# Aquatic Specialist Inputs to The Proposed Bank Stabilisation of an Unnamed Stream on RE/12861 in Boland Park, Mossel Bay.

**Prepared for HilLand Environmental (Pty) Ltd & SMEC SA, George**

**by**


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# TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

## 1. INTRODUCTION

Confluent Environmental was appointed by HilLand Environmental to provide aquatic specialist inputs to the proposed bank stabilisation of a natural stream located in an urban area in Mossel Bay. The area is known as Boland Park, and the stream is managed by the Mossel Bay Municipality on RE/12861.

Banks of the lower portion of the stream were heavily developed in the 1970ss with prefabricated houses built very close to the edge of the channel. In order to protect the houses, all natural features of the stream (ie. Bed and banks) were completely replaced with stepped gabions on the banks and open grass pavers on the channel bed. This essentially channelised the stream, but improved protection of the houses.

Further upstream, where the gabions end, houses constructed on steep slopes above the stream are showing signs of slippage down the slope. Several houses have visible cracks and unstable retaining walls. In the stream below, minor erosion is taking place, but in order to prevent collapse of the banks and houses above the banks, the Mossel Bay Municipality would like to extend the gabions further up the stream, and would also like to replace the stream bed with open pavers (See Appendix 1 for plan; Figure 1 and Figure 2).

In addition to unstable houses, the residents have complained of mosquitos, and believe that replacing the stream bed with grass pavers will alleviate this problem.

All instream and riparian vegetation along the stream is currently mowed and the stream habitat is intensively managed from this perspective.

The purpose of this report is to provide aquatic specialist inputs to the proposal to extend bank and bed stabilisation measures further upstream in support of a Basic Assessment and Water Use Authorisation. These authorisations are required in terms of the National Environmental Management Act (NEMA) and the National Water Act (NWA; Act No 36 of 1998) respectively.

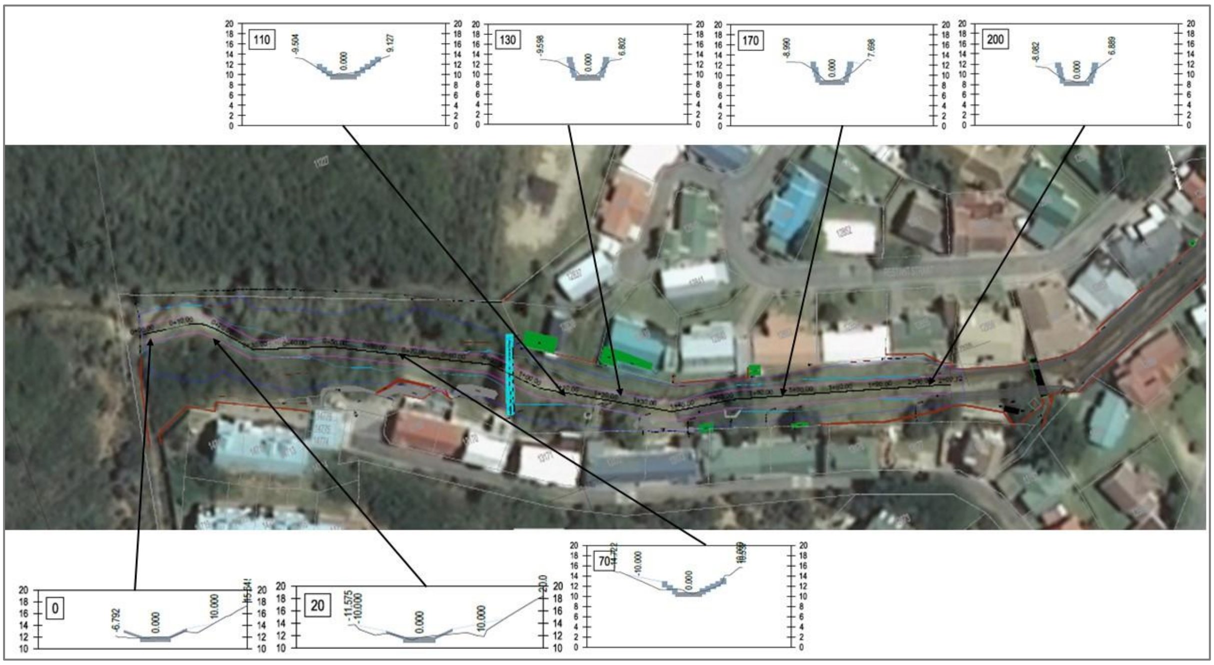



Figure 1. Simplified layout plan showing proposed cross-sectional bank and bed stabilisation (Modified from Appendix 1).

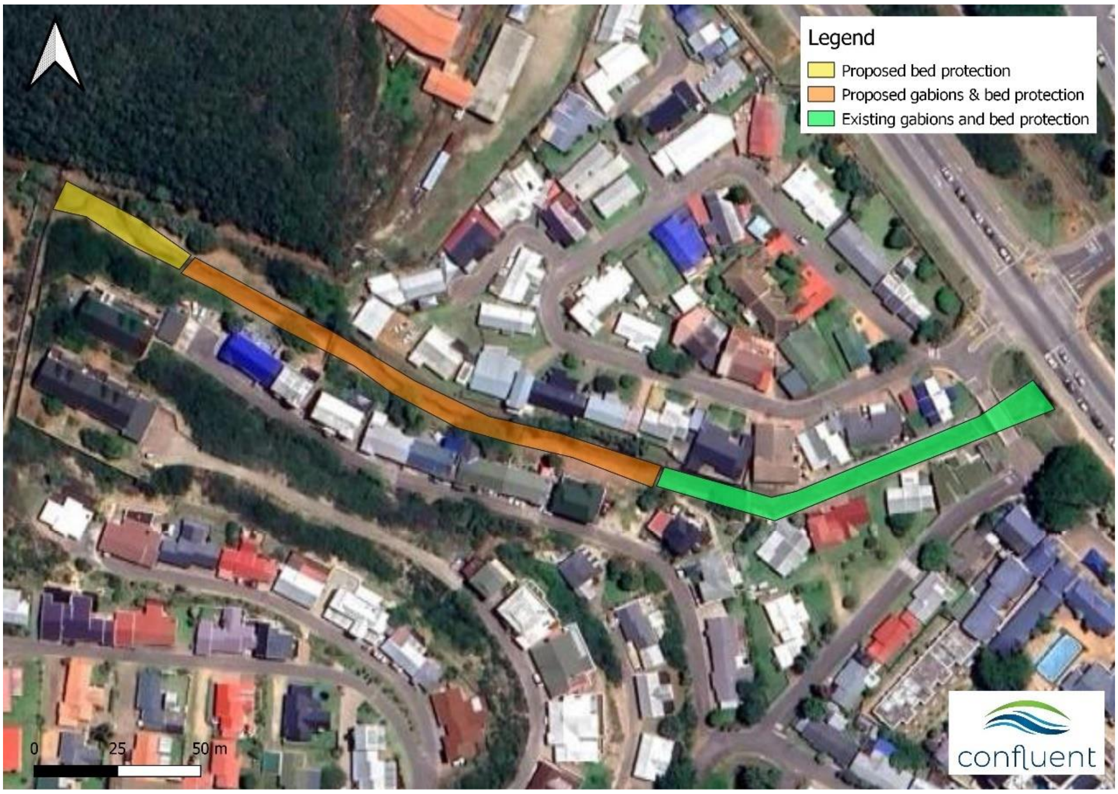



Figure 2. Graphic explanation of the bank and bed protection measures proposed along the watercourse in Boland Park.

## 1.1 Scope of work

The purpose of this assessment is as follows:

- Conduct a desktop assessment of the site characteristics including historical aerial photos, mapped aquatic features and catchment management.
- Compile a report with an assessment of the ecological state and sensitivity of the potentially affected watercourse.
- Compile an impact assessment for all phases of the development along with mitigation measures to minimise disturbance of the aquatic environment.
- Compile a Risk Matrix to assess the level of risk posed by the proposed activities to the watercourse in their mitigated state. If the risk is deemed Low, then the activities may be Generally Authorised. If the risk determined is High, then the activities will require an application for a Water Use License (WUL).

## 1.2 Assumptions and exclusions

It is assumed that the proposal to extend gabion bank protection further upstream is aimed at protecting houses above the stream banks which are showing signs of stress on the steep slopes in some areas.

Only one site visit was conducted during June 2022 which is considered Winter. It is possible that sensitive features such as rare or unique biota, plants or habitat were not observed during the site visit, but are influenced by season, time of day, flow level or vegetation cover (e.g. Pre-mowing).

# 2. CATCHMENT CONTEXT

## 2.1 Catchment features

The stream is unnamed and indicated as a channelled valley-bottom wetland grading to a non-perennial drainage line in the vicinity of the more intense development in Boland Park (NGI, 1:50 000 drainage lines). The stream is in quaternary catchment K10A (Figure 4). The lower, channelised section flows beneath the R102 (Louis Fourie Road) and the outflow to the sea is through a small estuary approximately 500 m away. The project area is located within the Southern Coastal Belt (Ecoregion Level 2:22.02). The terrain is described as closed hills of moderate and high relief and moderately undulating plains. Altitude ranges between 0 - 500 m.a.m.s.l. The Mean Annual Precipitation (MAP) is 450 mm. Rainfall in the catchment can occur year-round, although there are bimodal seasonal peaks in autumn and spring (Figure 3).

