6. DESCRIPTION OF ALTERNATIVES IDENTIFIED

This section provides:
- Details of the alternatives considered in terms of the proposed project;
- A motivation for the preferred project alternative.

6.1 Introduction

According to Afri Infra (2016), the objective of this project is to upgrade and refurbish the Bulk Water Supply Infrastructure to Amsterdam, situated in the jurisdiction area of the Mkhondo Local Municipality (MLM).

The Amsterdam Regional Water Supply Scheme currently serves a population of approximately 14 500 people who reside within the boundaries of the scheme. These residents are reliant on the scheme to provide a sustainable water supply. The future water requirement of Amsterdam is estimated at 1.09 million m^3/annum (Mallory and Jacobs, 2014).

The scheme currently abstracts water from a single location (Dorps Dam) within the catchment of the Gabosha River, a tributary of the Ngwempisi River. It relies on run-of-river abstraction only. It is not connected to any National Bulk Water Infrastructure.

The augmentation of the water supply to the town of Amsterdam has been investigated since 2014 and the following reports produced:
- Mallory, S.L.J. and H. Jacobs. 2014. **Hydrology and water resource assessment of the water supply to Amsterdam.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: December 2014.
- Mallory, S.L.J. and H. Jacobs. 2015. **Hydrology and water resource assessment of the Thole and Gabosche Rivers – assessment using daily hydrology.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: June 2015 (final)
- Mallory, S.L.J. and H. Jacobs. 2015a. **Hydrology and water resource assessment of the Thole and Gabosche Rivers – assessment using daily hydrology.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: May 2015.
- Mallory, S.L.J. and H. Jacobs. 2015b. **Hydrology and water resource assessment of the Thole and Gabosche Rivers – assessment using daily hydrology.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: May 2015.
- Mallory, S.L.J. and H. Jacobs. 2016. **Revised yield assessment of a small dam on the Ngwempisi River – assessment using daily hydrology.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: September 2016.

Subsequently, the following final report was produced summarizing all the options investigated to date and providing a final synthesis of the various options:
- Mallory, S.L.J. 2017. **Hydrology and water resource assessment towards augmenting the water supply to Amsterdam, Mpumalanga.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: June 2017.

The above-mentioned reports are all included in Appendix 17 and should be consulted with regards to the methodology used.

This section provides a summary of all the alternatives/options investigated in order to augment the water supply to Amsterdam and supply water on a sustainable basis. This includes yield analyses whereby the amount of water that can be abstracted from a river, dam or system of dams on a sustainable basis was determined. It should be noted that since the analyses were carried out for rural domestic use, a high assurance of supply (namely 98% assurance) was assumed in these investigations (Mallory, 2017).

6.2 Water Treatment Works (WTWs)

6.2.1 Amsterdam Water Treatment Works (WTWs)

The existing Amsterdam Water Supply Scheme allows for raw water abstraction from the Dorps Dam located in the Gabosha River (Figure 6.1). This water is treated at the existing Amsterdam Water Treatment Works located on the north eastern side of the town, Amsterdam (Figure 6.1). This WTWs is registered as a Class D works and has a reported capacity of 7Ml/day. On average, 2.4 Ml/day is treated (WSDP, 2010). Potable water is provided to Amsterdam and KwaThandeka by the Mkhondo Local Municipality who is in charge of the said works.

Photo 6.1: View of Amsterdam Water Treatment Works (WTW)

Preliminary investigations confirmed that the capacity of the Amsterdam Water Treatment Works (WTWs) is sufficient in terms of the 2034 demand requirements (Afri-Infra, 2016).

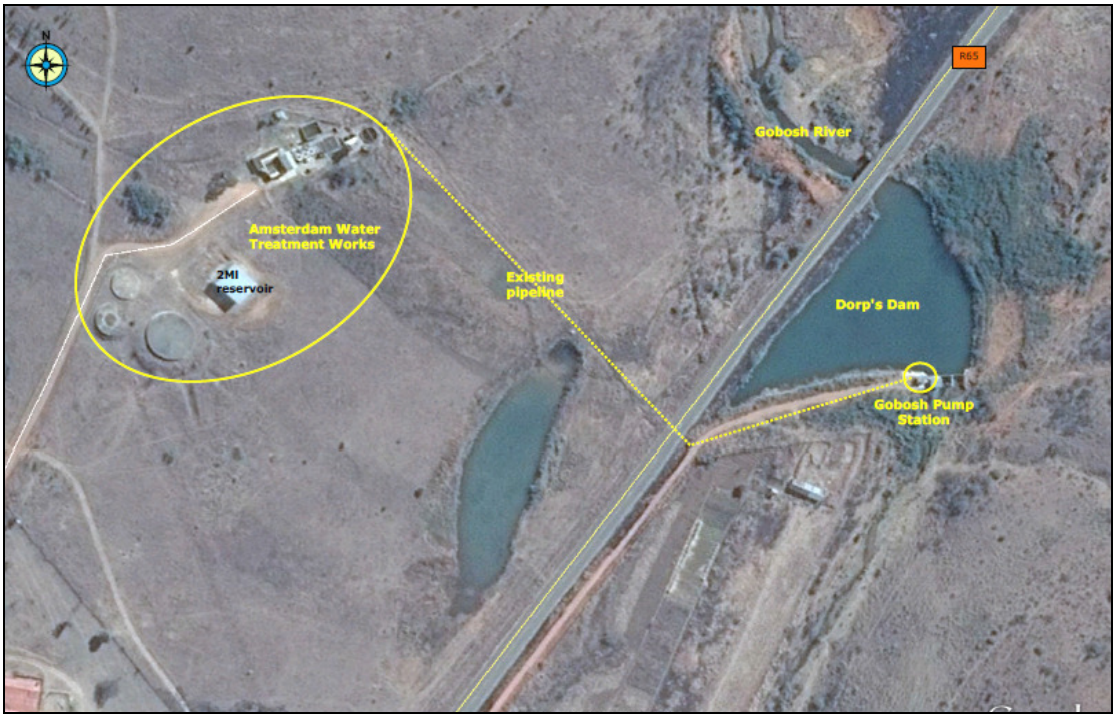

Figure 6.1: Amsterdam Water Treatment Works and associated infrastructure

However, the WTWs requires refurbishment and/or replacement of the following existing equipment housed within the existing WTW buildings:

- The refurbishment of valves and pumps:
  - Replace desludging valves with 150mm NB hand operated knife gate valves complete with extended spindles, etc.
- The refurbishment of the chlorination equipment:
  - Removal of existing equipment where refurbishment is required or new equipment will be supplied and installed.
- The refurbishment of sedimentation and filtration equipment:
  - Provide new filter media (various gradings);
  - Inspect filter floors and nozzles once media has been removed and determine if refurbishment is required;
  - Replace 'lamella' plate/membrane installations;
  - Removal of existing equipment where refurbishment is required or new equipment will be supplied and installed.
- The refurbishment of the chemical dosing equipment:
  - Refurbish existing powder lime feeder;
  - Removal of existing equipment where refurbishment is required or new equipment will be supplied and installed.
- Recommissioning of existing infrastructure:
  - Isolate, drain, high pressure wash, desludge, clean and recommission the following: inlet splitter tower; flocculation channels, sedimentation tanks, filter channels, filters, clear water tanks.
- The refurbishment of the WTWs building – general maintenance activities (e.g. new doors, re-glazing of windows, painting, plumbing, etc.);
- The refurbishment of the inlet works building – general maintenance activities (e.g. new polycarbonate roof sheets to enclose the chemical dosing house at the inlet works, etc.).

In addition to the above-mentioned, the following infrastructure also needs to be upgraded:

- Gabosha River Abstraction Pump Station;
- The existing rising main from the Gabosha River Abstraction Pump Station to the inlet works at the Amsterdam WTW;
- Storage facilities.

Upgrading of the Gabosha River Abstraction Pump Station

The Gabosha River Abstraction Pump Station is located on the wall of the Dorps Dam as indicated in Figure 6.1. It has an estimated pumping capacity of 36 l/s.

According to Afri-Infra (2016) the refurbishment of the said pump station would involve:

- The refurbishment of the pump station building i.e. general maintenance to existing pump station building.
- The upgrading of the pumps and Motor Control Centre (MCC) i.e. replacing/refurbishing existing pumps and MCC.

Upgrading of the existing rising main

The existing rising main consists of a 160 mm diameter uPVC Class 9 pipeline extending from the Gabosha River Abstraction Pump Station to the inlet works at the Amsterdam WTW (i.e. a distance of 500m; existing pipeline - Figure 6.1). According to the information provided, air valves, chambers, etc. associated with this pipeline would be refurbished. No new pipeline would be installed and thus there will be no increase in footprint or capacity.

Upgrading of storage facilities

Afri-Infra (2016) indicated that the storage facilities need to be upgraded by approximately 2 Ml.

A 2Ml reservoir has already been constructed on site as indicated in Photo 6.2 and Figure 6.1. This reservoir was unfortunately installed at the incorrect level resulting in the said reservoir not being able to be filled to capacity with water.

Photo 6.2: View of 2Ml reservoir adjacent to the existing reservoirs at the Amsterdam WTW

Afri-Infra indicated that the said reservoir would be decommissioned (i.e. broken down) and re-installed at the correct level (i.e. the site will be excavated to the correct level). There would thus be no increase in footprint

area or in capacity. All construction would thus take place within the existing footprint area and within the existing fenced area.

As indicated in Section 4.7.2.3, an Environmental Authorisation with regards to the upgrading/refurbishment of the Amsterdam WTWs is not required. **The upgrading/refurbishment will therefore not be discussed in this EIA Report.**

6.2.2 New Water Treatment Works (WTWs)

A new Water Treatment Works (WTWs) was not investigated since the existing Amsterdam WTWs has sufficient capacity in terms of the 2034 demand requirements (Afri-Infra, 2016). The upgrading of the facilities as indicated in Section 6.2.1 is however required. **The possibility of a new water treatment works will therefore not be discussed in this EIA Report.**

6.3 Integration with other water supply schemes

The following alternatives with regards to integrating the Amsterdam Regional Water Supply Scheme with other water supply schemes were investigated:

- Alternative 1: Gabosha River/Morgenstond Dam;
- Alternative 2: Gabosha River/Usuthu Vaal Scheme;
- Alternative 3: Usuthu River/Usuthu Vaal Scheme;

6.3.1 Alternative 1: Gabosha River/Morgenstond Dam

According to Afri-Infra (2016), this option allows for raw water abstraction (through a raw water pump station) from the Morgenstond Dam for the communities of Amsterdam and KwaThandeka.

The Amsterdam Pump Station would pump raw water via a 200mm diameter pipeline to a high level reservoir from where water would gravitate to the existing Amsterdam Water Treatment Works (WTWs). Clean water would then be supplied from the Amsterdam WTWs to the storage facilities of Amsterdam and KwaThandeka.

ALTERNATIVE 1: GABOSHA RIVER/MOREGENSTOND DAM		
Infrastructure requirements	**Size**	**Quantity**
Raw water pipeline (Rising Main) – Morgenstond Dam to Amsterdam WTW (PL1)	250mm uPVS Class 9	5000 m
Raw water pumpstation – Morgenstond Dam to High Level Reservoir (PS1)	47 l/s @ 67m	40 kW
Amsterdam WTW – 7 Ml/day	Existing sufficient	0
Amsterdam Storage Facility – upgrade from current 2.25 Ml/d to 4 Ml/d	2 Ml Concrete	2000 kl
Upgrade existing raw water pipeline – Gabosha River to Amsterdam WTW (PL3)	160 mm uPVC Class 9	500 m
Upgrade Existing Raw Water Pumpstation – Gabosha River to Amsterdam WTW (PS2)	11 l/s @ 48m	7 kW

Alternative 1 was discarded as Morgenstond Dam is committed to supply water for national energy needs and was therefore not considered a favourable option (Afri-Infra, 2016).

6.3.2 Alternative 2: Gabosha River/Usuthu Vaal Scheme

Alternative 2 involved augmenting the yield of the Gabosha River from the bulk link between Jericho and Westoe Dams. In essence, this entailed the following:

- Upgrading of the existing scour facility to a formalized facility in the pipeline to discharge into the Gabosha River;
- Upgrading of the existing raw water pump station in the Gabosha River from where raw water will be pumped to the Amsterdam WTW.

ALTERNATIVE 2: GABOSHA RIVER/USUTU VAAL SCHEME		
Infrastructure requirements	**Size**	**Quantity**
Upgrade Weir/Dorps Dam	3 Ml/day	1
Upgrade Scour Facility in Jericho/Westoe Dams Bulk Link	2.1 Ml/day	1
Upgrade existing raw water pipeline – Gabosha River to Amsterdam WTW (PL1)	315 mm uPVC Class 9	500m
Raw Water Pumpstation – Gabosha River to Amsterdam WTW (PS1)	61 l/s @ 48m	38 kW
Amsterdam WTW – 7 Ml/day	Existing sufficient	0
Amsterdam Storage Facility – upgrade from current 2.25 Ml/d to 4 Ml/d	2 Ml Concrete	2000 kl

In the Amsterdam Reconciliation Strategy Report, it is recorded that in times of water shortages the yield of the Gabosha River is augmented from Westoe Dam via the bulk link pipeline between Westoe Dam and Jericho Dam. This augmentation is not governed by an official agreement between the Department of Water and Sanitation (DWS) and the Mkhondo Local Municipality. Water releases only take place after lengthy negotiations at elevated VRESAP (Vaal River Eastern Sub-system Augmentation Project) tariffs.

Although functional as an emergency back-up, this action cannot be considered as a sustainable long term solution to the area's water resource planning (Afri-Infra, 2016). **Alternative 2 was thus discarded.**

6.3.3 Alternative 3: Usuthu River/Usuthu Vaal Scheme

Alternative 3 allows for the raw water abstraction from the Usuthu River at an existing measuring station (station number W05H25) as primary raw water source for Amsterdam. From the abstraction point raw water would be pumped via a new bulk water link to the existing Amsterdam WTWs.

The hydrology and water resource assessment however indicated that the W5H025 weir site is not suitable for abstraction as primary source due to the high upstream abstractions (see Section 6.5.3 & 6.5.4). **Alternative 3 was thus discarded.**

ALTERNATIVE 3: USUTU RIVER/USUTU VAAL SCHEME		
Infrastructure requirements	**Size**	**Quantity**
Raw Water Pumpstation – Usutu River to Amsterdam WTW	43 l/s @ 177m	141 kW
Raw Water Pipeline (Rising Main) – Usutu River to Amsterdam WTW (PLa)	315mm uPVC Class 16	5500m
Raw Water Pipeline (Gravity Main) – Usutu River to Amsterdam WTW (PL2)	2000mm uPVC Class 9	12 300m
Amsterdam WTW – 7 Ml/day	Existing sufficient	0
Amsterdam Storage Facility – upgrade from current 2.25 Ml/d to 4 Ml/d	2 Ml Concrete	2000 kl
Upgrade storage capacity at existing measuring station	Suitable for 3Ml/day	1

6.3.4 Conclusion

Afri-Infra (2016) indicated that during preliminary planning it was envisaged that the Amsterdam Water Supply Scheme would be integrated with the Empuluzi/Methula, Lusushwana and Sheepmoor Water Supply Scheme as a Regional Bulk Water Supply Scheme with Westoe and Morgenstond Dams as primary source. These dams are however committed to supply water for national energy needs and were therefore not considered as favourable options (Afri-Infra, 2016).

Subsequent discussion with stakeholders resulted in the decision being taken to deal with the Amsterdam Water Supply Scheme as a stand-alone scheme supplying water to the communities of Amsterdam and KwaThandeka (Afri-Infra, 2016). **The idea of integrating the Amsterdam Regional Water Supply Scheme with another water supply scheme was thus discarded.**

6.4 Weir sites

Three weir sites were assessed namely:

- Weir W5H025 located in the Usuthu River (Figure 6.2);
- Current abstraction weir (Dorps Dam) in Gabosha River (Figure 6.2);
- Weir in Thole River located upstream of Amsterdam (Figure 6.2).

Figure 6.2: Location of the three weirs investigated (taken from Mallory and Jacobs, 2014)

The current abstraction weir in the Gabosha River (Dorps Dam; Figure 6.1) has a gross capacity of 220 000m^3 but is silted up. This affects the water supply to Amsterdam as run-of-river water is relied upon. The desilting of the Dorps Dam is proposed as an activity to be undertaken as part of the upgrading of the Amsterdam Regional Water Supply Scheme.

The natural and present day Mean Annual Runoff (MAR) at the 3 weir sites are indicated in Table 6.1.

Table 6.1: Runoff at the 3 weir sites (taken from Mallory and Jacobs, 2014)

SITE	MEAN ANNUAL RUNOFF (million m^3/a)	
	Natural	Present Day
Gabosha (Dorps Dam)	6.66	6.01
Thole	30.28	23.84
W5H025	69.11	22.93

Mallory and Jacobs (2014) modelled two scenarios (Table 6.2) to assess the impact of increased domestic abstraction while allowing for the Interim IncoMaputo Agreement (IIMA) minimum cross-border flows of 0.1 m^3/a into Swaziland.

Table 6.2: Historical yields at abstraction points for Scenario 1 & 2 (taken from Mallory and Jacobs, 2014)

WEIR SITE	SCENARIOS (million m^3/annum)	
	1: No weir & no EWR	2: No weir with EWR
W5H025	0.347	0
Gabosha	0.242	0
Thole	0.790	0

Legend: EWR = Ecological Water Requirements

As indicated in Table 6.2, **the future water demand of Amsterdam (i.e. 1.9 million m^3/annum) cannot be met by any of the proposed weir sites without providing storage (i.e. Scenario 1 – no provision for EWR).**

Scenario 2 included the Ecological Water Requirements being released from the 3 weir sites. As indicated in Table 6.2, **no water will be available for abstraction if the EWR is met as first priority.**

It is a requirement of the National Water Act, 1998 (Act 56 of 1998) to leave some water in the river to sustain the ecological functioning of the river. This is referred to as the Ecological Reserve or the Ecological Water Requirement (EWR).

The W53C catchment in which the Amsterdam area falls only contributes 19% of the runoff at the border with Swaziland (Mallory and Jacobs, 2015a). The remaining 81% is derived from the W53A and W53D catchments. Mallory and Jacobs (2015a) was therefore of the opinion that the W53C catchment should only contribute 19% to the minimum cross-border flows.

Table 6.3 provides an indication of the run-of-river yield at the Gabosha and Thole Sites where no EWR was allowed and only 19% of the cross-border flow. This was done with no EWR as there is no yield available at 98% assurance when allowing for EWR.

Table 6.3: Run-of-river yield in the Thole and Gabosha Rivers – no EWR and only 19% of minimum cross-border flow (taken from Mallory and Jacobs, 2015a)

SITE	YIELD AT 98% ASSURANCE (million m^3/annum)
Thole	0.16
Gabosha (Dorps Dam)	0.15

Based on the above-mentioned, the 3 weir sites were discarded since there is insufficient water from run-of–river yield if the EWR and the minimum cross-border flows are to be included.

6.5 Construction of weirs/small dams

The possible construction of weirs/small dams at the 3 sites indicated in Figure 6.2 was investigated. Mallory and Jacobs (2014) modelled various dam sizes for each site until the yield was sufficient to meet Amsterdams's future demand (i.e. after meeting the Ecological Water Requirements (EWR)). In

addition, modelled cross-border flows were also checked for compliance and, where necessary, releases from the dams were made to meet this.

6.5.1 Gabosha Site

Table 6.4 provides the historical yields at the Gabosha Site (Figure 6.2) for different weir sizes and the EWR.

Table 6.4: Historical yields at the Gabosha Site for different weir sizes with EWR (taken from Mallory and Jacobs, 2014)

GABOSHA SITE (Dorps Dam; Figure 6.2)	
WEIR SIZE (million m^3)	**YIELD (million m^3/annum)**
2.2	1.1
2.5	**1.2**
3.0	1.25
3.5	1.30

The 2.5 million m^3 weir (Table 6.4) provides a 98% assurance of supply for the urban demand (based on a historical analysis) and can meet the cross border flow requirements acceptably.

The smaller sized weirs cannot meet the urban demand and the cross border flow requirements acceptably (Mallory and Jacobs, 2014).

6.5.2 Thole Site

Table 6.5 provides the historical yields at the Thole Site (Figure 6.2) for different weir sizes and the EWR.

Table 6.5: Historical yields at the Thole Site for different weir sizes with EWR (taken from Mallory and Jacobs, 2014)

THOLE SITE (Figure 5.2)	
WEIR SIZE (million m^3)	**YIELD (million m^3/annum)**
1.6	0.8
1.8	**1.2**
2.0	1.5
2.5	2.3
3.0	3.1

The 1.8 million m^3/annum sized weir (Table 6.5) is the smallest weir that can provide a 98% assurance of supply for urban demand and the minimum cross-border flows.

6.5.3 W5H025 Site

Mallory and Jacobs (2014) conducted a similar exercise with regards to the W5H025 Site located in the Usuthu River (Figure 6.2). It was however found that a very large dam would be required at this point to produce any yield. This is due to the large upstream dams (Westoe and Churchill) that retain all the water upstream of this site with little or no compensation releases (Mallory and Jacobs, 2014).

6.5.4 Conclusion

The W5H025 site located in the Usuthu River (Figure 6.2) was discarded from any further investigation as it is not suitable for a dam due to the massive upstream abstractions.

From a hydrological perspective, the Thole Site (Figure 6.2) would be the best option (Mallory and Jacobs, 2014). However, Mallory and Jacobs (2014) indicated that the terrain of the Gabosha Site (Figure 6.2) is better suited to the construction of a weir/dam as the valley sides are much steeper than those found in the Thole River valley. It was further indicated that a larger dam at the Gabosha Site could be more cost effective than a smaller dam at the Thole Site.

6.6 Type of dam construction

Based on the above-mentioned, Mallory and Jacobs (2014) indicated that building a larger weir or small dam at the Gabosha Site (Figure 6.2) would only provide temporary relief in view of the current problem experienced at the Dorps Dam (i.e. the dam is silted up).

Mallory and Jacobs (2014) indicated two options to solve this problem namely:

- Building a much larger dam to accommodate for example 20 years of silt;
- Building a so-called sand dam.

6.6.1 Dam with 20 years of sediment/silt

Two options at both the Thole and Gabosha Sites (Figure 6.2) were investigated namely:

- Option 1: assumes 1.09 million m^3/annum water being supplied – future water requirement of Amsterdam;
- Option 2: assumes 0.74 million m^3/annum water being supplied – it was assumed that the water requirement will not be constant throughout the year but vary with a higher demand being placed on the system in summer (Mallory and Jacobs, 2015).

Table 6.6 provides the dam sizes required allowing for 20 years of sediment/silt.

Table 6.6: Yield results with regards to the Dam with 20 years silt options (taken from Mallory and Jacobs, 2015a)

DAM WITH 20 YEAR SILT/SEDIMENT			
SITE	**YIELD AT 98% ASSURANCE (million m^3/annum)**	**20 YEAR SILT VOLUME (m^3)**	**FULL SUPPLY CAPACITY (million m^3)**
Thole (Figure 6.2)	1.09	131 000	0.97
	0.74	100 000	0.55
Gabosha (Figure 6.2)	1.09	116 000	1.60
	0.74	95 000	0.51

Alternative 1a: A 20 year silt dam in the Thole River

Alternative 1a allows for a new dam and abstraction facility at a new abstraction point in the Thole River (Figure 6.2).

The dam would have a full supply capacity of 0.55 M m^3 allowing for a 20 year silt volume estimated to be 100 000 m^3 (Table 6.6). This option allows for 0.15M m^3/a (0.41 Ml/d) of the Thole River to be augmented with 0.74Mm^3/a (2.03Ml/d) from the new storage dam. This would entail the provision of a new water abstraction pump station from where raw water would be pumped to the Amsterdam WTWs.

ALTERNATIVE 1a: A 20 YEAR SILT DAM IN THOLE RIVER		
Infrastructure requirements	**Size**	**Quantity**
New Dam with 20 years of silt	0.55M m^3	1
Raw Water Pipeline (Rising Main) – Usutu River to Amsterdam WTW (PLa)	315mm uPVC Class 12	4100m
Raw Water Pumpstation – Thole River to Amsterdam WTW (PS1)	61 l/s @ 108m	86 Kw
Refurbish weir/Dorps Dam	2 Ml/day	1
Upgrade existing Raw Water Pipeline – Gabosha River to Amsterdam WTW (PL2)	160mm uPVC Class 9	500m
Raw Water Pumpstation – Gabosha River to Amsterdam WTW (PS2)	11 l/s @ 48m	6 kW
Amsterdam WTW – 7 Ml/day	Existing sufficient	0
Amsterdam Storage Facility – upgrade from current 2.25 Ml/d to 4 Ml/d	2 Ml Concrete	2000 kl

Alternative 1b: A 20 year silt dam in the Gabosha River

Alternative 1b is similar to Alternative 1a with the new dam and abstraction facility at the new abstraction point in the Gabosha River. The dam will have a full supply capacity of 0.51Mm^3 allowing for a 20 year silt volume estimated to be 95 000m^3 and a 98% yield assurance of 0.74Mm^3/a (Table 6.6).

ALTERNATIVE 1b: THOLE RIVER/GABOSHA RIVER		
Infrastructure requirements	**Size**	**Quantity**
New Dam with 20 years of silt – Gabosha River	0.51M m^3	1
Realign Provincial Road – R65	3.6 lane widths	1000m
Refurbish weir/Dorps Dam	2 Ml/day	1
Upgrade existing Raw Water Pipeline – Gabosha River to Amsterdam WTW (PL2)	160mm uPVC Class 9	500m
Raw Water Pumpstation – Gabosha River to Amsterdam WTW (PS2)	61 l/s @ 48m	38 kW
Amsterdam WTW – 7 Ml/day	Existing sufficient	0
Amsterdam Storage Facility – upgrade from current 2.25 Ml/d to 4 Ml/d	2 Ml Concrete	2000 kl

Alternative 1b was discarded as the proposed dam site would have resulted in the flooding of the existing R65 provincial road requiring the re-routing of this road.

6.6.2 Sand dam

Mallory and Jacobs (2014) recommended the Sand Dam concept in view of the high silt load in the Usuthu catchment and the relatively small size of storage envisaged. This concept works well where the sediment consists mostly of sand, as in the case of the Usuthu catchment.

Sand dam concept (Mallory and Jacobs, 2014): During construction, abstraction pipes with specially designed inlet nozzles are laid in the river bed within the dam basin. Water will then be abstracted from the sand in the same way as a sand filter. Since sand is relatively porous, with approximately 35% voids, significant volumes of water will still be stored in a sand dam. The added advantage is that water abstracted from such a dam will already have a very low turbidity and only chlorination will be required.

Table 6.7 provides an indication of the recommended dam sizes (allowing for full sediment accumulation) at both the Thole and Gabosha Sites (Figure 6.2).

Table 6.7: Required Sand Dam size at the Thole and Gabosha sites – with EWR and minimum cross-border flows (taken from Mallory and Jacobs, 2014)

DAM	DAM SIZE (million m^3)
Gabosha	7.5
Thole	5.4

As indicated in Table 6.7, the construction of larger dams will be required but this will ensure a long-term sustainable solution. An alternative is to allow for the raising of the dam wall in future.

Two sand dam options at both the Thole and Gabosha Sites (Figure 6.2) were investigated namely

- Option 1: assumes 1.09 million m^3/annum water being supplied;
- Option 2: assumes 0.74 million m^3/annum water being supplied.

Table 6.8 provides the yield results with regards to the above-mentioned options.

It should be noted that Mallory and Jacobs (2015) made the following assumptions in modelling the sand dam options:

- The porosity of the sand is 30%;
- Evaporation from the surface of the dam decreases linearly from full evaporation when the dam is full down to zero evaporation when the water level in the dam is 8m or less than the full supply level. The reduced evaporation loss is one of the benefits of a sand dam.

Table 6.8 provides an indication of the sand dam size required when the EWR and only 19% of the minimum cross-border flows are taken into account.

Table 6.8: Sand Dam Size with regards to Option 1 and Option 2 (taken from Mallory and Jacobs, 2015a)

SITE	YIELD AT 98% ASSURANCE (million m^3/annum)	FULL SUPPLY CAPACITY (million m^3)
Thole River (Sand dam)	1.09	2.0
	0.74	1.1
Gabosha River (Sand Dam)	1.09	3.0
	0.74	1.2

As indicated in Table 6.8, the sand dam options at both sites require a significantly larger structure to be built and will thus be much more costly options.

6.6.3 Conclusion

Mallory and Jacobs (2015; 2015b) indicated that allowing for 20 years of sediment is more favourable than constructing a sand dam as this would result in a smaller and less costly dam as indicated in Table 6.6. The disadvantage is however the reduced lifespan of the smaller dam.

In addition, Afri-Infra (2016) indicated that **the sand dam option was discarded in view of the following:**

- The analysis of a sand dam was based on sand porosity of 30% which may be less in practical applications;
- A high level of maintenance will be required on inflow pipework to prevent siltation and blockages;
- Availability of resources for intensive maintenance actions may be a challenge.

Based on the above-mentioned, it was decided to pursue the 20 year silt/sediment dam option within the Thole River as well as the Gabosha River (i.e. a new site).

6.7 Additional 20 year silt/sediment dam sites

Two additional sites with regards to the 20 year silt/sediment dam were investigated namely:

- Thole dam site located downstream of the confluence of the Thole and Gabosha Rivers (Figure 6.3) i.e. Dam Site A;
- Gabosha dam site located on the Gabosha River about 1.3 km north of the R65 road and upstream of the Dorps Dam (Figure 6.3) i.e. Dam Site B.

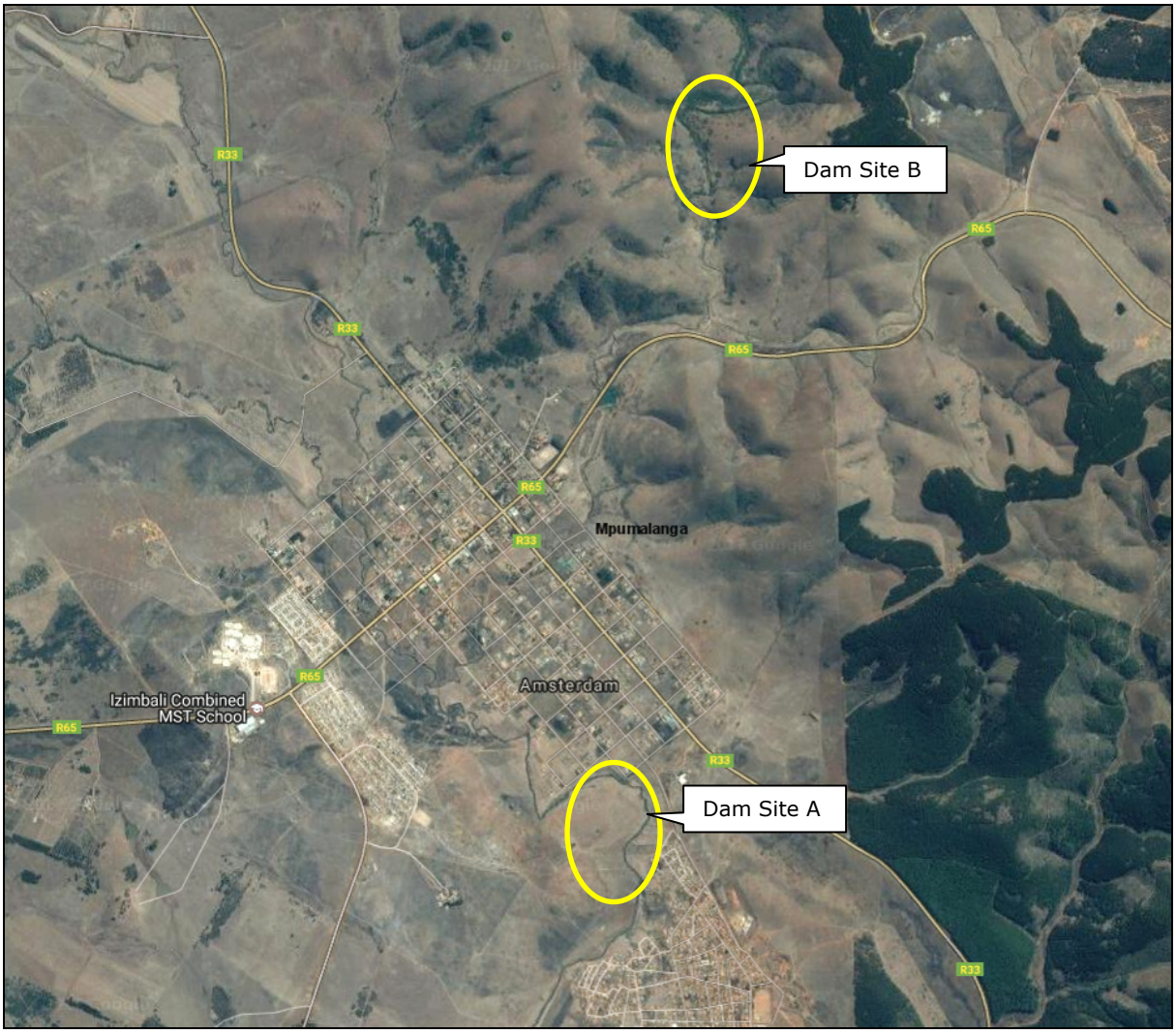

Figure 6.3: Dam Site A in the Thole River and Dam Site B in the Gabosha River

Table 6.9 provides the dam sizes required allowing for 20 years of sediment/silt at Dam Site A and Dam Site B.

Table 6.9: Dam sizes at Dam Site A and Dam Site B (taken from Mallory and Jacobs, 2015a)

SITE	YIELD AT 98% ASSURANCE (million m^3/annum)	FULL SUPPLY CAPACITY (m^3)	ALLOWANCE FOR SILT/SEDIMENT INCLUDED (m^3)
Thole River (Dam Site A)	0.74	465 000	105 000
Gabosha River (Dam Site B)	0.74	680 000	80 000

As part of the scoping phase, a desktop assessment of Dam Site A and Dam Site B was conducted of which the results are indicated in Table 6.10.

From this desktop assessment, it was apparent that Dam Site B would have a much higher Ecological Sensitivity than Dam Site A in view of less impacts

and the location away from the residential areas of Amsterdam and KwaThandeka. From an ecological point of view, the Dam Site B is seen as having a High Ecological Sensitivity (Niemand and Venter, 2017a).

According to Kotze (2017) there is no clear cut decision when comparing proposed Dam Site A (Thole River) and Dam Site B (Gaboshe River) in terms of its impact on the aquatic fauna component:

- The migratory impact of Dam Site A will be notably higher than Dam Site B, therefore opting for Dam Site B in this regard.
- The Gabosha River reach is currently in a better present ecological state (Ecostatus) than the Thole River. The general approach would therefore be to recommend that the more deteriorated river is considered for development and the more pristine reach conserved, hence pointing towards Dam Site A as the preferred option.
- Higher fish diversity in the Thole River than the Gabosha River indicates that more species may be impacted directly as a result of Dam Site A than Dam Site B.

However, it is apparent that the proposed Dam Site A (located in the Thole River) would have a greater socio-economic impact on the local community than the proposed Dam Site B (located in the Gabosha River). A few houses, gravel roads, footpaths and pieces of agricultural land would be flooded. The construction of the dam within the Thole River could also impact on the downstream users (e.g. irrigation farmers; etc.). In addition, in the long term the water quality could be impacted in view of its close proximity to residential areas, an existing landfill site, bulk sewer line, etc. This could ultimately impact on water treatment costs and the provision of potable water to the residents of Amsterdam. **It was therefore felt that Dam Site A was not suitable for a long term water supply dam in view of the potential pollution risk. In addition, the pumping of water to the Amsterdam WTWs would have resulted in ongoing and ever increasing operational costs (Mallory, 2017).**

Proposed Dam Site B would provide the more natural dam site in view of the topography of the site resulting in a reduced area being inundated by the proposed dam and thus a reduced impact on the natural environment. In view of the lack of activities taking place in the upstream area, the said site would be less prone to sedimentation and potential impacts on water quality in the long term. The downstream area has however already been impacted in terms of the existing Dorps Dam, existing abstraction from the Dorps Dam and the residential area of Amsterdam and is thus not pristine. In addition, a much shorter raw water pipeline (approximately 2175m in length) to the existing Amsterdam Water Treatment Works would be required thus reducing overall costs. An alternative is to release water directly into the Gabosha River downstream of Dam Site B and to abstract water at the existing Dorps Dam abstraction point.

