BASIC ASSESSMENT REPORT

PROPOSED NORTHERN AQUEDUCT AUGMENTATION PHASE 5: DURBAN HEIGHTS TO DUFFS ROAD STEEL PIPELINE PROJECT

Prepared for:

eThekwini Water and Sanitation
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Submitted to:

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NEA REF NO: KZN/EIA/0000082/2015

PURPOSE OF DOCUMENT

A period of **30 calendar days (5 August 2015 to 4 September 2015**) has been provided to the **State Departments** and **registered Interested and Affected Parties (I&APs)** for the review and commenting phase of the Basic Assessment Report (BAR). All I&APs as well as State Departments have been notified of this review period.

The BAR contains the following information:

- A description of the project, including project motivation;
- A description of the environment affected by the project;
- The public participation process;
- Discussion of applicable alternatives;
- Assessment of impacts for the construction and operational phases; and
- The EAP's recommendations.

The BAR can be viewed at the following venue:

Name of public venue	Name of Contact Person	Contact Number(s)	Viewing Times
Reservoir Hills Library 7 Sienna Crescent, Durban, 4091	Ms. Pamela Sankaran	(031) 262 5035	Mon (10h00 to 18h00) Tues - Fri (8h30 to 17h00) Sat (08h30 to 12h30)
Newlands East Library 5 Garrick Crescent, Newlands East, 4037	Ms. Thabisile Hlongwa	(032) 577 9278	Mon (10h00 to 18h00) Tues - Fri (10h00 to 17h00) Sat (08h30 to 12h30)
Newlands West Library 121 Loopwest Crescent, Newlands West, 4037	Ms. Sibongile Magubane	(031) 578 1121	Mon (10h00 to 18h00) Tues – Fri (10h00 to 17h00) Sat (08h30 to 12h30)
Firwood Road Library, 97 Firwood Road; Redhill, 4051	Mr. Makhaba	(031) 564 0961	Mon (10h00 to 17h00) Sat (08h30 to 12h30)

Public Open Days (POD's) will be held as follows during public review of the BAR:

Name of public venue	Date	Times
Resmount Primary School 2 Magdelan Ave, Durban, 4091	Tuesday, 18 August 2015	14h30 to 19h30
Corovoca Primary School 5 Pomegranate Rd, Avoca Hills, Durban, 4051	Wednesday, 19 August 2015	14h30 to 19h30
Newlands East Municipal / Community Hall 10 Tandipa Road, Newlands East, 4037	Thursday, 20 August 2015	14h30 to 19h30

The purpose of the POD's will be to have one-on-one discussions with groups or individuals regarding their concerns about the Environmental Process, the project, the route alignments, specialist study findings and so on, with the aid of visual representations.

Should you wish to participate in the Basic Assessment Process by contributing issues and concerns/comments, please register as an I&AP by completing the enclosed Registration and Comment Sheet or you can visit SEF's website at http://www.sefsa.co.za. To register as an I&AP or comment on the project, click on "Stakeholder Engagement" (seventh tab on the top of the home page). Click on the "register" button and complete the compulsory fields to register as an I&AP. On completion of these fields, you will be registered. Insert your username and password to log in. Click on Basic Assessments, under categories on the right side of the stakeholder engagement page. Please click BAR for the **Proposed Northern Aqueduct Augmentation Phase 5 Project** to view the report and associated appendices. Should you have any problems in obtaining the information from the Internet, please feel free to contact SEF for assistance.

Following the commenting period, the BAR will be updated (*with the comments received upon public review of the BAR*), and submitted to the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (KZN DEDTEA) for consideration towards Environmental Authorisation.

PROJECT SUMMARY	
Project Name	Proposed Northern Aqueduct Augmentation Phase 5
Brief Development Overview	The existing Northern Aqueduct system operated by EWS comprises of a network of potable bulk water supply pipelines that serve the north eastern region of the EWS area of supply. The Northern Aqueduct conveys potable water from the Durban Heights Waterworks to several terminal reservoirs and high level pressure zones, which supply commercial and residential consumers in the northern areas. The existing Northern Aqueduct pipeline system has, however, reached its flow capacity at various sections of the trunk main system as a result of growth in demand from major new developments and urbanization to the north east of Durban. Therefore, in order to provide a sustainable and assured supply of water to meet future demands in the northern areas of Durban, EWS has identified the requirement for a new steel gravity-fed bulk water supply pipeline carrying potable water, from Durban Heights Waterworks in Reservoir Hills and various other upgrades and changes to the bulk network, which are to be implemented in various phases. The latter has been called the Northern Aqueduct Augmentation Project (NAA). The proposed development is Phase 5 of the Northern Aqueduct Augmentation Project and comprises of a proposed new large bore 1 200mm ND welded steel pipeline from Durban Heights in Reservoir Hills to the northern side of Duffs Road. The proposed northern aqueduct pipeline starts at EWS valve chamber in Pridley Road, located just downstream of the Durban Heights Waterworks. From the bulk connection point in Reservoir Hills, the pipeline then descends into the uMngeni Valley, crosses the uMngeni River and traverses through the Newlands and Avoca Hills area, en-route to Duffs Road, where it will connect to the blank flange of the Phase 4 NAA pipeline which continues from Duffs Road to the Phoenix 2 Reservoir. A new bridge will be constructed across the uMngeni River and will be above the 1:100 year floodline. The proposed pipeline will be installed on the new bridge at the uMngeni River crossing. The proposed pipeline route traverses a number of landuses including the following, *viz*, densely populated, built-up areas, narrow roads and road reserve widths, high traffic routes, underground existing services, major roads and railways lines, Durban Metropolitan Open Space System (D'MOSS) areas.
Preferred Pipeline Route Location	The pipeline route commences at the tie-in chamber on Pridley Road in Reservoir Hills, from where it follows Pridley Road and crosses Mount Batten Drive, down to Battersea Avenue. It then proceeds along the back of the residential cadastral boundary located on Battersea Avenue/Middlemiss Crescent, from where it descends into the uMngeni Valley. A new bridge will be constructed over the uMngeni River and the proposed pipeline will be installed on the new bridge structure. The pipeline route will proceed into the D'MOSS area after it crosses the opposite bank of the uMngeni River, in the Hillgrove area. The route will cross Newlands West Drive traversing open space up to Sooklall Drive. The route then follows Sooklall Drive for approximately 250m and traverses through another D'MOSS area to reach the M21 (Inanda Road) in the Newlands East area. The route then continues along Inanda Road for approximately 215m before it deviates along Marble Ray Drive for approximately 430m. The pipeline then runs parallel to the overhead power line servitude for roughly 1.1km. The pipeline then follows the road verge in John Dory Drive to avoid the natural drainage lines to the north-west of the existing Northern Aqueducts. The pipeline route then follows parallel to the overhead powerlines and existing water mains, and crosses Newlands Drive, Queen Nandi Drive and Hippopark Avenue. The route then goes through the Quarry Heights area, following or parallel to the existing water mains, powerlines and Petronet gas pipelines. To avoid encroachment into the Eskom servitude, the proposed pipeline will be routed along 120844 Street (for easy access to the Aloes Reservoir). In the Avoca Hills area, the proposed pipeline will occur parallel to the Petronet gas pipeline. The route will occur on Sweetpea Close to follow in parallel to the two existing northern aqueduct pipelines and Metro Railway Line for approximately 700m along the back of Avoca Hills, and then crosses the Metro Railway Line. The Pipeline then continues in parallel to the two existing northern

	aqueduct pipelines and the Transnet Railway Line for approximately 900m. The pipeline then crosses the Transnet Railway Line, Lark Road, the M25 (Curnick Ndlovu Highway) and the M577 (Dumisani Makhaye Drive) to reach the Duffs Road tie-in chambers.
Development Footprint	During the construction phase, the construction corridor or 'working area' that is proposed for the movement of plant/equipment and materials is generally 30m. In steep areas, it may go up to 60m. However, in environmentally sensitive areas, such as the closed canopy woodland / forest at the Reservoir Hills area, the wooded grassland in the Hillgrove area, drainage and wetland areas, the construction corridor will be reduced to ensure minimal destruction. Materials will be placed and stored at strategic points along the pipeline route for ease of access and to limit movement along the pipeline corridor/working zone. The approximate depth of the trench to bury the pipe, is 2.5m to 4m. The approximate width of the proposed trench is 2.2m. The length of the proposed pipeline is approximately 11.7km During the operational phase, the 9m servitude in favour of the eThekwini Municipality will be registered for the proposed pipeline. If the servitude is adjacent to a road reserve, the width can be reduced to 6m because the road reserve affords additional space to access the main for maintenance purposes. No temporary and permanent structures will be allowed within the servitude. Trees may not be planted on the servitude, as the roots may damage the steel pipeline.
Current land uses	Predominantly road reserve, powerline servitude, water pipeline servitude, and rail reserve, D'MOSS areas.
Site Photographs	Appendix B1
Additional Authorisations Required	
Water Use Licenses	**National Water Act, 1998 (Act No. 36 of 1998)** There are various water use activities that are triggered as a result of construction of the proposed pipeline that require an Integrated Water Use Licence Application (IWULA) to be submitted to the Department of Water and Sanitation (DWS) for approval, in terms of Section 21 of the National Water Act, 1998 (Act No. 36 of 1998). An IWULA will be submitted for the following water uses, as there are various watercourses and wetlands occuring within the study area of the proposed construction activities: • Section 21 (c) - Impeding or diverting the flow of water in a watercourse and altering the bed, banks, course or characteristics of a watercourse. • Section 21 (i) Altering the bed, banks or characteristics of a watercourse. The IWULA and the BA processes will run concurrently.
Permits for the Relocation of Provincially and Nationally Protected Plants	**National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)** *Aloe cooperi* (currently listed as Declining) and *Hypoxis hemerocallidea* (currently listed as Declining) was confirmed in the areas associated with the preferred pipeline route. These plants are nationally protected by the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004). **National Forest Act, 1998 (Act No. 84 of 1998)** One protected tree species, *Sclerocarya birrea* (Marula), was confirmed in the area associated with the preferred pipeline alternative, this included seedlings within the rehabilitated area of the existing pipeline. A permit will be required from DAFF if any of these specimens are going to be destroyed or damaged during the construction of the pipeline.

	Schedule 5 of the KwaZulu-Natal Nature Conservation Management Amendment Act, 1999 (Act No. 5 of 1999) Provincially protected species which were confirmed in the corridor of the preferred pipeline route included the following: • *Gladiolus* sp. – *Gladiolus* sp. was recorded in the wooded grasslands and although this species was not in flower at the time of the survey, all species in the genus are protected; • *Eugenia albanensis* – Recorded in the wooded grasslands, all species in the genus are protected; • The two species of conservation concern, *Aloe cooperi* and *Hypoxis hemerocallidea* are also provincially protected. Both species were recorded in the wooded grasslands. The plant species listed above, may not be removed, picked, pruned or destroyed without permission or a permit from the KZN Department of Agriculture, Forestry and Fisheries (DAFF). Permits for the relocation and/or destruction of these plant species will be applied for, subsequent to receipt of the Environmental Authorisation (EA).

ENVIRONMENTAL ASSESSMENT PRACTITIONER

Strategic Environmental Focus (Pty) Ltd (SEF) is a privately owned company and was formed in 1997 with the objective of providing **expert solutions to pressing environmental issues. SEF is one of Africa's largest multi-disciplinary consultancies**, offering sustainable environmental solutions to private and public sector clients. With our integrated services approach in the management of natural, built and social environments; and with over a decade of experience, we bring a wealth of knowledge and expertise to each project.

SEF's Vision

SEF offers holistic and innovative sustainable solutions in response to global challenges.

SEF's Mission

SEF is a national sustainability consultancy which provides integrated and innovative Social, Biophysical & Economic solutions while fostering strategic stakeholder relationships, underpinned by SEF's core values.

SEF has assembled a team of professionals, consisting of a core of environmental experts with extensive experience in dealing with Environmental Impact Assessments (EIAs), Public Participation Processes, Architectural and Landscape Architecture, Mining and Environmental Management. SEF also has a team of specialist practitioners such as specialists in Wetland Delineation and Functional Assessments; Wetland/ Riparian Rehabilitation, Aquatic Assessments; Ecological (Fauna, Avifauna and Flora) Assessment, Visual Impact Assessments (VIAs), Socio-Economic Assessments, etc.

SEF commits itself to comply with the requirements and the implementation of a Quality Management System. The Quality Management System will be reviewed and implemented to continually improve efficiency and effectiveness of the organisation.

SEF uses a "green" approach to anything we embark on. We believe in using technology to our and the environment's best advantage. We encourage the use of green alternatives such as telephone and video conferencing instead of travelling for workshops and meetings and CDs instead of printed material, where possible.

The core project team members that are involved in this Basic Assessment Application Process is provided in Table 1:

Table 1: Project Team Members

Name	Organization	Project Role
Ms. Gerda Bothma	SEF	Project leader Project management and coordination Process management Specialist team management Public presentations and liaisons Internal report review
Ms. Natasha Lalie	SEF	Public presentations and liaisons Report compilation Environmental Management Programme
Mr. Justin Ellero	SEF	Public presentations and liaisons

Ms Gerda Bothma

Gerda is a Senior Environmental Scientist with over 16 years' experience in the field of environmental and waste management in South Africa. Her experience includes the undertaking of environmental impact assessments, the compilation of environmental management plans, the development of integrated waste management plans, peer reviewing of environmental impact assessments and assistance with the development of management frameworks as well as auditing and monitoring of landfill sites according to environmental principles and construction sites according to conditions set by the environmental authority. She furthermore has experience in dealing with projects which involve NEC3 Contracts. A former Assistant Director of the Gauteng Directorate of Environment she has extensive knowledge and experience in performance monitoring of general and hazardous waste landfill sites as well as the reviewing of environmental impact assessments and mining applications.

Ms Natasha Lalie

Natasha has a MSc. Environment and Society from the University of Pretoria and has been an Environmental Assessment Practitioner (EAP) for almost twelve years. She has undertaken numerous Scoping Reports, Environmental Management Programmes (EMP's) and Exemption Applications, as required by the Environment Conservation Act, 1989 (Act No. 73 of 1989); Environmental Screening and Feasibility Studies; and S&EIRs as well as BAs, as required by NEMA and the EIA Regulations. She has been involved in a wide range of projects, which include waste management, industrial, township establishments, mixed-use development, road upgrades, infrastructure developments, change of land use, lodge developments, proposed bulk water pipelines, proposed transmission power lines, proposed filling stations, shopping centre developments and so on.

Mr Justin Ellero

Justin is an Environmental intern who completed his MSc degree in Environmental Science at the University of KwaZulu-Natal in 2015. His experience includes project planning and implementation, tendering, general admin responsibilities, public participation, drafting of Basic Assessment Reports as well as Scoping & Environmental Impact Assessment.

Table 2: Contact Details of Environmental Assessment Practitioner

Name	Contact Details
Ms Gerda Bothma	Strategic Environmental Focus (Pty) Ltd Postal Address: PO Box 227, Pavilion, 3611 Tel: 031 266 1277 Fax: 031 266 6880 Email: gerda@sefsa.co.za

SPECIALIST TEAM

In order to comprehensively investigate the impact of the proposed pipeline on the receiving environment, a number of Specialist Studies were undertaken by independent specialists. The specialist team responsible for the various studies are presented in Table 3:

Table 3: Specialist Team Members

Theme	Specialist and Qualification	Years of Experience	Professional Registration
Terrestrial Ecologist - Flora	SEF Ms. Karin van der Walt BTech Nature Conservation	11 years	South African Council for Natural Scientific Professionals (SACNASP)
Terrestrial Ecologist - Fauna	SEF Ms. Robyn Phillips MSc in Zoology	11 years	SACNASP
Herpetofauna	James Harvey Ecological Researcher and Consultant Mr. James Harvey MEnvDev Environmental Management	14 years	Member of the Herpetological Association of Africa
Aquatic Environment (Aquatic Ecology)	SEF Mr. Byron Grant Masters degree in Aquatic Health Mr. Byron Bester MSc Aquatic Health	12 years 3.5 years	SACNASP South African Society of Aquatic Scientists, the South African Wetland Society, the Zoological Society of South Africa and the Aquatox Forum South African Council for Natural Scientific Professions (SACNASP): Cand. Sci. Nat. DWA Accredited SASS5 Practitioner River Health Programme training
Wetland Ecology	SEF Mr. Willem Lubbe B Tech in Nature Conservation	7 years	SACNASP
Estuarine Environment	Royal HaskoningDHV Ms. Catherine Meyer BSc Honours Marine Ecology MSc Estuarine Ecology	7 years	None
Air quality (particulate matter)	Ward Karlson Consulting Ms. Novania Reddy BScEng (Chem Eng) Mr. Marc Blanche BSc Hons MSc	3 years 10 years	Pr Sci Nat; MIAQM; MIEnSc
Noise	Ward Karlson Consulting Ms. Novania Reddy BScEng (Chem Eng) Mr. Marc Blanche BSc Hons MSc	3 years 10 years	Pr Sci Nat; MIAQM; MIEnSc

Theme	Specialist and Qualification	Years of Experience	Professional Registration
Cultural and built heritage	Mr. Polke Birkholtz Professional Grave Solutions (PGS) Heritage BA Hons (in Archaeology) (cum laude)	17 years	Association of Southern African Professional Archaeologists (ASAPA) Registered as a Professional Archaeologist with Amafa
Palaeontological heritage	Professional Grave Solutions (PGS) Heritage PhD in Geology and National Diploma in Nature Conservation	20 years	Member of Palaeontological Society of Southern Africa
Socio-economic environment	SEF Ms. Jessica de Beer BSocSci (Hons) Industrial Sociology and Labour Studies	11 years	Member of IAP2 South Africa Member of Golden Key International Honour Society Member of SASA (Sociology Association of South Africa)
Geohydrology	SEF Ms. John Sibanyoni M.Sc. in Geohydrology	10 years	SACNASP
Soils and Agricultural Potential	Msanzi Agriculture Mr. John Phipson BA Degree and Education Diploma	35 years	SA Sugar Technologists Association
Traffic Management	Mott Macdonald Mr. Juan Wood Pr Tech Eng: Transportation & Civils	15 years	Engineering Council of South Africa (ECSA) Professional Technologist 201470110

EXECUTIVE SUMMARY

1 INTRODUCTION

Strategic Environmental Focus (Pty) Ltd (SEF) has been appointed by the eThekwini Water and Sanitation Department (EWS), to undertake an environmental application process for the proposed Northern Aqueduct Augmentation Phase 5 Project.

The proposed construction of the 1 200mm ND (diameter) steel welded gravity-fed pipeline that forms part of the Northern Aqueduct Augmentation Phase 5 project requires Environmental Authorisation (EA) from the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (KZN DEDTEA) and a Water Use License (WUL) from the DWS prior to construction. The two processes, i.e. the EA and WULA will run concurrently. This Basic Assessment Report (BAR) deals with the EA process for consideration by the KZN DEDTEA.

An Application for Environmental Authorisation form by way of a Basic Assessment Process in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) as per the EIA Regulations of 2014 was submitted to the KZN DEDTEA on 8 July 2015. On15 July 2015, the KZN DEDTEA acknowledged receipt of the application form and issued the project with KZN DEDTEA reference no: DM/0008/2015 and NEA Ref No: KZN/EIA/0000082/2015.

This BAR includes the following details:

- A description of the project, including project motivation;
- A description of the environment affected by the project, including specialist study findings;
- The public participation process;
- Discussion of applicable alternatives;
- Assessment of impacts for the construction and operational phases; and
- The EAP's recommendations.

The purpose of *this* BAR is to provide all Interested and Affected Parties (I&APs) and relevant State Departments with an opportunity to comment and provide input into the process going forward. All comments received during the review and commenting phase will be incorporated into the BAR for consideration by the approving authority, KZN DEDTEA.

2 BRIEF PROJECT DESCRIPTION

The existing Northern Aqueduct system operated by EWS comprises of a network of potable bulk water supply pipelines that serve the north eastern region of the EWS area of supply. The Northern Aqueduct conveys potable water from the Durban Heights Waterworks to several terminal reservoirs and high level pressure zones, which supply commercial and residential consumers in the northern areas. The existing Northern Aqueduct pipeline system has, however, reached its flow capacity at various sections of the trunk main system as a result of growth in demand from major new developments and urbanization to the north east of Durban.

Therefore, in order to provide a sustainable and assured supply of water to meet future demands in the northern areas of Durban, EWS has identified the requirement for a new gravity bulk water supply pipeline from Durban Heights Waterworks in Reservoir Hills and various other upgrades and changes to the bulk network, which are to be implemented in various phases. The latter has been called the Northern Aqueduct Augmentation Project (NAA).

The proposed development is Phase 5 of the Northern Aqueduct Augmentation Project and comprises of a proposed new large bore 1 200mm ND welded steel pipeline from Durban Heights in Reservoir Hills to the northern side of Duffs Road. The proposed northern aqueduct pipeline starts at EWS valve chamber in Pridley

Road, located just downstream of the Durban Heights Waterworks. From the bulk connection point in Reservoir Hills, the pipeline then descends into the uMngeni Valley, crosses the uMngeni River and traverses through the Newlands and Avoca Hills area, en-route to Duffs Road, where it will connect to the blank flange of the Phase 4 NAA pipeline which continues from Duffs Road to the Phoenix 2 Reservoir. A new bridge will be constructed across the uMngeni River and will be above the 1:100 year floodline. The proposed pipeline will be installed on the new bridge at the uMngeni River crossing. The proposed pipeline route traverses a number of landuses including the following, *viz*, densely populated, built-up areas, narrow roads and road reserve widths, high traffic routes, underground existing services, major roads and railways lines, Durban Metropolitan Open Space System (D'MOSS) areas.

3 LOCATION OF THE PREFERRED PIPELINE ROUTE

The pipeline route commences at the tie-in chamber on Pridley Road in Reservoir Hills, from where it follows Pridley Road and crosses Mount Batten Drive, down to Battersea Avenue. It then proceeds along the back of the residential cadastral boundary located on Battersea Avenue/Middlemiss Crescent, from where it descends into the uMngeni Valley. A new bridge will be constructed over the uMngeni River and the proposed pipeline will be installed on the new bridge structure. The pipeline route will proceed into the D'MOSS area after it crosses the opposite bank of the uMngeni River. The route will cross Newlands West Drive traversing open space up to Sooklall Drive. The route then follows Sooklall Drive for approximately 250m and traverses through another D'MOSS area to reach the M21 (Inanda Road).

The route then continues along Inanda Road for approximately 215m before it deviates along Marble Ray Drive for approximately 452m. The pipeline then runs parallel to the overhead power line servitude for roughly 1.1km. The pipeline then follows the road verge in John Dory Drive to avoid the natural drainage lines to the north-west of the existing Northern Aqueducts. The pipeline route then follows parallel to the overhead powerlines and existing water mains, and crosses Newlands Drive, Queen Nandi Drive and Hippopark Avenue.

The route then goes through the Quarry Heights area, following or parallel to the existing water mains, powerlines and Petronet gas pipelines. To avoid encroachment into the Eskom servitude, the proposed pipeline will be routed along 120844 Street (for easy access to the Aloes Reservoir). In the Avoca Hills area, the proposed pipeline will occur parallel to the Petronet gas pipeline. The route will occur on Sweetpea Close to follow in parallel to the two existing northern aqueduct pipelines and Metro Railway Line for approximately 700m along the back of Avoca Hills, and then crosses the Metro Railway Line. The Pipeline then continues in parallel to the two existing northern aqueduct pipelines and the Transnet Railway Line for approximately 900m. The pipeline then crosses the Transnet Railway Line, Lark Road, the M25 (Curnick Ndlovu Highway) and the M577 (Dumisani Makhaye Drive) to reach the Duffs Road tie-in chambers.

4 KEY IMPACTS

The following key impacts were identified and assessed within this BAR.

4.1 Proposed construction of the pipe bridge across the uMngeni River during the construction phase

4.1.1 Biophysical Impacts

- Vegetation and habitat destruction;
- River flow modification;
- Riverbank modification and edge hardening;
- Increased erosion, turbidity and siltation;
- Decreased water and soil quality;
- Increased sedimentation; and
- Impact on fauna as a result of increased ambient noise levels.

4.2 Proposed construction of the pipeline

4.2.1 Biophysical Impacts

- Increased erosion and sedimentation;
- Surface and groundwater contamination;
- Destruction of natural vegetation (including Threatened/Protected Floral species and associated habitats);
- Spread of alien invasive plant species;
- Destruction and fragmentation of natural habitat and fauna; and
- Destruction of wetland and riparian habitat through reshaping and construction activities of the pipeline within or within the direct vicinity of wetland habitat.

4.2.2 Social Impacts

- Increased ambient dust levels and air emissions;
- Increased ambient noise levels;
- Visual impact of construction activities on visual receptors;
- Effect of temporary workers on social dynamics;
- Access of land for the servitude;
- Impact of socio-cultural processes;
- Impact on health and social well-being;
- Impact on localised traffic;
- Impact on heritage resources;
- Temporary job creation and supply of local material; and
- Emancipatory and empowerment processes/capacity building and skills transfer.

4.3 Proposed Pipe Bridge across the uMngeni River during the operational phase

4.3.1 Biophysical Impacts

- Modified flow, erosion and depositional patterns.

4.4 Proposed Pipeline during the operational phase

4.4.1 Biophysical Impacts

- Impact of erosion;
- Impact on water resources;
- Spread of alien invasive plant species;
- Disturbance to fauna and faunal habitats; and
- Habitat degradation and fragmentation.

4.5 Cumulative Impacts

- Increased traffic impacts during the construction phase as a result of road upgrades and installation of the pipeline;
- Destruction of high ecological sensitive vegetation within the D'MOSS areas as a result of the proposed pipeline and future proposed developments;
- Increased soil erosion and sedimentation of watercourses as a result of vegetation clearance in light of the past impacts such as industrial developments and the construction of the N2;
- Potential destruction of wetlands and riparian areas through removal of hydrophytic and riparian vegetation, and/or hydric soils and riparian bed and bank modification;
- Improved access to water will have a positive impact on the community through implementation of the infrastructure required for the Northern Aqueduct Phase 5 project.

5 PROJECT ALTERNATIVES

To give effect to the principles of NEMA and Integrated Environmental Management (IEM), an EIA should assess a number of reasonable and feasible alternatives that may achieve the same end result as that of the preferred project alternative. The following alternatives have been identified as part of this Environmental Process:

5.1 Proposed Pipeline Route

Various pipeline route alignments (six in total) were investigated at the planning stage of the project. The criteria deemed important in selecting the most preferred route alignment were as follows:

- The location of the pipeline route must connect with existing infrastructure such as the valve chamber at Pridley Road, the Aloes Reservoir at Quarry Heights, and blank flange at Duffs Road. In addition, other factors such as gravity, altitude and available pressure had to be considered in the location of the route.
- To minimise land acquisition from private landowners, the existing servitudes must be used for the route alignment, as far as practically possible.
- Where private land will be acquired for the route alignment, it must be taken along the edge of the cadastral boundary to minimise fragmentation of land and impacts on private land.
- Accessibility to the pipeline route during maintenance of the pipeline is important.
- As far as possible, D'MOSS areas should not be impacted by the pipeline route alignment. However, where this cannot be avoided, the construction and operational phase corridors must be as narrow as possible and the mitigation measures to ameliorate the negative impacts of construction in these areas must be implemented at all stages of the project.
- Geotechnical, topographical and land use factors must be favourable for the construction of the pipeline.

Alternative Route 1 is the most preferred route alignment as it is the shortest route, occurs along the edge of cadastral boundaries, occurs parallel to existing servitudes and has the least environmental and social impacts provided that the mitigation measures as stated in Section F of the BAR is implemented.

Alternative Route 4 was not investigated further as it would have led to major traffic disruptions along Mount Batten Drive, the main road to Reservoir Hills. Furthermore, this route would have been along the N2 and future widening of the N2 is likely to damage buried pipelines and lead disruptions in basic services.

Similarly, **Alternative Route 5** was not investigated further as it would have to be taken along Dumisane Makhaye Drive (MR 577). This road is proposed for widening as part of the eThekwini Bus Rapid Transit (BRT) project and traffic disruptions would prove problematic for mixed traffic and public transport.

Alternative Route 2 would require realignment of the M21 (Inanda Road), as there is minimal space for the installation of a 1 200mm diameter pipeline. In addition, the route would have to be taken along the M25 which is proposed for road widening by the Department of Transport (DoT).

Alternative Route 3 would require construction of the pipeline along narrow roads in the residential suburb of Reservoir Hills. In addition, construction along this route would disrupt access to private properties by the landowners. There is no space for construction of a 1 200mm diameter pipeline along the municipal roads.

Alternative Route 6 is the longest route and therefore the most costly to construct. In addition, there is a cemetery that would be impacted in the Riverhorse Valley Business Estate.

Upon further investigation of Alternative Route 1 by the Biodiversity specialists, various deviations were recommended to avoid construction within the D'MOSS areas of high and medium to high ecological sensitivity i.e. closed canopy woodland / forest, wooded-grassland and the *Hyparhennia hirta* grassland (associated with drainage lines) and the valley bottom floodplain wetland at the end of the route. Alternative route 1 was

amended further to some degree, based on the technical feasibility and practicality of implementing the various deviations to arrive at the final preferred route alignment.

5.2 Alternatives for crossing the uMngeni River

Seven alternatives for crossing the river were considered as follows:

- New concrete pipe bridge with pre-cast beams;
- New concrete pipe bridge cast in-situ with staged formwork;
- New concrete pipe bridge cast in-situ using incremental launch;
- New structural steel pipe bridge on concrete piers;
- Horizontal directional drilling;
- Existing concrete bridge; and
- Open cut trenching.

The most preferred option is the construction of a new concrete pipe bridge, cast *in-situ,* using the incremental launch approach on concrete piers, as it reduces the extent and duration of disturbance in the riverbed. Although the incrementally launched pipe bridge is also a fairly complex construction operation, it does have an advantage over the precast concrete beam option, as construction of the bridge can take place on the river bank and access to the river flood plain would only be required for the construction of the bridge piers. This reduces the risk of flood damage during construction.

The other alternatives listed above are not supported due to the following reasons:

Installation of a 1 200mm diameter pipe on the existing concrete bridge (in addition to the existing pipelines) will overload the bridge capacity and the bridge may collapse thus resulting in disruptions to existing water services. Recent flood line determination has revealed that the existing pipe bridge is below the 1:100 year floodline and the risk of the pipe bridge failing during a 1:100 year flood event is high.

The open cut trenching across the river has a potential for scouring the riverbed sediments during severe flood events for depths up to 15m and the highly erratic volumes of water flowing in the uMngeni River. There will be environmental impacts (such as removal of riparian vegetation, altered river flow dynamics) associated with burying the pipe across the entire width of the riverbed.

The cast in-situ concrete 'box section' bridge supported on cast in-situ concrete piers and piles, constructed with staged formwork requires substantial construction in the riverbed. This option would require, to a more substantial extent, the construction of temporary river diversion works, working platforms and access roads within the river floodplain for equipment and plan (e.g. for piling rigs, excavators, staged formwork and mobile cranes).

New concrete pipe bridge with pre-cast beams. This option will require~~,~~ complex construction for the following in the riverbed i.e. temporary diversion works, working platforms and access roads within the river floodplain for equipment and plants (e.g. piling rigs, excavators and mobile cranes to lift precast sections).

New Structural Steel Pipe Bridge, on Concrete piers. Highest bridge option cost. Limited construction in riverbed, therefore mitigation measures are required during construction. Susceptible to vandalism and theft of steel components. Corrosion is likely and therefore requires high maintenance.

Horizontal directional drilling. Due to the steep sides of the valey the horizontal directional drilling is not a viable option for construction. In addition the pipe will be buried across the river and therefore does not allow access for maintenance. There will be environmental impacts (such as sedimentation of the downstream watercourse, removal of riparian vegetation, altered river flow dynamics) associated with burying the pipe across the entire width of the riverbed through drilling/boring.

5.3 No Development Alternative

Should the KZN DEDTEA decline the application, the study area will not be impacted by the proposed pipeline construction. If the proposed Northern Aqueduct Phase 5 is not approved, the present state of the environment (in terms of the biological, physical, social and economic environment) would remain.

The 'no development' alternative refers to not augmenting the existing capacity of the bulk water infrastructure to the north-eastern suburbs of Durban with the installation of the Northern Aqueduct Phase 5 steel pipeline, thereby not alleviating the long-term water supply shortages. There is an increasing demand for an uninterrupted supply of clean water, due to the commercial and residential developments that are currently under construction and proposed within the eThekwini Municipality's area of jurisdiction. With the lack of augmentation of bulk water infrastructure, water supply requirements poses a problem in terms of development approvals, in light of the stress placed on the existing water schemes. The 'no development' alternative will still result in the need to upgrade the eThekwini Municipality's existing bulk water supply systems. Given the Government's objectives of ensuring the sustainable supply of potable water to all communities, and the Municipality's mandate to provide water to its region, the 'no development' option is not considered a viable alternative to the pipeline project. At present, the existing drought experienced in the the North Coast areas of KwaZulu-Natal have placed water restrictions on Hazelmere supply zone. The proposed Northern Aqueduct Phase 5 will augment, or relieve some of the demands from this system.

There would also not be any creation of temporary jobs that could have led to the employment of the local community and local contractors, skills transfer or the demand for materials.

The tourism, recreational and industrial opportunities in the municipal area would remain stagnant due to the lack of adequate water infrastructure. Therefore, the Municipality will fail in its mandate to contribute towards Local Economic Development (LED) due to stagnant growth of the economy that the proposed infrastructural developments would have generated.

6 CONCLUSIONS AND RECOMMENDATIONS

It is the opinion of the EAPs that should the project proceed, impacts on the receiving natural areas can be minimised through the careful adherence to suggested mitigation measures. It is also recommended that the possible impacts on the D'MOSS areas, uMngeni River, wetlands and drainage lines are monitored throughout the duration of the project.

The proposed Northern Aqueduct Phase 5 project will provide infrastructure for the provision of clean water to the northern suburbs of the eThekwini Municipality. Provision of water as a basic need through the implementation of this project, will ensure a sustainable and assured supply of water to meet the future demands from major new developments and urbanisation.

The steel pipeline will be buried during operation, and will follow the edge of cadastral boundaries and existing servitudes for the most part, thereby having minimal long-term impact on existing landuses or activities. The most significant impacts are likely to arise out of the construction process, but these will be temporary, and with careful management can be reduced or resolved. Re-alignment options for certain portions of the route such as sensitive biophysical areas *viz*, the closed canopy woodland / forest, wooded grassland and drainage lines have been suggested to minimise the impacts to important or sensitive areas that have been identified during the Biodiversity and Wetland Specialist's investigation. However, the practicality of adopting the suggested route realignments, or deviations, had to take into consideration social, economic, technical (*land acquisition, existing services, gradients, hydraulic flow factors)* and so on.

Where possible, the construction and operational phase servitudes must be reduced to minimise the impacts on the sensitive areas. Mitigation measures must be in place to ameliorate the impacts of construction of the route in sensitive areas such as those mentioned above (refer to site-specific mitigation measures in Section

F). A Wetland Rehabilitation Plan and Plant Rescue, Relocation and Rehabilitation Plan must be compiled prior to the tender stage and appended to the Construction EMPr.

Having assessed all the potential environmental impacts associated with the proposed development, it is the opinion of the EAP that the project is issued with a positive Environmental Authorisation from KZN DEDTEA for the following reasons:

- The pipeline route selection process has been given careful consideration to biophysical, socio-cultural and economic impacts;
- During the route selection process, the Project Team attempted to accommodate the biophysical and socio-economic concerns, derived from Specialist Investigations and consultation with landowners regarding land acquisition.
- Alternatives with regard to construction of the pipe bridge across the uMngeni River have been assessed which will have the least impact on the river / estuarine functional zone.
- A project-specific Draft Environmental Management Programme (EMPr) has been compiled according to *(but not limited to*) the impacts and mitigation measures included in this assessment. A more detailed EMPr must be submitted prior to the tender stage, which is inclusive of a Wetland Rehabilitation Plan and Plant Rescue, Relocation and Rehabilitation Plan, and conditions of the EA to the KZN DEDTEA for approval.
- The need and desirability of the project is attributed to the growth in demand for assured water supply for new developments and urbanization to the north-east of Durban. The proposed development falls within SIP 6 (Integrated Municipal Infrastructure Project)…"*Develop a national capacity to assist the 23 least resourced districts (17 million people) to address all the maintenance backlogs and upgrades required in water, electricity and sanitation bulk infrastructure".*
- In addition, the Phase 5: NAA Project also falls within SIP 18: Water and Sanitation Master Plan. The project will provide for new infrastructure to allow for a sustainable and assured supply of potable water in the region.
- The proposed development will also contribute to provide various employment opportunities to the local people with the Municipality.

The following mitigation measures are required for construction of the proposed pipe bridge:

- The area of construction activities must be kept to an absolute minimum and the construction site must be appropriately demarcated.
- All indigenous vegetation must be marked and avoided, as far as practicaly possible.
- The access route to the river edge must strictly follow the existing tracks and no deviations are permitted.
- In addition, repetitive or continuous movement of heavy construction machinery / plant should be limited in the river channel to reduce habitat destruction as well as the compaction of soils.
- While restoration of vegetation and estuarine habitats to pristine condition is virtually impossible, post-construction rehabilitation is essential to mitigate the negative impacts of construction activities and must be implemented as soon as possible.
- Given the designation of the uMngeni River and Estuary as a Critical Biodiversity Area, rehabilitation must be expanded to degraded areas beyond the construction site and maintained to assist and contribute to improving overall estuarine condition. The Contractor, Engineer, eThekwini Municiplaity Environmental Planning and Climate Protection Department (EPCPD) and Environmental Control Officer (ECO) must indentify the areas for rehabilitation. EWS must allocate sufficient funding in the project budget for the rehabilitation work.
- The instream construction of the piers should be undertaken in a phased approach whereby flow is only diverted around each construction node, as and when needed.
- Construction of the piers should preferably be undertaken during the dry winter months, when river input is naturally low, thereby reducing the risk of mass erosion of sediment from within the channel and exposed riverbanks.
- The site camp and ablution facilities must be positioned outside the Estuarine Functional Zone (EFZ)

and the 1:100 year floodline, and chemical toilets must be located away from stormwater culverts and drainage lines.
- Spillage of construction materials must be prevented, and a spill contingency plan must be developed as part of the Contractor's Construction Work Method Statements.

The following is recommended for stakeholder engagement:
- A comments and complaints register, accessible to members of public, should be implemented and maintained. Such a register would provide a formal framework within which to record any comments and complaints received, as well as to identify and action appropriate mitigation and/or remediation measures. The register should also include a means of recording and communicating the close-out of issues;
- Establish a Stakeholder Forum to ensure transparency in processes followed by EWS and to aid in the dissemination of information to disadvantaged community members, especially when operating in Avoca Hills;
- In order to mitigate most of the impacts highlighted in this report, EWS should consider the establishment of a Community Monitoring Forum (CMF) in order to monitor the construction phase and the implementation of the recommended mitigation measures. The CMF should be established before the construction phase commences, and should include key stakeholders, including representatives from local communities, local councillors (within the SIZ), affected landowners and the contractor(s);
- Engage with the local community representatives to dispense information relating to the project, possible employment opportunities and channels of communication (especially in terms of grievances);
- Engagement with community representatives, ward councillors and other existing community forums should be done to inform the general public about the project and project related impacts or opportunities;
- Public meetings or open days must be held to discuss traffic, dust, noise and construction related concerns with the community. These meetings should also provide information on project related impacts or opportunities;
- Local residents and land owners should inform mitigation measures when addressing any potential impact on cultural heritage sites or potential graves that may be exposed during excavation.

To ensure that identified negative impacts are minimised and positive impacts enhanced, the following clauses are recommended as conditions of the Environmental Authorisation:
- The EMPr is a legally binding document and the mitigation measures stipulated within the document and Basic Assessment Report must be implemented;
- An independent Environmental Control Officer (ECO) must be appointed to manage the implementation of the EMPr during the construction phase. Environmental Audit Reports must be compiled and made available for inspection;
- Continued offences of the EMPr on the part of the Contractor should be reported to the eThekwini Environmental Branch for further action;
- Any impact on surrounding or riparian vegetation must be rehabilitated. Where riparian vegetation is expected to be affected, ecologically significant plant material should be rescued from the site prior to construction beginning, to be utilised during rehabilitation;
- The working corridor through riparian areas must be as narrow as practically possible. i.e. machinery must utilise the same route through the systems at all times so as to avoid unnecessary disturbance to the riparian vegetation;
- Construction activities should commence during the winter months to minimise the impacts on breeding fauna, as far as practically possible;
- The construction corridormust be **as narrow as possible** in sensitive areas. No construction camps or storage areas should be placed within the construction corridor in sensitive areas;
- The operational phase servitude must be kept **as narrow as possible** in sensitive areas especially wooded drainage lines. Woody vegetation must be restored where possible;

- If individuals of any faunal species that cannot relocate themselves (e.g. burrowing animals) are encountered during construction, activities should cease until the individuals can be moved in an ecologically acceptable manner to a more suitable location. This should be undertaken by a faunal relocation expert;
- Removal and relocation of any species protected under the Natal Nature Conservation Ordinance No. 15 of 1974 will require a permit granted by the provincial conservation agency EKZNW;
- Areas which have been disturbed during construction should be rehabilitated with species naturally occurring in the study area, and the disturbed areas should be monitored quarterly to detect any alien plant species;
- During the operational phase, where possible, access to the proposed pipeline bridge over the uMngeni River should be restricted to the public;
- Where the pipeline is constructed within vegetated areas, it should follow within the footprint of existing pipelines, roads and/or track, as far as practically possible, rather than creating a new route through vegetated areas;
- Excavate wetland and riparian crossings in the winter months as this is the driest period for this region, as far as practically possible;
- The crossings of the riparian channels should be perpendicular to the direction of flow; as far as practically possible and in line with the final preferred route layout;
- The crossings should be designed to ensure that flow patterns along the stream/river channel are not altered or diverted potentially resulting in stream bank erosion;
- The crossings should be rehabilitated to ensure that no barriers exist within the stream and that in-stream habitat is similar to the natural situation;
- On steep slopes draining towards the identified freshwater ecosystems, small-scale diversion berms and or siltation nets should be constructed on the surface of the pipeline alignment to reduce the risk of the pipeline becoming a preferred surface flow path leading to erosion;
- “Trench-breakers”, which are in-trench barriers, should be installed along the length of the pipeline to minimise the interception and accumulation of water from the adjacent hillslope within the infilled trench;
- During installation, the excavated soil from the trench should be placed on the upslope side of the trench except in areas where it is not possible from an engineering perspective , minimizing the risk of excess sediment entering the downstream areas of the freshwater ecosystems;
- The pipeline alignment should be rehabilitated, with the wetland and riparian habitat at the crossing points being restored to near natural conditions. In addition, areas where disturbance adjacent to these ecosystems has occurred should also be rehabilitated. This should be done as soon as possible after the pipeline construction activities have ceased;
- In riparian areas, backfilling should occur as soon as possible, compact if possible and reshape river to original levels; and
- Where wetland and or riparian habitat is crossed, the top 50cm of seed containing topsoil should be kept separately from other soils in order to be utilised during rehabilitation. The remainder of the soil profile should also be placed back in-situ. Re-vegetation of disturbed areas must be undertaken with site indigenous species and in accordance with the instructions issued by the ECO. Areas where soil compaction or ruts developed should be rehabilitated.

The various mitigation measures as suggested by the environmental specialists i.e. Herpatofaunal specialist, faunal specialist, botanist, aquatic specialist, wetland ecologist, estuarine specialist, geohydrologist, soils specialist, traffic engineer, air quality specialist, noise specialist, heritage (built, cultural and palaeontologist) and social specialist have been included in the EMPr in Appendix F.

To ensure that identified negative impacts are minimised and positive impacts enhanced (Table 71), the mitigation measures in Sections F and the EMPr (Appendix F) must be implemented.

TABLE OF CONTENTS

ENVIRONMENTAL ASSESSMENT PRACTITIONER VII
SPECIALIST TEAM IX
EXECUTIVE SUMMARY XI
1 INTRODUCTION XI
2 BRIEF PROJECT DESCRIPTION XI
3 LOCATION OF THE PREFERRED PIPELINE ROUTE XII
4 KEY IMPACTS XII
5 PROJECT ALTERNATIVES XIV
6 CONCLUSIONS AND RECOMMENDATIONS XVI
TABLE OF CONTENTS XX
LIST OF FIGURES XXIV
LIST OF TABLES XXIV
LIST OF ABBREVIATIONS AND ACRONYMS XXVII
GLOSSARY OF TERMS XXXII
SECTION A: INTRODUCTION 1
A-1 DESCRIPTION OF PROPOSED ACTIVITY 1
A-1.1 Locality 1
A-1.2 Route Determination Process 1
A-1.2.1 Alternative Route 1 4
A-1.2.2 Alternative Route 2 4
A-1.2.3 Alternative Route 3 5
A-1.2.4 Alternative Route 6 6
A-1.3 Details of Re-Alignments / Deviations along Alternative Route 1 7
A-1.3.1 Deviation 1 7
A-1.3.2 Deviation 2a 9
A-1.3.3 Deviation 2b 10
A-1.3.4 Deviation 2c 10
A-1.3.5 Deviation 3 11
A-1.3.6 Deviation 4 12
A-1.3.7 Deviation 5 12
A-1.3.8 Deviation 6 13
A-1.3.9 Deviation 7 14
A-1.4 Description of the Preferred Route Alignment 16
A-1.5 Technical Details 18
A-1.5.1 Project Phases 18
A-1.5.2 Construction Phase 18
A-1.5.3 Operational Phase 23
A-1.5.4 Decommissioning of the Pipeline 23
A-1.6 Capacity Building 24
A-2 LEGAL REQUIREMENTS APPLICABLE TO THIS APPLICATION 24
A-2.1 NEMA and the Environmental Impact Assessment Regulations 24
A-2.2 National Water Act, 1998 (Act No. 36 of 1998) 30
A-2.3 Other Legal Requirements 30

A-2.3.1 Acts *30*
A-2.3.2 National and Provincial Policies and/or Guidelines *32*
A-2.3.3 Local Policies and/or Guidelines *33*
A-3 DETAILS OF THE APPLICANT **37**
A-4 NEED AND DESIRABILITY OF THE PROJECT **37**
A-5 NEED AND DESIRABILITY OF THE PROJECT IN RELATION TO ITS LOCATION **37**
SECTION B: THE RECEIVING ENVIRONMENT **39**
B-1 BIOPHYSICAL ENVIRONMENT **39**
B-1.1 Geology 39
B-1.1.1 Natal Group *39*
B-1.1.2 Dwyka Group *40*
B-1.1.3 Ecca Group *40*
B-1.2 Soils and Agricultural Potential 40
B-1.3 Hydrology 43
B-1.3.1 Geohydrology *43*
B-1.3.2 Wetland and Riparian Habitats *45*
B-1.3.3 Aquatic Environment *51*
B-1.3.4 Estuarine Assessment *52*
B-1.4 Climate 57
B-1.5 Flora 57
B-1.6 Fauna 58
B-1.7 Herpetofauna 59
B-1.7.1 Site characteristics and Habitat Diversity and Quality *59*
B-1.7.2 Summary of findings *63*
B-2 SOCIAL ENVIRONMENT **63**
B-2.1 Demographic Conditions 63
B-2.1.2 Dwelling Types *64*
B-2.1.3 Employment Statistics *68*
B-2.2 Built and Cultural Heritage 68
B-2.2.1 Site 1: S 29° 44' 52.9"E 31° 00' 33.4" *68*
B-2.2.2 Site 2: S 29° 45' 54.8" and E 30° 59' 58.3" *70*
B-2.2.3 Additional observations *71*
B-2.3 Palaeontological Overview and Findings 71
B-2.4 Traffic Management 71
B-2.4.1 Existing road geometry *72*
B-2.5 Air Quality 75
B-2.5.1 Pollutants of concern *75*
B-2.5.2 Sensitive Receptors (SR's) *76*
B-2.5.3 Construction Phase Assessment *78*
B-2.6 Noise 82
B-2.6.1 Project Standards *82*
B-2.6.2 Impact Assessment Methodology *83*
B-2.6.3 Baseline Noise Survey *84*
SECTION C: BASIC ASSESSMENT (BA) PROCESS **92**
C-1 APPROACH TO THE BA PROCESS **92**
C-2 GUIDING PRINCIPLES FOR A BA PROCESS **92**
C-3 BASIC ASSESSMENT TECHNICAL PROCESS **93**

C-3.1 EIA Enquiry Meeting 93
C-3.2 Application for Authorization 93
C-3.3 Information Gathering 93
C-3.4 Specialist Studies 93
C-4 PUBLIC PARTICIPATION PROCESS 93
C-4.1 Identification of Interested and Affected Parties 94
C-4.2 Public Announcement of the Project 94
C-4.3 Site Notices 94
C-4.4 Newspaper Advertisements 95
C-4.5 Distribution of the Background Information Document (BID) 95
C-4.6 Initial Meetings per Ward with Local Leadership 95
C-4.7 Database of Registered Interested and Affected Parties 96
C-4.8 Proposed Public Open Days 96
C-4.9 Basic Assessment Report for Public Review 96
SECTION D: ASSESSMENT CRITERIA 98
D-1 IMPACT IDENTIFICATION AND ASSESSMENT 98
D-1.1 Assessment Procedure: Proposed Impact Assessment Methodology 98
D-1.2 Integration of Specialist's Input 101
D-1.3 Mitigation Measures 102
D-1.4 Approach to the Assessment of Cumulative Impacts 102
D-1.4.1 Steps in Assessing Cumulative Impacts 102
D-1.4.2 Determining the Extent of Cumulative Impacts 103
D-1.4.3 Describing the Affected Environment 103
D-1.4.4 Assessment of Cumulative Impacts 103
SECTION E: ALTERNATIVES 104
E-1 IDENTIFICATION OF ALTERNATIVES 104
E-1.1 Location Alternatives 104
E-1.2 Alternatives for Crossing the uMngeni River 105
E-1.3 No Development Alternative 109
SECTION F: ASSESSMENT OF IMPACTS 110
F-1 IDENTIFIED IMPACTS 110
F-1.1 Proposed construction of the pipe bridge across the uMngeni River during the construction phase 110
F-1.1.1 Biophysical Impacts 110
F-1.2 Proposed construction of the pipeline 110
F-1.2.1 Biophysical Impacts 110
F-1.2.2 Social Impacts 110
F-1.3 Proposed Pipe Bridge across the uMngeni River during the operational phase 111
F-1.3.1 Biophysical Impacts 111
F-1.4 Proposed Pipeline during the operational phase 111
F-1.4.1 Biophysical Impacts 111
F-2 IDENTIFIED CUMULATIVE IMPACTS 111
F-3 IMPACT ASSESSMENT: CONSTRUCTION PHASE FOR THE PROPOSED PIPE BRIDGE ACROSS THE UMNGENI RIVER 112
F-3.1 Biophysical Environment 112
F-3.1.1 Vegetation and faunal habitat destruction 112
F-3.1.2 River flow modification 113

F-3.1.3 Riverbank modification and edge hardening 114
F-3.1.4 Increased erosion, turbidity and siltation 116
F.3.1.5 Decreased water quality of the uMngeni River 117
F-3.1.6 Increased sedimentation 118
F-3.1.7 Impact on fauna through increase ambient noise levels 120
F-3.1.8 Impact on water and soil quality 121
F-4 IMPACT ASSESSMENT: CONSTRUCTION PHASE FOR THE PROPOSED PIPELINE 122
F-4.1 Biophysical Environment 122
F-4.1.1 Increased Soil Erosion and Sedimentation 122
F-4.1.2 Surface and ground water contamination 123
F4.1.3 Destruction of natural vegetation including threatened and/or protected floral species and associated habitat 125
F-4.1.4 Spread of alien invasive plant species 126
F-4.1.5 Destruction and fragmentation of natural faunal habitat 127
F-4.1.6 Disturbance to areas containing natural habitat and fauna 128
F-4.1.7 Destruction of wetland and riparian habitat through reshaping and construction activities of the pipeline within the direct vicinity of wetland habitat 129
F-4.2 Socio-economic Environment 132
F-4.2.1 Increase in ambient dust levels and air emissions 132
F-4.2.2 Increase in ambient noise levels 133
F-4.2.3 Visual Impact of construction activities on visual receptors 135
F-4.2.4 Effect of temporary workers on social dynamics 136
F-4.2.5 Access of land due to servitude 137
F-4.2.6 Impact of Socio-cultural processes 138
F-4.2.7 Impact on Health and Social Well-being 140
F-4.2.8 Impact on localised traffic 141
F-4.2.9 Impacts on heritage resources 143
F-4.2.10 Temporary job creation and supply of local material 145
F-4.2.11 Emancipatory and empowerment processes / Capacity Building and Skills Transfer 147
F-5 IMPACT ASSESSMENT: OPERATIONAL PHASE FOR PIPE BRIDGE ACROSS THE UMNGENI RIVER 148
F-5.1 Biophysical Environment 148
F-5.1.1 Modified flow, erosion and deposition patterns 148
F-6 IMPACT ASSESSMENT: OPERATIONAL PHASE FOR THE PROPOSED STEEL PIPELINE 149
F-6.1 Biophysical Environment 149
F-6.1.1 Impact of erosion 149
F-6.1.2 Impact on water resources 150
F-6.1.3 Disturbance to fauna and faunal habitat during maintenance 151
F-6.1.4 Spread of alien invasive plant species 152
F-6.1.5 Habitat degradation and fragmentation 153
F-7 CUMULATIVE IMPACTS 154
F-7.1.1 Increased traffic during the construction phase 154
F-7.1.2 Destruction of natural vegetation within D'MOSS areas 154
F-7.1.3 Soil erosion and sedimentation 155
F-7.1.4 Potential destruction of wetland and riparian areas 156

F-7.1.5 Access to water through implementation of the Northern Aqueduct Phase 5 Project 157
F-8 IMPACT ASSESSMENT: DECOMMISIONING PHASE 157
SECTION G: CONCLUSIONS AND RECOMMENDATIONS 158
G-1 SUMMARY OF THE KEY FINDINGS OF THE BASIC ASSESSMENT 158
G-2 EAP'S RECOMMENDATION 161
SECTION H: REFERENCES 164
SECTION I: APPENDICES 166

LIST OF FIGURES

Figure 1: Locality Map of the Alternative Pipeline Routes 3
Figure 2: Deviation 1 8
Figure 3: Deviation 2a, 2b and 2c 9
Figure 4: Deviation 3 11
Figure 5: Deviation 4 12
Figure 6: Deviation 5 13
Figure 7: Deviation 6 14
Figure 8: Deviation 7 15
Figure 9: Locality Map of the proposed pipeline route 17
Figure 10: Proposed Pipeline Route in relation to the D'MOSS areas 36
Figure 11: Geology of the study area (Pipeline in yellow) 39
Figure 12: Location of 7 areas along the route with some Herpatofaunal species could occur 60
Figure 13: Access to toilets 65
Figure 14: Access to water 66
Figure 15: Spatial Representation of Water Sources 67
Figure 16: General view of the discard heap on which the three stone artefacts were identified. 69
Figure 17: The three lithics identified at the site 69
Figure 18: General view of the church with the rectangular building on the left and the area demarcated with white stones evident on the right. 70
Figure 19: Locations of Sensitive Receptors along the Proposed Pipeline Route 76
Figure 20: Locations of Sensitive Receptors at the Eastbury Pipe Yard 77
Figure 21: Locations of Sensitive Receptors at the Ottawa Pipe Yard 77
Figure 22: Description of bio-physical assessment parameters with its respective weighting 100
Figure 23: The identification of Cumulative Impacts 111

LIST OF TABLES

Table 1: Project Team Members vii
Table 2: Contact Details of Environmental Assessment Practitioner viii
Table 3: Specialist Team Members ix
Table 4: Advantages and Disadvantages of Alternative Route 1 4
Table 5: Advantages and disadvantages of Route 2A 5
Table 6: Advantages and disadvantages of Route 2B 5
Table 7: Advantages and disadvantages of Route 3 6
Table 8: Advantages and disadvantages of Route 6 7

Table 9: Operation Schedule for the Pipe Yards 19
Table 10: Soil conditions along the pipeline route 41
Table 11: Wet-Health scores for HGM 1 48
Table 12: Wet-Health scores for HGM 2 48
Table 13: Wet-Health scores for HGM 3 49
Table 14: Wet-Health scores for HGM 4 49
Table 15: Wet-Health scores for HGM 5 49
Table 16: Ecological Importance and Sensitivity scores for wetlands 50
Table 17: Estuary protection status and importance, and the basis for assigning a recommended ecological reserve category 55
Table 18: Type and extent of estuarine habitats in the uMngeni Estuary 56
Table 19: Potential occurrence of Important Herpatofaunal Communities or Species 60
Table 20: Rare and threatened amphibians occurring or likely to occur within the broader study area. (EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient) 61
Table 21: Rare and threatened reptiles occurring or likely to occur within the broader study area. (EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient) 62
Table 22: Employment Status 68
Table 23: Service Volumes for Urban Streets 73
Table 24: Locations of Sensitive Receptors 77
Table 25: Construction Equipment Inventory 79
Table 26: Emissions Associated with the Construction Phase 79
Table 27: Summary Dust and PM10 Risk Table to Define Site-Specific Mitigation 81
Table 28: Typical Rating Levels for Noise in Districts 82
Table 29: Categories of Community or Group Response 83
Table 30: Noise Limits for Construction Noise 84
Table 31: Baseline Noise Measurement Locations and Associated Noise Levels 85
Table 32: Construction Equipment Inventory 86
Table 33: SANS 10103 Day Time Assessment Results 87
Table 34: Construction Noise Levels at Sensitive Receptors (Project in Isolation) 89
Table 35: Example of an Impact Table 101
Table 36: Comparative Assessment of Alternatives for crossing the uMngeni River 106
Table 37: Vegetation and faunal habitat destruction 112
Table 38: River flow modification 114
Table 39: Riverbank modification and edge hardening 115
Table 40: Increased erosion, turbidity and siltation 116
Table 41: Decreased water quality 117
Table 42: Increased sedimentation 118
Table 43: Impact on fauna through increased noise levels 120
Table 44: Impact on water and soil quality 121
Table 45: Soil erosion and silting of the drainage lines 122
Table 46: Surface and ground water contamination 123
Table 47: Destruction of natural vegetation and associated habitat 125
Table 48: Spread of alien invasive plant species 126
Table 49: Destruction and fragmentation of natural faunal habitat 127
Table 50: Disturbance to areas containing natural habitat and fauna 128
Table 51: Destruction of wetland and riparian habitat through reshaping and construction activities of the pipeline within the direct vicinity of the wetland habitat 129
Table 52: Increase in ambient dust levels and air emissions 132

Table 53: Increase in ambient noise levels 134
Table 54: Change of visual character of the area 135
Table 55: Effect of temporary workers on social dynamics 136
Table 56: Access of land due to servitude 137
Table 57: Unacceptable social behavior 139
Table 58: Impact on health and social well-being 140
Table 59: Impact on localised traffic 142
Table 60: Impacts on heritage resources 144
Table 61: Modified flow, erosion and deposition patterns 148
Table 62: Impacts of erosion 149
Table 63: Impact on water resources 150
Table 64: Disturbance to fauna and faunal habitat during maintenance 151
Table 65: Spread of alien invasive plant species 152
Table 66: Habitat degradation and fragmentation 153
Table 67: Increased traffic during construction 154
Table 68: Destructions of natural habitat within the D'MOSS areas 155
Table 69: Soil erosion and sedimentation 155
Table 70: Potential Destruction of wetland and riparian areas 156
Table 71: Summary of the significance of identified impacts without and with mitigation measures 160

LIST OF ABBREVIATIONS AND ACRONYMS

ASAPA	Association of Southern African Professional Archaeologists
ASGISA	Accelerated Shared Growth Initiative for South Africa
BA	Basic Assessment
BAR	Basic Assessment Report
BAS	Best Attainable State
BBBEE	Broad Black-Based Economic Empowerment
BID	Background Information Document
BNML	Baseline Noise Measurement Locations
BS	British Standard
CBA	Critical Biodiversity Area
CP	Cathodic protection
CMF	Community Monitoring Forum
CR	Critical Endangered
CRM	Cultural Resources Management
CRR	Comments and Responses Report
DAFF	Department of Agriculture, Forest and Fisheries
DD	Data Deficient
DEA	Department of Environmental Affairs
DGC	Durban Green Corridor
D'MOSS	Durban Metropolitan Open Space System
DoT	Department of Transport
DUCT	Duzi uMngeni Conservancy Trust
DWS	Department of Water and Sanitation

EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
ECSA	Engineering Council of South Africa
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EIS_1	Ecological Importance and Sensitivity
EIS_2	Estuarine Importance Score
EKZNW	Ezemvelo KwaZulu-Natal Wildlife
eM	eThekwini Municipality
EMPr	Environmental Management Programme
EN	Endangered
EPCPD	Environmental Planning and Climate Protection Department
ETA	eThekwini Transport Authority
EWS	eThekwini Water and Sanitation
FEPA	Freshwater Ecosystem Priority Areas
GA	General Authorisation in terms of Section 39 of the NWA
GN	Government Notice
ha	Hectares
HDD	Horizontal Directional Drilling
HDI	Human Development Index
HDSAs	Historical Disadvantaged South Africans
HIA	Heritage Impact Assessment

HIV/AIDS	Human immunodeficiency Virus/Acquired Immune Deficiency Syndrome
I&APs	Interested and Affected Parties
IAP2	International Association for Public Participation
IAQM	Institute of Air Quality Management
IDP	Integrated Development Plan
IEM	Integrated Environmental Management
IRP	Integrated Resource Plan
IWULA	Integrated Water Use Licence Application
KDC	KwaZulu-Natal Dwarf Chameleons
km	Kilometre
KZN	KwaZulu-Natal
KZN DEDTEA	KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs
KZNSCP	KwaZulu-Natal Systematic Conservation Plan
LCC	Land Capability Class
LED	Local Economic Development
m	metres
MAR	Mean Annual Runoff
ME	Mitigation Efficiency
mm	Millimetres
NAA	Northern Aqueduct Augmentation Project
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEMBA	National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004)
NEMPAA	National Environmental Management Protected Areas Act, 2003 (Act No. 57of 2003)
NFEPA	National Freshwater Ecosystem Priority Areas
NHRA	National Heritage Resources Act, 1999 (Act No. 25 of 1999)

NSBA	National Spatial Biodiversity Assessment
NR	Nature Reserve
NT	Near threatened
NWA	National Water Act, 1998 (Act No. 36 of 1998)
OHS	Occupational Health and Safety
PES	Present Ecological State
PGS	Professional Grave Solutions
PIA	Palaeontological Impact Assessment
POD	Public Open Day
PSEDS	Provincial Spatial Economic Development Strategy
PRRRP	Plant, Rescue, Relocation and Rehabilitation Plan
QDGC	Quarter Degree Grid Cell
QDS	Quarter Degree Squares
RD	Red Data
RDP	Reconstruction and Development Programme
REC	Recommended Ecological Category
SACNASP	South African Council for Natural Scientific Professionals
SANAS	South African National Accreditation System
SANBI	South African National Biodiversity Institute
SANRAL	South African National Roads Agency SOC (Ltd)
SANS	South African National Standards
SAPD	South African Police Department
SASA	Sociology Association of South Africa
SEF	Strategic Environmental Focus (Pty) Ltd
SDF	Spatial Development Framework

SIZ	Social Impact Zone
SMME's	Small, Medium and Micro Enterprises
SR's	Sensitive Receptors
TMP	Traffic Management Plan
UEC	uMngeni Estuary Conservancy
UK	United Kingdom
USEPA	Unites States Environmental Protection Agency
VIA	Visual Impact Assessment
VU	Vulnerable
WF	Weighting Factor
WM	With Mitigation Measures
WOM	Without Mitigation Measures
WUL	Water Use License
WULA	Water Use License Application
WWTW	Waste Water Treatment Works

GLOSSARY OF TERMS

Applicant	Any person who applies for an authorisation to undertake an activity or to cause such activity to be undertaken as contemplated in sections 24(5), 24M and 44 of the National Environmental Management Act, 19998 (Act No. 107 of 1998).
Ecology	The study of the interrelationships between organisms and their environments.
Environment	The surroundings within which humans exist and that are made up of – (i) the land, water and atmosphere of the earth; (ii) micro-organisms, plant and animal life; (iii) any part or combination of (i) and (ii) and the interrelationships among and between them; and (iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing.
Environmental Impact Assessment	Systematic process of identifying, assessing and reporting environmental impacts associated with an activity and includes basic assessment and S&EIR.
Environmental Management Programme	A working document on environmental and socio-economic mitigation measures, which must be implemented by several responsible parties during all the phases of the proposed project.
Interested and Affected Party	Any person or groups of persons who may express interest in a project or be affected by the project, positively or negatively.
Key Stakeholder	Any person who acts as a spokesperson for his/her constituency and/or community/organization, has specialised knowledge about the project and/or area, is directly or indirectly affected by the project or who considers himself/herself a key stakeholder.
Stakeholder	Any person or group of persons whose live(s) may be affected by a project.
Study Area	Refers to the entire study area encompassing all the alternatives as indicated on the study area or locality map.
Succession	The natural restoration process of vegetation after disturbance.
State Department	Any department or administration in the national or provincial sphere of government exercising functions that involve the management of the environment.

