PROJECT LIMA – PUMPED STORAGE SCHEME

WETLAND ASSESSMENT REPORT – ENVIRONMENTAL IMPACT ASSESSMENT

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1 INTRODUCTION

Eskom plan to develop a hydropower (pumped storage) scheme in the Luipershoek / Sehlakwane area of the Limpopo Province. The proposed scheme would consist of two reservoirs, underground tunnels and associated infrastructure, including construction yards, construction villages and a visitor's centre. One of the two reservoirs would be located at the top of the Thaba ya Sekhukune escarpment near the town of Sehlakwane, and the other reservoir would be located to the east at a lower elevation within the Steelpoort River Valley. Water would be pumped from the lower reservoir (which would be fed by a pipeline from the De Hoop Dam to the north) up to the upper reservoir through a system of underground tunnels. The water would be released from the upper reservoir through the same tunnel system to generate electricity during peaking periods.

Under the National Water Act (no 36 of 1998), wetlands are termed as land that is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, where the land is periodically covered with shallow water, and which land in normal circumstances would support vegetation typically adapted to life in saturated soil. Wetlands are classified as water resources, and as such are protected and should not be subject to any pollution or damage. Thus the proposed development should in no way disturb damage or alter the characteristics of wetlands that may occur on the site (see Background – Acts and Policies section).

As part of the environmental studies for the proposed scheme, a scoping-level wetland assessment report was completed in November 2006 by SiVEST. The report assessed the alternative sites for the scheme as presented by Eskom. The report concluded that there was no preference in terms of wetlands for site selection. However it was noted that the construction of a reservoir at site A (the preferred site) may have implications for wetland functioning.

The focus of the EIA wetland assessment report is to confirm whether any wetlands / hydric soils occur within the footprint of the proposed reservoirs and associated infrastructure, and to undertake an assessment on the potential impact of the lower reservoir on certain aspects of wetland functioning in the catchment of the reservoir. A site visit to gather the necessary data to undertake the assessment was completed in January 2007. The results of the assessment are presented in the report below.

2 AIMS OF THE STUDY

The aims of the EIA-level wetland assessment study are as follows:

- To confirm that no wetland habitat or hydric soils occur within the footprint of the two reservoir sites, and to identify whether any wetland habitat / hydric soils occur within the footprint of associated infrastructure, including the construction villages.
- To undertake an assessment of the impact of the lower reservoir on certain aspects of the functionality of wetlands in the catchment of the reservoir.
- To recommend measures that should be included in the Environmental Management Plan to ensure that existing wetland areas are not affected in any way.

2.1 Assumptions and Limitations

The study has been based largely upon the findings of a site visit undertaken in January 2007. The study has also relied on the survey of soil forms undertaken by the Agricultural Research Council, the vegetation assessment undertaken by Bathusi Environmental Consultants, and the geohydrological and hydrological studies undertaken by GCS.

It is assumed that all technical information provided from the project applicant (Eskom) and the project engineers (BKS) via the lead consultants (Bohlweki Environmental) is accurate.

It is our understanding that the assessment of locations for borrow areas does not form part of the scope of the current application and associated environmental studies. Accordingly the occurrence of possible wetland habitat / hydric soils within the areas earmarked as borrow areas on the general scheme layout was not investigated as part of the scope of works of this study. Should the proposed locations for borrow areas be proposed to be used, the presence of wetlands / hydric soils would need to be investigated in detail as part of a separate study.

3 BACKGROUND – ACTS AND POLICIES / MANAGEMENT GUIDELINES

3.1 National Water Act (Act No 36 of 1998)

The National Water Act 36 of 1998 (NWA) was promulgated on 20 August 1998. This Act is important in that it provides a framework to protect water resources against over exploitation and to ensure that there is water for social and economic development, human needs and to meet the needs of the aquatic environment. The Act also recognises that water belongs to the whole nation for the benefit of all people.

It is important to note that wetlands are protected under the Act, and are defined as water resources. One of the main aims of the Act is the protection of water resources. 'Protection' in relation to a water resource entails:

- Maintenance of the quality of the quality of the water resource to the extent that the water use may be used in a sustainable way;
- Prevention of degradation of the water resource
- The rehabilitation of the water resource

In the context of the development of the proposed hydropower scheme and any potential impact on wetland areas the definition of pollution and pollution prevention contained within the Act is relevant. 'Pollution', as described by the Act is the direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it (inter alia)-

- less fit for any beneficial purpose for which it may reasonably be expected to be used; or
- harmful or potentially harmful to the welfare or human beings, to any aquatic or non-aquatic organisms, or to the resource quality.

This definition of pollution is quite wide ranging, and it applies to all types of water resource, including water bodies such as wetlands. The inclusion of physical properties of a water resource within the definition of pollution entails that any physical alterations to a water body, for example the excavation of a wetland or changes to the morphology of a water body can be considered to be pollution, and are thus not permitted. Activities which cause alteration of the biological properties of a watercourse, i.e. the fauna and flora contained within that watercourse are also considered pollution.

In terms of section 19 of the Act owners / managers / people occupying land on which any activity or process undertaken which causes, or is likely to cause pollution of a water resource must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring. These measures may include (inter alia)

- measures to cease, modify, or control any act or process causing the pollution
- comply with any prescribed waste standard or management practice
- contain or prevent the movement of pollutants
- remedy the effects of the pollution; and
- remedy the effects of any disturbance to the bed and banks of a watercourse

4 SITE DESCRIPTION AND GENERAL SITE CONDITIONS

The site of the proposed development is located to the north of Middelburg in the Sekhukhuneland district of the Limpopo Province. The Steelpoort River which rises near Belfast drains northwards from the Mpumalanga Highveld towards the Mpumalanga Lowveld where it joins the Olifants River. The Steelpoort River valley is bounded by a steep escarpment (the Thaba ya Sekhukune) which forms the eastern boundary of the Nebo Plateau, with the terrain rising dramatically to the west from the Steelpoort river (800m amsl) to an elevation of approximately 2000m amsl.

The terrain within the Steelpoort river valley is relatively flat, rising steeply towards the mountains of the escarpment. On top of the escarpment the terrain is undulating, with shallow valleys draining into steep poorts which dissect the mountains. The escarpment marks a stark divide in vegetation with bushveld vegetation occurring in the Steelpoort valley and grassland vegetation typical of the Mpumalanga Highveld existing to the west of the escarpment. The vegetation within the Steelpoort valley is predominantly natural, except in areas closer to the river where the natural vegetation has been cleared for irrigated cultivation. The main vegetation type in the valley is bushveld, with the Sekhukhune Mountain Bushveld vegetation type dominating. Grassveld (Rand Highveld Grassland) occurs on the top of the escarpment, with trees / shrubs only occurring where rocky outcrops provide protection from fire.

The escarpment also marks a stark socio-economic divide with the Steelpoort River valley being characterised by stock farming and mining and the areas to the west of the escarpment being formal homeland areas characterised by communal tenure, a weak economy and a legacy of underdevelopment.

4.1 Upper Reservoir Site and Surrounds

The proposed upper reservoir is located on the edge of the escarpment on gently sloping terrain. The proposed reservoir would straddle a local high point, with the terrain sloping down on either side to the east and the escarpment edge, as well as to the south and west towards a number of shallow valleys.

The vegetation within the footprint of the reservoir is largely grassland vegetation, with boulders occurring over much of this area. Localised bush clumps are interspersed amongst the grassland. The vegetation appears to be superficially undisturbed, and not subject to the higher grazing pressure experienced by grassland closer to the settled areas of Sehlakwane (approximately 1km to the west). The area appears to be used predominantly for grazing of cattle.

The proposed construction yard is located adjacent to the western end of the reservoir. This area appears to be slightly more disturbed, with ortho photographs indicating that part of the footprint occurs within areas that were previously cultivated. Part of the footprint appears to be fenced off and this area may be currently being used as a cattle camp.

