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Proposed 500mm Watermain Inlet to the West Riding Reservoir in the eThekwini Municipality, KwaZulu-Natal

Wetland & Riparian Zone Assessment Report

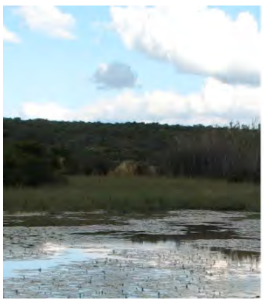
Version - 1

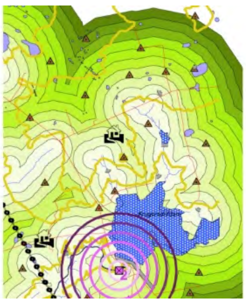
15 August 2014

GCS Project Number: 14-335

Prepared For:

GIBB

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Title	Proposed 500mm Watermain Inlet to the West Riding Reservoir in the eThekwini Municipality, KwaZulu-Natal: Wetland & Riparian Zone Assessment Report		
	Name	**Signature**	**Date**
Author	Ryan Edwards		15.08.2014
Document Reviewer	Russell Stow		15.08.2014
Director	Pieter Labuschagne		15.08.2014

EXPERTISE TO CARRY OUT THE SPECIALIST STUDY

The author, Ryan Edwards, holds a Bachelor of Science (BSc) in Geography and Environmental Management, a Bachelor of Science Honours (BSc Hons) in Geography and Environmental Management and a Master of Science (MSc) in Environmental Science (Research Masters). The author's MSc dissertation was on wetland geomorphology and as such the author has expertise in the methods of data collection, analysis and interpretation in the discipline of geomorphology. Furthermore, the author has 6 years experience in wetland and riparian zone assessments and is competent in data collection and analysis methods related to such assessments that include: soil sampling, description and analysis; vegetation sampling, description and analysis; wetland ecosystem/ecological importance determination; wetland ecosystem/ecological health determination; and wetland impact assessment. The author also has experience in wetland offset mitigation and wetland rehabilitation and management. The author is currently accredited as a professional natural scientist by the South African Council for Natural Scientific Professions (SACNASP) under the field of practice – 'environmental science'.

DECLARATION OF INDEPENDANCE

I, **Ryan Edwards**, declare that --

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing
    - any decision to be taken with respect to the application by the competent authority; and
    - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this report are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the specialist

GCS (Pty) Ltd

Name of company (if applicable)

15 August 2014

Date

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1 INTRODUCTION

1.1 Project Background and Description

The applicant/developer, eThekwini Water and Sanitation (EWS), intends to develop a ±4km 500mm steel water pipeline from Assagay Road to the existing West Riding Reservoir, within the West Riding area in Hillcrest, in the eThekwini Municipality, KwaZulu-Natal Province.

The proposed pipeline is planned to cross a number of watercourses and low lying areas and as such stands to impact directly and indirectly on watercourses. In this regard, GCS (Pty) Ltd ('GCS') was appointed by the environmental assessment practitioner (EAP), GIBB, on behalf of the EWS, to undertake a wetland and riparian assessment of the proposed pipeline route.

1.2 Terms of Reference

The appointed terms of reference were to:

- Delineate the wetland and riparian areas within 32m of the proposed development.
- Classify the delineated wetland and riparian units according to accepted classification systems.
- Provide a qualitative description of the present ecological state of the delineated wetland and riparian areas.
- Assess the functional and ecological importance of the delineated wetland and riparian areas.
- Identify, describe and assess the potential impacts of the proposed development on wetland and riparian habitat integrity and associated ecosystem services.
- Provide planning, construction phase and operational phase mitigation measures and recommendations to avoid, minimise, remediate and/or offset the potential impacts of the proposed development on local wetland/riparian integrity and associated freshwater ecosystem services.

1.3 Overview of Watercourses

For the purposes of this study, watercourses are defined as any distinct natural geomorphic feature or habitat associated with flowing water. The watercourse related habitats assessed as part of this study were wetlands and riparian zones.

1.3.1 Wetlands

Wetlands are areas that have water on the surface or within the root zone for extended periods throughout the year such that anaerobic (oxygen deficient) soil conditions develop which favour the growth and regeneration of hydrophytic vegetation (plants which are adapted to saturated and anaerobic soil conditions).

1.3.2 Streams, Rivers and Riparian Zones

Rivers and streams are natural channels that are permanent, seasonal or temporary conduits of freshwater. In terms of ecological habitats, rivers and streams comprise in-stream aquatic habitat and riparian habitat. Generally, riparian zones mark the outer edge of stream and river systems.

A riparian zone is a zone or habitat, comprising bare soil, rock and/or vegetation that is:

- associated with a watercourse;
- commonly characterised by alluvial soils; and
- inundated or flooded to an extent and with a frequency sufficient to support vegetation species with a composition and physical structure distinct from those of adjacent land areas (DWAF, 2005).

Riparian areas include plant communities adjacent to and affected by surface and subsurface hydrologic features, such as rivers, streams, lakes or drainage paths (DWAF, 2005). Riparian areas represent the interface between aquatic and terrestrial ecosystems and as such the vegetation within riparian areas have a mix of aquatic and terrestrial elements that creates unique habitats (DWAF, 2005). Due to water availability and rich alluvial soils, riparian areas are usually very productive (DWAF, 2005). Tree growth rates are high and the understorey usually comprises a variety of shrubs, grasses and wild flowers (DWAF, 2005).

2 LOCAL SETTING

The following section provides an overview of the study site in terms of climate, drainage setting, vegetation type setting and wetland ecosystem type setting and conservation context with the aim of contextualising the study site within the greater catchment and freshwater ecosystem conservation planning.

2.1 Climate

The study area falls within quaternary catchments U60F and U20M. The mean annual precipitation (MAP) of U60F is 967.8mm, potential evaporation (PET) is 1224.2mm and mean annual simulated runoff is 217.1mm, and that of U20M is 922.8mm, 1644.6mm and 180.1mm.

2.2 Drainage Setting

The proposed water pipeline traverses the outer reaches of two major catchments, namely the Mhlatuzana River catchment in the south-west and the Mgeni River catchment in the north-east. The alignment of Old Main Road roughly represents the location of the drainage divide between the two major catchments. The western portion of the pipeline route within the Mhlatuzana River catchment is located within quaternary catchment U60F and the eastern portion of the route within the Mgeni River catchment is located within U20M. More specifically, the south-western portion of the route is located within the catchment of a left-bank tributary of the Mhlatuzana River, in the upper-most reaches of the Mhlatuzana River catchment. The north-eastern portion of the route is located within the upper-most reaches of the Nkutu River, which is a left-bank tributary of the Molweni River that is a right-bank tributary of the Mgeni River.

2.3 Geological Setting

According to the eThekwini geology spatial dataset, the geology underlying the watercourses assessed and their catchments is a mix of Natal Group Sandstone and Megacrystic Biotite Granite. The soils generated by such lithologies are expected to be predominantly sandy in nature.

2.4 Vegetation Type Setting

The project site is located within the KZN Coastal Belt Vegetation Unit (CB 3) as defined by Mucina & Rutherford (2006). However, the site in particular would have likely coincided with that of the Subtropical Alluvial Vegetation Unit (AZa 7) and the Subtropical Freshwater Wetlands Unit (AZf 6) as defined by Mucina & Rutherford (2006). Both are azonal vegetation units located within the larger zonal KZN Coastal Belt Vegetation Unit (Mucina & Rutherford, 2006). Therefore, under natural conditions, the study area and surrounding landscape would have been characterised by these three vegetation types.

The KZN Coastal Belt vegetation unit predominantly comprises subtropical coastal forest with patches of primary grassland prevailing in hilly, high rainfall areas where pressure from natural fire and grazing regimes prevailed (Mucina & Rutherford, 2006). This vegetation unit is considered endangered and poorly protected with less than 0.6% receiving formal protection (Mucina & Rutherford, 2006). Of the remaining 50%, only a small proportion is conserved in the Ngoye, Mbumbazi and Vernon Crookes Nature Reserves.

2.5 Wetland Ecosystem Type Setting

2.5.1 National Freshwater Ecosystem Priority Areas and Threat Status

The National Freshwater Ecosystem Priority Area (NFEPA) project (Nel *et al*., 2011), is the first formally adopted national freshwater conservation plan that provides strategic spatial priorities for conserving the country's freshwater ecosystems and supporting the sustainable use of water resources that includes rivers, wetlands and estuaries. The purpose of the NFEPA project was to: (Nel *et al*., 2011)

- Identify Freshwater Ecosystem Priority Areas, referred to as 'FEPAs', to meet national biodiversity goals for freshwater ecosystems; and
- Develop a basis for enabling effective implementation of measures to protect FEPAs, including free flowing rivers.

FEPA maps show various different categories each with different management implications. The categories include river FEPAs and associated sub-quaternary catchments, wetland FEPAs, wetland clusters, Fish Support Areas (FSAs) and associated sub-quaternary catchments, fish sanctuaries, phase 2 FEPAs and associated sub-quaternary catchments, and Upstream Management Areas (UMAs). Categories relevant to this study are river FEPAs, wetland FEPAs and wetland clusters.