SECTION A: INTRODUCTION

Strategic Environmental Focus (Pty) Ltd (SEF) has been appointed by the eThekwini Water and Sanitation (EWS) Department to undertake the Basic Assessment (BA) process for the proposed Northern Aqueduct Augmentation Phase 5 project within the eThekwini Municipality in KwaZulu-Natal.

A-1 DESCRIPTION OF PROPOSED ACTIVITY

A-1.1 Locality

The proposed project is to be undertaken along the north central portion of the eThekwini Municipality boundary, province of KwaZulu-Natal. The ± 12km Northern Aqueduct Augmentation Phase 5 pipeline is proposed to extend from the proposed tie-in point on Pridley Road in Reservoir Hills (at the existing valve and metre chamber) and ending at the proposed tie-in point to the Phase 4 Northern Aqueduct Augmentation at the blank flange on Duffs Road, KwaMashu with gravity-fed potable water. The project will therefore be constructed mainly through road reserve and other servitudes, dense urban areas, D'MOSS areas and valley lines.

The proposed pipeline route occurs within the following wards *viz*, Ward 23 (Reservoir Hills), Ward 37 (Newlands West), Ward 11 (Newlands East), Ward 34 (Riverhorse Valley) and Ward 102 (Quarry Heights, Avoca Hills, Duffs Road).

The co-ordinates of the proposed pipeline route at 250m intervals starting at Pridley Road and ending at Duffs Road are provided in Appendix A1. The 21 Surveyor General (SG) code and the description of the directly affected properties is provided in Appendix A2.

Refer to the route plan map in Appendix A3, which illustrates the existing infrastructure such as water pipelines, gas pipelines, electrical powerlines, servitudes etc in relation to the proposed pipeline route.

A-1.2 Route Determination Process

Prior to the environmental investigations, the Design Engineers, Bosch Stemele undertook a Preliminary Routing Site Selection to determine an optimal route for the proposed Northern Aqueduct Augmentation Phase 5 Project. The various route options that were considered are discussed in the following report: Northern Aqueduct Augmentation Phase 5: Durban Heights to Duffs Road Steel Pipeline: Preliminary Routing Report prepared by Bosch Stemele – January 2015 (see Appendix A4).

There are numerous criteria to be considered when determining a pipeline route. The key engineering criteria are those surrounding the purpose of the pipeline. In this instance, the Northern Aqueduct Augmentation Phase 5 Project is to provide a new gravity bulk water supply pipeline from Durban Heights Waterworks in Reservoir Hills to the tie-in chambers in Duffs Road to ensure sufficient supply of water in the northern areas of Durban.

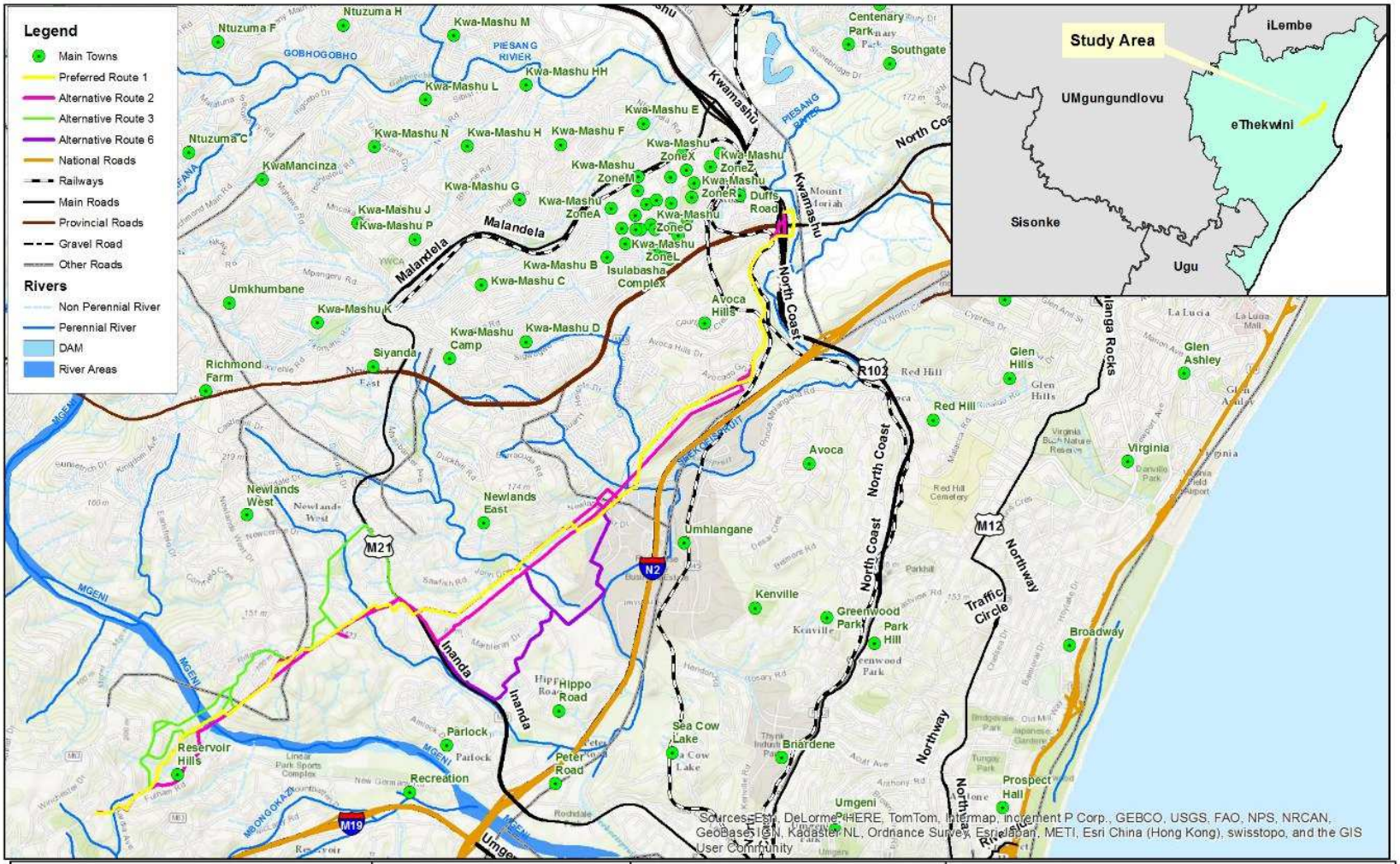
The connection of these points, taking into consideration gravity, altitude and available pressure presented engineers with the first rudimentary alignment options. However, many more requirements have been considered to refine these alignment options into a preliminary route. When connecting the reservoirs, waterworks, tie-in chambers and blank flange, it is important that the route follow existing eThekwini Water and Sanitation (EWS) servitudes, and where this is not practically possible, it is to make use of existing road reserves, rail or service infrastructure (e.g. Eskom) servitudes to reduce land acquisition requirements. Where existing servitudes cannot be used, new servitudes will have to be purchased, and these are to have a minimal impact on private property and both buried and above-ground services. New servitudes through private property are to follow cadastral boundaries, where possible thereby minimising the fragmentation of land. Access to use existing servitudes must be approved by the relevant service providers.

Further to this, the pipeline route is to be easily accessible for construction, maintenance and servicing of the pipe, and is to be optimally cost effective to construct. Physical factors such as geology, topography and land use have been considered in addition to the factors above, as well as environmental issues such as the Durban Metropolitan Open Space System (D'MOSS). The recommendations of the Preliminary Routing Report have been used as a basis for the choice of the 'preferred route'. The general alignment of the 'preferred route' is described in Section A-1.2.1 below.

Alternative Routes 1, 2, 3, 4, 5 and 6 were investigated. However, Alternative Route 4 was considered a fatal flaw and not investigated further as it would have traversed Mount Batten Drive in Reservoir Hills, which is the main road to the suburb, and would therefore be very disruptive in terms of traffic flow during construction. In addition, this route would have followed the N2 (north) and with future plans to extend the N2, this was another contributing factor which made the route unfeasible. Therefore, a detailed discussion of this route is not relevant.

Alternative Route 5 was also not considered feasible as it would entail construction along Dumisane Makhaye Drive, which will be upgraded for the eThekwini Bus Rapid Transit (BRT) Project. Construction associated with this route would have been highly disruptive to traffic and thus considered a fatal flaw. Therefore, a detailed discussion of this route is not relevant.

Alternative routes 1, 2, 3 and 6 were presented as the project proposal for the environmental investigations in January 2015 - April 2015 (refer to the route maps of the alternative routes in Appendix A4 and Figure 1). The eThekwini Municipality indicated that the engineering team appointed to carry out the detailed design of the Northern Aqueduct Augmentation Phase 5 Project, were required to adjust the preliminary route design to accommodate key environmental and social concerns, and issues that arise during the environmental investigations. Alternative alignment options for portions of the route were therefore considered and are described in the paragraphs that follow.



505904 Northern Aqueduct Phase 5 **Locality Map**	Source of Information Source of Information: Municipal Boundaries (Planet GIS: 2011) Roads: CDSM 2009	N 1:50 000 0 0.5 1 2 km	Map Produced by: S · E · F STRATEGIC ENVIRONMENTAL FOCUS Date: April 2015

Figure 1: Locality Map of the Alternative Pipeline Routes

A-1.2.1 Alternative Route 1

The pipeline route commences at the tie-in chamber on Pridley Road in Reservoir Hills, from where it follows Pridley Road and crosses Mount Batten Drive, down to Battersea Avenue. It then enters the D'MOSS area and proceeds along the back of the residential cadastral boundary located on Battersea Avenue and Middlemiss Crescent, from where it descends into the uMngeni Valley. A new bridge will be constructed across the uMngeni River and the proposed pipeline will be installed on the new bridge structure. The pipeline route will continue across the opposite bank of the uMngeni River and then proceeds along the back of the residential cadastral boundary located on various roads in the Hillgrove area. Still within the D'MOSS area, the route crosses Newlands West Drive traversing open space up to Sooklall Drive. The route then follows Sooklall Drive for approximately 250m and traverses through another D'MOSS area to reach the M21 (Inanda Road).

The route then continues along Inanda Road for approximately 215m before it deviates along Marble Ray Drive for approximately 430m. The pipeline route then runs parallel to the overhead power line servitude for roughly 4km, crossing John Dory Drive twice, Mackerel Avenue, Musa Dladla Drive (formerly Newlands East Drive), Queen Nandi Drive and Hippopark Avenue.

The route then deviates from the electrical servitude at Sweetpea Close to follow in parallel to the two existing northern aqueduct pipelines and Metro Railway Line for approximately 700m along the back of Avoca Hills, and then crosses the Metro Railway Line. The Pipeline then continues in parallel to the two existing northern aqueduct pipelines and the Transnet Railway Line for approximately 900m. The pipeline then crosses the Transnet Railway Line, Lark Road, the M25 (Curnick Ndlovu Highway) and the M577 (Dumisani Makhaye Drive) to reach the Duffs Road tie-in chambers.

The length of the route is 11,42km.

Table 4: Advantages and Disadvantages of Alternative Route 1

Advantages	Disadvantages
Shortest route from Durban Heights to Duffs Road.	Pipeline route traverses D'MOSS areas of high ecological sensitivity i.e. close canopy woodland / forest (Reservoir Hills) and wooded grassland (Hillgrove area).
Most direct route, reduced number of horizontal bends required.	Pipeline route also traverses perennial and non-perennial drainage lines.
Minimal traffic disruption. Minimal road rehabilitation and services relocation required.	
Easiest pipeline access for future maintenance and operation, and greater flexibility when routing through open spaces.	
Fewer landowners/households affected by the route alignment, therefore reduction in servitude acquisition.	
Most optimal route in terms of the Herpatofaunal Assessment. However, the construction corridor must be kept as close as possible to the edge of the built-up area in Avoca Hills, Quarry Heights and the closed canopy woodland / forest area in Reservoir Hills.	

A-1.2.2 Alternative Route 2

Route 2 follows the preferred route (Route 1) to Inanda Road (M21) with the exception of a portion of the pipeline traversing along the edge of the D'MOSS area in Reservoir Hills. Here the portion of Route 2 from Battersea Avenue follows the back of the residential cadastral boundary along Fulham Road on the right of the D'MOSS open space area, whereas Route 1 follows the cadastral to the left.

At Inanda Road, Route 2 then splits into two alternative route options, namely Route 2A which follows Inanda Road (M21) north up to Dumisani Makhaye Drive, and Route 2B which follows Inanda Road south to the overhead electrical cables. Route 2B then follows Route 1 to the right of the overhead power lines where it then joins Route 1 at the end of Sweetpea Close.

Route 2A follows Inanda Road north up to Dumisani Makhaye Drive. However, the M21 (Inanda Road) is in the process of being re-aligned and there is, at present, very little room to locate a 1200mm diameter steel pipeline along this road. Dumisani Makhaye Drive is also currently under construction to incorporate the Bus Rapid Transit (BRT), therefore space to include a 1200mm diameter steel pipeline along Dumisani Makhaye Drive is extremely limited. This section of Route 2A was therefore considered not feasible.

The length of Route 2A is 12,22km and Route 2B is 11.66km.

Table 5: Advantages and disadvantages of Route 2A

Advantages	Disadvantages
Easy pipeline access for future pipeline operation and maintenance	Re-alignment of M21 (Inanda Road) is required. There is minimal space for installation of a 1 200mm diameter steel pipeline.
	The BRT construction on Dumisane Makhaye Drive (MR 577) – limited space for installation of 1 200mm diameter steel pipeline.
	From an ecological perspective, the route goes through the closed canopy woodland behind Juba Place and Fulham Road, impacting on the vegetation and fauna in this area.
	In the Hillgrove area, the pipeline traverses the largest portion of the drainage line and the wooded grassland thereby impacting on the loss of biodiversity.
	The route traverses private land that is earmarked for development behind Hadley Grove in the Newlands East area.
	The route occurs within the M25 road reserve, which is earmarked for future road widening by the Department of Transport.

Table 6: Advantages and disadvantages of Route 2B

Advantages	Disadvantages
Most direct route, reduced number of horizontal bends required.	From an ecological perspective, the route goes through the closed canopy woodland / forest behind Juba Place and Fulham Road, impacting on the vegetation and fauna in this area.
The route will have minimal disruption to traffic. Therefore, there will be minimal road rehabilitation.	Additional cathodic protection mitigation is required for the steel pipeline laid alongside electrical power line (3.6km) and railway line (1.6km).
Easier pipeline access for future pipeline operation and maintenance, and greater flexibility when routing through open spaced.	
Fewer landowners/households affected by the route alignment, therefore reduction in servitude acquisition.	

A-1.2.3 Alternative Route 3

Route 3 follows Route 1 and Route 2 down Battersea Avenue but continues along Battersea Avenue and Middlemiss Crescent to the end of the road. Route 3 then crosses the uMngeni River further north of where the proposed Route 1 and Route 2 crosses the river, and then follows the valley line up the hill along the back of the residential cadastral boundaries located on Limehill Crescent.

From the top of the ridge Route 3 then crosses Newlands West Drive to proceed in parallel with the overhead power cables all the way to Duffs Road in KwaMashu.

Where the overhead powerlines traverse through densely populated areas, Route 3 deviates along Dumisani Makhaye Drive for approximately half a kilometre. However, Dumisani Makhaye Drive is currently under construction for the implementation of the new BRT system, subsequently there is very little room at present to install a 1200mm diameter steel pipeline along this road.

The length of the route is 11,6km.

Table 7: Advantages and disadvantages of Route 3

Advantages	Disadvantages
The route will have minimal disruption to traffic. Therefore, there will be minimal road rehabilitation.	Disruptions to traffic and buried/ existing services will occur where pipeline is located along narrow residential roads.
Easier pipeline access for future pipeline operation and maintenance, and greater flexibility when routing through open spaced.	BRT Construction on Dumisani Makhaye Drive – minimal space for location of 1200mm diameter steel pipeline
Fewer landowners/households affected by the route alignment, therefore reduction in servitude acquisition.	Additional cathodic protection mitigation is required for steel pipeline laid alongside electrical power line (1.9km)
	The route occurs on municipal roads in residential areas where existing water and sewer pipelines occur. In addition, these roads are narrow and will be disruptive to the residents.
	The route occurs in the vicinity of the Narainsamy Hindu Temple in Newlands East, which is formally declared as a Provincial Heritage Site.
	The route is long and will entail construction work within the channelled valley bottom wetland and riparian channel in the Hillgrove area.
	Construction along Hillgrove Drive will be disruptive as it is the main road in Newlands West.
	In the Newlands East area, the pipeline route will be very disruptive as it will be taken along Newlands West Drive, Newcentre Drive and Inanda Road which are main roads. Furthermore, Inanda Road will be widened as a result of the Ethekwini BRT and services installation on the newly constructed road will incur additional costs for repairs.
	Potential breeding habitat present for the Natal Leaf-Folding Frog, Spotted Shovel Nosed Frog, Pickersgill Reed Frog, Powers Reed Frog and Black Headed Dwarf Chameleon, 50m – 150m from a Portion of Alternative Route 3.

A-1.2.4 Alternative Route 6

Route 6 follows Route 1 up to the M21 (Inanda Road). It then follows Alternative Route 2 on Inanda Road for 372m. It continues to follow Inanda Road for 900m, then turns right along Bargreen Place and proceeds through residential areas of Newlands East along Barvale Road, Hippo Road, Yellowfin Crescent, turning right following the back of cadastral boundaries on Tiburon Place, crossing an open space area. The route skirts around the edge of cadastral boundaries at the Riverhorse Business Estate to join with Alternative Route 2 adjacent to existing powerlines opposite Mackerel Avenue.

Alternatively, Route 6 skirts around the back of the Riverhorse Business Estate at the back of Riverhorse Road, through open space areas and then joins with Alternative Route 1 after traversing Musa Dladla Road for 115m.

The length of the route is 13.8km.

Table 8: Advantages and disadvantages of Route 6

Advantages	Disadvantages
The pipeline route avoids the existing powerlines.	The route would require realignment of the M21 (Inanda Road) since there is minimal space for installation of 1 200mm diameter steel pipeline. In addition, Inanda Road will be used as a BRT in the future and construction work will be disruptive to flow of traffic.
There is greater flexibility when routing through open spaces behind industrial areas.	Will require excavating tarred roads. The residential roads are narrow and have existing buried services.
	This is the longest route and most costly to construct.
	There will be additional traffic impacts as a result of construction at the Riverhorse Valley Business Estate.
	This route traverses a cemetery behind the Riverhorse Valley Business Estate.
	Potential breeding habitat present for the Natal Leaf-Folding Frog, Spotted Shovel Nosed Frog, Pickersgill Reed Frog, Powers Reed Frog and Black Headed Dwarf Chameleon, 50m – 150m from a Portion of Alternative Route 6.

The outcome of the comparative assessment undertaken for the route determination process as describe above, culminated in Alternative Route 1 being the most preferred route in comparison to Alternative Routes 2, 3 and 6. Therefore, Alternative Route 1 was taken forward for further specialist assessment from a biophysical, socio-economic and cultural perspective.

A-1.3 Details of Re-Alignments / Deviations along Alternative Route 1

The majority of the proposed pipeline route follows the edge of cadastral boundaries, adjacent to existing services such as electrical servitudes and existing water mains, as far as practicably possible. Due to the built up nature of the surrounding project area, this was the only route identified for the proposed pipeline from an engineering perspective, and which would have the least environmental and social implications.

However, along various sections of the pipeline route, seven site deviations or realignments to the proposed route were identified, taking into consideration social, environmental and technical concerns. The no-go alternative was also considered.

The recommended route deviations have been suggested by the wetland and biodiversity specialists. The seven recommended route deviations within Alternative Route 1, together with their descriptions are outlined below.

A-1.3.1 Deviation 1

Please refer to the figure below:

Original Route shown in yellow – At Battersea Avenue, the 'original preferred pipeline route' continues north, traversing deep drainage lines, following the footprint of the existing water pipeline i.e. along the edge of the cadastral boundary behind the houses on Battersea Avenue and Middlemiss Crescent. This route occurs along

the edge of the closed canopy woodland, which has high ecological significance and occurs within the D'MOSS area.

Suggested deviation shown in blue – To avoid the impacts of construction along the edge of the forest, the Ecologists (flora, fauna and wetland) suggested that rather Deviation 1 is followed, which aligns along Battersea Avenue to the end of Middlemiss Crescent, in the residential area.

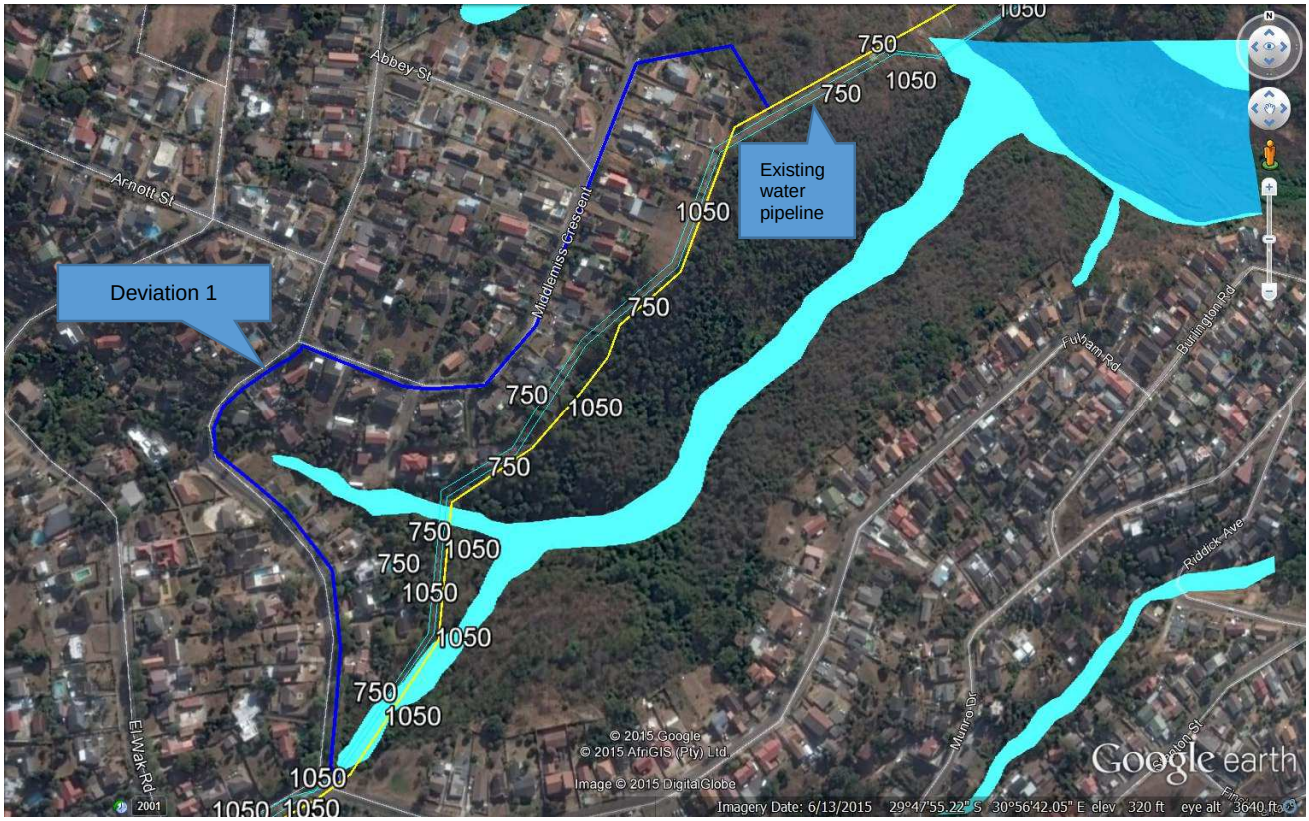


Figure 2: Deviation 1
Blue line is the suggested deviation and the yellow line is the original pipeline route

Deviation 1 **(blue route)** cannot be accommodated in the route alignment due to the following technical reasons:

- The deviation is much longer by + 345m and is estimated to cost an additional R17 million (excl. VAT);
- The embankment exiting Middlemiss Crescent down to the river bank is very steep and would make construction very difficult;
- Battersea Avenue and Middlemiss Crescent both offer limited space in road verges, have relatively steep banks on either side of the road surface and are in close proximity to boundary walls;
- Battersea Avenue and Middlemiss Crescent both offer limited space due to existing services buried within the road reserve;
- Residents along Battersea Avenue and Middlemiss Crescent will be directly affected during construction, as construction activities will occur within very close proximity to property frontages, which will also cause severe restrictions to access individual properties;
- Existing tarred road surfaces and layerworks will be damaged, and will require reconstruction;
- There is a higher risk of damage and disruptions to other existing services such as existing water reticulation mains, sewer mains, electricity and telecommunication cables and stormwater structures; and
- The progress of construction activities will be much slower due to restricted working space.

Deviation 1 will therefore not be considered for further investigation due to the above reasons.

In order to mitigate the impacts of construction of the original preferred pipeline route along the edge of the forest, the mitigation measures recommended in Section F-4.1.3, F-4.1.4, F-4.1.5, F-4.1.6 and F-4.1.7 must be implemented.

A-1.3.2 Deviation 2a

Please refer to the figure below:

Original Route shown in yellow – The original preferred pipeline route follows the edge of the cadastral boundary behind the houses on Towerhill Place, Loophill Avenue and Rockhill Grove. This route occurs along the edge of the wooded grassland in the D'MOSS area, which has high ecological significance.

Suggested deviation shown in blue – To avoid impacting on the edge of the wooded grassland (D'MOSS) in the Hillgrove area on the north bank of the uMngeni River, it is recommended that the route be taken along Royalhill Road and Hillgrove Drive before re-joining the preferred route across Newlands West Drive.

Figure 3: Deviation 2a, 2b and 2c
Deviation 2a: Blue line is the suggested deviation along Royalhill Road
Deviation 2b: Light blue line follows the edge of the cadastral boundary
Deviation 2c: Light blue line follows along Hillgrove Drive
The yellow line is the original preferred pipeline route

Deviation 2a **(blue route)** cannot be accommodated in the route alignment due to the following technical reasons:

- The deviation is much longer by + 170m and is estimated to cost an additional R19.4 million (excl. VAT);
- The deviation runs through the middle of the built-up Royalhill Road, which contains limited space in road verges and is in close proximity to boundary walls;
- The deviation runs along the edge of the built-up Hillgrove Drive, which also contains limited space in road verges, relatively steep banks on the southern section of the road and is in close proximity to boundary walls;

- Residents along Royalhill Road and Hillgrove Drive will be directly affected during construction, as construction activities will occur within very close proximity to property frontages, which will also cause severe restrictions of access to individual properties;
- Existing tarred road surfaces and layerworks will be damaged, and will require reconstruction;
- There is a higher risk of damage and disruptions to other existing services such as water reticulation mains, sewer mains, electricity, telecommunication cables and stormwater structures; and
- The progress of construction activities will be much slower due to restricted working space.

Deviation 2a will therefore not be considered for further investigation due to the above reasons.
In order to mitigate the impacts of construction of the original preferred pipeline route along the edge of the wooded grassland, the mitigation measures in Section F-4.1.3, F-4.1.4, F-4.1.5, F-4.1.6 and F-4.1.7, are recommended for implementation.

A-1.3.3 Deviation 2b

Please refer to the figure above:

Original Route shown in yellow – The original preferred pipeline route occurs through the wooded grassland area (D'MOSS), which has high ecological significance, occurring behind the corner of Rockhill Drive and Hillgrove Drive. The route crosses a riparian channel.

Suggested deviation shown in light blue – To avoid impacting on the wooded grassland area and the riparian channel, it is recommended that the route be taken along the edge of the cadastral boundary behind Rockhill Drive and Hillgrove Drive before re-joining the preferred route across Newlands West Drive.

Deviation 2b **(blue route)** cannot be accommodated in the route alignment due to the following technical reasons:

By accommodating the avoidance of construction through the drainage line, an additional bend would have to be introduced to the pipeline. To introduce a further bend in such close proximity is not recommended from a hydraulic design point of view, as it would affect the flow of water and cause excessive scouring. This deviation was therefore considered technically unfeasible. In addition to this the working space required during construction to lay the pipe in the corner of the cadastral would extend past the original pipeline position.

Mitigation measures in Section F-4.1.3, F-4.1.4, F-4.1.5, F-4.1.6 and F-4.1.7 must be implemented for construction of the original preferred pipeline route within the drainage line.

A-1.3.4 Deviation 2c

Please refer to the figure above:

Original Route shown in yellow – The original preferred pipeline route traverses the wooded grassland at Deviation 2c.

Suggested deviation shown in light blue – To avoid encroachment into the wooded grassland, the proposed pipeline should be routed along the edge of the cadastral boundary behind Rockhill Grove and Hillgrove Drive.

Deviation 2c has been incorporated into the preferred route alignment as recommended.

A-1.3.5 Deviation 3

Please refer to the figure below:
Original Route shown in yellow – The original preferred pipeline route traverses the wooded drainage line diagonally.
Suggested deviation shown in blue – To avoid impacting on the wooded drainage line between Newlands West Drive and Inanda Highway, it is suggested that the pipeline crosses perpendicular to the drainage line before re-joining the preferred route on Sooklall Drive.

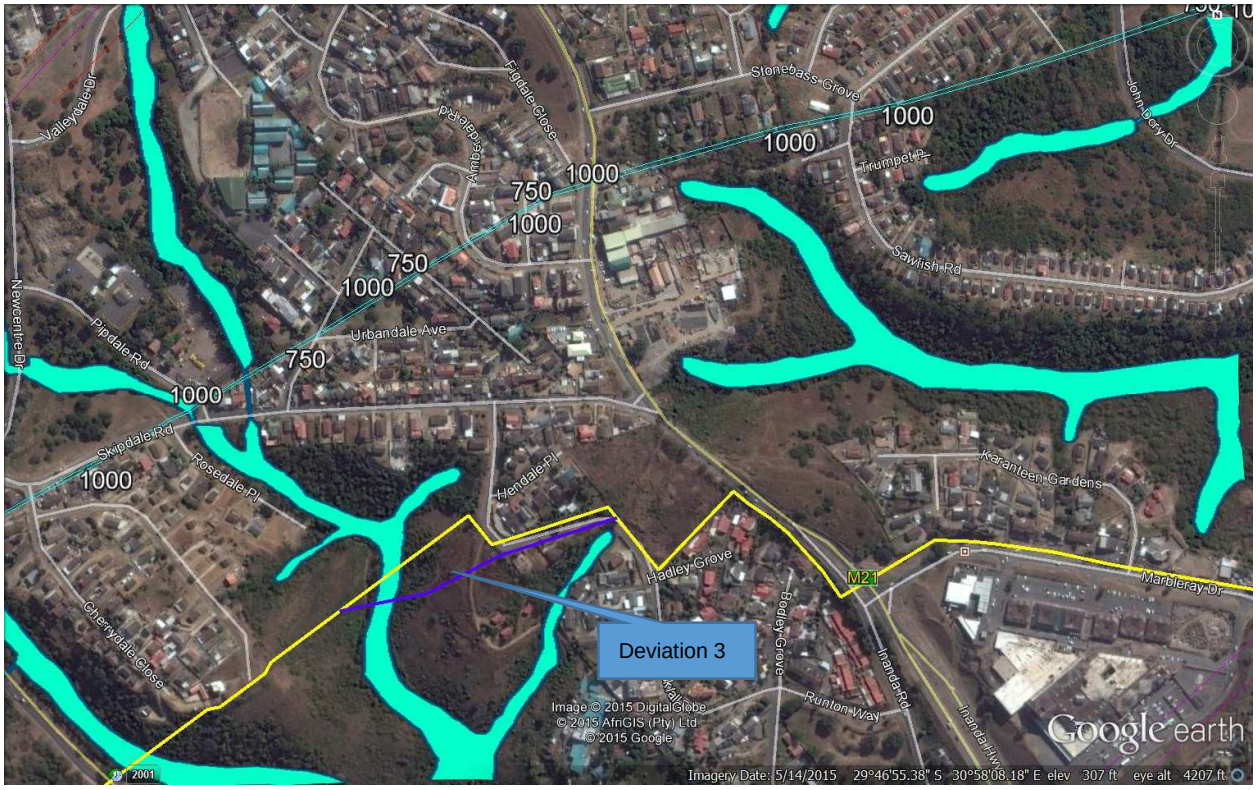


Figure 4: Deviation 3
Deviation 3: Yellow line is the original pipeline route through the wide part of the riparian area
Blue line is the suggested deviation perpendicular to the riparian area

Deviation 3 **(blue route)** cannot be accommodated in the route alignment due to the following technical reasons:

The suggested deviation cuts across private properties owned by Commercial Properties and Friends of the Sick Association (FOSA). The deviation cannot be considered due to the following reasons:

- Commercial Properties are intending to develop this land in the future. Therefore the proposed pipeline route must stay out of this private property, and follow the cadastral line through Municipal land up to Sooklall Drive; and
- FOSA are intending to develop this land at some stage in the future. Therefore the proposed pipeline route must stay out of this private property, and follow the cadastral line through Municipal land up to Sooklall Drive.

Deviation 3 will therefore not be considered for further investigation. In order to mitigate the impacts of construction within this area, mitigation measures are recommended for implementation as outlined in Section F-4.1.7 of this report.

A-1.3.6 Deviation 4

Please refer to the figure below:

Original Route shown in yellow – The original preferred pipeline route traverses *Hyparrhenia hirta* grassland and drainage lines, which has medium to high ecological significance, in the Newlands East area from Marble Ray Drive to John Dory Drive. The route then traverses wooded drainage lines behind the properties on John Dory Drive.

Suggested deviation shown in blue – To avoid impacting on the grassland and the drainage lines, it is recommended that the route run parallel to the existing powerlines, just south of the 'original route'. The route should then follow the verge in John Dory Drive, to avoid the natural drainage lines just to the north.

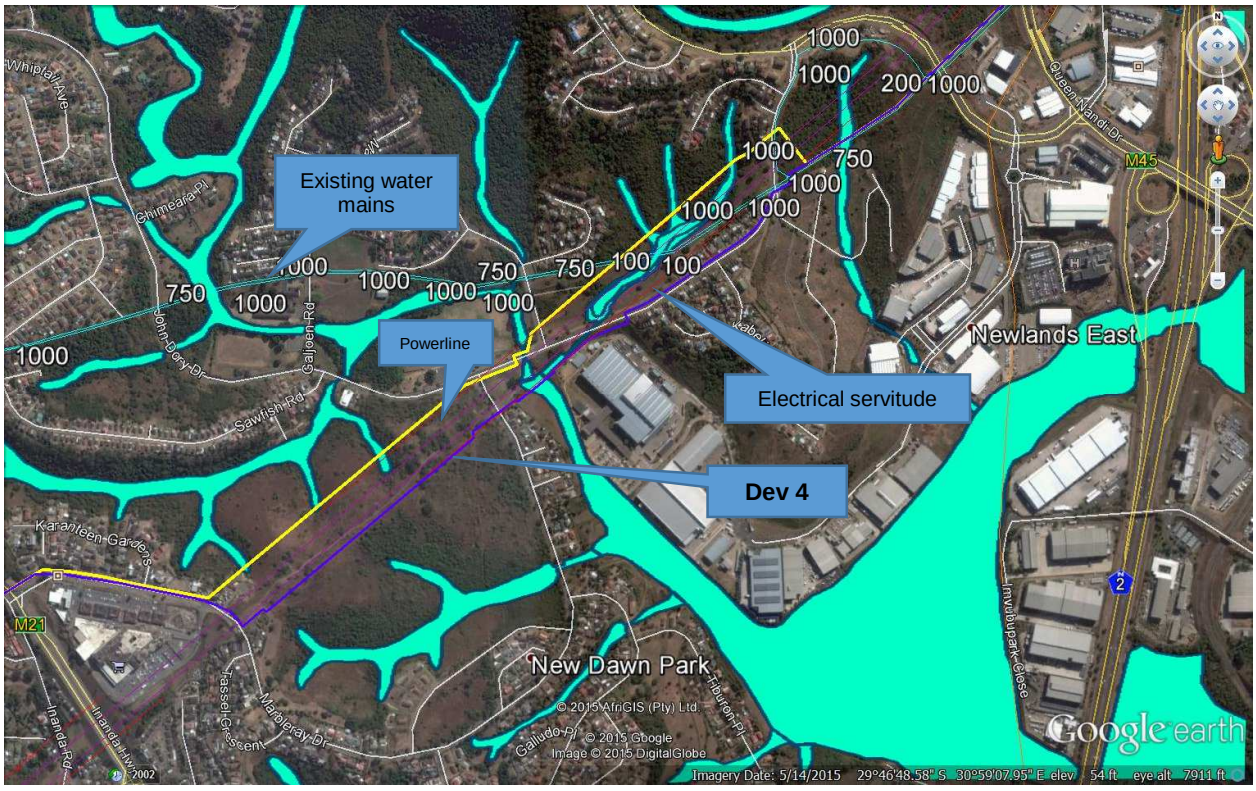


Figure 5: Deviation 4
Deviation 4: Blue line avoids traversing *Hyparrhenia hirta* grassland and drainage lines
Yellow line is the original pipeline route

Deviation 4 **(blue line)** is deemed a feasible route option and will be incorporated into the preferred route alignment as recommended, as it has the least biophysical impacts on the receiving environment in this area.

In terms of social impacts, there may be traffic impacts due to construction on the verge of John Dory Drive. Mitigation measures as suggested in the Traffic Management Plan (Appendix D12) must be adhered to during the construction phase for this section of the road.

A-1.3.7 Deviation 5

Please refer to the figure below:

Original Route shown in yellow – The original preferred pipeline route encroaches on the electrical servitude and eThekwini Electricity therefore objected to this route.

Suggested deviation shown in blue – The pipeline route has been moved further away from the electrical servitude to accommodate future powerline construction. Furthermore, the pipeline route along 120844 Street is better positioned, as it will have easy access to the Aloes Reservoir and reduces the length of the connection supply to Aloes Reservoir.

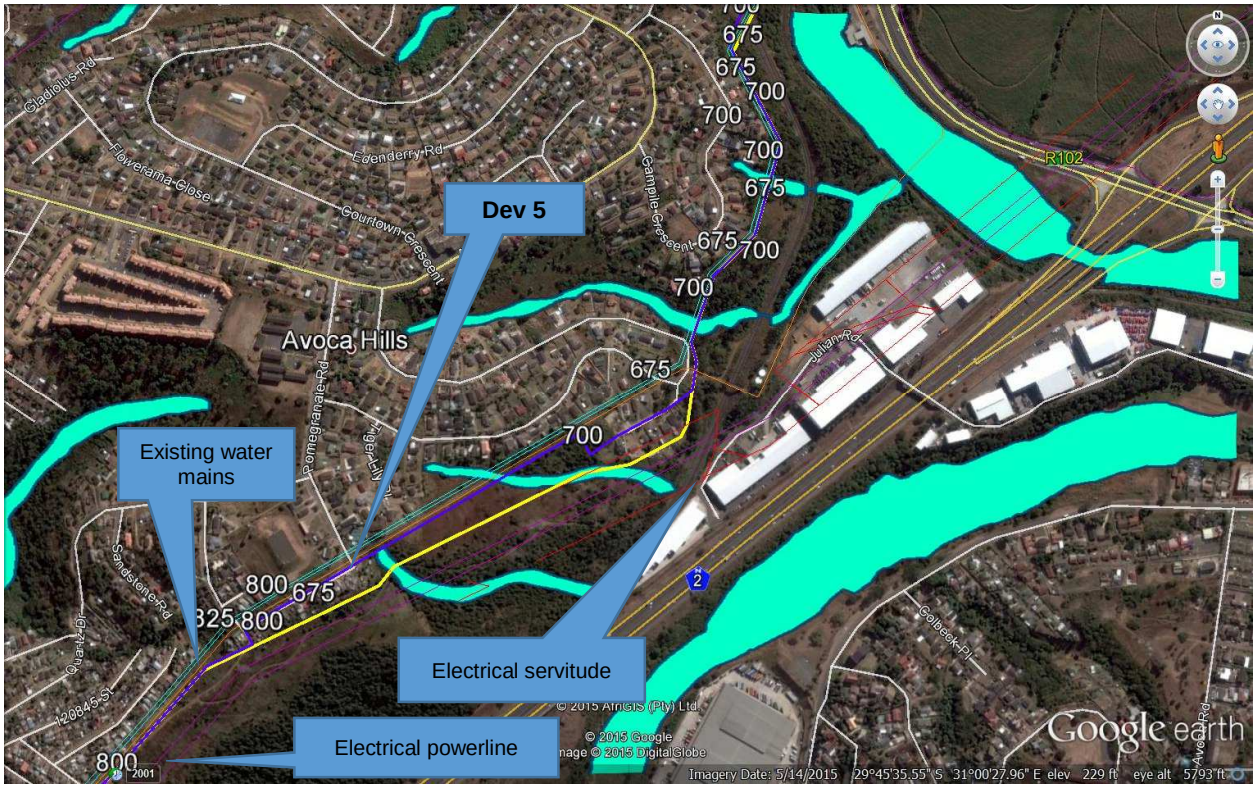


Figure 6: Deviation 5
Deviation 5: Blue line avoids encroachment into the electrical servitude
Yellow line is the original pipeline route

Deviation 5 **(blue line)** is deemed a feasible route option and will be incorporated into the preferred route alignment as recommended.

Please refer to section F-4.1.7 for mitigation measures for construction through drainage lines and vegetation areas.

A-1.3.8 Deviation 6

Please refer to the figure below:

Original Route shown in yellow – The original preferred pipeline route falls within the Transnet Freight Rail Servitude and east of the existing water mains. Transnet Freight Rail therefore requested that the pipeline be relocated to occur outside of the servitude. There is very little space to allow for construction between the railway line and the existing water mains. In addition, the embankment between the existing water mains and the railway line is relatively steep and would make construction in this area very difficult.

Suggested deviation shown in blue – Due to the reasons stated above, the proposed pipeline route has been moved west of the existing water mains. This route is therefore technically feasible. The ecological sensitivity in this area is medium and low.

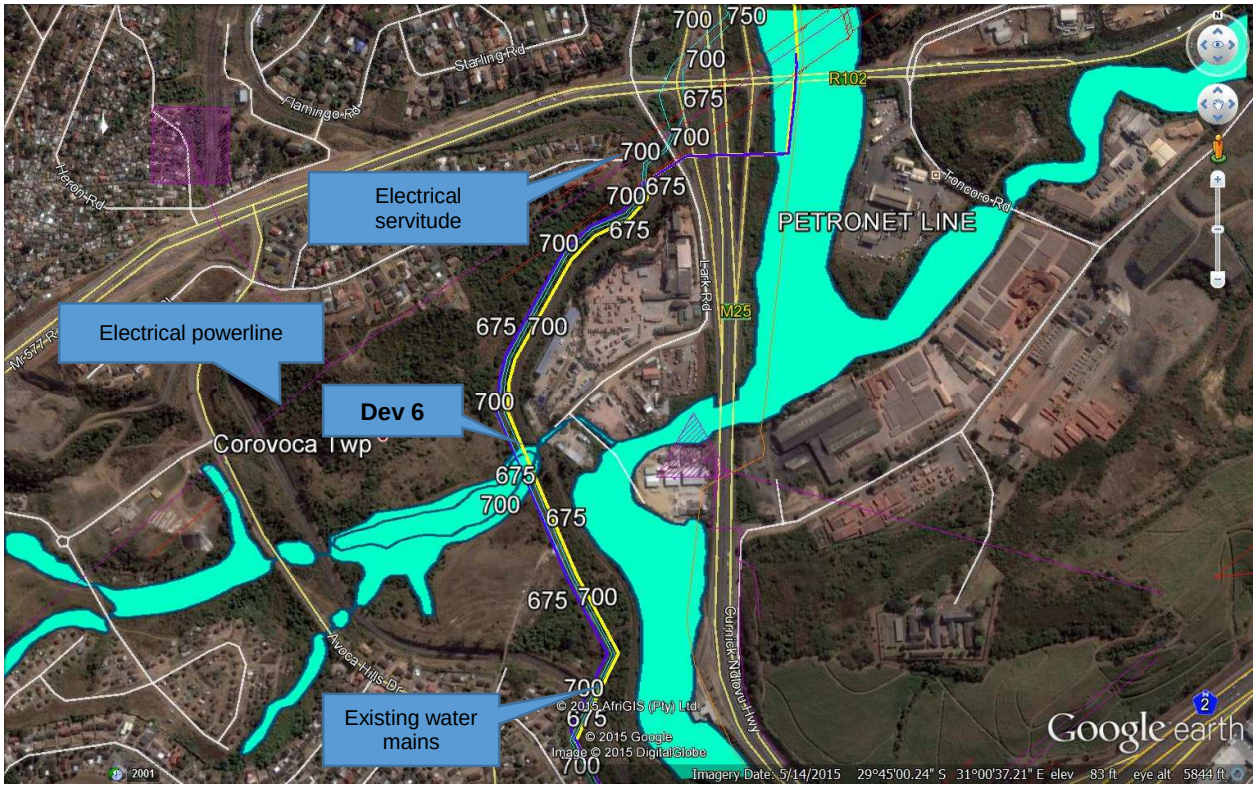


Figure 7: Deviation 6
Deviation 6: Blue line avoids encroachment into the Transnet Freight Rail servitude
Yellow line is the original pipeline route

Deviation 6 **(blue line)** is deemed a feasible route option and will be incorporated into the preferred route alignment as recommended.

Please refer to section F-4.1.7 for mitigation measures for construction through drainage lines and vegetated areas.

A-1.3.9 Deviation 7

Please refer to the figure below:

Original Route shown in yellow – The original preferred pipeline route is aligned through the Valley Bottom Floodplain Wetland. The Present Ecological State (PES) score for this wetland is Category E, meaning that the wetland is seriously modified. The losses of natural habitats and basic ecosystem functions are extensive. Large existing impacts on the hydrology of the wetland includes channel straightening and stream channel modification for the development of major linear infrastructure, such as the N2, as well as infilling of several areas for industrial purposes and the expansion of residential areas. Despite being highly modified from its natural state, the wetland still assists in regulating flow and controls erosion and flooding in the surrounding areas by absorbing excess of running and discharged waters.

Suggested deviation shown in blue – Due to the reasons stated above, it was suggested that the proposed pipeline route deviate to occur within the M25 road reserve.

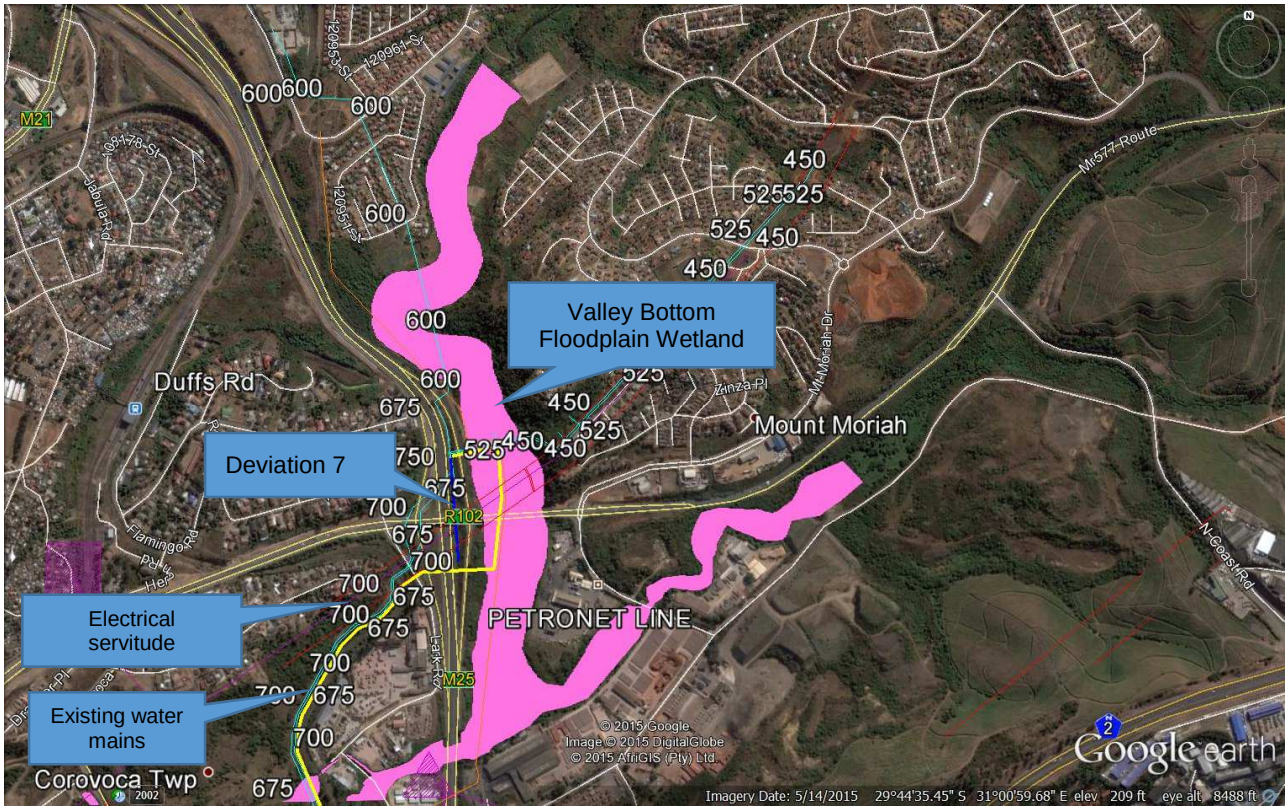


Figure 8: Deviation 7
Deviation 7: Blue line avoids encroachment into the Valley Bottom Floodplain Wetland
Yellow line is the original pipeline route

Deviation 7 (**blue route**) cannot be accommodated in the route alignment due to the following technical reasons:

The Department of Transport (DoT) intends to widen the M25 in the future and construction of a future lane will impact negatively on buried services.

Deviation 7 will therefore not be considered for further investigation due to the above reasons. However, mitigation measures must be in place to minimise the impacts of construction through the Valley Bottom Floodplain wetland. Refer to the specific mitigation measures in Section F-4.1.7.

A-1.4 Description of the Preferred Route Alignment

The final preferred route alignment is represented in Figure 9 and is described in the paragraphs that follow. The pipeline route commences at the tie-in chamber on Pridley Road in Reservoir Hills, from where it follows Pridley Road and crosses Mount Batten Drive, down to Battersea Avenue. It then proceeds along the back of the residential cadastral boundary located on Battersea Avenue/Middlemiss Crescent, from where it descends into the uMngeni Valley. A new bridge will be constructed over the uMngeni River and the proposed pipeline will be installed on the new bridge structure. The pipeline route will proceed into the D'MOSS area after it crosses the opposite bank of the uMngeni River, in the Hillgrove area. The route will cross Newlands West Drive traversing open space up to Sooklall Drive. The route then follows Sooklall Drive for approximately 250m and traverses through another D'MOSS area to reach the M21 (Inanda Road) in the Newlands East area.

The route then continues along Inanda Road for approximately 215m before it deviates along Marble Ray Drive for approximately 430m. The pipeline then runs parallel to the overhead power line servitude for roughly 1.1km. The pipeline then follows the road verge in John Dory Drive to avoid the natural drainage lines to the north-west of the existing Northern Aqueducts. The pipeline route then follows parallel to the overhead powerlines and existing water mains, and crosses Newlands Drive, Queen Nandi Drive and Hippopark Avenue.

The route then goes through the Quarry Heights area, following or parallel to the existing water mains, powerlines and Petronet gas pipelines. To avoid encroachment into the Eskom servitude, the proposed pipeline will be routed along 120844 Street (for easy access to the Aloes Reservoir). In the Avoca Hills area, the proposed pipeline will occur parallel to the Petronet gas pipeline. The route will occur on Sweetpea Close to follow in parallel to the two existing northern aqueduct pipelines and Metro Railway Line for approximately 700m along the back of Avoca Hills, and then crosses the Metro Railway Line. The Pipeline then continues in parallel to the two existing northern aqueduct pipelines and the Transnet Railway Line for approximately 900m. The pipeline then crosses the Transnet Railway Line, Lark Road, the M25 (Curnick Ndlovu Highway) and the M577 (Dumisani Makhaye Drive) to reach the Duffs Road tie-in position.