In addition, Mallory and Jacobs (2016) indicated that Dam Site B had the following advantages:

- it is located upstream of Amsterdam;
- less water use upstream of the dam site;
    - water use upstream appears to be limited to a small area of forestry which is estimated to reduce the natural runoff into the dam by 0.49 million m^3/annum;
    - irrigation upstream of the site appears to be negligible;
- smaller catchment less prone to sedimentation;

- smaller dam size: 510 000m^3;
- less costly to construct;
- water can be supplied under gravity hence saving on pumping costs.

As indicated in Section 6.3.2, in times of water shortages the yield of the Gabosha River is augmented from Westoe Dam via the bulk link pipeline between Westoe Dam and Jericho Dam. Dam Site B is ideally placed in terms of benefitting from this augmentation system.

In view of the above-mentioned and from a water resource management perspective, the proposed Dam Site B is the more preferable option to pursue.

Table 6.10: Comparison between Dam Site A and Dam Site B (updated).			
DAM SITE A (Thole River)		**DAM SITE B (Gabosha River)**	
GEOLOGY/GEOTECHNICAL ASPECTS			
The construction of Dam A would impact on ultrabasic rocks, pyroxenite and norite of the Suite Thole. The site is not affected by dolomites or mining (i.e. opencast or underground). A strong spring is present on the eastern flank of the Thole River almost on the proposed dam wall axis – this could affect the stability of the embankment dam.	X	The construction of Dam B would impact on pyroclastic rocks and ash-flow tuff of the Gobasha Member, Amsterdam Formation. Dykes might be present in areas. The said site is not affected by dolomites or mining (i.e. opencast or underground). According to the engineers, a large rock face and rocky outcrops are present where a dam wall can be constructed making it a more natural dam.	√
TOPOGRAPHY			
The construction of Dam A would impact on a valley located between low hills (i.e. terrain type Level Plains with some relief). In view of this flatter topography, a much larger dam (full supply capacity of 550 000m^3) will be required which will result in a greater area being inundated. This could result in the flooding of the surrounding areas namely the residential area of KwaThandeka, agricultural activities (cultivated lands), excavations, roads, etc.	X	The construction of Dam B would impact on a valley surrounded by very rugged topography (i.e. terrain type Open High Hills or Ridges). The terrain of the Gabosha River is better suited as the valley sides are much steeper than those found in the Thole River valley. A smaller dam (full supply capacity of 510 000m^3) would thus be required within this system which would result in the inundation of a smaller area (Mallory and Jacobs, 2015). Very little, if any, impact on topography has taken place within the proposed Dam Site B area due to the ruggedness of the topography.	√
SOILS/LAND CAPABILITY/AGRICULTURAL POTENTIAL			
The construction of Dam A would impact on red and yellow soils with low to medium base status, land type Ac and **Moderate potential arable land**. It would also impact on an area used for grazing (grazing potential of less than 4ha/animal unit) and cultivation purposes (fenced vegetable gardens) by local residents. Increased upstream activity results in greater sedimentation within the Thole River that will impact on the proposed dam. In addition, wetland soils associated with the Thole River would be impacted upon.	X	The construction of Dam B would impact on shallow soils (Glenrosa and/or Mispah soil forms) with minimal development potential and indicated as **Non-arable with low to moderate potential grazing land** (less than 4ha/animal unit). No cultivation would be impacted upon in view of the rocky nature of the area. Less sedimentation of the Gabosha River due to less upstream activities. No wetland soils are associated with the Gabosha River.	√

Table 6.10: Comparison between Dam Site A and Dam Site B (updated).			
DAM SITE A (Thole River)		**DAM SITE B (Gabosha River)**	
LAND USE			
Dam Site A property ownership: Re/11/408IT - belongs to the Mkhondo Local Municipality.	√	Dam Site B property ownership: Re/11/408IT - belongs to the Mkhondo Local Municipality.	√
Proposed Dam Site A is located downstream of the residential area of Amsterdam and adjacent to the residential area of KwaThandeka. The construction of Dam A would impact on the following: • An existing sewer line (sewer line will have to be relocated, which may not be possible or would result in added costs and the installation of pump stations, etc.). • Existing houses resulting in residents having to be relocated and compensated (long process to be followed and added costs). • Existing informal settlements and smallholdings; • Existing approved residential areas (areas not developed to date). • Agricultural activities – cultivated lands, communal grazing lands, vegetable gardens, etc. • Access roads and footpaths used by the community to cross the Thole River.	X	Proposed Dam Site B is located upstream of the Dorps Dam and the residential area of Amsterdam. The construction of Dam B would not impact on any infrastructure or servitudes. The construction of Dam B would not impact on the following: • Existing sewer lines; • Existing houses; • Approved residential areas; • Agricultural activities: cultivated lands and communal grazing land (if any, limited impact). • Afforestation; • Mining areas; • Footpaths may be present but are not used on a daily basis. There is a road located along the river of which the use is not known.	√
NATURAL VEGETATION			
The construction of Dam A would impact on KaNgwane Montane Grassland (GM16), classified as Vulnerable in terms of the National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004). In addition, the construction of Dam A would impact on the Thole River, associated wetlands and aquatic environment.	X	The construction of Dam B would impact on KaNgwane Montane Grassland (GM16), classified as Vulnerable in terms of the National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004). In addition, the construction of Dam B would impact on the Gabosha River, associated aquatic environment.	X
Dam Site A occurs within a: • Critical Biodiversity Area (CBA) (C-Plan, 2006); • Critical Biodiversity Area (CBA) Optimal (Mpumalanga Biodiversity Sector Plan, 2013);	X	The proposed Dam B site occurs within a: • Critical Biodiversity Area (CBA) (C- Plan, 2006); • Critical Biodiversity Area (CBA) Irreplaceable and CBA Optimal (Mpumalanga Biodiversity Sector Plan,	X

Table 6.10: Comparison between Dam Site A and Dam Site B (updated).			
DAM SITE A (Thole River)		**DAM SITE B (Gabosha River)**	
• Critical Biodiversity Area (CBA) - Aquatic Rivers (Mpumalanga Biodiversity Sector Plan, 2013).		2013); • Critical Biodiversity Area (CBA) - Aquatic Rivers (Mpumalanga Biodiversity Sector Plan, 2013).	
In addition, the grassland areas could provide possible habitat for 7 Red data plant species.	X	In addition, the grassland areas could provide possible habitat for 7 Red data plant species.	X
The construction of Dam A could impact on the following vegetation units: Montane Grassland, Modified Grassland, Weedy Grassland, River, Channeled Valley Bottom (CVB), Seep wetland. Although the vegetation is disturbed due to grazing and nearby development, the plant species diversity is still high and the Ecological Sensitivity moderate to high.	X	The construction of Dam B could impact on the following vegetation units: Indigenous Woody, Invasive Woody, Montane Grassland, Modified Grassland, Weedy Grassland, River, Drainage lines. Indigenous Woody vegetation is present on the hillslopes surrounding Dam Site B. The vegetation is fairly dense and has a high floristic species diversity. Patches of invasive woody vegetation is present in the valley bed and slopes at Dam Site B. The dam will therefore flood large portions affected by invasive vegetation establishment. Species of Conservation Importance could be present in either the Montane Grassland or the Indigenous Woody vegetation units although none were noted. From an ecological point of view, Dam Site B is seen as having an Ecological Sensitivity of low to high in places.	X
ANIMAL LIFE			
Red data fauna species: Possible habitat provided by the grassland areas and the Thole River for 14 mammal taxa of conservation concern.	X	Red data fauna species: Possible habitat provided by the grassland and woody areas and the Gabosha River for 14 mammal taxa of conservation concern.	X
Bird species: 21 threatened and near threatened bird species, 5 of which could be directly impacted.	X	Bird species: 21 threatened and near threatened bird species, 5 of which could be directly impacted.	X
Does not occur in an Important Bird and Biodiversity Area but it does provide for a number of biome-restricted species with high affinities to the Afrotropical highlands. Occurrence of Biome-restricted bird species: High	X	Does not occur in an Important Bird and Biodiversity Area but it does provide for a number of biome-restricted species with high affinities to the Afrotropical highlands. Occurrence of Biome-restricted bird species: High	X
SURFACE WATER/SENSITIVE LANDSCAPES			
The construction of Dam A would impact directly on the Thole River, associated wetland and aquatic environment.	X	The construction of Dam B would impact directly on the Gabosha River and associated aquatic environment. No	X

Table 6.10: Comparison between Dam Site A and Dam Site B (updated).			
DAM SITE A (Thole River)		**DAM SITE B (Gabosha River)**	
		wetlands were identified at Dam Site B by Venter and Niemand (2017).	
The Thole River is indicated as Critical Biodiversity Areas: Rivers and the surrounding areas Ecological Support Areas (ESAs): Important subcatchments in the freshwater assessment of Mpumalanga Biodiversity Sector Plan (2013). It is thus seen as important from an aquatic point of view.	X	The Gabosha River is indicated as Critical Biodiversity Areas: Rivers and the surrounding areas Ecological Support Areas (ESAs): Important subcatchments in the freshwater assessment of Mpumalanga Biodiversity Sector Plan (2013). It is thus seen as important from an aquatic point of view.	X
For sub-quaternary reach W53C – 1679 of the Thole River in which the proposed Dam A Site would be located, the following is applicable: • Present Ecological Status (PES) is estimated as moderately modified (Category C), • Ecological Importance is High; • Ecological Sensitivity is Very High (Kotze, 2016).	X	The Gabosha River is a tributary draining into sub-quaternary reach W53C-1679 and is anticipated to have a much higher PES (Category A or B) than the Thole River in view of less impacts.	X
The construction of the dam will impact on the Thole River and its downstream environment where irrigation is the major water use (Mallory and Jacobs, 2015). Irrigation farmers could object to the proposed dam construction.	X	The construction of the dam will impact on the Gabosha River and its downstream environment which is already impacted in terms of the Dorps Dam, residential area of Amsterdam, etc. No irrigation from the Gabosha River takes place.	√
The Thole River has a larger catchment with more upstream water use and stream flow reduction activities making it more prone to sedimentation (Mallory and Jacobs, 2015) which would impact on the proposed dam.	X	Gabosha River has a smaller catchment and less upstream water use and stream flow reduction activities making it less prone to sedimentation (Mallory and Jacobs, 2015) and result in less impact on a proposed dam.	√
In the long term, Dam A could be impacted in terms of the following emanating from the surrounding area: • Contaminated runoff from the residential areas of Amsterdam and KwaThandeka (e.g. sewage, waste, etc.); • The unrehabilitated Amsterdam Waste Disposal Site located on the western side of the proposed Dam Site A. This would impact on the water quality of the dam and the operational costs in terms of the WTWs. The potential risk	X	Dam Site B is located away from residential areas and no cultivation, afforestation, mining, etc. takes place. The risk in terms of potential pollution is therefore minimal.	√

Table 6.10: Comparison between Dam Site A and Dam Site B (updated).			
DAM SITE A (Thole River)		**DAM SITE B (Gabosha River)**	
in terms of pollution of Dam A is thus High.			
GROUNDWATER:			
The construction of Dam A would impact on groundwater associated with the Thole River and associated wetlands. It would also impact on a fountain/spring present on the eastern side of the proposed dam wall site. Potential sources of groundwater pollution within the surrounding area which in the long term could impact on Dam A include: • Contaminated runoff from the residential areas of Amsterdam and KwaThandeka (e.g. sewage, waste, etc.); • The unrehabilitated Amsterdam Waste Disposal Site located on the western side of the proposed Dam Site A. The potential risk in terms of pollution of Dam A is thus High.	X	The construction of Dam B would impact on groundwater associated with the Gabosha River. Since the immediate area surrounding the proposed Dam Site B is located away from residential areas and no cultivation, afforestation, mining, etc. takes place, the risk in terms of potential groundwater pollution that would in the long term impact on Dam B is minimal.	√
SITES OF ARCHAEOLOGICAL AND/OR CULTURAL INTEREST			
A spring on the eastern flank of Thole River could be of cultural significance to the community and the destruction thereof could result in objections from the community.	X	No sites of archaeological and/or cultural interest are known to be present at the proposed Dam Site B.	√
PALAEONTOLOGICAL SENSITIVITY			
At the proposed Dam Site A, the impact on palaeontology is Moderate as fossil resources (shale) may be impacted.	X	Dam Site B is indicated as having a low palaeontological sensitivity.	√
SOCIO-ECONOMIC ISSUES			
Located adjacent to KwaThandeka residential area - safety risk in terms of people and animals drowning due to the presence of the water body.	X	No residential areas located near site and therefore a very low risk of people and animals drowning due to the presence of the water body.	√
Located adjacent to KwaThandeka residential area - risk in terms of theft and vandalism of infrastructure (e.g. pump station, etc.)	X	Located away from residential areas and therefore a reduced risk of theft and vandalism of infrastructure.	√
The dam and the water resource could be affected by	X	No residential development is located in close proximity	√

Table 6.10: Comparison between Dam Site A and Dam Site B (updated).			
DAM SITE A (Thole River)		**DAM SITE B (Gabosha River)**	
activities associated with the existing developed areas namely, storm water runoff, sewage overflows, dumping of waste, etc. This could result in a negative impact on the water quality and result in greater costs in terms of treating the said water. In addition, the quality of the water could also be affected in terms of seepage/runoff from the existing landfill site located within the catchment of the proposed dam. This could have a long term impact on the water quality and thus the water supply dam.		thereof or upstream of the proposed site and therefore the dam and the resultant water resource will not be negatively impacted in terms of storm water runoff, sewage overflows/runoff, dumping of waste, etc. The water quality of this dam will thus be of a much better quality. No landfill site is known to be located within the upstream area of the proposed dam site which could impact on the water quality of the proposed dam. In the long term, the water quality should not be impacted resulting in reduced operational costs in terms of the Amsterdam Water Treatment Works.	
Agricultural activities located 4.5 km downstream, which could be impacted in terms of reduced water flow during filling of dam and future abstraction (especially irrigation farmers).	X	No agricultural activities located directly downstream of site (closest = 12km downstream; fed by additional water from other tributaries).	√
Houses located adjacent to the proposed Dam Site A, which stand a risk of being flooded. People would have to be relocated.	X	No houses located near proposed Dam Site B.	√
The said site is crossed by residents on a regular basis via gravel roads and footpaths.	X	People were noted crossing Dam Site B with donkey carts using the informal gravel road in order to chop wood in the area.	X

Legend: X = Negative; √ = Positive.

6.8 Dam Site B (new site in Gabosha River)

6.8.1 Yield analyses of various dam options

As indicated in the preceding sections, yield analyses in terms of several dam options were conducted. These analyses were aimed at determining the required size of dam to meet the known water demand. The water demand used in all yield analyses was 0.74 million m^3/annum. Table 6.11 provides a summary of the results of the yield analyses.

Table 6.11: Results of yield analyses (taken from Mallory, 2017)

OPTION	ESTIMATED YIELD AT 98% ASSURANCE (million m^3/annum)	FULL SUPPLY CAPACITY (million m^3)	ESTIMATED 20 YEAR SEDIMENT VOLUME (million m^3)
Thole (no dam)	0.15	0	N/A
Gabosche 1 (no dam)	0.14	0	N/A
Thole	0.74	0.55	0.100
Gabosche 1	0.74	0.51	0.095
Thole Sand Dam	0.74	1.10	N/A
Gabosche Sand Dam	0.74	1.20	N/A
Amsterdam Weir	0.74	0.47	0.110
Gabosche 2 (Dam Site B)	0.74	0.68	0.080

6.8.2 Updated full supply capacity

Mallory (2017) performed an updated analysis of the preferred option, namely the upstream site in the Gabosha River (i.e. Dam Site B). In this case, the WR2012 hydrology was used which indicated a significant increased runoff when compared with the WR2005 hydrology (Table 6.12).

Table 6.12: Hydrology and catchment information for the Gabosha River site (i.e. Dam Site B) (taken from Mallory, 2017)

CATCHMENT	ANALYSIS	CATCHMENT AREA (km^2) (incremental)	MEAN ANNUAL RUNOFF (million m3/a) (1950 to 1993)	
			Natural (cumulative)	Present Day (present day)
W53C	WR2005	316.0	30.3	27.8
	WR2012	316.0	35.2	32.7
Gaboshe 2 (Dam Site B)	WR2005	52.6	4.8	4.3
	WR2012	52.6	5.6	5.1

Legend: WR27005 = Middleton and Bailey, 2008; WR2012 = Bailey and Pitman, 2015.

As indicated in Table 6.12, the WR2012 hydrology is significantly higher than the WR2005 hydrology. The yield of the recommended option, namely the alternative dam site on the Gabosha River (Dam Site B) was therefore updated.

Based on the significantly increased natural runoff (4.8 to 5.6 million m^3/annum; Table 6.12), a dam with a full capacity of 450 000m^3 is now recommended (Mallory, 2017). Mallory (2017) indicated that this reduced full supply capacity allows for 70 000m^3 of sediment deposition over 20 years.

Previously, based on the WR2005 hydrology a full supply capacity of 680 000m^3 was recommended (see Table 6.9; Table 6.11).

6.8.3 Evaluation of existing water uses

6.8.3.1 Upstream water uses

As indicated in Table 6.13, the existing upstream water use is very limited and consists of irrigation and streamflow reduction due to commercial afforestation. The domestic water use referred to in Table 6.13 is the current estimated water requirement of Amsterdam.

Table 6.13: Existing water use upstream of dam site evaluated (taken from Mallory, 2017)

Quaternary Catchment/ Dam site	Water use (million m^3/annum)		Streamflow reduction (million m^3/annum)	
	Domestic	Irrigation	Forestry	Invasive alien plants
W53C	0.6	0.905	2.11	1.80
Gabosche 2 (Dam Site B)	0.6	0	0.47	0.19

6.8.3.2 Downstream water uses

Mallory (2017) evaluated the following two potential downstream impacts as a result of the proposed dam:

- downstream users;
- cross border flows into Swaziland.

Downstream users

Mallory (2017) indicated that other than the water use in the town of Amsterdam (to be supplied with water from the proposed new dam), there is very little water use downstream of the proposed dam.

According to Mallory (2017), there is an area of approximately 30 ha of irrigation (Figure 6.4a) that could be slightly impacted by the proposed dam. The said 30 ha of irrigation was simulated in the updated model and it was found that these irrigators enjoy a very high assurance of supply. According to Mallory (2017), these irrigators also benefit from return flows from the Amsterdam Waste Water Treatment Works which increases low flows. Pivot irrigation is also evident further downstream as indicated in Figure 6.4b.

Figure 6.4a: Irrigation downstream of Amsterdam on the Thole River (taken from Mallory, 2017).

Figure 6.4b: Pivot irrigation downstream of Amsterdam on the Thole River visible on Google aerial view

Cross border flows

Mallory (2017) indicated that South Africa is committed to ensuring the following flows from the Ngwempisi River into Swaziland as documented in the IncoMaputo Water Sharing Agreement:

- 30 million m^3/annum on average;
- 0.1 m^3/s minimum.

According to Mallory (2017), the Ngwempisi River catchment up to the Swaziland border consists of 4 quaternary catchments (W53A, W53B, W53D; Figure 6.5) and a third of the W53E quaternary catchment with a total area of about 1 540 km^2. Figure 6.6 provides a schematic diagram of the Ngwempisi River catchment and its various components.

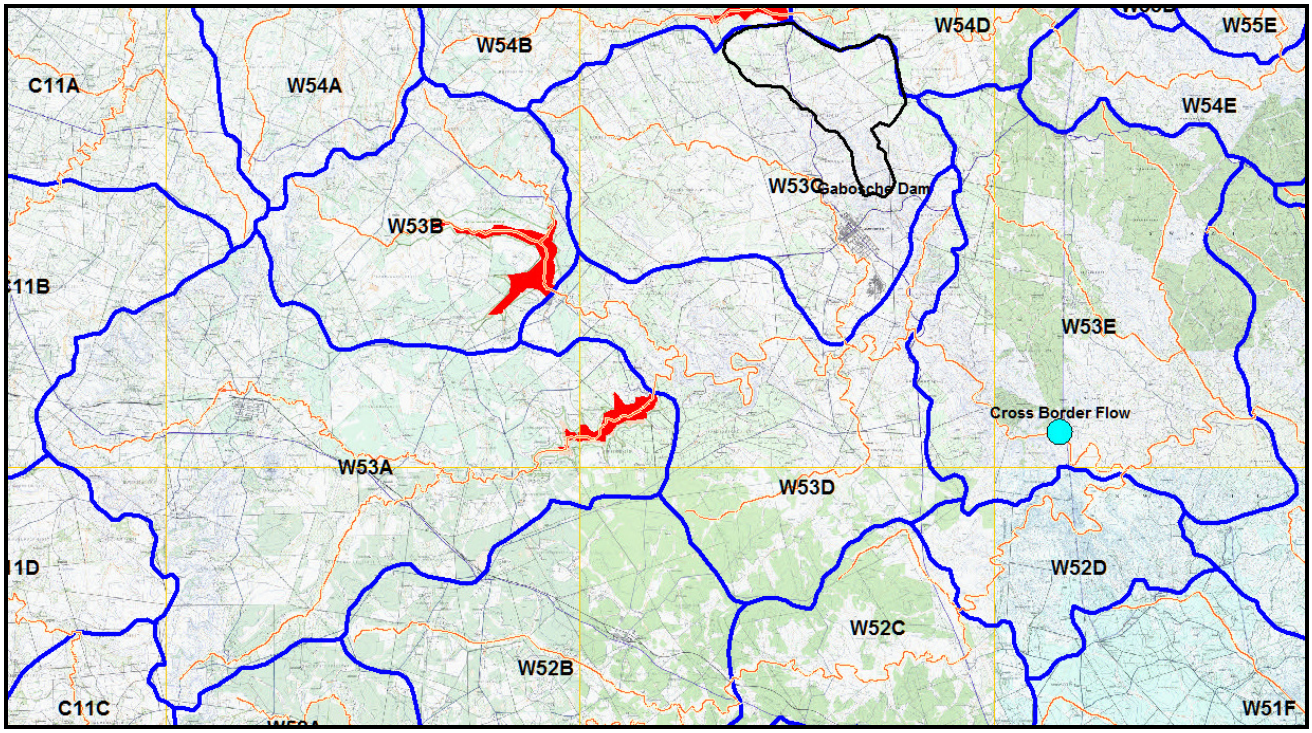

Figure 6.5: Cross border flows relative to the proposed Gabosche Dam (taken from Mallory, 2017)

Comparing the total Ngwempisi River catchment (1 540 km^2) to the catchment area of 53 km^2 (Table 6.11) of the proposed dam on the Gabosha River (i.e. Dam Site B), the impact of the new dam relative to the rest of the catchment is negligible.

Mallory (2017) indicated that the intention is nevertheless to make an ecological release (see Ecological Water Requirements) from the Gabosha Dam which will also serve as this development's contribution to cross border flows.

According to Mallory (2017), the updated water resources simulation of the entire Ngwempisi catchment (Figure 6.6) indicates that the minimum cross border flow is only violated twice over a simulation period of 85 years while the average cross border flow is estimated at 53 million m^3/annum. This simulation assumes no release from either the Morgenstond or Jericho dams (Figure 6.6). Mallory (2017) suggested that should the minimum cross border flows be in jeopardy that releases be made from one of these dams.

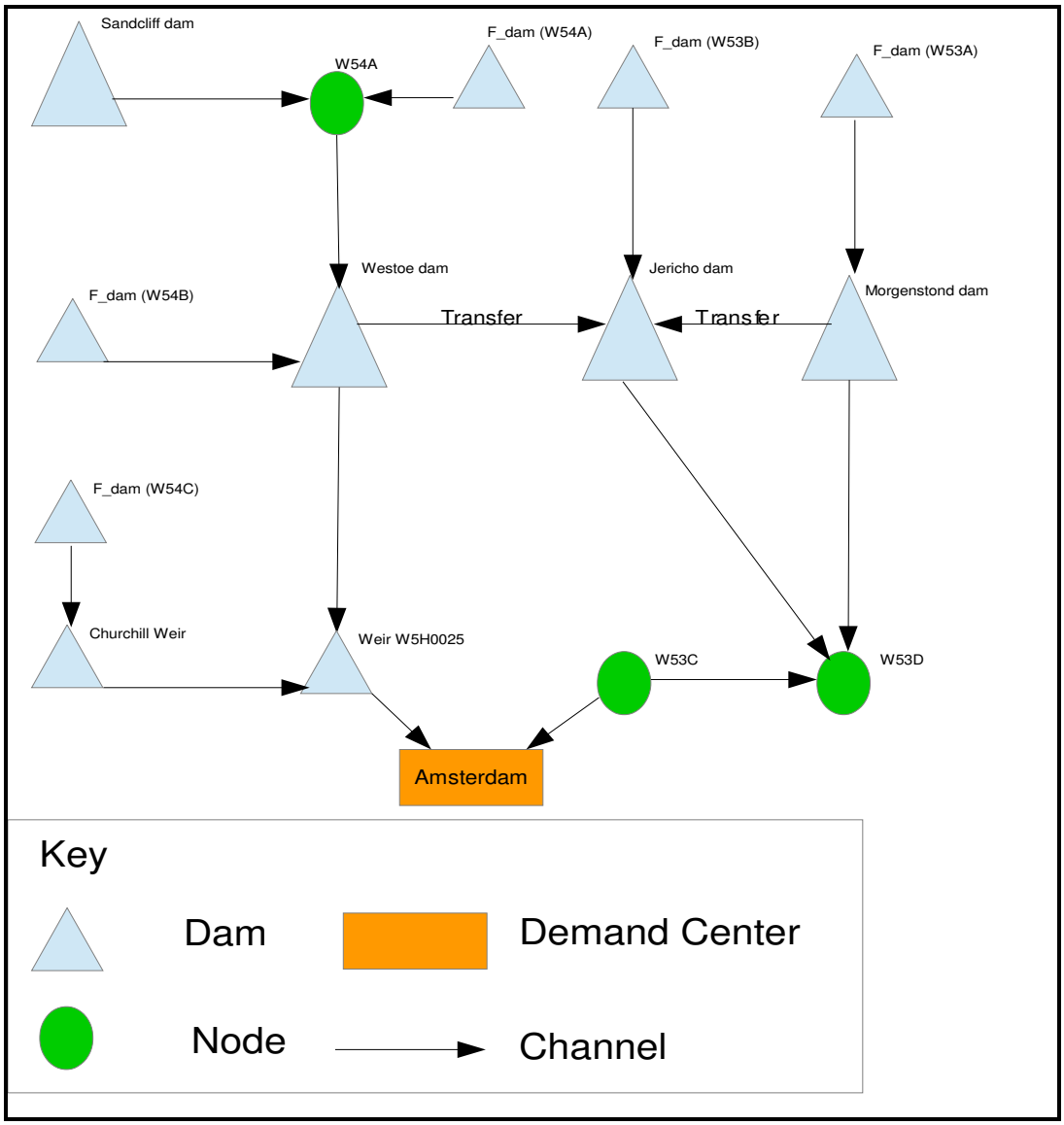

Figure 6.6: System Diagram of the Ngwempisi catchment and water provision to Amsterdam (taken from Mallory, 2017)

Ecological Water Requirements (EWR)

As previously indicated, it is a requirement in terms of South Africa's National Water Act to allow some water to remain in the river to sustain the ecological functioning of the river. This water is referred to as the Ecological Reserve or Ecological Water Requirement (EWR).

The EWR for the W53C catchment was estimated for a C ecological category using the Hughes Desktop model (Hughes and Hannart, 2003). The Rule Curve derived from this process (provided in Appendix A-1 of Appendix 17) is summarised in Table 6.14. According to Mallory (2017), the EWR was called down linearly based on the ration of catchment area for each dam option analysed.

Table 6.14: Summary of Ecological Reserve in terms of MAR (WR2005 hydrology) (taken from Mallory, 2017)

Catchment	MAR (natural)	EWR	
	million m^3/annum	million m^3/annum	% of MAR
W53C	30.3	8.03	26.5
Thole	22.1	5.86	26.5
Gabosche1	6.6	1.75	26.5
Amsterdam Weir	27.9	7.39	26.5
Gabosche 2	4.8	1.27	26.5

With the update of the hydrology to WR2012, it was necessary to recalculate the EWR (Appendix A-2 of Appendix 17).

According to Mallory (2017), the EWR as a percentage of the natural MAR remains at 26.5% (Table 6.14) and hence the EWR, as an annual mean is 1.48 million m^3/annum.

6.8.4 Conclusion

The report by Mallory (2017) summarises all the hydrological and water resource analyses carried out in support of identifying the best option to augment the water supply to the town of Amsterdam. Mallory (2017) indicated the following:

- Storage is definitely required;
- It is not possible to meet Amsterdam's growing water demand from run-of-river abstractions;
- Any of the dam options investigated are hydrologically feasible and hence the choice of dam sites must be based on cost and geological considerations.
- An analysis of the downstream impacts indicates that none of the options will impact on the very limited downstream use.

Mallory (2017) reported that the updated analysis of Dam Site B (using the latest WR2012 hydrology) indicated a dam with a full supply capacity of 450 000m^3 would be required at this site. In addition, Mallory (2017) indicated that an EWR release from this dam would be a fair contribution to cross border flow.

Mallory (2017) further indicated that it is possible that the minimum cross border flow into Swaziland is not being met 100% of the time. According to Mallory (2017), this is due to the Morgenstond and Jericho Dams (Figure 6.6) which were already in place when these cross border flows were determined. Mallory (2017) indicated that should shortages be experienced at the border then small releases could be made from either the Morgenstond or Jericho Dams.

6.9 Dam wall positions at Dam Site B (new site in Gabosha River)

Three alternative dam wall positions were investigated as part of the geotechnical investigation (Meyer, 2017a) namely: Option 1, Option 2 and Option 3 as indicated in Figure 6.7. Table 6.15 provides a comparison between the three alternative dam wall positions.

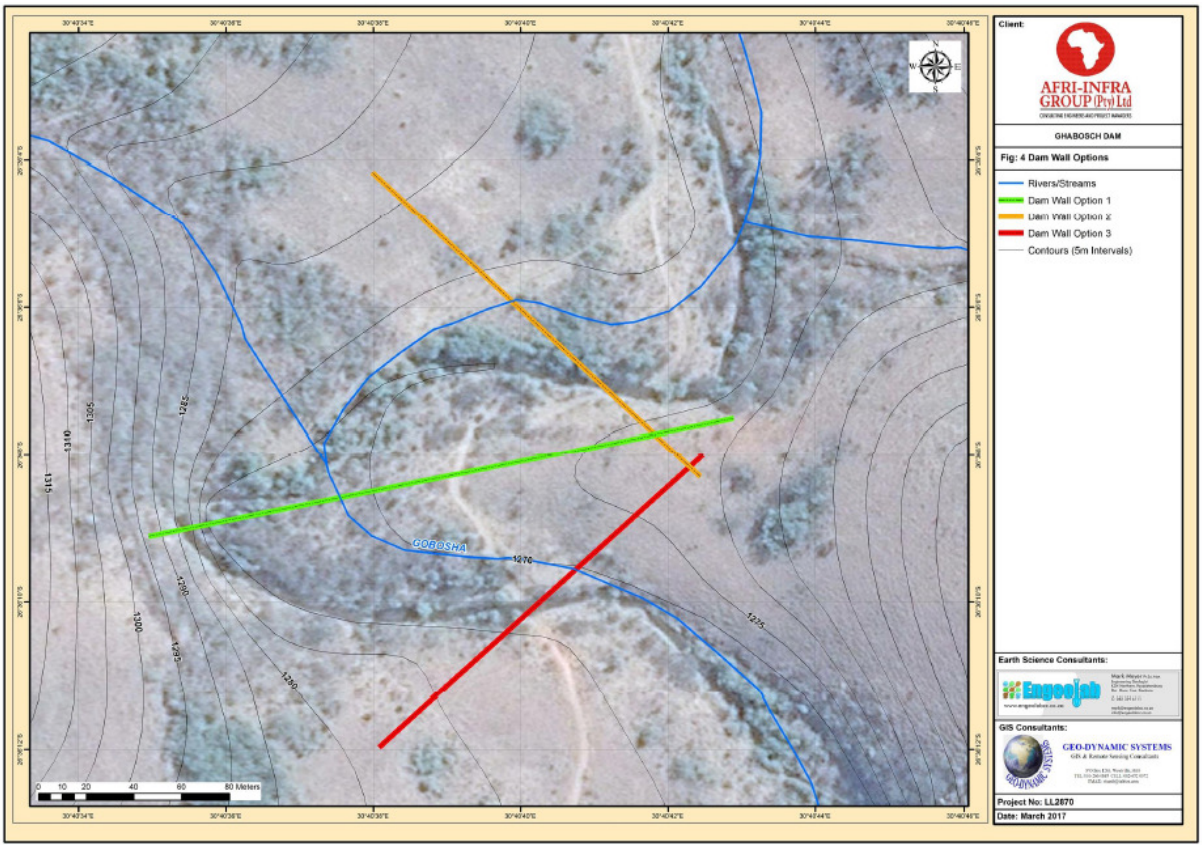

Figure 6.7: Alternative dam wall positions investigated (taken from Meyer, 2017a)

Table 6.15: Comparison of alternative dam wall positions (taken from Meyer, 2017a)

OPTION	POSITIVE	NEGATIVE
Option 1 (Figure 6.7):	• Good rock on both left flank and right flank; • Potential to use a rollcrete dam through the river channel; • Centre spillway; • Left flank rockfill/clay core embankment.	• Difficult excavation and tie-in to the cliff face on the right flank; • Leakage issues through the joint systems on the right flank abutment; • Problems with outflow from spillway – impeded by bend in river immediately downstream; • Poor outflow could increase scour in the stilling basin; • Possible deep palaeochannels beneath the concrete spillway – deep excavations; • Clay core material needed for the embankment.
Option 2 (Figure 6.7):	• Good rock on left flank; • Side spillway in rock on left flank – unlined and flows directly downstream;	• Requires more clay core material than Option 1; • Just upstream of a minor tributary – small loss of catchment (Option 2); • Possible palaeo-channel in the river

OPTION	POSITIVE	NEGATIVE
	• Embankment dam possible – cheaper to construct? Abundant rockfill available. • Would be easier to raise in future.	section; • Unknown rock conditions on the right flank (drilling); • Slightly smaller.
Option 3 (Figure 6.7):	• Good rock on left flank; • Side spillway in rock on left flank – unlined and flows directly downstream; • Embankment dam possible – cheaper to construct? Abundant rockfill available. • Would be easier to raise in future; • Slightly bigger; • Potential shallow rock on right flank.	• Requires more clay core material than Option 1; • Possible palaeo-channel in the river section.

Meyer (2017a) indicated Option 3 as the preferred dam wall position, even though the costs will be slightly higher.

6.10 Dam type selection at Dam Site B

Three dam types with varying spillway lengths were investigated namely:

- Option 1: Earth fill/rock fill wall with protected spillway or side spillway;
- Option 2: Concrete/RCC Central ogee spillway with earth fill on the flanks;
- Option 3: Concrete/RCC for full length of wall with central ogee spillway.

6.10.1 Option 1: Earth fill/rock fill wall with protected spillway or side spillway

Option 1 comprised of an earth embankment dam with a concrete-lined spillway, stilling basin, inlet tower and steel access bridge as indicated in Figure 6.8a. Table 6.16 provides particulars of the Option 1 dam and its basin.

