PROPOSED BULK SERVICES DEVELOPMENT AT BIRCHLEIGH NORTH EXT 4, GAUTENG.

WETLAND DELINEATION & ECOLOGICAL SURVEYS;
TERRESTRIAL FAUNA & FLORA SURVEYS;
ECOLOGICAL IMPACT SURVEYS

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DECLARATION

This report has been prepared according to the requirements of the Environmental Impact Assessments Regulations (GNR 982) in Government Gazette 38282 of 4 December 2014. We (the undersigned) declare the findings of this report free from influence or prejudice.

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DISCLAIMER, ASSUMPTIONS & LIMITATIONS

The findings of the survey provided within this report, together with the results and general observations and the conclusions and recommendations provided upon completion of the survey are based on the best scientific and professional knowledge of the field specialists. This is also dependent on the data and resources available at the time. The report is based on survey and assessment techniques that are limited by time and budgetary constraints relevant to the type and level of investigation undertaken.

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EXECUTIVE SUMMARY

A housing development on the remainder of Portions 39 and 63 of the Farm Witfontein-IR, which is currently a vacant plot of land within Birchleigh North, located to the northeast of Johannesburg (adjacent south of Tembisa) within the Ekurhuleni District Municipality. Enviross CC undertook a wetland survey for the proposed development in February 2016, during which the main wetland areas were delineated and the conservation buffers mapped. The development requires the installation of the bulk services (potable water pipelines and sewer lines), which may impact on ecologically sensitive features within the site. EnviRoss CC was requested to undertake an ecological and impact survey that encompasses the terrestrial and surface water ecosystem habitat units in order to offer mitigation measures to abate negative ecological impacts emanating from the proposed development activities.

The proposed development site was found to incorporate wetland habitat units and therefore these wetlands were delineated and the obligatory conservation buffers were designated from the outer limits of the temporary zones. The proposed development sites are located within the urban edge and therefore, according to GDARD (2014) regulations, buffer zones of 30 m are applicable to the wetlands (see Figure 17).

The wetland habitat units associated with the proposed development site were found to have been impacted by infrastructure development, exotic vegetation encroachment, informal dumping of rubble and domestic refuse, sewerage contamination and by the development activities on adjacent properties. Wetland functionality has been largely transformed and degraded within these areas, but has retained a degree of functionality.

Application of the WETLAND-IHI index showed that the ecological habitat integrity worked out to 72.4% (C category), which translates to a system that is moderately impacted. The ecological importance and sensitivity (EIS) was also worked out using the Wetland-Ecoservices index. This was calculated at 1.74 (out of 4), which also is regarded as a C category, translating to a system that offers moderate ecological services.

The site does include open grassland areas of varying degrees of transformation. The northern areas that are located closer to Tembisa suffer the highest level of degradation that lessen with distance toward the R25 roadway. South of the R25 sees transformation of the terrestrial habitat units, with altered vegetation

community structures being commonplace. The retention of primary grassland features is very limited and therefore a formal conservation initiative for the preservation of the grassland habitat is not thought viable.

Following the wetland survey, the following conclusions were drawn:

- A watercourse and associated wetland zones were observed within the impact areas of the proposed development site and therefore these wetland zones were delineated (according to DWAF, 2008 guidelines) and the 30 m obligatory conservation buffers were designated (according to GDARD, 2014 guidelines);
- Two pipeline alignment alternatives have been presented for evaluation. The alternative that seeks to join up with the existing ERWAT sewer network at the eastern side of the site is preferred as it will require no excavations, and therefore disturbances, within the wetland habitat. This is referred to as the proposal option;
- The overall ecological integrity of the terrestrial habitat units was shown to be relatively low, with very limited representation of primary grassland features remaining. A formal conservation initiative to preserve these areas is not thought to be viable;
- One of the most pertinent impacting features to the wetland unit will be that of soil erosion and the associated siltation of the wetland and watercourse. Silt traps and silt fencing must be used to stop sediments being transported to the wetland areas and smothering the habitat units;
- No dumping of any excess building material or other wastes or litter should be allowed within any wetland and buffer areas;
- Exotic vegetation recruitment was observed as an impacting feature within the wetlands. It is recommended that an exotic vegetation management strategy be developed to manage the present and future emergent exotic vegetation;
- Subsistence hunting or harvesting of fauna or flora within the wetland zones should be prohibited.

It should be noted that, in order to conserve the ecological structures within the region, a holistic habitat conservation approach should be adopted. This includes keeping general habitat destruction and construction footprints to an absolute minimum within the terrestrial habitat as well. Conserving the habitat units will ultimately conserve the species communities that depend on it for survival. This can only be achieved by the efforts of the contractor during the various processes of the construction phase.

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1. INTRODUCTION

1.1. Background

The City of Ekurhuleni: Department of Human Settlements has proposed a housing development on the remainder of Portions 39 and 63 of the Farm Witfontein-IR, which is currently a vacant plot of land within Birchleigh North X4, located to the northeast of Johannesburg (adjacent south of Tembisa) within the Ekurhuleni District Municipality. The proposed development site measures approximately 170 ha and is bordered in the north by Sam Molele Drive (M97) and the R25 (Modderfontein Road) runs through the southern section of the site. The locality of the survey area is presented in Figure 1.

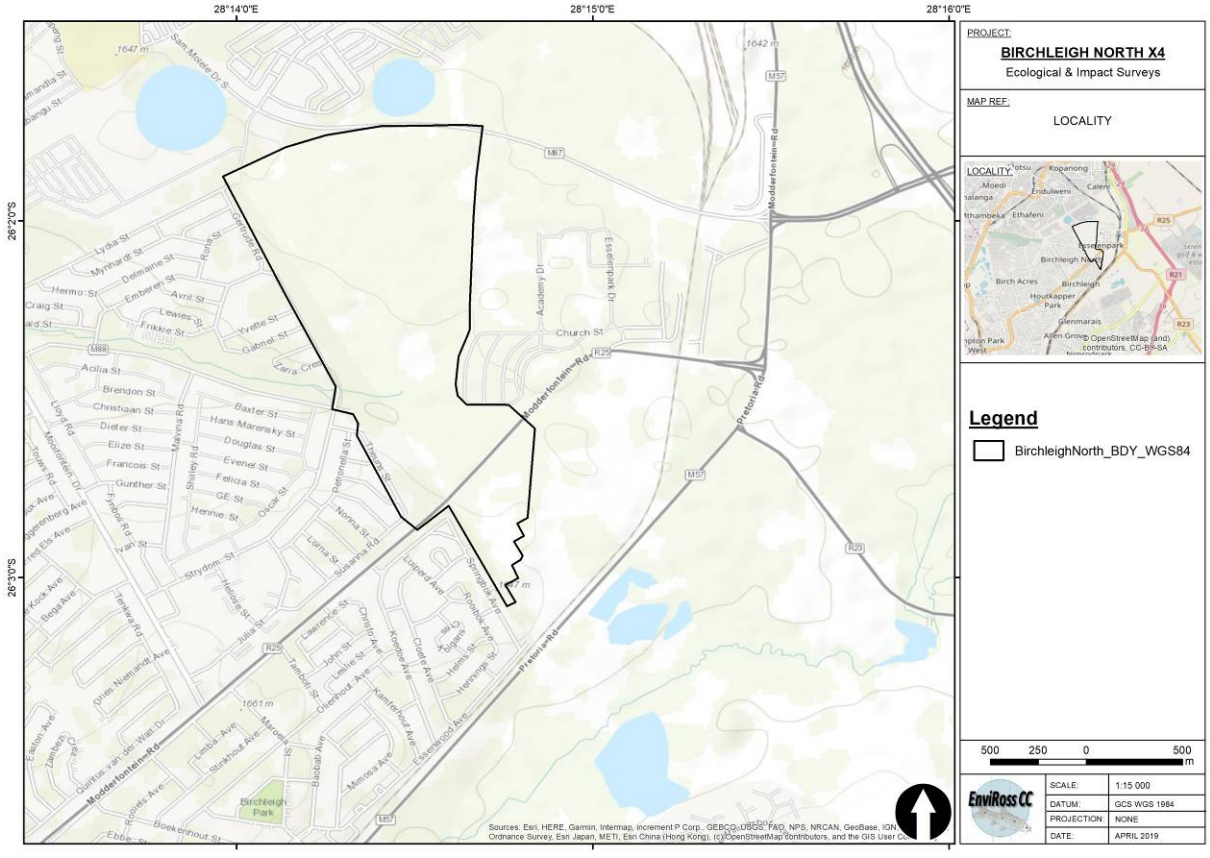


Figure 1: Locality of the survey area.

EnviRoss CC was requested to undertake an ecological survey for the proposed development site within the areas pertaining to the implementation of the bulk services (potable water and sewerage pipe lines). This report details the findings of a field survey undertaken during December 2018.

1.2. Proposed Infrastructure Layouts & Alternatives

There is a road upgrade development proposed for the northern section of the site. The localities and alignment of these roads is presented in Figure 2. Due to the close proximity and the respective association with the wetland unit that occurs on the site, various alternatives for the sewer and bulk water pipe alignments have been presented for consideration. The proposal for the pipeline alignment is presented in Figure 3. The alternative to the pipeline alignments are presented in Figure 4.