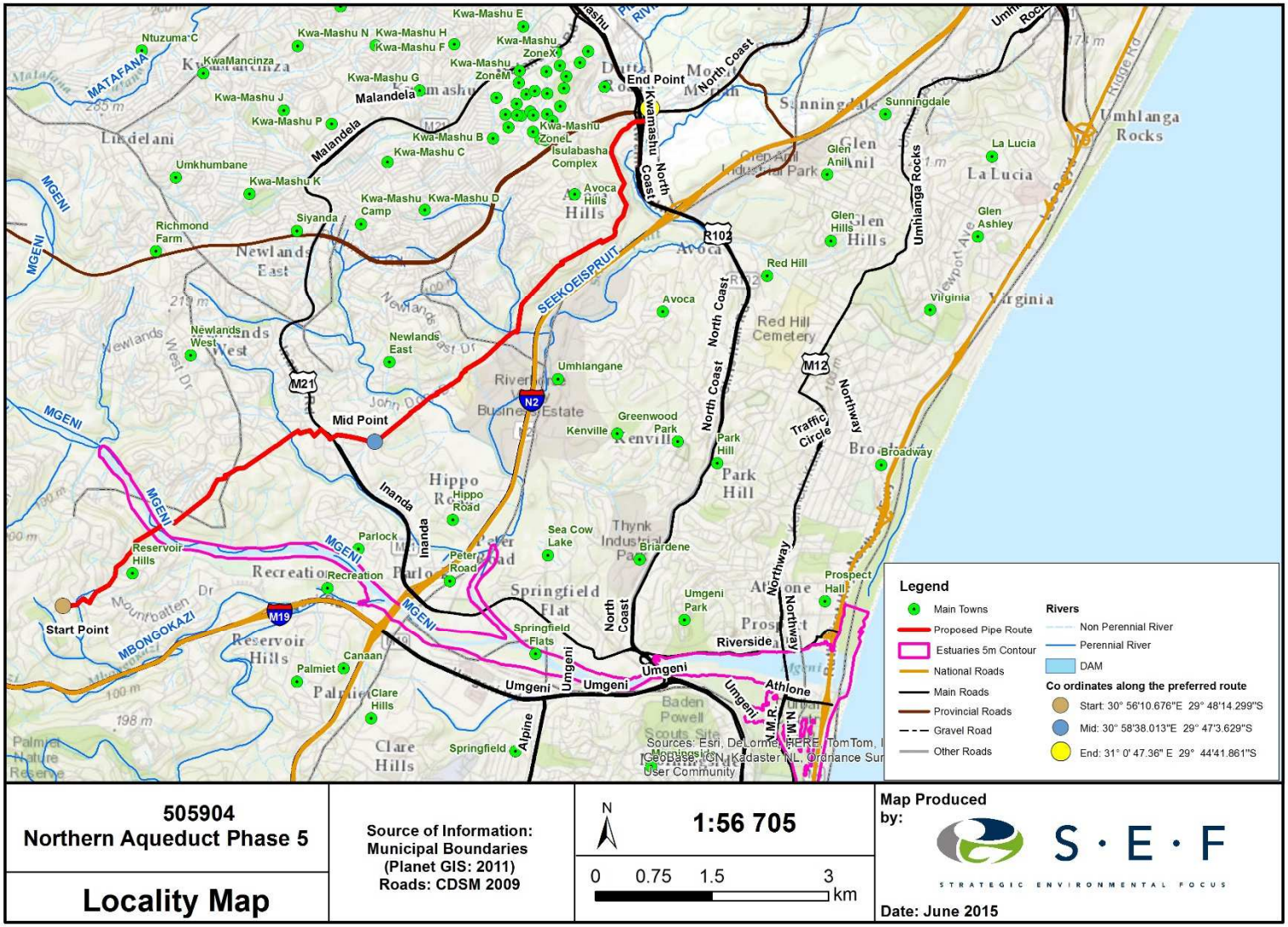


Figure 9: Locality Map of the proposed pipeline route

A-1.5 Technical Details

A-1.5.1 Project Phases

The project will take place in two phases, namely the Construction and Operational Phase.

Construction Phase: All the construction related activities on site, until the contractor leaves the site. Site clearing, trench excavations, installation of the pipeline, covering of the trenches and site rehabilitation may take approximately 24 months. Construction is anticipated to start in August 2016 and end in April 2018.

Operational Phase: All activities, including the operation and maintenance of the proposed pipeline.

A-1.5.2 Construction Phase

a) General

Subject to receiving the Environmental Authorisation (EA) from KZN DEDTEA and receipt of the approval for the IWULA, construction of the proposed pipeline is anticipated to commence in 2016. The construction period is estimated to be 24 months from inception to completion. Construction is anticipated to be completed by May 2018.

The appointed Contractor will be responsible to prepare a Construction Site Development Plan prior to establishing on site. This plan will indicate the boundaries of the site that encompasses all construction related activities, the construction corridor per area along the pipeline route, vehicle and pedestrian access points, laydown area/s, offices, stockpile areas, storage areas, ablution facilities, etc. This construction Site Development Plan must be approved by the appointed Environmental Control Officer (ECO) as provided for within the Environmental Management Programme (EMPr) (Appendix F).

Water will be needed during the construction phase and will be sourced from the eThekwini Municipality via water tankers.

Diesel generators will be utilised on site and stored within the storage area as far away from the wetlands/watercourse/ drainage line boundary as possible.

The Contractor will be responsible for the management and removal of all solid waste from site during the construction phase, to a designated landfill site. A method statement for the management of waste must be drafted and signed off by the ECO prior to commencement of construction activities, as per the attached EMPr (Appendix F).

The proposed pipeline will be constructed as a continuously steel welded steel pipe with a diameter 1 200mm ND diameter. A continuously welded steel pipeline if installed and maintained correctly could have a lifespan exceeding 50 years. Steel is also the most suitable material for the large diameters and high operating pressures in the pipeline. The pipe will be coated and lined to prevent corrosion. In addition, the pipeline will have a cathodic protection to further protect it against corrosion. Pipe material, design, construction and maintenance will be in accordance with all applicable South African standards, guidelines and legislation, as well as certain international specifications.

b) Cathodic Protection

The Northern Aqueduct will be a continuously welded steel pipeline and will therefore require cathodic protection (CP). The design and installation of a CP system should be coordinated with pipeline construction such that

continuity bonding and CP tests posts are installed during construction. The Applicant, EWS, would need to involve Transnet Pipelines, Transnet Freight Rail, PRASA and Ethekwini Electricity in the design and installation of the CP system to ensure that there are no adverse effects on the parastatals' pipeline and powerline infrastructure if in close proximity. Cathode beds will also be required.

c) Pipe Storage Yards

Two pipe yards are proposed for storage of the steel pipes situated at different locations as follows, *viz*, one at Ottawa, east of Old North Coast Road, Verulam and the other at Eastbury, Eastbury Drive Phoenix. The pipe yards are sized to approximately 250m by 100m. The pipe yard access roads are unpaved, and are approximately 15m wide. The access roads run adjacent to the pipe yards.

The construction activities associated with the pipe yard operation are expected to last approximately 24 months. The activities that are most likely to have an impact on the adjacent receptors are associated with transportation, specifically unloading and reloading of the pipe sections onto trucks at the pipe yard. The pipes will be delivered to the pipe yard on trucks in 18m lengths.

Trucks will arrive from the supplier in convoy, at a rate of approximately four trucks per day. As the pipes are sensitive to any abrasions or damage, the handling process is undertaken with caution. Pipe bedding in the form of river sand will be applied to the surface of the pipe yard, and rows of tires or sand bags will placed strategically to form a mattress for the pipes. The pipes are then offloaded from the trucks via a mobile crane, assisted and guided by the construction staff to avoid any contact with the adjacent pipes. The table below provides details of the proposed operation of the pipe yards.

Table 9: Operation Schedule for the Pipe Yards

Description		Pipe Yards at Ottawa and Eastbury Drive (per yard)
Pipe Delivery (Stocking the pipe yard)	No. of pipe lengths to be delivered and stored	690
	No. of pipes delivered per day	12
	No. of months for delivery	3
Pipe Removal (Construction Phase)	No. of pipe lengths to be stored	690
	No. of pipes delivered per day	5
	No. of months for delivery to site	18

In summary, it will take approximately three months to stock / fill the pipe yard (based on a nine hour day). Once the pipeline construction truck enters the vicinity of the pipe yard, pipe delivery to the construction site will commence, where approximately five pipes will be loaded and dispatched to site per day.

d) Servitudes and Crossings

(i) Servitude Requirements

The pipeline will be buried underground for its entire length, except where it will cross the uMngeni River. A new bridge will be constructed across the uMngeni River and the proposed pipeline will be installed on the newly constructed bridge.

For construction purposes, a corridor width of approximately 30 metres in places may be necessary, and where this is required negotiations will take place between the eThekwini Municipality and the individual landowners. In constrained places, the corridor may be reduced to 10m. In steep areas, the construction corridor may go up to 60m, but in environmentally sensitive areas such as the D'MOSS areas i.e. closed canopy woodland / forest at Reservoir Hills, the wooded grassland at Hillgrove, wetland and drainage lines, the servitude width must be reduced as far as practically possible.

An approximate depth of the trench to lay the pipe is 2.5m to 4m and the approximate width of the trench is 2.2m.

(ii) Proposed Pipe Bridge across the uMngeni River

The proposed 1, 200mm diameter water pipeline will be laid / fixed on the proposed new concrete bridge deck spanning across concrete support piers across the uMngeni River. The following can be inferred about the proposed pipe bridge construction:

- The new bridge will be constructed on the similar alignment as the previously collapsed steel suspension bridge and adjacent to the existing pipe bridge, approximately 9.6 km from the river mouth;
- The preferred access route is from the northern bank via the Parlock residential area;
- Construction will take place within the 5m topographical contour, that is, within the boundaries of the Estuarine Functional Zone, and within the 1:100 year floodline. However, the height of the completed deck structure supporting the pipeline will be elevated above the 1:100 year floodline;
- The structure will be generally parallel with the existing bridge, and at an angle perpendicular to the riverbanks;
- The proposed bridge is intended to span 234m over the uMngeni River, of which only approximately 8 m is over open water. The width of the channel of flow is however subject to seasonal changes in rainfall and consequently the volume of water entering the system;
- The structure requires five piers to span the uMngeni River and river banks: two on the northern bank and three in the river channel;
- The supporting sub-structure comprises solid concrete piers and cantilever abutments, with pilecaps supported on piles down to bed rock approximately 18m below the riverbed;
- Each pier requires approximately four 900 mm diameter piles to be installed by means of large track-supported piling rig. The method of piling employed will be determined based on the results of the forthcoming geotechnical investigation. However, it is likely that Auger Piling[1], which is a common method for the construction of bridge foundations in sensitive environments, will be employed based on existing geotechnical information for the existing pipe bridge;
- Thereafter, a reinforced concrete pilecap will be constructed for each individual pier, below the level of the riverbed to avoid alterations to normal river flow and for aesthetic reasons. The approximate dimensions of the pilecaps are 6.5m x 5m x 1.5m deep;
- The piers will be constructed using climbing or sliding formwork, and will be approximately 2m wide x 4.5m long and varying in height depending on the height above the riverbed. They will be in line with those of the existing downstream bridge;
- The proposed deck structure comprises a concrete box-type cross section that will be constructed using the 'Incremental Launch' method to obtain an overall length of 234m between abutments. This method will entail casting the deck behind the northern abutment, which will be launched out over the new piers by means of a light weight steel launching nose, resulting in no work in the river once the piers have been constructed;
- The installation of the piles and the construction of the pilecaps will require the construction of a

[1] A hollow-stemmed Continuous Flight Auger is drilled into the ground down to the founding level after which concrete / grout is pumped down the hollow-stemmed flight as the latter is gradually withdrawn. A steel reinforcing cage is then lowered into the wet concrete / grout in the pile shaft. This method causes minimal disturbance (limited noise and vibration, and is often used for noise and environmentally sensitive sites.

temporary berm within the riverbed to gain access to the construction points. The berm will likely be constructed from both banks, and will incorporate a number of pipes, as well as an open portion through the central span, to provide for uninterrupted river flow. This berm will comprise imported dump rock and limited sediment which is proposed to be sourced from either the local flood plain or a commercial source;

- Once the deck has been completed, the 1 200 mm diameter pipe will also be installed by working on the deck from the northern embankment.

The proposed pipe bridge deck will have a freeboard of 1.68m above the 1:100 year floodline. Some excavations will be required locally around each set of piles to form the pile cap for the piers to be constructed.

The steps in each stage are expected to be as follows:

- A temporary diversion / protection coffer dam wall using locally available selected material from the riverbed may be constructed for the work associated with the piers closest to mid-stream to avoid flooding of the works during high flows of the river. An approximate 15m wide inside working space will be required for these piers.
- Temporary access platforms for construction plant will be constructed using locally available selected material from the riverbed.
- Temporary pumps will be installed to dewater the excavations.
- The concrete piers will be constructed in-situ, while the bridge deck will be cast from the northern bank and incrementally launched over the new piers across the river.
- The working area inside the cofferdam and access platforms will be cleared of any rubbish, materials, equipment etc.
- The cofferdam will then be removed and relocated to provide protection for the next stage, with the river flow being diverted over the first stage. Stages will necessarily overlap.
- Coffer dam and access platform material will be returned to the original borrow areas and the areas covered and restored / rehabilitated.
- Surplus material from the excavations that cannot be used in the works will be spoiled at local fill sites approved by the environmental officer and the areas made good and planted with natural vegetation.
- River banks will be reinstated to original ground lines and re-vegetated in accordance with the environmental management plan.
- The opposite river embankment is protected from the increased erosion potential as a result of water being channelled past the coffer dam. The cofferdam is drained, the open-trench is excavated, the pipe is placed and encased in concrete, and the trench is backfilled. The process would then be repeated for the remaining portion of the river channel.

(iii) Wetland and Riparian Crossings

Any river, stream, drainage line, or water course crossing is subject to the necessary WULA approval process by DWS, and the detailed design of the crossings should reflect the relevant specifications. Generally, in the absence of existing culverts or bridges, the open-trench approach of embedding the pipe within the watercourse and wetland will be undertaken.

Pipeline installation will be open trench excavations within drainage lines and wetlands. The width of the working corridor will possibly be reduced to 16m in the immediate vicinity of the drainage lines and wetlands to minimise the construction impact. To limit the impact at drainage lines and wetland areas, possibly 2 x excavators or a mobile crane would lower the pipes into the trench spanning the drainage line / wetland. Seepage drains would be installed across the pipe trench to allow subsurface flow to continue where necessary.

Trenches will be barricaded in compliance with the safety plan. Working zones would be cordoned off to increase public safety. Safety officers will be on site monitoring construction and plant movement.

(iv) Services and Infrastructure Crossings

The proposed pipeline will cross various services and infrastructure, including rail and road. These crossings will be designed and constructed in accordance with standard industry practice and construction methodology. Generally, in the absence of existing culverts or bridges, the pipe will be bored under roads or railways (pipe jacking or horizontal directional drilling), or even constructed using open-cut techniques for lightly trafficked crossings.

Adjacent property access should be maintained and where this is not possible alternative arrangements should be negotiated with the property owner. Typically, any existing infrastructure that is damaged as a result of the construction activities on a project like this, will be reinstated to its original condition according to contract agreements. The rehabilitation of road and rail crossings is mandatory.

e) Typical Pipeline Construction Methodology

The typical pipeline construction methodology for a project of this nature involves a 'construction train' much like a production line, where a limited length of pipeline (usually guided by regulations) is constructed at any one time. A pre-determined length of construction corridor is prepared, excavated, the pipe placed, the trench backfilled and the area reinstated before the subsequent area can be excavated. Typically on a project of this scale, this 'construction train' can occur simultaneously in a number of areas along the route, and there is therefore seldom one beginning and one end point. The methodology described below is repeated per pre-determined length (usually no longer than 250m, depending on the topography, geology, environmental parameters and surrounding land uses).

(i) Site Preparation

The site preparation begins with a preliminary survey and staking exercise where the footprint of the construction area is pegged and the area is "grubbed" or cleared of vegetation and rocks. This clearing is usually undertaken using hand teams with clearing tools, as well as earth moving plant for larger obstacles. Machinery is used to cut platforms and level benches for the pipe and plant access. The pre-ordered pipe segments, typically between 12 and 18 meters in length are transported from the mill to the nearby pipe-yards on telescopic trailers. These are then strung along the construction corridor and moved to the open trenches (discussed below) as they are required.

(ii) Trenching and Bedding Preparation

The trench excavation begins with the staking of the centreline by the surveying team. This is followed by the actual excavation of the trench along the centreline by the earth moving equipment (usually backhoes or excavators or a combination of the two). The topsoil is typically removed and stockpiled away from the trench to avoid contamination with the underlying subsoil material. The subsoil material is then excavated and placed alongside the trench. Once the trench has been excavated to the design specification, suitable bedding is placed in the trench. This bedding is usually comprised of granular material (e.g. river sand), and serves as a layer between the pipe and the underlying material. Where the pipe is to be placed underneath paved areas or tarred roads, material is only to be excavated to the exact width of the pipe trench and this material will be stored separately from other excavated materials.

In instances where hard rock is encountered, blasting may be required. This is typically undertaken by a suitably qualified and experienced contractor according to a predetermined program, and relevant specifications/legislation. Any blasting should be limited to working hours as defined by the relevant guidelines and legislation and affected landowners are to be advised in advance of the intention to blast.

(iii) Bedding Requirements

The given amount of bedding material required will be calculated once the pipeline design is complete. The bedding material required, usually river sand, will be sourced from commercial sources and will be required for

the entire length of the pipeline construction.

(iv) Pipe Placement and Welding

The segments of pipe are brought from the nearby pipe-yards to the construction area, and are lowered into and aligned in the trench by side booms, and/or hydraulic cranes. Once the segments have been aligned, specialist welding contractors are called in to weld the joints in situ. The welding team follows the pipe laying team in sequential order, thus enabling the creation of a continuous length of welded pipe. Once the welding team has completed a predetermined length of welded pipe, the individual welds are X-rayed by technicians in order to detect any defective welds. Any defective welds are repaired, re-tested and re-welded if necessary. The welding operation is followed by a hydrostatic testing process whereby sections of the pipeline are filled with water and then pressure tested to a pressure greater than the maximum operational pressure. This would ensure that there are no leaks and that the pipe will be able to convey water under pressure without failing.

(v) Backfilling and Compaction

Once the pipe has been placed, welded and tested the backfilling operation can begin. The trench is backfilled in the reverse order to the excavation process, typically starting with suitable subsoil material. The trench is then compacted to specified compaction values with rammers and/or rollers. Any surplus subsoil material is usually spread out evenly over the working area, and should be followed by the careful placement of the topsoil. Spoil (soil over and above that which can be returned to the trench or the working area) is removed from site to landfill (for use as cover material) or alternative suitable sites which have been vetted for spoil acceptance.

(vi) Reinstatement and Rehabilitation

Once the topsoil has been evenly applied, the site must be allowed to rehabilitate with plant species as recommended by the Vegetation Specialist's Plant Rescue, Relocation and Rehabilitation Plan (PRRRP). Disturbed areas are readily colonised by alien invasive plant species and the work area will be have to be managed in this regard. Grasses will be planted along the operational phase servitude as deep rooted trees will damage the steel pipeline.

A-1.5.3 Operational Phase

The eThekwini Municipality will generally require a servitude width of approximately 9 metres to accommodate maintenance and servicing access during operation. However, if the servitude is adjacent to a road reserve, the width can be reduced to 6m because the road reserve affords additional space to access the main for maintenance purposes. Typically, deep-rooted trees, earth-moving activities, the construction of dams or buildings (temporary or permanent) are not allowed in the servitude. Cable crossings and service installations may be allowed with restrictions and conditions.

Once operational, this pipeline can convey water at flow rate of up to 187 megalitres/day, with an average operational pressure of 25 bar, and a maximum pressure of approximately 40 bar. The pipe should be continuously monitored and maintained throughout the design life of the pipeline. Systems should be put in place to provide early detection of any irregularities or failures within the pipe so that maintenance crews are able to rectify any problems in the shortest possible timeframes.

A-1.5.4 Decommissioning of the Pipeline

It is highly unlikely that the pipeline will be decommissioned as it is a permanent structure required for future growth demands in the municipality. In the unlikely event that the use of the pipeline is no longer feasible, appropriate decommissioning measures should be instated, in accordance with government legislation and environmental standards.

A-1.6 Capacity Building

a) Skills and labour requirements and opportunities

The construction phase will require skilled and unskilled labour. The project will however be used from the start to train people and transfer skills as far as possible. The tender specifications for any construction work on the project will include a compulsory utilisation of a certain percentage of local labour and the compulsory training of local labour.

Other employment opportunities for the duration of the construction period of the specific element of the project will include:

- Erection of shade cloth at the construction sites;
- Excavation of trenches;
- Flags men duties for traffic control; and
- Fencing of construction sites.

b) Availability

Labour skilled in the construction industry is available in the area, but would require upskilling and development of more specialised skills. Due to the high percentage of unemployment in the area, sufficient unskilled labour is available for the project, as the potential labour force resides in close proximity of the development site.

A-2 LEGAL REQUIREMENTS APPLICABLE TO THIS APPLICATION

The Application for Environmental Authorisation form was submitted to the KZN DEDTEA on 8 July 2015. The project was subsequently registered and KZN DEDTEA issued the project with reference number DM/0008/2015 and NEA Ref No: KZN/EIA/0000082/2015. Refer to Appendix C1 for the Application for Environmental Authorisation Form and Appendix C2 for the KZN DEDTEA acknowledgement of receipt of the application.

The legislation, guidelines and policies applicable to this project are as follows:

A-2.1 NEMA and the Environmental Impact Assessment Regulations

The EIA Regulations, promulgated under NEMA, focus primarily on creating a framework for co-operative environmental governance. NEMA provides for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by State Departments and to provide for matters connected therewith.

In terms of the EIA Regulations of 2014 and activities listed in GN No. 983 and GN No. 985 (requiring a Basic Assessment (BA) process), the following listed activities are deemed by the EAP to be applicable to the project based on the information provided by the project proponent, the consulting engineers and specialists.

The listed activities are deemed to include activities that could potentially have a detrimental impact on the social and biophysical state of an area and as such, the applicant is required to obtain an Environmental Authorisation (EA) by way of a BA process.

GN No & Activity Number		Activity Description	Project Description
GN No. 983 of 18 December 2014	19	**The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 meters cubic metres from –** **(i) a watercourse;** (ii) the seashore; or (iii) **the littoral active zone, an estuary** or a distance of 100 metres inland of the high- water mark of the sea or an estuary, whichever distance is the greater - but excluding where such infilling, depositing, dredging, excavation, removal or moving – (a) will occur behind a development setback; (b) is for the maintenance purposes undertaken in accordance with a maintenance management plan; or (c) falls within the ambit of activity 21 in this Notice, in which case that activity applies.	There may be removal or moving of sand, soil, pebbles or rock of more than 5m^3 from the uMngeni River to construct the new bridge and to lay the pipeline within the various watercourses in the study area. The point where the pipe will cross the uMngeni River falls within the Estuarine Functional Zone.

GN No. 985 of 8 December 2014	12	**The clearance of an area of 300 square metres or more of indigenous vegetation** except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. b) **In KwaZulu-Natal:** (i) Trans-frontier protected areas managed under international conventions; (ii) Community Conservation Areas; (iii) Biodiversity Stewardship Programme Biodiversity Agreement areas; (iv) Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; (v) **Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;** (vi) Within the littoral active zone or 100 metres inland from high water mark of the sea or **an estuarine functional zone**, whichever distance is the greater, excluding where such removal will occur behind the development setback line on erven in urban areas (vii) **On land, where, at the time of the coming into effect of this Notice or thereafter such land was zoned open space, conservation or had an equivalent zoning**; (viii) A protected area identified in terms of NEMPAA, excluding conservancies; (ix) World Heritage Sites; (x) Sites or areas identified in terms of an International Convention; **(xi) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose**; (xii) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; or **(xiii) In an estuarine functional zone.**	There will be clearance of approximately 93 000 square metres of indigenous vegetation to lay down the pipeline within the Durban Metropolitan Open Space (D'MOSS) areas (assuming a construction corridor width of 30m). There will be construction of a new bridge within the Estuarine Functional Zone of the uMngeni River. The proposed pipeline will be installed on the new bridge across the river. The recently updated Conservation-Plan (C-Plan) by EKZNW shows that the entire study area is located within a Critical Biodiversity Area 1 (CBA). However, ecologically sensitive areas are identified in the Floral and Faunal Assessments (Appendix D6 and D7 respectively).

		The development of – (i) canals exceeding 10 square metres in size; (ii) channels exceeding 10 square metres in size; **(iii) bridges exceeding 10 square metres in size;** (iv) dams, where the dam, including infrastructure and water surface area exceeds 10 square metres in size; (v) weirs, where the weir, including infrastructure and water surface area exceeds 10 square metres in size; (vi) bulk storm water outlet structures exceeding 10 square metres in size; (vii) marinas exceeding 10 square metres in size; (viii) jetties exceeding 10 square metres in size; (ix) slipways exceeding 10 square metres in size; (x) buildings exceeding 10 square metres in size; (xi) boardwalks exceeding 10 square metres in size; or **(xii) infrastructure or structures with a physical footprint of 10 square metres or more;** Where such development occurs – **(a) within a watercourse;** (b) in front of a development setback; or (c) if no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour.	There will be construction of a new bridge within the uMngeni River. The proposed pipeline will be installed on the new bridge across the river. The point where the pipe will cross the uMngeni River falls within the Estuarine Functional Zone. The proposed pipeline will be constructed within the D'MOSS areas along the route. The recently updated Conservation-Plan (C-Plan) by EKZNW shows that the entire study area is located within a Critical Biodiversity Area 1 (CBA). However, ecologically sensitive areas are identified in the Floral and Faunal Assessments (Appendix D6 and D7 respectively).
	14	**(i) In an estuarine functional zone**; (ii) Community Conservation Areas; (iii) Biodiversity Stewardship Programme Biodiversity Agreement areas; (iv) A protected area identified in terms of NEMPAA, excluding conservancies; (v) World Heritage Sites; (vi) Sites or areas identified in terms of an International Convention; **(vii) Critical biodiversity areas or ecological support areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;** (viii) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (ix) Core areas in biosphere reserves; (x)Outside urban areas: (aa) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; or (bb) Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined; or (**xi) In urban areas:** **(aa) Areas zoned for use as public open space**; **(bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority, zoned for a conservation purpose**; or (cc) Areas seawards of the development setback line or within 100 metres from the high-water mark of the sea if no such development setback line is determined.	

	23	**The expansion of –** (i) canals where the canal is expanded by 10 square metres or more in size; (ii) channels where the channel is expanded by 10 square metres or more in size; **(iii) bridges where the bridge is expanded by 10 square metres or more in size;** (iv) dams where the dam is expanded by 10 square metres or more in size; (v) weirs where the weir is expanded by 10 square metres or more in size; (vi) bulk storm water outlet structures where the structure is expanded by 10 square metres or more than size; (vii) marinas where the marina is expanded by 10 square metres or more in size; (viii) jetties where the jetty is expanded by 10 square metres or more in size; (ix) slipways where the slipway is expanded by 10 square metres or more in size; (x) buildings where the building is expanded by 10 square metres or more in size; (xi) boardwalks where the boardwalk is expanded by 10 square metres or more in size; **(xii) infrastructure or structures where the physical footprint is expanded by 10 square metres or more;** **Where such development occurs –** **(d) within a watercourse;** (e) in front of a development setback; or (f) if no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour. (**e) KwaZulu-Natal** (i) Community Conservation Areas; (ii) Biodiversity Stewardship Programme Biodiversity Agreement areas; **(iii) In an estuarine functional zone**; (iv) A protected area identified in terms of NEMPAA, excluding conservancies; (v) World Heritage sites; (vi) Sites or areas identified in terms of an International Convention; **(vii) Critical Biodiversity areas or ecological support areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;** (viii) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (ix) Core areas in biosphere reserves; (x)Outside urban areas: (aa) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; or (bb) Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined; or (**xi) In urban areas:** **(aa) Areas zoned for use as public open space;**	There will be construction of a new bridge within the uMngeni River, parallel to the existing bridge across the river. The proposed pipeline will be installed on the new bridge across the river. The point where the pipe will cross the uMngeni River falls within the Estuarine Functional Zone. The proposed pipeline will be constructed within the D'MOSS areas along the route and within 32m of wetlands and the river. The recently updated Conservation-Plan (C-Plan) by EKZNW shows that the entire study area is located within a Critical Biodiversity Area 1 (CBA). However, ecologically sensitive areas are identified in the Floral and Faunal Assessments (Appendix D6 and D7 respectively).

		(bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority, zoned for a conservation purpose; or (cc) Areas seawards of the development setback line or within 100 metres from the high-water mark of the sea if no such development setback line is determined.	

In accordance with the EIA Regulations (2014), a BA Report must contain all the information that is necessary for the competent authority to consider the application and to reach a decision which are laid out in the table below. In order to facilitate review by the competent authority, this report is structured around these requirements.

Basic Assessment Report Requirements	Relevant Section of the Report
Details of the EAP who compiled the report and the expertise of the EAP to carry out an environmental impact assessment	Page vi – vii and Appendix G
A detailed description of the proposed activity	Section A
A description of the property on which the activity is to be undertaken and the location of the activity on the property.	Section A
A description of the scope of the proposed activity and the listed activities triggered and applied for.	Section A
A description of the policy and legislative context within which the development is proposed.	Section A
A description of the environment that may be affected by the activity and the manner in which the physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity.	Section B
Details of the public participation process conducted including: (i) Steps undertaken in accordance with the plan of study; (ii) A list of persons, organisations and organs of state that were registered as interested and affected parties; (iii) A summary of comments received from, and a summary of issues raised by registered interested and affected parties, the date of receipt of these comments and the response of the EAP to those comments; and (iv) Copies of any representations and comments received from registered and affected parties.	Section C
A description of the need and desirability of the proposed activity	Section A
A description of the need and desirability of the activity in the context of the preferred location	Section A
A motivation of the preferred site, activity and technology alternative.	Section A
A description of the process followed to reach the proposed preferred alternative within the site.	Section A
A description of identified potential alternatives to the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity.	Section E
A description of the process undertaken to identify, assess and rank the impacts the activity will impose on the preferred location through the life of the activity.	Appendix D
A description and comparative assessment of all alternatives identified during the environmental impact process.	Section A and E
A summary of the findings and recommendations of any specialist report or report on a specialised process.	Section B, F and G
A description of all environmental issues that were identified during the environmental impact assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures.	Section F
An assessment of each identified potentially significant impact.	Section F
A description of assumptions, uncertainties and gaps in knowledge.	Section D
A summary of the findings and impact management measures identified in the specialist report and an indication as to how these findings and recommendations have been included in the report.	Section A, B, F and G

Basic Assessment Report Requirements	Relevant Section of the Report
A reasoned opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation.	Section G
An environmental impact statement which contains a summary of the key findings and a comparative assessment of the positive and negative implications.	Section G
A draft Environmental Management Programme	Appendix F
Findings of the EAP and specialist which are to be included as conditions of the EA	Section G
Undertaking of an oath by the EAP	Appendix G
Copies of any specialist reports and reports on specialist processes.	Appendix D
Any specific information that may be required by the competent authority.	Project Summary

A-2.2 National Water Act, 1998 (Act No. 36 of 1998)

The National Water Act, 1998 (Act No. 36 of 1998) (NWA) aims to provide management of the national water resources to achieve sustainable use of water for the benefit of all water users. This requires that the quality of water resources is protected as well as integrated management of water resources with the delegation of powers to institutions at the regional or catchment level. The purpose of the Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in responsible ways.

Of specific importance to this application is Section 19 of the NWA, which states that an owner of land, a person in control of land or a person who occupies or uses the land which thereby causes, has caused or is likely to cause pollution of a water resource must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring and must therefore comply with any prescribed waste standard or management practices.

There are various water use activities that are triggered as a result of construction of the proposed pipeline that will require an Integrated Water Use Licence Application (IWULA) to be submitted to the Department of Water and Sanitation (DWS) for approval, in terms of Section 21 of the National Water Act, 1998 (Act No. 36 of 1998).

An IWULA will be submitted for the following water uses, as there are various watercourses and wetlands occurring within the study area of the proposed construction activities:

- Section 21 (c) - Impeding or diverting the flow of water in a watercourse and altering the bed, banks, course or characteristics of a watercourse.
- Section 21 (i) Altering the bed, banks or characteristics of a watercourse.

The IWULA and the BA processes will run concurrently.

A-2.3 Other Legal Requirements

A-2.3.1 Acts

Constitution of the Republic of South Africa

The Constitution of the Republic of South Africa has major implications for environmental management. The main effects are the protection of environmental and property rights, the change brought about by the sections dealing with administrative law, such as access to information, just administrative action and broadening of the locus standing of litigants. These aspects provide general and overarching support and are of major assistance in the effective implementation of the environmental management principles and structures of the NEMA. Section 24 in the Bill of Rights of the Constitution specifically states that:

Everyone has the right -

- To an environment that is not harmful to their health or well-being; and
- To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that -
    - Prevent pollution and ecological degradation;
    - Promote conservation; and
    - Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)

The purpose of the Biodiversity Act is to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA and the protection of species and ecosystems that warrant national protection. As part of its implementation strategy, the National Spatial Biodiversity Assessment was developed.

This Act is applicable to this application for environmental authorisation, in the sense that it requires the project applicant to consider the protection and management of local biodiversity.

Aloe cooperi (currently listed as Declining) and *Hypoxis hemerocallidea* (currently listed as Declining) was confirmed in the areas associated with the preferred pipeline route. These plants are nationally protected by the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).

National Forest Act, 1998 (Act No. 84 of 1998)

The main purpose of the National Forests Act, 1998 (Act No. 84 of 1998) is to promote the sustainable management and development of forests for the benefit of all by creating the conditions necessary to restructure forestry in State forests; provide special measures for the protection of certain forests and trees; promote the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes.

One protected tree species, *Sclerocarya birrea* (Marula), was confirmed in the area associated with the preferred pipeline alternative, this included seedlings within the rehabilitated area of the existing pipeline. A permit will be required from DAFF if any of these specimens are going to be destroyed or damaged during the construction of the pipeline.

National Heritage Resources Act, 1999 (Act No. 25 of 1999)

This Act legislates the necessity for cultural and heritage impact assessment in areas earmarked for development, which exceed 0.5 hectares (ha) and where linear developments (including roads) exceed 300 metres in length. The Act makes provision for the potential destruction to existing sites, pending the archaeologist's recommendations through permitting procedures. Permits are administered by Amafa KwaZulu-Natal, the Provincial Heritage Resources Authority.

Refer to Section B-2.2 and B-2.3 for heritage resources identified along the preferred pipeline route.

Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)

To provide for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith.

In terms of the amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983), landowners are legally responsible for the control of alien species on their properties.

Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)
To provide for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work; to establish an advisory council for occupational health and safety; and to provide for matters connected therewith.

Promotion of Access to Information Act, 2000 (Act No. 2 of 2000)
The Act recognises that everyone has a Constitutional right of access to any information held by the state and by another person when that information is required to exercise or protect any rights. The purpose of the Act is to foster a culture of transparency and accountability in public and private bodies and to promote a society in which people have access to information that enables them to exercise and protect their rights.

A-2.3.2 National and Provincial Policies and/or Guidelines

a) Integrated Environmental Management (IEM)
IEM is a philosophy for ensuring that environmental considerations are fully integrated into all stages of the development process. This philosophy aims to achieve a desirable balance between conservation and development (DEAT, 1992). The IEM guidelines intend encouraging a pro-active approach to sourcing, collating and presenting information in a manner that can be interpreted at all levels.

The Department of Environmental Affairs (DEA) Integrated Environmental Management Information Series guidelines were also consulted during this BA process.

b) Schedule 5 of the KwaZulu-Natal Nature Conservation Management Amendment Act, 1999 (Act No. 5 of 1999)
This Act amends the KwaZulu-Natal Nature Conservation Management Act in a wide variety of matters relating to, among other things, the establishment and powers and functions of the KwaZulu-Natal Nature Conservation Board, the organization of the Kwazulu-Natal Nature Conservation Service, powers of honorary officers, protected areas, hunting, etc.

Provincially protected species which were confirmed in the corridor of the preferred pipeline route included the following:

- *Gladiolus* sp. – *Gladiolus* sp. was recorded in the wooded grasslands and although this species was not in flower at the time of the survey, all species in the genus are protected;
- *Eugenia albanensis* – Recorded in the wooded grasslands, all species in the genus are protected;
- The two species of conservation concern, *Aloe cooperi* and *Hypoxis hemerocallidea* are also provincially protected. Both species were recorded in the wooded grasslands.

The plant species listed above, may not be removed, picked, pruned or destroyed without permission or a permit from the KZN Department of Agriculture, Forestry and Fisheries (DAFF). Permits for the relocation and/or destruction of these plant species will be applied for, subsequent to receipt of the Environmental Authorisation (EA).

c) National Spatial Biodiversity Assessment
The National Spatial Biodiversity Assessment (NSBA) classifies areas as worthy of protection based on its biophysical characteristics, which are ranked according to priority levels.

d) Protected Species – Provincial Ordinances
Provincial ordinances were developed to protected particular plant species within specific provinces. The protection of these species is enforced through permitting requirements associated with provincial lists of protected species. Permits are administered by the KZN Department of Forestry and Fisheries (DAFF).

e) Accelerated Shared Growth Initiative for South Africa (ASGISA)

ASGISA resulted from Government's commitment to halve unemployment and poverty by 2014 and was launched in February 2006. ASGISA is not a government programme but a national initiative supported by key groups in the economy *viz*, Business, Labour, State-owned enterprises, Government economic agencies, Entrepreneurs and all spheres of government[2].

f) KwaZulu-Natal Heritage Act, 2008 (Act No. 4 of 2008)

KwaZulu-Natal Heritage Act provides for the conservation, protection and administration of both the physical and the living or tangible heritage resources of the Province of KwaZulu-Natal; and to establish a statutory Council to administer heritage conservation in the Province. Amafa / Heritage KwaZulu-Natali is the provincial heritage conservation agency for KwaZulu-Natal. Amafa was established as a statutory body in terms of the KZN Heritage Act of 1997, replaced by the KZN Heritage Act of 2008.

g) Provincial Spatial Economic Development Strategy (PSEDS)

The PSEDS is aimed at transforming the structure of the economy and narrowing and eventually eliminating the gap between the first and second economies. The four pillars of the strategy are as follows:

- Increasing investment in the province;
- Skills and capacity building;
- Broadening participation in the economy; and
- Increasing competitiveness.

The PSEDS identifies the sectors of the provincial economy which will drive the growth of the province and address unemployment and poverty as follows:

- Agriculture - including agri-industry (with opportunities to impact considerably on the economic needs of the poor through Land Reform);
- Industry - including heavy and light industry and manufacturing;
- Tourism - including domestic and foreign tourism; and
- Service sector - including financial, social, transport, retail and government.

A-2.3.3 Local Policies and/or Guidelines

a) eThekwini Municipality Integrated Development Plan (IDP)

eThekwini Municipality's IDP (2009/2010) has identified the following challenges:

- Low economic growth and high rate of unemployment;
- Access to basic household and community services are less than optimal;
- Relatively high levels of poverty;
- Low levels of literacy and skills development;
- Sick and dying population affected by HIV/AIDS;
- Exposure to unacceptably high levels of crime and risk;
- Many development practices still unsustainable; and
- Ineffectiveness and inefficiency of inward-looking local government still prevalent in the Municipality.

In order to achieve the vision of the municipality, six key choices have been identified which are used to create a framework around which the IDP can be implemented. These choices are as follows: -

- Improving our port and logistics Infrastructure;
- Using LUMS to increase densities and to reduce urban sprawl;
- Bridging the digital divide;
- Promoting public transport;

2 http://www.info.gov.za/asgisa/

- Prioritising Eco-Tourism; and
- Ensuring ecological integrity.

These choices, together with the city's 8 Point Plan, provide the underlying basis upon which the city is to grow and develop.

With regard to economic development the municipality aims to contribute towards the achievement of the key national targets, that is, annual growth rate of 6% between 2010 and 2014, as per the Accelerated and Shared Growth-SA Initiative (ASGISA).

Some of the key spatial planning issues that are contained within the IDP document and are applicable to proposed development are as follows:

- A need for strategic economic growth and investment;
- A need to protect key environmental assets and services; and
- A need to manage development growth.

b) eThekwini Municipality Spatial Development Framework (2014)

The provision of quality basic services in the eThekwini Metropolitan Municipality is a crucial element in the Spatial Development Framework. Water, electricity, sanitation, waste removal and other social amenities are key critical services which have been identified by communities that are required to meet their basic needs. However, due to limited funding and exponential growth in the eThekwini Municipality this has only increased the levels of backlogs of essential services. Vast strides have been made by the Municipality to address the service delivery backlogs and specific strategies have also been developed to deal with the existing backlogs. The eThekwini Municipality Spatial Development Framework makes reference to the provision of water supply in the city. The eThekwini supplies water to 852 000 customers. However, the Spatial Development Framework acknowledges that the Metropolitan area is experiencing serious difficulties in the provision of water supply. Poor long term infrastructure planning and a decline in investment in bulk infrastructure over the last 20 years have placed pressures on the supply of water. Furthermore, if the Metropolitan receives below average rainfall, there will be a need for water restrictions. Currently the backlog for water supply sits at 74 481 households and will take 37 years to meet. It is crucial for the continued economic growth and development of the eThekwini region that there is an assured water supply in line with DWS's policy of water for growth and development.

The eThekwini Municipality is committed to ensuring that all backlogs in the provision of infrastructure are removed and as such has embarked on a Municipal Infrastructure Investment Framework for the Municipality. It is within this context that the Northern Aqueduct Phase 5 project falls into.

c) Durban Metropolitan Open Space System (D'MOSS)

The proposed pipeline will traverse through D'MOSS areas. Refer to Figure 10: Locality Map for an illustration of the pipeline route in relation to the D'MOSS.

D'MOSS is a system of open spaces, some 74 000 ha of land and water, that incorporates areas of high biodiversity value linked together in a viable network of open spaces. D'MOSS is mapped by the Biodiversity Planning Branch of the Environmental Planning and Climate Protection Department (EPCPD) in consultation with relevant experts. D'MOSS thus provides a unique opportunity to conserve many of South Africa's threatened ecosystems. If protected and managed, D'MOSS will assist the province and the country in meeting biodiversity conservation targets.

Apart from contributing to the attainment of provincial and national biodiversity conservation targets, D'MOSS provides a range of ecosystem goods and services to all residents of Durban, including the formation of soil, erosion control, water supply and regulation, climate regulation, cultural and recreational opportunities, raw materials for craft and building, food production, pollination, nutrient cycling and waste treatment.

A meeting was held with the eThekwini Climate Protection unit on 18 February 2015 to understand the key concerns with regard to the proposed pipeline traversing the D'MOSS areas. As per the findings of the Floral and Faunal Assessments, the D'MOSS areas within the study that have high ecological significance i.e. closed canopy woodland / forest, wooded-grassland habitats, and areas with medium-high ecological significance i.e. *Hyparrhenia hirta* grasslands requires route realignments. The suggested route realignments and the extent to which these have been accommodated in the final preferred route alignment are discussed in more detail in Section A-1.2. The technical feasibility, biophysical and socio-economic impacts of the route realignment options were considered in reaching the final preferred route alignment.

There are other areas along the preferred route that occur within D'MOSS areas and these areas have low and medium ecological importance. The vegetation types in these areas are mainly alien shrubland and alien tree woodland. Route re-alignment is therefore not required for these areas.

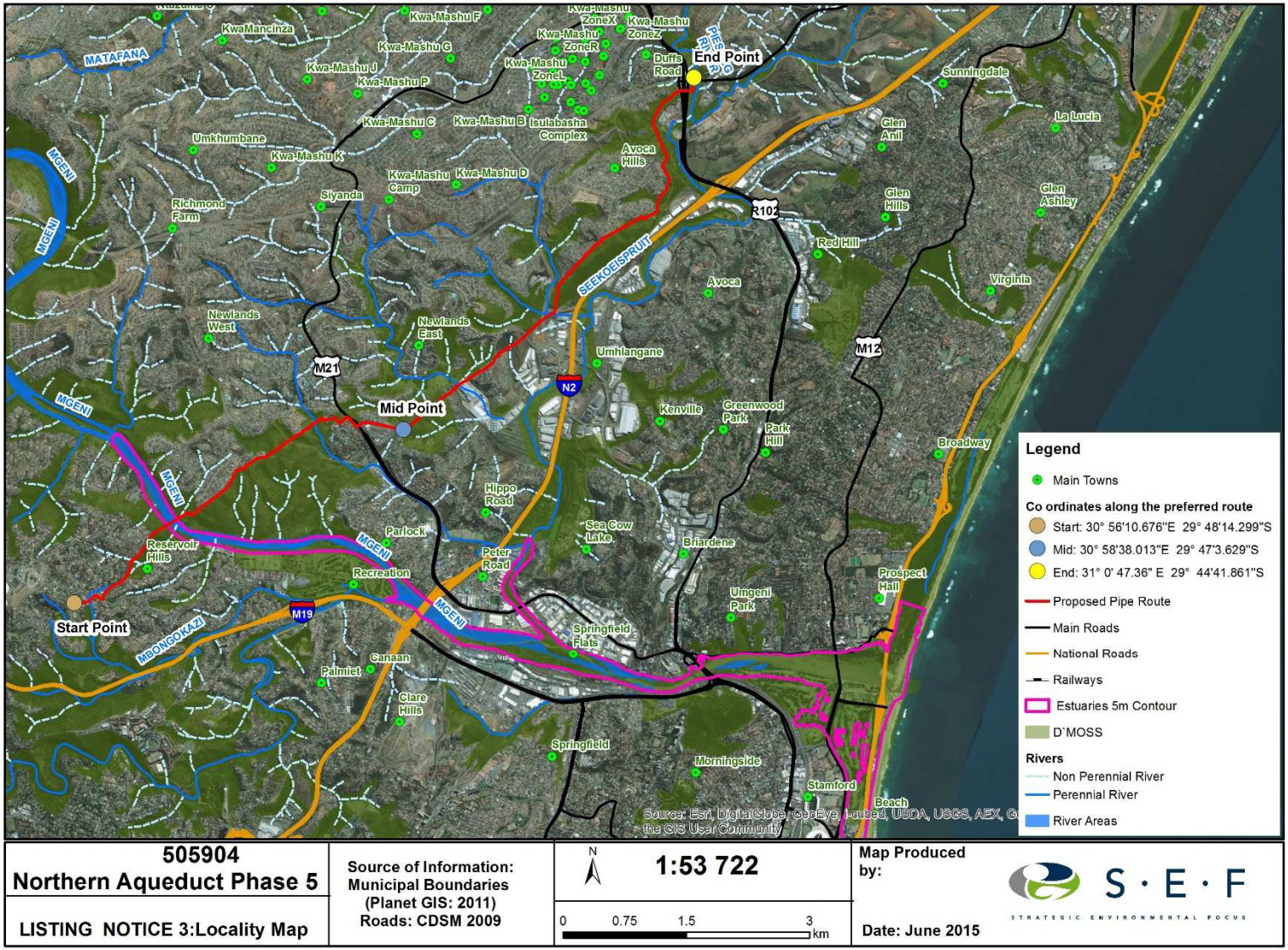


Figure 10: Proposed Pipeline Route in relation to the D'MOSS areas

A-3 DETAILS OF THE APPLICANT

The details of the project applicant are:

Name of Applicant	Postal Address	Relevant Numbers
Mr. Ednick S.M.B. Msweli eThekwini Water and Sanitation Department	P.O. Box 1038 Durban 4000	Tel: 031 311 8605 Cell: 083 989 0720 Fax: 031 311 8699 E-mail: Ednick.Msweli@durban.gov.za

A-4 NEED AND DESIRABILITY OF THE PROJECT

The existing Northern Aqueduct system operated by EWS comprises of a network of potable bulk water supply pipelines that serve the north eastern region of the EWS area of supply. The Northern Aqueduct conveys potable water from the Durban Heights Waterworks to several terminal reservoirs and high level pressure zones, which supply commercial and residential consumers in the northern areas. The existing Northern Aqueduct pipeline system has, however, reached its flow capacity at various sections of the trunk main system as a result of growth in demand from major new developments and urbanization to the north east of Durban.

Therefore, in order to provide a sustainable and assured supply of water to meet future demands in the northern areas of Durban, EWS has identified the requirement for a new gravity bulk water supply pipeline from Durban Heights Waterworks in Reservoir Hills and various other upgrades and changes to the bulk network, which are to be implemented in various phases. The latter has been called the Northern Aqueduct Augmentation Project (NAA).

Through the implementation of the Northern Aqueduct Phase 5 project, there would be an improved water supply, to a greater number of recipients, and water pressure, and a more reliable, predictable supply of water is expected to be of benefit to society. There will be less likelihood of water shortages or any other effects associated with restricted water supply.

A-5 NEED AND DESIRABILITY OF THE PROJECT IN RELATION TO ITS LOCATION

In terms of the preferred location of the proposed pipeline, the Phase 5 is intended to augment the existing Northern Aqueduct System from Durban Heights in Reservoir Hills to Duffs Road and connects and provides water via the Phase 4 and Phase 1 pipelines.

Phase 1 (EA obtained and the project is under construction) involves the following:

- The laying and commissioning of the section of pipeline linking Phoenix 2 reservoir to the proposed Blackburn Reservoir; and
- The laying and commissioning of the section of pipeline from the Blackburn Reservoir off-take to Umhlanga 2 Reservoir.

Phase 4 (EA obtained and the project is under construction) involves the following:

- The laying and commissioning of the section of pipeline linking Duffs Road to Phoenix 2 Reservoir;
- The laying and commissioning a section of pipeline link to Phoenix 1 Reservoir; and
- The upsizing of the existing inlet main to Phoenix 1 Reservoir.

Phase 5 of the project comprises of the following:

- The laying and commissioning of the section of pipeline from Durban Heights to Aloes Reservoir; and
- The laying and commissioning of the section of pipeline from the Aloes Reservoir to Duffs Road.

Therefore, the location of the Phase 5 pipeline commences at the tie-in chamber on Pridley Road in Reservoir Hills, is routed through the north eastern part of the Durban to connect with the Aloes Reservoir in Quarry Heights and end at the blank flange in Duffs Road.

A route determination process was undertaken to arrive at the most preferred route alignment that will have minimal impact on the receiving biophysical and socio-economic and cultural environment. Key factors in arriving at the preferred route, were favorable topography, accessibility to the site(s) in case of emergencies, maintenance and servicing, minimising of fragmentation of private land by keeping the route at the edge of the cadastral boundaries, approvals from services providers to follow alongside existing servitudes, minimising the impact on D'MOSS vegetation of high and medium-high ecological importance, minimising destruction of the wetland and riparian habitats, avoidance of destruction of areas of religious and cultural importance and minimization of destruction to existing services and infrastructure such as roads.

Various recommendations were provided by the specialist investigations that informed the final preferred pipeline route alignment. The environmental impacts of the proposed development i.e. the biophysical, social and economic impacts were evaluated to ensure that the proposed development is in line with the principles of sustainable development.

SECTION B: THE RECEIVING ENVIRONMENT

In order to, with any level of confidence, assess the potential impacts of the proposed development on the receiving environment, one needs to first assess the baseline conditions found over the study area. Using this *Status Quo* one can then, broadly speaking, determine the likely impacts that will emanate from a specific development typology on a well-defined receiving environment. The findings of the various Specialist Studies forms the basis of the description of the receiving biophysical and socio-economic environment within the study area.

B-1 BIOPHYSICAL ENVIRONMENT

B-1.1 Geology

A Desktop Assessment of the underlying geology of the study area was provided by PGS Heritage. The findings of the assessment are discussed below.

Most of the study area is underlain by Ordovician to Silurian-aged quartzites of the Natal Group, Carboniferous to Permian aged tillites of the Dwyka Group, Permian aged shales of the Pietermaritzburg Formation, Permian aged sandstone of the Vryheid Formation of the Karoo Supergroup, Jurassic aged Dolerite and Quaternary aged alluvium (Figure 11).

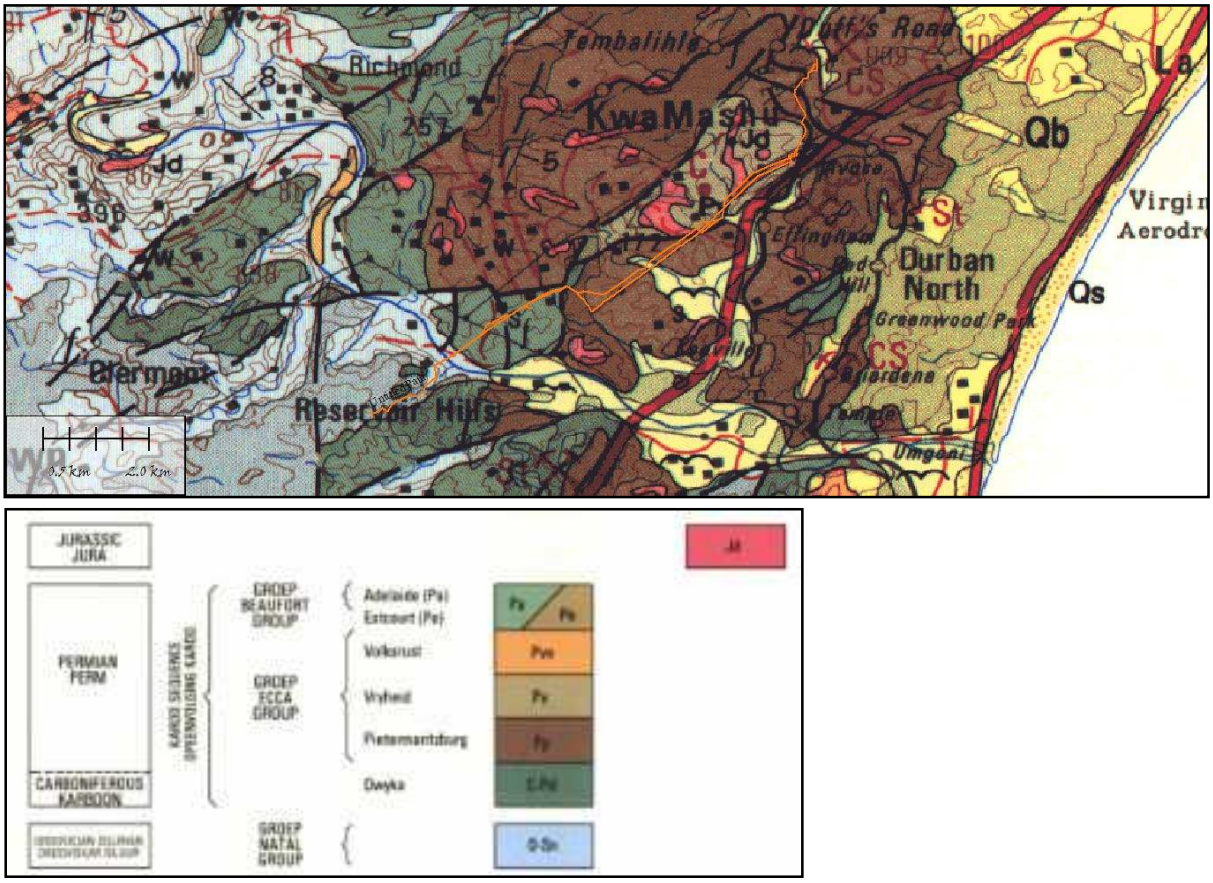


Figure 11: Geology of the study area (Pipeline in yellow)

B-1.1.1 Natal Group

The Ordovician to Silurian Aged Natal Group consists predominantly of relatively clean quartzite, with minor shale beds.

B-1.1.2 Dwyka Group

The Carboniferous to Permian aged Dwyka Formation is an assemblage of diamictites and glacial sediments, consisting of a mixture of fine-grained, poorly sorted sediments ranging from fine-grained silts and shales to sandy shales, with larger dropstones and angular cobbles in places. The deposits represent glacial activity in this part of Gondwanaland during the Carboniferous and Early Permian (Johnson et al, 2006).

B-1.1.3 Ecca Group

a) Pietermaritzburg Formation

The Permian aged Pietermaritzburg Formation consists mainly of dark grey to black shale deposits.

b) Vryheid Formation

The Permian aged Vryheid Formation consists mainly of coarse-grained sandstone and carbonaceous shale, with some prominent coal beds in many parts of the basin.

c) Dolerite

The Jurassic aged dolerite forms part of the main suite of Karoo Dolerite that was intruded during the breakup of Gondwanaland.

d) Alluvium

The alluvium deposits are associated with the deposits of the recent rivers in the area.

B-1.2 Soils and Agricultural Potential

A Soils and Agricultural Potential Assessment was undertaken by Mr. John Phipson of Mzansi Agriculture in February 2015 (refer to the study in Appendix D1). He is a member of the Custodians of Rare and Endangered Wildflowers and the Zululand Indigenous Tree Society. He is, or has been, a member of a number of soil fertility and crop management interest groups. His experience in this field is provided in Table 3 of the BAR.

The findings of the soils and agricultural potential assessment are as follows:

The land that the proposed pipeline route will traverse, has no productive agricultural or agribusiness value. No crops were found on or adjacent to the pipeline route. Apart from a few tethered goats and loose range chickens within properties close to the route, no livestock was noted. The goats seen were ‘Boerbokke’ imported from the Northern Cape or Namibia for ritual purposes.

Due to the shallow soils and rocky substrates found along the route, the aqueduct and its supporting structures will almost invariably be embedded into deep shale and solid rock.

The most commonly encountered soils along the route are as follows:

- The Mispah Soil Form;
- The Glenrosa Soil Form.

The Mispah Soil Form occurs throughout KZN, except for the Coastal Sands Soil System. The topsoil is typically sandy loam and is widespread through the site.

The Glenrosa Soil Form differs from Mispah Soil Form in its extent to which the rock and shale stratum has weathered. The weathering process allows tongues of soil to form into the rock, thus permitting deeper root, nutrient and moisture penetration. Mispah and Glenrosa Soil Forms frequently occur next to each other or in a

transitional phase from Mispah to Glenrosa.

The determinants of the Land Capability Class (LCC) of the soil along the route are measured against the following:

- Soil texture (clay content);
- Slope % of surrounding area
- Effective rooting depth
- Moisture intake rate
- Soil permeability
- Soil wetness
- Rockiness

All the soil profiles within the study area matched LCC VII, implying that the soil is suitable for livestock and game only. A description of the LCC VII is provided below:
"Land in Class VII has very severe limitations that make it generally unsuited to cultivation and that restricts its use largely to grazing, woodland, wildlife,; restrictions are more severe than those for Class VI because of the more continuing limitations that cannot be corrected, such as very steep slopes, erosion, shallow soil, stones, wet soil, salts or sodicity and unfavourable climate".

The soil conditions along the proposed pipeline route are provided in Table 10.