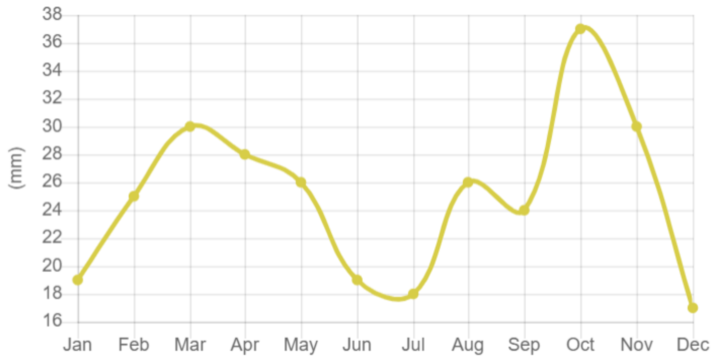



Figure 3. Mean monthly rainfall for the quaternary catchment (FBIS)

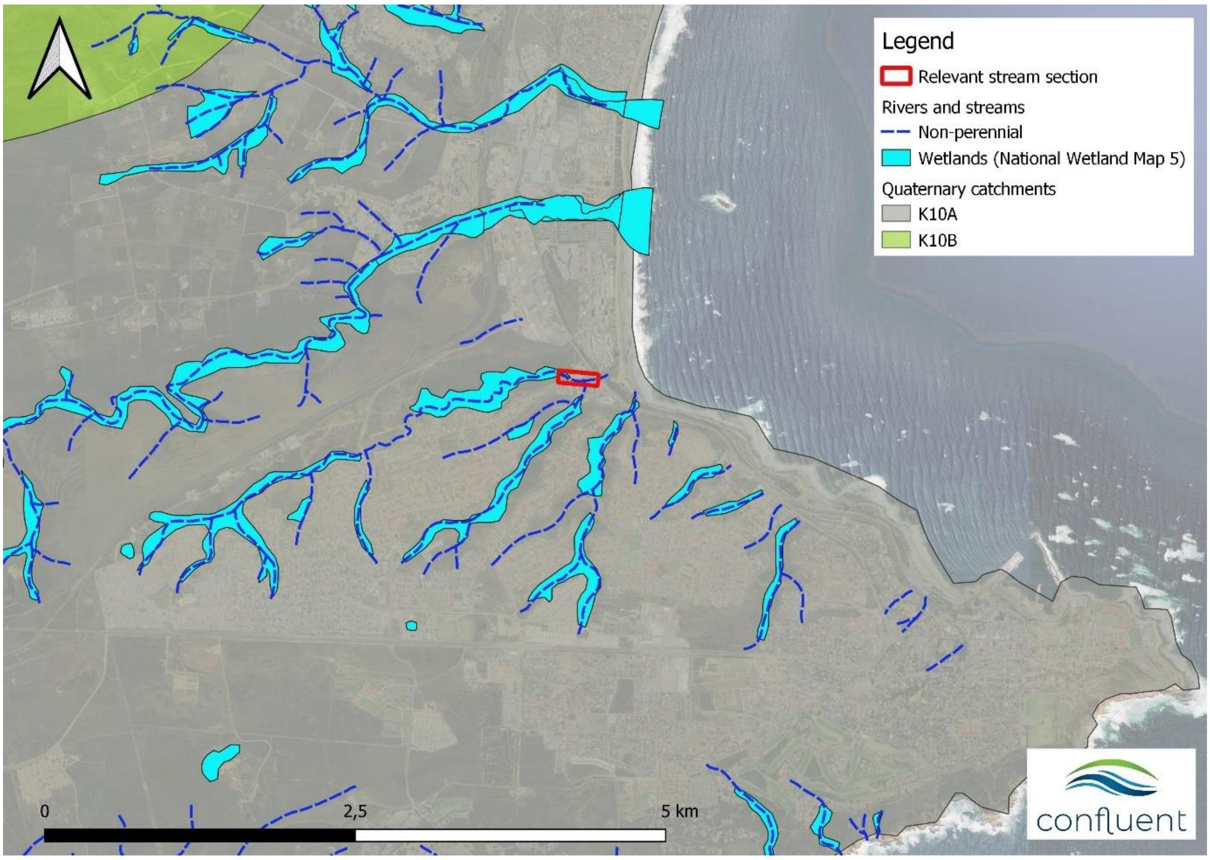



Figure 4. Location of the relevant stream section in Boland Park in relation to aquatic features and the quaternary catchment.

## 2.2 Vegetation

The mapped vegetation type at the site is Hartenbos Dune Thicket (AT40) which has a conservation status of Least Concern (SANBI NVM, 2018). Plants listed for the vegetation type were consulted to determine whether any important taxa associated with wetlands could be present at the site. No important wetland taxa were listed.

## 2.3 Conservation and catchment management

The Western Cape Biodiversity Spatial Plan (WCBSP; 2016) indicates a small area within the upstream area of the affected stream section as Critical Biodiversity Area 1 and Ecological Support Area 1 (Figure 5). The WCBSP defines systems in this category as follows:

**Critical Biodiversity Area**: "*Areas in a natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure*."

The management objective for systems in this category is to:

*"Maintain in a natural or near-natural state with no further loss of natural habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land-uses are appropriate."*

**Ecological Support Area:** *"Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs and are often vital for delivering ecosystem services."*

The remaining stream section is not identified in any category in the WCBSP.

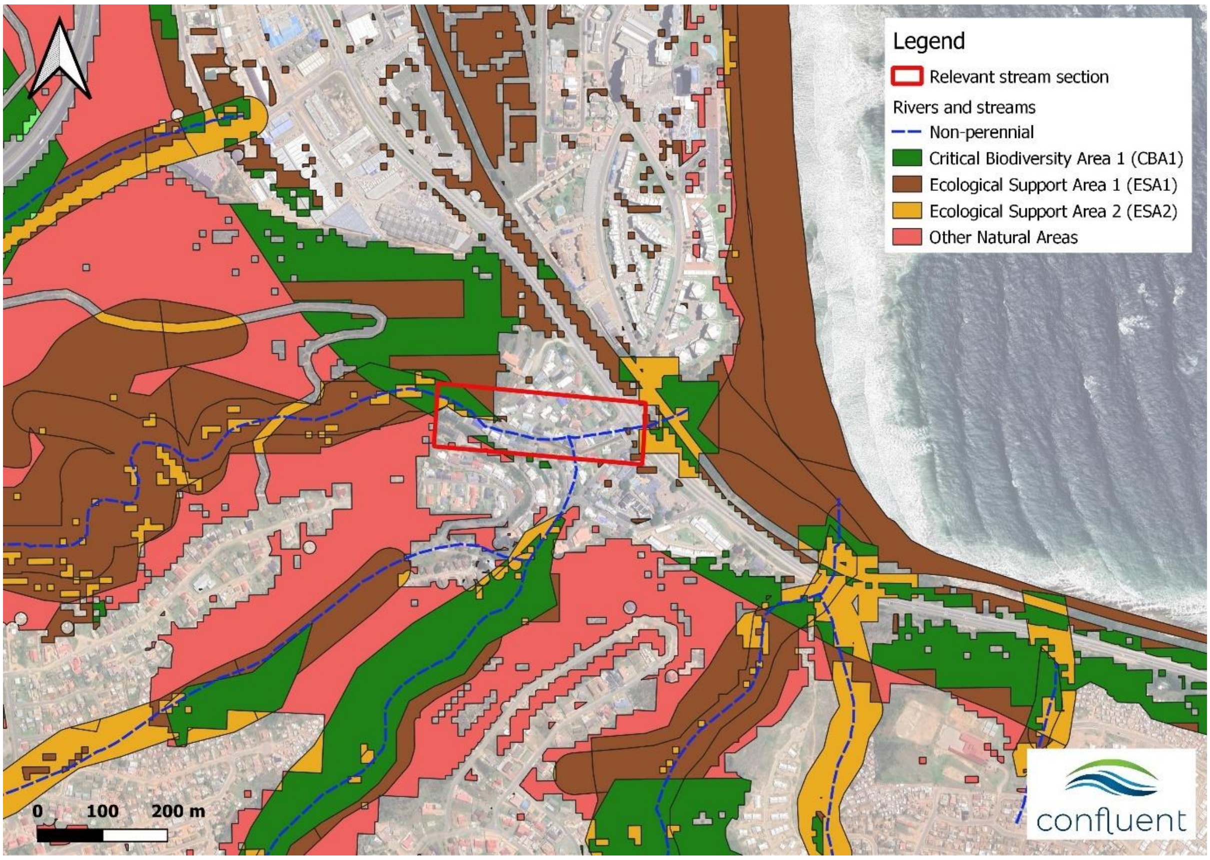



Figure 5. Mapped conservation areas according to the Western Cape Biodiversity Spatial Plan.

## 2.4 Historical assessment

Historical photos of the stream section show that it in the 1960s the site was probably more estuarine that the present-day situation. Sand from dunes at the site is evident in the 1964 aerial photo. A clear channel at the bottom of the valley can be distinguished in this photo (Figure 6).

Houses in Boland Park are only evident from a 1991 photo onwards and were probably constructed during the 1980s. Additional development in the catchment can be seen around this time.