Table 6.16: Particulars of the Option 1 dam and its basin (taken from Afri-Infra, 2017)

PARTICULARS OF DAM AND BASIN	
Type of dam:	Rockfill; Gravity
Maximum wall height: (i.e. the vertical difference between the lowest downstream ground elevation on the outside of the dam wall and the non-overspill crest or the general top level of the dam wall)	27.1m
Crest length of wall:	247 m
Gross storage capacity (estimated):	1 357 000m^3
Area of water surface at full supply level (estimated):	19.5 ha
Maximum full supply water depth (estimated):	19.2 m

Figure 6.8b provides the location of the cross-sections through the proposed Option 1 dam wall while Figure 6.9 provides the following cross-section information namely:

- Cross-section A indicates the earth-fill and steel access bridge;
- Cross-section B indicates the steel access bridge, concrete pillars, concrete spillway and stilling basin;
- Cross-section C indicates the inlet tower, concrete spillway and spilling basin.
- Cross-section D indicates the concrete spillway and the stilling basin;
- Cross-section E indicates the earthfill, clay core and earth-fill anchor;
- Cross-section F indicates the earthfill, clay core and earth-fill anchor.

This dam type must adhere to the DWS specifications for earth embankment dams as indicated in Table 6.17.

Table 6.17: DWS soil properties for earth embankment dams (taken from Meyer, 2017)

PROPERTIES	EMBANKMENT ZONES		
	IMPERVIOUS	SEMI-PERVIOUS	PERVIOUS
Clay content (%)	10-30	<25	<20
PI (%)	10-30	<10	<5
LL (%)	25-60	<25	<20
LS (%)	6-14	<5	<2
MDD (kg/m^3)	1350-1700	1600-1850	1700-2000
OMC (%)	12-25	10-15	8-12
Cohesion (kPa)	20-25	10-15	<10
Friction Angle (o)	20-30	30-35	<35
Permeability (m/sec)	1x10^{-8}	1x10^{-7}	1x10^{-5}

In view of the above-mentioned, the availability of the required earth-embankment dam material on site was assessed as part of the geotechnical investigation (Meyer, 2017a).

According to preliminary dam designs, approximately 66 000m^3 of clayey material would be required for the clay core. Meyer (2017a) indicated that the topsoil layer present in test pits TP1 to TP10 with an average depth of 0.75m can be stripped (area roughly 70-100m west of the stream, north of the dam) and used as clay core material as most of the DWS specifications (Table 6.17) are met. It should be noted that friction and cohesion were not tested but published typical tabulated values were used.

The clay content is slightly higher (1-2%) than specified, but one can assume that the material would be contaminated by the underlying more sandy/gravelly soils during earthworks which should bring it into the specified range for clay content. Meyer (2017a) reported that the soils are non-dispersive (using charts of Gerber & Harmse, 1987 and Sherard et al (1967a)) while the Crumb test indicated only slight dispersiveness.

A further 10 500 m^3 of fill material for the semi pervious zone would be required according to initial designs. The laboratory test results confirmed that the soils underlying the topsoil layer fall within the operational requirements of materials suitable for the construction of the semi-permeable zone of an earth embankment dam. The gravelly material underlying the

topsoil layer is ideally suited for this purpose. Restricted TLB excavations often refused on this material at depths of around 2.0m.

Based on soil exposures in the river bed, this material should extend to at least 3.0m below existing surface. The material exposed after the topsoil has been stripped can be used as well as the gravelly talus on the hillslope further west (100m) of the stream (north of the proposed dam-wall).

Rock used for rip-rap should be hard, durable, preferably angular in shape, resistant to weathering and water action, free from overburden. Specifications for rock used as riprap typically include rock density at least 2500/m^3 (the dacite on site falls well within this range), rock shape, and rock hardness and durability. The layer of rip-rap material should be thick enough to include all the rocks in the specified gradation within the layer as oversized rocks that project through the layer may contribute to failure by creating turbulence.

The apparently durable weathering resistant dacite on site should be well suited for this purpose. However, there are no readily available loose boulders for this purpose. A potential quarry area was however identified. From preliminary information gathered it seems as drilling and blasting will be required to excavate potential rip-rap material.

Although material according to the DWS specifications was available on site, **Option 1 was discarded in view of the high cost as indicated in Table 6.19 and Section 6.10.3.**

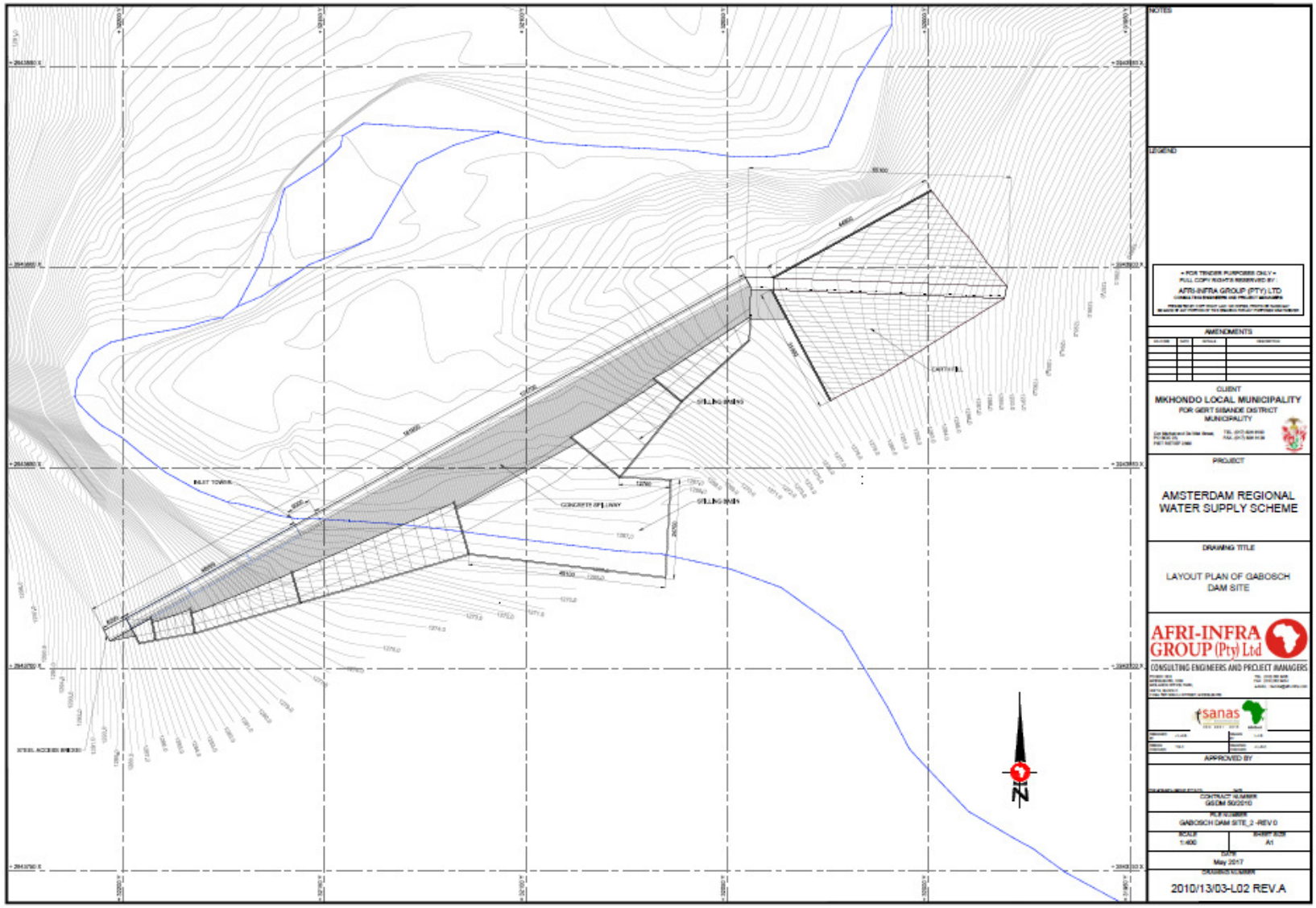

Figure 6.8a: Option 1 - layout plan of the proposed Dam B and its components.

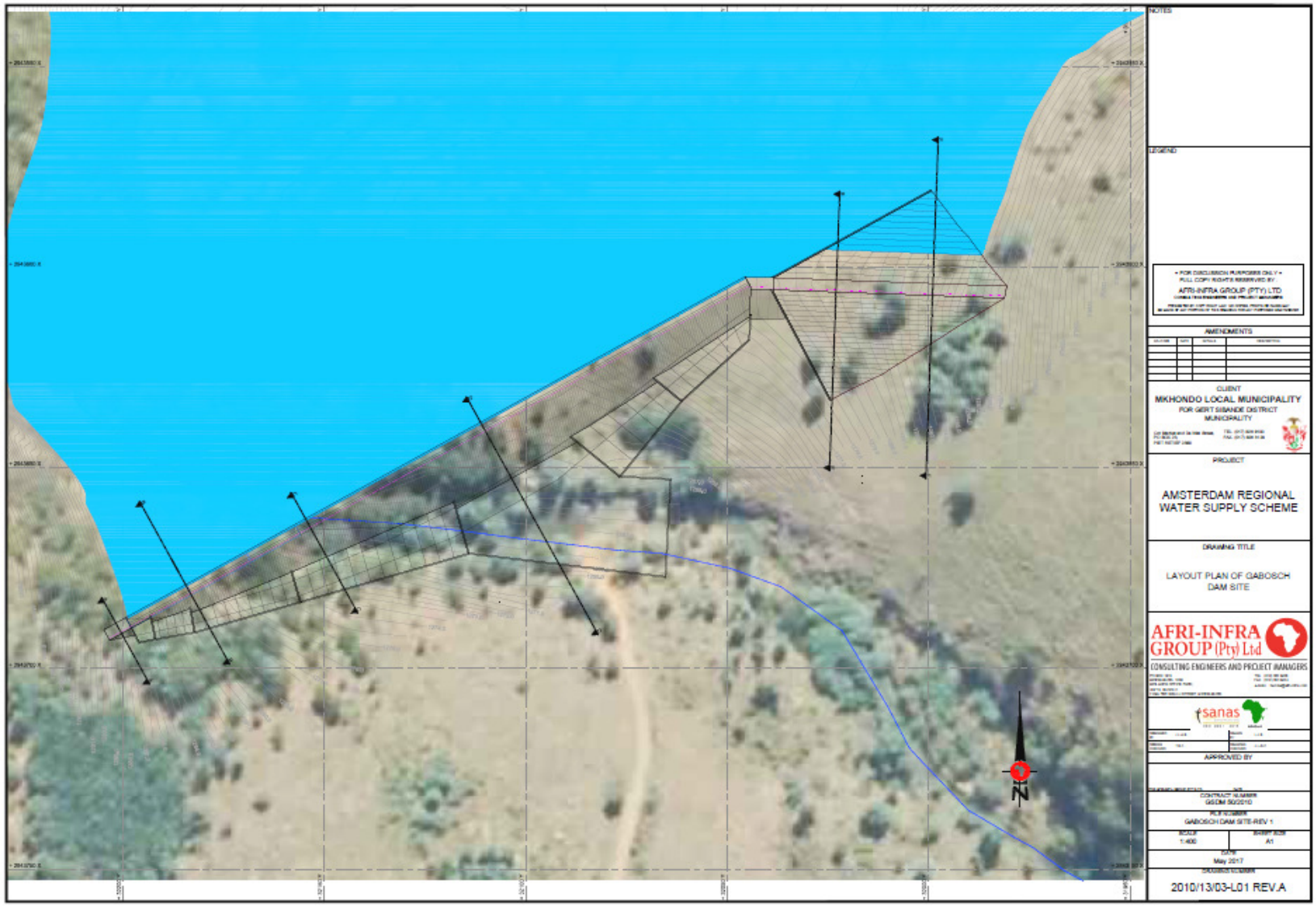

Figure 6.8b: Option 1 - location of the cross-sections through the proposed Dam B dam wall.

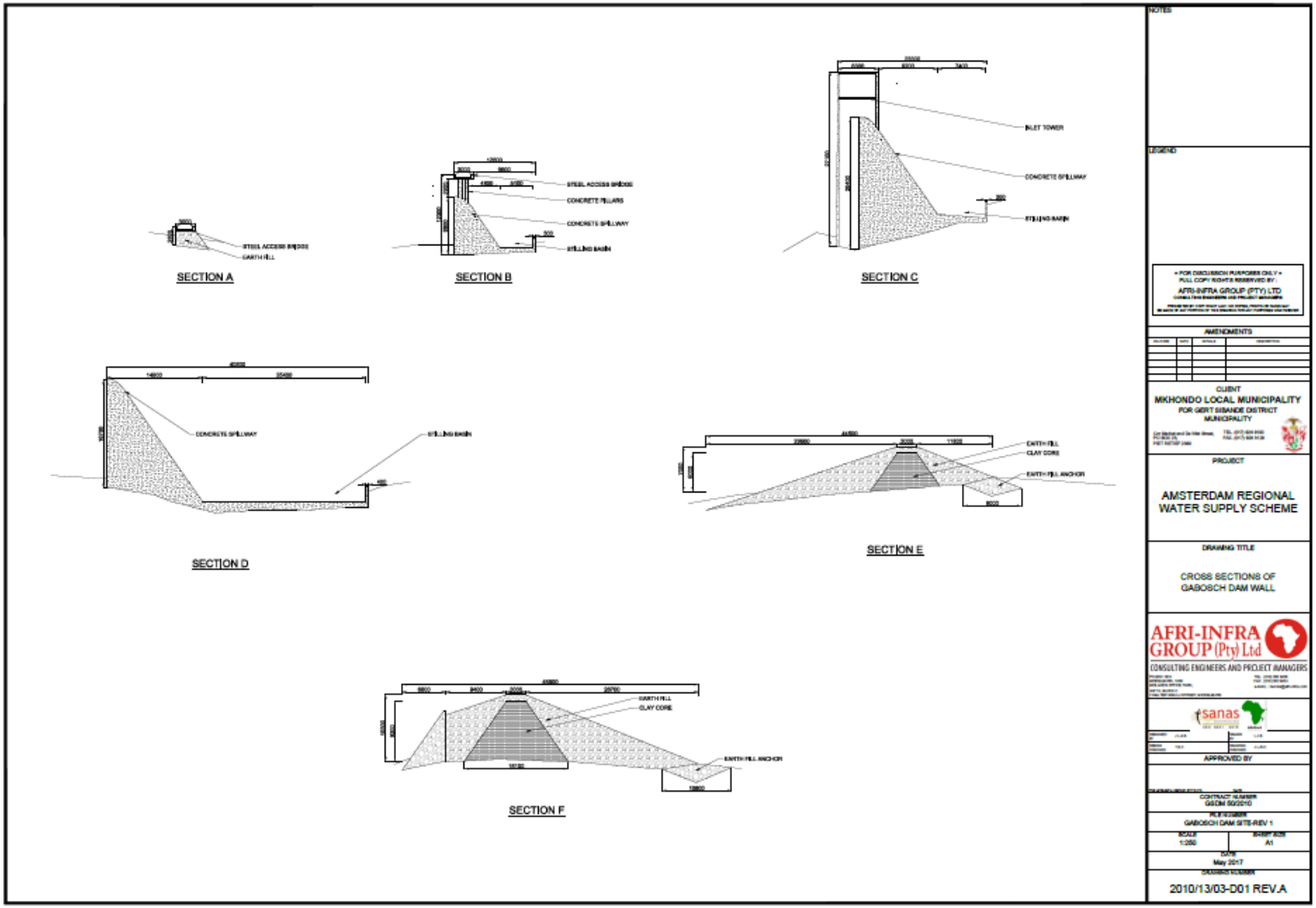

Figure 6.9: Option 1 - cross-sections through the proposed Dam B dam wall.

6.10.2 Option 2: Concrete/RCC Central ogee spillway with earth fill on the flanks

Option 2 comprised of a mass concrete or Roller Compacted Concrete (RCC) gravity structure with a central spillway and earth fill on the flanks. This option required retaining walls to prevent the earth fill from spilling into the river upstream of the dam (Afri-Infra, 2017).

Afri-Infra (2017) indicated that Option 2 was discarded in view of the additional cost in terms of the retaining walls (Table 6.19; Section 6.10.3).

6.10.3 Option 3: Concrete/RCC for full length of wall with central ogee spillway

Option 3 comprised of a mass concrete or Roller Compacted Concrete (RCC) gravity structure with a central spillway and the following components (Figure 6.10a; 6.10b):

- A central ogee crest concrete (Roller Compacted Concrete (RCC)) overspill section of 140m length and a maximum height above lowest foundation of 13.7 m;
- A non-overspill concrete (RCC) on the right flank of approximately 28.7m in length, including a 2.5m wide inlet tower;
- A non-overspill concrete (RCC) on the left flank of approximately 43.2m in length;
- A wet well outlet works, with internal plan cross-section dimensions of 2.0m x 2.0m, situated at the central end of the right embankment non-overspill section;
- A stilling basin of width varying from 1.5m to 15m with holding capacity for 1m water depth situated immediately downstream of the overspill section.

Table 6.18 provides information regarding Option 3. Further details are provided in Appendix 18.

Table 6.18: Option 3 – basic dam information (taken from Afri-Infra, 2017)

Location	Lat. 26º36'10"S, Long. 30º40'39"E
Catchment Area	44,9 km^2
Full Supply Level (FSL)	1281.2 m
Non-Overspill Crest (NOC) Level	1283.6 m
River Bed Level	1267.5 m
Reservoir Surface Area at FSL	18.15 ha
Gross Storage at FSL	450,318 m^3
Live Storage at FSL	370,318 m^3
Maximum Dam Height (above river bed)	16,1 m (approx)
Above estimated lowest foundation	21 m (approx)
Total dam wall length	212 m (approx)
Spillway Crest Length	140 m
Mean Annual Runoff (MAR) Natural	4,8 million m^3
Mean Annual Runoff (MAR) Developed)	4,3 million m^3
20 Year return period inflow flood peak (Q20)	155 m^3/s
100 Year return period inflow flood speak (Q100)	309 m^3/s
200 Year return period inflow flood speak (Q200)	412 m^3/s
Regional Maximum Flood (RMF)	670 m^3/s
Safety Evaluation Discharge (SED = RMF + Δ)	700 m^3/s

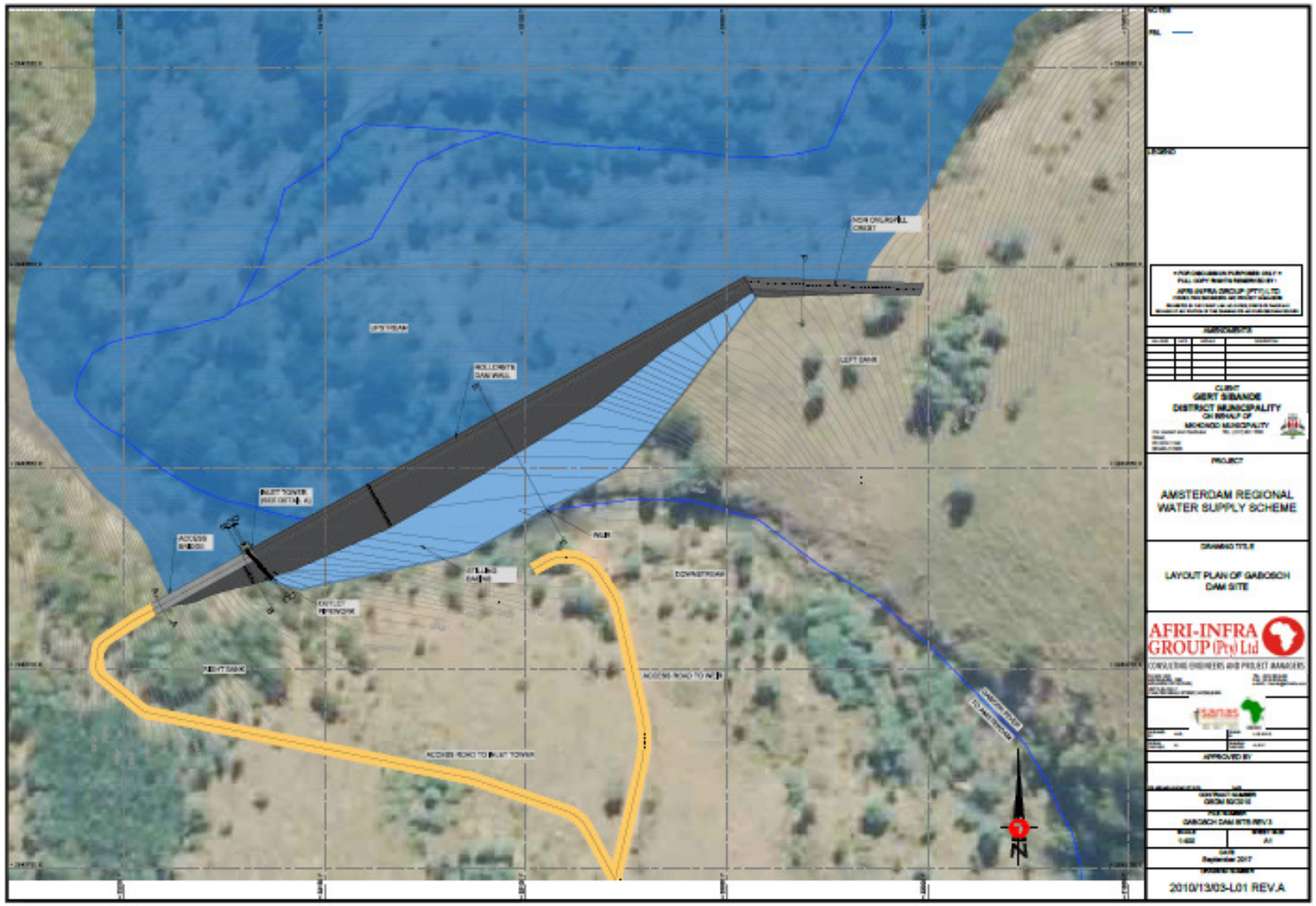

Figure 6.10a: Option 3 – layout plan of the dam

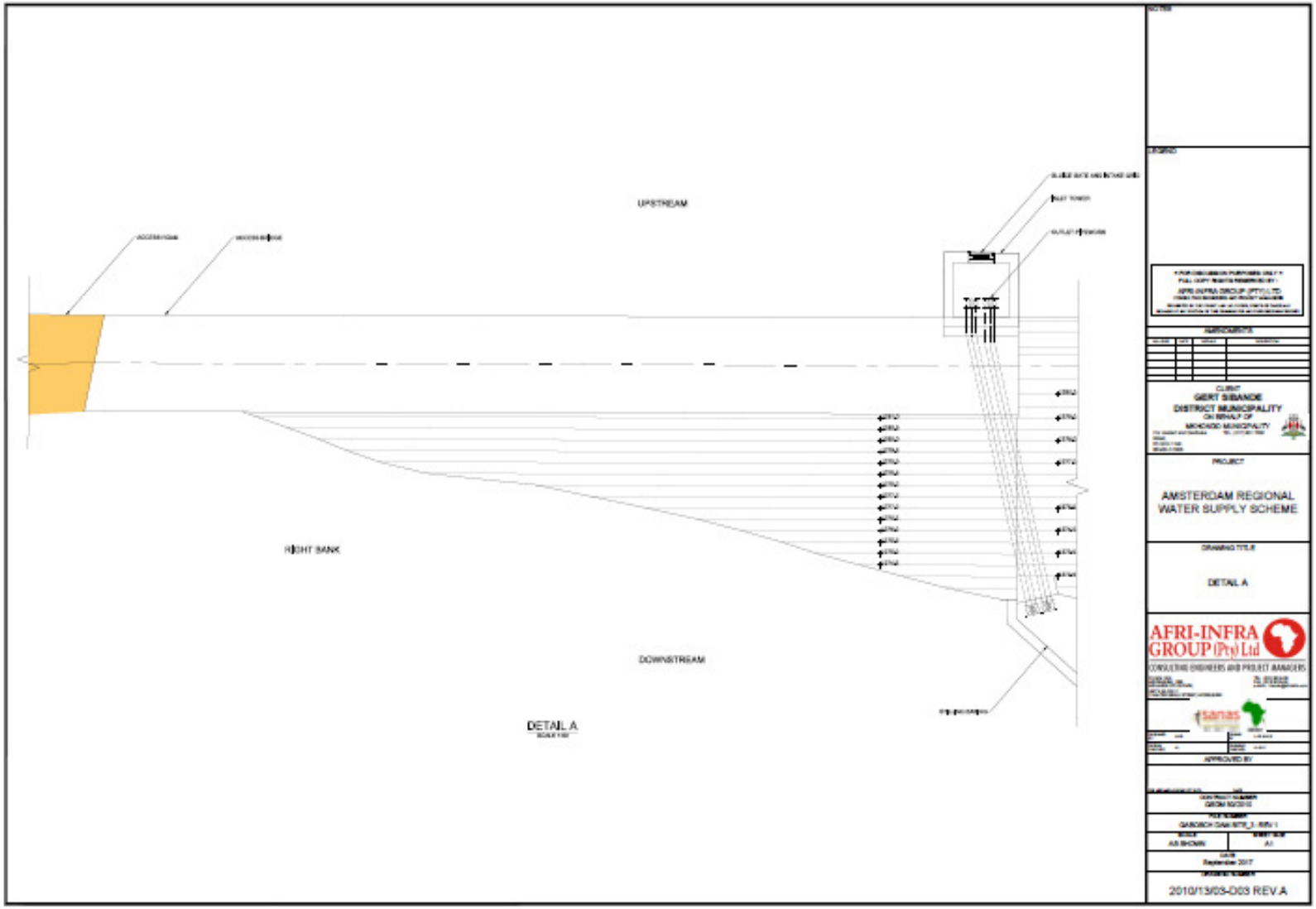

Figure 6.10b: Option 3 – layout plan of the dam

According to Afri-Infra (2017), the proposed Option 3 dam is classed as:

- a 'Medium' dam;
- either a 'significant' or 'High' hazard potential – in view of the existing development downstream of the dam;
- either a Category II or Category III dam in accordance with the current Dam Safety Regulations.

6.10.4 Conclusion

Table 6.19 provides a summary of the option cost comparison.

Table 6.19: Summary of Option Cost Comparison (taken from Afri-Infra, 2017)

DESCRIPTION	COST
Option 1	R 64,729,169.00
Option 2	R 34,364,677.00
Option 3	R 36,547,647.00

The analysis indicated that Option 1 (an earth fill flanked concrete/RCC central spillway) would be the most economical solution. However, after costing in the required retaining walls to prevent the earth fill from spilling into the river upstream of the dam, it was determined that Option 3 would be the most economical for a spillway length of 140m.

Option 1 and Option 2 were thus discarded.

6.11 Alternatives in terms of pipelines

As indicated in Section 5.10 of the Final Scoping Report, the following pipeline alternatives were to be investigated in further detail during the EIA phase:

- Pipeline from the existing Amsterdam Water Treatment Works (WTWs) to the proposed Dam Site A i.e. a pump line or gravity line (yellow line; Figure 2.1);
- Pipeline from the proposed Dam Site B to the existing Amsterdam WTWs i.e. bulk water supply pipeline (orange line; Figure 2.1).
- No pipeline from the proposed Dam Site B to the existing Amsterdam WTWs: water to be released directly into the Gabosha River downstream of the Dam Site B and abstracted at the existing Dorps Dam abstraction point.

6.11.1 Pipeline from the existing Amsterdam WTWs to the proposed Dam Site A

Afri-Infra (2016) indicated that a new raw water pipeline (pumpline) would be installed from the Amsterdam Water Treatment Works (Point A) to Point L (located within Kwathandeka) as indicated in Figure 6.11. At a later stage the said water pipeline would be extended to the proposed new raw water pump station to be located in close proximity of the new dam (Dam Site A) to be constructed. This pipeline would consist of a 315mm diameter uPVC Class 12 pipe and would extend over a distance of 4100m as indicated in Figure 6.11. The majority of the pipeline would be installed within a road reserve and within an urban area (Figure 6.11).

Figure 6.11: New bulk water pipeline route in Amsterdam (Point A to Point L)

As indicated in Section 6.7, Dam Site A will not be constructed. In view of this, the pipeline from the existing Amsterdam WTWs will become a gravity line providing potable water from the existing Amsterdam WTWs to the residential areas of Amsterdam and KwaThandeka.

The installation of a 315mm diameter bulk water pipeline would not trigger any listed activities in terms of Listing Notice 1 (R983 of 2014), Listing Notice 2 (R984 of 2014) or Listing Notice 3 (R985 of 2014). No Basic Assessment and/or Environmental Impact Assessment is thus required for the majority of the pipeline.

However, the installation of the said new bulk water pipeline will impact on a watercourse namely the Gabosha River (between C and D, Figure 6.11). A trench will be excavated, the pipeline installed and then backfilled. This would result in impacts on the water course (surface water environment), its associated aquatic environment and possibly wetlands. This would trigger listed activity 12 and 19 of Listing Notice 1 requiring a Basic Assessment to be conducted.

Watercourses are also present between Point G and H (Figure 6.11) and between Point I and Point J (Figure 6.11). However, the engineers indicated that a trench will not be excavated through the said watercourses into which the pipeline will be installed. According to the engineers, the new bulk water pipeline will be attached to the existing bridge structures and will thus not impact on the said watercourses. In view of the above-mentioned, it is felt that the installation of a 315mm diameter bulk water pipeline attached to existing bridge structure would not trigger any listed activities in terms of Listing Notice 1 (R983 of 2014), Listing Notice 2 (R984 of 2014) or Listing Notice 3 (R985 of 2014). No Basic Assessment and/or Environmental Impact Assessment is thus required.

A Water Use Licence in terms of the National Water Act, 1998 would be required with regards to where the new bulk water pipeline will impact on a water course and/or will be located within 500m of a wetland.

6.11.2 Pipeline from the proposed Dam Site B to the existing Amsterdam WTWs

A pipeline from the proposed Dam Site B to the existing Amsterdam WTWs (Figure 6.12) was indicated as an alternative.

The proposed pipeline from the proposed Dam Site B to the existing Amsterdam WTWs would extend through an area of High Ecological Sensitivity and is thus not a preferred option but was to be assessed as part of the EIA phase.

Figure 6.12: Aerial view of Bulk Water Pipeline.

This option was discarded in view of the following:

- The rugged topography of the area would increase the cost in terms of the installation of the pipeline.
- Increased risk of soil erosion during construction as a result of the steep topography.
- The proposed pipeline route would impact on a number of drainage lines (watercourses) that flow into the Gabosha River and have a High Sensitivity;
- The proposed pipeline route is located within an area:
  - With a high ecological sensitivity (Venter and Niemand, 2017b);
  - With a high diversity of plant species (Venter and Niemand, 2017);

- Where all of the Species of Conservation Importance (Table 5.4) are present in either the Montane Grassland or the Indigenous Woody vegetation units (Venter and Niemand, 2017b).
- That provides habitat for a number of biome-restricted species with high affinities to the Afrotropical Highlands. These include Bush Blackcap (*Lioptilus nigricapillus*), Chorister Robin-chat (*Cossypha dichroa*) and Olive Bush-shrike (*Chlorophoneus olivaceus)*, with the majority confined to the densely wooded kloofs corresponding to the Bulk Water Pipeline route (Venter and Niemand, 2017).

6.11.3 No pipeline from the proposed Dam Site B to the existing Amsterdam WTWs

The alternative of releasing water directly into the Gabosha River downstream of the Dam Site B and abstracting at the existing Dorps Dam abstraction point would impact on the aquatic environment associated with the Gabosha River in terms of increased flows, etc. The Gabosha River is indicated as Critical Biodiversity Areas: Rivers and the surrounding areas Ecological Support Areas (ESAs): Important subcatchments in the freshwater assessment of Mpumalanga Biodiversity Sector Plan (2013). The Gabosha River is a tributary draining into sub-quaternary reach W53C-1679 and is anticipated to have a much higher PES (Category A or B) than the Thole River in view of less impacts.

Although this option could impact on the aquatic environment of the Gabosha River, the potential impacts can be mitigated and will be significantly less than the installation of the Bulk Water Pipeline (Figure 6.12). This is thus the preferred option.

6.12 'No Project Option'

The 'No Project Option' is the alternative of not going ahead with the proposed upgrading of the Amsterdam Regional Water Supply Scheme. The 'No Project Option' is only considered if it is found that the proposed construction of a dam and associated infrastructure will have significant negative impacts on the environment, which cannot be mitigated or managed.

The Amsterdam Scheme currently abstracts water from a single location (Dorps Dam) within the catchment of the Gabosha River, a tributary of the Ngwempisi River. It relies on run-of-river abstraction only. It is not connected to any National Bulk Water Infrastructure.

The current abstraction weir in the Gabosha River (Dorps Dam; Figure 6.1) has a gross capacity of 220 000m^3 but is silted up. This affects the water supply to Amsterdam as run-of-river water is relied upon.

If the 'No Project Option' is implemented it would mean that the residents of Amsterdam and KwaThandeka would not be provided with a sustainable source of potable water and potable supply interruptions could continue.

In addition, it would mean that the following objectives in terms of the project would not be met:

- Eradicate Backlogs (access to basic infrastructure);
- Serve housing and settlement infrastructure;
- Support and stimulate economic growth and development;

  - Improve water service quality (e.g. drinking water quality (WTW); address Operation & Maintenance (O&M) challenges, etc.)
- Improve reliability of supply;
- Optimize cost/appropriate technology;
- Support integrated resource planning and management;
- Promote cooperation between authorities with regards to sharing of resources, responsibilities and risks; and
- Increase sustainability (Afri Infra, 2016).

If the 'No Project Option' in terms of the proposed dam site locations as well as the associated infrastructure was exercised, it would mean that other dam sites and the provision of associated infrastructure would have to be investigated, the potential impacts on the environment determined, the interested and affected parties consulted.

This would ultimately impact on the residents of Amsterdam and KwaThandeka in terms of the provision of potable water.

6.13 Conclusion

In view of the above-mentioned, the impact assessment (Section 7) will focus on the following alternatives:

- A 20 year silt/sediment dam at Dam Site B i.e. Option 3: Concrete/RCC for full length of wall with central ogee spillway;
- A gravity pipeline from the existing Amsterdam Water Treatment Works (WTWs) to Amsterdam/KwaThandeka;
- Releasing water directly into the Gabosha River downstream of the Dam Site B and abstracting water at the existing Dorps Dam abstraction point (i.e. no pipeline from the proposed Dam Site B to the existing Amsterdam WTWs).

As part of the overall project, the Dorps Dam (the current abstraction point for Amsterdam) will be desilted (accumulated silt in the dam to be removed) in order to increase the capacity of the dam in terms of the storage of water.

7. ENVIRONMENTAL IMPACT DESCRIPTION AND EVALUATION

This section of the report describes the impacts and risks identified (physical and social) as a result of the proposed project, including:
- the nature, significance, consequence, extent, duration and probability of the impacts;
- the degree to which these impacts can be reversed or may cause irreplaceable damage;
- the methodology used in determining and ranking the potential impacts;
- positive impacts.

7.1 Introduction

This section of the report describes and evaluates the potential impact of the proposed development on the environment. The impact of the development has to be assessed in terms of the following development phases:

- **Planning and design phase**
- **Construction phase**
- **Operational phase**

7.2 Evaluation of impacts

The evaluation of impacts is conducted in terms of the following criteria:

- **Nature of impact**

- **Extent of impact**

Site	Effect limited to the site and its immediate surroundings
Local	Effect limited to within 3-5 km of the site
Regional	Effect will have an impact on a regional scale

- **Duration of impact**

Short	Effect lasts for a period 0 to 5 years
Medium	Effect continues for a period between 5 and 10 years
Long	Effect will cease after the operational life of the activity either because of natural process or by human intervention
Permanent	Where mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient

- **Probability**

Improbable	Less than 33% chance of occurrence
Probable	Between 33 and 66% chance of occurrence
Highly probable	Greater than 66% chance of occurrence
Definite	Will occur regardless of any prevention measures

- **Significance of impact**

Low	Where the impact will have a relatively small effect on the environment and will not have an influence on the decision
Medium	Where the impact can have an influence on the environment and the decision and should be mitigated
High	Where the impact definitely has an impact on the

	environment and the decision regardless of any possible mitigation

- **Status**

Positive	Impact will be beneficial to the environment
Negative	Impact will not be beneficial to the environment
Neutral	Positive and negative impact

It must be noted that many of the potential negative consequences can be mitigated successfully. It is however, necessary to make a thorough assessment of all possible impacts in order to ensure that environmental considerations are taken into account, in a balanced way, as far as possible, supporting the aim of creating a healthy and pleasant environment.