Table 10: Soil conditions along the pipeline route

Ref	Co-ordinates	Soil Form	Slope %	Texture (Clay%)	Depth (mm)	Permeability	Wetness	Land Capability Class (LCC)
1.	South : 29.48.13.8" East : 30.56.13.6"	Mispah/ Witbank	>20	<15	100-200	4	W0	VII
2.	South : 29.48'.11.60" East : 30.56'.19.80"	Mispah/ Witbank	>20	<15	100-200	4	W0	VII
3.	South : 29.48'.5.23" East : 30.56'.31.84"	Mispah	>20	<15	100-200	4	W0	VII
4.	South : 29.48'.1.63 " East : 30.56'.35.03"	Mispah	>20	<15	100-200	4	W0	VII
5.	South : 29.47'.57.60" East : 30.56'.35.45"	Mispah	>20	<15	100-200	4	W0	VII
6.	South : 29.47'.48.01" East : 30.56'.44.27"	Mispah	>20	<15	100-200	4	W0	VII
7.	South: 29.47'.42.05" East : 30.56'.57.94"	Mispah/ Glenrosa	>20	<15	100-200	4	W0	VII
8.	South : 29.47'.35.85" East : 30.57'.7.52"	Glenrosa	>20	<15	100-200	4	W0	VII
9.	South : 29.47'.17.28" East : 30.57'.35.98"	Glenrosa	>20	<15	100-200	4	W0	VII

Ref	Co-ordinates	Soil Form	Slope %	Texture (Clay%)	Depth (mm)	Permeability	Wetness	Land Capability Class (LCC)
10.	South : 29.46'.57.73" East : 3.0.58'.10.77"	Mispah	>20	<15	100-200	4	W0	VII
11.	South : 29.46'.57.73" East : 30.58'.10.77"	Glenrosa	>20	<15	100-200	4	W0	VII
12.	South : 29.47'.0.97" East : 30.58'.22.62"	Witbank	<12	<15	100-200	4	W0	VII
13.	South : 29.47'.2.88" East : 30.58'.34.01"	Milkwood	<12	15 to 30	200-250	4	W0	VII
14.	South : 29.46'.47.93" East : 30.58'.55.10"	Glenrosa	>20	<15	100-200	4	W0	VII
15.	South : 29.46'.34.57" East : 30.59'.13.51"	Mispah/ Glenrosa	>20	<15	100-200	4	W0	VII
16.	South : 29.46'.21.96" East :30.59'.30.33"	Mispah/ Glenrosa	>20	<15	100-200	4	W0	VII
17.	South : 29.46'.17.46" East : 30.59'.44.06"	Mispah	>20	<15	100-200	4	W0	VII
18.	South : 29.46'.0.48" East : 30.59'.52.22"	Witbank	>20	<15	100-200	4	W0	VII
19.	South : 29.45'45.64" East : 31.0'12.87"	Glenrosa	>20	<15	100-200	4	W0	VII
20.	South : 29.45'26.94" East : 31.0'35.45"	Mispah	>20	<15	100-200	4	W0	VII
21.	South : 29.45'14.49" East : 31.0'36.05"	Mispah	>20	<15	100-200	4	W0	VII
22.	South : 29.44'51.51" East : 31.0'36.95"	Glenrosa	>20	<15	100-200	4	W0	VII

With regard to the erodibility of the soils along the preferred pipeline route, it is noteworthy that although most of the slopes encountered along the route are steep, no evidence was found of any soil erosion of consequence, even though the light topsoil texture lends itself to this risk. The perceived lack of soil erosion in the study area can mainly be attributed to the nature of the ground cover as evidenced by the high incidence of poor quality grasses which have substantial above surface biomass and strong root systems, effectively absorbing and arresting a portion of any precipitation, while the roots hold the grasses firmly in place, thus reducing the effect of the basic cause of water erosion of soils, namely the combination of high volume and velocity flows.

Typical of these grasses are Ngongoni Three-awn (*Aristida junciformis*) and thatching grasses (*Hyparrhenia* and *Cymbopogum* species). Similarly, dense overhead vegetation and liberal scatterings of leaf litter trap rainfall, thus inhibiting acceleration of runoff.

In terms of rainfall, although this is a relatively small catchment, it feeds into an area that is already experiencing

water shortages. Steep slopes and shallow topsoils underlain by impervious substrata contribute towards run off into the valleys and streams in this area. Care must be taken to avoid impairing this flow as this water will ultimately be needed to supplement water supplies to the low lying areas along the uMngeni River.

In conclusion, it was found that "There is no material reason from either a soils or agricultural standpoint why the aqueduct project should not go ahead. The soils are of an extremely poor quality and agricultural activity along the route is zero" (Phipson, 2015).

B-1.3 Hydrology

B-1.3.1 Geohydrology

A Geohydrological (Hydrocensus) Assessment was undertaken by Mr. John Sibanyoni of Strategic Environmental Focus (SEF) in April 2015 (refer to the study in Appendix D2). Mr. Sibanyoni has 10 years of experience and is a registered hydrologeologist with the South African Council for Natural Scientific Professions (SACNASP). The findings of this study are as follows:

The Geohydrological Assessment was undertaken in the form of a hydrocensus survey to collect baseline data for the assessment of the study area and impacts associated with the proposed project. This study focused on impacts related to the groundwater component based on surface activities.

Hydrochemical samples were submitted to a laboratory (Waterlab) which is registered with the South African National Accreditation System (SANAS). Water quality results were assessed against the South African Drinking Water Standard (241: 2011). The overall results indicated the following:

- Sampled points DP05, DP09 and DP10 indicated exceedances on nitrates (NO_3);
- Sampled points DP01, DP02; and DP03 indicated exceedances on iron (Fe);
- Manganese (Mn) exceeded the limits for the following sampled points;
- Water samples from DP03, DP04, DP06 and DP10 observed exceeded limits on Manganese (Mn); and
- Bacteriological results for the total coliforms have been exceeded for all selected points namely: UMG01, DP08, DP03, DP05, DP07 and SR01.

The exceedance on total coliforms can be attributed to an anthropogenic pollution associated with sewage discharge/leakage within the study area. The exceeded iron and manganese levels can be attributed the natural weathering of the shallow subsurface rocks within the area while nitrates can be associated with agricultural activities such the use of manure on the small-scale farming observed in the study area.

a) Hydrogeology of the study area

The hydrodynamic conditions of the site were discussed based on the geological influence of the study area. As discussed in the geology section above, the site is mostly underlain by the tillite of the Dwyka Formation from the southern start of the pipeline to Newland West. However, the central part of the pipeline layout (Newlands East to Avoca Hills) is underlain by the shale while the northern tip of pipeline is comprised of quartzite arenite (sandstone) of the Ecca Group.

The study area falls within the quaternary catchment U20M with general groundwater flow direction that is predominantly to the east. However, localised groundwater flow is towards the streams (lower-gradients) and converges to the east or reporting to the stream as baseflow. Fracture flow controls the flow direction on localised scale but the general flow mimics the topography. The aquifer type is indicated as intergranular and fractured.

The nature of the water-bearing rock is an assemblage of compact sedimentary, extrusive and intrusive rocks and other surrounding can be dominantly arenaceous strata or compact tillite and shale. The following

information from Water Research Commission (WRC) (2001) and Vegter (1995) is relevant particularly for future drilling purposes:

- The probability of drilling a successful borehole yielding greater than 2*l/s* (exploitability) is 10-20%;
- The probability of drilling a successful borehole (>0.1L/s) (accessibility) is 40-60%;
- Recommended drilling depth below groundwater level 20-30m;
- Mean depth to groundwater level is 10-20m with standard deviation range from mean greater than 15m;
- Mean annual flow (base flow) is 25-50mm;
- Mean annual recharge is 50-75mm/a;
- Aquifer classification is minor;
- Aquifer vulnerability ratings is moderate (lower part) to least (at upper part of the study area); and
- Aquifer susceptibility is medium to low.

b) Hydrochemical Analysis

The hydrochemical results were assessed with the consideration of the potential sources of contamination observed on site during the hydrocensus survey. Of the 14 samples taken from surface water and seepages or spring water, six samples were analysed for possible bacteriological contamination based on the observations noted from the site. The results were assessed against South African Drinking Water Standards, SANAS 241 of 2011. The following comments based the analyses are relevant:

- Nitrates (NO_3) exceeded the limits for the following sampled points (site IDs):
  - DP05;
  - DP09; and
  - DP10;

- Iron (Fe) exceeded the limits for the following sampled points:
  - DP01;
  - DP02; and
  - DP03.

- Manganese (Mn) exceeded the limits for the following sampled points:
  - DP01;
  - DP03;
  - DP04;
  - DP06; and
  - DP10.

- Bacteriological results for the total coliforms have been exceeded for all selected points provided below:
  - UMG01;
  - DP08;
  - DP03;
  - DP05;
  - DP07; and
  - SR01.

The exceedance of the limits on total coliforms is related to the observed sewage water entering the stream. In other instances, water smelled of the sewage contamination. The exceeded iron and manganese can be attributed the natural weathering of the shallow subsurface rocks within the area. Samples with exceeded iron are mostly from the seepage water where no visible human activities were observed.

The exceeded limit on nitrates is likely to be associated with small-scale farming (observed from site) which might have manure impact on water quality.

B-1.3.2 Wetland and Riparian Habitats

A Wetland / Riparian Delineation and Functional Assessment was undertaken by Mr. Willem Lubbe of SEF (refer to the study in Appendix D3). Mr. Lubbe is a Professional registered specialist and his experience in undertaking Wetland / Riparian Assessments is detailed in Table 3 of the BAR.

Five Hydro-Geomorphic (HGM) units, comprising two hydro-geomorphic types, namely valley bottom floodplain wetland and channelled valley bottom wetland, were delineated and classified within the study area and within 500m surrounding the proposed pipeline routes. In addition, several riparian areas were also delineated throughout the study area, some in conjunction with channelled valley bottom wetlands.

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services, including sediment trapping, nitrate removal, toxicant removal, erosion control, carbon storage, maintenance of biodiversity and flood attenuation. Present Ecological State scores were determined for wetlands within the study area using Wet-Health Level 2 assessment which indicated that wetlands within the study ranged from a moderately modified state to a seriously modified state depending on historic impacts on specific wetlands. The Ecological Importance and Sensitivity assessment was undertaken to rank water resources in terms of provision of goods and services or valuable ecosystem functions which benefit people, biodiversity support and ecological value and reliance of subsistence users. Ecological Importance and Sensitivity assigned to the HGM units ranged from low to high depending on their specific attributes within the study area. The most important wetland in terms of Ecological Importance and Sensitivity was wetlands associated with the uMngeni River as well as the Umhlangane River in combination with several confirmed biodiversity features and hydrological functional importance associated with the wetlands in the study area.

a) National Freshwater Ecosystem Priority Areas (NFEPA's)

The NFEPA project aims to:

- Identify Freshwater Ecosystem Priority Areas (hereafter 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.

Based on current outputs of the NFEPA project (Nel et al., 2011), the uMngeni River in the vicinity of the pipeline crossing is regarded as an estuarine FEPA, based on the mapped extent of the Estuarine Functional Zone, which was defined laterally as anything below the 5m mean sea level contour, and longitudinally as far as tidal variation or salinity penetration, whichever goes further upstream. Where this was not known, the 5m mean sea level contour was used as the upstream boundary (SEF, 2015a).

Further, a wetland cluster at Newlands East was identified to correspond with several portions of the various route alternatives. The wetland cluster contains wetlands that were identified by regional experts as impacted Working for Wetlands sites (refer to Figure 3 of Appendix D3). The 500m buffer of the proposed pipeline route does not fall within the wetland cluster (which appears to be transformed).

b) Wetland and Riparian Vegetation

The disturbed conditions in and around Durban as a result of historic anthropogenic impacts made vegetation a poor wetland indicator, particularly for temporary zoned wetland habitats. The desiccation of wetland habitat through negative impacts on the wetlands hydrology and geomorphology has caused the vegetation species composition to shift towards terrestrial and upland species. Species identified within the temporary zonation included *Eragrostis plana, Setaria sphacelata, Cymbopogon* sp*.* and *Aristida* sp.. Seasonal and especially permanent waterbodies were better represented by typical wetland-associated vegetation species such as *Typha capensis* (Bulrush), *Phragmites australis* (Common reed), *Persicaria* spp., *Mariscus congestus, Carex*

sp*., Cyperus* sp*., and Schoenoplectus* sp*.*. The presence and dominance of invasive species such as *Canna indica* (Canna), *Cardiospermum grandiflorum* (Balloon Vine) and *Pennisetum clandestinum* (Kikuyu) were common in wetland habitat.

Natural riparian habitat within the study area was structurally dominated by shrub and tree species such as *Faurea saligna, Ficus natalensis, Heteropyxis natalensis, Hippobromus pauciflorus, Spirostachys africana, Strychnos spinosa, Trimeria grandifolia*, *Monanthotaxis caffra, Ochna natalitia, Phyllanthus reticulatus, Asparagus falcatus,* and *Dioscorea sylvatica.* Anthropogenic impacts on the riparian habitat was evident as species composition was often dominated by declared invasive species such as *Arundo donax* (Giant Reed), *Bidens pilosa* (Blackjack), *Cestrum laevigatum (*Inkberry), *Chromolaena odorata* (Triffid Weed*), Colocasia esculenta* (Madumbi), *Conyza albida* (Fleabane), *Datura stramonium* (Malpitte), *Eucalyptus* spp. (Gum), *Lantana camara* (Tickberry*), Leucaena leucocephala* (Leucaena), *Melia azedarach* (Syringa*), Morus alba* (Mulberry), *Persicaria lapathifolia* (Spotted Knotweed), *Phytolacca dioica* (Balhambra), *Ricinus communis* (Castor Oil), *Rubus cuneifolius* (American Bramble), *Schinus terebinthifolius* (Brazilian Pepper), *Senna didymobotrya* (Peanut Butter Cassia), *Sesbania punicea* (Red Sesbania), *Solanum mauritianum* (Bugweed), *Tagetes minuta* (Khakibos), and *Verbena brasiliensis* (Brazilian Verbena).

c) Delineated wetland and riparian areas

The HGM units identified within the study area are presented in Figure 4, Figure 5, Figure 6 and Figure 7 of the Wetland and Riparian Impact Assessment (refer to Appendix D3). HGM 1, the uMngeni River, was classified as a narrow floodplain valley bottom wetland based on the low slope of 0.1%, the presence of stratified alluvium material as well as floodplain features such as flood terraces. It should be noted that HGM 1 within the study area also forms part of the Estuarine Functional Zone, based on the 5 metre above mean sea level contour.

HGM 2, HGM 3, HGM 4 and HGM 5 were classified as channelled valley bottom wetlands which also contained riparian elements. It should further be noted that HGM 3 contained floodplain features in various sections historically as evident by aerial imagery dating from 1937 (Appendix A of Appendix D3), and was therefore classified as a floodplain valley bottom wetland despite the average slope of 0.2% as taken over 12 kilometres. A large proportion of HGM 3's floodplain features have been infilled for linear infrastructure and industrial parks. The original extent of the floodplain features associated with HGM 3 was difficult to establish (Photograph 3 of Appendix D3).

Several riparian areas were also delineated throughout the study area, some in conjunction with channelled valley bottom wetlands (Figure 4, Figure 5, Figure 6 and Figure 7 of Appendix D3).

d) Functional and Present Ecological State (PES)

Each wetland's ability to contribute to ecosystem services within the study area is also dependant on the particular wetland's Present Ecological State (PES) in relation to a benchmark or reference condition. Present Ecological State scores were determined for wetlands within the study area using Wet-Health Level 2 assessment. Through the use of a scoring system, the perceived departure of elements of each particular system from the "natural-state" was determined (current state versus anticipated future rehabilitated state).

(i) HGM 1

From a functional perspective, HGM 1 (the uMngeni floodplain) was considered to be important for several reasons indicated by ecosystem services scores presented in Figure 8. Floodplains generally receive most of their water during high flow events when waters overtop the streambanks (Kotze *et al*., 2005). Floodplains are considered important for flood attenuation because of the nature of the vegetation and the topographic setting that they occupy. However, as a result of infilling for especially industrial areas as well as the relatively narrow nature of the uMngeni floodplain, flood attenuation of HGM 1 is not expected to be as high as compared to more typical lowland floodplains. According to Kotze *et al*., (2005), flood attenuation is likely to be high early in the season until the floodplain soils are saturated (McCartney *et al.* 1998) and the floodplain depressions filled. In

the late season, the flood attenuation capacity is usually reduced. Nevertheless, even in the late season it is still likely to be carried out to some extent, particularly in drier years. According to SEF (2015a), habitat diversity within the uMngeni River was regarded as being typical of that found in lower foothills, with the substrate dominated by depositional elements. However, the presence of Inanda Dam located some distance upstream of the proposed pipeline crossing does impact on the uMngeni River at the site assessed, as flows within the river downstream of the dam are largely governed by water released from the dam. Additional flows into the uMngeni River downstream of the dam are supported by tributaries. However, being located in urbanised catchments, flows received from such tributaries are often higher than natural flows as a result of increase catchment runoff, therefore increasing the importance of HGM 1's flood attenuation services even further.

Although floodplains are generally unlikely to contribute significantly to stream flow regulation according to Kotze *et al*., (2005), the coarse sandy nature of the uMngeni floodplain could contribute significantly to streamflow regulation compared to typical floodplains which often have soil profiles of a more clayey nature, tending to retain water which is likely to be lost through evapotranspiration thereby limiting their contribution to streamflow regulation.

In general, once the flood overtops the river banks, the velocity of flow decreases laterally, permitting the deposition of particles within the floodplain landscape (Kotze *et al*., 2005). Phosphorous and any toxicants bound to trapped sediments is therefore likely to be effectively retained on the floodplains, and this is a key mechanism through which wetlands trap phosphates (Boto and Patrick, 1979; Hemond and Benoit, 1988). Generally the inundation period in floodplains is short but in the depression features portions of the floodplain inundation is more prolonged and some of the deposited phosphates may be released as a consequence of change in redox potential, given that phosphorus is held more tightly to soil particles under oxidised conditions than under reduced conditions (Cronk and Siobhan Fennessy, 2001; and Keddy, 2002).

Nitrogen removal via nitrification/denitrification is likely to occur but will likely be limited due to short residence times during flood events (which limits contact between the bulk of the water and the sediments) as well as the general lack of lateral footslope seepage zones associated with the uMngeni floodplain. The behavior of nitrogen in floodplain depressions is likely to be similar to that in pans, with cycling between dissolved and organic forms and with some removal from the water through denitrification (Kotze *et al*., 2005).

The study area falls within the Estuarine Functional Zone, which is important for supporting the physical and biological processes and habitats necessary for estuarine function and health. According to Royal HaskoningDHV (2015), despite its highly modified and degraded state, the uMngeni Estuary was ranked the 52nd most important estuary out of 256 systems in South Africa, in terms of its biodiversity and the ecological habitat it provides (Turpie *et al*., 2007). HGM 1 was considered to be very valuable in terms of biodiversity as it serves as a biodiversity corridor for fauna and flora species ranging from estuarine to freshwater and terrestrial ecosystems further inland.

From a Wet-Health perspective, scores obtained for the hydrology module indicated that water inputs (derived from its catchment) and water retention and distribution patterns within HGM 1 itself, have been altered. According to Royal HaskoningDHV (2015), the uMngeni River is severely dammed with four major impoundments, namely the Inanda, Albert Falls, Midmar Dams, and the smaller Nagle Dam. Consequently, the mean annual runoff (MAR) for the system is significantly reduced at 262.68 m3 x 106, which equates to 39% of the natural MAR (DWA, 2011a). In addition, the catchment within the greater Durban area is a highly built up environment which equate to a significant increase in surface stormwater run-off and associated peak volume discharge rates received by the uMngeni River.

From a geomorphological perspective, the highest impact calculated within this wetland complex was related to altered runoff characteristics, which caused channel straightening and loss of stream sinuosity. Further impacts with regards to the geomorphology included infill of floodplain habitat for industrial purposes. Vegetation composition changes included dense alien vegetation infestation as well as removal of natural vegetation for

cultivation of pastures. PES and associated wetland functionality within the study area were therefore reduced as a result of these anthropogenic impacts, HGM 1 scoring a PES Category C, representing a moderately modified system (Table 11).

Table 11: Wet-Health scores for HGM 1

Hydrology	Geomorphology	Vegetation	PES category
5.0	1.3	3.9	C (3.6)

(ii) HGM 2

From a functional perspective this channelled valley bottom wetland received its highest scores for flood attenuation and sediment trapping. In general the HGM received low ecosystem services scores as a result of the wetlands relatively small size and impacted nature (Figure 9 of Appendix D3).

The HGM unit was determined to be largely modified as a result of dense formal housing and infrastructure developments within the wetland's catchment which increased surface stormwater run-off and associated peak volume discharges (PES Category D; Table 12). Infill for road infrastructure as well as sewerage and bulk water infrastructure has also been placed within the wetland unit which negatively affected the geomorphology and vegetation of the wetland. It was evident that the macro channel was rehabilitated and currently provides stable well vegetated embankments with wetland vegetation dominating the channel floor, affording sediment trapping and flood attenuation. Channelisation was evident on the downstream side of the wetland where rehabilitation has not been carried out.

Table 12: Wet-Health scores for HGM 2

Hydrology	Geomorphology	Vegetation	PES category
6.5	2.3	5.5	D (5.0)

(iii) HGM 3

From a functional perspective, HGM 3, the Umhlangane River, received its highest score for maintenance of biodiversity, flood attenuation and sediment trapping (Figure 10 of Appendix D3). Some elements of natural vegetation were retained as well as a relatively high sinuosity of the stream channel, affording the system potential to maintain biodiversity (especially as a biodiversity corridor) and trap sediment. The functionality of HGM 3 rated second highest within the study area as a result of the relatively large permanent zonation and associated opportunity to deliver ecosystem services. Despite being highly modified from its natural state, the wetland still assists in regulating flow and controls erosion and flooding in the surrounding areas by absorbing excess of running and discharged waters from various sources. However, the capacity of the Umhlangane River to control flooding of adjacent lands and residential areas is being questioned as a result of large amounts of infill that has taken place for especially industrial parks. Photodegradation of some toxins are expected because of several open water areas provided by HGM 3.

In terms of HGM 3's Present Ecological Status, the floodplain wetland was determined to be seriously modified as a result of historic impacts on especially the hydrology of the wetland (PES Category E; Table 13). Large impacts on the hydrology of the wetland included channel straightening and stream channel modification for the development of major linear infrastructure such as the N2 as well as infilling of several areas for industrial purposes and the expansion of residential areas. Surface drains including herringbone drains have been installed throughout HGM 3 since at least the mid 1930's for the growth of sugarcane and more recently for the expansion of industrial areas. Channelisation of especially the lower portion of the wetland has also taken place.

Considerable sections of natural vegetation within the wetland were lost as a result of the historic cultivation of sugarcane with some remnant patches of sugarcane still being present. Most of the vegetation observed within the current wetland was secondary in nature.

Table 13: Wet-Health scores for HGM 3

Hydrology	Geomorphology	Vegetation	PES category
8.6	3.1	5.8	E (5.0)

(iv) HGM 4

From a functional perspective this channelled valley bottom scored relatively low as a result of the small size and historic anthropogenic impacts associated with the wetland. Highest scores obtained for ecosystem services were the maintenance of biodiversity, erosion control and flood attenuation which was associated with the lower portion of the wetland which had a relatively lower slope compared to the upper portion of the wetland (Figure 11 of Appendix D3).

The HGM unit was determined to be largely modified as a result of formal housing and infrastructure developments within the wetland's catchment which increased surface stormwater run-off and associated peak volume discharges (PES Category D; Table 14). Infill for road infrastructure as well as sewerage and electrical infrastructure has also been placed within the wetland unit which negatively affected the hydrology and vegetation of the wetland. Channel and gully erosion of varying degrees was evident in the majority of the wetland, negatively affecting the hydrology with a portion of the HGM unit being desiccated.

Table 14: Wet-Health scores for HGM 4

Hydrology	Geomorphology	Vegetation	PES category
5.0	2.3	4.4	D (4.1)

(v) HGM 5

From a functional perspective this channelled valley bottom wetland received its highest scores for flood attenuation, stream flow regulation, maintenance of biodiversity and sediment trapping. Flood attenuation and some stream flow regulation by the wetland was afforded by the relatively low slope and relatively wide cross sectional profile of the wetland in combination of dense vegetation providing high surface roughness. The immediate catchment was semi natural with some connectivity to larger wetland units increasing the use of the wetland as a biodiversity corridor supporting the maintenance of biodiversity. The wetland was also utilised for grazing of livestock by local residents. In general the HGM received low ecosystem services scores as a result of the wetlands relatively small size and impacted nature (Figure 12 of Appendix D3).

The HGM unit was determined to be largely modified as a result of dense formal as well as informal housing and infrastructure developments within the wetland's catchment which increased surface stormwater run-off and associated peak volume discharges to the wetland (PES Category D; Table 15). Infill for road, railway and other linear infrastructure representing impeding features to the wetland's hydrology has been placed on the upstream and downstream side of the wetland unit.

Table 15: Wet-Health scores for HGM 5

Hydrology	Geomorphology	Vegetation	PES category
5.5	2.1	4.5	D (4.2)

e) Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS_1) assessment was undertaken to rank water resources in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- Biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

Water resources which have high values for one or more of these criteria may thus be prioritised and managed with greater care due to their ecological importance (for instance, due to biodiversity support for endangered species), hydrological functional importance (where water resources provide critical functions upon which people may be dependent, such as water quality improvement) or their role in providing direct human benefits (Rountree, 2013). EIS_1 scores results for each of the five HGM units are listed in Table 16.

Table 16: Ecological Importance and Sensitivity scores for wetlands

Wetland	Parameter	Rating (0 -4)	Confidence (1 – 5)
HGM 1	Ecological Importance & Sensitivity	Very High (3.8)	Moderate (2.8)
	Hydrological / Functional Importance	Moderate (2.9)	Moderate (2.1)
	Direct Human Benefits	High (3.0)	Moderate (2.00)
HGM 2	Ecological Importance & Sensitivity	Low (1.1)	Low (1.20)
	Hydrological / Functional Importance	Low (1.2)	Moderate (2.00)
	Direct Human Benefits	Very Low (0.3)	Moderate (2.00)
HGM 3	Ecological Importance & Sensitivity	High (3.30)	High (3.12)
	Hydrological / Functional Importance	High (3.19)	Moderate (2.00)
	Direct Human Benefits	Moderate (2.67)	Moderate (2.00)
HGM 4	Ecological Importance & Sensitivity	Low (1.2)	High (3.12)
	Hydrological / Functional Importance	Low (1.3)	Moderate (2.00)
	Direct Human Benefits	Very Low (0.5)	Moderate (2.00)
HGM 5	Ecological Importance & Sensitivity	Low (1.7)	High (3.12)
	Hydrological / Functional Importance	Low (1.9)	Moderate (2.00)
	Direct Human Benefits	Low (1.5)	Moderate (2.00)

HGM 1 and HGM 3 were considered to be highly important in terms of ecological importance and sensitivity. HGM 1 falls within the Estuarine Functional Zone, which is considered to be valuable habitat for supporting the

ecologically important uMngeni estuary. According to Royal HaskoningDHV (2015), the uMngeni estuary is one of the core estuarine systems that needs to be protected in order to reach the national estuarine biodiversity conservation targets (Van Niekerk *et al*., 2012). Royal HaskoningDHV (2015) further states that the national significance of the uMngeni Estuary is also recognised under the National Freshwater Ecosystem Priority Area Project for being considered a priority estuary (NFEPA) (Nel, et al. 2011). Further, according to SEF (2015b), all wetland and riparian habitat associated with the uMngeni, Piesang, and Umhlangane Rivers (HGM 3) were considered of high ecological importance. High faunal activity was detected in these areas and the habitat is considered an important corridor for movement of fauna. According to Harvey Ecological (2015), HGM 1 could possibly support one red data amphibian species while HGM 3 could potentially support up to three Red Data species and an additional rare species. Suitable habitat within HGM 1 for a floral red data species was also observed (SEF, 2015c). Several direct human benefits were also associated with HGM 1 and HGM 3 including grazing, potential harvesting of reeds, fishing, and cultivation for subsistence farming.

In general, HGM 2, HGM 4 and HGM 5 were considered to be of low ecological functional and sensitivity importance largely due to their disturbed and impacted nature. In terms of direct human benefits, HGM 4 and HGM 5 provided some extended grazing opportunities compared to terrestrial grasslands because of the higher moisture content of graminoids that are available later in the season.

B-1.3.3 Aquatic Environment

An Aquatic Impact Assessment was undertaken by Mr. Byron Grant of SEF in April 2015 (refer to the study in Appendix D4). Mr. Grant has a professional registration with the South African Society of Aquatic Scientists, the South African Wetland Society, the Zoological Society of South Africa and the Aquatox Forum and SACNASP and his experience in the field is provided in Table 3 of the BAR. This assessment focussed on the impact of the construction of the proposed bridge over the uMngeni River on the aquatic biota. The findings of this study are discussed below.

The present study area is located within the lower reaches of the uMngeni River catchment within the Durban metropolitan area, and more specifically within Quaternary Catchment U20M. Watercourses specifically associated with the present study included the uMngeni River, the Piesang River (Seekoeispruit), and an unnamed tributary of the Piesang River (Seekoeispruit). In addition, it was determined during the course of the present study that several sections of the Piesang River (Seekoeispruit) and its tributaries had been subjected to canalisation in order to facilitate runoff within the catchment following periods of rainfall.

Based on current outputs of the National Freshwater Ecosystem Priority Area (NFEPA) project (Nel et al., 2011), the uMngeni River in the vicinity of the pipeline crossing is regarded as an estuarine FEPA, based on the mapped extent of the Estuarine Functional Zone, which was defined laterally as anything below the 5m mean sea level contour, and longitudinally as far as tidal variation or salinity penetration, whichever goes further upstream. Where this was not known, the 5m mean sea level contour was used as the upstream boundary.

Based on the results of the present study, it could be determined that the Present Ecological State (PES) of the uMngeni River, the Piesang River (Seekoeispruit), and an unnamed tributary of the Piesang River (Seekoeispruit) were in a poor state at the time of the survey. This was primarily attributed to the urbanised nature of the catchments in which they were located, which is likely to increase the magnitude and periodicity of flood events, as well as increase the concentration of contaminants entering the watercourses. In the case of the uMngeni River the presence of the upstream Inanda Dam is likely to significantly impact on the hydrology of the uMngeni River downstream of the dam, the degree to which was unknown (*hydrological data for the uMngeni River downstream of the dam could not be obtained at the time of writing*). Of particular concern was the presence of alien and extralimital aquatic biota within the assessed watercourses which were noted to dominate the catch records within the Piesang River (Seekoeispruit) and its associated unnamed tributary. Nevertheless, several species of aquatic biota that are deemed to be of conservation concern i.e. *Hypseleotris cyprinoides* (Golden Sleeper), *Oreochromis mossambicus* (Mozambique Tilapia) were confirmed or likely to be

present within the study area.

As such, while the proposed activities are likely to have low significance given the impacts already present, the implementation of the recommended mitigation measures is likely to limit additional impacts on the watercourses as a result of the proposed activities.

B-1.3.4 Estuarine Assessment

An Estuarine Impact Assessment was undertaken by Ms. Catherine Meyer of Royal Haskoning DHV in April 2015 (refer to the study in Appendix D5). Ms. Meyer's experience in the field is provided in Table 3 of the BAR. This assessment focussed on the impact of the construction of the proposed pipe bridge across the upper reaches of the uMngeni River, approximately 1km from the upstream boundary of the Estuarine Functional Zone (EFZ), within the same area as the previous suspension bridge. The proposed bridge carrying the pipeline will span a distance of approximately 322m and the deck will be above the 1:100 year floodline.

The findings of this study are discussed below.

a) Physio-Chemical Characteristics

(i) Water Quality

The estuary is subject to rapid fluctuations in salinity driven by tidal changes through the predominantly open mouth. Consequently, a strong horizontal salinity gradient exists, where the salt concentration of the lower and middle reaches is typically that of seawater, which decreases gradually moving upstream.

Salinity stratification is a common feature, particularly during the summer high rainfall period, where surface freshwater outflow passes over full seawater at depth (Begg, 1978, 1984; Harrison, 1998 unpublished data; Forbes & Demetriades, 2010).

Dissolved oxygen levels are generally higher at the estuary mouth due to marine exchange and wave action. This however decreases rapidly upstream, indicating high biological or chemical demand in materials in the upper reaches (Forbes & Demetriades, 2010; DWS 2013/2014 unpublished data). Dissolved oxygen concentrations in both surface and bottom water in this area are frequently hypoxic[3] in nature (Begg, 1984; Harrison, 1998 unpublished data; Mackay, 2009 unpublished data; Forbes & Demetriades, 2010; DWS 2013/2014 unpublished data), particularly during winter low flow conditions. The DWS sampling data revealed that 33% and 46% of all water quality measurements (inclusive of bottom and surface water levels) in 2013 and 2014 respectively, produced oxygen levels below 5 mg/L, which is generally considered stressful for most aquatic organisms. Within the estuary proper, the level of turbidity is dependent on wind-induced turbulence and tidal currents which results in the mobilisation of sediments (Forbes & Demetriades, 2010). High turbidity levels are also a consequence of high rainfall in the catchment and associated run-off into the system, as well as the discharge of effluent, which is frequently observed in this system.

Due to the large, densely urbanised catchment area, the uMngeni River and its estuary have been subject to excessive levels of pollution over time, including sewage, industrial and solid waste contamination (Begg, 1978, 1984; Day 1981; Forbes & Demetriades, 2010), resulting in poor water quality. Begg (1978) commented that the "*estuary functions as a means for effluent and stormwater disposal*". Major pollution events have resulted in large fish kills in the system. Several stormwater outlets, which empty into the estuary, are the source of murky, foul smelling water, as well as litter and hydrocarbon contamination. Inappropriate land use along the estuary and river banks, such as informal settlements, solid waste dumping and scrap metal yards, are likely

[3] Hypoxia is the condition in which the dissolved oxygen concentration is below the tolerance levels for most aquatic organisms, generally <5 mg/L, in comparison with anoxic conditions which are characterised by virtually no oxygen (<2 mg/L).

sources of numerous pathogens, contaminants and toxic substances detrimental to the life of the estuary.

Forbes & Demetriades (2010) recorded nutrient levels (nitrogen and phosphorous) lower than those measured in the smaller adjacent systems (Table 3 of the Estuarine Assessment in Appendix D5) and attributed this to the "*permanently open mouth conditions and greater flushing of the estuary*". However, this may not be the case in the near future, given that the uMngeni Waste Water Treatment Works (WWTW) discharges directly into the system combined with the increasing frequency of mouth closure, which will lead to elevated nutrient levels; an unfavourable condition termed eutrophication.

Harrison et al. (2000) rated the overall water quality of the uMngeni Estuary as poor. This was further confirmed by Forbes & Demetriades (2010) who also discovered high concentrations of coliform bacteria, including *E.coli* and faecal coliforms, throughout the system (Table 3 of Appendix D5), which were above acceptable levels for recreational activities. It is clear that poor water quality emanating from various sources of pollution remains a serious environmental threat to the uMngeni estuarine system.

(ii) Sediments

Historically, the uMngeni Estuary has experienced substantial sedimentation as a result of canalisation and construction on the flood plain (Begg, 1984). However, scouring of the system and dramatic removal of sediment has occurred during extreme flood events. Numerous past sediment studies have been conducted relating to sediment composition and dynamics of the estuary (cf. Forbes & Demetriades, 2010), and more recently the sediment has been described as fine (0.125 mm) to medium (0.25 mm) grained sand near the mouth, homogeneous medium sands in the middle reaches, and medium sand to very fine grained material in the upper reaches (0.063 mm) (Forbes & Demetriades, 2010). Organic material is typically associated with the deposition of fine grained sediment, which accumulates generally during the winter low flow period, particularly in the upper reaches.

b) Ecological Features

(i) Fauna

Prawn species, *Macrobrachium equidens* and the swimming prawn, *Metapenaeus monoceros,* and crab species, *Scylla serrata* and *Paratylodiplax blephariskios* could potentially occur in the uMngeni Estuary as it was observed in past surveys.

As observed by the Estuarine Specialist, the prevalence of large crab holes in the exposed sand/mud banks in the lower reaches indicates an active community of sesarmid crabs in this area. Few mollusc species were also encountered by (Begg, 1984), including oysters, bivalves and three species of gastropods.
Research focussed on fauna living in the sediment indicates that the *soft-sediment* invertebrate community of the uMngeni Estuary comprises some 24 invertebrate taxa, which is relatively poor for a permanently open system (Mackay, 2009 unpublished data; McLean, 2008; Forbes & Demetriades, 2010). The polychaete worms, *Desdemona ornata* and *Capitella capitata*, were highly abundant throughout the system, comprising 20-21% of the total individuals sampled. The latter is a well-known indicator species of organic pollution, which reveals that such conditions persist within the uMngeni Estuary long enough for these species to become characteristic of this system.

Based on recent research, the fish community of the uMngeni Estuary is the most diverse of all the estuaries in the EMA, with 31 recorded species in 2008 (McLean, 2008). This is attributed to its permanently open mouth and strong longitudinal salinity gradient. Forbes & Demetriades (2010) recorded only 15 of these species across 115 individuals during their recent survey. As with historical catch records, mullet were the dominant species (six species, plus unidentified juveniles) comprising 44% of the catch. Overall, there appears to be a marked decline in fish abundance and diversity, which is possibly related to the deteriorating estuarine condition (Forbes & Demetriades, 2010).

Begg (1978) recorded 71 bird species plus occurrences of rare and unique species in and around the uMngeni Estuary, and emphasised the importance of the sandbar at the mouth and the centre island (that once existed) as critical refuge sites for birdlife (Begg, 1984). Some 28 years later, the avifauna of the uMngeni Estuary remains noteworthy. Bird communities are highly abundant and relatively diverse despite the degraded state of the system, with 44 recently recorded species of water birds, 25 of which are residents (Forbes & Demetriades, 2010). Shorebirds and terns are known to congregate near or at the mouth. Population numbers and/or occurrences of particular species are seasonally dependent. Currently, the extensive intertidal sandbanks provide preferable habitat for numerous wader species, which distinguish the uMngeni Estuary from other systems in the municipal area. On other occasions, flocks of cormorants and pelicans have been observed roosting on exposed sandbanks (Figure 3 of Appendix D5) and woolly-necked storks foraging in the intertidal saltmarsh closer to the mouth (pers. obs.). Forbes & Demetriades (2010) emphasised the fact that the present species represent only a portion of the bird community that once characterised the system.

Other noteworthy fauna in the system include otters, crocodiles, and marine life, such as sting rays trapped in the system during brief closure of the mouth. In addition, the black-headed dwarf chameleon, *Bradypodion melanocephalum*, a threatened species known to inhabit grassland areas in and around Durban, has been recorded along the uMngeni Estuary and the Umhlangane tributary. The coastal population and distribution is greatly reduced due to rapid urban expansion around the city, which prompted the translocation of individuals to safer, less vulnerable sites (Armstrong, 2008).

(ii) Flora

In terms of microalgae, Forbes & Demetriades (2010) found phytoplankton concentrations to be relatively low despite the availability of nutrients in the system. This was ascribed to low retention times, fairly strong flows, and higher turbidities and thus poor light penetration; all associated with the open mouth condition.

The most valuable botanical feature of the uMngeni Estuary is the protected Beachwood mangroves in the lower reaches of the system. The Beachwood Mangrove Nature Reserve (NR) and uMngeni Estuary Conservancy protect a significant stretch of estuarine habitat including mangrove swampland, intertidal saltmarsh, mud flats and indigenous tree species along the northern bank of the estuary close to the mouth. Outside of the nature reserve, the northern bank of the uMngeni Estuary is maintained by members of the Duzi uMngeni Conservancy Trust (DUCT), a Durban Green Corridor (DGC) initiative with collaboration with the uMngeni Estuary Conservancy (UEC), who have cleared vast areas of alien vegetation and replanted indigenous trees on the northern bank, as well as being responsible for, *inter alia*, the on-going collection of litter/solid waste. Areas which are not attended to by the conservancy groups, specifically the southern bank along much of the estuary, are severely disturbed and comprise invasive alien plant species.

c) Current impacts on the Umgeni Estuary

There has been a significant change to the estuarine system due to dense urban and industrial areas within and alongside the floodplain. Habitat loss is attributed to the construction of five major dams in the upper catchment and numerous bridge crossings, infilling and canalisation of the upstream estuarine channel and sandwinning activities.

Pollution from various sources, overexploitation in the form of illegal fishing and bait-harvesting concluded that the current health status of the estuary is highly degraded. The most significant threats are loss of habitat, freshwater deprivation, sewage and chemical pollution. Despite increasing human pressure, the system remains ecologically important for providing a sanctuary area, breeding and feeding grounds for numerous bird and fish species.

Management interventions proposed to ameliorate the degraded state, include sensitive catchment land use, removal of nutrients from Waste Water Treatment Works (WWTW) that discharge into the system, inter-catchment transfer of water to the uMngeni River to increase water quantity, and identification and removal of sources of pollution (McLean, 2008). Forbes & Demetriades (2010) strongly recommend rehabilitation of

estuarine support habitats, namely wetlands, reedbeds, intertidal, and mangrove habitats, to assist with water quality problems and removal of nutrients.

d) Current health status and importance

The provisional health condition (Present Ecological State – PES) of the estuary as per the National Biodiversity Assessment (NBA, 2011) is Category D i.e. Largely Modified, as a large loss of natural habitat, biota and basic ecosystem functions and processes have occurred.

A *formal rapid ecological reserve determination study*, undertaken prior to the release of the NBA yielded that the PES is Category E i.e. highly degraded, based on the low scores for water quality and physical habitat and all biological components. The system has experienced extensive loss of natural habitat, biota and basic ecosystem functioning and processes as a result of its severe modifications.

e) Regional and National Importance of the uMngeni Estuary

The Estuarine Importance Score (EIS_2) for the uMngeni Estuary based on its present state is 81, i.e. the estuary falls into the highest importance ranking of Highly Important. The outcome is mainly due to the high scores for the Functional Importance, Habitat Diversity and Biodiversity Importance which contributes to the uniqueness of the estuary (DWA, 2011a).

Despite its highly modified and degraded state, the uMngeni Estuary is ranked as the 52nd most important estuary out of 256 systems in South Africa, in terms of its biodiversity and the ecological habitat it provides (Turpie & Clark, 2007). Most importantly, it is one of the core estuarine systems that needs to be protected in order to reach the national estuarine biodiversity conservation targets (Van Niekerk & Turpie, 2012).

In addition, the national significance of the uMngeni Estuary is also recognised under the National Freshwater Ecosystem Priority Area Project (NFEPA) (Nel, et al. 2011). The Project, which aimed to identify critical freshwater ecosystems to meet national biodiversity targets and to provide the basis to strategically manage and protect the country's freshwater resources, was aligned with the NBA 2011. Consequently all priority estuaries, including the uMngeni Estuary, were also classified as estuarine FEPAs.

At a provincial level, the uMngeni Estuary is characterised as 'irreplaceable' and as a 'Critical Biodiversity Area' in the KZN Systematic Conservation Plan (Ezemvelo C-plan). This status is carried forward in the recently completed eThekwini Systematic Conservation Plan for the EMA, and as such, the uMngeni Estuary has been prioritised for the conservation of biodiversity and ecosystem services.

f) Recommended Ecological Category (REC) for the uMngeni Estuary

The Recommended Ecological Category (REC) represents the level of protection assigned to an estuary. The degree to which the REC needs to be elevated above the PES depends on the level of importance and level of protection of a particular estuary (DWA, 2011a).

Based on the regional and national importance of the uMngeni Estuary, and the fact that the system is required to be under partial protection, it was initially determined that the condition of the estuary should be elevated to a Category A or the Best Attainable State (BAS) (DWA, 2011a) (Table 9 of Appendix D5). However, restoration of the system to reach a Category A is virtually impossible given the irreversible modifications, habitat loss and significantly high urban inputs to the system. It was decided by estuarine experts that "*the physical restoration of some intertidal and supratidal habitats along with significant improvements in water quality and a slight increase in water quantity would allow the achievement of a* ***BAS of D***" (DWA, 2011a).

Table 17: Estuary protection status and importance, and the basis for assigning a recommended ecological reserve category

PROTECTION STATUS AND IMPORTANCE	RECOMMENDED ECOLOGICAL CATEGORY	POLICY BASIS
Protected area	**A or *BAS**	**Protected and desired protected areas**

Desired Protected Area (based on complementarity)		**should be restored to, and maintained in the best possible state of health**
Highly important	PES + 1, min B	Highly important estuaries should be in an A or B category
Important	PES + 1, min C	Important estuaries should be in an A, B or C category
Of low to average importance	**PES, min D**	**The remaining estuaries can be allowed to remain in a D category**

* BAS = Best Attainable State

g) Sensitive habitats

The uMngeni Estuary is transformed from its natural condition. Nonetheless, sensitive estuarine habitats are still prevalent (Table 18). The main channel constitutes the greatest area of available habitat (48 ha), the health of which is essential for all life in the estuary. The mangroves cover approximately 20.3 ha in the lower reaches, while the area of sand / mud banks is 11 ha. The extent of intertidal salt marsh, reeds and sedges is comparatively small (Van Niekerk & Turpie, 2012).

Table 18: Type and extent of estuarine habitats in the uMngeni Estuary

	Extent of habitat (ha)
Length (km) of estuarine zone	11
Open water	85
Type of habitat	
Intertidal salt marsh	2
Supratidal salt marsh	
Submerged macrophytes	
Reeds and sedges	2
Mangroves	20.3
Sand/mud bank	11
Channel	48
Rocks	
Swamp forest	
Total	83.3

Source: (Van Niekerk & Turpie, 2012)

The findings of the site conditions at the uMngeni Estuary at the proposed bridge are as follows:
The catchment area near the head of the uMngeni Estuary is characterised by steep terrain with residential settlement located in the higher lying areas. The site of the proposed pipe bridge crossing is confined within a steeply sided valley, across a relatively narrow portion of the floodplain. A school sports fields and a golf course are located within the low-lying flood plain approximately 500 m downstream. Thereafter, the estuary is flanked by the Springfield Flats Industrial area and the uMngeni Business Park en route to the estuary mouth.

In general, the area of the proposed bridge construction can best be described as highly disturbed. In the immediate vicinity of the crossing, the vegetation of the floodplain and the surrounding hillside is almost exclusively invasive alien species. The riparian margins have been invaded and transformed by terrestrial grasses, weeds and woody vegetation, while the remaining wet areas are overgrown with homogenous stands of hygrophilous grass. Conspicuous alien species observed include *Melia azedarach* (Syringa), *Ricinus communis* (Castor Oil plant), *Arundo donax* (Giant reed) *Cardiospermum grandiflorum* (Balloon vine), *Chromolaena odorata* (Triffid weed) and *Tithnia diversifolia* (Mexican sunflower).

There was evidence of ring barking and active clearing of invasive species on the southern bank by the local conservancy, however, the prevalence of indigenous vegetation was minimal. Investigation of Google Earth Imagery over recent past months revealed that a substantial portion of the site was cleared of vegetation during

the removal of the collapsed suspension bridge and to provide the necessary access to the site from both banks (Figure 11 of Appendix D5). Without adequate rehabilitation and on-going maintenance, this would have provided the opportunity for re-colonisation by invasive alien plants.

At the time of the field investigation, the main channel of flow was narrow (ca. 10m wide) and characterised largely by straight runs of shallow (<0.5 m depth) steady flowing water both upstream and downstream of the crossing. A small side channel was evident on the northern bank, which under high flow conditions would be fully inundated, or under lower flow conditions would cease to provide aquatic habitat. The immediate downstream environment encompasses a muddy sand bank, which alternates between states of submergence, exposure and becoming vegetated depending on the prevailing water levels, as evidenced by historical Google Earth Imagery. This sand bank provides a feeding and roosting habitat for wading birds, such as Little Egret (*Egretta garzetta*), however, the number of estuarine- or wetland-associated bird species noted at the site at the time of the investigation was limited to only two individuals.

In terms of water quality, water clarity was particularly poor yet not unexpected, given the heavy rainfall experienced in the 24 hours prior and associated increased runoff from the catchment, which would have brought about increased turbulence and turbidity due to sediment re-suspension. Anecdotal information from members of DUCT suggest that sandwinning operations below the proposed bridge site have deepened the estuary in this area, resulting in the penetration of saline water further upstream than normally expected. However, saline conditions were not detected at the bridge site at the time of the investigation and this was ascribed to the recent rainfall and increased runoff into the estuary, as well as distance from the mouth.

Rich benthic algal mats as well as muddy organic deposits were noted at the site accompanied by a slight odour. In addition, a single once-off dissolved oxygen measurement captured in fast-flowing water suggested that prevailing oxygen levels were low (4.30 mg/L) and hypoxic, that is, not conducive to a healthy living environment and therefore stressful for aquatic organisms. Low oxygen levels are generally linked to high biological and/or chemical oxygen demand of materials and substances present in the water column and sediment. These observations, together with the presence of the invasive aquatic plant *Eicchornia crassipes* (water hyacinth) and luscious growth of marginal vegetation, such as *Echinochloa* sp. (Antelope grass), are suggestive of nutrient enrichment within the system.

The overall state of the uMngeni Estuary at the proposed bridge crossing is degraded, as observed through the poor diversity and poor quality of the riparian and instream habitats. Environmental disturbance is on-going largely due to freshwater abstraction, numerous forms of water pollution, invasive alien vegetation and physical modification to the estuary channel (such as episodic sandmining).

B-1.4 Climate

The region is characterised by a hot, damp, tropical climate in summer and a mild and slightly drier sub-tropical climate in winter (Mucina & Rutherford, 2006). The area normally receives about 800mm of rain per year, with most rainfall occurring during summer with the highest (110mm) falling in January. Winter rainfall is usually associated with frontal systems. The average midday temperatures for the area range from 22.2°C in July to 27.5°C in February. The region is the coldest during July when the mercury drops to 9.5°C on average during the night. The site ranges in elevation from 10m to 145m above sea level.

B-1.5 Flora

The Floral Impact Assessment was conducted by Ms. Karin van der Walt of SEF (Pty) Ltd in February 2015 (refer to the study in Appendix D6). She has a professional SACNSAP registration and her experience in this field is detailed in Table 3 of the BAR. The findings of the Vegetation Assessment are discussed below.

Broad vegetation units within the study area included indigenous units (Closed canopy woodlands; wooded grassland, disturbed wooded grassland, *Hyparrhenia hirta* grassland and riparian vegetation) as well as vegetation units which were dominated by alien species (alien tree woodlands, alien shrublands and landscaped areas). Forty four plant species of conservation concern have been confirmed in the Quarter Degree Grid Cell (QDGC), two of these, *Aloe cooperi* and *Hypoxis hemerocallidea* (both species are currently listed as Declining) were confirmed during the field surveys. In addition to this, two species namely *Eulophia speciosa* (currently listed as Declining) and *Zeuxine africana* (currently listed as Endangered) were considered highly likely to occur in the study area based on the presence of suitable habitat. In addition to the species of conservation concern (which are also provincially protected), two species namely *Gladiolus* sp. (not in flower at the time of the survey) and *Eugenia albanensis* were confirmed in the wooded grasslands. One nationally protected tree, *Sclerocarya birrea* was also recorded in the closed canopy woodlands.

All the areas which supported intact indigenous vegetation such as closed canopy woodlands and wooded grasslands were classified as highly sensitive and it is recommended that the pipeline is rerouted to avoid these areas. Areas which contained disturbed indigenous vegetation such as disturbed wooded grassland and *Hyparrhenia hirta* grasslands were classified as medium to high sensitivity. Although no species of conservation concern or provincially protected species were confirmed in these areas at the time of the survey, suitable habitat for these species were still present. Areas which were dominated by dense stands of alien plants species were considered to be of medium sensitivity while build up, landscaped and cultivated areas were deemed to be of low sensitivity.

B-1.6 Fauna

The Faunal Assessment was undertaken by Ms. Robyn Phillips of SEF (Pty) Ltd in February 2015 (refer to the study in Appendix D7). She has a professional SACNASP registration and her experience in this field is detailed in Table 3 of the BAR. The findings of the Faunal Assessment are discussed below.

According to the KwaZulu-Natal Systematic Conservation Plan (KZNSCP), the majority of the study area site falls within 'Critical Biodiversity Area (CBA) 1 Mandatory' which implies that the area represents the only locality for which the conservation targets for one or more of the biodiversity features contained within, can be achieved. The distribution of the biodiversity features is not always applicable to the entire extent of the CBA and is often confined to a specific niche habitat e.g. a forest or wetland reflected as a portion of the CBA in question. In such cases, development could be considered if special mitigation measures are put in place to safeguard the feature(s) and if the nature of the development is sympathetic to the conservation objectives. In the case of the study area however, a large proportion of habitat has been modified by urban development and should now be classified as 100% transformed.

While no faunal species of conservation concern were identified in the study area during the field survey, suitable habitat for bird and mammal species of conservation concern was observed, mainly in the wooded areas. The proposed pipeline route extends through an urban landscape consisting of transformed and built-up areas as well as open areas supporting natural, disturbed or modified vegetation. Faunal habitat in the study area comprised steep forested valleys, riparian and wetland areas as well as grassland / woodland mosaic. Most of this habitat was considered to be of high ecological importance as they offer the only available refuge for fauna within the suburban and urban-industrial landscape. Forest patches may also be remnants of KwaZulu-Natal Coastal Forests, a Critically Endangered vegetation type. Grassland / woodland mosaic was also considered to be of high importance from a faunal perspective. An expanse of this habitat in the Hillgrove area on the northern bank of the UMngeni River was considered especially important. This area forms one of the largest tracts of undeveloped land in the urban landscape that is incorporated within D'MOSS and is linked to the uMngeni River system. It therefore has high value from an ecosystem services perspective.

In order to reduce the impact of the proposed development on sensitive faunal habitat in the study area, certain route deviations are recommended. These deviations are aimed at avoiding impact on the forested valley in

southwest near Reservoir Hills, the large open area of grassland / woodland mosaic near Hillgrove, aligning perpendicular to a drainage line near Newlands West Drive and avoiding a drainage line and riparian habitat in the Newlands East area.

Due to the nature of the development, loss of natural woody habitat is unavoidable. The maintenance of a tree-less operational phase servitude will mean the permanent loss of woody species and faunal habitat in wooded areas. To help compensate for the loss and fragmentation of habitat, it is recommended that the municipality commit resources to an urgent clean-up campaign focussed on drainage lines and bushy areas within the study area. Illegal dumping was observed throughout the study area and the impact was deemed to be severe in certain areas. eThekwini Municipality's Durban Solid Waste (DWS) must commit to better policing and a campaign to clamp down on illegal dumping in the study area.

B-1.7 Herpetofauna

A Herpetofaunal Assessment was undertaken by Mr. James Harvey of Harvey Ecological in April 2015 (refer to the study in Appendix D8). He has is a member of the Herpetological Association of Africa and his experience in this field is detailed in Table 3 of the BAR. The objectives of this assessment are as follows:

- Perform an assessment of the herpetofauna (*reptiles and amphibians*) occurring within the study area, with particular emphasis on rare and threatened species and sensitive communities; and
- Provide comment and recommendations concerning the effect of the development on these faunal groups occurring on or adjacent to the site.

The findings of the Herpetofauna Assessment are discussed below.

B-1.7.1 Site characteristics and Habitat Diversity and Quality

Overall, the habitats available for fauna, and herpetofauna in particular, within the route are of very low - medium quality. Much of the route goes through areas transformed by urban and peri-urban development which are of no value to these fauna. Away from these areas, the habitats available are for the most part highly disturbed and much of the vegetation is dominated by alien invasive plants. As a result, the area is of limited value for herpetofauna, and any rare and threatened species that may be present, would largely be confined to very few locations along the route, if at all present (see Figure 12).

Seven areas were considered potentially of some value – these locations are indicated in Figure 12 and are briefly described and assessed in Table 19.

Figure 12: Location of 7 areas along the route with some Herpatofaunal species could occur

Refer to Table 19 that describes the 7 sites identified and the potential for the presence of important Herpatofaunal communities or species (described from north to south).

Table 19: Potential occurrence of Important Herpatofaunal Communities or Species

Site	Description of route and habitat present	Assessment
1	The route passes through an open area, dominated by secondary, and largely exotic vegetation	*Bradypodion melanocephalum* (Black-headed Dwarf Chameleon) has been historically recorded, but is likely to be rare or absent in the area, given high levels of degradation.
2	A hilllslope with a large patch of largely indigenous woody vegetation. There is grassland on the crest above it, but this has been disturbed and transformed through cultivation and settlement.	*Bradypodion melanocephalum* has been historically recorded, and likely to still be present, but unlikely to occur regularly in the vicinity of the preferred route, which passes through transformed and disturbed areas.
3	Route passes in the vicinity of, yet some distance (ca. 100m) from, wetland habitats, including Phragmites reedbeeds.	Wetland areas may support R&T frogs and *Bradypodion melanocephalum*, however, these areas are typically >100m from the proposed route
4	Route crosses a large area of fairly undisturbed grassland and *Acacia* dominated woodland	Will support a fairly natural community of local herpetofauna and possibly support *Chamaesaura macrolepis* (Large-scaled Grass Lizard).
5	Route passes mostly highly disturbed grassland and a patch of mixed exotic/indigenous wooded habitat along a drainage line in the south-west section	Much of this area is heavily disturbed and relatively low value for herpetofauna. The wooded drainage line may support small numbers of *Macrelaps microlepidotus* (Natal Black Snake) and possibly *Dendroaspis angusticeps* (Green Mamba).
6	Route crosses a large area of fairly undisturbed grassland and *Acacia* dominated woodland	Will support a fairly natural community of local herpetofauna, and possibly support *Chamaesaura macrolepis*
7	Route passes riparian forest and crosses the uMngeni River, however options exist to largely follow previously disturbed pathways	Forested slopes may support *Macrelaps microlepidotus, Bradypodion melanocephalum* and possibly *Dendroaspis angusticeps*. River and surrounds could support *Hemisus guttatus* (Spotted shovel-nosed frog).

The diversity and presence of rare and endangered species of amphibians and reptiles are discussed below.

a) Amphibians

(i) Diversity

The study area sits within a broader area that supports high amphibian species diversity (Minter et al. 2004). In a biogeographical context, the study area primarily falls within a region that has been described in terms of amphibian fauna as the 'Maputaland assemblage' (Alexander et al. 2004), an area characterised by very high species diversity within a national context. This trend is followed locally, with at least 35 species recorded from the three Quarter Degree Squares (QDS) that incorporate the study area, and others are recorded in nearby areas (Minter et al. 2004). However, most frogs are tied to some degree to aquatic habitats for part of their life-cycle, and will use seasonal or permanent wetlands, slow flowing streams and other waterbodies for breeding. These landscape features are largely lacking from corridor and as a result this aspect will limit the importance of this area for amphibians to a large extent. Away from breeding sites, many species also utilise adjacent terrestrial habitats, however, given the lack of breeding sites within or in close proximity to the footprint area, together with the highly transformed and modified landscape currently present, it is likely that relatively few species routinely utilise much of the corridor, and those that do will primarily be adaptable species, tolerant of drier microhabitats. One exception, is in the vicinity of Alternative 3, where some habitat potentially suitable for a number of species exists on the floodplain south of Riverhorse Road (Site 3).

