F C G

CITY OF CAPE TOWN BULK WATER INFRASTRUCTURE PLANNING STUDY: FRESHWATER ECOSYSTEMS ENVIRONMENTAL IMPACT ASSESSMENT REPORT

February 2009

DRAFT REPORT

Client:

City of Cape Town

Report compiled by:

K. Snaddon

The Freshwater Consulting Group

P O Box 43935

Scarborough

7975

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

A joint venture of Orrie Welby-Solomon cc & Associates/BKS (Pty) Ltd (OWS / BKS JV) were appointed by the Bulk Water Branch of the City of Cape Town to determine the most appropriate location for a water treatment plant (WTP), reservoirs and associated infrastructure and pipelines, for the transport, storage and treatment of water from the Theewaterskloof Dam (via a tunnel system) and/or the new Berg River Dam for supply to Cape Town. A feasibility study, which identified a number of suitable alternatives, commenced in 2004. Chand Environmental were subsequently requested to manage an environmental impact assessment (EIA) process that would assess the environmental impacts associated with the identified alternatives, and produce an environmental impact assessment report (EIR). The Freshwater Consulting Group was commissioned in February 2006 to undertake an assessment of the alternatives with specific regard to the freshwater ecosystems that would be impacted by them. The following report is a standalone document, incorporating some of the information presented in the scoping report during the feasibility phase (Snaddon & Ewart-Smith, 2005).

Three potential location options for the WTP and its associated infrastructure (roads and pipelines) (Options A, B and G) have been proposed in the Muldersvlei area. Three alternative bulk water pipeline alignments have been proposed – a “high route” and a “low route”, with some additional alternative routings along the way, and a “preferred route”, which is a combination of various sections of the high and low routes. The main sections of pipe are as follows:

- Dasbos pump station to Dasbos tunnel outlet: total pipeline approximately 2km
- Dasbos to Klapmuts: total pipeline length of approximately 26km
- Muldersvlei to Spes Bona: total pipeline length of approximately 12km

The specific aims of the EIA were to:

- Identify the impacts associated with each of the proposed pipeline routes and locations for the water treatment plants. Impacts associated with both the construction and operational phases of the bulkwater pipeline project were identified, with reference to those identified during the Scoping Phase.
- Recommend mitigation measures for the minimisation of negative impacts and the maximisation of the positive impacts of the proposed bulkwater project.
- Provide a comprehensive assessment of the significance of the impacts associated with the proposed bulkwater project. The criteria that were used for this comparative assessment were drawn from the EIA Regulations, published by the Department of Environmental Affairs and Tourism (April 1998) in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989). The impacts associated with all pipeline and treatment plant alternatives were assessed, in addition to those associated with the "no development" option, which comprises the status quo.

1.2 Limitations

There was limited scope for primary data collection – the biota and water quality were not sampled at the sites visited. Thus, identification of rare or endangered plant and animal species was not included in the scope of the study. Where possible, other reports on the affected ecosystems were consulted for such data.

Design details for the pipeline and water treatment plant were not provided, as it is understood that these will be finalised at a later stage of the project. This means that the impacts described in the report are generic to construction projects of this nature and extent.

1.3 Overview of proposed project

The proposed bulk water pipeline would connect with the existing Department of Water Affairs (DWA) Riviersonderend (RSE) tunnel system, at the Dasbos outlet, situated in the upper Berg River catchment. The pipeline would begin at the Dasbos pump station located just downstream of the Berg River Dam (currently under construction), and would run parallel to the DWAF pipeline, to the Dasbos tunnel outlet (see Appendix 1 for map of this section of pipeline). From here, the pipeline would be routed in a north-westerly direction past Klapmuts, crossing the N1 close to the R101, and then entering the Mosselbank River catchment where it would discharge water into the future Spes Bona Reservoir north of Durbanville. Along this route, the pipeline has a few alternative alignments, all of which will impact on several small streams that enter either the Berg or the Mosselbank rivers, in addition to crossing both the Dwars River (a major tributary of the Berg) and the Mosselbank itself. A number of relatively small natural and artificial (associated with farm dams) wetland patches are also situated along the pipeline routes.

All of the proposed alternatives for the location of the water treatment plant are situated in the Muldersvlei area. Four alternative sites for the WTP and reservoir have been proposed, all of which are located on private farms. WTPA, WTPA1 and WTPB are located north of the N2 and WTPG is located to the south of the N2, near Klapmuts.

1.4 General description of freshwater ecosystems within the study area

The Berg River has its source in the Drakenstein and Franschhoek Mountains south of Franschhoek, and the river discharges into the Atlantic Ocean near Velddrif, some 285 km away. The river reaches within the study area are typical of the foothill, cobble-bed geomorphological subregion. Major tributaries that enter the river within the study area are the Franschhoek, Wemmershoek and the Dwars rivers. There is also a fairly high density of smaller drainage lines entering the river in this part of the catchment, which is underlain by weathered and fractured rocks, mostly of the Malmesbury and Table Mountain Group. In past work, these foothill reaches of the Berg River have been accorded a "moderately modified" ecological status – i.e. where a loss and change of natural habitat and biota has occurred, but basic ecosystem functioning appears to be predominantly unchanged. These reaches have also been assessed as being of "very high" ecological importance.

The Dwars River is an important perennial tributary of the Berg, flowing through heavily cultivated fruit-growing areas and the residential areas of Pniel and Kylemore. This river is a foothill, cobble-bed system typical of the Fynbos Biome – instream habitat is typically riffle-run sequences with some pools and marginal vegetation. Water quality on the Dwars River is impacted by runoff from Pniel and Kylemore, farming activities (e.g. severe impacts at times as a result of runoff from Boschendal piggery) and limited industrial activity in the area. During high flows, the Dwars River has high levels of phosphorus and total suspended solids, due to surface runoff from agricultural areas (e.g. Day, 2004).

The Mosselbank River rises in the low hills of Kraaifontein, near the Tygerberg Zoo, and flows in a westerly direction, passing first through an agricultural area, with occasional informal settlements, and then into farmland (Day *et al*., 1999). Downstream of the Kraaifontein / Durbanville area, the Mosselbank River is joined by a number of tributaries, the largest of which is the Klapmuts River. The Maasdrift Canal - a canalised tributary of the Mosselbank River that flows through the urban area of Kraaifontein, where it receives treated effluent from the Kraaifontein sewage works - joins the Mosselbank River near Lichtenburg. Downstream of its confluence with the Klapmuts River, the Mosselbank River meanders westwards towards the small farming settlement of Philadelphia, where it enters the Diep River. The Diep River flows into Rietvlei near Milnerton - Rietvlei was declared a Protected Natural Environment in 1989, and is of particular ecological importance in terms of its birdlife. The upper reaches of the Mosselbank have been classified as a "wetland transitional" river (Day *et al*., 1999), and in past reports, these reaches have marginally been accorded a "moderately modified" ecological status. The fact that the Mosselbank River has retained its seasonal flow regime, is still associated with extensive riparian wetlands in many places along its length and, most significantly, is a tributary of the Diep River, which feeds Rietvlei, has resulted in the river being accorded a "very high" ecological importance (Day *et al*. 1999).

1.5 Conservation importance of affected freshwater ecosystems

The following sections provide assessments of the conservation importance of the freshwater ecosystems that will be impacted by the construction and operation of the bulk water pipeline. These assessments were reported in the Freshwater Scoping Report (Snaddon & Ewart-Smith, 2005), which provides detail on the methods used to assess the systems, and are also provided in Appendix 1. Briefly, the conservation importance of the rivers and streams is based on assessments of the ecological importance and sensitivity of the systems, and the habitat integrity of the riparian and instream characteristics. For wetlands, conservation importance was determined based on the quality of wetland habitat, and the size and type of wetland.

1.5.1 Dasbos pump station – Dasbos outlet (Layout Plan 4)

The first 2 km of the bulk water pipeline are proposed to start at the Dasbos pump station sited below the Berg River Dam, and then to join up with the Dasbos-Muldersvlei section of pipeline just below the Dasbos outlet. A pipeline is currently being built more-or-less along this same route, in order to connect the Berg River Dam with the existing Riviersonderend-Berg-Eerste River Water Scheme. The pump station and first few hundred metres of the bulk water pipeline are located within the Berg River floodplain, and would impact on a floodplain wetland (which is also fed by a smaller stream coming down the slopes of the mountain) that was considered to be of **moderate** conservation importance. This is due to the importance of this wetland in providing good quality (currently) wetland habitat, and also in its role as an ecological corridor associated with the Berg River. The Berg River has and will be heavily impacted by the construction of the dam, and thus maintaining the ecological integrity of the riverine corridor is of critical importance.

Further along the route of the pipeline is a braided drainage area that lies within the Waterval River sub-catchment (itself part of the Berg River catchment). These streams were assessed to be of high ecological importance and sensitivity. The streams are considered to be "…unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species). These rivers (in terms of biota and habitat) may be sensitive to channel / bed modifications but in some cases, may have a substantial capacity for use." (see Scoping Report for definition of high ecological importance and sensitivity). Both the instream and riparian habitat integrity were assessed as being "moderately modified" (i.e. "a loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged"). These braided channels have been modified primarily as a result of alien tree encroachment. However, these trees are currently being removed, and recovery appears to occur fairly rapidly on these slopes (as can be seen nearby below the Dasbos outlet). Overall, this braided river was assessed to be of **high** conservation importance.

The pipeline also traverses a wetland that is located at the bottom of the steep slope below the outlet – this area used to be covered with pine trees which have now been removed. This wetland was assessed as being of **moderate to high** conservation importance, due to the fact that this is a fairly large seep area supporting diverse wetland vegetation components, although many of these components are characteristic of pioneer-state vegetation. This wetland probably forms as a result of the flattening out of the slope, and the resultant retention of water that seeps out of the mountain at this point.

1.5.2 "Low route" pipeline (& alternatives) – Dasbos-Klapmuts section (Layout Plan 3 and 4)

The Dasbos - Klapmuts section of the "low route" pipeline crosses the Waterval and Dwars rivers, which were both assessed to be of high ecological importance and sensitivity. The instream

habitat integrity of the sites assessed on these two rivers was categorised as "moderately modified", largely due to the presence of road crossings. The riparian habitat integrity was assessed as "largely modified" in both cases, largely due to encroachment by alien plant species and removal of indigenous vegetation. These rivers are considered both to be of high conservation importance, and thus the implementation of mitigation measures recommended for reducing the short-term impacts on these rivers, and avoiding any long-term impacts is of critical importance. In addition, measures could be implemented to improve the state of the riparian habitat, such as removal of alien trees.

Further, the low route crosses the "Bellingham Stream", the Graham Beck Stream, Stream a, and Stream d, all of which were assessed as having **moderate** ecological importance and sensitivity – i.e. "…considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These sites are all situated in the Berg River catchment. Most of these sites were assessed as having "largely to extensively modified" instream and riparian habitat, with the exception of the Graham Beck Stream on the Graham Beck wine farm, where the instream habitat integrity was considered to be only moderately modified – this stream has some good quality riffle and run habitat, typical of a stream in this area, especially in comparison with the other streams in this area that have been reduced to muddy trickles. Considerable modification of the beds and banks of these streams has occurred over the many years of agricultural activities in this area, however, these streams still provide important links between the mountain slopes and the Berg River itself, and so are of **moderate** conservation importance.

The remaining riverine sites impacted by the low route (streams c and e and the Klapmuts River) were assessed as having low / marginal ecological importance and sensitivity – i.e. "…not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to channel / bed modifications and usually have a substantial capacity for use". All of these sites are located on small streams that enter the Berg River along its left bank (streams c and e) or the Mosselbank River (Klapmuts River), and all have been heavily impacted by agricultural activities on the slopes of the mountains. These streams have been altered to become soft-bottomed (sand and mud) systems as a result of erosion and sedimentation, and they no longer provide the type or quality of habitat typical of the foothill, cobble-bed streams in this area. This assessment is reflected in the categorization of the instream habitat integrity of these sites as "largely modified". In addition, the riparian habitat was assessed as "largely to extensively modified". These streams are considered to be of **low** conservation importance.

The low route would cross three wetlands – one of these (low route 10) was assessed as having a **moderate** conservation importance. Although small and artificial (associated with a farm dam), the quality of the wetland vegetation here is such that it provides relatively good quality wetland habitat. The remaining two patches of wetland encountered along this route were assessed to be of **low** conservation importance, as both patches were of limited size and so limited value as habitat.

The various alternative routings on the low route do not cross any additional freshwater ecosystems.

1.5.3 "High route" pipeline (& alternatives) - Dasbos-Klapmuts section (Layout Plan 3 and 4)

The high route also crosses both the Waterval and Dwars rivers, assessed to be of **high** conservation importance. In addition, this route crosses Stream d, "Bellingham Stream", Stream a, Stream b, and the Graham Beck Stream which were assessed to be of **moderate** importance. Once again, with the exception of the Graham Beck Stream, these sites were assessed as having "largely to extensively modified" instream and riparian habitat, but are important systems in terms of providing ecological corridors through agricultural land (see Section 1.5.2 above).

The remaining streams were all of **low** conservation importance. In addition, all of the wetland patches impacted by this route were considered to be of **low** conservation importance.

The alternative routings for the high route on this section of pipeline cross the same streams as the high route, and one additional sedge wetland on the Graham Beck farm (see High route alternative 30 in Appendix 1), considered to be of **moderate** conservation importance.

1.5.4 Preferred pipeline route – Dasbos–Klapmuts section (Layout Plan 3 and 4)

The preferred route mostly follows the low route, taking a few of the alternative routings, particularly one section of pipeline that will follow the alternative routing to the south of, instead of the north of the R45. The preferred route avoid one significant wetland, of **moderate** conservation importance, that would be impacted the low route (impact area F10, or low route 10), and does not impact on any additional ecosystems.

1.5.5 "Low route" pipeline (& alternatives) - Spes Bona-Muldersvlei section (Layout Plan 1)

The low route would cross both the Mosselbank and its major tributary, described above (Section 1.4), and would also impact on four wetlands. The Mosselbank River was assessed as being of **moderate to high** conservation importance, due to its importance as a tributary of the Diep River, and an important riverine corridor in the area. Its tributary was assessed as being of **moderate** importance – this river is also an important corridor, but has been considerably modified (especially in terms of water quality) as a result of intensive agricultural activities in the area. All of the wetlands impacted by this pipeline route were considered to be of **low** conservation importance, due to their limited size. It should be noted, however, that although these systems do not offer high quality wetland habitat, their collective presence as patches of habitat in agricultural area does increase their ecological importance.

1.5.6 "High route" pipeline (& alternatives) - Spes Bona-Muldersvlei section (Layout Plan 1)

The high route (and its alternatives) also crosses the Mosselbank River, of **moderate to high** importance as described above, and a small tributary of the Mosselbank River to the west of the R302 (of **low** conservation importance due to impacts of farming), and also impacts on two wetland patches which were assessed as being of **low** conservation importance.

1.5.7 Preferred route - Spes Bona-Muldersvlei section (Layout Plan 1)

The preferred route for this section of the bulk water pipeline follows the high route, and thus avoids the wetlands that would be impacted by the low route. This preferred route would, however, still cross over the Mosselbank River at one point, and, while it would impact on the small tributary of the Mosselbank to the west of the R302 (**low** conservation importance), it avoids the major tributary higher up the catchment (**moderate** importance).

1.5.8 WTP A and WTP A1 and infrastructure (Maps 1a, 1b and 1c)

The two options for WTP A – WTP A and WTP A1 - are located on farmland, north of the N1. Both alternatives for the WTP and the reservoir would impact on a small earth farm dam, which has some wetland habitat around its perimeter. However, this is artificial habitat, and, due also to its small size, is considered to be of **low** conservation importance.

The proposed pipeline routes associated with this WTP option, which would be necessary to link up with the proposed bulk water pipeline and with the existing Wemmershoek pipeline, would impact on a number of wetlands of **moderate** and **low** conservation importance, and on a small stream in the Mosselbank River catchment, of **moderate** conservation importance.

The access road to both WTP A and A1 would impact on the same stream in the Mosselbank River catchment mentioned above, which is of **moderate** conservation importance. WTP A1 has three options for the access road – options A, B and C, all of which will impact in the same way on this stream, as they all require the road to cross the stream.

1.5.9 WTP B and infrastructure (Map 2)

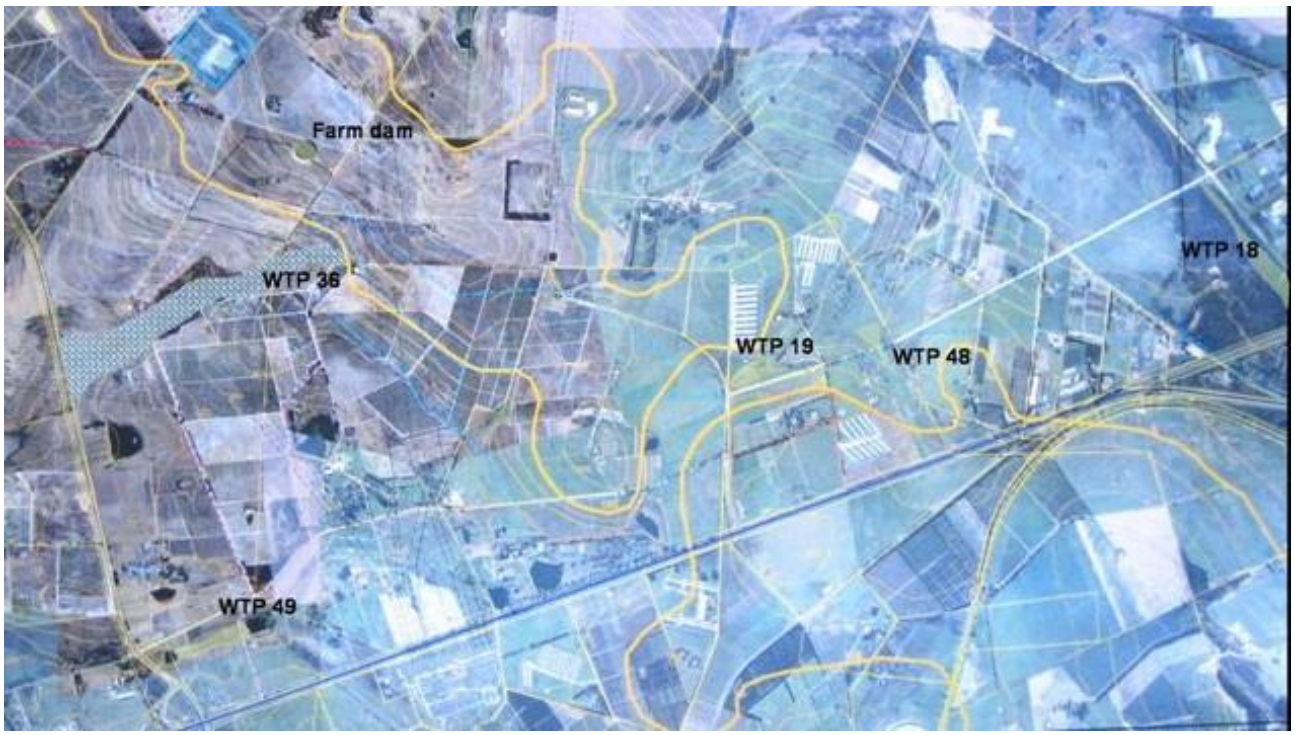
The site proposed for the location of WTP B and its reservoir would not impact on any freshwater ecosystems. The pipelines would impact on wetlands that are all of **moderate** conservation importance, and the same stream as that described for WTP A above, of **moderate** conservation importance.

The access roads would not impact on any additional freshwater ecosystems.

