Draft Freshwater Assessment:

Silo's Cemetery (Remaining Extent Erf 71 of 158), Ashton, Western Cape

Prepared for:

Langeberg Municipality

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Date: December 2018

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Executive Summary

The Langeberg Municipality (the proponent) proposes establishment of a 7ha memorial park on a portion of the remaining extent of erf 71 of 158, (Erf RE71/158) Ashton, Western Cape which is approximately 83.3ha in extent. Freshwater features have been documented by the Western Cape Biodiversity Spatial Plan (WCBSP, 2017) and National Geospatial Information Service (NGI) within the property, including a non-perennial drainage line which traverses the south-eastern portion of the property. Noteworthy existing infrastructure within the site includes the 1.71ha Silo's cemetery, the approximate 4.62ha waste water treatment plant, and a small-scale cattle farm in the centre of the property. A portion of the north-eastern corner of the erf has recently been cleared and levelled, presumably for future construction.

EnviroSwift Western Cape was therefore been appointed to undertake a specialist assessment of the freshwater features within Erf RE/71/158 to firstly inform the layout and location of the proposed development, and secondly to inform the Basic Assessment and Water Use Authorisation application for the proposed development. Since initial findings were provided to the proponent, two possible layouts have been proposed, and both were assessed.

Desktop Assessment

The remaining extent 71 of erf 158 (study area) lies in the Southern Folded Mountains ecoregion within the Breede Water Management Area (WMA) and the H30E quaternary catchment. It is characterised by Vulnerable Breede Shale Renosterveld and small tracts of Endangered Breede Alluvium Renosterveld and Muscadel Riviere terrestrial vegetation types (Mucina & Rutherford, 2012); and Critically Endangered East Coast Shale Renosterveld with small tracts of Critically Endangered East Coast Alluvium Renosterveld and Vulnerable Rainshadow Valley Karoo wetland vegetation types (National Freshwater Ecological Priority Areas - NFEPA, 2011).

NFEPA (2011) indicates the presence of an artificial unchanneled valley-bottom wetland, an artificial floodplain wetland, and a natural floodplain wetland within 500m of the study area. In addition, the NGI indicates four non-perennial drainage lines and two perennial rivers.

The WCBSP (2017) highlights a number of features within several spatial biodiversity categories. The study area is dominated by Type 1 Terrestrial Critical Biodiversity Areas (CBA 1) features, with tracts of Aquatic CBA 1. The aquatic CBA 1 features are further classified as wetland. Elements of Type 1 and Type 2 aquatic Ecological Support Areas (ESA 1 and ESA 2) features are also indicated and classified as watercourses.

Freshwater Assessment Results

Five watercourses were identified and delineated including a recently excavated artificial drainage channel (A), a formal stormwater canal system (B), a remnant portion of a natural drainage line (C), now fed almost entirely by a sewage works and continuously overflowing cattle trough, a remnant portion of natural drainage line (D) that has been cut off from its catchment, partially infilled and no longer function as a drainage line, and one artificial wetland area (E) that is, in the opinion of the specialist, entirely unnatural.

Watercourse D was found to no longer function as a watercourse and cannot in the opinion of the specialist be reinstated given the scale of the changes in the catchment and watercourse and is therefore, in the opinion of the specialist, no longer a watercourse. Watercourse E was also found to be unnatural given its conspicuous absence from aerial photographs from before 2012.

The resultant delineations for RE/71/158 are presented below:

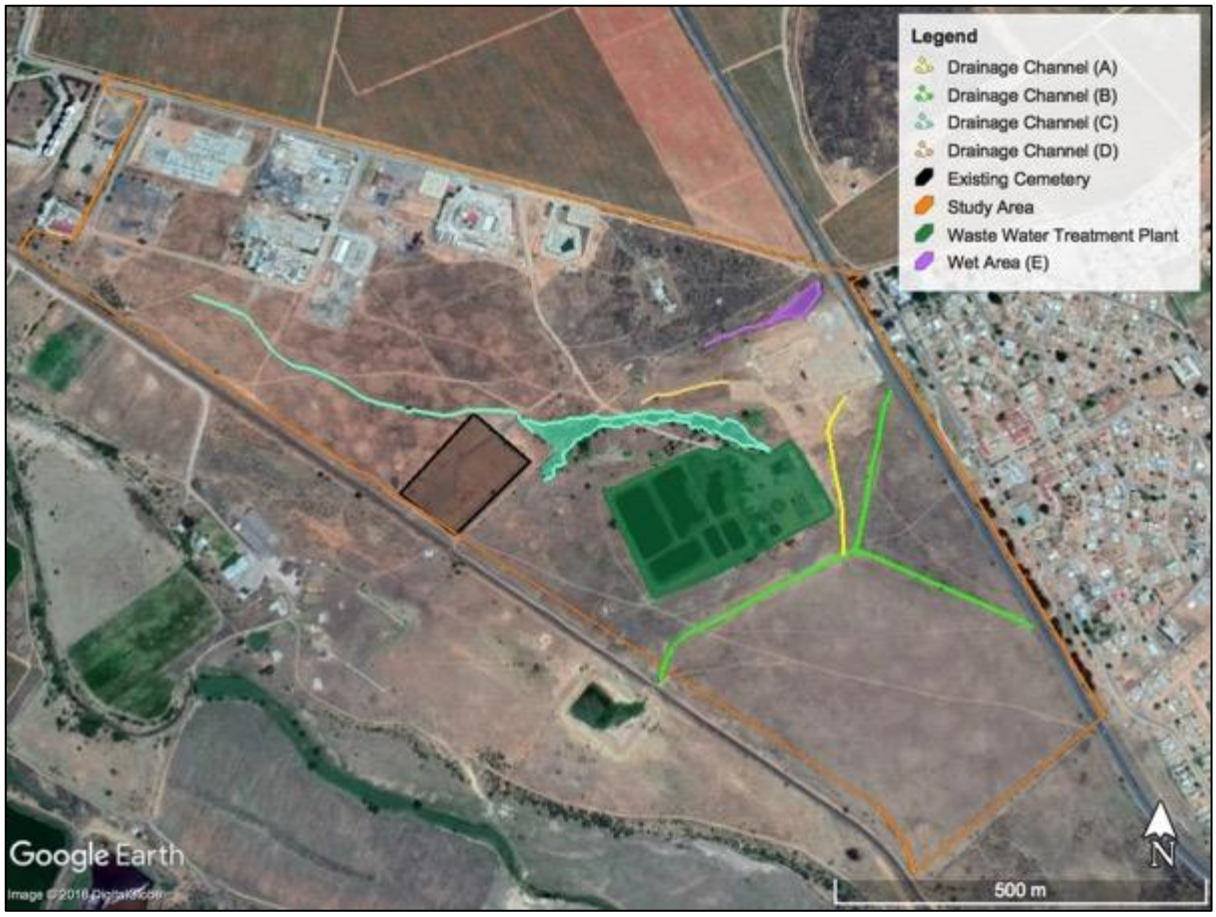

Figure A: Freshwater feature delineations on RE/71/158, Ashton.

Only watercourse C falls within the proposed layouts and none of the other watercourses identified are likely to be impacted in any way by the proposed development. Watercourse C was found to fall within a Category F since its entire catchment has been diverted into stormwater canal B and even the local catchment has been cut off by construction of elevated banks. A buffer of 15m was determined by best practice methods to be appropriate for this watercourse in its present state.

The only water supply to watercourse C comes from WWTW overflow and a drinking trough that overflows continually. Although the two water sources supply more water than would have naturally been available, resulting in the formation of artificial riparian and wetland habitat. Neither water source is sustainable however and the habitat will most likely be lost whether or not the development goes ahead. It is not possible to re-establish the historical flow from the catchment as the degree of catchment hardening would result in severe erosion within the watercourse and would not be sufficient to increase the PES beyond a category F. The REC was therefore confined to Category F.

Impact Assessment

Four impacts were assessed given the Preferred and Alternative Layouts, with and without essential mitigation measures applied. The results are presented in the table below:

Table A: Impact Assessment Results

Impact I: Impact on the Flow Regime					
	Intensity	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**
Construction Phase – Preferred Layout					
Without mitigation	Very Low	Local	Short term	Very Low	Very Low (-ve)
With mitigation	Very Low	Local	Short term	Very Low	Very Low (-ve)
Construction Phase – Alternative Layout					

Without mitigation	Very Low	Local	Short term	Very Low	Very Low (-ve)
With mitigation	Very Low	Local	Short term	Very Low	Very Low (-ve)
Operational Phase - Preferred Layout					
Without mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
With mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
Operational Phase - Alternative Layout					
Without mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
With mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
Impact 2: Impact on Water Quality					
Alternatives	**Intensity**	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**
Construction Phase					
Preferred Layout	Very Low	Local	Short Term	Low	Very Low (-ve)
Alternative Layout	Very Low	Local	Short Term	Low	Very Low (-ve)
Operational Phase					
Without mitigation	Very Low	Local	Short Term	Medium	Very Low (-ve)
With mitigation	Very Low	Local	Short Term	Medium	Very Low (-ve)
Impact 3: Impact on Riparian Habitat					
Alternatives	**Intensity**	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**
Construction Phase					
Preferred Layout	Low	Local	Short term	Very Low	Very Low (-ve)
Alternative Layout	Very Low	Local	Short term	Very Low	Very Low (-ve)
Operational Phase					
Preferred Layout	Not Applicable				
Alternative Layout	Not Applicable				
Impact 4: Impact on Biota					
Alternatives	**Intensity**	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**
Construction Phase					
Preferred Layout	Low	Local	Short term	Very Low	Very Low (-ve)
Alternative Layout	Very Low	Local	Short term	Low	Very Low (-ve)
Operational Phase					
Preferred Layout	Very Low	Local	Long term	Very Low	Very Low (-ve)
Alternative Layout	Very Low	Local	Long term	Very Low	Very Low (-ve)
	Intensity	Extent	Duration	Probability of impact occurring	Significance
'No Go Scenario'	Very Low	Local	Permanent	Definite	Very Low (-ve)

No cumulative or indirect impacts were identified.

Conclusion and Recommendation

Watercourse C is being kept alive by artificial water sources that are not sustainable and the watercourse will, in the opinion of the specialist, cease to exist as soon as the planned upgrade of the WWTW happens and the overflowing drinking trough tap is turned off. Impacts to this watercourse are therefore of only transient importance. The apparent ecological advantage of the Alternative Layout therefore in enclosing the watercourse in parkland is of no freshwater significance as the artificially sustained watercourse will soon cease to exist.

The potential impact of leachate from graves on the Sarahsrivier and its floodplain wetlands downslope was also assessed. Given that the proposed sites for the two layouts do not produce runoff that enters the Sarahsrivier, that floodplain wetlands are usually supplied primarily by the river and not by groundwater or interflow, given that the railway line between the river and the proposed sites forms a substantial barrier to subsurface flow and given the phased installation of graves over several years, it is unlikely that much leachate will reach the Sarahsrivier over 400m away, if at all. The impact

significance for this potential impact was therefore found to be Very Low (negative) regardless of the layout.

There is therefore no material difference between the two proposed layouts in terms of freshwater constraints and both layouts were found to be of Very Low (negative) impact for every impact assessed, with or without mitigation where mitigation has been provided. The provided mitigation measures will reduce impact however within the Very Low category, and it is therefore recommended that the proposed development be approved on condition that the proposed mitigation measures be implemented.

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Disclaimer

EnviroSwift (Pty) Ltd has exercised all due care in the reviewing of all available information. The freshwater assessment provided is entirely reliant on the accuracy and completeness of the provided specialist studies as well as professional judgement. EnviroSwift (Pty) Ltd does not accept responsibility for any errors or omissions in the assessment and therefore does not accept any consequential liability arising from commercial decisions made, which are based on the information contained in this report. Opinions presented in this report apply to conditions/site conditions applicable at time of review and those conditions which are reasonably foreseeable.

Glossary[1]

Alluvial soil: A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.

Biodiversity: The number and variety of living organisms on earth, the millions of plants, animals 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 contributing to runoff at a particular point in a river system.

Chroma: The relative purity of the spectral colour which decreases with increasing greyness.

Critical Biodiversity Areas: Areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services.

Delineation (of a wetland): To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.

Ecoregion: A recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region.

Ephemeral stream: A stream that has transitory or short-lived flow.

Groundwater: Subsurface water in the saturated zone below the water table.

Habitat: The natural home of species of plants or animals.

Hue (of colour): The dominant spectral colour.

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).

Hydrology: The study of the occurrence, distribution and movement of water over, on and under the land surface.

Hydrophytes: Also called obligate wetland plants - plants that are physiologically bound to water where at least part of the generative cycle takes place in the water or on the surface.

Halophytes: Salt tolerant plants.

[1] Adapted from DWA (2005) and WRC Report No. TT 434/09.

Helophytes: Also called facultative wetland plants - essentially terrestrial plants of which the photosynthetically active parts tolerate long periods of submergence or floating on water.

Indicator species: A species whose presence in an ecosystem is indicative of particular conditions (such as saline soils or acidic waters).

Intermittent flow: Flows only for short periods.

Macrophyte: A large plant - in wetland studies usually a large plant growing in shallow water or waterlogged soils.

Perennial: Permanent - persisting from year to year.

Riparian area delineation: The determination and marking of the boundary of the riparian area.

Riparian habitat: Includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils (deposited by the current river system) 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 areas.

Shrub: A shrub is a small to medium-sized woody plant.

Temporary zone: The zone that is alternately inundated and exposed.