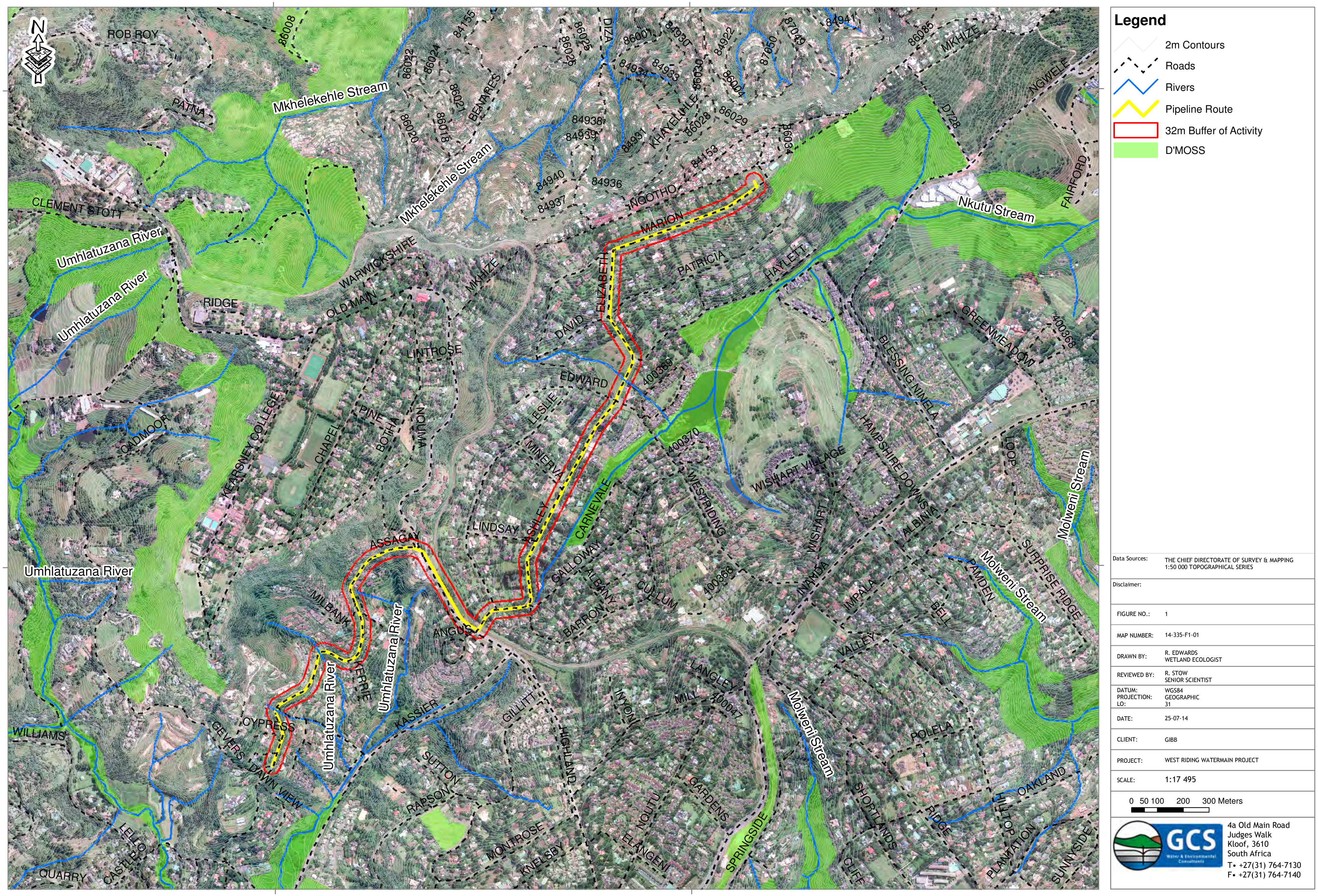
Furthermore, the NFEPA includes a national inventory of all mapped freshwater ecosystems as well as the Present Ecological State (PES) of these systems.

According to the current NFEPA coverage, the sub-quaternary catchment within which the proposed pipeline is located is not classified as a river or wetland FEPA. In terms of the NFEPA wetland habitat/vegetation groups, the watercourses fall within the Sub-escarpment Savanna_Seep Group. The ecosystem threat status of this group is classified as 'Critically Endangered' and the protection level is classified as 'Zero Protection'. It is important to note, however, that no primary wetland habitat that can be considered to be representative of the group is present within the watercourses assessed. Most of the riparian and wetland habitat was highly modified and degraded and characterised by secondary vegetation communities.

2.5.2 Role in Municipal Open Space and Biodiversity Conservation Planning

None of the watercourses crossed by the proposed pipeline route have been included in the Durban Metropolitan Open Space System (D'MOSS). However, the watercourses do drain into wetland areas that have been included in the D'MOSS and are classified as 'mixed floodplain freshwater wetland' (**Figure 1**).

FIGURE 1: STUDY AREAS AND ENVIRONMENTAL SETTING



3 METHODS

3.1 Wetland Assessment

3.1.1 Delineation

The outer temporary boundaries of the wetlands onsite were delineated using the method contained within the DWAF guideline 'A practical field procedure for the identification and delineation of wetlands and riparian areas' (DWAF, 2005). This guideline document stipulates that consideration be given to four specific wetland indicators required to determine the outer edge of the temporary boundary of a wetland. These indicators are:

- Terrain Unit - identify those parts of the landscape where wetlands are most likely to occur e.g. valley bottoms and low lying areas.
- Soil Form - identify the soil forms associated with prolonged and frequent saturation.
- Soil Wetness - identify the soil morphological "signatures" (redoximorphic features) that develop in soils characterised by prolonged and frequent saturation.
- Vegetation - identify the presence of hydrophytic vegetation associated with frequently saturated soils.

For this study the soil wetness indicator was considered the most important indicator for determining the outer boundary of wetlands and the other three indicators were used in a confirmatory role. The reasons or this being that soil wetness indicators provide a long-term indication of soil saturation levels and persist in the soil profile even if they are degraded or desiccated, thereby providing an indication of the natural extent of wetlands.

Soil and vegetation sampling was carried out along transects across the valley bottom and low-lying areas in the vicinity of proposed development. At each sample point, soil was sampled at 0-10 cm and 40-50 cm and dominant vegetation within a 5m radius of the sample point was recorded. The soil matrix chroma was recorded for each soil sample according to the Munsell Soil Colour Chart, as well as the degree and colour of mottling or any other redoximorphic features. Soil formation identification was not undertaken and considered unnecessary in this study.

A conventional handheld Global Positioning System (GPS) was used to record the location of the soil sampling points along each transect. The GPS points were then imported into ArcGIS 10 and the outer temporary wetland boundary along each transect determined. The boundary points were then combined to form a single continuous boundary using contour information, aerial photography and knowledge on the hydraulic conductivity of the soils. The GPS is expected to be accurate up to 3 metres.

3.1.2 Classification

The delineated wetlands were classified into individual hydro-geomorphic (HGM) units as per the proposed National Wetland Classification System developed by SANBI (2009). This was achieved by observing the topographical and geomorphic setting, and the general hydrology of the wetland units during the site visit.

3.1.3 Functional Importance / Wetland Ecosystem Services

The current level and extent of the ecosystem services being provided by the delineated wetland units was determined using the WET-EcoServices tool developed by Kotze *et al*. (2007). WET-EcoServices is designed for inland palustrine wetlands i.e. marshes, floodplains, vleis and seeps. It was developed to assess the goods and services that individual wetlands provide in order to allow for more informed planning and decision-making. The assessment is undertaken by determining the likely "effectiveness" or ability of a wetland to deliver an ecosystem service as well as providing a measure of the extent to which the wetland is delivering an ecosystem service referred to as "opportunity" (Kotze *et al*., 2007).

The ecosystem services assessed included:

- Regulating and supporting services:
  - Flood attenuation
  - Streamflow regulation
  - Sediment trapping
  - Phosphate removal
  - Nitrate removal
  - Toxicant removal
  - Erosion control
  - Carbon storage
- Biodiversity maintenance services
- Provisioning benefits:
  - Water for human use
  - Harvestable resources
  - Cultivated foods
- Cultural services:

- Cultural heritage
- Tourism and recreation
- Education and research

Specific information required to be entered into the predesigned WET-EcoServices spreadsheet was gathered during the field visit and during a desktop analysis using ArcView GIS 10. Once all the required information was entered into the spreadsheet, the effectiveness, opportunity and overall functional scores for each the ecosystem services provided by the wetland units was generated. Each overall functional score was then rated according to the rating scale in **Table 1** below.

Table 1: Classes for determining the likely extent to which a service is being supplied

Score	<0.9	0.9-1.5	1.6-2.4	2.5-3.0	>3.0
Level at which a service is being provided	Low	Moderately Low	Intermediate	Moderately High	High

The overall functional scores generated by the WET-EcoServices spreadsheet for each service do not incorporate the size of the wetlands and the size of the wetland's catchment, which are both important factors in understanding the importance of the services provided. Therefore, the overall functional scores were contextualised (weighted/adjusted) in light of the size of the wetland and the wetland's catchment to provide an indication of the importance of the wetland systems.

3.2 Riparian Zone Assessment

3.2.1 Riparian Zone Delineation

For this study, the edge of the riparian zone was used to represent the outer edge of stream and river systems onsite. In contrast to wetland areas, riparian zones are usually not saturated for periods long enough to develop hydric soils and associated redoximorphic features (DWAF, 2008). Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channels (DWAF, 2008).

The outer boundaries of the riparian areas onsite were delineated using the method contained within the DWAF guideline 'A practical field procedure for the identification and delineation of wetlands and riparian areas' (DWAF, 2005). This guideline document stipulates that consideration be given to four specific riparian indicators required to determine the outer edge. These indicators are:

- Landscape position – identify those parts of the landscape where riparian zones are most likely to occur e.g. along streams and rivers within valley bottom areas.
- Presence of alluvial soils – identify the presence of alluvial soils and fluvial deposits.
- Topography and morphological features associated with riparian areas – identify key morphological features created by fluvial activity.
- Vegetation associated with riparian areas – identify changes in plant species composition, structure and vigour relative to terrestrial/upland areas.

Soil and vegetation sampling, and the recording of riparian morphological features, was carried out along transects across the valley bottom and low-lying areas in the vicinity of proposed development. At each sample point, soil was sampled at 0-10 cm and 40-50 cm and dominant vegetation within a 5m radius of the sample point was recorded. The key morphological features associated with riparian zones that were investigated included:

- Active Channel Bank: The bank of the channel that has been inundated at sufficiently regular intervals to maintain channel form and to keep the channel free of vegetation (DWAF, 2005).
- Macro Channel Bank: The outer bank of a compound channel. The flood bench between active and macro-channel banks are usually vegetated (DWAF, 2005).
- Bar: Accumulations of sediment deposited within and along the edges of channels (DWAF, 2005).
- Mid-Channel Bar: Single bar(s) formed within the middle of the channel; flow on both sides (DWAF, 2005).
- Flood Bench (inundated by annual flood): Area between the active and macro-channel, usually vegetated (DWAF, 2005).
- Floodplain (inundated by annual flood): A relatively level alluvial (sand or gravel) area lying adjacent to the river channel, which has been constructed by the present river in its existing regime. Distinction should be made between active flood plains and relic flood plains (DWAF, 2005).
- High Terrace (rarely inundated): Relict floodplains which have been raised above the level regularly inundated by flooding due to lowering of the river channel (DWAF, 2005).
- Terrace (infrequently inundated): Area raised above the level regularly inundated by flooding (DWAF, 2005).