The proposed construction camp is located at the eastern end of part of Sehlakwane. The construction village footprint comprises of an area cleared of vegetation, as well as areas of grassy / scrub vegetation, interspersed with boulders that appear to be subject to heavy grazing pressure.

4.2 Lower Reservoir Site and Surrounds

The lower reservoir is located to the south-east of the upper reservoir and the escarpment. It is located relatively close to the Steelpoort River (approximately 600m to the west of the river) which drains northwards through the bottom of the valley. The reservoir is proposed to impound a tributary of the Steelpoort River which drains a catchment to the west, including areas beyond the escarpment edge. The reservoir would be located on relatively flat terrain which is characterised by natural bushveld vegetation and a riparian zone consisting of large trees along the tributary.

There are two proposed construction yards, one of which is located adjacent to the south-west boundary of the area that would be flooded by the reservoir. This construction yard would be located within an area characterised by natural bushveld.

An alternative construction yard would be located to the east of the reservoir footprint in a currently cultivated field.

The proposed construction village is also located within cultivated fields, parts of which are currently being used for the cultivation of maize using spray (centre pivot) irrigation. The cultivated areas are situated adjacent to the boundary of the riparian zone of the Steelpoort River at their eastern end.

5 ASSESSMENT OF WETLAND OCCURRENCE WITHIN THE FOOTPRINT OF THE PROPOSED SCHEME

The scoping level assessment did not reveal any wetland habitat within the footprint of the upper and lower reservoir. However the scoping-level assessment of wetland occurrence was not conducted in detail and the soils on the site were not examined for the occurrence of hydromorphic signatures. Thus it was necessary to confirm the absence of wetlands within the footprint of the two reservoirs during the EIA-level investigation.

In addition the proposed sites for the additional infrastructure associated with the scheme (including roads, construction villages and construction camps) was not made available to the project team in the scoping phase. The additional infrastructure was included on the general layout for the scheme provided at the commencement of the EIA phase, thus it became necessary to establish whether wetlands / hydric soils existed within the footprint of this proposed additional infrastructure.

5.1.1 Wetland Delineation / Occurrence Assessment Techniques

The potential occurrence / non-occurrence of wetland areas within the footprint of the proposed reservoirs and associated infrastructure has been assessed according to the method contained within the DWAF guideline 'A practical field procedure for the identification and delineation of wetlands and riparian areas' (DWAF, 2005).

The guideline document stipulates that consideration be given to four specific wetland indicators to determine whether an area is a wetland:

These indicators are:

- terrain unit

- soil form
- soil wetness
- vegetation

However, for an area to be considered a wetland, redoximorphic features must be present within the upper 500 mm of the soil profile (Collins, 2005). Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of Fe (iron) and Mn (manganese) oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Only once soils within 50cm of the surface display these redoximorphic features can the soils be considered to be hydric (wetland) soils. Redoximorphic features typically occur in three types (Collins, 2005):

- **A reduced matrix** – i.e. an *in situ* low chroma (soil colour), resulting from the absence of Fe^{3+} ions which are characterised by "grey" colours of the soil matrix.
- **Redox depletions** - the "grey" (low chroma) bodies within the soil where Fe-Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur.
- **Redox concentrations** - Accumulation of iron and manganese oxides (also called mottles). These can occur as:

    - Concretions - harder, regular shaped bodies
    - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours
    - Pore linings - zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognized as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres.

According to the DWAF guidelines for the delineation of wetlands (DWAF, 2005), soil wetness indicators (i.e. identification of redoximorphic features) are the most important indicator of wetland occurrence, due to the fact that soil wetness indicators (redoximorphic features) remain in wetland soils, even if they are degraded or desiccated. It is important to note that the presence or absence of redoximorphic features within the upper 500mm of the soil profile alone is sufficient to identify the soil as being hydric (a wetland soil) or non-hydric (non-wetland soil) (Collins, 2005). This is important to note in the context of the other wetland indicators discussed below.

Vegetation is a useful tool in determining wetland boundaries, although it does require that vegetation be in fairly good condition. A cautionary approach must be taken, however, as vegetation alone cannot be used to delineate a wetland; several species, while common in wetlands, can occur extensively outside of wetlands.

When examining plants within a wetland, a distinction between hydrophilic (vegetation adapted to life in saturated conditions) and upland species must be kept in mind. There is typically a well-defined 'wetness' gradient that occurs from the centre of a wetland to its edge that is characterised by a change in species composition between hydrophilic plants that dominate within the wetland to upland species that dominate on the edges of, and outside of the wetland (DWAF, 2003). It is important to identify the vegetative indicators which determine the three wetness zones (temporary, seasonal and permanent) which characterise wetlands. Each zone is characterised by different plant species which are uniquely suited to the soil wetness within that zone.

The soil form indicator examines soil forms, as defined by the Soil Classification Working Group. Typically soil forms associated with prolonged and frequent saturation by water, where present, are an indicator of wetland occurrence (DWAF, 2005). The Soil Classification Working Group has identified the soil types that typically occur within the different zones typically found within a wetland, i.e. permanent, seasonal and temporary.

Terrain unit refers to the terrain unit in which the wetland is found. Wetlands can occur across all terrain units, from the crest to valley bottom. Many wetlands occur within valley bottoms, but wetlands are not exclusively found within depressions. Terrain unit is a useful indicator in assessing the hydro-geomorphic form of the wetland.

In practice all four indicators should be used in any wetland assessment / delineation exercise, but the presence of redoximorphic features being most important, with the other indicators being confirmatory. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland and to delineate the boundary of a wetland. According to the DWAF delineation guidelines, the more wetland indicators that are present, the higher the confidence of the delineation.

In assessing whether an area is a wetland the boundary of a wetland or a non-wetland area should be considered to be the point where indicators are no longer present. Where a boundary needs to be delineated, the boundary should be physically marked on site, and a contour between the various markers should be established, taking into account, however, localised changes to the boundary that are evident. The boundary should then be recorded (preferably digitally).

5.1.2 Desktop and Field Assessment Methodologies Followed

Orthophotos of the areas in which the scheme and associated infrastructure are located were examined for the occurrence of any possible wetland areas. Identified wetland areas were marked digitally using GIS (changes in vegetation composition within wetlands as compared to surrounding non-wetland vegetation show up as a different hue on the orthophotos, thus allowing the identification of wetland areas). During the site visit undertaken in late January 2007 the method contained within the DWAF guidelines for wetland delineation was followed and certain of the wetland indicators, as well as general hydrology of the site were examined. Where required an on-foot survey of the footprint of the proposed reservoirs and associated infrastructure was conducted. A hand-held soil auger was used to take soil samples and examine the soils within the footprint of the development and photographs of the soils were taken. The auger was used to examine soils within 50cm of the surface (50cm is used as the depth in which soils should display signs of wetness as experience internationally has shown that frequent saturation of the soil within 50cm of the surface is necessary to support hydrophytic vegetation). For the indicators not examined in detail in the field (soil form and vegetation), the assessment relied on the agricultural potential studies and flora studies conducted as part of the EIA.

A GPS was used to mark the sampling locations to ensure that the samples collected did indeed occur within the proposed footprint. The soil study undertaken by Agricultural Research Council as part of the scoping study was utilised to provide an indication of the soil forms present on the site. The vegetation assessment was also consulted to provide information on plant species present within the footprint of the scheme.

5.2 Upper Reservoir site

The soils in the footprint of the Upper Reservoir site were examined at four locations across its footprint (please see map in Appendix 2). A soil sample was taken in the northern part of the reservoir footprint, and three samples in the southern half of the reservoir footprint. Table 5.1 below presents the findings of the soil sampling within the reservoir footprint.