Terrain unit morphological classes: Areas of the land surface with homogenous form and slope.

Watercourse (NWA):

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

Water table: The upper surface of groundwater or that level below which the soil is saturated with water. The water table feeds base flow to the river channel network when the river channel is in contact with the water table.

Wetland: An area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

Acronyms

CCT City of Cape Town
CBA Critical Biodiversity Area
DWA Department of Water Affairs
DWAF Department of Water Affairs and Forestry
DWS Department of Water and Sanitation
EIS Ecological Importance and Sensitivity
FEPA Freshwater Ecological Support Area
GPS Global Positioning System
HGM Hydrogeomorphic
IHI Index of Habitat Integrity
IHIA Intermediate Habitat Integrity Assessment
MAP Mean Annual Participation
NEMA National Environmental Management Act
NFEPA National Freshwater Ecosystem Priority Areas
NWA National Water Act
OESA Other Ecological Support Area

PES Present Ecological State
QDS Quarter Degree Square
REC Recommended Ecological Category
SANBI South African National Biodiversity Institute
Sub-WMA Sub - Water Management Area
VEGRAI Riparian Vegetation Response Assessment Index
WCBF Western Cape Biodiversity Framework
WMA Water Management Area
WUL Water Use Licence

Specialist Details and Experience

Joshua Gericke (Pr.Sci.Nat. 117997)

Joshua holds a Bachelor of Science Honours degree in Environmental Management from the University of Cape Town and graduated in 2008. He has completed several short courses in freshwater, estuarine and coastal resource management and in identification of freshwater and marine fish, birds and plants. He has more than 8 years of experience in management of freshwater, estuarine and coastal systems with the City of Cape Town. He has also consulted periodically on topics related to freshwater, estuarine and coastal ecology and management since 2010, and in 2017 began consulting full time.

Jocelyn Anderson (Cand.Sci.Nat. Registration pending)

Jocelyn graduated from the University of Cape Town with a Bachelor of Science degree in Applied Biology, and Ecology & Evolution. She later went on to complete her honours in Environmental Management from the University of South Africa. Jocelyn has just over two years of experience working in the nature conservation field where she has honed her bird and plant identification skills. Jocelyn began consulting part-time in the beginning of 2018 and has working experience in wetland assessments, wetland delineations, and risk assessments.

1 Introduction

1.1 Project Background

The Langeberg Municipality (the proponent) proposes establishment of a memorial park on the Remaining Extent 71 of Erf 158 (Erf RE/71/158 – refer to Figure 1 for location), Ashton, Western Cape which is approximately 83.3ha in extent. Noteworthy existing infrastructure within the site includes the 1.71ha Silo's cemetery, the approximate 4.62ha wastewater treatment works (WWTW), and a small-scale cattle farm in the centre of the property. A portion of the north-eastern corner of the erf has recently been cleared and levelled, presumably for future construction.

Watercourses have been indicated by the Western Cape Biodiversity Spatial Plan (WCBSP, 2017) and National Geographical Information (NGI) service data sets, including a non-perennial drainage line which traverses the south-eastern portion of the property, and the floodplain wetland of the Sarahsrivier within 500m of the proposed site. EnviroSwift Western Cape was therefore been appointed to undertake a freshwater specialist assessment of the freshwater features within Erf RE/71/158 (study area) to firstly inform the layout of the development and selection of the proposed site within the study area, and secondly to inform the Basic Assessment and Water Use Authorisation application for the proposed development.

After the initial findings were presented to the proponent, two layouts were proposed, each including a slightly different but largely overlapping proposed site within the study area, both incorporating the existing cemetery. The alternative layout includes 7ha of conventional graves and 3ha of parkland. The graves and parkland do not however allow room for expansion of the WWTW, and the preferred layout allows approximately 2.5ha of room for expansion of the WWTW and includes 7.5ha of graves and no parkland. Both layouts were assessed. Refer to Figures 2 and 3.

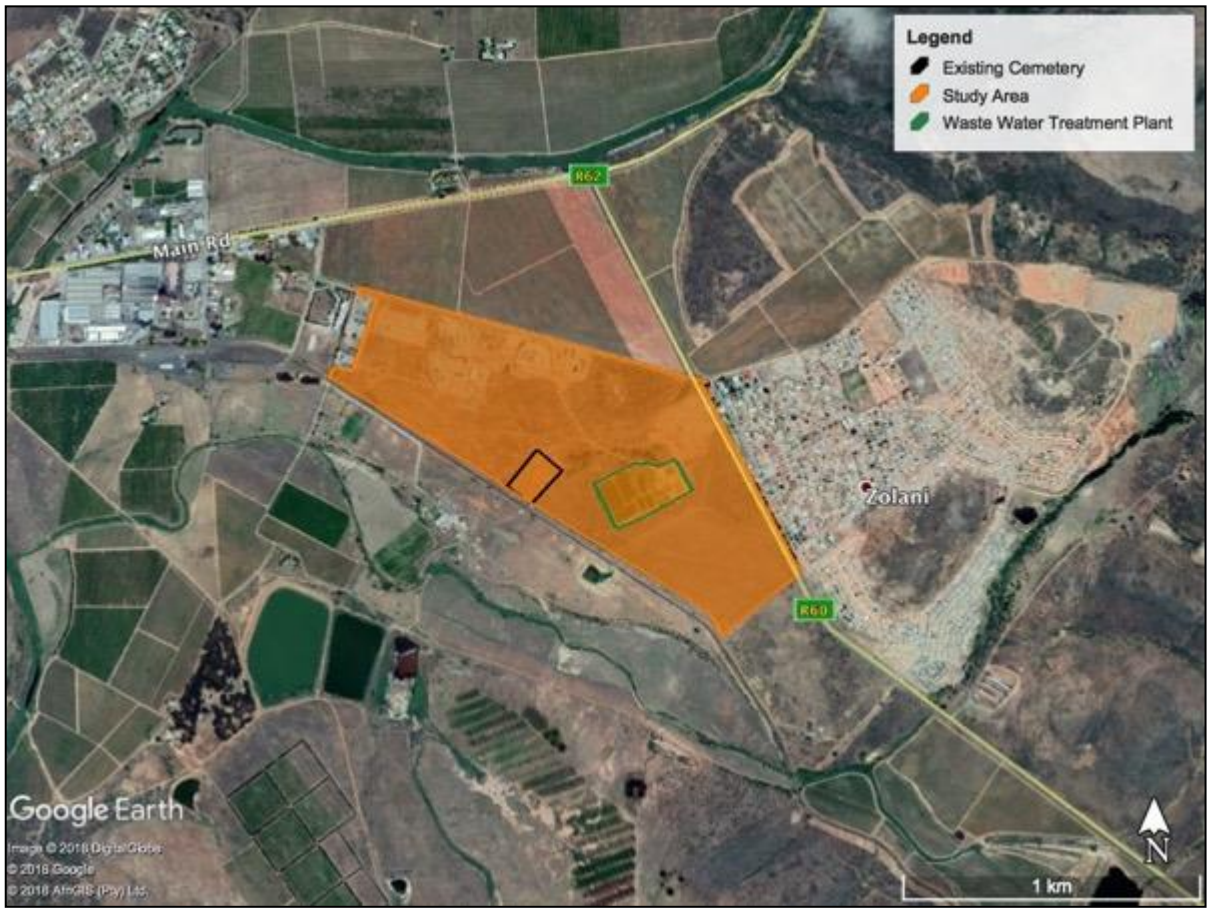

Figure 1: Location of the study area within Langeberg Local Municipality in relation to surrounding areas.

Ref	Town	Cemetery Site	Description of project	Property description	Ownership
3	Ashton	Silo's cemetery	Expansion of existing cemetery	RE/71/158	Langeberg Municipality

Langeberg Municipality
Identification of New Cemetery site Tender 09/2016
Expansion of Silo's cemetery
PROPOSED EXPANSION
CREATED BY
C.K. RUMBOLL & PARTNERS
TOWN PLANNERS
PROFFESIONAL SURVEYORS
16 RAINIER STREET, MALMESBURY

LEGEND
Erf RE/71/158 boundaries
Existing cemetery
Developable area
Interments
Park

Figure 2: Alternative Layout.

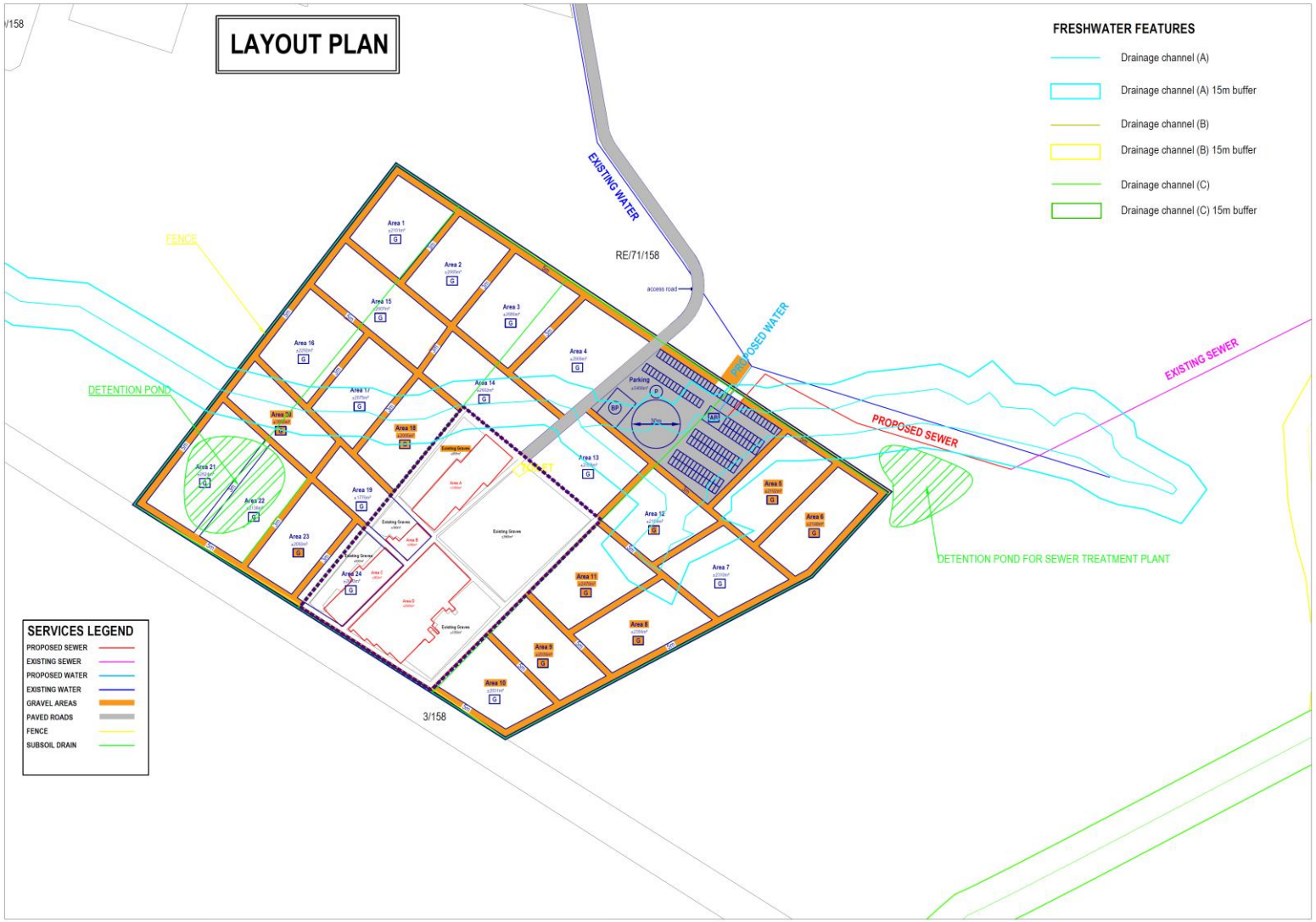

Figure 3: Preferred Layout.

1.2 Scope of Work

The scope of work which informs this assessment consists of:

- Assessment of relevant background information including the National Freshwater Ecological Database (NFEPA, 2011), the Western Cape Biodiversity Spatial Plan (WCBSP, 2017), the National Geospatial Information (NGI) Service topographical maps and vector data, and pertinent academic resources if needed;
- A site assessment including delineation of wetland temporary boundaries in accordance with best practice guidelines including the Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas (Department of Water Affairs and Forestry - DWAF, 2008) and the Application of the Department of Water Affairs and Forestry (DWAF) wetland delineation method to the wetland soils of the Western Cape (Job, *et. al*., 2009);
- Assessment of the Present Ecological State (PES) according to best practice methods;
- Application of the Macfarlane and Bredin (2016) buffer guidelines where necessary;
- Assessment of direct, indirect and cumulative freshwater impacts of the proposed development and development of mitigation measures; and
- Clarification of the freshwater legislative constraints applicable to the proposed development.

1.3 Limitations and Assumptions

The following assumptions and limitations apply to the freshwater assessment.

- A Garmin E-Trex 20 GPS was used to delineate the temporary boundary of wetland habitat identified on the study site and accuracy is therefore limited to the stated accuracy of the GPS of approximately 3m. All effort is made to improve on the stated accuracy including the use of the waypoint averaging function at the most critical points. It is however the opinion of the specialist that this limitation is of no material significance and that the freshwater constraints have been adequately identified.
- This study is limited to the upper 50cm of soil in accordance with the Updated Manual for Identification and Delineation of Wetland and Riparian Areas (Department of Water Affairs and Forestry - DWAF, 2008) and the Application of the DWAF (2008) Method to Wetland Soils of Western Cape (Job *et. al.* 2009).
- A single site assessment was conducted on 4 December 2018 during early summer, but it is the opinion of the specialist that the freshwater constraints were adequately identified, and no follow-up field work is required.