A conventional handheld Global Positioning System (GPS) was used to record the location of the soil sampling points, vegetation changes and key riparian morphological features along each transect. The GPS points were then imported into ArcGIS 10 and the outer boundary along each transect determined. The boundary points were then combined to form a single continuous boundary using contour information and aerial photography. The GPS is expected to be accurate up to 3 metres.

3.2.2 Ecological Importance and Sensitivity (EIS) Assessment

The ecological importance of the stream and river systems was assessed using the Ecological Importance and Sensitivity (EIS) tool developed by Kleynhans (1999).

The ecological importance of a river system is an expression of its importance to the maintenance of ecological 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) (Kleynhans, 1999).

The following ecological aspects should be considered as the basis for the estimation of ecological importance and sensitivity (Kleynhans, 1999):

- The presence of rare and endangered species, unique species (i.e. endemic or isolated populations) and communities, intolerant species and species diversity should be taken into account for both the in-stream and riparian components of the river.
- Habitat diversity should also be considered. This can include specific habitat types such as reaches with a high diversity of habitat types, i.e. pools, riffles, runs, rapids, waterfalls, riparian forests, etc.
- With reference to points 1 and 2, biodiversity in its general form should be taken into account as far as the available information allows.
- The importance of the particular river or stretch of river in providing connectivity between different sections of the river, i.e. whether it provides a migration route or corridor for species, should be considered.
- The presence of conservation or relatively natural areas along the river section should also serve as an indication of ecological importance and sensitivity.
- The sensitivity (or fragility) of the system and its resilience (i.e. the ability to recover following disturbance) of the system to environmental changes should also be considered.

Each one of these aspects was systematically rated and the median of these scores was calculated to derive the ecological importance and sensitivity category as per **Table 2**.

Table 2: Ecological Importance and Sensitivity Categories

Ecological Importance And Sensitivity Category	Range Of Median
Very high Quaternaries (main-stem river in quaternary) that are considered 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 flow modifications and have no or only a small capacity for use.	>3 and <=4
High Quaternaries 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 flow modifications but may have a substantial capacity for use.	>2 and <=3
Moderate Quaternaries 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 flow modifications and often have a substantial capacity for use.	>1 and <=2
Low/marginal Quaternaries that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use.	>0 and <=1

3.3 Impact Assessment

For the purposes of this assessment, the potential impacts to wetland and riparian habitats predicted to occur as a result of the proposed development were divided into construction phase and operational phase impacts. The change in wetland/riparian integrity and functionality resulting from construction and operational phases was assessed. The significance of the combined impact of the construction and operational phases were then assessed.

The significance of the combined impacts was determined by the assessment and integration of two criteria:

- **Impact Magnitude**: Measure of the degree of change, extent of change and duration of change to the freshwater environment (systems, processes, functions etc.).
- **Impact Importance:** Measure of the importance of the affected freshwater environment and associated services / resources.

The quantitative scoring method utilised in this assessment is summarised in **Table 3** below. The impact magnitude score for each identified impact was calculated by the addition of four criteria, namely 'intensity, 'duration', 'extent' and 'probability'. Thereafter, impact significance was calculated as the product of impact magnitude and impact importance as rated in **Table 3**. The formula can be expressed as follows:

IMPACT SIGNFICANCE =

IMPACT MAGNITUDE (Intensity + Extent + Duration + Probability) x IMPACT IMPORTANCE

Once the mitigation measures to minimise and rectify the impacts on the wetland units were identified and confirmed, the post-mitigation impact scenario was assessed according to the same method.

Table 3: Impact assessment criteria descriptions and scoring system

Score	Rating	Description
Intensity (I)		
5	High	Impact affects the continued viability of the systems/components and the quality, use, integrity and functionality of the systems/components permanently ceases and are irreversibly impaired (system/population collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
4	Medium-High	Impact affects the continued viability of the systems/components and the quality, use, integrity and functionality of the systems/components are severely impaired and may temporarily cease. High costs of rehabilitation and remediation, but possible.
3	Medium	Impact alters the quality, use and integrity of the systems/components but the systems/ components still continue to function but in a moderately modified way (integrity impaired but functionality and major key processes/drivers maintained).
2	Medium-Low	Impact alters the quality, use and integrity of the systems/components but the systems/ components still continue to function in a slightly modified way and maintain original integrity (no/limited impact on integrity).
1	Low	Impact affects the quality, use and integrity of the systems/components in a way that is barely perceptible.
Duration (D)		
5	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
4	Long-term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (30 – 100 years).
3	Medium-term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).

Score	Rating	Description
2	Medium-short	The impact and its effects will continue or last for the period of a relatively long construction period and/or a limited recovery time after this construction period, thereafter it will be entirely negated (5 – 10 years).
1	Short-term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 5 years).
Scale / Extent (S)		
5	National & International	Effects of an impact experienced within a large geographic area beyond national boundaries and occurring at national scale (500km radius of the site).
4	Municipal & Provincial	Effects of an impact experienced within the region beyond municipal and provincial boundaries and occurring at a municipal and provincial scales (e.g. between a 100km to 500km radius of the site).
3	Town & Suburban	Effects of an impact experienced within the local town or suburban area (e.g. between a 5km to 50km radius of the site).
2	Local	Effects of an impact experienced within the local area (within 5km radius of the site).
1	Site & Surrounds	Effects of an impact are experienced within or in close proximity (100m) to the project site. However, the size of the site needs to be taken into account.
Probability / Likelihood (P)		
5	Definite	Impact will certainly occur (Greater than 90% chance of occurrence).
4	Probable	The impact will likely occur (Between a 70% to 90% chance of occurrence).
3	Possible	The impact may/could occur and has occurred elsewhere under the same conditions (Between a 40% to 70% chance of occurrence).
2	Unlikely	The chance of the impact occurring is moderately-low (Between a 20% and 40% chance of occurrence).
1	Improbable	The chance of the impact occurring is extremely low (Less than a 20% chance of occurrence).
MAGNITUDE (MAG) = I+D+S+P		
4 - 6	High	The magnitude of change to environmental systems and processes is high.
7 - 10	Medium-High	The magnitude of change to environmental systems and processes is moderately-high.
11 - 13	Medium	The magnitude of change to environmental systems and processes is moderate.
14 - 17	Medium-Low	The magnitude of change to environmental systems and processes is moderately-low.
18 - 20	Low	The magnitude of change to environmental systems and processes is low / limited.
IMPACT IMPORTANCE (IMP)		
5	High	The affected systems are near pristine and/or have numerous qualities which make them extremely valuable from an ecological and/or social (resource) perspective (i.e. the ecosystem services and goods provided are of high to very high importance).
		System fulfils a critically/vitally important role in meeting the objectives of a strategic conservation plan.
4	Medium-High	The affected systems have qualities which make them highly valuable from an ecological and/or social (resource) perspective (i.e. the ecosystem services and goods provided are of moderately-high

Score	Rating	Description
		importance).
		System fulfils an important role in meeting the objectives of a strategic conservation plan.
3	Medium	The affected systems have certain qualities which make them ecologically and/or socially valuable (i.e. the ecosystem services and goods provided are of moderate importance).
		System fulfils a moderately-important (intermediate) role in meeting the objectives of a strategic conservation plan.
2	Medium-Low	The affected systems are of mild (moderately-low) importance in terms of ecological and/or social (resource) importance (i.e. the ecosystem services and goods provided are of mild/moderately low importance).
		System fulfils a moderately-low role in meeting the objectives of a strategic conservation plan.
1	Low	The affected systems have very little value in terms of ecological and/or social (resource) importance (i.e. the ecosystem services and goods provided are of low importance).
		System does not contribute to meeting the objectives of a strategic conservation plan.
SIGNIFICANCE = MAG x IMP		
>72	High	Totally unacceptable. Impact should be avoided and limited opportunity for offsets.
60 - 72	Medium-High	Generally to totally unacceptable. Ideally impact should be avoided unless offset by positive gains in other aspects of the environment that are of very to critically high importance i.e. national or international importance.
45 - 59	Medium	Undesirable to generally unacceptable. Ideally impact should be avoided unless offset by positive gains in other aspects of the environment that are of moderately-high to high importance.
37-44	Medium-Low	Acceptable but Undesirable. Ideally impact should be avoided or mitigated if possible.
32 - 36	Medium-Low	Acceptable. Apply generic mitigation.
4 - 31	Low	Acceptable. Apply generic mitigation.

4 LIMITATIONS, ASSUMPTIONS AND UNCERTAINTIES

4.1 Watercourse and Riparian Zone Delineation

In open sky conditions with limited tree cover, the GPS utilised is considered to be accurate up to 3m. However, under cloudy and/or tree cover, the accuracy of the GPS is reduced to 10-20m. Therefore, where tree cover resulted in substantial inaccuracies, aerial photography and contour information was utilised to extrapolate the edges of the watercourses.

4.2 Vegetation Sampling

The vegetation information is based on what was observed and no formal vegetation plots were undertaken within the wetland and riparian areas assessed. Furthermore, there was limited flowering of species due to field work being undertaken in the winter season, making plant identification difficult for some species. Thus, the list of vegetation cannot be considered exhaustive but the lists provide a general indication of the composition of the wetland and riparian vegetation communities encountered.

4.3 Faunal Sampling

No faunal sampling and assessment was undertaken for the areas proposed to be impacted. The assessment of biodiversity importance as part of the WET-EcoServices and Ecological Importance and Sensitivity (EIS) assessments was based on the habitat type and condition observed during the field work. This however, does not eliminate the possibility of threatened faunal species occurring within the areas to be affected.