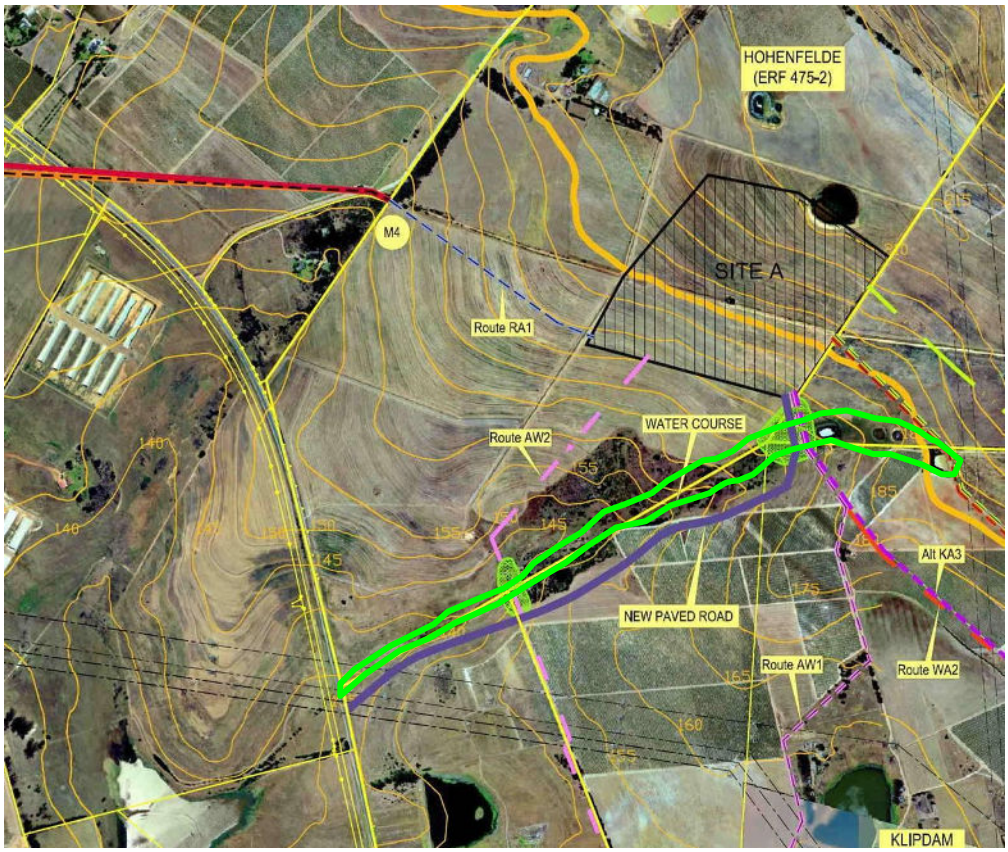
1.5.10 WTP G and infrastructure (Map 3)

The site proposed for the location of WTP G and its reservoir would not impact on any freshwater ecosystems. The pipelines would impact on fewer wetlands than both WTP A and B, but all of these are of **moderate** conservation importance. This option would also impact on the stream of **moderate** conservation importance, described above.

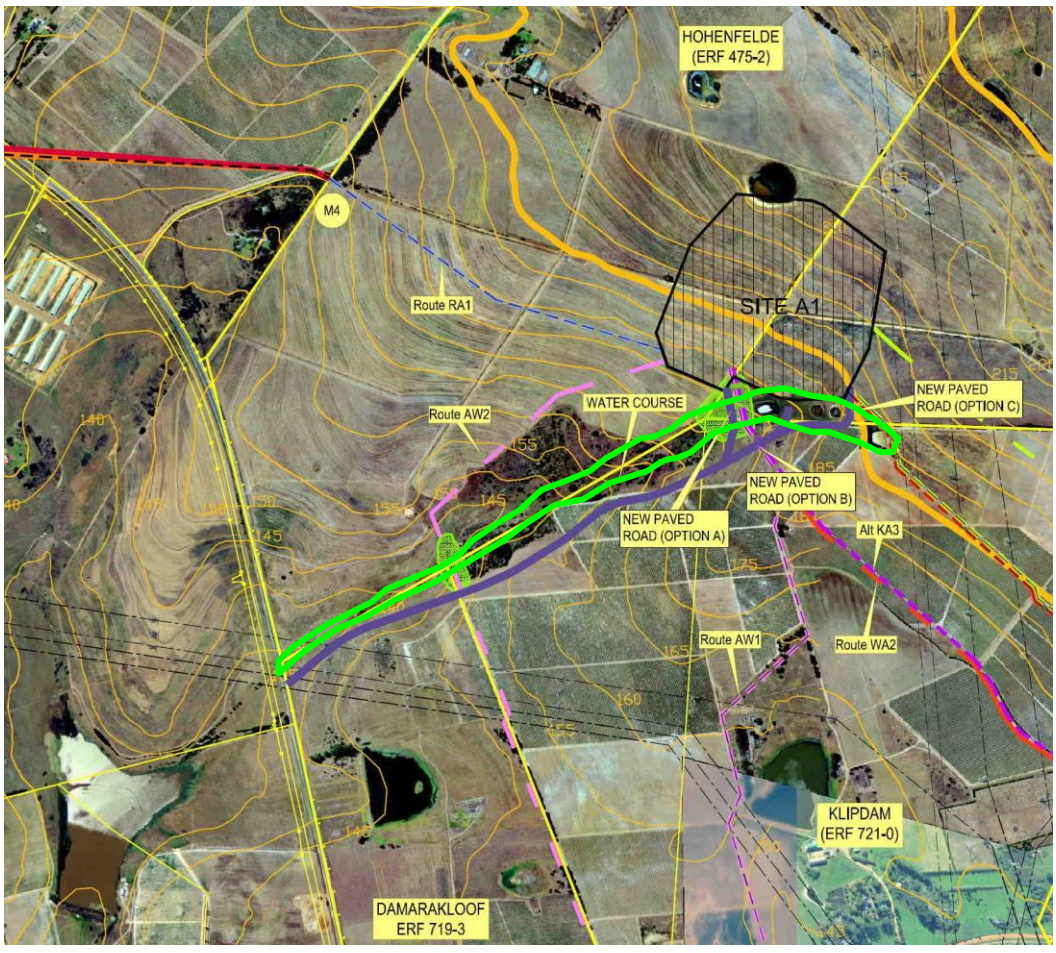
The new paved road required for this option would not impact on any additional freshwater ecosystems.



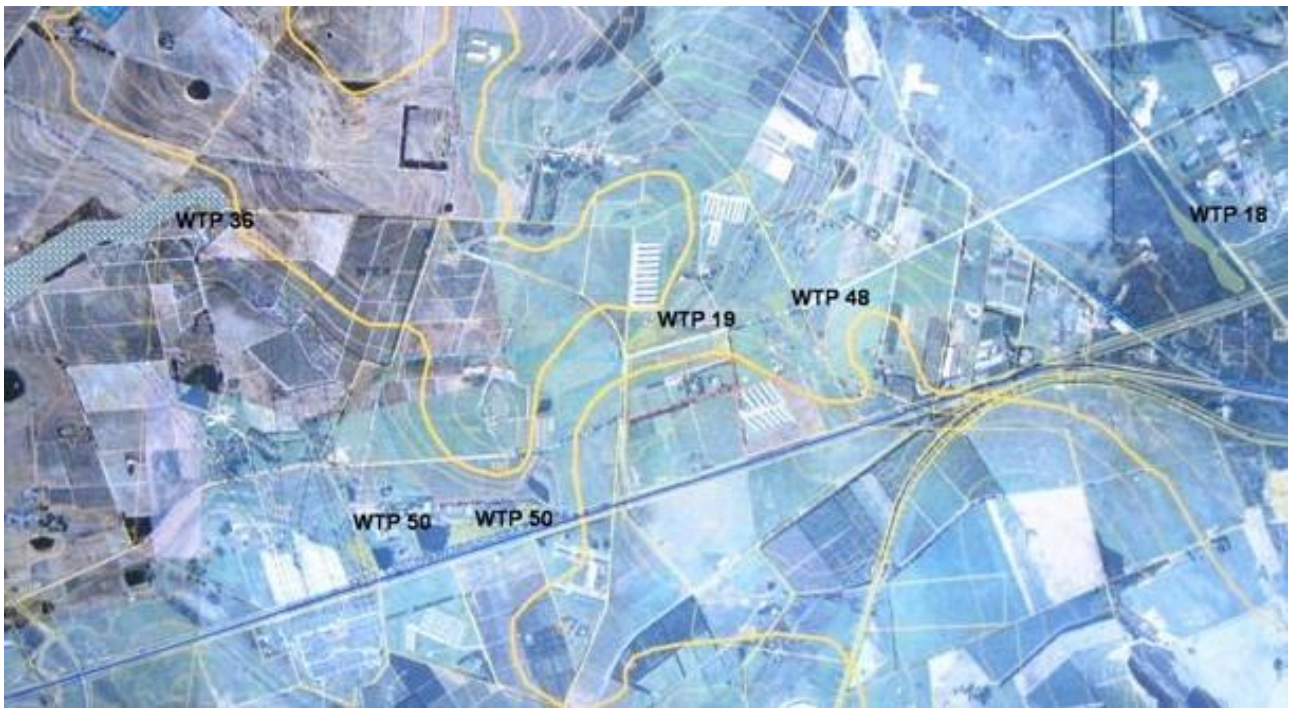
Map 1a **WTP A and associated pipelines, indicating the freshwater ecosystems that would be impacted by this option. Refer to Appendix 1 for interpretation of site codes.**



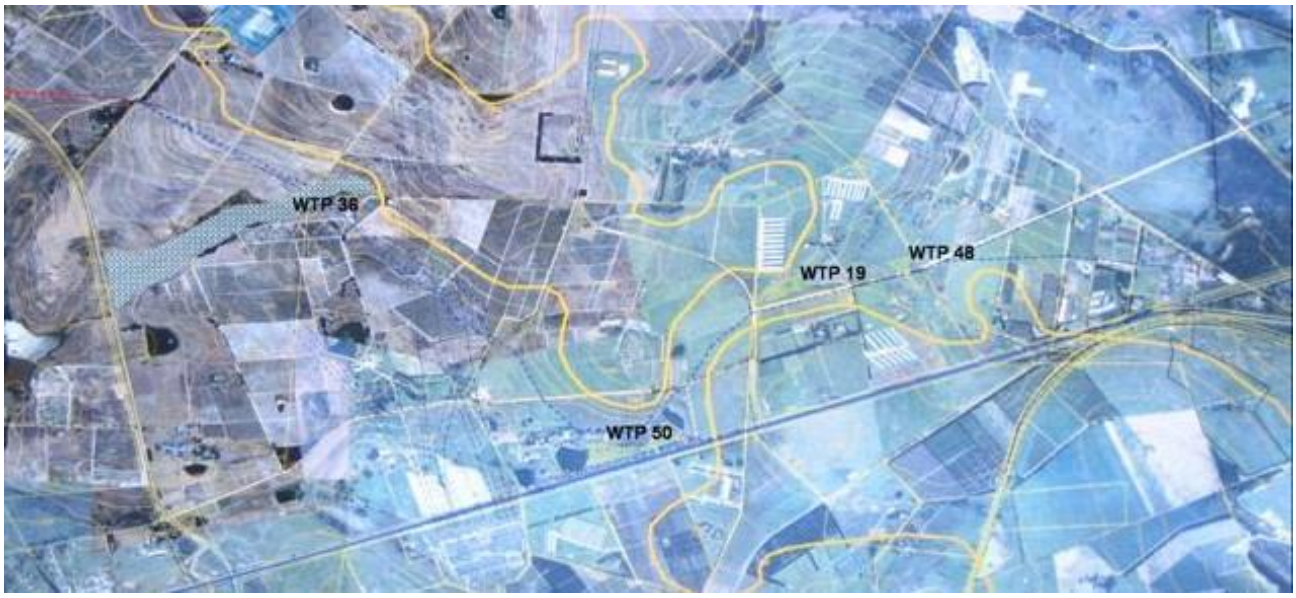
Map 1b Detail of the proposed WTP A site and the access road. The bright green outline shows the exact location of the stream (WTP36), as indicated on Map 1a.



Map 1c Detail of the proposed WTP A1 and the access road alternatives. The bright green outline shows the exact location of the stream (WTP36), as indicated on Map 1a.



Map 2 **WTP B and associated pipelines, indicating the freshwater ecosystems that would be impacted by this option. Refer to Appendix 1 for interpretation of site codes.**



Map 3 **WTP G and associated pipelines, indicating the freshwater ecosystems that would be impacted by this option. Refer to Appendix 1 for interpretation of site codes.**

2 ASSESSMENT AND MITIGATION OF IMPACTS

2.1 Protocol for the assessment of impacts

The evaluation of impacts was undertaken as stipulated in the EIA Regulations published by the Department of Environmental Affairs and Tourism (April 1998), in terms of the Environmental Conservation Act No. 73 of 1989, making use of the definitions and criteria detailed below.

Nature of the impact: Description of the **type of effect** the activity would have on the affected environment.

Extent: Reflects the importance of the environment on a **local** (site area), surrounds (site area and its surroundings), **regional** (Western Cape) or a **national** scale: impacts on threatened wetlands or seeps, or those that provide ecosystem functions on a regional or national scale are considered to constitute a regional or national scale impact.

Duration:

- **Short term** (0-5 years);
- **Medium term** (6-15 years);
- **Long term** (16-30 years);
- **Permanent** (mitigation, either human or natural, will not occur in such a way or in such a time span that the impact can be considered transient).

Intensity:

- **Low** (affects the environment such that natural functions or processes are not affected – or not degraded significantly more than their present state);
- **Medium** (affected environment is altered but natural functions or processes continue, albeit in a modified/ increasingly modified way);
- **High** (natural functions or processes are altered to the extent that they will temporarily or permanently cease).

Probability of occurrence:

- **Improbable** (low likelihood of the impact occurring);
- **Probable** (distinct possibility of the impact occurring);
- **Highly probable** (the impact will most likely occur).
- **Definite** (impact will occur regardless of any prevention measures)

Status of the impact:

- **Negative**
- **Positive**
- **Neutral**

Accumulative impact: Consideration must be given to the extent of any accumulative impact that may occur due to the proposed development. Such impacts must be evaluated with an assessment of similar developments already in the environment. Such impacts will be either **positive** or **negative**, and will be graded as being of **negligible**, **low**, **medium** or **high** impact.

Degree of confidence in predictions: It is necessary to state the degree of confidence (**low**, **medium** or **high**) in the predictions based on the available information and level of knowledge and expertise.

Significance of impact:

- **No significance:** the impacts do not influence the environment in any way.
- **Low significance:** the impacts will have a minor influence on the environment. These impacts require some attention to modification of the project design where possible, or alternative mitigation.
- **Moderate significance:** the impacts will have a moderate influence on the environment. The impact can be ameliorated by a modification in the project design or implementation of effective mitigation measures.
- **High significance:** the impacts will have a major influence on the environment.
- **No Development:** the impacts will have the "no-go" implication on the development or portions of the development regardless of any mitigation measures that could be implemented. This level of significance must be well motivated.

2.2 Legislation and guidelines for the conservation and management of rivers and wetlands

The following sections briefly summarise those sections of the South African legislation that pertain to the conservation and management of rivers and wetlands:

a) NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT NO 107, 1998)

The National Environmental Management Act of 1998 (NEMA), outlines measures that…."prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

Of particular relevance to this assessment is Chapter 1(4r), which states that sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

b) RAMSAR CONVENTION OF 1995

Signatories of the convention (which include South Africa) are obliged to promote the conservation of wetlands, whether they are listed or not.

c) CONSERVATION OF AGRICULTURAL RESOURCES ACT (Act 43 of 1983)

Key aspects include legislation that allows for:

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

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

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

d) NATIONAL WATER ACT

The Water Act recognises the importance of water resources and the need to protect them, and lists the protection of water resources and the associated aquatic and semi-aquatic biological diversity as part of its purpose. The Water Act lists both consumptive and non-consumptive (i.e. activities that may impact on the condition and functionality of water resources) water uses. Examples of non-consumptive uses relevant to the bulkwater pipeline project, and that require authorisation, are:

- Impeding and diverting the flow of water in a watercourse;
- Discharging waste or water containing waste into a water resource or in a manner that may detrimentally impact on the water resource, and
- Altering the beds, banks, course or characteristics of a water resource.

e) NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT

The purpose of the Biodiversity Act is to:

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

The Biodiversity Act deals with the protection of threatened and endangered ecosystems and species, and places limitations on activities that may impact on ecosystems, communities and species. The Act also describes which activities require permits and the process in obtaining these authorisations.

f) CAPE NATURE CONSERVATION ORDINANCE (Ordinance 19 of 1974; amended in 2000)

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

2.3 Potential impacts

The impacts associated with the construction and operation of the bulk water pipeline, the water treatment plant and reservoir, and all associated infrastructure, have been grouped into four main impacts for assessment. These are:

Loss of wetland habitat. As pointed out in the Scoping Report, the proposed pipeline routes will cross over several wetlands. The construction of the pipeline will thus have a significant impact on these ecosystems, which will be dug up, and vegetation removed, in order to lay the pipe underground. A major concern is the increased likelihood of erosion within the wetland, which can lead to creeping erosion moving up and down the system. Should it be a requirement that the pipeline route be kept clear of vegetation for maintenance purposes, this loss of wetland habitat would be permanent. The construction process is also likely to lead to pollution of marshy areas, due to the mobilisation and deposition of sediment, leakage of oil and fuels from machinery, and dumping of building material and rubble into the wetlands. The operation phase of the pipeline is unlikely to lead to any direct deterioration in water quality, except for the accumulative downstream impacts associated with the loss of wetland habitat.

Loss of connectivity within impacted wetlands. The laying of the pipeline across a wetland can lead to a loss of connectivity between the upstream and downstream sections. This is especially true of pipelines that lead to the draining of water down into the groundwater instead of allowing water to sit on the surface. Further, if the wetland vegetation is removed and does not recover, then a degraded swathe cutting through a wetland will also lead to a loss of connectivity within the wetland. This loss of connectivity will lead to a deterioration of both the upstream and downstream sections of wetland.

Loss of riverine habitat. The pipeline routes also cross a number of streams and rivers, and the preferred method, for financial reasons, is to lay the pipes under these systems, rather than cross over the stream or river. This constitutes a significant impact on these ecosystems for the same reasons outlined above for wetland habitat loss. This impact will be more severe where the presence of rock and bedrock requires the blasting of river beds and banks. This will reduce the likelihood of recovery. The bulldozing of the river banks and bed can lead to erosion, due to a shift in the shape of the system, and mobilisation of sediments.

Loss of connectivity within impacted rivers or streams. The laying of the pipes under the streams and rivers could lead to a loss of connectivity between the up- and downstream reaches of the system. The construction process can also lead to the obstruction of flow, and the build-up of sediments and nutrients that should rather be flushed through the system.

2.4 Impact assessment tables

The following assessment tables describe the expected impacts on the freshwater ecosystems affected by the proposed pipeline routes, and the proposed locations for the water treatment site, reservoir and associated infrastructure (i.e. roads and pipelines). The tables include impacts associated with both the construction and operational phases of the bulkwater project. The tables refer to the recommended mitigation measures, and provide an assessment of the impacts with and without mitigation. The mitigation measures are discussed in Section 2.5.

