6 IMPACT ASSESSMENT

In the sections that follow (Sections 7 to 10), the significance of potential impacts on the wetland and riparian integrity of the proposed development are presented, along with essential and recommended mitigation measures to minimise the perceived impacts on the wetland and riparian resources within the study area.

Three main aspects of wetland and riparian ecology were considered in the impact assessments of each phase of the project: loss of wetland / riparian habitat and ecological structure, loss of wetland / riparian ecoservices, and impacts on wetland / riparian hydrology and sediment balance.

Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, reducing biodiversity. Globally modification of habitats for agriculture is the chief cause of such habitat loss. Other causes of habitat destruction include surface mining, deforestation, slash and burn practices and urban development. Habitat destruction is presently ranked as the most significant cause of species extinction worldwide. Additional causes of habitat destruction include water pollution, introduction of alien species, overgrazing and overfishing.

Riverine systems and particularly ephemeral riverine systems (such as some of the drainage lines present within the study area) or river systems that have very low flows as part of their annual hydrological cycles are particularly susceptible to changes in habitat condition. The construction of the proposed Ntabelanga and Lalini Dams will lead to the loss of wetland / riparian habitat and/or alteration of the aquatic, wetland and riparian resources within the study area, particularly of breeding and foraging habitat utilised by threatened avifaunal species such as *Balearica regulorum (*Grey Crowned Crane) as well as a variety of amphibian species. In addition, impacts on the larger systems such as the Tsitsa River and its tributaries could lead to impacts on aquatic macro-invertebrates and riparian vegetation. Due to the nature of the development, it is deemed definite that it would not be possible to rehabilitate the drainage line and channelled valley bottom wetland features which will be flooded when the dams are commissioned. Thus, it is critical to ensure that mitigation takes place in order to preserve as much of these habitats as possible.

The Tsitsa River and its tributaries, along with the drainage lines and channelled valley bottom wetland features were considered to be of a marginally higher importance than the seep and depression wetlands, in terms of function and ecological service provision. Important eco-services provided by these features include erosion control, sediment trapping, and nutrient and toxicant assimilation capabilities; capabilities which will be reduced by the loss of the wetlands in the region of the dams. In addition, the rivers are considered to have moderate levels of socio-cultural value, specifically provision of water for domestic use and tourism and recreational value. The Tsitsa River, its tributaries and

the channelled valley bottom wetlands are deemed to have intermediate levels of biodiversity maintenance provision, primarily due to the presence of threatened avifaunal and floral species as observed during the site assessment.

The hydrological function and sediment balance of the Tsitsa River, the drainage lines and channelled valley bottom wetland features in particular will be impacted by the construction activities associated with the dams. As noted during the site assessment, the study area is prone to extensive and severe erosion. In the present state of the project site, natural vegetation cover reduces flow velocities by causing friction to rainfall runoff, consequently reducing forces between the water and ground surface, resulting in the ground surface remaining intact and therefore reducing the incidence of erosion. Increased flow velocities for any reason increase the potential for further erosion to occur. Increased erosion of disturbed surfaces means that the runoff contains a higher silt or sediment load, which is discharged to the surrounding river systems. A component of this sediment load is particles fine enough to remain in suspension, 'clouding' or 'muddying' the water, which can negatively affect biological life, for example by smothering.

Additionally, changed sediment loads can change channel character or dimensions, or have an effect on bed roughness; this was observed in several localities during the site assessments. Increased sediment in the drainage line and channelled valley bottom wetland features could result in altered streamflow patterns or altered vegetation communities as the boundaries shift or soil profile is changed as a result, particularly in those features which will be partially inundated by the dams.

The following activities are likely to cause an increase in flow velocities, or directly increase erosion:

- Stripping (vegetation clearance) of constructor laydown areas;
- Construction of hard standing areas that increase runoff volumes, including roads, buildings and paved areas;
- Construction activities that loosen the ground surface.

6.1 GENERAL MANAGEMENT AND GOOD HOUSEKEEPING PRACTICES

The following essential mitigation measures are considered to be standard best practice measures applicable to a development of this nature, and must be implemented during all phases of the proposed development activities, in conjunction with those stipulated in the following sections which define the mitigatory measures specific to the minimisation of impacts on wetland / riparian resources.

Essential mitigation:

- Minimise construction footprints prior to commencement of construction and control all edge effects of construction activities (proliferation of alien vegetation, disturbances of soils, dumping of construction waste);

- Ensure that contractor laydown areas are included in the initial areas demarcated for clearing in order to minimise vegetation loss, and ensure that as much as possible, they do not encroach into wetland / riparian zones or their respective buffer zones;
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration. If possible, such roads should be constructed a distance from the more sensitive wetland area and not directly adjacent thereto;
- Contractor laydown areas should be outside of wetland areas as far as possible;
- Construction vehicles must remain on demarcated roads and should not encroach into the wetland areas or their respective buffer zones;
- Clearly demarcate sensitive wetland areas into which no construction activities should encroach;
- Measures to minimise impacts on water quality on the tributaries of the Tsitsa River must be ensured;
- Install erosion berms during construction to prevent gully formation. Berms every 50m should be installed where the track has a slope of less than 2%, every 25m where the track slopes between 2% and 10%, every 20m where the track slope between 10% and 15% and every 10m where the track slope is greater than 15%;
- Any areas where bank failure is observed, due to the effects of bridge crossings, should be immediately repaired by reducing the gradient of the banks to a 1:3 slope;
- Access roads to the construction sites should be planned as close as possible to existing roads in order to minimise loss of wetland habitat;
- No fires whatsoever should be allowed within the study area during the construction phase;
- Appropriate sanitary facilities must be provided and all waste removed to an appropriate waste facility;
- Implement alien vegetation control program within wetland areas associated with the proposed development;
- No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species;
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil;
- It must be ensured that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss in the vicinity of the subject property;
- Ensure that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. Regularly inspect all vehicles for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;

- Storage of construction material used during the road upgrade should be localised within designated or selected areas, if possible, to ensure the minimisation of the ecological footprint area and prevent loss of natural habitat along the road;
- All soils compacted as a result of construction activities at the dam walls should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control within and around wetland / riparian areas should take place to prevent further loss of wetland / riparian habitat;
- No dumping of waste should take place. If any spills occur, they should be immediately cleaned up;

Recommended mitigation:

- As far as possible, restrict construction activities to the drier months wherever feasible, in order to avoid sedimentation and erosion of wetland / riparian features associated with the activities due to the soils of the area being highly susceptible to erosion.

7 IMPACT ASSESSMENT FOR DAMS AND ASSOCIATED WATER INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the dams and associated activities (DEA Ref no. 14/12/16/3/3/2/677).

The activities assessed under this chapter are listed below:

- The Ntabelanga and Lalini Dams;
- Five flow gauging weirs;
- Primary and secondary bulk potable water infrastructure:
  - Primary infrastructure: main water treatment works, including four major treated water pumping stations and three minor treated water pumping stations, main bulk treated water rising mains, and eight Command Reservoirs that will supply the whole region;
  - Secondary distribution lines: conveying bulk treated water from Command Reservoirs to existing and new District Reservoirs;
- Bulk raw water conveyance infrastructure (abstraction, pipelines, one raw water pumping station, one reservoir and two booster pumps) for irrigated agriculture (raw water supply up to field edge);
- Impact of commercial agriculture in earmarked irrigation areas;
- WWTWs at the Ntabelanga and Lalini Dam sites;
- Accommodation for operational staff at the Ntabelanga and Lalini Dam sites;
- Ten construction materials quarries and borrow pits;
- River intake structures and associated works;
- Information centres at the two dam sites; and
- Miscellaneous construction camps, lay down areas, and storage sites.

7.1 CONSTRUCTION AND FIRST FILLING PHASES

7.1.1 Ntabelanga Dam

Construction of the Ntabelanga Dam entails the construction of the dam wall and river intake structures, as well as associated infrastructure such as the gauging weirs, camp sites, quarries and borrow pits, accommodation for operational staff, waste water treatment works (WWTWs), information centre, and the first filling of the dam.

Construction of the dam wall not only necessitates the removal of riparian vegetation, but also requires the movement of construction vehicles in the vicinity of or through wetland features (existing roads, earmarked for upgrades, currently traverse several wetland features). The first filling of the dam will result in the permanent loss of wetland habitat; due to the nature of the development, this cannot be avoided. It is therefore imperative that measures are taken in order to minimise the impact on those portions of the affected wetland features which will not be inundated. Construction of associated infrastructure such as accommodation, WWTW and the information centre has the potential to result in

the loss of wetland habitat, although these impacts may be reduced with careful planning of the placement of these to minimise the footprint of these structures.

7.1.2 Lalini Dam

It is anticipated that the impacts on wetland and riparian habitat as a result of the construction and first filling of the Lalini Dam will be similar in nature to the impacts of the construction of the Ntabelanga Dam, i.e. loss of vegetation, sedimentation of features and permanent loss of habitat due to inundation.

7.1.3 Primary and secondary pipelines, and irrigation pipelines

During the site assessment, it was apparent that there are existing pipelines in certain areas of the study area, for example in the vicinity of Tsolo, within the existing pine plantation south of Tsolo, and where the proposed irrigation pipelines are to be located. It is therefore highly recommended that in order to minimise the impacts of the installation of these pipelines on wetland / riparian habitat, the routes of existing corridors of disturbance be followed. It is further recommended that pipeline routing be planned very carefully in order to avoid wetland / riparian habitat and should preferably not traverse drainage lines, channelled valley bottom wetlands or riparian zones. However, it is acknowledged that it may be unavoidable in some areas to prevent pipelines to crossing wetland / riparian habitat due to the nature of the terrain. Therefore, where it is essential that pipelines cross wetland / riparian habitat, with specific mention of drainage lines and channelled valley bottom wetlands, wherever feasible support structures should not be constructed within the active channels and must be placed outside of wetland / riparian habitat. In order to achieve this wetland crossings should take place at 90 degree angles wherever possible.