(ii) Rare and Threatened Species

The site falls within an area that is known to support a relatively high number of conservation important species (Branch & Harrison 2004, Measey 2011). However, as already discussed, the main proposed corridor footprint has no appropriate breeding habitat for most amphibians, and that includes these species. There are some restricted areas of the conservation area that may support breeding populations of three Red Data species and a further rare species. These are

- Wetland areas adjacent to Alternative Route 3, which could possibly support up to three Red Data species and an additional rare species. However, the more sensitive areas are some distance (ca. 100m) from the proposed route, and should not be severely impacted upon.
    - The crossing of the uMngeni River, which may possibly support one Red Data species.

Table 20 below provides a list of rare and threatened amphibian species occurring or likely to occur within the broader study area.

Table 20: Rare and threatened amphibians occurring or likely to occur within the broader study area. (EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient)

Common Name	Scientific Name	Conservation Status	Comment	Occurrence within the study area
Natal Leaf-folding Frog	*Afrixalus spinifrons*	RD - NT	Breeds in wetlands with dense, emergent vegetation and utilises adjacent terrestrial habitats. Threatened by habitat loss and degradation.	Potential breeding habitat is essentially absent from the route. Some potential breeding habitat is present, 50-150m from a portion of Alternative 3 (Site 3).
Spotted Shovel-nosed Frog	*Hemisus guttatus*	RD - VU	Breeds in standing and slow-moving aquatic systems, and moves widely in adjacent terrestrial habitats. Threatened by habitat loss and degradation.	Potential breeding habitat is essentially absent from the route. Some potential breeding habitat is present, 50-150m from a portion of Alternative 3 (Site 3), and possibly in the vicinity of the UMngeni River near the south-west edge of the corridor (Site 7).

Pickersgill's Reed Frog	*Hyperolius pickersgilli*	RD – Critically Endangered (CR)	Highly restricted, breeding in very densely vegetated coastal wetlands. Highly threatened by habitat loss and fragmentation	Potential breeding habitat is essentially absent from the route. Some potential breeding habitat is present, 50-150m from a portion of Alternative 3 (Site 3).
Kloof Frog	*Natalobatrachus bonebergi*	RD - EN	A patchy and localised endemic. Restricted to riparian forest along rocky streams. Threatened by habitat loss and degradation.	No suitable habitat is present within the development corridor. Will not occur within the study area.
Power's Reed Frog	*Hyperolius poweri*	Rare; requires re-evaluation	A rare species that may require conservation protection. Breeds in wetlands with dense, emergent vegetation and utilises adjacent terrestrial habitats. Threatened by habitat loss and degradation.	Potential breeding habitat is essentially absent from the route. Some potential breeding habitat is present, 50-150m from a portion of Alternative 3 (Site 3).

b) Reptiles

(i) Diversity

In a national context, the coastal KwaZulu-Natal reptile diversity is high, and the diversity in the QDSs is in line with that, with at least 63 reptile species recorded (excluding marine species), of which, up to 49 could occur (at least historically) within the broader area incorporating the corridor (Bates et al. 2014). However, as already mentioned, the limited diversity and quality of habitat available mean that it is likely that most areas will only support a small proportion of these species, and those that are will be species capable of living commensally with humans, and those capable of utilising a diversity of modified habitats. Some areas, notably Sites 4, 6 and 7, have habitat in less modified condition, and are likely to hold reptile communities closer to that typical of the area, under natural conditions.

(ii) Rare and Threatened Species

Four species within the area, two lizards and two snakes, are Red Data species (Bates et al. 2014) (Table 21). However, given the habitats available, all will be at best rare and/or localised within the study area if at all present.

Table 21 provides a list of Rare and Threatened Reptile Species occuring or likely to occur within the broader study area.

Table 21: Rare and threatened reptiles occurring or likely to occur within the broader study area. (EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient)

Common Name	Scientific Name	Conservation Status	Comment	Occurrence within the study area
Large-scaled Grass Lizard	*Chamaesaura macrolepis*	RD - NT	Localised primary grassland specialist in eastern South Africa. Threatened by habitat loss and degradation.	Suitable habitat is restricted and mostly sub-optimal. If present, will only occur within Sites 4 and 6.
Black-headed (KwaZulu) Dwarf Chameleon	*Bradypodion melanocephalum*	RD - VU	The coastal population of KwaZulu Dwarf Chameleon (KDC's) occurs mainly along river valleys, mostly in rank, tall-grass areas that are burnt infrequently, reedbeds and	Despite historical records from adjacent to and from the far northern portion of the site, habitat available currently ranges from completely unsuitable (the

			riparian vegetation associated with wetlands and drainage lines, and along or near ecotones between forest and grassland. While they will utilise alien plants within a matrix of indigenous vegetation, they are rare or absent in areas that are heavily invaded by alien plants. Areas under crops, sparsely grassed areas and areas under heavy alien plant infestation are unsuitable for KDCs.	majority of the corridor) to suboptimal (some open areas). Expected to be rare or absent from the majority of the corridor. Present in Site 2, and possibly 50-150m from Alternative 3 in Site 3, and Site 7.
Green Mamba	*Dendroaspis angusticeps*	RD - VU	Restricted to coastal KZN and northern Eastern Cape and confined to coastal forest. South African population isolated and possibly genetically distinct from those further north. Threatened by habitat loss and fragmentation	Good quality fully developed closed canopy forest is not present, and this species will be rare or absent from the study area. Two areas, the wooded drainage line component of Site 6 and the uMngeni River banks (Site 7) may possibly support the species, but are not optimal.
Natal Black Snake	*Macrelaps microlepidotus*	RD - NT	Confined to forest and occasionally moist grassland. A South African endemic with a fairly localised distribution. Threatened by habitat loss and fragmentation	Habitat is disturbed and suboptimal – will either be rare or absent from most of the site; may occur rarely along wooded drainage lines and in thicket on the uMngeni River (Site 7).

B-1.7.2 Summary of findings

The site includes areas of very low-medium importance for herpetofaunal communities. Given that much of the study area has been transformed or highly disturbed over an extended period of time, the area of the proposed development footprint can be expected to support a depauperate proportion of the fauna originally occurring there, mostly consisting of widespread, adaptable species. Selected areas maintain some higher value, given their less disturbed nature and the possible or known presence of Red Data species.

Overall, the proposed pipeline is not expected to have a significant negative impact on the Herpetofauna communities, particularly with adherence to mitigation measures as proposed and included in the EMPr in Appendix F.

B-2 SOCIAL ENVIRONMENT

A Social Impact Assessment was undertaken by SEF (refer to the study in Appendix D9). The compiler of the report is Ms. Jessica de Beer and she has 11 years of experience and is a member of IAP2 South Africa, member of Golden Key International Honour Society and member of SASA (Sociology Association of South Africa). Further details regarding her qualifications are provided in Table 3 of the BAR.

B-2.1 Demographic Conditions

The Social Impact Zone (SIZ) should be considered as the primary social environment from where employment should be sourced. Households within a 30km radius of the site should be provided preference when implementing socio-economic policies and mitigation measures.

The SIZ population makes out 58.65% of the entire eThekwini Municipality (eM), or about 20% of the KZN population. The study area consists of a diverse society, which faces various social, economic, environmental, and governance challenges.

The population of the eM has grown by 1.08 % from 2001 to 2011 as against 2.34% from 1996 to 2001 (Statistics SA). The median age of the EM is 26. When considering those aged between 16 and 64 years of age (Economically Active Population), there are approximately 1 434 817 economically active persons within the SIZ, which is 59.52% of the Municipality's Economically Active Population.

The eM's population consist predominantly out of African (73.80%) persons with Coloured persons being in the minority at 2.50%. The SIZ follows a similar trend, however, the population as fewer African persons (67.10%), 3.21% more Indian persons and 3.14% more White persons.

HIV/AIDS in South Africa has increased rapidly over the past decade. According to Stats SA (2013) the total number of persons living with HIV in South Africa increased from an estimated 4 million in 2002 to 5.26 million by 2013. For 2013, an estimated 10% of the total population was HIV positive.

The social and economic consequences of the disease are far reaching and affect every facet of life in South Africa. HIV/AIDS affects economic growth and poverty via various impact channels. At the household level, a wide range of factors influence poverty; these include vulnerability from deteriorating livelihoods, heightened stigmatism, fragmentation of social networks, and lower investments in human capital and nutrition. Moreover, while households are directly affected by HIV/AIDS, there are also broader implications for the economy as a whole.

Despite South Africa creating a progressive and far-sighted policy and legislative environment for dealing with HIV/AIDS, the prevalence of HIV/AIDS continues to increase. This indicates that policies and laws have not been adequately implemented and have not impacted significantly on the ground.

According to Statistics SA (2010) data, the percentage of deaths that was attributed to the HIV/AIDS disease increased from 1.7% in 1997 to 2.41%, before declining to 0.9% in 2003. From 2004, the percentage of deaths increased and in 2010 reached its highest recorded percentage at 2.99%. It is noted that the Jozini Local Municipality has the highest level of HIV related deaths (28.1%) within the KZN Province, followed by Umhlabuyalingana Local Municipality with 17.3% HIV related deaths. Health services in these areas are placed under more pressure.

B-2.1.1 Languages

There are 956 709 households within the Municipality and according to Statistics SA, with 15.6% residing in informal dwellings (shacks), which is nearly double the rate in KZN (8.3%), however, the largest majority (61.98%) reside in a formal house.

Within the SIZ, 15.18% of households live in informal dwellings and 60.36% reside in a formal house. Even though 19.03% of the KZN households live in traditional dwellings, only 2.25% of the SIZ reside in such structures.

B-2.1.2 Dwelling Types

Medium to High income residential areas occur in Reservoir Heights, Hillgrove, Newlands East and West and Riverhorse Valley.

Formal Reconstruction and Development Programme (RDP) Housing, combined with informal housing occurs in areas such as Avoca Hills and Corovoca Township.

Only 68.61% of eM households have access to flush toilets and only 1.61% have no access to toilets at all, which is about one-quarter of the rate in KZN (7%) or about one-third of the rate in South Africa (5.3%). The wards within the SIZ with the highest number of households without access to toilets is indicated in the Figure below.

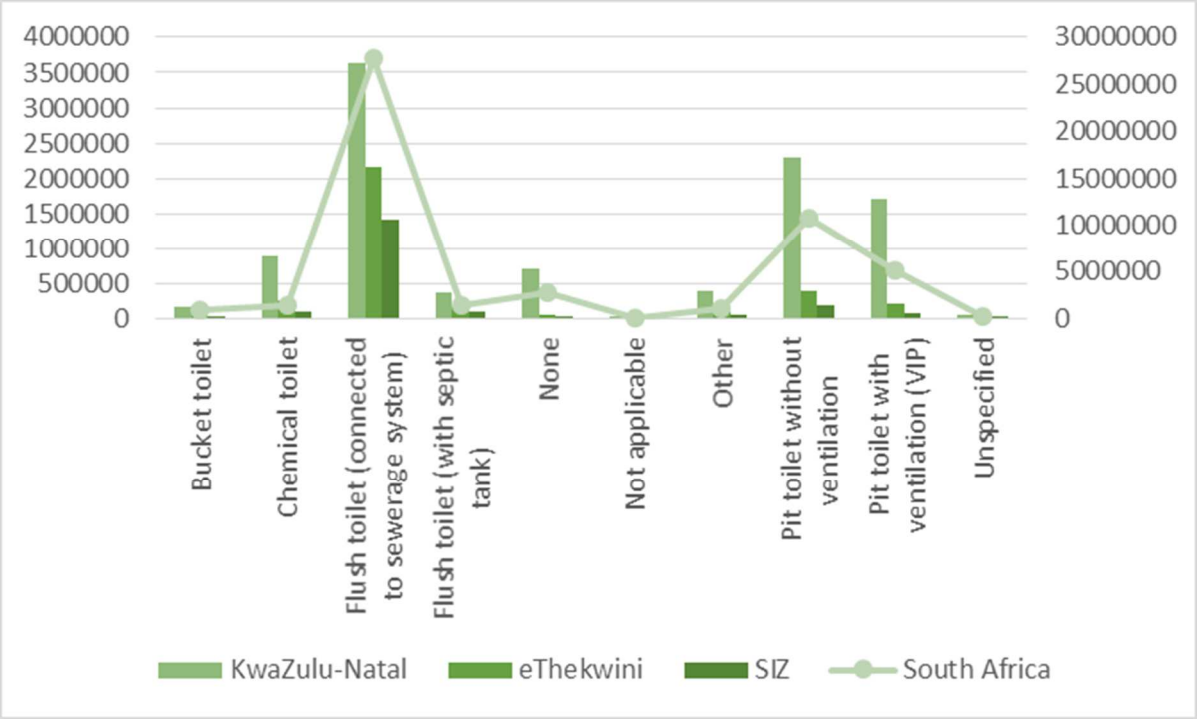


Figure 13: Access to toilets

The majority of households within the SIZ have access to flush toilets (75.33%), with a small number (1.54%) without any access to toilets. The majority of households in the EM (75.2%) have access to flush or chemical toilets, which is about 1.5 times the rate in KZN (47.9%) or about 25% higher than the rate in South Africa (59.3%).

According to Statistics SA (2001) data, a little over 85% of households use electricity for cooking, 11% use paraffin, and only 2% still use wood, mainly those households in informal and traditional dwellings. However, 90.8% of households within the EM have electricity for at least one of cooking, heating or lighting, which is about 20% higher than the rate in KZN (78.8%) and a little higher than the rate in South Africa (85.3%). The SIZ has the highest number of households with access to electricity for cooking, heating and lighting (73.34%), as compared to the EM (72.84%) and KZN (54.65%).

Within the EM, 89.63% of households are getting water from a regional or local service provider, which is about 1.3 times the rate in KZN (67.3%) or about 20% higher than the rate in South Africa (76.9%). Within the SIZ, 90.73% of households receive their water through a regional or local water scheme. Almost two thirds of EM households have water in their homes. Only 11% have taps in their yards and 17% obtain water from the communal taps.

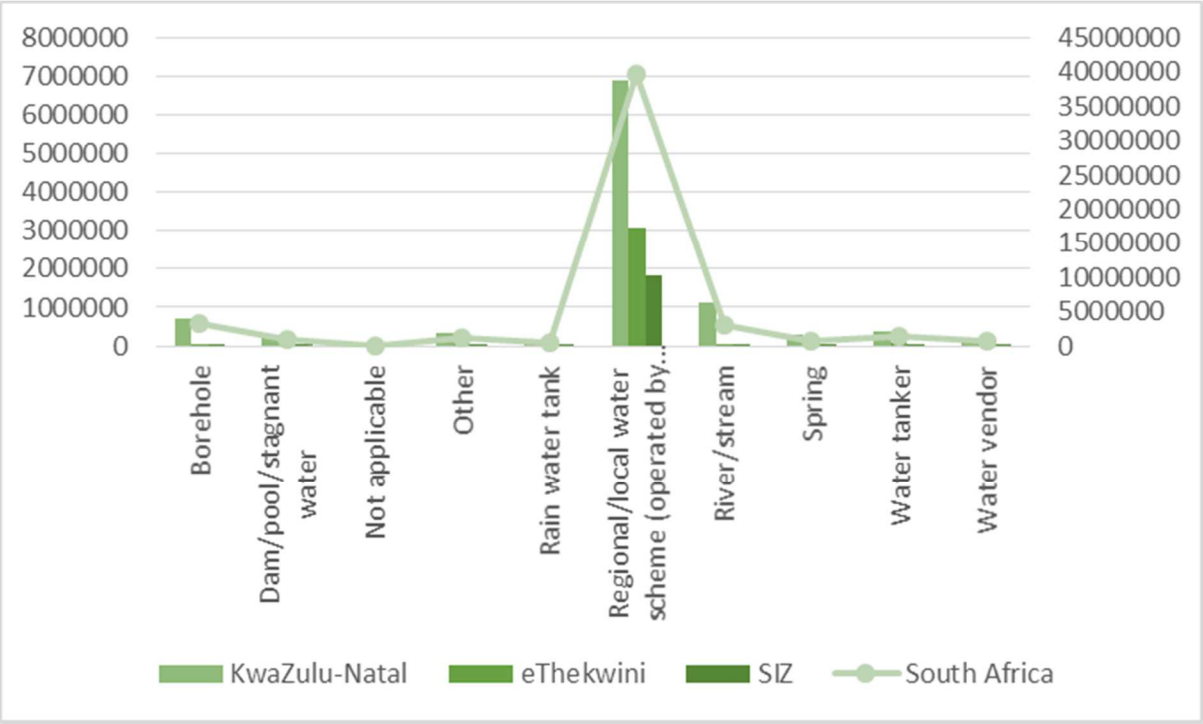


Figure 14: Access to water

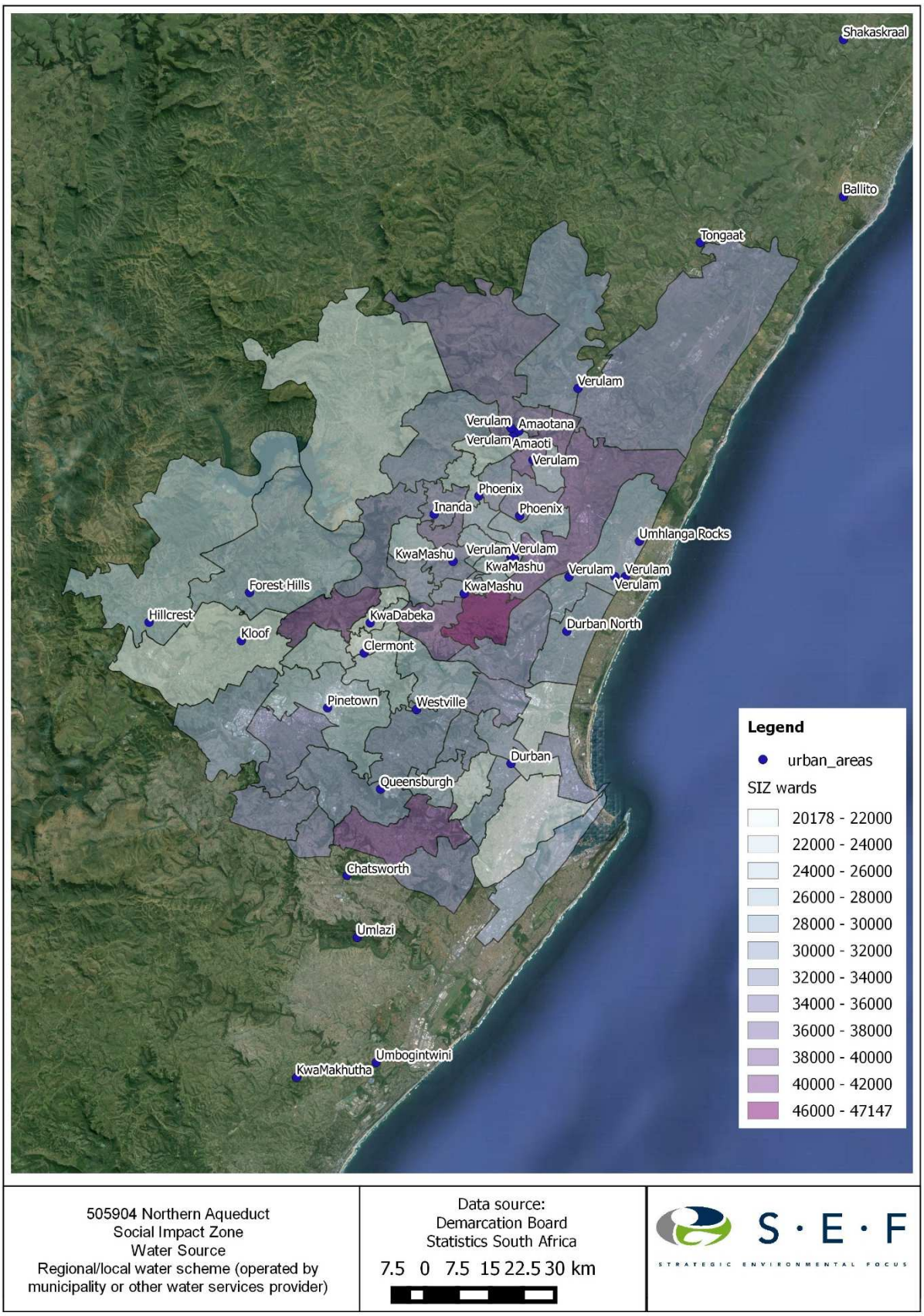


Figure 15: Spatial Representation of Water Sources

B-2.1.3 Employment Statistics

The unemployment rate in the Municipality was approximately 43% in 2001 and it has dropped by 12.5% according to Census 2011. Within the SIZ, 11.20% of those aged 15 years and older were unemployed, with 32.45% being employed.

Table 22: Employment Status

	Discouraged work-seeker	Employed	Not applicable	Other not economically active	Unemployed
South Africa	3.54%	25.46%	34.51%	25.68%	10.81%
KwaZulu-Natal	4.76%	19.88%	36.89%	28.67%	9.80%
eThekwini	3.32%	28.83%	29.97%	25.38%	12.50%
SIZ	2.87%	32.45%	28.93%	24.54%	11.20%

Source: Statistics SA, 2011

B-2.2 Built and Cultural Heritage

As per the National Heritage Resources Act, 1999 (Act No. 25 of 1999) a Heritage Impact Assessment (HIA) was conducted for the proposed development site (refer to the study in Appendix D10). The assessment was conducted by Mr. Polke Birkholtz of Professional Grave Solutions (PGS) Heritage in April 2015. Mr. Birkholtz is registered with the Association of Southern African Professional Archaeologists (ASAPA) as a Professional Archaeologist and is accredited with the Cultural Resources Management (CRM) Section of ASAPA. He is also registered with Amafa KwaZulu-Natal and his experience in the field is provided in Table 3 of the BAR. The findings of the Heritage Assessment (Built and Cultural Heritage) are as follows:

A total of 2 sites of potential archaeological importance has been found and is described in the following paragraphs:

B-2.2.1 Site 1: S 29° 44' 52.9"E 31° 00' 33.4"

a) Site Description

A Stone Age occurrence was exposed by excavations undertaken during maintenance work on an existing pipeline. The occurrence was identified roughly 15 m from the Preferred Route and Alternative Route 2 footprints.

Two Early Stone Age stone tools as well as a smaller flake were observed in the discard heap of the maintenance excavations. A thorough investigation of the walls of the excavations was subsequently made and no further lithics could be identified. It is therefore clear that the site comprises an occurrence of Stone Age lithics and does not constitute enough of a concentration of stone tools to classify it as a formal archaeological site.

(i) Site significance

Due to the lack of any concentration of artefacts, the site has very little scientific or historic significance. As a result, the site is deemed to be of Generally Protected C (Grade 4C), which represents a Low Significance. This indicates that the site may be destroyed without any further mitigation taking place.

Figure 16: General view of the discard heap on which the three stone artefacts were identified.

Figure 17: The three lithics identified at the site

B-2.2.2 Site 2: S 29° 45' 54.8" and E 30° 59' 58.3"

a) Site Description

A church was identified roughly 6 m from the Preferred Route. The church is located on the crest of a ridge with expansive views all around. It comprises a rectangular corrugated iron building with a pitched roof with a rectangular area demarcated with white painted stones located on the building's southern end. The demarcated rectangular area contains a number of small to medium sized trees.

The white painted stones used throughout the site as well as the association of the demarcated area with planted trees suggest that the church more than likely forms part of the Nazareth Baptist Church (also known as the "Shembe Church" or "iBandla lamaNazaretha"). While the Nazareth Baptist Church as a whole was established in 1910 by Isaiah Shembe, an assessment of the available historical imagery of Google Earth indicates that the church site under discussion was only built after 2005.

(i) Site Significance

The significance of a Shembe church such as the one located on Site 2 is usually found on three levels, namely a built heritage significance if the structure and buildings of the church are older than 60 years, secondly a historical significance if the church can be associated with a historic event or person in the church's history and thirdly on a social significance level in which the site has high emotional and religious value for a particular community.

In this case, the available Google Earth imagery indicates that the church was erected after 2005. This means that its structural component can certainly not be viewed as significant within the realms of the heritage legislation. Furthermore, it can also not be seen as a historic site associated with any historic person. For the purposes of this report, the site is deemed to be of Generally Protected C (GP. 4C) which equals a Low Heritage Significance. However, the church still has high social significance.

Figure 18: General view of the church with the rectangular building on the left and the area demarcated with white stones evident on the right.

B-2.2.3 Additional observations

Along Alternative Route 3, there is a temple of high significance, but at this stage, it is unknown if construction activity will impact on the temple.

Also Alternative 6 has a grave site that will be impacted on by that route. It is not impacted if Alternative Route 1 i.e. the preferred route is used.

B-2.3 Palaeontological Overview and Findings

A Palaeontological Assessment was conducted for the proposed development site (refer to the study in Appendix D11). The assessment was conducted by Dr. Gideon Groenewald of Professional Grave Solutions (PGS) Heritage in April 2015 (Appendix D11). Dr. Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years). His experience in the field is provided in Table 3 of the BAR. The findings of the palaeontological assessment is described below.

The likely impact of the proposed development on local fossil heritage is determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the extent of fresh bedrock excavation envisaged. The Natal Group is allocated a Low palaeontological sensitivity due to the fact that no fossils have up to date been recorded from this unit.

The Pietermaritzburg Formation and alluvial deposits have been allocated a medium palaeontological sensitivity whereas the areas underlain by dolerite are allocated a very low to non-significant rating for palaeontological sensitivity. The Vryheid Formation however is allocated a very high palaeontological sensitivity.

B-2.4 Traffic Management

Mott MacDonald PDNA was appointed to investigate the potential solutions to the anticipated traffic issues and impacts as a result of the construction of the Northern Aqueduct Augmentation Phase 5. Throughout the construction period, the proposed project will impact on the road network, as a significant portion of the proposed pipeline alignment impinges into existing road reserves. Thus a significant impact on traffic in the immediate vicinity and surrounds of the pipeline construction area can be expected. The purpose of this traffic investigation is to propose a set of coordinated transportation management strategies that will help to mitigate the impact of construction of the project on the current road network. The key benefits of this investigation will be the compilation of a Transport Management Plan (TMP), which will promote mobility and improve work zone safety for the travelling public and construction workers. The objectives of the study are to establish the traffic accommodation requirements for the construction of the pipeline and to undertake detour planning for traffic for the construction of the pipeline and identify the preferred detour routing.

To undertake the construction work, a Traffic Management Plan was required to inform the Contractor on which roads can be closed and which routes the vehicles can be redirected on, to enable the pipelines to be laid across the road crossings. Refer to the study in Appendix D12.

The TMP was compiled by Mr. Juan Wood of Mott MacDonald PDNA and he registered with the Engineering Council of South Africa (ECSA) and is a Professional Technologist. His experience in this field is provided in Table 3 of the BAR.

B-2.4.1 Existing road geometry

The existing configurations of the intersections and roadway lanes that are affected by the proposed pipeline were determined via the site visit and from Google Street View, and are provide in Table 3-2 of the Traffic Management Plan (refer to Appendix D12).

A summary of the findings of the TMP are as follows:

The preferred pipeline route will see the proposed route crossing the following roads (from south to north):

- Sienna Crescent (Reservoir Hills)
- Bardia Avenue (Reservoir Hills)
- Mountbatten Drive (Reservoir Hills)
- Fulham Road (Reservoir Hills)
- Juba Place (Reservoir Hills)
- Unnamed gravel track 1
- Unnamed gravel track 2
- Newlands West Drive (Newlands West)
- Sooklall Drive (Newlands West)
- Inanda Road (Newlands East)
- Karanteen Gardens (Newlands East)
- Marbleray Drive (Newlands East)
- John Dory Drive 1 (Newlands East)
- John Dory Drive 2 (Newlands East)
- Musa Dladla Drive (Riverhorse Valley)
- Queen Nandi Drive (Riverhorse Valley)
- Hippopark Avenue (Riverhorse Valley)
- Disused road over rail bridge
- Railway Tracks 1
- Railway Tracks 2
- Lark Road (Duffs Road)
- Sweetpea Close;
- 120844 Street;
- KwaMashu Highway/R102 Interchange offramp (Duffs Road)
- KwaMashu Highway (Duffs Road)
- R102 (Duffs Road)
- KwaMashu Highway/R102 Interchange offramp (Duffs Road)

In addition to the above roads, the pipeline will affect many driveways to private properties.
The majority of the roads being affected are low traffic residential roads; in terms of major roads, the pipeline will be crossing eight major arterials/highways.

B-2.4.2 Existing Traffic Volumes

The traffic count information provided by the Roads Authorities (eThekwini Transport Authority (ETA), South African National Roads Agency SOC (Ltd) (SANRAL) and KwaZulu-Natal Department of Transport (DoT) are counts that were manually conducted at the intersections. Where no numbers were available, a visual assessment was conducted on the roads during the weekday peak hours to establish how busy those roads were.

Traffic counts were available for all the major roads. Only minor Class 5 residential streets had no data; however, visual observations noted that the traffic volumes on these particular roads were very minimal.

To establish if it would be possible to close off any lanes to traffic for the construction of the pipeline, the traffic volumes were extrapolated over the number of existing lanes on the road. From this, it is possible to estimate if there is sufficient capacity on the roads to close off any lanes.

The Highway Capacity Manual - 2010 was utilised to determine what the maximum capacities per lane per hour was. The numbers that were extracted from the document are as follows:-

Table 23: Service Volumes for Urban Streets

Lanes	Service Volumes (veh/h)				
	A	B	C	D	E
Class I					
1	N/A	740	920	1010	1110
2	N/A	1490	1780	1940	2120
3	N/A	2210	2580	2790	3040
4	N/A	2970	3440	3750	4060
Class II					
1	N/A	N/A	620	820	860
2	N/A	N/A	1290	1590	1650
3	N/A	N/A	1920	2280	2370
4	N/A	N/A	2620	3070	3190
Class III					
1	N/A	N/A	600	790	840
2	N/A	N/A	1250	1530	1610
3	N/A	N/A	1870	2220	2310
4	N/A	N/A	2580	2960	3080
Class IV					
1	N/A	N/A	270	690	790
2	N/A	N/A	650	1440	1520
3	N/A	N/A	1070	2110	2180
4	N/A	N/A	1510	2820	2900

Notes
N/A - not achievable given assumptions below.
This table was derived from the conditions listed in the following table.

	Class			
	I	II	III	IV
Signal density (sig/km)	0.5	2	3	6
Free-flow speed (km/h)	80	65	55	45
Cycle length (s)	110	90	80	70
Effective green ratio	0.45	0.45	0.45	0.45
Adj. sat. flow rate	1850	1800	1750	1700
Arrival type	3	4	4	5
Unit extension (s)	3	3	3	3
Initial queue	0	0	0	0
Other delay	0	0	0	0
Peak-hour factor	0.92	0.92	0.92	0.92
% lefts, % rights	10	10	10	10
Left-turn bay	Yes	Yes	Yes	Yes
Lane utilization factor	According to Exhibit 10-23, Default Lane Utilization Factors			

Based on the class of road indicated in Table 3.1 of the Traffic Management Plan, the service volumes in Table 23 and the traffic volumes received, the possibilities of closing off roads, via stop/go controls, road narrowing for multiple lane roads or detours can be derived.

While no traffic volumes were available for the Class IV residential roads, visual observations during the peak hour indicated that the traffic can easily be controlled via stop/go controls and construct the pipeline across the road in half widths.

Based on the above table, it will not be possible to undertake open excavation across the following roads via stop/go controls and half width construction, as the current traffic volumes already exceeds the design capacity, and any stop/go control will result in the road network becoming gridlocked. Pipe jacking should be considered instead for these crossings:-

- Newlands West Drive
- John Dory Drive (crossing 2)

- Musa Dladla Drive
- KwaMashu Highway and Interchange Ramps

Further to the above, the following roads are not recommended for stop/go control.

- John Dory Drive - crossing 1
- R102

However unlike the previous roads, there is some spare capacity left on these two roads. The traffic volume is however significant enough to pose a threat to workers and there is a potential for gridlocking. In addition, these roads are two-lane, and as such it would not be possible to channelize the traffic into an existing middle lane. Alternative construction methods, such as constructing road bypasses, will need to be considered. For these roads, should stop/go be employed, it is strongly recommended that detailed modelling of the impact of a stop/go be undertaken by the designer.

The following roads, while also having high traffic volumes, are multiple-lane and have the spare capacity to consider channelizing the traffic onto one of the oncoming lanes in the adjacent carriageway. This would remove the need for a stop/go control as well as allow construction of the pipeline to take place over the full width of one of the carriageways:-

- Inanda Road (sufficient capacity for one lane of traffic per direction)
- Queen Nandi Drive (sufficient capacity for one lane of traffic per direction)

However, eThekwini Roads confirmed that there will be pipe jacking for these two crossings.

The following roads can be closed to allow for construction of the pipeline over the full width, and provide a detour for the traffic onto an alternative road:-

- Fulham Road (onto Juba Place)
- Juba Place (onto Fulham Road)
- Sooklall Drive (onto Runton Way and Skipdale Road)
- Hippopark Avenue (Onto Kubu Avenue - there is sufficient free capacity along Kubu Avenue to carry the deviated traffic)

Due to the narrow width of the verges, the proposed pipeline will likely be constructed under the roadway of the following roads:-

- Sweetpea Close
- 120844 Street

These two roads will need one lane to be closed off in order to place the pipeline. The remaining lane will therefor need to be converted to a one-way system for 120844 Street and a 2-stage stop/go control implemented along Sweatpea Close. As these two roads are very narrow, it may be necessary to widen the road into the verge to allow the vehicles to drive past the deviations.

B-2.4.3 Recommendations and Conclusions

Based on the traffic volumes and road categories, a Traffic Management Plan can be set out for the pipeline construction.

The TMP that needs to be implemented will be categorised as follows:-

- Pipe Jacking, where there is insufficient road capacity and traffic volumes are too high to allow for safe open excavation, and at railway lines.
- Construction of a surfaced bypass lane, where the traffic volumes of the road are sufficiently high that any lane closure could potentially result in gridlocking.
- Closing off of an existing lane to allow construction in that lane, where the traffic volumes of the road

are low enough that any lane closure will not result in the capacity of the open lanes being exceeded. This traffic will be channelised onto one of the oncoming traffic lanes.
- Construction of the pipeline in road half-widths, with traffic control via a stop/go.
- Detours, where alternative accesses are possible.
- Full Road Closure for pipeline construction, with no alternative access. This needs to be avoided as far as is practical, and is only allowed on abandoned roads and gravel tracks which do not service any access purposes (e.g. to municipal facilities, dwellings, etc)
- For pipeline construction across driveways and parking lots, access to these properties needs to be maintained at all times. This can be achieved via, for example, steel plats placed over the open excavation. These will need to be carefully designed, taking into consideration vehicle loading and safety considerations.

Based on the categories mentioned above, the TMP measures that need to be implemented at each of the road crossings are described in Table 4.1 and illustrated on sketch diagrams (recommended traffic control measures) in Annexure A of the TMP appended as Appendix D12.

For Municipal Roads, all traffic control signage, road furniture and controllers need to comply with City standards. The same applies to any controls located along any SANRAL or KZN DoT roads. In addition, all controls need to comply with the Occupational Health and Safety regulations – it is strongly recommended that a specialist Safety Consultant be appointed to undertake these designs.

B-2.5 Air Quality

Ward Karlson Consulting cc (WKC) was appointed to provide specialist comment on the potential issues associated with Air Quality (*especially dust and atmospheric emissions*) impacts in the vicinity of the proposed pipeline route and pipe yard (i.e. at Ottawa, Verulam and Eastbury, Phoenix). Refer to the study in Appendix D13. Construction-related dust can also have a negative impact on people and their surrounding environment. The purpose of obtaining such comment was to determine the nature of the potential impacts, and to suggest possible options for mitigation that will aid in reducing the impacts of construction-related dust.

The Air Quality Impact Assessment was conducted by Mr. Marc Blanche and Ms. Novania Reddy of WKC. Their qualifications and experience is provided in Table 3 of the BAR.

The findings of the Air Quality Assessment for the construction-related impacts associated with the proposed pipeline route, the proposed pipe yard located at Ottawa in Verulam and the existing pipe yard on Eastbury Drive in Phoenix are discussed below. The operational and decommissioning phase impacts associated with the pipeline are expected to be negligible and have therefore not been considered further.

B-2.5.1 Pollutants of concern

The following pollutants, listed below with their known effects on human health, are anticipated to be emitted during activities associated with the construction phase of the project (e.g. exhaust emissions from construction plant and vehicles, and dust from excavation and earthmoving activities):

- Nitrogen Dioxide (NO_2): NO2 is toxic at relatively low concentrations, and can be readily formed from oxidation of Nitric Oxide (NO) in the presence of atmospheric oxidants.
- Sulphur Dioxide (SO_2): Anthropogenic emissions of SO_2 originate from the combustion of sulphur containing fuels and materials. SO_2 in the ambient environment is linked with increased rates of respiratory illness including asthma.
- Carbon Monoxide (CO): CO is a poisonous gas produced by the incomplete combustion of various fuels. CO may be associated with the combustion of fossil fuels, however it's of relatively low toxicity when compared to, for example, NO_2 (the NO_2 standard for CO is 1,000 times less stringent than the corresponding CO standard).

- Finer fraction particulate matter (PM): PM10 and PM2.5 are the most commonly considered size classification and are both inhalable where once in the lungs they can penetrate upper regions of the respiratory system and defeat the body's defence mechanisms. Once inhaled, exposure to particles can lead to a variety of serious health effects.

B-2.5.2 Sensitive Receptors (SR's)

In establishing the nature of the receiving environment, SRs were selected based on possible impacts on people's health or convenience according to the level of development in the area, population density and types of activities carried out in the area. Refer to Figure below for information on the location and type of SRs.

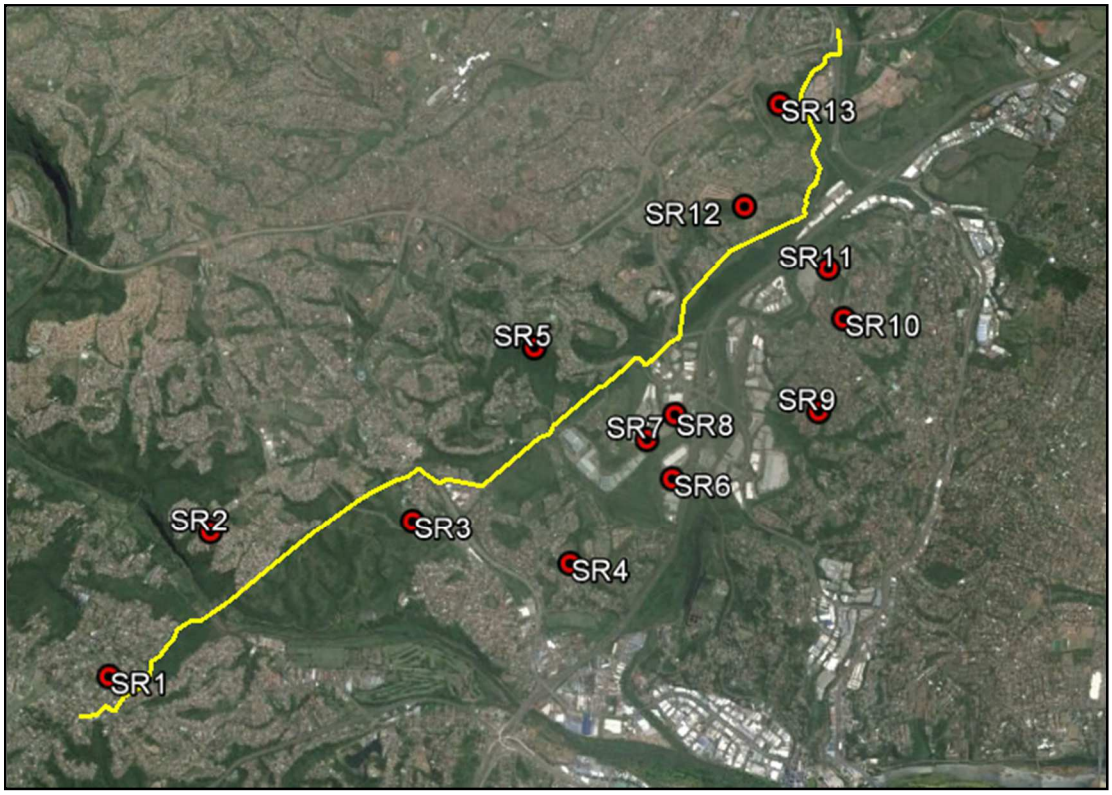


Figure 19: Locations of Sensitive Receptors along the Proposed Pipeline Route

Figure 20: Locations of Sensitive Receptors at the Eastbury Pipe Yard

Figure 21: Locations of Sensitive Receptors at the Ottawa Pipe Yard

Table 24: Locations of Sensitive Receptors

Receptor	Location / Description	Distance from Pipeline Route (m)	UTM Co-ordinates
SR1	Reservoir Hills Mosque	381	300,800.00 m E 6,701,605.00 m S
SR2	Ebenezer Celebration Centre – Church	736	301,727.00 m E 6,702,971.00 m S
SR3	Fosa T.B Settlement	444	303,707.00 m E 6,703,108.00 m S
SR4	Lakehaven Secondary School	1,168	305,246.00 m E 6,702,718.00 m S

Receptor	Location / Description	Distance from Pipeline Route (m)	UTM Co-ordinates
SR5	Hillview Secondary School	786	304,865.00 m E 6,704,792.00 m S
SR6	Discovery Health Medical Scheme	1,172	306,226.00 m E 6,703,559.00 m S
SR7	FTS Safety	674	305,971.00 m E 6,703,934.00 m S
SR8	eThekwini Hospital and Heart Centre	648	306,237.00 m E 6,704,178.00 m S
SR9	Effingham Heights Primary School	1,507	307,637.00 m E 6,704,239.00 m S
SR10	Effingham Secondary School	1,384	307,867.00 m E 6,705,126.00 m S
SR11	Iziko Medical and Surgical Supplies Cc	588	307,717.00 m E 6,705,599.00 m S
SR12	Corovoca Primary School	600	306,886.00 m E 6,706,194.00 m S
SR13	Corovoca Township	195	307,210.00 m E 6,707,189.00 m S

Receptor	Location	Distance from Pipe Yard (m)	UTM Co-ordinates
SR14	Eastbury Drive Pipe Yard Residential Area 1	113	307,348.00 m E 6,710,712.00 m S
SR15	Eastbury Drive Pipe Yard Residential Area 2	145	307,365.00 m E 6,711,213.00 m S
SR16	Ottawa Pipe Yard Residential Area 3	416	309,533.00 m E 6,714,388.00 m S
SR17	Ottawa Pipe Yard Residential Area 4	737	309,902.00 m E 6,715,490.00 m S

B-2.5.3 Construction Phase Assessment

Atmospheric emissions from construction activities can be broadly categorised into the following:

- Dust and PM10 from earth working and on-site vehicle movement activities;
- Emissions associated with construction vehicles transporting materials and personnel into and from the site, i.e. off-site emissions (e.g. construction vehicles, transport of workers and delivery vehicles); and
- Emissions associated with construction activities on-site (e.g. equipment, heavy machinery, vehicle idling, and dust emissions).

The majority of the releases are likely to occur during the 'working week'. However, for some potential release sources (e.g. exposed soil or dusty building materials) in the absence of dust control mitigation measures, dust generation has the potential to occur 24 hours per day over the period during which such activities are to take place.

The potential sources of emissions and resultant impacts are considered to be relatively universal across the different phases of construction. A brief summary of the construction phase emissions and likely impacts are presented in the following sections.

a) Releases to the Atmosphere

An inventory has been prepared quantifying the atmospheric emissions from all combustion sources (vehicle and plant engines). The inventory is based on the internationally recognised Unites States Environmental

Protection Agency (USEPA) Non-road Engine, and Vehicle Emissions Study methodology. Total releases (tonnes) of emissions have been estimated based on the construction period and type of construction equipment, the results of which are presented within the table below. The annualised emissions are based on the detailed equipment list provided by the project team and are presented in the table below.

Table 25: Construction Equipment Inventory

Equipment	Number in Operation	Estimated Emission Quantities (tonnes per week)				
		CO	CO_2	NO_x	SO_2	PM_{10}
Asphalt Pavers	1	<1	4	<1	<1	<1
Rollers	4	<1	17	<1	<1	<1
Paving Equipment	2	<1	13	<1	<1	<1
Bore / Drill Rigs	2	<1	53	<1	<1	<1
Excavators	6	<1	79	1	<1	<1
Cement and Mortar Mixers	2	<1	1	<1	<1	<1
Cranes	2	<1	23	<1	<1	<1
Graders	1	<1	9	<1	<1	<1
Dumpers/Tenders	5	<1	4	<1	<1	<1
Other Construction Equipment	15	1	308	1	<1	<1
Pump <50hp	2	<1	3	<1	<1	<1
Welders <50hp	8	<1	19	<1	<1	<1
4 x 4 Petrol	4	<1	27	<1	<1	<1
4 x 4 Diesel	4	<1	32	<1	<1	<1

Table 26: Emissions Associated with the Construction Phase

Species	Tonnes Emission / Peak Year
	Project Construction
CO	130
Carbon Dioxide (CO_2)	39,161
NO_x	192
SO_2	19
PM_{10}	927

b) Assessment of Dust and PM10 Emissions from On-site Activities

Dust generated during construction will result from clearing and earthworks, including pipe trenching, site levelling, and reinstatement operations. The major dust sources will be from the site preparation activities and the movement of vehicles over the cleared work area within the pipeline corridor.

Under normal meteorological conditions, dust impacts would be limited to a few hundred metres of the construction spread. However, under strong wind conditions, these effects could extend further. USEPA research shows that in excess of 90% of total airborne dust returns to the earth's surface within 100m of the emission source and over 98% within 250m. In summary airborne soil dust is typically coarse and therefore remains airborne only for short periods.

Dust generation can affect the ability of nearby vegetation to survive and maintain effective evapotranspiration. It may also pose health risks and irritation to humans, but typically where working in uncontaminated soils, wind-blown dust is normally only considered a nuisance to those exposed.

In the absence of a South African dust impact assessment methodology, a qualitative assessment of the likely significant impacts of the generation and dispersion of dust and PM10 during the construction phase has been undertaken using guidance produced by the United Kingdom (UK) Institute of Air Quality Management (IAQM).

The impacts associated with this phase of the Project have been assessed by identifying:

- The size of the site and the area of which construction activities are likely to take place;

- The construction activities associated with the Project that could generate dust and their likely duration;
- The proximity and type of SRs;
- The prevailing wind direction and local precipitation patterns in the area;
- The presence of vegetation surrounding the site, which might act as a buffer; and
- The potential distance which the construction traffic will travel across unpaved roads on the construction Site, prior to accessing the local road network (referred to as 'trackout').

The following potential impacts of increased dust and PM10 generated during the construction phase have been considered:

- Annoyance due to dust soiling; and
- The risk of health effects due to an increase in exposure to PM10.

The assessment of the risk of dust impacts for each of the four activity categories took into account both the scale and nature of the works, which determines the potential dust emission magnitude, in conjunction with the sensitivity of the area. Risks were described in terms of there being a low, medium or high risk of dust impacts for each of the four activity categories. Site-specific mitigations, corresponding to the level of risk anticipated, were identified and proposed.

WKC's experience and professional judgement has been applied in this assessment to ascertain the magnitude of dust and PM10 emissions associated with each activity category, the degree of sensitivity of the affected receptors, and the suitable mitigation measures to be applied to ensure that there will be no significant impact on local air quality from this phase of the project.

c) Assessment of Dust Emission Magnitude

The generation of dust in the four activity categories is classed as large, medium or small, based on criteria provided in the IAQM guidance. The results of the assessment are summarised below.

- Demolition

Total volume of buildings/structures to be demolished as a requirement of the project is anticipated to be significantly less than 20,000m^3 ("small" category threshold), with construction material presenting low potential for dust release. Therefore the magnitude of dust and PM_{10} emissions is considered small for demolition activities.

- Earthworks

Whist the total construction area footprint would be classified as "large" according to IAQM criteria, the linear shape of the affected area would reduce the classification. Furthermore, the scale, nature and spatial extent of the excavation activities is such that the magnitude of dust and PM_{10} emissions is considered medium for earthworks activities.

- Construction

General construction activities will be somewhat limited due to the nature of the Project. Therefore the magnitude of dust and PM_{10} emissions is considered small for construction activities.

- Trackout

There is likely to be between 10 and 50 ("medium" category range) heavy vehicle outward movements in any one day during the construction period. The ground surface material is likely to have a high potential for dust release and >100m of unpaved roads will be traversed by construction vehicles. Therefore, it is considered that the magnitude of dust and PM_{10} emissions is large for trackout.

d) Assessment of Sensitivity of the Study Area

The primary wind directions in the study area are north-easterly and south-westerly. North-easterly winds are typically associated with high atmospheric pressure and regional geostrophic flow. South-westerly winds associated with the passage of coastal low pressure systems and cold fronts are generally strong and may be accompanied by rain. In both summer and winter months wind velocity is greatest in the afternoon. SR's located to the east and northeast of the work sites are more likely to be affected by any dust emitted/re-suspended from construction activities and track-out.

Local background PM_{10} concentrations are anticipated to be below 75% of the annual mean standard for this pollutant and therefore PM_{10} generated by the construction phase of the project is considered unlikely to cause an exceedence of the standards for this pollutant at the nearby SR's.

The project work sites are in some instances adjacent to or within residential areas (*with some properties within 20m of the pipeline route*), but it is noted that the route is linear, and that only a small number of SR's would be affected by the project activities at any given time. Residential properties and other SR's are situated much further away (>100m) from the pipe yard boundaries.

Taking the above and guidance produced by the IAQM into account, the area surrounding the proposed development is considered to be of medium sensitivity to changes in dust and PM_{10} as a result of construction activities.

e) Risk Assessment

According to the IAQM assessment procedure, and based on the available information on the construction phase at the time of writing, the risk of the project work sites for each of the activity categories considered is summarised in the table below. The risk category identified for each activity has been used to define the list of site specific mitigation measures for each relevant construction component.

Table 27: Summary Dust and PM10 Risk Table to Define Site-Specific Mitigation

Potential Impact	Risk			
	Demolition	Earthworks	Construction	Trackout
Dust Fallout / Soiling	Low	Medium	Medium	Medium
Human Health	Low	Medium	Medium	Medium

Taking into account all of the above, the overall sensitivity of the surrounding area in terms of human receptors is medium, and the overall magnitude of change prior to mitigation is considered to range between small and large. Therefore overall, there is likely to be a direct, temporary, short-term impact on nearby sensitive receptors of slight to moderate adverse significance prior to the implementation of mitigation measures.

f) Emissions from Construction Equipment and Vehicles

Emissions of CO_2, CO, SO_2, Nitrogen Oxides (NO_x) and PM_{10} will result from the operation of construction equipment (such as graders and cranes) and road vehicles during installation of the pipeline and associated facilities. Emissions will arise over a large (diffuse) geographical area and during the entire construction period, hence any potential deterioration of ambient air quality at any particular location is expected to be temporary and transient and is unlikely to be significant.

g) Conclusion

Through good site practice and the implementation of suitable mitigation measures (refer to Section F-4.2.1), the impact of emissions from construction activities would be reduced and excessive releases prevented.

The residual impact of the construction phase on local air quality would therefore considered to be temporary, short-term, local and of negligible significance.

B-2.6 Noise

Ward Karlson Consulting cc (WKC) was appointed to provide specialist comment on the potential issues associated with noise impacts in the vicinity of the proposed pipeline route and pipe yard activity (at Ottawa, Verulam and Eastbury, Phoenix). Refer to the study in Appendix D14. The assessment was undertaken by Mr. Novania Reddy and Mr. Marc Blanche of WKC and their experience in the field is provided in Table 3 of the BAR. Construction-related noise could have a negative impact on people and their surrounding environment. The objectives of this assessment are as follows:

- Description of the existing ambient noise levels at selected noise sensitive receptors (SRs) using measurements collected in April 2015;
- Comparison of existing noise levels at SRs with noise guidance as presented in South African National Standards (SANS) 10103; and
- Determine the impact caused by noise from construction equipment to nearby SRs using British Standard (BS) 5228.

B-2.6.1 Project Standards

Both the SANS guidelines SANS 10103: 'The measurement and rating of environmental noise with respect to annoyance and to speech communication' and BS 5228 'Noise and Vibration Control on Construction and Open Sites' were used as a basis for the assessment.

a) SANS Guidelines

The local guideline for an environmental noise assessment is the SANS 10103:2008, '*The measurement and rating of environmental noise with respect to annoyance and to speech communication'*. The standard covers the methods and provides guidance in the assessment of working and living environments with respect to acoustic comfort, excellence, and the possible annoyance by noise.

For assessment purposes, recommended daytime noise levels have been established based on the land use classification of the area of concern. No night time levels have been assessed as the project operational activities will take place during the day time only. The SANS 10103 defines these noise limits as presented in the following table. It should be noted that the SANS 10103 does not differentiate between construction related noise and permanent noise (for example a road or industrial facility) and therefore the application of the SANS limits to temporary construction related activities is deemed conservative.

Table 28: Typical Rating Levels for Noise in Districts

Land Use Classification	Equivalent Continuous Rating Level for Outdoor Noise (dB(A))
	Day Time ($L_{REQ,D}$) 06h00 – 22h00
Residential Districts	
Rural	45
Suburban (with little road traffic)	50

Land Use Classification	Equivalent Continuous Rating Level for Outdoor Noise (dB(A))
	Day Time ($L_{REQ,D}$) 06h00 – 22h00
Urban	55
Non-Residential	
Urban (workshops, businesses and main roads)	60
Central Business Districts	65
Industrial Districts	70

According to SANS 10103, where a classified area experiences noise contributions at a level in excess of the recommended rating noise level described in the following table, complaints are likely. The categories of impact and likeliness of community complaints are summarised in the table below.

Table 29: Categories of Community or Group Response

Excess ($\Delta L_{Req,T}$)[a] (dB(A))	Category	Description
0 – 10	Little	Sporadic
5 – 15	Medium	Widespread complaints
10 - 20	Strong	Threats of community or group action
> 15	Very Strong	Vigorous community or group action

Note a: $\Delta L_{Req,T}$ calculated as the change in ambient noise level as a result of the proposed development under investigation.

In terms of noisy equipment, the SANS 10103 implies a 5 dB(A) penalty for noise that is of a regular impulsive nature, and a 12 dB(A) penalty for a highly impulsive noise.

B-2.6.2 Impact Assessment Methodology

a) Calculation of Construction Noise

British Standard (BS) 5228:2009 'Noise and Vibration Control on Construction and Open Sites' provides a calculation method, practical information on noise reduction measures, and promotes 'Best Practice Means' approach to control noise emissions during construction.

BS 5228:2009 also details the noise spectra associated with a wide variety of construction equipment, several items of which are used for reference noise levels within this assessment. Reference noise spectra for these vehicles and plant items have been taken from BS 5228:2009.

b) Construction Noise Significance Criteria

Construction noise cannot be assessed in the same way as more permanent noise sources due to the temporary nature of construction activities and the transient movement of plant and vehicles. BS 5228:2009 provides a number of alternative ways to assess the impact of construction noise of a project. For the purpose of this project, the impact assessment methodology stipulated in BS 5228:2009 Appendix E.2 - 'Significance based on fixed noise limits and eligibility for noise insulation and temporary rehousing', the noise levels generated from construction activities should not exceed 70 dB(A) in rural, suburban and urban areas away from main road traffic and industrial noise. Therefore, a threshold noise limit of 70 dB(A) has been set for the assessment of construction noise.

For the purpose of construction noise impact in terms of assessment criteria, BS 5228:2009 stipulates significance rating method based on noise change (from ambient baseline noise level prior to construction activities). For the purpose of this assessment, the significance criteria method stipulated in BS 5228:2009.

Appendix E.3.2 '2 - 5 dB(A) change' stipulates that construction noise impact is deemed significant when the total noise (pre-construction ambient noise plus construction noise) exceeds the pre-construction noise by 5 dB or more.

Table 30: Noise Limits for Construction Noise

Impact Significance	Description
Negligible Negative	Noise levels greater than the ambient LAeq
Low/Minor Negative	Noise levels greater than 65 dB LAeq but less than 70 dB LAeq.
Moderate Negative	Noise levels greater than 70 dB LAeq (daytime) but for no more than 4 hours a day, 10 days in any month.
High/Major Negative	Noise levels greater than 70 dB LAeq (daytime) for more than 4 hours a day, and 10 days in any month.

B-2.6.3 Baseline Noise Survey

The baseline noise survey was undertaken in accordance with best practice as specified in SANS 10103. Measurements were taken at a standard height of 1.5m and minimum of 3m away from any reflecting surfaces. No night time measurements were recorded as the Project construction activities will take place during the day time only.

A Casella CEL-490 Type 1 sound level meter (SLM) was used for the short-term measurements. The selected sound level meters automatically log environmental noise measurement parameters including LAeq, LA10, LA90, and LAmax.

A survey was conducted on the 8th, 9th and 13th of April 2015, and reported ambient noise levels ranged from 42.6 – 68.2 Leq dB(A).

One round of short-term measurements was recorded at the 11 Baseline Noise Measurement Locations (BNML) along the pipeline route and at the existing Eastbury pipe yard and proposed Ottawa pipe yard. Measurements were recorded for 10 minute intervals at each location.

The table below summarises the baseline noise measurement results recorded at each of the eleven measurement locations.