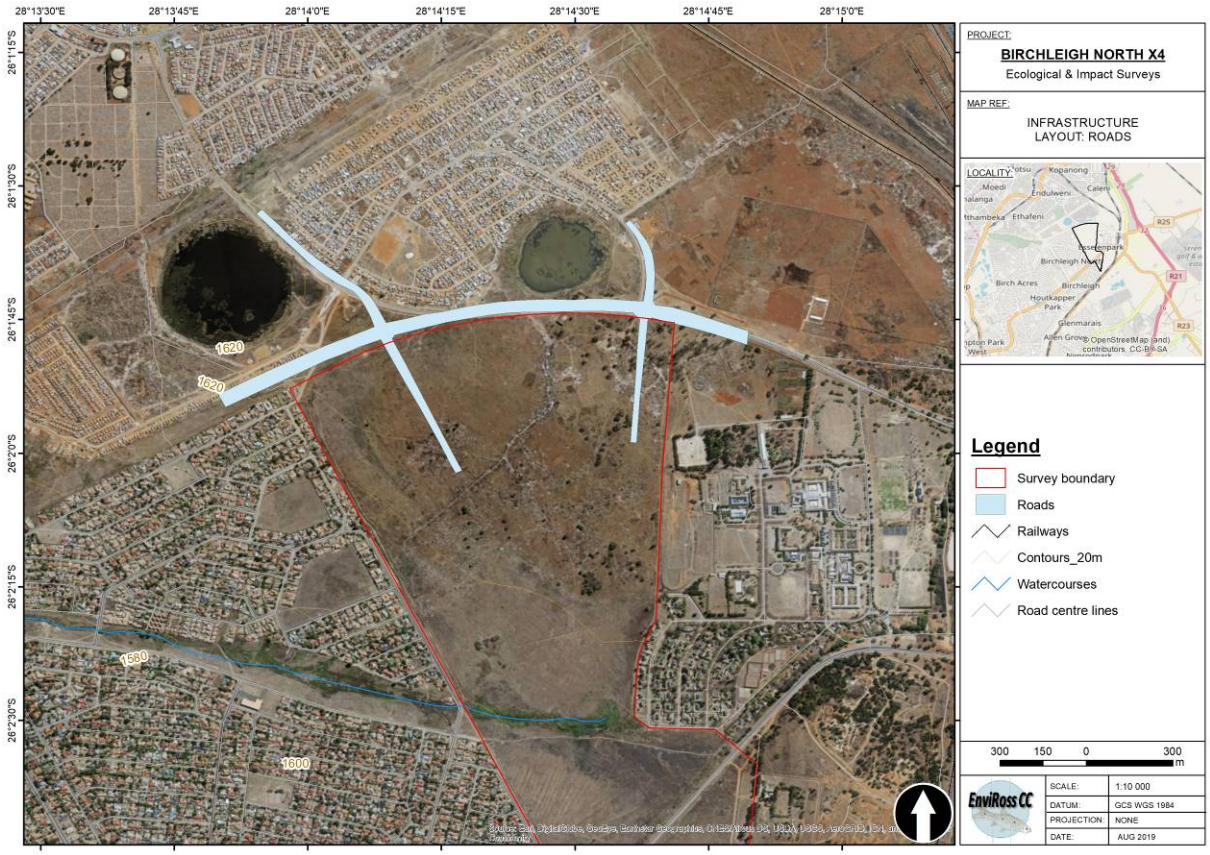


Figure 2: The proposed road alignments within the northern section of the site.

The proposed road development aligns with existing formal and informal roads, meaning that the impacts associated with this activity is considered to be relatively minor. There are wetland units located within these northern area (outside of the survey site) and therefore special conditions to development procedures and mitigation measures will apply. These wetland units are presently suffering a high level of transformation and degradation, with the main pressures and drivers of ecological change being water quality deterioration (from direct sewerage inputs as well as domestic refuse and building rubble dumping, brickworks, vehicle service and repair facilities, etc within the peripheral wetland zones) and physical alteration due to various activities that take place within the wetland zones (an established brickworks, sand winning, dumping of rubble, etc).

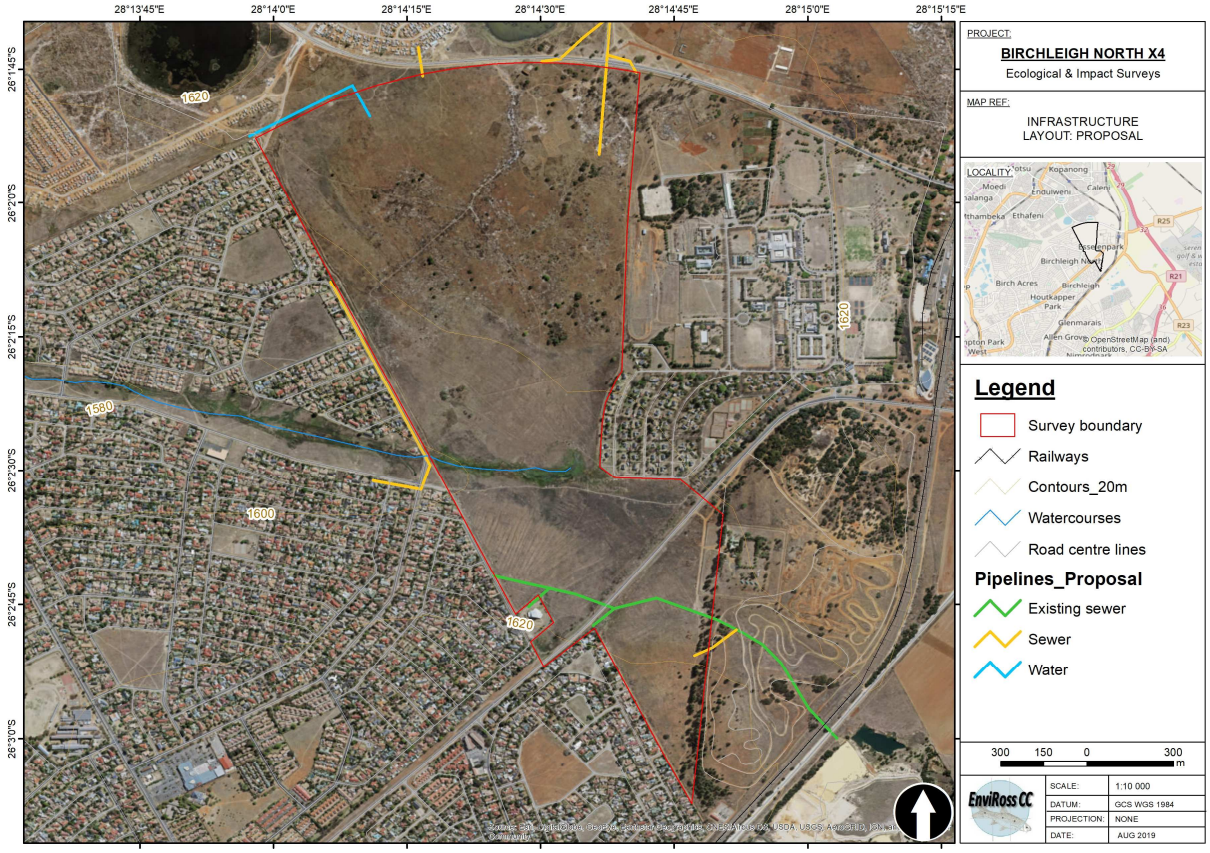


Figure 3: The proposal for the alignments of the various sewer and bulk water pipelines.

Figure 3 presents the proposed alignments of the various pipelines. The proposed sewer line in the south seeks to join into the existing ERWAT sewer line so no further significant excavations within the wetland unit within this area will be necessary. These pipelines are aligned to allow for service delivery whilst representing the comparably lesser overall impact of the two presented alternatives

as it impacts the least on the wetland features (the areas identified as ecologically sensitive within the survey site.

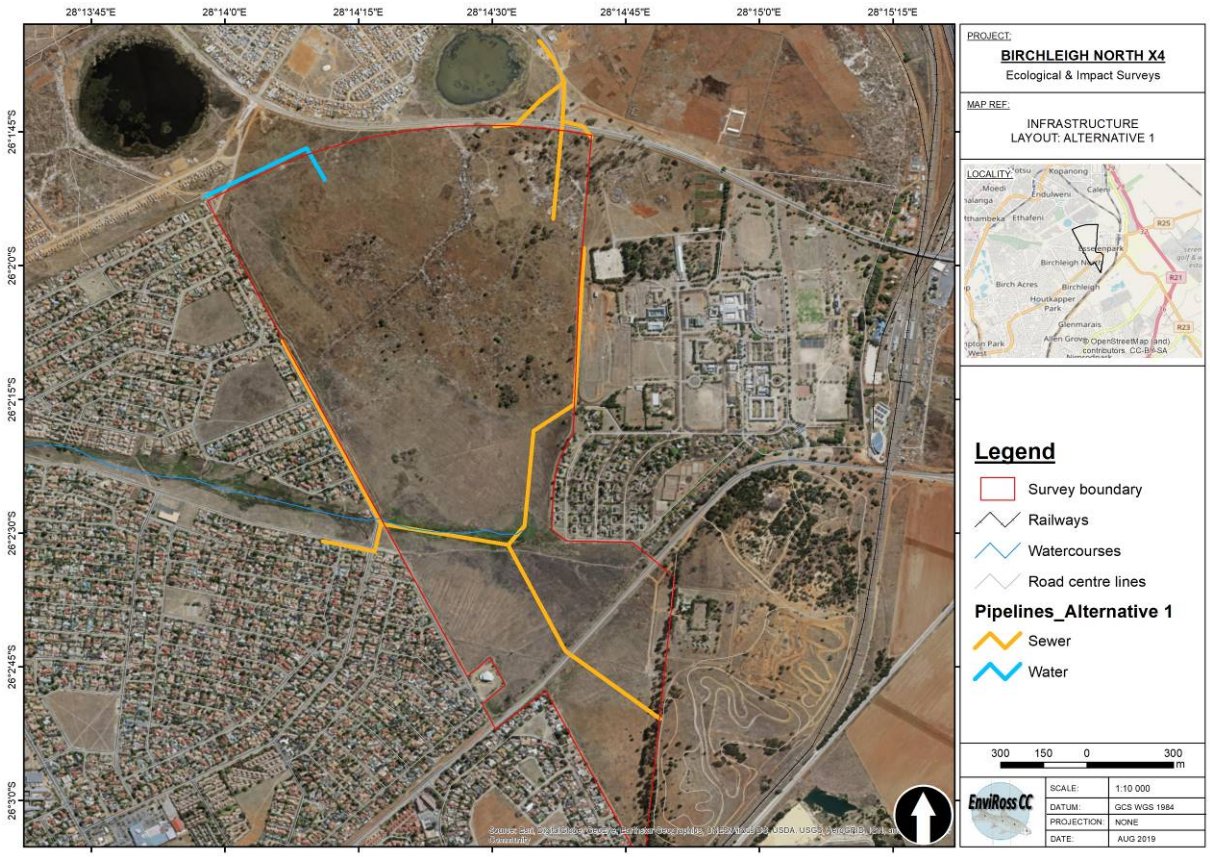


Figure 4: The alternative alignments of the various sewer and bulk water pipelines.