1.4 Applicable Legislation

1.4.1 National Water Act (36 of 1998)

The purpose of the NWA is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account amongst other factors -
(g) protecting aquatic and associated ecosystems and their biological diversity; and
(h) reducing and preventing pollution and degradation of water resources.

In order to understand and interpret the Act correctly, the following definitions are applicable to this project:
"pollution" means the direct or indirect alteration of the physical, chemical or biological properties of a water resource;
"protection", in relation to a water resource, means -
(a) maintenance of the quality of the water resource to the extent that the water resource may be used in an ecologically sustainable way;
(b) prevention of the degradation of the water resource; and
(c) the rehabilitation of the water resource;
"resource quality" means the quality of all the aspects of a water resource including -
(a) the quantity, pattern, timing, water level and assurance of instream flow;
(b) the water quality, including the physical, chemical and biological characteristics of the water;
(c) the character and condition of the instream and riparian habitat; and
(d) the characteristics, condition and distribution of the aquatic biota;
"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 in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks; and
"water resource" includes a watercourse, surface water, estuary, or aquifer.

The NWA deals with pollution prevention, and in particular the situation where pollution of a water resource occurs or might occur as a result of activities on land. The person who owns, controls, occupies or uses the land in question is responsible for taking measures to prevent pollution of water resources. The measures may include measures to -
(a) cease, modify or control any act or process causing the pollution;
(b) comply with any prescribed waste standard or management practice;
(c) contain or prevent the movement of pollutants;
(d) eliminate any source of the pollution;
(e) remedy the effects of the pollution; and
(f) remedy the effects of any disturbance to the bed and banks of a watercourse.

Water use is defined broadly, and includes taking and storing water, activities which reduce stream flow, waste discharges and disposals, controlled activities (activities which impact detrimentally on a water resource), altering a watercourse, removing water found underground for certain purposes, and recreation. In general a water use must be licensed unless it is listed in Schedule I, is an existing lawful use, is permissible under a general authorisation, or if a responsible authority waives the need for a licence.

1.4.2 General Notice 509 (2016) of the NWA

According to GN509 of 2016 the extent of a watercourse means:

a) a river, spring or natural channel in which water flows regularly or intermittently "within the outer edge of the 1 in 100 year floodline or riparian habitat measured from the middle of the watercourse from both banks", and for b) wetlands and pans "within a 500 m radius from the boundary (temporary zone) of any wetland or pan" (when the temporary zone is not present then the seasonal zone is delineated as the wetland boundary), and for c) lakes and dams "purchase line plus a buffer of 50 m".

According to the GN509 a General Authorisation (GA) may be acquired for the use of water in terms of section 21 c and i within the regulatory zone of a watercourse where the Risk Class as determined by the Risk Assessment Matrix is Low.

1.4.3 National Environmental Management Act (107 of 1998)

The NEMA states the following:

"Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment."

The Act also makes special mention of the importance of the protection of wetlands:

"Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure."

2 Method of Assessment

2.1 Desktop Assessment

Desktop resources and databases were consulted in order to contextualise the study area and findings of the field survey. Spatial and non-spatial resources accessed for this assessment include inter alia the NFEPA, (2011), the WCBSP (2017), as well as maps and vector data form the National Geospatial Information directorate. The WCBSP (2017) categorises natural features into Protected Areas (PAs), Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs), and Other Natural Areas (ONAs). These categories, as well as the applicable sub-categories, are defined in the table overleaf.

Table 1: WCBSP category definitions and management objectives.

MAP CATEGORY	DEFINITION	DESIRED MANAGEMENT OBJECTIVE	SUB-CATEGORY
Protected Area	Areas that are proclaimed as protected areas under national or provincial legislation.	Must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity. A benchmark for biodiversity.	n/a
Critical Biodiversity Area 1	Areas in a natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.	Maintain in a natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.	CBA: River CBA: Estuary CBA: Wetland CBA: Forest CBA: Terrestrial
Critical Biodiversity Area 2	Areas in a degraded or secondary condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.	Maintain in a functional, natural or near-natural state, with no further loss of natural habitat. These areas should be rehabilitated.	CBA: Degraded
Ecological Support Area 1	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs, and are often vital for delivering ecosystem services.	Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.	ESA: Foredune ESA: Forest ESA: Climate Adaptation Corridor ESA: Coastal Resource Protection ESA: Endangered Ecosystem ESA: River ESA: Estuary ESA: Wetland ESA: Watercourse Protection ESA: Water Source Protection ESA: Water Recharge Protection
Ecological Support Area 2	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs, and are often vital for delivering ecosystem services.	Restore and/or manage to minimise impact on ecological infrastructure functioning; especially soil and water-related services.	ESA: Restore from NN
ONA: Natural to Near-Natural	Areas that have not been identified as a priority in the current systematic biodiversity plan, but retain most of their natural character and perform a range of biodiversity and ecological infrastructure functions. Although they have not been prioritised for biodiversity, they are still an important part of the natural ecosystem.	Minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. Offers flexibility in permissible land uses, but some authorisation may still be required for high-impact land uses.	ONA: Natural to Near-Natural ONA: Degraded
No Natural Remaining	Areas that have been modified by human activity to the extent that they are no longer natural, and do not contribute to biodiversity targets. These areas may still provide limited biodiversity and ecological infrastructure functions, even if they are never prioritised for conservation action.	Manage in a biodiversity-sensitive manner, aiming to maximise ecological functionality. Offers the most flexibility regarding potential land uses, but some authorisation may still be required for high-impact land uses.	No Natural Remaining

2.2 Watercourse Identification and Delineation

A field survey of the study site, excluding the existing cemetery areas, other erven within the study area and the waste water treatment plant, was undertaken on 4 December 2018.

For the purpose of the identification of water resources, the definition as provided by the NWA (Act no. 36, 1998) was used to guide the field survey. The NWA defines a water resource as a watercourse, surface water, estuary or aquifer, of which the latter two are not applicable to this assessment due to an estuary being associated with the sea and, in line with best practice guidelines, wetland and riparian assessments only include the assessment of the first 50 cm from the soil surface, therefore aquifers are excluded. In addition, reference to a watercourse as provided above includes, where relevant, its bed and banks.

In order to establish if watercourses can be classified as 'wetland habitat' or 'river habitat', the definitions as drafted by the NWA (Act no. 36, 1998)[2] were taken into consideration:

- A 'wetland' 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; and
- 'Riparian' habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized 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 areas'.

Freshwater habitat was identified with the use of the definitions provided above and the delineation took place according to the method supplied by DWAF (2005, updated 2008). Several indicators are prescribed in the watercourse delineation guideline to facilitate the delineation of either the temporary wetland zone or the rivers riparian zone. Refer to Figure 4 and
Figure 5.

Indicators used to determine the boundary of the wetland temporary zone include:

1) The position in the landscape;
2) The type of soil form;
3) The presence of wetland vegetation species; and
4) The presence of redoximorphic soil features, which are morphological signatures that appear in soils with prolonged periods of saturation.

Indicators used to determine the boundary of the riparian zone include:

1) Landscape position;
2) Alluvial soils and recently deposited material;
3) Topography associated with riparian areas; and
4) Vegetation associated with riparian areas.

[2] The definitions as provided by the NWA (Act No. 36 of 1998) are the only legislated definitions of wetlands in South Africa.

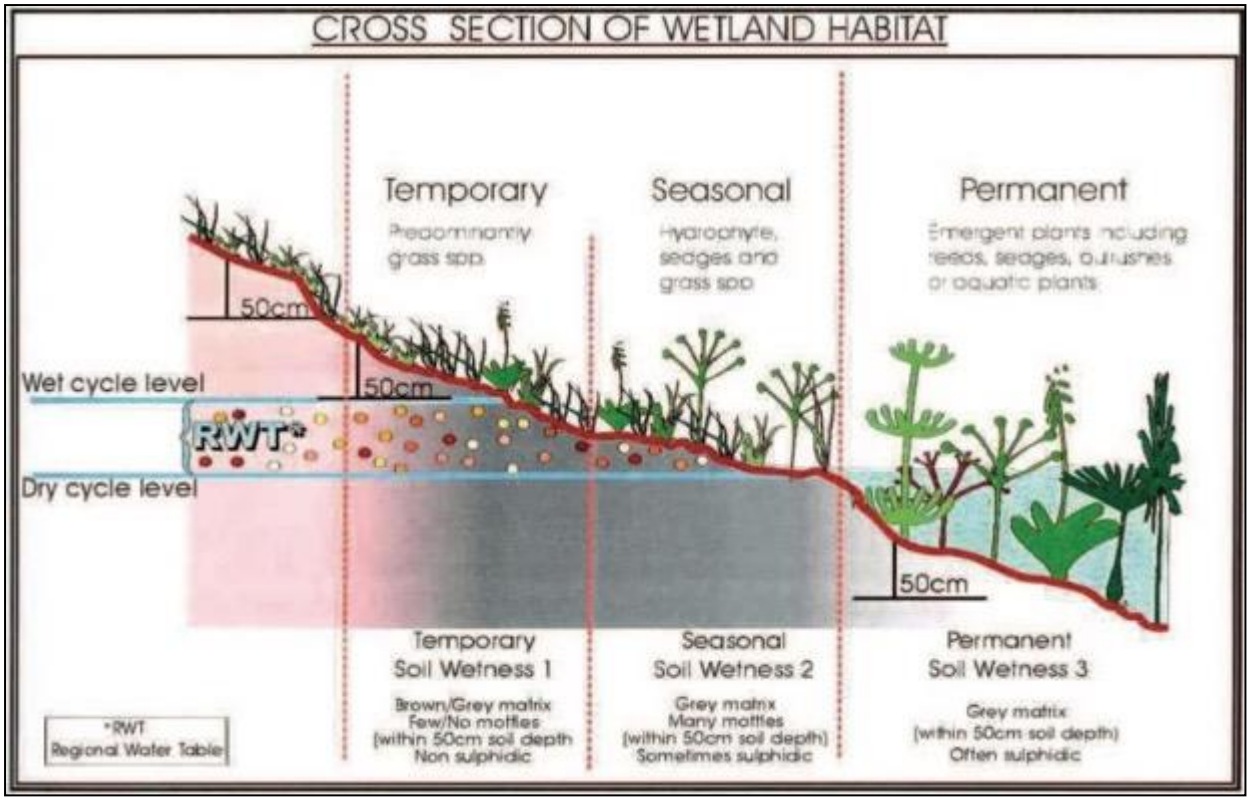

Figure 4: Cross section through a wetland (after DWAF, 2005).

Table 2: Vegetation characteristics used in the delineation of wetlands (after DWAF, 2005).

Terrestrial / Non-wetland	Temporary	Seasonal	Permanent / Semi-permanent
Dominated by plant species which occur extensively in non-wetland areas; hydrophytic[3] species may be present in very low abundance	Predominantly grass species; mixture of species which occur extensively in non-wetland areas and hydrophytic plant species which are restricted largely to wetland areas	Hydrophytic sedge and grass species which are restricted to wetland areas	Dominated by emergent plants, including reeds, sedges and bulrushes or floating or submerged aquatic plants

[3] Plants that are physiologically bound to water where at least part of the generative cycle takes place in the water or on the surface.

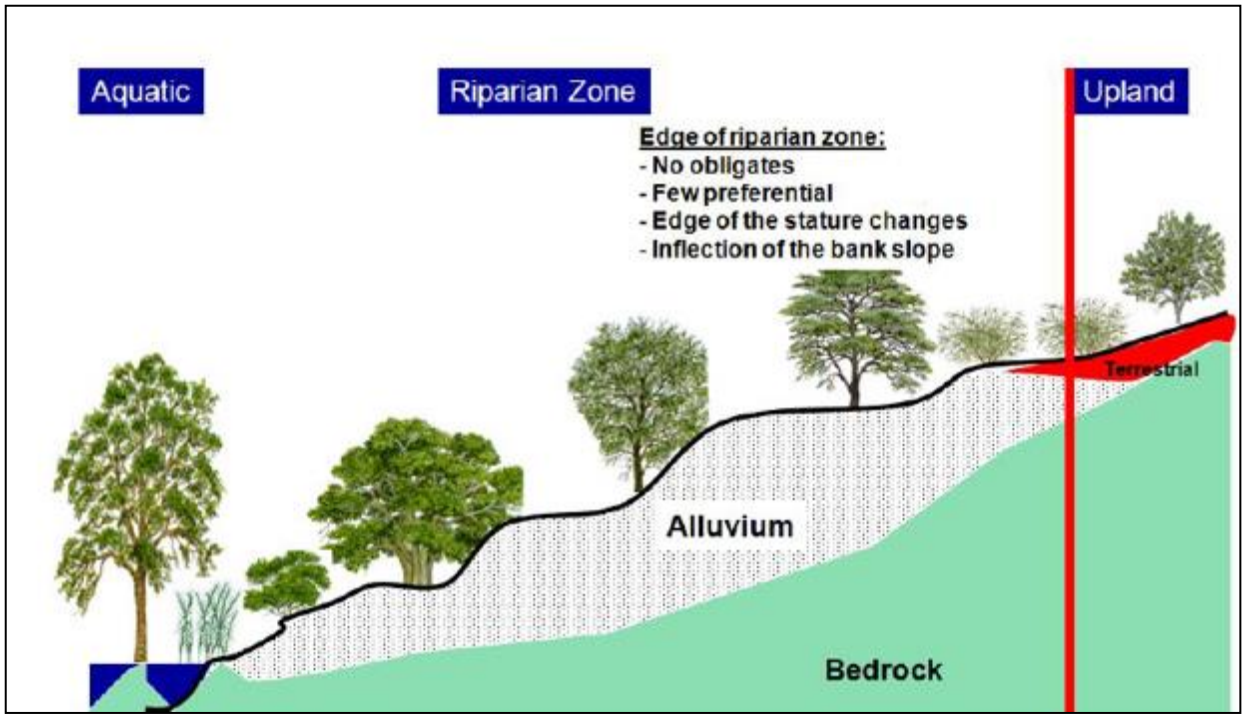

Figure 5: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river (DWA, 2008).

