Freshwater Consulting

Basic Assessment of freshwater ecosystems impacted by services to Founder Estates, Boschendal

August 2022

DRAFT REPORT

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Submitted to: Chand Environmental Consultants

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1 Introduction

1.1 Background and Approach

The Freshwater Consulting Group (FCG) was approached by Chand Environmental Consultants to provide freshwater ecological input to a Basic Assessment (BA0 of the proposed sub-division and development of a number of Founders' Estates (FEs) on a portion of the landholdings of Boschendal (Pty) Ltd (the proponent), Stellenbosch Municipality. The Founders' Estates comprise 18 farms of approximately 25ha each, with each one having an "Excluded Area" of 8000m², within which a homestead may be developed. A Developable Area (DA) has been provisionally defined within each Excluded Area, ranging from 1200m² to 2400m². The final positions for all Developable Areas will be determined at a later stage, and will be subject to a future environmental authorisation process, if required.

In the interim, the proponent intends to proceed with installation of services and roads to the 18 FEs. The siting and routing of infrastructure proceeded with the aim of remaining within existing roads, road shoulders and side drains. The scope of this BA includes the following:

- A new bulk foul sewer line, bulk water pipelines and rising main, stormwater infrastructure (swales and culverts) and fibre internet ducts;
- Expansion of existing electricity and irrigation lines;
- Formalisation of some existing farm roads;
- Development of new sections of road;
- Construction of a new 100kl reservoir and new sewer pump station, and
- Upgrading of a sewer pipeline and installation of a new water pipeline external to the Founder Estates, in order to connect to the municipal network.

FCG has worked on several assessments on the Boschendal Estate, including a broad-scale Constraints Analysis of the whole site, and a number of individual Basic Assessments (BAs) and Water Use Licence Authorisations (WULAs). This report adds further detail to these previous assessments, but focusing on the infrastructure associated with the Founders Estate development.

1.2 Brief and study approach

Specifically, the terms of reference for the Environmental Impact Assessment, and the approach followed, were as follows:

- Site visit to undertake visual scans of the affected freshwater ecosystems. Initial site visits were made on the 1st and 3rd September and 14th October 2020, with follow-up site visits on 25th September and 5th October 2021 to assess specific locations and ecosystems, and to ensure that all aquatic ecosystems within the regulated area specified by NEMA and for water use authorisation have been identified. Site visits allowed the identification and classification of the inland aquatic ecosystems according to the National Wetland Classification System (Ollis *et al.*, 2013), and the assessment of ecological importance and sensitivity (EIS) and present ecological state (PES) according to nationally accepted protocols.
- Describe and assess the impacts associated with the construction and operation of the proposed development activities. The impacts associated with the construction and operation of the proposed services were described. The impacts were assessed according to the criteria

recommended for EIAs, and mitigation measures to reduce the severity of the negative impacts and to enhance the positive impacts were recommended.

- Water Use Authorisation: A network of watercourses, riparian areas and wetlands is located on Boschendal Estate, and many of these may be impacted by the proposed services infrastructure. A risk assessment was completed for each of inland aquatic ecosystem (wetland or watercourse) affected by the proposed activities, addressing the possible impacts of the development on these ecosystems. The risk assessment matrix is as provided in Government Notice 509 of August 2016.
- Write a Basic Assessment report, incorporating all of the information described above.

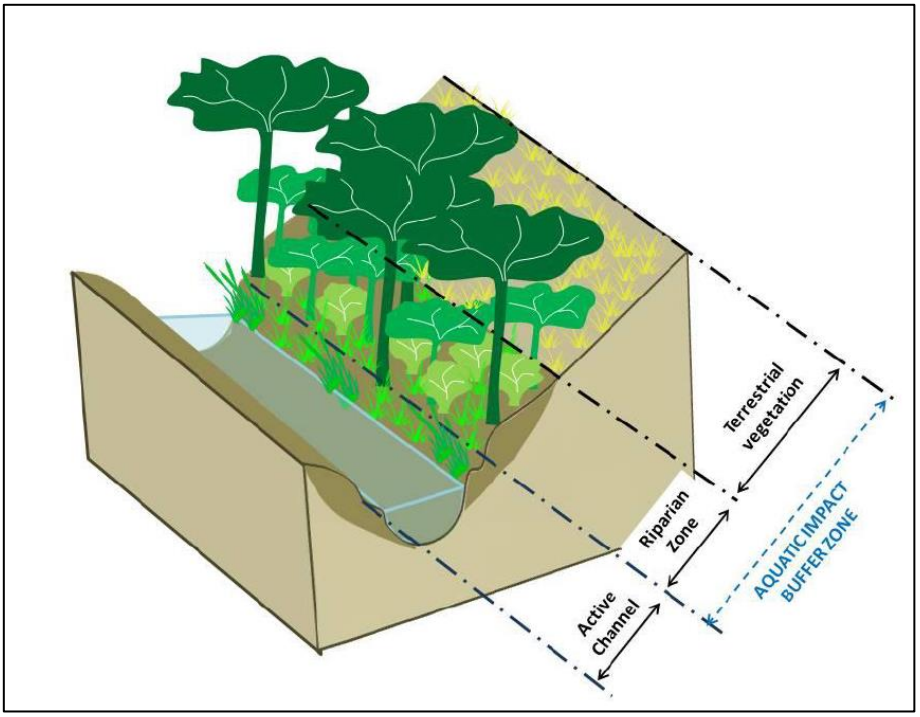


Figure 1.1 Schematic diagram indicating the boundary of active channel and riparian habitat, and the areas potentially included in an aquatic impact buffer zone (MacFarlane and Bredin, 2017). The buffer (measured from the edge of the active channel) protecting a watercourse must include the riparian zone, and can extend into terrestrial vegetation.

1.3 Definitions

The following definitions from the National Water Act (1998) are adhered to in this report:

- Watercourse:
    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 watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;
- Wetland:
    - 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 areas or zones (see Figure 1.1):

- Includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

1.4 Limitations

The Developable Areas (DAs) are excluded from this assessment, as these will be subject to a separate environmental application/s, if required, once defined.

Mapping was done with a hand-held GPS in order to save time and costs. Accuracy is estimated as being approximately 2-3m. All buffers and regulatory zones shown on maps in this report were measured as a horizontal distance using GIS software, and not surveyed in situ. It is recommended that these lines be surveyed in detail and demarcated on all plans, prior to development of the proposed infrastructure.

Delineation of wetlands was done using the indicators described in the DWAF (2005) guidelines for delineation of wetlands and riparian areas. Primary data were not collected from the aquatic ecosystems, however, the visual assessments done for this baseline assessment, and historical data collected on Boschendal Estate since 2005, are considered sufficient for the purposes of this project.

1.5 Use of this Report

This report reflects the professional opinions of its author. It is the policy of FCG that the full and unedited contents of this report should be presented to the client, and that any summary of the findings should only be produced in consultation with the author.

1.6 Declaration of Independence

This is to confirm that Kate Snaddon, the specialist consultant who is responsible for undertaking this study and preparing this environmental impact assessment report, is independent, and has no vested interests, financial or otherwise, in the development under consideration. A signed declaration is included in Appendix 1.

1.7 Specialist Details

The author of this report is an independent specialist consultant, with 25 years of experience in the field of freshwater ecology, registered with the South African Council for Natural Scientific Professions (Ecologist, registration number 400225/06). A Curriculum Vitae is included in Appendix 2.

2 Description of the site

Boschendal Estate is located in quaternary catchment G10C, in the Berg River Water Management Area, and the Stellenbosch Municipality. This catchment has a mean annual rainfall total of 1200 mm per annum, and lies in a high rainfall intensity zone (*sensu* Schulze, 2007).

The Boschendal Estate comprises a number of farms covering an area of approximately 1800 ha on either side of the Helshoogte Road (R310) which passes from Stellenbosch, *via* Johannesdal and Pniel, to the R45. The FEs are located only on the northern side of the R310, on the slopes of the Simonsberg Mountain. The Estate falls within two ecoregions known as the south western coastal belt and the southern folded mountains (from Kleynhans *et al.*, 2005a). The main attributes of these ecoregions are provided in Table 2.1.

Table 2.1 Main attributes of the ecoregions that intersect with the study area (from Kleynhans *et al.*, 2005a).

Ecoregion	Terrain morphology	Dominant vegetation types	Altitude	Mean Annual Precipitation	Rainfall seasonality
South Western Coastal Belt	Moderate relief plains; Closed hills; Mountains	West Coast Renosterveld; Sand Plain Fynbos; Mountain Fynbos	Mainly 0-300 mAMSL; hills up to 900 mAMSL	0 to 1500 mm/year	Winter
Southern Folded Mountains	Closed hills; Mountains; Moderate and High Relief	Mountain Fynbos, Grassy Fynbos and Little Succulent Karoo predominant	Mainly 300-1900 mAMSL	100 to 1500 mm/year	Very late summer to winter to all year

The underlying geology of the Dwars River Valley, in which most of the Estate lies, is dominated by granites of the Stellenbosch Pluton of the Cape Granite Suite, while the surrounding mountains comprise quartzitic Table Mountain Group sandstones (Parsons, 2010). The bed of the Dwars River is made up of quartzite cobbles and boulders that have been carried down the valley by the river and its tributaries.

Historically, the vegetation across much of the Estate would have been Boland Granite Fynbos (Skowno *et al.*, 2019), with Swartland Alluvium Fynbos, which is typical of riverine valley floors and floodplains, around the Dwars River (Rebelo *et al.*, 2006). The Boland Granite Fynbos is an endangered vegetation type found in the Dwars River Valley and on the surrounding mid-slopes, while the Swartland Alluvium Fynbos is also considered endangered (Skowno *et al.*, 2019). The streams that flow across the northern portion of the Estate, some of which flow past or through FEs, rise on the upper slopes of the Simonsberg Mountain, where the critically endangered Kogelberg Sandstone Fynbos is found.

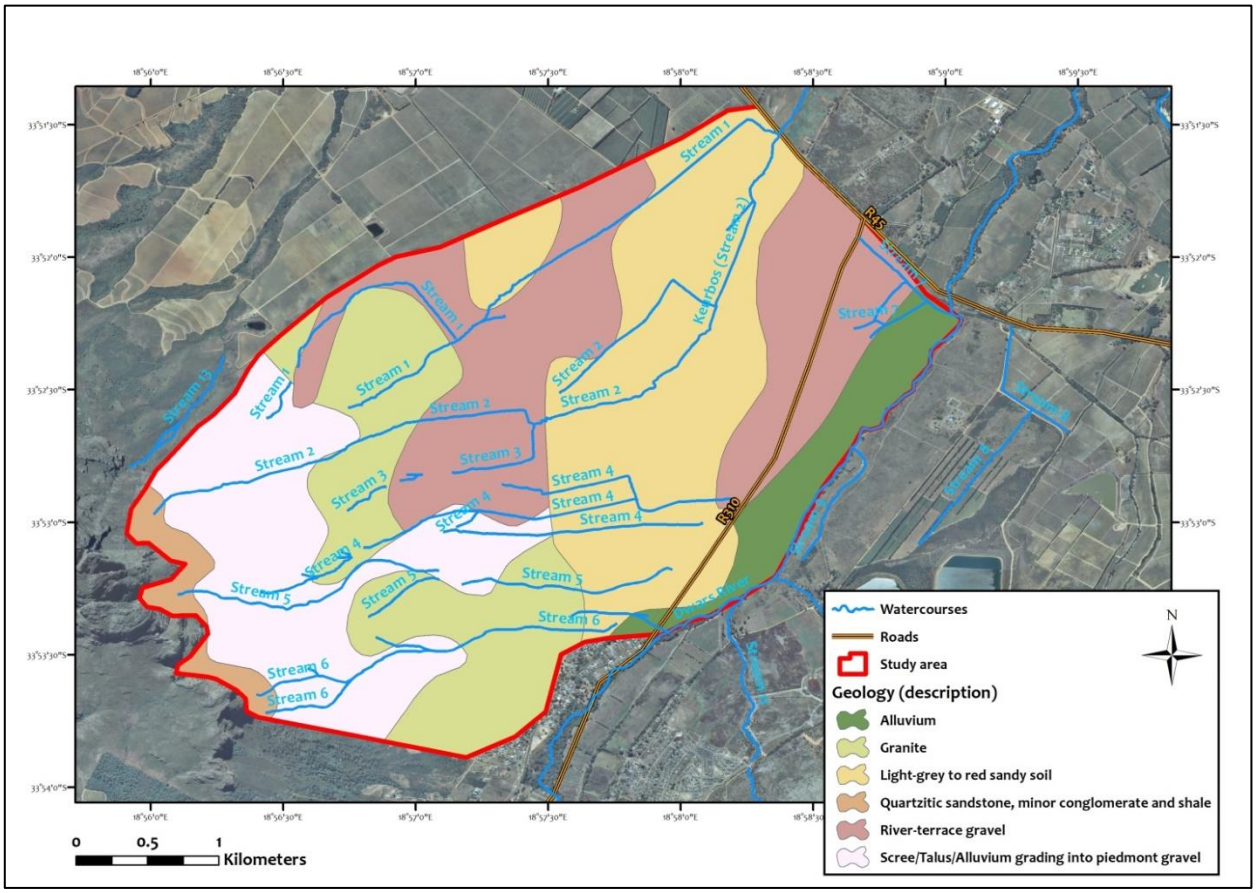


Figure 2.1 **Descriptions of the underlying geology on Boschendal Estate, north of the R310.**

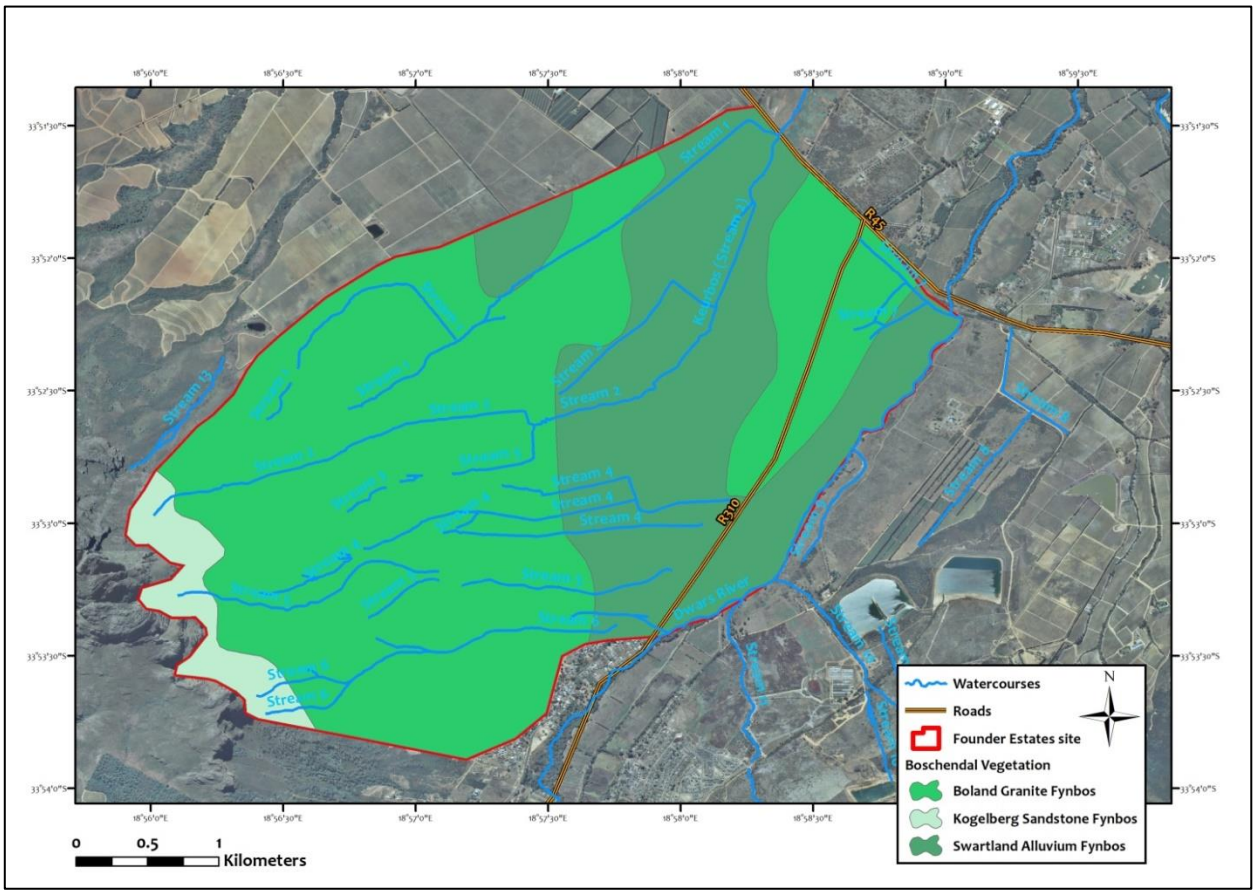


Figure 2.2 **Vegetation types on the Boschendal Estate north of the R310.**

Most of the Boschendal Estate north of the R310 has been heavily disturbed through agricultural activities (orchards and vineyards), road construction and use, holiday accommodation, residential houses and some industry. Very little of the original vegetation types remain, but most of it is located along the upper reaches of the streams flowing across the Estate, within the riparian areas around the streams. This can clearly be seen on the terrestrial sensitivity map prepared for Boschendal Estate north of the R310 (Figure 2.3.

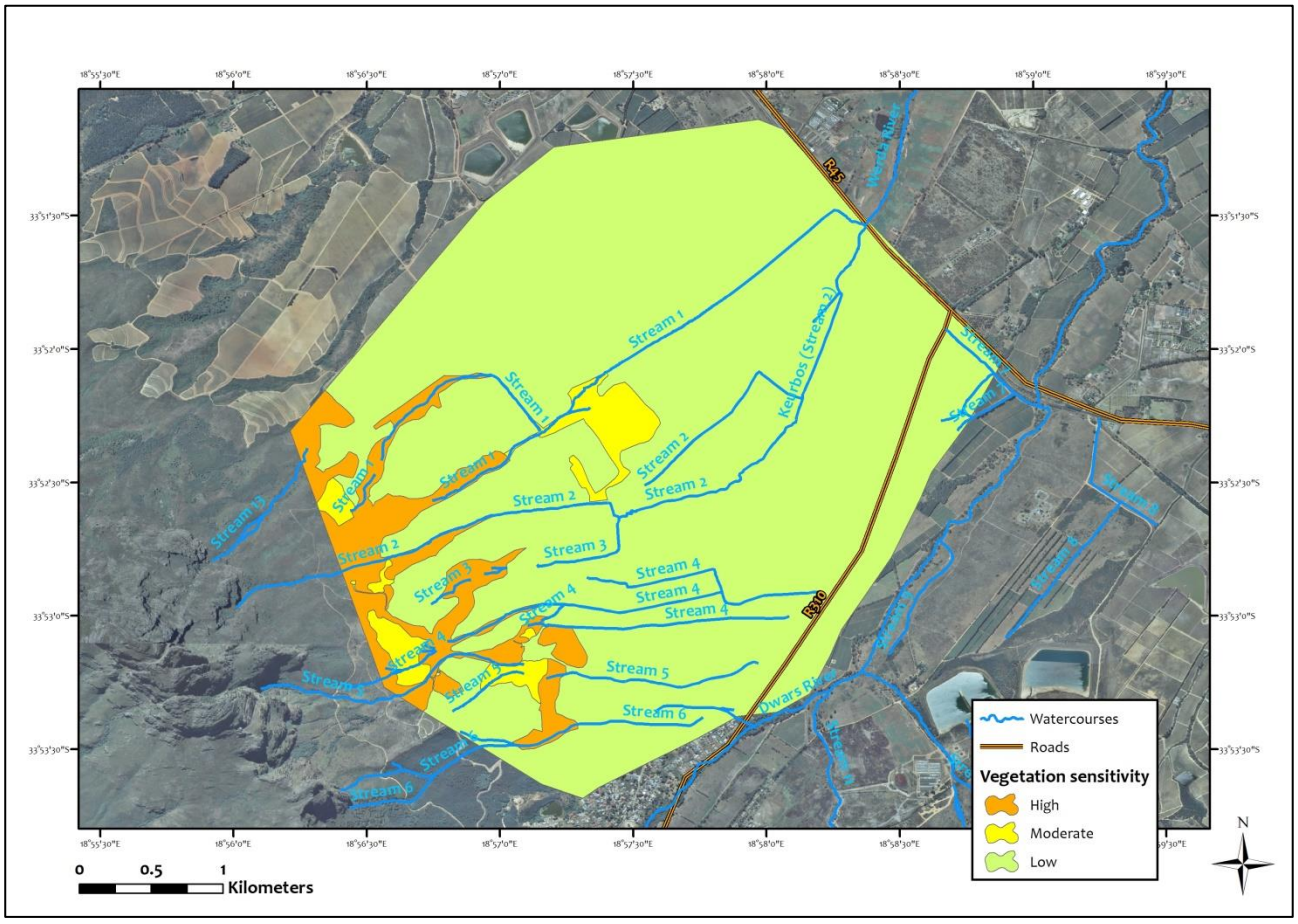


Figure 2.3 Terrestrial sensitivity map produced by the botanist for Boschendal Estate north of the R310.

The dominant aquatic ecosystem within the study area is the Dwars River, an important perennial tributary of the Berg River (Figure 2.4). This river is an upper foothill, cobble-bed system typical of the Fynbos Biome – instream habitat is typically riffle-run sequences with some pools and marginal vegetation. A number of small tributaries of the Dwars or Berg River flow through the Boschendal Estate. Those on the northern side of the R310 drain the Simonsberg Mountains, and many of these join to form a small tributary (Werda River) that flows directly into the Berg River. The watercourses on the southern side of the R310 originate on the Groot Drakenstein Mountains, and flow directly into the Dwars River. The streams on both sides of the Dwars River are relatively undisturbed in their upper catchments, arising on relatively pristine mountain slopes and with healthy riparian vegetation on the river margins. The watercourses are significantly altered from their natural state as soon as they flow into the cultivated areas – this is especially the case on the northern Simonsberg side – where exotic trees have invaded the riparian vegetation, and water quality is lower due to irrigation return-flows and polluted stormwater. Many of the streams enter farm dams located on the Boschendal Estate. There are numerous agricultural drains crossing the site, serving to channel surface water away from houses and fields.

There are a few wetlands on Boschendal Estate (Figure 2.4), some of which are associated with the agricultural drains and channels, while some are remnants of more extensive wetland areas, which have been impacted (drained or filled in) by the surrounding activities.