Figure 4 presents the alternative to the proposed pipeline alignments. It requires a pipeline to be established that runs parallel to the existing watercourse of the wetland unit that runs through the site. Although the impacts associated with pipeline excavation within wetland units can be successfully mitigated, it represents the greater ecological impact of the two presented alternatives.

1.3. Scope of Work

The Scope of Work for the ecological survey included a general terrestrial biodiversity ecological and impact survey, and a surface water ecosystem survey, including wetland delineation, ecological integrity and impact survey. The determination of the overall ecological impacts of the proposed development site allows for the designation of the required conservation buffer zones as a protective

factor to the areas regarded as being ecologically sensitive. Mitigation measures to abate these impacts that would allow for the ongoing functionality of the wetlands are then to be proposed.

1.4. Aims & Objectives

The objective of this report is to provide the relevant biological information pertaining to the status of the biodiversity and ecological features pertaining to the area and the implications of the potential to the planning, management and construction teams of the proposed development activities, so as to minimise the ecological impacts.

1.5. Assumptions & Limitations

The conclusions to overall perceived impacts have been based on a desktop survey that was reiterated by ground-truthing through a field survey of the proposed development area. Even though every effort was undertaken to identify ecologically sensitive habitats, the presence of RDL and protected species and other pertinent ecological issues relating to the project, the limited time spent on site (limited to a single field survey) necessitated certain assumptions regarding the potential presence or absence of species to be made. These assumptions were largely based on the professional judgement that is supported by similar field experience within similar areas of the specialist. More accurate species accounts (especially in terms of specific localities of RDL and protected species) will be possible with long term data. Long term and extensive field surveys are not thought to provide significantly beneficial data, however.

2. APPLICABLE LEGISLATION

2.1. Surface water ecosystems

2.1.1. National

Conservation of wetland habitat units and resources is protected by a myriad of legislature, including the Constitution of South Africa (Act no 108 of 1996), which states that everyone has a right to an environment that is not harmful or detrimental to their health and which is sustainable for future

generations. Further to this, South Africa uses environmental-specific legal frameworks based on principles found in the National Environmental Management Act (NEMA) (Act no 107 of 1998). Section 28 (1) states that any person who causes or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

The National Water Act (Act no 36 of 1998), which is the main water regulation statute of South Africa, defines what is meant as a "water use" as activities that require authorisation. Sections most applicable to developments impinging upon or within wetland boundaries are section 21(c) *impeding or diverting the flow of water in a watercourse;* and 21(i) *altering the bed, banks, course or characteristics of a watercourse*. As per definition, this means any change affecting the resource quality within the riparian habitat or 1:100 year floodline, whichever is the greater distance. Subsequent to this, DWA issued a Government Notice (GN) within the Government Gazette, No 1199 (18 December 2009), in which Section 6(b) indicates that any development within a 500 m radius of any wetland must seek authority through a Water User Licence Application (WULA) and that authority for these activities through a General Authorisation is no longer applicable. As the development activities are within a 500 m radial regulatory zone of the surrounding wetlands, authority will have to be sought prior to any development taking place.

2.1.2. Provincial

Provincial legislature pertaining to surface water resources and habitat units (rivers and wetlands) falls under the authority of GDARD (Gauteng Department of Agriculture and Rural Development). The GDARD sensitivity mapping rules stated within the *Minimum requirements for Biodiversity Assessments (2014)* state that the following conservation buffer zones are applicable to these habitat units:

- Rivers (perennial and non-perennial) *inside* the urban edge – 32 m from the outer edge of the riparian zones;
- Rivers (perennial and non-perennial) *outside* of the urban edge – 100 m from the outer edge of the riparian zones;
- Wetlands *inside* the urban edge – 30 m buffer zone from the outside of the temporary zones;

- Wetlands *outside* of the urban edge – 100 m buffer zone from the outside of the temporary zones.

The urban edge referred to is provided as a digital GIS shapefile (2010) by GDARD. The survey area falls within the designated urban edge, making a 30 m mandatory conservation buffer zone applicable.

2.2. Terrestrial biodiversity

The National Environmental Management Act (NEMA), 1998 (Act 107 of 1998) is the principle legislation governing Environmental Impact Assessment, under the authority of the National Department of Environmental Affairs, and is applicable to both water resources and terrestrial habitat units. NEMA makes provisions for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of the State and to provide for matters connected therewith. Section 2 of the Act establishes a set of principles, which apply to the activities of all organs of state that may significantly affect the environment. These include the following:

- Development must be sustainable;
- Pollution must be avoided or minimised and remedied;
- Waste must be avoided or minimised, reused or recycled;
- Negative impacts must be minimised and positive enhanced; and responsibility for the environmental health and safety consequences of a policy, project, product or service exists throughout its entire life cycle.

2.2.1 National Environmental Management Act: Biodiversity Act

The National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) operates in conjunction with the National Environmental Management: Protected Areas Act No. 57 of 2003. Both Acts emerge from the recommendations of the White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (1998) and were originally conceived of as one Act.

Within the framework of the National Environmental Management Act, to provide for:

- the management and conservation of biological diversity within the Republic and of the components of such biological diversity;

- the use of indigenous biological resources in a sustainable manner; and
- the fair and equitable sharing among stakeholders of benefits arising from bio-prospecting involving indigenous biological resources;
- to give effect to ratified international agreements relating to biodiversity which are binding on the Republic;
- to provide for co-operative governance in biodiversity management and conservation; and to provide for a South African National Biodiversity Institute (SANBI) to assist in achieving the objectives of the Act.

The Act provides specifically for the issuing of permits. Before issuing a permit, the issuing authority may in writing require the applicant to furnish it, at the applicant's expense, with such independent risk assessment or expert evidence as the issuing authority may determine. Regulations may be made pertaining to various matters regulated by the Act, offences and penalties are provided for, and consultation processes are prescribed. Should Red Data species be directly affected by the proposed project, then the necessary permits will be required to be applied for. A list of the protected species that fall under the auspice of the Act was published within the Government Gazette No 30568, under Government Notice No R 1187 issued on 14 December 2007.

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

The National Forest Act, 1998 (Act No. 84 of 1998) was promulgated to provide for the sustainable management and development of forests for the benefit of all and to promote the sustainable use of these forests. In addition to this function the Act also provides for the protection of trees which are threatened. A protected tree list was published in GN 33566 of 23 September 2010 and will need to be consulted during the preconstruction phase. Should a protected tree species occur within the proposed development footprint area that will require removal, authority will have to be sought in accordance with the Act.

3. METHODS OF INVESTIGATION

3.1. Desktop survey

Scrutiny of topographical maps, aerial photography and available GIS mapping databases (provincial and national) as well as the latest available literature were used to set the baseline data for the various route alternatives. A large source of data was from the SANBI Biodiversity GIS website

(www.bgis.sanbi.org.za) with specific reference to the status of ecosystems and biodiversity within the area.

3.2. Field survey

A field survey was undertaken to assess the site during December 2018, during which various areas pertaining to the proposed development area were assessed. This field survey allowed for the ground-truthing identification of ecologically sensitive habitat, the overall ecological integrity of the vegetation structures, and the areas where RDL and protected faunal and floral species could potentially occur. The general degree of transformation of the habitat types and units were also assessed during the field survey that allowed for overall general impressions as well as to allow for generalisations regarding habitat sensitivity. This allowed for cross-referencing to those data that were gathered during the desktop survey. The field survey was also undertaken to assess the extent of any wetland habitat units associated with the proposed development area as well as to assess the overall ecological condition of the terrestrial habitats, wetlands and any other habitat features of ecological significance associated with the proposed project development area.

Visual observations were undertaken to identify floral features of the site, including vegetation species composition, vegetation structures and evaluation of exotic vegetation encroachment. Faunal features were assessed through direct (visual observations) and indirect (call, scat and spoor identification) observations. Habitat availability, condition and ecological integrity was analysed during the field survey in order to cross reference the species from known historical distribution records and the potential of the survey area to support those species due to habitat availability.

3.3. Wetland survey

3.3.1. Wetlands forms and functions

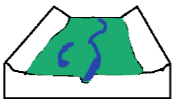
A wetland is defined as land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water and which, under normal circumstances, supports or would support vegetation typically adapted to life in saturated soil (National Water Act 36 of 1998). The identification of a wetland therefore requires a combination of factors, including hydrological (water drainage and movement),

geomorphological (soil types, characteristics and inundation) as well as vegetation (identification of hydrophytic species and communities).