5 RESULTS & DISCUSSION: DELINEATION, CLASSIFICATION AND KEY HABITAT CHARACTERISTICS

Soil and vegetation sampling, as well as the identification of key morphological terrain features, enabled the identification and delineation of three watercourses along the proposed pipeline route as shown in **Figures 2 and 3**, namely:

- Watercourse Unit 1 – Stream channel and riparian zone with patches of un-channelled valley bottom wetland
- Watercourse Unit 2 – Valley head seep with stream channels
- Watercourse Unit 3 – Stream channel and riparian zone

5.1 Watercourse Unit 1

Upstream of Assagay Road, Watercourse Unit 1 comprises a modified riparian zone that consists of a small narrow (0.5-1m wide x 0.5-1m deep) active channel bordered by a narrow corridor of channelled valley bottom wetland on a flood bench-like feature, which are all confined within a larger macro-channel bank feature that is highly modified. Nearing the road, the channel starts to deepen and widen and the riparian zone comprises a single incised and modified channel feature (1.5-2m wide x 0.5-1m deep) confined between modified embankments. Flow from the wetland is currently diverted through the Assagay

Road cut-to-fill crossing via a single culvert. Below the road, the channel is highly incised and modified (1.5-2m wide x 1-2m deep).

During the site visit, flow within the channel was gentle to moderate indicating that flow is perennial. However, the current flow regime has clearly been modified by increased and continuous water inputs from the adjacent residential estate and outputs from the sewerage treatment works that is located adjacent to the left bank of the stream. Based on the small size of the catchment and the location of the watercourse within the upper reaches, it the opinion of the author that flow would have been intermittent to seasonal under natural conditions.

Soil sampling revealed that no hydric soils are present outside of the macro-channel bank. However, seasonal hydric soils were found within the valley bottom areas bordering the active channel within the macro-channel bank. The soils sampled comprised medium grey silty sand with a Munsel Soil Chart description of 7.5YR 3/2. These soils had few to moderate amounts of large and distinct orange mottles.

In terms of vegetation, Watercourse Unit 1 had distinct non-marginal and marginal secondary[1] riparian vegetation communities. Adjacent to and upstream of Assagay Road, the vegetation comprised dense in-stream and channel bank vegetation communities. The in-stream community generally comprised herbaceous communities dominated by the alien hydrophyte[2] *Colocasia esculenta* (Taro), the facultative invasive wetland herb *Commelina* sp, the indigenous invasive hydrophytic sedge *Cyperus latifolius*, and the hydrophytic fern *Cyclosorus interruptus*. Another less dominant but prominent species observed was the indigenous hydrophyte *Ludwiga octovalvis* (Shrubby Ludwigia). The bank vegetation was also herbaceous and was almost completely dominated by the facultative shade-loving herb *Plectranthus fruticosus* (Forest Spur-flower).

Further upstream, the riparian area becomes more wooded. In this area the tree/woody component is dominated by *Ficus sur* (Cape Fig) and *Syzygium cordatum* (Water-berry), both typical wetland riparian trees, and the sparse herbaceous groundcover dominated by various weedy, facultative wetland herbs e.g. *Centella asiatica* (Marsh Pennywort).

Immediately downstream of the Assagay Road culvert outlet, but outside of the adjacent residential property, the channel is heavily incised and the in-stream (marginal areas) are dominated by *C. esculenta* within and the non-marginal banks by terrestrial alien invasive

[1] Vegetation communities re-established after clearing and/or other major disturbance.
[2] Plants adapted to grow in water.

species, the dominant of which is *Lantana camara*. Within the residential property the banks have largely been plated with common lawn grasses like *Stenotaphrum secundatum* (Buffalo Grass) and *Dactyloctenium australe* (LM Grass) or are covered with various garden herbs.

Plate 1: Densely vegetated channel of Watercourse Unit 1 upstream of Assagay Road.

Plate 2: Incised channel of Watercourse Unit 1 immediately downstream of the Assagay Road culvert outlet. Note *C. esculenta* in-channel infestation and the *L. camara* bank infestation.

5.2 Watercourse Unit 2

This unit comprised a highly modified, steep valley head seep wetland unit bisected by a pair of incised channels that converge at the culvert inlet of Assagay Road. Headward erosion is evident from the culvert outlet upstream and lateral drainage ditches have been excavated within the seep upstream of the road to facilitate stormwater diversion and removal.

During the site visit, surface flow within the incised channels was absent and predominately subsurface in nature. The channelled depressions were generally well vegetated and dominated by secondary and monotypic grass and herbaceous plant communities dominated by *Eichinochloa* sp., an invader of disturbed watercourses, and *Commelina* spp. The rest of the seep areas were generally covered with alien thicket dominated by *Lantana camara*. A few large riparian trees were evident within the depressional area providing shaded habitat, namely *F. sur* and *S. cordatum*. Soils sampled comprised dark, organic rich, wet sandy silt.

Plate 3: Incised valley head seep upstream of Assagay Road densely colonised by *Eichinochloa* sp.

5.3 Watercourse Unit 3

This unit comprised an incised stream channel comprising a narrow 1-1.5m wide active channel within a larger macro-channel (8-10m wide x 3m deep) formed by peak flows. No wetland or riparian habitat was present outside of the top of the channel banks. The channel is strongly V-shaped and the channel bed and banks are highly disturbed and modified as evidenced by the steepness and sparse vegetation cover along the banks.

During the site visit, flow within the channel was gentle to moderate indicating that flow is perennial. However, the current flow regime has clearly been modified by increased and continuous water inputs from leaking pipes from the surrounding residential properties. Based on the small size of the catchment and the location of the watercourse within the upper reaches, it the opinion of the author that flow would have been intermittent to seasonal under natural conditions.

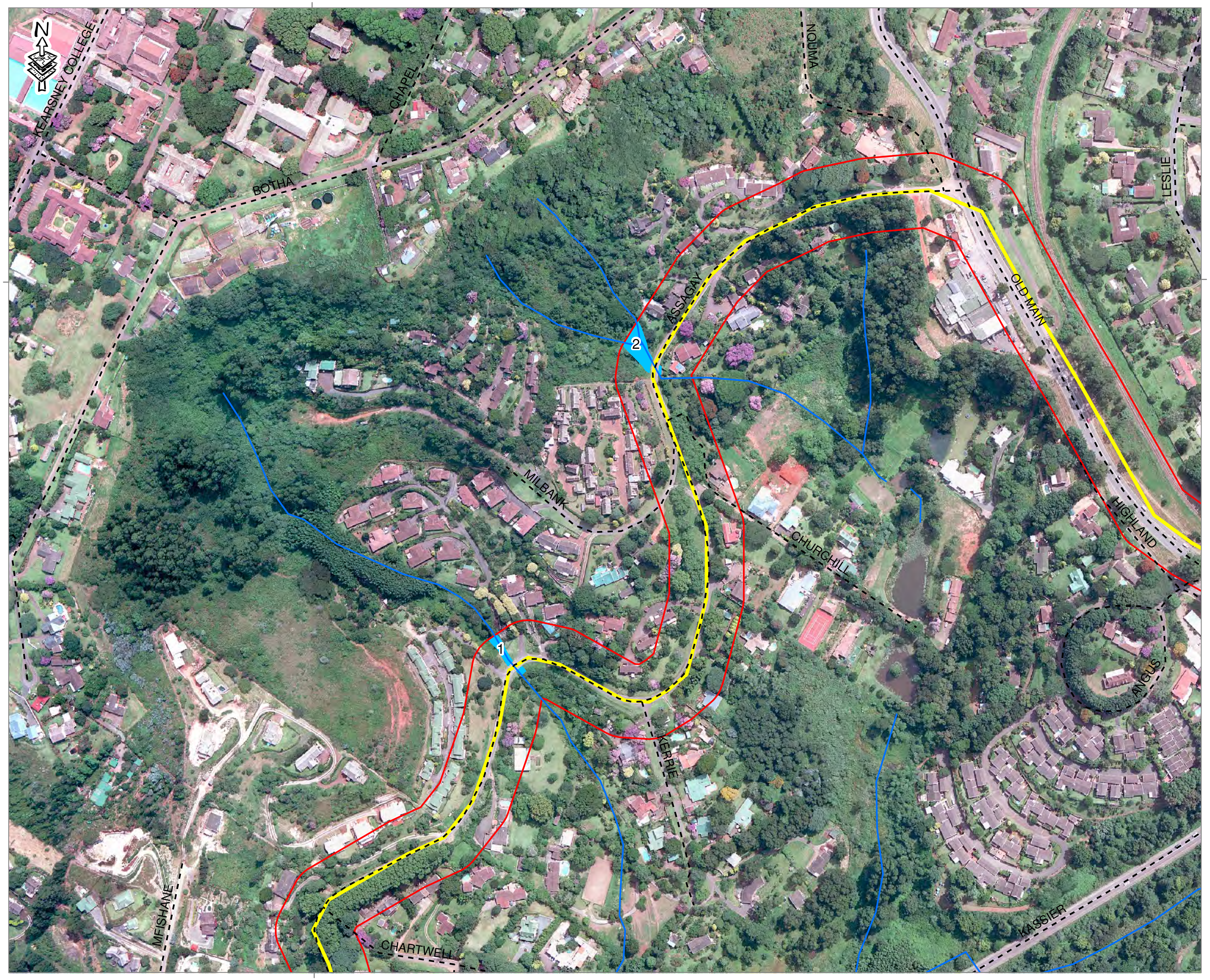
Soil sampling outside of the channel revealed that no wetland soils are present outside of the channel. The soils sampled comprised dark grey-brown to near black, stiff, silty clay characterised by relatively low values and chromas (7.5YR 2/2). No mottling was present within the top 50cm of the soil profile.

In terms of vegetation, the top of the banks were vegetated with lawn grasses that included *S. secundatum*. The banks were poorly vegetated due to ongoing bank instability and erosion and the isolated patches of vegetation present included clumps of the shade-loving *Setaria megaphylla* (Broad-leafed Bristle Grass), *Sporobolus africanus* (Rat's Tail Dropseed), *S. secundatum* and the terrestrial alien invasive *Ricinus communis* (Castor Oil Plant). The lower banks and marginal riparian areas comprised disturbed herbaceous communities dominated by obligate wetland species, namely *C. esculenta*, *C. interruptus* and *Carex* sp. The semi-stagnant in-stream open water habitat observed was dominated by dense infestations of the submerged aquatic alien invasive plant, *Myriophyllum aquaticum* (Parrot's Feather).