Table 5.1 – Analysis of Soil Samples at the Upper Reservoir Site

Point	Terrain and Site Description	Vegetation	Soil Characteristics
UR1	Slightly sloping in a north-south direction towards a valley to the south. The surrounding area did not visibly contain any natural depressions into which surface water flow would drain.	Vegetation at this point was dominated by bracken and forb species.	Very red sandy soils. These sandy soils extended to 50cm below surface level. The soils appeared to be very well-drained and *no redoximorphic features were observed* within the first 50cm of the surface. The predominant soil form is Mispah, which is not classified as a wetland soil. .
UR2	Slightly sloping down towards the escarpment edge to the east. The surrounding area did not visibly contain any natural depressions into which surface water flow would drain.	Vegetation at this point was dominated by bracken and forb species.	Very red sandy soils. These sandy soils extended to 50cm below surface level. The soils appeared to be very well-drained and *no redoximorphic features were observed* within the first 50cm of the surface. The predominant soil form is Mispah, which is not classified as a wetland soil.
UR3	Slightly sloping down towards the escarpment edge to the east. The surrounding area did not visibly contain any natural depressions into which surface water flow would drain.	Grassy vegetation, dominated by the grass species *Themeda triandra.*	Very shallow soils. The presence of boulders / bedrock in the vicinity made the collection of a soil sample impossible. The predominant soil form is Mispah, which is not classified as a wetland soil.

	Outcropping of bedrock and boulders dominant.		
UR4	**Note – out of reservoir footprint** Slightly sloping down towards the escarpment edge to the east. The surrounding area did not visibly contain any natural depressions into which surface water flow would drain. Outcropping of bedrock and boulders dominant.	Grassy vegetation, dominated by the species *Themeda triandra.*	Brownish, very sandy soils, only to 15cm. Underlain by bedrock / rocky substrate. *No redoximorphic features were observed* within the sample. The predominant soil form is Mispah, which is not classified as a wetland soil.
UR5	Generally flat, sloping slightly in an east-west direction to a local high point to the east. The surrounding area did not visibly contain any natural depressions into which surface water flow would drain.	A number of bedrock boulders occurred on the surface in the vicinity and the vegetation comprised of grasses and forbs with scattered bush clumps. No hydrophytic species in the vicinity were observed	Very red sandy soils. These sandy soils extended to 50cm below surface level. The soils appeared to be very well-drained and *no redoximorphic features were observed* within the first 50cm of the surface. The predominant soil form is Mispah, which is not classified as a wetland soil.

The lack of any indicators of a rising and falling water table and prolonged saturation of the soils (i.e. redoximorphic features) and prolonged saturation of soils in any of the soil samples examined entail that there is no wetland habitat within the footprint of the upper reservoir. The presence of shallow soils overlying a shallow (impervious) substrate in high rainfall areas can often lead to the saturation of soils above the substrate and development of wetland habitat, but the characteristics of the soils and the lack of any hydrophytic vegetation suggest that this is not the case on the site.

The floral report undertaken by Bathusi Environmental Consultants has identified that the dominant vegetation community over much of the footprint of the upper reservoir is Degraded Mountain Grassland Variation. The floral specialists have identified all of the grass species recorded on the site. Three of the grass species recorded are typically associated with wetlands: *Eragrostis plana, Panicum coloratum* and *Paspalum scrobiculatum.* The former is a facultative species in areas with a wet climate (such as the location of the proposed upper reservoir), entailing that it is equally likely to grow in wetland or non-wetland areas. The former two species are facultative wetland species, entailing that they usually grow in wetlands (67-99% of occurrences) but occasionally are found in non-wetland areas. The presence of these two facultative wetland grass species in the footprint of the upper reservoir alone is not sufficient to delineate the area as a wetland.

The proposed telecommunications mast occurs within the footprint of the proposed Upper Reservoir, and thus is not likely to exist within a wetland.

5.2.1 Wetlands to the south and west of the Upper Reservoir Site

A number of wetlands exist relatively close to the western part of the upper reservoir. Although these wetlands do not exist within the footprint of the reservoir, the possibility occurs that they may be disturbed by the movement of construction vehicles, or siltation as they occur on a lower part of the same sloping ground of the western parts of the upper reservoir. These wetlands are hillslope seepage wetlands, being characterised by the discharge of groundwater to the surface at their upper ends. The wetlands are linked to the drainage system, playing an important hydrological role in supplementing streamflow in the downstream catchment. The presence of groundwater discharge in the upper parts of the wetlands which are located closest to the upper reservoir entails that the upper parts of these wetlands are highly sensitive, and prone to disturbance. Accordingly the boundaries of these wetlands closest to the upper reservoir were located in the field using the methodology described in section 5.1.1 and 5.1.2 above.

Following the delineation of wetland boundaries, a buffer area surrounding the boundary has been demarcated. Wetland buffers are required to afford wetland areas adequate protection from adjacent land uses that may adversely affect them. Wetland buffers also allow the interaction between the wetland and adjacent (non-wetland) upland areas to be retained. Maintaining natural areas beyond the wetland boundaries is very important for many of the fauna species which occur in wetlands, as they rely on both the wetland and surrounding areas for foraging, breeding etc. In addition a buffer is important in protecting the groundwater-surface discharge interaction from being disturbed / impacted. A 50m buffer has been demarcated (see the map in Appendix 2). It is of crucial importance that no development or other impacts should be allowed within this zone; this would include traversing of the area by vehicles or the establishment of any ancillary infrastructure such as stockpile areas.

5.3 Proposed Upper Construction Yard

The proposed upper construction yard is located adjacent to the north-western part of the upper reservoir. No soil samples were taken here to establish the presence of wetlands as a visual scan of the area indicated that conditions were the same as those at point UR5 in the northern part of the reservoir footprint. The soils and vegetation in this area would be likely to be very similar to those in the northern part of the reservoir footprint and thus not a wetland. The siting of the construction yard in this area would seem to be warranted as the area seems to be more degraded due to the presence of cattle grazing and cattle camps.

5.4 Proposed Construction Village – Upper Reservoir

The proposed upper construction village is located at the eastern end of the settled area of Sehlakwane near the site. Part of the footprint of the proposed construction village is an area cleared of vegetation. The remainder consists of areas of grassy / scrub vegetation, interspersed with large boulders.

Two soil samples were taken from within the footprint of the proposed construction village to check for the occurrence of hydric soils. A third sample was attempted to be taken at UCV3 in the western part of the footprint, but the occurrence of rock at the surface did not allow a sample to be taken. The results of both samples are presented in Table 5.2 below.

Table 5.2 – Analysis of Soil Samples at the Upper Construction Village Site

Point	Terrain and Site Description	Vegetation	Soil Characteristics
UCV1 & UCV2	Relatively flat terrain sloping down to the north. The surrounding area did not visibly contain any natural depressions into which surface water flow would drain. Outcropping	Vegetation dominated by grass and scrub species. No hydrophytic plant species were observed.	Very red sandy soils. These sandy soils extended to 50cm below surface level. The soils appeared to be very well-drained and *no redoximorphic features were observed* within the

	of boulders occurs across the site, especially in the western part of the site. Termitaria occurred across the site.		first 50cm of the surface. Although soil forms within the footprint of the construction village were not surveyed as part of the agricultural potential report, it is expected that the predominant soil form is Mispah, which is not classified as a wetland soil.

The soils at the two sample sites were very similar to the soils within the northern part of the footprint of the upper reservoir. No redoximorphic features were observed in the soils on the site or in the vegetation on the site, and thus it can be concluded that no wetland habitat / hydric soils occur within the footprint of the proposed upper construction village.

5.5 Lower Reservoir Site

Analysis of ortho-photos and analysis of the lower reservoir site during the scoping phase of the study revealed that wetland habitat was unlikely to occur within the footprint of the reservoir, in spite of it being located along a natural drainage line. However in order to confirm that no wetland habitat occurred along the drainage line, a survey along a part of the drainage line within the eastern part of the footprint of the reservoir was conducted, and soil samples from three points were collected.