3.3.2. Hydrogeomorphic forms

The classification of the hydrogeomorphic forms of wetlands associated with the proposed development site are based on those defined in Table 1. The vast majority of the wetland habitat units have an association with a defined channel and are driven by sediment transport properties. This is influenced by erosion factors within the catchment area.

Table 1: Hydrogeomorphic forms of wetland habitat units.

Hydrogeomorphic types		Description	Source of water maintaining the wetland	
			Surface	Sub-surface
Floodplain		Valley bottom areas with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
Valley bottom with a channel		Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/***
Valley bottom without a channel		Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from the channel entering the wetland and also from adjacent slopes.	***	*/***
Hillslope seepage linked to a stream channel		Slopes on hillsides, which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and output is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
Isolated hillslope seepage		Slopes on hillsides, which are characterised by the colluvial movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel.	*	***
Depression (includes pans)		A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.	*/***	*/***

One of the functions of wetlands is to trap sediments by dispersing water flow over a larger area and allowing the sediments to settle out because of the lowered water velocity and the trapping by vegetation. Mismanagement of wetland area will primarily impact the vegetation structures and ground cover. This leads to erosion formation as surface water will follow a defined pathway, with the result that a defined channel is created. Once a channel has been created, erosion features inhibit the establishment of vegetation and the banks of the watercourse become unstable. A defined channel typically increases water velocities and therefore the transport of sediments, which means that sediments remain in suspension rather than settling out. When wetland functionality is adversely impacted, the capacity to trap sediments is therefore lost, with the result that aquatic habitats downstream become smothered through siltation where the sediments eventually do settle out. Sediment transport to the wetlands has been greatly enhanced through the overgrazing of livestock within wetland areas, and stripping of the vegetation to accommodate semi-formal, high density housing on the steep slopes along the eastern areas, as well as the informal sand winning activities that enhance both alluvial and colluvial sediment transport to the wetland areas (lowest point within the landscape). This has also had an adverse effect on the hydrology and geomorphological characteristics of the systems.

3.3.3. Soil types and characteristics

The occurrence of wetland conditions is almost primarily due to a combination of soil conditions (including stratification characteristics), soil type, and a water source (surface water, lateral movement of soil water, or the upwelling of groundwater). Soil forms that are regarded as being always associated with wetland conditions include Champagne, Katspruit, Willowbrook and Rensburg soils. Those soil forms that are *sometimes* associated with wetlands include Inhoek, Klapmunts, Dresden, Bloemdal, Dundee, Longlands, Tukulu, Avalon, Witfontein, Wasbank, Cartref, Pinedene, Sterkspruit, Lamotte, Fernwood, Glencoe, Sepane, Estcourt, Westleigh, Bainsvlei and Valsrivier (DWAF, 1999).

The degree of soil saturation is also important in discerning temporary, seasonal and permanent zones of wetland habitat units, as well as the colour (chroma) and degree of ferrolysis (observable as mottling) within the upper 500 mm of the soil profile. This feature is elaborated on under the section of Wetland Delineation Methods.

3.3.4. Vegetation structures

Wetlands tend to be transitional in nature and therefore a gradual transition of soils, inundation and vegetation structures can be observed from the terrestrial areas, temporary, seasonal and into the permanent zones of a wetland. The ability to identify and differentiate wetland floral species as being obligate wetland species, facultative wetland species, facultative species and facultative dryland species is important in discerning the occurrence of wetland conditions.

3.3.5. Wetland delineation methods

The wetland delineation assessment includes review of topographical maps and aerial photographs and an 'on-site' evaluation of the wetland and associated vegetation structure condition. This includes the general ecological integrity of the wetland itself as well as the identification of any sensitive biota that are potentially dependant on the wetland (if applicable).

The wetland delineation procedure takes into account (according to DWS guidelines for wetland delineations, 2008) the following attributes to determine the limitations of the wetland:

- Terrain Unit Indicator – helps to identify those parts of the landscape where wetlands are more likely to occur;
- Soil Form Indicator – identifies the hydromorphic soil forms, which are associated with prolonged and frequent saturation and associated anoxia and ferrolysis;
- Soil Wetness Indicator – identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and,
- Vegetation Indicator – identifies hydrophilic vegetation associated with frequently saturated soils.

According to the wetland definition used in the National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason is that vegetation responds relatively quickly to changes in soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained (perhaps several centuries) (DWA, 2005).

3.3.5.1. Terrain Unit Indicator (TUI)

The TUI takes into consideration the topography of the area to determine those areas most likely to support a wetland (DWA, 2008). These include depressions and channels where water would be most likely to accumulate. This is done with the aid of topographical maps, aerial photographs and engineering and town planning diagrams (these are most often used as they offer the highest degree of detail needed to accurately delineate the various zones of the wetland). Seepage zones are also very often characterised by depressions, the identification of which aids in determining the presence of a wetland.

3.3.5.2. Soil Form Indicator (SFI)

The SFI takes into account the identification of hydromorphic soils that display unique characteristics resulting from prolonged and repeated saturation. This ongoing saturation leads to the soil eventually becoming anaerobic and therefore a change in the chemical characteristics of the soil. Certain soil components, such as iron and manganese, which are insoluble under aerobic conditions, become soluble when the soil becomes anaerobic, and can thus be leached out of the soil profile. Iron is one of the most abundant elements in soils, and is responsible for the red and brown colours of many soils. Once most of the iron has been dissolved out of the soil as a result of the prolonged anaerobic conditions, the soil matrix is left a greyish, greenish or bluish colour, and is said to be "gleyed". A fluctuating water table, common in wetlands that are seasonally or temporarily saturated, results in alternation between aerobic and anaerobic conditions in the soil. Aerobic conditions in the soil leads to the iron returning to an insoluble state and being deposited in the form of patches or mottles within the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these insoluble iron compounds. Thus, soil that is gleyed and has many mottles may be interpreted as indicating a zone that is seasonally or temporarily saturated (DWA, 2005).

Soil samples are taken periodically in a line running perpendicular to the permanent water zone until the outer limits of this zone are identified. This normally coincides with a particular contour level, but transformations and modifications to the landscape often lead to the zone limits not conforming to this theory. Soil samples are taken using a Dutch-type soil auger to a depth of 500 mm. The soil sample is then examined for indications of soils particular to the characteristics described above.

Sample pits are also dug periodically as a more thorough and therefore more reliable means of confirming the presence or absence of hydromorphic soil characteristics. These were dug using a garden spade and the profiles thus created were examined for hydromorphic processes within the soil.

3.3.5.3. Soil Wetness Indicator (SWI)

In practise, this indicator is used as the primary indicator, but can be rendered unreliable during heavy rainfall periods. The colour of various soil components are also often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix. Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils, and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils, until they disappear altogether in dry soils (DWA, 2008). This indicator is also identified by taking a soil sample using a Dutch-type soil auger to a depth of 500 mm. The soil sample is then examined for indications of soils displaying these characteristics.

3.3.5.4. Vegetation Indicator (VI)

Vegetation is a key component of the wetland definition in the National Water Act (Act 36 of 1998). However, using vegetation as a primary indicator requires undisturbed conditions and expert knowledge (DWA, 2008). As a result of this, greater emphasis is often placed on the SWI and SFI. Nonetheless, plant community structure analyses are still viewed as helpful guides to finding the boundaries of wetlands. Plant communities undergo distinct changes in species composition along the wetness gradient from the centre of the wetland to the edge, and into adjacent terrestrial areas. This change in species composition provides valuable clues for determining the wetland boundary, and wetness zones. When using vegetation indicators for delineation, emphasis is placed on the group of species that dominate the plant community, rather than on individual indicator species (DWA, 2008). In wetlands that have undergone extensive transformation through landscaping, the vegetation unit indicators can potentially be absent.

3.3.6. Assessing the Present Ecological State (PES) of the wetland habitat units

3.3.6.1. Wetland Index of Habitat Integrity (WETLAND-IHI)

The WETLAND-IHI (Wetland Index of Habitat Integrity) was a wetland habitat assessment tool utilised to establish the overall PES of the various wetland habitat units associated with the proposed development area. The WETLAND-IHI was developed as a tool for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI was developed to allow the NAEHMP to include *floodplain and channelled valley bottom wetland types* to be assessed and the monitoring data incorporated into the national monitoring programme (DWA, 2007). The WETLAND-IHI was applied to each wetland habitat unit associated with the survey area and presented separately. The output scores of the WETLAND-IHI model are presented in the standard DWA A-F ecological categories (Table 2), and provide a score of the Present Ecological State (PES) of the habitat integrity of the wetland system being examined.

Table 2: Description of the A-F ecological categories (after Kleynhans, 1996; 1999) *from DWA, 2007.*

Ecological Category	PES % Score	Description
A	90-100%	Unmodified, natural.
B	80-90%	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified. A large loss of habitat, biota and basic ecosystem functions has occurred.
E	20-40%	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

The model is composed of four modules (shown in Figure 5). The *Hydrology, Geomorphology* and *Water Quality* modules all assess the contemporary *driving processes* behind the wetland formation and maintenance. The last module, *Vegetation Alteration*, provides an indication of the intensity of human land-use activities on the wetland surface itself and how these have modified the condition of the wetland. The integration of the scores from these 4 modules provides and overall PES score for the wetland system being examined (DWA, 2007).

