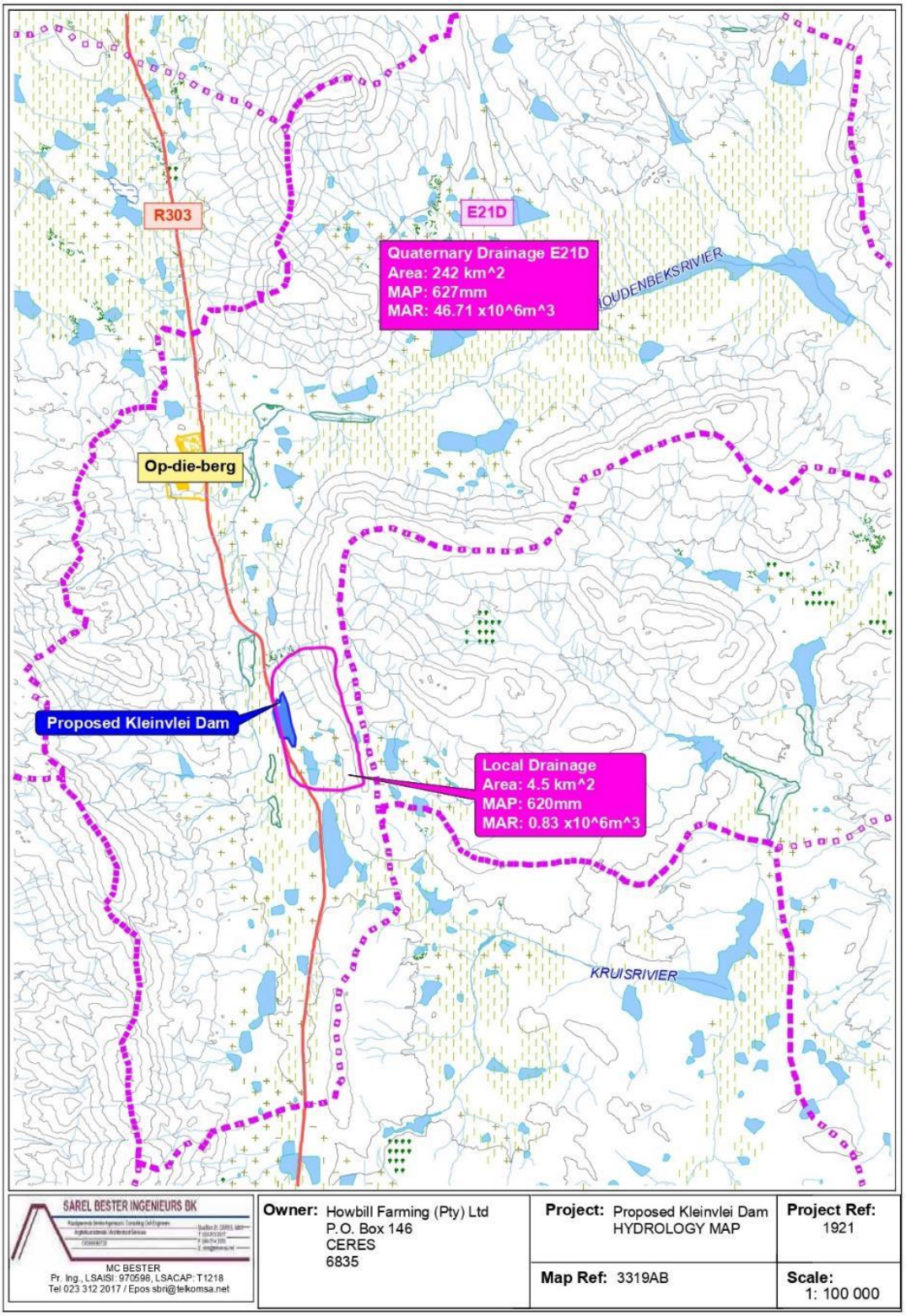


Figure 8: Characteristics of the E21D quaternary catchment relative to the local catchment of the proposed Kleinvlei Dam (Sarel Bester Ingenieurs, 2019).

[2] % MAR contribution = 0.87 (Local catchment of the proposed Kleinvlei Dam) / 46.71 (E21D Quaternary Catchment) * 100

On comparison of the earliest available digital satellite imagery (circa 2004) and imagery from 2018 of the study area, digital signatures that may potentially correspond to that of watercourses (Figure 9) are evident. It is expected that the identified signatures may correspond to the historical downstream extent of a drainage line, prior to the excavation of the channels which have hydrologically disconnected this portion from the upper reach of the episodic drainage line. Due to the irrigation of the agricultural fields and considering the slope of the area below the excavated channels (gentle slope facing west towards the Houdenbek River), irrigation runoff may potentially collect and flow into this remnant drainage line creating a more pronounced digital satellite signature. This area was investigated during the field assessment (full field verification results are presented in Section 5.1) and no watercourse indicators were identified (Figure 10).

Figure 9: Digital satellite imagery of the study area (red outline) from 2004 (left) and 2018 (right). The yellow arrow indicates digital signatures.

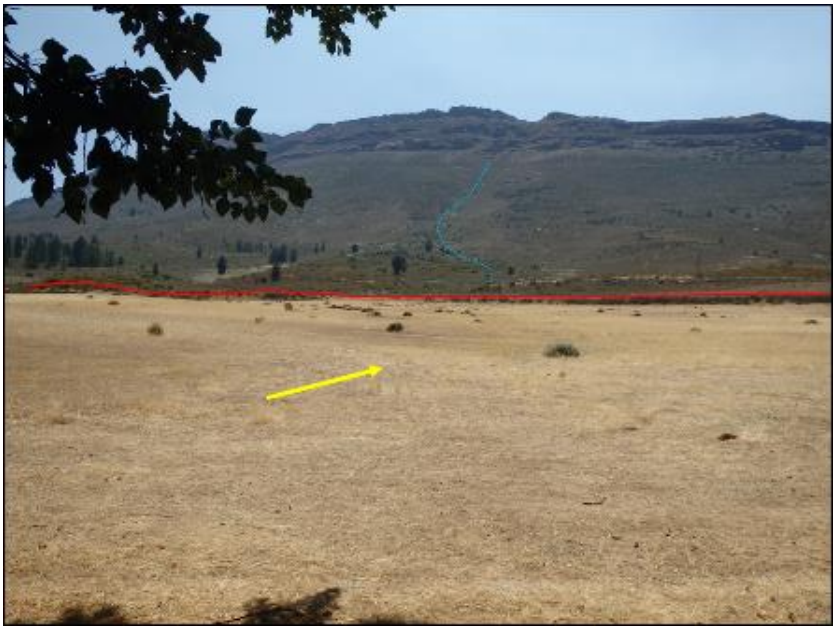


Figure 10: A photograph of the area (yellow arrow) which displayed wet response signatures on digital satellite imagery, but no wetland indicators were identified during the field investigation. Recharge from the drainage line (blue dashed line) is cut off from this area by the excavated channel (red line).