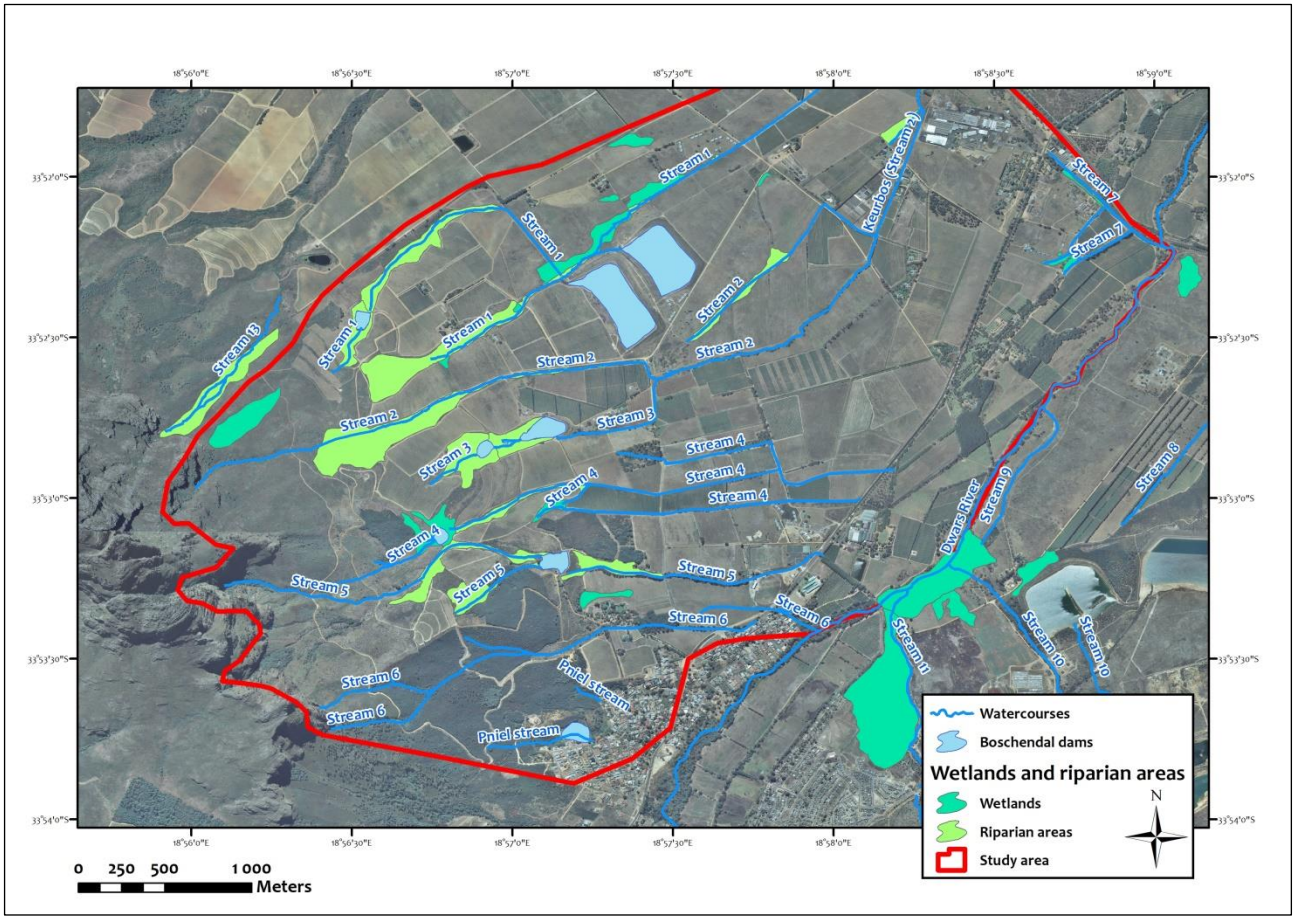


Figure 2.4 Wetlands, riparian areas and watercourses on Boschendal Estate, north of the R310.

For the purposes of this assessment, the study area (i.e. Boschendal Estate north of the R310) was divided into sub-catchments, according to the main watercourse running through it. There are seven sub-catchments (not all contain FEs), which are shown in Figure 2.5.

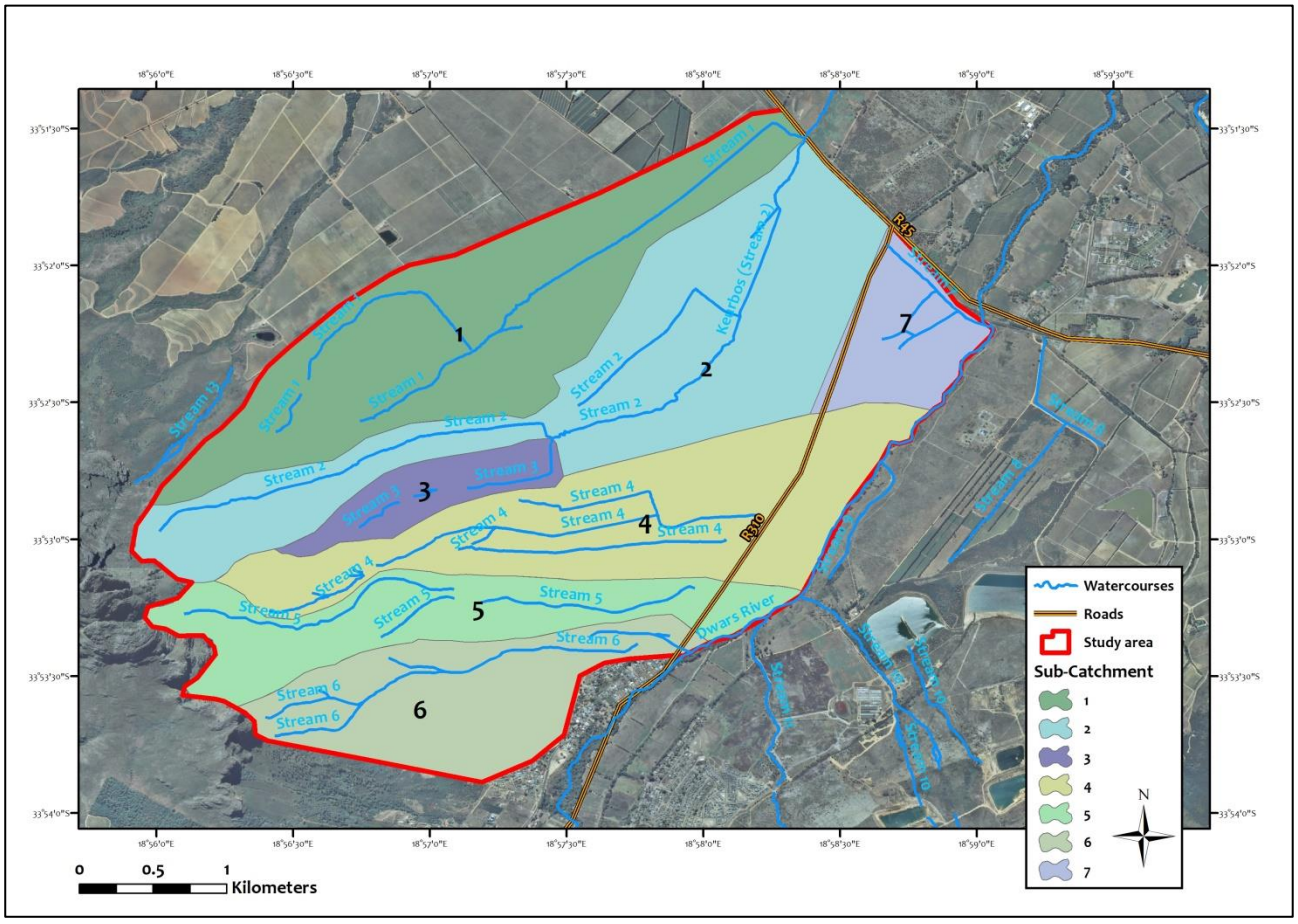
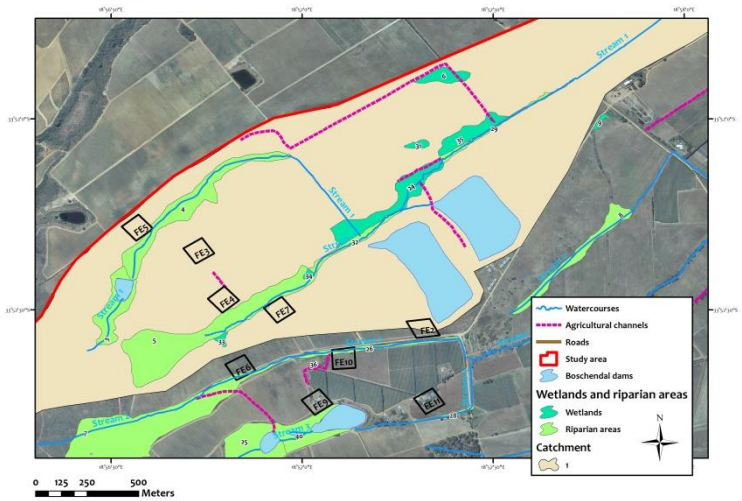
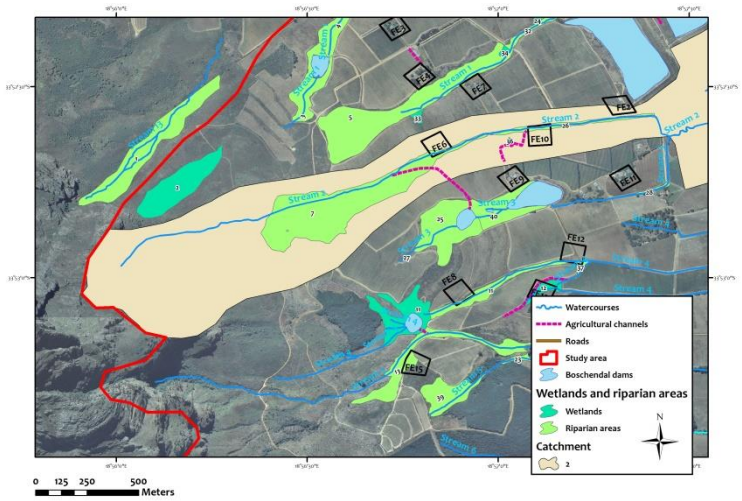


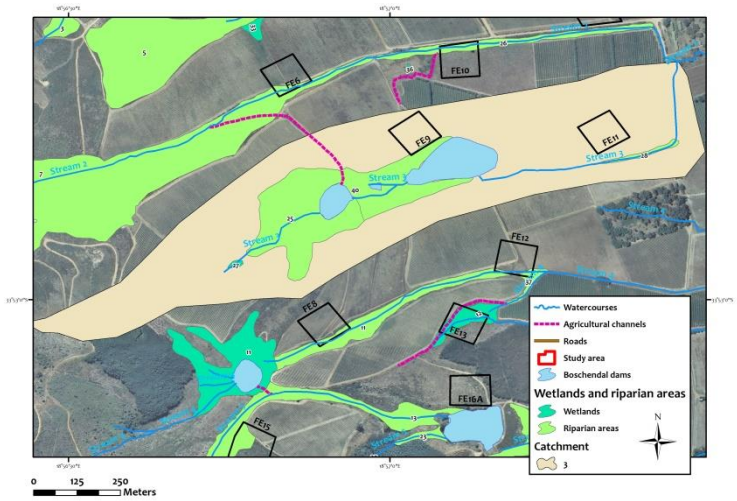
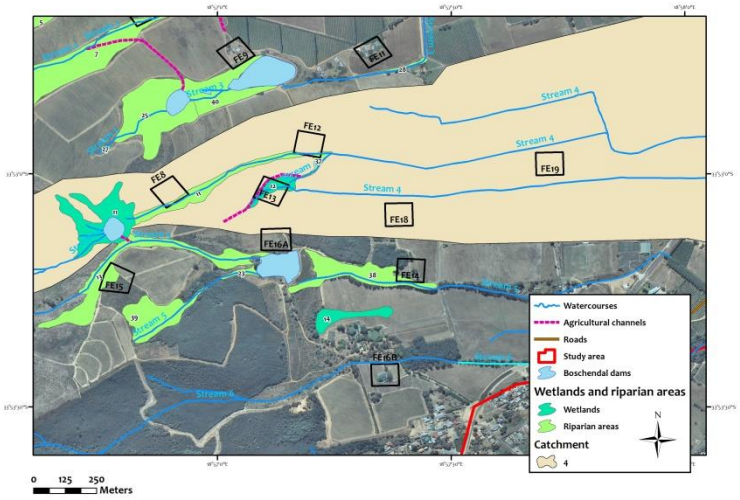
Figure 2.5 **Sub-catchments on Boschendal Estate, north of the R310. Not all catchments contain proposed FEs and/or services infrastructure).**

3 Description of the affected inland aquatic ecosystems

The inland aquatic ecosystems located in the six sub-catchments affected by the FE services development are listed in Table 3.1. More detailed information on the watercourses and wetlands, and their condition and importance, is included in Section 4.2.2.

Table 3.1 Summary list of inland aquatic ecosystems in each of the six sub-catchments affected by the FE services development.

Sub-catchment	Watercourses affected by FE development	Wetlands affected by FE development	FEs	Map
1	Two tributaries joining to form Stream 1, with riparian areas along the upper reaches of the watercourses Three farm dams	Two wetlands, one seep (#33) and one channelled valley-bottom wetland (#34) (additional valley-bottom wetlands located near the stream will not be impacted by the development	3, 4, 5 and 7	
2	Stream 2 with riparian areas, becoming the Keurbos Stream lower down the catchment. No dams.	One seep (#36)	2, 6, 10	

Sub-catchment	Watercourses affected by FE development	Wetlands affected by FE development	FEs	Map
3	Stream 3 with riparian areas around a farm dam	One small seep at the top of the catchment (#27)	9, 11	
4	Stream 4 with several tributaries and riparian areas. One farm dam	One extensive seep wetland around farm dam (#11), one seep on the FE13 site (#12)	8, 12, 13, 18, 19	

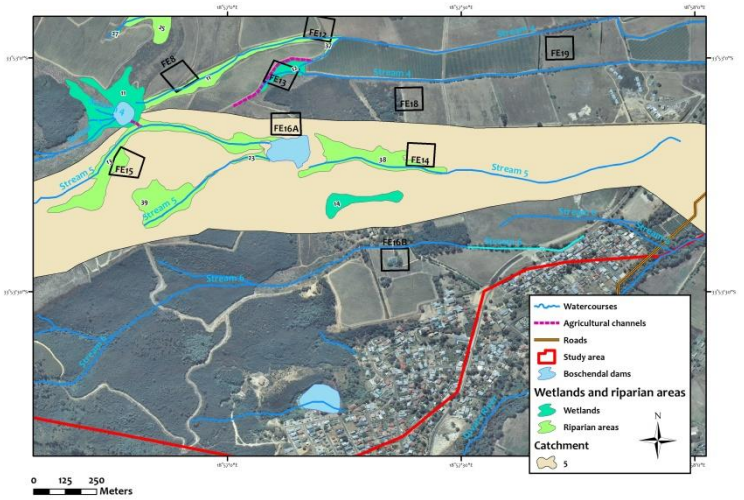
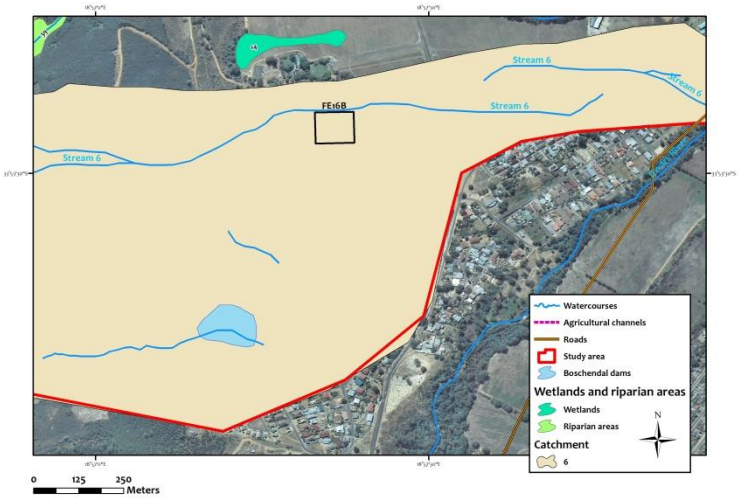
Sub-catchment	Watercourses affected by FE development	Wetlands affected by FE development	FEs	Map
5	Stream 5 with tributaries and riparian areas. One farm dam	One seep (#14)	14, 15, 16A	
6	Stream 6 with tributaries, plus small watercourses outside the Estate, close to dam above Pniel One dam in Pniel (outside the Estate)	No wetlands	16B	

Figure 3.1 (Top) Bracken and (bottom) tree species – *Kiggelaria africana* (middle), *Olea europaea* subsp. *africana* (right) and *Searsia angustifolia* (left) – typical of the riparian areas on Boschendal Estate. The *Seriphium plumosum* (slangbos) in the foreground is characteristic of more terrestrial vegetation.

4 Assessment of conservation importance of the affected inland aquatic ecosystems

4.1 Conservation Status and Ecological Sensitivity of the site

According to the National Freshwater Ecosystem Priority Area (NFEPA) project maps, the Dwars River sub-catchment is classified as a Phase 2 FEPA (Figure 4.1), while the remainder of the Estate has no FEPA catchment status. Phase 2 FEPAs include moderately modified rivers (C Present Ecological State (PES)), only in cases where it is not possible to meet biodiversity targets for river ecosystems in rivers that are still in good condition (A or B PES). The objective for Phase 2 FEPAs is not allow further degradation of rivers (Nel *et al.*, 2011).

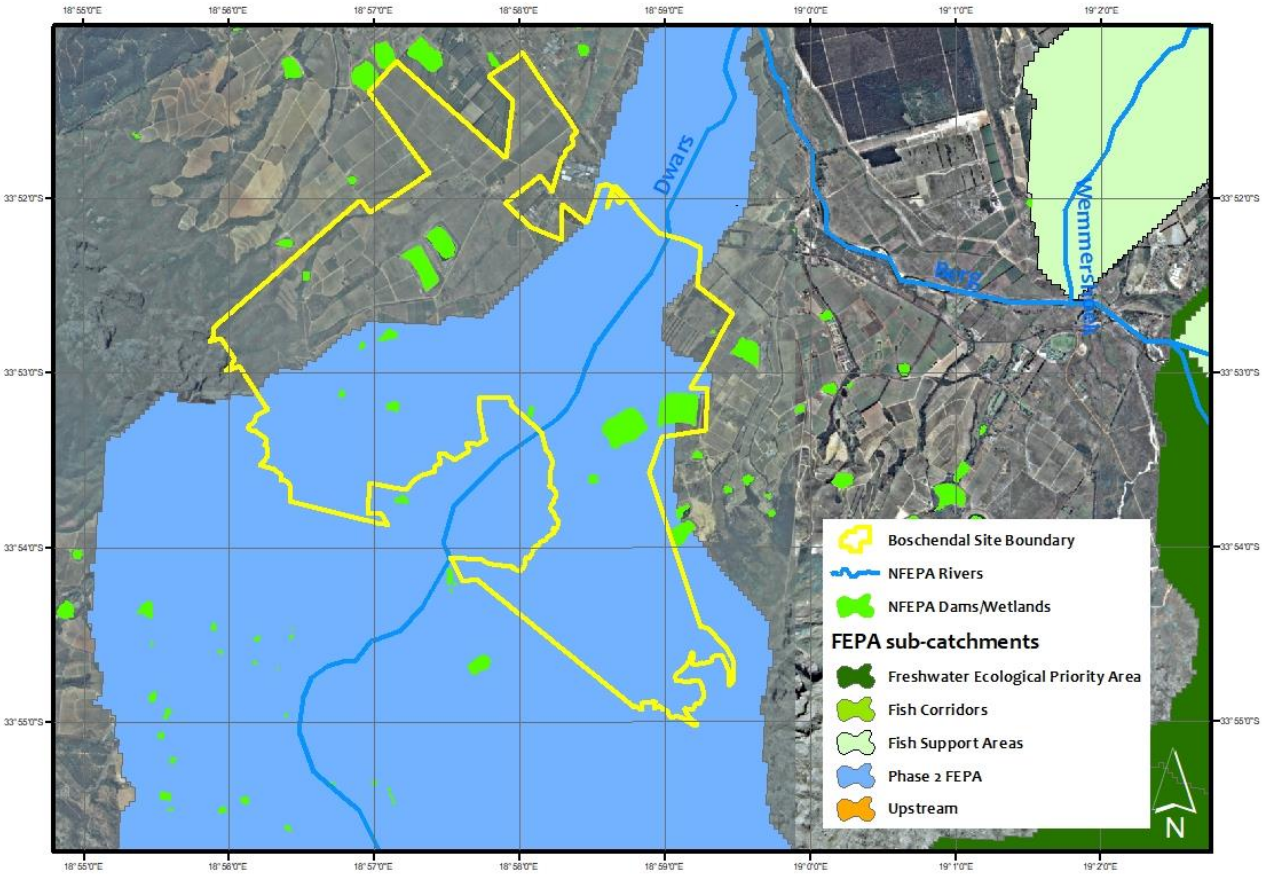


Figure 4.1 National freshwater priorities for the conservation of freshwater biodiversity and ecological processes in and around the Boschendal Estate. Adapted from the NFEPA map (Nel *et al.*, 2011).

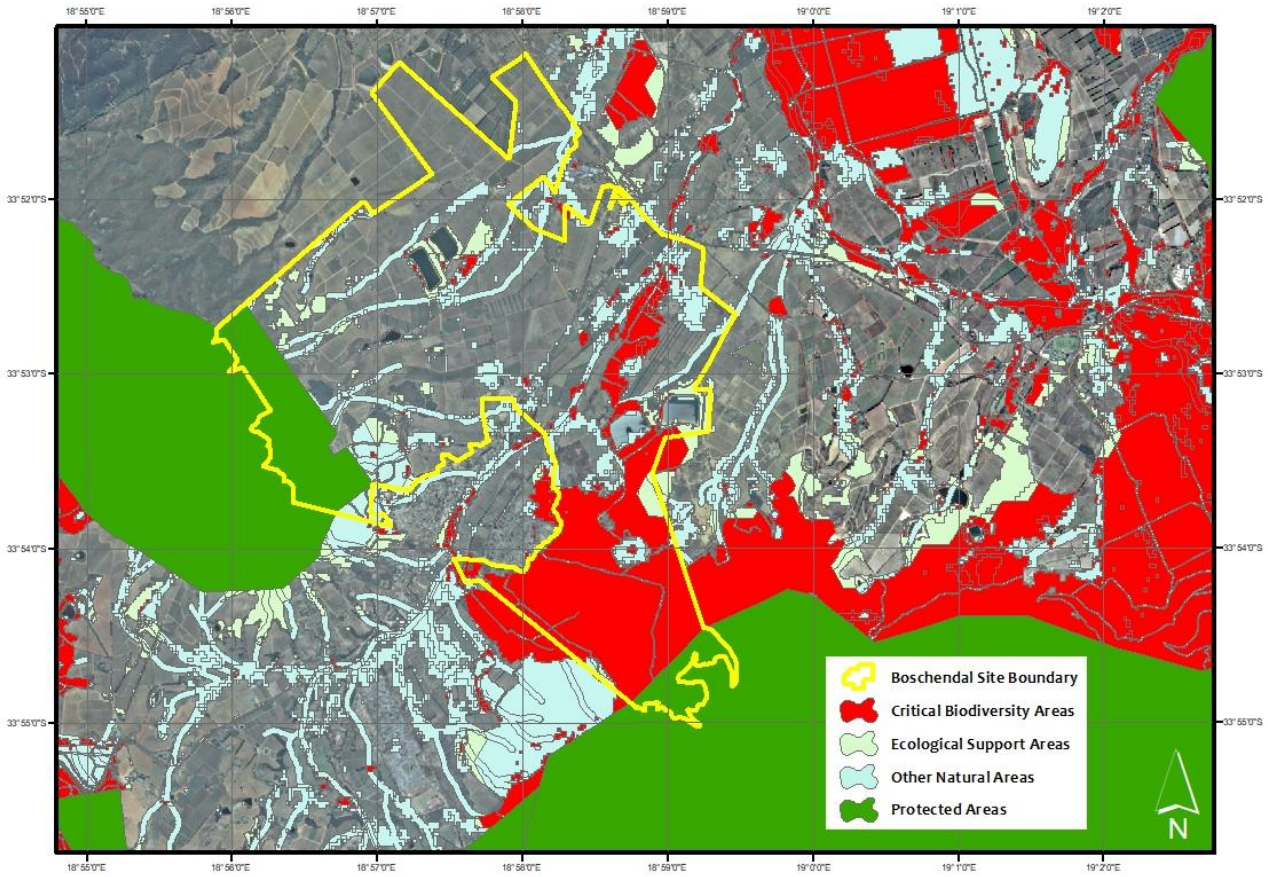


Figure 4.2 Map of Critical Biodiversity Areas, Ecological Support Areas and Protected Areas within and around the Boschendal Estate. Adapted from the Western Cape Biodiversity Spatial Plan (Pool-Stanvliet *et al.*, 2017).