2.3 Freshwater Feature Classification

Ecosystems included within the 'Classification System for Wetlands and other Aquatic Ecosystems in South Africa' (hereafter referred to as 'the Classification System') developed by Ollis *et. al*., (2013) encompass those that the Ramsar Convention defines, rather broadly, as 'wetlands', namely areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres (cited by Ramsar Convention Secretariat, 2011). The inland component of the Classification System has a six-tiered structure presented in the figure below.

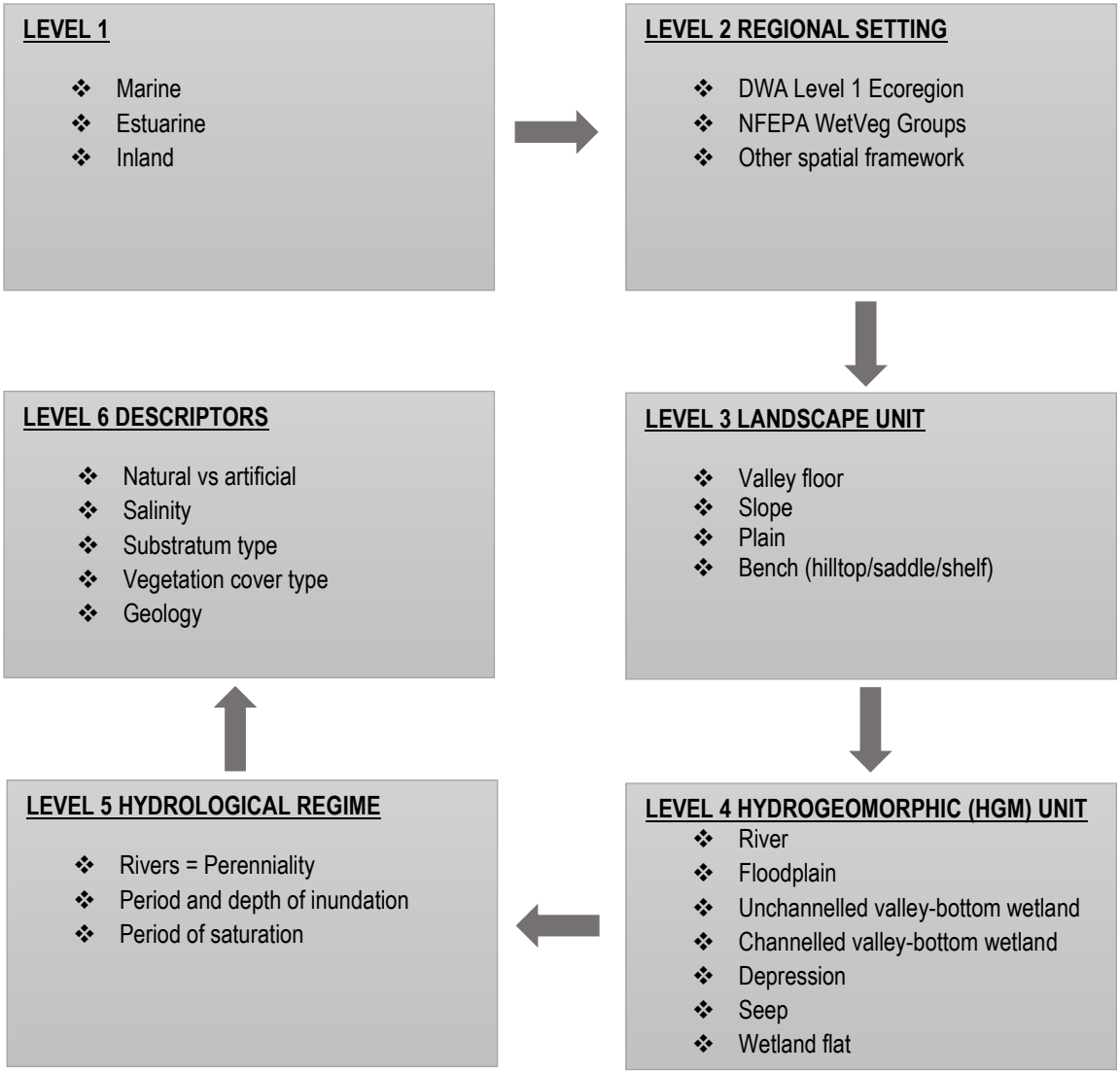

Figure 6: Classification System for wetlands and other aquatic ecosystems in South Africa.

2.4 Present Ecological State (PES)

The river IHIA is utilised in order to determine the PES of rivers. The river IHIA is based on two components of the watercourse, the riparian zone and the instream channel. Assessments are made separately for both aspects, but data for the riparian zone is primarily interpreted in terms of the potential impact on the instream component. The method involves the rating of the perceived modification of nine instream criteria and eight riparian criteria against a set scoring guideline. The final score is derived by calculating the average scores, which places the final score in one of the categories listed below.

Table 3: Intermediate habitat integrity categories (From Kleynhans, 1996).

CATEGORY	DESCRIPTION	SCORE (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79

D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0

2.5 Recommended Ecological Category (REC)

The Recommended Ecological Category (REC) is determined by the PES score as well as importance and/or sensitivity. Water resources which have a PES falling within an E or F ecological category are deemed unsustainable. In such cases the REC must automatically be increased to a D. Where the PES is determined to be within an A, B, C or D ecological category, the EIS components must be evaluated to determine if any of the aspects of importance and sensitivity are high or very high. If this is the case, the feasibility of increasing the PES (particularly if the PES is in a low C or D category) should be evaluated and either set at the same ecological category or higher depending on feasibility. This is recommended to enable important and/or sensitive water resources to maintain their functionality and continue to provide the goods and services for the environment and society.

2.6 Impact Assessment

A method of assessment summary is provided below; the detailed method is provided in Appendix 1.

The following criteria were taken into consideration when determining the impact of the proposed activities:

- The nature of the impact i.e. positive, negative, direct, indirect;
- The extent and location of the impact;
- The duration of the impact i.e. short term, long term, intermittent or continuous;
- The magnitude/intensity of the impact i.e. high, medium, low; and
- The likelihood or probability of the impact occurring.

Mitigation measures were subsequently identified and recommended for all impacts to reduce the overall impact significance to an acceptable level, where and if possible. Mitigation measures were aimed to ensure that:

- More environmentally sound designs / layouts / technologies, etc., are investigated and implemented, if feasible;
- Environmental benefits of a proposed activity are enhanced;
- Negative impacts are avoided, minimised or remedied; and
- Residual negative impacts are within acceptable levels.

3 Results

3.1 Desktop Assessment

3.1.1 Regional and Local Setting

The study area lies in the Southern Folded Mountains ecoregion, the main features of which are summarised in Table 4. Local climatic, topographic and soil conditions for the study area are shown by Table 5 which is adapted from the Cape Farm Mapper website (https://gis.elsenburg.com/apps/cfm/). The study area is furthermore within the Breede Water Management Area (WMA) and the H30E quaternary catchment.

The applicable terrestrial vegetation types are Breede Shale Renosterveld (Vulnerable) with small tracts of Breede Alluvium Renosterveld and Muscadel Riviere which are listed as Endangered (refer to Figure 7). The National Freshwater Ecological Priority Areas (NFEPA, 2011) project's applicable Wetland

Vegetation types are East Coast Shale Renosterveld with small tracts of East Coast Alluvium Renosterveld (Critically Endangered) and Rainshadow Valley Karoo, listed as Vulnerable (Figure 8).

Soils are expected to have diagnostic horizons dominant, usually shallow, on hard or weathering rock, with or without intermittent diverse soils, and lime generally present in part or most of the landscape. The topography of the study area falls from 200 metres to 170 metres above mean sea-level (AMSL) with the bulk of the site sloping from the north-eastern and south-eastern boundary at 3 – 10%, with the slope decreasing to between 0 and 3% in the centre and north-western portion of the site (refer to Figure 9).

Table 4: Overview of the Southern Folded Mountains Ecoregion (adapted from DWA, 2005)

Main Attributes	Southern Folded Mountains
Geology	Conglomerate, sandstone, siltstone, mudstone, grit and limestone, as well as talus and gravel.
Vegetation	Grassy Fynbos; Mountain Fynbos; Little Succulent Karoo; South West Coast Renosterveld
Landscape	Closed hills; mountains; moderate and high relief
Mean altitude	300-1900
Rainfall seasonality	Very late summer to winter to all year

Table 5: Local climate, topography and soil conditions (adapted from Cape Farm Mapper, 2015)

Parameters	Local Conditions
Mean annual precipitation (mm)	274 - 328 mm
Mean annual runoff (mm/annum)	6.63 mm
Mean annual temperature (°C)	17.8° C
Elevation (m above mean sea level)	170-200m
Slope classification (%)	0-10%
Soil characteristics	Prismacutanic and/or pedocutanic diagnostic horizons dominant. Miscellaneous land classes, undifferentiated deep deposits.
Soil depth (mm)	< 450 mm
Soil clay content (%)	< 15%

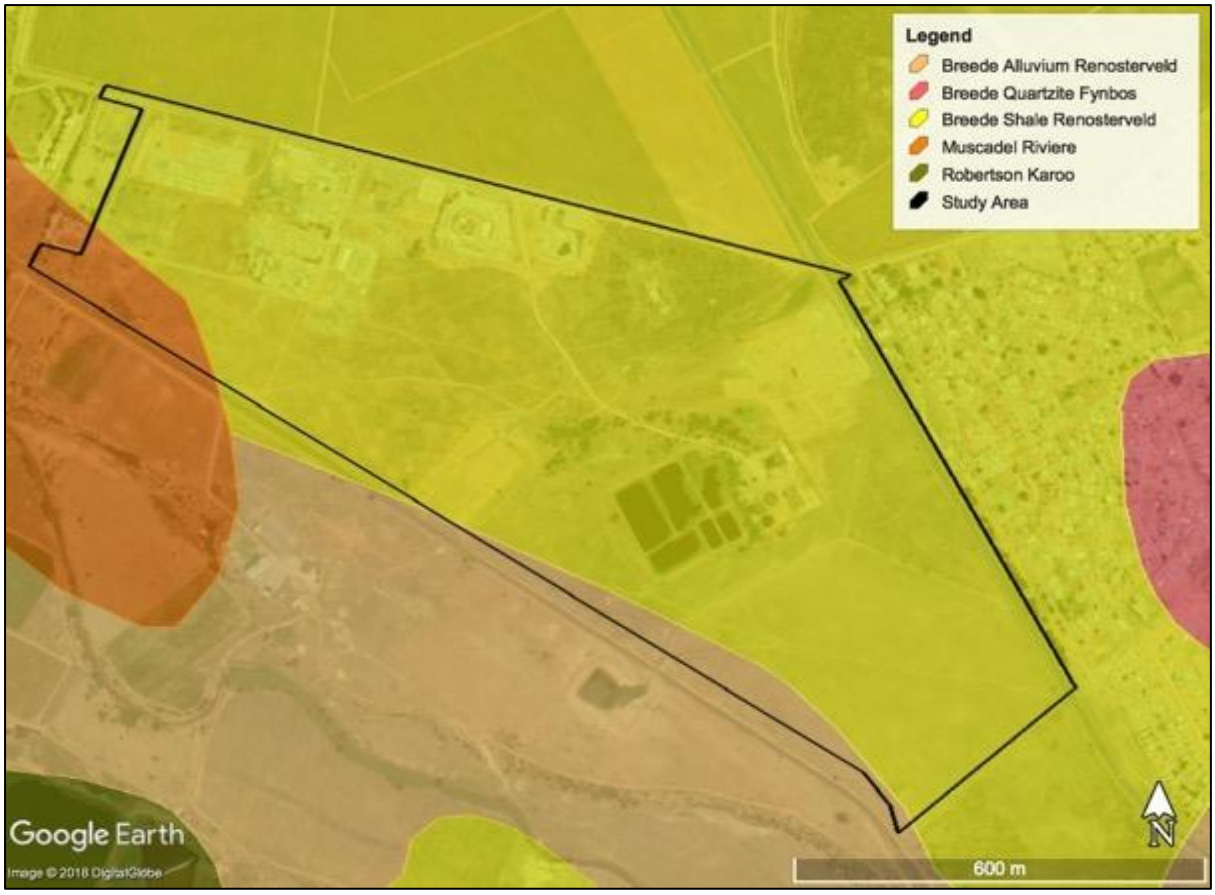

Figure 7: National Vegetation Map Terrestrial vegetation types (Mucina and Rutherford, 2012).