7.3 Description of impact assessment to be undertaken

As indicated in Section 6.13, the impact assessment will focus on the following:

- A 20 year silt/sediment dam at Dam Site B i.e. Option 3: Concrete/RCC for full length of wall with central ogee spillway;
- Releasing water directly into the Gabosha River downstream of the Dam Site B and abstracting water at the existing Dorps Dam abstraction point (i.e. no pipeline from the proposed Dam Site B to the existing Amsterdam WTWs).
- A gravity pipeline from the existing Amsterdam Water Treatment Works (WTWs) to Amsterdam/KwaThandeka;

As part of the overall project, the Dorps Dam (the current abstraction point for Amsterdam) will be desilted (accumulated silt in the dam to be removed) in order to increase the capacity of the dam in terms of the storage of water.

7.3.1 Dam Site B

The following construction would take place at Dam Site B:

- Construction of dam wall and dam basin;
- Construction of access road (with river crossings) to Dam Site B.

7.3.1.1 Construction of dam wall and dam basin

The construction at Dam Site B would entail the construction of a mass concrete or Roller Compacted Concrete (RCC) gravity structure with a central spillway (i.e. Option 3, Section 6.10.3) at dam wall Option 3 (Figure 6.7).

The following components would form part of the dam wall structure as indicated in Figure 6.10a and Figure 6.10b:

- An access bridge;
- A non-overspill concrete (RCC) on the right flank of approximately 28.7m in length, including a 2.5m wide inlet tower;
- A wet well outlet works, with internal plan cross-section dimensions of 2.0m x 2.0m, situated at the central end of the right embankment non-overspill section;
- A central ogee crest concrete (Roller Compacted Concrete (RCC)) overspill section of 140m length and a maximum height above lowest foundation of 13.7 m;
- A non-overspill concrete (RCC) on the left flank of approximately 43.2m in length;

- A stilling basin of varying width (from 1.5m to 15m) with holding capacity for 1m water depth situated immediately downstream of the overspill section. At the end of the stilling basin, a measuring weir (V-notch type) with flow depth logger will be provided to measure environmental flow releases and foundation seepage (if any) as well as to activate the sleeve valves (Afri Infra, 2017).

According to the project engineers, the following methodology would be adopted with regards to the construction of the dam wall and dam basin:

- The Gabosha River will be diverted to the eastern/western side of the valley by means of constructing a temporary channel that will follow the outline of the stilling basin so as to prevent additional construction impact on the environment.
- The diversion will be lined with gabions and temporary energy dissipators in order to minimise any erosion of the cut.

- The dam wall will be excavated from the furthest side of the diversion to suitable foundation level, and the dam wall construction will commence as per the final design specifications.
- The dam wall construction will include an outlet as per the anticipated final design specifications. The outlet will be formalised to a level that will allow the through flow of the normal run of water in order to:
    - Decommission the temporary diversion;
    - Allow the river to run along its normal route;
    - Allow construction of the remaining portion of the dam wall.

- No impounding of water would be allowed before the licence to impound has been granted. If necessary, a formalised temporary outlet would be constructed to allow for the normal run of river, should the final outlet be located at a higher level than the requirement for through flow of the river during construction. This temporary outlet would be properly sealed and decommissioned and would form part of the permanent construction of the dam wall.

- Intensive clearing would take place in the direct vicinity of the dam wall in order to prevent any possible tunnelling through the dam wall.
- The dam basin would be cleared of vegetation and large rocks to a required standard as indicated by the Appointed Professional Person (APP). Clearing of the dam basin will be confined to the top water level expected in the dam.

The operational phase would involve the following:

- Utilization of Dam Site B as a water storage facility (an area of approximately 19 hectares will be inundated) including releasing water directly into the Gabosha River downstream of Dam Site B and abstracting water at the existing Dorps Dam abstraction point (i.e. no pipeline from the proposed Dam Site B to the existing Amsterdam WTWs).

Table 7.1 provides a summary of the main environmental impacts identified in terms of the construction and operation of a dam at Dam Site B.

7.3.2 Construction and utilization of access road (with river crossings) to Dam Site B

According to the project engineers, the existing single track dirt road to Dam Site B (Figure 7.1) will be upgraded to a standard complying with the

requirements of the local municipality. This upgrading would include the construction of 2 or 3 river crossings as indicated in Figure 7.1.

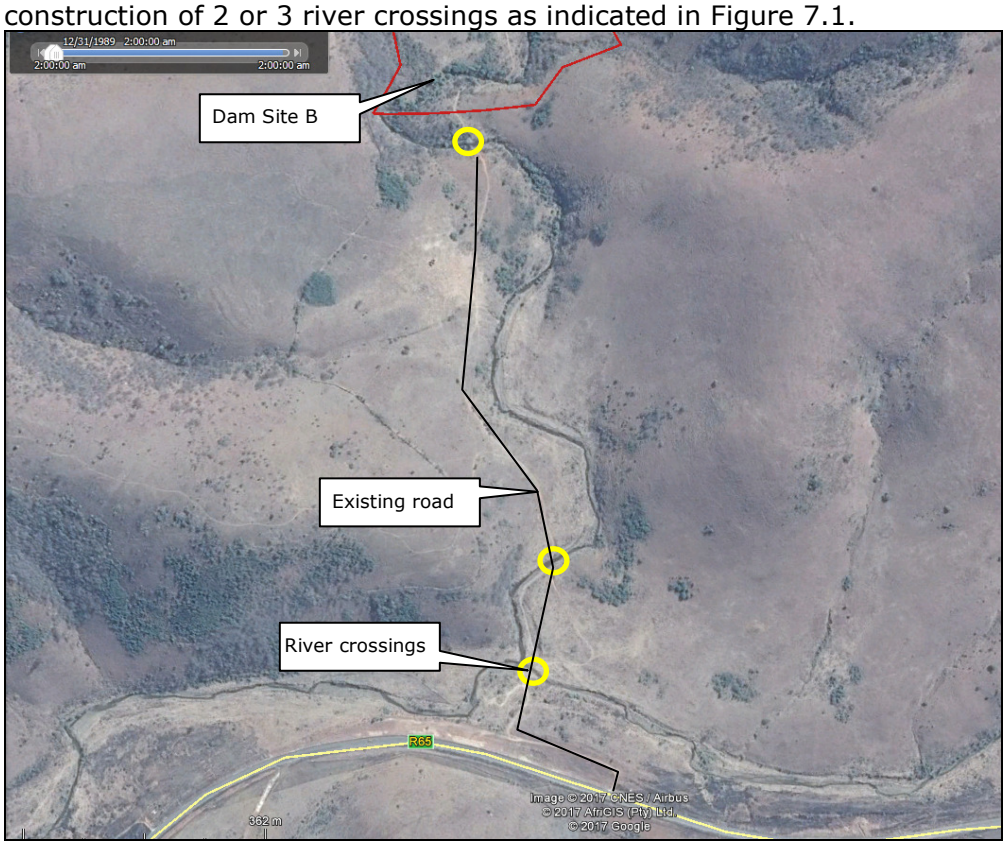

Figure 7.1: Proposed access road (with river crossings) to Dam Site B

Upgrading of this existing single track dirt road would involve the following:

- Clearing vegetation adjacent to existing road in order to widen it;
- Excavating and surfacing the said road;
- Constructing the necessary river/bridge crossings;
- Providing the necessary storm water control measures.

The operational phase would involve the following:

- Utilization of the access road (including river crossings) to Dam Site B.

Table 7.2 provides a summary of the main environmental impacts identified in terms of the construction and utilization of an access road (with river crossings) to Dam Site B.

7.3.3 Construction and utilization of Pipeline Crossing no. 1 (between Point C and D, Figure 6.11), part of the overall Distribution Pipeline to Amsterdam and KwaThandeka

As indicated in Section 6.11.1, a new raw water pipeline (gravity line) would be installed from the Amsterdam Water Treatment Works (Point A) to Amsterdam and KwaThandeka. This pipeline would consist of a 315mm diameter uPVC Class 12 pipe.

The majority of the pipeline would be installed within a road reserve and within an urban area (Figure 6.11). The installation of a 315mm diameter bulk water pipeline would not trigger any listed activities in terms of Listing Notice 1 (R983 of 2014), Listing Notice 2 (R984 of 2014) or Listing Notice 3 (R985 of 2014). No Basic Assessment and/or Environmental Impact Assessment is thus required for the majority of the pipeline.

However, the installation of the said new bulk water pipeline will impact on a watercourse namely the Gabosha River (between C and D, Figure 6.11). The impact assessment will therefore focus on this river crossing.

Construction of Pipeline Crossing no. 1 would involve the following:

- Clearing of vegetation;
- Excavation of trenches;
- Installation of pipes;
- Backfilling and rehabilitation of the disturbed area.

The operational phase would involve the following:

- Utilization of Pipeline Crossing no.1 as part of the overall Distribution Pipeline.

Table 7.3 provides a summary of the main environmental impacts identified in terms of the construction and utilization of Pipeline Crossing no. 1.

7.3.4 Desilting of the Dorps Dam

The current abstraction weir in the Gabosha River (Dorps Dam; Figure 6.1) has a gross capacity of 220 000m^3 but is silted up. This affects the water supply to Amsterdam as run-of-river water is relied upon.

The desilting of the Dorps Dam (removal of accumulated silt in the said dam) is proposed as an activity to be undertaken in order to increase the capacity of the dam in terms of the storage of water.

Table 7.4 provides a summary of the main environmental impacts identified in terms of desilting Dorps Dam.

7.4 Decommissioning phase

The decommissioning phase will not be discussed. It is recommended that at the time of decommissioning, a specific Environmental Management Programme (EMPr) be compiled which specifically addresses this phase. This EMPr would have to address issues such as the removal of building rubble and the rehabilitation of the site. Soil conservation measures would also have to be implemented.

TABLE 7.1: CONSTRUCTION AND OPERATION OF A DAM AT DAM SITE B

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT CONSTRUCTION PHASE: CONSTRUCTION OF DAM WALL AND BASIN AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT OPERATIONAL PHASE: UTILIZATION OF DAM AS A STORAGE FACILITY AND RELEASING WATER DIRECTLY INTO THE GABOSHA RIVER DOWNSTREAM OF DAM SITE B AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
TOPOGRAPHY	▪ Dam Site B is located within the Gabosha River. The proposed dam would be located within a narrow valley surrounded by very rugged topography (steep hills on either side) that extends to approximately 1480mamsl on both sides. Very little, if any, impact on topography has taken place within the proposed Dam Site B area due to the ruggedness of the topography. ▪ Direct impact on the valley topography i.t.o. the construction of a temporary diversion channel in order to divert the river in order to facilitate the damwall construction. ▪ Direct impact on the valley topography i.t.o. the clearing of the site and excavations for dam wall (trenches) as well as the required quarry for suitable material. ▪ The dam basin will be cleared of vegetation to a required standard. This clearing will be confined to the top water level expected in the dam. This will impact directly on approximately 20 hectares of the valley topography. ▪ Intensive clearing will take place in the direct vicinity of the dam wall in order to prevent any tunnelling through the wall.	SITE	PERMANENT	DEFINITE	MEDIUM NEGATIVE	MEDIUM NEGATIVE	▪ During the operational phase, the damwall will continue to impact on the topography of the area in view of being a topographical high. ▪ An area of 20 ha area will be covered with water resulting in the inundation of the valley floor.	SITE	LONG	DEFINITE	LOW NEGATIVE	LOW NEGATIVE
GEOLOGY/ GEOTECHNICAL ASPECTS	▪ Dam Site B is underlain by pyroclastic rocks and ash-flow tuff (Dacite lava) of the Gobasha Member, Amsterdam Formation of Randian Age (Meyer, 2017a). ▪ A large rock face and rocky outcrops are present at dam wall Option 3 where a dam wall can be constructed making it a more natural dam. ▪ Meyer (2017a) indicated that roughly half of the dam wall is underlain by outcrop/sub-outcrop while test pits excavated towards the west revealed abundant alluvial gravel/boulders. Gravelly alluvial material was noted in most test pits. ▪ Meyer (2017a) indicated that shallow good quality diabase exists on the eastern flank of the proposed dam for a potential side spillway. Early indications are that the material is very competent. ▪ The construction of the temporary diversion channel, the quarry, the dam wall and the dam basin will thus impact on the Gobasha Member of the Amsterdam Formation.	SITE	PERMANENT	DEFINITE	MEDIUM NEGATIVE	MEIDIUM NEGATIVE	NONE. No further impact on geology since no further construction activities will take place.					
	▪ Meyer (2017b) recorded no faults or large fissures although the right flank of the proposed site was clearly formed by a significant structure. ▪ The construction of the temporary diversions channel, the dam wall and the dam basin could impact on a main joint trending in a NE-SW direction which is perpendicular to the dam axis (Meyer, 2017b). This main joint will require grouting.	SITE	PERMANENT	HIGHLY PROBABLE	HIGH NEGATIVE	MEDIUM NEGATIVE	NONE. No further impact on geology since no further construction activities will take place.					
SOILS	• The excavation of the temporary diversion channel, quarry, dam wall and dam basin will impact on younger unconsolidated Quaternary alluvium consisting of transported sandy, silty and gravelly soils derived from upstream weathered bedrock (Meyer, 2017a). Clays are mostly absent in the streambed due to the generally high-energy depositional environment and are only present in the matrix within the alluvial gravel (Meyer, 2017a). The hillslopes on both sides of the stream are covered with a layer of gravelly Talus of mixed origin (Meyer, 2017a). ▪ The dam basin will be cleared of vegetation to a required standard. Intensive clearing will take place in the direct vicinity of the dam wall in order to prevent any tunnelling through the wall. This clearing will be confined to the top water level expected in the dam. This will impact directly on approximately 20 hectares of the valley soils. ▪ The above-mentioned excavation activities, the stockpiling of topsoil, subsoil, overburden and rocks would directly impact on the soil of the area in terms of soil structure, nutritional and chemical values. ▪ Soil erosion could occur if the necessary mitigation measures are not implemented during construction. ▪ Sediment transport and erosion may occur following the clearing of the site if mitigation measures are not implemented that could impact on the downstream areas of the Gabosha River.	SITE	LONG	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ Direct impact on soil will continue i.t.o. soil structure, nutritional and chemical values and soil compaction as a result of the presence of the dam wall and the inundation of the area (20 ha area will be affected). ▪ Soil erosion could occur if the disturbed areas and embankments were not properly rehabilitated and the erosion control measures not maintained. ▪ Releasing water into the Gabosha River at the dam wall could result in erosion if a stilling basin and energy dissipation measures are not provided as part of the dam design..	SITE	LONG	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE

TABLE 7.1: CONSTRUCTION AND OPERATION OF A DAM AT DAM SITE B

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT CONSTRUCTION PHASE: CONSTRUCTION OF DAM WALL AND BASIN AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT OPERATIONAL PHASE: UTILIZATION OF DAM AS A STORAGE FACILITY AND RELEASING WATER DIRECTLY INTO THE GABOSHA RIVER DOWNSTREAM OF DAM SITE B AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
SOILS	Construction activities could lead to soil pollution if: • the construction vehicles are not maintained/repaired resulting in oil leaks and fuel spills; • waste management measures are not implemented, • proper ablution and sanitation facilities are not provided for the site workers to use.	SITE	SHORT	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further impact on soil since no further construction activities will take place.					
LAND USE/ SENSE OF PLACE	• Dam Site B is currently vacant with no infrastructure and belongs to the Mkhondo Local Municipality. • Dam Site B is indicated as Non-arable. No cultivation was noted within the proposed Dam Site B area due to the rocky nature of the area • Dam Site B is indicated as low to moderate potential grazing land. The grazing potential is indicated as less than 4ha/animal unit. The said area is used for informal grazing purposes. • The construction of the temporary diversion channel, quarry, dam wall and dam basin will result in the area no longer being available for informal grazing purposes.	SITE	LONG	DEFINITE	LOW NEGATIVE	LOW NEGATIVE	• A new land use namely storage of water for municipal use will be created on the said property as part of the overall water provision service of the Mkhondo Local Municipality. In the long term, this would benefit the residents of Amsterdam and KwaThandeka. • In addition, the presence of a dam on the said property could result in the previously unutilised area being used for recreational purposes (e.g. fishing, birding, etc.) by the residents of Amsterdam and KwaThandeka. • In the Amsterdam Reconciliation Strategy Report, it is recorded that in times of water shortages the yield of the Gabosha River is augmented from Westoe Dam via the bulk link pipeline between Westoe Dam and Jericho Dam. This augmentation is not governed by an official agreement between the Department of Water and Sanitation (DWS) and the Mkhondo Local Municipality. Water releases only take place after lengthy negotiations at elevated VRESAP (Vaal River Eastern Sub-system Augmentation Project) tariffs. Dam Site B is thus ideally located in order to utilise this emergency back-up in times of need.	SITE	LONG	HIGHLY PROBABLE	MEDIUM POSITIVE	MEDIUM POSITIVE
NATURAL VEGETATION	Loss of watercourse habitat: • The construction of the temporary diversion channel, quarry, dam wall and dam basin will impact on watercourse habitat namely a river system (4.9 ha) and several drainage lines as identified by Venter and Niemand (2017b). The clearing of this vegetation as well as the subsequent inundation of the area cannot be mitigated.	SITE	LONG	DEFINITE	HIGH NEGATIVE	HIGH NEGATIVE	Loss of watercourse habitat: • No further construction will take place and the area will be inundated (flooded). The inundation impact cannot be mitigated.	SITE	LONG	DEFINITE	HIGH NEGATIVE	HIGH NEGATIVE
	Loss of sensitive vegetation: • The clearing of the dam basin (20 ha area) will impact on watercourse habitat (river and drainage lines) as well as 8.4 ha of Montane Grassland (high sensitivity) and 5.1 ha of Indigenous Woody vegetation (high sensitivity). Species of Conservation Importance (7 Red Data Plant Species) could be present in either vegetation unit although none were recorded to be present. • The site is however surrounded by similar grassland and the impact is therefore considered to be of medium significance (Venter and Niemand, 2017b).). The clearing of this vegetation as well as the subsequent inundation of the area cannot be mitigated.	LOCAL	LONG	DEFINITE	MEDIUM NEGATIVE	MEDIUM NEGATIVE	Loss of sensitive vegetation: • No further construction will take place and the area will be inundated (flooded). The inundation impact cannot be mitigated.	SITE	LONG	DEFINITE	MEDIUM NEGATIVE	MEDIUM NEGATIVE
	Infestation by invasive plant species: • Disturbance to the soil and clearing of indigenous vegetation often results in infestation by alien and invasive species (AIS). Several alien and invasive species are present on site and in the area and the proposed activities may potentially cause additional infestations as a result of the disturbance due to construction activities.	LOCAL	LONG	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	Infestation by invasive plant species: • Several alien and invasive species are present on site and in the area and the proposed activities may potentially cause additional infestations of the disturbed areas.	LOCAL	LONG	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE
	Erosion and increased sedimentation in downstream areas: • The removal of vegetation and disturbances to the soil may cause erosion on site and sedimentation in the downstream areas. Construction and reinstatement impacts are more likely to cause erosion and sedimentation impacts.	SITE	LONG	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	Erosion and increased sedimentation in downstream areas: • If rehabilitation of disturbed areas is not undertaken as part of the overall management of the dam, it may cause erosion on site and subsequent sedimentation in the downstream areas.	SITE	LONG	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE

TABLE 7.1: CONSTRUCTION AND OPERATION OF A DAM AT DAM SITE B

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT CONSTRUCTION PHASE: CONSTRUCTION OF DAM WALL AND BASIN AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT OPERATIONAL PHASE: UTILIZATION OF DAM AS A STORAGE FACILITY AND RELEASING WATER DIRECTLY INTO THE GABOSHA RIVER DOWNSTREAM OF DAM SITE B AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
ANIMAL LIFE (TERRESTRIAL FAUNA)	Loss of fauna richness and displacement of fauna (during construction): • Construction activities go hand in hand with high noise generation. Therefore it is anticipated that many mobile species will vacate the area during the construction phase. • However, less mobile and specialised taxa are more likely to be affected since they can't escape the ambit of the anticipated construction process. • It is fundamentally important to maintain connectivity with similar habitat types to allow fauna taxa the option to "escape" construction activities. • The impact is anticipated to be higher in rural landscapes located away from anthropogenic activities (i.e. Dam Site B).	SITE	LONG	DEFINITE	MEDIUM TO HIGH NEGATIVE	MEDIUM NEGATIVE	Direct loss of habitat (displacement of fauna) due to inundation: • The loss of habitat due to inundation during the operational phase is probably the largest impact regarding this project in terms of surface area (when compared to the other proposed activities). • Several natural habitat types (grassland, woody areas, Gabosha River) will become permanently lost impacting on Red Data Mammal (14 mammal taxa of conservation concern; Table 5.7) and bird species (21 threatened or near threatened bird species, 5 of which could be directly impacted, Table 5.12). • Although the impact appears to be of high magnitude, a large area of habitat is actually represented by alien invasive woody vegetation at Dam Site B. • At Dam Site B, large areas of similar habitat (mainly montane grassland) occurs adjacent to the proposed maximum inundation level of the proposed dam, which will in all likelihood result in the displacement of highly mobile fauna species (e.g. ungulates and birds). • However, species likely to be affected are those that are restricted to lotic habitat along the rivers and the riparian vegetation bordering the rivers. Typical species include dragonflies and damselflies with high DBI scores (e.g. *Zosteraeaschna minuscula* and *Onychogomphus supinus*) and aquatic-associated taxa such as the Half-collared Kingfisher, Serval and Swamp Musk Shrew. • Inundation will also affect less mobile terrestrial species that are either substrate-specific (e.g. scorpions) and many fossorial taxa and those with a high preference for terrestrial grassland units such as the White-tailed Rat (Venter and Niemand, 2017b).	SITE	PERMANENT	DEFINITE	HIGH NEGATIVE	MEDIUM NEGATIVE
							Changes in the fauna community structure: • The change from lotic to a lentic (dam) system will affect local changes in the composition and abundance of fauna species, especially birds. • Some species will become displaced during the inundation of the proposed dam. These pertain to species restricted to the riparian vegetation and the lotic conditions of the Gabosha and Thole Rivers. • However, it is possible that certain waterfowl (e.g. ducks), wading birds (e.g. herons) and piscivorous species (e.g. cormorants and darters) are likely to increase in numbers once the dam is in operation since these birds don't have to contend with shallow riffle water (at base flow conditions). • This impact cannot be ameliorated and is regarded as permanent as long as the dam remains in existence/inundated (Venter and Niemand, 2017b).	LOCAL	LONG	HIGHLY PROBABLE	MEDIUM TO HIGH NEGATIVE	N/A
	Impacts resulting in increased access to rural land: • The construction of service roads and access roads may potentially facilitate access to areas that were previously inaccessible. • At present, only a few dirt roads exist which allow access to the Dam Site B. It is possible that access roads, irrespective of their size, could facilitate access in the general area. • Increased access during the construction phase could easily disrupt the natural breeding and foraging regimes of large-bodied birds and mammal species. • In addition, better access to previously inaccessible areas may exuberate grazing and trampling by livestock in the area, but could also result in increased firewood collection and illegal poaching of animal resources. • Although the impact is perceived to operate at local scales, it will persist in the long term owing to the predictable and constant attraction of people (both pastoralists and job-seekers) to areas that were previously less accessible.	SITE	LONG	HIGHLY PROBABLE	MEDIUM TO HIGH NEGATIVE	LOW NEGATIVE	Impacts resulting in increased access to rural land: • During the operational phase, the constructed service roads and access roads may potentially facilitate access to areas that were previously inaccessible. • At present, only a few dirt roads exist which allow access to Dam Site B. It is possible that access roads, irrespective of their size, could facilitate access in the general area. • Increased access during the operational phase could easily disrupt the natural breeding and foraging regimes of large-bodied birds and mammal species. • In addition, better access to previously inaccessible areas may exuberate grazing and trampling by livestock in the area, but could also result in increased firewood collection and illegal poaching of animal resources. • Although the impact is perceived to operate at local scales, it will persist in the long term owing to the predictable and constant attraction of people (both pastoralists and job-seekers) to areas that were previously less accessible.	SITE	LONG	HIGHLY PROBABLE	MEDIUM TO HIGH NEGATIVE	LOW NEGATIVE

TABLE 7.1: CONSTRUCTION AND OPERATION OF A DAM AT DAM SITE B

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT CONSTRUCTION PHASE: CONSTRUCTION OF DAM WALL AND BASIN AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT OPERATIONAL PHASE: UTILIZATION OF DAM AS A STORAGE FACILITY AND RELEASING WATER DIRECTLY INTO THE GABOSHA RIVER DOWNSTREAM OF DAM SITE B AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
ANIMAL LIFE (TERRESTRIAL FAUNA)	Increased anthropogenic encroachment: • This impact is probably one of the most important and most difficult impacts to mitigate. • However, construction of the dam at Dam Site B may facilitate access to previously less accessible areas, but more importantly may also attract the attention of distant human communities. • Consequently, easier access to the dam may result in the exploitation of natural resources and wildlife in the area. • This impact will affect a larger area than the inundation zone itself, and it will increase the possibility of "urban-sprawl".	LOCAL	LONG	HIGHLY PROBABLE	MEDIUM TO HIGH NEGATIVE	MEDIUM NEGATIVE	Increased anthropogenic encroachment: • During the operational phase, the presence of the access road to the dam may attract the attention of distant human communities. • Consequently, easier access to the dam may result in the exploitation of natural resources and wildlife in the area. • This impact will affect a larger area than the inundation zone itself, and it will increase the possibility of "urban-sprawl".	LOCAL	LONG	HIGHLY PROBABLE	MEDIUM TO HIGH NEGATIVE	MEDIUM NEGATIVE
SURFACE WATER/ SENSITIVE LANDSCAPES/ AQUATIC FAUNA	Habitat loss and deterioration – Dam Site B: • The construction of Dam Site B would impact directly on the Gabosha River, its associated river habitat and aquatic environment. Several drainage lines will also be affected. • Increased erosion can be expected as result of the clearing of vegetation during construction at Dam Site B. • Erosion can also be aggravated by alien vegetation encroachment in disturbed areas and river banks. • Construction activities alongside and within rivers (during dam construction, road crossing construction) furthermore disturb bottom substrates. • Increased input of sediment due to above mentioned activities will cause sedimentation of bottom substrates. This is especially significant in the study area where various fish and invertebrates occur that requires clean rocky substrates for survival (*Amphilius* species, *Chiloglanis* species, various invertebrate species).	SITE	LONG	DEFINITE	HIGH NEGATIVE	MEDIUM NEGATIVE	Habitat loss and deterioration - Dam Site B: • The inundation of the area will result in the flooding of 4.9ha of river habitat associated with the Gabosha River. A section (approximately 1.8 kilometres) of the Gabosha River will be inundated by the proposed dam (at full supply level). • Several drainage lines will also be affected by the dam at Dam Site B • The habitat within this reach will be completely transformed and all fast habitat will be transformed to slow habitats. • A complete loss of all rheophilic species is expected from this section (especially *Amphilius* and *Chiloglanis* fish species). • Dams furthermore create favourable habitat for alien fish species (such as Largemouth Bass, Common carp) as well as some indigenous species such as Sharptooth catfish. This may lead to increase predation on the smaller indigenous fish species in the upper reaches of the Gabosha River.	SITE	PERMANENT	DEFINITE	HIGH NEGATIVE	HIGH NEGATIVE
	Habitat loss and deterioration – Gabosha and Thole Rivers downstream of Dam Site B: • Increased erosion can be expected as a result of the clearing of vegetation during construction at Dam Site B. • Erosion can also be aggravated by alien vegetation encroachment in disturbed areas and river banks. • Construction activities alongside and within rivers (during dam construction, road crossing construction) furthermore disturb bottom substrates. • Increased input of sediment due to above mentioned activities will cause sedimentation of bottom substrates. This is especially significant in the study area where various fish and invertebrates occur that requires clean rocky substrates for survival (*Amphilius* species, *Chiloglanis* species, various invertebrate species). • The modification of flow patterns and decrease in flows of the downstream river reaches reduce the quantity and quality of the habitats. • Fast habitats will be transformed into slow habitats; the decrease in velocity may increase sedimentation and loss of bottom substrate quality. • Natural seasonal variation may be altered due to water storage and altered release patterns.	LOCAL	SHORT	DEFINITE	HIGH NEGATIVE	MEDIUM NEGATIVE	Habitat loss and deterioration – Gabosha and Thole Rivers downstream of Dam B: • It is possible that the volume of water to be discharged at the dam wall could differ from normal baseline flows due to seasonal variation in rainfall and abstraction. • The modification of flow patterns and decrease in flows of the downstream river reaches reduce the quantity and quality of the habitats. Fast habitats will be transformed into slow habitats; the decrease in velocity may increase sedimentation and loss of bottom substrate quality. • Changes in the flow regime, especially when the variation in sediment loads exceeds the norm may possibly have disastrous impacts on nutrient levels and sediment accumulation at areas downstream of the dam. • The proposed dam may act as a "silt-trap", thereby reducing the downstream volume of sediment transport. • This reduction in sediment may result in a marked reduction of nutrient-rich sediment deposits (as explained above) to be transported. • A reduction in sediment will also result in increased scouring and erosion of the riverbank, and deepening of the riverbed with a subsequent reduction in primary production. • However, when the dam operates at maximum capacity an additional release of water may be required and the additional volume of water could scour recently established riparian vegetation (downstream) and increase erosion. • On the other hand, a flow regime below the baseline could initiate and promote the establishment of vegetation composition and floristic structure that is atypical of current vegetation units (at pre-construction), thereby inducing changes to the faunal composition. • In addition, the predicted flow regime could also perpetuate seasonal flows with a low predicted variation between the dry and wet season	REGIONAL	LONG	HIGHLY PROBABLE	MEDIUM TO HIGH NEGATIVE	MEDIUM NEGATIVE

TABLE 7.1: CONSTRUCTION AND OPERATION OF A DAM AT DAM SITE B

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT CONSTRUCTION PHASE: CONSTRUCTION OF DAM WALL AND BASIN AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT OPERATIONAL PHASE: UTILIZATION OF DAM AS A STORAGE FACILITY AND RELEASING WATER DIRECTLY INTO THE GABOSHA RIVER DOWNSTREAM OF DAM SITE B AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
SURFACE WATER/ SENSITIVE LANDSCAPES/ AQUATIC FAUNA	▪ A temporary diversion channel will be constructed in order to divert the river to facilitate the damwall construction and allow unobstructed flow of the river and the movement of aquatic fauna and fish.	SITE	SHORT	DEFINITE	MEDIUM POSITIVE	MEDIUM POSITIVE	NONE. Fragmentation: • Dams create migration barriers to fish and therefore limit their ability to migrate and move freely in the reach for processes such as breeding and feeding. • Kotze (2017) indicated that the construction of Dam Site B will not impact on the migration of any fish species since the downstream area of the Gabosha River already contains barriers (Dorps Dam) preventing fish from migrating up this stream.					
	Water quality deterioration: The proposed activity may impact on water quality in the following ways: • accidental spills (fuels, oils, cement, etc.) during construction, • construction vehicles are not maintained/repaired resulting in oil leaks and fuel spills, • waste management measures are not implemented, • proper ablution and sanitation facilities are not provided for the site workers to use on site, • reduced flow in downstream river may lead to increase in temperature and decrease in oxygen, • flushing of sediment from dams (proposed new dam) may increase turbidity of downstream river, • removal of vegetation during construction may increase turbidity and result in sedimentation.	REGIONAL	SHORT	PROBABLE	HIGH NEGATIVE	LOW NEGATIVE	Water quality deterioration: • If rehabilitation of disturbed areas is not undertaken as part of the overall management of the dam, it may cause erosion on site and an increase in turbidity of the water resulting in sedimentation and a deterioration of the water quality. • Water quality deterioration could however take place if unregulated development or activities takes place within the catchment of Dam Site B that would ultimately impact on the residents of Amsterdam and KwaThandeka in terms of the delivery of potable water.	REGIONAL	LONG	PROBABLE	HIGH NEGATIVE	LOW NEGATIVE
	▪ A temporary diversion channel will be constructed in order to divert the river to facilitate the damwall construction and allow unobstructed flow of the river and the movement of aquatic fauna and fish.	SITE	SHORT	DEFINITE	MEDIUM POSITIVE	MEDIUM POSITIVE	Altered hydrological regimes of rivers by damming and water abstraction. ▪ Water will be released directly into the river course from the dam outlet works and will subsequently be abstracted at the abstraction point (Dorps Dam) for purification at the Amsterdam WTWs. ▪ Afri-Infra (2017) indicated the following: maximum required release for water supply: 35l/s; maximum EWR release: 67l/s. • The natural hydrology of the downstream river will be influenced in terms of volume and timing of flow. • The extent of the impact will be determined by the size (volume) of the dam and the amount of water to be abstracted. • The altered flows will especially impact on fish and macroinvertebrates with a requirement for fast flowing habitats (various rheophilic species present in study area). • Unnatural releases from dams (such as during desilting operations) may trigger unnatural fish migration/movement.	REGIONAL	PERMANENT	DEFINITE	HIGH NEGATIVE	MEDIUM TO HIGH NEGATIVE
	▪ A temporary diversion channel will be constructed in order to divert the river to facilitate the damwall construction and allow unobstructed flow of the river and thus no impact on downstream users (including cross border flows).	SITE	SHORT	DEFINITE	MEDIUM POSITIVE	MEDIUM POSITIVE	Downstream users: • Mallory (2017) indicated that other than the water use in the town of Amsterdam (to be supplied with water from the proposed new dam), there is very little water use downstream of the proposed dam. • No agricultural activities are located directly downstream of Dam Site B. The closest are located approximately 12 km downstream of the site. • According to Mallory (2017), there is an area of approximately 30 ha of irrigation that could be slightly impacted by the proposed dam. Pivot irrigation is also evident further downstream. • The said 30 ha of irrigation was simulated in the updated model and it was found that these irrigators enjoy a very high assurance of supply. According to Mallory (2017), these irrigators also benefit from return flows from the Amsterdam Waste Water Treatment Works which increases low flows.	REGIONAL	LONG	PROBABLE	LOW NEGATIVE	LOW NEGATIVE

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SURFACE WATER/ SENSITIVE LANDSCAPES/ AQUATIC FAUNA	▪ A temporary diversion channel will be constructed in order to divert the river to facilitate the damwall construction and allow unobstructed flow of the river and thus no impact on downstream users (including cross border flows).	SITE	SHORT	DEFINITE	MEDIUM POSITIVE	MEDIUM POSITIVE	Cross border flows and Ecological Water Requirements: ▪ Comparing the total Ngwempisi River catchment (1 540 km^2) to the catchment area of 53 km^2 of the proposed dam on the Gabosha River (i.e. Dam Site B), the impact of the new dam relative to the rest of the catchment is negligible. ▪ Mallory (2017) indicated that the intention is nevertheless to make an ecological release (maximum EWR release: 67l/s) from the Gabosha Dam which will also serve as this development's contribution to cross border flows. ▪ According to Mallory (2017), the EWR as a percentage of the natural MAR is 26.5% and hence the EWR, as an annual mean is 1.48 million m^3/annum. A maximum EWR release of 67l/s is proposed from Dam Site B.	REGIONAL	LONG	PROBABLE	MEDIUM NEUTRAL	MEDIUM NEUTRAL
GROUNDWATER	• The construction of Dam Site B would impact directly on the Gabosha River and could thus impact on the groundwater associated with the Gabosha River.	SITE	LONG	PROBABLE	LOW NEGATIVE	LOW NEGATIVE	▪ The inundation of the area will result in the flooding of 4.9ha of river habitat and could have a positive impact on the groundwater associated with the Gabosha River.	SITE	LONG	PROBABLE	LOW POSITIVE	LOW POSITIVE
SITES OF ARCHAEOLOGICAL /CULTURAL INTEREST	▪ NONE. Van Vollenhoven (2017) identified no graves, archaeological or cultural sites, etc. within Dam Site B.						▪ NONE. No further construction activities would take place.					
SITES OF PALAEONTOLO-GICAL INTEREST	▪ According to Fourie (2017b), the Amsterdam Formation is present at the proposed Dam B Site. The Amsterdam Formation is in the form of a syncline and reaches a thickness of 250m. Rhyolite is present at the base and top. Two Members are present, the Gabosha Dacite and the Vaalkop Rhyolite. ▪ According to Fourie (2017), the palaeontological sensitivity of the Amsterdam Formation is Very Low and no study is required as no impact is foreseen.						▪ NONE. No further construction activities would take place.					
AIR QUALITY	▪ Dust generation and vehicle emissions due to construction activities and use of heavy machinery could impact on site workers. ▪ Dust generated could settle in the Gabosha River flowing through Dam Site B and could impact on the surface water quality and aquatic life onsite and downstream of Dam Site B. ▪ The extent of the impact would depend on the time of year, wind direction and velocity.	SITE	SHORT	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ No impact in terms of dust since no further construction activities will take place.					
VISUAL	▪ The construction activities would not be visible from any residential area or from the nearby R65 provincial road. ▪ The construction activities would however have a visual impact on the immediate surrounding rural area if not managed properly,	SITE	SHORT	DEFINITE	LOW NEGATIVE	LOW NEGATIVE	• If rehabilitation of disturbed areas is not undertaken as part of the overall management of the dam, it may cause erosion on site and result in a visual impact of the immediate rural area. • Once inundated, the presence of the waterbody (20ha in extent) should have a positive impact on the visual aspect of the area attracting visitors for recreation purposes e.g. bird watching, fishing, etc.	SITE	LONG	HIGHLY PROBABLE	LOW NEUTRAL	LOW NEUTRAL
NOISE	▪ Noise generated as a result of the construction activities (including use of heavy machinery, possible blasting) would impact on site workers. ▪ Noise generated could also impact on the animal life and aquatic fauna associated with the Gabosha River and Dam Site B. ▪ No farmsteads are located in close proximity to Dam Site B.	SITE	SHORT	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ NONE. No further impact **-** no further construction activities.					