The Western Cape Biodiversity Spatial Plan (Pool-Stanvliet *et al.*, 2017) identified large areas on the Boschendal Estate as Critical Biodiversity Areas, however these lie predominantly on the Drakenstein side of the property, south of the R310 (see Figure 4.2), and most of these CBAs are terrestrial. The watercourses and wetlands on the site are all categorised as Ecological Support Areas. The desired management objective for a CBA is "maintain natural land, rehabilitate to natural/near natural and manage for no further degradation" and for ESA is "maintain ecological processes".

The whole of Boschendal Estate lies within the Boland Surface Strategic Water Source Area (SWSA), as identified by Le Maitre *et al.* (2018). There is no current legislated protection of SWSAs, however, the Department of Fisheries, Forestry and the Environment's (DFFE) EIA Screening Tool considers these areas to be of very high aquatic sensitivity, requiring detailed impact assessment of aquatic impacts by an aquatic ecologist.

4.2 Present ecological status, ecological importance and sensitivity of the inland aquatic ecosystems

4.2.1 Methods

An assessment of the conservation importance of an inland aquatic ecosystem (i.e. watercourse or wetland) should combine assessments of both the present ecological state (PES) or integrity of the

ecosystem and its ecological importance and sensitivity (EIS). The *ecological integrity* of an ecosystem is defined as its ability to support and maintain a balanced, integrated composition of physico-chemical and habitat characteristics, as well as biotic components on temporal and spatial scales that are comparable to the natural characteristics of ecosystems of the region. The integrity of a system is directly influenced by its current state, and how much the system has been altered from the reference or unimpacted condition. The *ecological importance* of a freshwater ecosystem is an expression of its importance to the maintenance of ecological diversity (i.e. both species and habitat diversity) and functioning on local and wider scales. *Ecological sensitivity* (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Resh *et al.,* 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in an assessment of ecological importance and sensitivity. It is strongly biased towards the potential importance and sensitivity of a particular section of a stream or river, as it would be expected under *unimpaired* conditions.

4.2.1.1 Present Ecological State - watercourses

In the 1990s, the then Department of Water Affairs (now Department of Water and Sanitation, DWS) Resource Directed Measures (RDM) approach provided methods for the assessment of ecological integrity and of ecological importance and sensitivity, in the context of the determination of the ecological management class for riverine ecosystems as part of the Reserve Determination procedure (DWAF, 1999). This procedure could be followed at different levels of detail – desktop, rapid, intermediate and comprehensive. In 2005, the methods were revised during the development of the EcoClassification approach (Kleynhans *et al.*, 2005b), and the indices were reviewed. EcoClassification refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative the natural or close to the natural reference condition. This approach also allows for different levels of assessment, depending on time and budget, and the requirements of the assessment.

The rapid approach was followed for this study. Essentially this approach was based on assessment of existing impacts on two components of the river - the **riparian** zone and the **instream** habitat, using visual information.

Assessments were made separately for both components, but data for the riparian zone were interpreted primarily in terms of their potential impact on the instream component. Criteria within each component are pre-weighted according to the importance of each, and each criterion is scored between 0 and 25, with six descriptive categories ranging from 0 (no impact), 1 to 5 (small impact), 6 to 10 (moderate impact), 11 to 15 (large impact), 16 to 20 (serious impact) and 21 to 25 (critical impact). The criteria are provided in Table 4.1. The total scores for the instream and riparian zone components were used to place the river reach in a habitat integrity category (A – E/F) for both components (Table 4.2).

Table 4.1 Criteria used in the assessment of Present Ecological Status of watercourses (from Kleynhans, 1996).

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments.
Water quality modification	Originates from point and diffuse point sources. Measured directly or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Flow modification – floods and low flows	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic fauna	Invasion by exotic fauna will influence indigenous biodiversity, with possible knock-on effects for habitat quality and availability.
Solid waste disposal	This refers to litter and any other solid waste, i.e. a direct anthropogenic impact which may alter habitat structurally, obstruct flow, or have a direct impact on biota. Also a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the vegetated buffer will reduce its ability to protect the river from sediment and polluted runoff from the surrounding catchment. Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Riparian area habitat diversity is reduced, and timing and quality of food source (leaves, wood, etc) for aquatic biota altered.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 4.2 PES categories for watercourses (from Kleynhans, 1996).

Category	Description	Score (%)
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

4.2.1.2 Present Ecological State - wetlands

The WET-Health assessment methodology was developed for the assessment of the Present Ecological State (PES) of the hydrology, geomorphology, water quality and vegetation of wetlands (MacFarlane *et al.,* 2020). The method is based on the hydrogeomorphic (HGM) approach to wetland classification, providing a PES score for a wetland within each of the four modules – hydrology, geomorphology, water quality and vegetation - and a combined overall score. The score provides a quantitative measure of the extent, magnitude and intensity of deviation from the reference or unimpacted condition. The score places the wetland in a wetland health category, A – F (see Table 4.3). The wetland is either assessed as one HGM unit (the dominant one) or divided into HGM units, and each unit assessed separately.

Table 4.3 Present Ecological State categories used to define the overall health or integrity of a wetland (from MacFarlane *et al.*, 2020).

CATEGORY	PES SCORES (%)	DESCRIPTION
A	90 – 100	Unmodified, natural.
B	80 – 89	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.
C	60 – 79	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats and biota may have taken place.
D	40 – 59	Largely modified. A large change in ecosystem processes and loss of natural habitats and biota has occurred.
E	20 – 39	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.
F	0 – 19	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.

4.2.1.3 Ecological Importance and Sensitivity - watercourses

The DWS-recommended method for the determination of the Ecological Importance and Sensitivity of a particular ecosystem considers the following ecological aspects of watercourses, in general (DWAF, 1999):

- Rare and endangered instream and riparian biota;
- Unique instream and riparian biota;
- Intolerant instream and riparian biota;
- Species richness, both riparian and instream;

- Diversity of habitat types or features;
- Refuge value of habitat types;
- Sensitivity of habitat to flow changes;
- Sensitivity to water quality changes;
- Migration route/corridor for instream and riparian biota, and
- Presence of Protected Areas and conservation areas.

Each criterion is scored between 1 and 5, and the medians of these scores are calculated to derive the EIS category (Table 4.4).

Table 4.4 Ecological importance and sensitivity categories for rivers.

Ecological Importance and Sensitivity Categories	General Description
Very high (score >3 and ≤4)	Reaches or rivers that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to channel / bed modifications and have no or only a small capacity for use.
High (score >2 and ≤3)	Reaches or rivers that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to channel / bed modifications but in some cases, may have a substantial capacity for use.
Moderate (score >1 and ≤2)	Reaches or rivers that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to channel / bed modifications and often have a substantial capacity for use.
Low/marginal (score >0 and ≤1)	Reaches or rivers that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to channel / bed modifications and usually have a substantial capacity for use.

4.2.1.4 Ecological Importance and Sensitivity - wetlands

The importance of the seeps was assessed by considering the range of goods and services identified in the WET-Ecoservices V2 tool (Kotze *et al.*, 2020). These services include:

- Flood attenuation
- Streamflow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

The outcomes of the WET-Ecoservices assessment were then used to inform an assessment of the overall importance and sensitivity of the wetland using the Wetland Ecological Importance and Sensitivity (EIS) assessment tool of Rountree *et al.* (2013). The tool includes an assessment of three suites of importance criteria, namely:

- Traditional ecological importance and sensitivity (biodiversity support, landscape scale importance, and the sensitivity of the wetland to change);
- Hydrological and functional importance (water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide), and
- Human benefits (subsistence and cultural use of the wetland).

The maximum score for each suite of importance criteria was taken to be the overall EIS category for the wetland, as described in Table 4.5.

Table 4.5 Ecological Importance and Sensitivity Categories for Wetlands (Rountree *et al.*, 2013).

Ecological Importance and Sensitivity Categories	Range of EIS scores
Very high: Wetlands that are considered ecologically important and sensitive on a **national or even international** level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and ≤4
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and ≤3
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and ≤2
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and ≤1

4.2.2 Results

The results of the assessments of PES and EIS are provided in Table 4.6.

Table 4.6 Results of the assessments of PES and EIS for the watercourses and wetlands impacted by the FE services.

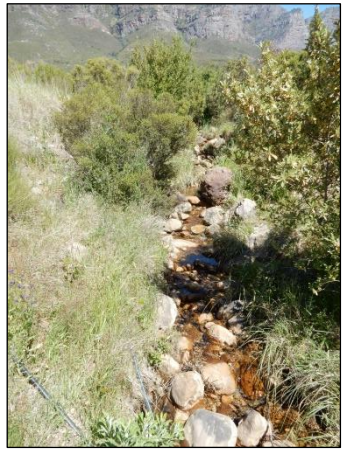
Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Upper Stream 1 (above the farm dam at the Tented Camp site), northern tributary	Mountain stream with associated riparian area	1	Stream flows down the slopes of the Simonsberg mountains, with a dense riparian growth of indigenous trees and shrubs with a few alien trees, such as pines. Water quality is good; and flow seasonal. There was no significant surface flow at the time of the field visit in March 2020.	 **Riparian area of the upper reaches of Stream 1**	**A**	**High**
Upper Stream 1 (below the farm dam), northern tributary	Upper foothill stream with associated riparian area	1	Stream flows below the farm dam for some distance and then becomes a seep wetland on agricultural lands.	 **Riparian area in the section of Stream 1 below the farm dam.**	**C**	**High**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Upper Stream 1, southern tributary	Upper foothill stream	1	Stream flows down the slopes of the Simonsberg mountains, with a dense riparian growth of indigenous trees (*Kiggelaria africana, Searsia angustifolia, S. glauca, Olea europaea subsp. africana, Brabejum stellatifolium*) and shrubs with a few alien trees, such as pines. Water quality is good; and flow seasonal.  **Two farm dams situated to the south of Stream 1, in sub-catchment 1.**	 **Riparian area (to the right) adjacent to Stream 1, southern tributary**  Southern tributary of Stream 1, above Road C crossing	**B**	**High**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Wetland #33 adjacent to Stream 1, southern tributary	Seep	1	Soil sample was augured in the seep. Using the Munsell soil colour chart, 10YR, the value was 3, and the chroma 2, indicating wetland soils. No mottles. Soils are very compacted in the road, and impacted by cultivated vines. Seasonally saturated wetland.	 **Soil sample from seep, showing almost black loam (10YR: 3/2)**	**D**	**Low**
Wetland #34 in Stream 1	Channelled valley-bottom wetland	1	Valley-bottom wetland is in the watercourse, dominated by the bracken, *Pteridium aquilinum*. Seasonally inundated wetland.	 **Channelled valley-bottom wetland at the road crossing over Stream 1**	**B**	**High**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Lower Stream 1, downstream of farm dams			Stream 1 has a cobble and gravel bed (Figure 2.2), and during the wet season, a variety of riverine biotopes (or habitats) including riffles, runs and pools. The channel has been straightened to flows past a number of cultivated fields before it joins with the Keurbos River and then the Werda River, a tributary of the Berg River. The straightened channel has vegetated berms on either side, to prevent flooding of fields. A narrow band of riparian vegetation is located on the margins of the stream, and a seep wetland is located upstream of The Retreat. Indigenous riparian species include *Searsia angustifolium* (smalblaar), *Kiggelaria africana* (wild peach), *Brabejum stellatifolium* (wild almond), *Pteridium aquilinum* (bracken), *Typha capensis* (bulrush), *Pennisetum macrourum* (fonteingras), *Chasmanthe aethiopica*, *Zantedischia aethiopica*.	 **Lower Stream 1 as it flows past The Retreat**	**C**	**Moderate**
Upper Stream 2, to FE6 / Road B	Upper foothill stream	2	Upper reaches of this stream are largely unmodified and natural, in terms of both instream and riparian characteristics. Healthy riparian growth of indigenous trees (*Kiggelaria africana, Searsia angustifolia, S. glauca, Olea europaea subsp. africana, Brabejum stellatifolium*). Upper section of the stream is a broad slope of riparian vegetation. An irrigation channel takes water from this stream, into a farm dam on Upper Stream 3 (see below). A water supply reservoir is currently located within the riparian area of the upper reaches of the stream.	 **Vegetated channel of Upper Stream 2.**	**A/B**	**High**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
			 **Current water supply reservoir in the upper catchment of Stream 2.**			
Lower Stream 2, to confluence with Stream 3	Upper foothill stream	2	Cobble, gravel and sand bed with very narrow riparian zone, which includes *Kiggelaria africana, Searsia* spp.). This is due to stone berms having been constructed on both sides of the stream. There are some alien plant species in the riparian zone such as *Rubus fruticosa* (brambles).	 **Lower Stream 2, as it flows under a gravel road (site of culvert 3A)**	**C**	**Moderate**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
				 **Lower Stream 2, showing narrow band of riparian vegetation and berm along the bank.**		
Wetland (#36)	Seep	2	Heavily transformed seep, on granite. Evidence of wetland presence is the black wetland soils, and wetland sedge growing where water seeps out of the ground.	 **Dark wetland soils showing presence of wetland #33**	**C/D**	**Low**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Upper Stream 3, above Kropman Cottages (including two farm dams)	Upper foothill stream	3	Stream 3 is a tributary of Stream 2. It starts on the steep upper slopes of the Estate, as a seep. The stream soon flows into a small farm dam, which is also fed via an irrigation canal from Stream 2. Stream 3 enters a second instream dam via a concrete canal. A third smaller dam is located between the two larger dams. In its upper reaches, the stream has a fairly undisturbed riparian zone, dominated by *Searsia angustifolia*.	 **Upper Stream 3 connects two farm dams**	**C/D**	**Moderate**
Lower Stream 3, below farm dam	Upper foothill stream	3	Channel is narrow –a maximum of 1.5 m in width – and has been highly modified. It conveys overflow water from an instream farm dam situated immediately upstream of the Kropman Cottages site, along a brick-lined channel which then discharges into a straightened, earth-lined channel that continues down the slope, and into the Keurbos River close to Orchard Cottages. Riparian and marginal vegetation includes a line of oak trees (exotic) on the left bank of the watercourse, wild almond (indigenous, *Brabejum stellatifolium*), arum lilies (indigenous, *Zantedischia aethiopica*), kikuyu grass (exotic, *Pennisetum clandestinum*) and rushes (indigenous, *Juncus kraussii*)	 **Lower Stream 3, below the dam and adjacent to Kropman cottages.**	**D**	**Moderate**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Stream 4, northern tributary	Lower foothill stream	4	Seasonal tributary of Stream 4 flows through a forest of oaks. Channel is heavily invaded by kikuyu. Bed is gravel and sand, with few cobbles.	 **Channel of Stream 4 is heavily invaded by kikuyu.**  **Stream 4 tributary as it flows under the gravel road**	**C/D**	**Low**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Stream 4, middle tributary, down to FE12	Upper foothill stream	4	The middle tributary of Stream 4 arises as a number of smaller streams flowing into a small farm dam. Most of the overflow from this farm dam is directed to flow down Stream 5, so Stream 4 below the top dam is very dry, and densely overgrown with bracken. Riparian vegetation still in good condition, and good riverine habitat.	 **Middle tributary of Stream 4 below the small farm dam, looking downslope.**	B	High
Wetland #11	Seep	4	Seep wetland around the top dam into which the middle tributary of Stream 4 flows. Recently cleared of alien vegetation. Some palmiet (*Prionium serratum*) grows on the slopes, indicating perennially wet conditions.	 **Seep wetland at the top of Stream 4, with Palmiet in the centre**	B	High

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Stream 4, middle tributary, downstream of FE12	Lower foothill stream	4	Downstream of FE12, the stream becomes channelised in places, flowing along a rock-lined channel. Vegetation is arum lilies, kikuyu, other alien grasses.	 **Rock-lined channel, middle tributary of Stream 4.**	**C/D**	**Low**
Stream 4, southern tributary, down to just below FE13	Upper foothill stream	4	Arises in the vicinity of FE13 in a seep (see below). Overgrown with wetland vegetation.	 **Overgrown channel. *Chasmanthe aethiopica* (cobra lily), *Zantedischia aethiopica* (arum lily), and *Pteridium aquilinum* (bracken)**	**C**	**Moderate**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Wetland, on FE13	Seep (#12)	4	Marshy seep, where three channels pass through, including the southern tributary of Stream 4. Vegetation includes *Carpha glomeratea, Pteridium aquilinum, Searsia angustifolia, Chasmanthe aethiopica*.	 **Marshy seep where the southern Stream 4 tributary arises.**	**C**	**Moderate**
Stream 4, southern tributary, downstream of FE13	Lower foothill stream	4	Soon after FE13, this tributary is channelised into an earth-lined channel, flowing past orchards. The channel is lined with beefwood, while the channel itself is overgrown with *Pennisetum macrourum* in places.	 **Overgrown channel in the lower tributary of Stream 4.**	**C/D**	**Low**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Upper Stream 5, northern tributary, to dam at Mountain Villa (FE16A)	Mountain stream into upper foothill river	5	Stream starts high up on the undisturbed slopes of the Simonsberg mountains. The stream bed is cobble, with perennial flow. Riparian vegetation and instream habitat in very good condition. A smaller tributary A SASS sample taken in the stream revealed a number of sensitive invertebrate taxa, including the Dipteran family Blephariceridae, which is highly sensitive to water quality. This is evidence that both the habitat and the water quality are very good.  **Blephariceridae, a Dipteran family, found in the upper reaches of Stream 5, downstream of FE15. This is an indicator of good water quality.**	 **Cobble bed of Upper Stream 5.**	**A/B**	**High**
Upper Stream 5, southern tributary, to dam at Mountain Villa (FE16A)	Upper foothill river	5	This tributary is also in good condition, although not as uninvaded as the northern tributary. Alien vegetation includes oaks ad poplars.	 ***Brabejum stellatifolium* (wild almond) growing in**		

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
				the riparian vegetation around Stream 5.		
Lower Stream 5, below Mountain Villa (FE16A)	Upper foothill river	5	Below Mountain Villa, the stream's riparian zone becomes more invaded by alien trees, such as oak and poplar. The streambed is still cobble, with some gravel and sand. Water quality is still good (EC of 58 µS/cm).	 **Lower Stream 5, where it crosses the tarred road.**	**C**	**Moderate**
Wetland	Seep	5	A fairly extensive seep wetland is located between Streams 5 and 6, close to FE16B. The seep is in good condition, dominated by *Pennisetum macrourum*, with some *Typha capensis* (bulrush). Soils are dark loam, on the Munsell chart 10YR 4/2.	 **Seep wetland close to FE16B**	**B**	**High**
Upper Stream 6, to downstream of FE16B	Upper foothill river	6	Stream 6 arises as several tributaries on the mountain slopes. As the stream passes through the Boschendal Estate, the riparian zone is increasingly invaded by alien tree species, such as oaks and poplars. In places the channel is concrete-lined or rock-lined, for stabilisation. Where the channel is natural, it is cobble and gravel.	 **Cobble bed of Stream 6, upstream of FE16B**	**C**	**Moderate**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
Stream 6, downstream of FE16B	Upper foothill river	6	The lower reaches of Stream 6 are impacted by alien tree invasion into the riparian zone, roads, and cultivation. Bed is a mix of cobble, sand and gravel.	 **Poplars dominate the riparian zone of lower Stream 6.**	**C/D**	**Low**
Small streams off-site	Upper foothill streams	6	Two small streams are located around the dam above Pniel. These streams are seasonal to ephemeral, and they both become part of the stormwater system in Pniel, as soon as they flow into the town. These are both heavily invaded, eroded, ill-defined channels, with low ecological value.	 **Small stream entering the dam above Pniel.**	**E**	**Low**

Water-courses or wetlands	Watercourse or wetland type	Sub-catchment	Comments	Photograph	PES Category	Ecological Sensitivity & Importance Category
				 **Eroded gully, which carries surface water in the wet season.**		

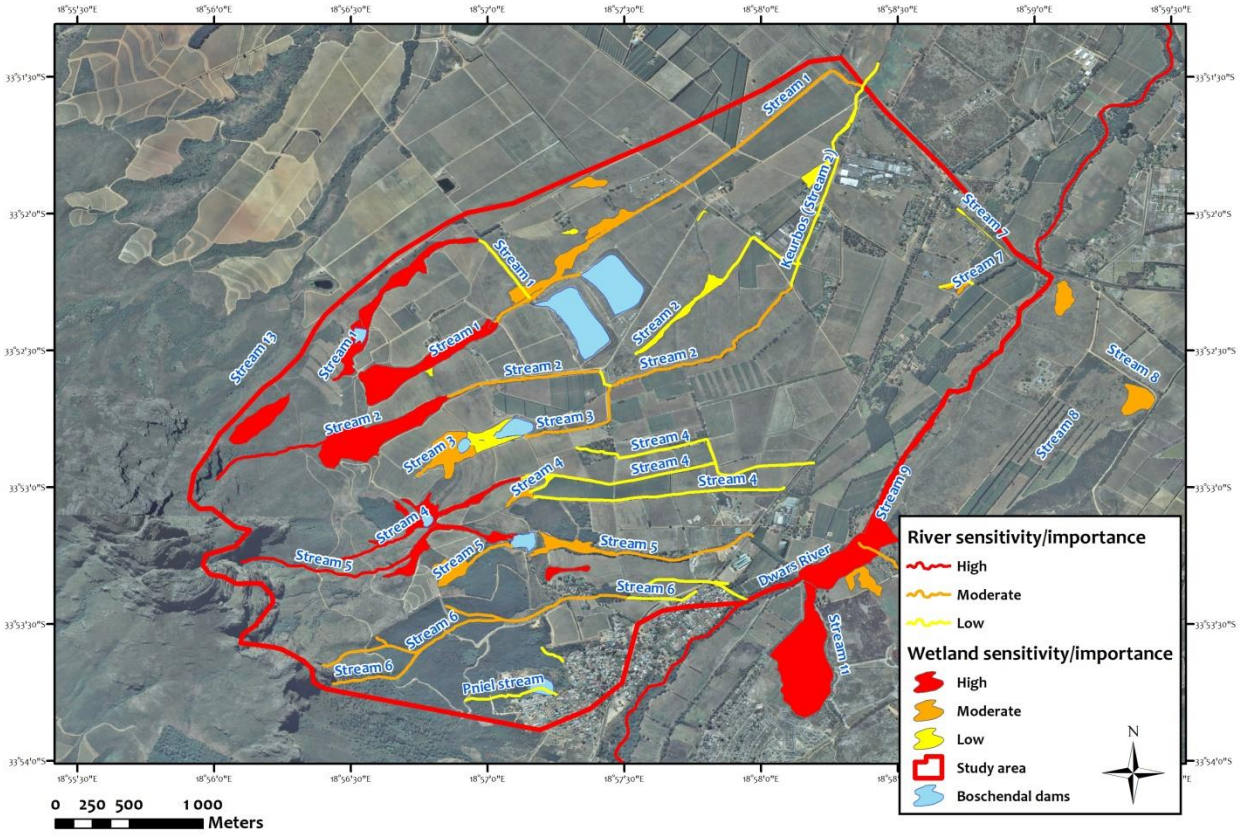


Figure 4.3 **Sensitivity and importance (low to high) for the inland aquatic ecosystems on Boschendal Estate, north of the R310.**

5 Legislation and guidelines governing the conservation and management of rivers and wetlands

5.1 National Environmental Management Act (Act 107 as amended by Act 62 of 2008)

The National Environmental Management Act of 2008 (NEMA), outlines measures that…."prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

Of particular relevance to this assessment is Chapter 1(4r), which states that 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.