Table 5.3 below presents the findings of the soil sampling within the reservoir footprint.

Table 5.3 – Analysis of Soil Samples at the Lower Reservoir Site

Point	Terrain and Site Description	Vegetation	Soil Characteristics
LR1	Located within a valley bottom. Sample taken from the top of the macro channel bank within the riparian zone. Main channel incised with	Woody vegetation characterised by tall mature trees of the riparian zone. Understorey comprised of a tall grassy layers dominated by the	Very loose sandy soil, brown in colour extended to 15cm bgl. Appears to be alluvial in character. Hard substrate at 15cm below soil surface precluded

	steep naturally eroded banks; bed comprising of pebbles and boulders located approximately 3m below the macro channel bank.	grass species *Panicum maximum*.	analysis of deeper material. The soils appeared to be very well-drained and *no redoximorphic features were observed* within the first 15cm of the surface. The predominant soil form is the Oakleaf form, which is not classified as a wetland soil.
LR2	Located within a valley bottom. Sample taken from the top of the macro channel bank within the riparian zone. Channel bed comprising of pebbles and boulders located approximately 2m below the top of macro channel bank.	Woody vegetation characterised by mature trees of the riparian zone. Understorey comprised of a tall grassy layers characterised by the grass species *Panicum maximum*.	Very loose sandy soil, brown in colour extended to 50cm below surface level. Soil is likely to be alluvial in character as it appears to be highly unconsolidated. The soils appeared to be very well-drained and *no redoximorphic features were observed* within the soil sample. The predominant soil form is the Oakleaf form, which is not classified as a wetland soil.
LR3	Located within a valley bottom. Sample taken from the macro channel bank within the riparian zone. Channel bed comprising of coarse alluvial material, vegetated in parts and containing surface flow located approximately 1.5m below the top of macro channel bank.	Woody vegetation characterised by mature trees of the riparian zone. Understorey comprised of some grassy vegetation with patches of bare soil.	Very loose sandy soil, brown in colour extended to 20cm below surface level. Soil is highly unconsolidated and is thus alluvial in character. Hard substrate at 20cm below soil surface precluded analysis of deeper material. The soils appeared to be very well-drained. Some very slight mottling was observed at 20cm below

			surface level, but a second sample at the same location revealed no evidence of mottling. No other redoximorphic features were observed. It is unlikely that these soils can be considered hydric soils. The predominant soil form is the Oakleaf form, which is not classified as a wetland soil.

None of the above soil samples revealed any wetland characteristics. These soils were all highly unconsolidated, appearing to have been of relatively recent origin through alluvial deposition. It should be noted that at all of the sample locations the channel bed could not be used to collect a soil sample as the channel bed was comprised of large pebbles to boulders and no soils. The dominance of the grass species *Panicum maximum* in the understorey of the channel banks (this is not a grass species associated with wetlands) and the lack of any hydrophytic species in this area supports this assessment.

The hydrology of the channel does not appear to be conducive to the formation of wetlands as the scoured nature of most of the channel and the presence of large rounded pebbles and boulders indicates that the drainage line is highly ephemeral, being prone to high spate flows in which the channel would be morphologically very active (this is confirmed by the flow duration curve for the tributary which has been generated by GCS as part of the hydrological report; this shows a relatively constant but small baseflow, and very high flows during flood events). Sub-surface flow within the channel is likely, as indicated by the presence of a number of 'dry reaches' in which no surface flow is present, interspersed by reaches in which water is discharged to the surface (this discharge of groundwater flow to the surface appears to correspond to the occurrence of bedrock outcropping which would force sub-surface flow above ground due to its impermeable nature), only to 'disappear' back into the subsurface of the channel at the end of the 'impermeable' reach. However the hydro-morphology of the channel appears to be unsuitable for the formation of wetland habitat, by which the flow of water would be slowed down or obstructed, leading to the saturation of the soils and the deposition of organic material.

Only lower down at a point downstream of the proposed dam wall do hydrophytic plant species more typical of wetlands (such as the species *Setaria sphacelata*) occur. However these plants occur over a pebbly substrate, and wetland soils do not occur here.

Lack of access to the western (upstream) part of the reservoir footprint precluded sampling of soils in this part of the proposed reservoir. However it is expected that conditions would be similar to the eastern end of the reservoir footprint. It can thus be concluded that wetlands do not occur within the footprint of the proposed lower reservoir.

5.6 Proposed Construction Village – Lower

The proposed construction village for the lower reservoir has been proposed to be located to the south-east of the reservoir site. It would be situated within currently cultivated fields between the Luipershoek gravel road to the west and the Steelpoort River and associated riparian zone to the east. A number of soil samples were taken within the footprint of the proposed construction village were taken to assess whether hydric soils occur within the footprint. Table 5.4 below presents the findings of the soil sampling within the reservoir footprint.

Table 5.4 – Analysis of Soil Samples at the Lower Construction Village Site

Point	Terrain and Site Description	Vegetation	Soil Characteristics
LCV1	Located within the footslope, close to the valley bottom. Located within a cultivated field, thus soils have been previously ploughed and the natural vegetation removed.	Emergent, weedy vegetation due to disturbance though ploughing and cultivation.	Dark brown, highly clayey soils to a depth of 50cm+ below surface level. Clay content appears to increase with depth. Some stony material evident at about 30cm. Change in soils at 50cm recorded with gravely material evident within the soils. The high clay content in the soils would entail that they are likely to be poorly drained. *No redoximorphic features were observed* within the first 50cm of

			the surface. The soil form of this area has not been assessed as part of the present study.
LCV2			Dark brown, highly clayey soils to a depth of 50cm+ below surface level. Change in soils at 30cm recorded with gravely material evident within the soils. The high clay content in the soils would entail that they are likely to be poorly drained. *No redoximorphic features were observed* within the first 50cm of the surface. The soil form of this area has not been assessed as part of the present study.
LCV3	**Note – outside the proposed footprint** Located within the valley bottom, directly adjacent to the riparian zone of the Steelpoort River which is characterised by tall, mature trees and a dense understorey.	Grasses forming a thin strip between the edge of the cultivated field and the edge of the riparian zone.	Dark brown, highly clayey soils to a depth of 30cm+ below surface level. Slight orange mottling present in the soil profile at 30cm below surface level. The high clay content in the soils would entail that they are likely to be poorly drained. *Redoximorphic features* in the form of orange (iron) mottling (redox concentrations) were present within the first 30cm of the surface. Thus this is likely to be part of a temporary wet zone of a wetland associated with the Steelpoort River riparian zone. The soil form of this area has not been assessed as part of the present study.
LCV4	**Note – outside the proposed**	Grassy vegetation between the edge of the cultivated	Dark brown, highly stiff clayey soils to a depth of 50cm+ below surface

	footprint Located within the valley bottom, directly adjacent to the riparian zone of the Steelpoort River	field and the edge of the riparian zone. The species *Setaria sphacelata* was dominant, with occurrence of *Hyparrhenia tamba*. *Setaria sphacelata* is a facultative wetland species, entailing that it usually grows in wetlands (67-99% of occurrences) but occasionally is found in non-wetland areas. The *Hyparrhenia tamba* is also usually associated with damp soils.	level. The high clay content in the soils would entail that they are likely to be poorly drained. *No redoximorphic features were observed* within the first 50cm of the surface. The soil form of this area has not been assessed as part of the present study.
LCV5	Located within the footslope. Located within a cultivated field, thus soils have been previously ploughed and the natural vegetation removed.	Emergent, weedy vegetation due to disturbance though ploughing and cultivation.	Dark brown, sandy soils to a depth of 50cm+ below surface level. *No redoximorphic features were observed* within the first 50cm of the surface. The soil form of this area has not been assessed as part of the present study.