The construction of the infrastructure associated with the pipelines, including but not limited to main water treatment works, pumping stations, command reservoirs, rising mains and booster pumps must not take place within the wetland resources or their respective buffer zones in order to prevent further losses of wetland resources within the study area.

The following tables present the impact ratings of the various activities to take place during the construction, operational, commissioning and decommissioning phases on the wetland / riparian habitats and ecological structure, ecological service provision, and wetland hydrology and sediment budget.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- Areas of increased sensitivity as shown in the sensitivity and buffer zone maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation

measures to limit the impacts (such as ensuring the design of crossings allows for the retention of wetland soil conditions as discussed in Section 9 of this report) must be implemented;

- Quarries and borrow pits should ideally be placed within the dam footprints in order to preserve wetland and riparian habitat outside of the dam footprints, and to reduce sedimentation of the riparian resources. According to the EAP, this has been achieved;
- Minimise the construction footprints and implement strict controls of edge effects;
- It is critical that an alien vegetation control programme is implemented, as encroachment of alien vegetation is apparent and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of disturbed areas, utilising indigenous wetland vegetation species, will assist in reducing the impact of construction.

Recommended mitigation:

- Restrict preparation (e.g. vegetation clearance) of the construction sites to the drier months to decrease the potential for erosion caused by rainfall;

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	2 (local)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	3 (Medium)	3 (medium)	3 (medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low

Residual Impact:

- Permanent loss, or transformation of wetland / riparian habitat leading to a reduced ability to support wetland / riparian vegetation and faunal species naturally occurring within the system;
- Proliferation of alien vegetation as a result of disturbances to the soil profile during construction, leading to transformed wetland / riparian habitat.
- Erosion and sedimentation of wetland resources downstream of pipelines and dams.

Loss of wetland / riparian ecoservices

Essential mitigation:

- Erosion management and sediment controls such as the use of gabions or reno mattresses, revegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps must be strictly implemented from the outset of construction activities;
- It is critical that an alien vegetation control programme is implemented, as encroachment of alien vegetation is already apparent in the study area, and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of disturbed areas during and post-construction, utilising indigenous wetland vegetation species, will assist in retaining essential wetland ecological services, particularly flood attenuation, sediment trapping and erosion control, and assimilation of nutrients and toxicants.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							

Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low
Residual Impact: • Permanent loss of wetland / riparian habitat leading to a reduction in the capability of wetland resources to provide ecological services and functions such as flood attenuation, sediment trapping, nutrient and toxicant assimilation etc.							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation:

- Erosion management and sediment controls such as the use of gabions or reno mattresses, revegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps must be strictly implemented from the outset of construction activities;
- Implement measures such as sediment control, and prevention of pollution (solid wastes, oil spills, discharge of sewage) to minimise impacts on the water quality of nearby adjacent rivers;
- Support structures for pipelines must be placed outside of riparian features, channelled valley bottom wetlands and drainage lines. Should it be essential to place such support structures within these features, the designs of such structures must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels and infrastructure should cross wetlands at right angles.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
With Mitigation	1 (site)	2 (medium)	5 (Very high)	5 (High)	(5) Definite	High	High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (medium)	High	Low

With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (low)	High	Very Low

Residual Impact:

- Increased sedimentation of rivers and wetland features as a result of increased erosion due to vegetation loss and due to increased runoff arising from increase impermeable surfaces;
- Altered flow patterns within wetland / riparian features, particularly within drainage lines, channelled valley bottom wetlands and rivers due to support structures placed within active channels;
- Earthworks within wetland / riparian habitats and in the vicinity of highly sensitive wetland / riparian areas leading to increased runoff and erosion and altered runoff patterns;
- Reduced ability to provide ecological services such as streamflow regulation, flood attenuation and sediment trapping as a result of altered habitat.

7.2 OPERATIONAL PHASE

7.2.1 Ntabelanga and Lalini Dams

Perceived impacts on wetland / riparian habitat will be of a considerably lower intensity during the operational phase of the project in comparison to the construction phase. This is attributed to the anticipated loss of habitat which will occur during the first filling of the dams. Thus, although the duration of the impact is considered to be permanent without the possibility of rehabilitation of those features which will be inundated, the intensity of the impact is considered low.

Fluctuations in the levels of water downstream of the dams as a result of incorrect environmental flow releases of water from the dams may have an impact on riparian vegetation. Prolonged exposure to dry conditions may result in the long-term loss of riparian vegetation, and subsequent increased incision and erosion of river banks leading to increased sedimentation of the river system. In addition rapid releases of large water volumes may lead to scouring of the riparian zone and a loss of some riparian zone cover and species.

7.2.2 Primary, secondary and irrigation pipelines

Major impacts on wetland / riparian features during the operational phases of the pipelines are not anticipated, provided that the impacts on these features are minimised during the construction phase, and that any wetland / riparian areas which were impacted during construction are monitored regularly for proliferation of alien vegetation and sedimentation in the areas of disturbance. During maintenance of pipelines, it is essential that maintenance vehicles remain on designated roads in order to limit the ecological footprint of maintenance activities and reduce further degradation of the wetland / riparian habitat.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operational use and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian

habitat, particularly on the edges of the dams where loss of wetland habitat is already severe due to the dam footprints;

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low

Residual Impact:

- Fluctuating water levels downstream of the dams as a result of periodic release of water from the dams, leading to altered wetland / riparian species composition and community structure, in turn resulting in altered habitats and decreased ability to support biodiversity;
- Increased water inputs to wetland features as a result of runoff arising from increased impermeable surfaces (paving, roofs, dam walls, etc);
- Increased sediment inputs to wetland / riparian habitat due to increased traffic volumes in the vicinity;

Loss of wetland / riparian ecoservices

Essential mitigation measures:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operation and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian habitat, particularly on the edges of the dams where loss of wetland habitat and therefore ability of the wetlands to provide ecological services, is already compromised.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low
Residual Impact: • Wetland / riparian functionality and capacity to provide ecological services, already compromised as a result of the construction of the dams, may be further reduced as a result of continued disturbances during operations;							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation measures:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Ntabelanga Dam and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 1 (preferred alternative) and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 2 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Lalini Dam size 3 and associated infrastructure							
Without Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	3 (medium)	5 (Definite)	High	Medium High
With Mitigation	2 (local)	4 (Permanent – mitigation)	2 (Low)	1 (Low)	5 (Definite)	High	Medium High
Primary, Secondary Pipelines and Irrigation Pipelines and associated infrastructure							
Without Mitigation	2 (local)	1 (short)	2 (Low)	3 (medium)	3 (Medium)	High	Low
With Mitigation	2 (local)	1 (short)	1 (Negligible)	1 (Low)	2 (Low)	High	Very Low

Residual Impact:

- Increased sediment inputs arising from increased run-off into wetland / riparian features;
- Sedimentation of the wetland / riparian habitat may lead to altered habitat, resulting in decreased ability to support biodiversity;
- Loss of riparian zone cover and species due to desiccation or flooding as a result of fluctuations in downstream water volumes.

8 IMPACT ASSESSMENT FOR ELECTRICITY GENERATION AND DISTRIBUTION INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the electricity generation and distribution related activities (DEA Ref no. 14/12/16/3/3/2/678).

The activities assessed under this chapter are listed below:

- Pipeline and tunnel (including tunnel alternatives) at the proposed Lalini Dam;
- Generation of hydro power and feeding of this power into the existing grid; and
- 18.5km power line from the Lalini Dam tunnel.

8.1 CONSTRUCTION PHASE

Power lines will be constructed to supply power for construction at the two dam sites and for operating five pumping and booster stations along the bulk distribution infrastructure. The construction of power lines is considered to be a moderately low risk activity in terms of wetland and riparian habitat conservation. The primary concern associated with this activity is the placement of support towers. Care should be taken to ensure that these structures are not placed within wetland or riparian habitat, or within their respective buffer zones. As with the construction of the pipelines, should it be necessary to place pylons within wetland habitat, it is highly recommended that these structures be placed outside of the active channels (in the case of the drainage lines or channelled valley bottom wetland features), in order to minimise the impacts on the hydrology of these systems.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- Areas of increased sensitivity as shown in the sensitivity maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation measures to limit the impacts (such as ensuring that support towers for power lines are not placed within wetland / riparian habitat) must be implemented;
- Construction vehicles must not be permitted to drive through wetland / riparian habitat, and must remain on designated roads; and
- Edge effects of construction, such as proliferation of alien vegetation and increased sedimentation due to soil disturbances must be strictly controlled, particularly in the vicinity of wetland resources, in order to minimise the loss of wetland habitat.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Loss of wetland / riparian habitat will lead to an overall reduction in biodiversity and functionality of the wetlands / riparian areas.							