Section 24 of NEMA requires that the potential impact on the environment, socio-economic conditions and cultural heritage of activities that require authorisation or permission by law, must be considered, investigated and assessed prior to implementation, and reported to the relevant regulatory authority.

For development outside the urban edge, many development activities within 32m of a watercourse, measured from the edge of the watercourse (taken to be the edge of the active channel), trigger the need for an environmental authorisation. This may be a basic assessment or a full environmental impact assessment, depending on the specifications of the activity.

5.2 Environmental Impact Assessment regulations issued in terms of NEMA (originally promulgated as Regulation 385, 2006, with new legislation adopted in December 2014)

These regulations identify activities deemed to have a potentially detrimental effect on natural ecosystems, including aquatic ecosystems, and outline the requirements and timeframe for approval of development applications. Different sorts of activities are listed as environmental triggers that determine different levels of impact assessment and planning required. The regulations detail the procedure to be followed for a basic or full environmental impact assessment.

5.3 Climate Change Bill (2018, 2022)

The vision of the Climate Change Bill (introduced to Parliament in February 2022) is to "…enable the development of an effective climate change response and a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa in the context of sustainable development; and to provide for matters connected therewith."

The objectives of the Act (when it is promulgated) are to:

a. Provide for a coordinated and integrated response by the economy and society to climate change and its impacts in accordance with the principles of cooperative governance;

b. Provide for the effective management of inevitable climate change impacts by enhancing adaptive capacity, strengthening resilience and reducing vulnerability

c. To climate change, with a view to building social, economic and environmental resilience and an adequate national adaptation response in the context of the global climate change response;

d. Make a fair contribution to the global effort to stabilise greenhouse gas concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system;

e. To ensure a just transition towards a low carbon economy and society considering national circumstances;

f. Give effect to the republic's international commitments and obligations in relation to climate change; and

g. Protect and preserve the planet for the benefit of present and future generations of humankind.

5.4 Western Cape Biodiversity Act (2022)

The Western Cape's Biodiversity Act aims to provide for "…the framework and institutions for nature conservation and the protection, management and sustainable use of biodiversity and ecosystems in the Province; and for matters incidental thereto." The objectives of the Act are to:

a. Give effect to the obligation of the state in terms of national legislation to act as trustee in relation to the environment;

b. Give effect to section 81(m) of the western cape constitution to protect and conserve the environment in the province, including its unique biodiversity, for the benefit of present and future generations;

c. Ensure the long-term ecological sustainability and resilience of biodiversity, ecosystems, ecosystem services and ecological infrastructure through implementation of the principles of ecological sustainability contemplated in section 6 and the protection of priority biodiversity and ecological infrastructure;

d. Ensure human well-being and the long-term resilience of society and the economy through the conservation of protected areas, biodiversity, ecosystems, ecosystem services and ecological infrastructure;

e. Enable reasonable and sustainable access to benefits and opportunities emanating from the conservation of protected areas, biodiversity, ecosystems, ecosystem services and ecological infrastructure;

f. Establish institutional structures and organisational capacity for the effective discharging of the conservation and management of biodiversity and nature in the province;

g. Promote consultation, cooperation, integrated planning, decision-making and management in support of the conservation and sustainable use of biodiversity and ecosystem services in the province;

h. Promote systematic biodiversity planning and the attainment of the biodiversity targets for conservation set in the biodiversity spatial plan and the provincial protected areas expansion strategy;

i. Regulate certain activities to be undertaken in a manner that enhances and protects the integrity and health of the environment;

j. Subject to section 231 of the constitution, implement and give effect to international agreements and best practices pertaining to the environment and conservation of biodiversity;

k. Enable the financial and economic sustainability of the relevant institutions responsible for the conservation and management of biodiversity and nature in the province; and

l. Enable and develop an equitable and sustainable biodiversity economy in the Province, including the promotion and development of eco-tourism in areas under the control of CapeNature.

5.5 Conservation of Agricultural Resources Act (Act 43 of 1983)

Key aspects include legislation that allows for:

Section 6: Prescription of control measures relating to the utilisation and protection of vleis, marshes, water sponges and water courses. These measures are described in regulations promulgated in terms of the Act, as follows:

Regulation 7(1): Subject to the Water Act of 1956 (since amended to the Water Act 36 of 1998), no land user shall utilise the vegetation of a vlei, marsh or water sponge or within the flood area of a water course or within 10 m horizontally outside such flood area in a manner that causes or may cause the deterioration or damage to the natural agricultural resources.

Regulation 7(3) and (4): Unless written permission is obtained, no land user may drain or cultivate any vlei, marsh or water sponge or cultivate any land within the flood area or 10 m outside this area (unless already under cultivation).

5.6 National Biodiversity Act

To provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act of **1998;** the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bio-prospecting involving indigenous biological resources; the establishment and functions of a South African National Biodiversity Institute.

5.7 Cape Nature Conservation Ordinance (Ordinance 19 of 1974; amended in 2000)

This ordinance provides measures to protect the natural flora and fauna, as well as listing nature reserves in the Western Cape that are managed by the Western Cape Nature Conservation Board (WCNCB). This ordinance, with the Western Cape Nature Conservation Board Act of 1998 was amended in 2000 to become the Nature Conservation Laws Amendment Act. Lists of endangered flora and fauna can be found in this act.

5.8 National Water Act (1998)

The main regulatory requirements with regards to aquatic features relates to the National Water Act No. 36 of 1998 (NWA). The NWA regulates 11 water uses that require authorisation, as follows:

a. Taking water from a water resource;

b. Storing water;

c. Impeding or diverting the flow of water in a watercourse;

d. Engaging in a stream flow reduction activity;

e. Engaging in a controlled activity identified and declared as such in terms of the Act;

f. Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

g. Disposing of waste in a manner which may detrimentally impact on a water resource;

h. Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i. Altering the bed, banks, course or characteristics of a watercourse;

j. Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

k. Using water for recreational purposes.

The construction of the new reservoir next to the old one on the slope close to Stream 2 constitutes storage of water (Section 21 (b)) but the volume to be stored is less than the 2000m^3 that may be stored on the property without requiring a water licence.

The construction of river crossings and the laying of pipes over a watercourse or wetland can lead to the changes in flow in (Section 21 (c)) or alterations to the bed and banks/characteristics of (Section 21 (i)) the affected watercourse, and so a water use authorisation must be obtained for these specific activities. Should stormwater be discharged directly into seeps or streams, this is generally authorised (but requires registration) up to 2000 m^3 per day (Section 21 (f)). Volumes higher than this will be subject to a full water use licence application.

DWA have issued a number of **General Authorisations** (GA) in terms of Section 39 of the National Water Act. A water use may be generally authorised if it falls within a specific threshold or area. The GA of the 26th August 2016 (Government Notice 509 of 2016) provides the limits and conditions of Section 21 (c) and (i) water uses that may be generally authorised, and defines the regulated zone within which the GA applies. The draft GA of April 2012 (Government Notice 288 of 2012) covers the conditions for taking (Section 21 (a)) and storing (Section 21 (b)) water. This GA states:

"A person who owns or lawfully occupies a property or piece of communal land may, in terms of this authorisation, on the property or piece of communal land occupied store water not containing waste up to the maximum volume given in Table 1: Surface water abstraction and storage volumes in Appendix A for the catchment in which the stored water is taken" … (2000 m^3 for catchment G10)… "subject to the following specific conditions and the general conditions in this notice.

Specific conditions for storing of water:

- Water stored in terms of this authorisation may only be stored off-channel.
- Retaining structures for the storing of water in terms of this authorisation that are constructed after this authorisation comes into effect must have outlet works that enable the full storage volume to be released within 30 days.
- Up to the maximum volume of water given for the resource in Table 1: Surface Water Abstraction Rates and Storage Volumes in Appendix A may be stored in terms of this authorisation for use on one property or per person in communal land.

General conditions of this GA include:

- Water stored must be used efficiently, and the water user must investigate and use all reasonable water conservation measures.
- The storage of more than 10 000 m^3 on one property must be registered with DWS.

5.9 Western Cape Provincial Spatial Development Framework (March, 2014)

Policies regarding the protection of biodiversity and ecosystem services in the Western Cape are:

- The Western Cape's Critical Biodiversity Area (CBA) mapping, which CapeNature are currently updating and refining, together with the draft priority climate change adaption corridors, comprise the spatial extent of the Western Cape's biodiversity network. This must inform spatial planning and land use management decisions throughout the province.
- Using the latest available CBA mapping as a primary informant, regional, district and municipal SDFs must delineate Spatial Planning Categories (SPCs) that reflect suitable land use activities in the different CBA categories.
- To complement CapeNature's protected area expansion strategy and their Stewardship programme, SDFs should highlight priority areas outside the protected area network that are critical for the achievement of the province's conservation targets.

Policies regarding the management, repair and optimisation of inland water resources are:

- Given current water deficits, which will be accentuated by climate change, a 'water wise' planning and design approach in the W Cape's built environment is to be mainstreamed.
- Rehabilitation of degraded water systems is a complex inter-disciplinary intervention requiring built environment upgrading (i.e. infrastructure and the built fabric), improved farming practises, as well as the involvement of diverse stakeholders.
- Introduce and retrofit appropriate levels of water and sanitation systems technologies in informal settlements and formal neighbourhoods with backyard shacks as a priority.
- An overarching approach to water demand management is to be adopted – firstly efficiencies must be maximised, storage capacity sustainably optimised and ground water extraction sustainably optimised, with the last resort option of desalination being explored, if necessary.
- Protection and rehabilitation of river systems and high yielding groundwater recharge areas, particularly in areas of intensive land use (i.e. agricultural use, industry, mining and settlement interactions) should be prioritised.
- Regional Plans to be developed for Water Management Areas to ensure clear linkages and interdependencies between the natural resource base (including water resources) and the socio-economic development of the region are understood and addressed.
- Agricultural water demand management programmes to be developed with an emphasis on the Breede Valley and Oliphants / Doorn agricultural areas. Industrial water demand management programmes to be developed with an emphasis on Saldanha, Southern Cape and Cape Town. Settlement water demand management programmes to be developed with an emphasis on the Cape Town functional region.
- Government facilities (inclusive of education, health and public works facilities) to lead in implementing effective and efficient water demand management programmes.
- Continue with programmes (such as Working for Water) which reduce the presence of alien vegetation along river systems.

5.10 Western Cape Biodiversity Spatial Plan (2017)

The Western Cape Biodiversity Spatial Plan (WCBSP) is the product of a systematic biodiversity planning assessment that delineates Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) which require safeguarding to ensure the continued existence and functioning of species and ecosystems, including the delivery of ecosystem services, across terrestrial and freshwater realms. These spatial priorities are used to inform sustainable development in the Western Cape Province. This product replaces all previous systematic biodiversity planning products and sector plans with updated layers and features.

5.11 Stellenbosch Municipality Spatial Development Framework

The principles contained in the Stellenbosch SPF that are pertinent to this study include:

- All rivers above a minimum size shall be protected by river conservation zones of 10-30m on either side of the bank, depending on the width and maturity of the river (as determined by an aquatic ecologist or land surveyor). These zones should be returned to their natural riparian status for passive recreational use only, and no urban development or intensive agriculture shall be permitted within them.
- No foundations of permanent buildings shall be located within the 1:100 year flood lines (as determined by a hydrological engineer).
- Peak water demand should be accommodated with supplementary storage and recycling (e.g. rainwater tanks, grey water recycling) of water so that the municipality can focus on satisfying base demand and meeting the needs of the poor.
- Urban water demand management programs should be implemented to ensure that urban water demand does not undermine agricultural needs, including:
    - Rainwater harvesting should be mandatory on all new urban developments, and retrofitting of rainwater harvesting should be encouraged on all existing developments (where heritage constraints allow for this).
    - Grey water recycling should be promoted on all residential, commercial and industrial units with gardens.
- Water conservation measures should be adopted, for example minimising unaccounted for water through leak repair and pressure adjustment, installing water meters, educating consumers about water saving, promoting water saving devices and promoting water-wise gardening.
- Technologies that facilitate the efficient use of irrigation water should be encouraged.
- Conservation areas should continue to enjoy the highest possible level of protection in order to ensure water quality and quantity at least in the upper reaches of the river system.
- The eradication of alien vegetation from all areas should be supported.
- Sensitive biodiversity areas should be mapped, and clear and appropriate guidelines introduced to conserve them.
- Crest lines should be kept free of buildings and intensive agriculture to protect biodiversity.
- Ridge lines should be used for properly managed walking trails to increase recreational potential, tourism and income.
- Outside of formal conservation areas, land owners should be encouraged to conserve vegetation classified by SANBI as Endangered or Critically Endangered (particularly along ridge lines) and to link to existing conservancies (e.g. through the CapeNature Stewardship Program). These land uses should be classified in the Core SPC.

6 Constraints to development

There are two considerations to bear in mind when determining development constraints – (1) the regulatory zone around inland aquatic ecosystems (watercourses and wetlands) within which environmental or water use authorisations are triggered, and (2) the protection of the inland aquatic ecosystems themselves through the establishment of ecological buffers.

6.1 Regulatory zone

There are two regulatory zones to take into account:

- A 32m-wide regulatory zone (measured from the edge of the banks of a watercourse or the outer boundary of a wetland) within which an environmental authorisation (according to NEMA) is required for certain activities above specified thresholds;
- A regulatory zone that extends 500m from the outer boundary of a **wetland**, and either up to the 1:100 year floodline (where this has been calculated) or 100m from the edge of the active channel or the outer boundary of the riparian area around a **watercourse**, within which a Section 21 (c) or (i) water use (according to the National Water Act) may apply.

The 1:100 and 1:50 year floodlines were determined for the relevant (i.e. affected by FE services) reaches of Streams 1, 2, 4, 5 and 6, where they flow past an FE, by Graeme McGill Consulting.

6.2 Development setbacks (ecological buffers)

Ecological buffers for the wetlands and watercourses were determined using the site-based protocol for wetland buffer determination of MacFarlane and Bredin (2017). The assessment is based on the PES and EIS of the ecosystems (see Section 4.2.2), and the assumed quality of the buffer during both phases of the project. It was assumed in all cases that the current vegetation would be representative of the buffers for both design / construction and operational phases, as it is unlikely that the vegetation will change from the current state. The density of vegetation plays a major role in determining the effectiveness of a buffer – a well-vegetated buffer, with a high basal cover (such as grass or sedges) is the most effective buffer, due to the ability of the plants and their roots to trap sediments, toxins and other pollutants before they reach the wetland or watercourse.

The buffers ranged from 10m for agricultural channels, dams and ecosystems in poor condition (D or E PES category) and of low sensitivity and importance, up to 42m for the pristine stretches of river up on the slopes of the mountain.

7 Description of the development

This assessment focuses only on the services intended to supply the 18 FEs, and not the development within each FE, which will be the responsibility of each owner. Where services run along the same route, lines will be laid in combined trenches where possible.

7.1 Stormwater management

A stormwater management plan was developed by Graeme McGill Consulting (March, 2022), with the required objective of reducing suspended solids by 80% and total phosphorus by 45%. These objectives were applied to the 24-hr duration 1:0.5-year storm.

Grassed swales will provide for the conveyance and attenuation of runoff from domain roads, located within the disturbed footprints of the roads. Swales are proposed for Roads A, B, C, D and D_1. The purpose of the swales is to allow surface runoff from roads and the surrounding landscape to be attenuated, treated to acceptable levels, and discharged into the nearest stream while avoiding the concentration of flows and increases in runoff peaks. Multiple outlets have been designed to spread discharged flows wherever possible, and these would be placed 10 – 25m apart (Figure 7.1 and Figure 7.2). The outflows will be lined with geotextile (Class A3), over which two layers of dry-stone (open joints, no mortar) with rip-rap will be placed. Runoff will be discharged from the outflows to flow overland towards the nearest watercourse.

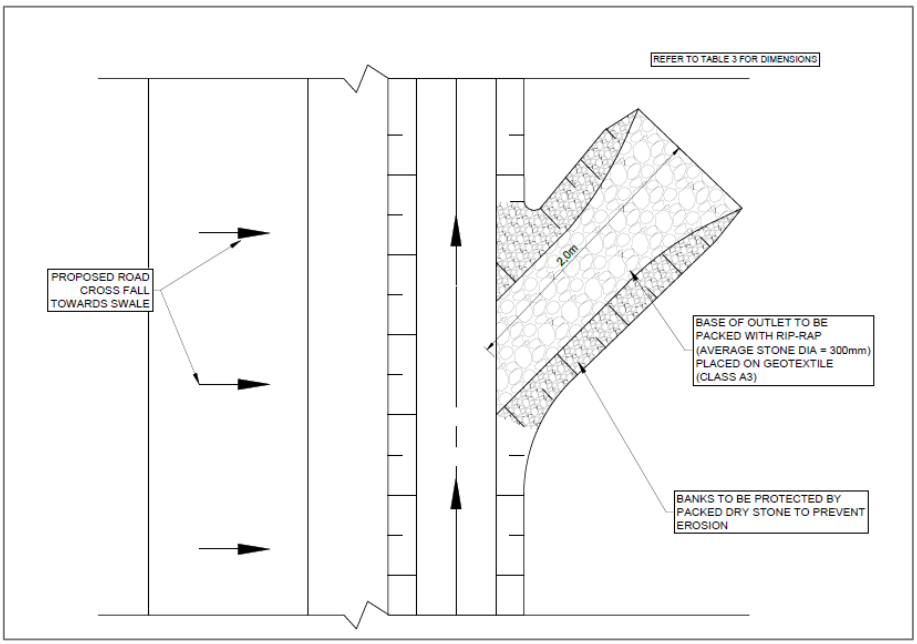


Figure 7.1 Proposed swale, with outlet towards stream to be placed at 20-25m intervals.

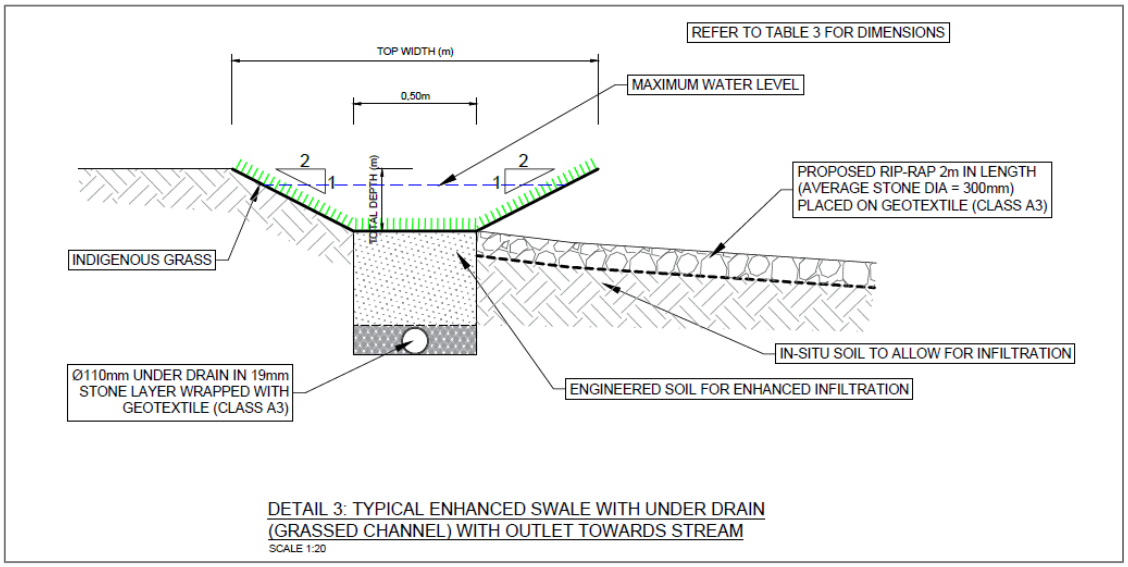


Figure 7.2 Cross-section of swale with outlet towards stream.

7.2 Roads

Access to Boschendal Estate is north off the R310, via a security-controlled gate, and there are existing roads to most of the FEs. The surfacing of existing roads ranges from *in situ* cast concrete exposed aggregate roads, to precast concrete brick paved roads and gravel roads. The width of the paved roads varies between 2.5m and 3.0m with gravel shoulders of varying width, and gravel roads are wider but often not suitable for trafficking across their entire width. Five existing gravel roads – Roads A, B, C, D and D_1, referred to as "domain roads" - will be upgraded to paved roads (Table 7.1). All roads will have a 2.5m surfaced width, with 1.25m cement-stabilized laterite shoulders on either side. The first 400m of Road B will be 3m-wide. All five roads will follow existing gravel road alignments and watercourse crossings.

Private roads will be constructed from the domain roads to each FE, with new access roads proposed for FE5, FE10, FE13 and FE19. A new road would also be constructed between FE12 and FE13. The sections and specifications of proposed new access roads are summarised in Table 7.2 below. All roads would have an exposed aggregate finish, with interlocking precast concrete brick pavers (refer to Figure 5) or *in situ* cast concrete (refer to Figure 6).

Table 7.1 Detailed specifications for domain roads to be upgraded.

ROAD No	ACCESS TO FE	LENGTH (m)	WIDTH (m)	MIN GRADIENT (%)	MAX GRADIENT (%)
A	19	325	2.5	0.15	5.89
B	2, 3, 4, 5, 6, 7, 9, & 10	856	2.5 & 3.0	0.83	9.19
C	3, 4, & 5	1072	2.5	0.60	16.93
D	8, 12, 13, & 15	1105	2.5	1.39	11.76
D-1	15	207	2.5	1.64	11.31

Table 7.2 Description of proposed new FE access roads.