Table 31: Baseline Noise Measurement Locations and Associated Noise Levels

BNML	Location	Distance from Pipeline (m)	UTM Co-ordinates	LA_{eq} dB(A)	LA_{90} dB(A)	Comment
BNML1	Pridley Road	10	300 545 m E 6 701 147 m S	57.3	38.0	Located on an island between 4 roads. Generally quiet other than the occasional traffic noise of loud busses.
BNML2	Mountbatten Drive – Reservoir Hills Mosque	340	300 800 m E 6 701 605 m S	68.2	43.5	On a noisy road with birds chirping and loud traffic noise (trucks and tractors.)
BNML3	Hillgrove Secondary School	445	301 904 m E 6 702 805 m S	63.1	44.0	Generally quiet apart from traffic noise and birds chirping. Distant helicopter/airplane.
BNML4	Royal Hill Road – Newlands West	10	302 057 m E 6 702 373 m S	42.6	40.5	Cul-de-sac elevated end. No nearby noise sources except for distant industrial noise –such as a compactor. Kids riding around on scooters.
BNML5	eThekwini Hospital and Heart Centre	535	306 237 m E 6 704 178 m S	61.1	58.5	Constant highway noise with cars passing by. Guards talking on their walky talkies. People patrolling up and down the parking lot of the hospital.
BNML6	Avocado Grove	15	307 459 m E 6 706 196 m S	52.6	51.0	Generally quiet residential area with almost no traffic. Constant highway traffic noise from the east.
BNML7	Corovoca Township (Dead end)	80	307 518 m E 6 707 563 m S	56.6	54.0	Highway noise with lorries reversing (alarm sound). Noises are faint from the dead end road.
BNML	**Location**	**Distance from Pipe Yard (m)**	**UTM Co-ordinates**	**LA_{eq} dB(A)**	**LA_{90} dB(A)**	**Comment**
BNML8	Eastbury Drive Pipe Yard Location 1	115	307 347 m E 6 710 720 m S	65.4	53.5	Traffic noise (mostly trucks). Edge trimmer noise. Piping yard is visible.
BNML9	Eastbury Drive Pipe Yard Location 2	75	307 462 m E 6 710 829 m S	57.6	47.5	Muffled traffic sound. People passing by on the sandy road.
BNML10	Ottawa Pipe Yard Location 1	180	309 912 m E 6 714 910 m S	55.8	50.5	The main noise source was existing construction noise and traffic along Chris Hani road. The final minute included a security truck idling 5 metres away and security personnel conversing. No wind.
BNML11	Ottawa Pipe Yard Location 2	385	309 539 m E 6 714 380 m S	53.2	48.0	The main noise source was the traffic from the adjacent R102, which was partially shielded by houses. Other noise sources included some quiet domestic noises and occasional birds chirping. No wind.

a) Sensitive Receptors

For the purposes of this assessment all BNMLs considered as part of the baseline survey have been included as SRs.

By calculating the combined noise contributions at each BNML, the overall impact of the construction noise can be assessed using a combination of SANS 10103 and BS 5228:2009.

b) Construction Noise Assessment

An assessment of predicted noise emissions from construction activities at the sensitive receptor points associated with the Project was carried out in accordance with BS 5228. A construction noise threshold of 70 dB (A) has been applied at all receptors. As the construction activities are only expected to occur during the day, night time impacts are not included in the assessment.

(i) Equipment Numbers

The construction assessment was based on impact durations and equipment numbers for the construction of the project facilities, provided by the engineers. The anticipated construction equipment types, number of items required for construction and noise emissions are detailed in the table below. The equipment list represents the maximum number of equipment items working at the boundary at any one time and is deemed to be conservative approach.

Table 32: Construction Equipment Inventory

Equipment Item	Approximate Size (tonnes)	Power (kW)	Estimated Number of Items on Construction Site	Noise Level @ 10m (dB(A)) [1]
Pipeline				
FH330 Excavator	30 - 35	185	4	76
ZA200 Excavator	18 - 22	105	2	71
Doser	40	350	2	80
Grader		110	1	86
Side Boom	40	230	4	N/A
8 Tonne Truck	10		1	N/A
Welding Trucks			5	N/A
Welding Machines		N/A	8	73
Diesel Re-Fueling Truck	20	150	1	N/A
Bell ADT	25	200	1	81
Tipper Trucks (10m^3)	26	200	4	74
Water Tanker (18m^3)	25	170	2	79
Light Duty Vehicle	1.5	80	8	N/A
Roads				
Asphalt Pavers	20	170	1	75
Pnematic Roller	4	75	1	74
Smooth Drum Roller	10	100	1	73
Bomag Roller			2	73
Mobile Spray Unit (Bitument)			1	N/A
Asphalt Kerb Extruder	0.5	15	1	N/A
Bridge				
Tower Cranes for Piers [2]			1	76
Crane for Casting Yard			1	77
Piling Rigs	5	550	2	N/A
Cement Mixers			2	71
Dewatering Pumps		10	2	65

Note 1: Noise levels of construction equipment as per BS 5228 estimates and vendor data for equipment of similar capacity and size.

Note 2: The same noise levels are applied for the use of a mobile telescopic crane within the pipe yards

c) Impact Assessment Summary - SANS 10103

Following the calculation of noise levels caused by the expected construction equipment inventory, the maximum noise levels associated with the project (in isolation) are expected to occur during the pipeline construction phase.

Based on the residential classification of all SRs, the applicable ambient noise limit is set as either 50 or 55 dB(A) depending on the surrounding road network in the area of each SR. Only SR4 is classified as being suburban and is thus the only SR for which the applicable noise limit is 50 dB(A).

When considering the cumulative context, where background noise levels are added to the predicted results (which include a 5 dB(A) penalty for impulsive noise), the ambient noise levels (LAeq) at ten of the eleven identified receptors are expected to exceed the SANS 10103 ambient noise limits. The baseline level at SR11 is the only receptor for which the ambient noise level is below the SANS guideline value of 55 dB(A).

According to the SANS guidelines, the change between the existing and future ambient noise levels will determine the significance of the impact from Project operation and the resultant likelihood of complaints. This criteria suggests that noise levels at five of the SRs are within the highest impact category of 'very strong' indicating that sporadic complaints could occur. It is noted however that due to the transient nature of the pipeline construction site, it is not expected that these (maximum expected) noise levels would occur for an extended period of time. The likelihood of strong community action as a result of the construction noise is thus significantly diminished.

Table 33: SANS 10103 Day Time Assessment Results

Pipeline Receptor	Baseline LAeq dB(A)	Estimated Total LAeq dB(A)	SANS Ambient Guideline dB(A)	Above or Below SANS Guideline	Change in Total Noise Level (dB(A))	Community Response Category
BNML1	57.3	95.3	55	Above	38	Very Strong
BNML2	68.2	68.8	55	Above	1	Little
BNML3	63.1	64.1	55	Above	1	Little
BNML4	42.6	95.3	50	Above	53	Very Strong
BNML5	61.1	62.2	55	Above	1	Little
BNML6	52.6	91.7	55	Above	39	Very Strong
BNML7	56.6	72.3	55	Above	16	Very Strong
Pipe Yard Receptor	**Baseline LAeq dB(A)**	**Estimated Total LAeq dB(A)**	**SANS Ambient Guideline dB(A)**	**Above or Below SAN Guideline**	**Change in Total Noise Level (dB(A))**	**Community Response Category**
BNML8	65.4	65.7	55	Above	0	Little
BNML9	57.6	60.6	55	Above	3	Little
BNML10	55.8	58.4	55	Above	3	Little
BNML11	53.2	53.6	55	Below	0	Little
Key	Above the appropriate SANS Day Time Guideline Value					
	Below the appropriate SANS Day Time Guideline Value					

Note 1: Sound levels are expressed in decibels, which are logarithmic and therefore cannot be manipulated without being converted back to a linear scale. In order to add sound levels each number must be converted to the antilog, then added together and converted back to the log.

d) Impact Assessment Summary – BS 5228:2009

Noise emissions from construction activities have been estimated for the 11 SRs that were identified. The construction noise threshold (due to its temporary nature) is 70 dB(A) with impact severity assessed as per Section 3.2.2. of Appendix D14.

To represent the worst case scenario, the construction equipment detailed in the table below has been assumed to be operating simultaneously at all SRs. Where applicable, a 3 dB addition has been included to take into account of reflections and a 5 dB barrier correction has been included based on the “line of sight” between the construction site and SR location.

The results for the construction phase of the project in isolation are presented in the following table.

Table 34: Construction Noise Levels at Sensitive Receptors (Project in Isolation)

			Ambient Noise			Construction Noise			Total Noise		
Construction Phase	Sound Receptor	Classification	Ambient Level Measured (dB(A))	Ambient Limit (dB(A))	Ambient Exceedance	Predicted Noise Level (dB(A))	Threshold (dB(A))[2]	Exceedance	Total Predicted Noise Level (dB(A))[1]	Change in Ambient Noise Level (dB)	Impact Significance
Pipeline Construction	BNML1	Residential	57.3	55	Yes	95.3	70	Yes	95.3	38.0	Moderate Negative
	BNML2	Residential	68.2	55	Yes	59.6	70	No	68.8	0.6	Low/Minor Negative
	BNML3	Residential	63.1	55	Yes	57.3	70	No	64.1	1.0	Negligible Negative
	BNML4	Residential	42.6	50	No	95.3	70	Yes	95.3	52.7	Moderate Negative
	BNML5	Residential	61.1	55	Yes	55.7	70	No	62.2	1.1	Negligible Negative
	BNML6	Residential	52.6	55	No	91.7	70	Yes	91.7	39.1	Moderate Negative
	BNML7	Residential	56.6	55	Yes	72.2	70	Yes	72.3	15.7	Moderate Negative
Pipe Yard Loading/ Unloading	BNML8	Residential	65.4	55	Yes	53.8	70	No	65.7	0.3	Low/Minor Negative
	BNML9	Residential	57.6	55	Yes	57.5	70	No	60.6	3.0	Negligible Negative
	BNML10	Residential	55.8	55	Yes	54.9	70	No	58.4	2.6	Negligible Negative
	BNML11	Residential	53.2	55	No	43.3	70	No	53.6	0.4	Negligible Negative

Note 1: The total predicted noise level is the cumulative of the ambient limit and the predicted noise level.

Note 2: BS 5228-1:2009 E.2 Significance based on fixed noise limits – 70 dB(A) in urban areas near main roads in heavy industrial areas.

The noise predictions presented in Table 34 are for activities with all assumed construction equipment operating concurrently with no site hoarding acting as a noise control measure, therefore this can be considered a 'worst case' scenario.

When the project is considered in isolation, construction noise contribution at SRs are all anticipated to be below the applicable construction noise limit in terms of BS 5228 – significance based on fixed noise limits, except for BNML 1, 4, 6 and 7.

Based on the rate of construction of the pipeline, the noise levels generated during the construction phase of the project are only anticipated to be applicable for a short period of time (less than 10 days). In terms of the significance criteria, the total noise level (construction noise) is considered significant if the change between the ambient and the predicted total is greater than 5 dB. In the case of this assessment, that equates to a moderate negative impact.

The cumulative noise level at BNML 1, 4, 6 and 7 are expected to cause moderate negative impacts with changes in ambient noise levels of 38.0 dB(A), 52.7 dB(A), 39.1 dB(A) and 15.7 dB(A) respectively. At receptors BNML 2,3,5,8,9,10, and 11 the significance ranges from low minor negative to negligible negative. As the duration of the maximum construction noise is expected to be less than 10 days, any significant impact arising from construction noise is expected to be temporary and transient in nature.

e) Key Findings/Conclusion

The construction activities associated with the pipe yard operation are most likely to have an impact on the adjacent receptors, associated with transportation, unloading and reloading of the pipe sections onto trucks at the pipe yard. As the pipes are sensitive to any abrasions or damage, the handling process is undertaken with caution, which also has the added benefit of reducing the pipe offloading noise.

f) SANS 10103 Assessment

The highest predicted day time noise level from the construction is 95.3 dB(A) at SR1 and SR4, with all but one of the SRs experiencing noise levels in excess of the SANS 10103 guideline limits.

Despite the aforementioned exceedances of the SANS noise limits, the overall increase in noise level at all but four of the SRs, fall within the impact category of 'little' which indicates the potential for sporadic complaints. The remaining four SRs are expected to fall in the 'very strong' community response category with vigorous community or group action, however it should be noted that due to the transient nature of the construction site (moving at approximately 90 metres per day), any significant impacts caused by construction noise are not expected to last for more than 10 days and will be restricted to daytime hours and as such the likelihood of community action is significantly diminished.

g) BS 5228: Construction Phase Assessment

Calculation of noise impacts due to construction equipment at various identified SRs was calculated based on the methodology outlined in BS 5228. The noise significance at these SRs were assessed based on the impact significance in terms of BS 5228 – significance based on fixed noise limits.

Eleven SRs were selected for assessment purposes. The impact at SRs arising from construction activities are not anticipated to be significant with the exception of SRs 1, 4, 6 and 7 where the cumulative noise level is anticipated to increase by more than 5 dB(A).

However, the duration of maximum construction noise impacts is expected to be less than 10 days, and thus any noise impact arising from construction in considered temporary.

A variety of possible noise mitigation measures have been suggested, which if implemented effectively, could lead to reduction in impacts for the SRs in close proximity to the pipeline route and pipe yards that may be

affected by construction noise, and therefore should be implemented through the environmental management plans. With the implementation of the construction noise mitigation measures it is unlikely that any adverse significant impacts to the local noise climate at the identified sensitive receptors shall be experienced during the construction phase.

SECTION C: BASIC ASSESSMENT (BA) PROCESS

C-1 APPROACH TO THE BA PROCESS

A Basic Assessment (BA) is an effective environmental planning tool. It identifies the environmental impacts of a proposed project and assists in ensuring that a project will be environmentally acceptable and integrated into the surrounding environment in a sustainable way.

The BA process for this project complies with the requirements of the National Environmental Management Act, 1998 (Act 107 of 1998) [NEMA] and the NEMA EIA Regulations, 2014 of the DEA. The guiding principles of a BA Process are listed below.

Definition of the term "environment"

The term "environment" is used in the broadest sense in an environmental impact assessment. It covers the physical, biological, social, economic, cultural, historical, institutional and political environments.

C-2 GUIDING PRINCIPLES FOR A BA PROCESS

The BA Process must take an open participatory approach throughout. This means that there should be no hidden agendas, no restrictions on the information collected during the process and an open-door policy by the proponent. Technical information must be communicated to stakeholders in a way that is understood by them and that enables them to meaningfully comment on the project.

There should be ongoing consultation with Interested and Affected Parties (I&APs) representing all walks of life. Sufficient time for comment must be allowed. The opportunity for comment should be announced on an on-going basis. There should finally be opportunities for input by specialists and members of the public. Their contributions and issues should be considered when technical specialist studies are conducted and when decisions are made.

The eight guiding principles that govern the entire process of BA Process are as follows:

- **Participation:** An appropriate and timely access to the process for all interested parties.
- **Transparency:** All assessment decisions and their basis should be open and accessible.
- **Certainty:** The process and timing of the assessment should be agreed in advanced and followed by all participants.
- **Accountability:** The decision-makers are responsible to all parties for their action and decisions under the assessment process.
- **Credibility:** Assessment is undertaken with professionalism and objectivity.
- **Cost-effectiveness:** The assessment process and its outcomes will ensure environmental protection at the least cost to the society.
- **Flexibility:** The assessment process should be able to adapt to deal efficiently with any proposal and decision making situation.
- **Practicality:** The information and outputs provided by the assessment process are readily usable in decision making and planning.

A BA process is considered as a project management tool for collecting and analysing information on the environmental effects of a project. As such, it is used to:

- Identify potential environmental impacts;
- Examine the significance of environmental implications;
- Assess whether impacts can be mitigated;
- Recommend preventive and corrective mitigating measures;
- Inform decision makers and concerned parties about the environmental implications; and
- Advise whether development should go ahead.

The Public Participation Process forms an integral part of the Basic Assessment Process and is discussed in greater detail in Section C – 4 of this BAR.

C-3 BASIC ASSESSMENT TECHNICAL PROCESS

This section provides a summary of the technical process that has been followed to date for this BA process.

C-3.1 EIA Enquiry Meeting

An EIA enquiry meeting was held between SEF, the eThekwini Municipality and KZN DEDTEA on 3 February 2015. The objectives of this meeting were to obtain guidance from KZN DEDTEA regarding the Basic Assessment (BA) Process under the 2014 EIA Regulations; and to obtain requirements from KZN DEDTEA on the BA Process. Refer to the minutes of the EIA Enquiry Meeting and the Attendance Register in Appendix C3.

C-3.2 Application for Authorization

Subsequent to the EIA Enquiry Meeting as explained above, the Application Form informing the Department of the intent to obtain an Environmental Authorisation in terms of NEMA was submitted to the KZN DEDTEA on 8 July 2015. The project was subsequently registered and KZN DEDTEA issued the project with reference number DM/0008/2015 and NEA Ref No: KZN/EIA/0000082/2015. Refer to Appendix C1 for the Application for Authorisation Form and Appendix C2 for the KZN DEDTEA acknowledgement of receipt of the application.

C-3.3 Information Gathering

Early in the BA process, the technical specialists identified the information that would be required for the impact assessment and the relevant data was obtained. In addition, the specialists sourced available information about the receiving environment from reliable sources, I&APs, previous documented studies in the area and previous BA and EIR Reports.

C-3.4 Specialist Studies

The following specialist studies have been undertaken for the BA process:

- Ecological Assessment (includes the floral and faunal assessment);
- Phase 1 Heritage Impact Assessment (includes cultural and built heritage assessment;
- Traffic Management Plan;
- Geohydrological Assessment;
- Soils and Agricultural Potential Assessment;
- Herpetofaunal Assessment;
- Aquatic Assessment;
- Estuarine Assessment;
- Social Impact Assessment;
- Noise Impact Assessment;
- Air Quality Assessment; and
- Wetland Delineation and Functional Assessment.

C-4 PUBLIC PARTICIPATION PROCESS

The principles of NEMA govern many aspects of the BA process, including consultation with I&APs. These principles include the provision of sufficient and transparent information to I&APs on an ongoing basis, to allow them to comment; and ensuring the participation of historically disadvantaged individuals, including women, the

disabled and the youth.
The principal objective of public participation is thus to inform and enrich decision-making. This is also the key role in the scoping phase of the process.

C-4.1 Identification of Interested and Affected Parties

I&APs representing the following sectors of society were identified (see Appendix E1 for a complete preliminary I&AP distribution list):

- National Departments;
- Provincial Authorities;
- Local Authorities;
- Ward Councillors (Wards 11, 23, 34, 37 and 102);
- Parastatal/ Service Providers;
- Non-governmental Organisations;
- Local forums/ unions; and
- Landowners directly affected by the project and in the vicinity of the proposed construction areas.

C-4.2 Public Announcement of the Project

I&APs were informed of the project and were requested to register and send their comments to SEF in the following manner (see Appendix E for public announcement documentation):

- Publication of media advertisements (in English) in the Mercury on 20 March 2015 and in the MetroBeat on 20 March 2015 to 2 April 2015;
- Publication of media advertisements (in Zulu) in the Isolezwe on 20 March 2015 and in the Ikhasi on 20 March 2015 to 2 April 2015;
- On-site notices (in English and Zulu) detailing the proposed development, the BA process and invitation to register and comment, were placed on and around the site on 25 March 2015; and
- Distribution of letters by fax/ by post/ email to the I&APs identified in Section C-4.1 above, including Registration and Comment Sheets on 23 to 25 March 2015.

C-4.3 Site Notices

Site notices in English and Zulu were placed at strategic places to inform the public about the proposed development and the processes to be followed if they wanted to be part of the Environmental Authorisation (EA) process or if they wanted further technical information (see Appendix E2 for the site notice text and the photographic proof of placements).

Site notices were placed at strategic locations as follows:

- English site notice was placed on the fence of the Reservoir Hills Mall (*next to the bus stop*) on Mount Batten Drive, Reservoir Hills;
- English site notice was placed on a light pole in Pridley Road, Reservoir Hills (*opposite the local shopping centre*);
- English site notice was placed on a light pole in Battersea Avenue, Reservoir Hills;
- English and Zulu site notices were placed on a light pole at the entrance to Newlands City Shopping Centre on Marble Ray Drive, Newlands East;
- English and Zulu site notices were placed on Kubu Avenue, Riverhorse Valley Business Estate;
- Zulu site notice was placed on a light pole at the Quarry Heights Settlement;
- English site notice was placed on the fence at the Corovoca Primary School on Pomegranate Road, Avoca Hills (*near Quarry Heights*);
- English site notice was placed on the mid-section of Avoca Hills Drive; and
- Zulu site notice was placed at the entrance to Avoca Hills Drive, near the semi-formal and informal

human settlement.

C-4.4 Newspaper Advertisements

An English newspaper advert was placed in the legal notices column of the Mercury Newspaper on 20 March 2015, informing the readers of the proposed development, and details of methods to participate should they wish to register as I&APs or comment on the project.

A Zulu advertisement in the legal notices column of the Isolezwe Newspaper was published on 20 March 2015 providing the same details as above.

The English and Zulu adverts were respectively placed in the English newspaper, Metro Beat and Zulu newspaper, Ikhasi, which are distributed free of charge in the Durban area in the 20 March 2015 to 2 April 2015 editions.

Refer to the English and Zulu newspaper advertisement texts and the proof of publication in Appendix E3.

C-4.5 Distribution of the Background Information Document (BID)

Properties that are situated next to the proposed Northern Aqueduct Augmentation Phase 5 pipeline servitude and the directly affected landowners were identified as main stakeholders in the project. This was motivated by the fact that the proposed servitude will be situated close to private properties. It was therefore important to make sure that all of these households are notified and that they were given an opportunity to raise their concerns.

The database of landowners occurring next to and directly affected by the proposed servitude were obtained from the design engineers, Bosch Stemele. Bosch Stemele is undertaking the land acquisition process and obtained the contact details of the landowners from the eThekwini Rates Department. Refer to Appendix E1 for a database of the landowners and other statekholers that were sent a copy of the BID in English and Zulu. Refer to Appendix E4 for the English and Zulu bids and the proof of notification.

The BID was posted, faxed and emailed to the landowners. The BID contained the following information:

- Purpose of the BID;
- Need for the project and project description;
- Location of the project / description of the pipeline route;
- Description of the receiving biophysical environment;
- The applicable NEMA legislation and EIA Regulations;
- Ways to participate in the Basic Assessment Process;
- Locality map of the study area; and
- Comments and Registration Sheet.

SEF's contact details were provided to the I&APs on the BID, and they were requested to forward any comments, registrations and so on, to SEF in order to participate in the project and be kept informed of the progress of the project.

C-4.6 Initial Meetings per Ward with Local Leadership

In order to maximise the level of public participation, Focus Group Meetings were held with the Ward Councillors of the Interested and Affected communities. The importance of these meetings was founded in:

- The necessity of obtaining the cooperation of the leadership in unlocking access to community members;
- Obtaining local advice and guidance on access protocols and mechanisms for informing and involving local IAPs; and

- Understanding of the key issues faced in the affected areas.

Introductory telephone calls were made and meetings were held with the respective councillors. The notes or minutes of these meetings are in Appendix E5.

The Focus Group Meetings took place as follows:

- Ward 23, Councillor Themba Mtshali at his council office on 1 April 2015;
- Ward 34, Councillor Ganesh Deochand at his office on 1 April 2015;
- Ward 102, Councillor Bongumusa Dludla at the City Hall on 2 April 2015;
- Ward 37, Councillor Siphiwe Lubhede at his council office on 2 April 2015; a
- Ward 11, Councillor Obed Qulo at this council office on 16 April 2015.

The Public Participation team and Social Impact Assessment Specialist briefly introduced the project and the Basic Assessment Process, to the ward councillors who were informed that the full details of the project will be covered in the forthcoming Basic Assessment Report, which will be available for public review.

The motivation for the project was explained to the ward councillors who commented that the supply of an uninterrupted access to clean water, as a basic need, in the Durban area is important to cater for the growing population and future development within the municipal area.

At the meeting of 2 April 2015, Councillor Lubhede of Ward 37 requested a site visit of the pipeline route in Ward 37. SEF undertook a site visit with Councillor Lubhede and his committee members on 24 April 2015. Refer to the attendance register in Appendix E5. SEF confirmed that the construction corridor will be constricted to the edge of the cadastral boundaries thereby minimising the impact on the landowners. Furthermore, mitigation measures relating to social impacts such as noise (Section F-4.2.2), dust and air emmissions (Section 4-2.1) must be adhered to during the construction phase of the project. The mitigation measures related to the biophysical impacts as described in Sections 4.1.3 to 4.1.7 must also be strictly adhered to during construction. At this site visit, Councillor Lubhede confirmed that he was satisfied with the route as long as there would not be any encroachment into private landowner's properties.

C-4.7 Database of Registered Interested and Affected Parties

An extensive database adapted to fit the needs of the project was devised. All IAPs who registered included within this database (refer to Appendix E6). The registered I&APs are those that provided written correspondence via fax, email and post and those that called in telephonically requesting to be registered/requesting further information/providing comments.

C-4.8 Proposed Public Open Days

Public Open Days (POD's) are proposed as per the table below. The purpose of the meetings will be to interact with the public on a on-on-one basis or a group to provide an understanding of the project, the pipeline route, specialist study findings and so on.

Name of public venue	Physical Address	Date and Time of Meeting
Resmount Primary School	2 Magdalen Avenue, Reservoir Hills	18 August 2015 from 14h30 to 19h30
Corocova Primary School	5 Pomegranate Road, Avoca Hills	19 August 2015 from 14h30 to 19h30
Newlands East Community Hall	10 Tandipa Road, Newlands East	20 August 2015 from 14h30 to 19h30

C-4.9 Basic Assessment Report for Public Review

All the comments and concerns raised by I&APs during the registration and comment period (i.e. 20 March 2015 to 10 April 2015) are included in a Comments and Responses Report (see Appendix E7). SEF responded to

the comments and registrations received from the I&APs. Refer to the actual comments and responses in Appendix E8.

The concerns raised were as follows:

- Impact on the uMngeni River;
- Impact of construction of the pipeline on private property and compensation;
- Impact on existing services;
- Impact on biodiversity (D'MOSS areas, wetland and riparian areas) and assessment of alternative routes;
- The need for concurrent EA and IWULA processes;
- Impacts of noise;
- Impacts of air quality and dust;
- Adherence to the Occupational Health and Safety Act;
- Impacts on surface and groundwater;
- Impacts of waste management;
- Impacts on Transnet Gas Pipelines;
- Impacts of crime; and
- Impacts on traffic.

A period of **30 calendar days** (**5 August 2015 to 4 September 2015**) was provided to the **State Departments**, and the **general public** for the review and commenting phase of the Basic Assessment Report. The availability of the Basic Assessment Report and invitation to the POD's was announced by means of personal letters to all the registered I&APs on the distribution list (refer to the notification letter in Appendix E9).

Newspaper adverts announcing public review of the Basic Assessment Report and the POD's were placed as follows:

An English newspaper advert was placed in the legal notices column of the Mercury Newspaper on 5 August 2015;

A Zulu advertisement in the legal notices column of the Isolezwe Newspaper was published on 5 August 2015;

The English and Zulu adverts were respectively placed in the English newspaper, Metro Beat and Zulu newspaper, Ikhasi, which are distributed free of charge in the Durban area on the 7 August 2015 edition.

Refer to the English and Zulu newspaper advertisement texts in Appendix E10.

In addition, the Basic Assessment Report was distributed for public comment and review as follows:

- Reservoir Hills Library;
- Newlands East Library;
- Newlands West Library;
- Firwood Public Library;
- Hand-delivered/ couriered to the relevant authorities; and
- Posted on SEF's website at http://www.sefsa.co.za.

Comments that will be received during public review of the BAR, will be captured in a Comment and Response Report for inclusion in the Final BAR. I&APs will receive letters acknowledging their contributions where appropriate.

SECTION D: ASSESSMENT CRITERIA

D-1 IMPACT IDENTIFICATION AND ASSESSMENT

The assessment criteria must clearly identify the environmental impacts of the proposed development. The environmental impacts identified will be quantified and the significance of the impacts assessed according to the criteria set out below. The EAP must make a clear statement, identifying the environmental impacts of the construction, operation and management of the proposed development. As far as possible, the EAP must quantify the suite of potential environmental impacts identified in the study and assess the significance of the impacts according to the criteria set out below. Each impact will be assessed and rated. The assessment of the data must, where possible, be based on accepted scientific techniques, failing which the specialist is to make judgements based on his/ her professional expertise and experience.

D-1.1 Assessment Procedure: Proposed Impact Assessment Methodology

For the purpose of assessing impacts of the proposed development, the project will be divided into two phases from which impacting activities can be identified, namely:

Construction Phase:	All the construction related activities on site, until the contractor leaves the site.
Operational Phase:	All activities, including the operation and maintenance of the proposed development.

The activities arising from each of these phases will be included in the impact assessment tables. This is to identify activities that require certain environmental management actions to mitigate the impacts arising from them. The assessment of the impacts will be conducted according to a synthesis of criteria required by the integrated environmental management procedure.

Extent The physical and spatial scale of the impact.	Footprint	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.
	Site	The impact could affect the whole, or a significant portion of the site.
	Regional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.
	National	The impact could have an effect that expands throughout the country (South Africa).
	International	Where the impact has international ramifications that extend beyond the boundaries of South Africa.

Duration The lifetime of the impact, that is measured in relation to the lifetime of the proposed development.	Short Term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than that of the construction phase.
	Short-Medium Term	The impact will be relevant through to the end of a construction phase.
	Medium Term	The impact will last up to the end of the development phases, where after it will be entirely negated.
	Long Term	The impact will continue or last for the entire operational lifetime of the development, but will be mitigated by direct human action or by natural processes thereafter.
	Permanent	This is the only class of impact, which will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient.
Intensity Is the impact destructive or benign, does it destroy the impacted environment, alters its functioning, or slightly alter the environment itself?	Low	The impact alters the affected environment in such a way that the natural processes or functions are not affected.
	Medium	The affected environment is altered, but functions and processes continue, albeit in a modified way.
	High	Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.
Probability The likelihood of the impacts actually occurring. The impact may occur for any length of time during the life cycle of the activity, and not at any given time.	Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0%).
	Possible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chances of this impact occurring is defined as 25%.
	Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of this impact occurring is defined as 50%.
	Highly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined as 75%.
	Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined as 100%.

Mitigation – The impacts that are generated by the development can be minimised if measures are implemented in order to reduce the impacts. These measures ensure that the development considers the environment and the predicted impacts in order to minimise impacts and achieve sustainable development.

Determination of Significance – Without Mitigation – Significance is determined through a synthesis of impact characteristics as described in the above paragraphs. It provides an indication of the importance of the impact in terms of both tangible and intangible characteristics. The significance of the impact "without mitigation" is the prime determinant of the nature and degree of mitigation required. Where the impact is positive, significance is noted as "positive". Significance will be rated on the following scale:

No significance: The impact is not substantial and does not require any mitigation action;
Low: The impact is of little importance, but may require limited mitigation;
Medium: The impact is of importance and is therefore considered to have a negative impact. Mitigation is required to reduce the negative impacts to acceptable levels; and
High: The impact is of major importance. Failure to mitigate, with the objective of reducing the impact to acceptable levels, could render the entire development option or entire project proposal unacceptable. Mitigation is therefore essential.

Determination of Significance – With Mitigation – Determination of significance refers to the foreseeable significance of the impact after the successful implementation of the necessary mitigation measures. Significance with mitigation will be rated on the following scale:

No significance: The impact will be mitigated to the point where it is regarded as insubstantial;
Low: The impact will be mitigated to the point where it is of limited importance;
Low to medium: The impact is of importance, however, through the implementation of the correct mitigation measures such potential impacts can be reduced to acceptable levels;
Medium: Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw;
Medium to high: The impact is of major importance but through the implementation of the correct mitigation measures, the negative impacts will be reduced to acceptable levels; and
High: The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

Assessment Weighting – Each aspect within an impact description was assigned a series of quantitative criteria. Such criteria are likely to differ during the different stages of the project's life cycle. In order to establish a defined base upon which it becomes feasible to make an informed decision, it will be necessary to weigh and rank all the identified criteria.

Ranking, Weighting and Scaling – For each impact under scrutiny, a scaled weighting factor will be attached to each respective impact. The purpose of assigning such weightings serve to highlight those aspects considered the most critical to the various stakeholders and ensure that each specialist's element of bias is taken into account. The weighting factor also provides a means whereby the impact assessor can successfully deal with the complexities that exist between the different impacts and associated aspect criteria.

Simply, such a weighting factor is indicative of the importance of the impact in terms of the potential effect that it could have on the surrounding environment. Therefore, the aspects considered to have a relatively high value will score a relatively higher weighting than that which is of lower importance (Figure below: Weighting description).

Extent	Duration	Intensity	Probability	Weighting Factor (WF)	Significance Rating (SR)	Mitigation Efficiency (ME)	Significance Following Mitigation (SFM)
Footprint 1	Short term 1	Low 1	Probable 1	Low 1	Low 0-19	High 0,2	Low 0-19
Site 2	Short to medium 2		Possible 2	Low to medium 2	Low to medium 20-39	Medium to high 0,4	Low to medium 20-39
Regional 3	Medium term 3	Medium 3	Likely 3	Medium 3	Medium 40-59	Medium 0,6	Medium 40-59
National 4	Long term 4		Highly Likely 4	Medium to high 4	Medium to high 60-79	Low to medium 0,8	Medium to high 60-79
International 5	Permanent 5	High 5	Definite 5	High 5	High 80-100	Low 1,0	High 80-100

Figure 22: Description of bio-physical assessment parameters with its respective weighting

Identifying the Potential Impacts Without Mitigation Measures (WOM) – Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned weightings, resulting in a value for each impact (prior to the implementation of mitigation measures).

Equation 1: Significance Rating (WOM) = (Extent + Intensity + Duration + Probability) x Weighting Factor

Identifying the Potential Impacts With Mitigation Measures (WM) – In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact.

Mitigation Efficiency (ME) – The most effective means of deriving a quantitative value of mitigated impacts is to assign each significance rating value (WOM) a mitigation effectiveness (ME) rating. The allocation of such a rating is a measure of the efficiency and effectiveness, as identified through professional experience and empirical evidence of how effectively the proposed mitigation measures will manage the impact.

Thus, the lower the assigned value the greater the effectiveness of the proposed mitigation measures and subsequently, the lower the impacts with mitigation.

Equation 2: Significance Rating (WM) = Significance Rating (WOM) x Mitigation Efficiency
Or
WM = WOM x ME

Significance Following Mitigation (SFM) – The significance of the impact after the mitigation measures are taken into consideration. The efficiency of the mitigation measure determines the significance of the impact. The level of impact will, therefore, be seen in its entirety with all considerations taken into account.

D-1.2 Integration of Specialist's Input

In order to maintain consistency in the impact assessment, all potential impacts to the environment (or component of the environment under review) will be listed in a table similar to the example shown below (more than one table will be required if impacts require assessment at more than one scale). The assessment parameters used in the table will be applied to all of the impacts and a brief descriptive review of the impacts and their significance will then be provided in the accompanying text. The implications of applying mitigation are reviewed in Section D-1.3 below.

Table 35: Example of an Impact Table

Impact source(s)			Status	-
Nature of impact				
Reversibility of impact				
Degree of irreplaceable loss of resource				
Affected stakeholders				
Magnitude	*Extent*			
	Intensity			
	Duration			
	Probability			
Significance	*Without mitigation*			H
	With mitigation			L
Significance Following Mitigation (SFM)				

D-1.3 Mitigation Measures

Mitigation measures will be recommended in order to enhance benefits and minimise negative impacts and they will address the following:

- Mitigation objectives: what level of mitigation must be aimed at: For each identified impact, the specialist must provide mitigation objectives (tolerance limits) which would result in a measurable reduction in impact. Where limited knowledge or expertise exists on such tolerance limits, the specialist must make an "educated guess" based on his/ her professional experience;
- Recommended mitigation measures: For each impact the EAP must recommend practicable mitigation actions that can measurably affect the significance rating. The specialist must also identify management actions, which could enhance the condition of the environment. Where no mitigation is considered feasible, this must be stated and reasons provided;
- Effectiveness of mitigation measures: The specialist must provide quantifiable standards (performance criteria) for reviewing or tracking the effectiveness of the proposed mitigation actions, where possible; and
- Recommended monitoring and evaluation programme: The specialist is required to recommend an appropriate monitoring and review programme, which can track the efficacy of the mitigation objectives. Each environmental impact is to be assessed before and after mitigation measures have been implemented. The management objectives, design standards, etc., which, if achieved, can eliminate, minimise or enhance potential impacts or benefits. National standards or criteria are examples, which can be stated as mitigation objectives.

Once the above objectives have been stated, feasible management actions, which can be applied as mitigation, must be provided. A duplicate column on the impact assessment tables described above will indicate how the application of the proposed mitigation or management actions has reduced the impact. If the proposed mitigation is to be of any consequence, it should result in a measurable reduction in impacts (or, where relevant, a measurable benefit).

D-1.4 Approach to the Assessment of Cumulative Impacts

Cumulative impacts can arise from one or more activities. A cumulative impact may result in an additive impact i.e. where it adds to the impact which is caused by other similar impacts or an interactive impact i.e. where a cumulative impact is caused by different impacts that combine to form a new kind of impact. Interactive impacts may be either countervailing (the net adverse cumulative impact is less than the sum of the individual impacts) or synergistic (the net adverse cumulative impact is greater than the sum of the individual impacts).

Possible cumulative impacts of the project will be evaluated in this assessment.

The assessment of cumulative impacts on a study area is complex; especially if many of the impacts occur on a much wider scale than the site being assessed and evaluated. It is often difficult to determine at which point the accumulation of many small impacts reaches the point of an undesired or unintended cumulative impact that should be avoided or mitigated. There are often factors that are uncertain when potential cumulative impacts are identified.

D-1.4.1 Steps in Assessing Cumulative Impacts

The assessment of cumulative impacts will not be done separately from the assessment of other impacts. Cumulative impacts however, tend to have different time and space dimensions and therefore require specific steps. This may even mean that some of the actions in the assessment process, that preceded general impact identification, may have to be revisited after potential cumulative impacts have been identified. This will ensure that the scope of the BAR process is adequate to deal with the identified cumulative impacts.

Three (3) general steps, which are discussed below, will be recommended to ensure the proper assessment of cumulative impacts.

D-1.4.2 Determining the Extent of Cumulative Impacts

To initiate the process of assessing cumulative impacts, it is necessary to determine what the extent of potential cumulative impacts will be. This will be done by adopting the following approach:

- Identify potentially significant cumulative impacts associated with the proposed activity;
- Establish the geographic scope of the assessment;
- Identify other activities affecting the environmental resources of the area; and
- Define the goals of the assessment.

D-1.4.3 Describing the Affected Environment

The following approach is suggested for the compilation of a description of the environment:

- Characterise the identified external environmental resources in terms of their response to change and capacity to withstand stress;
- Characterise the stresses affecting these environmental resources and their relation to regulatory thresholds; and
- Define a baseline condition that provides a measuring point for the environmental resources that will be impacted on.

D-1.4.4 Assessment of Cumulative Impacts

The general methodology that is used for the assessment of cumulative impacts should be coherent and should comprise of the following:

- An identification of the important cause-and-impact relationships between proposed activity and the environmental resources;
- A determination of the magnitude and significance of cumulative impacts; and
- The modification, or addition, of alternatives to avoid, minimise or mitigate significant cumulative impacts.

SECTION E: ALTERNATIVES

E-1 IDENTIFICATION OF ALTERNATIVES

The EIA procedures and regulations stipulate that the environmental investigation needs to consider feasible alternatives for any proposed development. Therefore, a number of possible proposals or alternatives for accomplishing the same objectives should be identified and investigated. During the investigative phase of the project, the identified alternatives will be assessed, in terms of environmental acceptability as well as socio-economic feasibility. To define the term alternatives as per Government Notice No. 982 of the NEMA EIA Regulations 2014 means:

"…in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity, which may include alternatives to:

(a) The property on which or location where it is proposed to undertake the activity;
(b) The type of activity to be undertaken;
(c) The design or layout of the activity;
(d) The technology to be used in the activity;
(e) The operational aspects of the activity; and
(f) The option of not implementing the activity."

E-1.1 Location Alternatives

The route selection process in determining the preferred pipeline route has been discussed in detail in Section A-1.2 and A-1.3. Inputs from various specialists (Floral, Faunal, Wetland Ecologists and Social Specialists) and the engineering team that provided technical recommendations, were considered in deriving the preferred pipeline route.

Various factors were considered in selecting the preferred route for the project, for further investigation by the environmental specialists.

Important criteria in route selection were as follows:

- Location of a pipeline route that will augment water supply to the northern areas of Durban with connection of reservoirs, valve chambers and blank flange had to take factors such as gravity, altitude and available pressure into consideration.
- As far as possible, the existing EWS servitudes should be followed. If this is not practically possible, existing road reserves, rail or service infrastructure (e.g. Ethekwini Electricity) servitudes to reduce purchase of private land for land acquisition requirements. Encroachment into existing servitudes requires approvals from the affected parties.
- As far as possible, new servitudes through private properties should follow cadastral boundaries, to minimise fragmentation of land and minimise the impact on private property.
- Accessibility of the pipeline route for construction, maintenance and servicing of the pipe, is important, and is to be optimally cost effective to construct.
- Physical factors such as geology, topography and land use have been considered in addition to the factors above, as well as environmental sensitive areas such as the Durban Metropolitan Open Space System (D'MOSS), wetland and riparian areas. The recommendations of the Preliminary Routing Report have been used as a basis for the choice of the 'preferred route'.

Alternative Routes 1, 2, 3, 4, 5 and 6 were investigated and Alternative Route 1 was deemed as the 'preferred route' based on technical, biophysical, socio-economic and cultural factors. Refer to Section A-1.2 for a detailed assessment of the Alternative Routes. The majority of Alternative 1 pipeline route follows the edge of cadastral

boundaries, follows adjacent to existing services such as electrical servitudes and existing water mains, as far as practicably possible. Due to the built up nature of the surrounding project area, Alternative route 1 was identified for the proposed pipeline from an engineering perspective, and which would have the least environmental and social implications. A thorough investigation of Alternative Route 1 was undertaken.

Based on recommendations by the flora, faunal and wetland specialist, various deviations off the Alternative Route 1 were suggested to minimise the impacts on the areas of high and medium to high ecological sensitivity (D'MOSS areas), as well as the riparian areas. The various deviations are discussed in detail in Section A-1.3 and the technical feasibility of construction of the deviations are explained.

The final preferred route was derived based on the specialists and engineer's recommendations. Refer to the visual representation of the final preferred route in Figure 9 and Appendix A3. Mitigation measures must be implemented where the various deviations cannot be accommodated due to technical reasons. These mitigation measures are discussed in detail in Section F.

E-1.2 Alternatives for Crossing the uMngeni River

Various alternatives were considered for installing the pipeline across the uMngeni River, as follows (refer to the Repor on Umgeni River Crossing Options in Appendix A5):

- New concrete pipe bridge with pre-cast beams;
- New concrete pipe bridge cast in-situ with staged formwork;
- New concrete pipe bridge cast in-situ using incremental launch;
- New structural steel pipe bridge on concrete piers;
- Horizontal directional drilling;
- Existing concrete bridge; and
- Open cut trenching.

Table 36 below provides a comparative assessment of the proposed alternatives for crossing the uMngeni River.

Table 36: Comparative Assessment of Alternatives for crossing the uMngeni River

Crossing Option	Construction Time	Durability/Maintenance	Advantages	Disadvantages
New Concrete Pipe Bridge with Pre-cast Beams, on Concrete Piers	15 months	Very good durability, minimal / easy maintenance	Shorter construction period, which is favorable considering the unpredictable nature of working within a watercourse. This is the lowest cost option. Allows for the installation of future proposed pipelines.	Limited construction of concrete piers and piling within the riverbed, therefore requires mitigation measures to minimise disturbance during construction. Specialised heavy-lifting equipment and expertise is required to achieve the launching and placement of the heavy precast concrete beams into their final position. This option will require, complex construction for the following in the riverbed i.e. temporary diversion works, working platforms and access roads within the river floodplain for equipment and plants (e.g. piling rigs, excavators and mobile cranes to lift precast sections).
New Concrete Pipe Bridge Cast in-situ using Incremental Launch, on Concrete Piers	15 to 18 months	Very good durability, Minimal / easy maintenance	Second lowest cost option. The bridge deck would be launched as a cast in-situ cantilever between the concrete piers. The deck structure will be constructed using the Incremental Launch method, which reduces the extent and duration of the disturbance in the riverbed. Allows for the installation of future proposed pipelines.	Limited construction in riverbed (i.e. temporary vertical support structures may be required) and therefore requires mitigation measures to minimise disturbance. This option would require construction of concrete piers and piling within the riverbed. To a limited extent, the construction of temporary river diversion works, working platforms and access roads within the river flood plain for equipment and plant (e.g. for piling rigs, excavators, mobile cranes).
New Structural Steel Pipe Bridge, on Concrete piers	15 months	Moderate durability, Frequent and difficult maintenance for steel sections with safety issues working at height	Allows for the installation of future proposed pipelines.	Highest bridge option cost Limited construction in riverbed, therefore mitigation measures are required during construction Susceptible to vandalism and theft of steel components. Corrosion is likely and therefore requires high maintenance.

Horizontal Directional Drilling (HDD)	9 months	Good durability, difficult maintenance, safety issues working underground – enclosed, restricted access	No obstructions (piers) within riverbed zone Shortest construction time	Does not allow for the installation of future proposed pipelines, since this option involves burying the pipe. Does not allow for accessibility and maintenance on the deep buried pipeline. The steep slopes and distance between the possible entry and exit pits would require forming an estimated 1200m to 1500m curvature / arch for the HDD, which made for potentially difficult and impractical drilling / boring. The entry and exit space needed to "feed" the pipe into the bored tunnel would extend beyond this arch. This is a concerning factor on the steep slopes with respect to access and environmental damages. The latter factors make the HDD option the highest cost option, and therefore not very viable.
New Concrete Pipe Bridge Cast in-situ using Staged Formwork, on Concrete Piers	18 months	Very good durability, minimal / easy maintenance		The cast in-situ concrete 'box section' bridge supported on cast in-situ concrete piers and piles, constructed with staged formwork requires substantial construction in the riverbed – high level of environmental management required during construction. Safety concerns with higher percentage of personnel working at heights and within the riverbed. Higher risk of losses caused by flood damage due to a high risk of floodwater undermining or destabilizing the temporary staging and resulting in washaways during construction. This option would require, to a more substantial extent, the construction of temporary river diversion works, working platforms and access roads within the river floodplain for equipment and

				plan (e.g. for piling rigs, excavators, staged formwork and mobile cranes).
Existing Concrete Bridge	N/A	Existing bridge will require some refurbishment and review of structural integrity	Depending on the structural integrity, least amount of work is required.	Does not allow for the installation of future proposed pipelines, since there is no space for additional infrastructure. Existing bridge is below the 1:100 year floodline, and thus, has a high risk of losing major supply to northern areas, if the bridge is damaged in a major flood event. All new infrastructure assets must be placed outside of this zone to reduce their vulnerability to flood damage. Overloading of the existing bridge beyond its design strength and capacity could affect its structural integrity, thereby considerably increasing the risk of collapse and consequent loss of water supply.
Open Cut Trenching	N/A	Moderate durability, difficult maintenance, safety issues working, underground – restricted access	No obstructions (piers) within riverbed zone	Laying the pipe in the riverbed using this method with lateral supports has a potential for scouring the river bed sediments during severe flood events for depths up to 15m and the highly erratic volumes of water flowing in the uMngeni River. High risk of damage/loss of pipe in riverbed, in a major flood event. There is no allowance for future services provision. Does not allow for accessibility and ease of maintenance for the buried pipeline.

Considering the above alternatives for crossing the uMngeni River, the most preferred option is the new concrete pipe bridge cast in-situ using the incremental launch, on concrete piers, as it reduces the extent and duration of disturbance in the riverbed. Although the incrementally launched pipe bridge is also a fairly complex construction operation, it does have an advantage over the precast concrete beam option, as construction of the bridge can take place on the river bank and access to the river flood plain would only be required for the construction of the bridge piers. This reduces the risk of flood damage during construction.

E-1.3 No Development Alternative

Should the KZN DEDTEA decline the application, the study area will not be impacted by the proposed pipeline construction. If the proposed Northern Aqueduct Phase 5 is not approved, the present state of the environment (in terms of the biological, physical, social and economic environment) would remain.

The 'no development' alternative refers to not augmenting the existing capacity of the bulk water infrastructure to the north-eastern suburbs of Durban with the installation of the Northern Aqueduct Phase 5 steel pipeline, thereby not alleviating the long-term water supply shortages. There is an increasing demand for an uninterrupted supply of clean water, due to the commercial and residential developments that are currently under construction and proposed within the eThekwini Municipality's area of jurisdiction. With the lack of augmentation of bulk water infrastructure, water supply requirements poses a problem in terms of development approvals, in light of the stress placed on the existing water schemes. The 'no development' alternative will still result in the need to upgrade the eThekwini Municipality's existing bulk water supply systems. Given the Government's objectives of ensuring the sustainable supply of potable water to all communities, and the Municipality's mandate to provide water to its region, the 'no development' option is not considered a viable alternative to the pipeline project.

There would also not be any creation of temporary jobs that could have led to the employment of the local community and local contractors, skills transfer or the demand for materials.

The tourism, recreational and industrial opportunities in the municipal area would remain stagnant due to the lack of adequate water infrastructure. Therefore, the Municipality will fail in its mandate to contribute towards Local Economic Development (LED) due to stagnant growth of the economy that the proposed infrastructural developments would have generated.

SECTION F: ASSESSMENT OF IMPACTS

F-1 IDENTIFIED IMPACTS

The following impacts were investigated and assessed for the proposed Northern Aqueduct Phase 5 project:

F-1.1 Proposed construction of the pipe bridge across the uMngeni River during the construction phase

F-1.1.1 Biophysical Impacts

- Vegetation and habitat destruction;
- River flow modification;
- Riverbank modification and edge hardening;
- Increased erosion, turbidity and siltation;
- Decreased water and soil quality;
- Increased sedimentation; and
- Impact on fauna as a result of increased ambient noise levels.

F-1.2 Proposed construction of the pipeline

F-1.2.1 Biophysical Impacts

- Increased erosion and sedimentation;
- Surface and groundwater contamination;
- Destruction of natural vegetation (including Threatened/Protected Floral species and associated habitats)
- Spread of alien invasive plant species;
- Destruction and fragmentation of natural habitat and fauna; and
- Destruction of wetland and riparian habitat through reshaping and construction activities of the pipeline within or within the direct vicinity of wetland habitat.

F-1.2.2 Social Impacts

- Increased ambient dust levels and air emissions;
- Increased ambient noise levels;
- Visual impact of construction activities on visual receptors;
- Effect of temporary workers on social dynamics;
- Access of land for the servitude;
- Impact of socio-cultural processes;
- Impact on health and social well-being;
- Impact on localised traffic;
- Impact on heritage resources;
- Temporary job creation and supply of local material; and
- Emancipatory and empowerment processes/capacity building and skills transfer.

F-1.3 Proposed Pipe Bridge across the uMngeni River during the operational phase

F-1.3.1 Biophysical Impacts

- Modified flow, erosion and depositional patterns.

F-1.4 Proposed Pipeline during the operational phase

F-1.4.1 Biophysical Impacts

- Impact of erosion;
- Impact on water resources;
- Spread of alien invasive plant species;
- Disturbance to fauna and faunal habitat; and
- Habitat degradation and fragmentation.

F-2 IDENTIFIED CUMULATIVE IMPACTS

Cumulative impacts, as illustrated below, occur as a result from the combined effect of incremental changes caused by other activities together with the particular project. In other words, several developments with insignificant impacts individually may, when viewed together, have a significant cumulative adverse impact on the environment (see Figure below).

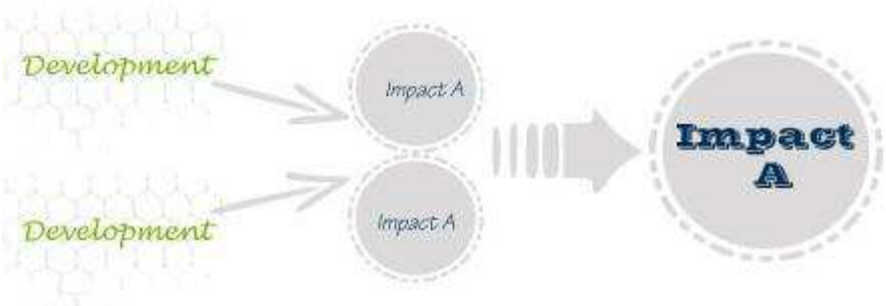


Figure 23: The identification of Cumulative Impacts

The following cumulative impacts have been identified in terms of the proposed development:

- Increased traffic impacts during the construction phase as a result of road upgrades and installation of the pipeline;
- Destruction of high ecological sensitive vegetation within the D'MOSS areas as a result of the proposed pipeline and future proposed developments;
- Increased soil erosion and sedimentation of watercourses as a result of vegetation clearance in light of the past impacts such as industrial developments and the construction of the N2;
- Potential destruction of wetlands and riparian areas through removal of hydrophytic and riparian vegetation, and/or hydric soils and riparian bed and bank modification;
- Improved access to water will have a positive impact on the community through implementation of the infrastructure required for the Northern Aqueduct Phase 5 project.

F-3 IMPACT ASSESSMENT: CONSTRUCTION PHASE FOR THE PROPOSED PIPE BRIDGE ACROSS THE UMNGENI RIVER

F-3.1 Biophysical Environment

F-3.1.1 Vegetation and faunal habitat destruction

Source and nature of the impact

The construction of the pipe bridge will result in the direct disturbance and loss of estuarine habitat for various organisms. The magnitude of the disturbance is dependent, in part, on the design of the proposed bridge, as well as the construction method employed for the bridge foundations. The proposed crossing design employs an incrementally launched bridge design, which is more intrusive on the estuarine environment than the previous suspension bridge design, as it requires five supporting piers to be constructed within the riverbed compared to the two requied for the suspension bridge. However, there are various piling methods that can be employed depending on the local conditions and the environmental sensitivities. Augercast piling is the preferred method as it causes minimal disturbance[4]. In addition, the deck structure will be constructed using the Incremental Launch method, which reduces the extent and duration of the disturbance in the riverbed.

Nonetheless, the construction of the bridge piers within the riverbed will cause destruction of soft sediment habitat for invertebrates, as well as cause substantial disturbance to adjacent aquatic areas. Littoral habitats will be severely disturbed or destroyed to enable access to the riverbed, however, the integrity of these areas has already been affected by the recent removal of the collapsed bridge. Even so, alien invasive vegetation still performs useful ecosystem services, such as binding the soil against erosion, flood attenuation and provision of habitat. For both instream and littoral habitats, the area impacted during construction will be greater than the footprint occupied by the bridge in the operational phase.

While the uMngeni system is an estuary of national importance, in terms of preserving biodiversity of estuaries, particularly permanently open systems, the overall significance of the impact is not considered severe due to the size of the affected area relative to:

- The size of the estuary as a whole;
- The existing highly modified state of the construction site, and;
- The degraded state of the uMngeni Estuary.

Although habitat loss within the Estuarine Functional Zone as a result of the permanent construction of the piers, as governed by the bridge design, will be irreversible; the rehabilitation of the immediate site and access routes is feasible and must be undertaken.

Table 37: Vegetation and faunal habitat destruction

Impact source(s)	Construction of pipe bridge and associated structures such as the deck, piers and foundations within the riverbed		Status	-
Nature of impact	Vegetation and faunal habitat destruction due to construction activities			
Reversibility of impact	The impact is reversible through the implementation of rehabilitation measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding land owners, conservation groups, upstream and downstream users			
Magnitude	*Extent*	Site - 2		
	Intensity	Medium – 3		

[4] A hollow-stemmed Continuous Flight Auger is drilled into the ground down to the founding level after which concrete / grout is pumped down the hollow-stemmed flight as the latter is gradually withdrawn. A steel reinforcing cage is then lowered into the wet concrete / grout in the pile shaft. This method causes minimal disturbance (limited noise and vibration, and is often used for noise and environmentally sensitive sites.

	Duration	Long-term to permanent – 4.5	
	Probability	Definite - 5	
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+3+4.5+5) x 3 = 43.5 Medium	M
	With mitigation	*WOM x ME = WM* 48 x 0.6 = 26.1 Low - Medium	L - M

Mitigation measures

- The uMngeni River is already a heavily modified system, and as such, the destruction or disturbance to the Estuarine Functional Zone and supporting habitats should be minimised as much as possible.
- The destruction of littoral and in-stream habitats is inevitable and unavoidable in river crossings, and to a certain extent permanent in the case of infrastructure in a water course.
- The reinstatement of these habitats will be governed largely by river flow, in combination with estuarine processes, such as the state of the mouth and marine input, which will take place over a considerable period of time, from months to several years.
- For these reasons, the area of construction activities must be kept to an absolute minimum and the construction site must be appropriately demarcated.
- Areas beyond this demarcation must be considered as 'No go zones', unless for rehabilitation purposes, to prevent unnecessary additional disturbance.
- All indigenous vegetation must be marked and avoided as far as practicaly possible, in line with the PRRRP. The access route to the river edge must strictly follow the existing tracks and the creation of ad hoc access paths must not be permitted. In addition, the movement of heavy construction machinery should not be permitted in the river channel to reduce habitat destruction as well as the compaction of soils.
- While restoration of vegetation and estuarine habitats to pristine condition is virtually impossible, post-construction rehabilitation is essential to mitigate the negative impacts of construction activities and must be implemented as soon as possible.
- An invasive alien plant eradication programme, as well as an indigenous replanting and maintenance programme, must be implemented and maintained to prevent the proliferation of invasive species into open areas and to re-establish natural vegetation, respectively.
- Given the designation of the uMngeni River estuary as Critical Biodiversity Area, rehabilitation must be expanded to degraded areas beyond the construction site and maintained to assist and contribute to improving overall estuarine condition. The areas for rehabiltiatoin must be indentified in consultation with the Contractor, EPDCPD, Engineers and the ECO.
- Invasive alien plants also provide highly flammable bulk material that produces intense heat during veld fires. Given the prevalence of invasive plants on site and the proximity to residential development, no open fires should be permitted and on-site smoking must be confined to designated smoking areas within the site camp to prevent the risk of run-away fires.

Significance of the impact

The significance of this impact is regarded as low to medium. The impact is still important however, through the implementation of the correct mitigation measures, such potential impacts can be reduced to acceptable levels.

F-3.1.2 River flow modification

Source and nature of the impact

River inflow is one of key drivers of estuarine processes and functioning. Construction activities within the riverbed will undoubtedly require the diversion of water and modification of the riverbed and riverbanks (e.g. infilling of the riverbed, creation of berms). These activities will have significant consequences in terms of

modifications to the flow patterns of the river. The downstream flow will be impeded and forced through specific channels to accommodate construction, leading to increased erosion and deposition of sediment in new areas not previously experienced, and ultimately cause changes to the river morphology and habitat quality and availability. Closure of the estuary mouth due to construction activities alone is not anticipated provided that river flow is not completely obstructed so as to compromise scouring action created by outward river flow.