2.4.1 Pipeline routes

2.4.1.1 Dasbos pump station to Dasbos outlet

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Medium
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Moderate	Low to moderate
Level of significance after mitigation	Low negative	Low negative

Nature of impact	Loss of wetland connectivity – the pipeline could effectively cut the wetlands off from subsurface seepage up the slopes (this is especially so for the Berg River floodplain wetland)	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Low	Medium
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Moderate
Level of significance after mitigation	Low negative	Low negative

Nature of impact	Loss of riverine habitat – one stream crossing (over more than one channel) would be required	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Local and surrounds
Duration of impact	Medium-term	Medium
Intensity	Medium to high	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Moderate negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Medium
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative

2.4.1.2 <u>Dasbos outlet to Klapmuts</u>

HIGH ROUTE (& alternatives)

Nature of impact	Loss of wetland habitat

STAGE	CONSTRUCTION PHASE	OPERATION PHASE
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	None	Low negative

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium

Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low to moderate negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low to moderate
Level of significance after mitigation	Low negative	Low negative to no significance

LOW ROUTE (& alternatives)

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable

Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Medium
Level of significance	Low to moderate	Low to moderate
Level of significance after mitigation	None	Low negative

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High

Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low to moderate negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Local and surrounds
Duration of impact	Short-term	Short-term
Intensity	Low to medium	Low to medium
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative

PREFERRED ROUTE

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low to moderate	Low to moderate
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Medium
Level of significance	Low to moderate	Low to moderate
Level of significance after mitigation	None	Low negative

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**

Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low to moderate negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Local and surrounds
Duration of impact	Short-term	Short-term
Intensity	Low to medium	Low to medium
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative

2.4.1.3 <u>Muldersvlei to Spes Bona</u>

HIGH ROUTE (& alternatives)

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**

Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Low
Level of significance	Low	Low
Level of significance after mitigation	None	None

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high

Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	None	Low negative

LOW ROUTE (& alternatives)

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative

Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Low
Level of significance	Low	Low
Level of significance after mitigation	None	None

Nature of impact	Loss of riverine habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high

Level of significance after mitigation	Moderate negative	Low negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	None	Low negative

PREFERRED ROUTE

Nature of impact	Loss of wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	Low negative	Low negative to low positive (depending on extent of damage and offset)

Nature of impact	Loss of ecological connectivity within impacted wetlands	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds
Duration of impact	Short-term	Short- to medium-term
Intensity	Low	Low
Probability of occurrence	Probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	Medium	Low
Level of significance	Low	Low
Level of significance after mitigation	None	None

Nature of impact	Loss of riverine habitat

STAGE	CONSTRUCTION PHASE	OPERATION PHASE
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	High	Moderate to high
Level of significance after mitigation	Moderate negative	Low negative

Nature of impact	Loss of riverine connectivity	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Short-term	Short- to medium-term
Intensity	Low to medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Medium negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	None	Low negative

2.4.2 WTP sites and infrastructure

2.4.2.1 Option A

Nature of impact	Loss of wetland habitat at the WTP site – this is a farm dam so is artificial wetland habitat

STAGE	CONSTRUCTION PHASE	OPERATION PHASE
Extent of impact	Local	Local
Duration of impact	Short-term	Permanent
Intensity	Low	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	None	Low positive

Nature of impact	Loss of wetland habitat – associated with the laying of pipelines to and from the Dasbos pipeline to WTP A and from reservoir A to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None
Nature of impact	Loss of wetland connectivity within impacted wetlands - associated with the laying of pipelines to from the Dasbos pipeline to WTP A and from reservoir A to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local

Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of riverine habitat – associated with the pipelines connecting reservoir A with the Wemmershoek pipeline, and the proposed access road	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate to high	Moderate
Level of significance after mitigation	Low to moderate negative	Low negative

Nature of impact	Loss of riverine connectivity - associated with the pipelines connecting reservoir A with the Wemmershoek pipeline and the proposed access road	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds (i.e. downstream)
Duration of impact	Short-term	Medium term
Intensity	Medium	Low

Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	None	None
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

2.4.2.2 Option A1

Nature of impact	Loss of wetland habitat at the WTP site – this is a farm dam so is artificial wetland habitat	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short-term	Permanent
Intensity	Low	Low
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	High
Level of significance	Low	Low
Level of significance after mitigation	None	Low positive

Nature of impact	Loss of wetland habitat – associated with the laying of pipelines to and from the Dasbos pipeline to WTP A and from reservoir A to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable

Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of wetland connectivity within impacted wetlands - associated with the laying of pipelines to and from the Dasbos pipeline to WTP A and from reservoir A to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of riverine habitat – associated with the pipelines connecting reservoir A with the Wemmershoek pipeline and the proposed access road (all three options)	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative

Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate to high	Moderate
Level of significance after mitigation	Low to moderate negative	Low negative

Nature of impact	Loss of riverine connectivity - associated with the pipelines connecting reservoir A with the Wemmershoek pipeline and the proposed access road (all three options)	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds (i.e. downstream)
Duration of impact	Short-term	Medium term
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	None	None
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

2.4.2.3 Option B

Nature of impact	Loss of wetland habitat – associated with the laying of pipelines from the Dasbos pipeline to WTP B and from reservoir B to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Moderate
Level of significance after mitigation	Low negative	Low negative

Nature of impact	Loss of wetland connectivity within impacted wetlands - associated with the laying of pipelines to from the Dasbos pipeline to WTP A and from reservoir A to the Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of riverine habitat – associated with the pipelines connecting reservoir B with the Spes Bona pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate to high	Moderate
Level of significance after mitigation	Low to moderate negative	Low negative

Nature of impact	Loss of riverine connectivity - associated with the pipelines connecting reservoir B with the Spes Bona pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds (i.e. downstream)
Duration of impact	Short-term	Medium term
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	None	None
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

2.4.2.4

2.4.2.5 **<u>Option G</u>**

Nature of impact	Loss of wetland habitat – associated with the laying of pipelines from reservoir G to the Spes Bona pipeline, and reservoir G to Wemmershoek pipeline

STAGE	CONSTRUCTION PHASE	OPERATION PHASE
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Moderate	Low to moderate
Level of significance after mitigation	Low negative	Low negative

Nature of impact	Loss of wetland connectivity within impacted wetlands - associated with the laying of pipelines from reservoir G to the Spes Bona pipeline, and reservoir G to Wemmershoek pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local
Duration of impact	Short- to medium-term	Permanent
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Low negative
Degree of confidence	High	Medium
Level of significance	Low to moderate	Low
Level of significance after mitigation	Low negative	None

Nature of impact	Loss of riverine habitat – associated with the laying of pipelines from reservoir G to the Spes Bona pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**

Extent of impact	Local and surrounds	Regional
Duration of impact	Medium-term	Medium
Intensity	High	Medium to high
Probability of occurrence	Highly probable	Highly probable
Status of the impact	Negative	Negative
Accumulative Impact	Low negative	Medium negative
Degree of confidence	High	High
Level of significance	Moderate to high	Moderate
Level of significance after mitigation	Low to moderate negative	Low negative

Nature of impact	Loss of riverine connectivity - associated with the laying of pipelines from reservoir G to the Spes Bona pipeline	
STAGE	**CONSTRUCTION PHASE**	**OPERATION PHASE**
Extent of impact	Local	Local and surrounds (i.e. downstream)
Duration of impact	Short-term	Medium term
Intensity	Medium	Low
Probability of occurrence	Highly probable	Probable
Status of the impact	Negative	Negative
Accumulative Impact	None	None
Degree of confidence	High	Medium
Level of significance	Moderate	Low
Level of significance after mitigation	Low negative	None

2.5 Mitigation measures

2.5.1 Construction phase

It should be noted that site-specific impacts can only be identified once the specific engineering options have been provided and evaluated. In addition, most of the impacts associated with construction can be mitigated through use of strict guidelines relating to the design, pre-construction, construction and clean-up phases of the project, all of which would be outlined in a detailed environmental management plan (EMP) for the project and enforced by an on-site environmental control officer (ECO). The impacts and mitigation measures listed below apply to all areas where the pipeline impacts on an aquatic ecosystem, but would be particularly applicable to those river / stream sites that were assessed as having fairly good quality riparian and / or instream habitat (i.e. at worst, moderately modified), and those wetlands assessed as being of moderate conservation importance.

Table 2.1 Impacts and mitigation measures associated with the construction of the pipelines and WTP.

Impact	Mitigation
Loss of wetland and / or riverine habitat, through removal of indigenous riparian vegetation from rivers and wetlands	▪ Ideally, alignment of the pipeline should attempt to avoid wetlands and rivers - especially for sites listed to be of moderate to high conservation importance. ▪ The design of the pipe should aim to minimise the footprint of construction (e.g. the shallower the pipe, the narrower the disturbed area), and sensitive ecosystems should be demarcated prior to any construction activities, so that these can be avoided. ▪ Where construction occurs: o Identification and removal of rare / endangered plant species where appropriate – a botanist should visit the site in late winter / spring to identify sites and plants. o Removal and bagging of plants useful for rehabilitation of banks ▪ Removal of alien species (e.g. acacias, kikuyu grass) can be considered as a positive impact of construction. ▪ Removal of vegetation should be kept to a minimum, and cleared areas must be re-vegetated after clean-up. A detailed planting plan should be developed, in consultation with a landscaper and ecologist.
Loss or deterioration of wetland and riverine habitat through bulldozing and blasting of river banks / wetlands, leading to erosion	▪ Ideally, alignment of the pipeline should attempt to avoid wetlands and rivers - especially for sites listed as of moderate ecological or conservation importance. ▪ Construction should take place during the dry season, in order to minimise the impacts of bulldozing and blasting. ▪ Where river crossings are necessary, attempts should be made to make use of existing crossings

Impact	Mitigation
	(such as road bridges) ▪ Consideration should be given at the design phase to remedial shaping of banks to their near-natural slope, geomorphological and bed characteristics and re-vegetated after clean-up. ▪ Banks should be re-vegetated after clean-up.
Loss of connectivity and deterioration of habitat through disruption of flow regime leading to nutrient / sediment build-up and eutrophication	▪ Disruption of flow should be kept to a minimum, but where necessary, temporary diversion measures should allow flushing of the system to prevent build-up of material. For perennial rivers, construction should take place in late summer, so that winter rains will flush the system after construction. For seasonal rivers, construction should take place when the system is dry. ▪ Diversion techniques should take measures to limit erosion from temporary channels into streams or rivers. ▪ The final design of temporary diversion measures should be ratified by a freshwater ecologist. ▪ No obstructions to flow shall remain in the river or wetland after construction is completed.
Dumping of building material and rubble – resulting in potential contamination of river as a result of accidental runoff, or in infilling and general degradation and disturbance to wetlands and floodplains	▪ All building materials should be stored away (at least 50m) from aquatic ecosystems and the areas bunded appropriately such that there will be no runoff from these areas towards aquatic systems. All building materials should be removed after construction. ▪ If construction areas are to be pumped of water (e.g. after rains), this water must first be pumped into a settlement area, and not directly into a natural ecosystem. ▪ The pipeline contractor should work the pipeline in sections, backfilling as they go, which will reduce the width of disturbed area – i.e. it is not as necessary to spread the spoil wide, if it can spread along a greater length
Deterioration in wetland and riverine habitat through spillage of building materials and oil / fuel	▪ Washing of vehicles and machinery should take place well away (50m) from aquatic ecosystems. All machinery should be regularly checked for leaks. ▪ No runoff shall enter the wetlands, streams or rivers.

2.5.2 Operational phase

The impacts associated with the operational phase of the project relate primarily to the long-term loss or deterioration of aquatic habitat, and the long-term or permanent loss of connectivity within the impacted ecosystems. This is applicable both to the WTP reservoir site and the pipeline, as,

although the pipe will be buried, there will be some long-term disturbance within the approximately 27m-wide pipe servitude along the route. The significance of these impacts would be influenced by the nature and extent of the habitat destroyed or altered, and the success of restoration after construction. A detailed EMP should be developed which will deal with ongoing monitoring and maintenance of the pipeline route, to minimise the negative impacts of the operational phase.

Table 2.2 Impacts and mitigation measures associated with the operation of the pipelines and the reservoir.

Impact	Mitigation
Permanent loss of wetland and riverine habitat, and loss of connectivity within impacted ecosystems	▪ This should be minimised through sensitive alignment of the pipe and location of the WTP and reservoir to reduce the impact on the aquatic environment. ▪ The pipes should not be laid in coarse gravel "sleeves", these act as subsurface drains, which would be a problem in a wetland area, and would also disrupt the connectivity within the rivers / streams. The pipe should rather be contained in a solid sleeve. ▪ The impacted footprint of the pipeline and WTP/reservoir site should be kept to a minimum, e.g. reducing the depth to which the pipes are laid, where possible. ▪ Where a river or wetland must be traversed by either a road or a pipeline, these crossings should be minimised, e.g. laying pipelines under or next to the roads.
Loss of habitat through ongoing erosion	▪ The geomorphological characteristics of the impacted ecosystems must be re-instated after construction – this will reduce the likelihood of increased erosion or sedimentation. ▪ If it is necessary to stabilise the river bed or banks with gabions, these should be kept to a minimum, and should be done in an ecologically sensitive manner. For example, gabions could be topsoiled to allow for the establishment of vegetation, which would also serve the purpose of reducing erosion.
Deterioration in wetland and riverine habitat through loss of indigenous vegetation	▪ Vegetation within the pipeline servitude should be allowed to recover (in some cases, re-planted), within the constraints of ongoing maintenance of the pipeline. ▪ Ongoing monitoring of the pipeline and WTP/reservoir site and associated infrastructure should be implemented (part of the ongoing EMP) in order to ensure that exotic plant species are not introduced or become established due to the disturbance.
Loss of artificial habitat, such as farm dams	▪ Artificial habitat can be re-created fairly effectively elsewhere. Planting of wetland plants in this "new" wetland will improve the ecological value of the

Impact	Mitigation
	ecosystem.

3 CONCLUSIONS AND RECOMMENDATIONS

- A summary of the assessment of the main categories of impacts associated with the construction and operation of the bulk water pipeline, WTP, reservoir and associated roads and pipelines, is provided in Table 3.
- An overall assessment of the impacts is provided in Table 4.
- In terms of impacts on freshwater ecosystems, the preferred WTP/reservoir option is Site G and its associated pipelines / roads. This option would impact on fewer wetlands than the other two options. However, this option does not appear to be viable from an overall environmental impact perspective, and thus, Site B would be preferable to Site A (as of January 2010). The favoured routing for the bulkwater pipeline is the "preferred route", from the Dasbos Outlet to Klapmuts, and the "preferred route" from Muldersvlei to the proposed Spes Bona reservoir. The pipeline running from the Dasbos Pump Station to the Dasbos Outlet will have highly significant negative impacts associated with it, but there are no alternatives for this route. The impacts associated with construction can be mitigated to some extent. This is more true for the wetlands than for the rivers – it is expected that the rivers will take some time to recover from the impacts of construction, even with the implementation of mitigation measures.
- Detailed construction and operational environmental management plans (EMPs) must be developed prior to construction, as these EMPs will deal in greater detail with the impacts and how to mitigate against them.

Table 3.1 Summary of the assessment of impacts associated with the construction and operation of the bulk water pipeline, and the WTP site and infrastructure.

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
Construction Phase					
WTP and infrastructure options					
WTP A	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Medium		Low to moderate	Low negative
	Loss of riverine habitat	High		Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Medium		Moderate	Low negative
WTP A1	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Medium		Low to moderate	Low negative
	Loss of riverine habitat	High		Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Medium		Moderate	Low negative
WTP B	Loss of wetland habitat	Medium		Moderate	Low negative
	Loss of wetland connectivity	Medium		Low to moderate	Low negative
	Loss of riverine habitat	High		Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Medium		Moderate	Low negative
WTP G	Loss of wetland habitat	Medium		Moderate	Low negative

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
	Loss of wetland connectivity	Medium		Low to moderate	Low negative
	Loss of riverine habitat	High		Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Medium		Moderate	Low negative
Dasbos pump station to Dasbos outlet					
	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Low	Negative	Low	Low negative
	Loss of riverine habitat	Medium to high	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Dasbos outlet to Klapmuts					
High route (& alternatives)	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Low to medium	Negative	Low to moderate	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Low route (and alternatives)	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Low to medium	Negative	Low to moderate	None
	Loss of riverine habitat	High	Negative	High	Moderate negative

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Preferred route	Loss of wetland habitat	Medium	Negative	Low to moderate	Low negative
	Loss of wetland connectivity	Low to medium	Negative	Low to moderate	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Muldersvlei to Spes Bona					
High route (& alternative)	Loss of wetland habitat	Medium	Negative	Low	Low negative
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	None
Low route (& alternatives)	Loss of wetland habitat	Medium	Negative	Low	Low negative
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	None
Preferred route	Loss of wetland habitat	Medium	Negative	Low	Low negative
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	None

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
Operational Phase					
WTP and infrastructure options					
WTP A	Loss of wetland habitat	Low	Negative	Low	Low positive
	Loss of wetland connectivity	Low		Low	None
	Loss of riverine habitat	Medium to high		Moderate	Low negative
	Loss of riverine connectivity	Low		Low	None
WTP B	Loss of wetland habitat	Low		Moderate	Low negative
	Loss of wetland connectivity	Low		Low	None
	Loss of riverine habitat	Medium to high		Moderate	Low negative
	Loss of riverine connectivity	Low		Low	None
WTP G	Loss of wetland habitat	Low		Low to moderate	Low negative
	Loss of wetland connectivity	Low		Low	None
	Loss of riverine habitat	Medium to high		Moderate	Low negative
	Loss of riverine connectivity	Low		Low	None
Dasbos pump station to Dasbos outlet					
	Loss of wetland habitat	Medium	Negative	Low to moderate	Low negative

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
	Loss of wetland connectivity	Medium	Negative	Moderate	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Moderate negative
	Loss of riverine connectivity	Medium	Negative	Moderate	Low negative
Dasbos outlet to Klapmuts					
High route - (& alternatives)	Loss of wetland habitat	Low	Negative	Low	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Low	Negative	Low to moderate	Low negative to none
Low route - (& alternatives)	Loss of wetland habitat	Low	Negative	Moderate	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low to moderate	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Preferred route	Loss of wetland habitat	Low	Negative	Low to moderate	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low to moderate	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low to moderate negative

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Pipeline alternatives at Muldersvlei					
Eastern alignments	Loss of wetland habitat	Low	Negative	Low	None
Midway alignments	Loss of wetland habitat	Low	Negative	Low	None
Western alignments	Loss of riverine habitat	Medium to high	Negative	Moderate	Low negative
	Loss of riverine connectivity	Low	Negative	Low to moderate	Low negative
Muldersvlei to Spes Bona					
High route	Loss of wetland habitat	Low	Negative	Low	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low negative
	Loss of riverine connectivity	Low	Negative	Low	Low negative
Low route	Loss of wetland habitat	Low	Negative	Low	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low negative
	Loss of riverine connectivity	Low	Negative	Low	Low negative
Preferred route	Loss of wetland habitat	Low	Negative	Low	Low negative to low positive

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
	Loss of wetland connectivity	Low	Negative	Low	None
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low negative
	Loss of riverine connectivity	Low	Negative	Low	Low negative

Table 3.2 Overall ratings of the impacts without and with mitigation (0 = no impact; L = low; M = moderate; H = high; - = negative; + = positive).

PIPELINE

Dasbos pump station to Dasbos outlet	Dasbos outlet to Klapmuts			Muldersvlei to Spes Bona		
Preferred route (one alternative)	High route (+ alternatives)	Low route + alternatives	Preferred route	High route + alternatives	Low route + alternatives	Preferred route
CONSTRUCTION PHASE						
M-H$^-$ M$^-$	**M-H$^-$ M$^-$**	**M-H$^-$ M$^-$**	**M-H$^-$ M$^-$**	**H$^-$ M$^-$**	**H$^-$ M$^-$**	**H$^-$ L-M$^-$**
OPERATIONAL PHASE						
M-H$^-$ M$^-$	**H$^-$ L-M$^-$**	**H$^-$ L-M$^-$**	**H$^-$ L-M$^-$**	**M-H$^-$ L-M$^-$**	**M-H$^-$ L-M$^-$**	**M-H$^-$ L-M**

TREATMENT PLANT AND INFRASTRUCTURE

WTP A + infrastructure					WTP B + infrastructure					WTP G + infrastructure				
WTPA	Dasbos to WTP	Wemmers	Res A to	Res A to Spes	WTPB	Dasbos to WTP	Wemmers	Res B to	Res B to Spes	WTP G	Dasbos to WTP	Wemmers	Res G to	Res G to Spes

	A	to Res A	Wemmers	Bona		B	to Res B	Wemmers	Bona		G	to Res G	Wemmers	Bona
CONSTRUCTION PHASE														
L- 0	L-M- L-	0 0	M-H- L-M-	0 0	0 0	L-M- L-	0 0	M- L-M-	M-H- L-M-	0 0	0 0	0 0	M- L-	M-H- L-M-
OVERALL RATING: M- L-M-					M-H- L-M-					M- L-				
OPERATIONAL PHASE														
L- L+	L- 0	0 0	M- L-	0 0	0 0	L-- 0	0 0	L-M- L-	M- L-	0 0	0 0	0 0	L-M- L-	M- L-
OVERALL RATING: L- 0					L- 0					L- 0				

4 REFERENCES

Day, L. 2004. Water Quality. Chapter in: Berg River Baseline Monitoring Programme. Initialisation Report Volume 1: Introduction to the Berg River Catchment; Groundwater and Riverine environment. Report prepared by Anchor Environmental Consultants and the Freshwater Consulting Group, for the Department of Water Affairs and Forestry, September 2004.

Day, E., Harding, W. and Brown, C. (1999).Environmental guidelines for the maintenance of river courses in the Cape Metropolitan Area: Assessment of Ecological Status of selected major rivers within the CMA. Southern Waters final report for Ninham Shand.