New Roadway	Length	Width	Development Footprint
Entrance to FE5	65 m	3 m	195 m²
Entrance to FE10	45 m	3 m	135 m²
New Road between FE12 and FE13	160 m	3.5 m	560 m²
Entrance to FE13	26 m	3 m	78 m²
Entrance to FE19	17 m	3 m	51 m²
TOTAL	**313 m**	**N/A**	**1 019 m²**

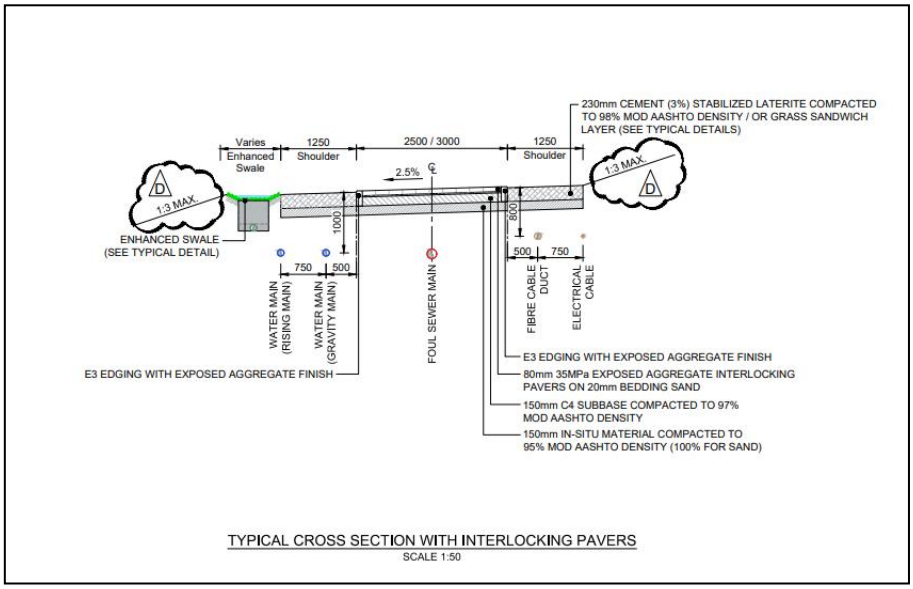


Figure 7.3 Typical cross-section for access roads, with interlocking pavers

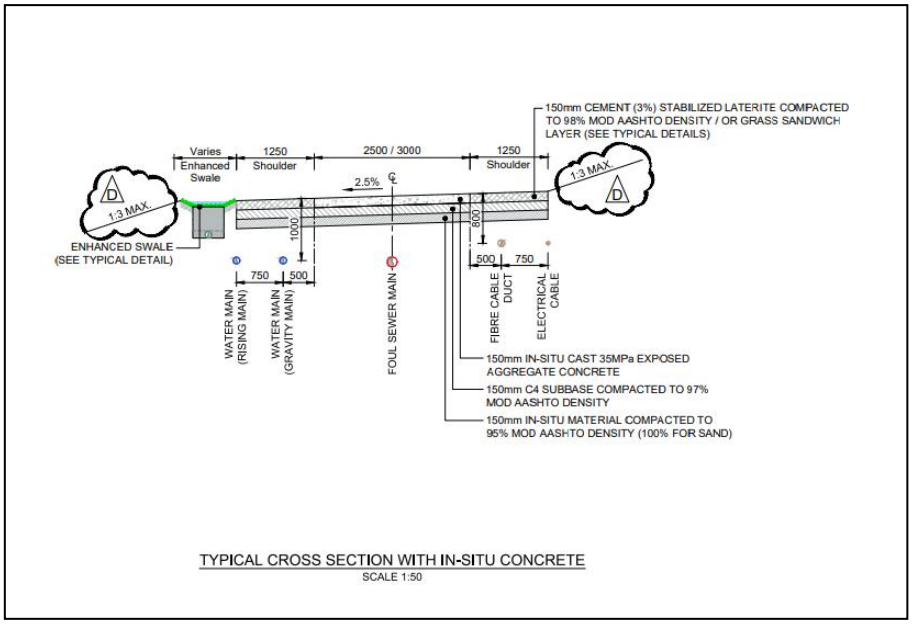
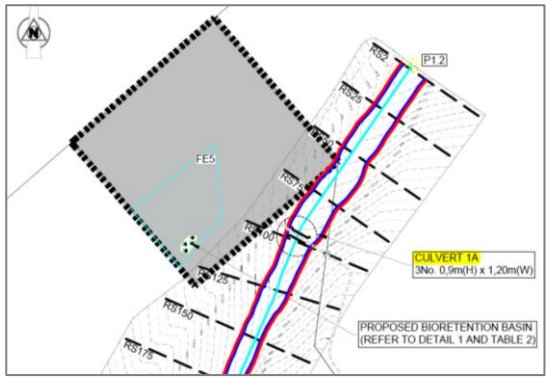
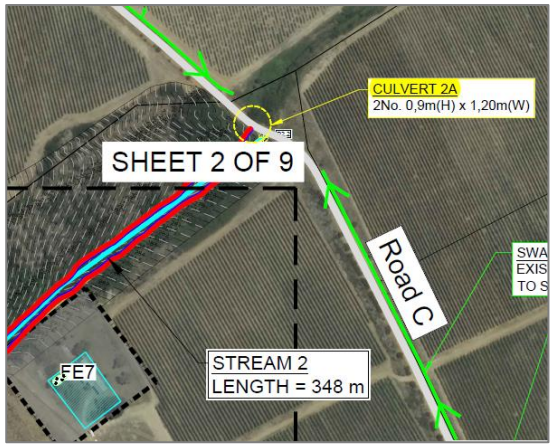
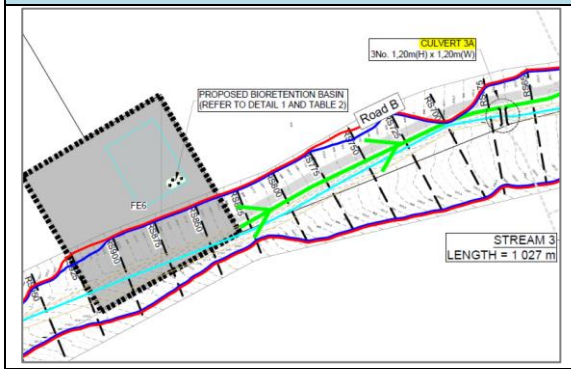
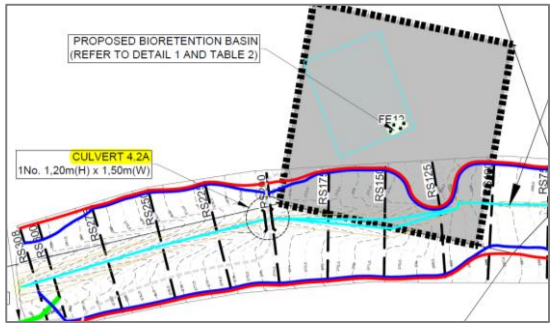
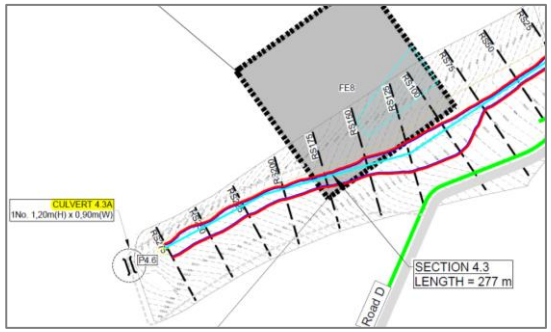


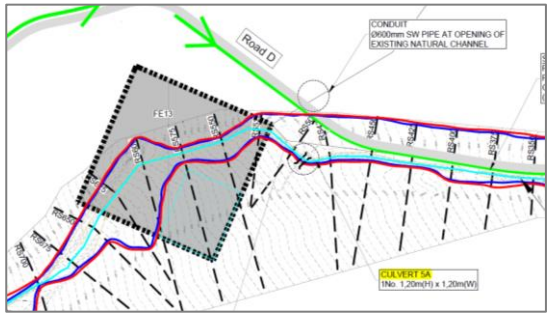
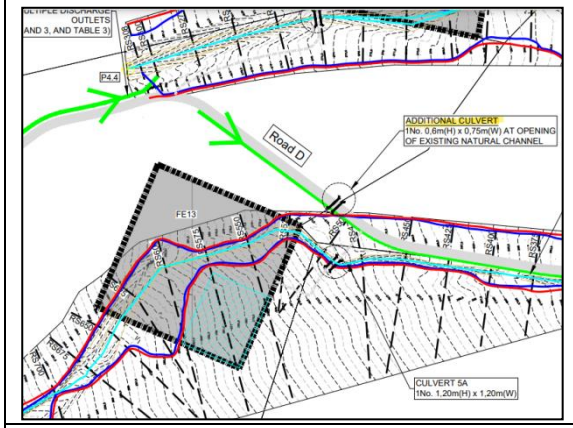
Figure 7.4 Typical cross-section for access roads, with *in-situ* cast concrete.

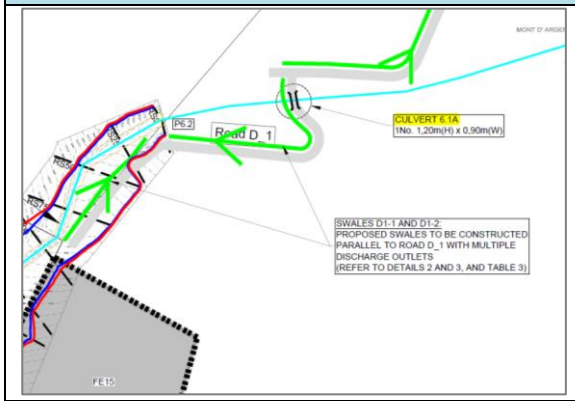
Eight new culverts are proposed over watercourses; the locations and specifications are provided in Table 7.3.

Table 7.3 Summary of proposed new culvert crossings. All culverts are rectangular.

Culvert Name and affected stream	Approx. Length of crossing (m)	Approx. depth of stream (m)	Proposed number and culvert sizes (m)	Capacity of proposed culvert (m³/s)
Culvert 1A on Stream 1 Below new access road for FE5: 	17.3	0.81	3 0.9m (H) x 1.20m (W)	6.20
Culvert 2A on Stream 1 Below existing road (Road C) north-east of FE7 (currently a low-level bridge): 	18.0	0.86	2 0.9m (H) x 1.20m (W)	4.13
Culvert 3A on Stream 2 Below existing road at watercourse crossing east of FE6 (currently a low-level bridge):	9.6	1.10	3 1.20m(H) x 1.20m(W)	11.93

Culvert Name and affected stream	Approx. Length of crossing (m)	Approx. depth of stream (m)	Proposed number and culvert sizes (m)	Capacity of proposed culvert (m³/s)
				
Culvert 4.2A on Stream 4 Below existing access road to FE12 (currently a low-level bridge): 	12.5	0.41	1 1.20m(H) x 1.50m(W)	3.98
Culvert 4.3A on Stream 4 Below existing road west of FE8 (currently a low-level bridge): 	13.6	1.28	1 1.20m(H) x 0.90m(W)	2.39

Culvert Name and affected stream	Approx. Length of crossing (m)	Approx. depth of stream (m)	Proposed number and culvert sizes (m)	Capacity of proposed culvert (m³/s)
Culvert 5A on Stream 4 Below existing road at FE13 (currently a low-level bridge) 	11.4	1.50	1 1.20m(H) x 1.20m(W)	3.18
Additional culvert on Stream 4 Road D 	5.0	0.5	1 0.60m(H) x 0.75m(W)	0.7
Culvert 6.1A on Stream 5 Below existing road (Road D) between FE15 and FE8 (currently a low-level bridge):	12.0	1.02	1 1.20m(H) x 1.50m(W)	19.89

Culvert Name and affected stream	Approx. Length of crossing (m)	Approx. depth of stream (m)	Proposed number and culvert sizes (m)	Capacity of proposed culvert (m^3/s)
				

7.3 Sewer Reticulation

A new internal sewer reticulation network will be developed to connect to the existing municipal line in Pniel. An external sewer gravity main is proposed, which would connect the internal system to an existing pump station and rising main that is routed on the northern side of the R310, to a manhole near the Coronation Cricket Club sports field. Sewage continues to flow by gravity under the R310 to a manhole in Pniel, and then on to the Pniel Waste Water Treatment Works. Sewage from FE16B will flow through a gravity main under the R310, and connect directly to a manhole in Pniel.

Internally, a new pump station is proposed to be located close to Stream 1, downstream of FE7. A short section of rising main will run from the new pump station towards the watershed between Streams 1 and 2, where it will connect with the gravity main. Below-ground sections of pipeline consist of a 160mm diameter PVC-u Class 34 pipeline on a Class B bedding material within a backfilled trench of approximately 760mm width. Above-ground sections of pipeline at crossings over Streams 1 (to FE5) and Stream 4 (to FE8) will comprise a 250mm diameter galvanised steel pipe, with concrete supports placed approximately every 2m. The pipe will be at a height of 1.5m above ground. Excavation required to construct the supports can be done by hand.

7.4 Water supply

A new water supply reticulation network is proposed, to supply potable water to each FE, securing supply from the existing municipal water network in Pniel. A 250mm-diameter water main is recommended to run for 750m from the Pniel Lower Reservoir to a future 8000litre reservoir that is proposed to be built on the boundary of Boschendal Estate (not assessed as part of this BA). A sump and booster pump will pump water from this new reservoir into a 75mm-diameter rising main, which will be 2350m in length, running to a proposed new 100m^3 reservoir close to Stream 2. This new reservoir will be constructed adjacent to an existing smaller reservoir, and will occupy a total footprint of 400m^2.

The internal reticulation system will consist of 110mm-diameter PVC pipes, as well as pressure reducing valves, scour valves, and isolation valves. A total length of 7350 m pipe would be installed.

7.5 Electricity supply

Municipal supply is already being provided to the farm via an existing 11kV overhead power line. New connections would extend from the existing overhead line to each FE, and would be installed in underground ducting within the combined services trench to each Estate.

The internal reticulation services will generally be installed in road reserves. The position of above ground equipment such as miniature substations and metering kiosks will be selected to minimise visual impact. No street or area lighting will be installed as part of the private reticulation network.

7.6 Irrigation supply

Irrigation connections will be supplied to each FE. Existing irrigation lines are currently extensive, supplying water from a number of farm dams on the Estate. Additional 10kl tanks (two per FE) are also proposed for

irrigation (and fire fighting). Additional irrigation pipes are proposed to ensure that all FEs are connected to the irrigation network through 32mm-diameter pipes.

7.7 Fibre ducts

New fibre sleeves would be installed across the site. The fibre sleeves would consist of 90mm PVC-u Class 9 pipes.

8 ENVIRONMENTAL IMPACT ASSESSMENT

8.1 Assessment methods

The impact assessment criteria that were used to describe and assess the probable impacts associated with construction and operation of the proposed services infrastructure are provided in Table 7.4. These are as provided by Chand Environmental Consultants.

The development activities were compared against the no-go development option. It is assumed that all activities currently observed on the Estate that are undertaken in order to keep the services in working order, will continue and that mitigation measures recommended here could be applied.

Table 7.4 Criteria used to assess the impacts associated with the construction and operation of the proposed services infrastructure for Founder Estates, Boschendal.

Criteria	Description
Impact	A description of the impact and/or risk to the water resource
Extent (spatial scale) of impact	Extent can be localised within the project site boundary (**low**), widespread impact beyond the site boundary (**medium**), or widespread far beyond the site boundary (> 50km) affecting the region or nation (**high**).
Duration of impact	Impacts can be short-term and quickly reversible, i.e. 0 to 5 years (**low**), medium-term, i.e. 5 – 15 years, and reversible over time (**medium**) or long-term / permanent, leading to irreplaceable or irretrievable commitment of resources (**high**).
Intensity of the impact	Impact can cause minor change in species/habitat/ diversity or resource, no or very little quality deterioration (**low negative**), or partial loss of habitat/biodiversity/resource or slight alteration (**medium negative**), or loss of habitat/diversity or resource, severe alteration or disturbance of important processes (**high negative**). Positive impacts can range from minor improvement or restoration (**low positive**), to moderate improvement (**medium positive**) or substantial improvement (**high positive**).
Probability of occurrence of impact	Probability can be infrequent, or of low likelihood, with no known risk or vulnerability to natural or induced hazards (**low**), frequent, or possible, with low to medium risk (**medium**), or definite/highly likely (regardless of intervention measures), with a high risk or vulnerability to natural or induced hazards (**high**),
Degree to which the impact can be avoided	Degree to which the impact can be avoided
Extent to which the impact can be mitigated on site	Extent to which an impact can be mitigated on site.
Degree to which the impact can be reversed	Impacts are reversible at the end of the project phase or project life; or impacts are permanent and non-reversible.
Degree to which the impact may cause loss of irreplaceable resources	Degree to which the impact may cause loss of irreplaceable resources
Indirect impacts	Impacts on the environment, which are not a direct result of the project, often produced away from or as a result of a complex pathway.
Status of impact	Negative, positive or neutral
Significance rating of impact without mitigation	Significance of impact without mitigation
Significance rating of impact with mitigation	Significance of impact with mitigation (as recommended)

The significance of each impact was derived from a matrix of duration, extent and intensity (see Table 7.5). This method was prescribed by Chand Environmental Consultants.

Table 7.5 Impact significance rating matrix, using impact duration, intensity and extent to assess significance (from Chand Environmental Consultants).

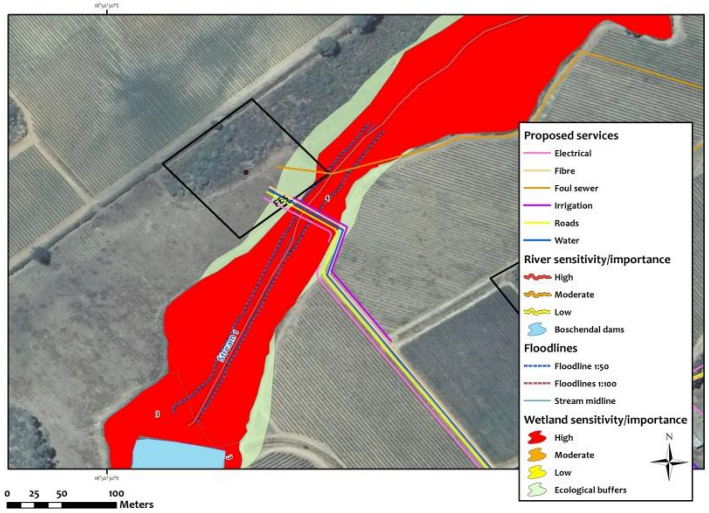
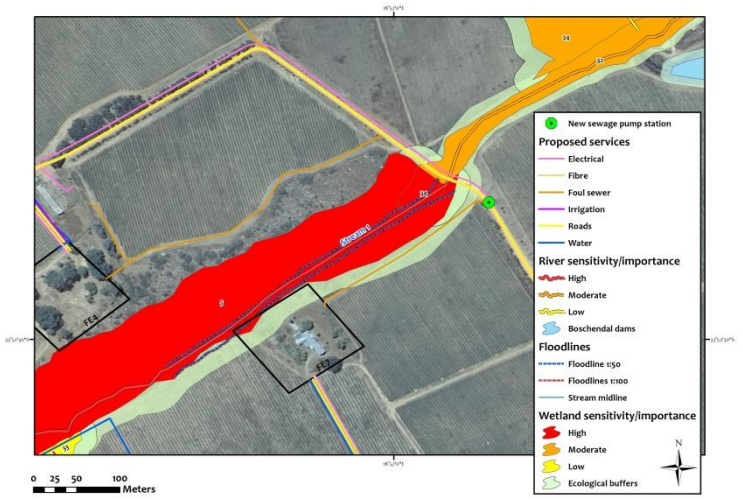
Intensity = Low				
Duration	**High**	Medium	Medium	Medium
	Medium	Low	Low	Medium
	Low	Low	Low	Medium
Intensity = Medium				
Duration	**High**	Medium	High	High
	Medium	Medium	Medium	High
	Low	Low	Medium	High
Intensity = High				
Duration	**High**	High	High	High
	Medium	Medium	Medium	High
	Low	Medium	Medium	High
		Low	**Medium**	**High**
		Extent		

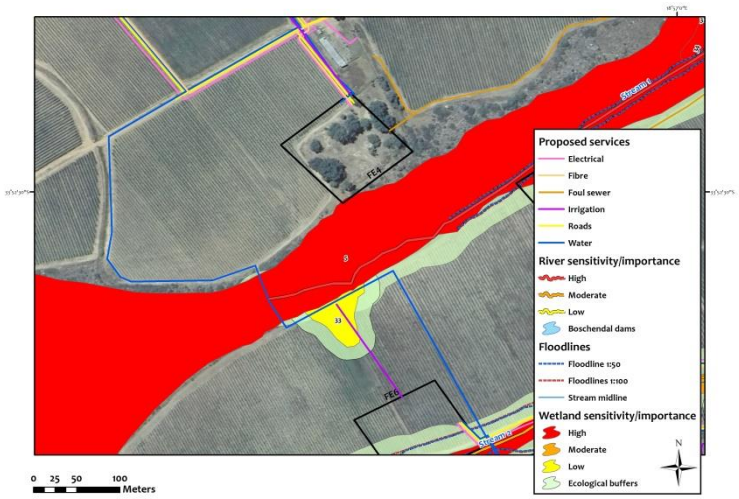
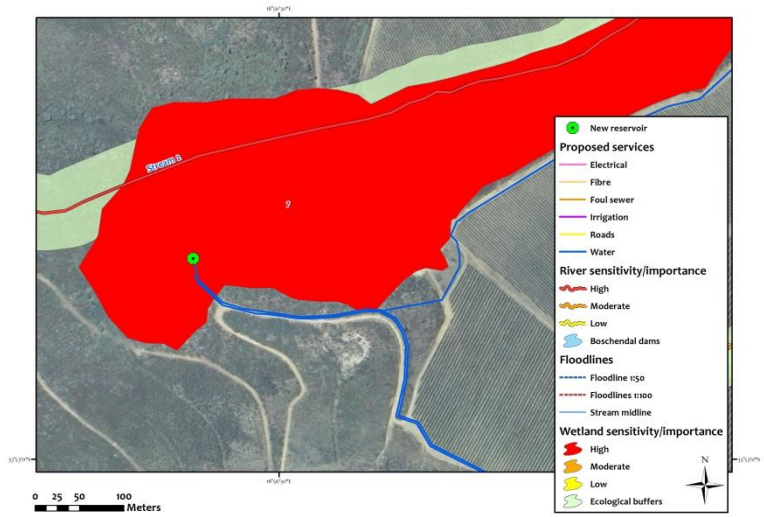
8.2 Description of probable impacts and mitigation measures

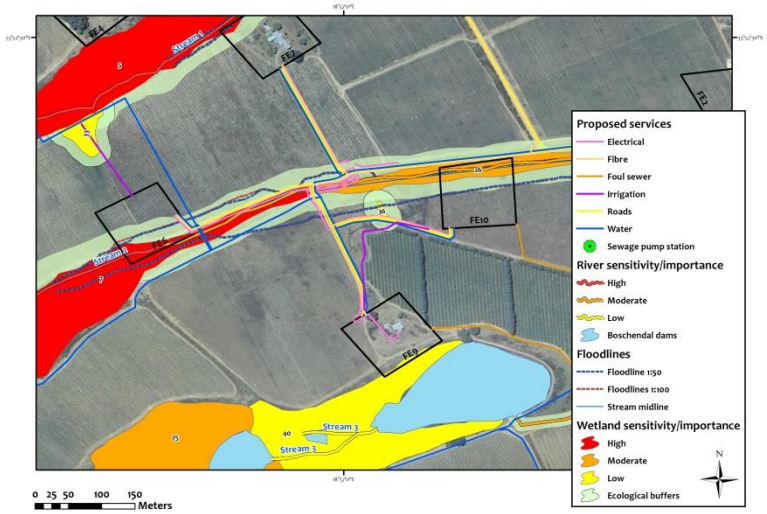
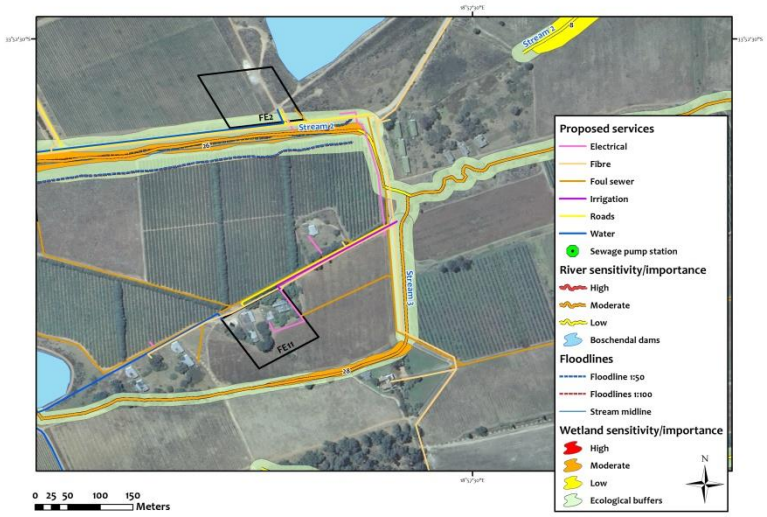
The following sections describe the impacts that are expected to affect the biodiversity and/or ecosystem functioning of the wetlands on the property. The current development footprints have been determined in a manner which has considered the environmental sensitivities present on the Boschendal Estate and have intentionally tried to avoid highly sensitive areas.