Figure 8: Wetland vegetation types according to NFEPA (2011).

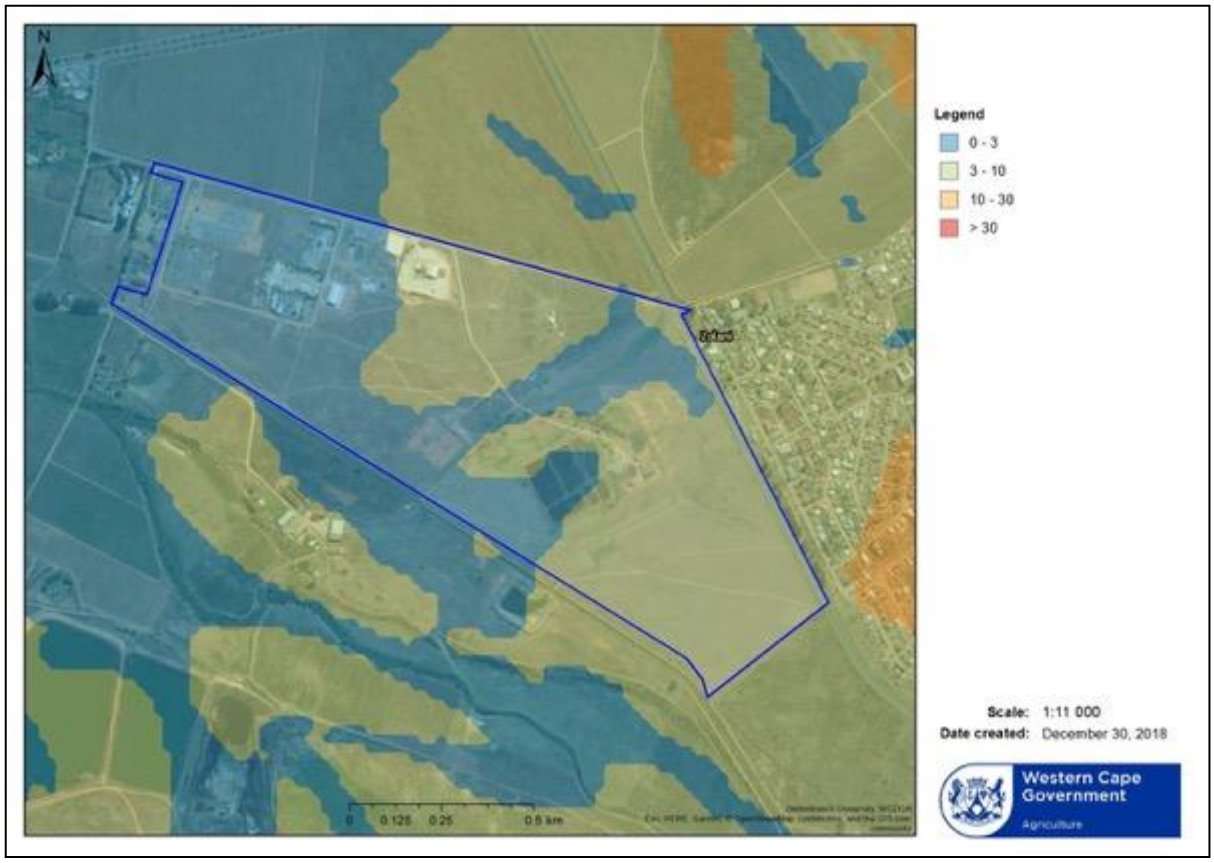

Figure 9: Topography of the study area and surrounds (Cape Farm Mapper, 2018).

Figure 10: Five metre interval contour lines to indicate the flat topographical context of the site.

3.1.2 Watercourses within the study area and 500m regulated zone

The NWA (1998) defines a regulated area of 500m around wetlands, within which risks to these wetlands must be considered. Additionally, the NWA requires that risks to rivers, streams and drainage lines are also considered within a regulated area defined by the 1:100- year floodline. Floodlines are not available in this case, so all known rivers, streams, drainage lines and wetlands, within 500m of the study area, according to the available desktop resources, are presented below.

The NFEPA wetland layer (2011) indicates the presence of an artificial unchannelled valley-bottom wetland, an artificial floodplain wetland, and a natural floodplain wetland within 500m of the study area (refer to Figure 11). In addition, the National Geospatial Information Service (NGI) indicates four non-perennial drainage lines (one of which traverses the south-eastern portion of the property) and two perennial rivers (refer also to Figure 11).

According to the Western Cape Biodiversity Spatial Plan (WCBSP, 2017) the study area intersects a number of features within several spatial biodiversity categories, as described by

Table 1. Figure 12 depicts the location of the study area relative to the features and shows that the study area is dominated by Terrestrial CBA 1 features, with tracts of Aquatic CBA 1. The aquatic CBA 1 features are further classified as wetland. Elements of aquatic ESA 1 and ESA 2 features are also indicated and classified as watercourses. The role played by the ESA1 and ESA 2 areas in water resource protection within the critically endangered Renosterveld vegetation type are the reasons cited by the WCBSP (2017) for the relatively high conservation value of the study area.

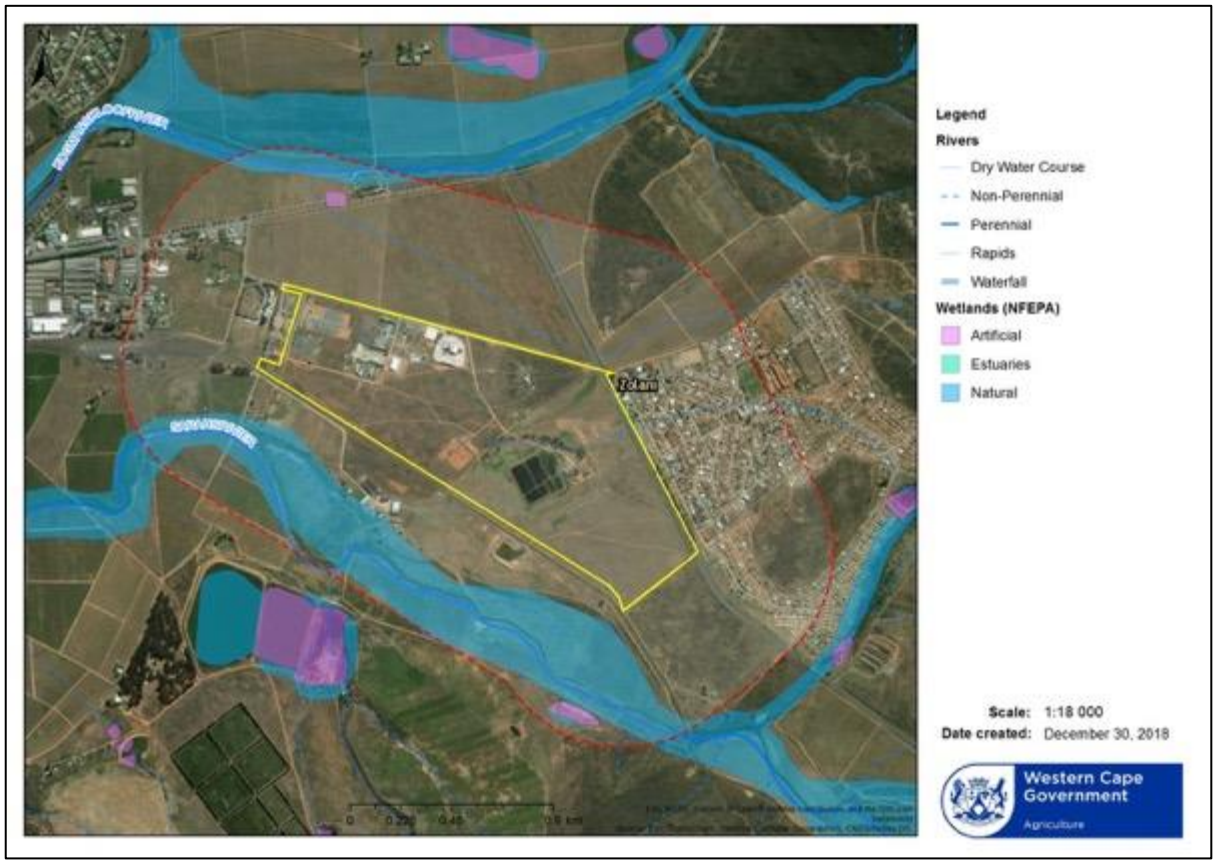

Figure 11: Documented watercourses within the study area and 500m regulated zone

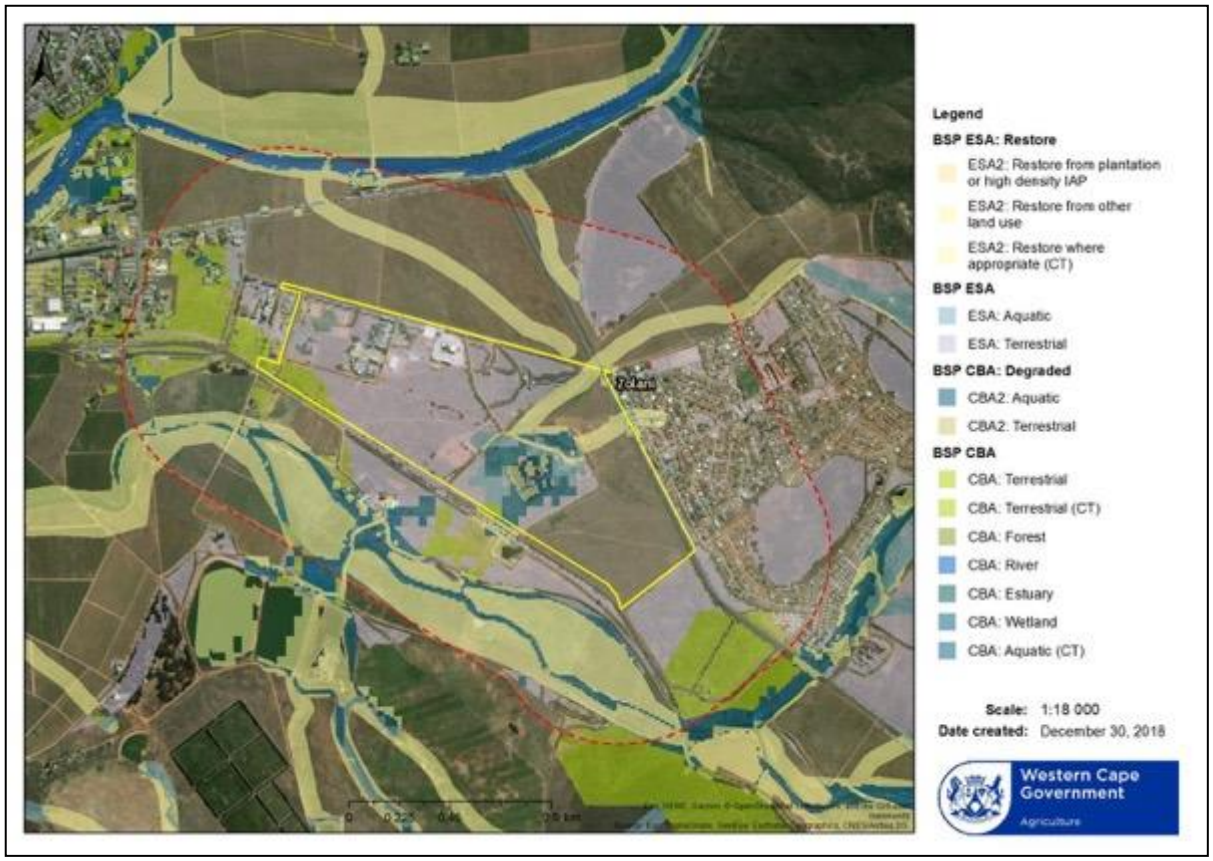

Figure 12: Location of the study area relative to spatial biodiversity categories (WCBSP, 2017)

3.1.3 Aerial Photography

Historical imagery from 1948 and 1966 indicates the presence of drainage lines in a south-eastern portion of the study area (refer to Figure 13 and Figure 14 respectively). The drainage lines indicated in the 1948 historical imagery are in line with the non-perennial drainage lines indicated by the NGI present in the centre of the study area. What appears to be a wet area is visible in the 1966 historical imagery and is in line with the eastern CBA wetland feature indicated by the WCBSP (2017).

Imagery from 2013 onwards indicates the presence of a wet area, but this area is not present in imagery from 2012 and earlier (refer to Figure 15). This suggests that the watercourse is entirely unnatural and more than likely related to a burst pipe or similar artificial water source.