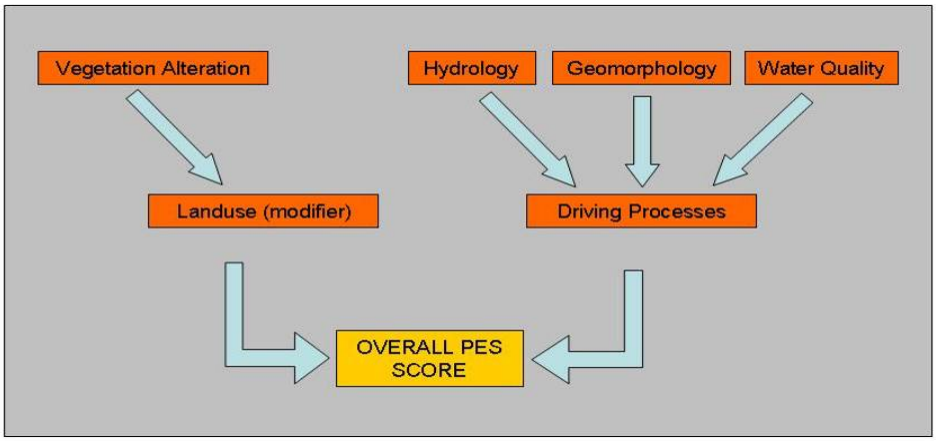


Figure 5: The four modules of the WETLAND-IHI model, and their relationship to the overall PES score, which is derived from them (from DWA, 2007).

Further observations of general ecological integrity at each site during the routine surveys will also be reported on. These points include:

- Erosion trends;
- Degree of siltation at downstream points;
- Unnecessary vegetation removal;
- Other general impacts on the aquatic system (dumping of rubble, litter, etc);
- Impacts of surrounding land use, including encroachment, restriction on the natural movement of water, etc.

3.3.6.2. WET-Ecoservices

WET-Ecoservices was used to assess the goods and services that individual wetlands provide (Kotze et al, 2007). This is taken as a combination of both ecological services and provision of services and resources to users. Through a series of scoring matrices for 15 different goods and service characteristics of a particular wetland, a rating score (out of 4) is provided. This is then compared to the class categories presented in Table 3. This sensitivity categorisation is based on strategic ecological functionality classes typical of environmental scoring systems, with this particular categorisation being based on those established by Wetland Consulting Services (2007).

Table 3: Recommended ecological importance and sensitivity categories (*taken from* WCS, 2007). Interpretation of the median values and categories is also provided.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and ≤4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and ≤3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and ≤2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and ≤1	D

3.3.7. Mapping, sensitivity analysis and designation of buffer zones

A handheld GPS (Global Positioning System) (Model: *Garmin Montana 650*) was used to mark the outer edges of the various wetland zones. This information was then used to generate digital shapefiles (ArcGIS) and maps of the various wetland zones.

National legislature does not specify a distance for buffer zone regulations pertaining to wetland units, but developments that are associated with surface water ecosystems are required to gain permission through the Department of Water and Sanitation (DWS) prior to permission being granted to start the construction phase of the proposed development. The current DWS guidelines allude to an "appropriate buffer zone in accordance to the surrounding land use" (DWAF, 2008). At the provincial level, GDARD has stipulated guidelines for designation of buffer zones to wetland units within the province (see Section 2.1.2.). The buffer zone regulations indicate a 30 m conservation buffer zone being applicable to all wetland units pertaining to the site. Special restrictions are imposed on construction activities that are to be undertaken within these conservation zones to limit the overall negative ecological impacts of these activities, and usually this area is also precluded from any impacting development activities.

Sensitivity mapping can then be developed for the proposed development area, which takes into consideration the ecologically sensitive features of the site, whilst considering the overall pressures and drivers of ecological change pertaining to the surrounding area.

3.3.8. DWS Risk Assessment Matrix

The DWS developed a risk-based analysis matrix (published in Government Gazette 39458, Notice 1180 of 2015, 27 Nov 2015) that stipulates that a Risk Assessment Matrix be applied to water users in terms of the National Water Act (Act 36 of 1998), which then allows for the categorisation of the severity of the ecological risks pertaining to proposed developments associated with wetland habitat units. Based on the outcome of the Risk Assessment Matrix, *Low* risk activities will be generally authorised with conditions, while *Moderate* to *High* risk activities will be required to go through a Water Use Licence Application (WULA) Process. Water use activities that are authorised in terms of the General Authorisations (GA) will still need to be registered with the DWS. The Risk Assessment Matrix has been used in the assessment of the risk posed to the wetland ecosystems for the proposed development in an attempt to better quantify the risk to the resource.

The categories (and interpretations of the scores) are assigned to the final ratings based on the ratings analysis (Table 4).

Table 4: Ratings of the risk and associated management descriptions (DWS, 2015).

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

4. RESULTS & DISCUSSIONS

4.1. General description of the study area

The survey area represents a green zone in amongst an otherwise urbanised setting. The R25 roadway bisects the survey site. This is a formal tarred road that caters for a large volume of traffic. It therefore poses a considerable migratory barrier for ground-dwelling species between the two areas of the site. The eastern part of the site is bordered by a residential area. The western boundary of the site includes residential, recreational and commercial sectors. The mixed-use (residential, commercial, industrial, recreational of both the formal an informal sectors) area of Tembisa forms the northern boundary of the site. The southern boundary includes a wastewater facility as well as an open area utilised for recreational motor cross (dirt-biking), quad biking and 4x4 tracks. The site itself can be regarded as an open grassland that is bisected by a wetland unit that originates within the southern portion that carries through to the northern portion, being supplemented by stormwater inflows from the east and west. This wetland unit has been impacted by historical infrastructure development, such as sewer lines.

The open grassland area located to the south of the R25, showing the avenue of exotic trees planted within the road reserve of the R25.

The open grassland area located to the south of the R25, showing the cultivated pine trees and the area where sewerage tankers access an open sewer line for disposal purposes. This is part of the existing ERWAT sewer line.

	
The open grassland area located to the south of the R25.	The open grassland area located to the south of the R25.
	
The road reserve of the R25, where wetland floral indicators occur due to the landscaped depression, and the resulting accumulation of sediments and moisture.	The road reserve of the R25, where wetland floral indicators occur due to the landscaped depression, and the resulting accumulation of sediments and moisture.
	
The open grassland area located to the north of the R25.	The open grassland area located to the north of the R25.

The wetland area.

The wetland area.

The northern area of the site showing the result of impacting features such as landscaping, dumping and exotic vegetation.

The northern area of the site showing the result of impacting features such as landscaping, dumping and exotic vegetation.

Figure 6: Various views of the general characteristics of the site.

The site is subject to varying forms and degrees of pressures and drivers of ecological change. Exotic vegetation is more prominent within the southern boundary area as well as a concentration associated with the road reserve areas of the R25. Informal dumping of building materials and rubble is concentrated along the peripheral areas as well as where roads allow access into the site. The central area includes a prominent linear wetland feature that runs in an east-west direction. The northern areas suffer from the greatest level of ecological degradation, where dumping of rubble and domestic refuse, landscaping and other high-impact land uses are prominent drivers of ecological change. Further to the north of the site are two prominent depression-type wetland features. Land uses such as informal mechanical workshops, cement brick manufacturing and informal trading all take place within the wetland zones, which have an obvious deleterious impact on the habitat unit.

The GDARD (Gauteng Department of Agriculture and Rural Development) has undertaken to map the areas that are regarded as being important to biodiversity conservation within the province. This is presented as the Conservation Plan (C-Plan ver 3.3). The association that the site has with the current C-Plan is presented in Figure 7.

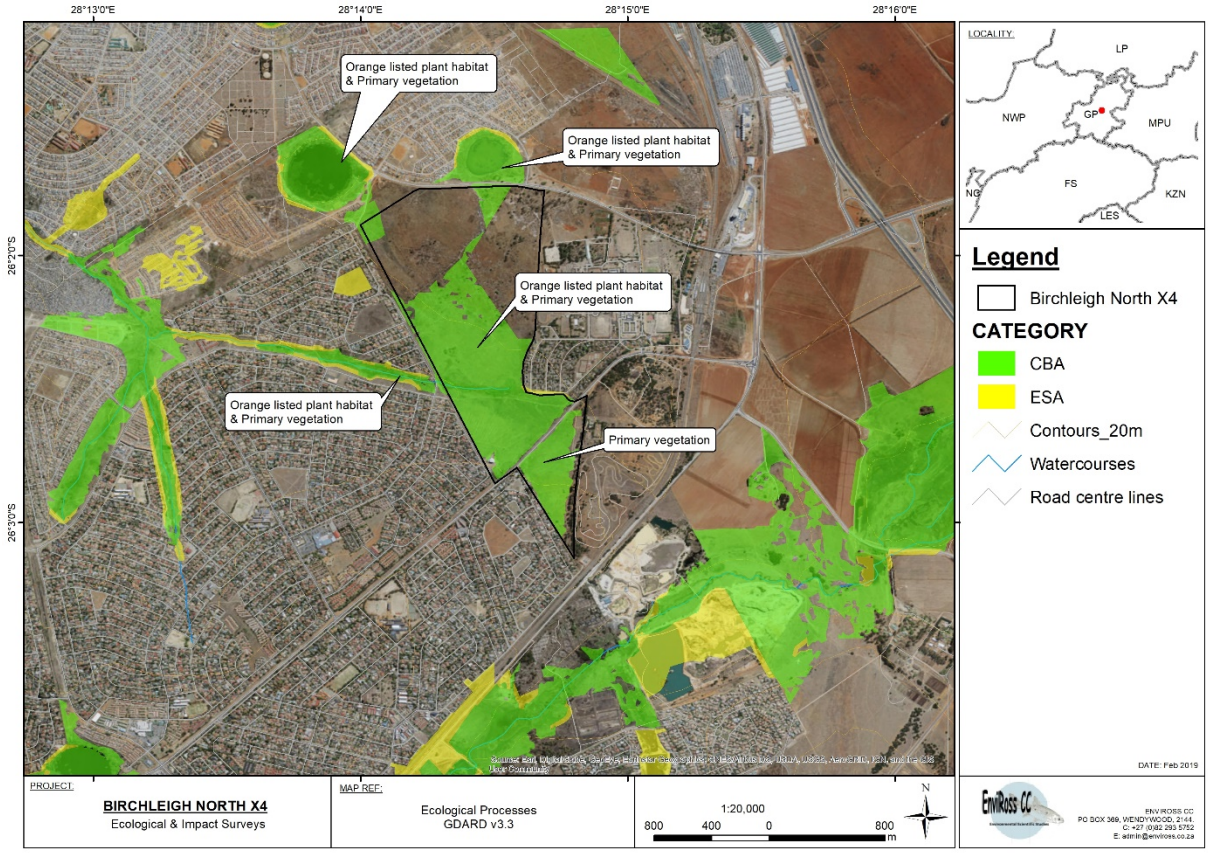


Figure 7: The ecological processes associated with the site according to the GDARD C-Plan (2010).