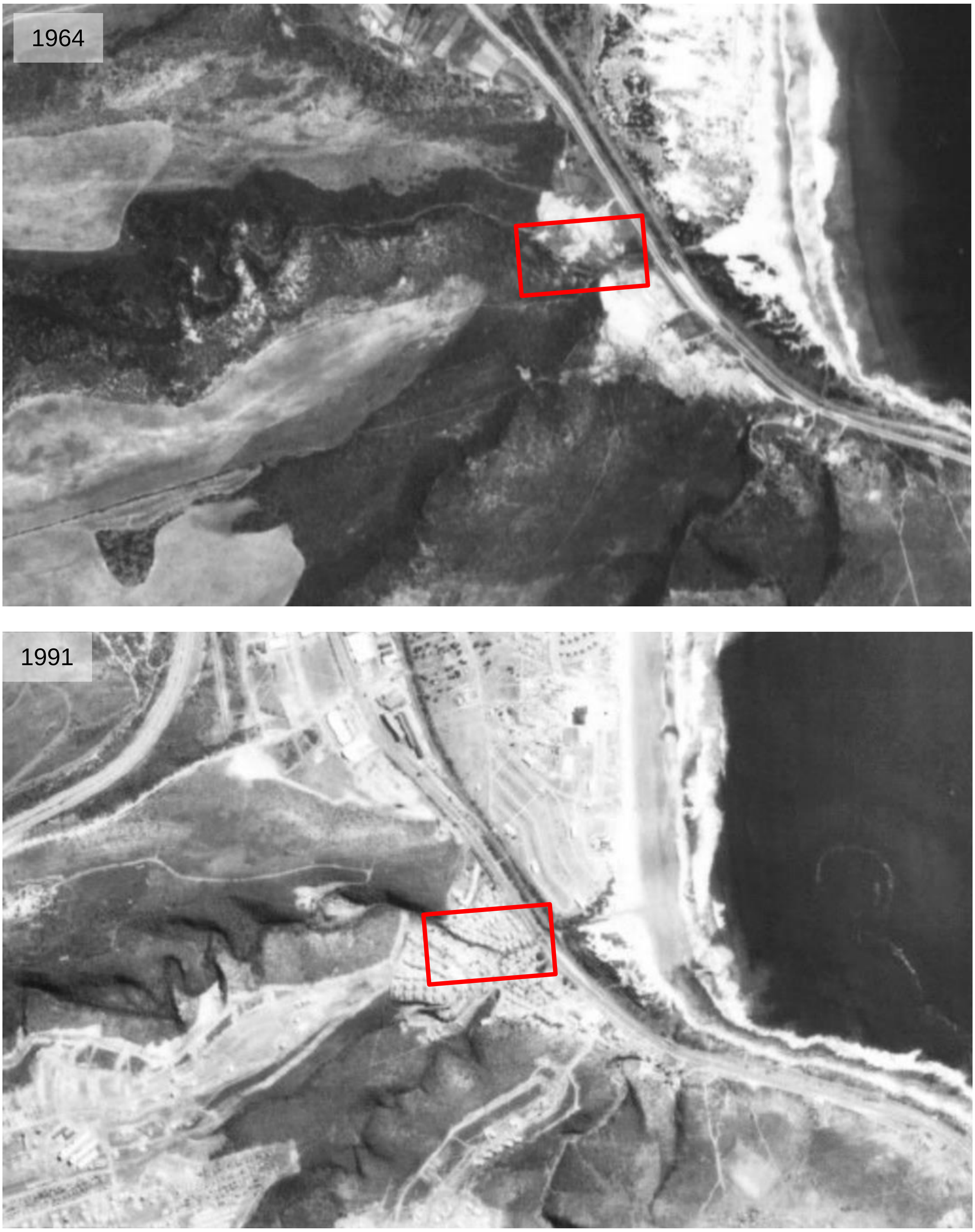



Figure 6. Historical aerial photos of the project area.

### 2.4.1 Resource Quality Objectives

Resource Quality Objectives (RQOs) are defined as clear goals (numerical or descriptive statements) relating to the quality of a water resource and are set in accordance to the management class for the resource to ensure the water resource is protected. The purpose of RQOs is to set clear objectives for the resource against which WULs and the related impacts can be evaluated and managed to achieve a balance between the need to protect and utilise the resource.

The Breede-Gouritz Catchment Management Agency recently concluded an assessment of major rivers in the Water Management Area (DWS, 2018).

In quaternary catchment K10A, the Blinde, Tweekuilen and Gericke Estuaries were assessed. The relevant stream portion for this assessment has a small, unnamed estuary and was excluded from the RQO report.

### 2.5 Extent of catchment development

Informal and formal high-density housing is the predominant land use in the catchment. Government housing projects have formalised informal settlements, theoretically improving water quality in aquatic ecosystems through the implementation of upgraded stormwater and sanitation facilities but increasing inflowing water volumes due to the increased impervious surfaces and associated runoff. Additional high density low-cost housing is planned in the catchment which will add to stormwater flows entering the stream during rainfall events. This must be taken into account when planning protection measures for houses in Boland Park.

## 3. SITE ASSESSMENT

### 3.1 Site visit

The site was visited on 27 May 2022 which is considered winter. Conditions on the day were clear and sunny, and no significant rainfall had been recently recorded in the area. The full extent of the proposed stream reach for bank protection was walked in both upstream and downstream directions. The inspection included the downstream section that is already modified with gabions and open pavers (Figure 7).

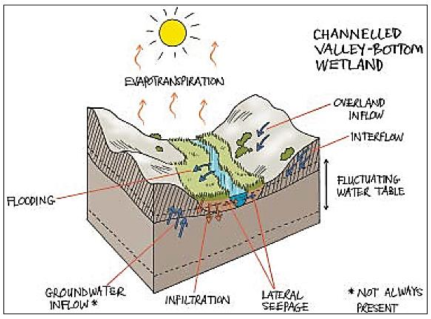

Figure 7. Photos of typical stream sections.

## 3.2 Watercourse classification

The watercourse has a channel and was probably a channelled valley-bottom wetland along a greater extent of its reach prior to channelisation. A trickle-flow of water was present during the site inspection, and although water was not tested on the day, the quality appeared to be good, and the water was very clear. The presence of supra-tidal vegetation (*Cotula coronopifolia)* in the middle reaches of the stream are a reminder of the historically more significant connection of the watercourse to the sea.

Classification of the watercourse at the site followed the methods developed by Ollis *et al*. (2013) up to Level 4 categorisation of different hydrogeomorphic (HGM) units. The steep gradient on either side of the channel in the middle and lower reaches of the watercourse result in a channel that is relatively confined. Although the valley broadens out and the watercourse is less confined in the upstream area. The hydrogeomorphic unit at the site is classified as a channelled valley-bottom wetland in the upstream section, grading to a drainage line in the middle to lower reaches. Field observations reflect the spatial mapping of the wetland indicated in the NWM5 layer (Figure 4).

Figure 8. Classification of wetland hydrogeomorphic units using methods described by Ollis *et al*. (2013).

| Level 1 | Level 2 | | Level 3 | Level 4 | Graphic |
|---|---|---|---|---|---|
| **System** | **DWS Ecoregion** | **Vegetation** | **Landscape Unit** | **4A** | **From Ollis *et al.* (2013)** |
| Inland | 22.02 Southern Coastal Belt | Hartenbos Dune Thicket | Valley-bottom | Channelled valley-bottom wetland |  |



## 3.3 Functional Assessment of the Wetland

Various methods used for determining the present state of the wetland are provided in the Appendices. The Present Ecological State was determined using WET-Health Version 2 (Kotze *et al*., 2020), Ecological Importance and Sensitivity (DWAF, 1999) and Wet EcoServices (Kotze *et al*., 2020).

### *3.3.1 Present Ecological State*

The Present Ecological State of the small wetland area upstream of the pipeline crossing was determined to be in a **C/D category** which indicates Moderate to Largely Modified conditions (Table 1). This was mainly due to the system's hydrology which has been influenced by increased flood peaks due to development in the catchment. The wetland's geomorphology is in largely natural condition, while the vegetation has been moderately impacted by frequent mowing (Figure 9). The fact that indigenous wetland species (e.g. *Cyperus textilis*) are still rooted at the site and will regrow is a positive aspect. If left to regenerate the vegetation should recover well, as it hasn't been physically removed in this area.

Table 1. Summarised WET-Health assessment to determine the PES for the wetland at Boland Park.

| PES: Boland Park channelled valley-bottom wetland |
| --- |
| **HYDROLOGY** |
| Slight increase in base flows due to discharges in the intensively developed catchment |
| Large increase in flood peaks due to urban development in the catchment |
| Localised reduction in roughness due to intensive mowing of vegetation |
| **Hydrology PES Category: E** |
| **GEOMORPHOLOGY** |
| Increased runoff from the catchment due to residential developments |
| Moderate erosional features on channel meanders |
| Minor depositional features instream |
| **Geomorphology PES Category: A** |
| **VEGETATION** |
| Instream and bank-side vegetation cut back severely on a regular basis |
| Eroded areas cause minor vegetation loss |
| Moderate encroachment of alien and exotic species (especially lawn grass) |
| **Vegetation PES Category: C** |
| **OVERALL PES: C/D, Moderately to Largely Modified** |


Figure 9. Photos of various aspects of the wetland considered in the PES assessment.

## 3.4 WET-EcoServices Version 2

Ecosystem services provided by the wetland in its present state were assessed following methods developed by Kotze *et al*. (2020). Results are presented in Figure 10 and Table 2. While demand for flood attenuation and sediment trapping are high, the supply of these services is currently low due to the modified state of the wetland. The proliferation of natural wetland vegetation in stream would improve the supply of these services. The demand for assimilation of nutrients is anticipated to be moderate from a catchment with high density housing, but the lack of wetland vegetation means the wetland cannot currently provide this service to a great degree. Apart from mobile species such as birds, the wetland has limited biodiversity value given that the area is double-fenced with high security fencing – completely restricting the movement of small to medium-sized animals. The present and potential value of the wetland for recreation for local residents is currently under-utilised. Restoration of some of the key services of the wetland would improve the value of the site as a natural green space for residents to enjoy. There are limited opportunities for walking paths, but a few benches at scenic points would provide opportunities for the appreciation of the wetland.