5.1 *Field verification results*

During the site visit undertaken on the 16th of January 2020, several episodic[1] drainage lines were identified in the eastern portion of the investigation area, conveying surface water into the excavated channels in the study area, which ultimately flow into the Houdenbek River, located to the west of the study area. Historically (prior to any land use transformation) these excavated channels were potentially functioning waterways (as part of the upstream drainage lines) which have become severely degraded as all indigenous vegetation has been removed, and the channels straightened to optimise the area for cultivation, to the point that they only function as artificial waterways, through episodic conveyance of water from the limited upgradient catchment area to the downstream Houdenbek River. Thus, these excavated channels do not receive and retain sufficient water to support a wetland response or sustain riparian characteristics, such as:

- Facultative or obligate wetland vegetation species:
  The excavated channel does not retain sufficient water to support wetland or riparian characteristics (such as facultative or obligate wetland vegetation; soils with prolonged and frequent saturation; no indication of a saturated soil zone within 50 cm of the soil surface and no significant change in structure and composition of bankside vegetation due to hydromorphological drivers). Clearance of excavated channels were noted, while other channels hosted well established terrestrial vegetation cover (Figure 11);

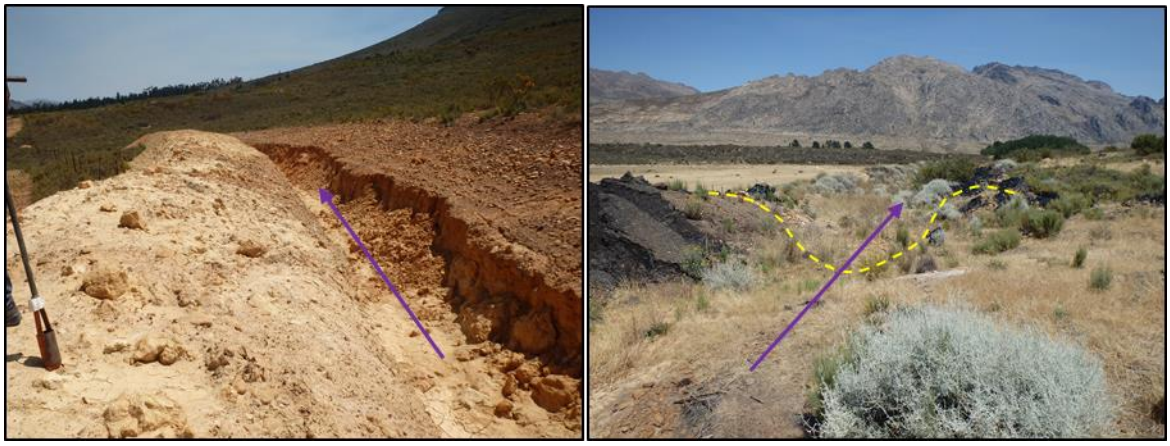


Figure 11: (Left) Clearance of excavated channels noted. (Right) some of the excavated channels are well vegetated, predominantly with terrestrial shrubs and graminoid species.

- Have a change in structure and composition of bankside vegetation due to hydromorphological drivers:
  Although there is a change from the vegetation species located within the excavated channels to that of the surrounding area, it is only due to the surrounding area being cultivated (all natural vegetation has been removed) and only graminoid and shrub species, which are not considered indicators of wetland conditions/riparian habitat, persist within the excavated channels. Thus, there are no distinct changes in structure from the vegetation within the drainage line to that of the surrounding area.
- Have soils with prolonged and frequent saturation:
  The soil profile associated with the excavated channels was investigated using a hand auger (Figure 11). Due to the clayey nature of soils in the area, it was only possible to auger to a depth of 20cm. This auger sample was uniform in colour (orange/brown) and did not show any

[1] "Highly flashy systems that flow or flood only in response to extreme rainfall events, usually high in their catchments. May not flow in a five-year period, or may flow only once in several years." (Uys and O'Keeffe, 1997, in Rossouw *et. al*, 2006).

redoximorphic features such as mottling or gleying (which is caused by prolonged saturated conditions in the soil and the subsequent development of anaerobic conditions).

The episodic drainage lines located outside of the study area were identified primarily due to prominent vegetation growth, due to thicket vegetation propagating in these drainage lines on the steep slope (Figure 12). This is mainly due to ideal microclimatic conditions, protection from fires etc. that these ravine areas provide, especially in gullies that provide protection from adverse weather conditions and reduce evaporation potential as a result of increased canopy cover.

Figure 12: A photograph depicting the upstream reaches of the episodic drainage lines (white dashed lines and arrows). These drainage lines are identifiable based on the increased density and size of vegetation in the drainage lines compared to that of the surrounding terrestrial areas.

The soil profile of the episodic drainage lines was investigated (Figure 13), which indicated that no redoximorphic characteristics are present and that the water moves longitudinally through the drainage lines during periods of rainfall. The soil profile consisted of a deep clay layer with finer material with cobbles above it. Alluvial soils consisting of fine silts with small rounded cobbles were also identified in drainage line (Figure 13).

Figure 13: (Left) the soil profile of an ephemeral drainage line. (Right) A soil auger sample taken in the episodic drainage line indicates the deposition of fine alluvium material with round cobbles.

It can be derived from the description of the drainage network associated with the study area as presented above, that the excavated channels lack the characteristics that define a wetland or river with associated riparian zone and as such the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the excavated channels in the study area was not deemed applicable. The upstream reaches of the episodic drainage lines associated with the surrounding mountainous area (upgradient from the proposed dam) are considered true watercourses. The excavated channels cannot be classified as watercourses from an ecological perspective due to the lack of saturated soils and wetland/riparian vegetation. However, based on the definition of a watercourse (see Section 3.1) water flows regularly or intermittently within these excavated channels, conveying water from the limited upgradient catchment area - from the episodic drainage lines - into the downgradient Houdenbek River. As such, they can be considered as watercourses due to their importance for hydrological functioning as they do function as waterways and therefore enjoy protection in terms of the National Water Act, 1998 (Act No. 36 of 1998).

Figure 14 below presents the locality of the excavated channels relative to the proposed Kleinvlei Dam footprint and the study area.