All of the five sample points except for one (LCV3) did not indicate any evidence of hydric soils. Although two of the samples were taken out of the proposed footprint, soils in these two locations were examined to establish whether hydric / wetland soils were associated with proximity to the Steelpoort River and its riparian zone. Sample point LCV3 formed part of a transect of three sample points which were taken to establish whether a wetness gradient existed with increasing proximity to the Steelpoort River or to the bottom of the slope. Soils sampled at LCV3 closest to the river displayed redoximorphic features in the form of redox concentrations (mottling) within 30cm of the surface. As mentioned in Table 5.4 above, this point likely to be part of a temporary wet zone of a wetland associated with the Steelpoort River riparian zone or its location at the foot of the sloping ground. The other two points higher up along the footslope and further away from the river did not display any redoximorphic features, although the stiff clayey nature of the soils would entail that the soil drainage characteristics are likely to be poor. In addition the fact that these two sample points exist within a previously cultivated field would entail that the soils would have been altered through ploughing, and that the soil structure would have been disturbed. However in spite of the disturbance of the soil profile, redoximorphic features (if originally present) would be likely to have been visible. Vegetation indicators were unable to be used for these two locations due to the location within a previously cultivated area.

The sample point at LCV4 was dominated by the grass species *Setaria sphacelata*, with occurrence of *Hyparrhenia tamba. Setaria sphacelata* is a facultative wetland species, entailing that it usually grows in wetlands (67-99% of occurrences) but occasionally is found in non-wetland areas. The dominance of this species suggests that the soils at this point are saturated for long enough to be hydric. This location is roughly on the same contour as that of LCV3, and although no redoximorphic features were observed here, it is likely that this forms part of the same temporary wetland zone adjacent to the riparian zone of the river or at the footlslope.

It seems likely that the hydric soils would end somewhere between LCV2 and LCV3, which would mean that the boundary would be outside of the footprint of the proposed construction village. Even if hydric soils would have extended up the slope, any associated wetland functioning would have been completely lost due to the transformation of the area through cultivation and the removal of the natural vegetation. The nature of the soils at point LCV5, much higher up the slope, indicates that the majority of the footprint would be located within an area in which soils were not hydric.

It is recommended that in the light of a likely natural wetland boundary occurring close to the boundary of the Steelpoort River riparian zone and just outside the footprint of the eastern part of the proposed construction village, that the eastern boundary of the construction village be pulled back slightly (to the west) to accommodate the boundary and a buffer zone. The area between the current edge of the Steelpoort Riparian zone and the eastern boundary of the construction village should be rehabilitated and the natural vegetation allowed to re-colonise this area. This measure would also effectively buffer the riparian zone of the Steelpoort River from any effects associated with the siting of the lower construction village.

5.7 Proposed Construction Yard(s) – Lower

Two sites for the proposed construction yards at the lower reservoir site have been included on the general scheme layout. The first is located to the east of the proposed reservoir, between it and the proposed construction village. It would be located within a cultivated field. The second would be located adjacent to the south-west part of the footprint of the reservoir. Neither of these areas was sampled for possible occurrence of wetlands. Access to the latter location proved difficult. For the former location, it is likely that the soils would be similar to the soils within the western parts of the construction village location, and thus not likely to display any hydromorphic signature. It is strongly recommended that the former site be used for the construction yard, as this area has been transformed through cultivation and thus has very little ecological value. Should the latter site be used, natural bushveld vegetation would have to be cleared, thus being likely to have a much greater ecological impact.

6 POTENTIAL IMPACT OF DEWATERING ON GROUNDWATER FLOW INPUTS INTO WETLANDS NEAR THE UPPER RESERVOIR

The proposed hydropower scheme will be likely to be associated with a certain degree of dewatering of groundwater during the construction and operational phases. Dewatering of the surge shaft and pressure tunnel excavations may be required during the construction phase should water-bearing fractures be intercepted. This may have an impact on the wetlands (as described in section 5.2.1 above) located to the west of the upper reservoir, as these appear to be primarily fed by groundwater discharge in their upper reaches.

If the side wall of the structures are grouted during the excavations, this will prevent the inflow of water into these structures (Johannes van der Walt - GCS, pers comm), thus minimising the need for dewatering. The 1: 250 000 geological map of the area indicates that there are two parallel-running dolerite dikes situated directly south of the upper reservoir position, running in a NW-SE direction. In geohydrological terms these structures act as underground barriers preventing groundwater flow (Johannes van der Walt - GCS, pers comm). However the three wetlands located closest to the upper reservoir are likely to exist on the eastern side of the dolerite dykes, i.e. between the dykes and the upper reservoir and would thus be unlikely to be affected hydrologically by the dykes. However seepage emanating from the upper reservoir may negate any effects due to dewatering and may replace groundwater seepage as water input to the wetlands in this area.

There is thus a possibility that dewatering associated with the scheme would negatively affect the water inputs into the three wetlands closest to the upper reservoir. It is recommended that Eskom institute all measures during construction (such as grouting of side walls of tunnels) that would minimise the need to undertake dewatering. In addition it is recommended that as part of their programme for the monitoring of boreholes at the Upper Reservoir site, that a borehole be drilled in the area between the upper reservoir and the three wetlands at a point close to the upper parts of the wetlands. The borehole should be drilled prior to the construction of the reservoir to enable baseline water levels to be established, against which any impacts of the scheme on groundwater levels (flows) can be measured. Water levels in this borehole should be monitored through the use of piezometers on a quarterly basis to assess any changes in groundwater levels that may be caused by the proposed upper reservoir.

7 IMPLICATIONS FOR USE OF BORROW AREAS INDICATED ON THE SCHEME LAYOUT

The assessment of the environmental impact of proposed extraction of fill material from borrow areas that have been identified on the site layout does not form part of the scope of this project. However it should be noted that the borrow areas may contain wetland habitat / hydric soils, especially those areas close to the Steelpoort River, as identified along the Steelpoort riparian zone in the vicinity of the lower construction village. The use of these areas for the extraction of material should be subject to investigation for the presence of wetlands / hydric soils. Should wetlands / hydric soils be found to occur in these areas, they should not be utilised as borrow areas and alternate areas should be found.

8 ASSESSMENT OF THE POTENTIAL IMPACT OF THE SCHEME ON WETLAND FUNCTIONING

As discussed in section 5 above, no wetlands / hydric soils are located within the footprint of the two reservoir sites, or within the footprint of the associated infrastructure (except for a small area just to the east of the proposed lower construction village) and thus these would have no impact on wetlands.

However the Lower Reservoir would impound a tributary of the Steelpoort River. The tributary drains a catchment of 33,5km^2 in size (according to the calculations undertaken for the internal hydrology report for the proposed scheme), a significant part of which is comprised of the area on the top of the escarpment and the Sehlakwane area. A number of wetlands are located within the part of the catchment located above (to the west of the escarpment). According to the hydrology report compiled by the project engineers, it is proposed that no discharge be released from the Lower Reservoir into the downstream part of the tributary and the Steelpoort

River. The scheme will thus affect the flows delivered from its catchment into the lower part of the tributary and the Steelpoort River beyond.

Wetlands typically have a number of functions, one of which is streamflow regulation (Kotze *et al*, 2005). Streamflow regulation refers to the sustaining effect of an area on streamflow during low-flow periods (Kotze *et al*, 2005). Although wetlands do not generate water, and may indeed 'lose' water through evapotranspiration, through their water retention capabilities, they are able regulate flow in the downstream catchment in low flow periods. The ability of wetlands to perform streamflow regulation functions depends on a number of factors, such as the hydrological zonation within a wetland, the degree of loss of water through evapotranspiration etc. It is possible that the wetlands in the catchment of the Lower Reservoir play an important role in the streamflow regulation of the downstream river, and possibly of rivers into which the tributary drains (i.e. the Steelpoort River). With the construction of the Lower Reservoir and the termination of any discharge downstream of the reservoir, the streamflow function of the wetlands may be impaired, and the benefit of streamflow regulation potentially provided by the wetlands in times of low flow could potentially be lost. However even if this function is lost, this may not be significant in the context of the Steelpoort River as flows delivered into it by the tributary are expected to be relatively insignificant. The section below explores the potential functionality of these wetlands in terms of streamflow regulation, and assesses whether this is significant in the context of the affected parts of the tributary and the Steelpoort River beyond.