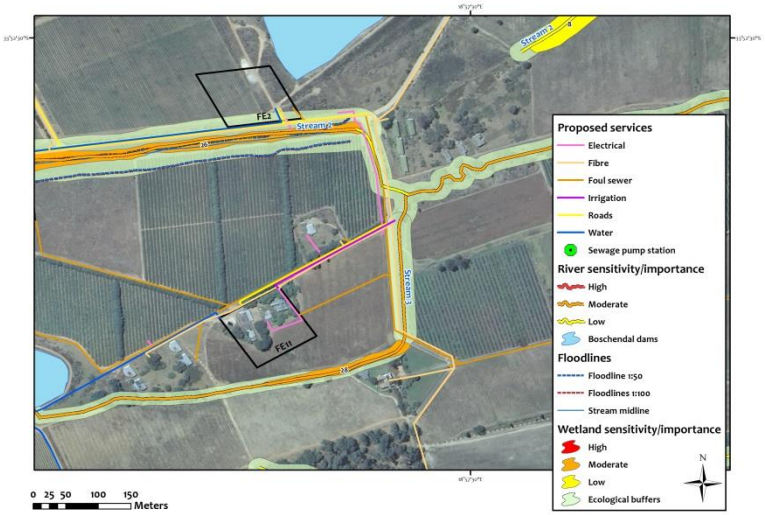
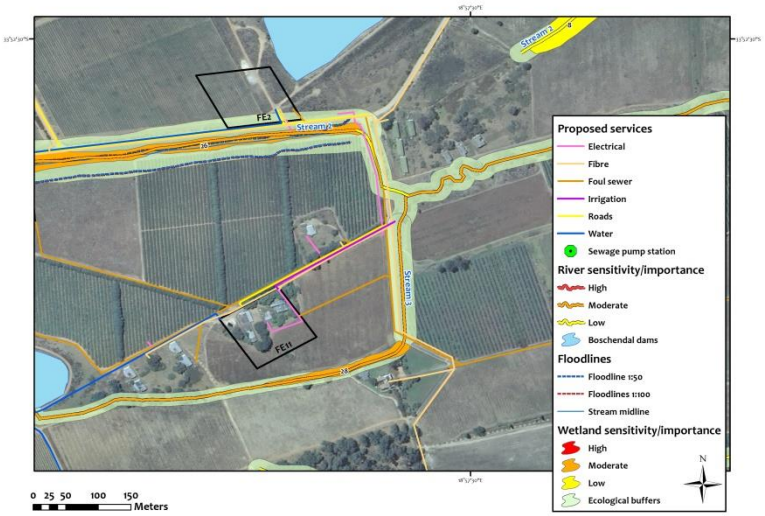
8.2.1 Areas of impact

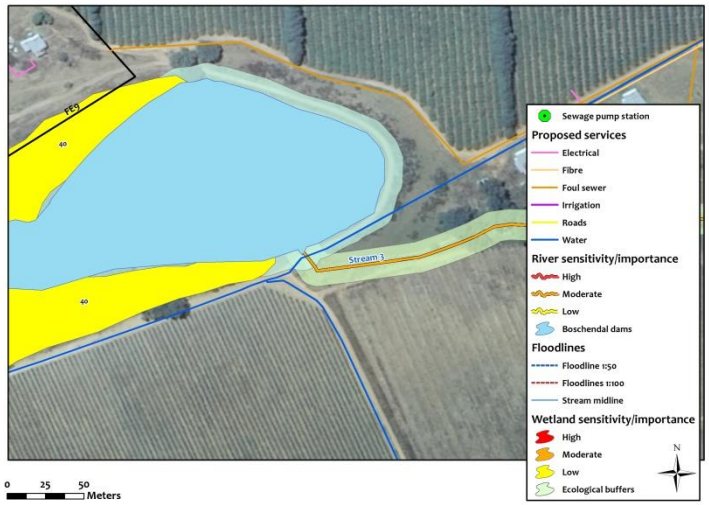
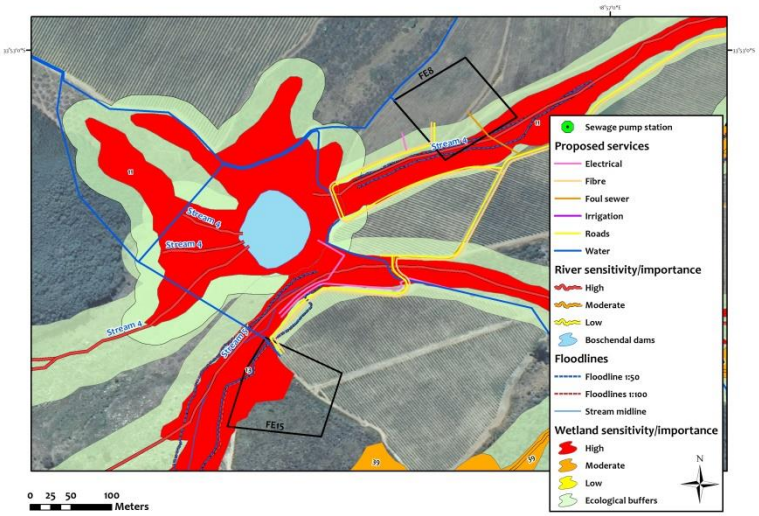
There are a number of areas of possible negative impact, where services have been placed within watercourses, wetlands or their ecological buffers. These are listed and shown graphically below.

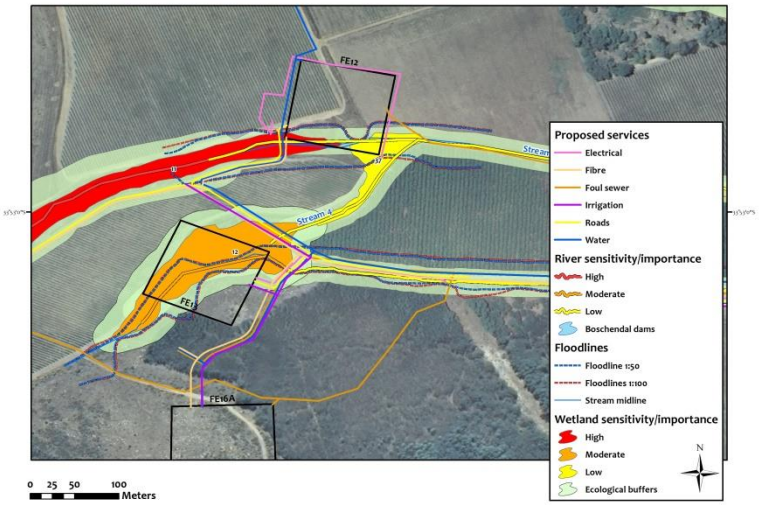
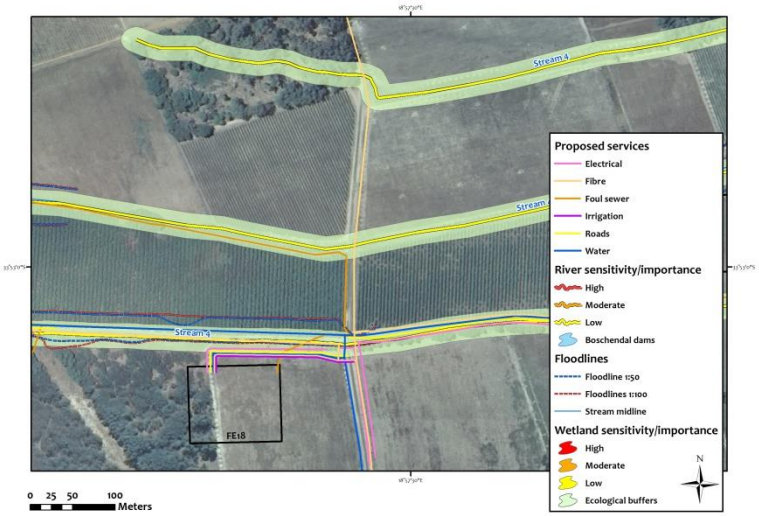
Area Number	Sub-catchment	FE, services	Map
1A	1	FE5: Electrical; Road and new culvert (is an existing but not used road track); Water & irrigation; Fibre – all crossing a watercourse (Stream 1).	
1B	1	Foul sewer over watercourse (Stream 1) - will be aboveground over the channel, and belowground for the remainder	
1C	1	Electrical, foul sewer, upgrade to road and new culvert (Road C), fibre crossing a watercourse (Stream 1). All services will be in the road reserve, and installed as part of road construction.	
1D	1	Pump station (within 500m of a wetland (#34)) FE7: Foul sewer (within ecological buffer)	

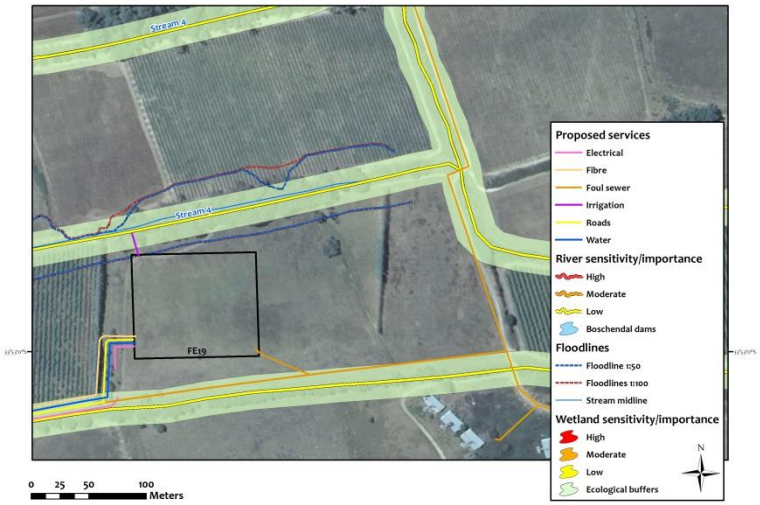
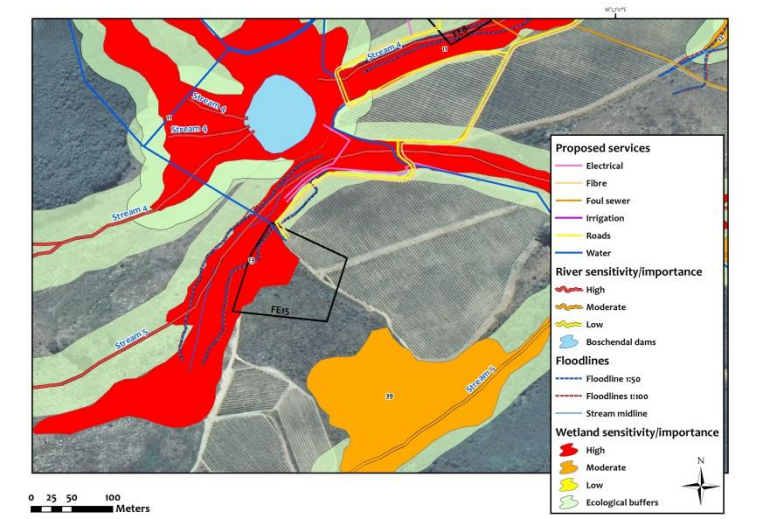
Area Number	Sub-catchment	FE, services	Map
1E	1	FE4: Water pipelines crossing a watercourse (Stream 1) and wetland (#33). Pipe is in existing road reserve.	
1F	1	Irrigation pipeline crossing a wetland (#33)	
2A	2	New water supply reservoir within riparian area of Stream 2 Water pipeline in riparian area of watercourse. Laid in existing road reserve.	

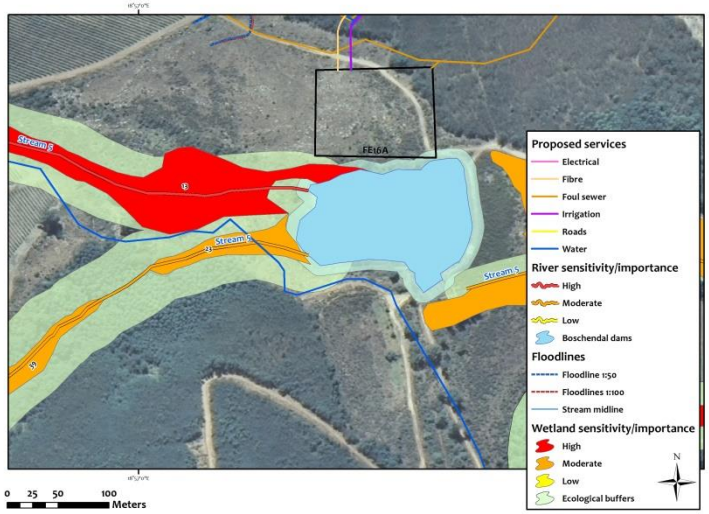
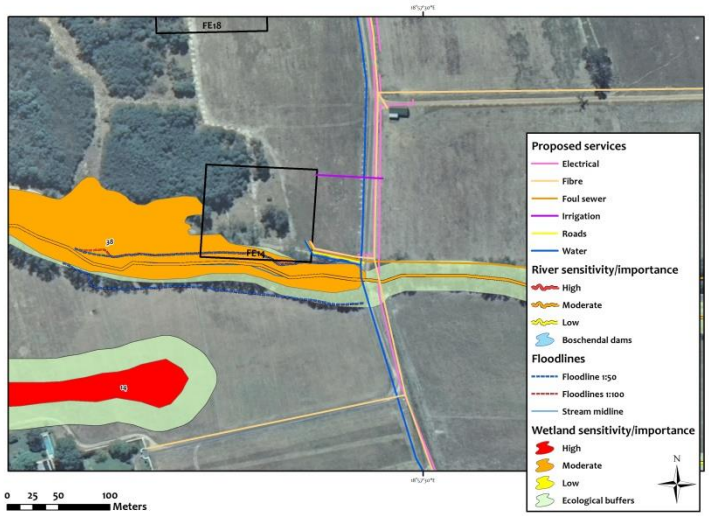
Area Number	Sub-catchment	FE, services	Map
2B	2	FE6: Electrical; Road and new culvert (using existing road); Water & irrigation; Fibre– in ecological buffer and crossing over watercourse (in existing road) (Stream 2) to FE9 FE6: Water pipeline crossing watercourse (Stream 2) not in existing road. FE6: Foul sewer in ecological buffer (Stream 2)	
2C	2	FE10: Electrical; upgrade to existing road (Road B); Water & irrigation; Fibre – crossing a wetland (#36)	
2D	2	FE2: Electrical; Road (using existing road); Water & irrigation; Fibre – in ecological buffer (Stream 2)	

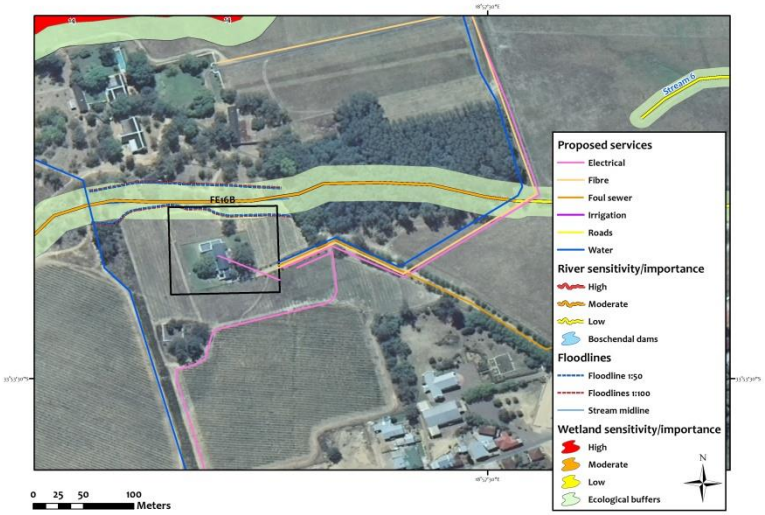
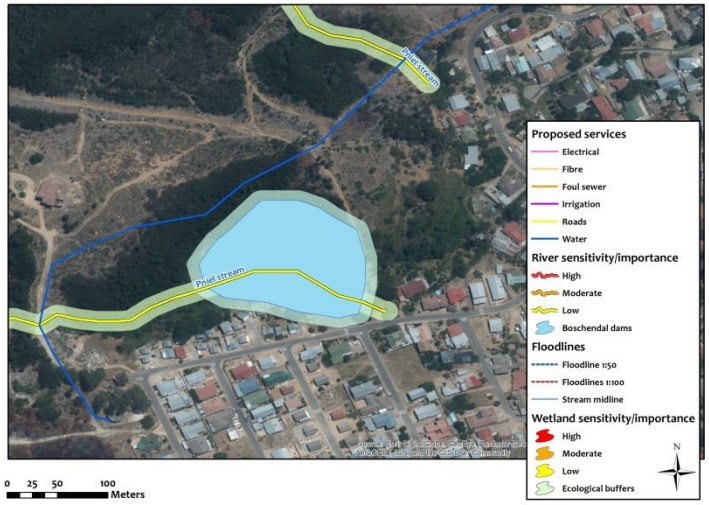
Area Number	Sub-catchment	FE, services	Map
2E	2	FE2: Foul sewer in ecological buffer (Stream 2) Foul sewer crossing watercourse (Stream 2)	
3A	3	Foul sewer in ecological buffer (Stream 3) and crossing Stream 3	

Area Number	Sub-catchment	FE, services	Map
3B	3	Water pipeline crossing Stream 3 (in existing road reserve) and in ecological buffer (dam)	
4A	4	Water pipeline crossing tributaries of Stream 4	
4B	4	FE8: Water; Road and new culvert (existing road and low-level bridge); and Fibre crossing watercourse (Stream 4) – in existing road reserve Road and Fibre in ecological buffer (Stream 4) (on existing road)	
4C	4	FE8: Foul sewer crossing watercourse (Stream 4)	

Area Number	Sub-catchment	FE, services	Map
4D	4	FE12: Water; Road and new culvert (existing road and low-level bridge); Fibre crossing watercourse (Stream 4) on existing track.	
4E	4	FE12: Foul sewer crossing watercourse (Stream 4) and in ecological buffer	
4F	4	FE13: Electrical; Road and new culverts (one is an existing road and low-level bridge) (Road D); Water & irrigation; Fibre– in ecological buffer and crossing over watercourse (Stream 4)	
4G	4	FE13: Foul sewer crossing watercourse (Stream 4)	
4H	4	FE18: Fibre, water pipeline crossing watercourses (Stream 4) – existing track	
4I	4	FE18: Foul sewer crossing watercourse (Stream 4)	

Area Number	Sub-catchment	FE, services	Map
4J	4	FE19: Foul sewer crossing watercourse (Stream 4) (in existing road) and in ecological buffer (Stream 4); upgrade to existing road (Road A)	
4K	4	FE19: Electrical; Road (using existing road); Water & irrigation; Fibre – in ecological buffer and crossing over watercourse (Stream 4)	
5A	5	FE15: Electrical; Upgrade to existing road (Road D_1) and new culvert (currently a low-level bridge); Water & irrigation; Fibre– crossing watercourse and in ecological buffer (Stream 5)	
5B	5	FE15: Foul sewer crossing watercourse (Stream 5) in existing road	

Area Number	Sub-catchment	FE, services	Map
5C	5	Water crossing a watercourse (Stream 5) – existing track	
5D	5	FE14: Electrical; water and fibre crossing a watercourse (Stream 5) – in existing road	

Area Number	Sub-catchment	FE, services	Map
6A	6	FE16B: Electrical; Water; Fibre crossing a watercourse (Stream 6)	
6B	6	Water pipeline crossing over two small watercourses (Pniel streams)	

8.2.2 Construction phase

The activities (underlined), impacts (in italics) and mitigation measures associated with the design / construction phase are detailed in the table below.

There are no construction impacts associated with the no-go option, which assumes no development.