This comes in the form of CBA (critical biodiversity areas) and ESA (ecological support areas) zones. It can be seen from Figure 7 that the site has an association with both CBA as well as ESA areas for the reasons indicated on the figure. The designation of the area as a CBA indicates primary vegetation as the justification, but the field survey indicated that primary vegetation features are limited throughout the whole site. The wetland zone, being a linear habitat feature associated with a watercourse, has been designated as an ESA. This is justified and therefore the disturbances of these wetland areas should be limited.

4.2. Floral features

4.2.1. Floral endemism

Centres of floral endemism refer to areas that have characteristics that allow for a high degree of incorporation of endemic (specific to only that region, climatic zone, topographical features or other defining feature) floral species. The survey area does not fall within or near any centres of plant endemism.

4.2.2. Vegetation types and floral community structures

The proposed development site falls within the *Grassland* biome and falls within a transitional zone between the bioregions of Dry Highveld Grasslands (Carletonville Dolomite Grassland vegetation unit) and Mesic Highveld Grasslands (Egoli Granite Grasslands and Soweto Highveld Grasslands vegetation units). The proposed development site also includes a wetland unit with the vegetation unit being representative of Eastern Temperate Freshwater Wetlands (an azonal unit representative of the Freshwater Wetlands bioregion). The site therefore includes elements representative of all of these vegetation types where natural vegetation remains. Egoli Granite Grassland and Soweto Highveld Grassland, as vegetation units, are regarded as conservationally endangered, whereas Carletonville Dolomite Grassland has a lesser conservation status of vulnerable and Eastern Temperate Freshwater Wetland vegetation is regarded as least threatened. The pressures and drivers of ecological change associated with urbanisation, which include transformation of the vegetation to accommodate infrastructure development, agriculture and mining, are all factors that contribute to the decline of the representation of primary features. Overall geographical distribution and percentage of the unit represented within formally conserved areas also are factors that derive the conservation status of the units (Mucina & Rutherford, 2006). The conservation of primary vegetation features where they occur within areas large enough to be considered as conservationally sustainable is therefore important to the preservation of these vegetation units. The regional vegetation mapping is presented in Figure 8.

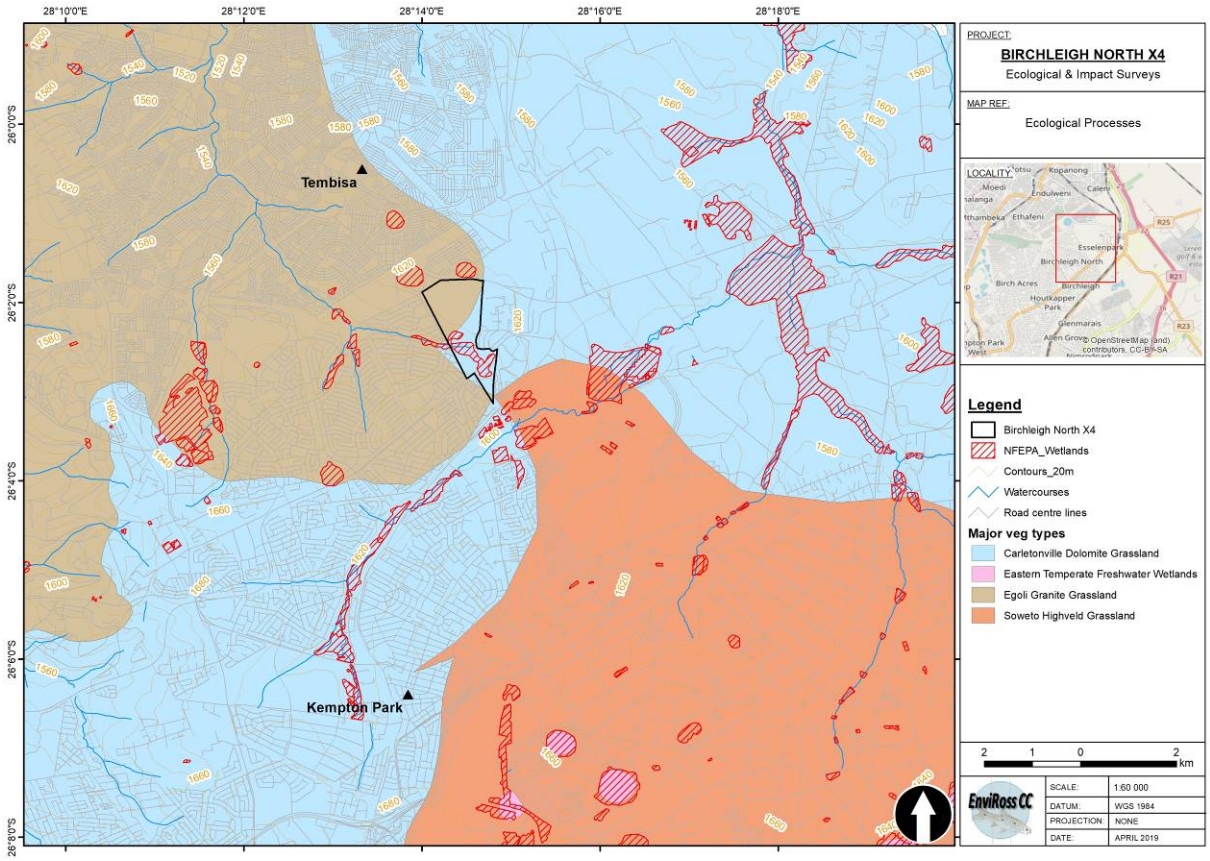


Figure 8: Vegetation mapping and other ecological processes associated with the proposed development site.

As Soweto Highveld Grassland does not fall directly within the boundaries of the proposed site, it will not be dealt with in more detail within the descriptive sections that follow.

4.2.2.1. Egoli Granite Grassland

Egoli Granite Grassland occurs on moderately undulating plains and low hills supporting tall, usually *Hyparrhenia hirta*-dominated grasslands, with some woody species on rocky outcrops or rock sheets. The geology is dominated by Archaean Granite and Gneiss of the Halfway House granites at the core of the Johannesburg Dome, supporting leached, shallow, coarsely-grained and sandy soil poor in nutrients of the Glenrosa form. Small areas are built by ultramafics. The rocky habitat show a high diversity of woody species, which occur in the form of scattered shrub groups or solitary small trees. Its distribution is limited to Gauteng Province, and occurs within the Johannesburg Dome, extending in the region between northern Johannesburg (in the south), and from near Lanseria Airport and Centurion (south of Pretoria) to the north, westwards to about Muldersdrif and eastwards to

Tembisa (Mucina & Rutherford, 2006). Table 5 presents the floral species that are regarded as being diagnostic of primary vegetation status of the vegetation unit.

Table 5: Diagnostic floral components of Egoli Granite Grassland (SANBI, 2006).

Trees/Shrubs	Herbs	Grasses/Sedges
Aristida canescens (d)	*Acalypha angustata*	*Vangueria infausta*
Aristida congesta (d)	*Acalypha peduncularis*	*Rhus pyroides*
Cynodon dactylon (d)	*Becium obovatum*	*Anthospermum hispidulum*
Digitaria monodactyla (d)	*Berkheya insignis*	*Anthospermum rigidum* subsp. *pumilum*
Eragrostis capensis (d)	*Crabbea hirsuta*	
Eragrostis chloromelas (d)	*Cyanotis speciosa*	*Gnidia capitata*
Eragrostis curvula (d)	*Dicoma anomala*	*Helichrysum kraussii*
Eragrostis racemosa (d)	*Helichrysum rugulosum*	*Ziziphus zeyheriana*
Heteropogon contortus (d)	*Justicia anagalloides*	*Lopholaena coriifolia*
Hyparrhenia hirta (d)	*Kohautia amatymbica*	
Melinis repens subsp. *repens* (d)	*Nidorella hottentotica*	
Monocymbium ceresiiforme (d)	*Pentanisia prunelloides* subsp. *latifolia*	
Setaria sphacelata (d)		
Themeda triandra (d)	*Pseudognaphalium luteo-album*	
Tristachya leucothrix (d)	*Senecio venosus*	
Andropogon eucomus (c)		
Aristida aequiglumis (c)	Geophytic herbs:	
Aristida diffusa (c)		
Aristida scabrivalvis subsp. *borumensis* (c)	*Cheilanthes deltoidea*	
Bewsia biflora (c)	*Cheilanthes hirta*	
Brachiaria serrata (c)		
Bulbostylis burchelli (c)		
Cymbopogon caesius (c)		
Digitaria tricholaenoides (c)		
Diheteropogon amplectens (c)		
Eragrostis gummiflua (c)		
Eragrostis sclerantha (c)		
Panicum natalense (c)		
Schizachyrium sanguineum (c)		
Setaria nigrirostris (c)		
Tristachya rehmannii (c)		
Urelytrum agropyroides (c)		

The greater majority of the central to northern portions of the site include this vegetation type, but these areas showed the greatest degree of degradation due to the land use. Some indigenous species were noted that are included as diagnostic features, but the community structures indicated no retention of primary grassland features. Much of these areas was dominated by exotic pioneering annual weeds. The observed floral species list is presented in Table 24.