8.1 Occurrence of wetlands in the catchment of the Lower Reservoir

A number of wetlands are located within the upper catchment of the lower reservoir; i.e. that part of the upper catchment located to the west of the escarpment. The majority of the wetlands are narrow valley bottom wetlands which are confined by rocky ground adjacent to them. These valley bottoms all have natural channels. They appear to be fed primarily by groundwater discharge in their upper reaches, and in some areas, primarily near the catchment divide, hillslope seepage wetlands associated with shallow groundwater tables occur. Site investigation revealed the occurrence of ferricrete in parts of the upper catchment in Sehlakwane. Ferricrete (also known as hardpan, laterite, or ouklip) is a mineral formed in the soil profile at the water-table when iron-oxides accumulate and cement together to form a gravely or nodule-rich band which is usually impervious to water. The occurrence of a shallow ferricrete substrate within the ground is typically associated with the development of hydric soils as the impermeable substrate prevents vertical drainage through the soil, thus leading to seasonally saturated conditions. Hillslope seepage wetlands in the upper parts of Sehlakwane near the R579 road are associated with ferricrete.

A number of hillslope seepage wetlands which feed into channelled valley bottom wetlands lower down within the narrow valleys occur close to the site of the upper reservoir. Site investigation revealed that groundwater discharge in the uppermost reaches was feeding the downstream wetland. In places these natural springs are used for water supply, especially in areas closer to Sehlakwane.

A visual scan of the wetlands during site investigation revealed most of the wetlands (even those running through Sehlakwane) to be apparently relatively healthy and subject to a low degree of threat to their functioning from factors such as erosion, cultivation, alien vegetation encroachment and urban development. However the lack of formal services such as bulk water supply and formal sewage systems within Sehlakwane (and the resultant use of wetlands for clothes washing, as well as the occurrence of informal sanitation) is likely to entail that water quality problems may be present within the wetlands.

Most wetlands are relatively small in size, being 5ha on average. Desktop delineation of wetland boundaries within the catchment has indicated that wetlands make up 100ha in the catchment. The scope of the project did not allow a detailed inventory / wetland delineation of all wetlands in the catchment to be undertaken. It is possible that more wetlands may occur, especially in areas where the occurrence of ferricrete occurs.

Below (to the east of) the escarpment, no wetland occurrence was noted. Gradients are very steep, which entail that the conditions are not suitable for the development of wetlands or wetland soils. Along the drainage line to the east of the escarpment, soils appear to be primarily alluvial and not hydromorphic, in character.

8.2 Streamflow Regulation Functional Assessment of Wetlands in the catchment

The only function of wetlands in the upper catchment that may be affected by the damming of the tributary in its lower reaches is the function of streamflow regulation. The WET-Ecoservices methodology (Kotze *et al*, 2005) has been developed to assess the functionality of wetlands. This methodology is based on a ranking system which uses a number of criteria to assign a particular functional value to each aspect of wetland functioning. For the purposes of this project, the WET-Ecoservices methodology was used to assign a score in terms of the streamflow regulation function for selected wetlands in the upper catchment. This scoring system was used as a guide to assess the level of streamflow regulation function being performed by wetlands in the upper catchment and to allow an assessment of the impact of the Lower Reservoir on this aspect of wetland functioning to be undertaken.

WET-Ecoservices uses a number of criteria to assess the streamflow regulation function performed by a wetland. These criteria are:

- Representation of different hydrological zones within the wetland (i.e. the percentage of the wetland that is taken up by permanent, seasonal and temporary zones)
- Linkage of the wetland to the downstream drainage network
- Presence of fibrous peat or unconsolidated sediments below a floating marsh within the wetland
- Reduction in evapotranspiration through frosting back of the wetland vegetation
- Wetland occurrence over underlying geology with strong surface-groundwater linkages
- Presence of any important wetlands or aquatic systems downstream

During the field assessment a sample of wetlands in the catchment was selected (see map the in Appendix 2 for wetland locations and streamflow regulation scores) and the above characteristics were examined and assessed. Certain of the characteristics (such as the level of vegetation die-back due to frost) were not able to be assessed in the field, and thus desktop analysis was used to assess the particular characteristic.

8.2.1 Streamflow Regulation Scores and Assessment

The table below presents the findings of the streamflow regulation functions for the wetlands assessed:

Table 8.1 – Streamflow Regulation scores for 8 selected wetlands in the upper catchment of the Lower Reservoir

Wetland Name	Size (ha)	Hydrogeomporphic Type	Streamflow Regulation Score (*/6)	Likely extent to which a benefit is being supplied (see below**)
Sehlakwane 1A	9.2	Hillslope seepage feeding a water course	2.2	Moderately high
Sehlakwane 1B	2.9	Hillslope seepage feeding a water course	2.3	Moderately high
Sehlakwane 1C	3.8	Valley bottom with channel	2.3	Moderately high
Sehlakwane 1D	6.6	Valley bottom with channel	2.3	Moderately high
Sehlakwane 3	7.9	Valley bottom with channel	2.0	Intermediate
Sehlakwane 4	8.1	Valley bottom with channel	1.7	Intermediate
Escarpment 2	3.5	Hillslope seepage feeding a water course	1.3	Intermediate
Escarpment 1	4	Hillslope seepage feeding a water course	1.3	Intermediate

**Rating of the likely extent to which a benefit is being supplied (Kotze *et al*, 2005):

Score <0.5	Low
Score 0.5-1.2	Moderately Low
Score 1.3-2.0	Intermediate
Score 2.1-3.0	Moderately High
Score >3.0	High

Differences in criteria reflect the slightly different scores achieved for each of the sampled wetlands. However many of the parameters sampled were uniform across the catchment area:

- All wetlands in the catchment appear to be linked to the stream network, and thus would contribute to streamflow regulation.
- No fibrous peat or unconsolidated sediments occurring below a floating marsh were encountered in any of the wetlands in the area; most wetland soils observed were highly clayey in nature, and although some wetland soils had a high organic content, no peat was encountered.
- It was assumed that no important wetlands or aquatic systems occurred downstream of the wetlands. However it must be noted that the riparian zone of the downstream tributary is characterised by high levels of biodiversity, and natural features worthy of conservation, such as old and large *Acacia galpinii* trees.
- Due to their location on the top of the escarpment at a high, exposed altitude, it was assumed that the frosting back of vegetation during winter was relatively prominent. The occurrence of frost is confirmed by the Soils / Agricultural Potential Study (Paterson, 2007) which confirms that there will be a definite frost hazard in winter on the top of the plateau).

The occurrence of groundwater input into the wetlands was thought to differ slightly, depending on geological characteristics observed. The representation of hydrological zones also differed from wetland unit to wetland unit, although most wetlands sampled displayed a seasonally wet zone which comprised a significant portion of the wetland's width.

Table 8.1 above has been differentiated into valley bottom and hillslope seepage wetlands. Of the four hillslope seepage wetlands sampled, the two wetlands within Sehlakwane displayed a higher level of functioning than the two wetlands closer to the escarpment. A similar spatial pattern existed with respect to the valley bottom wetlands. It thus appears as if wetlands that occur within the more westerly part of the upper catchment that falls within the Sehlakwane area perform a higher streamflow regulation function than those closer to the escarpment. This may be related to their characteristics; those closer to the escarpment appear to have significant groundwater input due to the presence of Ferricrete which is an indicator of shallow groundwater tables. In addition the wetlands within Sehlakwane are slightly shallower and occur in terrain that is less steep and incised, appearing to have a greater portion of seasonally flooded areas.