Table 2. Ecosystem services provided by the wetland in its present state.

| | | Present State | | | |
|---|---|---|---|---|---|
| ECOSYSTEM SERVICE | | Supply | Demand | Importance Score | Importance |
| REGULATING AND SUPPORTING SERVICES | Flood attenuation | 0,6 | 2,4 | 0,3 | Very Low |
| | Stream flow regulation | 2,7 | 0,0 | 1,2 | Low |
| | Sediment trapping | 0,8 | 2,3 | 0,4 | Very Low |
| | Erosion control | 0,9 | 0,7 | 0,0 | Very Low |
| | Phosphate assimilation | 0,3 | 1,5 | 0,0 | Very Low |
| | Nitrate assimilation | 0,5 | 1,5 | 0,0 | Very Low |
| | Toxicant assimilation | 0,6 | 1,5 | 0,0 | Very Low |
| | Carbon storage | 0,4 | 0,0 | 0,0 | Very Low |
| | Biodiversity maintenance | 1,7 | 1,0 | 0,7 | Very Low |
| PROVISIONING SERVICES | Water for human use | 0,0 | 0,0 | 0,0 | Very Low |
| | Harvestable resources | 0,0 | 0,0 | 0,0 | Very Low |
| | Food for livestock | 2,0 | 0,0 | 0,5 | Very Low |
| | Cultivated foods | 2,3 | 0,0 | 0,8 | Very Low |
| CULTURAL SERVICES | Tourism and Recreation | 1,3 | 0,0 | 0,0 | Very Low |
| | Education and Research | 0,9 | 0,0 | 0,0 | Very Low |
| | Cultural and Spiritual | 1,0 | 0,0 | 0,0 | Very Low |

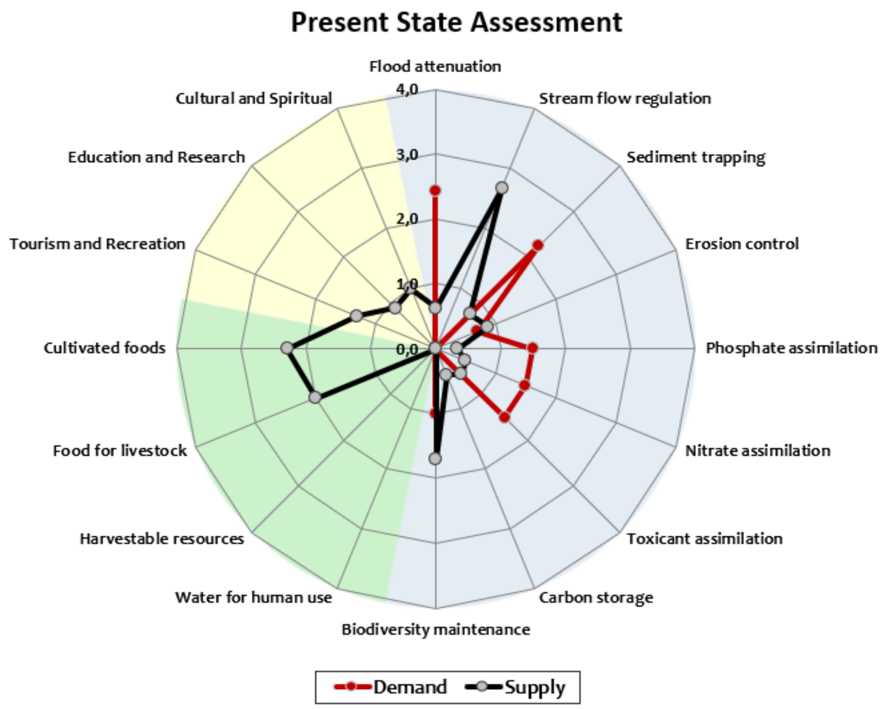



Figure 10. Graphic representation of ecosystem services provided by the wetland.

## 3.5 Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) score was determined using methods developed by Rountree *et al.* (2013). Ecological Importance provides a measure of a wetland's importance to the maintenance of ecological diversity and functioning at local and broader spatial scales. Ecological Sensitivity describes the wetland's ability to tolerate disturbance and recover from these events.

The wetland's EIS was classified as **Moderate** (Table 3). No Red Data or unique aquatic species are expected to occur in the wetland. The importance of the wetland as a migration route and for feeding and breeding of biota would be relatively high under natural circumstances, but this role has been compromised by constant mowing of vegetation and high security fencing across the upstream area.

Table 3. Summarised assessment of the Ecological Importance and Sensitivity of the Boland Park wetland.

| Ecological importance and sensitivity | Score 0-4 | Confidence 1-5 | Motivation |
|---|---|---|---|
| **Biodiversity support** | **1.3** | | |
| Presence of Red Data species | 0 | 3 | None observed, but not impossible. |
| Populations of unique species | 0 | 3 | None observed, but likely given the mapped vegetation type. |
| Migration/feeding/breeding sites | 2 | 4 | Potentially good habitat for amphibians, reptiles, small mammals, birds etc. |
| **Landscape scale** | **1.6** | | |

| | | | |
|---|---|---|---|
| Protection status of wetland | 0 | 4 | Partially mapped CBA in the WCBSP. No formal protection. |
| Protection status of vegetation type | 1 | 4 | Listed as Least Concern |
| Regional context of the ecological integrity | 2 | 4 | Degraded, but improved function is achievable |
| Size and rarity of the wetland types present | 2 | 4 | Small and relatively common |
| Diversity of habitat types | 2 | 4 | Low diversity, but could have been higher prior to modifications. |
| **Sensitivity of the wetland** | **2.6** | | |
| Sensitivity to changes in floods | 3 | 3 | Excessive floods likely to cause erosion and channel incision. |
| Sensitivity to changes in low flows | 1 | 3 | Small inflow, so likely to be resilient to low flows. |
| Sensitivity to changes in water quality | 2 | 3 | Relatively high sensitivity. Includes increased temperature due to lack of vegetation. |
| **ECOLOGICAL IMPORTANCE AND SENSITIVITY** | **2** | **MODERATE** | |

## 4. IMPACT ASSESSMENT

Methods for the Impact Assessment are explained in Appendix 3. Prior to presentation of the impact assessment, the proposed interventions are considered with regard to site-specific conditions and published literature on river stabilisation using the methods proposed (Day *et al*., 2016; Groundtruth, 2020; Freeman & Fischenich, 2000).

### 4.1 Do nothing option

This option must always be considered as it may be the option with the least risk if:

- Erosion is a natural phenomenon (e.g. river meanders in a floodplain)
- Rate of erosion of banks year on year, including response to large floods, is very low
- Ecological condition of the banks is already very poor
- **There is no risk to nearby infrastructure, or to economic activities if erosion continues**
- The risk to up and downstream environments is considered minimal

Areas of the watercourse where banks have a steep gradient with houses constructed above represent a risk to infrastructure (Figure 11). The right-hand bank is approximately 6m high (rise) over a distance of 8.6m distance (run) which is a bank angle of 35° (70% slope). The left-hand bank is approximately 3.5m high over a distance of 5.9m which is a bank angle of 31° (60% slope). The general guide for bank stability given in Figure 11 indicates that although both banks have steep slopes, they are still within the stable category, but heading towards unreliability. Given the existing and ongoing development in the catchment, generating increased stormwater runoff, this risk will be increased in the future.

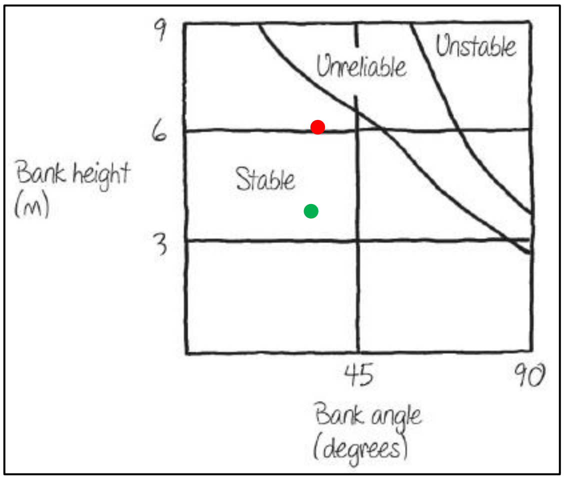



Figure 11. Dependence of bank stability on bank height and angle. Used as a general guide (Federal Interagency Stream Restoration Working Group, 2001). Red dot is approximate right-hand bank, and green dot is the left-hand bank.

Doing nothing in this instance could potentially result in damage to existing infrastructure within the watercourse which includes houses, a pedestrian bridge and a pipeline crossing. These risks are significant when compared to the ecological and financial costs of intervention.

## 4.2 Proposed protective measures

The proposed intervention is to use a rock-filled gabion retaining wall to protect and stabilise the stream banks and grass pavers or reno mattresses to protect the stream bed. This proposal is made with the aim of protecting infrastructure, minimising maintenance, and to a lesser extent, reducing mosquitos.

### *4.2.1 Gabion retaining wall*

*The advantages of a gabion retaining wall are:*

- The structure has a small footprint and allows creation of a wider flow channel in a confined environment
- You can use naturally occurring rock and the structure blends into the environment more than concrete
- They offer flexibility, deforming in sympathy to changes in the structure
- They can create jobs
- Gabions can be ‘greened’ by planting in them

*The disadvantages are:*

- A retaining wall is a large scale and undesirable engineered alteration of a wetland / river environment
- The near vertical face encourages a greater zone of high velocity flow in the channel
- Basket wire decays over time

In this situation where space is constrained and infrastructure is at risk if banks should collapse, a gabion retaining wall is justified. For instance, moderate erosion is taking place at the toe of the bank at around 110m cross section (Figure 1 and Figure 12). However, the risk to infrastructure is significantly reduced upstream of the pipe crossing where the stream channel is a lot less confined, and the stream banks have a lower gradient. This can be seen in cross sections at 0, 20 and 70 m in Figure 1 and the photo in Figure 9. There is also only minor erosion of the left-hand bank in this stream section which is on a bank with no infrastructure on it. Gabion retaining walls and / or bed protection upstream of the pipeline crossing are therefore not supported as the risk to infrastructure appears to be minor.