The plant species community structures observed showed that the grasslands were not considered to have retained primary grassland features.

4.2.2.2. Carletonville Dolomite Grassland

Carletonville Dolomite Grasslands is distributed in the North-West, Gauteng and marginally in the Free State Provinces in the region of Potchefstroom, Ventersdorp and Carletonville. It extends westward to the vicinity of Ottoshoop, but also occurs as far east as Centurion and Bapsfontein in Gauteng Province, where occurs at an altitude of 1,360-1,620m, but largely between 1,500 and 1,560m AMSL on slightly undulating plains dissected by prominent rocky chert ridges. It is characterised by species-rich grasslands forming a complex mosaic pattern dominated by many species. It occurs on geologies dominated by dolomite and chert of the Malmani Subgroup (Transvaal Supergroup) supporting mostly shallow Mispah and Glenrosa soil forms typical of the Fa land type. Deeper red to yellow apedal soils (Hutton and Clovelly forms) occur sporadically, representing the Ab land type. Table 6 presents the dominant and diagnostic floral species typical of the vegetation unit.

Table 6: Important and dominant floral species typical of *Carletonville Dolomite Grassland* (Mucina & Rutherford, 2006).

Grasses/sedges	Forbs	Trees/shrubs
Aristida congesta *Cynodon dactylon* *Brachiaria serrata* *Digitaria tricholaenoides* *Diheteropogon amplectens* *Eragrostis chloromelas* *Eragrostis racemosa* *Heteropogon contortus* *Loudetia simplex* *Schizachyrium sanguineum* *Setaria sphacelata* *Themeda triandra* *Alloteropsis semialata* subsp. *eckloniana* *Andropogon schirensis* *Aristida canescens* *Aristida diffusa* *Bewsia biflora* *Bulbostylis burchellii* *Cymbopogon caesius* *Cymbopogon pospischilii* *Elionurus muticus* *Eragrostis curvula* *Eragrostis gummiflua* *Eragrostis plana* *Eustachys paspaloides* *Hyparrhenia hirta* *Melinis nerviglumis* *Melinis repens* subsp. *repens* *Monocymbium ceresiiforme*	*Acalypha angustata* *Barleria macrostegia* *Chamaecrista mimosoides* *Chamaesyce inaequilatera* *Crabbea angustifolia* *Dianthus mooiensis* *Dicoma anomala* *Helichrysum caespititium* *Helichrysum miconiifolium* *Helichrysum nudifolium* var. *nudifolium* *Ipomoea ommaneyi* *Justicia anagalloides* *Kohautia amatymbica* *Kyphocarpa angustifolia* *Ophrestia oblongifolia* *Pollichia campestris* *Senecio coronatus* *Vernonia oligocephala* *Boophane disticha* *Habenaria mossii*	*Anthospermum rigidum* subsp. *pumilum* *Indigofera comosa* *Pygmaeothamnus zeyheri* var. *rogersii* *Rhus magalismontana* *Tylosema esculentum* *Ziziphus zeyheriana* *Elephantorrhiza elephantina* *Parinari capensis* subsp. *capensis*

Grasses/sedges	Forbs	Trees/shrubs
Panicum coloratum *Pogonarthria squarrosa* *Trichoneura grandiglumis* *Triraphis andropogonoides* *Tristachya leucothrix* *Tristachya rehmannii*		

The observed floral species list is presented in Table 24. The plant species community structures observed showed that the grasslands were not considered to have retained primary grassland features.

4.2.2.3. Eastern Temperate Freshwater Wetlands

Eastern Temperate Freshwater Wetlands is distributed in the Northern Cape, Eastern Cape, Free State, North-West, Gauteng, Mpumalanga and Kwazulu-Natal Provinces as well as in neighbouring Lesotho and Swaziland where it surrounds water bodies with stagnant water (lakes, pans, periodically flooded vleis, edges of calmly flowing rivers. It is supported by flat landscapes or shallow depressions filled with (temporary) water bodies supporting zoned systems of aquatic and hygrophilous vegetation of temporarily flooded grasslands and ephemeral herblands. It is embedded in the grassland biome within an altitude range of 750-2,000m. The unit is found on younger Pleicostene to recent sediments overlying fine-grained sedimentary rocks of the Karoo Supergroup (on sediments of both Ecca and Beaufort Groups due to the large extent of the area of occurrence) as well as of the much older dolomites of the Malmani Subgroup of the Transvaal Supergroup in the northwest. Especially in the areas built by Karoo Supergroup, sediments area associated with the occurrence of Jurassic Karoo dolerite dykes having a profound influence on run-off. Soils are peaty (Champagne soil form) to vertic (Rensburg soil form). The vleis from where flow of water is impeded by impermeable soils and/or by erosion resistant features, such as dolerite intrusions. Many vleis and pans of this type of freshwater wetlands are inundated and/or saturated only during the summer rainfall season, and for some months after this into the middle of the dry winter season, but they may remain saturated all year round. Surface water inundation may be present at any point while the wetland is saturated and some plant species will be present only under inundated conditions, or under permanently-inundated conditions. The presence of standing water should not be taken as sign of permanent wet conditions. The dominant and diagnostic floral species for the vegetation type are presented in Table 7.

Table 7: Dominant and typical floristic species of Eastern Temperate Freshwater Wetlands (Mucina & Rutherford, 2006).

Grass/sedge/reed species		Forb species	
Marshes			
Cyperus congestus *Agrostis lachnantha* *Carex acutiformis* *Eleocharis palustris* *Eragrostis plana* *Eragrostis planiculmis* *Fuirena pubescens* *Helictotrichon turgidulum* *Hemarthria altissima* *Imperata cylindrica* *Leersia hexandra* *Paspalum dilitatum* *Paspalum urvillei* *Pennisetum thunbergii* *Schoenoplectus decipiens* *Scleria dieterlenii* *Setaria sphacelata* *Andropogon appendiculatus* *Andropogon eucomus* *Aristida aequiglumis* *Ascolepis capensis*	*Carex austro-africana* *Carex schlechteri* *Cyperus cyperoides* *Cyperus distans* *Cyperus longus* *Cyperus marginatus* *Echinochloa holubii* *Eragrostis micrantha* *Ficinia acuminata* *Fimbristylis complanata* *Fimbristylis ferruginea* *Hyparrhenia dregeana* *Hyparrhenia quarrei* *Ischaemum fasciculatum* *Kyllinga erecta* *Panicum schinzii* *Pennisetum sphacelatum* *Pycreus macranthus* *Pycreus nitidus* *Setaria pallide-fusca* *Xyris gerrardii*	*Centella asiatica* *Ranunculus multifidus* *Berkheya radula* *Berkheya speciosa* *Berula erecta* subsp. *thunbergii* *Centella coriacea* *Chironia palustris* *Equisetum ramosissimum* *Falckia oblonga* *Haplocarpha lyrata* *Helichrysum difficile* *Helichrysum dregeanum* *Helichrysum mundtii* *Hydrocotyle sibthorpioides* *Helichrysum verticillata* *Lindernia conferta* *Lobelia angolensis* *Lobelia flaccida* *Mentha aquatica*	*Monopsis decipiens* *Pulicaria scabra* *Pycnostachys reticulata* *Rorippa fluviatilis* var. *fluviatilis* *Rumex lanceolatus* *Senecio inornatus* *Senecio microglossus* *Sium repandum* *Thelypteris confluens* *Wahlenbergia banksiana* *Cordylogyne globosa* *Crinum bulbispermum* *Gladiolus papilio* *Kniphofia ensifolia* *Kniphofia fluviatilis* *Kniphofia linearifolia* *Neobolusia tysonii* *Nerine gibsonii* *Satyrium hallackii* subsp. *hallackii*
Reed & Sedge beds			
Phragmites australis (d) *Schoenoplectus corymbosus*	*Typha capensis* *Cyperus immensus* *Carex cernua*	*None*	
Waterbodies			
None		*Aponogeton junceus* *Ceratophyllum demersum* *Lagarosiphon major* *Lagarosiphon muscoides* *Nymphoides thunbergiana* *Potamogeton thunbergii* *Utricularia inflexa*	*Marsilea farinosa* subsp. *farinosa* *Marsilea capensis* *Myriophyllum spicatum* *Nymphaea lotus* *Nymphaea nouchali* var. *caerulea*

(*(d) – Dominant species for the vegetation type; (c) – Common species for the vegetation type.)

Figure 9: Various views of the features associated with Eastern Temperate Freshwater Wetlands within the site as well as for the depression wetland located further to the north.