Plate 4: Highly disturbed stream habitat of Watercourse Unit 3 upstream of the Ashley Road bridge within the shade of a large *S. cordatum*. Note the stagnant open water along channel.

Plate 5: Existing pipeline and cable crossings across the highly disturbed banks of Watercourse Unit 3 upstream of Ashley Road.

FIGURE 2: DELINEATED WATERCOURSE UNITS WITHIN MHLATUZANA RIVER CATCHMENT



Legend

- Roads
- Drainage Lines
- Pipeline Route
- 32m Buffer of Activity
- Watercourse Units

Data Sources:	THE CHIEF DIRECTORATE OF SURVEY & MAPPING 1:50 000 TOPOGRAPHICAL SERIES
Disclaimer:	
FIGURE NO.:	2
MAP NUMBER:	14-335-F2-01
DRAWN BY:	R. EDWARDS WETLAND ECOLOGIST
REVIEWED BY:	R. STOW SENIOR SCIENTIST
DATUM: PROJECTION: LO:	WGS84 GEOGRAPHIC 31
DATE:	05-08-14
CLIENT:	GIBB
PROJECT:	WEST RIDING WATERMAIN PROJECT
SCALE:	1:4 250

0 25 50 100 150 Meters

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FIGURE 3: DELINEATED WATERCOURSE UNITS WITHIN NKUTU RIVER CATCHMENT

Legend

- Roads
- Drainage Lines
- Pipeline Route
- 32m Buffer of Activity
- Watercourse Units

Data Sources:	THE CHIEF DIRECTORATE OF SURVEY & MAPPING 1:50 000 TOPOGRAPHICAL SERIES
Disclaimer:	
FIGURE NO.:	3
MAP NUMBER:	14-335-F3-01
DRAWN BY:	R. EDWARDS WETLAND ECOLOGIST
REVIEWED BY:	R. STOW SENIOR SCIENTIST
DATUM: PROJECTION: LO:	WGS84 GEOGRAPHIC 31
DATE:	05-08-14
CLIENT:	GIBB
PROJECT:	WEST RIDING WATERMAIN PROJECT
SCALE:	1:2 785

0 25 50 100 Meters

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6 RESULTS & DISCUSSION: ECOLOGICAL STATE DESCRIPTION

Although the assessment of the present ecological state of the riparian area delineated was not included in the scope of this study, a qualitative description of ecological state has been provided in this section based on visual observations.

Based on onsite observations it was clear that the hydrological, geomorphological and ecological integrity of the three delineated watercourses were highly disturbed and modified. The direct and indirect impacts on all the watercourse units were generally the same and included:

Direct impacts:

- Clearing, infilling, excavation and modification of the watercourses for the establishment of road crossings and flow diversion through piped culverts and bridges.
- Clearing, infilling, excavation and modification of the watercourses for the establishment of residential and road stormwater outlets.
- Clearing, infilling, excavation and modification of the watercourses for the establishment of formal residential embankments.
- Clearing, infilling, excavation and modification of watercourses for the establishment of water and sewage pipeline crossings along the road servitudes.

Indirect impacts:

- Gully erosion, sedimentation and existing channel bank and bed erosion/down-cutting resulting from catchment transformation and poor stormwater management that contributes to increased floodpeaks as well as flow concentration through culverts.
- The degeneration in stream water quality as a result of the disposal and discharge of urban residential stormwater and treated sewage as well as the episodic sewage pipeline leakages and/or surcharging sewer manholes in close proximity to the watercourses.
- Litter and solid waste pollution and associated water quality and habitat degradation.
- In-stream and riparian plant community transformation and alien invasive and ruderal plant species domination and proliferation as a result of all the above-listed direct and indirect impacts.

As a result of the above-listed impacts, the watercourses assessed were observed to be highly modified with limited natural vegetation communities and habitat structure remaining, and the habitat and communities present were all secondary in nature.

From a hydrological perspective, the Watercourse Units 1 and 3 receive increased surface and subsurface water inputs, mainly in the form of stormwater, leaking pipes and treated water from the surrounding residential properties in the case of Unit 1. The result has been the deepening and widening of the stream channels over time as the channels have adjusted to the increased mean and peak discharges. Furthermore, the establishment of the road crossings across the three watercourses has resulted in the filling in of a section of the watercourses and the diversion of flow under the road through a piped culverts and narrow bridges. This has also acted to initiate bed and bank erosion and modification both upstream and downstream of the crossings. The lowering of the channel bed/valley bottom surface at the road crossings has resulted in the headward migration of incision from the crossings. This was particularly evident in watercourse Unit 2 where wide gullies had migrated up into the valley head seep above Assagay Road. The effect of incision has been the lowering of the local water tables and levels of soil saturation, the drying out of the higher lying channel bank and valley bottom areas outside of the channels.

From an ecological perspective, the present habitats can all be considered secondary in nature and highly modified in terms of morphology and vegetation when compared to a reference state. Watercourse Units 1 and 3 are in essence functioning as urban-residential stormwater conduits and, as a result, the ecology present comprises hardy and generalist flora and fauna species that can withstand the present altered hydrological and geomorphological regimes. Similarly, Watercourse Unit 2 has been altered by the headward migration of erosion and associated soil moisture changes, which, coupled with a lack of management, has resulted in the invasion of the altered habitat by alien invasive plants species. Thus, the present ecological state of the three watercourses is speculated to be poor and seriously modified.

7 RESULTS & DISCUSSION: PRESENT STATE ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) ASSESSMENT

The current state ecological importance and sensitivity assessment of the stream habitats as delineated in **Figures 2 and 3** was undertaken only. An assessment of the functional importance of the larger systems was not undertaken.

7.1 Ecological Importance of Riparian Units

The two delineated riparian units, Watercourse Units 1 and 3 were assessed as being of **low/marginal ecological importance** and sensitivity according to the EIS (DWAF, 1999) tool as summarized in **Table 4** below. This low/marginal rating is described as: "Quaternaries that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use" DWAF, 1999). This is expected for reasons as explained in the paragraphs below.

Table 4: Ecological Importance and Sensitivity Scores

Ecological Importance & Sensitivity (EIS)	Unit 1	Unit 3
Rare & endangered biota	0	0
Unique biota	0	0
Intolerant biota	0	0
Species richness	1	1
Diversity of aquatic habitats/features	1	1
Refuge value of habitats	2	1
Sensitivity of habitats to flow changes	1	1
Sensitivity of habitats to water quality changes	1	1
Migration route/corridor (aquatic & riparian)	2	2
Conservation importance ito protected areas & heritage sites	0	0
EIS Score	**1**	**1**
EIS Ranking	**Low / Marginal**	**Low / Marginal**

The ten (10) components of the DWAF (1999) Ecological Importance and Sensitivity (EIS) assessment tool related to the riparian zone under investigation are discussed below.

The Rare and Endangered Biota:

Due to the highly modified nature of the in-stream and riparian habitat and the resultant alien plant infestation, the likelihood of the presence of rare and endangered floral, invertebrate, fish, amphibian, reptile, mammal and bird species is considered to be low. As a result, this component was rated as '0' for both units.

Endemic and Uniquely Isolated Biota (not rare and endangered):

The likelihood of the presence of endemic or uniquely isolated floral and faunal species is considered to be low for the same reasons as provided in the paragraph above. Thus this component was rated as '0' for both units.

Species/Taxon Richness:

Floral species richness was confirmed to be low as a result of the highly disturbed, secondary and ruderal nature of the riparian and wetland vegetation communities and the substantial infestation of the habitats by alien invasive plant species. In terms of fauna, the riparian and in-stream habitats are expected to be used by a low number of generalist bird, amphibian, reptile and invertebrate species that can withstand some form of disturbance but which ultilise the riparian areas for foraging and refuge due to the limited alternative sites available in the area. Species richness was rated as '1' for both units.

Diversity of Aquatic Habitat Types and Features:

In-stream and riparian habitat diversity was low due to the highly modified nature of the bed and banks of the systems and the high disturbance regime. Erosion and sedimentation in conjunction with historical physical modification altered the natural in-stream and riparian habitats and created a rather monotypic in-stream and riparian environment. As a result, overall habitat diversity is low and not unique or significant locally, for both units. Habitat diversity was higher for Watercourse Unit 1 than 3.

Refuge Value of Habitat Types:

Both riparian units provide some limited refuge value due to the transformation of the surrounding areas. Nevertheless, the refuge value of two watercourses can be considered moderately-low. Refuge value was higher for Watercourse Unit 1 than 3.

Sensitivity of Habitats to Flow Changes:

At present, the sensitivity of the habitats to flow changes is low due to the fact that the habitats have already been transformed by flow alteration.

Sensitivity of Habitats to Water Quality Changes:

At present, the sensitivity of the habitats to water quality changes is low due to the fact that the habitats have already been transformed by flow alteration.

Migration Route or Corridor:
For the same reasons explained above for the refuge value component, the riparian habitat can be considered of moderately-low importance from an ecological corridor and connectivity perspective.

Conservation Importance in terms of Protected Areas:
The watercourses are not located within any legally protected areas. Thus, the score is zero.

7.2 Ecological Importance of Wetland Units

The ecological importance of Watercourse Unit 2 (valley head seep) was assessed as being reflected in the level of biodiversity maintenance services provided by the wetland unit as assessed in **Section 8.1** below. Overall, the wetland unit was assessed as providing a moderately-low level of biodiversity maintenance services and as such can be considered of medium-low ecological importance.

8 RESULTS & DISCUSSION: PRESENT STATE FUNCTIONAL IMPORTANCE ASSESSMENT

Watercourse Unit 2 was formally assessed using the WET-EcoServices assessment tool (Kotze *et al.*, 2007) for wetlands. The estimated functional value of the two riparian units were discussed but not formally assessed due to a lack of accepted assessment tools.

8.1 Functional Importance of Wetland Units

The WET-EcoServices scores for Watercourse Unit 2 are summarized in **Table 5** below.