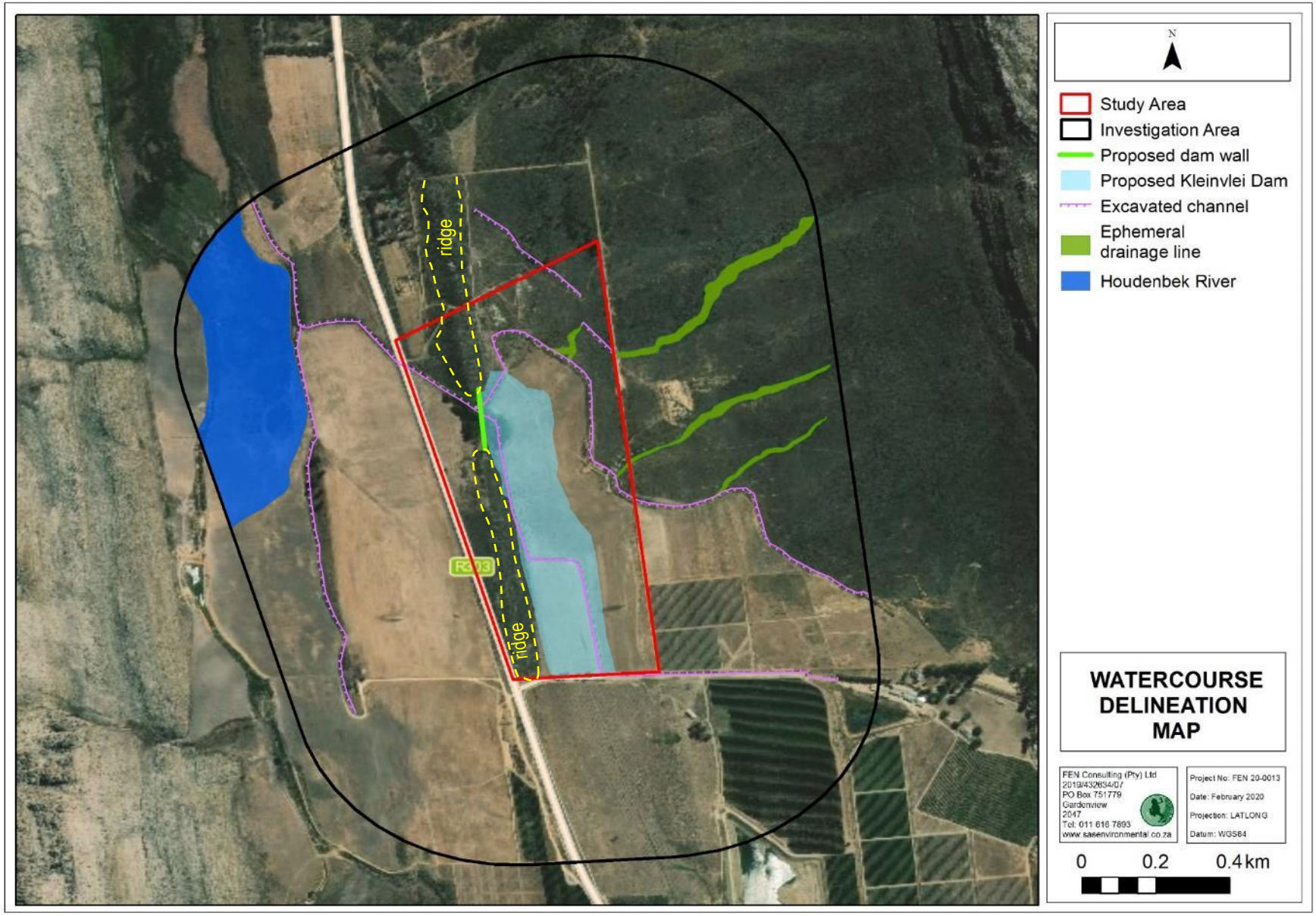


Figure 14: A map presenting the delineation of the watercourses identified relative to the proposed Kleinvlei Dam.

6 LEGISLATIVE REQUIREMENTS

The following legislative requirements were considered during the assessment. A detailed description of these legislative requirements is presented in **Appendix B** of this report:

- The Constitution of the Republic of South Africa, 1996[3];
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998).

According to Macfarlane *et al.* (2015) the definition of a buffer zone is variable, depending on the purpose of the buffer zone, however in summary, it is considered to be "a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another". Buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of aquatic and wetland ecological services), reduce impacts on watercourses arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015). It should be noted, however that buffer zones are not considered to be effective mitigation against impacts such as hydrological changes arising from stream flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

Although the excavated channels lack the characteristics that define a wetland or riparian systems, they can be considered as watercourses due to their importance for hydrological functioning as they do function as waterways and therefore enjoy protection in terms of the National Water Act, 1998 (Act No. 36 of 1998). Therefore the following legislative articles should be considered.

Table 3: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Water Use License Application for water uses as stipulated in Section 21(c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998).	**Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)** In accordance with GN509 of 2016 as it relates to the National Water Act, 1998 (Act 36 of 1998), a regulated area of a watercourse in terms of water uses as listed in Section 21c and 21i is defined as: • the outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; • in the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or • a 500m radius from the delineated boundary (extent) of any wetland or pan in terms of this regulation.

[3] Since 1996, the Constitution has been amended by seventeen amendment acts. The Constitution is formally entitled the 'Constitution of the Republic of South Africa, 19996". It was previously also numbered as if it were an Act of Parliament – Act No. 108 of 1996 – but since the passage of the Citation of Constitutional Laws Act, neither it nor the acts amending it are allocated act numbers.

Regulatory authorisation required	Zone of applicability
Listed activities in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA Regulations (2014), as amended.	**Activity 12** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended) states that: *The development of:* *(xii) Infrastructure or structures with a physical footprint of 100 square meters or more; Where such development occurs outside the urban edge—* *a) Within a watercourse;* *b) In front of a development setback; or* *c) If no development setback has been adopted, within 32 meters of a watercourse, measured from the edge of a watercourse.* Excluding- *…* *(dd) where such development occurs within an urban area;* *(ee) where such development occurs within existing roads, road reserves or railway line reserves; or* *(ff) the development of temporary infrastructure or structures where such infrastructure or structures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared.* **Activity 19** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA regulations, 2014 (as amended) states "*The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse.*"

The figure below presents the applicable Zones of Regulations (ZORs). Only the excavated channels connecting to the true watercourses (those between the episodic drainage lines and the Houdenbek River) were afforded ZORs since they are considered severely altered watercourses.