Figure 12. Most eroded bank on the left-hand side around the 110m cross section.

### *4.2.2 Bed Protection*

Hardening of the riverbed using concrete blocks or a reno mattress may be suitable when there is clear downcutting and channel incision occurring that needs to be halted. This was not observed to a major extent along the length of the affected stream. Minor bank erosion is present at a few points, but there is no evidence of vertical erosion of the stream channel that would justify the need for extensive bed protection. The 'do nothing' approach in this case is preferable. However, construction of the gabion banks must ensure the width of the stream channel is maintained, as channel width reduction in combination with vertical surfaces along the gabion walls would increase flow velocities, possibly resulting in channel incision. If this is not possible, then bed protection may be justified, however, the proposed layout in Figure 1 appears to indicate that the toe of gabion retaining walls on both banks would retain, if not increase, the width of the stream channel.

## 4.3 Design Phase Impact Assessment

The current interventions proposed cover the bed and banks of the entire stream section between the existing area of protection and the upper limit of the stream in Boland Park where the boundary fence intersects the stream. This would in effect channelise the entire reach of the stream which further decreases the ecological structure and function of the wetland / stream and increases flow velocities to the receiving environment downstream. Given the broader channel bottom, lower slope gradient, and reduced risk to infrastructure in the section upstream from the pipeline, the proposed interventions are not supported in this area (Figure 13). Gabion retaining walls are supported downstream of the pipeline crossing to tie in with the current extent of bank protection. However, bed protection is not supported given the lack of observable channel incision along the length of the stream. Mitigation measures to reduce anticipated impacts during the construction and operational phases of the development are proposed in the following sections.

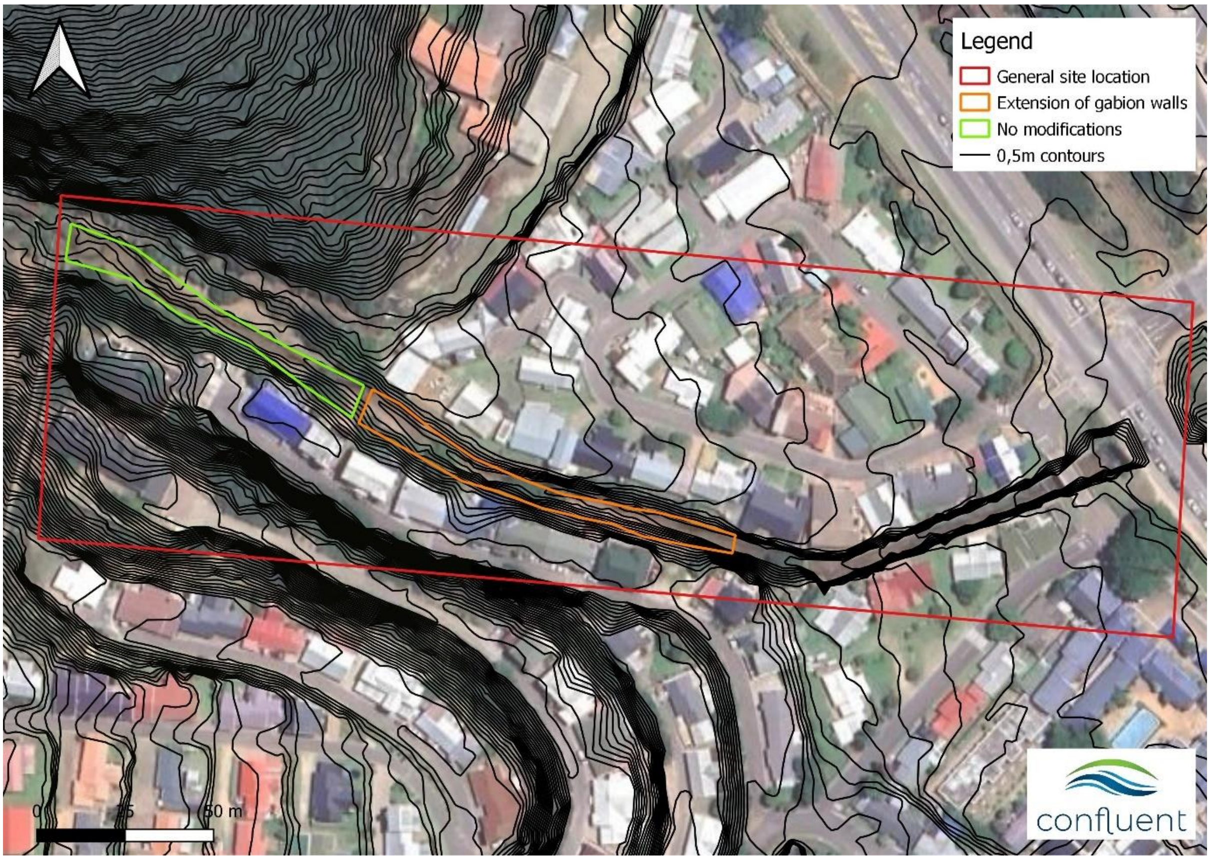



Figure 13. Mapped 0.5m contours of the stream channel indicating sections where gabion bank protection is supported (orange) and where no interventions are supported (green). (Contours courtesy of the W. Cape Government Lidar survey)

## 4.4 Construction Phase Impact Assessment

### *4.4.1 Vehicle access and earth-moving in and adjacent to the watercourse*

Access to the site will be from a parking area on Rooibekkie Lane which is located immediately upstream of the pipeline crossing. Access options are limited to this point because houses on steep slopes line the watercourse on both sides. Methods to mitigate anticipated impacts of working within the watercourse are presented in Table 4.

Table 4. Impact assessment of vehicle access and earth-moving in and adjacent to the watercourse

| | | | | |
|---|---|---|---|---|
| **Project phase** | **Construction** | | | |
| **Impact** | **Vehicle access and earth moving in and adjacent to the watercourse** | | | |
| **Description of impact** | **Instream soil disturbance leading to downstream sedimentation** | | | |
| **Mitigatability** | Medium | Mitigation exists and will notably reduce significance of impacts | | |
| **Potential mitigation** | **• Access point from the parking area on Rooibekke Lane, upstream of the pipeline crossing.<br>• Materials (rock and soil) should be stockpiled in the parking area. Not in the watercourse.<br>•Erect temporary fencing / danger tape across the stream upstream of the access point as in indication that this is a No-Go area.<br>• Undertake work during low flow periods with low rainfall anticipated (Dec-Feb and May-Jul).<br>• Erect a series of 2 to 3 silt fences perpendicular to stream flow downstream of the works. Silt fences must be flush with the stream bed and cross the entire width of the channel to account for periods of higher flows. Use a more permeable fabric such as shade cloth as opposed to bidim which does not allow sufficient through flow.<br>• Work in the direction from downstream to upstream to minimise disturbance.<br>• The largest vehicle that may access the channel is a bobcat. Otherwise work must be undertaken by hand.<br>• Wide planks or tracks should be placed along the stream bed for access by the bobcat and wheel barrows, to reduce disturbance of the substrate and vegetation.** | | | |
| **Assessment** | **Without mitigation** | | **With mitigation** | |
| **Nature** | Negative | | Negative | |
| **Duration** | Short term | Impact will last between 1 and 5 years | Brief | Impact will not last longer than 1 year |
| **Extent** | Local | Extending across the site and to nearby settlements | Limited | Limited to the site and its immediate surroundings |
| **Intensity** | High | Natural and/ or social functions and/ or processes are notably altered | Moderate | Natural and/ or social functions and/ or processes are moderately altered |
| **Probability** | Almost certain / Highly probable | It is most likely that the impact will occur | Probable | The impact has occurred here or elsewhere and could therefore occur |
| **Confidence** | High | Substantive supportive data exists to verify the assessment | Medium | Determination is based on common sense and general knowledge |
| **Reversibility** | Medium | The affected environment will only recover from the impact with significant intervention | High | The affected environment will be able to recover from the impact |
| **Resource irreplaceability** | Low | The resource is not damaged irreparably or is not scarce | Low | The resource is not damaged irreparably or is not scarce |
| **Significance** | **Minor - negative** | | **Negligible - negative** | |
| **Comment on significance** | | | | |
| **Cumulative impacts** | It is important that mitigation measures are implemented to reduce the cumulative effects of stream degradataion | | | |

### *4.4.2 Correct placement and construction of rock-filled gabions*

This section considers the placement and construction methods used to install the gabions. Figure 14 provides a graphic explanation of key aspects of installation. Note that the live branch cuttings depicted are <u>not</u> required.

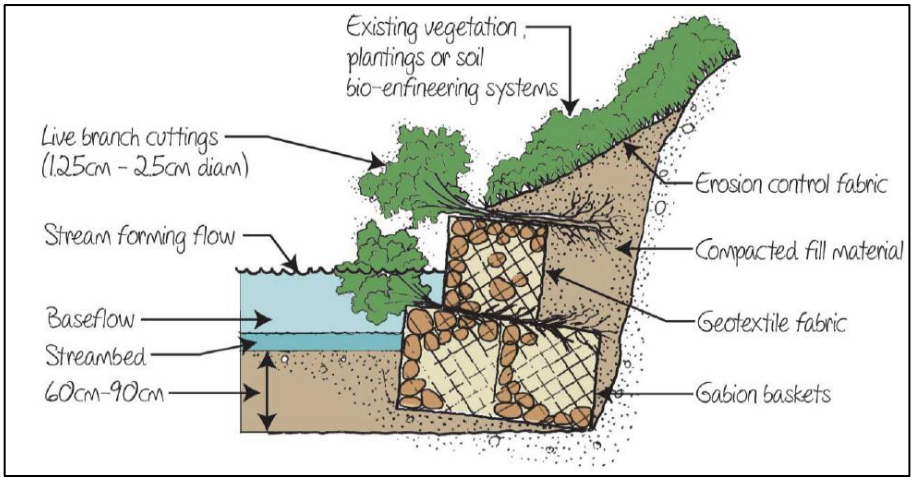



Figure 14. Key features of correct gabion retaining wall installation.