Loss of wetland / riparian ecoservices

Essential mitigation measures:

- Construction vehicles must not be permitted to drive through wetland / riparian habitat, and must remain on designated roads; and
- Edge effects of construction, such as proliferation of alien vegetation and increased sedimentation due to soil disturbances must be strictly controlled, particularly in the vicinity of wetland resources, in order to minimise the loss of wetland habitat.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Loss of ecological service provision arising from alteration or loss of habitat leading to increased erosion and sedimentation of the wetland / riparian features; • Habitat alteration or loss arising during construction activities leading to a decreased capacity to support a variety of wetland faunal and floral species; • Proliferation of alien vegetation due to soil disturbances during construction leading to altered habitat, thus a reduction in the ability of the wetland / riparian features to provide essential ecological services.							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation measures:

- Areas of increased sensitivity as shown in the sensitivity maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation measures to limit the impacts (such as ensuring that support towers for power lines are not placed within wetland / riparian habitat, particularly within active channels of drainage lines, channelled valley bottom wetlands and active river channels) must be implemented; and

- Strict control of edge effects of the construction of the power line infrastructure must be implemented in order to minimise sedimentation and erosion as a result of vegetation clearing and disturbances to the soil profile.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low

Residual Impact:

- Poor planning, leading to placement of pylons within wetland / riparian areas, leading to altered flow patterns within active channels;
- Altered hydrology as a result of the above, leading to increased incision of channels, and increased sedimentation of the system as a result.

8.2 OPERATION PHASE

Loss of wetland / riparian habitat and ecological structure

Release of water in the generation tunnels, and maintenance of the power line infrastructure will be the primary impacting factors on wetland / riparian habitat during the operational phase. Species composition and community structure of riparian vegetation may be influenced by the release of water in the generation tunnels if the EWR is not managed properly.

Essential mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- Maintenance vehicles must remain on designated roads, and must not be permitted to traverse wetland / riparian habitat; and
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Periodic disturbances to vegetation and soil profile in the immediate vicinity of each pylon during maintenance activities leading to altered wetland vegetation community structure and species composition, and increased sedimentation;							

Loss of wetland / riparian habitat ecoservices

Essential mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- Maintenance vehicles must remain on designated roads, and must not be permitted to traverse wetland / riparian habitat; and
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Periodic disturbances to the soil profile and natural wetland / riparian vegetation as a result of routine maintenance activities leading to reduced ability to provide essential wetland ecological services such as flood attenuation, sediment trapping and erosion control, etc.							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation:

- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;

- Maintenance vehicles must remain on designated roads, and must not be permitted to traverse wetland / riparian habitat; and
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Peak power generation with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Peak power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation and with hydropower tunnel and power line alternative 1							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 2							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Base-load power generation with hydropower tunnel and power line alternative 3							
Without Mitigation	1 (site)	1 (Short)	3 (Medium)	3 (Medium)	4 (High)	High	Medium-Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact:							

9 IMPACT ASSESSMENT FOR ROADS INFRASTRUCTURE

This Chapter presents the findings of the environmental impact assessment for the road infrastructure (DEA Ref no. 14/12/16/3/3/1/1169).

The activities included under this chapter are listed below:

- Upgrading and relocation of roads and bridges;
- Construction of new access roads around the Lalini Dam site.

9.1 CONSTRUCTION PHASES

The construction of the dams will require the upgrade of existing roads, and in some areas around the Lalini Dam, construction of new roads. Existing roads currently traverse some wetland or riparian habitat, and thus these habitats have already undergone some transformation as a result. The construction of new roads therefore poses a greater threat to the integrity of wetland or riparian habitats, particularly in the vicinity of the Lalini Dam where few roads presently exist. It is highly recommended that access roads to both construction sites be planned along existing roads wherever possible in order to minimise further impacts on wetland or riparian habitat. Should it not be feasible to do this, new roads should be planned in areas of lowered sensitivity and should preferably not traverse drainage lines, channelled valley bottom wetlands or riparian habitat. It is however acknowledged that in some instances, it will be necessary for roads to cross wetland / riparian habitat. Where this is necessary, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;
- Where it is necessary to traverse features such as drainage lines, channelled valley bottom wetlands and riparian habitat, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated. The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:

  - The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;
  - The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 300mm of the soil surface during the summer rainfall period;
  - Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer rainfall period;
- Stabilisation of river banks in the vicinity of any bridge crossings over the Tsitsa River or any of its tributaries by either employing one of the individual techniques below or a combination thereof, including:
  - Re-sloping of banks to a maximum of a 1:3 slope;
  - Revegetation of re-profiled slopes;
  - Temporary stabilisation of slopes using geotextiles; and
  - Installation of gabions and reno mattresses.
- Construction vehicles must be restricted to designated access roads and should not be permitted to drive through sensitive wetland / riparian habitat;
- Strict controls of edge effects such as proliferation of alien vegetation and increased sedimentation due to disturbances to the soil profile must be implemented;
- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles; and
- Monitor all systems for incision and sedimentation.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Permanent loss of wetland habitat during construction phases							

Loss of wetland / riparian ecoservices

Essential mitigation:

- Edge effects of activities including erosion and alien / weed control need to be strictly managed in the wetland areas;
- As much vegetation growth as possible should be promoted within the wetland areas in order to protect soils. In this regard, special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Reduction in the ability of wetland / riparian features to provide ecological services due to altered habitat arising from construction-related activities.							

Impacts on wetland / riparian hydrology and sediment balance

Essential mitigation:

- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;
- It is preferable that new road routes are planned in such a way as to avoid traversing wetland / riparian habitats, with special mention of drainage lines, channelled valley bottom wetlands and riparian habitat. Where it is necessary to traverse such features, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated. The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:
  - The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;
  - The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 500mm of the soil surface at all times;
  - Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer season;
- Construction vehicles must be restricted to designated access roads and should not be permitted to drive through sensitive wetland / riparian habitat;
- Strict controls of edge effects such as proliferation of alien vegetation and increased sedimentation due to disturbances to the soil profile must be implemented;
- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;

- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles; and
- Monitor all systems for incision and sedimentation.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Construction of roadways through wetlands, altering stream and baseflow patterns and water velocities; • Increased water and sedimentation inputs to wetlands / riparian habitat due to runoff resulting from increased impermeable surface area.							

9.2 OPERATION PHASE

As with the pipelines and power lines, the primary impact on wetland / riparian habitat during the operational phase of the roads is that of maintenance. Additionally, the anticipated increased volume of traffic on the roads due to the continued operations of the dams escalates the risk of toxicants such as motor vehicle oil reaching the wetlands and river systems in runoff from the roads. In the same manner, the likelihood of increased sediment and water inputs to the wetlands and river systems is increased.

Loss of wetland / riparian habitat and ecological structure

Essential mitigation:

- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat;
- Regularly inspect wetland and riparian crossings for sedimentation and incision;
- Monitor wetland crossings for proliferation of alien vegetation;
- Spills from motor vehicles must be cleaned up and treated immediately; and
- All staff motor vehicles should be regularly inspected for leaks, and re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Runoff from road surfaces contaminating wetland / riparian areas; • Erosion and sedimentation of wetland / riparian habitat due to altered runoff patterns.							

Loss of wetland / riparian ecoservices

Essential mitigation:

- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat;
- Regularly inspect wetland and riparian crossings for sedimentation and incision;
- Monitor wetland crossings for proliferation of alien vegetation;
- Spills from motor vehicles must be cleaned up and treated immediately; and
- All staff motor vehicles should be regularly inspected for leaks, and re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Inability to support biodiversity as a result of changes to water quality, increased sedimentation and alteration of natural hydrological regimes; • Alteration of natural hydrological regime, impacting on flood attenuation and streamflow regulation capabilities							

Impact on wetland / riparian hydrology and sediment budget

Essential mitigation:

- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat;
- Regularly inspect wetland and riparian crossings for sedimentation and incision; and
- Monitor wetland crossings for proliferation of alien vegetation.

	Extent	Duration	Intensity	Potential for irreplaceable loss of resources	Probability	Confidence	Significance
Without Mitigation	1 (site)	1 (short)	3 (Medium)	3 (Medium)	3 (Medium)	High	Low
With Mitigation	1 (site)	1 (Short)	2 (Low)	3 (Medium)	2 (Low)	High	Very Low
Residual Impact: • Erosion and increased sedimentation leading to altered geomorphology and smothering of wetland biota							

9.3 IMPACT STATEMENT FOR IRRIGATION AREAS

The irrigation fields were briefly assessed and selected areas were investigated as examples of the condition of these areas. The proposed agricultural fields are located

within old farming lands, historically used since they have the highest agricultural potential and yield the highest harvests. No wetland features were identified in these areas during the field assessments. Furthermore, the fields have been uniformly heavily disturbed due to prior farming activities, and as such provide very limited habitat to faunal or floral species within the area and region, and the decommissioning of these areas as irrigated croplands is considered an insignificant impact to the regional wetland ecology.

9.4 POST CONSTRUCTION MAINTENANCE

Upon completion of this assessment, the following recommendations have been made:

- Regularly monitor and maintain the state of the gabions in order to ensure the stability of the gabion structures and prevent bank failure.
- Inspections should be repeated at least bi-annually and maintenance work should be completed as soon as damage is observed. The wall should be additionally inspected after severe weather or flood occurrences.
- If there has been a failure of one or more mesh wires, the area must be patched.
- The gabion structures should be inspected for excessive localised bulging and settlement.
- Where settlements have occurred, the cause should be investigated. In severe cases, the affected area should be taken down and reconstructed, reinstating the foundation. Where settlements are minor, these should be monitored on a six monthly basis to determine if it is an initial settlement problem or a long-term problem. Initial settlements generally stabilise and do not cause further problems. Long-term settlements must be investigated as to the cause and remedial action taken.
- Excessive localised bulging of gabions should be repaired by opening, emptying and repacking the affected units.

10 IMPACT ASSESSMENT FOR THE NO PROJECT ALTERNATIVE

This Chapter presents the findings of the environmental impact assessment for the no-project alternative.