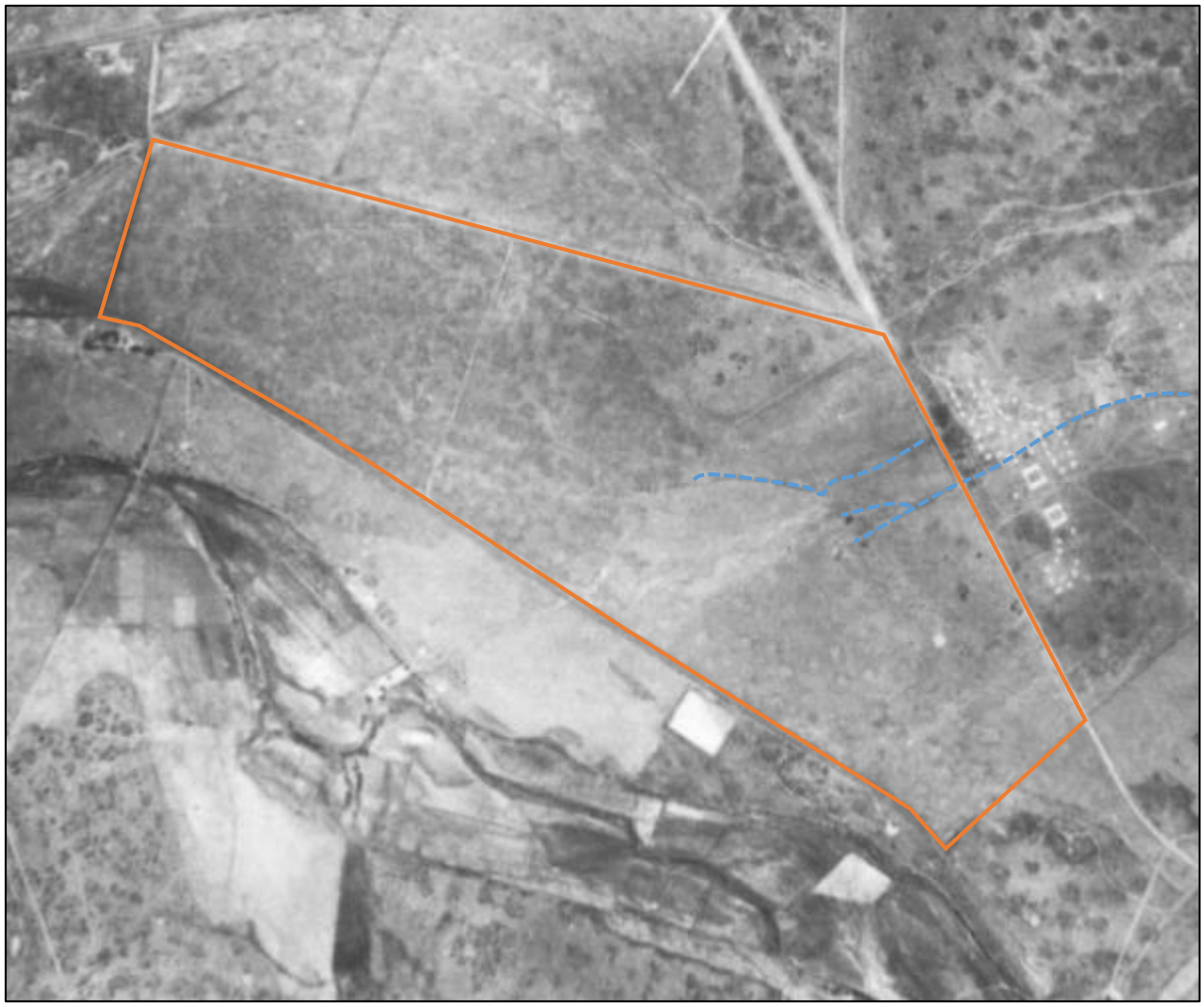

Figure 13: Historical imagery of RE/71/158, Ashton (orange) in 1948 showing historical drainage lines, indicated in blue.

Figure 14: Historical imagery of RE/71/158, Ashton (orange) in 1966 showing evidence of a historical wet area indicated in blue.

Figure 15: Historical imagery of RE/71/158, Ashton (orange) from 2012 and 2013 with the wet area (indicated in blue) that formed after 2012.

3.2 Description and Delineation of Watercourses

An in-field delineation of watercourses was undertaken on the 4th of December 2018. The method supplied by DWAF (2005, updated 2008) for delineation of wetlands and riparian zones was followed. The presence of hydromorphic and alluvial soil features, hydrophytic vegetation, terrain units and soil hydrology within the upper 50cm of the soil were all used in varying combinations as indicators of temporary wetland and riparian boundaries.

Five separate watercourses were identified, all of which were severely transformed, or created by human activities:

- One excavated earth channel (A) drains from the recently levelled works area and appears recently excavated for this purpose.

- Two concrete stormwater canals carry stormwater from the residential area to the northwest on the far side of the R60 and join within the study area to form a larger canal. The system has been labelled B.

- A natural drainage line (C) has been cut off from the majority of its catchment by construction of the R60 and of the stormwater system in the residential area to the northwest that enters B above, along with raised banks that prevent any input from the historical catchment. The drainage line is now supplied with water entirely from sewage works overflow and (further downstream) from a drinking trough for cattle that appears to overflow permanently. A substantial riparian zone is present and wetland vegetation and soils have also formed. Both wetland and riparian habitat are inconsistent with the typical nature of ephemeral drainage lines of this scale in this area and both habitats are confined to portions of the drainage line that receive large, regular artificial hydrological augmentation. Historical aerial photographs such as Figure 13 above clearly indicate a lack of wetland or riparian vegetation within this drainage line. It is therefore the opinion of the specialist that the wetland and riparian habitat and conditions are entirely unnatural and would cease to exist should the WWTW cease and drinking trough cease to overflow.

- Another historically excavated channel (D) begins at the recently levelled area and ends abruptly near watercourse C. There are no recent signs of this channel having carried water. It is likely given its position that this was once one of the historical drainage lines indicated by the NGI service, but runoff from its catchment has most likely been redirected into the stormwater channels (B) and it appears to have been infilled in during the aforementioned recent levelling.

- A wet area (E), likely of artificial origins, is present adjacent to the north-eastern most corner of the study area. The wet area is absent from all aerial photographs preceding 2012 and is therefore most likely of artificial origins. The water source could not be located, but is likely a leaking pipe, possibly a sewage pipe that feeds the sewage works. It is therefore the opinion of the specialist that the wet area is entirely artificial and will not remain after the artificial source is removed.

Watercourses A to E are presented in Figure 10. A detailed description of each watercourse including the hydrophytic vegetation, soil hydromorphic features and general surroundings is provided in the sections that follow.

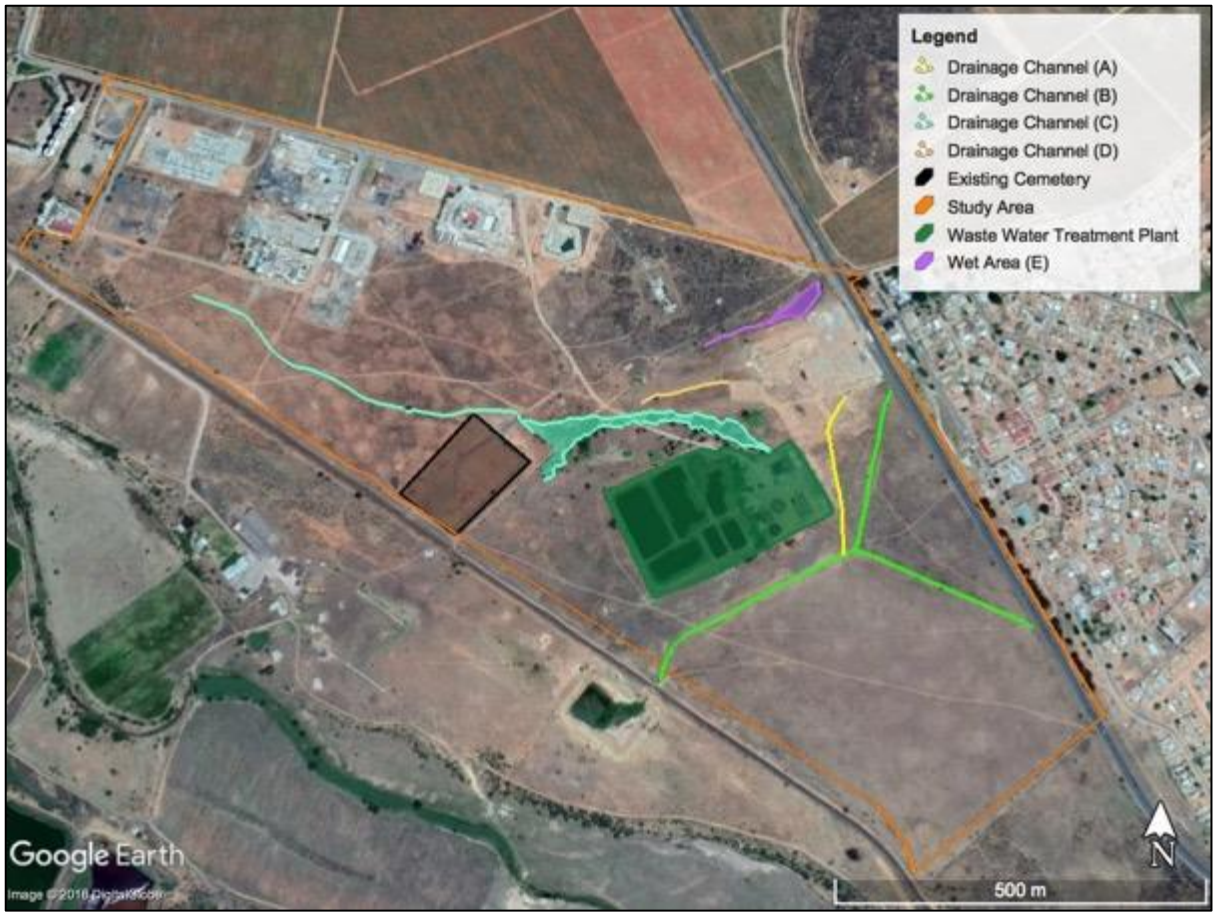

Figure 16: Freshwater feature delineations on RE/71/158, Ashton.

3.2.1 Drainage Channel – A

Watercourse A was found to be an artificially excavated channel draining from the recently levelled works area and appears to have been recently excavated for this purpose. The channel and surrounds were devoid of any hydrophytic vegetation. This channel is therefore, in the opinion of the specialist, unnatural and will not be assessed.

3.2.2 Canal System – B

Canal system B, the concrete stormwater canals, receive water from the historical catchment of Drainage Line C (below) and amount to the diverted drainage line C. The canals are part of a formal stormwater system that drains into the Sarahsrivier and were devoid of any indigenous vegetation.

Despite the summer season, free water was observed within the canal. Solid waste was prevalent throughout large portions of the canal.

3.2.3 Drainage Line – C

Drainage line C appears to be a remnant of a natural drainage line as it is approximately in line with the one of the drainage lines indicated by NGI data. It exhibits an extensive riparian zone consisting primarily of dense stands of *Acacia karoo* (refer to Figure 17). The drainage line has however been cut off from its historical catchment to a large degree by installation of a stormwater system on the far side of the R60 to the west which drains via canal system B. The banks of the drainage line have been built up artificially and have been cut off from surrounding runoff, the primary input is likely from the sewage works overflow that enters the drainage line directly, as evidenced by the presence of substantial volumes of toilet paper in the over flow channel. The drainage line also receives water from a cattle trough that overflows continually near the sewage works.

The drainage line upslope of the sewage works has been infilled historically and could not be located. Hand augering was conducted downstream of the sewage works outflow and sparse mottling (refer to Figure 15), an organic surface layer (refer to Figure 16) and sparse mottling indicative of temporary wetland conditions was found within the channel. Below the overflowing cattle trough the drainage line and surrounds are exceedingly green and exhibit standing water within 50cm of the soil surface for at least 100m downstream. Mottling on the periphery of this zone was dense and indicative of seasonal wetland conditions, with the wettest areas exhibiting limited to no mottling which indicates of permanent wetland conditions. *Zantedeschia aethiopica, Cynodon dactylon,* and *Cyperus textilis* were found in this area.

The wetland conditions are however likely the result of the change in hydrological seasonality and volume of input described above. They should therefore be considered unnatural. The wetland conditions are therefore an impact on the drainage line and the drainage line will therefore not be assessed as a wetland but as a non-perennial drainage line. The riparian zone is also most likely unnatural since it is absent from historical aerial photographs and was only present in artificially augmented areas.

Drainage Line C does not reach the Sarahsrivier, but shallows and disappears beforehand likely due to evaporation and groundwater recharge. The reddish-brown soil colour throughout this area also indicates that water flows downwards to recharge interflow or groundwater well below the 50cm depth sampled.

Figure 17: Representative moist wetland soil sample with an extensive organic surface layer.

Figure 18: Representative wetland soil sample from the outer temporary zone with sparse mottling circled in blue.

Figure 19: Dense stands of *Acacia karoo* in the background, with *Cynodon dactylon* in the foreground.

3.2.4 Drainage Line – D

Drainage line D was historically excavated but may be of natural origins as it aligns approximately with both historical aerial photography and NGI drainage lines. If this is the case, it has been cut off from its historical catchment by the R60 and by installation of the stormwater system in the residential area on the far side of the R60 to the west that now flows into canal system B. Its western parts have been infilled within the levelled area and since its sides have historically been built up higher than the surroundings in this area,. There is no evidence of recent flow within the channel and it is, in the opinion of the specialist unlikely that water ever flows in this channel.

No hydrophytic vegetation or aquatic habitat of any nature was noted within the channel. Given the scale of changes within the catchment it is extremely unlikely that the channel may be reinstated. It is therefore the opinion of the specialist that drainage line D can no longer be considered a watercourse of any nature, and it will therefore not be assessed further.

3.2.5 Wet Area – E

This area exhibited significant hydrology and was extremely green, which is unusual given that the survey was undertaken during early to mid-summer. The species diversity is also very low in this area, with alien and cosmopolitan grasses dominating. It is entirely absent from historical aerial photographs before 2013 and is therefore artificial in nature. No artificial water source could be located, but it is likely fed by a large leak in a sewage pipe or similar source. It is therefore the opinion of the specialist that this watercourse is entirely unnatural and can therefore not be assessed by means of the methods below that compare watercourses to a reference state.