Table 5. Impact assessment of correct placement and construction of rock-filled gabions

| | | | | |
|---|---|---|---|---|
| **Project phase** | **Construction** | | | |
| **Impact** | **Correct placement and construction of rock-filled gabions** | | | |
| **Description of impact** | **Incorrect placement or filling could lead to failure resulting in erosion and sedimentation** | | | |
| **Mitigatability** | High | Mitigation exists and will considerably reduce the significance of impacts | | |
| **Potential mitigation** | **Refer to Figure 14 as reference for sever of these mitigation measures.**<br>**•The toe of the gabions must align with the current toe of the bank, or wider. This is to ensure the channel is not constricted by gabions which could result in channel incision**<br>**• Foundation gabions must be dug 60-90cm below the channel bed level to reduce scour effect**<br>**• A filter fabric / geotextile must be placed behind and under gabions to prevent the movement of soil through the gabion baskets.**<br>**• Soil excavated from the stream bed / banks can be used as fill material on the slopes above / behind the gabion baskets. This must be well compacted to reduce instability.**<br>**• As far as possible, gabion baskets should follow the natural profile of the banks, reducing the need for backfill, and preventing unnecessary confinement of the streamflow.**<br>**• Backfilled soil must slope seamlessly from the bank above onto the uppermost gabion so that runoff from banks is directed through the gabion baskets and not behind them.**<br>**• Stone sizing should follow that used further downstream where gabions haven't deformed over time. The smallest stones must be sized that they cannot pass through the wire mesh.**<br>**• Slopes with bare soil above the gabions must be reseeded with a suitable indigenou grass such as kweek (Cynodon dactylon), covered with a light mulch, and protected with soil saver matting pinned over the surface.** | | | |
| **Assessment** | **Without mitigation** | | **With mitigation** | |
| **Nature** | Negative | | Positive | |
| **Duration** | Long term | Impact will last between 10 and 15 years | Long term | Impact will last between 10 and 15 years |
| **Extent** | Limited | Limited to the site and its immediate surroundings | Limited | Limited to the site and its immediate surroundings |
| **Intensity** | Moderate | Natural and/ or social functions and/ or processes are moderately altered | Very low | Natural and/ or social functions and/ or processes are slightly altered |
| **Probability** | Probable | The impact has occurred here or elsewhere and could therefore occur | Rare / improbable | Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere |
| **Confidence** | Medium | Determination is based on common sense and general knowledge | Medium | Determination is based on common sense and general knowledge |
| **Reversibility** | Medium | The affected environment will only recover from the impact with | High | The affected environment will be able to recover from the impact |
| **Resource irreplaceability** | Medium | The resource is damaged irreparably but is represented elsewhere | Low | The resource is not damaged irreparably or is not scarce |
| **Significance** | **Minor - negative** | | **Negligible - positive** | |
| **Comment on significance** | | | | |
| **Cumulative impacts** | Mitigation measures must be fully implemented to ensure the impacts of hardening the banks are not exacerbated by failure of the gabion baskets. | | | |

## 4.5 Operational Phase Impact Assessment

### *4.5.1 Maintenance of gabions*

Table 6. Impact assessment of gabions maintenance

| | | | | |
|---|---|---|---|---|
| **Project phase** | **Operation** | | | |
| **Impact** | **Maintenance of gabions** | | | |
| **Description of impact** | **Failure may result in collapse of the structure and degradatio of the stream along with risk to houses** | | | |
| **Mitigatability** | High | Mitigation exists and will considerably reduce the significance of impacts | | |
| **Potential mitigation** | **• Check surrounding residences for stormwater outflow pipes discharging direct concentrated flows behind the gabion baskets causing erosion<br>• Maintenance team including a municipal engineer to inspect the gabions annually for failures which include wire breakage and / or undercutting which must be repaired.<br>• Litter, tree roots / branches and other debris must be cleared out of gabions** | | | |
| **Assessment** | **Without mitigation** | | **With mitigation** | |
| **Nature** | Negative | | Positive | |
| **Duration** | Short term | Impact will last between 1 and 5 years | Medium term | Impact will last between 5 and 10 years |
| **Extent** | Local | Extending across the site and to nearby settlements | Limited | Limited to the site and its immediate surroundings |
| **Intensity** | Low | Natural and/ or social functions and/ or processes are somewhat altered | Negligible | Natural and/ or social functions and/ or processes are negligibly altered |
| **Probability** | Probable | The impact has occurred here or elsewhere and could therefore occur | Likely | The impact may occur |
| **Confidence** | High | Substantive supportive data exists to verify the assessment | High | Substantive supportive data exists to verify the assessment |
| **Reversibility** | High | The affected environment will be able to recover from the impact | High | The affected environment will be able to recover from the impact |
| **Resource irreplaceability** | Low | The resource is not damaged irreparably or is not scarce | Low | The resource is not damaged irreparably or is not scarce |
| **Significance** | **Minor - negative** | | **Negligible - positive** | |
| **Comment on significance** | | | | |
| **Cumulative impacts** | | | | |

### *4.5.2 Impact of maintenance of the natural stream areas*

This section refers to areas where natural features of the watercourse have not been replace by gabions. In other words, the wetland area upstream of the pipeline and the stream bed between the gabion walls downstream of the pipeline. The current practice of removing all instream and bankside vegetation by mowing seriously limits the value of several important ecosystem services. Implementation of these mitigation measures will improve the ecological structure and function of the watercourse and make it a more aesthetically pleasing feature for local residents.

Table 7. Impact assessment of maintenance of the natural stream areas.

| Project phase | Operation | | | |
|---|---|---|---|---|
| Impact | Maintenance of the natural stream areas (channel and upstream of the pipeline crossing) | | | |
| Description of impact | Reduced biodiversity ecosystem services due to mowing | | | |
| Mitigatability | High | Mitigation exists and will considerably reduce the significance of impacts | | |
| Potential mitigation | • Stop mowing the instream and bankside vegetation. This practice reduces the wetland's ability to trap sediment, remove nutrients, reduce flow velocities, absorb nutrients and provide habitat for predators of mosquitos.<br>• Remove alien vegetation along the stream banks by cutting stems and painting stumps with a registered herbicide. Do not use heavy machinery for this purpose and do not remove the stumps to ensure minimal disturbance of soil. | | | |
| Assessment | Without mitigation | | With mitigation | |
| Nature | Negative | | Positive | |
| Duration | Long term | Impact will last between 10 and 15 years | Long term | Impact will last between 10 and 15 years |
| Extent | Very limited | Limited to specific isolated parts of the site | Limited | Limited to the site and its immediate surroundings |
| Intensity | Moderate | Natural and/ or social functions and/ or processes are moderately altered | Moderate | Natural and/ or social functions and/ or processes are moderately altered |
| Probability | Almost certain / Highly probable | It is most likely that the impact will occur | Almost certain / Highly probable | It is most likely that the impact will occur |
| Confidence | High | Substantive supportive data exists to verify the assessment | High | Substantive supportive data exists to verify the assessment |
| Reversibility | High | The affected environment will be able to recover from the impact | High | The affected environment will be able to recover from the impact |
| Resource irreplaceability | Low | The resource is not damaged irreparably or is not scarce | Low | The resource is not damaged irreparably or is not scarce |
| Significance | Minor - negative | | Minor - positive | |
| Comment on significance | | | | |
| Cumulative impacts | | | | |

## 5. RISK MATRIX

The purpose of this section is to confirm whether any water uses associated with the proposed bank protection in Boland Park will require registration in terms of a Water Use Licence ("WUL") in accordance with the provisions of the National Water Act, 1998 (No. 36 of 1998) (“NWA”).

The proposed bank protection will trigger Section 21 (c) “Impeding or diverting the flow of water in a watercourse”; and (i) “Altering the beds, banks, course or characteristics of a watercourse” of the NWA.

The 21 (c) and (i) Risk Assessment conducted for the Boland Park bank protection indicated that the proposed water uses will have a Low-Risk Rating after considering all listed control measures (Table 8). Had the PES&EIS been higher, the risks considered would have been higher, but the Low-Risk rating reflects the modified state of the watercourse. Due to the Low Risk Rating, a General Authorisation in terms of Section 39 of the NWA will be required for this development. The applicant must take note that all mitigation measures indicated in the Risk Matrix and Impact Assessment must be fully implemented for this risk rating to be maintained.