The wetland unit was assessed as providing a medium/intermediate level of key freshwater ecosystem regulating and supporting services, namely flood attenuation, sediment trapping, phosphate removal, nitrate removal, toxicant removal and erosion control services. This is largely because of the good vegetation cover and associated high roughness of the wetland in conjunction with the predominant subsurface through flow. The steepness of the wetland unit's catchment also contributes to the increased opportunity for the realization of flood attenuation and erosion control services. The rest of the services were assessed as being provided at low to moderately-low levels.

Contextualizing these services within the catchment, the key surface water management and water quality enhancement services can be considered of moderately-low importance due to the small size of the both the wetland unit and its catchment.

Table 5: WET-EcoService Scores under the Current State Scenario

Ecosystem Services	Current State		
	Score	Rating	Importance
Flood attenuation	2.1	Medium	Medium-Low
Stream flow Regulation	1.2	Medium-Low	Low
Sediment Trapping	2.1	Medium	Medium-Low
Phosphate Removal	1.9	Medium	Medium-Low
Nitrate Removal	2.1	Medium	Medium-Low
Toxicant Removal	1.7	Medium	Medium-Low
Erosion Control	1.8	Medium	Medium-Low
Carbon Storage	0.7	Low	Low
Biodiversity Maintenance	1.4	Medium-Low	Medium-Low
Water Supply	0.4	Low	Low
Harvestable Resources	0.0	Low	Low
Cultivated Foods	0.0	Low	Low
Cultural Significance	0.0	Low	Low
Tourism and Recreation	0.0	Low	Low
Education and Research	0.5	Low	Low

8.2 Functional Importance of Riparian Units

Although both Watercourse Units 1 and 3 are highly modified, they both still provide ecosystem services related to surface flow management and water quality enhancement, particularly during low flows periods. It is the author's opinion that both riparian units are providing moderately-low levels of surface flow management and water quality enhancement services as a result of dense vegetated in-stream and marginal riparian habitats. However, such services will be significantly reduced during high flow events. Therefore, the riparian units can be considered of medium-low functional importance.

9 PLANNING IMPLICATIONS AND CONSTRAINTS

Due to the low ecological importance of the three watercourses delineated, there are no fatal flaws to the current alignment of the proposed pipeline. Nevertheless, it is important that negative impacts to the watercourses and minimised through best environmental planning and construction management practices. See recommendations provided in **Section 10** below.

10 POTENTIAL IMPACT PREDICTION, DESCRIPTION AND MITIGATION

This section describes and assesses the predicted potential impacts on the integrity and functionality of the three delineated watercourses in the vicinity of the proposed pipeline as well as the significance of these impacts. As requested by the EAP, GIBB, the impact of the proposed pipeline route shown in **Figures 1** and **2** was assessed.

10.1 Impacts Resulting from Construction Phase Activities

The construction activities associated the proposed development are listed as follows:

- Pipeline footprint clearing (vegetation and soil stripping)
- Pipe trench excavation
- Pipe trench dewatering
- Pipe bridge plinth construction
- Topsoil and subsoil stockpiling
- Hazardous substances storage, handling, mixing and disposal
- Stormwater management and erosion control
- Waste generation and disposal

10.1.1 Description of the Potential Anticipated Impacts

The potential direct and indirect (primary and secondary/tertiary) impacts resulting from each of these activities are summarised in **Table 6** below.

Table 6: Potential Construction Phase Impacts Summary

Construction Activity	Direct / Primary Impacts	Indirect / Secondary & Tertiary Impacts
Pipeline footprint clearing (vegetation and soil stripping)	Vegetation removal, vegetation compaction, soil compaction, topsoil removal, bed and bank modification, noise and dust pollution, faunal fatalities	Erosion, sedimentation, alien plant invasion, onsite and localised habitat degradation, reduction in flood attenuation services, reduction in water filtration services, habitat and water quality degradation in downstream systems
Pipe trench excavation	Vegetation compaction, soil compaction, topsoil removal, bed and bank modification, noise and dust pollution, faunal fatalities	Erosion, sedimentation, alien plant invasion, onsite and localised habitat degradation, reduction in flood attenuation services, reduction in water filtration services, habitat and water quality degradation in downstream systems
Pipe trench dewatering	Vegetation removal, vegetation compaction, soil compaction, topsoil removal, bed and bank modification, noise pollution	Erosion, sedimentation, alien plant invasion, onsite and localised habitat degradation, reduction in flood attenuation services, reduction in water filtration services, habitat and water quality degradation in downstream

Construction Activity	Direct / Primary Impacts	Indirect / Secondary & Tertiary Impacts
		systems
Pipe bridge plinth construction	Vegetation compaction, soil compaction, bed and bank modification, noise pollution	Erosion, sedimentation, alien plant invasion, onsite and localised habitat degradation, reduction in flood attenuation services, reduction in water filtration services, habitat and water quality degradation in downstream systems
Topsoil and subsoil stockpiling	Vegetation smothering and compaction, soil compaction, noise and dust pollution	Sedimentation, alien plant invasion, onsite and localised habitat degradation
Hazardous substances storage, handling, mixing and disposal	Cement/concrete mixing spillages, oil spillages, hydrocarbon spillages, noise and dust pollution	
Stormwater management and erosion control	n/a	Erosion, sedimentation, alien plant invasion, onsite and localised habitat degradation, reduction in flood attenuation services, reduction in water filtration services, habitat and water quality degradation in downstream systems
Waste generation and disposal	Solid waste pollution and entrainment	Onsite and localised habitat degradation, reduction in flood attenuation services, reduction in water filtration services, habitat and water quality degradation in downstream systems

As summarized in **Table 6** above, the proposed construction and establishment of the pipeline will result in a number of direct/primary impacts to the watercourse habitats that include:

- Wetland, riparian and in-stream vegetation clearing and removal (planned and accidental).
- Wetland, riparian and in-stream vegetation and soil compaction (planned and accidental).
- Wetland and riparian bed and bank modification (planned and accidental)
- Noise pollution.
- Dust pollution.
- Faunal fatalities.
- Cement/concrete mixing spillages, oil and hydrocarbon spillages and use of watercourses as toilets.
- Disposal of solid waste into the watercourses.

Impacts Resulting from Physical Disturbances:

The physical clearing of the pipeline construction servitudes will result in the clearing of riparian vegetation and topsoil, and the exposure of the bare surfaces to the elements. Such clearing and physical modification activities will likely result in the erosion and sedimentation of onsite and downstream riparian areas during rainfall events. Furthermore, sedimentation is likely to occur as a result of soil and bank destabilization associated with the physical modification activities irrespective of rainfall events. Physical modification is also likely to alter flow paths which could also lead to some channel erosion and sedimentation, especially during large storm events during the construction phase. Further erosion will contribute to increased disturbance and increased invasion by alien and indigenous pioneer plant species.

The deepening of the channels/gullies within the wetland and riparian areas will further reduce soil moisture rates through the lowering of the local water table. However, in this case, the impacts to Watercourse Units 1 and 3 will likely be low as they are already incised and eroded. Similarly, Watercourse Unit 3 is also eroded, but further erosion could initiate further headward incision.

Further, erosion onsite will likely lead to onsite and downstream sedimentation. Impacts resulting from sedimentation include the covering over of the existing wetland and riparian vegetation. The smothering of the wetland plants and soils will result in the formation of a dry soil layer above the original wetland soils that will be susceptible to invasion by invasive and pioneer plants species. In addition, eroded upland seed banks will be deposited within the wetland which will likely result in the introduction of upland plant species into the wetland vegetation assemblage. The deposition of sediment within the wetlands and riparian zones can also result in the alteration of flow paths and gradients, which may lead to erosion.

Furthermore, the proposed clearing and modification of the watercourses unit may also result in the death of sedentary fauna like frogs, chameleons and millipedes. As the watercourses to be affected are already highly disturbed, generalist and adaptable sedentary species are likely present and the potential for threatened and conservation worthy faunal fatalities is low. Nevertheless, the potential for sedentary wetland/riparian faunal fatalities is moderately-high.

Noise and Dust Disturbances:

Undertaking construction within the wetland and riparian areas will also expose the modified freshwater habitats to noise and dust pollution. The clearing of vegetation and the exposure of bare soils in combination with extensive earthworks and the use of heavy machinery will definitely result in dust pollution. Similarly, these activities will also result in noise pollution. The majority of the noise will be generated by the construction vehicles and machinery. These impacts to flora and fauna will be diminished by the fact that the habitats are already highly disturbed and colonised by generalist species.

Impacts Resulting from the Handling, Storage and Disposal of Potential Pollutants:

Groundwater and surface runoff contamination may occur during the construction phase as a result of negligence, inappropriate planning, lack of supervision and general handling errors. Potential pollutants include cement, oils, hydrocarbons and waste from chemical toilets. The degree of contamination depends on the extent of the chemical spill or cumulative effects of a number of chemical spills. Based on professional experience with South African contractors appointed by the eThekwini Municipality, the risk of contamination due to negligence is moderate to high. No sampling of the in-stream water quality of the watercourses was undertaken as part of the assessment. However, based on the moderately-high level of catchment transformation, pollution point sources in the catchment and observed water quality, it is expected that the current stream water quality of the three watercourses is moderately poor, particularly for Watercourse Units 1 and 3. Thus, the impact on local stream water quality resulting from the episodic contamination impacts during the construction phase will likely be moderately-low. However, when viewed cumulatively, this impact will be higher.

Potential contamination of the wetlands and streams on site will likely result in disturbances to the floral and faunal communities within the watercourses. Disturbances include the domination of a particular species as a result of the competitive advantage created by pollutants or the dieback of floral and faunal species and the resultant loss of biodiversity (Coetzee, 1995). However, it is important to note that the monotypic floral species assemblages observed were likely already impacted on by water quality changes. Thus, the impact of further contamination events on habitat integrity will be reduced. Nevertheless, pollution of the wetlands and streams will likely lead to further degradation from an ecological perspective as well as contribute cumulatively to a decreased water quality within the larger catchment, particularly the Mhlatuzana and Nkutu Rivers.