Activity and *Impact*	**Mitigation measures**
Excavation of trenches for services, underground lines within watercourses, wetlands and ecological buffers– will cause *changes in movement of water across the site if left open for an extended period of time, generate mobile sediments, lead to habitat fragmentation, and limit movement of aquatic and terrestrial fauna* across the Estate.	• Wherever possible, services must be placed in existing disturbed footprints, such as roadways. • Trenching in watercourses / wetlands or within their ecological buffers may be conducted during the dry, summer months • Trench excavation should take place in short sections – 50 m per working front is recommended, or at least the minimum length required for laying of relevant services. • A 10m construction corridor will be demarcated prior to construction, and no construction work or machinery will be permitted outside this area. • Opened trenches must be filled as quickly as possible after trenching is initiated. This is to keep the disturbed areas open for the shortest period possible and avoid accumulation of water. No trenches must be opened within three days of predicted heavy rainfall. • Water pumped out of trenches must be pumped into settling tanks or porta-pools to allow settling of sediments before water is allowed to filter into the surrounding ground. • Shoring of side walls of trenches through wetlands and watercourses that are deeper than 1.5 m-depth will be necessary to prevent the sides from collapsing when waterlogged. • Trenches must be inspected after rainfall, to ensure that there is no washing of fine sediments into sensitive areas. • Erosion prevention guidelines provided by Graeme McGill Consulting must be followed.
Construction of concrete supports for aboveground pipelines This could lead to *loss of riverine habitat* (no aboveground pipes are planned to cross wetlands), *loss of riparian vegetation*, *compaction of soils*, *altered morphology* of the channel, which may lead to *pooling of water or erosion*, and the *creation of preferred flow pathways*. A portion of the sewer pipes going to FE5 and FE8 will be aboveground, to avoid trenching for laying of belowground pipes. Supports will be placed at intervals of approximately 2m.	• Location of concrete supports must be done in consultation (preferably in field) with a freshwater ecologist. • No indigenous riparian trees may be removed or damaged during construction. • Excavation for concrete supports must be done by hand within the watercourse and its ecological buffer. • A 5m x 5m buffer around each support must be demarcated prior to construction commencing, and no work can take place outside this area. • Concrete foundations and columns must be pre-cast, if possible. Where this is not possible, concrete mixing must take place outside of the watercourse buffer, and care taken to avoid spillage of any cement/concrete. • Excavations must be back-filled and covered with a 15cm layer of topsoil, and re-shaped to ensure that the natural slope of the channel or bank is maintained, and no concentrated flow pathways are created.

Activity and *Impact*	**Mitigation measures**
	• The construction area for each support must be rehabilitated (i.e. re-vegetated with appropriate plants, in autumn) to the satisfaction of the freshwater ecologist and ECO.
Construction of new reservoir This will require the construction of a level, stable platform for the reservoir, and clearing of vegetation – the exposed ground will be susceptible to *erosion* and *IAP invasion* as well as lead to changes in the *movement of sediment and water across the site,* and *compaction of soils*.	• If possible, the reservoir should be located on a previously disturbed area. • Placing of the reservoir in this location may not lead to the creation of concentrated flowpaths, which may cause erosion. • During construction, the site must be demarcated including a buffer of 10m around the perimeter of the reservoir site, and no machinery or personnel may work beyond the demarcation. • Post construction, the reservoir site not occupied by the reservoir itself must be rehabilitated. To this end, excavations must be backfilled and covered with 15cm of topsoil, and replanted (in spring). • Erosion prevention guidelines provided by Graeme McGill Consulting must be followed. • The site should be inspected by a freshwater ecologist after construction.
Construction of new culverts for road upgrades This could lead to *loss of riverine habitat*, *loss of riparian vegetation*, *compaction of soils*, *altered morphology* of the channel, which may lead to *pooling of water or erosion*, and the *creation of preferred flow pathways*. Diversion of water during the construction period may lead to the *deterioration of riverine habitat, erosion and sedimentation*.	• New culverts may only be constructed during the dry period. • All new culverts must be inspected by a freshwater ecologist after construction. • Erosion prevention guidelines provided by Graeme McGill Consulting must be followed.
Storage of building materials in laydown areas (sand, soil, bricks etc.) in sensitive areas – this would *damage the soil structure, and would destroy or shade out plants growing in and around these ecosystems*. Stockpile areas frequently lead to the *compaction of soils*, which can influence re-growth of plants after construction.	• Ensure that all building materials and rubble are stored at least 50m away from the edge of the wetlands or watercourses, as demarcated prior to construction. Storage areas should be bunded adequately to prevent contaminated runoff from entering the aquatic ecosystems. • Materials should be stored in piles that do not exceed 1.5m in height and should be protected from the wind (such as using shade-cloth), to prevent spread of fine materials across the site. • All natural areas that are to remain untransformed but that are impacted by the dumping of materials must be ripped and re-planted after construction is complete, to the satisfaction of the Environmental Control Officer (ECO).
Leakage of fuels, oils, etc. from construction machinery – this would lead to *pollution of the wetlands or watercourses*.	• No mixing of concrete may occur close to (less than 50m away) any wetlands and watercourses. • Machinery prone to oil or fuel leakage must be located at least 50m away from the edge of the watercourse, and the area adequately bunded in order to contain leakages. • Water pumps and cement mixers shall have drip trays to contain oil and fuel leaks – these must be cleaned regularly.
Foot and vehicular traffic across the site, leading to *destruction or deterioration of aquatic habitat.* Access to the watercourses or wetlands during construction will lead to *damage of soils, substrate (in the stream) and vegetation*. Regular use of a particular area for pathways will lead to the *compaction of soils*.	• Pathways and access roads for construction must avoid the watercourses and wetlands – including their buffers. • Where construction work must happen close to watercourses and wetlands, the edges of the ecological buffers must be clearly demarcated and fenced off (using temporary fencing and danger tape) before any work or

Activity and *Impact*	Mitigation measures
	site preparation begins. These are no-go areas during the construction phase. • All impacted natural areas must be ripped and re-planted after construction, to the satisfaction of the ECO.
Presence of construction teams and their machinery on site – this may lead to *trampling of vegetation and compaction of soils*, and *noise and light pollution* in the area, which will *disturb aquatic and terrestrial fauna and flora*.	• If lights are used, these must be directed away from all sensitive areas. • Sensitive areas, such as the boundary of the watercourse and wetland buffers, must be clearly demarcated and fenced off (using temporary fencing and danger tape) before any work or site preparation begins. These are no-go areas during the construction phase.
Top soil or sand brought onto the site, for filling and construction can lead to the *introduction of alien or invasive seedbanks*.	• Top soil and sand brought onto the site should be inspected for seedlings throughout construction. Seedlings must be removed regularly. • Constant monitoring of the construction site by the Site Engineer and ECO must occur, and all alien plant species removed from or destroyed on the site.
Generation of wastewater and solid waste by construction workers – may lead to *pollution of the terrestrial and aquatic ecosystems and thus deterioration of ecosystem health on site.*	• Suitable toilet and wash facilities must be provided to avoid the use of sensitive areas for these activities. These service areas must be maintained, and toilets emptied on at least a weekly basis. • All solid waste must be removed from site on a weekly basis. • Construction sites must be inspected regularly for toilet paper and other waste.

8.2.3 Operational phase

The activities (underlined), impacts (in italics) and mitigation measures associated with the operational phase are detailed in the table below.

Activity and *Impact*	Mitigation measures
Discharge of water into natural areas – water quantity and quality impacts. *Changes in water quantity and quality* arising from stormwater runoff (rain), washing of panels, roads (dust control) can deteriorate aquatic ecosystems. Pollutants, such as oil and petrol from vehicles as well as nutrients such as nitrates and phosphates from soaps, cleaning agents can all decrease the water quality of the watercourses and wetlands – especially in the drier season. Any hardened surfaces on the Estate (newly paved roads) will lead to *changes in water inputs and flow patterns*, as there will be an *increase in the quantity* of stormwater runoff exiting these areas as opposed to filtering into the ground. Flow patterns will also be impacted, as *flood peaks will be increased in volume as well as frequency*. Discharge of stormwater into seasonal watercourses or wetlands may lead to a *loss of habitat quality*, as these ecosystems will be inundated or saturated for longer and will *lose their seasonal character*.	• Effort should be made to minimise the hardening of surfaces wherever possible. Natural areas and road verges are areas where water can filter into the ground. • If used, soaps and cleaning agents must be biodegradable. • Areas receiving stormwater runoff from roads and other hardened surfaces must be protected by vegetated strips, and/or infiltration strips comprising gravel or small stones. • All newly hardened areas across the Estate should be associated (where possible) with vegetated filter strips (broad, sloped vegetated areas that accept shallow runoff from hardened surfaces), bioswales (landscaped areas that are designed to remove silt and a number of pollutants from runoff, through ensuring that water flows slowly along these gently sloping (<6% slope) features, often planted with grass or other plant species, mulch or riprap), and / or bio-retention systems (vegetated areas where runoff is filtered through a filter media layer, e.g. sand, as it percolates downwards), all of which are designed to reduce the quantity of runoff leaving a hardened surface and entering the stormwater

Activity and *Impact*	Mitigation measures
	system.
Disturbance of soils and vegetation during services maintenance Alien or invasive seeds and seedlings may be transported *onto site* during ongoing maintenance. Alien vegetation is well adapted to establishing on previously disturbed soils and road verges. This may lead to a further loss of habitat quality, and increase in water uptake through transpiration. Unpaved road maintenance may lead to *erosion and sedimentation.*	• The spread of alien plant species (especially trees e.g. *Acacia saligna*, *A. mearnsii* and *A. longifolia*) into all natural areas must be prevented and monitored. • Road verges must be monitored for alien species, especially grasses. • Road edges to be monitored for concentrated flow paths and erosion during maintenance. • Gravel should not be pushed into natural areas during road maintenance.
On site water use – servicing of the Boschendal Estate for increased occupation will lead to a higher demand for potable water.	• Homeowners should be encouraged to use water sparingly at all times. • Wherever possible, homeowners should be encouraged to use non-potable (recycled or grey) water for activities outside the home.
Leaks or failure of foul sewer system (pipes and pump station) This would lead to *severe organic pollution* in the receiving watercourse or wetland, and will possibly even affect groundwater. There are several instances where the foul sewer (all gravity mains) cross over watercourses, or are placed in ecological buffers. In addition, the proposed new sewer pump station is located close to (but not in) the ecological buffer of a watercourse (Stream 1).	• Backup generators must be available for the pump station, in the event of a power failure, which may lead to overflow of sewage. • All sewer reticulation systems and the pump station must be inspected regularly. • Leaks must be repaired immediately. • Waste water leaking from sewage infrastructure must be contained, using berms, temporary pools and pipes, and pumps. • Leaked waste water must be disposed of in the correct manner.

8.2.4 Cumulative impacts

The cumulative impacts of most concern in this area are:

- Loss of open space, through catchment hardening, and deterioration of habitat condition;
- Fragmentation of aquatic ecosystems, and loss of connectivity between aquatic ecosystems and the surrounding landscape, through construction of crossings over watercourses and wetlands, and
- Loss of riverine or wetland habitat, as a result of encroachment of infrastructure into inland aquatic ecosystems and/or their ecological buffers, and
- Deterioration in aquatic/wetland habitat due to changed water inputs and flow patterns associated with stormwater discharge.

8.3 Results of impact assessment

8.3.1 Construction phase

Excavation of trenches for services, underground lines within watercourses, wetlands and ecological buffers– will cause *changes in movement of water across the site if left open for an extended period of time, generate mobile sediments, lead to habitat fragmentation, and limit movement of aquatic and terrestrial fauna* across the Estate.

Extent: in watercourses, trench construction can impact on downstream reaches, and it is possible that this impact will extend off-site (i.e. **medium** extent) unless mitigated. Mitigation centres around containing the construction related impacts at the site of the activity. In wetlands, the impact extent is likely to be **low** in

wetlands that are not connected to the river network, and **medium** in those connected to streams, as sediment etc mobilised during construction could enter downstream reaches of the streams. As for watercourses, the extent of the impact can be reduced to low, with mitigation that aims to contain construction-related impacts to the site of the trenching.

Duration: in watercourses that have a high diversity of habitats, such as a mixture of boulders, cobble, sand and gravel (e.g. the upper reaches of all streams, and also lower Streams 5 and 6), the activity of trenching is likely to have an impact that will endure for up to 5 years, so **short-term**. In watercourses with sandy beds, the duration is likely to be shorter, as a homogeneous sandy bed can be replaced more effectively than a diverse, heterogeneous streambed. In all cases, recovery will be more rapid and effective when the bed material is stockpiled during construction and replaced. In wetlands requiring trenching, trenching impacts are likely to endure for up to 5 years (i.e. **short-term**), with restoration of sub- and topsoil being achievable if these are stockpiled during construction.

Intensity: the sensitivity of the receptor (ecological importance and sensitivity (EIS) of the watercourse, wetland or buffer) has a direct impact on impact intensity. In ecosystems with a high to very high EIS, trenching is likely to be of **medium** intensity, leading to possible loss of a small area of sensitive habitat. It is unlikely that whole ecosystems will be lost, or that important ecological processes will be impacted. Trenching through aquatic ecosystems of medium and low EIS will likely be of **low** intensity. Ecological buffers are less sensitive than the ecosystems they protect. Services laid in trenches in existing roads or road reserves will lead to impacts of a lower intensity, due to the road reserve itself being of **low** sensitivity.

Degree to which the impact can be avoided: Moderate – the impacts of trenching can be mitigated and some consequences avoided.

Extent to which the impact can be mitigated on site: Moderate – with the recommended mitigation measures, the significance of the impact can be reduced but not avoided.

Degree to which the impact can be reversed: Moderate – rehabilitation of the trenched corridors can be successful, however a full return to pre-development state will require complete removal of the trenched services.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
1A	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	High	Medium / High
1A	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
1B	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	High	Medium / High
1B	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
1C	**Without mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
1C	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
1D	**Without mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
1D	**With**	Low	Short-term	Low	Negative	**Low**	Medium	Medium

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
	mitigation							
1E	**Without mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
1E	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
1F	**Without mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium
1F	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium
2A	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
2A	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
2B	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	High	Medium / High
2B	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
2C	**Without mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium
2C	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium
2D	**Without mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
2D	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
2E	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium / High
2E	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
3A	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
3A	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
3B	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium
3B	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium
4A	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	High	Medium / High
4A	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
4B	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
4B	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
4C	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	High	Medium / High
4C	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
4D	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
4D	**With**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium /

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
	mitigation							High
4E	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium / High
4E	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
4F	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
4F	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
4H	**Without mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
4H	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
4I	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium / High
4I	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
4J	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium
4J	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium
4K	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium / High
4K	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
5A	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
5A	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
5B	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
5B	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
5C	**Without mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
5C	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium / High
5D	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium / High
5D	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
6A	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium / High
6A	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High
6B	**Without mitigation**	Medium	Short-term	Low	Negative	**Low**	Medium	Medium / High
6B	**With mitigation**	Low	Short-term	Low	Negative	**Low**	Medium	Medium / High

Construction of concrete supports for aboveground pipelines

This could lead to *loss of riverine habitat* (no aboveground pipes are planned to cross wetlands), *loss of riparian vegetation*, *compaction of soils*, *altered morphology of the channel*, which may lead to *pooling of water or erosion*, and the *creation of preferred flow pathways*.

A portion of the foul sewer pipes going to FE5 and FE8 will be aboveground, to avoid trenching for laying of belowground pipes in river channels. Supports will be placed at intervals of approximately 2m.

Extent: the extent of the construction-related impact is likely to be medium if holes are dug using an excavator, which can be reduced to low if holes are dug by hand. Removal of riparian vegetation for construction of aboveground services is likely to be limited to the site of the activity.

Duration: Stream 1 is a sandy-bed system where the foul sewer will cross aboveground, whereas Stream 4 is a mixture of boulders, cobble, sand and gravel. Construction work in the channel for placing of supports is likely to have an impact that will endure for up to 5 years, so **short-term**. In both cases, recovery will be more rapid and effective when the bed material is stockpiled during construction and replaced.

Intensity: the sensitivity of the receptor (ecological importance and sensitivity (EIS) of the watercourse) has a direct impact on impact intensity. Both streams that will be crossed by aboveground sewer pipelines are of high EIS and the pipes will not follow existing tracks or roads, however, the area of impact is small and important ecological processes are unlikely to be disrupted, so the intensity of the impact will be medium.

Degree to which the impact can be avoided: Moderate – the impacts of the above ground sections of pipeline can be mitigated and some consequences avoided.

Extent to which the impact can be mitigated on site: Moderate – with the recommended mitigation measures, the significance of the impact can be reduced but not avoided.

Degree to which the impact can be reversed: High – removal of the aboveground services will lead to complete recovery of the impacted ecosystems.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
1B	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium
1B	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
4C	**Without mitigation**	Medium	Short-term	High	Negative	**Medium**	Medium	Medium
4C	**With mitigation**	Low	Short-term	High	Negative	**Medium**	Medium	Medium

Construction of new reservoir

This will require the construction of a level, stable platform for the reservoir, and clearing of vegetation – the exposed ground will be susceptible to *erosion* and *IAP invasion* as well as lead to changes in the *movement of sediment and water across the site,* and *compaction of soils*.

Extent: construction-related impacts can be expected to extend beyond the site of the activity, due to the steepness of the slope. With mitigation, however, the impact should effectively be contained within the working area.

Duration: construction-related impacts are likely to be short-term, as long as the site is maintained free of IAPs.

Intensity: the new reservoir is located adjacent to an old reservoir, in the riparian area of a watercourse of high EIS. The intensity of the activity is considered to be medium, as the area of impact is relatively small, and no ecological processes are expected to be disrupted.

Degree to which the impact can be avoided: Low – the impacts of the construction of the reservoir cannot be fully avoided due to the location of the site in a riparian area.

Extent to which the impact can be mitigated on site: Moderate – with the recommended mitigation measures, the significance of the impact can be reduced, especially due to limiting the extent of the impact.

Degree to which the impact can be reversed: Moderate – completion of the reservoir will lead to recovery of the surrounding habitat, but the site itself will continue to be impacted.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
2A	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium
2A	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium

Construction of new culverts for road upgrades

Eight new culverts are proposed on Streams 1, 2, 4 and 5. This could lead to *loss of riverine habitat*, *loss of riparian vegetation*, *compaction of soils*, *altered morphology* of the channel, which may lead to *pooling of water or erosion*, and the *creation of preferred flow pathways*. Diversion of water during the construction period may lead to the *deterioration of riverine habitat, erosion and sedimentation*.

Extent: construction-related activities are likely to lead to impacts that will extend downstream for some distance, especially when watercourses are on steep slopes (i.e. upper reaches of watercourses) or where the culvert and road are not located in an existing disturbed road footprint. Mitigation measures are likely to reduce impact extent somewhat, however this is unlikely to be confined to the site only.

Duration: impacts are likely to be short-term, i.e. less than 5 years, where culverts will be placed in existing disturbed road footprints. Duration may exceed 5 years in rivers of high EIS, where the working area is not in an existing road footprint.

Intensity: the intensity of the construction-related activities is likely to be medium where work will take place in an existing disturbed footprint, and high where this is not the case.

Degree to which the impact can be avoided: Low – the impacts of the construction of the culverts cannot be fully avoided due to the location of the crossings in the watercourses.

Extent to which the impact can be mitigated on site: Moderate – with the recommended mitigation measures, the significance of the impact can be reduced, specifically by limiting the extent of the impact.

Degree to which the impact can be reversed: Moderate – completion of the culverts will lead to recovery of the surrounding habitat.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
1A	**Without mitigation**	Medium	Medium-term	High	Negative	**Medium**	Medium	Medium / High
1A	**With mitigation**	Low	Medium-term	High	Negative	**Medium**	Medium	Medium
1C	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
1C	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
2B	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
2B	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
4B	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
4B	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
4D	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
4D	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium
4F	**Without mitigation**	Medium	Short-term	High	Negative	**Medium**	Medium	Medium / High
4F	**With mitigation**	Low	Short-term	High	Negative	**Medium**	Medium	Medium
5A	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium / High
5A	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium

Storage of building materials in laydown areas (sand, soil, bricks etc.) in sensitive areas – this would *damage the soil structure, and would destroy or shade out plants growing in and around these ecosystems*. Stockpile areas frequently lead to the *compaction of soils*, which can influence re-growth of plants after construction.

Degree to which the impact can be avoided: High – location of laydown areas can easily avoid sensitive areas.

Extent to which the impact can be mitigated on site: High – with the recommended mitigation measures, the significance of the impact can be reduced.

Degree to which the impact can be reversed: High – removal of stored material is likely to lead to recovery of the affected habitat.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
All construction sites	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium
All construction sites	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium

Leakage of fuels, oils, etc. from construction machinery – this would lead to *pollution of the wetlands or watercourses*.

Degree to which the impact can be avoided: High – locating machinery some distance from sensitive environments should avoid this impact.

Extent to which the impact can be mitigated on site: High – with the recommended mitigation measures, the significance of the impact can be reduced.

Degree to which the impact can be reversed: Moderate – pollution from leaks or spills may take some time to be reversed.

Degree to which the impact may cause loss of irreplaceable resources: This will depend on where spills or leaks occur. If this occurs in watercourses or wetlands, there may be a loss of irreplaceable resources.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
All construction sites	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium
All construction sites	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium

Foot and vehicular traffic across the site, leading to *destruction or deterioration of aquatic habitat.* Access to the watercourses or wetlands during construction will lead to *damage of soils, substrate (in the stream) and vegetati*on. Regular use of a particular area for pathways will lead to the *compaction of soils*.

Degree to which the impact can be avoided: High – sensitive areas can easily be avoided.

Extent to which the impact can be mitigated on site: High – with the recommended mitigation measures, the significance of the impact can be reduced.

Degree to which the impact can be reversed: Moderate –recovery of the affected habitats may take some time.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
All construction sites	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium
All construction sites	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium

Presence of construction teams and their machinery on site – this may lead to *trampling of vegetation and compaction of soils*, and *noise and light pollution* in the area, which will *disturb aquatic and terrestrial fauna and flora*.

Degree to which the impact can be avoided: High – sensitive areas can easily be avoided.

Extent to which the impact can be mitigated on site: High – with the recommended mitigation measures, the significance of the impact can be reduced.

Degree to which the impact can be reversed: Moderate – after construction, the disturbance will be removed, and disturbed fauna are likely to return. However, flora may take some time to recover.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: Fauna and flora may move to other areas.

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
All construction sites	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium
All construction sites	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium

Generation of wastewater and solid waste by construction workers – may lead to *pollution of the terrestrial and aquatic ecosystems and thus deterioration of ecosystem health on site.*

Degree to which the impact can be avoided: High – sensitive areas can easily be avoided.

Extent to which the impact can be mitigated on site: High – with the recommended mitigation measures, the significance of the impact can be reduced.

Degree to which the impact can be reversed: Moderate – after construction, affected areas may take some time to recover from pollution.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
All construction sites	**Without mitigation**	Medium	Short-term	Medium	Negative	**Medium**	Medium	Medium
All construction sites	**With mitigation**	Low	Short-term	Medium	Negative	**Low**	Medium	Medium

8.3.2 Operational phase

Discharge of water into natural areas – water quantity and quality impacts. *Changes in water quantity and quality* arising from stormwater runoff (rain), washing of panels, roads (dust control) can deteriorate aquatic ecosystems. Pollutants, such as oil and petrol from vehicles as well as nutrients such as nitrates and phosphates from soaps, cleaning agents can all decrease the water quality of the watercourses and wetlands – especially in the drier season. Any hardened surfaces on the Estate (newly paved roads) will lead to *changes in water inputs and flow patterns*, as there will be an *increase in the quantity* of stormwater runoff exiting these areas as opposed to filtering into the ground. Flow patterns will also be impacted, as *flood peaks will be increased in volume as well as frequency*. Discharge of stormwater into seasonal watercourses or wetlands may lead to a *loss of habitat quality*, as these ecosystems will be inundated or saturated for longer and will *lose their seasonal character*.