Table 8. Risk Assessment Matrix for proposed bank protection measures in Boland Park, Mossel Bay.

| Phases | Activity | Aspect | Impact | Flow Regime | Water Quality | Habitat | Biota | Severity | Spatial scale | Duration | Consequence | Frequency of activity | Frequency of impact | Legal Issues | Detection | Likelihood | Significance | Risk Rating | Confidence level | Control Measures | PES AND EIS OF WATERCOURSE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Construction Phase | Vehicle access and earth-moving within the watercourse | Preparation of the work area | Extended footprint of disturbance | 0 | 1 | 1 | 1 | 0,75 | 1 | 2 | 3,75 | 1 | 2 | 5 | 2 | 10 | 37,5 | Low | 80 | • Access point from the parking area on Rooibekkie Lane, upstream of the pipeline crossing.<br>• Materials (rock and soil) should be stockpiled in the parking area. Not in the watercourse.<br>• Erect temporary fencing/danger tape across the stream upstream of the access point as an indication that this is a No-Go area. | |
| | | Disturbance to watercourse bed and banks | Sedimentation of the watercourse downstream | 0 | 2 | 2 | 1 | 1,25 | 1 | 2 | 4,25 | 1 | 2 | 5 | 2 | 10 | 42,5 | Low | 80 | • Undertake work during low flow periods with low rainfall anticipated (Dec-Feb and May-Jul)<br>• Erect a series of 2 to 3 silt fences perpendicular to stream flow downstream of the works. Silt fences must be flush with the stream bedand cross the entire width of the channel to account for periods of high flows. Use a more permeable fabric such as shade cloth as opposed to bidim which does not allow sufficient through flow.<br>• Work in the direction from downstream to upstream to minimise disturbance.<br>• The largest vehicle that may access the channel is a bobcat. Otherwise work must be undertaken by hand.<br>• Wide planks or tracks should be placed along the stream bed for access by the bobcat and wheel barrows, to reduce disturbance of the substrate and vegetation. | |
| | | Alignment of the gabion wall with the channel | Increased flow velocities and channel incision | 2 | 1 | 2 | 1 | 1,5 | 2 | 2 | 5,5 | 1 | 1 | 5 | 2 | 9 | 49,5 | Low | 70 | • The toe of the gabions must align with the current toe of the bank, or wider. This is to ensure the channel is not constricted by gabions which could result in channel incision<br>• Foundation gabions must be dug 60-90cm below the channel bed level to reduce scour effect | |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Correct placement and construction of rock-filled gabions | Correct steps in construction of the gabions | Failure could result in several aspects of degradation | 2 | 2 | 1 | 0 | 1,25 | 2 | 2 | 5,25 | 1 | 3 | 1 | 3 | 8 | 42 | Low | 70 | • A filter fabric / geotextile must be placed behind and under gabions to prevent the movement of soil through the gabion baskets.<br>• Soil excavated from the stream bed / banks can be used as fill material on the slopes above / behind the gabion baskets. This must be well compacted to reduce instability.<br>• As far as possible, gabion baskets should follow the natural profile of the banks, reducing the need for backfill, and preventing unnecessary confinement of the streamflow.<br>• Backfilled soil must slope seamlessly from the bank above onto the uppermost gabion so that runoff from banks is directed through the gabion baskets and not behind them.<br>• Stone sizing should follow that used further downstream where gabions haven't deformed over time. The smallest stones must be sized that they cannot pass through the wire mesh.<br>• Slopes with bare soil above the gabions must be reseeded with a suitable indigenou grass such as kweek (Cynodon dactylon), covered with a light mulch, and protected with soil saver matting pinned over the surface. | PES = C/D Moderately to Largely Modified<br>EIS = Moderate |
| Operational Phase | Maintenance | Maintenance of gabion bank protection | Increase in alien vegetation | 0 | 0 | 2 | 2 | 1 | 1 | 2 | 4 | 1 | 2 | 5 | 4 | 12 | 48 | Low | 70 | • Check surrounding residences for stormwater outflow pipes discharging direct concentrated flows behind the gabion baskets causing erosion.<br>• Maintenance team including a municipal engineer to inspect the gabions annually for failures which include wire breakage and / or undercutting which must be repaired.<br>• Litter, tree roots / branches and other debris must be cleared out of gabions | |
| | | Maintenance of natural stream / wetland areas | Habitat loss, erosion and sedimentation | 1 | 0 | 0 | 1 | 0,5 | 2 | 3 | 5,5 | 1 | 1 | 5 | 2 | 9 | 49,5 | Low | 80 | • Stop mowing the instream and bankside vegetation. This practice reduces the wetland's ability to trap sediment, remove nutrients, reduce flow velocities, absorb nutrients and provide habitat for predators of mosquitos.<br>• Remove alien vegetation along the stream banks by cutting stems and painting stumps with a registered herbicide. Do not use heavy machinery for this purpose and do not remove the stumps to ensure minimal disturbance of soil. | |

## 6. CONCLUSIONS

Proposed bank and channel protection measures on an unnamed stream / wetland in Boland Park were proposed by the Mossel Bay Municipality with the aim of protecting houses on steep banks from subsidence and collapse.

An extensive section of the stream has already been channelised with gabion retaining walls and open concrete pavers along the channel. The proposal was to extend this approach for the full length of the stream in Boland Park.

The site was assessed, and the upstream portion of the watercourse was classified as a channelled valley-bottom wetland, grading to a drainage line / stream. The watercourse has been highly modified, especially the proximity of residential construction and frequent mowing of all instream and riparian vegetation. The PES was determined to be a C/D which is Moderately to Largely Modified. The EIS was determined to be Moderate.

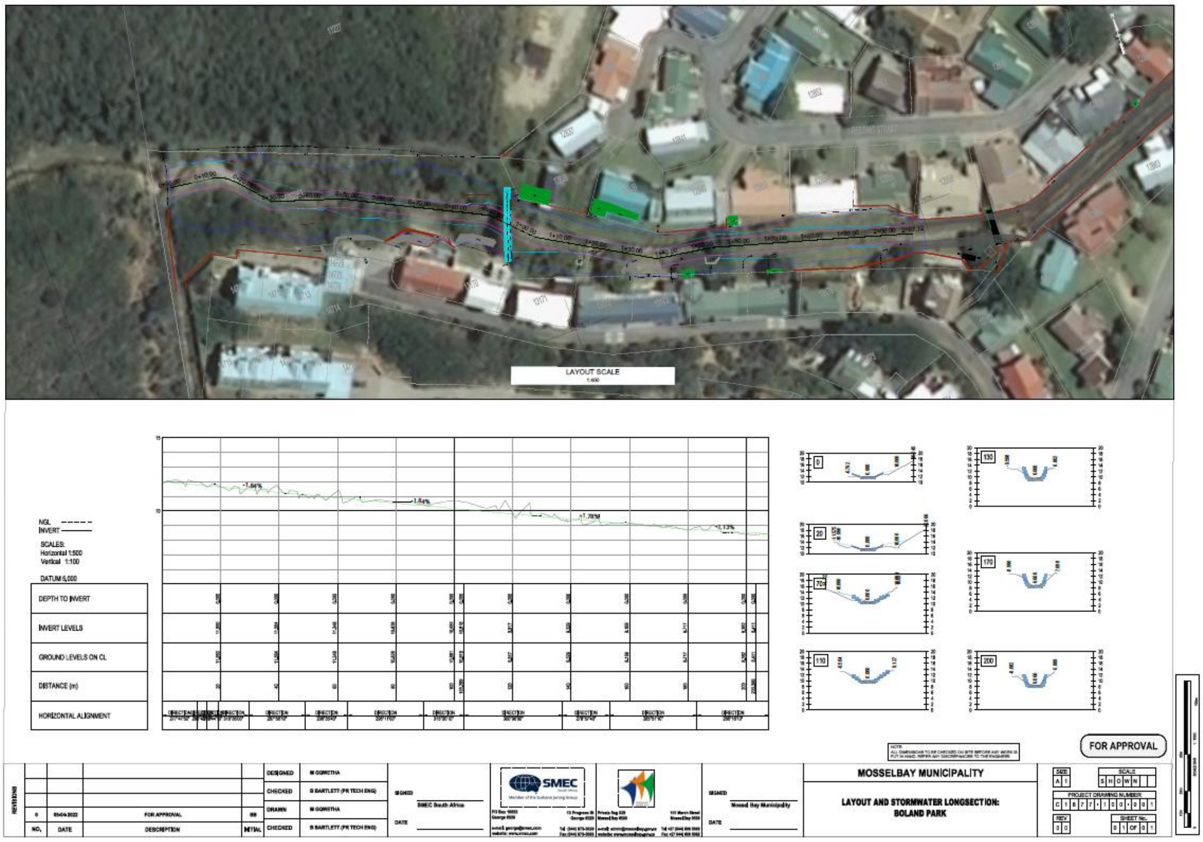
Complete channelisation of the watercourse is considered an extreme measure given that most natural features of the watercourse are replaced with hard infrastructure. Many ecological functions are lost in this process, but it does have application in certain circumstances.

An assessment of the site indicated no serious channel incision, and therefore channel protection is not supported. The wetland section upstream from the pipeline crossing has a broader valley bottom with lower gradient slopes, and housing on only one bank. Therefore protective measures were not supported at all for this section. Maintenance of a natural stream profile without modification to the bed and banks in the stream section upstream of the pipe crossing is consistent with the management objectives for CBA1 and ESA1 in the WCBSP.

Mitigation measures were recommended for the layout, construction and operational phases required for bank protection in the middle reach of the watercourse. Assuming full implementation of these control measures, the outcome of the Risk Matrix was a Low Risk rating, meaning the bank protection (as modified per recommendations in this report) can be Generally Authorised in terms of the National Water Act (Act No. 36 of 1998).

# 7. APPENDICES

## 7.1 Proposed bank protection – engineering plan




## 7.2 Eco-classification Methods

### *7.2.1 Present Ecological State*

The wetland area was assessed using the Level 1 WET-Health assessment tool developed by Macfarlane *et al*. (2008). The tool aims to assess the integrity of a wetland which is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. The method combines an assessment of hydrological, geomorphological and vegetation health in three modules.

Data collection involved a desktop review of the extent and intensity of catchment land use impacts and was undertaken using historical and recent aerial imagery of the site (Chief Directorate: National Geo-spatial Information and satellites). Fieldwork onsite involved the identification and recording of observable impacts to the wetland at the site of relevant activities as well as at reference points upstream. The magnitude of observed impacts to the hydrological, geomorphological and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall wetland condition. The condition ranges in scale from 1-10 and resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 9.