From a wetland and riparian ecology perspective, should the project not proceed, no significant impacts on wetland or riparian habitat, ecological functioning, hydrology or sediment balance are anticipated. The construction of the Ntabelanga and Lalini Dams are expected to result in significant permanent losses of wetland and riparian habitat, subsequently resulting in the loss of ecological functioning and alterations to the hydrology and sediment balance of these habitats. Furthermore, altered instream flows due to the periodic release of water from the dams would impact on riparian vegetation and aquatic organisms, although this can be mitigated by adhering to the stipulated EWRs for each dam.

Nevertheless, it is expected that should the status quo remain within the study area, these habitats will still undergo alterations as a result of the continued impacts of anthropogenic activities such as vegetation clearing, sediment winning, crop cultivation within wetland habitats, etc. Additionally, due to the extensive erosion within the study area and the catchment, sediment inputs to wetland and riparian habitats are anticipated, thus potentially altering flow patterns within wetlands and riparian zones, as well as smothering vegetation and aquatic macro-invertebrates.

11 MITIGATION HIERARCHY AND OFFSET DISCUSSION

'Mitigation' is a broad term that covers all components of the 'mitigation hierarchy' defined hereunder. It involves selecting and implementing measures – amongst others – to conserve biodiversity and to protect, the users of biodiversity and other affected stakeholders from potentially adverse impacts as a result of development. The aim is to prevent adverse impacts from occurring or, where this is unavoidable, to limit their significance to an acceptable level. Offsetting of impacts is considered to be the last option in the mitigation hierarchy for any project.

The mitigation hierarchy in general consists of the following in order of which impacts should be mitigated (DEA *at al.* 2013):

1. **Avoid/prevent impact:** can be done through utilising alternative sites, technology and scale of projects to prevent impacts. In some cases if impacts are expected to be too high the "no project" option should also be considered, especially where it is expected that the lower levels of mitigation will not be adequate to limit environmental damage and eco-service provision to suitable levels;
2. **Minimise impact:** can be done through utilisation of alternatives that will ensure that impacts on biodiversity and ecoservices provision are reduced. Impact minimisation is considered an essential part of any development project;
3. **Rehabilitate impact** is applicable to areas where impact avoidance and minimisation are unavoidable where an attempt to re-instate impacted areas and return them to conditions which are ecologically similar to the pre-project condition or an agreed post project land use, for example arable land. Rehabilitation often only restores ecological function to some degree to avoid ongoing negative impacts and to minimise aesthetic damage to the setting of a project.
4. **Offset impact:** refers to compensating for latent or unavoidable negative impacts on biodiversity. Offsetting should take place to address any impacts deemed to be unacceptable which cannot be mitigated through the other mechanisms in the mitigation hierarchy. The objective of biodiversity offsets should be to ensure no net loss of biodiversity. Biodiversity offsets can be considered to be a last resort to compensate for residual negative impacts on biodiversity.

Following the assessment of the resources within the study area, impacts associated with the project, with specific mention of the construction of the Ntabelanga and Lalini Dams and their associated infrastructure, are deemed high largely due to the impact assessment method. Nevertheless, the impacts are considered acceptable when taking into account the socio-economic value of the dams compared to the residual impacts on wetland biodiversity. Whilst the riparian and wetland habitats within the study area are considered to be ecologically important and sensitive on a localised and provincial scale, these habitats have already undergone varying degrees of transformation due to ongoing anthropogenic activities within the area, thus the integrity and overall value of these riparian and wetlands areas has been compromised to some extent. Residual impacts such as crane conservation within wetland habitat are deemed unlikely to be mitigated by

offsetting the riparian and wetland habitats thus limiting the significance of an offset programme. Nevertheless, although it is the opinion of the specialists that a formal offset is not required, conservation initiatives could potentially contribute to the overall success and value of the project. The mitigation hierarchy as defined above should therefore be implemented accordingly in order to minimise the significance of the impact of the proposed development to ensure that regional conservation targets and objectives are met while still ensuring sustainable development.

12 CONSULTATION PROCESS

12.1 CONSULATION PROCESS FOLLOWED

PUBLIC PARTICIPATION

Engagement with Interested and Affected Parties (I&APs) forms an integral component of the EIA process. I&APs have an opportunity at various stages throughout the EIA process to gain more knowledge about the proposed project, to provide input into the process and to verify that their issues and concerns have been addressed.

The proposed project was announced in April 2014 to elicit comment from and register I&APs from as broad a spectrum of public as possible. The announcement was done by the following means:

- The distribution of Background Information Documents (BIDs) in English and IsiXhosa;
- Placement of site notices in the project area and Municipal offices (Tsolo and Qumbu);
- Placement of advertisements in one regional (The Herald) and two local (Daily Dispatch and the Mthatha Fever) newspapers; and
- Publication of all available information on the DWS web site (www.dwa.gov.za/mzimvubu).

The Draft Scoping Report (DSR) was made available for a 30 day public comment period in May 2014. All documents were uploaded to the web, notification letters were sent out, the summary of the DSR was translated into isiXhosa, distributed to all registered stakeholders and hardcopies of the full report and translated summary report were available at public places. Additionally, three public meetings were held in the affected areas, Siqhungqwini, Tsolo and Lalini respectively. An Authorities Forum Meeting with all relevant authorities was held in the Eastern Cape on the 28 May 2014. This was to assist the authorities with commenting on the relevant documentation.

Comments received from stakeholders were captured in the Issues and Response Report (IRR) which formed part of the Final Scoping Report (FSR). The FSR was made available to the public for a 21 day comment period on 13 June 2014 and was submitted to the Department of Environmental Affairs (DEA). Comments received during the Final Scoping public comment period were compiled and an updated IRR was submitted to DEA on 8 July 204 and uploaded to the website. The FSR was accepted by DEA with certain conditions on 15 July 2014. Following this, a newsletter was compiled and translated to isiXhosa, explaining everything that has happened to date as well as what is to come. Both the English and isiXhosa versions were electronically distributed to all registered stakeholders and hardcopies were distributed by the local facilitators in the affected areas.

The Draft Environmental Impact Assessment Report (DEIR), its summary (translated into isiXhosa), the various specialist studies, the Environmental Management Programmes (one for the construction and operation of the project, and one for the borrow areas and

quarries) as well as the Water Use Licence Application will be made available for a period of thirty (30 days) for stakeholders to comment. Hardcopies will be made available at the same venues as the DSR and all documents will be uploaded to the website. The availability of these documents as well as the announcement of the upcoming public meetings in Siqhungqwini, Tsolo and Lalini will be advertised on the Eastern Cape SABC radio station, Umhlobo Wenene FM, which has a listenership of over 4 million people. Another Authorities Forum Meeting is scheduled for October 2014.

Stakeholder comments will be taken into consideration with the preparation of the final documents. The availability of the final documents will be announced prior to submission to the decision-making authority. Once a decision has been made by the DEA, all stakeholders will again be notified.

The Issue and Response Report (Final Version 1) as submitted to the Department of Environmental Affairs with the Final Scoping Report did not contain matters pertaining to wetlands, as no applicable comments were received during the process.

12.2 SUMMARY OF COMMENTS RECEIVED

No comments pertaining to the impact of the proposed development on wetland resources were received.

13 OTHER INFORMATION REQUESTED BY THE AUTHORITY

DEA requested that the impacts of the proposed facility on water courses and water resources in the area be assessed in the EIA phase. The impact on wetlands is assessed in this report.

14 IMPACT STATEMENT

Table 37 summarises the perceived impacts before and after the implementation of mitigation measures. The Ntabelanga and Lalini Dams will have the greatest impact on wetland and riparian habitat, as wetland habitat will be permanently lost during the first filling.

Table 37: Summary of impacts of the construction and operations of the two dams and their associated infrastructure on wetland and riparian ecology.

Impact	Construction and First Filling		Operational Phase	
Mitigation Status	Unmitigated	Mitigated	Unmitigated	Mitigated
Roads and pipelines: impact on habitat	Low	Very Low	Low	Very Low
Roads and pipelines: impact on ecoservices	Low	Very Low	Low	Very Low
Roads and pipelines: impact on hydrology and sediment balance	Low	Very Low	Low	Very Low
Electricity generation and distribution: impact on habitat	Low	Very Low	Medium Low	Very Low
Electricity generation and distribution: impact on ecoservices	Low	Very Low	Medium Low	Very Low
Electricity generation and distribution: impact on hydrology and sediment balance	Low	Very Low	Medium Low	Very Low
Ntabelanga and Lalini Dams: impact on habitat	High	High	Medium High	Medium High
Ntabelanga and Lalini Dams: impact on ecoservices	High	High	Medium High	Medium High
Ntabelanga and Lalini Dams: impact on hydrology and sediment balance	High	High	Medium High	Medium High

14.1 NTABELANGA DAM

Construction of the Ntabelanga Dam entails the construction of the dam wall, associated infrastructure such as the camp sites, quarries and borrow pits, accommodation for operational staff and the first filling of the dam.

Construction of the dam wall not only necessitates the removal of riparian vegetation, but also requires the movement of construction vehicles in the vicinity of or through wetland features (existing roads, earmarked for upgrades, currently traverse several wetland features). The first filling of the dam will result in the permanent loss of wetland habitat; due to the nature of the development, this cannot be avoided. It is therefore imperative that measures are taken in order to minimise the impact on those portions of the affected wetland features which will not be inundated with special mention of areas downstream of the proposed dam. Due to the extensive loss of drainage lines, channelled valley bottom wetland features and riparian habitat during the first filling of the dam, the perceived impacts of the dam during the construction phase are considered to be high. However, taking into account that permanent habitat loss will already have occurred, the perceived impacts of the dam during its operational phase are deemed to be medium high.