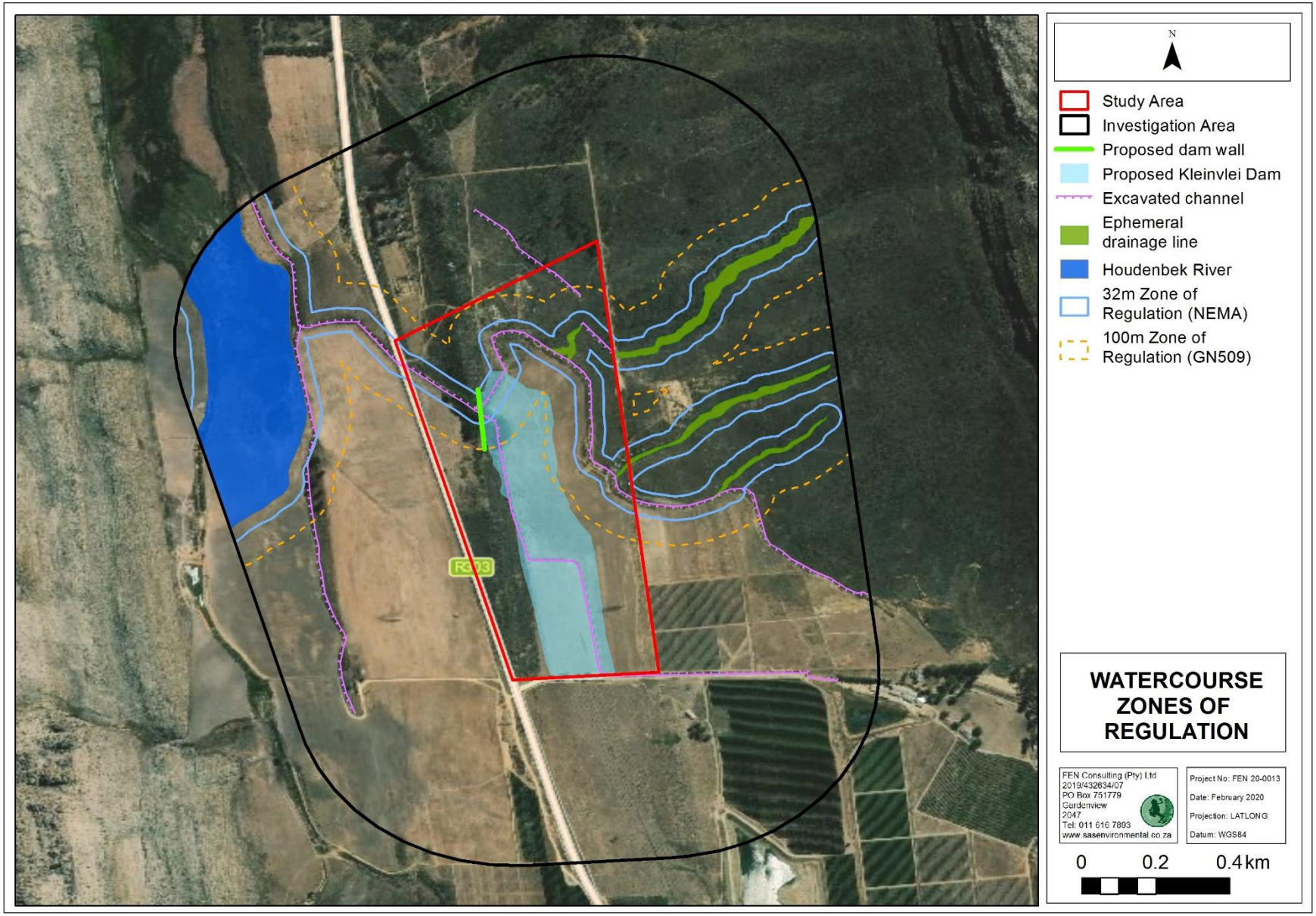


Figure 15: Watercourse delineation and associated 32m NEMA and 100m GN509 regulatory zones.

7 RISK ASSESSMENT

Although the excavated channels in the study area are not considered watercourses from an ecological perspective (but are regarded as watercourses due to their importance for hydrological functioning), the DWS specified Risk Assessment Matrix (as promulgated in GN509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)) was applied to ascertain the significance of risk associated with the proposed Kleinvlei Dam development on the key drivers and receptors (predominantly hydrological) of the downgradient Houdenbek River. Since the excavated channels are important for retaining hydrological connectivity between the upgradient episodic drainage lines and downgradient Houdenbek River, it was deemed relevant to undertake the risk assessment, albeit the risks are considered limited in nature.

The points below summarise the considerations undertaken:

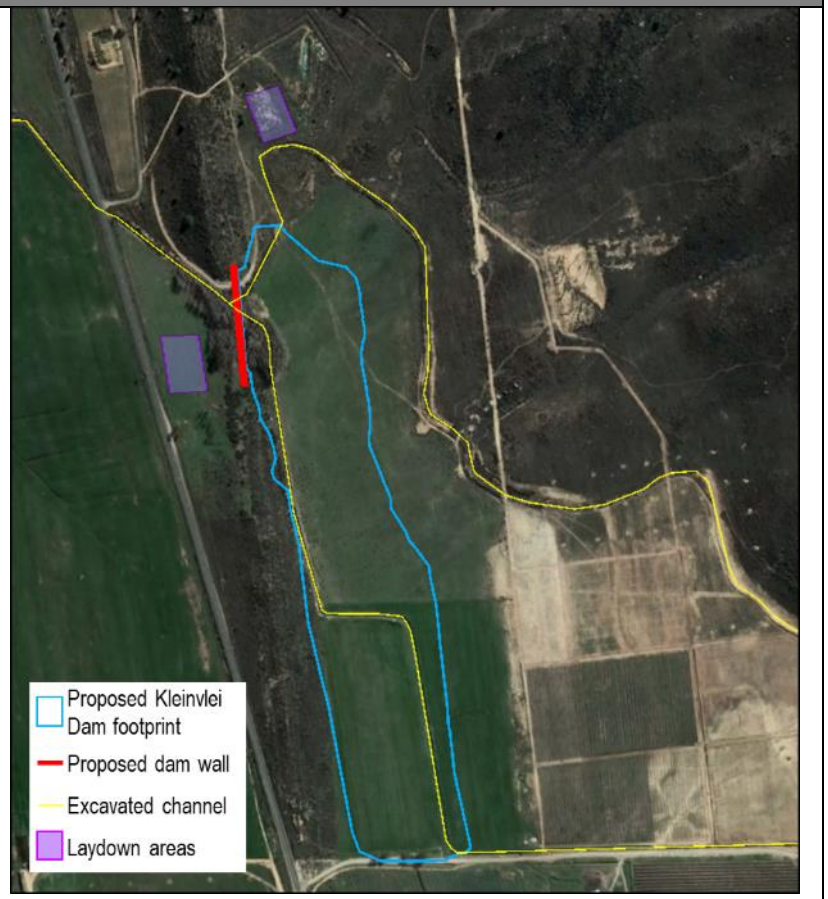
- The DWS risk assessment was applied assuming that a high level of mitigation measures is implemented, thus the results of the DWS risk assessment provided in this report presents the perceived impact significance ***post-mitigation***;
- Based on the footprint area of the proposed Kleinvlei Dam (Figure 15), the hydrological connectivity of the excavated channels, conveying catchment runoff from the upgradient episodic drainage lines to the Houdenbek River, will be lost as a result of the proposed Kleinvlei dam. All runoff from the upper catchment area will be stored within the dam;
- Since the upgradient catchment area is limited to 1.8% of the MAR and hydrological inputs from the upgradient episodic drainage lines are relatively limited (refer to Figure 8 as provided by Sarel Bester Ingenieurs, 2019), the need to release water for the EWR is undetermined. A hydrological investigation would need to be conducted to determine the volume of water entering the Kleinvlei Dam from the upgradient catchment and the relevant releases (should this be required by the relevant authorities) determined from the dam. It must be noted that the determination of the EWR did not part of the scope of works for this report;
- In applying the risk assessment, it was assumed that the mitigation hierarchy as advocated by the DEA *et al* (2013) would be followed, i.e. the impacts would first be avoided, minimised if avoidance is not feasible, rehabilitated as necessary and offset if required. The inundation of a portion of the excavated channels will occur as a result of the full supply level footprint for the Kleinvlei Dam will (Figure 15). The loss of the channels was not further assessed as they do not provide any ecological services;
- However, the proposed Kleinvlei Dam will impede the flow of water from the upgradient catchment to the downstream Houdenbek River, and therefore a maximum value of “5” for all legal issues was assigned;
- The activities and the associated risks they pose are all highly site-specific, not of a significant extent relative to the area of the watercourse assessed, and therefore have a limited spatial extent. The exception is possible risk of water contamination, however, if the dam is well managed, this risk is considered very low;
- While the operation and maintenance of the activities associated with the proposed Kleinvlei Dam development will be permanent, the construction thereof is envisioned to take no more than a few months. However, the frequency of the construction impacts may be daily during this time; and
- The considered mitigation measures are easily practicable.

7.1 *Risk Assessment Discussion*

The DWS Risk Assessment focussed primarily of the risk of the impacts to the hydrological functioning of the watercourse network associated with the study area. The results of the risk assessment are summarised in Table 4 below, including key mitigation measures for each activity that must be implemented in order to reduce the impacts of the dam development activities on the watercourse network as a whole, as summarised in Section 2 of this report.