Department of Water Affairs and Forestry. (1999). Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version 1.0, Pretoria. Resource Directed Measures for Protection of Water Resources, Pretoria, South Africa.

Ewart-Smith, F. & Ractliffe, G. 2002. Proposed N1 N2 Winelands Toll Highway Project – specialist assessment of freshwater ecosystems. Report prepared by Southern Waters Consulting and The Freshwater Consulting Group.

Kleynhans, C.J. 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo System, South Africa). Journal of Aquatic Ecosystem Health 5: 41-54.

Milner, A.M. 1994. System recovery. In, P.Calow & G.E. Petts (eds.): The rivers handbook. Vol. 2. Blackwell Scientific Publications. London.

Noss, R.F. 1990. Indicators for monitoring biodiversity: a hierarchical approach. Conservation Biology 4:355-364.

Resh, V.H., A.V. Brown, A.P. Covich, M.E. Gurtz, H.W. Li, G.W. Minshall, S.R. Reice, A.L. Sheldon, J.B. Wallace & R.C. Wissmar. 1988. The role of disturbance theory in stream ecology. Journal of the North American Benthological Society. 7: 433-455.

Snaddon, K. & Ewart-Smith, J. 2005. City of Cape Town Bulk Water Infrastructure Planning Study: Freshwater ecosystems scoping study. Report prepared for City of Cape Town Council (Orrie Welby-Solomon & Associates / BKS), October 2005.

VKE Consulting Engineers (Pty) Ltd. 2000. Development control guidelines in flood prone areas. Report to the Cape Metropolitan Council. Cape Town.

5 APPENDIX 1: DESCRIPTION OF SITES VISITED ALONG THE PIPELINE ROUTES. SITE NUMBERS (1, 2 ETC) ARE FOR OUR IDENTIFICATION PURPOSES AND DO NOT NECESSARILY IMPLY A SEQUENCE.

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
Dasbos pump station to Dasbos outlet								
DasPump-Das 44	Floodplain wetland close to Berg River, below Dam site	▪ Seep area essentially within the Berg River floodplain. Various wetland species are evident here. ▪ Small stream traverses the wetland, approximately through proposed pumping station location.	wetland seep and streams	Berg				MODERATE – plays an important role as part of Berg River floodplain, important as ecological corridor, in addition to providing relatively good wetland habitat.
DasPump-Das 45	Stream I, braided channels east of Dasbos outlet	▪ Braided cobble / bedrock / sand streams, with a wider (3-4m) main channel and narrower side channels. ▪ Water flowing in channels at the time of site visit appeared clear and clean, with some algae noted. ▪ Riparian vegetation has been fairly heavily infested by alien tree species, mainly by Port Jackson (*Acacia saligna*), black wattle and pines. ▪ Instream vegetation was in good condition, comprising *Isolepis* spp., sedges, restio's.	foothill cobble-bed stream	Berg	C	C	HIGH	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
DasPump-Das 46	Wetland below Dasbos tunnel	▪ Wetland is formed where steep slope flattens out – water seeps out of the slope, and is retained here. ▪ This area was previously forested with pine trees, but is now recovering well. ▪ Fairly diverse vegetation characteristic of the "pioneer" stage of recovery was noted, such as *Eriocephalus* sp.. Other typical wetland species were also recorded, including restios and sedges, grasses (e.g. *Pennisetum macrourum*) and ferns (*Pteridium* sp.), that would indicate that this is a seasonal wetland / marsh.	wetland seep					MODERATE / HIGH - Large seep area supporting diverse wetland vegetation components; form an integral part of the habitat mosaic within the landscape and, because of these habitat characteristics, may support rare or threatened biota
Muldersvlei to Dasbos outlet								
Low route 2	Waterval River, below Dasbos Tunnel outlet	▪ Cobble / boulder bed stream. ▪ Stream substrate is covered with algae, which indicates high organic load, probably from agricultural activities in upper catchment. Abstraction of water for irrigation has also reduced the volume and frequency of flushing flows necessary to rid the stream of algae. ▪ Riparian vegetation has indigenous elements (such as olive trees, *Olea europea* subsp. *africana*, and the wild almond, *Brabejum stellatifolium*), but is infested with alien trees such as long-leaf wattle (*A.*	foothill cobble-bed stream	Berg	C	D	HIGH	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		longifolia), black wattle (*A. mearnsii*) and Port Jackson (*A. saligna)*, an*d* also kikuyu *grass (Pennisetum clandestinum*).						
Low route 1	"Bellingham Stream", small stream on southern side of Klapmuts Road	▪ Riverine site, macro-channel of approx. 5m width, flow is largely runoff from surrounding cultivated fields (vineyards) and overflow / leaks from upstream dams. Substrate is sand. ▪ Water quality appears relatively poor, as a result of agricultural runoff - water is opaque. ▪ Banks are infilled and steep. ▪ Riparian vegetation (closed canopy over stream) is almost entirely alien – willows, herbaceous shrubs, acacias (some of which have been chopped down). Vineyards encroach to within approx. 30m of the stream banks. Indigenous lilies (*Zantedischia aethiopica*) were present.	foothill cobble-bed stream	Berg	D	E	MODERATE	
Low route 31	Graham Beck Stream, Graham Beck wine farm	▪ This is a shaded cobble-bed, riffle / run stream, flowing through a 2m-wide channel (width decreases downstream, probably due to encroachment of farm buildings, roads and vineyards) and steep banks, which is reduced to a trickle in the dry months. Mud, probably sedimentation from bank disturbance, has settled on the stream bed in places – sedimentation increases with distance downstream. Little or no abstraction of water was noted until below this site, where abstraction leads to a proliferation of algae in the river.	foothill cobble-bed stream	Berg	C	D	MODERATE	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		▪ Water quality is probably relatively unmodified, with no algae recorded at the time of the site visit. ▪ The riparian forest is dominated by pines, oaks, black wattles and indigenous olives (alien invasion increases with distance downstream). A prolific understorey of herbaceous plants (mostly weeds, but also ferns near the river) is also evident.						
Low route 3	Stream a, flowing through L'Ormarins farm, southern side of Klapmuts Road	▪ Cobble bed stream. ▪ Banks have been modified through infilling, and are steep. ▪ Alien riparian vegetation includes oaks, eucalypts. Indigenous sedges were recorded within the stream and long its banks. ▪ Water quality appears to be poor, such as indicated by presence of algae – probably as a result of agricultural runoff entering stream.	foothill cobble-bed stream	Berg	D	D	MODERATE	
Low route 6	Dwars River, southern side of Klapmuts Road	▪ Cobble / boulder bed river, typical of foothill reaches. Channel is approx. 30 – 40m wide. ▪ Water quality appears poor – water is opaque indicating sediment transport. Runoff from the town of Pniël as well as from adjacent wine farms, is known to pollute the waters of the Dwars. ▪ Some indigenous riparian tree species (such as the willow *Salix capensis*), but many acacias and poplars have invaded the riparian belt.	foothill cobble-bed stream	Berg	C	D	HIGH	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
Low route 7	Stream c, southern side of Klapmuts Road	▪ Small trickle over muddy substrate. ▪ Water quality appears relatively good – water is quite clear. ▪ Some arum lilies, wild almond, and *Rhus* spp. noted, but also aliens such as Sesbania sp., acacias and Spanish reed (*Arundo donax*).	foothill cobble-bed stream	Berg	D	E	LOW / MARGINAL	
Low route 8	Stream d, southern side of Klapmuts Road	▪ Channel of approx. 15m width, with deeply incised, steep banks. Mostly run on mud, but with some riffle over cobble. ▪ Water quality is very poor. ▪ Some indigenous elements present in riparian vegetation (a few large olive trees), but mostly aliens such as poplars, oaks. Vineyards encroach to within less than 20m of the stream.	foothill cobble-bed stream	Berg	D	D	MODERATE	
Low route 9	Stream e, on northern side of Klapmuts Road	▪ Very small (less than 3m wide) muddy-bottomed stream, largely dry due to abstraction of water by farmers. ▪ Some good quality, indigenous vegetation on stream banks (*Rhus* spp., *Olea europea*, *Eriocephalus* sp., *Persecaria* sp.), and a few alien acacias.	foothill cobble-bed stream	Berg	D	D	LOW / MARGINAL	
Low route 10	Wetland on northern side of Klapmuts Road	▪ Patch of wetland with a muddy-bottomed stream flowing through it – this patch is located at the upstream end of a farm dam which creates this wetland habitat. A second stream is located to the west of the wetland. ▪ Indigenous lilies, reeds *(Phragmites* sp.), grass (*Pennisetum macrourum*) were	wetland marsh	Berg				MODERATE - plays a polishing role within catchment; quite a few indigenous species; limited alien species,

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		noted. Some black wattles have invaded the wetland.						therefore provides relatively good habitat
Low route 14	Wetland on northern side of Klapmuts Road	▪ This site comprises a wetland patch supporting the bulrush, *Typha capensis*, *Phragmites* reed and *Pennisetum* grasses. It is fed by water leaked from a dam on the southern side of the road. A small channel carries water from the dam through a culvert under the road and into the wetland. ▪ Some aliens such as *Acacia saligna* and pines have invaded the wetland to a certain extent.	wetland marsh	Berg				LOW - although it may provide wetland habitat, this is limited because of its limited size.
Low route 15	Wetland on northern side of Klapmuts Road	▪ Same type of habitat as described for Low route 14 above.	wetland marsh	Berg				LOW - although it may provide wetland habitat, this is limited because of its limited size.
Low route 17	Klapmuts River	▪ This is a grassy channel, dry at the time of the site visit. Channel is approx. 5m wide and banks are steeply incised and 2m high. ▪ Vegetation is all alien species such as poplars, pines, acacias, kikuyu grass.	foothill cobble-bed stream	Mosselbank	D	E	LOW / MARGINAL	
High route 2	Waterval River, below Dasbos Tunnel outlet	▪ See Low route 2 above	foothill cobble-bed stream	Berg	C	D	HIGH	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
High route 34	*Pennisetum* marsh, Graham Beck wine farm	▪ This marsh is situated along the edge of the vineyards at the eastern boundary of the farm. ▪ The marsh has been invaded by alien acacias.	wetland marsh	Berg				LOW - although it may provide wetland habitat, this is limited because of its limited size and infestation of alien acacias
High route 32	Grassed wetland, Graham Beck wine farm	▪ This grassed wetland was a shallow dam a few years ago, but is now a seasonally wet sandy area which is heavily grazed. ▪ The wetland is dominated by the indigenous wetland grass, *Pennisetum macrourum*., and also overgrown with kikuyu. Acacias and gum trees have invaded the wetland. Some terrestrial species are establishing here.	wetland marsh	Berg				LOW / MODERATE - fairly extensive *Pennisetum* seasonal wetland habitat but impacted by grazing and severely manipulated in the past
High route 35	"Bellingham Stream", upstream of Low route 1, and downstream of High route alternative 30, Graham Beck wine farm	▪ The channel is approx. 3m wide, with riffle-pool sequences and a cobble and mud substrate (as a result of upstream erosion of banks and sedimentation). There was little baseflow at the time of the site visit (i.e. end of summer). Banks are largely modified. ▪ Water quality appears relatively poor, as evidenced by large quantities of algae on the stream bed. ▪ Riparian belt is infested with alien acacias and herbaceous understorey. Indigenous sedges (including *Juncus* sp.) and alien kikuyu grass were also recorded on the	foothill cobble-bed stream	Berg	**D**	**E**	MODERATE	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		river banks.						
High route 31	Graham Beck Stream, Graham Beck wine farm	▪ See Low route 31 above	foothill cobble-bed stream	Berg	C	D	MODERATE	
High route 5	Stream b, on L'Ormarins	▪ Stream appears to be very similar to Stream a, described for Low route 3 above.	foothill cobble-bed stream	Berg	D	D	MODERATE	
High route 4	Stream a, upstream of Low route 3	▪ Same as Low route 3, above	foothill cobble-bed stream	Berg	D	D	MODERATE	
High route 6	Dwars River, southern side of Klapmuts Road	▪ See Low route 6 above.	foothill cobble-bed stream	Berg	C	D	HIGH	
High route 7	Stream c, southern side of Klapmuts Road	▪ See Low route 7 above.	foothill cobble-bed stream	Berg	D	E	LOW / MARGINAL	
High route 8	Stream d, southern side of Klapmuts Road	▪ See Low route 8 above.	foothill cobble-bed stream	Berg	D	D	MODERATE	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
High route 12	Stream f, Backsberg Farm	▪ This site is located below a farm dam, and is a stream that carries overflow from the dam. The channel is approx. 2m wide. ▪ Stream banks are incised and steep. ▪ The stream channel is invaded by kikuyu grass, acacias, gums and some indigenous olive trees. A swathe of the common reed, *Phragmites* sp., has spread below the dam and within the stream channel.	foothill cobble-bed stream	Berg	D	E	LOW / MARGINAL	
High route 11	Channel on Backsberg Farm	▪ Channelised ditch following the edge of a ploughed field. The channel is sandy-bottomed. ▪ Channel is heavily invaded by kikuyu grass. Oaks, pines and some indigenous olives located on the banks of the channel. A wetland fringe is evident next to the channel, with some sedges recorded in the channel itself. Vineyards are planted right up to the edge of the channel.	runoff conveyance channel	Berg				LOW - highly engineered with little wetland habitat and therefore low ecological functioning.
High route 13	Stream g, Klein Simonsvlei	▪ 1m wide muddy stream, which has probably been channelised. ▪ Water quality appears to be relatively good, water is only slightly opaque. Litter was observed in the stream. ▪ Riparian vegetation includes lilies, some sedges (probably *Juncus* sp.), *Persecaria* sp. and *Phragmites* reeds. Alien tree species have invaded the riparian belt, including acacias (black wattle is the dominant species) and eucalypts.	foothill cobble-bed stream	Berg	D	D	LOW / MARGINAL	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
High route 16	Channel below dam, east of Klapmuts Road, Backsberg Trust farm	▪ This site has a small stream below a dam. It was completely dry at the time of the site visit. ▪ The site is heavily invaded by the alien tree species *Acacia saligna*. Some *Typha capensis* was recorded in the channel.	runoff conveyance channel	Berg				LOW - no significant wetland/riparian habitat and therefore it has a limited functional role in the catchment
High route 17	Klapmuts River	▪ See Low route 17 above.	foothill cobble-bed stream	Mosselbank	D	E	LOW / MARGINAL	
High route alternative 30	Wetland on Graham Beck wine farm, upstream of High route 35	▪ Small stream carries overflow / leaks from a farm dam through a wetland swathe of grasses and sedges. This area is grazed by sheep, and is regularly mown by the farmer. The wetland swathe is approximately 20m wide, and used to be planted with plum trees. ▪ Water sitting in the wetland is orange as a result of high iron content. The water in the farm dam above this site is unusable for irrigation due to the iron. ▪ The wetland is dominated by at least 2 species of sedge, while the surrounding slopes are grassed with kikuyu and other indigenous species, such as *Pennisetum macrourum*. Some indigenous olive trees, alien acacias and pines are situated at the edge of the wetland.	wetland marsh	Berg				MODERATE - sedge wetland provides a relatively large area of wetland habitat; fulfils corridor function
High route alternative 31	Graham Beck Stream, Graham	▪ See Low route 31 above	foothill cobble-bed stream	Berg	C	D	MODERATE	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
	Beck wine farm							
High route alternative 8	Stream d, flowing through Plaisir de Merle farm	▪ See Low route 8 above.	Foothill cobble-bed stream	Berg	D	D	MODERATE	
Spes Bona to Muldersvlei								
High route 25	Wetland alongside R312	▪ This site is a small buffalo grass wetland which would probably have been a natural drainage line which now has been bisected by the road and reduced to small patches of wetland fed by groundwater. ▪ Some sedges and bulrush were also recorded.	wetland seep	Mosselbank				LOW - although it may provide wetland habitat, this is limited because of its limited size.
High route 28	Mosselbank River, at nursery alongside R302	▪ This typical wetland transitional river flows along an approx. 6m wide channel, with a mud and sand bottom. Flow conditions are predominantly slow run. The river might have been channelised here, and the river banks are impacted by cattle trampling and some infilling. It is likely that the river used to braid through an extensive floodplain wetland, but it is now confined to a river channel through grassed flats used primarily for grazing. ▪ Water appears to be of fairly good quality – the water is clear with little evidence of algal growth. ▪ The riparian fringe is dominated by dense stands of *Cyperus textilis* (it is possible that the proliferation of this species is due to	wetland transitional river	Diep	D	D	MODERATE to HIGH	

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		the more fixed nature of the river channel which is now probably deeper and more perennial than in the past). Gum trees and black wattle have invaded the floodplain, while indigenous *Phragmites* sp reeds, *Persecaria* sp., lilies and sedges were recorded within and alongside the river channel. Duckweed (*Lemna gibba)* was present on the water surface.						
High route 47	Small stream on hillslope	▪ This is a narrow, grassed drainage line flowing in a south-easterly direction under the R302, and into the Mosselbank River. ▪ The banks are eroded, and the riparian belt invaded by alien acacia's (Port Jackson).	Wetland transitional river	Mosselbank	E	E	LOW / MARGINAL	
High route alternative 26	Mosselbank River, adjacent to R312	▪ The river flows under the road to Durbanville and continues northwards towards the Mosselbank River. At the time of the site visit, the stream was fairly dry. The stream has been modified (channelised) by the construction of the road and road bridge. ▪ The stream has a well-vegetated channel, supporting dense stands of the reed, *Cyperus textilis*, *Persecaria* sp., *Rumex* sp., and bulrush. Fairly large individuals of the indigenous olive tree were recorded, while alien riparian trees include poplars, and gum trees. Duckweed, *Lemna gibba*, was observed on the surface of standing water in the channel.	wetland transitional river	Diep	D	E	MODERATE to HIGH	
High route alternative	Grassed channel,	▪ This channel is grassed with kikuyu grass, which is heavily grazed. The banks of	runoff conveyance	Mosselbank				LOW - eutrophic channel with

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
38	Patrysfontein	the channel are impacted by the trampling of cattle, and through modification of the banks for channelisation. ▪ The water in the channel is highly eutrophic, probably due to runoff from cow fields.	channel					poor quality runoff (dam overflow), trampled by cattle and grassed with kikuyu therefore no aquatic habitat
Low route 37	Restio wetland, Patrysfontein	▪ This wetland is dominated by restios and indigenous grasses. It is situated alongside an area cultivated with kikuyu grass for sale.	wetland marsh	Mosselbank				LOW - although it may provide wetland habitat (indigenous restios), this is limited because of its limited size.
Low route 39	Wetland patch, Patrysfontein	▪ This wetland patch is linked with a drainage line that enters two farm dams on the property. ▪ Wetland is dominated by kikuyu grass, and another indigenous wetland grass species (possibly *Cynodon dactylon*). *Acacia saligna* has invaded this area.	wetland seep	Mosselbank				LOW - limited in size with low habitat quality
Low route 40a	Wetland patch, Patrysfontein	▪ This is a small wetland patch in a depression alongside the fenceline drainage channel. It is likely that the wetlands in this area were more extensive in the past, but these have been reduced to small patches through artificial drainage of fields for cultivation and grazing. ▪ *Acacia saligna* has invaded the	wetland seep	Mosselbank				LOW - limited in size with low habitat quality

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
		wetland patch and also the drainage line that follows the fence.						
Low route 40b	Fenceline drainage line, Patrysfontein	▪ Drainage line below dam, following fenceline. ▪ Grassed, with a few sedges	runoff conveyance channel	Mosselbank				LOW - poor quality aquatic habitat with no real ecosystem functions
Low route 41	Mosselbank River, on Patrysfontein	▪ This site is upstream of sites 26 and 27 on the same river, described above. The channel has been impacted through infilling, and is approx. 2m wide here. ▪ The stream is dominated by kikuyu, with some indigenous reeds (such as *Cyperus textilis*) and grass species (*Pennisetum macrourum*). *Acacia saligna* is also present.	wetland transitional river	Mosselbank	D	D	MODERATE to HIGH	
Low route 43	Tributary of the Mosselbank River	▪ This river site is upstream of High route 28 described above. Here, the river is a slow, meandering system flowing in multiple channels over a muddy substrate. The grassed floodplain is grazed, and some excavation of sand has damaged the banks. ▪ Water quality appears to be poor. ▪ The riparian belt comprises *Cyperus textilis* and *Phragmites* reeds. Alien *Sesbania* sp. is also evident. Waterlilies have established on the water surface. Waterbirds were observed during the site visit.	wetland transitional river	Mosselbank	E	D	MODERATE	
WTPs and infrastructure								
WTP 18	Wetland on northern side of N1,	▪ This is a grazed wetland patch, with a fine sand and silt bottom. Some flow of water was observed at the time of the field visit. It is	wetland seep	-				MODERATE - large enough to provide