3.2.6 Freshwater Feature Classification

The study area is situated within the Southern Folded Mountains ecoregion and the Breede Water Management Area (WMA) as defined by NFEPA (2011). The table below summarise the results from **Level 4** through to **Level 6** of the wetland and aquatic ecosystem classification user manual (Ollis *et. al.* 2013).

Table 6: Level 4, 5 and 6 of the wetland and aquatic ecosystem classification

Level 4 (Hydrogeomorphic unit)	**River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit.
Level 5 (Hydrological regime)	**Non-perennial:** does not flow continuously throughout the year, although pools may persist.

Level 6 (Descriptors)	**Natural:** existing in, or, produced by nature; not made or caused by humankind. **Artificial:** produced by human beings, not naturally occurring.

3.3 Present Ecological State

3.3.1 Drainage line – C

In order to determine the PES of watercourse C, the river IHIA was applied. The IHIA includes the assessment of riparian and instream habitat as two separate modules. In this case however, the riparian zone is not, in the opinion of the specialist, a natural feature of the stream and criteria related to riparian habitat was therefore not assessed.

The key reasoning behind the river IHIA results for the instream module is summarised below:

- Water abstraction:
    - No direct abstraction was noted.
    - Diversion of water into artificial concrete channels (A and B) upstream has cut off the majority of the drainage line's catchment, and the built-up walls of the drainage line has removed the remainder, such that all natural runoff, apart from rain that falls directly within the channel, no longer supplies the channel. This has reduced natural flow in the watercourse to the degree that a watercourse would not exist. In terms of impact on the watercourse, this amounts to 100% abstraction.
    - No instream alien invasive vegetation species were noted, but the artificial riparian zone dominated by *Acacia karoo* has caused additional abstraction through evapotranspiration.
- Flow modification:
    - Flow has been artificially augmented by the sewage works and overflowing drinking trough to the degree that an artificial riparian zone and permanent wetland has formed. Annual flow within the watercourse is therefore greater than the natural case and is spread across the seasons and is not confined to the winter rainy season.
- Channel and bed modification:
    - Informal weirs have been constructed within portions of the channel, likely to manage flow;
    - The bed predominantly consisted of sand and large rocks, moderate erosion was observed;
    - Informal roads have been constructed and reinforced over and adjacent to the channel.
    - The nature of the sediments with the bed has also changed and seasonal and permanent wetland zones included several areas of soft sludgy organic sediments that area likely due directly to sewage works runoff.
    - The sides of the channel have been modified
- Water quality modification:
    - The water within the watercourse is limited to tap water which is high in chlorine, and partially treated effluent that will have elevated bacterial pathogen levels and extremely high nutrient loads. Water quality is therefore critically altered.

- Inundation:
    - A portion of the channel has become permanently saturated not due to a flow obstruction like a dam or weir, but rather due to augmentation.
- Exotic Macrophytes and Fauna:
    - No invasive alien species were noted within the stream channel or riparian zone, but all wetland and riparian vegetation is artificial and therefore alien to this portion of this watercourse;
    - Cattle frequent the watercourses and were the only alien species noted.
- Solid waste disposal:
    - Small volumes of litter was noted within the riparian and instream areas.
- Indigenous vegetation removal:
    - It is unlikely that any indigenous aquatic or riparian vegetation would have been removed from this system.
- Bank erosion:
    - Moderate unnatural erosion of the channel and banks was observed.

The overall habitat integrity score for watercourse A was 26.4, which falls within a high IHIA Category F: "Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible." In this case, it is the opinion of the specialist that the basic ecosystem functions have been destroyed and that the changes are irreversible, short of redirecting the stormwater canal E into the historical drainage line, which is not feasible for a variety of reasons.

Table 7: Descriptive classes for the assessments of modifications to the habitat integrity (after IHIA, 1999).

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability is also very small.	1–5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited.	6 – 10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11 – 15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area is affected. Only small areas are not influenced.	16 – 20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section is influenced detrimentally.	21 - 25

Table 8: Results of the IHI assessment for watercourse C.

	Impact score, Pre-development	Weight	IHI Score, Pre-development
Instream criteria			
Water abstraction	25	14	14

Flow modification	25	13	13
Bed modification	20	13	10,4
Channel modification	20	13	10,4
Water quality	25	14	14
Inundation	20	10	8
Exotic macrophytes	12	9	4,32
Exotic fauna	16	8	5,12
Solid waste disposal	4	6	0,96
Provisional Instream Habitat Integrity			19,8
PES Category			F

	Impact score, Pre-development	Weight	IHI Score, Pre-development
Instream criteria			
Water abstraction	25	14	14
Flow modification	25	13	13
Bed modification	20	13	10,4
Channel modification	20	13	10,4
Water quality	25	14	14
Inundation	20	10	8
Exotic macrophytes	12	9	4,32
Exotic fauna	16	8	5,12
Solid waste disposal	4	6	0,96
Provisional Instream Habitat Integrity			19,8
PES Category			B

3.3.2 Canal B

This canal system is fed directly by stormwater from the development to the north of the proposed site. This system carries the runoff that would historically have been carried by Drainage Line C to the a dam downslope and therefore amounts a diversion of Drainage Line C into a dam. It was therefore assessed as a diverted channelled natural non-perennial drainage line.

Watercourse B fall within a low IHIA Category E: "The loss of natural habitat, biota and basic ecosystem functions is extensive".

Table 9: Results of the IHI assessment for watercourse A.

	Impact score, Pre-development	Weight	IHI Score, Pre-development
Instream criteria			
Water abstraction	25	14	14
Flow modification	25	13	13
Bed modification	25	13	13
Channel modification	25	13	13
Water quality	20	14	11
Inundation	0	10	0
Exotic macrophytes	0	9	0

Exotic fauna	0	8	0
Solid waste disposal	0	6	0
Provisional Instream Habitat Integrity			35,8

Table 10: Results of the IHI assessment for watercourse B.

	Impact score, Pre-development	Weight	IHI Score, Pre-development
Instream criteria			
Water abstraction	25	14	14
Flow modification	25	13	13
Bed modification	25	13	13
Channel modification	25	13	13
Water quality	25	14	14
Inundation	15	10	6
Exotic macrophytes	0	9	0
Exotic fauna	0	8	0
Solid waste disposal	20	6	4,8
Provisional Instream Habitat Integrity			22,2

3.4 Recommended Ecological Category

Watercourse B was found to fall within a high IHIA Category E and the watercourse C was found to fall within a Category F; (refer to section 3.3.1). While all natural watercourses are recommended to fall within a Category D or better, this is not practically achievable in this case as a result of the extreme degree of historical transformation of the three watercourses within the study area.

Watercourse B could be de-canalised and reshaped, but given the hardened catchment and resultant increase in runoff of storm peak flows, this would likely result only in a heavily eroded earth channel which may receive a lower score than the current Category E. It is likewise impossible to improve watercourse C as this would require removing the artificial augmentation and restoring the natural flow from Watercourse B. The increased runoff and storm peak flows due to catchment hardening would also most likely cause severe erosion that would not amount to an increase in PES.

Rehabilitation of either watercourse is therefore not practically possible without terrestrial rehabilitation of the majority of the urban catchment, which is not feasible at all. The REC for Canal B is therefore E, and Drainage Line C should be considered lost, with the apparent remaining remnant sustained entirely artificially.

3.5 Buffer Determination

Application of the Macfarlane (2016) method for determination of the minimum effective buffer for channel C found that a buffer of 15m was appropriate. In addition, the minimum effective buffer of 15m was found by application of the method to be appropriate for channel B as well (refer to Figure 20). The key factor that determined the buffer width was the lack of natural wetland habitat, and the extreme degree of transformation of the watercourses from their natural state. The method cannot be applied to the other watercourses, but should they be retained for stormwater drainage or aesthetic purposes, it is recommended that a 10m buffer be maintained along either bank to control erosion and limit other impacts.

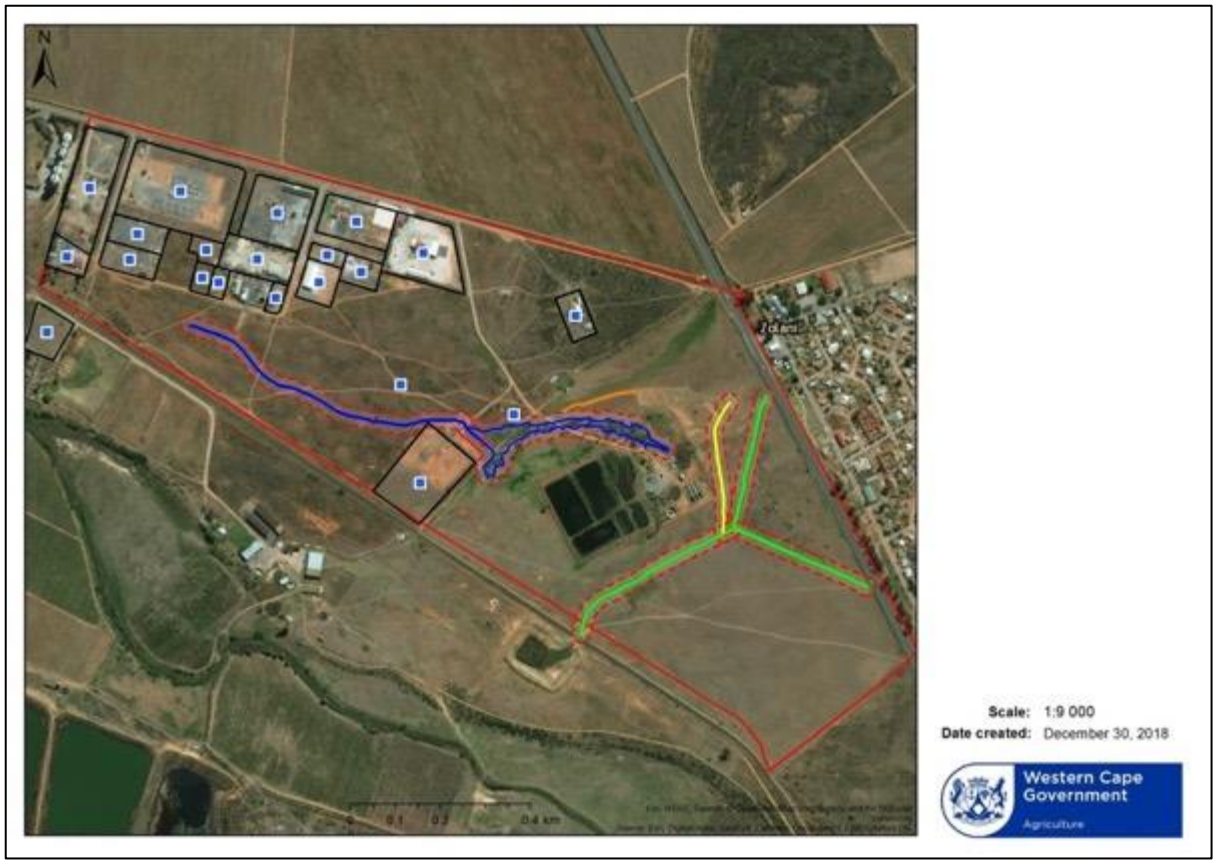

Figure 20: Minimum effective buffer of 15m applied to the assessed watercourses. A 10m buffer is applied to the channel A as an example of the buffer to be applied to any artificial channels that will be retained

4 Assessment of Impacts

4.1 Activity Description

Preferred and alternative layouts have been provided both of which adjoin the current cemetery. Both layouts fall within a portion of RE/71/158 that includes only Drainage Line C and no other watercourses within the study area are likely to be impacted directly. Both layouts consist largely of traditional internment areas (approximately 7ha) but the alternative layout also includes a 3ha memorial park that coincides with Drainage Line C. The preferred layout rather allows for 3ha of expansion of the WWTW. The preferred layout includes infilling and use of Drainage Line C for traditional graves.

The farmland will become part of the memorial park in both layouts and the continually flowing cattle feeding trough will cease to supply Drainage Line C with water. The planned upgrade and expansion of the WWTW also would negate the need for the overflow into Drainage Line C and the drainage line would then no longer have a water supply of any description and would cease to be a watercourse.

The only other activity that may be significant in terms of impact on watercourses and perhaps groundwater is the installation of graves. Each grave will produce approximately 30 litres of leachate high in bacteria and nutrients during the course of decomposition (Zychowski, et. al., 2015) which may in theory impact the Sarahsrivier and its floodplain wetlands downslope. However, since the site runoff will be retained on site within a retention pond, since floodplain wetlands are not typically fed by groundwater or interflow, and since the proposed site is separated from the floodplain wetlands by a railway line with a deep, largely impermeable foundation, the connectivity between the Sarahsrivier and the proposed site is likely extremely limited.

4.2 Direct Impacts

Advice is presently being sought from DWS as to whether any water use authorisation is required for the proposed development and it is the opinion of the specialist that no water use authorisation should be required. It is however a requirement of the WUL application process that potential impact on the four characteristics be determined and these have been addressed in case the WUL or GA process is in fact required.

- Impact on the flow regime;
- Impact on the water quality;
- Impact on biota – the animal and plant life of a particular region or habitat;
- Impact on wetland and riparian habitat.

These four potential direct impacts therefore formed the foundation of the impact assessment and no additional potential impacts were identified.