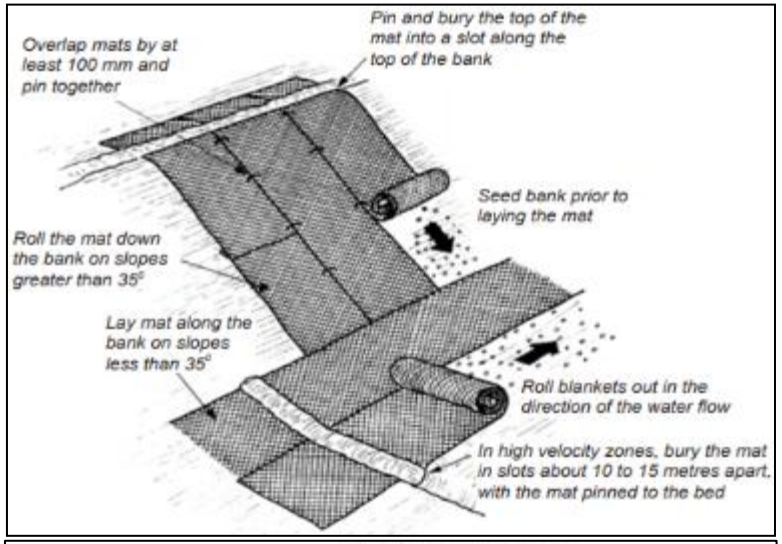
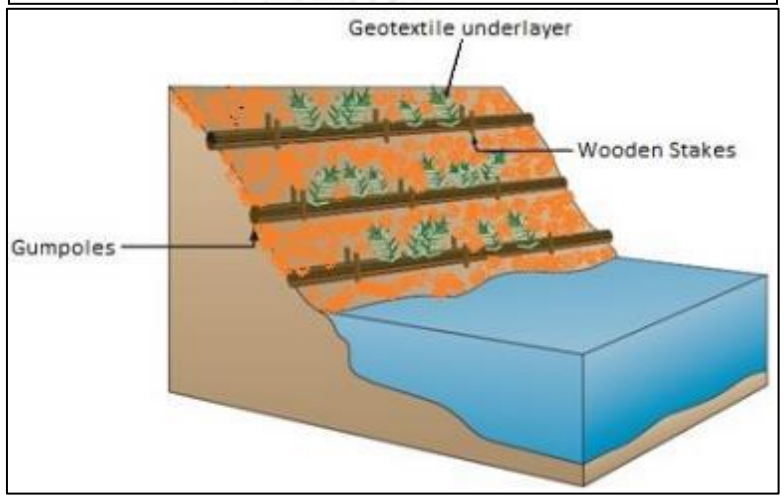
Table 4: Summary of the results of the DWS risk assessment of the proposed Kleinvlei Dam.

	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures
1	Construction Phase	Site preparation prior to construction activities (applicable to all proposed project activities)	Vehicular movement (transportation of construction materials) and access to the site.	*Transportation of construction materials can result in disturbances to soils, and increased risk of sedimentation/erosion; and *Soil and stormwater contamination from oils and hydrocarbons originating from construction vehicles.	1,25	3,25	13	42,25	L	*It is imperative that all construction works be undertaken during the dry, summer months as it is expected that surface runoff collected in the excavated channels will be minimal and no diversion of flow would be necessary and would prevent any indirect effects impacting on the downstream Houdenbek River; *Due to the accessibility of the site, no unnecessary crossing of the excavated channels may be permitted (with specific mention of the excavated channel section between the proposed dam wall and the R303 road). This will limit edge effects, erosion and sedimentation of the downstream excavated channel (the portion of channel between the proposed dam wall and the R303 crossing) which connects to the Houdenbek River; *Contractor laydown areas, vehicle re-fuelling areas and material storage facilities to remain outside of the excavated channels and may be located either south of the proposed dam wall or north east thereof but must be at least 10m away from the excavated channels (Figure 16). These localities and the access to them are considered to have the minimal edge effects on the downstream excavated channel; *The removal of the blue gum trees may potentially result in an increase of dust and sediments in the downstream excavated channel. Thus, sediment control devices (such as silt traps - Figure 17) should be constructed in the downstream excavated channel (just before the R303 road crossing culvert) prior to any vegetation clearing, if construction occurs during the wet winter season. This will prevent any blockages of the portion of excavated channel before the R303 road crossing; *All cleared vegetation must be stockpiled in a designated area, at least 10m from the excavated channels. Vegetation may not be disposed of in the excavated channels as this may cause blockages. During the removal of the blue gum trees, a temporary stockpile may be created directly east thereof (in the proposed dam footprint). Once all clearing activities has commenced all material must be disposed of at a registered garden refuse site and may not be burned or mulched on site; *Any topsoil removed must be stockpiled separately from all other materials, for use covering the new dam wall. Soil stockpiles may not be contaminated, and it must be ensured that the minimum surface area is taken up, however the stockpiles may not exceed 2m in height; *All exposed soils must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent dust generation resulting in vegetation smothering and sedimentation of the downstream excavated channel. This is especially important since the surrounding landscape is utilised for harvestable fruits/crops that may be sensitive to excessive dust.
2			Removal of vegetation and associated disturbances to soils.	*Removal of vegetation, including the large stand of poplar trees between the two ridges, leading to the exposure of soils; *These soils can be transported into the excavated channel (the portion of channel between the proposed dam wall and the R303 crossing) underneath the R303 road, causing sedimentation of the downstream Houdenbek River; *Any sheet runoff from the dam footprint area cleared of vegetation can cause erosion, resulting in a high sediment load entering the downstream excavated channel; *Proliferation of alien vegetation as a result of disturbances.	1,75	3,75	13	48,75	L	

	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures
										 **Figure 16: Proposed contractor laydown areas relative to the proposed dam wall and dam footprint area.**

	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures
										  **Figure 17: Examples of the installation of silt traps which could be used if necessary, during the construction phase, to limit additional sediment from entering the downstream excavated channel.**
3		Construction activities related to construction of the dam wall utilising excavated material from the basin of the proposed dam	*Excavation of dam basin to source fill material; *Stockpiling of material; *Infilling and compaction of the proposed dam wall footprint .	*Runoff from stockpiled material or sediment laden runoff from the construction footprint area could enter the excavated channel between the proposed dam wall and the R303 road and result in blockages; *Disturbance to vegetation and soils due to edge effects.	1,25	3,25	14	45,5	L	*On completion of the civil works for the construction of the dam wall, the wall must be covered with topsoil (removed during site preparation activities), specifically the crest and outer side; *Should additional topsoil be imported, it must be ensured that the topsoil used are weed-free to limit the establishment of alien and invasive vegetation species; *The slope of the dam wall may not exceed the maximum slope ratio of 3:1, and must be stabilised (on the western embankment of the dam wall) during the construction phase with the use of a geotextile product such as hessian or Geojute, which is to be staked to the surface of the dam wall slope while revegetation of the dam wall occurs; *The dam wall must be revegetated after the construction activities, to stabilize the soils and prevent erosion of the dam wall. A graminoid seed mixture (such as the MayFord Fynbos Biomosome seed mixture) can be used for this purpose, as it will allow for quick establishment.