14.2 LALINI DAM

It is anticipated that the impacts on wetland and riparian habitat as a result of the construction and first filling of the Lalini Dam will be similar in nature to the impacts of the construction of the Ntabelanga Dam, i.e. loss of vegetation, sedimentation of features and permanent loss of habitat due to inundation. Due to the permanent loss of drainage lines, channelled valley bottom wetlands and riparian habitat, as with the Ntabelanga Dam, the perceived impacts of the Lalini Dam on these features is deemed to be high. Impacts during the operational phase are considered to be medium high, due to the extent and intensity of the impacts during the construction and first filling of the dam.

Three capacities are under consideration for Lalini Dam. The second alternative, i.e. a Full Supply Level of 752.42mamsl, will result in the lowest direct loss of wetland habitat, and is thus considered to be the most viable option in terms of wetland conservation.

14.3 PRIMARY, SECONDARY AND IRRIGATION PIPELINES

It was evident during the site assessment that existing pipelines are laid in close proximity to existing roads, and it is therefore highly recommended that new pipelines are laid along these routes as far as possible. Whilst it is acknowledged that it may not be feasible in all areas to avoid wetland / riparian habitat, careful planning should take place to avoid the laying of pipelines within or traversing wetland / riparian features wherever possible, with specific mention of drainage lines, channelled valley bottom wetlands or riparian zones. Where it is essential that pipelines cross wetland / riparian habitat, no support structures should be constructed within the active channels and must be placed outside of wetland / riparian habitat. In addition wherever possible this infrastructure should cross wetlands at right angles to minimise the footprint in wetland areas. The impacts associated with the installation and operation of the pipelines is nevertheless considered to be very low should suitable mitigation take place.

14.4 ROAD UPGRADES AND CONSTRUCTION OF NEW ROADS

Existing roads are deemed to have already impacted on wetland and riparian habitat to some degree, altering flow patterns, sediment balance, vegetation communities in the vicinity of wetland crossings, and introducing additional water inputs to the wetlands as a result of runoff. Therefore, the proposed upgrades to the existing roads are deemed to have a marginally lower level of impacts than the construction of new roads. It is highly recommended that access roads to both construction sites be planned along existing roads wherever possible in order to minimise further impacts on wetland or riparian habitat. Should it not be feasible to do this, new roads should be planned in areas of lowered sensitivity and should preferably not traverse drainage lines, channelled valley bottom wetlands or riparian habitat. It is however acknowledged that in some instances, it will be necessary for roads to cross wetland / riparian habitat. Where this is necessary, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be

constructed within the active channels. In addition wherever possible this infrastructure should cross wetlands at right angle to minimise the footprint in wetland areas.

14.5 POWER GENERATION WITH HYDROTUNNELS AND POWER LINE ALTERNATIVES

The construction of power lines is considered to be a moderately low risk activity in terms of wetland and riparian habitat conservation. The primary concern associated with this activity is the release of water in the generation tunnels, as the fluctuating water levels in the riparian zone particularly could potentially alter the floral species composition and community structure, thus altering the riparian habitat, influencing the ability of the riparian zone to support biodiversity. All three routing options of the hydrotunnels under consideration have equal potential to impact on the riparian zone in this manner. As the tunnels will be predominantly below ground, it is considered unlikely that wetland habitat will be impacted significantly by these tunnels.

The placement of support towers for the power lines is also of concern. Care should be taken to ensure that these structures are not placed within wetland or riparian habitat, or within their respective buffer zones. As with the construction of the pipelines, should it be necessary to place support towers within wetland habitat, it is highly recommended that these structures be placed outside of the active channels (in the case of the drainage lines or channelled valley bottom wetland features), in order to minimise the impacts on the hydrology of these systems.

14.6 KEY MITIGATION MEASURES

The essential mitigation measures referred to in Section 6: General Management and Good Housekeeping Practices must be adhered to, in addition to the key mitigation measures presented in Sections 7 to 9. These key mitigation measures are:

- Areas of increased sensitivity as shown in the sensitivity and buffer zone maps developed (**Figures 22-23 and 30-31**) should ideally be avoided in terms of the placement of infrastructure in order to minimise the footprints within wetland features. However, it is acknowledged that due to the scale of this project and the mountainous terrain within which much of the infrastructure is planned, it will not always be possible to completely avoid all wetland or riparian habitat. In such instances, mitigation measures to limit the impacts (such as ensuring the design of crossings allows for the retention of wetland soil conditions as discussed in Section 9 of this report) must be implemented;
- Quarries and borrow pits should ideally be placed within the dam footprints in order to preserve wetland and riparian habitat outside of the dam footprints, and to reduce sedimentation of the riparian resources. According to the EAP this has been achieved;
- Minimise the construction footprints and implement strict controls of edge effects;

- Erosion management and sediment controls such as the use of gabions or reno mattresses, revegetation of profiled slopes, erosion berms, drift fences with hessian and silt traps must be strictly implemented from the outset of construction activities;
- It is critical that an alien vegetation control programme is implemented, as encroachment of alien vegetation is already apparent in the study area and is expected to increase as a result of the disturbances resulting during the construction process. Rehabilitation of disturbed areas, utilising indigenous wetland vegetation species, will assist in retaining essential wetland ecological services, particularly flood attenuation, sediment trapping and erosion control, and assimilation of nutrients and toxicants, thus reducing the impacts of construction related activities;
- Implement measures such as sediment control, and prevention of pollution (solid wastes, oil spills, discharge of sewage) to minimise impacts on the water quality of nearby adjacent rivers;
- Support structures for pipelines must be placed outside of riparian features, channelled valley bottom wetlands and drainage lines. Should it be essential to place such support structures within these features, the designs of such structures must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- The Ecological Water Requirements (EWR) as set out in the Reserve Determination Volume 1: River (Report P WMA 12/T30/00/5212/7) for the Ntabelanga Dam, and the EWR determined for the Lalini Dam, must be adhered to;
- During operations and maintenance of infrastructure, vehicles must remain on designated roads and not be permitted to drive through sensitive wetland / riparian habitat, particularly on the edges of the dams where loss of wetland habitat and therefore ability of the wetlands to provide ecological services, is already compromised.
- Maintenance personnel must ensure that any tools and/or waste products resulting from maintenance activities are removed from the site following completion of maintenance.
- Wherever possible, it is preferable that existing roads be upgraded, rather than constructing new roads, in order to minimise the impact of construction on wetland / riparian habitat;
- Where it is necessary to traverse features such as drainage lines, channelled valley bottom wetlands and riparian habitat, the crossing designs of bridges must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channels. In order to achieve this all crossings of wetlands should take place at right angles wherever possible;
- If it is absolutely unavoidable that wetland / riparian habitat is affected during the construction of new roads, especially during bridge or culvert construction, disturbance to any wetland crossings must be minimised and suitably rehabilitated.

The design of such culverts / bridges should allow for wetland soil conditions to be maintained both upstream and downstream of the crossing to such a degree that wetland vegetation community structures upstream and downstream of the crossing are maintained. In this regard, special mention is made of:

- The design of such culverts and/or bridges should ensure that the permanent wetland zone should have inundated soil conditions throughout the year extending to the soil surface;
- The design of such culverts and/or bridges should ensure that the seasonal wetland zone should have water-logged soils within 500mm of the soil surface during the summer rainfall period;
- Temporary wetland zone areas should have waterlogged soil conditions occurring to within 300m of the land surface during the summer rainfall period;

- Ensure that no incision and canalisation of the wetland system takes place as a result of the construction of the culverts;
- It must be ensured that flow connectivity along the wetland features is maintained;
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles;
- Monitor all systems for incision and sedimentation;
- As much vegetation growth as possible should be promoted within the wetland areas in order to protect soils. In this regard, special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented;
- Regular maintenance of all roads, with specific mention of wetland / riparian crossings, must take place in order to minimise the risk of further degradation to wetland / riparian habitat.

15 CONCLUSION AND RECOMMENDATIONS

The riparian habitat of the Tsitsa River and its tributaries, including the Inxu River, have undergone moderate levels of transformation as a result of anthropogenic activities, such as as grazing of cattle, harvesting of thatching grass and firewood, and sand winning. Despite these disturbances however, these systems are deemed to provide moderately high levels of functionality and ecological and socio-cultural services. The assessment of these riparian features indicated that they all fall within a PES Category C (moderately modified; loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged). Due to the presence of suitable breeding and foraging habitat for a number of faunal species of conservation concern, the high level of integrity of the river and levels of ecological service provision, the Tsitsa River and the tributaries assessed are deemed to be in an EIS Category B, indicating that they are considered ecologically important and sensitive on a regional, and potentially provincial scale.

In terms of wetland features, four basic HGM units were identified within the study area, namely channelled valley bottom, hillslope seeps, depressions and drainage lines. Of these, the channelled valley bottom wetland features are considered to hold the greatest value, as they obtained scores indicating moderately high levels of ecological and socio-cultural service provision and functionality, and were found to be in a PES Category C and EIS Category B. Whilst the drainage lines received similar scores to the hillslope seep and depression wetlands and were thus placed in the same PES Category (C) they are deemed to have moderately higher ecological importance and sensitivity than the other two HGM units, and were placed in an EIS Category B.