TABLE 7.1: CONSTRUCTION AND OPERATION OF A DAM AT DAM SITE B

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT CONSTRUCTION PHASE: CONSTRUCTION OF DAM WALL AND BASIN AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT OPERATIONAL PHASE: UTILIZATION OF DAM AS A STORAGE FACILITY AND RELEASING WATER DIRECTLY INTO THE GABOSHA RIVER DOWNSTREAM OF DAM SITE B AREA: 20 ha	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
TRAFFIC	▪ During the construction phase, heavy vehicles will utilise the R65 provincial road and the proposed access road for the delivery of material. Depending on the frequency of deliveries, the heavy vehicles could impact on the condition the roads and the traffic flow along these roads. The deliveries would however, not occur on a continuous basis and the impact is expected to be low.	SITE	SHORT	PROBABLE	LOW NEGATIVE	LOW NEGATIVE	▪ NONE.					
INTERESTED AND AFFECTED PARTIES	▪ Contractors working on site could be directly impacted upon if the necessary safety and occupational health measures are not adhered to (especially if blasting is required due to the underlying geology).	SITE	SHORT	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ Employees of the Mkhondo Local Municipality could be impacted upon if the necessary safety and occupational health measures are not adhered to during the operational phase of the project.	SITE	LONG	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE
	▪ Job opportunities would be provided during the construction phase.	SITE	SHORT	HIGHLY PROBABLE	MEDIUM POSITIVE	MEDIUM POSITIVE	▪ A few job opportunities may be available during the operational phase.	SITE	LONG	PROBABLE	MEDIUM POSITIVE	MEDIUM POSITIVE
							If dam failure occurs, the road users of the provincial R65 road as well as the residents of Amsterdam and KwaThandeka could be impacted in terms of flooding.	LOCAL	LONG	IMPROBABLE	HIGH NEGATIVE	LOW NEGATIVE
	• Dam Site B is currently vacant with no infrastructure and belongs to the Mkhondo Local Municipality. • Dam Site B is indicated as Non-arable. No cultivation was noted within the proposed Dam Site B area due to the rocky nature of the area • Dam Site B is indicated as low to moderate potential grazing land. The grazing potential is indicated as less than 4ha/animal unit. The said area is used for informal grazing purposes. • The construction of the temporary diversion channel, quarry, dam wall and dam basin will result in the area no longer being available for informal grazing purposes**.**	SITE	LONG	DEFINITE	LOW NEGATIVE	LOW NEGATIVE	• A new land use namely storage of water for municipal use will be created on the said property as part of the overall water provision service of the Mkhondo Local Municipality. In the long term, this would benefit the residents of Amsterdam and KwaThandeka. • In addition, the presence of a dam on the said property could result in the previously unutilised area being used for recreational purposes (e.g. fishing, birding, etc.) by the residents of Amsterdam and KwaThandeka. • In the Amsterdam Reconciliation Strategy Report, it is recorded that in times of water shortages the yield of the Gabosha River is augmented from Westoe Dam via the bulk link pipeline between Westoe Dam and Jericho Dam. This augmentation is not governed by an official agreement between the Department of Water and Sanitation (DWS) and the Mkhondo Local Municipality. Water releases only take place after lengthy negotiations at elevated VRESAP (Vaal River Eastern Sub-system Augmentation Project) tariffs. Dam Site B is thus ideally located in order to utilise this emergency back-up in times of need.	SITE	LONG	HIGHLY PROBABLE	MEDIUM POSITIVE	MEDIUM POSITIVE

TABLE 7.2: CONSTRUCTION AND UTILIZATION OF ACCESS ROAD WITH RIVER CROSSINGS

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT: CONSTRUCTION PHASE CONSTRUCTION OF ACCESS ROAD WITH RIVER CROSSINGS AREA: ±1km X 8m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT: OPERATIONAL PHASE UTILIZATION OF ACCESS ROAD WITH RIVER CROSSINGS AREA: ±1km X 8m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
TOPOGRAPHY	▪ The construction of a gravel access road/upgrading of the existing dirt track would impact directly on the topography of the site i.t.o. the clearing of the road footprint area and required excavations. ▪ The construction of the river/bridge crossings would impact on the Gabosha River.	SITE	SHORT	HIGHLY PROBABLE	LOW NEGATIVE	LOW NEGATIVE	The impact on topography in terms of the presence of the road and the river/bridge crossings will continue during the operational phase.	SITE	LONG	HIGHLY PROBABLE	LOW NEGATIVE	LOW NEGATIVE
GEOLOGY	▪ Depending on the depth of excavations required in terms of the widening and upgrading of the existing dirt track, the underlying geology (pyroclastic rocks and ash-flow tuff (Dacite lava) of the Gobasha Member, Amsterdam Formation) could be impacted upon. The possible impact on the underlying geology cannot be mitigated.	SITE	PERMANENT	DEFINITE	LOW NEGATIVE	LOW NEGATIVE	NONE. No further impact on geology since no further construction activities will take place.					
SOILS	▪ The existing dirt track and informal river crossings have already impacted on the soil of the area in terms of compaction. ▪ The construction of a gravel access road/widening and upgrading of the existing dirt track will impact directly on the soil of the proposed road route. In addition, the stockpiling of topsoil, subsoil, overburden and rocks would also directly impact on the soil in terms of soil structure, nutritional and chemical values. ▪ The construction of the river/bridge crossings would involve the cleaning and shaping of the riverbed that would impact negatively on the soil in terms of excavation, compaction, etc. ▪ Sediment transport and erosion may occur following the excavation activities if mitigation measures are not implemented.	SITE	SHORT	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ Impact on soil would continue i.t.o. soil structure, nutritional and chemical values and soil compaction. ▪ Erosion may take place if the disturbed areas at the river crossings are not revegetated and rehabilitated after construction. ▪ Soil erosion could also occur if the necessary storm water infrastructure is not provided as part of the upgrading of the road and the river/bridge crossings or if this infrastructure is not installed properly and maintained.	SITE	LONG	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE
	Construction activities could lead to soil pollution if: ▪ the construction vehicles are not maintained/repaired resulting in oil leaks and fuel spills; ▪ waste management measures are not implemented, ▪ proper ablution and sanitation facilities are not provided for the site workers to use on site.	SITE	SHORT	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further impact on soil since no further construction activities will take place.					
LAND USE/ SENSE OF PLACE	NONE. An existing road with informal river crossings will be upgraded in order to gain access to the proposed Dam Site B. The construction activities would not impact on any land use/activities as the said site is currently vacant and the said property also belongs to the Mkhondo Local Municipality.						• The access road will provide access to the proposed Dam Site B that forms part of the overall water provision services of the Mkhondo Local Municipality that ultimately provides water to the residents of Amsterdam and KwaThandeka. It will thus have a positive impact on interested and affected parties residing in Amsterdam and KwaThandeka.	LOCAL	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE
NATURAL VEGETATION AND ASSOCIATED ANIMAL LIFE	The existing dirt track and informal river crossings have already impacted on the natural vegetation and animal life of the area. The construction of a gravel access road/upgrading and widening of the existing dirt track would impact directly on the following vegetation units and associated fauna (Venter and Niemand, 2017b) namely: • Montane Grassland; • Weedy Grassland; • Invasive Woody. The construction of the river/bridge crossings will impact on the River (watercourse) vegetation unit associated with the Gabosha River and therefore the associated aquatic fauna. No wetland vegetation units would be impacted.	SITE	LONG	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ No further direct impact on vegetation since no further construction activities will take place. ▪ However, if the disturbed areas at the river crossings are not properly rehabilitated it could lead to erosion and sedimentation of downstream areas associated with the Gabosha River. ▪ In addition it could result in the introduction of alien plants into areas disturbed by construction activities and not rehabilitated.	SITE	LONG	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE

TABLE 7.2: CONSTRUCTION AND UTILIZATION OF ACCESS ROAD WITH RIVER CROSSINGS

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT: CONSTRUCTION PHASE CONSTRUCTION OF ACCESS ROAD WITH RIVER CROSSINGS AREA: ±1km X 8m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT: OPERATIONAL PHASE UTILIZATION OF ACCESS ROAD WITH RIVER CROSSINGS AREA: ±1km X 8m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
SURFACE WATER/ SENSITIVE LANDSCAPE/ AQUATIC FAUNA	The construction of a gravel access road/upgrading of the existing dirt track will impact directly on the Gabosha River in terms of the provision of river/bridge crossings. This will result in the removal of vegetation within the footprint area of the river crossing that could result in the habitat loss as well as the deterioration of habitat in close proximity thereof. It could also lead to increased erosion that could be aggravated by alien vegetation encroachment in disturbed areas and river banks. Construction activities alongside and within rivers furthermore disturb bottom substrates. Increased input of sediment due to above mentioned activities will cause sedimentation of bottom substrates. This is especially significant in the study area where various fish and invertebrates occur that requires clean rocky substrates for survival (*Amphilius* species, *Chiloglanis* species, various invertebrate species).	SITE	SHORT	DEFINITE	MEDIUM NEGATIVE	MEDIUM NEGATIVE	▪ If disturbed areas are not properly rehabilitated and proper stormwater control measures are not implemented, it could lead to erosion and sedimentation of downstream areas associated with the Gabosha River. ▪ Soil erosion and resultant sedimentation of the Gabosha River could also occur if the necessary storm water infrastructure is not provided as part of the upgrading of the road and the river/bridge crossings or if this infrastructure is not installed properly and maintained.	SITE	LONG	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE
	The construction of the river/bridge crossings may impact on water quality and aquatic fauna in the following ways: • accidental spills (fuels, oils, cement, etc.) during construction, • construction vehicles are not maintained/repaired resulting in oil leaks and fuel spills; • reduced flow in downstream river may lead to increase in temperature and decrease in oxygen, • removal of vegetation during construction may increase turbidity and result in sedimentation. • waste management measures are not implemented, • proper ablution and sanitation facilities are not provided for the site workers to use on site.	SITE	SHORT	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ The utilization of the road and river/bridge crossings could result in contaminated surface water runoff (containing fuel, oils, etc.) flowing into the Gabosha River.	LOCAL	LONG	PROBABLE	MEDIUM NEGATIVE	MEDIUM NEGATIVE
GROUNDWATER	▪ The construction of river/bridge crossings could impact on the groundwater associated with the Gabosha River.	SITE	SHORT	PROBABLE	LOW NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
SITES OF ARCHAEOLOGICAL /CULTURAL INTEREST	▪ NONE. Van Vollenhoven (2016) identified no graves, archaeological or cultural sites, etc. along the dirt track or at the proposed river crossing.						NONE. No further construction will take place.					
SITES OF PALAEONTOLO-GICAL INTEREST	▪ The pipeline is underlain by pyroclastic rocks and ash-flow tuff (Dacite lava) of the Gobasha Member, Amsterdam Formation. ▪ According to Fourie (2017), the palaeontological sensitivity of the Amsterdam Formation is Very Low.	SITE	SHORT	IMPROBABLE	LOW NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
AIR QUALITY	▪ Dust generation and vehicle emissions due to construction activities and use of heavy machinery could impact on site workers as well as the water quality and aquatic fauna of the Gabosha River. ▪ The extent of the impact would depend on the time of year, wind direction and velocity.	SITE	SHORT	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	• If the gravel road is not tarred or paved, dust could be generated when vehicles utilise the said road to gain access to Dam Site B. This could impact on the water quality and aquatic fauna of the Gabosha River in close proximity to the river/bridge crossings. • The extent of the impact would depend on the time of year, wind direction and velocity. It would also depend on how often the road is used.	SITE	LONG	PROBABLE	LOW NEGATIVE	LOW NEGATIVE
VISUAL	▪ The construction activities could be visible from the immediate surrounding area and the nearby provincial R65 road. ▪ The presence of construction activities on the said site could potentially impact on the visual aspect of the site if the site is not kept neat and tidy at all times.	SITE	SHORT	PROBABLE	LOW NEGATIVE	LOW NEGATIVE	▪ The access road and the river/bridge crossings could be visible from the immediate surrounding area and the nearby provincial R65 road.	SITE	LONG	PROBABLE	LOW NEGATIVE	LOW NEGATIVE

TABLE 7.2: CONSTRUCTION AND UTILIZATION OF ACCESS ROAD WITH RIVER CROSSINGS

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT: CONSTRUCTION PHASE CONSTRUCTION OF ACCESS ROAD WITH RIVER CROSSINGS AREA: ±1km X 8m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT: OPERATIONAL PHASE UTILIZATION OF ACCESS ROAD WITH RIVER CROSSINGS AREA: ±1km X 8m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
NOISE	▪ Noise generated as a result of the construction activities (including use of heavy machinery) would impact on site workers and fauna present in the surrounding area. ▪ Noise generated as a result of the construction of the river/bridge crossings could impact on the aquatic fauna associated with the Gabosha River.	SITE	SHORT	DEFINITE	MEDIUM NEGATIVE	MEDIUM NEGATIVE	Noise would be created by vehicles utilizing the gravel access road and river crossings. The impact of the additional noise on fauna in the area would depend on the volume of traffic.	LOCAL	LONG	PROBABLE	LOW NEGATIVE	LOW NEGATIVE
TRAFFIC	▪ During the construction phase, heavy vehicles will utilise the provincial R65 road and the existing dirt track to gain access to the construction site in order to deliver material to site. ▪ Depending on the frequency of deliveries, the heavy vehicles could impact on the condition of the roads and the traffic flow along these roads. The deliveries would however, not occur on a continuous basis and the impact is expected to be low.	SITE	SHORT	PROBABLE	LOW NEGATIVE	LOW NEGATIVE	NONE. Traffic flow along the access road is expected to be very low once the dam is operational.					
INTERESTED AND AFFECTED PARTIES	▪ The gravel access road and river crossings will be located on property belonging to the Mkhondo Local Municipality and will form part of the overall service provision of the said municipality.	SITE	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE	• During the operational phase, the gravel road will allow access to the new dam for general management and maintenance purposes and will thus have a positive impact on residents in Amsterdam and KwaThandeka in terms of ensuring water supply and dam safety.	LOCAL	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE
	▪ Contractors working on site could be directly impacted upon if the necessary safety and occupational health measures are not adhered to. ▪ Injury to pedestrians if the necessary safety precautions are not taken.	SITE	SHORT	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
	▪ Job opportunities would be provided during the construction phase.	SITE	SHORT	DEFINITE	MEDIUM POSITIVE	MEDIUM POSITIVE	• No job opportunities would be provided during the operational phase.					
	▪ Other potential impacts on I&AP's in terms of noise, visual, etc. are indicated above.						▪ Other potential impacts on I&AP's in terms of noise, visual, etc. are indicated above.					

TABLE 7.3: CONSTRUCTION AND UTILIZATION OF PIPELINE CROSSING NO. 1

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT: CONSTRUCTION PHASE CONSTRUCTION OF PIPELINE CROSSING NO. 1 AREA: 200m X 10m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT: OPERATIONAL PHASE UTILIZATION OF PIPELINE CROSSING NO. 1 AS PART OF OVERALL DISTRIBUTION LINE	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
TOPOGRAPHY	▪ Direct impact i.t.o. the clearing of the site and excavations (trenches). The impact will however, be temporary in nature since the pipeline will be located underground and the site will be rehabilitated.	SITE	SHORT	HIGHLY PROBABLE	LOW NEGATIVE	LOW NEGATIVE	NONE. No further impact on the topography since the pipeline will be located underground and will be rehabilitated.					
GEOLOGY	▪ The pipeline will be installed at a depth of ±2m. The underlying geology (pyroclastic rocks and ash-flow tuff (Dacite lava) of the Gobasha Member, Amsterdam Formation) would thus be impacted upon. The possible impact on the underlying geology cannot be mitigated.	SITE	PERMANENT	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further impact on geology since no further construction activities will take place.					
SOILS	▪ The excavation of a trench will impact directly on the soil associated with an area of approximately 200m x 10m. In addition, the stockpiling of topsoil, subsoil, overburden and rocks would also directly impact on the soil in terms of soil structure, nutritional and chemical values. ▪ Sediment transport and erosion may occur following the excavation activities if mitigation measures are not implemented.	SITE	SHORT	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ Impact on soil will continue i.t.o. soil structure, nutritional and chemical values and soil compaction. ▪ Erosion may take place if the disturbed area is not revegetated and rehabilitated after installation.	SITE	LONG	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE
	Construction activities could lead to soil pollution if: ▪ the construction vehicles are not maintained/repaired resulting in oil leaks and fuel spills; ▪ waste management measures are not implemented, ▪ proper ablution and sanitation facilities are not provided for the site workers to use on site.	SITE	SHORT	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further impact on soil since no further construction activities will take place and the said site will be rehabilitated.					
LAND USE/ SENSE OF PLACE	NONE. The construction activities would not impact on any land use/activities as the said site is currently vacant and located within the residential area of Amsterdam. The said property also belongs to the Mkhondo Local Municipality. The pipeline forms part of the overall service provision of the Mkhondo Local Municipality.						• The overall installation of the Distribution Pipeline from the Amsterdam Water Treatment Works to Amsterdam and KwaThandeka will provide potable water to the residents. It will thus have a positive impact on interested and affected parties residing in Amsterdam and KwaThandeka.	LOCAL	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE
NATURAL VEGETATION AND ASSOCIATED ANIMAL LIFE	The construction of Pipeline Crossing No. 1 will impact directly on the following vegetation units present between Point C and Point D namely: • River (watercourse) vegetation unit associated with the Gabosha River; • Modified grassland present on the embankment of the Gabosha River. No wetland vegetation units will be impacted by the proposed construction of Pipeline Crossing No. 1.	SITE	LONG	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ No further direct impact on vegetation since no further construction activities will take place. ▪ However, if the disturbed areas are not properly rehabilitated it could lead to erosion and sedimentation of downstream areas. ▪ In addition it could result in the introduction of alien plants into areas disturbed by construction activities and not rehabilitated.	SITE	LONG	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE
SURFACE WATER/ SENSITIVE LANDSCAPE/ AQUATIC FAUNA	The construction of Pipeline Crossing No. 1 will impact directly on the Gabosha River and result in the removal of vegetation within the footprint area that could result in habitat loss as well as the deterioration of habitat in close proximity thereof. It could also lead to increased erosion that could be aggravated by alien vegetation encroachment in disturbed areas and river banks. Construction activities alongside and within rivers furthermore disturb bottom substrates. Increased input of sediment due to above mentioned activities will cause sedimentation of bottom substrates. This is especially significant in the study area where various fish and invertebrates occur that requires clean rocky substrates for survival (*Amphilius* species, *Chiloglanis* species, various invertebrate species).	SITE	SHORT	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	▪ If disturbed areas are not properly rehabilitated it could lead to erosion and sedimentation of downstream areas. ▪ Increased sedimentation could impact on aquatic species that requires clean rocky substrates for survival.	SITE	LONG	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE

TABLE 7.3: CONSTRUCTION AND UTILIZATION OF PIPELINE CROSSING NO. 1

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT: CONSTRUCTION PHASE CONSTRUCTION OF PIPELINE CROSSING NO. 1 AREA: 200m X 10m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT: OPERATIONAL PHASE UTILIZATION OF PIPELINE CROSSING NO. 1 AS PART OF OVERALL DISTRIBUTION LINE	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
SURFACE WATER/ SENSITIVE LANDSCAPE/ AQUATIC FAUNA	The construction of Pipeline Crossing No. 1 may impact on water quality and aquatic fauna in the following ways: • accidental spills (fuels, oils, cement, etc.) during construction, • construction vehicles are not maintained/repaired resulting in oil leaks and fuel spills; • reduced flow in downstream river may lead to increase in temperature and decrease in oxygen, • removal of vegetation during construction may increase turbidity and result in sedimentation. • waste management measures are not implemented, • proper ablution and sanitation facilities are not provided for the site workers to use on site.	SITE	SHORT	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
GROUNDWATER	▪ The excavation of the trench for the pipeline could impact on the groundwater associated with the Gabosha River.	SITE	SHORT	PROBABLE	LOW NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
SITES OF ARCHAEOLOGICAL /CULTURAL INTEREST	▪ NONE. Van Vollenhoven (2016) identified no graves, archaeological or cultural sites, etc. along the pipe line route from Point C to Point D (i.e. Pipeline Crossing no. 1).						NONE. No further construction will take place.					
SITES OF PALAEONTOLO-GICAL INTEREST	▪ The pipeline is underlain by pyroclastic rocks and ash-flow tuff (Dacite lava) of the Gobasha Member, Amsterdam Formation. ▪ According to Fourie (2017), the palaeontological sensitivity of the Amsterdam Formation is Very Low.	SITE	SHORT	IMPROBABLE	LOW NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
AIR QUALITY	▪ Dust generation and vehicle emissions due to construction activities and use of heavy machinery could impact on site workers as well as the water quality and aquatic fauna of the Gabosha River. ▪ The extent of the impact would depend on the time of year, wind direction and velocity.	SITE	SHORT	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
VISUAL	▪ The construction activities would be visible from the nearby homes since the construction site is located within the residential area of Amsterdam. ▪ The presence of construction activities on the said site could potentially impact on the visual aspect of the site if the site is not kept neat and tidy at all times.	SITE	SHORT	HIGHLY PROBABLE	LOW NEGATIVE	LOW NEGATIVE	NONE. The Distribution Pipeline will be located underground and would not be visible.					
NOISE	▪ Noise generated as a result of the construction activities (including use of heavy machinery) would impact on site workers, the aquatic fauna associated with the Gabosha River as well as any other animals present within the said area. ▪ In addition, it could impact on the residents of the nearby homes since the construction site is located within the residential area of Amsterdam.	SITE	SHORT	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
TRAFFIC	▪ During the construction phase, heavy vehicles will utilise the roads extending through the residential area of Amsterdam in order to deliver material to site. ▪ Depending on the frequency of deliveries, the heavy vehicles could impact on the condition of the roads and the traffic flow along these roads. The deliveries would however, not occur on a continuous basis and the impact is expected to be low.	SITE	SHORT	PROBABLE	LOW NEGATIVE	LOW NEGATIVE	NONE. The pipeline will be located underground and will have no impact on traffic during the operational phase.					

TABLE 7.3: CONSTRUCTION AND UTILIZATION OF PIPELINE CROSSING NO. 1

ENVIRONMENTAL FEATURE(S)	PREDICTED IMPACT: CONSTRUCTION PHASE CONSTRUCTION OF PIPELINE CROSSING NO. 1 AREA: 200m X 10m	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)	PREDICTED IMPACT: OPERATIONAL PHASE UTILIZATION OF PIPELINE CROSSING NO. 1 AS PART OF OVERALL DISTRIBUTION LINE	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
INTERESTED AND AFFECTED PARTIES	▪ The proposed pipeline will be located on property belonging to the Mkhondo Local Municipality and will form part of the overall service provision of the said municipality.	SITE	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE	• The overall installation of the Distribution Pipeline from the Amsterdam Water Treatment Works to Amsterdam and KwaThandeka will provide potable water to the residents. It will thus have a positive impact on interested and affected parties residing in Amsterdam and KwaThandeka.	LOCAL	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE
	▪ Contractors working on site could be directly impacted upon if the necessary safety and occupational health measures are not adhered to. ▪ Injury to pedestrians if the necessary safety precautions are not taken.	SITE	SHORT	HIGHLY PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE	NONE. No further construction will take place.					
	▪ Job opportunities would be provided during the construction phase.	SITE	SHORT	DEFINITE	MEDIUM POSITIVE	MEDIUM POSITIVE	• No job opportunities would be provided during the operational phase.					
	▪ Other potential impacts on I&AP's in terms of noise, visual, etc. are indicated above.						▪ Other potential impacts on I&AP's in terms of noise, visual, etc. are indicated above.					

TABLE 7.4: DESILTING OF DORPS DAM


Kotze (2017) indicated the following regarding the existing Dorps Dam and abstraction facility located in the Gabosha River:

- Dorps Dam is currently a migration barrier to fish movement in the Gabosha River;
- Extensive grown of alien vegetation (wattle) along dam and downstream river reach;
- Proposed desilting may impact downstream reaches of the Gabosha and Thole Rivers.

DESCRIPTION OF IMPACT:	EXTENT	DURATION	PROBABILITY	SIGNIFICANCE (PRE-MITIGATION)	SIGNIFICANCE (POST MITIGATION)
No potential impacts identified The desilting of the Dorps Dam would not impact on the following environmental features: Topography, Geology, Groundwater, Sites of Archaeological and/or Cultural Interest, Sites of Palaeontological Interest, Sense of Place, Visual aspect, Traffic. These above-mentioned environmental features will therefore not be discussed any further.					
Soil: The removal of accumulated silt from the Dorps Dam and the subsequent stockpiling thereof could impact on the underlying soil in terms of compaction and quality (especially if pollutants/waste are present in the silt).	SITE	SHORT	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE
Land Use: The current abstraction weir in the Gabosha River (Dorps Dam) has a gross capacity of 220 000m^3 but is silted up. This affects the water supply to Amsterdam as run-of-river water is relied upon. The desilting of the Dorps Dam (removal of accumulated silt in the said dam) will increase the capacity of the dam in terms of the storage of water and will thus have a positive impact on the current land use (i.e. storage of water).	SITE	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE
Natural vegetation: The removal of silt from the Dorps Dam will not impact on any natural vegetation. However, it is understood that as part of this project the alien trees on the embankments of the dam will be removed.	SITE	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE
Surface water and aquatic fauna - altered hydrological regime: Kotze (2017) indicated that unnatural releases from the Dorps Dam as a result of the desilting operation may trigger unnatural fish migration/movement.	REGIONAL	SHORT	DEFINITE	HIGH NEGATIVE	MEDIUM NEGATIVE

TABLE 7.4: DESILTING OF DORPS DAM					
Surface water and aquatic fauna - habitat loss and deterioration: Kotze (2017) indicated that increased sedimentation due to the desilting of the Dorps Dam can also be expected in the downstream Gabosha River if the sediment is disturbed in the dam and flushed into the downstream river. Increased input of sediment due to above mentioned activities will cause sedimentation of bottom substrates. This is especially significant in the study area where various fish and invertebrates occur that requires clean rocky substrates for survival (*Amphilius* species, *Chiloglanis* species, various invertebrate species).	LOCAL	SHORT	DEFINITE	HIGH NEGATIVE	MEDIUM NEGATIVE
Surface water - water quality deterioration: Kotze (2017) indicated that increased sedimentation due to the desilting of the Dorps Dam can result in increased turbidity and thus water quality deterioration in the downstream Gabosha River if the sediment is disturbed in the dam and flushed into the downstream river.	REGIONAL	SHORT	DEFINITE	HIGH NEGATIVE	LOW NEGATIVE
Noise: Noise generated as a result of the desilting operation (including use of heavy machinery) would impact on site workers, the aquatic fauna associated with the Dorps Dam/Gabosha River as well as any other animals present within the said area.	SITE	SHORT	DEFINITE	MEDIUM NEGATIVE	LOW NEGATIVE
Air quality: The removal of accumulated silt from the Dorps Dam and the subsequent stockpiling thereof could impact on the air quality of the site if allowed to dry out and dust is generated. This could impact on the site workers and also settle on the surface of the Dorps Dam affecting water quality and the aquatic fauna. It could also impact on the downstream environment.	SITE	SHORT	PROBABLE	MEDIUM NEGATIVE	LOW NEGATIVE
Interested and affected parties: Increased sedimentation due to the desilting of the Dorps Dam can result in increased turbidity and thus water quality deterioration in the downstream Gabosha River if the sediment is disturbed in the dam and flushed into the downstream river. This could impact on downstream water users.	REGIONAL	SHORT	DEFINITE	HIGH NEGATIVE	LOW NEGATIVE
Interested and Affected Parties: The current abstraction weir in the Gabosha River (Dorps Dam) has a gross capacity of 220 000m^3 but is silted up. This affects the water supply to Amsterdam as run-of-river water is relied upon. The desilting of the Dorps Dam (removal of accumulated silt in the said dam) will increase the capacity of the dam in terms of the storage of water and will thus have a positive impact on the storage of water and therefore water provision to the residents of Amsterdam and KwaThandeka.	SITE	LONG	DEFINITE	HIGH POSITIVE	HIGH POSITIVE

7.5 Cumulative impacts

Natural vegetation and Terrestrial fauna
The loss of habitat as a result of clearing the dam basin and subsequent inundation thereof is probably the largest impact regarding this project in terms of surface area (when compared to the other proposed activities). Several natural habitat types (grassland, woody areas, Gabosha River) will become permanently lost impacting on Red Data Mammal (14 mammal taxa of conservation concern) and bird species (21 threatened or near threatened bird species, 5 of which could be directly impacted). Although the impact appears to be of high magnitude, a large area of habitat is actually represented by alien invasive woody vegetation at Dam Site B. With reference to Dam Site B, large areas of similar habitat (mainly montane grassland) occurs adjacent to the proposed maximum inundation level of the proposed dam, which will in all likelihood result in the displacement of highly mobile fauna species (e.g. ungulates and birds).

Aquatic fauna
The primary impacts that will have a cumulative impact in terms of aquatic fauna are *water quality deterioration* and *water quantity/hydrological alterations* (Kotze, 2017).

The stability of a system could be described by concepts such as resilience (ability of system to recover from disturbance) and elasticity (speed with which the system returns to its original state after removal of the disturbance). The important issue is however, not whether an ecosystem can be classified as stable or fragile, but how much the particular ecosystem changes after a specific disturbance (Roux, 1999). Although these ecosystems have a limited ability to recover after pollution incidence or prolonged exposure to impacts, the overall ecological integrity of the system will generally be altered from its natural state and is unlikely to ever return to the pre-disturbance condition. The more severe and widespread (in spatial and temporal terms) an impact occurs, the lower the possibility of recovery [Such as the eradication of fish due to a spill in an area. Should there be dams and other migration barriers, physical or chemical, they are unlikely to return or recolonise the area again and may be lost with a radical impact on the aquatic ecosystem].

Water quality: The proposed activity is not expected to have a significant cumulative contribution to water quality deterioration in the area with the following impacts expected. Decreased flows in Thole River (due to damming of Gabosha River) may reduce the natural dilution of pollutants from Amsterdam town and hence lead to overall deterioration in water quality of lower Thole River (downstream of Gabosha confluence).

Water quantity: The proposed activity is expected to contribute to a decrease in the flows available in the rivers. The abstraction of water is an important socio-cultural commitment. This activity will contribute to the overall decrease in the quantity of water available to the environment and it is essential that ecological water requirements (environmental reserves) should be met.

8. ENVIRONMENTAL IMPACT STATEMENT

8.1 Introduction

The objective of this project is to upgrade and refurbish the Bulk Water Supply Infrastructure to Amsterdam, situated in the jurisdiction area of the Mkhondo Local Municipality (MLM). The Amsterdam Regional Water Supply Scheme currently serves a population of approximately 14 500 people who reside within the boundaries of the scheme. These residents are reliant on the scheme to provide a sustainable water supply. The scheme currently abstracts water from a single location (Dorps Dam) within the catchment of the Gabosha River, a tributary of the Ngwempisi River. It relies on run-of-river abstraction only. It is not connected to any National Bulk Water Infrastructure.

The augmentation of the water supply to the town of Amsterdam has been investigated since 2014. As indicated in Section 6, a number of alternatives were investigated.

The construction of a new Water Treatment Works (WTWs) was not investigated since the existing Amsterdam WTWs has sufficient capacity in terms of the 2034 demand requirements (Afri-Infra, 2016). The upgrading of the facilities as indicated in Section 6.2.1 is however required. As indicated in Section 4.7.2.3, an Environmental Authorisation with regards to the upgrading/refurbishment of the Amsterdam WTWs is not required

The current abstraction weir in the Gabosha River (Dorps Dam) has a gross capacity of 220 000m^3 but is silted up. This affects the water supply to Amsterdam as run-of-river water is relied upon. The desilting of the Dorps Dam is proposed as an activity to be undertaken as part of the upgrading of the Amsterdam Regional Water Supply Scheme. The potential impact as a result of the desilting of this dam is detailed in Table 7.4. Mitigation measures to be implemented to reduce the potential impact are detailed in Section 9.

Afri-Infra (2016) indicated that during preliminary planning it was envisaged that the Amsterdam Water Supply Scheme would be integrated with the Empuluzi/Methula, Lusushwana and Sheepmoor Water Supply Scheme as a Regional Bulk Water Supply Scheme with Westoe and Morgenstond Dams as primary source. These dams are however committed to supply water for national energy needs and were therefore not considered as favourable options (Afri-Infra, 2016).

Subsequent discussion with stakeholders resulted in the decision being taken to deal with the Amsterdam Water Supply Scheme as a stand-alone scheme supplying water to the communities of Amsterdam and KwaThandeka (Afri-Infra, 2016). The idea of integrating the Amsterdam Regional Water Supply Scheme with another water supply scheme was thus discarded.

Mallory (2017) indicated that storage is definitely required and that it is not possible to meet Amsterdam's growing water demand from run-of-river abstractions.

8.2 Sites investigated

Three (3) weir sites were investigated and discarded since there is insufficient water from run-of–river yield if the Ecological Water Requirements (EWR) and the minimum cross-border flows are to be included.

The W5H025 site located in the Usuthu River was also discarded from further investigation as it is not suitable for a dam due to the massive upstream abstractions.

From a hydrological perspective, the Thole Site would be the best option (Mallory and Jacobs, 2014). However, Mallory and Jacobs (2014) indicated that the terrain of the Gabosha Site is better suited to the construction of a weir/dam as the valley sides are much steeper than those found in the Thole River valley. It was further indicated that a larger dam at the Gabosha Site could be more cost effective than a smaller dam at the Thole Site.

Dam Site A (Thole River) would have a greater socio-economic impact on the local community than the proposed Dam Site B. A few houses, gravel roads, footpaths and pieces of agricultural land would be flooded. The construction of the dam within the Thole River could also impact on the downstream users (e.g. irrigation farmers; etc.). In addition, in the long term the water quality could be impacted in view of its close proximity to residential areas, an existing landfill site, bulk sewer line, etc. This could ultimately impact on water treatment costs and the provision of potable water to the residents of Amsterdam. It was therefore felt that Dam Site A was not suitable for a long term water supply dam in view of the potential pollution risk. In addition, the pumping of water to the Amsterdam WTWs would have resulted in ongoing and ever increasing operational costs (Mallory, 2017).