	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures
4		Construction of an open side channel spillway against the northern bank of the dam wall	*Use of concrete within close proximity to the excavated channel; *Connecting the downstream excavated channel to the spillway outlet	*Potential negative impact on the water quality (if present); *Potential erosion of excavated channel	1,25	3,25	14	45,5	L	*The proposed spillway placement must connect with the downstream excavated channel that has a culvert below the R303; *No mixed concrete may be deposited outside of the designated construction footprint. The following recommendations must be adhered to: - Fresh concrete and cement mortar should not be mixed near the excavated channel. Preferably in the laydown area/construction camp, may not be mixed on bare soil, and must be within a lined, bound or bunded portable mixer. Consideration must be taken to use ready mix concrete; - No mixed concrete shall be deposited directly onto the ground within the excavated channel. A batter board or other suitable platform/mixing tray is to be provided onto which any mixed concrete can be deposited whilst it awaits placing; - A washout area must be designated outside of the excavated channel and dam footprint area, and wash water must be treated on-site or discharged to a suitable sanitation system. Wash water may not be discharged into the excavated channel without treatment; - Empty cement bags must be disposed of through the hazardous substance waste stream; - Concrete spillage outside of the demarcated area must be promptly removed and taken to a suitably licensed waste disposal site. *As a precautionary principle, it should be ensured that the spillway (when in use) does not cause erosion of the downstream excavated channel when water is flowing. As such, scour protection (either loose rocks or reno mattresses) must be placed at the base of the outlet to decrease the velocity of water and prevent erosion from occurring; *The inlet and outlet of the proposed spillway must be of equal width to allow water to enter the spillway and diffusely flow through the spillway and into the downstream excavated channel, without the flow being concentrated.
5	**Operational phase**	Operation of the dam	*First filling od dam to full supply level; *Potential foundation seepage of stored water into the downstream excavated channel and eventually into the Houdenbek River (positive impact); *Overflow of water over the spillway when the dam is at full capacity.	*Increase in the volume of water that may seep through the dam wall into the excavated channel (positive impact); *Erosion of the excavated channel where water enters the excavated channel from the spillway; *Potential increased sedimentation of the excavated channel due to erosion associated with the spillway.	1	6	8	48	L	*The dam and spillway should regularly be inspected for erosion, especially after heavy rainfall events when overflow form the dam is expected and the flow velocity is increased. If erosion is noted, this should be rectified, preferably reinstating vegetation in the eroded areas in the excavated channel. If erosion is pronounced, erosion control devices such as reno mattresses should be considered, in consultation with a freshwater ecological specialist; *If erosion is apparent on the dam wall, immediate measures such as strategic placement of hessian sheets or gum poles (Figure 18) or stabilisation with sandbags must be taken in order to prevent additional erosion from occurring; *The spillway and excavated channel must be maintained free of any debris and silt/sediment that could block the system.

	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures
										  **Figure 18: Use of hessian sheeting and gumpoles as a stabilisation method.**

	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures
6		Maintenance of the dam	Maintenance of the dam wall, including inspections, desilting and leak detection.	Desilting activities resulting in the: *Removal of vegetation; and *Earthworks and silt stockpiling, the runoff from which has the potential to increase silt loads within the downstream excavated channel.	1,25	3,25	9	29,25	L	Control measures applicable to this activity would be as per Activity 2 and 3 above. Additionally, the following is applicable: *During desilting, silt associated with the dam should immediately be removed in order to prevent sedimentation of the downstream excavated channel. Additionally, during desilting a temporary silt trap would be installed at the spillway and in the excavated channel. This would be emptied on a regular basis and not allowed to reduce the capacity of the dam.
7				In the event where a leak has been detected within the dam wall itself, impacts include: *An increase in water quantity downstream (potential seepage below dam wall) could cause extended periods of water saturation of the downstream excavated channel eliciting a wetland response; *Repair of a leak would entail the impacts as per Activity 2 and 3 above.	1,5	3,5	9	31,5	L	

Based on the outcome of the risk assessment, the proposed Kleinvlei Dam development is expected to have a low risk significance to the excavated channel and ultimately to the Houdenbek River, however, the loss of EWR (albeit limited volumes) must be verified by a suitably qualified hydrologist to ensure no significant loss of recharge to the Houdenbek River will occur which could pose a risk to the long term ecological functioning of the system. It is considered imperative that all works be undertaken during the drier summer months to limit surface water contamination and the need for any surface water diversion during the construction works. Should construction be scheduled for the winter rainy season, the construction of silt traps in the excavated channels prior to any construction activities will limit the impact of edge effects from occurring on the downstream Houdenbek River.

8 CONCLUSION

FEN Consulting was appointed to conduct a specialist watercourse assessment as part of the Environmental Authorisation (EA) and Water Use Licence Application (WULA) process for the proposed Kleinvlei Dam development.

During the site assessment undertaken in January 2020. Several ephemeral drainage lines were identified in the eastern portion of the investigation area (conveying surface water into excavated channels located in the study area, which ultimately flow into the Houdenbek River (located approximately 510m west of the study area). Historically (prior to any land use transformation) these excavated channels were potentially functioning watercourses (as part of the upgradient drainage lines, in the eastern portion of the investigation area) which have become severely degraded (as a result of removal of all indigenous vegetation and straightening of the channels to optimise the study area for cultivation) to the point that they only function as waterways, through episodic conveyance of water from the limited upgradient catchment area into the downstream Houdenbek River.

The upstream reaches of the episodic drainage lines associated with the surrounding mountainous area (upgradient from the proposed dam) are considered true watercourses. The excavated channels cannot be classified as watercourses from an ecological perspective due to the lack of saturated soils and wetland/riparian vegetation. However, based on the definition of a watercourse (see Section 3.1) water flows regularly or intermittently within these excavated channels, conveying water from the limited upgradient catchment area - from the episodic drainage lines - into the downgradient Houdenbek River. As such, they can be considered as watercourses due to their importance for hydrological functioning as they do function as waterways and therefore enjoy protection in terms of the National Water Act, 1998 (Act No. 36 of 1998).

Due to the lack of watercourse characteristics of the excavated channels, determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the excavated channels was not deemed applicable. Since the upgradient catchment area is limited to 1.8% of the MAR and hydrological inputs from the upgradient episodic drainage lines are relatively limited (refer to Figure 8 as provided by Sarel Bester Ingenieurs, 2019), the need to release water for the EWR is undetermined. A hydrological investigation would need to be conducted to determine the volume of water entering the Kleinvlei Dam from the upgradient catchment and the relevant releases (should this be required by the relevant authorities) determined from the dam. It must be noted that the determination of the EWR did not part of the scope of works for this report.

Since the excavated channels are important for retaining hydrological connectivity between the upgradient and downgradient natural watercourses, it was deemed relevant to undertake a risk assessment, albeit the quantum of risk is considered limited. The following summarises the risks associated with the proposed activities associated with the construction and operational phases:

Table 5: Summary of the DWS Risk Assessment outcomes.

Phases	Activity	Risk Rating
Construction Phase	Site preparation prior to construction activities (applicable to all proposed project activities) • Removal of vegetation, including the large stand of poplar trees between the two ridges, leading to the exposure of soils; • Exposed soils can be transported into the excavated channel underneath the R303 road, causing sedimentation of the downstream Houdenbek River; • Any sheet runoff from the dam footprint area cleared of vegetation can cause erosion, resulting in a high sediment load entering the downstream excavated channel; • Proliferation of alien vegetation as a result of disturbances.	L
	Construction activities related to construction of the dam wall utilising excavated material from the basin of the proposed dam. • Runoff from stockpiled material or sediment laden runoff from the construction footprint area could enter the excavated channel between the proposed dam wall and the R303 road and increase its sediment load; • Disturbance to vegetation and soils due to edge effects.	L
	Construction of an open side channel spillway against the northern bank of the dam wall • Potential negative impact on the water quality (if present); • Potential erosion of excavated channel.	L
Operational Phase	Operation of the dam.	L
	Maintenance of the dam.	L

Based on the findings of the watercourse assessment and the results of the impact assessment, it is the opinion of the ecologist that the proposed Kleinvlei Dam poses a **low risk to the integrity of the watercourses downgradient of the proposed dam development** provided that adherence to cogent, well-conceived and ecologically sensitive construction plans are implemented and the mitigation measures provided in this report as well as general good construction practice are adhered to.