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
	Boland District Municipality	likely that the stream leaving the wetland has been channelised in order to drain the wetland area for grazing. Trampling by cattle has destroyed some of the wetland habitat and has modified the stream banks. ▪ Water quality appears relatively good, especially at the downstream edge of the wetland patch. Some algae were recorded in the water. The indigenous but invasive duckweed, *Lemna gibba*., was observed on the surface of the water, an indication of organic pollution. ▪ The wetland supports large stands of sedges (including *Juncus* sp.), bulrush, lilies and the indigenous wetland grass, *Pennisetum macrourum* sp. Kikuyu grass was plentiful within the wetland and surrounding it. *Acacia saligna* has invaded the area.						important habitat, despite highly eutrophic status (cattle trampling); also functions as a corridor
WTP 19	Wetland on Hoopenberg farm, Muldersvlei	▪ This is a fairly large *Pennisetum* wetland patch, which is in a relatively good condition (i.e. fairly unimpacted). Several bird species were observed visiting this wetland. ▪ Some alien willow trees, *Salix babylonica*, were observed here.	wetland marsh	-				MODERATE - large enough to provide important habitat; fairly unimpacted *Pennisetum* wetlands within cultivated area
WTP 48	Wetland seep and stream	▪ Dry at the time of the field visit, but clearly a seasonal seep / stream system. ▪ Grassed and quite heavily grazed.	wetland seep	-				MODERATE - large enough to provide important

Site code	Location	Description and general comments	Type of aquatic system	Catchment	Instream Habitat Integrity (RIVERS)	Riparian Habitat Integrity (RIVERS)	Ecological Importance and Sensitivity (RIVERS)	Conservation Importance (WETLANDS)
								habitat, and important stream corridor.
WTP 49	Wetland seep and stream, below farm dam	▪ This is a grassed, and quite impacted stream / seep below a farm dam.						LOW - poor quality aquatic habitat
WTP 50	Wetland marsh between farm dams, alongside N1	▪ The area between two farm dams, is a *Pennisetum* wetland, of good quality. ▪ Was probably a seasonal stream before construction of the dams.	wetland marsh	-				MODERATE - large enough to provide important habitat.
WTP 36	Stream k, south of Bakenrug farm	▪ The stream here was dry at the time of the site visit. This channel has 3 small farm dams at the top of its catchment, and drains into an indigenous *Pennisetum*-dominated wetland (with sedges) near the R304, through which the stream meanders. ▪ An indigenous riparian corridor (dominated by renosterveld) surrounds the stream towards the top of its catchment (where the pipeline will cross), providing an approx. 50m swathe of vegetation, representing an important natural corridor between the vineyards and wheatfields.	wetland transitional stream	Mosselbank	**B**	**C**	MODERATE	

6 APPENDIX 2 COMMENT ON MINOR CHANGES TO ALIGNMENT OF PIPELINE – EMAIL DATED 26TH JUNE 2006

6.1 Background

An email received from BKS (from Isak Malherbe, dated 26/06/06) reads as follows:

"Subsequent to the drawings I gave you of the pipelines, we had to make minor changes to the pipeline routes as a result of landowner feedback and in order to avoid sensitive areas. Therefore some additional alternatives, indicated on the attached images (sent in 3 mails because of the size), were added to the drawings.

The location of these sites:

Alt RB1 : Between sites A and B - vineyards

Alt KA6 : Immediately west of Klapmuts - in road reseve

Alt Alternatives: Between Klapmuts and Simondium - on farm Babylonstoren"

The abovementioned sections of pipeline are provided below in Photo's 5.1 – 5.3.

6.2 Comment on impacts associated with alternatives

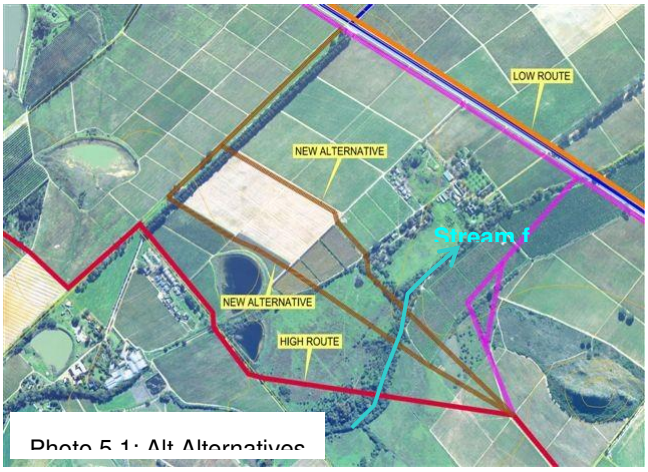


Photo 5.1: Alt Alternatives

6.2.1 Alt Alternatives

These alternative routings cross over Stream f on Backsberg Farm. The stream is located below a farm dam, and carries overflow from the dam along a channel approximately 2m in width. The stream is heavily impacted by the surrounding agricultural activities, and is invaded by a number of exotic plant species. The stream was assessed as being of low/marginal ecological importance and sensitivity, and, overall, of low conservation importance. The high route also crosses this stream, thus the impacts associated with this alternative routing are the same as those described for the high route between the Dasbos Outlet and Klapmuts in Section 1.5.3 and assessed in Section 2.4.1.

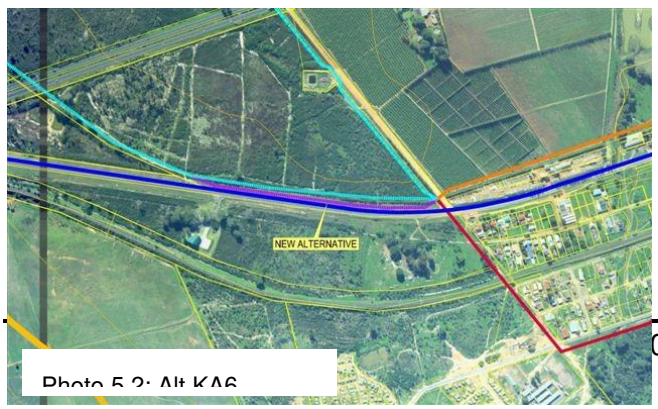


Photo 5.2: Alt KA6

6.2.2 Alt KA6

There are no additional impacts associated with this alternative alignment, which makes places the pipeline within the road reserve just west of Klapmuts. The impacts on freshwater ecosystems associated with WTPA and WTPB and infrastructure remain the same as those

described in Sections 1.5.8 and 1.5.9 and assessed in Section 2.4.2.

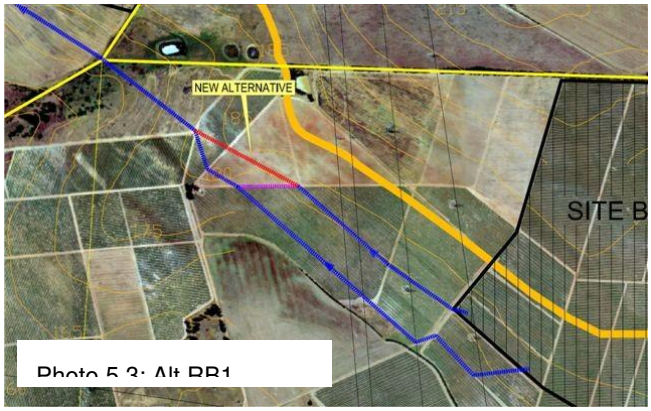


Photo 5.3: Alt RB1

6.2.3 Alt RB1

No additional impacts on freshwater ecosystems are associated with this alternative routing, and none are cancelled out. Thus, the impacts associated with WTPB and its infrastructure remain the same as those described in Section 1.5.9 and assessed in Section 2.4.2.

7 APPENDIX 3 COMMENT ON MINOR CHANGES TO ALIGNMENT OF LOW ROUTE THROUGH KLAPMUTS – EMAIL DATED 20TH JANUARY 2009

7.1 Background

A further email was received from BKS (from Isak Malherbe, dated 20/01/09), which stated that a new alternative route for the "low route" through Klapmuts had been identified. The email reads as follows:

"As a result of new developments in the vicinity of Klapmuts, an alternative to the Low Route through Klapmuts (along the R101 – Old Paarl Rd) has also been identified, although we still in the process to obtain final approval from the authorities (Stellenbosch Municipality and the Provincial Roads Branch) for this route (see figure attached)."

Consequently, two alternatives were described – KP1 (preferred route) and KP2 (Figure A3.1).

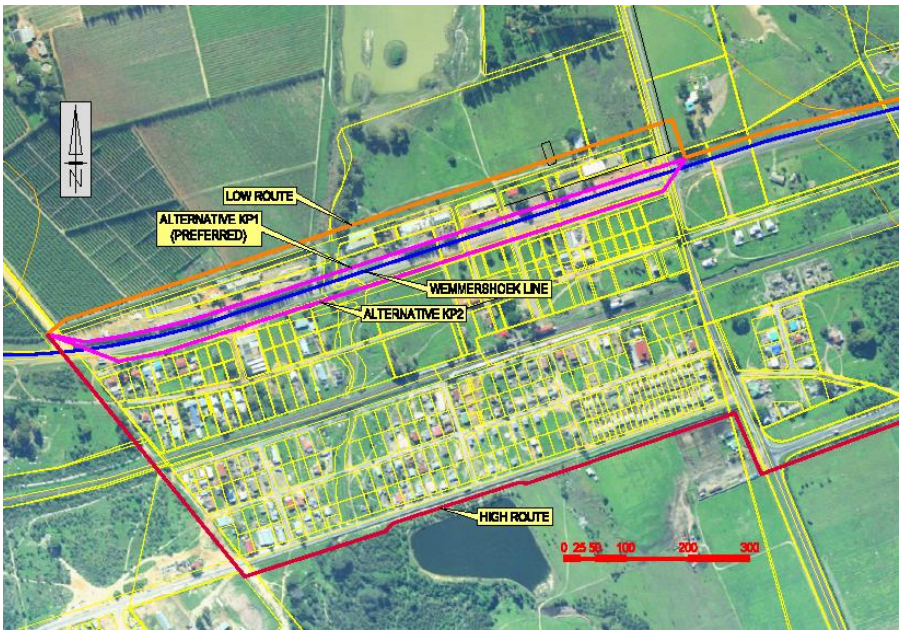


Figure A3.7.1 The alignment of the proposed alternatives for the "low route" through Klapmuts.

7.2 Comment on impacts associated with the alternatives

Both alternatives would cross over the Klapmuts River (a river of low conservation importance in this area), either to the south or north of the R101. KP2 requires a narrower working space – 18m – compared with KP1 – 30m. The "low route" alignment assessed in the EIA report to which this addendum is attached also crosses the Klapmuts River. Although the location of the river crossing differs between options, the impacts are considered to be similar. However, the advantage of both KP1 and KP2 are that they will be constructed close to the road, where the ground is already disturbed. Thus, KP1 and KP2 would be preferred to the "low route", from a freshwater ecological perspective. The impact assessment is amended and provided in Table A3.1.

Table A3.1 Summary of the assessment of impacts associated with the construction and operation of the low route and its alternatives for the Dasbos outlet to Klapmuts section of the bulk water pipeline.

Development option	Impact	Intensity of impact	Status of impact	Significance of impact (before mitigation)	Significance of impact (after mitigation)
Construction Phase					
Dasbos outlet to Klapmuts					
Low route	Loss of wetland habitat	Medium	Negative	Moderate	Low negative
	Loss of wetland connectivity	Low to medium	Negative	Low to moderate	None
	Loss of riverine habitat	High	Negative	High	Moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
KP1 and KP2	Loss of riverine habitat	High	Negative	Moderate	Low to moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
Operational Phase					
Dasbos outlet to Klapmuts					
Low route	Loss of wetland habitat	Low	Negative	Moderate	Low negative to low positive
	Loss of wetland connectivity	Low	Negative	Low to moderate	Low negative
	Loss of riverine habitat	Medium to high	Negative	Moderate to high	Low to moderate negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative
KP1 and KP2	Loss of riverine habitat	Medium to high	Negative	Moderate	Low negative
	Loss of riverine connectivity	Low to medium	Negative	Moderate	Low negative

The overall assessment has been modified, as provided below in Table A3.2.

Table A3.2 Overall ratings of the impacts without and with mitigation (0 = no impact; L = low; M = moderate; H = high; - = negative; + = positive).

Dasbos pump station to Dasbos outlet	Dasbos outlet to Klapmuts					Muldersvlei to Spes Bona		
Preferred route (one alternative)	High route (+ alternatives)	Low route	KP1	KP2	Preferred route	High route + alternatives	Low route + alternatives	Preferred route
M-H^{-} M^{-}	M-H^{-} M^{-}	M-H^{-} M^{-}	M^{-} L-M^{-}	M^{-} L-M^{-}	M-H^{-} M^{-}	H^{-} M^{-}	H^{-} M^{-}	H^{-} L-M^{-}
M-H^{-} M^{-}	H^{-} L-M^{-}	H^{-} L-M^{-}	M^{-} L^{-}	M^{-} L^{-}	H^{-} L -M^{-}	M-H^{-} L -M^{-}	M-H^{-} L -M^{-}	M-H^{-} L-M

8 APPENDIX 4 COMMENT AND ASSESSMENT OF IMPACTS ASSOCIATED WITH CHANGES TO THE ACCESS ROAD TO THE RESERVOIR SITE, AND THE WYNLAND PIPELINES - EMAIL DATED 13TH DECEMBER 2022

8.1 Background

Additional amendments were proposed in late 2022, affecting the access road to the reservoir site (WTP A, as assessed in the 2009/2010 EIA report), and the removal and relocation of sections of the Wynland pipeline that runs under the reservoir site.

The reasons provided by Zutari (email dated 13th December 2022) for the change in alignment and location of the access road were as follows:

1. "The intersection with the R304 was shifted to allow for a perpendicular connection between the access road and the R304 as per Western Cape Provincial Government: Department Transport and Public Works requirements".
2. "The City of Cape Town agreed to relocate the existing access road to County Fair on the eastern side of the R304. This will result in a single intersection for both access roads which will result in a significant improvement in the road safety. This was also a requirement from Western Cape Provincial Government: Department Transport and Public Works. County Fair has also given consent for the relocation of their access road as per attached documentation".
3. "The access road alignment had to be adjusted for the first 100m after the intersection for the road to navigate through the existing Eskom pylons as safely as possible. The current alignment provides optimal clearances from the pylons and thus minimising the impact on Eskom and improving the safety through which vehicles can travel through the pylons".
4. "Other minor refinements to the access road were required to minimise the vertical slopes and provide improved sight distance for users of the access road. These changes are required to improve the road safety."

Figure A4.8.1 Alignment of the Muldersvlei Reservoir access road, as planned in 2009/10 (yellow line), in comparison with the new alignment and extension of the road to include a new access road to Country Fair (purple outline).

The Wynland pipelines that run underground through the proposed reservoir site (WTP A) must be relocated before construction can commence. The relocated pipeline runs within the land parcels expropriated by the City of Cape Town.

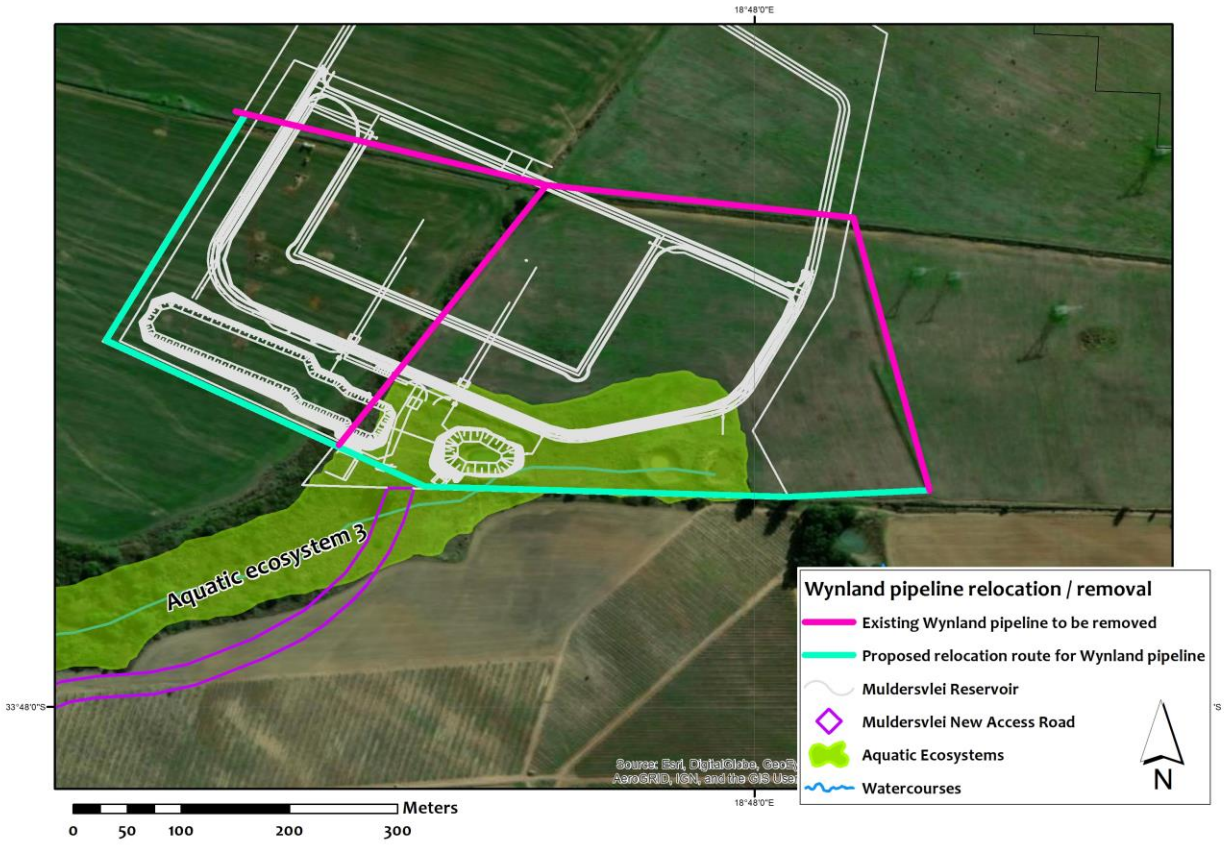


Figure A4.8.2 Existing Wynland pipeline sections to be removed, and proposed relocation route at the Muldersvlei Reservoir site.

8.2 Methods for assessment of amendments

The original EIA was completed in 2009, and updated in 2010, before several amendments to existing EIA legislation and the introduction of new legislation guiding the assessment of environmental impacts, specifically those affecting aquatic biodiversity. Due to the fact that these amendments have been made in late 2022, all effort has been made to adhere to the current legislation. In particular, this assessment is guided by the gazetted "Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity" (Government Notice 370, March 2020), which replaces Appendix 6 of the EIA Regulations as promulgated in terms of Section 24 (5) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (see Section 2.2 above).

8.3 Site sensitivity

The Department of Fisheries, Forestry and the Environment's (DFFE) EIA Screening Tool shows that portions of the affected area are of very high aquatic biodiversity sensitivity (Figure A4.8.3). These areas correspond with a seep and watercourse, identified as Aquatic Ecosystem 3 in the more recent Water Use Licence Application report prepared by FCG. The wetland and watercourse maps used by the DFFE are not always accurate, and indeed the wetlands and watercourse affected by the access road and the relocation of the Wynland pipeline are more extensive than that provided by the Screening Tool. The ground-truthed location and extent of the affected wetlands and watercourses are shown above in Figure A4.8.1 and Figure A4.8.2. It can be assumed that these ecosystems are of very high sensitivity.

There are no surface or groundwater strategic water source areas within the affected area.

Figure A4.8.3 Aquatic Biodiversity Sensitivity within the area affected by the Mulderslei Reservoir access road and the relocation of the Wynland pipeline route, extracted from the Department of Fisheries, Forestry and Environment's (DFFE's) EIA Screening Tool.