The construction of the Ntabelanga and Lalini Dams pose a significant threat to the conservation of wetland and riparian resources in the study area. The anticipated cumulative loss of riparian and wetland habitat arising from the construction and first filling of the dams is estimated to be 1034.30 hectares; overall this is deemed to be a relatively insignificant fraction of the wetland resources within the Mzimvubu subWMA. The loss of wetland habitat will result in the loss of the associated ecoservices such as flood attenuation and sediment trapping. Additionally, populations of wetland-dependent faunal and floral species may be lost or reduced as a result of the loss of wetland habitat. Whilst the proposed dams have the potential to provide foraging habitat to certain faunal species, particularly avifauna, and certain obligate and facultative floral species may grow around the edge of the dams, the structure and function of this newly established littoral zone will not significantly compensate for the loss of wetland and riparian resources that will occur as a result of first flooding.

The construction of associated infrastructure, such as pipelines, power lines and roads, is anticipated to have a relatively low impact on the ecology of wetland and riparian habitat, provided the mitigation measures set out in this report are implemented.

Upon completion of this wetland assessment, it is the opinion of the specialist that, from a wetland ecological point of view, the proposed development be considered favourably, provided that the essential impact mitigation measures as set out in Sections 6 to 9 of this report are adhered to and with special mention of the strict adherence to the EWR's to ensure that impacts are limited to the FSL of the dams and that impacts of downstream areas are limited.

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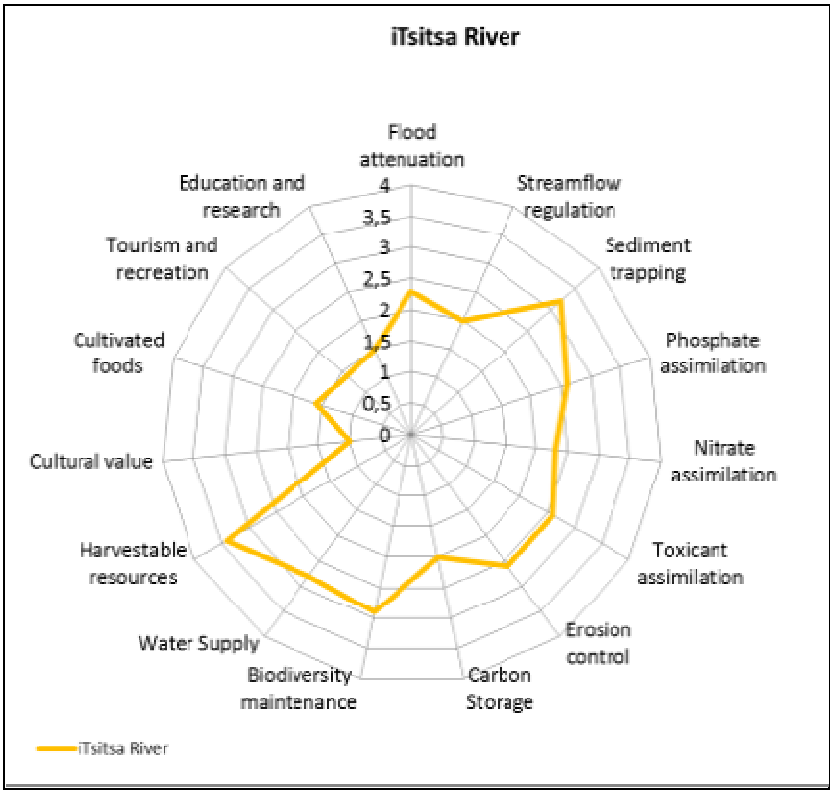
APPENDIX A
PRESENTATION OF WETLAND FUNCTION ASSESSMENT RESULTS

Results of the WET-Ecoservices assessment applied to the Tsitsa River.

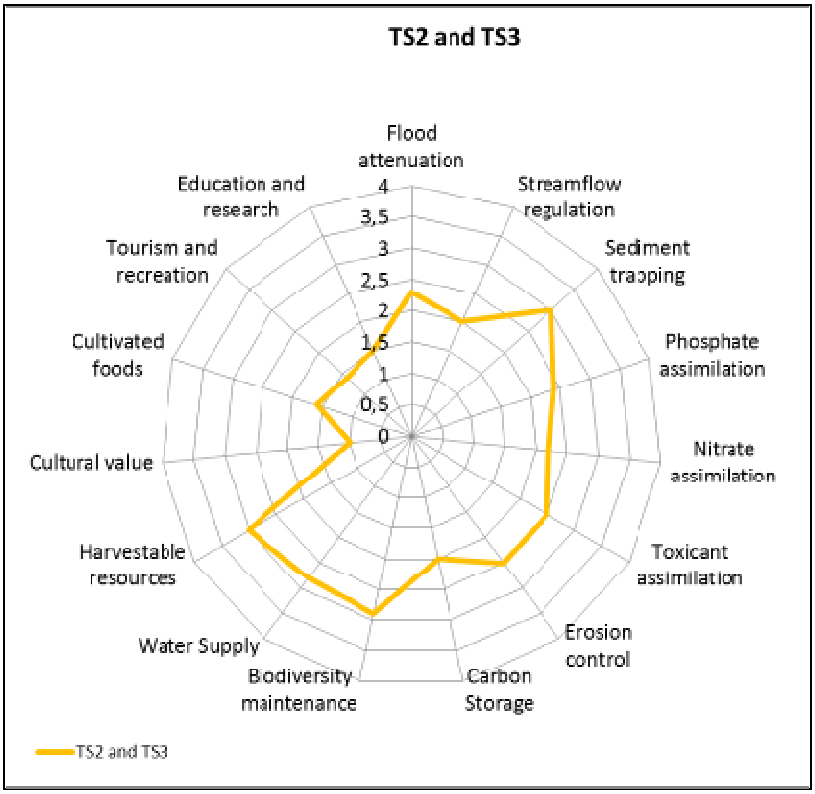
Ecosystem service	Tsitsa River
Flood attenuation	2,3
Streamflow regulation	2
Sediment trapping	3,2
Phosphate assimilation	2,6
Nitrate assimilation	2,3
Toxicant assimilation	2,6
Erosion control	2,6
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,8
Harvestable resources	3,4
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	34,2
Average score	2,3



Radar plot of wetland services provided by the Tsitsa River.

Results of the WET-Ecoservices assessment applied to riparian zones of the unnamed tributaries of the Tsitsa River (TS2 and TS3).

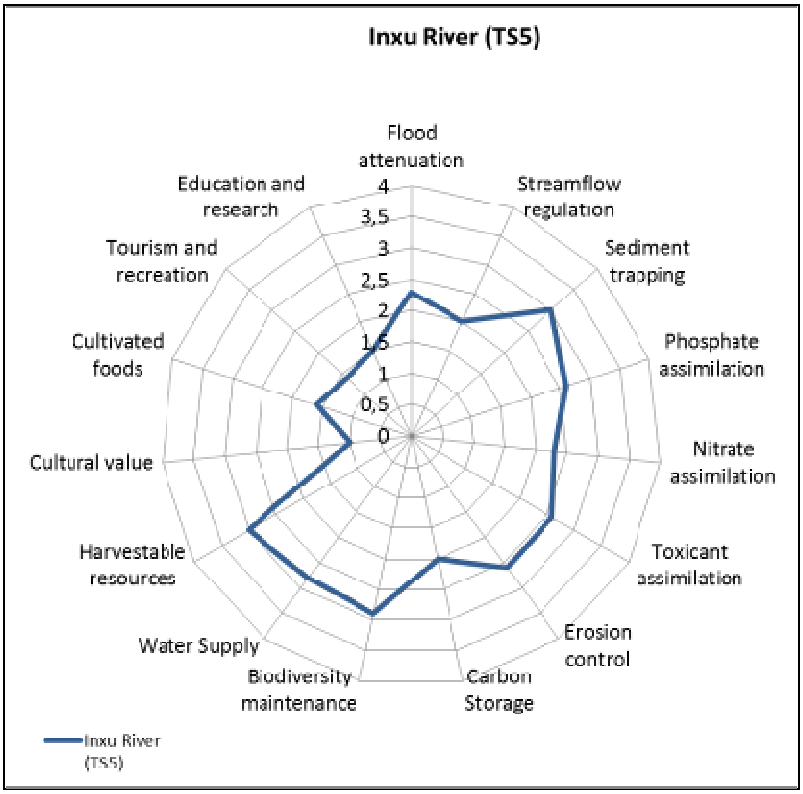
Ecosystem service	TS2 and TS3
Flood attenuation	2,3
Streamflow regulation	2
Sediment trapping	3
Phosphate assimilation	2,4
Nitrate assimilation	2,2
Toxicant assimilation	2,5
Erosion control	2,5
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,8
Harvestable resources	3
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	33,1
Average score	2,2



Radar plot of wetland services provided by the riparian zones of the unnamed tributaries of the Tsitsa River (TS2 and TS3).