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APPENDIX A: Indemnity and Terms of Use of this Report

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and FEN CC and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field or pertaining to this investigation.

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

APPENDIX B: Legislative Requirements

The Constitution of the Republic of South Africa, 1996	The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development. Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive normalization of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.
National Environmental Management Act, 1998 (Act No. 107 of 1998)	The National Environmental Management Act, 1998 (Act No. 107 of 1998) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
National Water Act , 1998 (Act No. 36 of 1998)	The National Water Act, 1998 (Act No. 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i). A watercourse is defined as: a) A river or spring; b) A natural channel in which water flows regularly or intermittently; c) A wetland, lake or dam into which, or from which water flows; and d) Any collection of water which the minister may, by notice in the Gazette, declare a watercourse.
Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act , 1998 (Act No. 36 of 1998)	In accordance with Government Notice (GN)509 of 2016, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: ➢ The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; ➢ In the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or ➢ A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice **replaces GN1199** and may be exercised as follows: i) Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation; ii) Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; iii) Do maintenance with their existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix; iv) Conduct river and storm water management activities as contained in a river management plan; v) Conduct rehabilitation of wetlands or rivers where such rehabilitation activities have a LOW risk class as determined through the Risk Matrix; and vi) Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.

APPENDIX C: Method of Assessment

1. Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and ecostatus of the larger aquatic system within which the watercourses and drainage line features present in close proximity of the proposed development are located. Aspects considered as part of the literature review are discussed in the sections that follow.

1.1 National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), DWA, South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

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

1.2 *Department of Water and Sanitation (DWS) Resource Quality Information Services Present Ecological State / Ecological Importance and Sensitivity (PES/EIS) Database (2014)*

The PES/EIS database as developed by the DWS RQIS department was utilised to obtain background information on the project area. The PES/EIS database has been made available to consultants since mid-August 2014. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, EWR sites and Hydro WMS sites. The results obtained serve to summarise this information as a background to the conditions of the watercourse traversed by the proposed linear development.

2. Classification System for Wetlands and other Aquatic Ecosystems in South Africa (2013)

All wetland or riparian features encountered within the study area was assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the "Classification System" (Ollis et. al., 2013). A summary on Levels 1 to 4 of the classification system are presented in the tables below.

Table C1: Classification System for Inland Systems, up to Level 3.

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

Table C2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4:HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems
From the classification system, Inland Systems are defined as **aquatic ecosystems that have no existing connection to the ocean**[4] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but **which are inundated or saturated with water, either permanently or periodically.** It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups
For Inland Systems, the regional spatial framework that has been included in Level 2 of the classification system is that of the DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et. al.,* 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

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

Level 3: Landscape Setting
At Level 3 of the classification system for Inland Systems, a distinction is made between four Landscape Units (Table C1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et. al.,* 2013):

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

Level 4: Hydrogeomorphic Units
Seven primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table C2), on the basis of hydrology and geomorphology (Ollis *et. al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and

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

- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley, but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et. al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et. al*., 2009).

3. Watercourse Delineation

For the purposes of this investigation, a wetland is defined in the National Water Act, 1998 (Act No. 36 of 1998) as "land which is transitional between terrestrial and aquatic systems where the water table is at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".
The wetland zone delineation took place according to the method presented in the DWAF (2005) document "A practical field procedure for identification and delineation of wetlands and riparian areas.

An updated draft version of this report is also available and was therefore also considered during the wetland delineation (DWAF, 2008). The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The position in the landscape, which will help identify those parts of the landscape where wetlands are more likely to occur;
- The type of soil form (i.e. the type of soil according to a standard soil classification system), since wetlands are associated with certain soil types;
- The presence of wetland vegetation species; and
- The presence of redoxymorphic soil feature, which are morphological signatures that appear in soils with prolonged periods of saturation.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF, 2005 and 2008).
Riparian and wetland zones can be divided into three zones (DWAF, 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant period of wetness (at least three months of saturation per annum) and the temporary zone surrounds the seasonal zone and is only saturated for a short period of saturation (typically less than three months of saturation per annum), but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

APPENDIX D: Risk Assessment Methodology

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

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

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation;
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[5]. The interaction of an aspect with the environment may result in an impact;
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is;
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems;
- **Resources** include components of the biophysical environment;
- **Frequency of activity** refers to how often the proposed activity will take place;
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor;
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards;
- **Spatial extent** refers to the geographical scale of the impact; and
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[6].

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act, 1998 (Act No. 107 of 1998) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

[5] The definition has been aligned with that used in the ISO 14001 Standard.

[6] Some risks/impacts that have low significance will however still require mitigation

"RISK ASSESSMENT KEY" (Based on DWS 2015 publication: Section 21 c and i water use Risk Assessment Protocol)

Table D1: Severity (How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.	

Table D2: Spatial Scale (How big is the area that the aspect is impacting on)

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

Table D3: Duration (How long does the aspect impact on the resource quality)

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
PES and EIS (sensitivity) must be considered.	

Table D4: Frequency of the activity (How often do you do the specific activity)

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Table D5: The frequency of the incident or impact (How often does the activity impact on the resource quality)

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table D6: Legal issues (How is the activity governed by legislation)

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

Table D7: Detection (How quickly or easily can the impacts/risks of the activity be observed on the resource quality, people and resource)

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table D8: Rating Classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

A low risk class must be obtained for all activities to be considered for a GA

Table D9: Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence X Likelihood

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for construction phase and operational phase; and
- Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status were assessed.

Control Measure Development

The following points presents the key concepts considered in the development of mitigation measures for the proposed construction:

- Mitigation and performance improvement measures and actions that address the risks and impacts[7] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
- Desired outcomes are defined and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the freshwater ecology of the resources in traversed by or in close proximity of the proposed infrastructure.

[7] Mitigation measures should address both positive and negative impacts

APPENDIX E: Risk Analysis and Mitigation Measures

General construction management and good housekeeping practices

Latent and general impacts which may affect the freshwater ecology and biodiversity, will include any activities which take place in close proximity to the proposed activities that may impact on the receiving environment. Mitigation measures for these impacts are highlighted below and are relevant to the watercourse identified in this report:

Development footprint

- All development footprint areas should remain as small as possible and should not encroach into watercourses unless absolutely essential and where project activities are located in the watercourses. It must be ensured that the watercourse habitat is off-limits to construction vehicles and non-essential personnel;
- The boundaries of footprint areas, including contractor laydown areas, are to be clearly defined and it should be ensured that all activities remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes (if applicable) should avoid watercourses and be restricted to existing roads where possible;
- Appropriate sanitary facilities must be provided for the life of the construction phase and all waste removed to an appropriate waste facility;
- All hazardous chemicals as well as stockpiles should be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage;
- No fires should be permitted in or near the construction area; and
- Ensuring that an adequate number of waste and “spill” bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Vegetation

- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) and Section 28 of the National Environmental Management Act, 1998 (Act No. 107 of 1998)) Removal of species should take place throughout the construction, operational, and maintenance phases; and
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas should be kept as small as possible when removing alien plant species*;* and
  - No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species.