Dam Site B would provide the more natural dam site in view of the topography of the site resulting in a reduced area being inundated by the proposed dam and thus a reduced impact on the natural environment. In view of the lack of activities taking place in the upstream area, the said site would be less prone to sedimentation and potential impacts on water quality in the long term. The downstream area has however already been impacted in terms of the existing Dorps Dam, existing abstraction from the Dorps Dam and the residential area of Amsterdam and is thus not pristine.

Venter and Niemand (2017b) indicated that the ecological impact is considered to be high for both Dam Site A and Dam Site B, although a higher percentage of sensitive habitat is likely to become inundated at Dam Site A, which renders Dam Site B more feasible. Although the impact appears to be of high magnitude, a large area of habitat is actually represented by alien invasive woody vegetation at Dam Site B. With reference to Dam Site B, large areas of similar habitat (mainly montane grassland) occurs adjacent to the proposed maximum inundation level of the proposed dam, which will in all likelihood result in the displacement of highly mobile fauna species (e.g. ungulates and birds).

When comparing proposed Dam Site A (Thole River) and B (Gabosha River) in terms of its impact on the aquatic fauna component, Kotze (2017) indicated that there is no clear cut decision in terms of the most preferred option:

- The migratory impact of Dam Site A will be notably higher than Dam Site B, therefore opting for Dam Site B in this regard.

- The Gabosha River reach is currently in a better present ecological state (Ecostatus) than the Thole River. The general approach would therefore be to recommend that the more deteriorated river is considered for development and the more pristine reach conserved, hence pointing towards Dam Site A as the preferred option.
- Higher fish diversity in the Thole River than the Gabosha River indicates that more species may be impacted directly as a result of Dam Site A than Dam Site B. Kotze (2017) indicated that the construction of Dam Site B will not impact on the migration of any fish species since the downstream area of the Gabosha River already contains barriers (Dorps Dam) preventing fish from migrating up this stream.

Mallory and Jacobs (2016) indicated that Dam Site B had the following advantages:

- it is located upstream of Amsterdam;
- less water use upstream of the dam site;
    - water use upstream appears to be limited to a small area of forestry which is estimated to reduce the natural runoff into the dam by 0.49 million m^3/annum;
    - irrigation upstream of the site appears to be negligible;
- smaller catchment less prone to sedimentation;
- smaller dam size: 510 000m^3;
- less costly to construct;
- water can be supplied under gravity hence saving on pumping costs.

Dam Site B is also ideally placed in terms of benefiting in times of water shortages when the yield of the Gabosha River is augmented from Westoe Dam via the bulk link pipeline between Westoe Dam and Jericho Dam.

In view of the above-mentioned and from a water resource management perspective, the proposed Dam Site B was therefore indicated as the more preferable option to pursue.

8.3 Dam design

8.3.1 Dam wall positions

Three alternative dam wall positions at Dam Site B were investigated as part of the geotechnical investigation. Meyer (2017a) indicated Option 3 as the preferred dam wall position, even though the costs will be slightly higher.

8.3.2 Type of dam

As indicated in Section 6, the construction of a 20 year silt/sediment dam and a sand dam were investigated.

Mallory and Jacobs (2015; 2015b) indicated that allowing for 20 years of sediment is more favourable than constructing a sand dam as this would result in a smaller and less costly dam. The disadvantage is however the reduced lifespan of the smaller dam. In addition, the sand dam option was discarded in view of the following:

- The analysis of a sand dam was based on sand porosity of 30% which may be less in practical applications;
- A high level of maintenance will be required on inflow pipework to prevent siltation and blockages;
- Availability of resources for intensive maintenance actions may be a challenge.

In terms of the 20 year silt/sediment dam, the following three dam types with varying spillway lengths were investigated namely:

- Option 1: Earth fill/rock fill wall with protected spillway or side spillway;
- Option 2: Concrete/RCC Central ogee spillway with earth fill on the flanks;
- Option 3: Concrete/RCC for full length of wall with central ogee spillway.

The analysis indicated that Option 1 (an earth fill flanked concrete/RCC central spillway) would be the most economical solution. However, after costing in the required retaining walls to prevent the earth fill from spilling into the river upstream of the dam, it was determined that Option 3 would be the most economical for a spillway length of 140m. Option 1 and Option 2 were thus discarded.

The construction at Dam Site B would thus entail the construction of a mass concrete or Roller Compacted Concrete (RCC) gravity structure with a central spillway (i.e. Option 3, Section 6.10.3) at dam wall Option 3.

8.3.3 Size of dam

Yield analyses in terms of several dam options were conducted. These analyses were aimed at determining the required size of dam to meet the known water demand i.e. 0.74 million m^3/annum.

Based on the significantly increased natural runoff (4.8 to 5.6 million m^3/annum), a dam with a full capacity of 450 000m^3 was recommended (Mallory, 2017). Mallory (2017) indicated that this reduced full supply capacity allows for 70 000m^3 of sediment deposition over 20 years. Previously, based on the WR2005 hydrology a full supply capacity of 680 000m^3 was recommended.

As indicated in Section 6.8, Option 3 would have a Gross Storage at Full Supply Level (FSL) of 450,318 m^3 and a Live Storage at FLS of 370,318 m^3. The estimated 20 year sediment load for the dam is 70 000m^3.

According to Afri Infra (2017), this silt is not expected to be deposited directly against the dam wall due to the reduction of cross-section water area as it approaches the dam wall. The invert level of the lowest intake was designed 100mm lower than the maximum 20 year silt build up should the silt load accumulate against the dam wall.

According to Afri Infra (2017), a review of the flood hydrology must still be undertaken as part of the design development and the reported hydrology information must be updated accordingly. It is however not anticipated that the updated flood hydrology information will impact on the RMF flood calculations and influence the overall dam and spillway configuration,

According to Afri-Infra (2017), the proposed Option 3 dam is classed as:

- a 'Medium' dam;
- either a 'significant' or 'High' hazard potential – in view of the existing development downstream of the dam;
- either a Category 2 or Category 3 dam in accordance with the current Dam Safety Regulations.

The recommended Design Flood (RDF) and the Safety Evaluation Flood (SEF) must still be calculated for this dam and will depend on whether it is a Category 2 or Category 3 dam. In addition, the Dam Classification application

must be submitted to the Department of Water and Sanitation (see Section 4.9.4).

8.4 Pipeline alternatives

As indicated, Dam Site A will not be constructed. In view of this, the pipeline from the existing Amsterdam WTWs will become a gravity line providing potable water from the existing Amsterdam WTWs to the residential areas of Amsterdam and KwaThandeka and will be located within the road reserve. These areas are already impacted by development and the impacts on these areas are mostly small. The potential impact of Pipeline Crossing No. 1 on the river habitat of the Gabosha River was investigated as indicated in Table 7.3. Mitigation measures are provided in Section 9 in order to reduce this potential impact on this river habitat. The necessary Water Use Licence Application will also be submitted to the IUCMA.

A Bulk Water Pipeline from the proposed Dam Site B to the existing Amsterdam WTWs was indicated as an alternative but was discarded as it would extend through an area of High Ecological Sensitivity as indicated in Section 6.11.2.

The alternative of releasing water directly into the Gabosha River downstream of the Dam Site B and abstracting at the existing Dorps Dam abstraction point would impact on the aquatic environment associated with the Gabosha River in terms of increased flows, etc. However, the potential impacts can be mitigated and will be significantly less than the installation of the Bulk Water Pipeline proposed. This option will thus be implemented at Dam Site B and was investigated as indicated in Table 7.1.

8.5 Potential impacts identified in terms of the development of Dam Site B (including the release of water and access road).

Dam Site B is currently vacant with no infrastructure and belongs to the Mkhondo Local Municipality. No other interested and affected party would be directly impacted in terms of the development of this site.

A new land use namely storage of water for municipal use will be created on the said property as part of the overall water provision service of the Mkhondo Local Municipality. In the long term, this would benefit the residents of Amsterdam and KwaThandeka. In addition, the presence of a dam on the said property could result in the previously unutilised area being used for recreational purposes (e.g. fishing, birding, etc.) by the residents of Amsterdam and KwaThandeka.

Dam Site B is indicated as Non-arable. No cultivation was noted within the proposed Dam Site B area due to the rocky nature of the area. Dam Site B is indicated as low to moderate potential grazing land. The grazing potential is indicated as less than 4ha/animal unit. The said area is used for informal grazing purposes.

The proposed dam would be located within a narrow valley associated with the Gabosha River and surrounded by very rugged topography (steep hills on either side) that extends to approximately 1480mamsl on both sides. Very little, if any, impact on topography has taken place within the proposed Dam Site B area due to the ruggedness of the topography.

The dam basin will be cleared of vegetation to a required standard. This clearing will be confined to the top water level expected in the dam. Intensive clearing will take place in the direct vicinity of the dam wall in order to prevent any tunnelling through the wall. An area of 20 ha area will be covered with water resulting in the inundation of the valley floor and valley topography.

8.5.1 Geology/geotechnical aspects

Dam Site B is underlain by pyroclastic rocks and ash-flow tuff (Dacite lava) of the Gobasha Member, Amsterdam Formation of Randian Age (Meyer, 2017a).

The excavation of the temporary diversion channel, quarry, dam wall and dam basin will impact on younger unconsolidated Quaternary alluvium consisting of transported sandy, silty and gravelly soils derived from upstream weathered bedrock (Meyer, 2017a).

A large rock face and rocky outcrops are present at dam wall Option 3 where a dam wall can be constructed making it a more natural dam. Meyer (2017a) indicated that roughly half of the dam wall is underlain by outcrop/sub-outcrop while test pits excavated towards the west revealed abundant alluvial gravel/boulders. The geotechnical investigations indicated suitable founding depths at an average depth of 2.5m below surface on the left flank.

Meyer (2017a) indicated that shallow good quality diabase exists on the eastern flank of the proposed dam for a potential side spillway. Early indications are that the material is very competent.

Meyer (2017b) recorded no faults or large fissures although the right flank of the proposed site was clearly formed by a significant structure. The construction of the temporary diversions channel, the dam wall and the dam basin could impact on a main joint trending in a NE-SW direction which is perpendicular to the dam axis (Meyer, 2017b). This main joint will require grouting.

A potential quarry site was located as near to the centerline as safely possible and within the dam basin, so it will be submerged when at full supply level. Estimates of material volumes for concrete have not been established but the lava bedrock is predominantly unweathered and is expected to make suitable aggregate. Good quality fresh rock is available between 2.5m and 5.5 m below surface. The cover rock is excavatable and useable for road and general construction applications. Laboratory testing is still required before any detailed design is finalized (Afri Infra, 2017).

The geotechnical investigation undertaken at Dam Site B was a low-level feasibility investigation to assist with the preliminary design. Engeolab cc recommended the following additional geotechnical investigations as part of the detailed design phase:

- additional geotechnical mapping to define the major structures more effectively;

- an evaluation of the area's seismicity (using records from the Council of Geoscience) to determine the expected acceleration forces on the dam;
- Additional drilling in the quarry area to define the extent of the quarry once construction volumes are known;
- Additional drilling and pump testing in the river section where the deepest excavations are anticipated and higher up on the right flank where keying into the rock cliff is still a concern;
- Seismic refraction surveys along the centerline (especially the right flank and quarry area);
- Grouting test to determine the cost and effectiveness of cement grouting.
- Rock tests to determine the suitability and aggressiveness towards concrete of the dacite lava cores that were extracted from the quarry boreholes.

8.5.2 Natural vegetation

Venter and Niemand (2017b) identified the following vegetation units at Dam Site B: Indigenous Woody; Invasive Woody; Montane Grassland; Modified Grassland and Weedy Grassland.

The following watercourses were identified – River (Gabosha River); Drainage lines (5 first order drainage lines) - within the proposed Dam Site B. No wetlands or artificial wetlands were identified (Venter and Niemand, 2017b).

The clearing of the dam basin (20 ha area) will however, impact on watercourse habitat (river, 4.9ha and drainage lines) as well as 8.4 ha of Montane Grassland (high sensitivity) and 5.1 ha of Indigenous Woody vegetation (high sensitivity) as identified by Venter and Niemand (2017b). Species of Conservation Importance (7 Red Data Plant Species) could be present in either vegetation unit although none were recorded to be present. The clearing of this vegetation as well as the subsequent inundation of the area cannot be mitigated. The site is however surrounded by similar grassland and the impact is therefore considered to be of medium significance (Venter and Niemand, 2017b).

Several first order drainage lines are present on the steep slopes surrounding the proposed Dam Site B. The vegetation component of these drainage lines are the same as the indigenous woody vegetation present on these slopes, with a few patches invaded by *Acacia dealbata*. These linear features play a major role in providing fauna taxa access to the large rivers where perennial surface water is present. This vegetation is therefore considered to have the same sensitivity as the indigenous woody vegetation unit and is therefore of high sensitivity.

Although several sensitive vegetation and habitat units are present on site, the habitat is well represented in the surrounding areas. Large stands of alien and invasive species are present in the valley floor of Dam Site B and the sensitive habitat is therefore largely present along the upper slopes at maximum inundation level.

The overall need for a dam to provide sufficient water for Amsterdam and KwaThandeka should therefore be weighed against the minor loss of sensitive vegetation. The impacts of the vegetation can mostly be mitigated to lower the impact of the project on the environment.

8.5.3 Animal life/fauna

Construction activities go hand in hand with high noise generation. Therefore it is anticipated that many mobile species will vacate the area during the construction phase. However, less mobile and specialised taxa are more likely to be affected since they can't escape the ambit of the anticipated construction process. It is fundamentally important to maintain connectivity with similar habitat types to allow fauna taxa the option to "escape" construction activities (Venter and Niemand, 2017b).

The loss of habitat caused by inundation or flooding will be pronounced on sessile taxa and smaller-bodied fauna. Many of these species are either stenotopic, being habitat or substrate specialists, or their area of occupancy is highly restricted or localised. These taxa will find it difficult or virtually impossible to escape the rising water levels, and will surely perish during inundation (Venter and Niemand, 2017b).

Most of the birds and mammal taxa with larger body sizes are in general more mobile and therefore able to vacate areas when adverse environmental conditions prevail. Therefore, direct impacts on adult mortality are less likely to occur, although indirect impacts could have consequences on their "fitness" (e.g. the ability of a species to reproduce). Likely examples include habitat loss (due to flooding) and displacement of individuals preventing them from breeding successfully (e.g. an indirect loss of habitat due to flooding). Persistent disturbances across extended temporal scales will eventually affect any population's ability to sustain itself, and will more than likely result in the total abandoning of a particular area (Venter and Niemand, 2017b).

Species most likely to be affected are either K-selected species or habitat specialists. K-selected species are mostly long-lived species with slow reproductive rates (e.g. large terrestrial bird and mammal species) while habitat specialists (e.g. rupicolous mammal taxa) are those restricted to a particular type of micro-habitat or niche, be it structural, altitudinal or floristic. Most of these species are also threatened or near threatened, and therefore of conservation importance (Venter and Niemand, 2017b).

The loss of habitat due to inundation during the operational phase is probably the largest impact regarding this project in terms of surface area (when compared to the other proposed activities). Several natural habitat types (grassland, woody areas, Gabosha River) will become permanently lost impacting on Red Data Mammal (14 mammal taxa of conservation concern) and bird species (21 threatened or near threatened bird species, 5 of which could be directly impacted). Although the impact appears to be of high magnitude, a large area of habitat is actually represented by alien invasive woody vegetation at Dam Site B. With reference to Dam Site B, large areas of similar habitat (mainly montane grassland) occurs adjacent to the proposed maximum inundation level of the proposed dam, which will in all likelihood result in the displacement of highly mobile fauna species (e.g. ungulates and birds).

However, species likely to be affected are those that are restricted to lotic habitat along the rivers and the riparian vegetation bordering the rivers. Typical species include dragonflies and damselflies with high DBI scores (e.g. *Zosteraeaschna minuscula* and *Onychogomphus supinus*) and aquatic-associated taxa such as the Half-collared Kingfisher, Serval and Swamp Musk Shrew (Venter and Niemand, 2017b). Inundation will also affect less mobile terrestrial species that are either substrate-specific (e.g. scorpions) and many

fossorial taxa and those with a high preference for terrestrial grassland units such as the White-tailed Rat (Venter and Niemand, 2017b).

The change from lotic to a lentic (dam) system will affect local changes in the composition and abundance of fauna species, especially birds. Some species will become displaced during the inundation of the proposed dam. These pertain to species restricted to the riparian vegetation and the lotic conditions of the Gabosha and Thole Rivers. However, it is possible that certain waterfowl (e.g. ducks), wading birds (e.g. herons) and piscivorous species (e.g. cormorants and darters) are likely to increase in numbers once the dam is in operation since these birds don't have to contend with shallow riffle water (at base flow conditions). This impact cannot be ameliorated and is regarded as permanent as long as the dam remains in existence/inundated (Venter and Niemand, 2017b).

It is possible that the volume of water to be discharged at the dam wall could differ from normal baseline flows due to seasonal variation in rainfall and abstraction. Changes in the flow regime, especially when the variation in sediment loads exceeds the norm may possibly have disastrous impacts on nutrient levels and sediment accumulation at areas downstream of the dam. However, when the dam operates at maximum capacity an additional release of water may be required and the additional volume of water could scour recently established riparian vegetation (downstream) and increase erosion.

On the other hand, a flow regime below the baseline could initiate and promote the establishment of vegetation composition and floristic structure that is atypical of current vegetation units (at pre-construction), thereby inducing changes to the faunal composition. In addition, the predicted flow regime could also perpetuate seasonal flows with a low predicted variation between the dry and wet season (Venter and Niemand, 2017b).

The proposed dam may act as a "silt-trap", thereby reducing the downstream volume of sediment transport. This reduction in sediment may result in a marked reduction of nutrient-rich sediment deposits (as explained above) to be transported. A reduction in sediment will also result in increased scouring and erosion of the riverbank, and deepening of the riverbed with a subsequent reduction in primary production (Venter and Niemand, 2017b).

In order to access the proposed site, a gravel road with river crossings will be constructed along an existing dirt track from the R65 to the dam wall (see Section 7.3.2). Better access to previously inaccessible areas may exuberate grazing and trampling by livestock in the area, but could also result in increased firewood collection and illegal poaching of animal resources.

Increased anthropogenic encroachment is probably one of the most important and most difficult impacts to mitigate. However, construction at Dam Site B dam may facilitate access to previously less accessible areas, but more importantly may also attract the attention of distant human communities. Consequently, easier access to the dam may result in the exploitation of natural resources and wildlife in the area. This impact will affect a larger area than the inundation zone itself, and it will increase the possibility of "urban-sprawl" (Venter and Niemand, 2017b).

The constructed service roads and access roads may potentially facilitate access to areas that were previously inaccessible. At present, only a few dirt roads exist which allow access to Dam Site B. It is possible that access roads, irrespective of their size, could facilitate access in the general area. Increased

access during the operational phase could easily disrupt the natural breeding and foraging regimes of large-bodied birds and mammal species. In addition, better access to previously inaccessible areas may exuberate grazing and trampling by livestock in the area, but could also result in increased firewood collection and illegal poaching of animal resources. Although the impact is perceived to operate at local scales, it will persist in the long term owing to the predictable and constant attraction of people (both pastoralists and job-seekers) to areas that were previously less accessible.

Venter and Niemand (2017b) indicated that most of the natural vegetation units - primarily all the watercourses, the indigenous woody areas, and untransformed (montane) grassland units - are regarded as sensitive. These units provide potential habitat for a high richness of threatened and near threatened bird and mammal species. More importantly, the watercourses play an important role in animal dispersal and genetic cohesion between faunal sub-populations.

The overall need for a dam to provide sufficient water for Amsterdam and KwaThandeka should therefore be weighed against the minor loss of sensitive vegetation and faunal habitat units. The impacts of the vegetation and fauna assemblages can mostly be mitigated to lower the impact of the project on the environment.

8.5.4 Aquatic fauna

Kotze (2017) indicated that the habitat integrity of the upstream reach of the Gabosha River within the study area (sites GB1 to GB3; i.e. Dam Site B) was in a very good condition, with the instream zone falling in a category A/B (largely natural with few modifications), while the riparian zone ranged between a category A and C. The habitat integrity of the lower Gabosha River at Pipeline Crossing 1 (PLC1; downstream of Dam Site B) was in a deteriorated state, with the instream zone falling in a category C and the riparian zone in a category E (seriously modified). The habitat integrity of the Thole River reach of concern was in a moderately modified state, with the instream and riparian zones falling in a category C.

Based on limited *in-situ* water quality measurements and visual observations it seems that the overall water quality of the Gabosha River in the vicinity of Dam Site B is currently very good, while the quality may be moderate to good in the Thole River (Kotze, 2017).

Five indigenous fish species were sampled in the Gabosha River and nine in the Thole River. Based on all available information it is estimated that eleven (possibly 12) indigenous fish species may occur (or have occurred under pre-disturbed conditions) in the river to be potentially impacted by the proposed activities (Kotze, 2017).

Many of the expected and observed fish species are rheophilic species, requiring flowing habitats during all life stages and therefore have a requirement and preference for fast-shallow and fast-deep habitats. It is therefore essential that the current proposed activity should not allow cessation of flow downstream of the dam at any stage, since it will lead to the loss of these fish species (Kotze, 2017).

Kotze (2017) indicated that some of the fish species sampled in the study area are classified as being **intolerant** to changes in the environment. These species can be expected to be the first to react to changes and deterioration

in the study area as a result of any activities and should be valuable indicator species for monitoring.

None of the fish species expected or observed in the study area are classified as threatened based on international criteria (IUCN) with all falling in the "least concern" IUCN category. One species with a very low probability of occurrence in the river reaches of concern namely *Chiloglanis emarginatus* is classified as near threatened (RSA red list). The conservation status of *Amphilius cf. natalensis* requires further verification.

A detailed migratory impact assessment was done for proposed Dam Site A (Thole River) and proposed Dam Site B (Gabosha River). This assessment indicated that a fishway is required for Dam Site A, but may add very little value to Dam Site B, where other mitigation actions may be more suitable (Kotze, 2017).

The Present Ecological Status (PES), based on fish, of the Gabosha River reach of concern was calculated to fall in an ecological category B (largely natural to slightly modified). The PES of the Thole River reach of concern was estimated to fall in a category C (moderately modified).

Thirty-four aquatic invertebrate taxa (family level) were sampled at the aquatic sampling sites in the study area. Four taxa (or indicator groups) with a high requirement for unmodified water quality were sampled in the study area. These are the most valuable indicator taxa to be used to monitor potential deterioration associated with the proposed or other activities in the catchment, especially in terms of water quality and flow modification as well as increased sedimentation due to their preference for substrate habitats.

Based on the macroinvertebrates the upper reaches of the Gabosha River (GB1 to GB3; i.e. Dam Site B) was in a very good ecological state (category B to B/C), which deteriorated downstream (after the Dorps Dam and associated Amsterdam town influences) to a category C. Overall the Gabosha River reach of concern (site GB1 to PLC1) can be classified in a category B/C based on macroinvertebrates. The Thole River reach of concern was placed in a category C/D based on the macroinvertebrate assemblage.

Kotze (2017) indicated the primary impacts on the aquatic fauna as a result of the construction and operation of Dam Site B to be related to:

- Altered hydrological regime (flow modification and water abstraction);
- Habitat deterioration (inundation upstream of dam wall, decreased flows in downstream river reaches, sedimentation of bottom substrates);
- Water quality deterioration.

A section (approximately 1.8 kilometres) of the Gabosha River will be inundated by the proposed dam (at full supply level). The habitat within this reach will be completely transformed and all fast habitat will be transformed to slow habitats. A complete loss of all rheophilic species is expected from this section (especially *Amphilius* and *Chiloglanis* fish species). Dams furthermore create favourable habitat for alien fish species (such as Largemouth Bass, Common Carp) as well as some indigenous species such as Sharptooth Catfish. This may lead to increase predation on the smaller indigenous fish species in the upper reaches of the Gabosha River (Kotze, 2017).

Water will be released directly into the river course from the dam outlet works and will subsequently be abstracted at the abstraction point (Dorps

Dam) for purification at the Amsterdam WTWs. Afri-Infra (2017) indicated the following: maximum required release for water supply: 35l/s; maximum EWR release: 67l/s. The natural hydrology of the downstream river will be influenced in terms of volume and timing of flow. The extent of the impact will be determined by the size (volume) of the dam and the amount of water to be abstracted.

The altered flows will especially impact on fish and macroinvertebrates with a requirement for fast flowing habitats (various rheophilic species present in study area). Unnatural releases from dams (such as during desilting operations) may trigger unnatural fish migration/movement (Kotze, 2017).

Mitigation measures were recommended for the different identified impacts as indicated in Section 9. Kotze (2017) strongly recommended that a biomonitoring programme be implemented as soon as possible to increase the accuracy of baseline (predevelopment) information, and should continue for the duration of the activity. It is furthermore recommended that the aspects highlighted in this report should be considered during the weir design, water use licence application and surface layout design should the project be approved.

8.5.5 Sites of archaeological and/or cultural interest

Van Vollenhoven (2017b) indicated that no sites of cultural heritage significance were identified within the proposed development area of Dam Site B.

The possibility of finding Iron Age remains is real, as such features have previously been found. There is also always a chance that Stone Age tools might be found. It seems however, unlikely that a large site will be identified during the survey, due to the proposed dam being located within a valley (i.e. Dam Site B).

In view of the above-mentioned, Van Vollenhoven (2017b) recommended the following:

- This report is seen as ample mitigation and the proposed development may thus continue, but only after the report is approved by SAHRA.
- It should be noted that the subterranean presence of archaeological and/or historical sites, features or artefacts is always a distinct possibility.
- Due to the density of vegetation it is also possible that some site may only become known later on.
- Operating controls and monitoring should therefore be aimed at the possible unearthing of such features. Care should therefore be taken when development commences that if any of these features are discovered, a qualified archaeologist be called in to investigate the occurrence.

8.5.6 Palaeontological sensitivity

Fourie (2017b) indicated that the development of the proposed Dam Site B would be preferable as the Amsterdam Formation with a Very Low Palaeontological Sensitivity would be impacted. This would also be the case in terms of the distribution line.

8.5.7 Surface water

The report by Mallory (2017) summarises all the hydrological and water resource analyses carried out in support of identifying the best option to

augment the water supply to the town of Amsterdam. Mallory (2017) indicated the following:

- Storage is definitely required;
- It is not possible to meet Amsterdam's growing water demand from run-of-river abstractions;
- Any of the dam options investigated are hydrologically feasible and hence the choice of dam sites must be based on cost and geological considerations.
- An analysis of the downstream impacts indicates that none of the options will impact on the very limited downstream use.

8.5.7.1 Water users

The existing upstream water use is very limited and consists of irrigation and streamflow reduction due to commercial afforestation.

Mallory (2017) indicated that other than the water use in the town of Amsterdam (0.6 million m^3/annum; to be supplied with water from the proposed new dam), there is very little water use downstream of the proposed dam.

No agricultural activities are located directly downstream of Dam Site B. The closest are located approximately 12 km downstream of the site. According to Mallory (2017), there is an area of approximately 30 ha of irrigation that could be slightly impacted by the proposed dam. Pivot irrigation is also evident further downstream. The said 30 ha of irrigation was simulated in the updated model and it was found that these irrigators enjoy a very high assurance of supply. According to Mallory (2017), these irrigators also benefit from return flows from the Amsterdam Waste Water Treatment Works which increases low flows.

8.5.7.2 Cross border flows

Mallory (2017) indicated that South Africa is committed to ensuring the following flows from the Ngwempisi River into Swaziland as documented in the IncoMaputo Water Sharing Agreement:

- 30 million m^3/annum on average;
- 0.1 m^3/s minimum.

The Ngwempisi River catchment up to the Swaziland border consists of 4 quaternary catchments (W53A, W53B, W53D; and a third of the W53E quaternary catchment with a total area of about 1 540 km^2. Comparing the total Ngwempisi River catchment (1 540 km^2) to the catchment area of 53 km^2 of the proposed dam on the Gabosha River (i.e. Dam Site B), the impact of the new dam relative to the rest of the catchment is negligible (Mallory, 2017).

Mallory (2017) indicated that the intention is nevertheless to make an ecological release from the Gabosha Dam which will also serve as this development's contribution to cross border flows.

According to Mallory (2017), the updated water resources simulation of the entire Ngwempisi catchment indicated that the minimum cross border flow is only violated twice over a simulation period of 85 years while the average cross border flow is estimated at 53 million m^3/annum. This simulation assumes no release from either the Morgenstond or Jericho dams. Mallory (2017) suggested that should the minimum cross border flows be in jeopardy that releases be made from one of these dams.

8.5.7.3 Ecological Water Requirements (EWR)

Mallory (2017) reported that the updated analysis of Dam Site B (using the latest WR2012 hydrology) indicated a dam with a full supply capacity of 450 000m^3 would be required at this site.

As previously indicated, it is a requirement in terms of South Africa's National Water Act to allow some water to remain in the river to sustain the ecological functioning of the river. This water is referred to as the Ecological Reserve or Ecological Water Requirement (EWR).

The EWR for the W53C catchment was estimated for a C ecological category using the Hughes Desktop model (Hughes and Hannart, 2003). According to Mallory (2017), the EWR as a percentage of the natural MAR remains at 26.5% and hence the EWR, as an annual mean is 1.48 million m^3/annum. As indicated, a maximum EWR release of 67l/s is proposed for Dam Site B.

It should be noted that a temporary diversion channel will be constructed during the construction phase in order to ensure continued water flow to the downstream reach of the Gabosha River.

8.5.7.4 Impact on downstream structures/communities

As indicated, the proposed Option 3 dam is classed as a 'Medium' dam; either a 'significant' or 'High' hazard potential (i.e. in view of the existing development downstream of the dam) and either a Category II or Category III dam in accordance with the current Dam Safety Regulations.

If dam failure occurs, the road users of the provincial R65 road as well as the residents of Amsterdam and KwaThandeka could be impacted in terms of flooding. Afri Infra (2017) indicated that a dam break analysis still needs to be done in order to establish the associated flood levels within the river downstream of the dam in the eventuality of dam failure.

It should be noted that the design, design methodologies, design presentation and related reports will be formulated for compliance with the requirements of the South African Dam Safety Legislation and for submission and approval by the Dam Safety Office (DSO) of the Department of Water and Sanitation. In addition, the necessary Water Use Licence Application will be submitted to the IUCMA for approval. Construction will only commence after the licence to construct has been issued.

8.6 Public participation

Section 4 provides a description of the public participation process undertaken as part of this EIA. Table 4.4 provides a summary of all the issues of concern received through this public participation process as well as feedback in terms of the said issues.

To date, no objections in terms of the said project were received.

The development of Dam Site B will impact on land belonging to the Mkhondo Local Municipality. No other interested and affected party would be directly impacted in terms of the development of this site. A new land use namely storage of water for municipal use will be created on the said property as part of the overall water provision service of the Mkhondo Local Municipality.

In the long term, this would benefit the residents of Amsterdam and KwaThandeka. In addition, the presence of a dam on the said property could result in the previously unutilised area being used for recreational purposes (e.g. fishing, birding, etc.) by the residents of Amsterdam and KwaThandeka.

It is unlikely that downstream water users and cross border flows would be impacted in terms of the proposed dam. The impact of the proposed dam on the Gabosha River relative to the overall catchment is negligible.

8.7 Conclusion

In view of the findings of this EIA, it is felt that the following could be approved subject to the implementation of certain mitigation measures:

- Construction and operation of a dam on Dam Site B ;
- Construction and utilization of an access road from the R65 to Dam Site B;
- The construction of Pipeline Crossing No.1 as part of the installation of the Distribution Line;
- Desilting of Dorps Dam.

9. ENVIRONMENTAL MANAGEMENT PROGRAMME

9.1 Definition and objectives

The Environmental Management Programme (EMPr) was compiled in accordance with Appendix 4 of the Environmental Impact Assessment (EIA) Regulations, 2014 as well as the Western Cape Guideline for Environmental Management Plans (Lochner, 2005).

According to the Western Cape Guideline, an Environmental Management Programme (EMPr) can be defined as:

> *An environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented; and that the positive benefits of the projects are enhanced.*

According to the EIA Regulations, 2014, an EMPr must include-
(d) A description of the impact management objectives, including management statements, identifying the impacts and risks that need to be avoided, managed or mitigated as identified through the environmental impact assessment process for all phases of the development including -
(i) planning and design;
(ii) pre-construction and construction activities;
(iii) operation or undertaking of the activity;
(iv) rehabilitation of the environment; and
(v) closure, where relevant.

This section therefore provides an indication of the mitigation measures to be implemented by the site operator (and site workers) in order to reduce the potential impacts identified (see Section 7).

9.2 Contact details

An EMPr must include -
(a) details of-
(i) the EAP who prepared the environmental management programme; and
(ii) the expertise of that person to prepare an environmental management programme, including a curriculum vitae.

The contact details and expertise of the environmental consultant are provided in Section 2 of this report.

The applicant will be responsible for the implementation of the EMPr. The contact details are provided in Section 2.

9.3 Description of the proposed project

An EMPr must provide -
(b) a detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description.
(c) a map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that should be avoided, including buffers.

A detailed description of the proposed development and aspects covered by the EMPr is provided in Section 2 of this report. Section 5 provides a description of the biophysical environment of Dam Site B as well as the pipeline routes.

9.3.1 Construction of dam at Dam Site B

Based on the findings of this EIA, the dam will be constructed at Dam Site B.

Venter and Niemand (2017b) identified the following vegetation units at Dam Site B (Figure 5.14) which will be impacted: Indigenous Woody; Invasive Woody; Montane Grassland; Modified Grassland; Weedy Grassland; River and Drainage lines (Figure 5.14). No wetlands or artificial wetlands were identified (Venter and Niemand, 2017b).

Table 9.1 and Figure 9.1 provide an indication of the sensitivity of these units from a vegetation and fauna viewpoint.

Table 9.1: Sensitivity of vegetation units at Dam Site B (taken from Venter and Niemand, 2017b)

VEGETATION UNIT	SUB-UNIT	SENSITIVITY			
		VEGETATION	WATERCOURSE	FAUNA	COMBINED
Watercourse	River	Low	High	High	High
	Drainage lines	High	High	High	High
Woody areas	Indigenous	High	Low	High	High
	Invasive	Low	Low	Low	Low
Grassland areas	Montane Grassland	High	Low	High	High
	Modified grassland	Moderate	Low	Moderate	Moderate
	Weedy	Low	Low	Moderate	Moderate

With reference to Dam Site B, large areas of similar habitat (mainly montane grassland) occurs adjacent to the proposed maximum inundation level of the proposed dam, which will in all likelihood result in the displacement of highly mobile fauna species (e.g. ungulates and birds).

The sensitive habitat is largely present along the upper slopes at maximum inundation level (Figure 9.1). Several first order drainage lines are present on the steep slopes surrounding the proposed Dam Site B. The vegetation component of these drainage lines are the same as the indigenous woody vegetation present on these slopes, with a few patches invaded by *Acacia dealbata*. These linear features play a major role in providing fauna taxa access to the large rivers where perennial surface water is present. This vegetation is therefore considered to have the same sensitivity as the

indigenous woody vegetation unit and is therefore of high sensitivity (Venter and Niemand, 2017b).