8.4 Description of affected aquatic ecosystems

The new access road and the relocation of the Wynland pipeline through the Reservoir site will affect a seasonal watercourse and its associated wetlands on the upper reaches of the Mosselbank River, identified as "Stream k" in Appendix 1 of this report, and Aquatic Ecosystem 3 in the Water Use Licence Application Report for the Reservoir and infrastructure (Figure A4.8.4). The watercourse type – non-perennial upper foothill river in the South Western Coastal Ecoregion – is critically endangered and poorly protected. The wetlands include a West Coast Renosterveld seep at the upper end of the ecosystem, , and a West Coast Renosterveld valley-bottom wetland at the lower end where the access road crosses, both of which are critically endangered, poorly protected wetland types.

The affected watercourse and wetlands arise in the vicinity of the proposed Muldersvlei Reservoir, and then flow in a westerly direction down a slope before going under the R304 and joining with the Mosselbank River. The watercourse arises as a fairly wide seep, with patches of *Cenchrus setaceus* but otherwise dominated by alien grasses such as *Lolium multiflorum* (ryegrass). The wetland spreads around and between a series of three small impoundments (Figure A4.8.6). The upper seep wetland is significantly impacted by the presence of the three impoundments, but the section of watercourse that leads down to the R304 is relatively unimpacted.

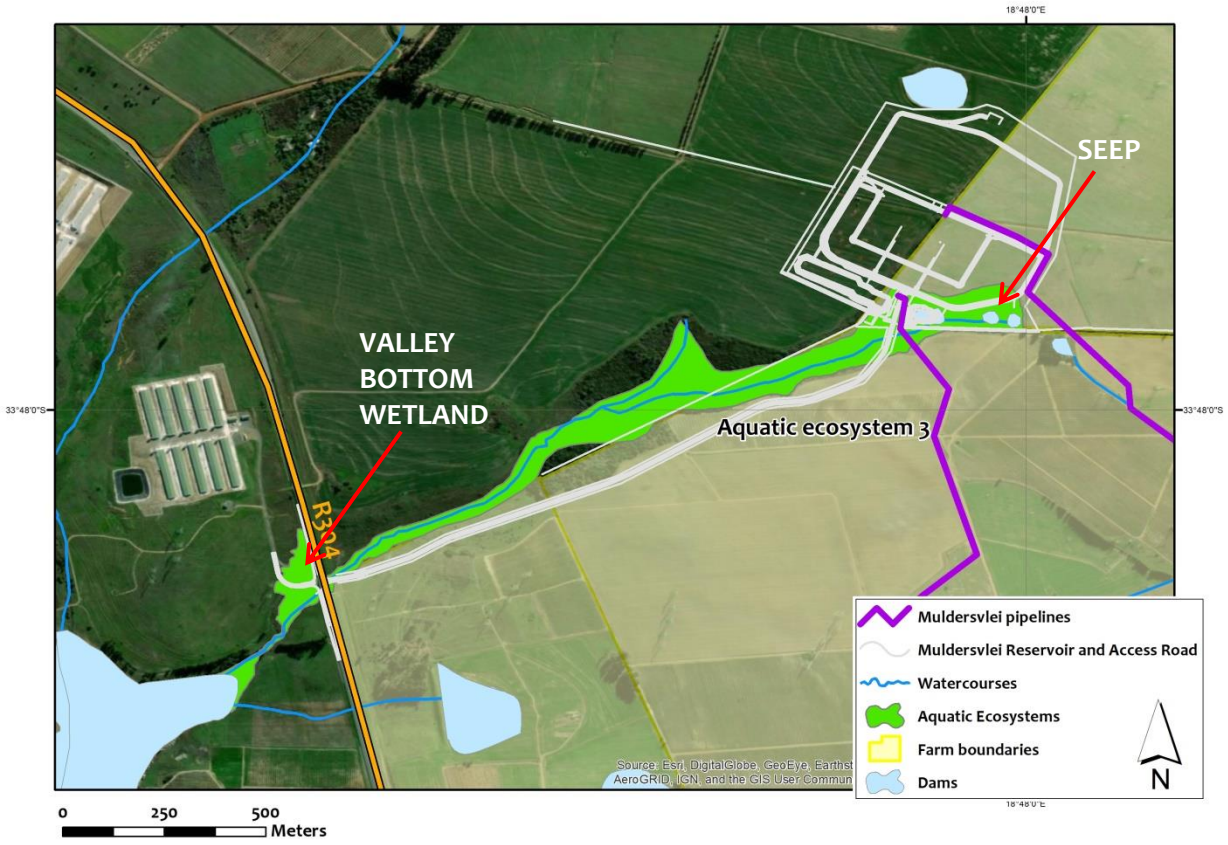


Figure A4.8.4 Aquatic Ecosystem 3 in relation to the proposed pipelines, access road, and Reservoir. A seep is located at the upper end of the ecosystem, and a valley-bottom wetland at the lower end, with a watercourse connecting the two.

Figure A4.8.5 View of Aquatic Ecosystem 3 from the upstream end in the vicinity of the proposed Reservoir and WTP, looking down the watercourse from the seep towards the R304.

Figure A4.8.6 One of the small farm dams in the seep at the upper end of Aquatic Ecosystem 3.

As the watercourse nears the R304, the wetland broadens into a valley-bottom wetland (Figure A4.8.7) around the channel, which becomes incised, down to approximately 0.5m, before it passes under the road in a 1.8 x 1.5 m box culvert (Figure A4.8.8). Additional runoff from alongside the R304 also enters the channel on the up- and downstream sides of the road. Below the road the watercourse runs westwards in an unlined channel towards a farm dam (Figure A4.8.9).

It is likely that the valley-bottom wetland at the lower end of the ecosystem has been influenced by the roads in that area – water may accumulate against the obstruction of the roads, but also may be drained, due to the straightened and deepened (incised) channel leading water away from the wetland. At the time of the spring 2022 site visit, masses of chincherinchees (*Ornithogalum thyrsoides*) were flowering in the wetland (Figure A4.8.10).

Soil samples taken in the seep wetland between the impoundments showed few indicators of soil wetness (Figure A4.8.11) and thus it is likely that this area around the impoundments is at most temporarily wet due to seepage from the dams. According to the delineation guideline, however, these still qualify as wetland soils.

Details of soil samples from the seep:

Depth	Soil colour chart: value/chroma	Mottles
0 – 10 cm	10YR:5/3	At 40 – 50 cm
10 – 30 cm	10YR: 5/3	At 40 – 50 cm
30 – 50 cm	10YR: 5/3	At 40 – 50 cm

Figure A4.8.7 View of Aquatic Ecosystem 3 from the downstream end, looking upstream at the valley-bottom wetland adjacent to the R304.

Figure A4.8.8 Culvert under the R304, carrying the watercourse (Aquatic Ecosystem 3) under the road.

Figure A4.8.9 Channelised watercourse as it runs downstream of the R304, towards a farm dam.

Figure A4.8.10 The common chink (*Ornithogalum thyrsoides*) flowering in the valley-bottom wetland below the R304 (Aquatic Ecosystem 3).

The vegetation type in this area is Swartland Shale Renosterveld, a critically endangered vegetation type which has been significantly (> 90%) destroyed and transformed through agricultural activities in the Swartland (Rebelo *et al.,* 2006). The riparian vegetation comprises predominantly *Searsia* spp., *Stoebe plumosa*, *Olea europea* subsp. *africana* and various grasses. Some alien acacia species (*Acacia mearnsii* and *A. saligna*) were noted in the riparian zone. At the downstream end towards the R304, watsonias (probably *Watsonia meriana* - Figure A4.8.7) and kikuyu grass (*Cenchrus clandestinus*) dominate the in-channel vegetation.

Figure A4.8.11 Soil sample collected from within the boundary of the seep wetland in the upstream portion of Aquatic Ecosystem 3, in the vicinity of the proposed Muldersvlei Reservoir.

8.5 Condition and sensitivity of aquatic ecosystems

An assessment of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) was done for the WULA report (December 2022). The results are presented below.

Table A4.8.1 Results of the Level 2 Wet-Health assessment for the seep in the upper reaches of Aquatic Ecosystem 3, using WET-Health version 2 (MacFarlane et al., 2020).

Aquatic Ecosystem 3 - SEEP				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	2.5	1.5	4.2	6.5
PES Score (%)	75%	85%	58%	35%
Ecological Category	**C**	**B**	**D**	**E**
Trajectory of change	**Remain the same**	**Remain the same**	**Remain the same**	**Remain the same**
Confidence (revised results)	Moderate	Moderate	Moderate	Moderate
Combined Impact Score	3.5			
Combined PES Score (%)	65%			
Combined Ecological Category	**C**			
Hectare Equivalents	1.6 Ha			

Table A4.8.2 Results of the Level 2 Wet-Health assessment for the valley-bottom wetland in the lower reaches of Aquatic Ecosystem 3.

Aquatic Ecosystem 3 – VALLEY-BOTTOM WETLAND				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	3.0	1.3	4.3	6.5
PES Score (%)	70%	87%	57%	35%
Ecological Category	**C**	**B**	**D**	**E**
Trajectory of change	**Remain the same**	**Remain the same**	**Remain the same**	**Remain the same**
Confidence (revised results)	Moderate	Moderate	Moderate	Moderate
Combined Impact Score	3.7			
Combined PES Score (%)	63%			
Combined Ecological Category	**C**			
Hectare Equivalents	1.1 Ha			

Table A4.8.3 Results of the assessment of the EIS assessments for aquatic ecosystem 3.

Ecological Importance	Aquatic Ecosystem 3 - SEEP	Aquatic Ecosystem 3 - VB
Biodiversity support	**0.83**	**0.67**
Presence of Red Data species	0	0
Populations of unique species	0	0
Migration/breeding/feeding sites	2.5	2
Landscape scale	**1.2**	**1.0**
Protection status of the wetland	1	1
Protection status of the vegetation type	1	1
Regional context of the ecological integrity	1	1
Size and rarity of the wetland type/s present	1	1
Diversity of habitat types	2	1
Sensitivity of the wetland	**2.00**	**2.33**
Sensitivity to changes in floods	3	3
Sensitivity to changes in low flows/dry season	1	2
Sensitivity to changes in water quality	2	2
ECOLOGICAL IMPORTANCE & SENSITIVITY	**2.00 - High**	**2.33 - High**
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**1.84**	**1.83**
DIRECT HUMAN BENEFITS	**0.51**	**0.42**

Table A4.8.4 Results of the PES and EIS assessments for the watercourse in Aquatic Ecosystem 3.

River name	Ecoregion[1] and river type	Instream Habitat Integrity Score (%) and Category		Riparian Habitat Integrity Score (%) and Category		Ecological Sensitivity & Importance Score and Category	
Aquatic ecosystem 3	South western coastal belt – upper foothills	65	**C**	60	**C**	3.0	**High**

8.6 Buffer determination

The river and wetland buffer width tool developed by MacFarlane and Bredin (2017) was used to determine appropriate buffers for the aquatic ecosystems, for both the construction and operation phases of the project. The assessment is based on the PES and EIS of each aquatic ecosystem, and the quality of the buffer during both phases of the project. It was assumed that the current vegetation would be representative of the buffers for both phases, unless the actual removal of vegetation and soils is expected. The density of vegetation plays a major role in determining the effectiveness of a buffer – a well-vegetated buffer, with a high basal cover (such as grass or sedges) is the most effective buffer, due to the ability of the plants and their roots to trap sediments, toxins and other pollutants before they reach the watercourse.

The results of the buffer determination are presented in Table A4.8.5.

[1] Level 1 ecoregions are described in Kleynhans *et al.* (2005).

Table A4.8.5 Results of the buffer width determination for the four aquatic ecosystems impacted by the proposed bulkwater project. The determination was done using the tool of MacFarlane and Bredin (2017).

Buffer attributes	Buffer details	
	Aq ecosystem 3 – wetlands	Aq ecosystem 3 – watercourse
Slope of the buffer	Very gentle	Very gentle
Vegetation characteristics (Construction phase)	Dense vegetation with good basal cover	Dense vegetation with good basal cover
Vegetation characteristics (Operational phase)	Dense vegetation with good basal cover	Dense vegetation with good basal cover
Soil permeability	Moderately low	Moderately low
Topography of the buffer zone	Dominantly uniform	Dominantly uniform
Construction Phase Buffer	15m	15m
Operational Phase Buffer	15m	15m

In all instances, the recommended minimum buffer for the affected aquatic ecosystems is **15m**, for both the construction and operational phases, assuming that the vegetation cover currently observed surrounding these ecosystems is maintained or rehabilitated.

During construction, the boundary of the ecological buffer must be clearly demarcated (temporary fencing, or well-maintained danger tape) before commencing. Unless construction work must occur within the buffer or aquatic ecosystem, the buffers, wetlands and watercourses are no-go areas for workers, stockpiles, temporary roads, pathways, construction machinery (either in use or parked) and toilets.

8.7 Description of the proposed activities

8.7.1 Access road

An approximately 1.4km access road will be constructed leading from the R304 up to the Muldersvlei Reservoir. The road will be approximately 10m wide with a servitude of 20m, and surface stormwater will be conveyed on the eastern, uphill side of the road in a cut-off drain within the servitude, and into the watercourse through three proposed culverts. Erosion protection will be provided downstream of all culverts.

8.7.2 Wynland pipeline

The Wynland pipe has a diameter of 160mm. The sections of pipeline to be removed either lie under the reservoir site and so opened trenches will be left as is until construction begins, or where old sections of pipe do not lie within the reservoir footprint, the trenches will be filled with soil, and re-vegetated, where appropriate, or left for agricultural use, where on private farmland.

The construction footprint for the relocated pipes will vary in depth, but never greater than 2m, and in width up to 27m.

8.8 Impact assessment

8.8.1 Methods

For each potential impact, criteria were ascribed according to the methods provided by Zutari, which include the intensity (size or degree scale), the type of impact (either a positive or negative impact), the duration (temporal scale); and the extent (spatial scale), as well as the probability (likelihood). The method is quantitative, whereby professional judgement is used to identify a rating for each criteria based on a seven-point scale (refer to Table 1); and the significance is auto-generated using a spreadsheet through application of the calculations in Figure A4.8.12.

Calculations

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

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

Consequence = type x (intensity + duration + extent)

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

Significance = consequence x probability

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

Figure A4.8.12 Calculation of significance

Other considerations included the level of confidence in the assessment rating (Table A4.8.7), the reversibility of the impact (Table A4.8.8), and the irreplaceability of the resource (Table A4.8.9).

The no-go option was taken to be the status quo scenario – i.e. no development, and the site continues to be used for agricultural purposes.

Table A4.8.6 Assessment criteria for the evaluation of impacts

Criteria	Numerical Rating	Category	Description
Duration	1	Immediate	Impact will self-remedy immediately
	2	Brief	Impact will not last longer than 1 year
	3	Short term	Impact will last between 1 and 5 years
	4	Medium term	Impact will last between 5 and 10 years
	5	Long term	Impact will last between 10 and 15 years
	6	On-going	Impact will last between 15 and 20 years
	7	Permanent	Impact may be permanent, or in excess of 20 years
Extent	1	Very limited	Limited to specific isolated parts of the site
	2	Limited	Limited to the site and its immediate surroundings
	3	Local	Extending across the site and to nearby settlements
	4	Municipal area	Impacts felt at a municipal level
	5	Regional	Impacts felt at a regional level
	6	National	Impacts felt at a national level
	7	International	Impacts felt at an international level
Intensity	1	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
	2	Very low	Natural and/ or social functions and/ or processes are slightly altered
	3	Low	Natural and/ or social functions and/ or processes are somewhat altered
	4	Moderate	Natural and/ or social functions and/ or processes are moderately altered
	5	High	Natural and/ or social functions and/ or processes are notably altered
	6	Very high	Natural and/ or social functions and/ or processes are majorly altered
	7	Extremely high	Natural and/ or social functions and/ or processes are severely altered
Probability	1	Highly unlikely / None	Expected never to happen
	2	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
	3	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
	4	Probable	Has occurred here or elsewhere and could therefore occur
	5	Likely	The impact may occur
	6	Almost certain / Highly probable	It is most likely that the impact will occur
	7	Certain / Definite	There are sound scientific reasons to expect that the impact will definitely occur

Table A4.8.7 Definition of confidence ratings.

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

Table A4.8.8 Definition of reversibility ratings.

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

Table A4.8.9 Definition of irreplaceability ratings.

Category	Description
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere
High	The resource is irreparably damaged and is not represented elsewhere

8.8.2 Description of probable impacts and mitigation measures

The following sections describe the likely impacts associated with the proposed activities, each of which is linked to a desired, measurable outcome with regards to the affected aquatic ecosystems. A number of mitigation measures are proposed, which are designed to support the achievement of the desired outcomes.

8.8.2.1 Design and Construction phase

The mitigation measures provided below should be incorporated into Method Statements, which can then be added to the existing authorised Construction Environmental Management Programme (CEMPr), and audited throughout the construction process. An adequately qualified independent environmental control officer (ECO) must be appointed before construction begins.

Table A4.8.10 Activities and impacts associated with the design and construction of the access road and the relocation of the Wynland pipelines. Each of these is associated with a desired outcome with regard to the protection of the freshwater ecosystems on the site, and recommended mitigation measures designed to achieve the desired outcome are listed. Should the Contractor propose alternative mitigation measures to achieve the desired outcomes, these have to be approved by the Employer's Representative.