Results of the WET-Ecoservices assessment applied to riparian zone of the Inxu River (TS5)

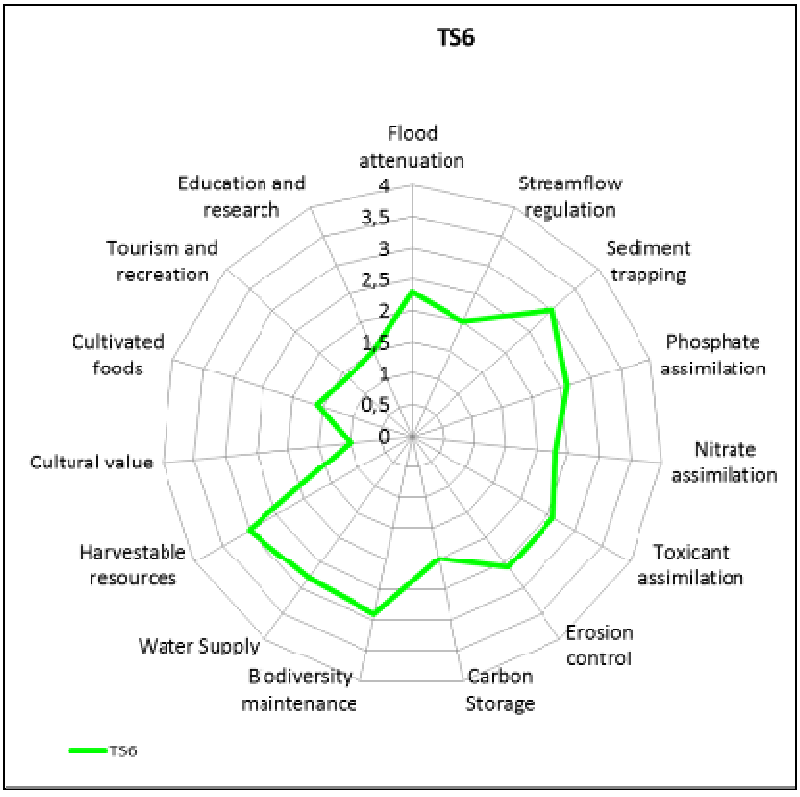
Ecosystem service	Inxu River (TS5)
Flood attenuation	2,3
Streamflow regulation	2
Sediment trapping	3
Phosphate assimilation	2,6
Nitrate assimilation	2,3
Toxicant assimilation	2,6
Erosion control	2,6
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,8
Harvestable resources	3
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	33,6
Average score	2,2



Radar plot of wetland services provided by the Inxu River (TS5)

Results of the WET-Ecoservices assessment applied to riparian zone of the unnamed tributary of the Tsitsa River (TS6)

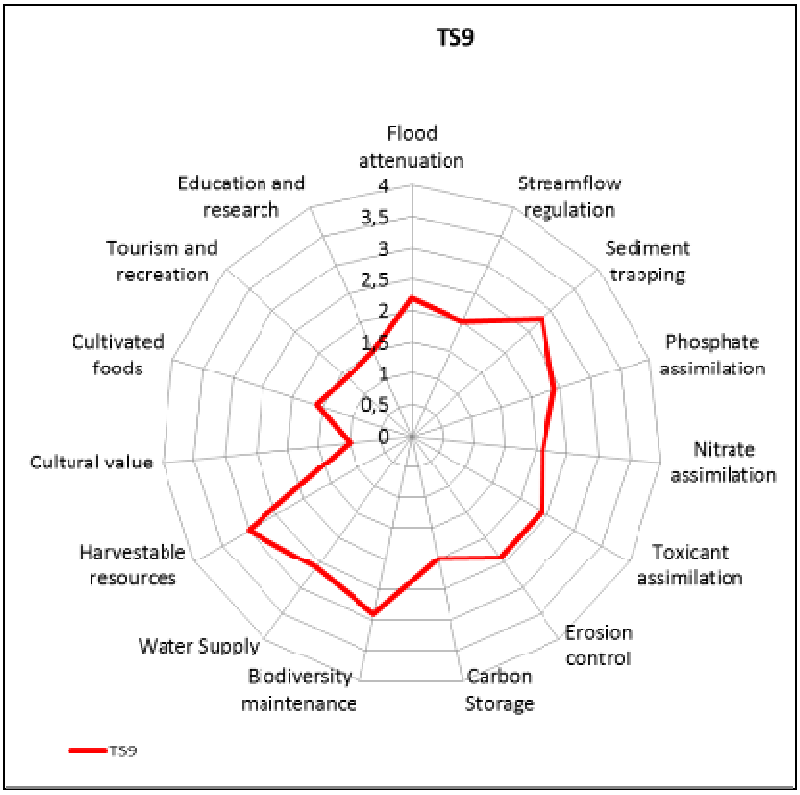
Ecosystem service	TS6
Flood attenuation	2,3
Streamflow regulation	2
Sediment trapping	3
Phosphate assimilation	2,6
Nitrate assimilation	2,3
Toxicant assimilation	2,6
Erosion control	2,6
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,8
Harvestable resources	3
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	33,6
Average score	2,2



Radar plot of wetland services provided by the riparian zones of the unnamed tributaries of the Tsitsa River (TS6).

Results of the WET-Ecoservices assessment applied to riparian zone of the unnamed tributary of the Tsitsa River (TS9)

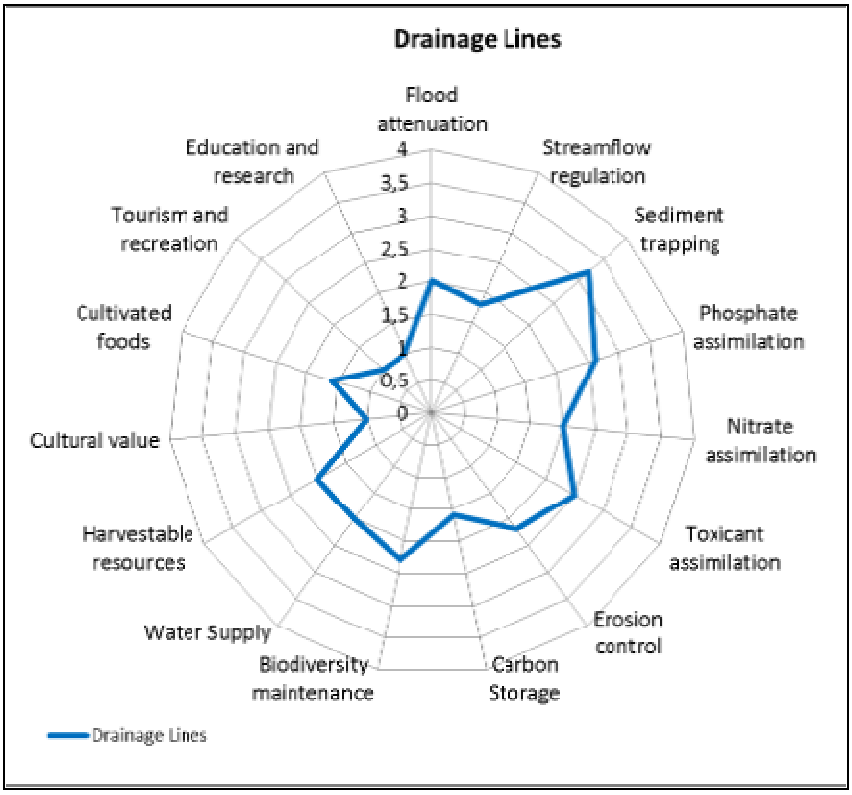
Ecosystem service	TS9
Flood attenuation	2,2
Streamflow regulation	2
Sediment trapping	2,8
Phosphate assimilation	2,4
Nitrate assimilation	2,1
Toxicant assimilation	2,4
Erosion control	2,4
Carbon Storage	2
Biodiversity maintenance	2,9
Water Supply	2,6
Harvestable resources	3
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1,4
Education and research	1,5
SUM	32,3
Average score	2,2



Radar plot of wetland services provided by the riparian zones of the unnamed tributaries of the Tsitsa River (TS9).

Results of the WET-Ecoservices assessment applied to the drainage line features.

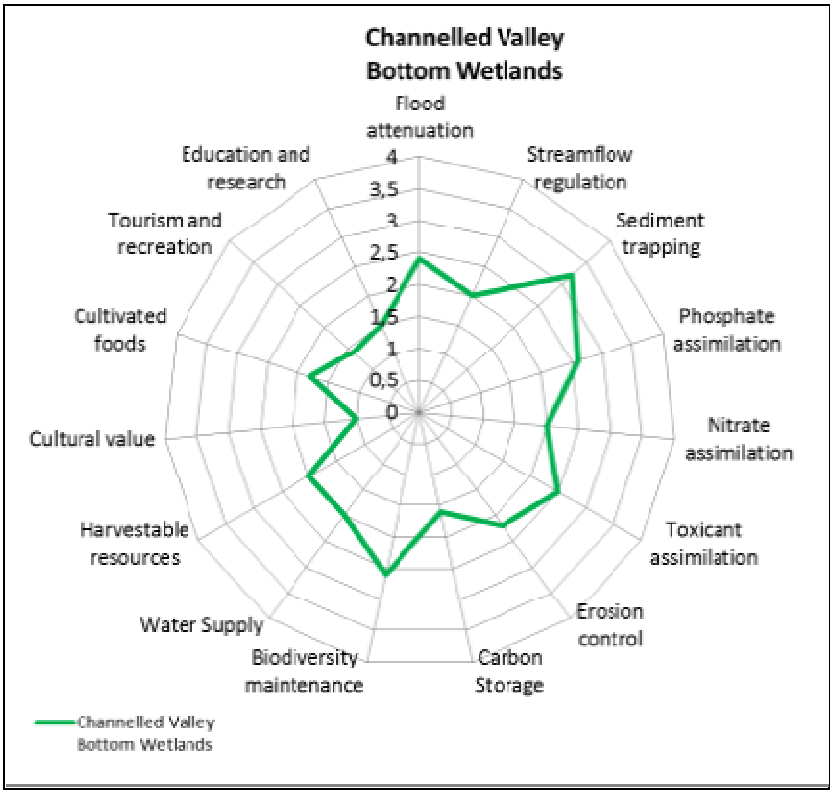
Ecosystem service	Drainage Lines
Flood attenuation	2
Streamflow regulation	1,8
Sediment trapping	3,2
Phosphate assimilation	2,6
Nitrate assimilation	2
Toxicant assimilation	2,5
Erosion control	2,2
Carbon Storage	1,6
Biodiversity maintenance	2,3
Water Supply	2
Harvestable resources	2
Cultural value	1
Cultivated foods	1,6
Tourism and recreation	1
Education and research	1
SUM	28,8
Average score	1,9



Radar plot of wetland services provided by the drainage line features.