Overall, it is expected that the wetlands perform a moderate level of streamflow function (It must be noted that the relatively small size of wetland units in the catchment may affect their streamflow regulation functioning potential to some degree as size of a wetland unit is listed as usually moderately important by WET-Ecoservices). The flow patterns observed in the lower part of the tributary, to the east of the escarpment within the footprint of the lower reservoir are informative in this context. During the scoping-level site visit undertaken in early October 2006, flows were observed within the tributary in the footprint of the lower reservoir site. This time of the year is at the end of the dry season, and as the area falls within a summer rainfall period, this would have been a time of low flows in the tributary. It seems likely that the flow observed was base flow, emanating from wetlands / areas of groundwater discharge in the upper catchment. This would suggest that the streamflow regulation function performed by wetlands (in acting as the interface between groundwater discharge and surface flows) is relatively important in the context of low flows in the tributary.

8.3 Potential Impact of the Lower Reservoir on Wetland Functioning

Bearing in mind the assessment that wetlands in the upper catchment of the proposed Lower Reservoir perform a moderate (but locally important) streamflow regulation function, the impact of the Lower Reservoir on wetland (in terms of streamflow regulation) functioning can be assessed.

The proposed design of the reservoir which entails that no discharge is planned to be released downstream of the reservoir and the flooding of parts of the tributary by the reservoir footprint would suggest the impact on functioning (i.e. the loss of streamflow regulation during low flow periods in the downstream stretch of the tributary) would be significant. However there are a number of factors which would minimise the potential impact:

- The Lower Reservoir is located at the downstream end of the tributary. This entails that only a small portion of its length would be affected by a reduction in flows. A length of 370m between the dam wall and the point at which the tributary joins the Steelpoort River would be denuded of flows. Thus (apart from the area that would be flooded by the reservoir), the majority of the length of the tributary to the east of the escarpment would not be affected by the proposed reservoir. It is conservatively estimated that 68% of the length of the tributary east of the escarpment edge would be unaffected by the reservoir. Thus in these sections the streamflow regulation functioning of the wetlands in the upper catchment would still be able to be performed.

- The volume of flows draining from the tributary into the Steelpoort River is expected to be minimal when compared to the flow volumes in the Steelpoort River. The Steelpoort River is a perennial river, rising on the Mpumalanga Highveld to the south in the area between Arnot and Belfast. The river at the point at which it runs past the site of the proposed development thus drains a large catchment. Flow patterns in the upper reaches of the Steelpoort River are relatively stable as the upper catchment receives a relatively high amount of rainfall (MMSD South Africa, 2001). However flow patterns do respond to rainfall events, with flows typically being higher in the summer months. Baseflow (groundwater input to river flow) is provided by groundwater discharge from the Chuniespoort dolomites which are located in the upper catchment of the river (MMSD South Africa, 2001). Although no comparative flow figures are available, the low flow volumes at the downstream point of the tributary are expected to be minimal when compared to those in the Steelpoort River into which it drains. Thus the loss of flow input from the tributary into the Steelpoort River is expected to be minimal, and thus the streamflow regulation input of the wetlands in the upper catchment of the lower reservoir to the Steelpoort River is negligible. The loss of this function is thus thought to be insignificant in the context of the Steelpoort River.

- The dam wall is proposed to be rock-based, hence there is likely to be a degree of seepage that drains from the reservoir into the downstream parts of the tributary. The amount of seepage is expected to be 68 m^3/day (~0.79l/s).Thus some water would be bypassed downstream of the dam wall. However it is unlikely that this 'source' of water would be constant, as due to the purpose of the reservoir to form part of a pump storage scheme, the Lower Reservoir is unlikely to always be fill, instead being empty for periods of time when the scheme is not operative. In addition it is expected that this flow would be much less than the baseflow in the tributary, and not all of the seepage may flow into the tributary due to the length of the dam wall. Accordingly the contribution of seepage to maintaining flows downstream of the reservoir is thought to be negligible.

Due to the above-mentioned factors the loss of streamflow regulation function, is not expected to be highly significant in the context of the stretch of the tributary to be flooded by the reservoir and the short stretch downstream of the dam wall. The loss of high-end (spate) flows which are important in maintaining the hydromorphological characteristics of the tributary as well as downstream rivers such as the Steelpoort, and the loss of the riparian zone that falls within the reservoir are far more significant than the loss of low-flow streamflow regulation functions which would affect a portion of the lower part of the tributary.

The release of a compensation flow downstream of the reservoir would mitigate the impact in terms of a loss of streamflow regulation function in the affected part of the tributary. For hydropower schemes where flows in a river are reduced (either due to the presence of a dam or due to an in-stream abstraction), a Q90-95 flow has often been used as a compensation flow (SNIFFER, 2004). The release of a compensation flow equivalent to a Q90 flow into the downstream stretch of the tributary would effectively mitigate the loss of streamflow regulation function. The flow duration curve (a graphical representation of the percentage of time in the historical record that a flow of any given magnitude has been equalled or exceeded) generated by GCS for the tributary reveals that low flows are relatively constant, and that there is not much difference in flows between the Q90 and the Q70 flow. The flow duration curve indicates that baseflow in the tributary is relatively constant, and is responsible for all flows in the river that occur between 0 and 50% of the time. This confirms that the wetlands (and associated groundwater discharge) in the upper catchment are largely responsible for sustaining flows in the downstream tributary.

The release of a Q70 flow downstream of the reservoir is anticipated to be an effective mitigation measure against the loss of streamflow regulation function performed by wetlands in the upper catchment, although this needs to be assessed against a separate assessment of the ecological in-stream flow requirements for the tributary. In their report, GCS have assessed that an adequate in-stream river flow ecological requirement, would be 432 000 m^3 per annum, slightly more that the Q70 flow. The release of this flow would be an adequate mitigation measure to counter loss of streamflow regulation functioning in the downstream stretches.

9 IMPACT TABLES

Impact Tables for the wetland-related impacts are presented below. As no wetlands exist within the footprint of the two reservoirs, and thus no wetland destruction would be caused, there is no need to rate the impacts in this regard. The potential impact of dewatering associated with the scheme is also not expected to impact on groundwater input into wetlands, and thus this has also not been rated. However the potential impact on wetlands and associated buffer zones close to the upper reservoir during construction, as well as the impact of the proposed scheme of wetland (streamflow regulation functioning) have been assessed.

9.1.1 Impact of Wetlands adjacent to Upper Reservoir Site during Construction

CATEGORY	DESCRIPTION OF DEFINITION
Nature	Construction Activities may affect nearby wetlands and associated buffer zones (to the west of the Upper Reservoir) if the construction footprint spreads.
Extent (Scale)	Site
Duration	Short Term
Intensity	Moderate
Probability	Possible

Significance

Rating Matrix for Wetland Impacts	
Criteria	**Rating**
Extent	1
Duration	1
Intensity	2
Probability of occurrence	2
Total	**6**
Rating : Low Negative Impact (before the implementation of mitigation and management measures)	
Mitigation and Management measures Ensuring that wetlands and associated buffers are not affected by any construction activities.	