Table 38: River flow modification

Impact source(s)	Construction of foundations and piers within the riverbed and diversion of water through berms		Status	-
Nature of impact	River flow modification due to diversion of water and alterations to the riverbed			
Reversibility of impact	The impact is reversible through the implementation of adequate rehabilitation measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding landowners, conservation groups, upstream and downstream water users			
Magnitude	*Extent*	Site - 2		
	Intensity	Medium – 3		
	Duration	Short – Medium Term – 2		
	Probability	Definite - 5		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+3+2+5) x 5 = 60 Medium to High		M -H
	With mitigation	*WOM x ME = WM* 60 x 0.8 =48 Medium		L - M

Mitigation measures

- River flow should not be constricted in totality, i.e. full impoundment of the system at the construction site should be strictly prohibited.
- Furthermore, the main channel of flow should not be entirely diverted. The instream construction of the piers should be undertaken in a phased approach whereby flow is only diverted around each construction node, as and when needed.
- Construction of the piers should preferably be undertaken during the dry winter months when river input is naturally low, thereby reducing the risk of mass erosion of sediment from within the channel and exposed riverbanks.
- Channel crossing during the construction period must be restricted to a single designated crossing point of suitable design that does not restrict river flow and allows only for the passage of light vehicles.
- All imported or repositioned sediment and materials within the river channel and on the riverbanks must be removed, and the disturbed environment(s) must be returned to its pre-construction state, or an improved state, once construction is complete or as soon as practicably possible during the construction phase.

Significance of the impact

The significance of this impact is regarded as medium to high. The impact is of low to medium importance, through the successful implementation of the mitigation measures to reduce the negative impact to an acceptable level.

F-3.1.3 Riverbank modification and edge hardening

Source and nature of impact

The current ecological status of the uMngeni River is a product of decades of human disturbance. Very few areas of the estuarine river system remain unmodified. The proposed bridge construction will result in further

direct modification of the system through replacement of portions of instream and marginal habitats, including vegetation and soils, with smooth hardened edges, thereby reducing channel roughness and in turn, potentially affecting flow velocities. While the majority of the uMngeni River system is highly canalised with limited capacity for flood attenuation, the overall significance of edge-hardening and permanent bank modification is not considered severe, as the proposed design concept does not require large-scale application of concrete, bank stabilisation, or culvert installations.

Table 39: Riverbank modification and edge hardening

Impact source(s)	Construction of foundations and piers within the riverbed		Status	-
Nature of impact	River bank modification and edge hardening as part of the bridge structural design			
Reversibility of impact	The impact is reversible through the implementation of adequate rehabilitation measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding landowners, conservation groups, upstream and downstream water users			
Magnitude	*Extent*	Footprint - 1		
	Intensity	Low – 2		
	Duration	Permanent – 5		
	Probability	Definite – 5		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (1+2+5+5) x 2 = 26 Low to Medium		L - M
	With mitigation	*WOM x ME = WM* 26 x 0.4 = 10.4 Medium		L

Mitigation measures

- Edge-hardening of the riverbanks should be kept to a minimum.
- Design options should be investigated to minimise the modification of the marginal habitats to concrete environments, taking into account the type of structure, materials to be used and area to be covered.
- Compaction of sediments by heavy vehicles and plant must be kept to a minimum by restricting their paths of movement.
- Marginal indigenous vegetation should be reinstated alongside hardened areas, as well as instream areas that may have been cleared as a result of construction, to promote growth for flood attenuation.
- All imported or repositioned sediment and materials within the river channel and on the riverbanks to support construction activities must be removed, and the disturbed environment(s) must be returned to its pre-construction state, or an improved state, once construction is complete or as soon as practicably possible during the construction phase.
- In addition, compacted soils must be ripped and suitably rehabilitated and re-vegetated with indigenous plant species.

Significance

The significance of this impact is regarded as low-medium. The impact is still important however, through the implementation of the correct mitigation measures, such potential impacts can be reduced to acceptable levels.

F-3.1.4 Increased erosion, turbidity and siltation

Source and nature of impact

Agitation of the sediment during earthmoving activities in the riverbed and on the riverbanks, compounded by the clearing of marginal vegetation and stockpiling of soil will lead to increased erosion potential and mobilisation of sediment. This will in turn increase the turbidity of the water column due to suspended particulate matter. This has important implications for light penetration and the primary productivity of microalgae, as well as submerged plants. In addition, fine particulate matter is likely to clog the feeding and breathing apparatus of certain organisms (invertebrates and fish), and dramatic deposition will smother entire soft-sediment invertebrate communities, as well as change fundamental habitat characteristics. An example of these impacts occurred during the historic canalisation of the Springfield Flats and associated spillage of silt (Begg, 1984), which resulted in dramatically reduced water clarity, raising of the riverbed by more than 15 cm causing decreased water depth at low tide, and coverage of sandy areas with a layer of silt. This may affect potential food resources for bottom-feeding fish and birds.

The uMngeni system does close periodically, due to a combination of reduced freshwater inflow, strong winds and wave action, tidal fluctuations and movement of marine sand at the mouth. However, mouth closure is occurring with increased frequency (despite being characterised as a permanently open system) and this is ascribed to further reductions in river flow caused by impoundments in the catchment. Catastrophic erosion of sediment (for example, caused by land slippages) and subsequent transportation and deposition in the lower reaches, would not only contribute to shallowing of the system, but also potential severance of certain areas from the main channel and potential prolonged closure of the mouth due to the accumulation of sediment. This would have severe consequences for the health and ecological functioning of the system. The likelihood of land slippage occurring is possible given the presence of steep slopes at the river crossing, however the likelihood of mouth closure due to construction activities alone is unlikely.

Given the biodiversity value of the uMngeni system as a permanently open estuary, any impacts likely to affect its biodiversity, health and functioning must be considered highly significant at the national level.

Table 40: Increased erosion, turbidity and siltation

Impact source(s)	Construction of foundations and piers within the riverbed		Status	-
Nature of impact	Increased erosion and turbidity, and redistribution of sediment as a result of disturbance, excavations and removal of marginal vegetation			
Reversibility of impact	The impact is reversible through the implementation of adequate rehabilitation measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding landowners, conservation groups, upstream and downstream water users			
Magnitude	*Extent*	National - 4		
	Intensity	High – 5		
	Duration	Short-medium term – 2		
	Probability	Definite – 5		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (4+5+2+5) x 5 = 80 High		H
	With mitigation	*WOM x ME = WM* 80 x 0.8 = 64 Medium - High		M – H

Mitigation measures

- Terrestrial areas with steep slopes and high erosion potential must be identified by the site engineer prior to the commencement of construction.
- These areas must be stabilised using biddim or other agreed materials to prevent slippages and loss

of soil.

- Appropriate stormwater management must be implemented at the worksite as well as at the construction site camp.
- A shallow drain network can be constructed during the land clearing phase to contain any soil lost during rainy periods.
- Vegetation clearing must be kept to a minimum and grass buffer strips must be implemented wherever possible at the development edge at the start of construction.
- For instream works, the construction of sand berms and platforms must be restricted to specific areas, reduced in size and for a short duration.
- All soft edges, including berms, platforms, and coffer dams etc., must be stabilised using sandbags, biddim, or other suitable materials.
- Soil erosion and downstream deposition must be monitored regularly to timeously apply appropriate mitigation measures.
- Restoration and re-vegetation of exposed areas must take place as soon as practically possible to reduce the chances of erosion.

Significance of the impact

The significance of this impact is regarded as high. The impact is of major importance however, through the implementation of the correct mitigation measures, the negative impact can be reduced to acceptable level. Taken within the overall context of the project, the impact does not constitute a fatal flaw.

F.3.1.5 Decreased water quality of the uMngeni River

Source and nature of impact

The water quality of the uMngeni River is already compromised as a result of the intensive urbanised surroundings. Chemical contamination is likely to arise from construction methods and processes, materials, incidental spillages, leaking machinery and vehicles, with the potential for sewage contamination from temporary ablution facilities, polluting both the soil and the water course. The disturbance of the riverbed will release sequestered heavy metal contaminants and other toxic substances from the sediment into the water column to be carried into the downstream environments. Should Auger Piling be employed, the occurrence of undesirable spillages is probable, as this method utilises large volumes of grout. Without mitigation, these impacts will result in further deterioration of the water quality of the system, particularly during low flow periods and periodic mouth closure, with significant knock-on effects for the biological estuarine components (fauna and flora). The implications for estuarine health and biodiversity are of national concern.

Table 41: Decreased water quality

Impact source(s)	Construction of the proposed pipe bridge across the river		Status	-
Nature of impact	Soil and water contamination through construction methods, materials, and ablutions			
Reversibility of impact	The impact is reversible through the implementation of adequate rehabilitation measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding landowners, conservation groups, upstream and downstream water users			
Magnitude	*Extent*	National - 4		
	Intensity	Medium – 3		
	Duration	Short-medium term – 2		
	Probability	Highly likely – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (4+3+2+4) x 3 = 39 Low to medium		–L- M
	With mitigation	*WOM x ME = WM* 39 x 0.4 = 15.6 Low		L

Mitigation measures

- Construction best practise must be applied at all times, through the implementation and enforcement of a stringent Construction Environmental Management Programme (EMPr).
- The site camp and ablution facilities must be positioned outside the estuarine functional zone and the 1:100 year floodline, and chemical toilets must be located away from stormwater culverts and drainage lines.
- Sewage waste from chemical toilets may not be discharged into the estuary environment.
- The work area within the floodplain, as well as the construction site camp, must regularly checked for spillages and leakages.
- Spillage of construction materials must be prevented, and a spill contingency plan must be developed as part of the EMPr.
- The bulk supply of wet concrete is the preferred method of concrete production over the establishment of an on-site concrete batching plant.

Significance of the impact

The significance of this impact is regarded as low to medium. The impact is important however, though the implementation of the correct mitigation measures, such potential impact can be reduced to an acceptable level.

F-3.1.6 Increased sedimentation

Source and nature of the impact

Clearance of existing vegetation and exposure of the upper layers of the soil horizon may lead to erosion during times of rainfall, as will the location of any borrow pits within the 1:100-year floodline used for the construction of the temporary berm across the uMngeni River, and the temporary berm itself. The transport of eroded soil into surrounding surface water resources will increase the Total Suspended Solids (TSS), which may adversely affect the aquatic fauna in a number of ways. For example, transport of sediment into watercourses decreases the amount of aquatic habitat available for utilisation due to smothering and increased embeddedness of substrata, resulting in a significant decrease in the aquatic macroinvertebrates. It is however acknowledged that habitat structure within the study area was dominated by highly dynamic alluvial substrate, and as such imbedding of substrate was unlikely.

Various authors (Barton, 1977; Taylor & Roff, 1986; Ogbeibu & Victor, 1989) have assessed the impact of increases in suspended solids and sediment deposition on aquatic macroinvertebrates. Specifically, these studies determined that while no significant change in the abundance of species occurred as a result of such construction activates, a shift in the species composition was noted, and incorporated the concept of invertebrate drift (i.e. the movement of aquatic invertebrates into or out of an area of impact by relinquishment of hold on substrate). However, biotic communities were determined to return to normal within eight months after construction was complete (Dallas and Day, 2004).

Nevertheless, given the degree of urbanisation present within the catchments of the associated watercourses (and downstream of the Inanda Dam in the case of the uMngeni River) and the associated increased periodicity and magnitude of flooding, the additional impacts associated with potential sedimentation are considered to be low in terms of the freshwater ecosystem. It should however be noted that impact associated with sedimentation on the downstream estuarine ecosystem may be more significant than that identified for the freshwater ecosystem, as sediment fluxes pays a vital role in the functioning of the estuarine environment. In this regard, the reader is referred to Royal HaskoningDHV (2015). Nevertheless, the mitigation measures as provided below are likely to decrease the potential impacts associated with the proposed activity on the estuarine ecosystem.

Table 42: Increased sedimentation

Impact source(s)	Construction of the proposed pipe bridge across the river	Status	-
Nature of impact	Input of sediment due to construction activities		
Reversibility of impact	The impact is reversible through the implementation of adequate rehabilitation measures		

Degree of irreplaceable loss of resource	Low		
Affected stakeholders	Surrounding landowners, conservation groups, upstream and downstream water users		
Magnitude	*Extent*	Regional - 3	
	Intensity	Medium – 3	
	Duration	Medium term – 2	
	Probability	Highly likely – 4	
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+2+4) x 3 = 36 Low to medium	**L - M**
	With mitigation	*WOM x ME = WM* 36 x 0.2 = 7.2 Low	**L**

Mitigation measures

- Proposed piling and pipeline supports at the proposed crossing of the uMngeni River are to be constructed in line with supports of the existing collapsed bridge structures;
- Ensure that all material excavated for the purpose of sinking piling is not placed within the 1:100 year floodline or any drainage lines. At the soonest possible time following excavation, such material should be transported out of the uMngeni River valley, as this may act as a source of sediment which may impact on the uMngeni River system;
- Ensure flow diversion structures are placed upslope of any earth stockpiles that have been removed for the purposes of sinking piling;
- Ensure that sediment curtains are installed downslope and/or on the downstream side of any earth stockpiles;
- Material used for the construction of the temporary sediment berm (including dump rock and/or fines) should not be sourced from within the floodplain of the uMngeni River, as any additional excavation activities within the area will result in additional exposed sediment sources that may impact the downstream estuarine environment. Instead, such material should be imported from authorised commercial sources. Further, the amount of fines required should be kept at a minimum so as to prevent sedimentation of the downstream estuarine environment;
- Following completion of the construction period for the pilings at the proposed crossing of the uMngeni River, material used for the temporary sediment berm should be removed and transported out of the uMngeni River valley;
- The construction of sand berms and platforms at any river crossing must be restricted to specific areas, reduced in size and for a short duration;
- All soft edges, including berms, platforms, and coffer dams etc., must be stabilised using sandbags, bidim, or other suitable materials;
- Ensure that all such mechanisms (i.e. flow diversion structures, sediment curtains, sand bags, etc.) are inspected on a weekly basis or after any rainfall events exceeding 10mm;
- Ensure that all piling structures or any other structures associated with the proposed pipeline crossing of the uMngeni River remain outside the active channel wherever possible. In this regard, consideration should be given to conducting all construction-related activities outside of the rainfall season;
- The disturbance of instream channels and riparian zones during construction of proposed pipeline crossing must be minimised as far as practical;
- Where instream and riparian elements are disturbed during the construction process, rehabilitation of such disturbed areas is to take place as soon as possible following completion of the activity;
- An adaptive management approach should be taken with regards to the assessment of impacts during the construction phase; and
- Ensure strict adherence to all guidelines as specified in Environmental Best Practice Specifications:

Construction Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition compiled by DWAF (2005).

Significance of the impact

The significance of this impact is regarded as low to medium. The impact is important however, though the implementation of the correct mitigation measures, such potential impact can be reduced to an acceptable level.

F-3.1.7 Impact on fauna through increase ambient noise levels

Source and nature of the impact

Construction activities and the movement of vehicles will create a certain level of noise pollution during the construction period, which may affect numerous bird populations that utilise the river as a sanctuary and feeding area, and other wildlife, as well as residents living in close proximity to the site. In contrast, the level of noise created during the operational phase will be nil.

Table 43: Impact on fauna through increased noise levels

Impact source(s)	Construction of associated structures for the proposed bridge		Status	-
Nature of impact	Increased erosion and turbidity, and redistribution of sediment as a result of disturbance, excavations and removal of marginal vegetation			
Reversibility of impact	The impact is reversible through the implementation of adequate rehabilitation measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding landowners, conservation groups, upstream and downstream water users			
Magnitude	*Extent*	Site - 2		
	Intensity	Low – 1		
	Duration	Short-term – 2		
	Probability	Highly likely – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+1+2+4) x 1 = 9 Low		L
	With mitigation	*WOM x ME = WM* 9 x 0.4 = 3.6 Low		L

Mitigation measures

- Low-noise construction methods must be employed wherever possible, e.g. auger piling in place of pile driven foundations.
- Noise suppression devices should be installed on all high-decibel plant machinery and vehicles. Construction should only take place during office/daylight hours.

Significance of the impact

The significance of this impact is regarded as low since the impact can be mitigated to the point where it is of limited importance.

F-3.1.8 Impact on water and soil quality

Source and nature of the impact

The water quality of the uMngeni River is already compromised as a result of the intensive urbanised surroundings. Chemical contamination is likely to arise from construction methods and processes, materials, incidental spillages, leaking machinery and vehicles, with the potential for sewage contamination from temporary ablution facilities, polluting both the soil and the watercourse. The disturbance of the riverbed will release sequestered heavy metal contaminants and other toxic substances from the sediment into the water column to be carried into the downstream environments. Should auger piling be employed, the likelihood of undesirable spillages is high, as this method utilises large volumes of grout. Without mitigation, these will result in further deterioration of the water quality of the system, particularly during periodic mouth closure, with significant knock-on effects for other estuarine components (fauna and flora). The implications for estuarine health and biodiversity are of national concern.

Table 44: Impact on water and soil quality

Impact source(s)	Construction of the bridge and associated structures		Status	-
Nature of impact	Soil and water contamination through construction methods, materials and ablutions			
Reversibility of impact	The impact is reversible through the implementation of adequate rehabilitation measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding landowners, conservation groups, upstream and downstream water users			
Magnitude	*Extent*	National – 4		
	Intensity	Medium – 3		
	Duration	Short – term – 2		
	Probability	Highly Likely - 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (4+3+2+4) x = 39 Low to medium		L - M
	With mitigation	*WOM x ME = WM* 39 x 0.4 = 15.6 Low		L

Mitigation measures

- Construction best practise must be applied at all times, through the implementation and enforcement of a stringent Construction Environmental Management Programme (EMPr).
- The site camp and ablution facilities must be positioned outside the estuarine functional zone and the 1:100 year floodline, and chemical toilets must be located away from stormwater culverts and drainage lines.
- Sewage waste from chemical toilets may not be discharged into the estuary environment.
- The work area within the floodplain, as well as the construction site camp, must regularly checked for spillages and leakages.
- Spillage of construction materials must be prevented, and a spill contingency plan must be developed as part of the EMPr. The bulk supply of wet concrete is the preferred method of concrete production over.

Significance of the impact

The significance of this impact is regarded as low to medium. The impact is important however, though the implementation of the correct mitigation measures, such potential impact can be reduced to an acceptable level.

F-4 IMPACT ASSESSMENT: CONSTRUCTION PHASE FOR THE PROPOSED PIPELINE

F-4.1 Biophysical Environment

F-4.1.1 Increased Soil Erosion and Sedimentation

Source and nature of the impact

The removal of surface vegetation will cause exposed soil conditions where rainfall and high winds can cause mechanical erosion. Rainfall and inadequate drainage systems would lead to sediments washing down into wetlands, water courses and low lying areas, causing sedimentation. In addition, indigenous vegetation communities are unlikely to colonise eroded soils successfully and seeds from proximate alien invasive trees can spread easily into these eroded soil.

Table 45: Soil erosion and silting of the drainage lines

Impact source(s)	Increased exposed surfaces devoid of vegetation, as a result of construction activities and vehicles		Status	-
Nature of impact	Increased soil erosion and sedimentation			
Reversibility of impact	The impact is reversible through the implementation of adequate stormwater management measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding and downstream land owners			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Short – Medium Term – 2		
	Probability	Highly Likely - 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+2+4) x 4 = 48 Medium		M
	With mitigation	*WOM x ME = WM* 48 x 0.4 =19.2 Low - Medium		M - L

Mitigation measures

- An ecologically-sound stormwater management plan must be implemented during construction and appropriate water diversion systems put in place;
- The stormwater management plan must be compiled and approved post authorisation;
- Erosion must not be allowed to develop on a large scale before effecting repairs;
- Vegetation and soil must be retained in position for as long as possible, and removed immediately ahead of construction / earthworks in that area (DWAF, 2005);
- Runoff must be managed to avoid erosion and pollution problems;
- All areas susceptible to erosion must be protected and it must be ensured that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas;
- All topsoil and spoil (excavated subsoil) must be stored in such a way and in such a place that it will not cause the damming up of water, erosion gullies, or wash away itself (DWAF, 2005);
- Remaining areas exposed to erosion due to construction should be vegetated with species naturally occurring in the area;
- Surface water or stormwater must not be allowed to concentrate, or flow down cut or fill slopes without erosion protection measures being in place;
- All areas of disturbed and compacted soil need to be ripped and re-profiled before rehabilitation; and
- Concurrent rehabilitation must take place throughout the construction phase.

Significance of the impact

Due to the nature of the impact (as described above), the significance of this impact without mitigation, is regarded to be medium. Implementation of the mitigation measures will decrease the significance of the impact to medium-low.

F-4.1.2 Surface and ground water contamination

Source and nature of the impact

Groundwater recharge through openings created during construction may alter direction of flow and water quality, if not properly sealed to prevent infiltration of surface water runoff or contaminants. Hydrocarbon-based fuels or lubricants spilled from construction vehicles, construction materials that are not properly stored, and litter deposited by construction workers may be washed into the surface water bodies. If appropriate toilet facilities are not provided for construction workers at the construction site camps, the potential exists for surface water resources and surrounds to be contaminated by raw sewage. While it is acknowledged that the impacts associated with the proposed activities will be negligible given the degree of urban runoff and therefore contaminants already entering the associated watercourses, every effort should still be taken limit additional contributions.

Table 46: Surface and ground water contamination

Impact source(s)	Hydrocarbon and other chemical spillages		Status	-
Nature of impact	Contamination of surface and ground water during heavy rainfall events			
Reversibility of impact	The impact is reversible by containing and clearing spills as and when they occur by means of an appropriate spill kit.			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding and downstream land owners			
Magnitude	*Extent*	Site -3		
	Intensity	Medium – 3		
	Duration	Short – Medium Term - 2		
	Probability	Likely – 3		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+2+3) x 4 = 44 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.4 =17.6 Low		L

Mitigation measures

- Open trenches must be properly sealed to prevent infiltration of surface water runoff or contaminants.
- Construction vehicles are to be maintained in good working order, to reduce the probability of leakage of fuels and lubricants;
- Vehicles used during the construction phase must be parked in a designated area and containers should be used to prevent any oil leaks;
- Formal waste management and sewerage systems must be put in place for contractors;
- A walled concrete platform, dedicated store with adequate flooring or bermed area should be used to accommodate chemicals such as fuel, oil, paint, herbicide and insecticides, as appropriate, in well-ventilated areas;
- Storage of potentially hazardous materials should be above the current (i.e. not historic) 1:100 year floodline, and 100m from the wetlands, or as agreed with the ECO. These materials include fuel, oil, cement, bitumen etc;
- Sufficient care must be taken when handling these materials to prevent pollution;
- Surface water draining off contaminated areas containing oil and petrol would need to be channelled

towards a sump which will separate these chemicals and oils;

- Oil residue shall be treated with oil absorbent such as Drizit or similar and this material removed to an approved waste site;
- It is preferable that ready-mix concrete is used. However, if batching on site takes place the following must be followed:
  - Concrete, if used, is to be mixed on mixing trays only, not on exposed soil;
  - Concrete and tar shall be mixed only in areas which have been specially demarcated for this purpose;
  - All concrete and tar that is spilled outside these areas shall be promptly removed by the Contractor and taken to an approved dumpsite;
  - After all the concrete / tar mixing is complete all waste concrete / tar shall be removed from the batching area and disposed of at an approved dumpsite;
  - Stormwater shall not be allowed to flow through the batching area. Cement sediment shall be removed from time to time and disposed of in a manner as instructed by the Consulting Engineer;
  - All construction materials liable to spillage are to be stored in appropriate structures with impermeable flooring;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- Portable septic toilets are to be located outside of the 1:100 year floodline and at least 100m from the wetlands;
- Under no circumstances may ablutions occur outside of the provided facilities;
- At all times care should be taken not to contaminate surface water resources;
- Uncontrolled discharges from the construction site camps (where applicable) to any surface water resources shall not be permitted. Any discharge points need to be approved by the relevant authority;
- In the case of pollution of any surface or groundwater, the Regional Representative of the DWS must be informed immediately;
- Where construction in close proximity to sewer lines is unavoidable then excavations must be done by hand while at all times ensuring that the soil beneath the sewer lines is not destabilised;
- Store all litter carefully so it cannot be washed or blown into any of the water courses within the study area;
- Provide bins for construction workers and staff at appropriate locations, particularly where food is consumed;
- The construction site should be cleaned daily and litter removed;
- Conduct on-going staff awareness programs so as to reinforce the need to avoid littering; and
- An adaptive management approach should be taken with regards to the assessment of impacts during the construction phase. In this regard, water quality both upstream and downstream of the proposed bridge construction across the uMngeni River should be conducted on a monthly basis.

Significance of the impact

The significance of this impact is regarded as medium without mitigation; however, if spillages are effectively mitigated to reduce the likelihood of surface and/or ground water contamination, the significance will be reduced to low.

F4.1.3 Destruction of natural vegetation including threatened and/or protected floral species and associated habitat

Source and nature of the impact

The construction of the pipeline on the preferred route alignment will lead to the destruction of natural, indigenous vegetation that is representative of the following KZN threatened vegetation types:

- KwaZulu-Natal Coastal Belt Thornveld;
- Southern Mesic Coastal Lowlands Forest;
- KwaZulu-Natal Coastal Belt Grassland; and
- Southern Moist Coastal Lowlands Forest.

In addition, the preferred pipeline route alignment falls within D'MOSS areas as well as areas classified as CBA1 according to the KZN C-Plan. In order to minimise the impact of the construction of the pipeline on the receiving environment, it is recommended that the pipeline route should be constructed in residential areas. Where this proves not to be feasible, the pipeline should not traverse through the middle of natural areas, but should be aligned along the interface of natural areas and residential/built up areas.

Table 47: Destruction of natural vegetation and associated habitat

Impact source(s)	Vegetation clearance and construction-related activities		Status	-
Nature of impact	Floral species may be lost and fauna may be displaced due to the removal of vegetation.			
Reversibility of impact	The impact is irreversible as the original state of the vegetation cannot be re-instated.			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	NA			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Permanent – 5		
	Probability	Definite – 5		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+5+5) x 4 = 64 Medium to High		M-H
	With mitigation	*WOM x ME = WM* 64 x 0.8 =51.2 Medium		M

Mitigation measures

Construction along D'MOSS areas having high ecological importance i.e. at the edge of the closed canopy woodland / forest area in Reservoir Hills, and the wooded-grassland in Hillgrove, must take cognisance of the following, as strict mitigation measures must be in place:

- The construction corridor must be **as narrow as possible** in sensitive areas. Construction camps or storage areas should not be placed within the construction corridor in sensitive areas;
- The operational phase servitude must be kept **as narrow as possible** in sensitive areas especially wooded drainage lines. Woody vegetation must be restored where possible;
- All natural areas that have been modified by construction activities must be re-vegetated using indigenous grassland or riparian species found in the area (as specified in the Plant Rescue, Relocation and Rehabilitation Plan to be compiled by a suitably qualified ecologist);
- Alien invasive plants that emerge on topsoil stockpiles must be removed immediately (DWAF, 2005);
- Due to the nature of the development, loss of natural woody habitat is unavoidable, however at a small scale. To help compensate for the loss and fragmentation of habitat, it is recommended that the municipality commit resources to an urgent clean-up campaign focussed on drainage lines and bushy areas within the study area (as specified in the PRRRP to be compiled by a suitably qualified ecologist). Illegal dumping was observed throughout the study area and the impact was deemed severe in certain

areas. eThekwini Municipality must commit to better policing and a campaign to clamp down on illegal dumping in the study area.

- Removal and relocation of any species protected under the Natal Nature Conservation Ordinance No. 15 of 1974 will require a permit granted by the provincial conservation agency EKZNW;
- Removal and relocation of any species protected under NEMBA (Act 10 of 2004): Threatened or Protected Species Regulations will require a permit obtained from the provincial MEC;
- An education programme / information sheet must be put in place to inform contractors and workmen about appropriate conduct in natural areas e.g. no littering;
- An alien invasive plant species monitoring and management plan must be put in place throughout the duration of the operational phase to ensure that alien plant infestations do not ensue as a result of the development;
- A Plant Rescue, Relocation and Rehabilitation Plan should be compiled by a suitably qualified botanist or ecologist to ensure natural areas are appropriately rehabilitated; and
- Areas that have been disturbed during construction should be rehabilitated with species naturally occurring in the study area, and the disturbed areas should be monitored quarterly to detect any alien plant species (as specified in the PRRRP to be compiled by a suitably qualified ecologist).

Significance of the impact

Due to the conservation status and vegetation type within an urbanised area, the impact of the removal of vegetation to make space for the development is regarded as medium to high without mitigation. Implementation of mitigation measures will decrease the significance of the impact to medium.

F-4.1.4 Spread of alien invasive plant species

Source and nature of the impact

The removal of indigenous vegetation may result in a disruption of ecological processes making vegetation communities vulnerable to invasion by alien plant species. Although many areas have been densely infested by alien plants such as *Melia azedarach*, *Chromolaena odorata* and *Lantana camara*, intact natural areas such as the wooded grasslands and closed canopy woodlands were largely devoid of dense infestations except along the edges adjacent to roads, previous pipeline footprint and residential areas. The construction of the pipeline through these units may weaken the vegetation units resulting in the establishment of alien species.

Table 48: Spread of alien invasive plant species

Impact source(s)	Increased spread of alien invasive plant species		Status	-
Nature of impact	Loss of biodiversity and faunal displacement			
Reversibility of impact	The impact is irreversible as the loss of natural vegetation will result in a loss of faunal habitat.			
Degree of irreplaceable loss of resource	High			
Affected stakeholders	Surrounding land owners, eThekwini Municipality			
Magnitude	*Extent*	Site -2		
	Intensity	High - 5		
	Duration	Long Term - 4		
	Probability	Definite - 5		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+5+4+5) x 4 = 64 Medium to high		M-H
	With mitigation	*WOM x ME = WM* 64 x 0.6 =38.4 Low to Medium		L-M

Mitigation measures

- Disturbance to natural vegetation should be minimised as far as possible to limit opportunities for

alien invasive plant species to become established;

- Areas that have been disturbed during construction should be rehabilitated with species naturally occurring in the study area, and the disturbed areas should be monitored quarterly to detect any alien plant species; and
- This should be included in an Alien Invasive Plant Management Plan compiled for the operational phase. The alien invasive plant management plan will be included in the PRRRP that will be compiled by a suitably qualified ecologist.

Significance of the impact

Due to the occurrence of the site in close proximity to the D'MOSS areas, the significance of the impact without mitigation is regarded to be medium-high. Implementation of the mitigation measures will decrease the significance of the impact to a low-medium.

F-4.1.5 Destruction and fragmentation of natural faunal habitat

Source and nature of the impact

Clearing of the construction corridor and removal of earth from the trench may destroy natural faunal habitat in certain areas. The maintenance of a tree-less operational phase servitude will mean the permanent loss of woody species and faunal habitat in places. Areas most affected include all areas deemed highly important / sensitive faunal habitat (Figures 6 to 11 of Appendix D7), such as forested valleys, wooded drainage lines and wooded grassland. The maintenance of a tree-less operational phase servitude in wooded areas, will permanently fragment these habitats and increase edge effects.

Table 49: Destruction and fragmentation of natural faunal habitat

Impact source(s)	Construction-related activities and conduct of construction personnel		Status	-
Nature of impact	Interference with flora and faunal behaviour patterns			
Reversibility of impact	The impact is reversible if mitigated to a large extent			
Degree of irreplaceable loss of resource	High			
Affected stakeholders	Surrounding land owners, custodians of D'MOSS areas			
Magnitude	*Extent*	Regional - 3		
	Intensity	High - 5		
	Duration	Permanent – 5		
	Probability	Highly likely – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+5+5+4) x 5 = 85 High		H
	With mitigation	*WOM x ME = WM* 85 x 0.6 =51 Medium		M

Mitigation measures

- Construction activities should commence during the winter months to minimise the impacts on breeding fauna, as far as practically possible;
- The construction corridor must be as narrow as possible in sensitive areas. Construction camps or storage areas should not be placed within the construction corridor in sensitive areas;
- The operational phase servitude must be kept to a minimum in sensitive areas especially wooded drainage lines;
- Where access through drainage lines and riparian zones is unavoidable, the route should be constructed perpendicular to the watercourse, as far as practically possible (DWAF, 2005);

- All natural areas that have been modified by construction activities must be re-vegetated using indigenous grassland and/or herbaceous riparian species found in the area (more specific details will be provided in the PRRRP to be compiled by a suitably qualified ecologist);
- Due to the nature of the development, loss of natural woody habitat is unavoidable, however at a small scale. To help compensate for the loss and fragmentation of habitat, it is recommended that the municipality commit resources to an urgent clean-up campaign focussed on drainage lines and bushy areas within the study area. Illegal dumping was observed throughout the study area and the impact was deemed severe in certain areas. eThekwini Municipality must commit to better policing and a campaign to clamp down on illegal dumping in the study area (specific details will be provided in the PRRRP to be compiled by a suitably qualified ecologist).

Significance of the impact

Due to the occurrence of the site in close proximity to the D'MOSS areas, the significance of the impact without mitigation is regarded to be high. Implementation of the mitigation measures will decrease the significance of the impact to a medium.

F-4.1.6 Disturbance to areas containing natural habitat and fauna

Source and nature of the impact

The proposed construction activities may have a disturbance effect on adjacent or surrounding natural areas. Construction may result in high levels of noise, vibrations and the operation of floodlights, should construction continue in the night. This may disturb the fauna utilising the natural areas, especially nocturnal species, and could result in a localised decrease in biodiversity as faunal species move away from the disturbance. The presence of the construction site may also result in negative faunal interactions that could be associated with construction personnel including poaching, trapping and hunting of faunal species, as well as possible collisions of fauna with construction vehicles. Food and rubbish can attract wildlife to the area, increasing risk of negative interactions.

Table 50: Disturbance to areas containing natural habitat and fauna

Impact source(s)	Construction activity, construction equipment and artificial light in the construction area		Status	-
Nature of impact	Disturbance to areas containing natural habitat and fauna			
Reversibility of impact	The impact is irreversible as the disturbance of faunal habitat may result in displacement of fauna			
Degree of irreplaceable loss of resource	High			
Affected stakeholders	Surrounding land owners, custodians of D'MOSS			
Magnitude	*Extent*	Regional -3		
	Intensity	Intensity - 3		
	Duration	Medium Term – 3		
	Probability	Highly likely – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+3+4) x 4 = 52 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.6 =31.2 Low		L

Mitigation measures

- Construction activities should commence during the winter months to minimise the impacts on breeding fauna, as far as practically possible;
- If individuals of any faunal species that cannot relocate themselves (e.g. burrowing animals) are encountered during construction, activities should cease until the individuals can be moved in an

ecologically acceptable manner to a more suitable location. This should be undertaken by a faunal relocation expert;

- Removal and relocation of any species protected under the Natal Nature Conservation Ordinance No. 15 of 1974 will require a permit granted by the provincial conservation agency EKZNW;
- Removal and relocation of any species protected under NEMBA (Act 10 of 2004): Threatened or Protected Species Regulations will require a permit obtained from the provincial MEC;
- No wild animal may under any circumstance be handled, removed or be interfered with by construction workers;
- No wild animal may under any circumstance be hunted, snared, captured, injured or killed, including animals perceived to be vermin. Checks of the surrounding natural areas must be regularly undertaken to ensure no traps have been set. Any snares or traps found on or adjacent to the site must be removed and disposed of;
- No domesticated animals must be allowed on site;
- To prevent possible collisions with animals in natural areas, drivers of construction vehicles must remain vigilant to the possibility of animals crossing their paths and a strict speed limit should be adhered to;
- All food should be securely stored away to prevent attraction of faunal species and all rubbish should be disposed of away from the site. Bins should have tightly fitting lids to prevent faunal species raiding the bins; and
- If possible, construction activities should cease at night.

Significance of the impact

The significance of the impact without mitigation is regarded to be medium. Implementation of the mitigation measures will decrease the significance of the impact to low.

F-4.1.7 Destruction of wetland and riparian habitat through reshaping and construction activities of the pipeline within the direct vicinity of wetland habitat

Source and description of the impact

The footprint of the pipeline and associated construction corridor could infringe or destroy wetland and riparian habitat with associated biota through removal of hydrophytic and riparian vegetation and or hydric soils and riparian bed and bank modification.

Table 51: Destruction of wetland and riparian habitat through reshaping and construction activities of the pipeline within the direct vicinity of the wetland habitat

Impact source(s)	Construction activities within and in close proximity to the wetlands and riparian areas		Status	-
Nature of impact	destruction of wetland and riparian habitat			
Reversibility of impact	The impact is not reversible			
Degree of irreplaceable loss of resource	High			
Affected stakeholders	Surrounding land owners			
Magnitude	*Extent*	Regional -3		
	Intensity	High – 5		
	Duration	Permanent – 5		
	Probability	Definite – 5		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+3+2+3) x 4 = 40 Medium		M
	With mitigation	*WOM x ME = WM* 40 x 0.6 = 24 Low to Medium		L - M

Mitigation measures

In general, the pipeline route should attempt to follow the watershed (highest point) to avoid riparian and wetland habitat. Where all practical mitigation measures and viable route options have been applied, and it is not deemed feasible to avoid riparian or wetland habitat, the crossing of the water resource should be perpendicular with the smallest footprint possible.

Various drainage lines and wetlands may be traversed during construction of the pipeline along the proposed route, including the closed canopy woodland / forest area, wooded-grassland area and valley bottom floodplain wetland area. The following mitigation measures must be in place:

- Excavate wetland and riparian crossings in the winter months as this is the driest period for this region as far as practically possible;
- The crossings of the riparian channels should be perpendicular to the direction of flow, as practically possible;
- The crossings should be designed to ensure that flow patterns along the stream/river channel are not altered or diverted potentially resulting in stream bank erosion;
- The crossings should be rehabilitated to ensure that no barriers exist within the stream and that in-stream habitat is similar to the natural situation;
- On steep slopes draining towards the identified freshwater ecosystems, small-scale diversion berms and or siltation nets should be constructed on the surface of the pipeline alignment to reduce the risk of the pipeline becoming a preferred surface flow path leading to erosion;
- “Trench-breakers”, which are in-trench barriers, should be installed along the length of the pipeline to minimise the interception and accumulation of water from the adjacent hillslope within the infilled trench;
- During installation, the excavated soil from the trench should be placed on the upslope side of the trench, minimising the risk of excess sediment entering the downstream areas of the freshwater ecosystems;
- The pipeline alignment should be rehabilitated, with the wetland and riparian habitat at the crossing points being restored to near natural conditions. In addition, areas where disturbance adjacent to these ecosystems has occurred should also be rehabilitated. This should be done immediately after pipeline construction activities have moved from the area;
- The working corridor across the systems must be as narrow as practically possible i.e. machinery must utilise the same route through the systems at all times so as to avoid unnecessary disturbance;
- In riparian areas, backfilling should occur as soon as possible, compact if possible and reshape drainage channels to original levels;
- Where wetland and or riparian habitat is crossed, the top 50cm of seed containing topsoil should be kept separately from other soils in order to be utilised during rehabilitation. The remainder of the soil profile should also be placed back *in situ*. Re-vegetation of disturbed areas must be undertaken with site indigenous species and in accordance with the instructions issued by the ECO. Areas where soil compaction or ruts developed should be rehabilitated. Specific mitigation measures must be included in the Wetland Rehabilitation Plan that must be compiled by a suitably qualified wetland ecologist.
- A wetland monitoring programme must be implemented that ensure that all impacted wetland and riparian areas are adequately rehabilitated;

For the uMngeni River crossing, mitigation measures as proposed by SEF (2015a) for piling and pipeline bridge supports should be adhered to, including:

- Proposed piling and pipeline supports at the proposed crossing of the uMngeni River are to be constructed in line with supports of the existing pipeline crossing;
- Ensure that all earth excavated for the purpose of sinking piling is not located within any drainage lines;
- Ensure flow diversion structures are placed upslope and/or on the upstream side of any earth stockpiles that have been removed for the purposes of sinking piling;

- Ensure that sediment curtains are installed downslope and/or on the downstream side of any earth stockpiles that have been removed for the purposes of sinking piling;
- Ensure that such mechanisms as placed around earth stockpiles (i.e. flow diversion structures and sediment curtains) are inspected on a weekly basis or after any rainfall events exceeding 10mm;
- Ensure that all piling structures or any other structures associated with the proposed pipeline crossing of the uMngeni River remain outside the active channel wherever possible. In this regard, consideration should be given to conducting all construction-related activities outside of the rainfall season;
- The disturbance of instream channels and riparian zones during construction of proposed pipeline crossing must be minimised;
- An adaptive management approach should be taken with regards to the assessment of impacts during the construction phase. In this regard, water quality monitoring both upstream and downstream of the proposed bridge expansion should be conducted on a monthly basis; and
- Ensure strict adherence to all construction guidelines as specified in DWAF (2005).

Further, avoid unnecessary construction activities in wetland and riparian areas at all cost through proper demarcation and appropriate environmental awareness training. The Contractor has a responsibility to inform all staff of the need to be vigilant against any practice that will have a harmful effect on wetlands. This information shall form part of the Environmental Education Programme to be effected by the Contractor, including the following:

- Any proclaimed weed or alien species that germinates during the contract period shall be cleared by hand before flowering;
- Infilling, excavation, drainage, dumping of building material and hardened surfaces (including buildings and asphalt) should not occur in any of the wetland or riparian areas, or within 30m of a wetland or riparian area if possible to avoid;
- Imported fill material should be monitored during and after construction for the presence of any alien species. Any such species should be removed immediately;
- Emergency plans must be in place in case of pollutant spillages into wetland systems;
- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds. It should also only be stored for the minimum amount of time necessary;
- Erosion control of all banks must take place so as to reduce erosion and sedimentation into river channels or wetland areas;
- Littering and contamination of water sources during construction must be mitigated by effective construction camp management;
- All construction materials including fuels and oil should be stored in a demarcated area that is contained within a bunded impermeable surface to avoid spread of any contamination. The storage areas should be constructed as far away as practically possible outside of wetland habitat; and
- It is preferable that ready-mix concrete be used. However, if cement batching occurs on site the following should be undertaken:
  - Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area, in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase.

Significance of the impact:

The significance of the impact without mitigation is regarded to be medium, due to the presence of a number of drainage lines and wetlands on the site and within 500m of the construction corridor. Implementation of the mitigation measures will decrease the significance of the impact to a low-medium.

F-4.2 Socio-economic Environment

F-4.2.1 Increase in ambient dust levels and air emissions

Source and nature of the impact

The primary wind directions in the study area are north easterly and south westerly. North easterly winds are typically associated with high atmospheric pressure and regional geostrophic flow. South westerly winds associated with the passage of coastal low pressure systems and cold fronts are generally strong and may be accompanied by rain. In both summer and winter months wind velocity is greatest in the afternoon. Sensitive Receptors (SR's) located to the east and northeast of the work sites are more likely to be affected by any dust emitted/re-suspended from construction activities and track-out.

Local background PM_{10} concentrations are anticipated to be below 75% of the annual mean standard for this pollutant and therefore PM_{10} generated by the construction phase of the project is considered unlikely to cause an exceedence of the standards for this pollutant at the nearby SR's.

The project work sites are in some instances adjacent to or within residential areas (with some properties within 20m of the pipeline route), but it is noted that the route is linear, and that only a small number of SR's would be affected by the project activities at any given time. Residential properties and other SR's are situated much further away (>100m) from the pipe yard boundaries.

Taking the above into account, the area surrounding the proposed development is considered to be of medium sensitivity to changes in dust and PM_{10} as a result of construction activities.

Emissions of CO_2, CO, SO_2, Nitrogen Oxides (NO_x) and PM_{10} will result from the operation of construction equipment (such as graders and cranes) and road vehicles during installation of the pipeline and associated facilities. Emissions will arise over a large (diffuse) geographical area and during the entire construction period, hence any potential deterioration of ambient air quality at any particular location is expected to be temporary and transient and is unlikely to be significant.

Table 52: Increase in ambient dust levels and air emissions

Impact source(s)	Transportation vehicles travelling over exposed surfaces, earthworks and impacts of wind direction		Status	-
Nature of impact	Increased levels of ambient dust			
Reversibility of impact	The impact is irreversible but can be mitigated to a large extent			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding land owners			
Magnitude	*Extent*	Regional -3		
	Intensity	Medium – 3		
	Duration	Medium Term – 3		
	Probability	Highly likely – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+3+4) x 4 = 52 Medium		M
	With mitigation	*WOM x ME = WM* 52 x 0.6 =31.2 Low to Medium		L - M

Mitigation Measures

The mitigation measures which would be required to eliminate any identified risk of dust and PM_{10} impacts associated with construction activities are listed below:

- A comments and complaints register, accessible to members of public, should be implemented and maintained. Such a register would provide a formal framework within which to record any comments and complaints received, as well as to identify and action appropriate mitigation and/or remediation measures. The register should also include a means of recording and communicating the close-out of issues.
- The need for dust containment should be assessed on a daily basis to avoid unnecessary wastage of non-potable water used in dust suppression. Site runoff of water or mud should be avoided.
- Bonfires and burning of waste materials must be prohibited.
- Cover should ideally be removed in small areas during work and not all at once.
- Stockpile surface areas to be minimised to reduce area of surfaces exposed to wind pick-up.
- Where appropriate, windbreak netting/screening can be positioned around material stockpiles, as well as exposed excavation and material handling operations, to provide a physical barrier between the works and the surroundings.
- Where practicable, stockpiles of soils and materials should be located as far as possible from sensitive properties, taking account of prevailing wind directions and seasonal variations in the prevailing wind.
- During dry or windy weather, material stockpiles and exposed surfaces could be dampened down using a water spray to minimise the potential for wind pick-up. Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable. Where it is not possible to re-vegetate or cover with topsoil, the use of hessian, mulches or tackifiers (soil binding agents) should be considered.
- If trackout is identified to be occurring, use an appropriate means of sweeping access and local roads, to remove, as necessary, any material tracked out of the site. Dry sweeping of large areas should be avoided.

The following mitigation measures are proposed for construction equipment and vehicles:

- All vehicles and equipment will undergo regular maintenance, will be operated to manufacturers' guidelines, and where appropriate, idling of engines will be avoided. Where black smoke is observed from exhausts, the equipment will be safely shut down and maintenance measures undertaken.
- Where possible, the Contractor is expected to make use of low sulphur diesel.
- Wherever feasible, construction traffic should avoid sensitive roads (residential roads, congested roads, via unsuitable junctions, etc.) where possible, and that vehicles are kept clean and sheeted when on public roads. Timing of any large-scale vehicle movements to avoid peak hours on the local road network would also be beneficial.
- Vehicle speeds (especially on unpaved roads) should be reduced so as to limit the re-entrainment of dust.

Significance of the impact

The significance of this impact, without mitigation, is regarded to be medium. Implementation of the mitigation measures will decrease the significance of the impact to low - medium.

F-4.2.2 Increase in ambient noise levels

Source and nature of the impact

Based on the rate of construction of the pipeline, the noise levels generated during the construction phase of the project are only anticipated to be applicable for a short period of time (less than 10 days). In terms of the significance criteria, the total noise level (construction noise) is considered significant if the change between the ambient and the predicted total is greater than 5 dB. In the case of this assessment, that equates to a moderate negative impact. The overall increase in noise level at all but four of the SRs, fall within the impact category of 'little' which indicates the potential for sporadic complaints. The remaining four SRs are expected to fall in the 'very strong' community response category with vigorous community or group action, however it should be noted that due to the transient nature of the construction site (*moving at approximately 90 metres per day*), any

significant impacts caused by construction noise are not expected to last for more than 10 days and will be restricted to daytime hours and as such the likelihood of community action is significantly diminished.

As the duration of the maximum construction noise is expected to be less than 10 days, any significant impact arising from construction noise is expected to be temporary and transient in nature.

Table 53: Increase in ambient noise levels

Impact source(s)	Construction activities		Status	-
Nature of impact	Increased level of ambient noise			
Reversibility of impact	The impact is irreversible but can be mitigated to a large extent			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding land owners			
Magnitude	*Extent*	Site - 2		
	Intensity	Medium – 3		
	Duration	Short term – 1		
	Probability	Highly likely – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+3+1+4) x 4 = 40 Medium		M
	With mitigation	*WOM x ME = WM* 40 x 0.4 = 16 Low		L

Mitigation measures

Where reasonable and feasible, the proponent will apply best practice noise mitigation measures including:

- Maximising the offset distance between noisy equipment items and residential receptors;
- Avoiding the coincidence of noisy equipment working simultaneously close together when adjacent to sensitive receptors;
- Minimising consecutive works in the same locality;
- Orienting equipment away from noise sensitive receptors; and
- Carrying out loading and unloading away from noise sensitive areas.
- Site inductions should cover the importance of noise control and available noise reduction measures;
- Construction contractors should be required to use equipment that is in good working order and that meets current best practice noise emission levels. This should be achieved by making it a component of contractual agreements with the construction contractors;
- Community liaison would form a critical element in the management of the impacts. If provided with adequate warning, affected sensitive receptors are sometimes willing to accept excessive noise for a short period of time. Designation of a community liaison officer who will be able to deal with the concerns of residents and establishment of a complaint response programme can enable the identification and resolution of any noise related concerns at an early stage;
- Noise monitoring should be undertaken in order to determine the construction noise emission levels and to aid the selection of additional noise controls where necessary. Additional noise controls such as portable screening would be employed if monitoring indicates the need or in response to concerns;
- Where limit values are exceeded immediate appropriate action will be undertaken for example reducing hours of heavy construction works or replacing tooling techniques;
- Minimise reversing of equipment to prevent nuisance caused by reversing alarms;
- Driver practices when approaching and leaving the site should minimise noise emissions created through activities such as unnecessary acceleration and breaking squeal;
- All mobile or fixed noise-producing equipment used on the project, which is regulated for noise output by a municipal by-law or National Legislation, shall comply with such regulation while in the course of project activity;

- Electrically-powered equipment instead of pneumatic or internal combustion powered equipment shall be used, where feasible;
- Material stockpiles and mobile equipment staging, parking, and maintenance areas shall be located as far as practicable from noise-sensitive receptors;
- Construction site and haul-road speed limits shall be established and enforced during the construction period;
- The use of noise-producing signals, including horns, whistles, alarms, and bells shall be for safety warning purposes only;
- The on-site construction supervisor shall have the responsibility and authority to receive and resolve noise complaints. A clear appeal process to the Owner shall be established prior to construction commencement that will allow for resolution of noise problems that cannot be immediately solved by the site supervisor;
- The contractor shall develop a project noise control plan, which shall have been approved and implemented prior to commencement of any construction activity; and
- Contract incentives may be offered to the construction contractor to minimise or eliminate noise complaints resulting from project activities where project construction would result in significant noise impacts.

Significance of the impact

Due to the limited number of noise receptors (adjacent landowners) the impact associated with increased ambient noise levels during the construction phase is predicted to be of a medium significance, however the implementation of mitigation measures will reduce the significance of the impact to low.

F-4.2.3 Visual Impact of construction activities on visual receptors

Source and nature of the impact

The construction activities and camps will alter the current visual character of the area, from one of open spaces to a construction site associated with people, vehicles and equipment. There are a number of visual receptors occurring at the residential areas of Reservoir Hills, Hillgrove, Newlands East, Quarry Heights, Avoca and Duffs Road, and businesses at Riverhorse Valley and Duffs Road. Most of them will have a direct view of the construction activities.

Table 54: Change of visual character of the area

Impact source(s)	Construction activities and placement of construction equipment, stockpiles and earthworks		Status	-
Nature of impact	Visual character of the area will be altered by construction activities and equipment			
Reversibility of impact	The impact is irreversible but will be less visually intrusive if appropriate mitigation measures are adopted			
Degree of irreplaceable loss of resource	Medium			
Affected stakeholders	Surrounding landowners and motorists			
Magnitude	*Extent*	Regional -3		
	Intensity	Medium – 3		
	Duration	Short to Medium term – 2		
	Probability	Highly likely – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+2+4) x 4 = 48 Medium		M
	With mitigation	*WOM x ME = WM* 48 x 0.4 = 19.2 Low		L

Mitigation measures

- The construction area must at all times be neat and tidy.
- All litter must be collected and removed (daily) and disposed of appropriately.
- Equipment and construction vehicles must be stored or parked in designated areas.
- The construction camp must be screened with shade cloth.
- If construction is necessary during night-time, light sources should be directed inwards and downwards to prevent obtrusive lighting and light pollution.
- Dust suppression techniques should be implemented especially on windy days. Exposed soil stockpiles shall be covered, kept damp or protected using organic binding agents or alternative techniques that are not water intensive.

Significance of the impact

The visual impact associated with construction activities during the construction phase is predicted to be of a medium significance; however the implementation of mitigation measures will reduce the significance of the impact to a low.

F-4.2.4 Effect of temporary workers on social dynamics

Source and nature of the impact

There is a likelihood of job seekers moving into the study area. Even though it is not expected that the presence of temporary workers will have a major impact on the social dynamics of the area, it is worth briefly mentioning it here.

In most cases, the potential in-migration of workers is likely to result in other cumulative impacts, such as conflict with existing community members, social inconveniences and/or problems and pressures on existing infrastructure. Recently, South Africa has seen xenophobic attracts on "outsiders" due to competition for business opportunities, scarce resources such as jobs or land, or due to other conflicts. These types of attacks, although it can be viewed as isolated incidences, should serve as a reminder of the very volatile situation on most low-income residential areas. This process of potential in-migration is anticipated to have a low effect on the communities in close proximity to the proposed project, especially within low-income residential areas.

Table 55: Effect of temporary workers on social dynamics

Impact source(s)	In-migration		Status	-
Nature of impact	Presence of temporary workers			
Reversibility of impact	The impact is reversible.			
Degree of irreplaceable loss of resource	Medium			
Affected stakeholders	Local residents, construction workers, local authorities			
Magnitude	*Extent*	Regional -3		
	Intensity	Low – 1		
	Duration	Medium term – 3		
	Probability	Likely – 3		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+1+3+3) x 4 = 40 Medium		M
	With mitigation	*WOM x ME = WM* 40 x 0.2 = 8 Low		L

Mitigation measures

- Should these impacts take place, it is only anticipated to most likely occur during the construction phase of the project. It is therefore advised that construction workers who are already housed within

the Social Impact Zone (SIZ) of the proposed site, be employed as opposed to establishing temporary housing for workers. It is not advised that temporary workers assimilate with the local communities and suitable accommodation in larger centres should be considered.

- In order to mitigate most of these impacts, EWS should consider the establishment of a Community Monitoring Forum (CMF) in order to monitor the construction phase and the implementation of the recommended mitigation measures. The CMF should be established before the construction phase commences, and should include key stakeholders, including representatives from local communities, local councillors (within the SIZ), affected landowners and the contractor(s). The CMF should also be briefed on the potential risks to the local community associated with construction workers.
- It is further advised that EWS, along with the appointed contractor(s) should, in consultation with representatives from the CMF, develop a code of conduct for workers during the construction phase. The code should identify which types of behaviour and activities are not acceptable to the community and measures should be in place to monitor and manage this. Construction workers in breach of the code should face appropriate disciplinary steps. All dismissals must comply with the South African labour legislation.
- In order to address any potential health impacts, it is advised that EWS along with the appointed contractor(s) devise and implement an HIV/AIDS awareness programme for all construction workers at the outset of the construction phase. All permanent employees should receive basic HIV/AIDS awareness training at the onset of their employment.
- Furthermore, the movement of construction workers on and off the site should be closely managed and monitored by EWS. In this regard the necessary arrangements should be made for the housing and transport of temporary construction workers. Allowance should be made for workers from outside the area to return home over weekends and/ or on a regular basis. This would reduce the risk posed to local family structures and social networks.

Significance of the impact

The social impact associated with temporary workers during the construction phase is predicted to be of a medium significance; however the implementation of mitigation measures will reduce the significance of the impact to a low.

F-4.2.5 Access of land due to servitude

Source and nature of the impact

Land and the right to use land is a very important requirement for the construction, upgrading and/or maintenance of national infrastructure. However, property related rights are clearly entrenched in the Constitution of the Republic of South Africa, 1996 (Act 108 of 1996). For instance, in terms of Section 25 of the Constitution, "…no one may be deprived of property except in terms of law of general application, and no law may permit arbitrary deprivation of property".

Therefore, all land that must be acquired for or as a result of the construction, upgrading or maintenance of a national infrastructure, must be acquired in accordance with the provisions of the Constitution and all other applicable and relevant legislation.

Table 56: Access of land due to servitude

Impact source(s)	Proposed pipeline servitude during construction		Status	-
Nature of impact	Loss of land due to servitude			
Reversibility of impact	The impact is reversible.			
Degree of irreplaceable loss of resource	Medium			
Affected stakeholders	Affected landowners and occupiers of the land			
Magnitude	*Extent*	Site - 2		
	Intensity	Medium – 3		

	Duration	Long term – 4	
	Probability	Definite – 5	
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+3+4+5) x 4 = 56 Medium	M
	With mitigation	*WOM x ME = WM* 56 x 0.2 = 11.2 Low	L

Mitigation measures

- There must always be an attempt to acquire land and the right to use land through negotiation (willing buyer, willing seller principle). This, in terms of (amongst others) the Alienation of Land Act, 1981 (Act 68 of 1981), inter alia requires written Agreements with affected landowners.
- A servitude such as Right of Way Servitudes or Servitudes in favour of providers of services such as electricity and water is an example of "Real Rights". Once again, these Rights must be noted as these Servitudes may have to be acquired or accommodated in the Agreements to be entered into with landowners, or may have to be acquired or otherwise accommodated by way of separate Agreements. The possibility that it will be a requirement that the services that are protected by these Servitudes, will have to be relocated or re-instated during the relevant construction phase, must also be considered.
- During the design phase of a pipeline, all rights that may be affected by the proposed alignment, including the possible socio-economic impact thereof, on affected people and communities must be considered. Such rights and the said possible socio-economic impact must always be considered during the acquisition process. If such rights are ignored, there will be a real risk that the outcome would be a designed route superior in terms of engineering requirements, but that it may in reality simply be impossible to construct the designed route due to the impact thereof on these Rights, people or communities.
- In order to obtain a servitude for the proposed pipeline, private landowners will, inevitably, be impacted in terms of loss of land. Private landowners will receive an agreed upon compensation for the loss of land based on the current landuse of that land. It is advised that the consultation with landowners with regard to this compensation take place as soon as possible in order to allow all parties to motivate their individual case for compensation. It is advised that assets such as fences or any immovable infrastructure that will have to be removed must be replaced at cost or better than the original.

Significance of the impact

The impact associated with acquiring access to the construction and operational is predicted to be of a medium significance; however the implementation of mitigation measures will reduce the significance of the impact to a low.

F-4.2.6 Impact of Socio-cultural processes

Source and nature of the impact

Socio-cultural processes are those that affect the culture of a society, that is, all aspects of the way that people live together. This impact can be defined as types of social behaviour that might be considered deviant or antisocial, such as excessive alcohol consumption, illegal drug use, prostitution, petty crime and vandalism. It is expected that this potential impact would only occur to a certain degree during the construction phase. There is a risk that the presence of "incoming" workers and or the influx of jobseekers can exacerbate deviant social behaviour in the communities they occupy.