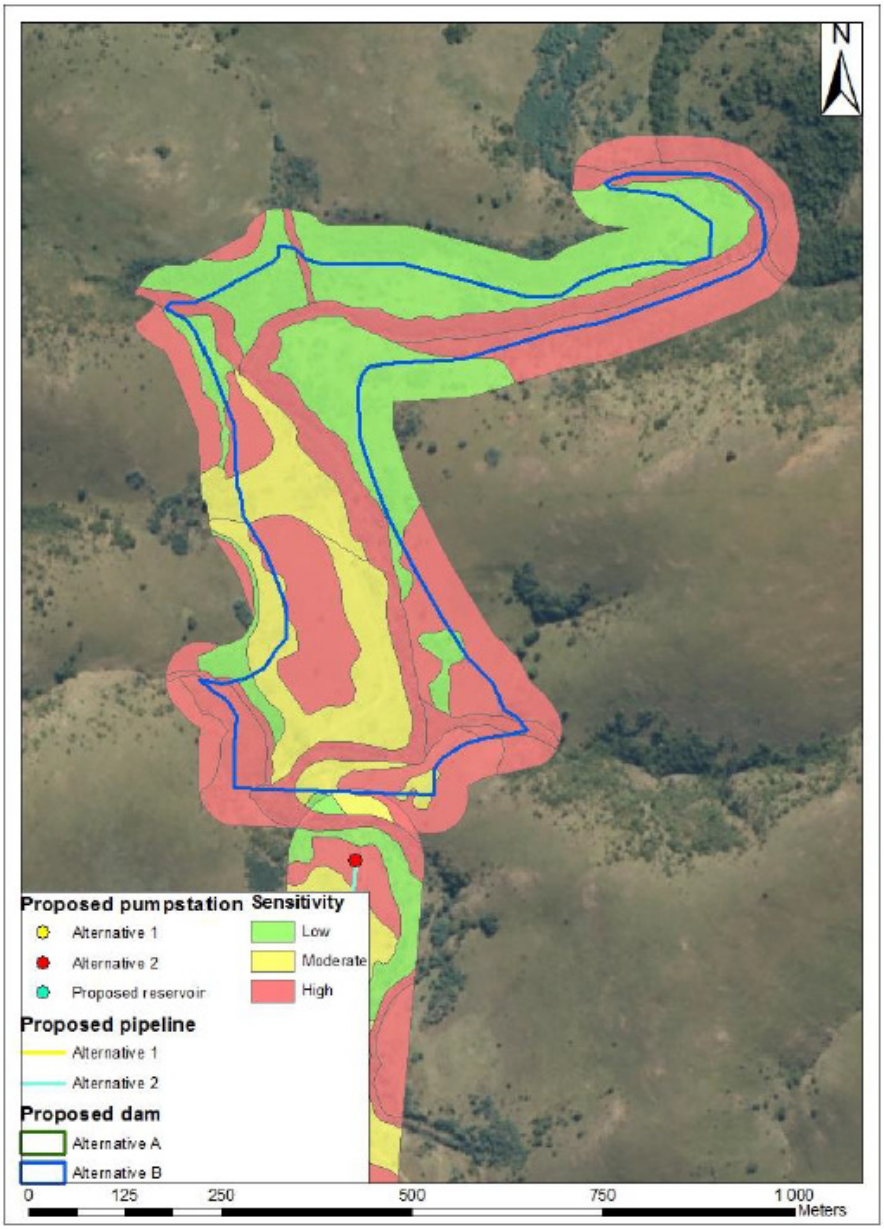

Figure 9.1: Sensitivity of Dam Site B (taken from Venter and Niemand, 2017b)

9.3.2 Access road (with river crossings) to Dam Site B

According to the project engineers, the existing single track dirt road to Dam Site B (Figure 7.1) will be upgraded to a standard complying with the requirements of the local municipality. This upgrading would include the construction of 2 or 3 river crossings as indicated in Figure 7.1.

The following vegetation units would be impacted in terms of this activity: Montane Grassland (High Sensitivity), Weedy Grassland (Moderate Sensitivity) and Invasive Woody (Low Sensitivity). The River vegetation unit (High sensitivity) would be impacted at the 3 river crossings. No wetlands or artificial wetlands are present at the 3 river crossings. Table 9.1 and Figure 9.2 provide an indication of the sensitivity of these units from a vegetation and fauna viewpoint.

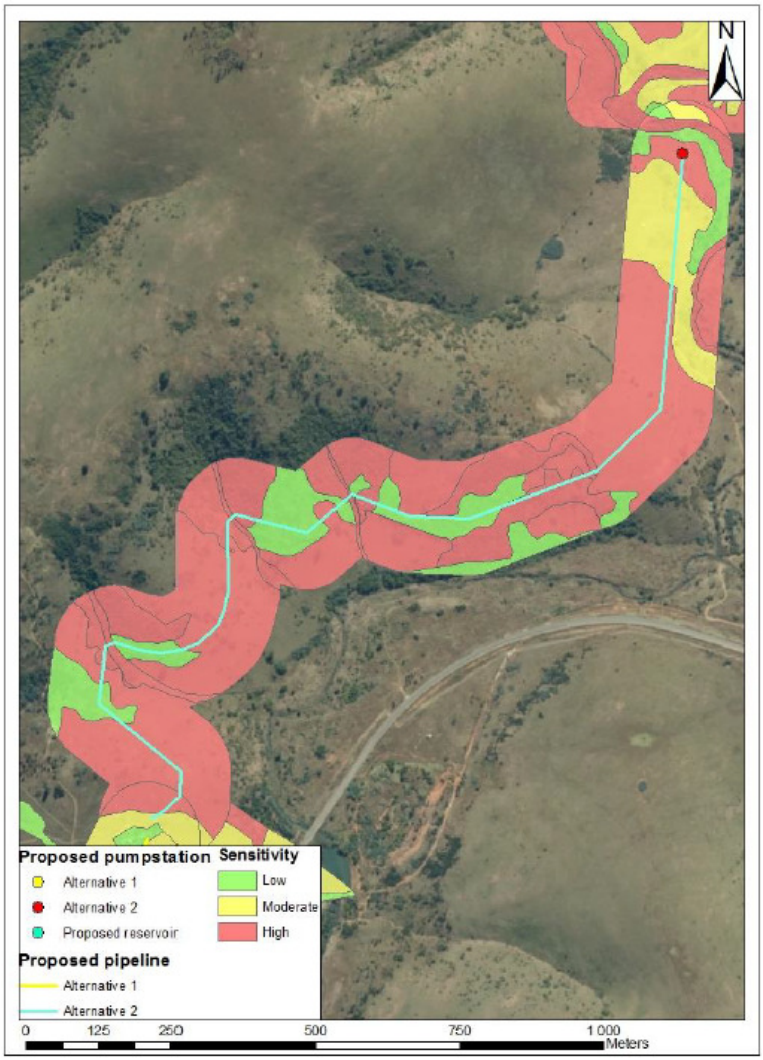

Figure 9.2: Sensitivity of area through which the Access Road (with river crossings) will extend downstream of Dam Site B (taken from Venter and Niemand, 2017b)

9.3.3 Pipeline Crossing no. 1 (between Point C and D, Figure 6.11), part of the overall Distribution Pipeline to Amsterdam and KwaThandeka

As indicated in Section 6.11.1, a new raw water pipeline (gravity line) would be installed from the Amsterdam Water Treatment Works (Point A) to Amsterdam and KwaThandeka. This pipeline would consist of a 315mm diameter uPVC Class 12 pipe.

The majority of the pipeline would be installed within a road reserve and within an urban area (Figure 6.11). The installation of a 315mm diameter bulk water pipeline would not trigger any listed activities in terms of Listing Notice 1 (R983 of 2014), Listing Notice 2 (R984 of 2014) or Listing Notice 3 (R985 of 2014). No Basic Assessment and/or Environmental Impact Assessment is thus required for the majority of the pipeline.

However, the installation of the said new bulk water pipeline will impact on a watercourse namely the Gabosha River (between C and D, Figure 6.11). It will therefore impact on the River vegetation unit that has a High Sensitivity (Figure 9.3 and Table 9.1) as Modified Grassland (Moderate Sensitivity; Table 9.1 and Figure 9.3).

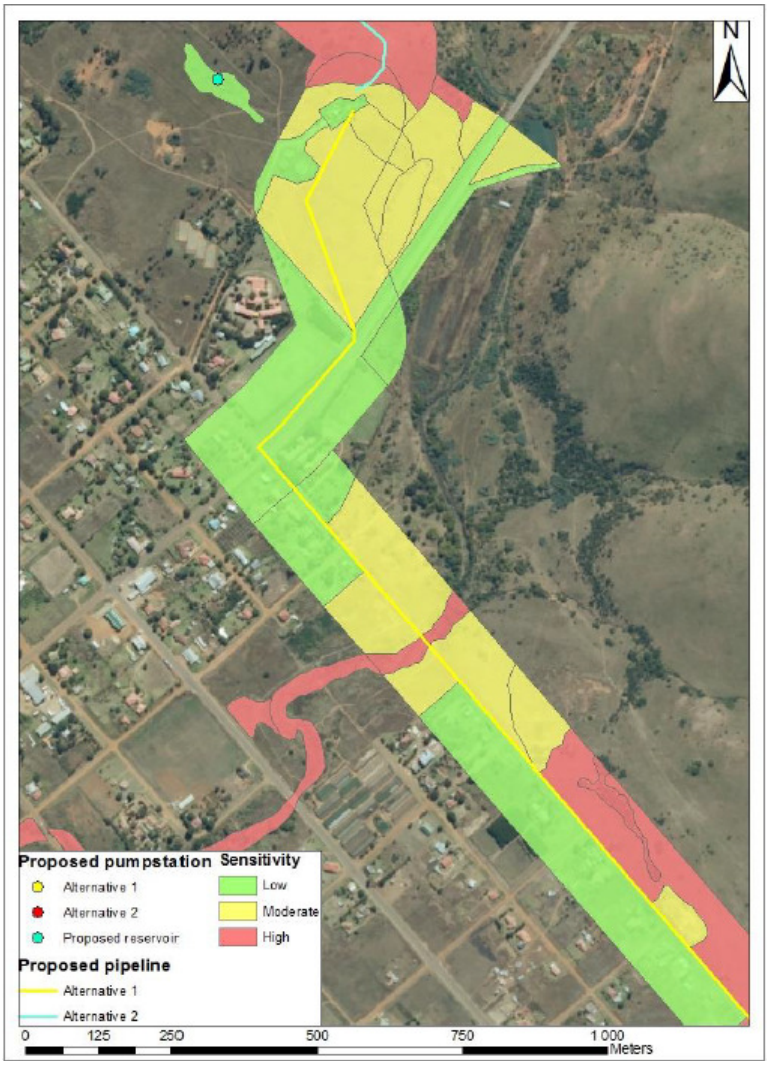

Figure 9.3: Sensitivity of area through which Pipeline Crossing no. 1, part of the Distribution Line, will extend downstream of Dam Site B (taken from Venter and Niemand, 2017b)

9.3.4 Desilting of the Dorps Dam

The desilting of the Dorps Dam (removal of accumulated silt in the said dam) is proposed as an activity to be undertaken in order to increase the capacity of the dam in terms of the storage of water.

The said activity will thus take place within the existing Dorps Dam located within the Gabosha River and would affect the associated aquatic environment which has a High Sensitivity (River unit, Table 9.1).

9.4 Phases of the development and timeframe

9.4.1 Planning and design phase

The planning and design phase involved mostly office work and site surveys with regards to the design of the sewer line, the Environmental Impact Assessment and the specialist studies. It also involves obtaining the necessary authorisations for the said project.

No actual construction took place on site.

9.4.2 Construction phase

9.4.2.1 Construction of dam wall and dam basin

The construction at Dam Site B would entail the construction of a mass concrete or Roller Compacted Concrete (RCC) gravity structure with a central spillway (i.e. Option 3, Section 6.10.3) at dam wall Option 3 (Figure 6.7).

The following components would form part of the dam wall structure as indicated in Figure 6.10a and Figure 6.10b:

- An access bridge;
- A non-overspill concrete (RCC) on the right flank of approximately 28.7m in length, including a 2.5m wide inlet tower;
- A wet well outlet works, with internal plan cross-section dimensions of 2.0m x 2.0m, situated at the central end of the right embankment non-overspill section;
- A central ogee crest concrete (Roller Compacted Concrete (RCC)) overspill section of 140m length and a maximum height above lowest foundation of 13.7 m;
- A non-overspill concrete (RCC) on the left flank of approximately 43.2m in length;
- A stilling basin of varying width (from 1.5m to 15m) with holding capacity for 1m water depth situated immediately downstream of the overspill section. At the end of the stilling basin, a measuring weir (V-notch type) with flow depth logger will be provided to measure environmental flow releases and foundation seepage (if any) as well as to activate the sleeve valves (Afri Infra, 2017).

According to the project engineers, the following methodology would be adopted with regards to the construction of the dam wall and dam basin:

- The Gabosha River will be diverted to the eastern/western side of the valley by means of constructing a temporary channel that will follow the outline of the stilling basin so as to prevent additional construction impact on the environment.
- The diversion will be lined with gabions and temporary energy dissipators in order to minimise any erosion of the cut.

- The dam wall will be excavated from the furthest side of the diversion to suitable foundation level, and the dam wall construction will commence as per the final design specifications.
- The dam wall construction will include an outlet as per the anticipated final design specifications. The outlet will be formalised to a level that will allow the through flow of the normal run of water in order to:
    - Decommission the temporary diversion;
    - Allow the river to run along its normal route;
    - Allow construction of the remaining portion of the dam wall.

- No impounding of water would be allowed before the licence to impound has been granted. If necessary, a formalised temporary outlet would be constructed to allow for the normal run of river, should the final outlet be located at a higher level than the requirement for through flow of the river during construction. This temporary outlet would be properly sealed and decommissioned and would form part of the permanent construction of the dam wall.

- Intensive clearing would take place in the direct vicinity of the dam wall in order to prevent any possible tunnelling through the dam wall.
- The dam basin would be cleared of vegetation and large rocks to a required standard as indicated by the Appointed Professional Person (APP). Clearing of the dam basin will be confined to the top water level expected in the dam.

Table 7.1 provides a summary of the main environmental impacts identified in terms of the construction of a dam at Dam Site B.

Construction timeframe:
Construction will commence as soon as the relevant approvals are obtained.

9.4.2.2 Construction of access road (with river crossings) to Dam Site B

Upgrading of the existing single track dirt road would involve the following:
- Clearing vegetation adjacent to existing road in order to widen it;
- Excavating and surfacing the said road;
- Constructing the necessary river/bridge crossings;
- Providing the necessary storm water control measures.

Table 7.2 provides a summary of the main environmental impacts identified in terms of the construction of an access road (with river crossings) to Dam Site B.

Construction timeframe:
Construction will commence as soon as the relevant approvals are obtained.

9.4.2.3 Construction of Pipeline Crossing no. 1 (between Point C and D, Figure 6.11), part of the overall Distribution Pipeline to Amsterdam and KwaThandeka

Construction of Pipeline Crossing no. 1 would involve the following:
- Clearing of vegetation;
- Excavation of trenches;
- Installation of pipes;
- Backfilling and rehabilitation of the disturbed area.

Table 7.3 provides a summary of the main environmental impacts identified in terms of the construction and utilization of Pipeline Crossing no. 1.

Construction timeframe:
Construction will commence as soon as the relevant approvals are obtained.

9.4.2.4 Desilting of the Dorps Dam

The current abstraction weir in the Gabosha River (Dorps Dam; Figure 6.1) has a gross capacity of 220 000m^3 but is silted up. This affects the water supply to Amsterdam as run-of-river water is relied upon.

The desilting of the Dorps Dam (removal of accumulated silt in the said dam) is proposed as an activity to be undertaken in order to increase the capacity of the dam in terms of the storage of water.

Table 7.4 provides a summary of the main environmental impacts identified in terms of desilting Dorps Dam.

Desilting timeframe:
Desilting will commence as soon as the relevant approvals are obtained.

9.4.3 Operational phase

9.4.3.1 Utilization of Dam Site B as a water storage facility

The operational phase would involve the following:

- Utilization of Dam Site B as a water storage facility (an area of approximately 19 hectares will be inundated) including releasing water directly into the Gabosha River downstream of Dam Site B and abstracting water at the existing Dorps Dam abstraction point (i.e. no pipeline from the proposed Dam Site B to the existing Amsterdam WTWs).

Table 7.1 provides a summary of the main environmental impacts identified in terms of the operation of a dam at Dam Site B.

Operational timeframe:
Unknown.

9.4.3.2 Utilization of access road (with river crossings) to Dam Site B

The operational phase would involve the following:

- Utilization of the access road (including river crossings) to Dam Site B.

Table 7.2 provides a summary of the main environmental impacts identified in terms of the utilization of an access road (with river crossings) to Dam Site B.

Operational timeframe:
Unknown.

9.4.3.3 Utilization of Pipeline Crossing no. 1 (between Point C and D, Figure 6.11), part of the overall Distribution Pipeline to Amsterdam and KwaThandeka

The operational phase would involve the following:

- Utilization of Pipeline Crossing no.1 as part of the overall Distribution Pipeline.

Table 7.3 provides a summary of the main environmental impacts identified in terms of the utilization of Pipeline Crossing no. 1.

Operational timeframe:
Unknown.

9.4.4 Decommissioning and rehabilitation phase

The decommissioning phase will not be discussed. It is recommended that at the time of decommissioning, a specific Environmental Management Programme (EMPr) be compiled which specifically addresses this phase. This EMPr would have to address issues such as the removal of building rubble and the rehabilitation of the site. Soil conservation measures would also have to be implemented.

9.5 Permissions required

Before any construction can commence, the following permissions are required.

9.5.1 Construction of dam at Dam Site B:

- Environmental Authorisation in terms of the Environmental Impact Assessment Regulations, 2014;
- Water Use Licence in terms of the National Water Act, 1998 (Act 36 of 1998);
- Licence to construct in terms of the National Water Act, 1998 (Act 36 of 1998) and the dam safety regulations.

9.5.2 Construction and utilization of access road (with river crossings) to Dam Site B:

- Environmental Authorisation in terms of the Environmental Impact Assessment Regulations, 2014;
- Water Use Licence in terms of the National Water Act, 1998 (Act 36 of 1998).

9.5.3 Construction of Pipeline Crossing no. 1 (between Point C and D, Figure 6.11), part of the overall Distribution Pipeline to Amsterdam and KwaThandeka

- Environmental Authorisation in terms of the Environmental Impact Assessment Regulations, 2014;
- Water Use Licence in terms of the National Water Act, 1998 (Act 36 of 1998).

9.5.4 Desilting of the Dorps Dam

- Environmental Authorisation in terms of the Environmental Impact Assessment Regulations, 2014;
- Water Use Licence in terms of the National Water Act, 1998 (Act 36 of 1998).

9.6 Mitigation and management measures to be implemented

An EMPr must include -
(f) a description of proposed impact management actions, identifying the manner in which the impact management objectives and outcomes contemplated in paragraphs (d) and (e) will be achieved, and must, where applicable, include actions to -
(i) avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation;
(ii) comply with any prescribed environmental management standards or practices;
(iii) comply with any applicable provisions of the Act regarding closure, where applicable; and
(iv) comply with any provisions of the Act regarding financial provisions for rehabilitation, where applicable.

9.6.1 Construction site office

Impact management objective:

1) *To ensure that an appropriate site is selected for the construction site office and that the site office is managed in an environmentally responsible manner with the least impact on the natural environment, site workers and persons residing near the proposed route.*

Mitigation and management measures:

a. A suitable site must be identified for the construction site office.
b. The construction site office must be demarcated and fenced.
c. It is recommended that the construction site office be located within an already disturbed area. If this is not possible, the footprint thereof must be limited as far as possible. If located near rivers, the construction site office (including the storage of material) must be located at least 100m there from and outside of the 1:100 year floodline.
d. Proper ablution and sanitation facilities must be provided if onsite accommodation is to be provided.
e. Chemical toilets must be provided for use by the site workers. These must be serviced on a regular basis. No long drop toilets may be allowed.
f. Potable water must be made available to site workers.
g. The waste management measures as indicated in Section 9.6.5 must be implemented.
h. An area for the parking of construction vehicles and other vehicles should be clearly demarcated within or in close proximity to the construction site office. When not in use, all vehicles should be parked within this area.
i. As far as practically possible, vehicles must not be serviced/repaired on site. However, should it not be possible to take the vehicle to a service centre in town for repair, the contractor must ensure that the vehicles are serviced/repaired on a cement slab and that drip trays are utilized. Waste oil, filters, etc. must be properly disposed of (see Section 9.6.5).
j. If an aboveground diesel tank is provided, it must be properly bunded to contain 110% of the volume of the tank and provided with a sump and pump. A concrete slab should be provided for refuelling purposes.

9.6.2 General construction principles

Impact management objective:

1) *To ensure that the activities that occur during the construction phase have the least impact on the surrounding natural environment, site workers and landowners/users.*

Mitigation and management measures:

a. All relevant authorizations must be obtained before construction commences.
b. A water use licence in terms of the National Water Act, 1998 (Act 36 of 1998) to be obtained before any construction activities take place

9.6.2 General construction principles

within the river.

c. The extent of the river must be clearly indicated on site (marked in the field with signs and/or highly visible flagging and construction impacts minimised in the river areas. Only necessary construction activities may take place within the river areas. These areas must be designated as 'NO-GO AREAS'. All contractors to be informed of these NO-GO AREAS through the environmental awareness programme and to be made aware of penalties (fines to be paid) to be imposed due to infringements.

d. Temporary diversion at Dam Site B: The proposed route of the temporary diversion must be clearly demarcated and the footprint (removal of vegetation) must be kept as small as possible.

e. Dam wall at Dam Site B: The dam wall construction area must be clearly demarcated and the footprint (removal of vegetation) must be kept as small as possible until such time that clearing of dam basin takes place.

f. Access road with river crossings to Dam Site B: The proposed access road (with river crossings) route must be clearly demarcated and the footprint (removal of vegetation) must be kept as small as possible.

g. Pipeline Crossing No. 1: The pipeline route extending through the Gabosha River must be clearly demarcated and the footprint (removal of vegetation) must be kept as small as possible.

h. Any sensitive landscapes in the surrounding area (see Figure 9.1, 9.2 and 9.3) must be clearly demarcated and protected as 'No-Go Areas'.

i. No unnecessary removal of vegetation should take place outside of the demarcated area.

j. For each construction area, an area must be selected and demarcated for the stockpiling of spoil (e.g. rocks, soil, etc.).

k. The excavated material (soil, rocks, etc.) must be separately stockpiled until rehabilitation, or alternatively disposed off.

l. No members of the general public should be allowed at the construction site or to set up camp in the area surrounding the construction sites.

m. Contractors to be informed to keep to low speeds along the gravel roads to reduce the amount of dust.

n. Dust suppression measures must be implemented during dry and windy periods to prevent air-borne dust deposition on the remaining natural vegetation and the streams/wetlands.

o. The applicant/contractor must appoint a Safety Officer and Environmental Control Officer (ECO) in order to ensure compliance with the relevant legislation.

p. Construction activities to be restricted to normal working hours.

q. All machinery used during the construction phase must be properly muffled and maintained so as to reduce noise generation to a minimum.

r. If archaeological remains are exposed during the construction phase, the construction must be terminated immediately and the Provincial Heritage Resources Authority (SAHRA) must be notified in this regard. A qualified archaeologist must be requested to investigate the occurrence. The applicant must take note of the requirements in

9.6.2 General construction principles

terms of the National Heritage Resources Act, 1999 (Act 25 of 1999).

s. If any graves are discovered during construction, the discovery must be reported to the SA Police Service and/or SAHRA or an archaeologist must be called in to handle the matter.

t. If any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All construction activities must be stopped and a palaeontologist must be called to determine proper mitigation measures.

u. All pollution incidents must be reported to the Department of Agriculture, Rural Development, Land and Environmental Affairs and the Department of Water and Sanitation within 24 hours of occurrence.

9.6.3 Rehabilitation of the environment after construction

Impact management objective:

1) *To ensure that the areas disturbed due to construction activities are properly rehabilitated and maintained.*
2) *To control the growth of declared weeds and/or invader plants.*

Mitigation and management measures:

a. Before construction, topsoil must be removed and stockpiled in a demarcated area for rehabilitation purposes. The topsoil layer generally has a high organic content and carries the seed bank. It is invaluable for post-development rehabilitation.

b. Once construction has been completed, all temporary structures, excess materials, equipment and waste must be removed from site.

c. All residual stockpiles must be removed to spoil or spread on site as directed by the ECO.

d. The disturbed areas must be top soiled and re-vegetated (i.e. rehabilitated) as soon as possible in order to prevent soil erosion and the establishment of alien vegetation.

e. For rehabilitation purposes, use an appropriate seed mix comprising species indigenous to the area (Venter and Niemand, 2017b). The planting of any alien plant species as part of landscaping should be prohibited.

f. Kikuyu grass (*Pennisetum clandestinum*) is a proposed declared Invader that is highly invasive. It is therefore recommended that this species is not used for rehabilitation of the area.

g. A vegetation basal cover of at least 25% must be present after the first year. Reseed areas with poor species establishment (Venter and Niemand, 2017b).

h. Proper stormwater control measures and erosion control must be implemented to prevent erosion of the newly rehabilitated areas during heavy rainfall. This is especially important at the river crossings.

i. Temporary erosion control measures (e.g. geo-textile silt fences, diversion ditches, sediment traps) and temporary seeding with fast growing annuals to be kept in place to control erosion until the long-term erosion control methods are established and functioning (Venter

9.6.3 Rehabilitation of the environment after construction

and Niemand, 2017b).

j. If soil erosion is noted, appropriate remediation measures must be implemented.

k. The regulations in terms of Alien Invasive Species, the Conservation of Agricultural Resources Act, 1983 and the Mpumalanga Nature Conservation Act, 1998 (Act 10 of 1998) with regards to declared alien species must be noted and complied with.

l. Regular site inspections will be conducted to identify any declared weeds and/or invader plants. If identified, the plants will be eradicated using appropriate methods.

m. It is advisable to consult the latest edition of 'A guide to the use of herbicides' or contact the National Department of Agriculture, Forestry and Fisheries with regards to the latest information pertaining to the application of herbicides. If pesticides or herbicides are to be used, the product should be chosen responsibly. Storage, administering and disposal must be done according to the prescribed methods.

n. A post-construction audit must be conducted to ensure that any shortcomings are identified and addressed.

9.6.4 Soil management

Impact management objective:

1) *To ensure that the activities that occur during the construction phase have the least impact on the soils in terms of soil quality, structure and erosion potential.*
2) *To reduce the potential impact of storm water drainage from the site on the surrounding area and nearby drainage areas in terms of flooding and soil erosion during the construction and operational phases.*

Mitigation and management measures:

a. Construction should take place during the dry season to prevent soil erosion.

b. Stripping of vegetation for construction must occur in a phased manner and must be restricted to the construction footprint to reduce the risk of erosion during precipitation.

c. Before construction, topsoil must be removed and stockpiled in a demarcated area within the footprint area for rehabilitation. The topsoil layer generally has a high organic content and carries the seed bank. It is invaluable for post-development rehabilitation.

d. Topsoil stockpiles must be located on flat areas (if possible) and must not be higher than 2 m.

e. Subsoil, rocks, etc. removed must also be stockpiled separately along within the footprint area.

f. Any stockpile, which is likely to remain for 12 months or more, must be vegetated.

g. All residual stockpiles must be removed to spoil or spread on site as directed by the ECO.

h. The contractor must ensure that excessive quantities of sand, silt and

9.6.4 Soil management
silt-laden water do not enter or are placed with the watercourses. Increased run-off during construction/excavation must be managed using berms and other suitable structures as required to ensure flow velocities are reduced and to prevent soil erosion. This is of special importance at river crossings. i. Sediment barriers (e.g. geo-textile silt fences) should be installed immediately after initial disturbance of the river and must be maintained throughout the construction phase and until the area is rehabilitated. j. Monitor for erosion and intervene and/or rehabilitate where necessary.
Impact management objective: *3) To reduce potential soil pollution as a result of construction and operational activities.*
Mitigation and management measures: a. The waste management measures as indicated in Section 9.6.5 must be implemented during both the construction and operational phases. b. If any soil or surface water contamination is noted, appropriate remediation measures must be implemented immediately. An environmental incident report must be completed indicating the date of the incident, description of incident and action taken. The Department of Agriculture, Rural Development, Land and Environmental Affairs and the Department of Water and Sanitation must be informed of the event within 24 hours. A copy of the environmental incident report must be kept on file at the site office.
Impact management objective: *4) To reduce the potential impact of stockpiling of the removed silt on soil as a result of the desilting of the Dorps Dam.*
Mitigation and management measures: a. An area must be demarcated for the temporary stockpiling of silt. b. The removed silt must be placed in such a way that it will not re-enter the Dorps Dam. c. The necessary storm water management measures to be provided for the demarcated stockpiling area.
Impact management objective: *5) To ensure that the geotechnical recommendations are taken into account during the construction phase in order to prevent an impact on structures during the operational phase.*
Mitigation and management measures: a. Mitigation measures recommended by Meyer (2017) and subsequent geotechnical investigations must be implemented in terms of the construction of the dam wall.

9.6.5 Waste management

Impact management objective:

1) *To ensure the proper storage, management and disposal of waste during the construction phase.*
2) *To reduce potential soil, surface water and groundwater pollution as a result of waste management activities during construction.*

Mitigation and management measures:

General/building waste

a. Proper waste management measures must be implemented at the site.
b. No waste may be burnt, buried or dumped on site or the surrounding area.
c. Waste skips to be provided for placement of general waste, building rubble, etc.
d. Continually reduce resource waste by applying the waste hierarchy (i.e. waste avoidance, reduction, reuse, recycling and disposal).
e. Promote source separation through the provision of waste bins clearly marked for recycling and general waste. These bins should be emptied on a regular basis and disposed of accordingly (i.e. sent for recycling, taken to licensed waste disposal site, etc.).
f. Waste and building rubble not to be placed on the soil stockpiles resulting in the contamination of the soil.
g. Building rubble must be disposed of at a site specifically earmarked for that purpose. No building rubble is to be disposed of in a haphazard way in the area surrounding the development site.
h. During the construction phase, cement/concrete should be mixed in either demarcated areas or on metal sheeting or conveyor belts. If mixed in demarcated areas, these areas to be ripped and the cement/concrete removed on completion of construction activities. The applicant will have to ensure that the contractor removes the rubble and any domestic waste to a licensed waste disposal site.
i. Site workers must be instructed to collect windblown rubbish which may collect in the surrounding area, on the said site or along the route. This will assist with the overall visual appearance of the site.
j. The applicant/contractor must ensure that all site workers receive appropriate training with regards to the overall waste management measures to be implemented for the said site.
k. Site workers must be aware of the importance of the implementation of the waste management measures.

Hazardous waste management

a. Proper bunded storage facilities must be provided for the storage of oils, grease, fuels, etc. to be used during the construction or operational phases.
b. Workers to be trained to contain equipment spills and leaks.
c. Refuel well away from the river.
d. Wash-down water from the equipment not to enter the river.
e. Keep fresh concrete out of the river.

9.6.5 Waste management
f. Collection containers (e.g. drip trays) must be placed under all dispensing mechanisms for hydrocarbons or hazardous liquid substances to ensure that potential contamination from leaks/spillage is reduced. g. No hazardous substance is to be disposed of on site. h. No bins containing organic solvents, paint tins or bins containing thinning agents may be cleaned on site, unless containers for liquid disposal are provided. The tins must be collected and rinsed at a central waste collection point, where it poses no threat to surface or ground water. i. All spills of chemicals or hydrocarbons (oil, grease, diesel, petrol, etc.) should be cleaned with the use of suitable absorbent materials such as drizit or oclanzorb. Appropriate soil remediation measures should be implemented where soil has been contaminated with oil. j. Contaminated soil generated as a result of fuel, oil, etc. spills to be disposed of in a specially marked drum located at the site office. An approved waste contracting firm (e.g. Enviroserv) to collect the drum and dispose of the contaminated soil at an appropriate waste disposal site. k. Contaminated soil/fuel that cannot be removed will be treated in situ with an appropriate remedial agent. In this instance, the services of an expert may be required. l. Waste oils collected on site should be stored in drums in a designated, bunded area and removed by an approved recycling contractor and disposed of at an appropriate licensed waste disposal facility. m. In all instances where a firm is contracted to collect waste (e.g. Enviroserv, Wastetech, Oilkol, etc.), the site operator will ensure that the correct documentation is completed and filed for future reference. n. Certificates of hazardous waste disposal (waybills) are to be kept for auditing purposes. o. Records of environmental related incidents should be maintained. p. The applicant must ensure that all workers receive relevant training with regards to the handling of hazardous substances and the potential health risks thereof. q. The contractor and/or applicant will be responsible for establishing an emergency procedure for dealing with spills.

9.6.6 Water management
Impact management objective: *1) To minimize the impact on and loss of the river habitat and within 100m thereof.* *2) To minimize the impact on the surface water environment and the river habitat at the river crossings.*
Mitigation and management measures: a. A water use licence in terms of the National Water Act, 1998 (Act 36 of 1998) to be obtained before any construction activities take place within the river. b. The extent of the river must be clearly indicated on site (marked in

9.6.6 Water management

the field with signs and/or highly visible flagging and construction impacts minimised in the river areas. These areas must be designated as 'NO-GO AREAS'. All contractors to be informed of these NO-GO AREAS through the environmental awareness programme and to be made aware of penalties (fines to be paid) to be imposed due to infringements.

c. Only necessary construction activities may take place in the river areas (Venter and Niemand, 2017b).

d. The temporary diversion of the river to one side of the natural channel will be required to enable construction of the dam wall. The diversion must be protected by using sandbags, clean rock or non-erodible material. Changes to water flow must be minimized.

e. Place excavated material well away from the river to minimize erosion back into the river.

f. Use existing crossings as far as possible and avoid crossing the river unnecessarily.

g. Limit compaction by not working in wet conditions and limiting vehicular access.

h. Stabilize and rehabilitate banks as soon as possible.

i. Geo-textile silt fences should be installed along the bases of fills and cuts, on the downhill side of soil stockpiles, and along river banks adjacent to cleared areas. They should be installed along a contour, and be entrenched and staked. They should extend the full width of the cleared area.

j. No water may be abstracted from the river for construction activities. If water from the river is to be used for dust suppression, a water use licence in terms of the National Water Act, 1998 (Act 36 of 1998) must be obtained from the Department of Water and Sanitation.

k. Venter and Niemand (2017b) indicated the following additional river crossing recommendations with regards to the access road and Pipeline Crossing no. 1.

Soil excavation

l. Soil management is very important to ensure successful rehabilitation of the system. The soil types and layering is very important in water movement and the correct reinstatement is therefore critical in rehabilitation.

m. The topsoil (top 50cm of soil) must be removed and stored separately from the subsoil. The topsoil must be windrowed separately from the subsoil.

n. Watercourse soil, topsoil and subsoil must be stored separately from the soil of terrestrial areas.

o. The entire extent of the alluvial soil along the excavation must be removed and stored separately. Not all of the watercourse types have alluvial soil, the alluvial soil is confined to the Gabosha River.

p. The soil must be reinstated in the watercourse in the correct order. The subsoil must be replaced first with the topsoil placed on top. The alluvial soil must be replaced in the watercourse channel, in the correct position.

q. No soil may be stored within the watercourse or watercourse buffers.

Reinstatement and revegetation

r. Sufficiently compact the reinstated soil to ensure stability.

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s. The topsoil should not be compacted.

t. Topsoil placed on the river banks must be stabilised with jute. Install jute according to the manufactures specification, including correct overlap, pegging and anchoring of the jute. Do not skimp on the jute or pegs. Jute is a biodegradable, loosely weaved material similar to hessian or burlap bags and can be purchased in large rolls.

u. Collect grass seeds from the surroundings and reseed on site. Mowed grass with seeds can be used for mulching.

v. Use brush packing on bare areas that may be trampled by livestock.

Approaches

w. Bare areas are more prone to erosion than vegetated areas.

x. Revegetate exposed areas as soon as possible.

y. Use sandbags for contour berms to limit erosion on the pipeline. The contour berms can be removed by hand as soon as vegetation cover is sufficient.

z. Install storm water retaining walls where necessary.

aa. Install energy dissipaters where storm water from the road intersect with the pipeline route and watercourses. These are areas prone to disturbance.

Impact management objective:

3) To ensure that construction and operational activities do not impact on the river in terms of water quality.