4.2.1 Impact 1 – Impact on the flow regime

4.2.1.1 Construction Phase

Clearing of vegetation for construction of the proposed development would likely increase runoff from the proposed development, but runoff presently percolates into the soil rapidly within this site and does not enter a watercourse. It is unlikely that the increased runoff from clearing will cause runoff to enter a watercourse and no impact is therefore likely on a watercourse.

Drainage Line C will lose its hydrological input from the sewage works and from the overflowing drinking trough, but neither of these is likely to be sustainable in any case, so the impact on the flow regime within this watercourse is equivalent to the 'no-go' scenario. The flow regulation function currently filled by Drainage Line C will be filled and improved on by the upgraded WWTW. The impact significance is therefore Very Low (negative) for both layouts, with and without mitigation.

Essential Mitigation Measures

- Clear and construct in summer when rainfall is minimal.

4.2.1.2 Operational Phase

The operational phase impact is similar to the construction phase impact in that hardened infrastructure increases runoff. All runoff will however be directed into a stormwater retention pond and not into any watercourse. The only potential impact is a reduction in groundwater or interflow recharge, but this is not likely to be significant. All impact significance ratings for both layouts and both construction and operational phases are Very Low (negative) for this impact.

Essential Mitigation Measures

The following mitigation measures are considered essential:

- Direct all stormwater into the retention pond.
- Construct the retention pond from permeable materials such that maximum groundwater/interflow recharge still occurs.

4.2.1.3 Results

Impact I: Impact on the Flow Regime					
	Intensity	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**
Construction Phase - Preferred Layout					

Without mitigation	Very Low	Local	Short term	Very Low	Very Low (-ve)
With mitigation	Very Low	Local	Short term	Very Low	Very Low (-ve)
Construction Phase - Alternative Layout					
Without mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
With mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
Operational Phase - Preferred Layout					
Without mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
With mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
Operational Phase - Alternative Layout					
Without mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)
With mitigation	Very Low	Local	Long term	Very Low	Very Low (-ve)

4.2.2 Impact 2 – Impact on Water Quality

4.2.2.1 Construction Phase

Clearing for the construction phase would expose sediment for erosion which may increase sediment in the runoff from the site. Landscaping within the parkland area (Alternative Layout) may add nutrients to Drainage Line C. The impact is therefore limited by the fact that the watercourse is no longer natural and by the fact that the sewage works most likely provides a greater nutrient load than the vegetation can utilise, such that an increase in nutrients will not result in a further increase in the level eutrophication. The impact significance for the construction phase was therefore Very Low (negative) for both layouts.

Essential Mitigation Measures

- No mitigation is required.

4.2.2.2 Operational Phase

Routine use of compost and fertilizer in the landscaped area (Alternative Layout) and the presence of laterite roads and pathways (if used) would result in increased nutrient load (particularly phosphates and nitrates) in runoff, which may enter Drainage Line C. The intensity of the impact within Drainage Line C is limited by the fact that the watercourse is no longer natural and by the fact that the sewage works most likely provides a greater nutrient load than the vegetation can utilise, such that an increase in nutrients will not result in a further increase in the level eutrophication. The duration is also limited by the fact that the now artificial watercourse will cease to exist once the WWTW is upgraded and overflow is no longer necessary. Given the Preferred Layout, no water quality impact is likely on Drainage Line C as it will be infilled.

The presence of graves may increase the nutrient load within interflow and/or groundwater. This impact is however limited by the small volume of leachate that each grave can produce, by the phased input of graves and by the limited and indeed questionable hydrological connection between the proposed site and the Sarahsrivier previously discussed. The impact significance was determined to be of Very Low (negative) significance for both layouts.

Essential Mitigation Measures

- No mitigation required.

4.2.2.3 Results

Impact 2: Impact on Water Quality					
Alternatives	**Intensity**	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**

Construction Phase					
Preferred Layout	Very Low	Local	Short Term	Low	Very Low (-ve)
Alternative Layout	Very Low	Local	Short Term	Low	Very Low (-ve)
Operational Phase					
Without mitigation	Very Low	Local	Short Term	Medium	Very Low (-ve)
With mitigation	Very Low	Local	Short Term	Medium	Very Low (-ve)

4.2.3 Impact 3 – Artificial Wetland and Riparian Habitat

4.2.3.1 Construction Phase

All artificial wetland and riparian habitat within Drainage Line C will be permanently lost to infilling during the construction phase if the Preferred Layout is approved. The artificial wetland and riparian habitat will however be retained in part if the Alternative Layout is approved, but only until the WWTW ceases releasing overflow, which is likely to occur during or before the construction phase in any case. The Alternative Layout therefore has only the advantage in terms of freshwater impact, that the artificial wetland and riparian habitat may be allowed to linger a little before its inevitable demise. The impact intensity was marginally higher for the alternative layout, but this was not sufficient to increase the impact significance which was Very Low (negative) for both.

Essential Mitigation Measures

The artificial wetland and riparian habitat will be lost with or without this development taking place, so mitigation is not appropriate.

4.2.3.2 Operational Phase

There is not likely to be any riparian or wetland habitat during the operational phase, so no operational phase impact is likely.

Essential Mitigation

- No mitigation is appropriate.

4.2.3.3 Results

Impact 3: Impact on Riparian Habitat					
Alternatives	**Intensity**	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**
Construction Phase					
Preferred Layout	Low	Local	Short term	Very Low	Very Low (-ve)
Alternative Layout	Very Low	Local	Short term	Very Low	Very Low (-ve)
Operational Phase					
Preferred Layout	Not Applicable				
Alternative Layout	Not Applicable				

4.2.4 Impact 4 – Impact on Biota

4.2.4.1 Construction and Operational Phases

Limited wetland and riverine biota is likely to inhabit the watercourse, given the degraded, eutrophic nature thereof and impact thereon is likely to be extremely limited during both the construction and operational phases and is limited to incidental deaths. No mitigation is required. The impact significance is extremely low for both proposed layouts, although it is lower where the parkland around Drainage Line C is landscaped rather than developed.

4.2.4.2 Results

Impact 4: Impact on Biota					
Alternatives	**Intensity**	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**
Construction Phase					
Preferred Layout	Very Low	Local	Short term	Very Low	Very Low (-ve)
Alternative Layout	Low	Local	Short term	Low	Very Low (-ve)
Operational Phase					
Preferred Layout	Very Low	Local	Long term	Very Low	Very Low (-ve)
Alternative Layout	Very Low	Local	Long term	Very Low	Very Low (-ve)

4.3 'No Go' Scenario

The 'No Go' scenario would likely result in complete loss of Drainage Line C as soon as the WWTW and overflowing drinking troughs cease to supply water to the watercourse. The impact on groundwater and interflow would improve however given that the effluent currently released into Drainage Line C which soaks away into the ground would not be released after the WWTW upgrade. Overall the loss of artificial wetland was found to be in an Low (negative) impact significance category in isolation, but reduction of effluent input into groundwater reduced the overall impact significance to Very Low (negative),

	Intensity	**Extent**	**Duration**	**Probability of impact occurring**	**Significance**
'No Go Scenario'	Very Low	Local	Permanent	Definite	Very Low (-ve)

4.4 Indirect Impacts

No indirect impacts were identified.

4.5 Cumulative Impacts

No cumulative impacts were identified.

5 Conclusion and Recommendation

Five watercourses were identified and delineated including a recently excavated artificial drainage channel (A), a formal stormwater canal system (B), a remnant portion of a natural drainage line (C), now fed almost entirely by a sewage works and continuously overflowing cattle trough, a remnant portion of natural drainage line (D) that has been cut off from its catchment, partially infilled and no longer function as a drainage line, and one artificial wetland area (E) that is, in the opinion of the specialist, entirely unnatural.

Watercourse D was found to no longer function as a watercourse and cannot in the opinion of the specialist be reinstated given the scale of the changes in the catchment and watercourse and is therefore, in the opinion of the specialist, no longer a watercourse. According to aerial imagery, the watercourse appeared during 2013 and is in the opinion of the specialist, likely the result of a burst pipe. Only watercourses A, B and C were assessed further.

Watercourses B and C were therefore evaluated by best practice methods to determine current (pre-development) Present Ecological State (PES). Watercourse C fell within the IHIA Category F, while watercourse B was found to fall within a category E.

The degree of transformation of the two watercourses and their catchments was such that neither can practically achieve a higher category than the present state and were therefore assigned an REC equal

to their current PES. Application of the best practice method for determination of an appropriate minimum buffer found that a buffer of 15m would be appropriate for watercourses A, B, and C.

The potential impacts of the two proposed layouts was then assessed on the watercourses B and C. B was found to be too far from the proposed layouts to be impacted, while C falls within both layouts. The preferred layout includes Watercourse C within the proposed parkland, while the preferred layout proposes infilling and installation of graves over Watercourse C. This watercourse has however been cut off historically from its catchment in its entirety and would not exist if not for augmentation from the WWTW and an overflowing cattle trough. The overflowing cattle trough, presently fed by a hose from a municipal water main, falls within the proposed site for both layouts and will be shut down as part of the development. The WWTW augmentation will also cease after the sewage works is upgraded. Once the two artificial water sources no longer supply the watercourse, it will cease to exists. The riparian and wetland vegetation will most likely die off rapidly, and this area will become entirely terrestrial in nature.

The potential impact of leachate from graves on the Sarahsrivier and its floodplain wetlands downslope was also assessed. Given that the proposed sites for the two layouts do not produce runoff that enters the Sarahsrivier, that floodplain wetlands are usually supplied primarily by the river and not by groundwater or interflow, given that the railway line between the river and the proposed sites forms a substantial barrier to subsurface flow and given the phased installation of graves over several years, it is unlikely that much leachate will reach the Sarahsrivier over 400m away, if at all. The impact significance for this potential impact was therefore found to be Very Low (negative) regardless of the layout.

There is therefore no material difference between the two proposed layouts in terms of freshwater constraints and both layouts were found to be of Very Low (negative) impact for every impact assessed, with or without mitigation where mitigation has been provided. The provided mitigation measures will reduce impact however within the Very Low category, and it is therefore recommended that the proposed development be approved on condition that the proposed mitigation measures be implemented.

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Appendix 1 – Impact Assessment Criteria

The criteria used to determine impact consequence are presented in the tables below.

Table 1: Description of criteria considered when assessing potential impacts.

CRITERIA	DESCRIPTION OF ELEMENTS THAT ARE CENTRAL TO EACH ISSUE	
Extent or spatial influence of the impact	SITE SPECIFIC	Site specific/Local: Extends only as far as the activity
	LOCAL	Limited to the site and its immediate surroundings
	REGIONAL	Regional/Provincial: Will have an impact on the region/province
Duration of impact	SHORT TERM	Construction phase
	MEDIUM TERM	Operational phase
	LONG TERM	Where the impact will cease after the operational or working life of the activity, either due to natural processes or by human intervention
	PERMANENT	Where mitigation or moderation by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient or temporary
Intensity of impact	VERY LOW INTENSITY	Natural, cultural and social functions and processes are not affected
	LOW INTENSITY	Affects the environment in such a way that natural, cultural and social functions and processes continue, although in a slightly modified way
	MEDIUM INTENSITY	Affects the environment in such a way that natural, cultural and social functions and processes continue, although in a modified way
	HIGH INTENSITY	Natural, cultural or social functions or processes are altered to the extent that they will temporarily or permanently cease
Probability of impact occurring	LOW	Improbable
	MEDIUM	Probable
	HIGH	Highly probable
	DEFINITE	Impact will occur regardless of any prevention methods
Determination of significance		
	LOW	The impacts will have a minor or insignificant influence on the watercourse.
	MEDIUM	The impacts will have a moderate influence on the watercourse. The impact can be ameliorated (lessened or improved) by a modification in the project design or implementation of effective mitigation measures.
	HIGH	The impacts will have a high influence on the watercourse. The impact can be ameliorated (lessened or improved) by a modification in the project design or implementation of effective mitigation measures. Should have an influence on decision, unless it is mitigated
	VERY HIGH	The impacts will have a major influence on the watercourse. The impacts could have the no-go implications on portions of the development regardless of any mitigation measures that could be implemented. Influence decision, regardless of any possible mitigation.

SIGNIFICANCE RATING	LIST OF CRITERIA USED IN ASSIGNING A SPECIFIC SIGNIFICANCE RATING		
	INTENSITY	**EXTENT**	**DURATION**
Very High	High	National	Permanent / Long Term
	High	Regional	Permanent / Long Term
	Medium	National / Regional	Permanent
High Significance	High	Regional	Medium Term
	High	National	Short Term

SIGNIFICANCE RATING	LIST OF CRITERIA USED IN ASSIGNING A SPECIFIC SIGNIFICANCE RATING		
	INTENSITY	**EXTENT**	**DURATION**
	High	Local	Long Term / Permanent
	Medium	National	Medium Term
	Medium	Regional	Long Term
Medium Significance	High	Local	Medium Term
	Medium	Local	Permanent
	High	Regional	Short Term
	Medium	National	Short Term
	Medium	Regional	Medium Term
	Medium	Local	Long Term / Permanent
	Low	National	Medium Term
	Low	Regional	Long Term
Low Significance	High	Local	Short term
	Medium	Local	Short Term / Medium Term
	Medium	Regional	Short Term
	Low	National	Short Term
	Low	Regional	Medium Term
	Low	Local / Site specific	Long Term
	Low	Local	Permanent
Very Low Significance	Very Low	Local	Long Term / Permanent
	Low	Local	Short term
	Low	Site specific	Medium / Short Term
	Very low	Site specific / Local	Short Term