10.1.2 Overall Impact to Watercourse Habitat Integrity

Ultimately the above-listed impacts will result in the alteration of the current hydrology, geomorphology and ecology of the wetland, riparian and in-stream habitats delineated as well as downstream areas. It is anticipated that the impact to ecological integrity of the three delineated watercourse units will be **moderately-low** assuming that construction is undertaken in a responsible manner. Poor construction practices will likely result in a moderate impact to ecological integrity. However, it is likely that habitats downstream of the delineation sites will also be affected, mostly in terms of flow, erosion, sedimentation and water quality related impacts. If the construction is managed properly, the extent and intensity of the impacts felt downstream should be reduced to local and moderately-low levels respectively. However, onsite erosion and sedimentation events will likely be experienced a few hundred meters downstream, especially if there are contamination events. Fortunately, contamination events will be episodic over a relatively short construction phase, thus reducing the impact on downstream aquatic and wetland habitat over the long term.

10.1.3 Impacts to Ecosystem Services and Freshwater Ecosystem Functioning

As discussed above, the proposed pipeline development is likely to have a moderately-low impact to the integrity of the three watercourse units provided that construction is undertaken in a responsible manner. This moderately-low impact to system integrity can be translated into a moderately-low impact on the current level of ecosystem services provided by the units, which are of moderately-low importance. Similarly, if poor construction practices are implemented, the degree of change in integrity and ecosystem services could be moderate.

Although the impacts on the integrity of the wetland riparian system will be moderately-low to moderate at worst, the cumulative impact on freshwater ecosystem services and resources provided by the larger river systems, particularly water quality impacts, could be higher.

10.1.4 Recommended Mitigation Measures

Pipeline alignment and crossing design recommendations:

- Wherever possible, the pipeline should be established within the watercourses as close to the road crossings as possible as these areas are already disturbed and transformed.
- Wherever possible, all watercourses crossings must be via pipe bridges.

- The pipeline must be routed so that the watercourses are crossed at as close to right angles to the direction of flow as possible.
- The number of bridge piers within the watercourses must be minimised as far as possible and the central/wettest parts (active channels/channel beds) of the watercourses must be spanned where possible.

General site setup recommendations:

- The location of the existing sewer and water lines must be surveyed and demarcated prior to construction commencing.
- During the construction phase, the edge of the riparian and wetland areas to be crossed extending 5m beyond the crossing must be clearly demarcated.
- The centre line of the excavation for the pipe through a river or stream is to be marked with survey pegs and the extent of the working servitude demarcated.

Construction and rehabilitation recommendations for pipe bridge crossings:

- Construction should be undertaken between the months of April and August.
- A photographic record of the state of the watercourse prior to construction must be compiled for reference purposes.
- Disturbance to the delineated riparian and wetland areas and soils along the pipeline route should be restricted to an established construction right-of-way (ROW) corridor. The width of the ROW corridor should be as narrow as practically possible and should be demarcated and fenced off during the site setup phase to the satisfaction of the Environmental Control Officer (ECO).
- Once the construction ROW is established, all areas outside of the demarcated ROW must be considered no-go areas. Encroachment into no-go areas without prior approval from the ECO must be penalised with a fine.
- All pipes and equipment must be stored outside of the demarcated watercourses in a stockpile area approved by the ECO.
- The construction ROW should comprise the following:
  - a one-way running track of a maximum width of 2m.
  - a pipeline bridge and plinth corridor of a maximum width of 1.5m.
- Notwithstanding the above, every effort should be made to utilise the existing roads and associated embankments as running tracks for the establishment of the pipe bridges.
- The running track should not be established within the central, wettest lowest lying portions of the watercourses where no piers are proposed. In this regard, the running tracks must extend into the watercourses from each valley side to the furthest pier construction site, thus avoiding the crossing of the central wet or channelled areas.

- Before clearing, indigenous plants suitable for rescue are to be relocated to a temporary holding area by a vegetation specialist. Indigenous plants suitable for rescue include small ingenious shrubs and trees (saplings) and grass clumps.
- Before stripping, all vegetation within the wetland and riparian areas must be chopped down by hand prior to more intensive wetland clearing and alteration. Any fauna encountered during the clearing process must be relocated to the adjacent habitats under the supervision of the ECO.
- Thereafter, the working servitude is to be stripped of topsoil and vegetation to a nominal depth and this top soil placed at a temporary stockpile area and maintained for re-use.
- Soil stockpiles must be located outside of the demarcated watercourses. The location of these topsoil stockpiles must be agreed upon by the ECO prior to construction commencing.
- Topsoil and subsoil must be stored separately.
- Wherever possible, excavations within the watercourses should be undertaken by hand. If this is unfeasible for sound reasons, a small excavation vehicle may be used.
- Once the pipe bridge is completed, the running track must be removed by hand wherever possible.
- Once completed, the disturbed bed and banks of the streams and wetlands must be re-shaped.
- Compacted wetland and riparian soils along the running track must be ripped to a depth of 30cm.
- Once the watercourses are re-shaped and the compacted soils are ripped, topsoil from that particular area must be reinstated within the wetland and riparian areas along the running track by hand to the satisfaction of the ECO.
- The prepared soils along the construction corridor must be re-vegetated via hand broadcasting and plugs by a professional. For un-shaded areas, the seed mix should comprise an indigenous grass mix comprising of 'runner' grasses like Cynodon dactylon var. Sea Green. If the construction corridor is shaded, the grass mix should comprise shade tolerant species. In addition, the rescued indigenous plants must also be re-planted within the construction corridor by a professional.
- Biodegradable geofabrics to be used on steep slopes to facilitate establishment of vegetation e.g. Geojute®.
- The areas to be hand broadcasted must be lightly watered before planting to ensure that the seed material does not come into contact with dry ground.
- The seed mixture must be evenly broadcasted over the entire surface of the construction corridor. In this regard, a mechanical seeding device may be used in order to ensure a uniform distribution of grass seed over the area to be rehabilitated.

- The grass seed must be lightly worked into the upper topsoil layer by means of hand labour (using a rake).
- The seeded area must be watered daily until planting has been completed.
- The soil must be kept moist for the first two weeks after hand broadcasting to ensure seed germination. Thereafter irrigation should be applied weekly until reasonable groundcover is obtained.
- Watering should be gentle so that rill erosion is avoided and minimised.
- Any erosion damage resulting from watering/irrigation must be repaired immediately.
- The disturbed area should be monitored for erosion and alien plant encroachment weekly for a month, and monthly for 3 months.
- Alien plants within the rehabilitated area must be eradicated immediately. The alien plant species should be removed by hand-pulling where possible. Herbicides should be utilised where hand pulling is not possible.
- ONLY herbicides which have been certified safe for use in wetlands by independent testing authority to be used.
- The ECO must undertake a close-out audit after the monitoring period and sign-off on the success of the rehabilitation.
- A detailed method statement for all watercourse pipe bridge crossings must be submitted to the ECO by the contractor for approval prior to construction commencing.

Construction and rehabilitation recommendations for trenched crossings:

The above-listed measures applicable to the trenched crossings must be adhered to. Additional measures specific to trenched crossings include:

- The construction ROW should comprise the following:
  - a one-way running track of a maximum width of 2m.
  - a pipeline trench zone of a maximum width of 1.5m
- Geotextile/geofabric must be laid down along the running track and crusher run/stone/rock material laid down on top of the geofabric.
- The running track should be located upstream of the trench so that it can act as the dam above the trench. Water from the dammed up section must be diverted into the stream areas below the trench via pumping or fluming if necessary.
- Care must be taken to ensure that water pumped or flumed from the dammed area above the trench does not erode the channel at the discharge point. In this regard, any water pumped out of the trench must be discharged into a hay bale silt trap outside of the watercourse to ensure erosion and/or sedimentation of the watercourse is minimised. The location of the silt trap must be agreed upon by the engineer and the ECO prior to construction commencing. The silt trap must be regularly monitored during dewatering.

- If the more perennial flowing streams are to be trenched (not advisable), water from the stream is to be piped over the working area to allow the excavation to take place. This will be by means of sand bag embankments forming an in-stream dam with a pipe carrying the water past the working area. The water must remain within the watercourse. The following measures apply to flow diversion:
  - The pipe section where the machinery is to cross the river or stream must be covered with spoil material to minimise damage to the pipe and allow machines to cross.
  - The discharge from the pipe is to be located so as to minimise the risk of erosion. Remedial measures such as discharging the water onto a rock bed may be required.
- The trench must be backfilled first and the subsoils and topsoils must be reinstated in the proper order that they were excavated.
- Thereafter the running track must be removed in a phased manner. Firstly, a section of the track must be removed by the excavator working back along the running track. Thereafter, the underlying soils must be ripped to a depth of 30cm and the top soils reinstated. This sequence should continue until the running track has been removed and the top soils reinstated.

General construction management measures:

- All contractor staff working onsite must undergo an environmental induction prior to moving onto site and all site managers must be well acquainted with the construction phase environmental management programme (EMPr). This EMPr must be kept onsite at all times. Failure to show proof of staff inductions and failure to keep the EMPr onsite must be penalised with a fine. The education of the contractor staff is the responsibility of the site manager. The appointed Environmental Control Officer must oversee the induction programme.
- Strict solid waste management and disposal measures must be included in the construction phase environmental management programme (EMPr).
- Chemical toilets must be provided for the construction workers and these toilets must be located within 32m of the delineated watercourses and should be regularly serviced.

Noise and dust minimisation recommendations:

- Appropriate dust suppression measures must be applied at all times, particularly during winter.
- Noise impacts generated by machinery must be minimised as far as possible by ensuring all machinery is in good working order, all machinery has the necessary noise suppression, and working hours are restricted to 7am – 5pm.

Alien plant removal recommendations:

- All bare surfaces across the construction site must be checked for alien plants at the end of every week and alien pants removed by hand pulling and adequately disposed.