Criteria	Rating
Extent	1
Duration	1
Intensity	1
Probability of occurrence	1
Total	**4**
This is rated as a **Low** Negative Impact after the implementation of mitigation and management measures. No negative impacts on the adjacent wetlands are likely	

9.1.2 Impact of the Scheme on (Streamflow Regulation) Functioning of Wetlands in the Catchment

CATEGORY	DESCRIPTION OF DEFINITION
Nature	The lower reservoir will prevent any flows from bypassing downstream of it. This may impact on the functioning of wetlands in the upper catchment in terms of their provision of a streamflow regulation function to downstream watercourses, including the Steelpoort River. This impact table considers the nature of the impact of a loss of wetland streamflow regulation functioning on downstream watercourses.
Extent (Scale)	Site*
Duration	Long Term
Intensity	Medium
Probability	Highly Probable

* The extent has been classified as the site as due to differences in flow volumes, the impact on the Steelpoort River is likely to be negligible.

Significance

Rating Matrix for Wetland Impacts	
Criteria	**Rating**
Extent	1
Duration	3
Intensity	2
Probability of occurrence	3

Total	**9**
Rating : Medium Negative Impact (before the implementation of mitigation and management measures)	
Mitigation and Management measures Release of a Q70 (i.e. the flow within the tributary that is exceeded more than 90% of the time) flow from the reservoir as a compensation flow. This would mimic the baseflow that typically occurs in the tributary during low flow periods	
Criteria	**Rating**
Extent	1
Duration	1
Intensity	1
Probability of occurrence	1
Total	4
This is rated as a **Low** Negative Impact after the implementation of mitigation and management measures	

9.2 Cumulative Impacts

It is difficult to assess whether the proposed scheme would form part of a cumulative impact on the loss of aspects (streamflow regulation) of wetland functioning in the wider area, as no data exists as to the level of degradation of wetlands in the upper catchment of the Steelpoort River, and especially those wetlands that occur to the west of the Thaba ya Sekhukune escarpment.

The examination of wetlands in the upper catchment of the tributary revealed that the wetlands were not subject to high levels of degradation, and that their functioning appeared to be fairly healthy. If this trend is extrapolated over the area to the west of the Thaba ya Sekhukune escarpment, it is unlikely that overall wetland loss and loss of functioning would be a prevalent. It is thus unlikely that the proposed scheme would cause a cumulative impact in this context.

10 CONCLUSIONS

As no wetlands occur within the footprint of the proposed scheme (except for a small area in the vicinity of the lower construction village), the scheme will not cause a loss of physical wetland habitat. Wetland (hydric) soils were found to exist just to the east of the footprint of the proposed lower construction village. It is recommended that the construction village be moved to the west so that it falls outside a buffer of these hydric soils and the riparian zone of the Steelpoort River.

A number of wetlands are located close to the upper reservoir, and may be affected if the construction footprint extends towards them and a buffer zone around them. Accordingly a buffer has been drawn around these wetlands, into which the construction footprint and associated infrastructure must not extend.

By preventing any discharge of flows downstream of the Lower Reservoir, the scheme would impact on a component of the functioning of wetlands in the upper catchment – their streamflow regulation component. These wetlands are associated with the discharge of groundwater into the drainage network, and are thus important in the provision of baseflow in the lower reaches of the tributary (baseflow provides the primary component of the low flows in the tributary during dry periods). Although the potential impact of a loss of streamflow regulation is mitigated by factors such as the location of the reservoir at the downstream end of the tributary, the loss of baseflow would still have an impact on the tributary. This impact could be mitigated by the release of a compensation flow downstream of the reservoir which would mimic the natural baseflow within the tributary.

In spite of the proposed mitigation measures, the lower reservoir would have a significant impact on the riparian zone of a portion of the tributary. Although no wetlands exist within the riparian zone, the loss of the riparian zone along the portion of the tributary which falls into the Lower Reservoir footprint would constitute a significant environmental impact, as the riparian zone contains high levels of biodiversity, and natural features worthy of conservation and having outstanding natural value, such as the large, old *Acacia galpinii* trees which occur along its length. In addition the construction of the reservoir would radically alter the hydrology and hydromorphology of the flooded stretch of the tributary, as well as the downstream stretch. It is thus suggested that in return for the destruction of this length (approx. 1400m) of riparian zone and alteration of the hydrology and hydromorphology of the tributary, that Eskom make a commitment to formally conserve an equivalent stretch of riparian zone in the area. This area should form part of a greater conserved area that could be established as part of the mitigation of the loss of habitat and biodiversity due to the proposed scheme.

In spite of the loss of a certain degree of streamflow regulation functioning of wetlands in the upper catchment, the scheme may have an indirect positive benefit on wetlands in the upper catchment, especially those within Sehlakwane. The provision of piped water to the communities within Sehlakwane that is proposed as part of the scheme would reduce the dependence of the communities on the wetlands in Sehlakwane for water supply and for activities such as washing of clothes. This would entail that the wetlands would be less likely to be polluted through these activities. In addition, the provision of water-borne services would also assist in the establishment of formal sanitation services. This would in turn reduce the dependence on informal sanitation (such as pit latrines), and would likely reduce any pollution of the wetlands or groundwater which is discharged into wetlands that may currently be occurring.

11 RECOMMENDATIONS

A set of general recommendations should be instituted as part of the development of the scheme:

Wetlands to the West of the Upper Reservoir

- The three wetlands (and associated buffer zones) to the west of the upper reservoir should not fall within, or be affected by construction activities at the upper reservoir. No development or other construction-related impacts should be allowed within the buffer zones; this would include traversing of the area by vehicles the establishment of any ancillary infrastructure such as stockpile areas, or the sedimentation of the wetlands.

- It is recommended that Eskom institute all measures during construction (such as grouting of side walls of tunnels) that would minimise the need to undertake dewatering that may affect water inputs to wetlands which occur adjacent to the upper reservoir.

- It is recommended that a borehole be drilled to the west of the upper reservoir site which is situated close to the upper portions of the three wetlands to the immediate west of the upper reservoir. This borehole should be monitored that as part of Eskom's programme for the monitoring of boreholes at the Upper Reservoir site. The borehole should be drilled prior to the construction of the reservoir to enable baseline water levels to be established, against which any impacts of the scheme on groundwater flows can be measured. Water levels in this borehole should be monitored through the use of piezometers on a quarterly basis to assess any changes in groundwater levels that may be caused by the proposed upper reservoir.

Lower Construction Village

- The presence of hydric soils adjacent to the riparian zone of the Steelpoort River in the vicinity of the proposed lower construction village should be taken into account in the location of the construction village. The footprint of the construction village should not fall within this area, or within the 50m buffer delineated around it. Thus the eastern boundary of the construction village should be moved to the west so that it lies outside the buffer. No other construction-related impacts should be allowed within the buffer zone; this would include traversing of the area by vehicles or the establishment of any ancillary infrastructure such as stockpile areas.

Lower Construction Yards

- Two sites have been selected for the location of construction yards at the lower reservoir. It is strongly recommended that the site closer to the proposed construction village (located within cultivated the cultivated field) be used for the construction yard, as this area has been transformed through cultivation and thus has very little ecological value. Should the site closer to the reservoir be used, natural bushveld vegetation would have to be cleared, thus being likely to have a higher ecological impact than that associated with the former site.

Potential Borrow Areas associated with the scheme

- Any potential borrow areas associated with the scheme should be investigated for the presence of wetlands / hydric soils prior to excavation of material occurring within them.

Lower Reservoir

- A compensation flow should be released downstream of the lower reservoir to mitigate against the loss of the streamflow regulation function performed by wetlands in the upper catchment that would be impacted by the flooding of a length of the tributary and the proposed prevention of any discharge downstream of the lower reservoir. This compensation should be equivalent to the ecological flow requirement as suggested by GCS in the hydrological report.

- As a portion of the riparian zone along the tributary will be destroyed by the lower reservoir, it is suggested that Eskom formally conserve an equivalent stretch of riparian zone in the area. This area should form part of a greater conserved area that could be established as part of the mitigation of the loss of habitat and biodiversity due to the proposed scheme.

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Appendix 1:

PHOTOGRAPHS

Appendix 2:

MAPS