Results of the WET-Ecoservices assessment applied to the channelled valley bottom wetland features.

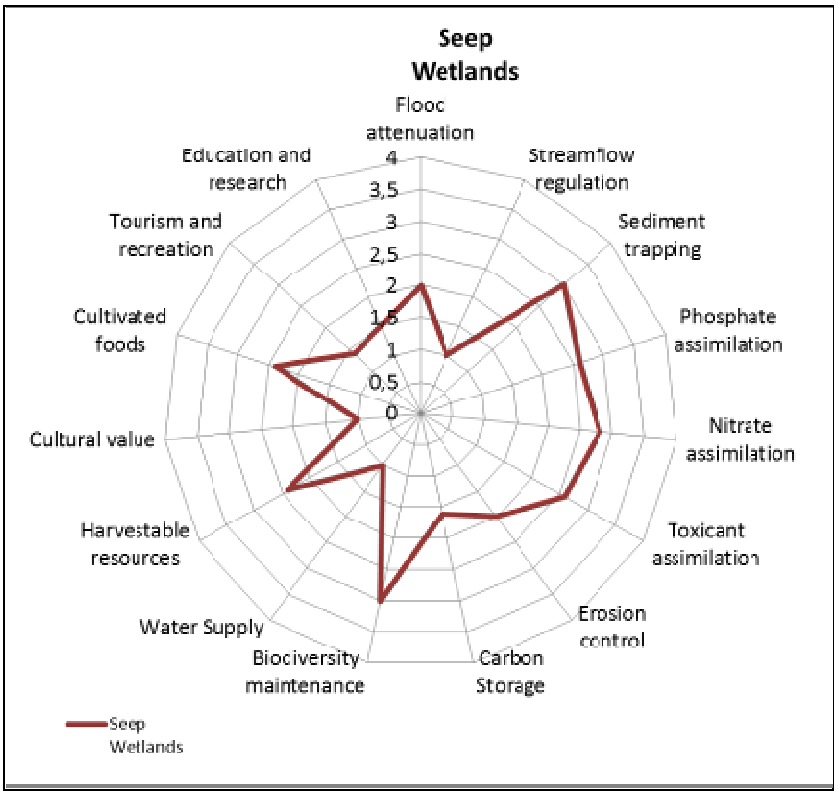
Ecosystem service	Channelled Valley Bottom Wetlands
Flood attenuation	2,4
Streamflow regulation	2
Sediment trapping	3,2
Phosphate assimilation	2,6
Nitrate assimilation	2
Toxicant assimilation	2,5
Erosion control	2,2
Carbon Storage	1,6
Biodiversity maintenance	2,6
Water Supply	2
Harvestable resources	2
Cultural value	1
Cultivated foods	1,8
Tourism and recreation	1,4
Education and research	1,5
SUM	30,8
Average score	2,1



Radar plot of wetland services provided by the channelled valley bottom wetland features.

Results of the WET-Ecoservices assessment applied to the seep wetland features.

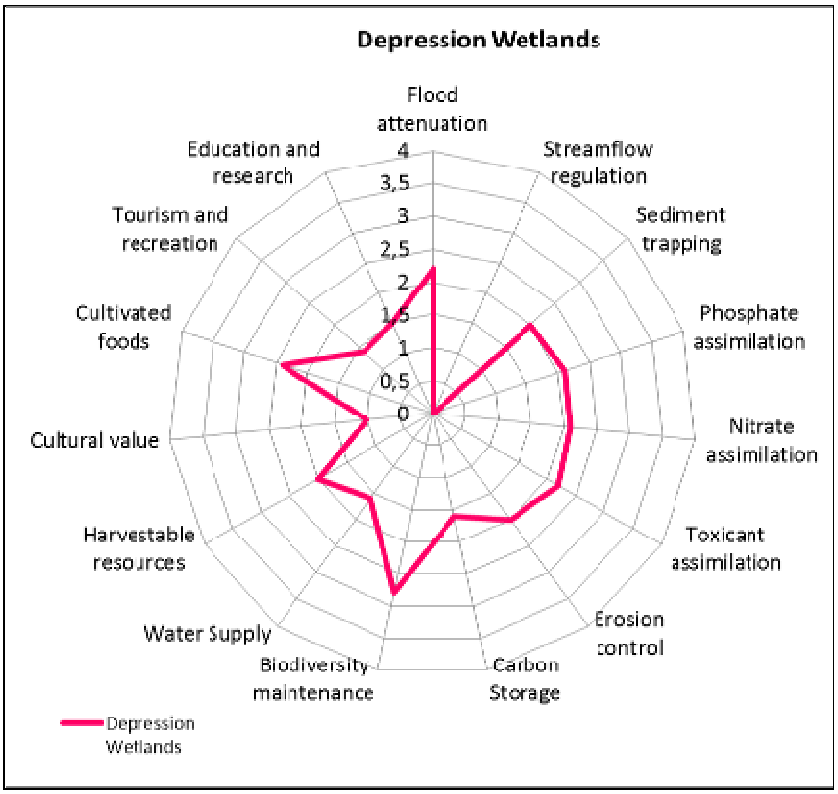
Ecosystem service	Seep Wetlands
Flood attenuation	2
Streamflow regulation	1
Sediment trapping	3
Phosphate assimilation	2,6
Nitrate assimilation	2,8
Toxicant assimilation	2,6
Erosion control	2
Carbon Storage	1,6
Biodiversity maintenance	3
Water Supply	1
Harvestable resources	2,4
Cultural value	1
Cultivated foods	2,4
Tourism and recreation	1,4
Education and research	1,5
SUM	30,3
Average score	2,0



Radar plot of wetland services provided by the seep wetland features.

Results of the WET-Ecoservices assessment applied to the depression wetland features.

Ecosystem service	Depression Wetlands
Flood attenuation	2,2
Streamflow regulation	0
Sediment trapping	2
Phosphate assimilation	2,1
Nitrate assimilation	2,1
Toxicant assimilation	2,2
Erosion control	2
Carbon Storage	1,6
Biodiversity maintenance	2,8
Water Supply	1,6
Harvestable resources	2
Cultural value	1
Cultivated foods	2,4
Tourism and recreation	1,4
Education and research	1,5
SUM	26,9
Average score	1,8



Radar plot of wetland services provided by the depression wetland features.

APPENDIX B
PRESENTATION OF WET-IHI ASSESSMENT RESULTS FOR THE RIPARIAN SYSTEMS

Summary of results of the WET-IHI assessment applied to the Tsitsa River.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		100	1,4		
Hydrology	1	100	1,0	*3,0*	B/C
Geomorphology	2	80	2,1	*3,8*	C/D
Water Quality	3	30	0,8	*2,0*	B
WETLAND LANDUSE ACTIVITIES:		80	0,9	*3,6*	
Vegetation Alteration Score	1	100	0,9	*3,6*	B/C
OVERALL SCORE:			1,2		
PES %			76,7	*Confidence Rating*	
PES Category:			C	*1,6*	

Summary of results of the WET-IHI assessment applied to the unnamed tributaries of the Tsitsa River (TS2 and TS3).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		100	1,7		
Hydrology	1	100	1,1	*3,0*	B/C
Geomorphology	2	80	2,8	*3,8*	D
Water Quality	3	30	1,0	*2,0*	B/C
WETLAND LANDUSE ACTIVITIES:		80	0,9	*3,7*	
Vegetation Alteration Score	1	100	0,9	*3,7*	B
OVERALL SCORE:			1,3		
PES %			73,3	*Confidence Rating*	
PES Category:			C	*1,6*	

Summary of results of the WET-IHI assessment applied to the Inxu River (TS5).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		100	1,4		
Hydrology	1	100	1,1	*3,0*	C
Geomorphology	2	80	2,0	*3,8*	C/D
Water Quality	3	30	1,0	*2,0*	B/C
WETLAND LANDUSE ACTIVITIES:		80	0,9	*3,8*	
Vegetation Alteration Score	1	100	0,9	*3,8*	B/C
OVERALL SCORE:			1,2		
PES %			75,9	*Confidence Rating*	
PES Category:			C	*1,7*	

Summary of results of the WET-IHI assessment applied to the unnamed tributary of the Tsitsa River (TS6).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		100	1,4		
Hydrology	1	100	1,1	*3,0*	B/C
Geomorphology	2	80	2,0	*3,8*	C/D
Water Quality	3	30	1,0	*2,0*	B/C
WETLAND LANDUSE ACTIVITIES:		80	0,9	*3,8*	
Vegetation Alteration Score	1	100	0,9	*3,8*	B/C
OVERALL SCORE:			1,2		
	PES %		76,2	*Confidence Rating*	
	PES Category:		C	*1,7*	

Summary of results of the WET-IHI assessment applied to the unnamed tributary of the Tsitsa River (TS9).

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		100	1,3		
Hydrology	1	100	0,9	*3,1*	B/C
Geomorphology	2	80	2,0	*3,8*	C/D
Water Quality	3	30	0,9	*2,0*	B
WETLAND LANDUSE ACTIVITIES:		80	1,0	*3,9*	
Vegetation Alteration Score	1	100	1,0	*3,9*	B/C
OVERALL SCORE:			1,2		
	PES %		76,7	*Confidence Rating*	
	PES Category:		C	*1,7*	