Table 57: Unacceptable social behavior

Impact source(s)	Newcomers, construction workers in the study area		Status	-
Nature of impact	Unacceptable social behaviour			
Reversibility of impact	The impact is reversible.			
Degree of irreplaceable loss of resource	Medium			
Affected stakeholders	Affected landowners and occupiers of the land			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Short term – 2		
	Probability	Likely – 3		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+3+2+3) x 4 = 40 Medium		M
	With mitigation	*WOM x ME = WM* 40 x 0.2 = 8 Low		L

Mitigation measures

In order to address this impact, the establishment of accommodation in construction camps should be avoided as far as possible, by employing local labour and by providing transport to main city centres where required. Transporting of employees may create the opportunity for SMME entrepreneurs to provide shift-time related transport on assigned routes. Consultation with the local taxi associations will be required to discuss options for cooperation.

It is, furthermore, recommended that the South African Police Department (SAPD) be used to monitor and assist with the management of the negative social effects of incoming job seekers and strangers. Local community policing forums should also be informed of the proposed project, construction and operational timeframes and the movement of construction workers (i.e. from place of transport to construction site).

The following measures are recommended:

- Establish a code of conduct for workers with strict control measures.
- Require personnel to wear identification badges to distinguish them from trespassers or unwanted loiterers.
- Life orientation programmes, explaining the dangers of drug and alcohol abuse should be organised for workers by appointed contractor.
- Educate employees of the detrimental effects of drug and alcohol abuse.
- Conduct random drug testing of all employees.
- Require mandatory testing of all persons involved in accidents.
- Conduct tests for reasonable suspicion of substance abuse.
- Provide workers with organisation policies and procedures concerning substance abuse.
- Provide materials that educate workers about what constitutes substance abuse.
- Liaise with the SAPD in order to implement effective crime prevention strategies.
- Liaise with existing forums in the community to communicate information to the community and to assist in the monitoring of compliance.

Significance of the impact

The impact associated with acquiring access to the construction and operational is predicted to be of a medium significance; however the implementation of mitigation measures will reduce the significance of the impact to a low.

F-4.2.7 Impact on Health and Social Well-being

Source and nature of the impact

Health aspects are included from a social perspective and will be expressed in non-medical terminology.

The Occupational Health and Safety (OHS) Act (Act 85 of 1993) provides for the protection of the health and safety of employees and other persons at a workplace. The prevention and management of work related incidents are addressed by the OHS Act. It is, however, advised that EWS develop a comprehensive policy in order to train all new employees in terms of the relevant health, safety and quality procedures.

Table 58: Impact on health and social well-being

Impact source(s)	Construction activities		Status	-
Nature of impact	Environmental impacts (water, dust, noise, vibration)			
Reversibility of impact	The impact is reversible.			
Degree of irreplaceable loss of resource	Medium			
Affected stakeholders	Affected landowners and occupiers of the land			
Magnitude	*Extent*	Site - 2		
	Intensity	Medium – 3		
	Duration	Short term – 2		
	Probability	Highly Likely – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+3+2+4) x 4 = 44 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.2 = 8.8 Low		L

Mitigation measures

Construction related public health impacts due to possible air/dust pollution, noise pollution, light pollution and vibration should also be considered. The contractor as well as EWS should strive to abide by the abovementioned Act, in addition to international best practice guidelines.

Furthermore it is advised that EWS ensure that everyone working at a project are competent for the work they do. They must be properly trained and have the experience and knowledge to work in a safe and responsible manner.

Areas of the project where there are particular health or safety hazards need to be marked and treated as danger areas. All people, other than those who have been specifically authorised to enter, must be excluded from such areas, for example by erecting warning signs and barriers. The barriers should clearly identify the boundary of the danger area and make entry impossible without a conscious effort. Suitable barriers must be provided around the project if members of the public are likely to trespass onto the site. Barriers should always be provided at project boundaries such as hedges, trenches and mounds. If heavy pedestrian traffic is noted in the area, it is recommended that more extreme measures be used such as the erection of sophisticated metal paling fences.

The following measures are recommended:

- Environmental pollution (noise, dust, etc.) must be limited as far as possible and the requirements of the EMPr be implemented to reduce the impact on surrounding residents.
- The necessary safety precautions should be taken and first aid supplies should be made available on site;
- All project employees (including contractors) should undergo health and safety training on induction

and thereafter on a regular basis;
- Instruct contractors on how to work in line with the health and safety document and site rules; and
- Appoint a Health and Safety representative who must:
  - Inspect and take samples after an accident or dangerous occurrence;
  - Carry out an inspection of every part of the project at monthly intervals;
  - Have a good understanding of all the applicable health and safety documents for the site;
  - Review any risk assessments which form part of the health and safety document and suggest improvements;
  - Make a written report on any health and safety problems found during their inspections.

Significance of the impact

The impact associated with health and well-being during the construction phase is predicted to be of a medium significance; however the implementation of mitigation measures will reduce the significance of the impact to a low.

F-4.2.8 Impact on localised traffic

Source and nature of the impact

Due to construction activities and associated machinery movement, the traffic patterns of the affected road and surrounding roads network will be affected. In the absence of mitigation measures, access to driveways and parking lots may be affected.

A Traffic Management Plan was undertaken by Mott MacDonald PDNA for the proposed Northern Aqueduct Phase 5 project. According to this study, majority of the roads being affected by the proposed pipeline are low traffic residential roads. In terms of major roads, the pipeline will be crossing eight major arterials/highways. Based on the above study, it is not possible to undertake open excavation across the following roads via stop/go controls, and half width construction, as the current traffic volumes already exceeds the design capacity, and any stop/go control will result in road network becoming gridlocked. Pipe jacking should be considered instead for these crossings:

- Newlands West Drive;
- John Dory Drive (crossing 2)
- Musa Dladla Drive;
- KwaMashu Highway and Interchange Ramps.

Further to the above, the following roads are not recommended for stop/go control.

- John Dory Drive - crossing 1
- R102

However unlike the previous roads, there is some spare capacity left on these two roads. The traffic volume is however significant enough to pose a threat to workers and there is a potential for gridlocking. In addition, these roads are two-lane, and as such it would not be possible to channelize the traffic into an existing middle lane. Alternative construction methods, such as constructing road bypasses, will need to be considered. For these roads, should stop/go be employed, it is strongly recommended that detailed modelling of the impact of a stop/go be undertaken by the designer.

The following roads, while also having high traffic volumes, are multiple-lane and have the spare capacity to consider channelizing the traffic onto one of the oncoming lanes in the adjacent carriageway. This would remove the need for a stop/go control as well as allow construction of the pipeline to take place over the full width of one of the carriageways:

- Inanda Road (sufficient capacity for one lane of traffic per direction)
- Queen Nandi Drive (sufficient capacity for one lane of traffic per direction).

However, eThekwini Roads confirmed that there will be pipe jacking at these two crossings.

The following roads can be closed to allow for construction of the pipeline over the full width, and provide a detour for the traffic onto an alternative road:-

- Fulham Road (onto Juba Place)
- Juba Place (onto Fulham Road)
- Sooklall Drive (onto Runton Way and Skipdale Road)
- Hippopark Avenue (Onto Kubu Avenue - there is sufficient free capacity along Kubu
- Avenue to carry the deviated traffic)

Due to the narrow width of the verges, the proposed pipeline will likely be constructed under the roadway of the following roads:-

- Sweetpea Close
- 120844 Street

These two roads will need one lane to be closed off in order to place the pipeline. The remaining lane will therefor need to be converted to a one-way system for 120844 Street and a 2-stage stop/go control implemented along Sweatpea Close. As these two roads are very narrow, it may be necessary to widen the road into the verge to allow the vehicles to drive past the deviations.

Table 59: Impact on localised traffic

Impact source(s)	Construction activities along the roads and vehicle movement		Status	-
Nature of impact	Traffic patterns of the affected roads that are impacted by the laying of the pipe.			
Reversibility of impact	The impact is reversible with implementation of mitigation measures			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Residents, businesses, motorists and surrounding land owners			
Magnitude	*Extent*	Regional -3		
	Intensity	Medium – 3		
	Duration	Short – Medium Term - 2		
	Probability	Definite - 5		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+2+4) x 5 = 60 Medium - High		M – H
	With mitigation	*WOM x ME = WM* 60 x 0.6 = 36 Low to Medium		L - M

Mitigation measures

Based on the traffic volumes and road categories, a Traffic Management Plan (TMP) can be set out for the pipeline construction.

The TMP that needs to be implemented will be categorised as follows:-

- Pipe jacking, where there is insufficient road capacity and traffic volumes are too high to allow for safe open excavation, and at railway lines.
- Construction of a surfaced bypass lane, where the traffic volumes of the road are sufficiently high that any lane closure could potentially result in gridlocking.
- Closing off of an existing lane to allow construction in that lane, where the traffic volumes of the road are low enough that any lane closure will not result in the capacity of the open lanes being exceeded. This traffic will be channelised onto one of the oncoming traffic lanes.
- Construction of the pipeline in road half-widths, with traffic control via a stop/go.
- Detours, where alternative accesses are possible

- Full road closure for pipeline construction, with no alternative access. This needs to be avoided as far as is practical, and is only allowed on abandoned roads and gravel tracks which do not service any access purposes (e.g. to municipal facilities, dwellings, etc)

For pipeline construction across driveways and parking lots, access to these properties needs to be maintained at all times. This can be achieved via, for example, steel plates placed over the open excavation. These will need to be carefully designed, taking into consideration vehicle loading and safety considerations.

Significance of the impact

The impact that construction related traffic would have on this the current traffic patterns is predicted to be of a medium to high significance without mitigation measures, however, this impact can be reduced to a medium significance if appropriate measures are adopted.

F-4.2.9 Impacts on heritage resources

Source and nature of the impact

The desktop survey of the study area revealed that the banks of the uMngeni River may possess the potential for the occurrence of graves and Iron Age sites. This area therefore has moderate significance in terms of possible graves and Iron Age sites.

In terms of palaeontological resources, the study area is mostly underlain by Ordovician to Silurian aged quartzites of the Natal Group, Carboniferous to Permian Aged tillites of the Dwyka Group, Permian aged shales and sandstones of the Ecca Group, Jurassic aged dolerite and Quaternary aged alluvium. Trace fossils have been recorded from the Dwyka Group and Pietermaritzburg Formation of the Ecca Group, whereas fossils are abundantly known from rocks of the Vryheid Formation, also from the Ecca Group. No fossils are expected from the alluvial deposits and the dolerite will no contain fossils (PGS Heritage, 2015).

Two sites of potential archaeological importance were identified in close proximity to the footprint area as follows:

Site 1: 29°44’52.9” S and 31°00’33.4”E - A Stone Age occurrence consisting of two Early Stone Age tools, as well as a smaller flake were observed in the discard heap of earlier excavations for maintenance work on an existing pipeline. This occurrence occurs 15m from the preferred route alignment. A thorough investigation of the walls of the excavations was subsequently made and no further lithics could be identified. It is therefore clear that the site comprises an occurrence of Stone Age lithics and does not constitute enough of a concentration of stone tools to classify it as a formal archaeological site. As a result, the site is deemed to have very little scientific or historic significance and is deemed to be Generally Protected C (Grade 4C), which is low significance. This indicate that the site may be destroyed without any further mitigation taking place.

Site 2: 29°45’54.8” S and 30°59’58.3”E – A Shembe Church is located on the crest of a ridge at Quarry Heights Settlement, with expansive views all around. It comprises a rectangular corrugated iron building with a pitched roof with a rectangular area demarcated with white painted stones located on the building’s southern end. The demarcated rectangular area contains a number of small to medium sized trees. The white painted stones used throughout the site as well as the association of the demarcated area with planted trees suggest that the church more than likely forms part of the Nazareth Baptist Church (also known as the “Shembe Church” or “iBandla lamaNazaretha”). While the Nazareth Baptist Church as a whole was established in 1910 by Isaiah Shembe, an assessment of the available historical imagery of Google Earth indicates that the church site under discussion was only built after 2005.

The significance of a Shembe church such as the one located on Site 2 is usually found on three levels, namely a built heritage significance if the structure and buildings of the church are older than 60 years, secondly a historical significance if the church can be associated with a historic event or person in the church's history and thirdly on a social significance level in which the site has high emotional and religious value for a particular community.

In this case, the available Google Earth imagery indicates that the church was erected after 2005. This means that its structural component can certainly not be viewed as significant within the realms of the heritage legislation. Furthermore, it can also not be seen as a historic site associated with any historic person. For the purposes of this report, the site is deemed to be of Generally Protected C (GP. 4C) which equals a Low Heritage Significance. However, the church still has high social significance.

Table 60: Impacts on heritage resources

Impact source(s)	Construction of the proposed pipeline within and close to heritage sites		Status	-
Nature of impact	Impacts on heritage resources (as listed above)			
Reversibility of impact	The impact is irreversible			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Families of ancestral graves, Shembe Community, historians, surrounding landowners			
Magnitude	*Extent*	Site – 2		
	Intensity	Medium – 3		
	Duration	Long-term - 4		
	Probability	Highly likely - 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+3+4+4) x 4 = 52 Medium		M
	With mitigation	*WOM x ME = WM* 52 x 0.2 = 10.4 Low		L

Mitigation measures

The following mitigation measures are required for the possible presence of graves and Iron Age sites:

- An archaeological watching brief (monitoring) will be required during the construction of the section of the pipeline where the desktop study has identified a risk for the possible presence of graves and Iron Age sites.
- The archaeological monitoring must be conducted during all vegetation clearing and earth-moving activities by an archaeologist for signs of the presence of informal graves and Iron Age sites.
- Archaeological monitoring must take place along the pipeline between the following coordinates: S 29° 46' 59.7" E 30° 58' 01.6" (near Sookall Drive) and S 29° 48' 05.3" E 30° 56' 32.1" (near Juba Place Road).
- Should the presence of graves or Iron Age sites be confirmed, all construction activities in that area will have to cease to allow the archaeologist to assess the discovery and provide recommendations.

The following mitigation measures with respect to palaeontological resources must be in place:

- The Environmental Control Officer (ECO) of the project must be made aware of the possibility of finding trace fossils in areas underlain by the Dwyka Group and Pietermaritzburg Formation. There is a very high possibility of fossils being present in the areas underlain by the Vryheid Formation.
- Due to the fact that the presence/absence of fossils will only be recorded during the execution of the excavation activities, it is recommended that a qualified palaeontologist be appointed to compile a Phase 1 Palaeontological Impact Assessment (PIA) if fossils are recorded during the construction phase of the project.

Specific requirements for the reduction of the construction working area in the vicinity of the Church must be stipulated in the Contract Specifications so that the Church remains intact during the construction phase. The construction activities, including pipe installations must be undertaken at suitable times to least disrupt the

church meetings[5].

The contractor must provide the Church Leader with details of the timing of construction activity in the vicinity of the Church prior to commencing with the activity. Such detail must also be included in the contract specifications.

Significance of the impact

The impact associated with construction of the proposed pipeline on the destruction of heritage resources during the construction phase is predicted to be of a medium significance without mitigation measures, however, this impact can be reduced to a low significance if appropriate measures are adopted.

F-4.2.10 Temporary job creation and supply of local material

Source and nature of the impact

a) Employment creation and opportunities for local labour

For the most part, the excavation of the trench within which the pipeline is to be laid will be done by heavy mechanical equipment, as it is not time and cost effective to dig trenches over such as long distance manually. However, there will still be a fair number of new employment opportunities created, especially for local labour. Other opportunities exist for flags men duties. Against the background of the high levels of unemployment and poverty within the municipality, this could be a significant positive impact. A pipeline of this nature requires very few people for on-going maintenance, and it is likely that EWS will use existing maintenance teams or contractors to conduct this. However, in the process, there may be additional opportunities created within these existing teams and/or contractors.

RECOMMENDATIONS FOR BENEFIT ENHANCEMENT

- As far as possible, employ local residents during construction, where applicable. This will ensure a reduced dependency on temporary employment in addition to enhancing the living standards of local people.
- Use manual labour where possible and practical.
- Ensure recruitment measures are aimed particularly at construction workers classified as designated employees in terms of the Employment Equity Act (black people, as defined in the Act, women, and disabled people). A local employment procedure and recruitment process should be developed in consultation with local authorities and representatives. EWS should ensure that a transparent process of employment is followed to limit opportunities for conflict situations.
- In order to ensure that the resultant positive impact develop into a long term boost to the economy, it is suggested that, where possible, EWS advise and assist, in liaison with the local ward committees within the SIZ, local business operators, etc. to establish and grow SMMEs. The support of local business and the use of their products and services should be promoted as far as possible.
- Affirmative procurement is an ideal mechanism for the economic empowerment of HDSAs. Therefore, EWS should procure locally and assist potential HDSA suppliers, through mentoring, to become part of the project's supply chain. Through this proposed project, EWS has the ability to create an enabling environment for the empowerment of HDSAs within the surrounding areas. It is therefore suggested that EWS's Broad-Based Black Economic Empowerment (B-BBEE) Preferential Procurement Policy provide local residents and business owners in the surrounding communities with a preferred supplier status in all 3 levels of procurement, namely: capital goods, consumables and services.
- EWS can provide preferred supplier status to local HDSAs through implementation of the following measures:
    - Identifying products which could be supplied by local suppliers; and

[5] During an informal meeting with the Church Leader's (*Father Dlamini's*) wife and other church members on 31 March 2015, it was communicated that the Church Meeting times are 09h00 to 10h00 and 13h00 to 14h00 on Saturdays.

  - Identifying prospective procurement suppliers from employees/surrounding communities, by means of a Local Economic Development (LED) Forum.
- EWS should also require in its tender process the following from suppliers:
  - The promotion of SMMEs, especially within the direct environment of the project;
  - The creation of new jobs; and
  - The upliftment of communities.
- EWS should aim to procure from local service providers in the area. Various procurement outsourcing services could benefit the wider community such as:
  - Construction – building material and building;
  - Transportation – material, waste and workers;
  - Accommodation for workers;
  - Recycling;
  - Security services; and
  - Equipment renting and maintenance.
- A Skills Audit should be conducted within the community to verify which skills area readily available within the community;
- Ensure that local businesses, especially those of HDI, women and of SMMEs get allocated the maximum appropriate share of project related business opportunities;
- Ensure that the Labour Relations Amendment Act, 2002 (Act No. 12 of 2002) as well as the necessary policies and procedures are taken into consideration to ensure the correct procurement procedures.
- As far as possible, trade locally during operation, where applicable.

b) Opportunities for local contractors

Although certain aspects of the construction pipeline are technically specialised and will, therefore, be carried out by technically specialised contractors, there remain opportunities for local contractors to become involved in components of construction, which are less specialised. Such activities could include bush clearing of the 30m wide construction corridor, fencing, etc. Using local contractors may also increase the number of employment opportunities for local people during the construction phase. To lay almost 12km of 1 200mm diameter pipe, a significant amount of construction and other material will be required. Opportunities will therefore be created for the suppliers of such materials.

RECOMMENDATIONS FOR BENEFIT ENHANCEMENT

- Where possible, prioritise sub-contracting to local SMEs.
- It is, furthermore proposed that EWS's procurement policy require its core contractors to recruit and employ, where possible, local job seekers from the immediate communities. A further measure to ensure the employment of local persons is to require that project contracts between EWS and the appointed sub-contractors stipulate the use of local labour for unskilled and semi-skilled jobs as well as local service providers.
- Training and support should be provided to SMMEs, where feasible.
- As far as possible, trade should occur locally during construction.
- The overall environmental management approach must include provision for the use of local contractors, as far as possible.

c) Opportunities for gender equality

EWS should ensure that their recruitment policy incorporate a robust gender policy, which should aim to achieve broadly equal outcomes for women and men. To achieve this EWS should:

- Provide equal remuneration for women and men for work of equal or comparable value;
- Remove barriers to the full and equal participation of women in the workforce;
- Provide full and genuine access to all occupations, including to leadership roles for women and men;
- Eliminate discrimination on the basis of gender particularly in relation to family and caring responsibilities for both women and men; and
- Encourage workplace consultation between employers and employees on issues concerning gender

equality in employment and in the workplace.

The following actions can be taken to promote gender equity within the EWS workplace:

- Establish a policy that ensures that men and women are compensated equally for performing the same work. Beyond equal pay for equal work, the policy should also ensure that both genders are treated equally in recruitment, training, hiring and promotion;
- Establish a policy that strictly and specifically forbids any form of sexual harassment; and
- Provide training on gender equality to management personnel. Educate managers in both the obvious and the subtle discrimination that takes place in organisations.

Various recommendations for the enhancement of opportunities for gender equality are suggested in the Social Impact Assessment (see Appendix D9).

In light of the above, the project will positively impact on the surrounding community and local economy due to possible skills development and income generation. This impact is predicted to have a **high positive significance**.

F-4.2.11 Emancipatory and empowerment processes / Capacity Building and Skills Transfer

Source and nature of the impact

Emancipatory and empowerment processes are those that lead to an increase in the ability of local people to contribute to the decision-making that affects their lives. It is likely that capacity building will take place during the construction and operational phase of the project.

Capacity building refers to the conscious increasing of knowledge, networking capability and the skills base amongst local people. It is predicted that the proposed project will add, to a significant degree, capacity building in the community, as opportunities do exist to develop the skills of local residents as well as opportunities for businesses and service providers. Skills development for employees and community members wishing to obtain employment through the project should, however, encompass more skills than merely the technical skills and should include life skills training and mentorship. In terms of training, it is suggested that all employees be trained in the function of their job and that this training incorporate health, safety, security and environmental aspects. The development and support of SMMEs in the local communities should also be encouraged as far as possible.

In order to ensure that the local communities enjoy equal advantage, it is advised that EWS provide training and skills development programmes specifically tailored to local persons interested in obtaining employment as part of municipal infrastructure programmes. It is furthermore advised that recognition of prior learning and training take place for all applicants with the relevant skills, but who may not have the necessarily qualifications.

In order to ensure that all EWS's policies and procedures translate into real time benefits to the local community it must become a requirement of all tender procedures that bidders comply with EWS principles and policies. A key requirement should be that local communities, especially those within the SIZ be used for temporary, low and semi-skilled job opportunities. The use of local business within the eThekwini Municipality should also be promoted as far as possible by providing them with preferential procurement status.

Various recommendations for the enhancement of opportunities for gender equality are suggested in the Social Impact Assessment (see Appendix D9).

In light of the above, the project will positively impact on the surrounding community and local economy due to possible skills development and income generation. This impact is predicted to have a **high positive significance**.

F-5 IMPACT ASSESSMENT: OPERATIONAL PHASE FOR PIPE BRIDGE ACROSS THE UMNGENI RIVER

F-5.1 Biophysical Environment

F-5.1.1 Modified flow, erosion and deposition patterns

Source and nature of the impact

During normal flow conditions, edge hardening and reduced roughness will lead to increased flow velocities in the immediate area of the bridge. This will prevent the settlement of fine materials by acting as a 'chute' for the rapid transportation of sediment to the broader downstream environment, either bypassing previous deposition sites or leading to greater accumulation of sediment in out-of-current areas. It is highly likely that river flow modification will have an impact on sediment distribution patterns downstream of the development site. This may have implications for fauna and flora with specific sediment requirements.

During extreme flood events, bottlenecking caused by additional concrete structures in the riverbed, together with river debris washed down from the catchment, may result in damming and consequently severe back-flooding, potentially placing upstream infrastructure, development and human life at risk.

Table 61: Modified flow, erosion and deposition patterns

Impact source(s)	Fully constructed concrete pipe bridge across the uMngeni River		Status	-
Nature of impact	Modified flow, erosion and deposition patterns due to permanent infrastructure			
Reversibility of impact	The impact is reversible by undertaking regular maintenance of the bridge			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding landowners, conservation groups and upstream and downstream water users			
Magnitude	*Extent*	Regional - 3		
	Intensity	Low – 1		
	Duration	Long-term - 4		
	Probability	Highly likely – 4		
Significance	*Without mitigation*	*Extent + Intensity + Duration + Probability) x WF* (3+1+4+4) x 2 = 24 Low - Medium		L - M
	With mitigation	*WOM x ME = WM* 24 x 0.8 = 19.2 Low		L

Mitigation measures

- Due to the permanence of the pipe bridge structure, there are no measures to mitigate the post-construction changes to flow patterns as well as erosion-deposition patterns. However, alignment of the pier supports with the existing pipe bridge, as part of the design concept would reduce additional obstruction to flow and the risk of damming due to the accumulation of flood debris.
- Regular maintenance and monitoring of the bridge must take place to ensure that all debris is cleared and the bridge is structurally stable.

Significance of the impact

The significance of this impact is regarded as low to medium, since the impact can be mitigated to the point where it is of limited importance.

F-6 IMPACT ASSESSMENT: OPERATIONAL PHASE FOR THE PROPOSED STEEL PIPELINE

F-6.1 Biophysical Environment

F-6.1.1 Impact of erosion

Source and nature of the impact

The excavation of the watercourses where pipes will be installed within trenches and the reshaping/resetting of the local base level at these points is likely to result in increased velocity of water intercepting the backfilled material, therefore increasing the erosive potential. As such, it is likely that the backfilled material placed on top of the encased pipeline will erode away, thus exposing the concrete encasement. In addition, this may also initiate headway erosion in an upstream direction. The development of an inappropriate servitude and poor rehabilitation of the pipe trench during the construction phase could increase impermeable surfaces with an associated increase in flow velocities and erosion potential for affected downslope riparian and wetland habitats. Runoff from the servitude road surface may enter into the associated watercourse and wetlands, resulting in higher catchment runoff, wetland scouring and increased flooding of downstream areas.

If correctly managed and implemented, limited long-term impact is foreseen for the riparian habitat structure, and the hydrology of wetland systems. Only in the unlikely event of a major failure or blowout of the pipeline is it probable that the systems will be undermined by the increased volumes of water passing through the system, which would cause erosion and other related impacts.

Table 62: Impacts of erosion

Impact source(s)	Erosion		Status	-
Nature of impact	Altered wetland and river profile at point of excavation			
Reversibility of impact	The impact is irreversible with maintenance			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Affected landowners			
Magnitude	*Extent*	Site - 2		
	Intensity	Low – 1		
	Duration	Short-term - 1		
	Probability	Highly Probable – 4		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (2+1+1+4) x 3 = 24 Low to medium		L - M
	With mitigation	*WOM x ME = WM* 24 x 0.4 = 9.6 Low		L

Mitigation measures

- The servitude should be appropriately grassed to achieve a high basal cover, where steep gradients require hardened surface (tarring/concrete) appropriate stormwater design should be implemented in order to disperse any concentrated run-off generated by the servitude;
- Where excavations within watercourses is required, the profile of the wetland and river must be restored to the pre-excavation level so as to prevent any increases in water velocity, and therefore erosion potential, at these points; and
- A wetland and riparian monitoring programme should be initiated at the start of the construction phase. The monitoring programme should be designed *in situ* with construction and rehabilitation plans by a wetland specialist. The Environmental Control Officer should be briefed by a wetland specialist on

specific monitoring issues. Appropriate mitigation needs to be implemented after consultation with relevant specialist if any problems are detected.

Significance of the impact

The significance of this impact is regarded as medium to low without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-6.1.2 Impact on water resources

Source and nature of the impact

The operational phase is not likely to have any impact on groundwater particularly from the pipeline, as the proposed water supply is for drinking and thus clean/potable.

If water leakage or pipe burst were to occur during the operational phase, the following scenarios are the considered possible outcomes/influences to the groundwater:

- Aquifer recharge; and
- Rise of groundwater table.

The unlikely event of sinkhole formation or breakage to the pipe may bring about contamination to water inside the pipe from the crossed streams, as it was observed from the sampled water that most waters are contaminated with sewage-associated contamination (SEF, 2015).

The contamination may enter the pipeline when the supply has stopped for a while, and the pressure inside the pipe becomes less, thus allowing foreign water to get in.

In the unlikely event that the pipe bridge across the uMngeni River collapses and the pipe bursts, the estuarine ecosystem may be impacted through changes in salinity, displacement and destruction of the microfaunal and microfloral habitat.

Table 63: Impact on water resources

Impact source(s)	Contamination of the potable water inside the pipe Changes in estuarine ecosystem if the bridge collapses		Status	-
Nature of impact	Contamination of potable water Alteration of estuarine functioning			
Reversibility of impact	The impact is irreversible with maintenance			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Ratepayers within the municipality			
Magnitude	*Extent*	Regional - 3		
	Intensity	High – 5		
	Duration	Short - 1		
	Probability	Probable – 1		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+5+1+1) x 2 = 20 Low to medium		L - M
	With mitigation	*WOM x ME = WM* 20 x 0.4 = 8 Low		L

Mitigation measures

- A Maintenance Plan must be in place for the operational phase of the project.
- An Emergency Plan must be in place for implementation during the operational phase.
- Emergency procedures are to be determined and staff trained to respond to any pipe ruptures.
- The pipeline must be constantly monitored using pressure gauges, and any leaks must be reported and repaired immediately.
- Repair identified leaks and address issues of water wastage as soon as these are identified.
- Monitoring and repair of the broken pipe will be very imperative.

Significance of the impact

The significance of this impact is regarded as medium to low without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-6.1.3Disturbance to fauna and faunal habitat during maintenance

Source and nature of the impact

The proposed maintenance activities could disturb the adjacent or surrounding natural areas. The use of floodlights at night, and the use of excavation equipment may cause noise and vibrations that will disturb fauna utilising the natural areas, especially nocturnal species, and could result in a localised decrease in biodiversity as faunal species move away from the disturbance. The presence of the maintenance staff may also result in negative faunal interactions that could be associated with poaching, trapping and hunting of faunal species, as well as possible collisions of fauna with maintenance vehicles. Food and rubbish can attract wildlife to the area, increasing risk of negative interactions.

Table 64: Disturbance to fauna and faunal habitat during maintenance

Impact source(s)	Maintenance-related activities and conduct of personnel		Status	-
Nature of impact	Interference with flora and faunal behaviour patterns			
Reversibility of impact	The impact is reversible if mitigated to a large extent			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Conservation groups			
Magnitude	*Extent*	Regional - 3		
	Intensity	Low – 1		
	Duration	Short - 1		
	Probability	Probable – 1		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+1+1+1) x 4 = 24 Low to medium		L - M
	With mitigation	*WOM x ME = WM* 24 x 0.4 = 9.6 Low		L

Mitigation measures

- If individuals of any faunal species that cannot relocate themselves (e.g. burrowing animals) are encountered during maintenance, activities should cease until the individuals can be moved in an ecologically acceptable manner to a more suitable location. This should be undertaken by a faunal relocation expert;
- Removal and relocation of any species protected under the Natal Nature Conservation Ordinance No. 15 of 1974 will require a permit granted by the provincial conservation agency EKZNW;
- Removal and relocation of any species protected under NEMBA (Act 10 of 2004): Threatened or Protected Species Regulations will require a permit obtained from the provincial MEC;

- No wild animal may under any circumstance be handled, removed or be interfered with by construction workers;
- No wild animal may under any circumstance be hunted, snared, captured, injured or killed, including animals perceived to be vermin. Checks of the surrounding natural areas must be regularly undertaken to ensure no traps have been set. Any snares or traps found on or adjacent to the site must be removed and disposed of;
- No domesticated animals may be allowed on site;
- To prevent possible collisions with animals in natural areas, drivers of construction vehicles must remain vigilant to the possibility of animals crossing their paths and a strict speed limit should be adhered to;
- All food should be securely stored away to prevent attraction of faunal species and all rubbish should be disposed of away from the site. Bins should have tightly fitting lids to prevent faunal species raiding the bins;
- Should emergency work take place at night, LED lighting focussed downwards and inwards on the site activity is required to avoid impacting on fauna in the area.

Significance of the impact

The significance of this impact is regarded as medium to low without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-6.1.4 Spread of alien invasive plant species

Source and nature of the impact

Post-construction of the proposed pipeline, alien invasive plants may spread across the study area in the absence of rehabilitation of the site.

Table 65: Spread of alien invasive plant species

Impact source(s)	Increased spread of alien invasive plant species		Status	-
Nature of impact	Loss of biodiversity and faunal displacement			
Reversibility of impact	The impact is irreversible as the loss of natural vegetation will result in a loss of faunal habitat.			
Degree of irreplaceable loss of resource	High			
Affected stakeholders	Conservation groups, custodians of D'MOSS			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Long-term - 4		
	Probability	Probable – 1		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+4+1) x 4 = 44 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.4 = 17.6 Low		L

Mitigation measures

- Areas which have been disturbed during construction should be rehabilitated with species naturally occurring in the study area, and the disturbed areas should be monitored throughout the operational phase to detect any alien plant species (*more details regarding the rehabilitation of the working corridor will be specified in alien plant management plan which will form part of the PRRRP to be compiled by a suitably qualified ecologist*).

Significance of the impact

The significance of this impact is regarded as medium without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-6.1.5 Habitat degradation and fragmentation

Source and nature of the impact

The proposed linear development could destroy natural vegetation and fragment wooded habitats as the operational phase servitude will be maintained and mostly kept free of trees. If the recommended mitigation measures for the operational phases are not strictly adhered to, impacts associated with habitat destruction and fragmentation will accumulate and lead to increased edge effects and habitat degradation in natural areas throughout the study area. Impacts resulting from an incremental degradation of the surrounding natural areas may be avoided and mitigated by adhering to all suggested mitigation measures during the operational phase.

Table 66: Habitat degradation and fragmentation

Impact source(s)	Operational phase servitude		Status	-
Nature of impact	Habitat degradation and fragmentation			
Reversibility of impact	The impact is irreversible as fragmentation would displace faunal movement			
Degree of irreplaceable loss of resource	High			
Affected stakeholders	Conservation groups, custodians of D'MOSS			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Long-term - 4		
	Probability	Probable – 1		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+4+1) x 4 = 44 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.4 = 17.6 Low		L

Mitigation measures

- The operational phase servitude must be kept to a minimum in sensitive areas especially wooded drainage lines. Where possible, woody vegetation must be replaced / regrown;
- An alien invasive plant species monitoring and management plan must be put in place throughout the duration of the operational phase to ensure that alien plant infestations do not ensue as a result of the development;
- Due to the nature of the development, loss of natural woody habitat is unavoidable. To help compensate for the loss and fragmentation of habitat, it is recommended that the municipality commit resources to an urgent clean-up campaign focussed on drainage lines and bushy areas within the study area. Illegal dumping was observed throughout the study area and the impact was deemed to be severe in certain areas. eThekwini Municipality's DWS must commit to better policing and a campaign to clamp down on illegal dumping in the study area.

Significance of the impact

The significance of this impact is regarded as medium without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-7 CUMULATIVE IMPACTS

Cumulative impacts are those impacts that are created as a result of the combination of the impacts of the proposed project, with impacts of other projects or operations, to cause related impacts. These impacts occur when the incremental impact of the project, combined with the effects of other past, present and reasonably foreseeable future projects, are cumulatively considerable. The assessment of cumulative impacts on a site-specific basis is however complex – especially if many of the impacts occur on a much wider scale than the site being assessed and evaluated. Cumulative impacts as a result of the project include the following:

F-7.1.1 Increased traffic during the construction phase

Source and nature of the impact

Additional traffic may be generated during the construction phase of the project through installation of the pipeline and other road upgrades.

Table 67: Increased traffic during construction

Impact source(s)	Traffic generated by construction of the pipeline and other road upgrades in the region		Status	-
Nature of impact	Increased traffic during construction			
Reversibility of impact	The impact is reversible			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Commuters, residents, motorists			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Long-term - 4		
	Probability	Probable – 1		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+4+1) x 4 = 44 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.4 = 17.6 Low		L

Mitigation measures

- The recommendations as stated in the Traffic Management Plan must be adhered to.
- The timing of construction must be such that the road upgrades and the installation of the pipeline do not occur at the same time. Consultation with the relevant traffic departments must take place prior to construction.

Significance of the impact

The significance of this impact is regarded as medium without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-7.1.2 Destruction of natural vegetation within D'MOSS areas

Source and nature of the impact

As far as possible, there will be minimal destruction of the areas of high biodiversity along the route such as the closed canopy woodland and the wooded grassland for construction of the pipeline. Large open tracts of land are often seen as 'prime land for development' and together with the proposed pipeline and other 'potential future developments' within D'MOSS areas, remnant vegetation in the urban areas could be lost permanently.

Table 68: Destructions of natural habitat within the D'MOSS areas

Impact source(s)	Proposed pipeline construction and potential future development in D'MOSS areas		Status	-
Nature of impact	Loss of biodiversity			
Reversibility of impact	The impact is irreversible			
Degree of irreplaceable loss of resource	High			
Affected stakeholders	Conservation groups and eThekwini Municipality Biodiversity Unit			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Long-term - 4		
	Probability	Probable – 1		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+4+1) x 4 = 44 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.4 = 17.6 Low		L

Mitigation measures

- Refer to Section F-4.1.3 and F-4.1.6 for mitigation measures.

Significance of the impact

The significance of this impact is regarded as medium without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-7.1.3 Soil erosion and sedimentation

Source and nature of the impact

There are existing anthropogenic impacts such as industrial developments and the construction of the N2 that has modified the wetlands and the riparian areas in the study area through infilling, flow modification and decreased water quality. In the absence of mitigation measures for construction of the pipeline, the existing impacts of soil erosion and sedimentation may be exacerbated.

Table 69: Soil erosion and sedimentation

Impact source(s)	Increased exposed surfaces devoid of vegetation, as a result of construction activities and vehicles		Status	-
Nature of impact	Increased soil erosion and sedimentation			
Reversibility of impact	The impact is irreversible			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding and downstream land owners			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Long-term - 4		
	Probability	Probable – 1		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+4+1) x 4 = 44 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.4 = 17.6 Low		L

Mitigation measures

- The mitigation measures as provided in Section F-4.1.1 must be strictly implemented for the duration of construction activities.

Significance of the impact

The significance of this impact is regarded as medium without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-7.1.4 Potential destruction of wetland and riparian areas

Source and nature of the impact

Various wetlands and riparian areas have been modified, infilled or destroyed as a result of past housing, commercial, industrial developments and the construction of the N2. Construction of the proposed pipeline could infringe or destroy wetland and riparian habitat with associated biota through removal of hydrophytic and riparian vegetation and or hydric soils and riparian bed and bank modification.

In the absence of mitigation measures for construction of the pipeline, the existing impacts of soil erosion and sedimentation may be exacerbated. The construction of the proposed pipeline in addition to the past activities as described herein, may lead to a cumulative loss of wetlands and riparian habitat in this region.

Table 70: Potential Destruction of wetland and riparian areas

Impact source(s)	Construction activities within and in close proximity to the wetlands and riparian areas		Status	-
Nature of impact	Destruction of wetland and riparian habitat in the region			
Reversibility of impact	The impact is irreversible			
Degree of irreplaceable loss of resource	Low			
Affected stakeholders	Surrounding and downstream land owners			
Magnitude	*Extent*	Regional - 3		
	Intensity	Medium – 3		
	Duration	Long-term - 4		
	Probability	Probable – 1		
Significance	*Without mitigation*	*(Extent + Intensity + Duration + Probability) x WF* (3+3+4+1) x 4 = 44 Medium		M
	With mitigation	*WOM x ME = WM* 44 x 0.4 = 17.6 Low		L

Mitigation measures

- The mitigation measures as provided in Section F-4.1.7 must be strictly implemented for the duration of construction activities.

Significance of the impact

The significance of this impact is regarded as medium without mitigation, however, with mitigation measures, the significance will be reduced to low.

F-7.1.5 Access to water through implementation of the Northern Aqueduct Phase 5 Project

Source and nature of the impact

The proposed Northern Aqueduct Phase 5 project is anticipated to have a high positive impact on the community as there would be an improved access to clean water to the northern suburbs of Durban. Provision of water as a basic need through the implementation of this project, will ensure a sustainable and assured supply of water to meet the future demands from major new developments and urbanisation.

In light of the above, there will be further positive social impacts from the new developments in the form of employment opportunities, skills transfer and capacity-building and contribution towards LED. This impact is therefore predicted to have a **high positive significance**.

F-8 IMPACT ASSESSMENT: DECOMMISIONING PHASE

Decommissioning of the Northern Aqueduct steel water pipeline is not expected to occur, but if it were, the top structures e.g. manholes will be probably be removed, as deemed necessary and measures will be in place to ensure compliance to safety standards. Below ground structures will be left in place.

SECTION G: CONCLUSIONS AND RECOMMENDATIONS

In accordance with the EIA Regulations (GN No. 982), this section provides a summary of the key findings of the Basic Assessment (BA) Process and a comparative assessment of the positive and negative implications of the proposed activity and identified alternatives. This section also provides a reasoned opinion as to whether the activity should or should not be authorised and conditions that should be made in respect of that authorisation, as necessary.

G-1 SUMMARY OF THE KEY FINDINGS OF THE BASIC ASSESSMENT

It is the opinion of the EAPs that should the project proceed, impacts on the receiving natural areas can be minimised through the careful adherence to suggested mitigation measures. It is also recommended that the possible impacts on the D'MOSS areas, uMngeni River, wetlands and drainage lines are monitored throughout the duration of the project.

The proposed Northern Aqueduct Phase 5 project will provide infrastructure for the provision of clean water to the northern suburbs of the eThekwini Municipality. Provision of water as a basic need through the implementation of this project, will ensure a sustainable and assured supply of water to meet the future demands from major new developments and urbanisation.

The findings of the specialist studies undertaken together with the broader environmental assessment conclude that there are no fatal flaws that should prevent the project from proceeding. However, the following key impacts (Table 71) have been identified which will require the application of site and activity specific mitigation measures. These mitigation measures are included within the EMPr to ensure that they receive the necessary attention.

The steel pipeline will be buried during operation, and will follow the edge of cadastral boundaries and existing servitudes for the most part, thereby having minimal long-term impact on existing landuses or activities. The most significant impacts are likely to arise out of the construction process, but these will be temporary, and with careful management can be reduced or resolved. Re-alignment options for certain portions of the route such as sensitive biophysical areas *viz*, the closed canopy woodland, wooded grassland and drainage lines have been suggested to minimise the impacts to important or sensitive areas that have been identified during the Biodiversity and Wetland Specialist's investigation. However, the practicality of adopting the suggested route realignments, or deviations, had to take into consideration social, economic, technical aspects (*land acquisition, existing services, gradients, hydraulic flow factors)* and so on. Refer to Section A-1.3.

The following deviations have been incorporated into the final preferred route alignment:

- Deviation 2c: This part of the route follows the edge of the cadastral boundary and does not impact on the wooded grassland in Hillgrove, Newlands West.
- Deviation 4: The route runs parallel to the existing electrical powerlines and along the road verge of John Dory Drive, thereby avoiding encroachment into the drainage lines and *Hyparhennia hirta* grasslands in Newlands East
- Deviation 5: The route avoids encroachment into the electrical servitude in Quarry Heights, by following adjacent to 120844 Street. In addition, the route is better positioned, as it will have easy access to the Aloes Reservoir. Therefore, moving the pipeline to this street reduces the length of the connection supply to Aloes Reservoir.
- Deviation 6: The route avoids encroachment into the Transnet Freight Rail servitude, by occurring west of the existing water mains. In addition, the route avoids steep terrain, which would have led to construction difficulties.

The following route deviations were not incorporated into the final preferred route alignment (please see Section A-1.3 for more details):

- **Deviation 1 was intended to avoid construction along the edge of the closed canopy woodland / forest.**
  Deviation 1: Battersea Avenue and Middlemiss Crescent has existing buried sewer lines, water reticulations pipelines, electrical powerlines and telecommunication cables, which may be damaged as a result of installation of a 1 200mm dia pipeline. In addition, these roads are narrow and there is insufficient space to install a 1 200mm dia pipeline. There are various other negative socio-economic impacts of construction of this deviation.

- **Deviation 2a was intended to avoid construction through the edge of the wooded grassland area.**
  Deviation 2a: Royalhill Road has similar impacts as Deviation 1.

- **Deviation 2b was intended to avoid traversing the non-perennial riparian area.**
  Deviation 2b: Due to the additional bends required at the edge of the cadastral boundary, and its implication on hydraulic flow of water, it is unavoidable that this route will traverse the non-perennial riparian area in Hillgrove.

- **Deviation 3 was intended to be routed perpendicular to the wooded drainage line.**
  Deviation 3: The pipeline route has to follow the edge of the cadastral boundaries, due to proposed developments by Commercial Properties and FOSA in the area suggested for deviation.

- **Deviation 7 was intended to avoid construction activities through the valley bottom floodplain wetland.**
  Deviation 7: The M25 is proposed for future widening and therefore the valley bottom floodplain wetland will be traversed during construction.

Where possible, the construction and operational phase servitudes must be reduced to minimise the impacts on the sensitive areas. Mitigation measures must be in place to ameliorate the impacts of construction of the route in sensitive areas such as those mentioned above (refer to site specific mitigation measures in Section F-4.1.3, F-4.1.5, F-4.1.6 and F-4.1.7). A Wetland Rehabilitation Plan and Plant Rescue, Rehabilitation and Relocation Plan must be compiled prior to the tender stage and appended to the Construction EMPr.

Table 71: Summary of the significance of identified impacts without and with mitigation measures

Impact	Significance	
	Without Mitigation	With Mitigation
Construction Phase: Construction of the Pipe Bridge across the uMngeni River		
Biophysical Environment		
Vegetation and faunal habitat destruction	Medium	Medium - Low
River flow modification	Medium - High	Low - Medium
Riverbank modification and edge hardening	Low to Medium	Low
Increased erosion, turbidity and siltation	High	Medium - High
Decreased water quality of the estuary	Medium to High	Low - Medium
Increased sedimentation	Low - Medium	Low
impact on fauna through increased noise	Low	Low
Impact on water and soil quality	Low to Medium	Low
Construction Phase: Construction of the Pipeline from the Pridley Road to Duffs Road		
Biophysical Environment		
Soil erosion and silting of the drainage lines	Medium	Medium - Low
Surface and groundwater contamination	Medium	Low
Destruction of natural vegetation including threatened/protected floral species and associated habitat	Medium to High	Medium
Spread of alien invasive plant species	Medium to High	Low - Medium
Destruction and fragmentation of natural faunal habitat	High	Medium
Disturbance to areas containing natural habitat and fauna	Medium	Low
Destruction of wetland and riparian habitat through reshaping and construction activities within and in the vicinity of the wetlands	Medium	Low to Medium
Socio Economic Environment		
Increase in ambient dust levels and air emission	Medium	Low - Medium
Increase in ambient noise levels	Medium	Low
Visual disturbance at ground level	Medium	Low
Effect of temporary workers	Medium	Low
access of land due to the servitude	Medium	Low
impact of socio-cultural processes	Medium	Low
Impact of health and well-being	Medium	Low
Impacts on localised traffic	Medium - High	Low - Medium
Impacts on heritage resources	Medium	Low
Emancipatory and empowerment processes/capacity-building and skills transfer	**High Positive**	
Temporary employment opportunities and supply of local materials	**High Positive**	
Operational Phase: Proposed Bridge across the uMngeni River		
Biophysical Environment		
Modified flow, erosion and deposition patterns	Medium to Low	Low
Operational Phase: Proposed Pipeline from Pridley Road to Duffs Road		
Biophysical Environment		
Impacts of erosion	Medium to Low	Low
Impacts on water resources	Medium to Low	Low
Disturbance to fauna and faunal habitats	Medium to Low	Low
Habitat degradation and fragmentation	Medium	Low
Cumulative Impacts		
Increase traffic within the surrounding area	Medium - High	Low - Medium
Impact on biodiversity (D'MOSS)	Medium - High	Medium
Increased soil erosion and sedimentation	Medium	Medium - Low
Destruction of wetlands and riparian areas	Medium	Medium - Low
Improved access to water	**High Positive**	

G-2 EAP'S RECOMMENDATION

Having assessed all the potential environmental impacts associated with the proposed development, it is the opinion of the EAP that the project is issued with a positive Environmental Authorisation from KZN DEDTEA for the following reasons:

- The pipeline route selection process has been given careful consideration to biophysical, socio-cultural and economic impacts;
- During the route selection process, the project team attempted to accommodate the biophysical and socio-economic concerns, derived from specialist investigations and consultation with landowners regarding land acquisition.
- Alternatives with regard to construction of the pipe bridge across the uMngeni River have been assessed which will have the least impact on the estuary.
- A project-specific Draft Environmental Management Programme (EMPr) has been compiled according to *(but not limited to*) the impacts and mitigation measures included in this assessment. A more detailed EMPr must be submitted prior to the tender stage, which is inclusive of a Wetland Rehabilitation Plan and Plant Rescue, Relocation and Rehabilitation Plan, and conditions of the EA to the KZN DEDTEA for approval.
- The need and desirability of the project is attributed to the growth in demand for assured water supply for new developments and urbanisation to the north-east of Durban. The proposed development falls within SIP 6 (Integrated Municipal Infrastructure Project)…"*Develop a national capacity to assist the 23 least resourced districts (17 million people) to address all the maintenance backlogs and upgrades required in water, electricity and sanitation bulk infrastructure".*
- In addition, the Phase 5: NAA Project also falls within SIP 18: Water and Sanitation Master Plan. The project will provide for new infrastructure to allow for a sustainable and assured supply of potable water in the region.
- The proposed development will also contribute to provide various employment opportunities to the local people with the Municipality.

The following mitigation measures are required for construction of the proposed pipe bridge:

- The area of construction activities must be kept to an absolute minimum and the construction site must be appropriately demarcated.
- All indigenous vegetation must be marked and avoided as far as possible.
- The access route to the river edge must strictly follow the existing tracks and no deviations permitted.
- In addition, repetitive or continuous movement of heavy construction machinery / plant should be limited in the river channel to reduce habitat destruction as well as the compaction of soils.
- While restoration of vegetation and estuarine habitats to pristine condition is virtually impossible, post-construction rehabilitation is essential to mitigate the negative impacts of construction activities and must be implemented as soon as possible.
- Given the designation of the uMngeni River and Estuary as Critical Biodiversity Area, rehabilitation must be expanded to degraded areas beyond the construction site and maintained to assist and contribute to improving overall estuarine condition. The areas for rehabilitation must be identified in collaboration with the EPCPD, Contractor, Engineer and the ECO. EWS must allocate sufficent funding in the project budget for the rehabilitation work.
- The instream construction of the piers should be undertaken in a phased approach whereby flow is only diverted around each construction node, as and when needed.
- Construction of the piers should be undertaken during the dry winter months, when river input is naturally low, thereby reducing the risk of mass erosion of sediment from within the channel and exposed riverbanks.
- The site camp and ablution facilities must be positioned outside the estuarine functional zone and the 1:100 year floodline, and chemical toilets must be located away from stormwater culverts and drainage lines.

- Spillage of construction materials must be prevented, and a spill contingency plan must be developed as part of the EMPr.

The following is recommended for stakeholder engagement:

- A comments and complaints register, accessible to members of public, should be implemented and maintained. Such a register would provide a formal framework within which to record any comments and complaints received, as well as to identify and action appropriate mitigation and/or remediation measures. The register should also include a means of recording and communicating the close-out of issues;
- Establish a Stakeholder Forum to ensure transparency in processes followed by EWS and to aid in the dissemination of information to disadvantaged community members, especially when operating in Avoca Hills;
- In order to mitigate most of the impacts highlighted in this report, EWS should consider the establishment of a Community Monitoring Forum (CMF) in order to monitor the construction phase and the implementation of the recommended mitigation measures. The CMF should be established before the construction phase commences, and should include key stakeholders, including representatives from local communities, local councillors (within the SIZ), affected landowners and the contractor(s);
- Engage with the local community representatives to dispense information relating to the project, possible employment opportunities and channels of communication (especially in terms of grievances);
- Engagement with community representatives, ward councillors and other existing community forums should be done to inform the general public about the project and project related impacts or opportunities;
- Public meetings or open days must be held to discuss traffic, dust, noise and construction related concerns with the community. These meetings should also provide information on project related impacts or opportunities;
- Local residents and land owners should inform mitigation measures when addressing any potential impact on cultural heritage sites or potential graves that may be exposed during excavation.

To ensure that identified negative impacts are minimised and positive impacts enhanced, the following clauses are recommended as conditions of the Environmental Authorisation:

- The EMPr is a legally binding document and the mitigation measures stipulated within the document and Basic Assessment Report must be implemented;
- An independent Environmental Control Officer (ECO) must be appointed to manage the implementation of the EMPr during the construction phase. Environmental Audit Reports must be compiled and made available for inspection;
- Continued offences of the EMPr on the part of the Contractor should be reported to the eThekwini Environmental Branch for further action.
- Any impact on surrounding or riparian vegetation must be rehabilitated. Where riparian vegetation is expected to be affected, ecologically significant plant material should be rescued from the site prior to construction beginning, to be utilised during rehabilitation.
- The working corridor through riparian areas must be as narrow as practically possible, i.e. machinery must utilise the same route through the systems at all times so as to avoid unnecessary disturbance to the riparian vegetation.
- Construction activities should commence during the winter months to minimise the impacts on breeding fauna, as far as practically possible;
- Excavate wetland and riparian crossings in the winter months as this is the driest period for this region as far, as practically possible;
- The construction corridor must be **as narrow as possible** in sensitive areas. No construction camps or storage areas should be placed within the construction corridor in sensitive areas;
- The operational phase servitude must be kept **as narrow as possible** in sensitive areas especially wooded drainage lines. Woody vegetation must be restored where possible;
- Proactive measures must be taken to ensure that sediments and contaminants do not enter the

sensitive ecological areas, drainage lines, rivers and wetlands.

- Sensitive areas must be backfilled as soon as possible.
- If individuals of any faunal species that cannot relocate themselves (e.g. burrowing animals) are encountered during construction, activities should cease until the individuals can be moved in an ecologically acceptable manner to a more suitable location. This should be undertaken by a faunal relocation expert. If such animals are encountered, including those perceived to be vermin and all herpetofauna, they must not be killed or injured.
- Removal and relocation of any species protected under the Natal Nature Conservation Ordinance No. 15 of 1974 will require a permit granted by the provincial conservation agency EKZNW;
- Areas that have been disturbed during construction should be rehabilitated with species naturally occurring in the study area, and the disturbed areas should be monitored quarterly to detect any alien plant species.
- During the operational phase, access to the pipe bridge should be restricted to the public.
- Where the pipeline is constructed within vegetated areas, it should follow within the footprint of existing pipelines, roads and/or tracks as far as possible, rather than creating a new route through vegetated areas;
- The crossings of the riparian channels should be perpendicular to the direction of flow, where practically possible;
- The crossings should be designed to ensure that flow patterns along the stream/river channel are not altered or diverted potentially resulting in stream bank erosion;
- The crossings should be rehabilitated to ensure that no barriers exist within the stream and that in-stream habitat is similar to the natural situation;
- On steep slopes draining towards the identified freshwater ecosystems, small-scale diversion berms and or siltation nets should be constructed on the surface of the pipeline alignment to reduce the risk of the pipeline becoming a preferred surface flow path leading to erosion;
- “Trench-breakers”, which are in-trench barriers, should be installed along the length of the pipeline to minimise the interception and accumulation of water from the adjacent hillslope within the infilled trench;
- Disturbed surfaces to be rehabilitated must be ripped and the area must be backfilled with excavated material from the site.
- The trench must be backfilled with the same soils as was excavated in the specific hydromorphic zone.
- During installation, the excavated soil from the trench should be placed on the upslope side of the trench, minimizing the risk of excess sediment entering the downstream areas of the freshwater ecosystems;
- The pipeline alignment should be rehabilitated, with the wetland and riparian habitat at the crossing points being restored to near natural conditions. In addition, areas where disturbance adjacent to these ecosystems has occurred should also be rehabilitated. This should be done as soon as possible after the pipeline construction activities have ceased;
- In riparian areas, backfilling should occur as soon as possible, compact if possible and reshape river to original levels;
- Where wetland and or riparian habitat is crossed, the top 50cm of seed containing topsoil should be kept separately from other soils in order to be utilised during rehabilitation. The remainder of the soil profile should also be placed back in-situ. Re-vegetation of disturbed areas must be undertaken with site indigenous species and in accordance with the instructions issued by the ECO. Areas where soil compaction or ruts developed should be rehabilitated.

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SECTION I: APPENDICES

Appendix A: Drawings/Maps/Co-ordinates/Routing Reports
Appendix A1: Pipeline Route Co-ordinates
Appendix A2: SG cadastral codes and property description
Appendix A3: Pipeline Route Map
Appendix A4: Route Selection Report
Appendix A5: Proposed uMngeni River Crossing Options

Appendix B: Photograph plate
Appendix B1: Photoplate of the general pipeline route

Appendix C: Correspondence with KZN DEDTEA
Appendix C1: Application Form to KZN DEDTEA
Appendix C2: Acknowledgement of the Application for Authorisation Form
Appendix C3: Minutes of EIA Enquiry Meeting and Attendance Register

Appendix D: Specialist Studies
Appendix D1: Soils and Agricultural Potential Assessment Report
Appendix D2: Geohydrological Assessment
Appendix D3: Wetland and Riparian Assessment
Appendix D4: Aquatic Assessment
Appendix D5: Estuarine Assessment
Appendix D6: Floral Impact Assessment
Appendix D7: Faunal Assessment
Appendix D8: Herpetofaunal Assessment
Appendix D9: Social Impact Assessment
Appendix D10: Heritage Impact Assessment
Appendix D11: Palaeontological Assessment
Appendix D12: Traffic Management Plan
Appendix D13: Air Quality Assessment
Appendix D14: Noise Impact Assessment

Appendix E: Public Participation Process
Appendix E1: Interested and Affected Party (I&AP) Distribution List
Appendix E2: Site Notice Text (English and Zulu) and Proof of Placement
Appendix E3: Newspaper Advert Text (English and Zulu) and Proof of Placement
Appendix E4: Background Information Document (BID) in English and Zulu and proof of notification
Appendix E5: Minutes of the Focus Group Meetings and Attendance Registers
Appendix E6: Registered I&AP Database
Appendix E7: Comments and Responses Report
Appendix E8: Actual Comments and Responses
Appendix E9: Notification Letter regarding POD and public review of the BAR
Appendix E10: Newspaper Advert regarding POD and public review of the BAR

Appendix F: Environmental Management Programme (EMPr)

Appendix G: Other Information
Appendix G1: Declaration of Oath by EAP
Appendix G2: CV's of the EAPs

Appendix A1: Pipeline Route Co-ordinates

Appendix A2: SG cadastral codes and property description

Appendix A3: Pipeline Route Maps

Appendix A4: Route Selection Report

Appendix A5: Proposed uMngeni River Crossing Options

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Appendix C3: Minutes of EIA Enquiry Meeting and Attendance Register

Appendix D1: Soils and Agricultural Potential Assessment Report

Appendix D2: Geohydrological Assessment

Appendix D3: Wetland and Riparian Assessment

Appendix D4: Aquatic Assessment

Appendix D5: Estuarine Assessment

Appendix D6: Floral Impact Assessment

Appendix D7: Faunal Assessment

Appendix D8: Herpetofaunal Assessment

Appendix D9: Social Impact Assessment

Appendix D10: Heritage Impact Assessment

Appendix D11: Palaeontological Assessment

Appendix D12: Traffic Management Plan

Appendix D13: Air Quality Assessment

Appendix D14: Noise Impact Assessment

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