Extent: this impact will extend beyond the site of the activity (i.e. generation of stormwater), with the likely exception of the bio-retention facilities constructed at each FE. Although mitigation measures recommended in this report and in the stormwater management plan will significantly reduce the extent of this impact, it is unlikely to be reduced to the site only, and will continue to have downstream effects, especially downstream of roads and other hardened surfaces.

Duration: the impact will be of long-term duration, as the stormwater system, once in place, will continue to discharge stormwater into natural areas.

Intensity: the intensity of the impact is likely to be, at worst, medium for receiving channels and wetlands that are of high EIS, as many of these channels have been receiving stormwater runoff for many years.

Degree to which the impact can be avoided: Low – stormwater runoff will generally find its way into surface and groundwater systems.

Extent to which the impact can be mitigated on site: Moderate – with the implementation of recommended mitigation measures, the extent of the impacts can be reduced.

Degree to which the impact can be reversed: Low – the discharge of stormwater into a freshwater ecosystem will lead to fairly long-term changes to the ecosystem, which are not easily reversed.

Degree to which the impact may cause loss of irreplaceable resources: Unlikely.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
All construction sites	**Without mitigation**	Medium	High	Medium	Negative	**Medium**	High	Medium
	With mitigation	Low	Medium	Medium	Negative	**Medium**	Medium	Low/medium
No-go option	**Without mitigation**	Low	Medium	Low	Negative	**Low**	High	High
	With mitigation	Low	Low	Low	Negative	**Low**	High	Medium

Disturbance of soils and vegetation during services maintenance

Alien or invasive seeds and seedlings may be transported *onto site* during ongoing maintenance of services. Alien vegetation is well adapted to establishing on previously disturbed soils and road verges. This may lead to a further loss of habitat quality, and increase in water uptake through transpiration. Unpaved road maintenance may lead to *erosion and sedimentation.*

Degree to which the impact can be avoided: High – only good quality soils can be brought onto site, and continual monitoring of disturbed areas will ensure that IAPs do not establish.

Extent to which the impact can be mitigated on site: Moderate – with the implementation of recommended mitigation measures, the extent of the impacts can be reduced.

Degree to which the impact can be reversed: Low – encroachment of IAPs cannot easily be reversed, and so the impact can be medium-term, without mitigation.

Degree to which the impact may cause loss of irreplaceable resources: If this occurs in a previously uninvaded watercourse or wetland, this may lead to the loss of irreplaceable resources.

Indirect impacts: None

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
All construction sites	**Without mitigation**	Medium	Medium	Medium	Negative	**Medium**	High	Medium
	With mitigation	Low	Short-term	Medium	Negative	**Low**	Medium	Low/medium
No-go option	**Without mitigation**	Low	Medium	Low	Negative	**Low**	High	High
	With mitigation	Low	Low	Low	Negative	**Low**	High	Medium

On site water use – servicing of the Boschendal Estate for increased occupation will lead to a higher demand for potable water.

Degree to which the impact can be avoided: Moderate – it is difficult to reduce water demand, however there are measures that can be established to accomplish this.

Extent to which the impact can be mitigated on site: Moderate – with the implementation of recommended mitigation measures, the extent of the impacts can be reduced.

Degree to which the impact can be reversed: Moderate to low – impacts on groundwater are difficult to reverse, however impacts on surface water resources will reduce significantly if the demand is removed.

Degree to which the impact may cause loss of irreplaceable resources: Again, the impacts on groundwater are more severe as this is an irreplaceable resource, to a certain extent (recharge is only roughly 5 – 10%), while surface water can be replenished.

Indirect impacts: This may have an impact on agriculture and development in the area, if water resources are fully allocated.

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
All construction sites	**Without mitigation**	Medium	Medium	Low	Negative	**Medium**	High	Medium
	With mitigation	Medium	Short-term	Low	Negative	**Low**	Medium	Low/medium
No-go option	**Without mitigation**	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	With mitigation	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Leaks or failure of foul sewer system (pipes and pump station)

This would lead to *severe organic pollution* in the receiving watercourse or wetland, and will possibly even affect groundwater.

The proposed new sewer pump station is located close to (but not in) the ecological buffer of a watercourse (Stream 1) of medium EIS.

Degree to which the impact can be avoided: Moderate – if a failure of the pump station or pipelines is responded to immediately, the impact can be avoided.

Extent to which the impact can be mitigated on site: Moderate – the extent of the impact can be reduced through mitigation.

Degree to which the impact can be reversed: Moderate to low – depending on the extent and severity of the failure.

Degree to which the impact may cause loss of irreplaceable resources: the importance of the watercourse downstream of the proposed pump station is moderate, and the ecosystem itself is not irreplaceable.

Indirect impacts: None.

Area of impact	Mitigation	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
1B	**Without mitigation**	Medium	Low	High	Negative	**Medium**	Low	Medium
1B	**With mitigation**	Low	Low	High	Negative	**Medium**	Low	Medium
1C	**Without mitigation**	Medium	Low	High	Negative	**Medium**	Low	Medium
1C	**With mitigation**	Low	Low	High	Negative	**Medium**	Low	Medium
1D	**Without mitigation**	Medium	Low	Medium	Negative	**Medium**	Low	Medium
1D	**With mitigation**	Low	Low	Medium	Negative	**Low**	Low	Medium
2B	**Without mitigation**	Medium	Low	Medium	Negative	**Medium**	Low	Medium
2B	**With mitigation**	Low	Low	Medium	Negative	**Low**	Low	Medium
2E	**Without mitigation**	Medium	Low	Medium	Negative	**Medium**	Low	Medium
2E	**With mitigation**	Low	Low	Medium	Negative	**Low**	Low	Medium
3A	**Without mitigation**	Medium	Low	Medium	Negative	**Medium**	Low	Medium
3A	**With mitigation**	Low	Low	Medium	Negative	**Low**	Low	Medium
4C	**Without mitigation**	Medium	Low	High	Negative	**Medium**	Low	Medium
4C	**With mitigation**	Low	Low	High	Negative	**Medium**	Low	Medium
4E	**Without mitigation**	Medium	Low	Medium	Negative	**Medium**	Low	Medium
4E	**With mitigation**	Low	Low	Medium	Negative	**Low**	Low	Medium
4G	**Without mitigation**	Medium	Low	High	Negative	**Medium**	Low	Medium
4G	**With mitigation**	Low	Low	High	Negative	**Medium**	Low	Medium
4I	**Without mitigation**	Medium	Low	Medium	Negative	**Medium**	Low	Medium
4I	**With mitigation**	Low	Low	Medium	Negative	**Low**	Low	Medium
4J	**Without mitigation**	Medium	Low	Medium	Negative	**Medium**	Low	Medium
4J	**With mitigation**	Low	Low	Medium	Negative	**Low**	Low	Medium
5B	**Without mitigation**	Medium	Low	High	Negative	**Medium**	Low	Medium
5B	**With mitigation**	Low	Low	High	Negative	**Medium**	Low	Medium
No-go option	**Without mitigation**	Medium	Low	Low	Negative	**Low**	Low	Medium
	With mitigation	Low	Low	Low	Negative	**Low**	Low	Medium

9 WATER USE AUTHORISATION

9.1 Water uses

The construction and operation of the FE services may have an impact on the bed and banks of and flow in the watercourses and wetlands identified and mapped on Boschendal Estate, thus triggering non-consumptive water uses in terms of Section 21 of the Water Act (1998). Such water uses apply within a **regulatory zone**, as discussed in Section 6.1, which extends 500m from the outer boundary of a **wetland**, and either up to the 1:100 year floodline (where this has been calculated) or 100m from the edge of the active channel or the outer boundary of the riparian area around a **watercourse**.

Non-consumptive water uses include:

a. Taking water from a water resource;

b. Storing water;

c. Impeding or diverting the flow of water in a watercourse;

d. Engaging in a stream flow reduction activity;

e. Engaging in a controlled activity identified and declared as such in terms of the Act;

f. Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

g. Disposing of waste in a manner which may detrimentally impact on a water resource;

h. Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i. Altering the bed, banks, course or characteristics of a watercourse;

j. Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

k. Using water for recreational purposes.

The process to be followed to obtain authorisation for these categories of water use is different for each water use, and relates to the **risk** associated with the water use. The General Authorisation (GA) in terms of Section 39 of the Water Act (1998) provided in Notice 509 of 2016 (GN 40229 of 26th August 2016) provides guidance and the conditions of authorisation regarding impeding and diverting the flow in a watercourse (Section 21 (c)), or altering the bed, banks, course and characteristics of a watercourse (Section 21 (i)). The recent amendment of the Section 21 (c) and (i) GA introduced a risk assessment matrix that allows for the determination of the level of risk associated with any given activity. Low risk water uses are **generally authorised**, requiring registration of the water use only, while activities with a moderate to high level of risk to the water resource require a full water use licence application.

9.2 Risk assessment matrix

The risk assessment matrix introduced in August 2016 adopts an approach similar to the EIA regulations, where each impact is assessed in terms of severity, likelihood and consequence. The matrix requires the assessment of each activity associated with the construction and operation of any development project in terms of the impacts expected to affect resource quality characteristics (flow regime, water quality,

geomorphology, and habitat/biota) of watercourses and wetlands. Each impact is scored in terms of the severity of its effect on each of the resource quality characteristics, and the scores are then averaged to give a total for severity. Each impact is then scored in terms of its:

- **Consequence**, which is the product of the severity of the impact, the spatial scale or extent, and the duration of the impact; and
- **Likelihood**, which is the sum of the frequency of the activity, frequency of the impact, existence of legislation governing the activity and ecosystem; and the *ease of detection* of the impact.

The significance of the impact is calculated as the product of its consequence and likelihood. The final score is used to assign a risk rating to the impact (see Table 7.6), **assuming implementation of effective mitigation measures as outlined in the Appendix**.

Table 7.6 Rating Classes for the Risk Assessment.

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.

9.3 Results of risk assessment

Summary results for the assessment of risks to the various inland aquatic ecosystems impacted by the development of services for the Founder Estates are provided in Table 7.7. All risk assessment matrices are provided in Appendix 1.

The activities of concern that pose more than a low risk, after mitigation, include the road upgrades (construction phase) in Streams 1 and 4, and the operational phase impacts associated with possible failure of sewage infrastructure in or close to aquatic ecosystems.

Table 7.7 Summary of risk assessments for all impacted aquatic ecosystems. L = Low; M = Medium.

Phase	Activity	Aspect	Stream 1 NORTH	Stream 1 SOUTH	Stream 2 UPPER	Stream 2 LOWER	Stream 3 LOWER	Stream 4 NORTH	Stream 4 UPPER MIDDLE	Stream 4 LOWER MIDDLE	Stream 4 UPPER SOUTH	Stream 4 LOWER SOUTH	Stream 5 UPPER NORTH	Stream 5 UPPER SOUTH	Stream 5 LOWER	Stream 6	Pniel Streams	Wetland #33	Wetland #34	Wetland #36
Construction	Laying of services	Excavation of trenches for services, underground lines and roads	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
		Construction of concrete supports for aboveground pipelines	L	n/a	n/a	n/a	n/a	n/a	L	n/a	n/a	n/a	L	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Road upgrades	Construction of new culverts	M	L	n/a	L	n/a	n/a	M	L	L	L	L	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	New reservoir	Clearing of vegetation and construction of platform for reservoir	n/a	n/a	L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Storage of materials in laydown areas	Storage or dumping of building materials in close proximity to the watercourse	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Operation of machinery close to the watercourse	Leakage of fuels, oils, etc. from construction machinery.	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Construction teams working in proximity to the watercourse	Pedestrian access onto and around the construction site	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
		Use of temporary toilets on site	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Topsoil brought onto site for landscaping, infilling, etc	Introduction of alien or invasive seedbanks	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Operational	Stormwater	Discharge of	L	L	n/a	L	n/a		L	L	L	L	L	n/a	L	n/a	n/a	n/a	n/a	n/a

Phase	Activity	Aspect	Stream 1 NORTH	Stream 1 SOUTH	Stream 2 UPPER	Stream 2 LOWER	Stream 3 LOWER	Stream 4 NORTH	Stream 4 UPPER MIDDLE	Stream 4 LOWER MIDDLE	Stream 4 UPPER SOUTH	Stream 4 LOWER SOUTH	Stream 5 UPPER NORTH	Stream 5 UPPER SOUTH	Stream 5 LOWER	Stream 6	Pniel Streams	Wetland #33	Wetland #34	Wetland #36
	management	stormwater runoff into watercourse																		
	Disturbance of soils and vegetation during services maintenance	Alien or invasive seeds and seedlings may be transported onto site during ongoing maintenance. Alien vegetation is well adapted to establishing on previously disturbed soils and road verges.	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Operation of sewage system	Leaks or failure of foul sewer system (pipes and pump station)	M	M	n/a	M	n/a	M	M	M	M	M	M	n/a	n/a	n/a	n/a	n/a	M	n/a

10 CONCLUSIONS

- The construction and operation of services proposed for the Founder Estates on Boschendal will impact on a number of watercourses and wetlands located on the slopes of the Simonsberg Mountain. The watercourses flow into the Dwars and Berg Rivers, in the Berg River quaternary catchment, G10C. The inland aquatic ecosystems mapped and assessed on Boschendal Estate vary in condition, ecological importance and sensitivity, and so the activities associated with the services will impact on the ecosystems with varying significance.
- The initial planning phase for the FE services was an iterative process, where the main focus was to **avoid** very sensitive aquatic ecosystems and their buffers. The final layouts for services has allowed for the determination of areas where primarily construction-phase impacts must be **mitigated** in order to reduce the negative significance of these impacts.
- Construction of trenches to lay down below-ground infrastructure (pipes, fibre) will lead to impacts of low to medium negative significance without mitigation. Although impacts will be short-lived and impact on a small area, in streams and wetlands connected to the river network, this may have downstream effects. Mitigation measures, which focus on the containment of the impact, aim to reduce the extent of the impact. Even in streams that are of high ecological importance and sensitivity, there is unlikely to be long-term or extensive habitat destruction and disruption of important ecological processes. In all cases, bed material (in wetlands or streams) must be stockpiled during trenching and replaced during restoration activities. Services laid in trenches in existing roads or road reserves will lead to impacts of a lower intensity, due to the road reserve itself being of low sensitivity.
- In two instances, foul sewer pipelines will be carried over river channels (Streams 1 and 4) to reach FEs, to avoid trenching through streams that are of high ecological importance and sensitivity. Due to the sandy / fine sediment nature of the streambed of Stream 1, recovery is likely to be quick and comprehensive, while the more complex, cobble and boulder bed of Stream 4 may take more time to recover. Neither of the routes to be taken by the above-ground infrastructure are existing tracks, so the intensity of the impact will be medium to high before mitigation. Overall, the significance of the residual (post-mitigation) impact associated with this activity will be low for Stream 1, and medium for Stream 2.
- Other construction activities that are likely to have a residual impact (i.e. with mitigation) of medium significance are the culverts to be placed for upgraded and new crossings over Streams 1 and 4. Additional culverts to be placed in other streams across the Estate are likely to lead to impacts of low negative significance.
- All remaining construction-phase impacts can be reduced to low negative significance with mitigation. Mitigation measures must be included in a comprehensive construction phase environmental management programme (EMPr).
- Operational-phase impacts of concern include increased discharge of stormwater into streams, primarily as runoff from newly hardened roads and road verges. Increased formalisation of stormwater runoff is also likely to lead to an increase in discharge into natural areas. Although much of this runoff is natural, increased use of roads across the Estate is likely to lead to increase pollution of stormwater. The design of the stormwater management system aims to decrease impacts on water quantity and quality, however there will be unavoidable impacts on surface flow across the site, leading to an overall residual impact of medium negative significance.
- The other impact of concern is the placement of foul sewer pipes over streams, and the proximity of the new foul sewer pump station to an ecological buffer and stream (Stream 1). Although the

likelihood of failure of this infrastructure is low, the intensity of this impact is medium to high. In some instances, the impact of such failure is thus of medium negative significance.

- The cumulative impacts of most concern across Boschendal Estate and the immediate surrounding area are:
    - Loss of open space, through catchment hardening, and deterioration of habitat condition;
    - Fragmentation of aquatic ecosystems, and loss of connectivity between aquatic ecosystems and the surrounding landscape, through construction of crossings over watercourses and wetlands, and
    - Loss of riverine or wetland habitat, as a result of encroachment of infrastructure into inland aquatic ecosystems and/or their ecological buffers, and
    - Deterioration in aquatic/wetland habitat due to changed water inputs and flow patterns associated with stormwater discharge.
- Despite some of the impacts associated with the proposed services for the Founder Estates being of medium negative significance, a biodiversity offset is not recommended. Instead, it is recommended that the aquatic habitat and biodiversity of the broader Boschendal Estate be managed in such a way that protects important and sensitive habitats (by providing conservation areas), allows connectivity between aquatic and terrestrial landscapes, and between streams and wetlands (by protecting ecological corridors, see below), and guides activities that encroach into or near sensitive habitats (a Maintenance Management Plan for the Estate).
- In the Constraints Analysis of 2019 (Snaddon, 2019), a number of ecological corridors were identified across the Boschendal Estate. The aim of the ecological corridors would be to retain and, in some cases, improve the aesthetics of the area and the ecological functioning of the various inland aquatic ecosystems. The establishment of corridors through the Estate will ensure that any designated conservation areas (such as on the mountain slopes) do not become isolated and disconnected from the ecosystems that arise there, such as the watercourses that flow from the slopes of the Groot Drakenstein and Simonsberg mountains.
- Activities and features that can occur within the recommended corridors include:
    - Walkways, boardwalks and benches;
    - Bird hides;
    - Cultural or religious ceremonies;
    - Signage;
    - Permeable fences;
    - Grazing;
    - Picnic areas;
    - Indigenous gardens; and
    - Parking areas with permeable surfaces.
- In conclusion, sufficient effort has been made by the proponents to avoid, where possible, sensitive aquatic ecosystems. Although the no-go option is the preferred option from a freshwater ecological perspective, as it has fewer negative impacts associated with it, the mitigation measures recommended in this report will reduce the negative impacts of the proposed services and

infrastructure to an acceptably low level. The effectiveness of the mitigation measures need to be monitored in the long-term, and compared against the current situation. Such a monitoring programme should form part of the Environmental Management Programme (EMPr) developed for the Founder Estates.

11 References

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Appendix 1: Declaration

DECLARATION OF THE SPECIALIST

I, **Kate Snaddon**, as the appointed Specialist hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that:

- In terms of the general requirement to be independent:
  - other than fair remuneration for work performed in terms of this application, have no business, financial, personal or other interest in the development proposal or application and that there are no circumstances that may compromise my objectivity; or

  - am not independent, but another specialist (the "Review Specialist") that meets the general requirements set out in Regulation 13 of the NEMA EIA Regulations has been appointed to review my work (Note: a declaration by the review specialist must be submitted);

- In terms of the remainder of the general requirements for a specialist, have throughout this EIA process met all of the requirements;

- I have disclosed to the applicant, the EAP, the Review EAP (if applicable), the Department and I&APs all material information that has or may have the potential to influence the decision of the Department or the objectivity of any Report, plan or document prepared or to be prepared as part of the application; and

- I am aware that a false declaration is an offence in terms of Regulation 48 of the EIA Regulations.

29th August 2022

Signature of the EAP: Date:

Freshwater Consulting cc

Name of company (if applicable):

Appendix 2: CV

Kate Snaddon Pr. Sci. Nat.

Freshwater Consulting

Curriculum vitae

Full name	Catherine Diana Snaddon
SACNASP registration number	400225/06
Address	P O Box 43935 Scarborough 7975 Cape Town
Telephone number	021 780 1027
Cell number	072 232 7709
Email	katesnaddon@telkomsa.net
Date of birth	19 July 1969
Nationality	South African
Position in company	Member, Senior consultant

KEY QUALIFICATIONS

- B.Sc., Majoring in Zoology (with Distinction), University of Cape Town, 1989
- B.Sc. (Hons), Zoology (with Distinction),.University of Cape Town, 1990
- M.Sc, Zoology (with Distinction), University of Cape Town, 1998

WORK EXPERIENCE & RESPONSIBILITIES

March 2003 – present	Freshwater Ecological Consultant, The Freshwater Consulting Group, Cape Town
March 2012 - present	Researcher, Freshwater Research Centre, Cape Town
Position held within FCG	Member and Senior consultant. The FCG is a registered company (Freshwater Consulting cc) of freshwater ecological consultants, based in Cape Town.
Responsibilities	Responsibilities on projects completed for the FCG range from specialist consultant on small projects, to working as a team of multi-disciplinary consultants on larger projects. The maximum number of sub-consultants, or assistants under my employ as lead consultant, is seven. I have managed some of the larger projects on which fellow FCG consultants have worked.
July 2000 - October 2002	Sustainable Business Solutions team, PricewaterhouseCoopers, London, UK
Position held within company	Senior associate
Responsibilities	My responsibilities at PwC were primarily as co-consultant on large projects focusing on waste management, environmental compliance, life cycle analysis, and environmental due diligence.

March 1995 - March 2000, part-time basis	Freelance ecological consultant, Cape Town
January 1996 - January 2000	Research Officer on Water Research Commission Project, Freshwater Research Unit, University of Cape Town
February 1991 - August 1992	Research Assistant, Freshwater Research Unit, University of Cape Town

KEY EXPERIENCE

Kate has 24 years of experience in the field of freshwater ecology (both as a researcher and consultant) and general environmental consulting. Her specialist skills lie in the areas of:

- Freshwater ecology, specifically wetlands, lakes and rivers
- Wetland mapping and delineation;
- River and wetland management and rehabilitation;
- Conservation planning for the aquatic environment;
- Strategic Environmental Assessments of infrastructure projects that may impact on the aquatic environment;
- Environmental Impact Assessment, specifically the assessment of the impacts of anthropogenic activities on freshwater ecosystems;
- Management and implementation of ecological monitoring and research programmes;
- Freshwater macroinvertebrate collection and identification;
- SASS5 bio-monitoring and water quality monitoring.

Kate has worked extensively in the Western Cape, and, more recently, in the Northern Cape, and elsewhere in Africa including Mozambique and Kenya. She has submitted over 100 specialist freshwater ecological consultancy reports, and has published three Water Research Commission reports, two chapters in international books, a South African National Biodiversity Institute wetland classification manual and 11 scientific papers. For the past four years, Kate has been the wetland specialist for the Western Cape's Working for Wetlands Programme.

Kate is a professional member (ecologist) of the South African Council for Natural Scientific Professionals. She is also an accredited SASS5 practitioner. Kate sits on SANBI's National Wetland Ecosystem Classification Committee, and is a Founding Board Member of the South African Wetland Society. Kate is also a researcher at the Freshwater Research Centre, a research Non-Profit Organisation, which runs and participates in freshwater ecological research projects around the country.

Appendix 3: Risk assessment matrices