Soils

- Sheet runoff from access roads should be slowed down by the strategic placement of berms;
- As far as possible, all construction activities should occur in the low flow season, during the drier summer months;
- As much vegetation growth as possible (of indigenous floral species) should be encouraged to protect soils;

- No stockpiling of topsoil is to take place within the recommended buffer zone around the watercourses (unless specified otherwise), and all stockpiles must be protected with a suitable geotextile to prevent sedimentation of the wetland;
- All soils compacted as a result of construction activities as well as ongoing operational activities falling outside of project footprint areas should be ripped and profiled; and
- A monitoring plan for the development and the immediate zone of influence should be implemented to prevent erosion and incision.

Rehabilitation

- Construction rubble/silt removed from the dam must be collected and disposed of at a suitable landfill site; and
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed development should be removed. Alien vegetation control should take place for a minimum period of two growing seasons after rehabilitation is completed.

Risk significance on the watercourse ecology of the study area

The table below serves to summarise the anticipated impacts that might occur during the construction and operational phases as well as the mitigation measures that must be implemented in order to maintain and enhance the ecological integrity of the resource.

Table F1: Risk Assessment outcomes for the proposed Kleinvlei Dam development

	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph & Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
1	Construction Phase	Site preparation prior to construction activities (applicable to all proposed project activities)	Vehicular movement (transportation of construction materials) and access to the site.	*Transportation of construction materials can result in disturbances to soils, and increased risk of sedimentation/erosion; and *Soil and stormwater contamination from oils and hydrocarbons originating from construction vehicles.	1	2	1	1	1,25	1	1	3,25	5	2	5	1	13	42,25	L
2			Removal of vegetation and associated disturbances to soils.	*Removal of vegetation, including the large stand of poplar trees between the two ridges, leading to the expose of soils; *These soils can be transported into the excavated channel underneath the R303 road, causing sedimentation of the downstream Houdenbek River; *Any sheet runoff from the dam footprint area cleared of vegetation can cause erosion, resulting in a high sediment load entering the downstream excavated channel; *Proliferation of alien vegetation as a result of disturbances.	1	2	3	1	1,75	1	1	3,75	5	2	5	1	13	48,75	L
3		Construction activities related to construction of the dam wall utilising excavated material from the basin of the proposed dam	*Excavation of dam basin to source fill material; *Stockpiling of material; *Infilling and compaction of the proposed dam wall footprint .	*Runoff from stockpiled material or sediment laden runoff from the construction footprint area could enter the excavated channel between the proposed dam wall and the R303 road and increase its sediment load; *Disturbance to vegetation and soils due to edge effects.	1	1	2	1	1,25	1	1	3,25	5	3	5	1	14	45,5	L

	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph & Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
4		Construction of an open side channel spillway against the northern bank of the dam wall	*Use of concrete within close proximity to the excavated channel ; *Connecting the downstream excavated channel to the spillway outlet	*Potential negative impact on the water quality (if present); *Potential erosion of excavated channel	1	2	1	1	1,25	1	1	3,25	5	3	5	1	14	45,5	L
5	Operational phase	Operation of the dam wall	*Potential foundation seepage of stored water into the downstream excavated channel and eventually into the Houdenbek River; *Overflow of water over the spillway when the dam is at full capacity.	*Increase in the volume of water that may seep through the dam wall into the excavated channel (positive impact); *Erosion of the excavated channel where water enters the excavated channel from the spillway; *Potential increased sedimentation of the excavated channel due to erosion associated with the spillway.	1	1	1	1	1	1	4	6	1	1	5	1	8	48	L
6		Maintenance of the dam.	Maintenance of the dam wall, including inspections, desilting and leak detection.	Desilting activities resulting in the: *Removal of vegetation; and *Earthworks and silt stockpiling, the runoff from which has the potential to increase silt loads within the downstream excavated channel .	2	1	1	1	1,25	1	1	3,25	1	2	5	1	9	29,25	L
7				In the event where a leak has been detected within the dam wall itself, impacts include: *An increase in water quantity could cause extended periods of water saturation of the downstream excavated channel ; *Repair of a leak would entail the impacts as per Activity 2 and 3 above.	2	2	1	1	1,5	1	1	3,5	1	2	5	1	9	31,5	L

APPENDIX F: Details, Expertise and Curriculum Vitae of Specialists

1. (a) (i) Details of the specialist who prepared the report

Kim Marais	BSc (Hons) Zoology (Herpetology) (University of the Witwatersrand)
Christel du Preez	MSc Environmental Sciences (North West University)

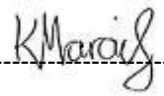
1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	SAS Environmental Gorup of Companies		
Name / Contact person:	Christel du Preez		
Postal address:	221 Riverside Lofts, Tygerfalls Boulevard, Bellville,		
Postal code:	7539	Cell:	071 413 2245
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	christel@sasenvgroup.co.za		
Qualifications	MSc Environmental Sciences (North West University)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Member of the South African Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Kim Marais, declare that -

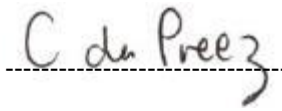
- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Christel du Preez, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



SAS ENVIRONMENTAL GROUP OF COMPANIES – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTEL DU PREEZ

PERSONAL DETAILS

Position in Company	Senior Scientist Watercourse ecology
Joined SAS Environmental Group of Companies	2016

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Professional member of the South African Council for Natural Scientific Professions (SACNASP)

Member of the Western Cape Wetland Forum (WCF)

Member of the Gauteng Wetland Forum (GWF)

EDUCATION

Qualifications

MSc Environmental Sciences (North West University)	2017
BSc Hons Environmental Sciences (North West University)	2012
BSc Environmental and Biological Sciences (North West University)	2011

Short Courses

Wetland and Aquatic plant Identification presented by Carin van Ginkel	2019
Wetland Management: Introduction and Delineation presented by the Centre of Environmental Management University of the Free State	2018
Tools for Wetland Assessment presented by Prof. F. Ellery and Rhodes University	2017
Basic Principles of ecological rehabilitation and mine closure presented by the Centre for Environmental Management North West University	2015

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Limpopo, Western Cape, Northern Cape, Eastern Cape

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan

SAS ENVIRONMENTAL GROUP OF COMPANIES – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF KIM MARAIS

PERSONAL DETAILS

Position in Company	Senior Scientist Water Resource Manager
Joined SAS Environmental Group of Companies	2015

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Professional member of the South African Council for Natural Scientific Professions (SACNASP – Reg No. 117137/17)
Member of the Western Cape Wetland Forum (WCWF)

EDUCATION

Qualifications

BSc (Hons) Zoology (University of the Witwatersrand)	2012
BSc (Zoology and Conservation) (University of the Witwatersrand)	2011

Short Courses

Aquatic and Wetland Plant Identification (Cripsis Environment)	2019
Tools for Wetland Assessment (Rhodes University)	2018
Certificate in Environmental Law for Environmental Managers (CEM)	2014
Certificate for Introduction to Environmental Management (CEM)	2013

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Biodiversity Action Plans (BAP)
- Alien and Invasive Control Plans (AICP)
- Faunal Eco Scans
- Faunal Impact Assessments

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Watercourse Maintenance and Management Plans
- Freshwater Offset Plan

Aquatic Ecological Assessment and Water Quality Studies

- Riparian Vegetation Integrity (VEGRAI)
- Water quality Monitoring
- Riverine Rehabilitation Plans

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions
- Public Participation processes