Stormwater management and erosion control recommendations:

Stormwater and erosion control measures must be implemented during the construction phase to ensure that erosion and sedimentation impacts to the riparian and in-stream habitats are minimised and avoided. In this regard, the following measures should be implemented:

- Clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected, clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- Construction activities should be scheduled to minimise the duration of exposure to bare soils on site, especially on steep slopes.
- The full length of works must NOT be stripped of vegetation prior to commencing with other activities.
- The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes.
- A combination of sandbags and silt fences must be established along the edge of all bare and exposed surfaces above the wetland and riaprian to capture sediment and excess runoff.
- The berms, sandbags and/or silt fences must be monitored for the duration of the construction phase and repaired immediately when damaged. The berms, sandbags and silt fences must only be removed once vegetation cover has successfully re-colonised the embankments.
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gulleys must be filled-in with appropriate material and silt fences or fascine work must be established along the gulley for additional protection until grass has re-colonised the rehabilitated area.

It is important that all of the above-listed mitigation measures are costed for in the construction phase financial planning and budget so that the contractor and/or developer cannot give financial budget constraints as reasons for non-compliance. Proof of financial provision of these mitigation measures must be submitted to the ECO prior to construction commencing.

Hazardous substances handling, storage and disposal recommendations:

- If applicable, hazardous storage and refuelling areas must be bunded prior to their use on site during the construction period. The number of bunds and their location and their construction should occur during the site setup phase.
- Mixing and/or decanting of all chemicals and hazardous substances must take place on a tray, shutter boards or on an impermeable surface and must be protected from the ingress and egress of stormwater.
- No vehicles transporting concrete, asphalt or any other bituminous product may be washed on site.
- Vehicle maintenance should not take place on site unless a specific bunded area is constructed for such a purpose.
- Ensure correct location of construction camps, equipment yards, concrete batching plants, etc. to avoid areas susceptible to soil and water contamination.
- Ensure that transport, storage, handling and disposal of hazardous substances is adequately controlled and managed. Correct emergency procedures and cleaning up operations should be implemented in the event of accidental spillage.
- Implement appropriate operation and maintenance of construction equipment to avoid petrochemical products from polluting the soil.
- A spill contingency plan for both the construction phase must be drawn up and incorporated into the EMPr. This should include procedures to guide the clean-up of accidental spillages and its disposal.
- Bins should be provided to all areas that generate waste e.g. worker eating and resting areas and the camp site. General refuse and construction material refuse should not be mixed.

10.1.5 Impact Significance Assessment

The significance of the potential construction phase impacts under a pre-mitigation or poorly implemented mitigation scenario was assessed as being **medium-low** and **acceptable** (**Table 7**). The significance of the impacts with the implementation of the recommended mitigation measures was assessed as being **low** and **acceptable** (**Table 7**).

Table 7: Impact Assessment: Construction Phase Activities

Assessment Criteria	Pre-mitigation Rating		Post-mitigation Rating	
Intensity	3	Medium	2	Medium-Low
Extent	3	Suburban	2	Local
Duration	4	Long-term	2	Medium-Short-term
Probability	4	Probable	3	Possible
Impact Magnitude	**14**	**Medium**	**10**	**Medium**
Impact Importance	**2**	**Medium**	**2**	**Medium**
Impact Significance	**28**	**Medium-Low**	**20**	**Low**
Acceptability	**Acceptable**			**Acceptable**

10.2 Impacts Resulting from Operational Phase Activities

Once the pipeline is established and the construction servitude rehabilitated, the only operational activities will be:

- Pipeline operation
- Pipeline maintenance

10.2.1 Description of the Potential Anticipated Impacts

The potential direct and indirect (primary and secondary/tertiary) impacts resulting from each of these activities are summarised in **Table 8** below.

Table 8: Potential Operational Phase Impacts Summary

Operational Activity	Direct / Primary Impacts	Indirect / Secondary & Tertiary Impacts
Pipeline operation	Pipeline leakages, pipeline bursting, pipeline damage/collapse, flow alteration due to plinth location	Erosion, sedimentation, alien plant invasion, onsite and localised habitat degradation, reduction in flood attenuation services, reduction in water filtration services, habitat and water quality degradation in downstream systems
Pipeline maintenance	Vegetation and soil compaction, bed and bank modification	Erosion, sedimentation, alien plant invasion, onsite and localised habitat degradation, reduction in flood attenuation services, reduction in water filtration services, habitat and water quality degradation in downstream systems

Water pipe leakages as a result of poor pipeline construction and establishment or damage to the pipeline from future developments and/or high flow events will result in an increase in water inputs to the affected watercourses. The artificially increased water inputs will both increase the volumes of flow through the delineated watercourses and result in a continuous flow of water to the watercourses that will alter seasonality of flows. Such increased flows will likely result in channel bed and bank erosion and sedimentation, and ultimately habitat disturbance and the increased alien plant invasion.

Furthermore, the location of the pipe bridge plinths may cause flow diversion and alteration that could result in increased flow velocities and ultimately increased bank and bed erosion.

Lastly, maintenance to repair damage could result in physical disturbances similar but likely less intense than those described for the direct impacts during the construction phase in **Section 10.1** above.

10.2.2 Overall Impact to Watercourse Habitat Integrity

Ultimately the above-listed impacts will result in the alteration of the current hydrology, geomorphology and ecology of the wetland, riparian and in-stream habitats delineated as well as downstream areas. It is anticipated that the impact to ecological integrity of the three delineated watercourse units will be **moderately-low**. However, under a worst case scenario where pipes are poorly established and uncontrolled maintenance is undertaken, the impact is likely to be moderate. Further, the impact on the integrity of the freshwater habitats downstream of the delineation sites will also be affected, mostly by flow, erosion and sedimentation related impacts. For the most-likely scenario, the impacts to the integrity of downstream systems should also be moderately-low and the impact is likely to be experienced locally. However, under the worst-case scenario, the downstream impacts are likely to extend to larger systems downstream and possibly be of suburban extent.

10.2.3 Impacts to Ecosystem Services and Freshwater Ecosystem Functioning

As discussed above, the operation of the proposed pipeline is likely to have a moderately-low impact to the integrity of the three watercourse units provided that the pipeline is implemented properly and maintenance undertaken in a responsible manner. This moderately-low impact to system integrity can be translated into a moderately-low impact on the current ecosystem services provided by the units, which are of moderately-low importance.

10.2.4 Recommended Mitigation Measures

Pipeline alignment and crossing design recommendations:

- The number of bridge piers within the watercourses must be minimised as far as possible and the central/wettest parts (active channels/channel beds) of the watercourses must be spanned where possible.
- Substantial maintenance work to the pipeline servitude within the watercourses must be undertaken according to the basic and applicable measures provided in the construction method statement.

10.2.5 Impact Significance Assessment

The significance of the potential construction phase impacts under a pre-mitigation or poorly implemented mitigation scenario was assessed as being **medium-low** and **acceptable** (**Table 9**). The significance of the impacts with the implementation of the recommended mitigation measures was assessed as being **low** and **acceptable** (**Table 9**).

Table 9: Impact Assessment: Operational Phase Activities

Assessment Criteria	Pre-mitigation Rating		Post-mitigation Rating	
Intensity	3	Medium	2	Medium-Low
Extent	3	Suburban	2	Local
Duration	4	Long-term	4	Long-term
Probability	4	Probable	3	Possible
Impact Magnitude	**14**	**Medium**	**11**	**Medium**
Impact Importance	**2**	**Medium-Low**	**2**	**Medium-Low**
Impact Significance	**28**	**Medium-Low**	**22**	**Low**
Acceptability	**Acceptable**			**Acceptable**

11 CONCLUSION

GCS (Pty) Ltd was appointed by GIBB, on behalf of the eThekwini Municipality, to conduct a wetland and riparian assessment of the proposed water pipeline to connect to the West Riding Reservoir in Hillcrest, eThekwini Municipality. The appointed scope of work was to delineate all watercourses within 32m of the proposed pipeline, assess the ecological and functional importance of the delineated watercourses and identify and describe the potential impacts of the proposed pipeline on the delineated watercourses as well as identify mitigation measures to be implemented.

Soil and vegetation sampling in conjunction with the recording of riparian morphological features identified the presence of three watercourses along the proposed pipeline route. Watercourse Units 1 and 3 were identified as riparian units and Watercourse Unit 2 as a valley head seep wetland.

All three watercourses were found to be highly modified and in a poor state as a result of direct physical disturbances and indirect catchment related disturbances that have altered hydrological and geomorphological processes. As a result, all three watercourse units were found to be dominated by mixes of alien invasive and indigenous ruderal and invasive plant species typical of disturbed freshwater habitats.

The ecological importance of both of the riparian units were assessed as being low according to the EIS tool (DWAF, 1999). Similarly, the ecological importance of the valley head seep was assessed as being moderately-low due to the provision of a moderately-low level of biodiversity services. Furthermore, all three systems have not been included in the D'MOSS and are thus are of low importance in terms of current conservation planning.

Watercourse Unit 2 (valley head seep) was assessed as providing a moderate level of surface water management and water quality enhancement ecosystem services. This was largely due to the nature of the wetland's catchments and the high opportunity for the realisation of freshwater supporting and regulation ecosystem services despite the general low to moderately-low ability of the wetland to provide such services. The importance of these ecosystem services is considered to be moderately-low due to the small size of the wetland habitat and the wetland's catchment. The riparian units are also expected to provide some freshwater supporting and regulating ecosystem services, although at a slightly lower level. Due to the highly degraded nature of the catchments of the riparian units as well as the slightly larger catchments extents, the freshwater related ecosystem services provided by the riparian units were also assessed as being moderately-low importance.

The proposed pipeline is expected to result in a number of potential direct and indirect impacts to the watercourses during the construction and operational phases. Overall, the most significant impacts are the direct physical disturbance impacts and the water quality impacts that will/could occur during the construction phase. Potentially significant operational impacts may result from poor design and establishment of the pipelines that could result in the pipe damage and leakages. The findings of the significance assessment indicate that the proposed construction and operational impacts pre- and post-mitigation are acceptable.

The potential construction phase impacts were assessed as being of medium-low significance pre-mitigation and of low significance post-mitigation. Similarly, potential operational phase impacts were also assessed as being of medium-low significance pre-mitigation and of low significance post-mitigation. Nevertheless, the success of the proposed development lies in the proper design and construction/establishment of the pipeline. The worst-case or poorly mitigated scenario should still be considered an unacceptable scenario as moderate impacts to watercourses when viewed cumulatively are generally substantial and significant due to the prevalence of poor catchment management practices in the eThekwini urban areas.

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