Impact #	Activities and Impacts	Desired outcome	Recommended Mitigation Measures
1	Road and pipeline crossings over wetlands and watercourses leading to *loss of wetland, riverine and / or riparian habitat*, where infrastructure is located within the boundaries of wetlands and / or watercourses. This will occur where the access road will cross over the valley-bottom wetland and watercourse at the lower end of Aquatic Ecosystem 3. An approximate area of 1636m^2 of wetland will be lost, and 1119m^2 gained where the old road is rehabilitated, leading to a residual loss of 517m^2 of wetland area and a loss of 700m^2 of riparian area. The relocated Wynland pipeline will cross over the seep wetland and watercourse at the upper end of Aquatic Ecosystem 3. The maximum construction footprint for the trenches will be 27m wide, impacting on approximately 3770m^2 of wetland area within the seep wetland and 2890m^2 of riparian habitat, but not necessarily leading to permanent loss. The removal of existing sections of the Wynland pipeline is outside the seep wetland, but will cross through the ecological buffer of the seep. No wetland will be gained. Ideally, alignment of the pipelines and access road should attempt to **avoid** wetlands and watercourses and their ecological buffers. This mitigation measure is not considered a reality, as the layout provided for this assessment is assumed to be final.	• No net loss of wetland area. • No net loss of riparian habitat.	• Where the pipe comes close to (< 30m) a wetland or watercourse, the specifications for the pipe trenches should aim to minimise the footprint of construction (e.g. the shallower the pipe, the narrower the disturbed area). • Sensitive ecosystems must be demarcated prior to any construction activities, so that these can be avoided, unless construction is taking place within the boundaries of a wetland or watercourse. • Removal of indigenous vegetation should be kept to a minimum, and refilled trenches must be rehabilitated after construction. Refer to Section 8.8.3 for rehabilitation plan and guidelines (Note: Areas under cultivation where the Wynland pipeline is removed can be returned to cultivation). • Where the access road will be re-aligned through the valley-bottom wetland in lower Aquatic Ecosystem 3, the old road footprint (current access road to County Fair) must be rehabilitated, to the guidelines provided. A total of 1636m^2 of wetland and 700m^2 of riparian habitat will be lost, and 1119m^2 gained. Additional rehabilitation of the wetland (such as shaping of the erosion gullies in the wetland) and watercourse (such as stabilising erosion and re-planting with indigenous plant species) will achieve the balance required, such that there will be

Impact #	Activities and Impacts	Desired outcome	Recommended Mitigation Measures
			no residual loss.
2	Bulldozing and blasting of watercourses and wetlands, leading to *erosion and sedimentation and loss or deterioration of wetland and riverine habitat*. This will be necessary for the preparation of sites within the wetlands and watercourses for construction of the road and the relocation of the Wynland pipeline. Ideally, alignment of the pipelines and access road should attempt to **avoid** wetlands and watercourses and their ecological buffers. Where river crossings are necessary, attempts should be made to make use of existing crossings (such as existing tracks, culverts and road bridges).	• No permanent loss of wetland area. • No permanent loss of riparian habitat. • No new erosion gullies on site.	• The specifications for the relocated pipe trenches should aim to minimise the footprint of construction (e.g. the shallower the pipe, the narrower the disturbed area) where the pipe comes close to (< 30m) a wetland or watercourse, and sensitive ecosystems should be demarcated prior to any construction activities, so that these can be avoided, wherever possible. • Special care should be taken around storm and heavy rain events. The construction sites should be inspected for erosion damage at these times. • Consideration should be given at the design phase to remedial shaping of banks to their near-natural slope, geomorphological and bed characteristics and re-vegetated after clean-up. • Banks and slopes should be re-vegetated after construction is completed. A detailed planting plan should be developed, in consultation with a landscaper and ecologist. • If construction areas are to be pumped of water (e.g. after rains), this water must first be pumped into a settlement area, and not directly into a natural aquatic ecosystem.
3	Construction activities within the watercourse and wetlands leading to *loss of connectivity and deterioration of habitat through disruption of flow regime leading to nutrient / sediment build-up and eutrophication.*	• No disruptions to surface flow in the two watercourses. • No build-up of sediment downstream of construction activities.	• Disruption of flow should be kept to a minimum, but where necessary, temporary diversion measures should allow flushing of the system to prevent build-up of material. • Diversion techniques should take measures to limit erosion from temporary

Impact #	Activities and Impacts	Desired outcome	Recommended Mitigation Measures
			channels into watercourses or wetlands. • No obstructions to flow shall remain in the watercourses or wetlands after construction is completed. • Temporary diversion channels must be rehabilitated.
4	Storage of building materials (sand, soil, bricks etc) in sensitive areas – this would *damage the soil structure, and would destroy or shade out plants growing in and around these ecosystems.* Dump areas frequently lead to the *compaction of soils, which can influence re-growth of plants. Invasive alien plants frequently take advantage of disturbed areas such as these.*	• No encroachment of building materials into wetlands, watercourses or their recommended buffers	• All building materials must be stored away (at least 15m) from all aquatic ecosystems and the areas bunded appropriately such that there will be no runoff from these areas towards aquatic systems. All building materials should be removed after construction. • Materials should be stored in piles that do not exceed 1.5m in height and should be protected from the wind, to prevent spread of fine materials across the site. • Sensitive areas that are impacted by the dumping or storage of materials must be ripped and re-planted after construction is complete. • The pipeline contractor should work the relocated Wynland pipeline route in sections, backfilling as they go, which will reduce the width of disturbed area – i.e. it is not as necessary to spread the spoil wide, if it can spread along a greater length.
5	*Deterioration in wetland and riverine habitat and water quality* through spillage of building materials and oil / fuel, and seepage of pollutants from stockpiles. Due to the fact that the wetlands and watercourses are all seasonal to ephemeral, with little or no inundation in summer and flushing only in winter, it is likely that pollutants could accumulate and persist for some time.	• No spills or seepage of pollutants into wetlands, watercourses or their recommended buffers.	• Washing of vehicles and machinery should take place well away (50m) from aquatic ecosystems. • Machinery prone to oil or fuel leakage must be located at least 50m away from any aquatic ecosystem, and the area adequately bunded in order to contain leakages. • Water pumps and cement mixers shall

Impact #	Activities and Impacts	Desired outcome	Recommended Mitigation Measures
			have drip trays to contain oil and fuel leaks – these must be cleaned regularly. • Concrete batching must be done well away from (50m minimum) from all sensitive environments. • All machinery should be regularly checked for leaks. • Suitable toilet and wash facilities must be provided to avoid the use of sensitive areas for these activities. These service areas must be maintained, and toilets emptied on at least a weekly basis. • If construction areas are to be pumped of water (e.g. after rains), this water must first be pumped into a settlement area, and not directly into a natural ecosystem.
6	*Destruction or deterioration of freshwater habitat* as a result of foot and vehicular traffic – access across and around the wetlands and watercourses onto and across the building sites, and for road construction and pipe laying, is likely to lead to damage of soils and vegetation. Regular use of a particular area will lead to the compaction of soils.	• No access to wetlands, watercourses or their buffers when construction activities do not impact directly on these areas. • Rehabilitation of affected areas where construction occurs within wetlands, watercourses or their buffers.	• Pathways and temporary access roads must be routed around the wetlands and should cross drainage channels as seldom as possible. • Sensitive areas must clearly be demarcated and fenced off (using temporary fencing and danger tape) before any construction work or site preparation begins. These are no-go areas during the construction process. • Affected areas must be ripped and re-planted after construction, according to the specifications set out in the CEMPr, and to the satisfaction of the ECO.
7	Disturbance of freshwater fauna and flora – the presence of construction teams and their machinery will lead to *noise and light pollution* in the area.	• No loss of animal life as a result of construction activities. • Successful relocation of animals directly affected by construction activities. • No loss of wetland or riparian areas.	• The construction sites and pathways must avoid sensitive areas. If lights are used, these must be directed away from all sensitive areas. • The sensitive areas (i.e. the edges of the buffers around the wetlands, watercourses) not affected by

Impact #	Activities and Impacts	Desired outcome	Recommended Mitigation Measures
			construction must clearly be demarcated and fenced off (using temporary fencing and danger tape) before any construction work or site preparation begins. These are no-go areas during the construction process, except where work is occurring.
8	*Introduction and spread of invasive alien plants* – where *in situ* top soils (i.e. top 20 cm of soil) are insufficient, soils brought onto the sites for filling and landscaping can contain alien or invasive seedbanks.	• No new infestations of invasive alien plants. • Reduction in current infestations of invasive alien plants.	• *In situ* soils must preferably be used for rehabilitation of construction sites. • Where *in situ* soils are insufficient, top soils used after construction must be bought from reliable sources, and must be free of alien seeds or grass runners. • Constant monitoring of the construction sites by the Site Engineer and ECO must occur, and all alien plant species removed from or destroyed on the site.

8.8.2.2 Operational phase

The impacts associated with the operational phase of the project relate primarily to the long-term loss or deterioration of aquatic habitat, and the long-term or permanent loss of connectivity within the impacted aquatic ecosystems. There is likely to be some long-term disturbance within the maximum 16.45m-wide pipe servitudes along the relocated pipeline route. Further operational impacts relate to the management of stormwater runoff from the access road, especially at the lower end close to the wetland and watercourse.

Table 8.11 Activities and impacts associated with the operation of the access road and relocated Wynland pipeline. Each of these is associated with a desired outcome with regard to the protection of the freshwater ecosystems on the site, and recommended mitigation measures designed to achieve the desired outcome are listed. Should the Contractor propose alternative mitigation measures to achieve the desired outcomes, these have to be approved by the Employer's Representative.

Impact #	Activities and Impacts	Desired outcome	Recommended Mitigation Measures
1	Crossings of road and pipeline over wetlands and watercourses, can lead to the *loss of surface flow connectivity at pipeline and road crossings or erosion within impacted ecosystems.* This may occur where the Wynland pipeline is laid at an incline across the seep wetland and watercourse (aquatic ecosystem 3). The stone drainage layer at the bottom of trenches during construction, as well as the granular bedding often used as bedding material around the pipe can potentially act as subsurface transfer conduits of groundwater; potentially intercepting groundwater seepage in the wetland groundwater catchment, and transferring it to a lower lying section of the pipeline. This could disrupt the connectivity within watercourses and wetlands. The culverts under the new access road will replace existing pipes, so the impacts are similar. Surface flow through pipes or narrow culverts can lead to the concentration of flow and subsequent erosion downstream of crossings.	• No permanent loss of wetland area. • No permanent loss of riparian habitat. • No gully formation or new erosion (such as head-cuts) in the watercourse or wetlands.	• The potential interception and transfer of subsurface water by the drainage- and bedding material under and around inclined pipes should be inhibited with cut-off barriers perpendicular to the longitudinal profile of the trench (for example, 0.3m thick bentonite). The barriers should be spaced at 24m intervals and extend a minimum of 0.5m past the sides of the trench profile, and up to rock level or a minimum of 0.5m deeper than the trench bottom (whichever comes first). • At all road crossings over aquatic ecosystem 3, the natural surface flow of water should be accommodated in several pipes or wide culverts, in order ensure that flow is not concentrated downstream of the crossings. • The impacted footprint of the pipeline and road should be kept to a minimum in close (< 30m) proximity to all wetlands and watercourses, e.g. by reducing the depth to which the pipes are laid, where possible. • Mowing or clearing of the pipeline or road servitudes of vegetation must be kept to a minimum.
2	Increased discharge of stormwater off the access road may lead to the *loss or deterioration of aquatic habitat through ongoing erosion and sedimentation.*	• No gully formation or new erosion (such as head-cuts) in the watercourse or wetlands.	• The geomorphological characteristics (shape, gradient, slopes) of the impacted ecosystems must be re-instated after construction – this will reduce the likelihood of increased erosion or

Impact #	Activities and Impacts	Desired outcome	Recommended Mitigation Measures
			sedimentation. • If it is necessary to stabilise the watercourse or wetland bed or banks with gabions or rip rap, these should be kept to a minimum, and should be done in an ecologically sensitive manner. For example, gabions could be top-soiled to allow for the establishment of vegetation, which would also serve the purpose of reducing erosion. See Section 8.8.2.2 for further recommendations.
3	The regular removal or mowing of indigenous vegetation along pipeline and road servitudes may lead to *deterioration in wetland and riverine habitat through loss of indigenous vegetation*.	• No permanent loss of wetland area. • No permanent loss of riparian habitat.	• Mowing should not be more frequently than annually. • Vegetation within the pipeline servitudes should be allowed to recover (in some cases, re-planted), within the constraints of ongoing maintenance of the pipeline. • Ongoing monitoring of the pipeline and WTP site and associated infrastructure should be implemented (part of the ongoing EMP) in order to ensure that exotic plant species are not introduced or become established due to the disturbance.

8.8.3 Results of individual impact assessment

The results of the impact assessment are presented in the tables below.

Ref:	1			
Project phase	**Construction**			
Impact	**Road and pipeline crossings over wetlands and watercourses**			
Description of impact	**Crossings may lead to loss of wetland, riverine and / or riparian habitat.**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Where the pipe comes close to (< 30m) a wetland or watercourse, the specifications for the pipe trenches should aim to minimise the footprint of construction (e.g. the shallower the pipe, the narrower the disturbed area).** **• Sensitive ecosystems must be demarcated prior to any construction activities, so that these can be avoided, unless construction is taking place within the boundaries of a wetland or watercourse.** **• Removal of indigenous vegetation should be kept to a minimum, and refilled trenches must be rehabilitated after construction. Refer to Section 8.9 for rehabilitation plan and guidelines (Note: Areas under cultivation where the Wynland pipeline is removed can be returned to cultivation).** **• Where the access road will be re-aligned through the valley-bottom wetland in lower Aquatic Ecosystem 3, the old road footprint (current access road to County Fair) must be rehabilitated, to the guidelines provided. A total of 1636m2 of wetland and 700m2 of riparian habitat will be lost, and 1119m2 gained. Additional rehabilitation of the wetland (such as shaping of the erosion gullies in the wetland) and watercourse (such as stabilising erosion and re-planting with indigenous plant species) will achieve the balance required, such that there will be no residual loss.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Permanent	Impact may be permanent, or in excess of 20 years	Permanent	Impact may be permanent, or in excess of 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Low	The affected environment will not be able to recover from the impact - permanently modified
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Moderate - negative**		**Negligible - negative**	

Ref:	2
Project phase	**Construction**

Impact	**Bulldozing and blasting of watercourses and wetlands**			
Description of impact	**This will be necessary for the preparation of sites within the wetlands and watercourses for construction of the road and the relocation of the Wynland pipeline. This may lead to erosion and sedimentation and loss or deterioration of wetland and riverine habitat.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• The specifications for the relocated pipe trenches should aim to minimise the footprint of construction (e.g. the shallower the pipe, the narrower the disturbed area) where the pipe comes close to (< 30m) a wetland or watercourse, and sensitive ecosystems should be demarcated prior to any construction activities, so that these can be avoided, wherever possible.** **• Special care should be taken around storm and heavy rain events. The construction sites should be inspected for erosion damage at these times.** **• Consideration should be given at the design phase to remedial shaping of banks to their near-natural slope, geomorphological and bed characteristics and re-vegetated after clean-up.** **• Banks and slopes should be re-vegetated after construction is completed. A detailed planting plan should be developed, in consultation with a landscaper and ecologist.** **• If construction areas are to be pumped of water (e.g. after rains), this water must first be pumped into a settlement area, and not directly into a natural aquatic ecosystem.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Minor - negative**	

Ref:	3	
Project phase	**Construction**	
Impact	**Construction activities within the watercourse and wetlands**	
Description of impact	**This may lead to loss of connectivity and deterioration of habitat through disruption of flow regime leading to nutrient / sediment build-up and eutrophication.**	
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts

Potential mitigation	**• Disruption of flow should be kept to a minimum, but where necessary, temporary diversion measures should allow flushing of the system to prevent build-up of material. • Diversion techniques should take measures to limit erosion from temporary channels into watercourses or wetlands. • No obstructions to flow shall remain in the watercourses or wetlands after construction is completed. • Temporary diversion channels must be rehabilitated.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Brief	Impact will not last longer than 1 year	Immediate	Impact will self-remedy immediately
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur	Probable	The impact has occurred here or elsewhere and could therefore occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Negligible - negative**		**Negligible - negative**	

Ref:	4			
Project phase	**Construction**			
Impact	**Storage of building materials (sand, soil, bricks etc) in sensitive areas**			
Description of impact	**This could damage the soil structure, and would destroy or shade out plants growing in and around these ecosystems. Dump areas frequently lead to the compaction of soils, which can influence re-growth of plants. Invasive alien plants frequently take advantage of disturbed areas such as these.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• All building materials must be stored away (at least 15m) from all aquatic ecosystems and the areas bunded appropriately such that there will be no runoff from these areas towards aquatic systems. All building materials should be removed after construction. • Materials should be stored in piles that do not exceed 1.5m in height and should be protected from the wind, to prevent spread of fine materials across the site. • Sensitive areas that are impacted by the dumping or storage of materials must be ripped and re-planted after construction is complete. • The pipeline contractor should work the relocated Wynland pipeline route in sections, backfilling as they go, which will reduce the width of disturbed area – i.e. it is not as necessary to spread the spoil wide, if it can spread along a greater length.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Brief	Impact will not last longer than 1 year	Brief	Impact will not last longer than 1 year
Extent	Very limited	Limited to specific isolated parts of the site	Very limited	Limited to specific isolated parts of the site

Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Negligible - negative**		**Negligible - negative**	

Ref:	5			
Project phase	**Construction**			
Impact	**Spillage of building materials and oil / fuel, and seepage of pollutants from stockpiles**			
Description of impact	**This may lead to deterioration in wetland and riverine habitat and water quality. Due to the fact that the wetlands and watercourses are all seasonal to ephemeral, with little or no inundation in summer and flushing only in winter, it is likely that pollutants could accumulate and persist for some time.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Washing of vehicles and machinery should take place well away (50m) from aquatic ecosystems.** **• Machinery prone to oil or fuel leakage must be located at least 50m away from any aquatic ecosystem, and the area adequately bunded in order to contain leakages.** **• Water pumps and cement mixers shall have drip trays to contain oil and fuel leaks – these must be cleaned regularly.** **• Concrete batching must be done well away from (50m minimum) from all sensitive environments.** **• All machinery should be regularly checked for leaks.** **• Suitable toilet and wash facilities must be provided to avoid the use of sensitive areas for these activities. These service areas must be maintained, and toilets emptied on at least a weekly basis.** **• If construction areas are to be pumped of water (e.g. after rains), this water must first be pumped into a settlement area, and not directly into a natural ecosystem.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge

Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	

Ref:	6			
Project phase	**Construction**			
Impact	**Foot and vehicular traffic across and onto construction sites.**			
Description of impact	**This can lead to the destruction or deterioration of freshwater habitat as a result of damage to soils and vegetation. Regular use of a particular area will lead to the compaction of soils.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Pathways and temporary access roads must be routed around the wetlands and should cross drainage channels as seldom as possible.** **• Sensitive areas must clearly be demarcated and fenced off (using temporary fencing and danger tape) before any construction work or site preparation begins. These are no-go areas during the construction process.** **• Affected areas must be ripped and re-planted after construction, according to the specifications set out in the CEMPr, and to the satisfaction of the ECO.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Brief	Impact will not last longer than 1 year	Immediate	Impact will self-remedy immediately
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
Probability	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Negligible - negative**		**Negligible - negative**	

Ref:	7
Project phase	**Construction**
Impact	**Presence of construction teams and their machinery close to wetlands and watercourses.**
Description of impact	**The noise and light pollution associated with construction activities may disturb freshwater fauna and flora.**

Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• The construction sites and pathways must avoid sensitive areas. If lights are used, these must be directed away from all sensitive areas. • The sensitive areas (i.e. the edges of the buffers around the wetlands, watercourses) not affected by construction must clearly be demarcated and fenced off (using temporary fencing and danger tape) before any construction work or site preparation begins. These are no-go areas during the construction process, except where work is occurring.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	impact will last between 1 and 5 years	Short term	impact will last between 1 and 5 years
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Negligible - negative**	

Ref:	8			
Project phase	**Construction**			
Impact	**Soils brought onto the sites for filling and landscaping**			
Description of impact	**Where in situ top soils (i.e. top 20 cm of soil) are insufficient, soils brought onto the sites for filling and landscaping can contain alien or invasive seedbanks.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• In situ soils must preferably be used for rehabilitation of construction sites. • Where in situ soils are insufficient, top soils used after construction must be bought from reliable sources, and must be free of alien seeds or grass runners. • Constant monitoring of the construction sites by the Site Engineer and ECO must occur, and all alien plant species removed from or destroyed on the site.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Medium term	Impact will last between 5 and 10 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings

Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Likely	The impact may occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	High	Substantive supportive data exists to verify the assessment	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	

Ref:	9			
Project phase	**Operation**			
Impact	**Crossings of road and pipeline over wetlands and watercourses**			
Description of impact	**Crossings can lead to the loss of surface flow connectivity at pipeline and road crossings or erosion within impacted ecosystems.**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• The potential interception and transfer of subsurface water by the drainage- and bedding material under and around inclined pipes should be inhibited with cut-off barriers perpendicular to the longitudinal profile of the trench (for example, 0.3m thick bentonite). The barriers should be spaced at 24m intervals and extend a minimum of 0.5m past the sides of the trench profile, and up to rock level or a minimum of 0.5m deeper than the trench bottom (whichever comes first).** **• At all road crossings over aquatic ecosystem 3, the natural surface flow of water should be accommodated in several pipes or wide culverts, in order ensure that flow is not concentrated downstream of the crossings.** **• The impacted footprint of the pipeline and road should be kept to a minimum in close (< 30m) proximity to all wetlands and watercourses, e.g. by reducing the depth to which the pipes are laid, where possible.** **• Mowing or clearing of the pipeline or road servitudes of vegetation must be kept to a minimum.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge

Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	

Ref:	10			
Project phase	**Operation**			
Impact	**Increased discharge of stormwater off the access road**			
Description of impact	**This may lead to the loss or deterioration of aquatic habitat through ongoing erosion and sedimentation.**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• The geomorphological characteristics (shape, gradient, slopes) of the impacted ecosystems must be re-instated after construction – this will reduce the likelihood of increased erosion or sedimentation.** **• If it is necessary to stabilise the watercourse or wetland bed or banks with gabions or rip rap, these should be kept to a minimum, and should be done in an ecologically sensitive manner. For example, gabions could be top-soiled to allow for the establishment of vegetation, which would also serve the purpose of reducing erosion.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Low	Judgement is based on intuition
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Low	The affected environment will not be able to recover from the impact - permanently modified
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Moderate - negative**		**Negligible - negative**	

Ref:	11	
Project phase	**Operation**	
Impact	**Regular removal or mowing of indigenous vegetation along pipeline and road servitudes**	
Description of impact	**This may lead to deterioration in wetland and riverine habitat through loss of indigenous vegetation.**	
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts

Potential mitigation	**• Mowing should not be more frequently than annually. • Vegetation within the pipeline servitudes should be allowed to recover (in some cases, re-planted), within the constraints of ongoing maintenance of the pipeline. • Ongoing monitoring of the pipeline and WTP site and associated infrastructure should be implemented (part of the ongoing EMP) in order to ensure that exotic plant species are not introduced or become established due to the disturbance.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Likely	The impact may occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	

8.8.4 Results of cumulative impact assessment

Cumulative impacts were considered, and took into account the Phase 1 and Phase 2 development of the Muldersvlei Reservoir and WTP.