Mitigation and management measures:

a. Waste management measures as indicated in Section 9.6.5 must be implemented in order to reduce the potential impact on the downstream drainage areas and wetlands.

b. All equipment should be parked overnight at the construction site office and refuelled at least 100 meters from a river.

c. Drip trays (minimum of 10cm deep) must be placed under all vehicles that stand for more than 24 hours and generators used within wetland habitat. Vehicles suspected of leaking must not be left unattended, drip trays must be utilised.

d. Drip trays must be utilised during repairs and maintenance of all machinery. The depth of the drip tray must be determined considering the total amount / volume of oil in the vehicle. The drip tray must be able to contain the volume of oil in the vehicle.

e. No construction vehicles should be serviced/repaired within the river or within 100m thereof.

f. Portable toilets should be located outside of river areas and not within 100m thereof.

g. Engineering measures must be in place to limit the risk of spillages into rivers.

h. If any soil or surface water contamination is noted, appropriate remediation measures must be implemented immediately. An environmental incident report must be completed indicating the date of the incident, description of incident and action taken. The Department of Agriculture, Rural Development, Land and Environmental Affairs and the Department of Water and Sanitation

9.6.6 Water management

must be informed of the event within 24 hours. A copy of the environmental incident report must be kept on file at the site office.

Impact management objective:

4) *To reduce the potential impact on the surface water and associated aquatic environment of the Gabosha River and the downstream water users during both the construction and operational phases in terms of water quantity.*

Mitigation and management measures:

a. The ecological water requirements of the downstream reaches (Gabosha, Thole, Ngwempisi Rivers) must be met (Kotze, 2017).
b. No cessation of flow to downstream reaches as the said system must remain perennial (Kotze, 2017).
c. A temporary diversion of the river to be built to one side of the natural channel to enable construction of the dam wall and continued flow of the Gabosha River during the construction phase.
d. Instrumentation must be provided for the monitoring of flow from the dam. A measuring weir to be provided immediately downstream of the dam (V-notch type at the end of the stilling basin) to measure environmental flow releases.
e. A biomonitoring programme must be implemented prior to commencing with any development on site in order to expand the baseline information and ensure adequate seasonal coverage (Kotze, 2017). The baseline information is critical in enabling detection of future changes associated with the proposed development. The following is proposed:

SITES	BIOMONITORING PROTOCOL	FREQUENCY
GB1, GB3, PLC1, TR-US and TR-DS	Habitat assessment (photographic, IHI), SASS5 and fish survey	Bi-annually (wet and dry season surveys)
Any other potential pollution source or effluent (such as purification plant effluents)	DWS's DEEP protocol: Whole effluent toxicity testing using at least three different organisms (fish, daphnia, algae, bacteria)	Quarterly (4 times per year)

Impact management objective:

5) *To reduce the potential impact of increased sedimentation on water quality and aquatic fauna associated with the Gabosha River during the desilting of the Dorps Dam.*
6) *To reduce the potential impact on downstream water users (interested and affected parties) in terms of water quality deterioration (increased turbidity).*

Mitigation and management measures:

a. Desilting should ideally be done during the wet season when adequate flows will be present in the receiving rivers (Gabosha and Thole) to

9.6.6 Water management

decrease the impact of increased sedimentation and high turbidity (Kotze, 2017).

b. Silt to be removed from the Dorps Dam and not flushed down the Gabosha River system (Kotze, 2017).
c. The removed silt must be placed in such a way that it will not re-enter the Dorps Dam during rainy periods.
d. Removal of alien trees on the embankment of the Dorps Dam to be managed so that no unnecessary sedimentation takes place resulting in an increase in turbidity of the water.

Impact management objective:

7) To reduce the potential impact of unnatural releases on fish associated with the Gabosha River during the desilting of the Dorps Dam.

Mitigation and management measures:

a. No unnatural releases from the Dorps Dam into the downstream Gabosha River to take place as this may trigger unnatural fish migration/movement (2017).
a. The ecological water requirements of the downstream reaches (Gabosha, Thole, Ngwempisi Rivers) to be met (Kotze, 2017).
b. No cessation of flow to downstream reaches as the said system must remain perennial (Kotze, 2017).

9.6.7 Vegetation and animal life management

Impact management objective:

1) To reduce the potential impact on the vegetation and animal life during the construction phase;
2) To minimize loss of habitat and the displacement of threatened and near threatened fauna during the construction phase.

Mitigation and management measures:

a. The placement of infrastructure should preferably be restricted to areas identified with low ecological sensitivity (Venter and Niemand, 2017b).
b. No movement of vehicles or people to be allowed within any area of high ecological sensitivity during construction (Venter and Niemand, 2017b).
c. During construction, no unnecessary removal of vegetation should take place outside of the demarcated area. Mass clearing of vegetation will not be allowed until such time as the dam basin must be cleared.
d. Where possible, existing roads should be used for access during the construction phase (Venter and Niemand, 2017b).
e. During construction, connectivity between the various grassland and watercourses (drainage lines) that are not part of the development footprint should be maintained. Therefore, natural corridors (e.g. grassland units, drainage lines) must be retained where possible to promote the movement of fauna (Venter and Niemand, 2017b).
f. All construction activities to be limited to daylight hours (Venter and Niemand, 2017b).

9.6.7 Vegetation and animal life management
g. No poaching of animals to take place on site or in the surrounding area. h. Intentional killing of fauna, in particular invertebrates (e.g. scorpions) and herpetofauna (e.g. snakes) should be avoided by means of awareness programmes presented to the site workers. The site workers to be made aware of the conservation issues pertaining to the fauna/animal life occurring on site. i. Should any animals (e.g. reptiles, mammals, etc.) be found or exposed during the construction phase, a specialist should be contacted immediately to ensure the safe removal of the specimen(s) and translocation to adjacent suitable habitat. j. Exterior lighting to be reduced and strategies must be implemented to reduce 'spill light'. Outside lighting could attract night-migrating bird and invertebrate taxa, and can result in collisions with infrastructure. If possible, outside lighting should make use of lights with blue or green hues rather than light that contain red wavelengths. In addition, features should be illuminated (for security reasons) by using 'down-lighting' rather than 'up-lighting' (Venter and Niemand, 2017b). k. No fires to be made on site. l. The establishment of informal settlements in the surrounding area to be monitored and removed as soon as possible in order to prevent any impact on the animal life.
Impact management objective: *3) To reduce the potential impact on the surrounding vegetation and animal life during the operational phase.*
Mitigation and management measures: a. Exterior lighting must be reduced and strategies implemented to reduce 'spill light'. Outside lighting could attract night-migrating bird and invertebrate taxa, and can result in collisions with infrastructure. If possible, outside lighting should make use of lights with blue or green hues rather than light that contain red wavelengths. In addition, features should be illuminated (for security reasons) by using 'down-lighting' rather than 'up-lighting' (Venter and Niemand, 2017b). b. Monitor the site for the establishment of invasive plant species. c. The regulations in terms of the Alien Invasive Species, Conservation of Agricultural Resources Act, 1983, and the Mpumalanga Nature Conservation Act, 1998 (Act 10 of 1998) with regards to declared alien species must be noted and complied with. d. An Alien and Invasive Species Management Plan must be developed and implemented in order to manage and control all exotic and alien vegetation. e. The establishment of informal settlements in the surrounding area to be monitored and removed as soon as possible in order to prevent any impact on the animal life. f. No uncontrolled development to be allowed in the surrounding area.

9.6.8 Interested and affected parties
Impact management objective: *1) To ensure that site workers are not impacted upon in terms of the construction work being performed.*
Mitigation and management measures: a. The applicant/contractors must ensure that the necessary protective gear (PPE) is worn at all times and that signs are erected to warn workers to use hearing protection as well as any other hazards. b. The applicant/contractor must adhere (at all times) to the requirements of the Occupational Health and Safety Act, 1993 (Act 85 of 1993), the Construction Regulations, 2014 and any other applicable legislation. c. For safety purposes, excavations must not be undertaken until such time as all required materials are available and services can be laid. d. Excavations should be closed as soon as is practically possible. e. If blasting is required, the requirements of the Explosives Act, 2003 (Act 15 of 2003) must be put in place in order to prevent any impact on site workers, etc.
Impact management objective: *2) To reduce the potential impact of dust generation as a result of the stockpiling of silt on water quality and aquatic fauna associated with the Gabosha River during the desilting of the Dorps Dam.* *3) To reduce the potential impact of dust generation as a result of the stockpiling of silt on site workers and downstream water users (interested and affected parties) in terms of water quality deterioration (increased turbidity).*
Mitigation and management measures: a. Desilting should ideally be done during the wet season (Kotze, 2017). b. The stockpiling of silt should only be allowed for a limited time period before being removed from site.

9.7 Implementation and monitoring of the EMPr

An EMPr must include -
(g) the method of monitoring the implementation of the impact management actions contemplated in paragraph (f);
(h) the frequency of monitoring the implementation of the impact management actions contemplated in paragraph (f);
(i) an indication of the persons who will be responsible for the implementation of the impact management actions;
(j) the time periods within which the impact management actions contemplated in paragraph (f) must be implemented;
(k) the mechanism for monitoring compliance with the impact management actions contemplated in paragraph (f);
(l) a program for reporting on compliance, taking into account the requirements as prescribed by the Regulations;

The implementation of the Environmental Management Programme (EMPr) as part of the daily construction and operational activities is crucial and requires commitment from all levels of management and the on-site workers. The successful implementation of an EMPr has the following advantages:

- Meeting legal obligations;
- Contributes to environmental awareness;
- Can facilitate the prevention of environmental degradation;
- Can minimize impacts when they are unavoidable;
- Can ensure good environmental performance and improve community relations.

An approved contractor should be appointed to do the necessary construction on the said site. The contractor and site workers must be aware of their environmental responsibilities. Penalty clauses, in terms of the environment, must be built into the contracts and must be implemented. Monitoring of the environmental management programme must take place on a regular basis in order to ensure compliance.

The contractor must inform all site workers of their environmental responsibility during the construction phase. Measures to protect the environment and mitigation measures formulated in this EMPr must be implemented by the contractor and the site workers. The contractor must thus ensure that the site workers are aware of the Environmental Authorisation and this EMPr and understand the contents thereof.

In order to achieve the above-mentioned, the contractor and site workers should undergo basic environmental awareness training with regards to the contents of this EMPr. Environmental awareness training is critical for the contractor and site workers to understand how they can play a role in achieving the objectives specified in the EMPr. The contractor must ensure that the site workers undergo the necessary environmental awareness training (see Section 9.7.1) before commencing with activities on the site.

This section must be completed on acceptance of the appointment.

MANAGEMENT ACCOUNTABILITY		
Accountability	**Title**	**Name**

MANAGEMENT DECLARATION

I, the undersigned in my capacity as designated above hereby undertake to ensure that the conditions and recommendations in terms of the Environmental Authorisation and Environmental Management Plan (EMPr) are implemented and assume responsibility and accountability in this respect.

I further understand that officials from the eMalahleni Local Municipality, Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA) and Department of Water and Sanitation (DWS) may (at any time) conduct an inspection of the project in order to ensure compliance with the conditions and recommendations in the EMPr.

CONTRACTOR

……
Name and Designation

……
Signature:

……
Date:

EMPLOYER

……
Name and Designation:

……
Signature:

……
Date:

9.7.1 Environmental Awareness Plan (EAP)

An EMPr must include -
(m) An environmental awareness plan describing the manner in which-
- *(i) the applicant intends to inform his or her employees of any environmental risk which may result from their work; and*
- *(ii) risks must be dealt with in order to avoid pollution or the degradation of the environment.*

It is recommended that the employees receive basic environmental awareness training. In order to ensure proper training, the applicant must develop and implement an Environmental Awareness Plan (EAP). This section provides an overview of what the proposed EAP will contain and how it will be implemented.

The following components would form an essential part of an Environmental Awareness Plan (EAP): -

- Development of an environmental policy;
- Identification of environmental impacts/risks and mitigation measures;
- Environmental training, awareness and competence;
- Environmental communication and reporting.

Development of an environmental policy
The applicant would have to compile an Environmental Policy (if they do not have one already), which is a one page statement setting out certain principles in terms of their environmental performance.

The environmental policy should indicate the following:
- The applicant's commitments in terms of the environment;
- Identify environmental impacts as a result of the activities taking place on site;

- Actions to be taken to minimize/mitigate the environmental impacts.
- Signature of management.

In order to ensure effective environmental management, it is important that the Environmental Policy is known and understood by all employees. It should thus be displayed at the construction site office.

An Environmental Policy Template is provided to assist the applicant in the compilation of their Environmental Policy. A number of templates are also available on the internet.

Environmental Policy Template (taken from Richmond upon Thames, 2012)

*[*Insert company name here*] believe that we have a responsibility to care for and protect the environment in which we operate. We are fully committed to improving environmental performance across all of our business activities, and will encourage our business partners and members of the wider community to join us in this effort.*

*[*Insert company name here*] recognises our key impacts to be in the areas of [for example]:*

- *energy use*
- *raw material use*
- *waste generation*
- *emissions to air/water*
- *water use*
- *transport*
- *procurement*

We will strive to:

- *Adopt the highest environmental standards in all areas of operation, meeting and exceeding all relevant legislative requirements.*
- *Assess our organisational activities and identify areas where we can minimise impacts.*
- *Minimise waste through careful and efficient use of all materials and energy.*
- *Purchase sustainable products wherever feasible [e.g. recycled, FSC or low environmental impact products and energy from renewable sources].*
- *Train employees in good environmental practice and encourage employee involvement in environmental action.*
- *Reduce risks from environmental, health or safety hazards for employees and others in the vicinity of our operations.*
- *Adopt an environmentally sound transport strategy.*
- *Aim to include environmental and ethical considerations in investment decisions where appropriate.*
- *Assist in developing solutions to environmental problems.*
- *Continually assess the environmental impact of all our operations.*

*[*Insert company name here*] have developed a series of action plans to supplement each of our environmental policy objectives. These can be found* [in an appropriate place*].*

*[*Insert company name here*] will periodically review performance and publish these results [*in an appropriate manner*].*

Signed _____

Identification of environmental impacts / risks and mitigation measures

Environmental impacts/risks in terms of the development are indicated in Section 7 of this document while mitigation measures to be implemented are provided in Section 9.

Activities or work procedures that could have a significant impact on the environment have thus been identified and mitigation measures proposed in order to avoid pollution or the degradation of the environment.

This information must be communicated to the employees and thus forms the basis for developing an Environmental Awareness Plan (EAP) in order to ensure effective environmental management.

Environmental training, awareness and competence

Training is necessary in order to advance the competency of employees in implementing the Environmental Policy and the EMPr and to ensure effective overall environmental management.

The applicant (including appointed contractor) must inform all his employees of their environmental responsibilities in terms of this Environmental Management Programme (EMPr). Measures to protect the environment and mitigation measures formulated in this EMPr must thus be implemented by the applicant and employees (including appointed contractor).

In addition, job specific training must be conducted that will be appropriate to the activity and the responsibility of the individual employees. Ad-hoc training will be undertaken as required.

Through training/awareness, the applicant will also make his employees aware of:

- the importance of conformance with the environmental policy and the requirements of the EMPr;
- the significant environmental impacts, actual or potential, of their work activities and the environmental benefits of improved personal performance;
- their roles and responsibilities in achieving conformance with the environmental policy and the requirements of the EMPr, including emergency preparedness and response requirements; and
- the potential consequences of departure from the specific operating procedures and/or mitigation measures specified in the EMPr.

Environmental training and development needs of employees will be identified on a regular basis through:

- Identification of significant environmental impacts;
- Analysis of non-conformance and incident reports;
- Audit reports.

Environmental communication and reporting

Environmental communication and reporting form an integral part of an Environmental Awareness Plan. It is important to maintain effective communication internally and to ensure that external communication (e.g. with government departments or adjacent landowners) is maintained.

In general, environmental communication and reporting will aim to:

- Ensure that employees understand the environmental policy and objectives;
- Ensure that information is communicated and readily accessible to the relevant parties;
- Improve feedback of operational and environmental performance to management;
- Ensure effective and constructive communication with relevant government departments and adjacent landowners (if applicable);
- Ensure that records are kept of environmental communication and interaction.

The following are some of the topics that should be discussed with new employees:

- Time of commencement and completion of duties;
- Cleaning of workplace and the importance thereof;
- Safety clothing and its importance and correct use;
- Procedure to follow in case of illness and injury;
- Annual leave and when due;
- Importance of instructions;
- Late for work and leaving workplace without permission;
- Emergency procedures;
- Environmental awareness;
- Training and its importance;
- Alcohol and drug abuse;
- Medical fitness;
- Disciplinary procedures.

The following topics should form part of the environmental awareness discussions to be held with the employees:

- NO-GO areas;
- Water;
- Fauna and flora;
- Smoking and fires;
- Dust;
- Noise;
- Waste management.

Various signs (including the Environmental Policy) should be displayed on site to remind site workers of the basic environmental principles and inform them of the 'DO'S' and 'DON'TS'.

The applicant must conduct regular inspections to check on site conditions and to provide training when necessary to ensure that the mitigation measures are being implemented and that the environment is carefully looked after.

9.7.2 Site documentation and record keeping

The following documentation must be available (at all times) at the site office:

- A copy of the Environmental Impact Assessment Report (EIAR) and Environmental Management Programme;
- A copy of the Environmental Authorisation;
- A copy of the Environmental Policy;
- A copy of site audit reports;

- A copy of any other permits/approvals and/or service agreements from other authorities/landowners/etc.

The documents should be kept as hard copies as well as in electronic format.

Complaints Register
A complaints register must be kept at the site office. Any complaints received with regards to the project must be recorded in the complaints register. The following information must be recorded:

- Date complaint recorded;
- Nature of complaint;
- Details of complainant (name, address, telephone number, etc.);
- Manner in which complaint was dealt with;
- Date when complaint was reported to the Department of Agriculture, Rural Development, Land and Environmental Affairs and the Department of Water and Sanitation.

Emergency numbers
Emergency numbers (e.g. manager, police, fire department, ambulance, etc.) must be prominently displayed at the site office.

Contact details of affected landowners/users must also be kept on file.

Other legislation
The following should also be displayed at the site office:

- Occupational Health and Safety Act, 1993 (Act 85 of 1993) as amended;
- Basic Conditions of Employment Act, 1997;
- Summary of the Employment Equity Act.

Supplementary documentation
The following supplementary documentation should be kept at the site office:

- Site instructions;
- Emergency preparedness and response procedures;
- Incident reports;
- Training records;
- Site inspection, monitoring and auditing reports.

During the course of the development, the applicant and employees must also comply with all other relevant legislation.

9.7.3 Auditing and corrective action

Environmental audits identify existing and potential environmental problems and determine what action is needed to comply with legal requirements and the Environmental Management Programme (EMPr). Subsequent audits then confirm that corrective actions have been taken and assess the effectiveness of such actions.

Construction phase:
The applicant must appoint an Environmental Control Officer (ECO) who will have the responsibility of monitoring and reporting on compliance with the conditions of the Environmental Authorisation as well as monitoring and reporting on the implementation of the EMPr.

The ECO must be appointed before the commencement of construction and must remain employed until all rehabilitation measures as well as site clean-up are completed.

The ECO will be responsible to:

- Monitor and audit the construction activities on a weekly basis;
- Keep a record of each site inspection and the findings thereof;
- Make a register of the environmental monitoring and auditing results available for inspection at the construction site office;
- Keep records relating to the compliance and non-compliance with the conditions of the Environmental Authorization;
- Make these records available to the Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA) within seven (7) working days of the date of the written request by the Department for such records.

A good approach to facilitate legal enforceability of the EMPr during the construction phase is to integrate the EMPr into the tender and contract document (i.e. between the project applicant and the contractors) as a set of environmental specifications. The contractor will thus be informed prior to being appointed of his environmental responsibilities.

Penalties in terms of the environment should be implemented upon non-compliance. This will ensure that the project applicant does not sit with an environmental liability at the end of the contract.

A post-construction audit should be conducted prior to the contractors leaving site.

There are several levels at which corrective action can be affected, namely verbal instructions, written instructions and contract notices.

Level 1: The problem is discussed with the contractor and a solution is worked out together. The discussion is minuted for record purposes and the solution implemented.

Level 2: When a more serious infringement is observed, the contractor is notified in writing and given a deadline by which the issue must be rectified. Costs to be borne by the contractor.

Level 3: The contractor will be ordered to suspend all or part of the work until such time as the problem is rectified or remedial measures put in place. Costs to be borne by the contractor and no extension of time will be granted.

Level 4: Breach of contract and/or termination of employment. The applicant may also institute legal proceedings against the contractor.

An example of a penalty schedule is provided below.

PENALTY SCHEDULE

Level	Description	Penalty	Offences
1	Minor offence	R1000 first offence R2000 second offence And R1000/per day that offence continues beyond notification of offence	• Littering; inadequate or inappropriate on-site waste management or sanitation • Uncontrolled noise and dust nuisance Poaching on site • Inadequate soil / water protection controls for fuel storage & dispensing areas, vehicle parking areas
2	Moderate offence	R5000 first offence R10 000 second offence And R5000 per day that the offence continues beyond notification of offence	• Trespassing onto neighbours properties • Removal of indigenous trees marked for conservation purposes without the permission of the ECO, or trees in demarcated sensitive environmental zones • Disposal of any form of waste to a non-approved dump site • Any illegal /non-permitted abstraction or use of water from a natural resource • The withholding of pertinent information or provision of false information to the ECO or Project Manager
3	Significant offence	R30 000 first offence R50 000 second offence And R30 000 per day that the offence continues beyond notification of offence	• Non-compliance with any risk or safety management requirements • Significant spillage of hazardous materials • Use of natural materials not sourced from a legally permitted source • Construction or use of roads/access across rivers, streams or wetlands that has not been authorized by the Project Manager and ECO
4	Serious offence	Up to R500 000 or total cost of rehabilitating damaged environment	• Any serious pollution event or accident • Any serious encroachment into demarcated sensitive environmental zones, by accident or on purpose • Any serious stormwater damage that could have been avoided through appropriate management interventions

In addition to the schedule of penalties, a portion of the Retention on all contracts could be apportioned to compliance with the EMPr.

<u>Operational phase:</u>
The applicant will be responsible for auditing and corrective action during the operational phase of the development.

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- Mallory, S.L.J. 2017. **Hydrology and water resource assessment towards augmenting the water supply to Amsterdam, Mpumalanga.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: June 2017.

- Mallory, S.L.J. and H. Jacobs. 2014. **Hydrology and water resource assessment of the water supply to Amsterdam.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: December 2014.

- Mallory, S.L.J. and H. Jacobs. 2015. **Hydrology and water resource assessment of the Thole and Gabosche Rivers – assessment using daily hydrology.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: June 2015 (final)

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- Meyer, M. 2017b. **Factual report on a geotechnical investigation for the proposed Gabosche River Dam, Amsterdam, Mpumalanga.** Report prepared by: Engeolab cc. Report dated: August 2017. Report number: LL2870. Report version: Version 2.

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- **Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom of Swaziland for co-operation on the protection and sustainable utilization of the water resources of the Incomati and Maputo watercourses** (also referred to as the Interim IncoMaputo Agreement, 2002).

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- Venter, I. and L. Niemand. 2017b. **Ecological Assessment for the proposed Amsterdam dam and associated infrastructure.** Report compiled by: Kyllinga Consulting and Pachnoda Consulting. Report dated: August 2017.

- WSDP, 2010. **Gert Sibande District Municipality Integrated Regional Water Services Development Plan 2010 – 2014.** Prepared by WSP SA Civil and Structural Engineers (Pty) Ltd, WRP Consulting (Pty) Ltd., PD Naidoo & Associates Consulting Engineers (Pty) Ltd and Tlou Consulting (Pty) Ltd. Report dated: December 2014.

APPENDIX 1:

APPLICATION FORM

APPENDIX 2:

CURRICULUM VITAE

- Mrs. A. Erasmus *Pr. Sci. Nat.*
- Ms. R. Janse van Rensburg
- List of projects

APPENDIX 3:

TRIPARTITE AGREEMENT

- **Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom of Swaziland for co-operation on the protection and sustainable utilization of the water resources of the Incomati and Maputo watercourses** (also referred to as the Interim IncoMaputo Agreement, 2002).

APPENDIX 4:

ADVERTISING OF THE PROJECT

- A copy of the notice published in the Hoëvelder, 24 February 2017.
- A copy of the on-site notice.
- Printout of company website pages www.adienvironmental.co.za.

APPENDIX 5:

BACKGROUND INFORMATION DOCUMENT

APPENDIX 6:

CORRESPONDENCE WITH INTERESTED AND AFFECTED PARTIES

- E-mail from AdiEnvironmental cc (dated: 20 March 2017) to Mr. R. Smith.
- E-mail from AdiEnvironmental cc (dated: 27 February 2017) to the following:

F Mashabela	Department of Agriculture, Forestry and Fisheries
J Venter	Department of Agriculture, Rural Development and Land Administration
S Mbuyane	Department of Agriculture, Rural Development, Land and Environmental Affairs
S Marebane	Department of Agriculture, Rural Development, Land and Environmental Affairs
M Loock	Department of Co-operative Governance and Traditional Affairs
S Mathavhela	Department of Mineral Resources
B Viljoen	Department of Public Works, Roads and Transport
T Ludere	Eskom Distribution
L Motsisi	Eskom Transmission
N Ndlovu	Mkhondo Local Municipality
R Nkambule	Mkhondo Local Municipality
K Knarasoo	Mpumalanga Tourism and Parks Agency
H Marais	Mpumalanga Wetland Forum
H Kusel	Piet Retief Agricultural Union
J Smit	Telkom
D du Plessis	Transvaal Landbou Unie
S Sukazi	Ward 19 Community Development
L Betha	Wildlife and Environment Society of South Africa
K Marx	Wildlife and Environment Society of South Africa

- E-mail from AdiEnvironmental cc (dated: 27 February 2017) to Mr. H. Marais.
- E-mail from AdiEnvironmental cc (dated: 28 February 2017) to A Mazibuko (Mkhondo Local Municipality) and M Dondo (Gert Sibande District Municipality).
- E-mail from AdiEnvironmental cc (dated: 28 February 2017) to S Mbuyane (Department of Agriculture, Rural Development, Land and Environmental Affairs).
- E-mail from AdiEnvironmental cc (dated: 28 February 2017) to S Mathavhela (Department of Mineral Resources), B Viljoen (Department of Public Works, Roads and Transport), S Marebane (Department of Agriculture, Rural Development, Land and Environmental Affairs) and J Wesson (Wildlife and Environment Society of South Africa).
- E-mail from AdiEnvironmental cc (dated: 28 February 2017) to S Shabangu (Inkomati Usuthu Catchment Management Agency (IUCMA)).
- E-mail from AdiEnvironmental cc (dated: 28 February 2017) to N Nkambule (Department of Rural Development and Land Reform).
- Printout of South African Heritage Resources Agency (SAHRIS) website.
- Facsimile from AdiEnvironmental cc (dated: 27 February 2017) to Councilor Ngobeza**.**
- E-mail from AdiEnvironmental cc (dated: 14 March 2017) to Mr. D. Marnewick (Birdlife South Africa).
- E-mail from AdiEnvironmental cc (dated: 14 March 2017) to Mr. G. Masuku (National Department of Public Works).
- E-mail from AdiEnvironmental cc (dated: 14 March 2017) to Mr. A. Grobbelaar.
- E-mail from AdiEnvironmental cc (dated: 14 March 2017) to Mr. P. Venter.

APPENDIX 7:

COMMENTS RECEIVED

- E-mail from B. Viljoen (Department of Public Works, Roads and Transport) (dated: 1 March 2017) to AdiEnvironmental cc.
- E-mail from S. Shabangu (Inkomati Usuthu Catchment Management Agency) (dated: 1 March 2017) to AdiEnvironmental cc.
- E-mail from A. Mazibuko (Mkhondo Local Municipality) (dated: 2 March 2017) to AdiEnvironmental cc.
- E-mail from M. Dondo (Gert Sibande District Municipality) (dated: 2 March 2017) to AdiEnvironmental cc.
- Completed comment sheet (dated: 15 March 2017) from L. Botha.
- E-mail from AdiEnvironmental cc (dated: 16 March 2017) to L. Botha.

APPENDIX 8:

CORRESPONDENCE WITH DEPARTMENT OF AGRICULTURE, RURAL DEVELOPMENT, LAND AND ENVIRONMENTAL AFFAIRS (DARDLEA)

- Letter from AdiEnvironmental cc (dated: 14 December 2016) to Mr. S. Marebane (DARDLEA) regarding the water pipeline.
- Letter from AdiEnvironmental cc (dated: 14 December 2016) to Mr. S. Marebane (DARDLEA) regarding the upgrading of the Amsterdam WTWs.
- Letter from DARDLEA (dated: 14 March 2017; Ref: 1/3/1/16/3 G-85) to AdiEnvironmental cc.
- Letter from AdiEnvironmental cc (dated: 28 March 2017) to Mr. S. Marebane (DARDLEA).

APPENDIX 9:

EVALUATION OF DRAFT SCOPING REPORT

- Letter from AdiEnvironmental (dated: 5 April 2017; Ref: EIA 2017/01) to the Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA).
- Letter from DARDLEA (dated: 12 April 2017; Ref: 1/3/1/16/1 G-56) to AdiEnvironmental regarding the submission of the application form.
- Letter from AdiEnvironmental (dated: 5 April 2017; Ref: EIA 2017/01) to the Inkomati Usuthu Catchment Management Agency.
- Letter from AdiEnvironmental (dated: 5 April 2017; Ref: EIA 2017/01) to the Mpumalanga Tourism and Parks Agency.
- Letter from AdiEnvironmental (dated: 5 April 2017; Ref: EIA 2017/01) to the Mkhondo Local Municipality.
- Example of the e-mails from AdiEnvironmental (dated: 6 April 2017) forwarded to the various I&APs/government departments/stakeholders.
- Facsimile sent (dated: 6 April 2017) to Ms. Ngobeza (Councillor: Ward 19).
- Copy of the notice displayed at the Amsterdam Public Library and register**.**
- www.adienvironmental.co.za web page printouts.
- Copy of the notice placed in the Hoëvelder, 7 April 2017.
- Copy of the notice placed in the Excelsior News, 7 April 2017.
- Letter from the South African Heritage Resources Agency (dated: 31 March 2017; Ref: 10740).
- Letter from the Inkomati Usuthu Catchment Management Agency (dated: 26 April 2017; Ref: 14/1/3/4/1/X53C).
- E-mail from Mr. H. Ludere (Eskom) (dated: 6 April 2017) to AdiEnvironmental.
- E-mail from AdiEnvironmental (dated: 6 April 2017) to Mr. Ludere.
- Letter from Eskom (dated : 19 April 2017 ; Ref : LD-INVET/E/TT/011/2017).
- Letter from OpenServe (dated : 4 April 2017 ; Ref : TK17/32).
- Letter from DARDLEA (dated: 15 February 2017; Ref: 1/3/1/16/1 G-86) to AdiEnvironmental regarding the proposed upgrading/refurbishment of the Amsterdam Water Treatment Works and the upgrading of the existing bulk water supply infrastructure.
- Letter from DARDLEA (dated: 4 April 2017; Ref: 1/3/1/16/1 G-85) to AdiEnvironmental regarding the new water pipeline from the Amsterdam Water Treatment Works to the proposed new pumpstation.

APPENDIX 10:

EVALUATION OF FINAL SCOPING REPORT

- Letter from AdiEnvironmental (dated: 16 May 2017; Ref: EIA 2017/01) to the Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA).
- Printout of courier delivery report.
- Letter from DARDLEA (dated: 29 May 2017; Ref: 1/3/1/16/1 G-56) to AdiEnvironmental regarding the submission of the application form.
- Letter from DARDLEA (dated: 3 July 2017; Ref: 1/3/1/16/1 G-56) to AdiEnvironmental accepting the Final Scoping Report.
- E-mail from AdiEnvironmental (dated: 4 September 2017) to DARDLEA regarding the extension of time.
- E-mail and letter from AdiEnvironmental (dated: 11 October 2017) to DARDLEA requesting extension of time.
- Letter from DARDLEA (dated: 16 October 2017; Ref: 1/3/1/16/1 G-56) granting extension of time.

APPENDIX 11:

COMMENTS RECEIVED DURING EIA PHASE

- E-mail from AdiEnvironmental (dated: 31 May 2017) to Mondi (M. Sikhakhane).
- E-mail from AdiEnvironmental (dated: 31 May 2017) to B Mlomo and P Lukhele.
- E-mail from AdiEnvironmental (dated: 1 June 2017) to L. Shezi.
- E-mail from AdiEnvironmental (dated: 2 June 2017) to S. Mabuza.
- E-mail from S. Mabuza (dated: 2 June 2017) to AdiEnvironmental confirming receipt of the e-mail.
- E-mail from AdiEnvironmental (dated: 2 June 2017) to S. Mabuza regarding the draft Scoping Report.
- E-mail from S. Mabuza (dated: 2 June 2017) to AdiEnvironmental regarding the due date for comments.
- E-mail from AdiEnvironmental (dated: 3 June 2017) to S. Mabuza regarding the due date for comments.
- E-mail from S. Mabuza (dated: 13 June 2017) to AdiEnvironmental cc providing comment.
- E-mail from AdiEnvironmental (dated: 13 June 2017) responding to S. Mabuza.
- E-mail from AdiEnvironmental (dated: 31 May 2017) to M. de Kock (Department of Rural Development and Land Reform.
- Letter from the South African Heritage Resources Agency (dated: 20 October 2017; Ref: 10740) to AdiEnvironmental.
- E-mail from S. Hashveer (dated: 24 July 2017) to AdiEnvironmental registering as an interested and affected party.
- E-mail from AdiEnvironmental (dated: 25 July 2017) to S. Hashveer.

APPENDIX 12:

GEOTECHNICAL ASSESSMENT

- Meyer, M. 2016. **Report on a geotechnical investigation for the proposed Amsterdam Dam, Mpumalanga.** Report prepared by: Engeolab cc. Report dated: October 2016. Report number: LL2768. Report version: Version 1.
- Meyer, M. 2017a. **Report on a Phase 1 geotechnical investigation for the proposed Gabosche River Dam, Amsterdam, Mpumalanga.** Report prepared by: Engeolab cc. Report dated: March 2017. Report number: LL2870. Report version: Version 1.
- Meyer, M. 2017b. **Factual report on a geotechnical investigation for the proposed Gabosche River Dam, Amsterdam, Mpumalanga.** Report prepared by: Engeolab cc. Report dated: August 2017. Report number: LL2870. Report version: Version 2.

APPENDIX 13:

ECOLOGICAL ASSESSMENT

- Venter, I. and L. Niemand. 2017b. **Ecological Assessment for the proposed Amsterdam dam and associated infrastructure.** Report compiled by: Kyllinga Consulting and Pachnoda Consulting. Report dated: August 2017.

APPENDIX 14:

AQUATIC ASSESSMENT

- Kotze, P. 2017. **Aquatic fauna baseline assessment of the Gaboshe and Thole Rivers in the vicinity of a proposed dam and associated infrastructure, Mpumalanga, South Africa.** Report prepared by: Clean Stream Biological Services (Pty) Ltd. Report dated: June 2017. Report number: AMS/A/17.

APPENDIX 15:

HERITAGE IMPACT ASSESSMENT

- Van Vollenhoven, A. 2017b. **A Report on a Cultural Heritage Impact Assessment for a proposed new dam and pipelines at Amsterdam, Mpumalanga Province.** Report compiled by: Archaetnos Culture & Cultural Resource Consultants. Report dated: 19 May 2017. Report no.: AE01717V.

APPENDIX 16:

PALAEONTOLOGICAL IMPACT ASSESSMENT

- Fourie, H. 2017b. **Palaeontological Impact Assessment: Desktop Study - Construction of a new dam and associated infrastructure as part of the upgrading of the bulk water supply scheme to Amsterdam, Mpumalanga.** Report compiled by: Dr. H. Fourie. Report dated: 30 June 2017.

APPENDIX 17:

WATER SITUATION AND AVAILABILITY ASSESSMENT

- Mallory, S.L.J. 2017. **Hydrology and water resource assessment towards augmenting the water supply to Amsterdam, Mpumalanga.** Report prepared by: IWR Water Resources (Pty) Ltd. Report dated: June 2017.

APPENDIX 18:

DAM DESIGN DETAILS

- Afri Infra. 2017. **Amsterdam Bulk Water Supply Scheme Phase 3: Design Criteria Memorandum.** Report compiled for: Gert Sibande District Municipality. Report compiled by: Afri-Infra Group (Pty) Ltd. Report dated: September 2017. GSDM Project No.: 50/2010.