Table 9.Wetland Present Ecological State categories and impact descriptions.

| Ecological Category | Description | Impact Score |
|---|---|---|
| A | Unmodified, natural. | 0 – 0.9 |
| B | Largely natural with few modifications / in good health. A small change in natural habitats and biota may have taken place but the ecosystem functions are still predominantly unchanged. | 1 – 1.9 |
| C | Moderately modified / fair condition. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. | 2 – 3.9 |
| D | Largely modified / poor condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred. | 4 – 5.9 |
| E | Seriously modified / very poor condition. The loss of natural habitat, biota and basic ecosystem functions is extensive. | 6 – 7.9 |
| F | Critically modified / totally transformed. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. | 8 - 10 |

### *7.2.2 Ecosystem Services*

Ecosystem services provided by the wetland were assessed using the WET Eco-Services toolkit (Kotze *et al*., 2020). The assessment uses an Excel model based on the functions of wetlands related to their hydrogeomorphic setting and classification. Ecosystem service scores are grouped into broad categories which are then integrated into an overall ecological importance score as follows:

1. **Biodiversity maintenance importance**

   Importance score derived from the biodiversity maintenance component.
2. **Regulating services importance**

   Calculated as the maximum score of all the importance scores for regulating services.
3. **Provisioning and cultural services importance**

   Calculated as the maximum score of all the importance scores for provisioning and cultural services.

### *7.2.3 Ecological Importance and Sensitivity*

The revised method for the determination of the EIS of a wetland considers the three following ecological aspects (Rountree *et al*., 2013):

- **Ecological importance and sensitivity**
  - Biodiversity support including rare species and feeding/breeding/migration;
  - Protection status, size and rarity in the landscape context;
  - Sensitivity of the wetland to floods, droughts and water quality fluctuations.
- **Hydro-functional importance**
  - Flood attenuation;

- Streamflow regulation;
- Water quality enhancement through sediment trapping and nutrient assimilation;
- Carbon storage

- **Direct human benefits**
  - Water for human use and harvestable resources;
  - Cultivated foods;
  - Cultural heritage;
  - Tourism, recreation, education and research.

Each criterion is scored between 0 and 4, and the average of each subset of scores is used to derive a score for each of the three components listed above. The highest score is used to determine the overall Importance and Sensitivity category of the wetland system (Table 10).

Table 10.Ecological importance and sensitivity categories for wetlands. Interpretation of average scores for biotic and habitat determinants.

| Ecological Importance and Sensitivity Category (EIS) | Range of Median | Recommended Ecological Management Class |
|---|---|---|
| **Very high:** Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains 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 | A |
| **High:** Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these floodplains 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 | B |
| **Moderate:** Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains 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 | C |
| **Low/marginal:** Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains 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 | D |

## 7.3 Impact Assessment Methods

Criteria are ascribed for each predicted impact. These include the intensity (size or degree scale), which also includes the type of impact, being either a positive or negative impact; the duration (temporal scale); and the extent (spatial scale), as well as the probability (likelihood). The methodology is quantitative, whereby professional judgement is used to identify a rating for each criterion based on a seven-point scale (Table 11) and the significance is auto-generated using a spreadsheet through application of the calculations.

For each predicted impact, certain criteria are applied to establish the likely **significance** of the impact, firstly in the case of no mitigation being applied and then with the most effective mitigation measure(s) in place.

These criteria include the **intensity** *(*size or degree scale), which also includes the **nature** of impact, being either a positive or negative impact; the **duration** (temporal scale); and the **extent** (spatial scale). These numerical ratings are used in an equation whereby the **consequence** of the impact can be calculated. Consequence is calculated as follows:

**Consequence = type x (intensity + duration + extent)**

To calculate the significance of an impact, the **probability** (or likelihood) of that impact occurring is applied to the consequence.

**Significance = consequence x probability**

Depending on the numerical result, the impact would fall into a significance category as negligible, minor, moderate or major, and the type would be either positive or negative.

Table 11. Assessment criteria for the evaluation of impacts

| Criteria | Numeric Rating | Category | Description |
|---|---|---|---|
| Duration | 1 | **Immediate** | Impact will self-remedy immediately |
| | 2 | **Brief** | Impact will not last longer than 1 year |
| | 3 | **Short term** | Impact will last between 1 and 5 years |
| | 4 | **Medium term** | Impact will last between 5 and 10 years |
| | 5 | **Long term** | Impact will last between 10 and 15 years |
| | 6 | **On-going** | Impact will last between 15 and 20 years |
| | 7 | **Permanent** | Impact may be permanent, or in excess of 20 years |
| Extent | 1 | **Very limited** | Limited to specific isolated parts of the site |
| | 2 | **Limited** | Limited to the site and its immediate surroundings |
| | 3 | **Local** | Extending across the site and to nearby settlements |
| | 4 | **Municipal area** | Impacts felt at a municipal level |
| | 5 | **Regional** | Impacts felt at a regional level |
| | 6 | **National** | Impacts felt at a national level |
| | 7 | **International** | Impacts felt at an international level |
| Intensity | 1 | **Negligible** | Natural and/ or social functions and/ or processes are negligibly altered |
| | 2 | **Very low** | Natural and/ or social functions and/ or processes are slightly altered |
| | 3 | **Low** | Natural and/ or social functions and/ or processes are somewhat altered |
| | 4 | **Moderate** | Natural and/ or social functions and/ or processes are moderately altered |
| | 5 | **High** | Natural and/ or social functions and/ or processes are notably altered |
| | 6 | **Very high** | Natural and/ or social functions and/ or processes are majorly altered |
| | 7 | **Extremely high** | Natural and/ or social functions and/ or processes are severely altered |
| Probability | 1 | **Highly unlikely / None** | Expected never to happen |
| | 2 | **Rare / improbable** | Conceivable, but only in extreme circumstances, and/or might occur for this |

| Criteria | Numeric Rating | Category | Description |
|---|---|---|---|
| | | | project although this has rarely been known to result elsewhere |
| | **3** | **Unlikely** | Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur |
| | **4** | **Probable** | Has occurred here or elsewhere and could therefore occur |
| | **5** | **Likely** | The impact may occur |
| | **6** | **Almost certain / Highly probable** | It is most likely that the impact will occur |
| | **7** | **Certain / Definite** | There are sound scientific reasons to expect that the impact will definitely occur |

When assessing impacts, broader considerations are also considered. These include the level of confidence in the assessment rating; the reversibility of the impact; and the irreplaceability of the resource as set out in (Table 12, Table 13, & Table 14), respectively.

Table 12. Definition of confidence ratings.

| Category | Description |
|---|---|
| **Low** | Judgement is based on intuition |
| **Medium** | Determination is based on common sense and general knowledge |
| **High** | Substantive supportive data exists to verify the assessment |

Table 13. Definition of reversibility ratings.

| Category | Description |
|---|---|
| Low | The affected environment will not be able to recover from the impact - permanently modified |
| Medium | The affected environment will only recover from the impact with significant intervention |
| High | The affected environmental will be able to recover from the impact |

Table 14. Definition of irreplaceability ratings.

| Category | Description |
|---|---|
| Low | The resource is not damaged irreparably or is not scarce |
| Medium | The resource is damaged irreparably but is represented elsewhere |

## 7.4 Risk Matrix Methods

The risk assessment matrix (Based on DWS 2016 publication: Section 21 (c) and (i) water use Risk Assessment Protocol) was implemented to assess risks for each activity associated with the construction and operational phase of the proposed stream protection measures.

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

- An activity is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An aspect is an 'element of an organizations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an impact.
- Environmental impacts are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity.
- Resources are components of the biophysical environment and include the flow regime, water quality, habitat and biota of the affected watercourse.
- Severity refers to the degree of change to the status of each of the receptor. An overall severity score is calculated as the average of all scores receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.

Spatial extent refers to the geographical scale of the impact

- Table 16.
- Duration refers to the length of time over which the stressor will cause a change in the resource or receptor (Table 17).
- Frequency of activity refers to how often the proposed activity will take place (Table 18).
- Frequency of impact refers to the frequency with which a stressor (aspect) will impact on the resource (Table 19).

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

In accordance with the method stipulated in the risk assessment key, all impacts for flow regime, water quality, habitat and biota were scored as a 5 (i.e. average severity score of 5) as all activities occurred within the delineated boundary of the wetland.

Table 15: Scores used to rate the impact of the aspect on resource quality (flow regime, water quality, geomorphology, biota and habitat)

| Insignificant / non-harmful | 1 |
|---|---|
| Small / potentially harmful | 2 |
| Significant / slightly harmful | 3 |
| Great / harmful | 4 |
| Disastrous / extremely harmful and/or wetland(s) involved | 5 |

**Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland.**

Table 16: Scores used to rate the spatial scale that the aspect is impacting on.

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

Table 17: Scores used to rate the duration of the aspects impact on resource quality

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

Table 18: Scores used to rate the frequency of the activity

| Annually or less | 1 |
|---|---|
| Bi-annually | 2 |
| Monthly | 3 |
| Weekly | 4 |
| Daily | 5 |

Table 19: Scores used to rate the frequency of the activity's impact on resource quality

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

Table 20: Scores used to rate the extent to which the activity is governed by legislation

| No legislation | 1 |
|---|---|
| Fully covered by legislation (wetlands are legally governed) | 5 |

Table 21:Scores used to rate the ability to identify and react to impacts of the activity on resource quality, people and property.

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

Table 22: Rating classes

| RATING | CLASS | MANAGEMENT DESCRIPTION |
|---|---|---|
| 1 – 55 | (L) Low Risk | Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. |
| 56 – 169 | (M) Moderate Risk | Risk and impact on watercourses are notable 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. |

Table 23: Calculations used to determine the risk of the activity to water resource quality

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

# 8. REFERENCES

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