Ref:	12	
Project phase	**Construction**	
Impact	**Road and pipeline crossings over wetlands and watercourses**	
Description of impact	**Crossings may lead to loss of wetland, riverine and / or riparian habitat.**	
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts

Potential mitigation	**• Where the pipe comes close to (< 30m) a wetland or watercourse, the specifications for the pipe trenches should aim to minimise the footprint of construction (e.g. the shallower the pipe, the narrower the disturbed area). • Sensitive ecosystems must be demarcated prior to any construction activities, so that these can be avoided, unless construction is taking place within the boundaries of a wetland or watercourse. • Removal of indigenous vegetation should be kept to a minimum, and, where possible, impacted areas rehabilitated after construction.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Permanent	Impact may be permanent, or in excess of 20 years	Permanent	Impact may be permanent, or in excess of 20 years
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Low	The affected environment will not be able to recover from the impact - permanently modified
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Moderate - negative**		**Negligible - negative**	

Ref:	13	
Project phase	**Construction**	
Impact	**Construction work close to wetlands or watercourses**	
Description of impact	**This may lead to erosion and sedimentation, pollution of wetlands and watercourses, disturbance of aquatic and semi-aquatic fauna and flora.**	
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts

Potential mitigation	**• Sensitive ecosystems should be demarcated prior to any construction activities, so that these can be avoided, wherever possible. • Special care should be taken around storm and heavy rain events. Cconstruction sites should be inspected for erosion damage at these times. • All building materials must be stored away (at least 15m) from all aquatic ecosystems and the areas bunded appropriately such that there will be no runoff from these areas towards aquatic systems. All building materials should be removed after construction. • Consideration should be given at the design phase to remedial shaping of banks and slopes to their near-natural slope, geomorphological and bed characteristics and re-vegetated after clean-up. • Banks and slopes should be re-vegetated after construction is completed. • If construction areas are to be pumped of water (e.g. after rains), this water must first be pumped into a settlement area, and not directly into a natural aquatic ecosystems.• Care should be taken to not disturb flora and fauna, and construction lights (if needed) must be directed away from sensitive areas. • Fencing must allow free movement of fauna. • Disruption of flow should be kept to a minimum, but where necessary, temporary diversion measures should allow flushing of the system to prevent build-up of material. • Diversion techniques should take measures to limit erosion from temporary channels into watercourses or wetlands. • No obstructions to flow shall remain in the watercourses or wetlands after construction is completed. • Temporary diversion channels must be rehabilitated. Washing of vehicles and machinery should take place well away (50m) from aquatic ecosystems. • Machinery prone to oil or fuel leakage must be located at least 50m away from any aquatic ecosystem, and the area adequately bunded in order to contain leakages. • Water pumps and cement mixers shall have drip trays to contain oil and fuel leaks – these must be cleaned regularly. • Concrete batching must be done well away from (50m minimum) from all sensitive environments. • All machinery should be regularly checked for leaks. • Suitable toilet and wash facilities must be provided to avoid the use of sensitive areas for these activities. These service areas must be maintained, and toilets emptied on at least a weekly basis.**

Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Short term	impact will last between 1 and 5 years	Brief	Impact will not last longer than 1 year
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	High	The affected environmental will be able to recover from the impact	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Minor - negative**	

Ref:	14
Project phase	**Construction**

Impact	Soils brought onto the sites for filling and landscaping			
Description of impact	**Where in situ top soils (i.e. top 20 cm of soil) are insufficient, soils brought onto the sites for filling and landscaping can contain alien or invasive seedbanks.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• In situ soils must preferably be used for rehabilitation of construction sites. • Where in situ soils are insufficient, top soils used after construction must be bought from reliable sources, and must be free of alien seeds or grass runners. • Constant monitoring of the construction sites by the Site Engineer and ECO must occur, and all alien plant species removed from or destroyed on the site.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Medium term	Impact will last between 5 and 10 years	Brief	Impact will not last longer than 1 year
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Likely	The impact may occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
Confidence	High	Substantive supportive data exists to verify the assessment	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	

Ref:	15	
Project phase	**Operation**	
Impact	**Crossings of road and pipeline over wetlands and watercourses**	
Description of impact	**Crossings can lead to the loss of surface flow connectivity at pipeline and road crossings or erosion within impacted ecosystems.**	
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts
Potential mitigation	**• The potential interception and transfer of subsurface water by the drainage- and bedding material under and around inclined pipes should be inhibited with cut-off barriers perpendicular to the longitudinal profile of the trench (for example, 0.3m thick bentonite). The barriers should be spaced at 24m intervals and extend a minimum of 0.5m past the sides of the trench profile, and up to rock level or a minimum of 0.5m deeper than the trench bottom (whichever comes first). • At all road crossings over aquatic ecosystem 3, the natural surface flow of water should be accommodated in several pipes or wide culverts, in order ensure that flow is not concentrated downstream of the crossings. • The impacted footprint of the pipeline and road should be kept to a minimum in close (< 30m) proximity to all wetlands and watercourses, e.g. by reducing the depth to which the pipes are laid, where possible. • Mowing or clearing of the pipeline or road servitudes of vegetation must be kept to a minimum.**	

Assessment	Without mitigation		With mitigation	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Probable	The impact has occurred here or elsewhere and could therefore occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	

Ref:	16			
Project phase	**Operation**			
Impact	**Increased discharge of stormwater off roads and hardened areas**			
Description of impact	**This may lead to the loss or deterioration of aquatic habitat through ongoing erosion and sedimentation.**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• The geomorphological characteristics (shape, gradient, slopes) of the impacted ecosystems must be re-instated after construction – this will reduce the likelihood of increased erosion or sedimentation.** **• If it is necessary to stabilise the watercourse or wetland bed or banks with gabions or rip rap, these should be kept to a minimum, and should be done in an ecologically sensitive manner. For example, gabions could be top-soiled to allow for the establishment of vegetation, which would also serve the purpose of reducing erosion.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Permanent	Impact may be permanent, or in excess of 20 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Limited	Limited to the site and its immediate surroundings
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Low	Judgement is based on intuition

Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Low	The affected environment will not be able to recover from the impact - permanently modified
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Moderate - negative**		**Negligible - negative**	

Ref:	17			
Project phase	**Operation**			
Impact	**Regular removal or mowing of indigenous vegetation along pipelines and road servitudes**			
Description of impact	**This may lead to deterioration in wetland and riverine habitat through loss of indigenous vegetation.**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Mowing should not be more frequently than annually. • Vegetation within the pipeline servitudes should be allowed to recover (in some cases, re-planted), within the constraints of ongoing maintenance of the pipeline.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Very limited	Limited to specific isolated parts of the site
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Likely	The impact may occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	

8.8.5 Impact summary table

Table A4.8.12 Summary table of impacts and significance assessment, without and with the recommended mitigation measures.

Ref #	Project phase	Impact	Without mitigation						With mitigation					
			Nature	Duration	Extent	Intensity	Probability	Significance	Nature	Duration	Extent	Intensity	Probability	Significance
1	Construction	Road and pipeline crossings over wetlands and watercourses	Negative	Permanent	Limited	Moderate	Certain / definite	Moderate - negative	Negative	Permanent	Limited	Very low	Rare / improbable	Negligible - negative
2	Construction	Bulldozing and blasting of watercourses and wetlands	Negative	Short term	Limited	Moderate	Almost certain / Highly probable	Minor - negative	Negative	Brief	Limited	Low	Almost certain / Highly probable	Minor - negative
3	Construction	Construction activities within the watercourse and wetlands	Negative	Brief	Limited	Moderate	Probable	Negligible - negative	Negative	Immediate	Very limited	Low	Probable	Negligible - negative
4	Construction	Storage of building materials (sand, soil, bricks etc) in sensitive areas	Negative	Brief	Very limited	Moderate	Unlikely	Negligible - negative	Negative	Brief	Very limited	Very low	Rare / improbable	Negligible - negative
5	Construction	Spillage of building materials and oil / fuel, and seepage of pollutants from stockpiles	Negative	Short term	Local	High	Probable	Minor - negative	Negative	Brief	Limited	Very low	Rare / improbable	Negligible - negative
6	Construction	Foot and vehicular traffic across and onto construction sites.	Negative	Brief	Limited	Low	Unlikely	Negligible - negative	Negative	Immediate	Very limited	Negligible	Rare / improbable	Negligible - negative
7	Construction	Presence of construction teams and their machinery close to wetlands and watercourses.	Negative	Short term	Local	Low	Probable	Minor - negative	Negative	Short term	Limited	Very low	Unlikely	Negligible - negative
8	Construction	Soils brought onto the sites for filling and landscaping	Negative	Medium term	Local	High	Likely	Minor - negative	Negative	Brief	Limited	Low	Rare / improbable	Negligible - negative
9	Operation	Crossings of road and pipeline over wetlands and watercourses	Negative	On-going	Local	High	Probable	Minor - negative	Negative	On-going	Limited	Low	Unlikely	Negligible - negative

Ref #	Project phase	Impact	Without mitigation						With mitigation					
			Nature	Duration	Extent	Intensity	Probability	Significance	Nature	Duration	Extent	Intensity	Probability	Significance
10	Operation	Increased discharge of stormwater off the access road	Negative	On-going	Local	Moderate	Almost certain / Highly probable	Moderate - negative	Negative	On-going	Limited	Low	Unlikely	Negligible - negative
11	Operation	Regular removal or mowing of indigenous vegetation along pipeline and road servitudes	Negative	On-going	Limited	Low	Likely	Minor - negative	Negative	On-going	Very limited	Very low	Unlikely	Negligible - negative
Cumulative Impacts														
12	Construction	Road and pipeline crossings over wetlands and watercourses	Negative	Permanent	Local	Moderate	Certain / definite	Moderate - negative	Negative	Permanent	Limited	Very low	Rare / improbable	Negligible - negative
13	Construction	Construction work close to wetlands or watercourses	Negative	Short term	Limited	Moderate	Almost certain / Highly probable	Minor - negative	Negative	Brief	Limited	Low	Almost certain / Highly probable	Minor - negative
14	Construction	Soils brought onto the sites for filling and landscaping	Negative	Medium term	Local	High	Likely	Minor - negative	Negative	Brief	Limited	Low	Rare / improbable	Negligible - negative
15	Operation	Crossings of road and pipeline over wetlands and watercourses	Negative	On-going	Local	High	Probable	Minor - negative	Negative	On-going	Limited	Low	Unlikely	Negligible - negative
16	Operation	Increased discharge of stormwater off roads and	Negative	Permanent	Local	Moderate	Almost certain / Highly	Moderate - negative	Negative	On-going	Limited	Low	Unlikely	Negligible - negative

Ref #	Project phase	Impact	Without mitigation						With mitigation					
			Nature	Duration	Extent	Intensity	Probability	Significance	Nature	Duration	Extent	Intensity	Probability	Significance
		hardened areas					probable							
17	Operation	Regular removal or mowing of indigenous vegetation along pipelines and road servitudes	Negative	On-going	Local	Low	Likely	Minor - negative	Negative	On-going	Very limited	Very low	Unlikely	Negligible - negative

8.9 Rehabilitation and Monitoring

8.9.1 Rehabilitation

It is recommended that rehabilitation of affected aquatic ecosystems be implemented, as mitigation of the negative impacts associated with the design, construction and operation of the proposed reservoir and associated infrastructure. The sites for rehabilitation should include:

- Pipeline crossings over aquatic ecosystems 1, 3 and 4;
- Road crossings over aquatic ecosystem 3;
- The area where farm dams will be removed from the seep at the upper end of aquatic ecosystem 3;
- The section of road accessing the chicken farm through the valley-bottom wetland at the lower end of aquatic ecosystem 3, which will be removed and re-aligned.

The areas delineated as wetland or riparian area, and their recommended buffers (see Section **Error! Reference source not found.**) should be included.

The objectives of rehabilitation would be as follows:

- Improved biodiversity value: This will be achieved through planting of the affected areas with appropriate wetland plants. These plants will attract a wider range of faunal groups (e.g. invertebrates such as dragonflies and damselflies, or vertebrates such as frogs and birds), than has previously inhabited or passed through the sites. All invasive alien plants must be cleared from the sites. These species tend to grow in disturbed soils, especially where there is available water, spreading further into previously undisturbed areas.
- Improved water quality: Planting of the affected areas will ensure that any stormwater entering the systems will flow slowly through beds of plants and sediments, which play an important role in taking up excess nutrients and in capturing sediments, toxins and hydrocarbons. In this way, runoff exiting the sites is likely to be purer than that entering the watercourse / wetland.
- Improved infiltration: Water attenuated by the rehabilitated areas will filter slowly into the ground, thereby improving the subsurface flow of water in the area.
- Maintenance of natural slope and geomorphology**:** The natural gradients of wetland and watercourse beds and banks, and the natural geomorphology of these systems, must be reinstated, as far as possible. This is in order to ensure that the flow of water into through and out of these ecosystems is undisturbed, reduce the likelihood of erosion and downstream sedimentation, and the development of head-cut gullies. The slope of the site is generally steep, although varied across the site, and a change in the shape and slope of the freshwater ecosystems is likely to lead to the development of head-cuts, rill erosion, and erosion gullies. Sandy slopes are particularly vulnerable to rill erosion.

It is envisaged that the rehabilitation of the affected ecosystems will ensure that the PES will not decrease, and, in the case of aquatic ecosystem 4, may lead to an improvement in current condition, especially in terms of riparian habitat.

Some more detailed recommendations are made in the sub-sections that follow.

8.9.1.1 Removal of dumped soil or sand in aquatic ecosystems

- Wetlands and watercourses and their buffers that have been impacted by dumped soil, or where soil and sand have been transported into undisturbed areas, or into wetlands and watercourses, must be cleared by hand.

8.9.1.2 Stabilisation of banks

- It is important to consider using various stabilisation measures after banks or slopes have been shaped, in order to prevent erosion. Stabilisation materials may include:
    - Ecologs (dry woody material or sand contained in a hessian and chicken wire roll – see Figure A4.8.13) – these are particularly effective in areas of low gradient;
    - Biodegradable netting/matting (e.g. hessian);
    - Geotextile matting of thick filaments designed to be secured over a vulnerable slope to prevent surface erosion, see Figure A4.8.14), and
    - Mulch stabilisation.

Figure A4.8.13 Ecologs installed for stabilisation.

Figure A4.8.14 Banks stabilised by geofabric, showing natural re-growth of indigenous species through the mat.

8.9.1.3 Re-shaping of slopes, beds and banks

- The natural longitudinal gradient of slopes must be reinstated.
- The ideal longitudinal slope to prevent erosion in a watercourse channel is 1:7, while re-shaped bank slopes should, in general, not be steeper than 1:3 (Russell, 2009). In some instances, where a less erosive longitudinal gradient cannot be achieved, a re-shaped bed may be stepped. This should be done with input from a freshwater ecologist.
- It is recommended that the shape of the rehabilitated river or wetland bank be fairly heterogeneous – with steeper sections and gentler sections, in order to mimic the natural shape of a river bank.
- Work in watercourses and wetlands shall be undertaken in such a manner so as to minimise the extent of impacts caused by such activities. Surface flow should be diverted while work is underway, in such a way that does not cause erosion of the surrounding landscape, and in order to avoid mobilisation of sediments downstream.
- All river diversion materials must be completely removed from the river after completion of the rehabilitation works.

8.9.1.4 Removal of exotics and re-vegetation of cleared areas

- All kikuyu must be removed from the construction sites through spraying and removal by hand. Kikuyu grass shall be sprayed, using Focus Ultra (preferable to Roundup near surface or groundwater resources), prior to planting. Spraying should preferably occur during the autumn, but if this is not possible, a follow-up spray should be done in the autumn following the original spraying. Dead grass can then be removed by hand.
- Cleared areas should be re-vegetated with seedlings rather than seeds.
- *In situ* topsoil must preferably be used, but if insufficient, then topsoil must be sourced from a reliable source, and must be free of weeds and invasive alien plants and their seeds. Topsoil may be required in areas that have been scraped down to the subsoils.
- Mulch can be used in areas where planting is to take place. All mulch shall be free of alien species. Vegetative material that is to be chipped on site for mulch shall be reduced by either mechanical means (chipper) or by hand-axing to sticks no longer than 100 mm.
- Compost from a local source can also be utilised as mulch during planting and rehabilitation, but such compost must be well decayed, crumbly (friable) and free from weed seeds.
- Wood chips (including bark), which are half composted and have not been treated with preservatives can also be utilised as mulch during replanting and rehabilitation of the site. These shall only be obtained from indigenous species removed from the area through unavoidable clearing of areas of the site.
- Sods of wetland plants (such as sedges, grasses) are generally the best means of planting, rather than seeds. Plants should preferably be sourced from a local nursery, in order to maximise the genetic integrity of the plants.
- The following species are appropriate around the wetlands and watercourses (a more detailed list must be developed with input from a botanist/landscape architect, so that the species are relevant to each site):
    - *Bolboschoenus maritimus* – sedge that grows in wetter areas (good filterer of water), good combination with *Ficinia nodosus, Elegia nudum* and *Juncus kraussii*
    - *Carpobrotum edulis* (good stabiliser of soils)
    - Chondropetalum nudum – restio
    - Cyperus textilis – sedge

- Elegia capensis - restio
- *Elegia tectorum* (margins of wetter areas)
- *Eleocharis* spp. – sedge (wetter areas)
- *Ficinia nodosus* (margins of wetter areas)
- *Juncus kraussii* (margins of wetter areas, or dry banks)

- Unless proper nursery conditions are created on site, plants should not be stored for longer than 10 days on site prior to planting.
- The planted areas shall be monitored for erosion, and areas that are subject to erosion should be stabilised. See above point for recommendations regarding stabilisation.
- No fertiliser shall be used in the wetlands or watercourses. Fertilisers could have a negative impact on the relatively nutrient-poor soils and sands of the site and surrounds, and thus on the associated vegetation, and also on the water quality within the wetland and in subsurface waters.
- No construction equipment, vehicles or unauthorised personnel should be allowed onto areas that have been planted. Only persons or equipment required for the preparation of areas and spreading of topsoil shall be allowed to work in these areas.
- All planted areas must be regularly **monitored** for weeds and invasive plants and all problem plants removed.
- Where there is significant die-back, areas must be re-planted.
- Where necessary, compost or mulch must be applied, and plants pruned and / or staked to prevent deterioration of the health of the plants.
- Any cut, dead or pruned plant material shall be removed to an appropriate waste management site.

8.9.2 Monitoring

The rehabilitation of construction sites in the wetlands and watercourses must be monitored seasonally for at least **one year** after construction is completed. The rehabilitated sites must be monitored for invasive alien plant encroachment, and for the establishment of indigenous plants in revegetated areas.

8.10 Conclusions

- The amendments to the Muldersvlei Reservoir access road and relocation of the Wynland pipeline at the Reservoir site will affect Aquatic Ecosystem 3 as identified and described in the Water Use Licence Application Report for the Reservoir and infrastructure, and identified as “Stream k” in Appendix 1 of this report. The ecosystem comprises a seep wetland at its source, a watercourse, and a valley-bottom wetland at its lower end.
- Ecological buffers of 15m for both construction and operational phases are recommended for the protection of these ecosystems.
- The amendments will result in construction and operational phase impacts that range from negligible to medium negative significance without mitigation. With effective mitigation, as recommended in this Appendix, these impacts can be reduced to negligible to minor negative significance. The amendments do not raise any issues that are in addition to those already identified in the original EIA and the WULA report, and the amendments do not raise the significance level of the overall project.
- The amendments will lead to additional pipeline trenches being excavated through the seep wetland, and additional road footprint within the valley-bottom wetland. However, the mitigation

measures recommended here, in particular the rehabilitation of impacted wetland areas, will ensure that the impacts remain of minor negative significance.

- The no-go option was taken to be the status quo scenario – i.e. no development, and the site continues to be used for agricultural purposes. As such, the no-go option is still considered to carry the least negative impact, and so is the preferred option.