4.2.3. Floral species of conservational concern & protected species

The desktop survey for protected, RDL and Orange listed floral species, showed that various species of conservational concern do occur within the Quarter Degree Square (QDS) grid associated with the proposed development area (and also according to the latest available data from SANBI [2019]). Specific localities of these species are not alluded to as a protection factor against rare plant collectors and therefore only references to the QDS in which they have been recorded are provided (SANBI, 2019). As these QDS areas are relatively large (approximately 920 km^2) they incorporate a wide diversity of habitat types. The presence of these habitat types within the QDS that are relevant to the habitat requirements of the recorded RDL and protected floral species are then of particular relevance to the project. Figure 10 presents that analysis of the conservation status of the floral species recorded from the region. This is from the QDS of 2628AA, and so includes an area far greater, with a wider diversity of habitat units, than that proposed development site. From this it

was found that, of the 1040 floral species recorded from the region (excluding species cultivated within residential gardens), there are no critically endangered species, and one endangered species that occurs within the region. Three vulnerable species has been recorded (1%). Six (1%) species are regarded as near threatened, and one as critically rare. There are three species included as declining, and five as data deficient. Of the remaining 1020 species, 870 (84%) are regarded as being of least concern and 150 (14%) are naturalised exotic species.

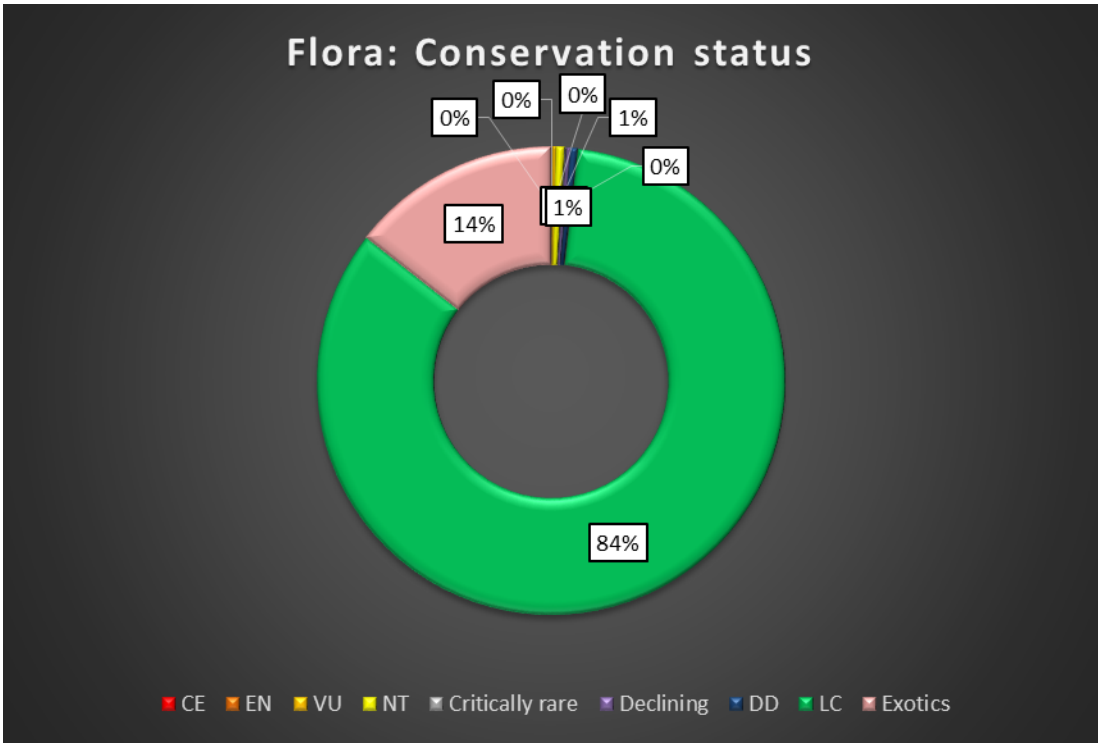


Figure 10: Conservation status analysis of the floral species recorded from the region.

The desktop survey indicated that four species recorded from the region are regarded as Red Data Listed (Table 8). From the habitat notes provided, it can be seen that the proposed development site does not offer viable habitat for this species through the lack of the particular habitat units, but also through the largely transformed nature of the area. Orange listed species, which include those categorised as declining or data deficient are also presented in the table, of which one species, namely *Hypoxis hemerocallidea* (Hypoxidaceae) was noted. Observations of individuals of this species were noted throughout grassland areas. This is a commonly occurring species within its distribution range, which is declining due to collection pressure for the traditional medicine trade. It is a bulbous species that takes readily to removal and translocation if required. It should be noted that the impacts to the proposed recipient site should be investigated prior to translocation.

Table 8: Floral species of conservational concern recorded from the region associated with the proposed development site.

Family	Species	Cons status	Notes
RED LISTED SPECIES			
PROTEACEAE	*Leucadendron daphnoides* (Thunb.) Meisn.	EN	Not applicable - locality
ASTERACEAE	*Cineraria longipes* S.Moore	VU	Gauteng endemic, found in Klipriviersberg and Suikerbosrand, inhabiting grassland, amongst rocks and along seepage lines, exclusively on basalt kopjes on south-facing slopes. Threatened as a result of extensive habitat loss over a long period of time only six subpopulations of this species now remain, occupying an estimated AOO of 5-14 km². Conservation policies are in place to prevent further destruction of the habitat, however, it remains potentially threatened (Pfab & Victor, 2005). *No viable habitat within the scope of the proposed development site.*
FABACEAE	*Indigofera hybrida* N.E.Br.	VU	Not applicable - locality
MESEMBRYA-NTHEMACEAE	*Khadia beswickii* (L.Bolus) N.E.Br.	VU	Open shallow soil over rocks in grassland. 10 known locations are declining due to habitat loss to urban and infrastructure development, alien plant invasion, mining and collecting for the specialist succulent horticultural trade (Victor & Pfab, 2005). *No viable habitat within the scope of the proposed development site.*
ORANGE LISTED SPECIES			
APOCYNACEAE	*Stenostelma umbelluliferum* (Schltr.) S.P.Bester & Nicholas	NT	SA endemic, GP & NWP. Pretoria North and adjacent areas in North West Province. Suspected to occur at 13 locations, declining as a result of urban expansion. Occur in terrestrial savanna, in deep black turf in open woodland mainly in the vicinity of drainage lines (Victor & Pfab, 2007). *No viable habitat within the scope of the proposed development site.*
ASPHODELACEAE	*Trachyandra erythrorrhiza* (Conrath) Oberm.	NT	Threatened by habitat loss and fragmentation due to urban development, crop cultivation and invasive plant species. A terrestrial species found in black turf marshes (Mills & Raimondo, 2013). *No viable habitat within the scope of the proposed development site.*
ASTERACEAE	*Cineraria austrotransvaalensis* Cron	NT	Scattered throughout Gauteng and the North West Province and at Standerton in southern Mpumalanga. Terrestrial, grasslands and savanna, where it occurs amongst rocks on steep hills and ridges, at the edge of thick bush or under trees on a range of rock types: quartzite, dolomite and shale, 1400-1700 m (Cron *et al.,* 2006). *No viable habitat within the scope of the proposed development site.*

Family	Species	Cons status	Notes
CRASSULACEAE	*Adromischus umbraticola* C.A.Sm. subsp. umbraticola	NT	Terrestrial savanna, where it occurs on South-facing rock crevices on ridges, restricted to Gold Reef Mountain Bushveld in the northern parts of its range, and Andesite Mountain Bushveld in the south (Helme & Raimondo, 2006). *No viable habitat within the scope of the proposed development site.*
FABACEAE	*Pearsonia bracteata* (Benth.) Polhill	NT	Terrestrial, savanna and plateau grassland. An estimated eight to 14 locations continue to decline due to ongoing habitat loss to urban development, agriculture and mining in Gauteng and North West. Southern populations in Gauteng and North West are threatened by habitat loss to agriculture, urban expansion, mining, quarrying and alien invasive plants (von Staden, 2011). *No viable habitat within the scope of the proposed development site.*
ORCHIDACEAE	*Holothrix randii* Rendle	NT	Terrestrial grasslands, where it occurs on grassy slopes and rock ledges, usually southern aspects. Declining as a result of urban expansion in the Gauteng area. (Pfab & Victor, 2009). *No viable habitat within the scope of the proposed development site.*
CRASSULACEAE	*Crassula arborescens* (Mill.) Willd. subsp. *undulatifolia* Toelken	Critically Rare	Not applicable - locality
ASTERACEAE	*Callilepis leptophylla* Harv.	Declining	A widespread species that is currently declining as a result of overexploitation for the medicinal plant trade. A terrestrial grassland/ open woodland species, often on rocky outcrops or rocky hill slopes (Victor, 2009). *No viable habitat within the scope of the proposed development site.*
GUNNERACEAE	*Gunnera perpensa* L.	Declining	Grows in damp, marshy freshwater wetlands. Large volumes of this species is traded in traditional medicine markets and declines in availability and local extirpations have been noted. It is, however, widespread, somewhat resilient to harvesting and tends to grow back after the roots have been removed (Williams *et al.,* 2008). *No viable habitat within the scope of the proposed development site.*
HYPOXIDACEAE	*Hypoxis hemerocallidea* Fisch., C.A.Mey. & Avé-Lall.	Declining	Extensive commercial exploitation since 1997 has caused declines in some subpopulations, especially in Gauteng, South Africa, where it is additionally threatened by habitat loss and degradation. This species is however naturally abundant and widespread. Occurs in a wide range of habitats, including sandy hills on the margins of dune forests, open, rocky grassland, dry, stony, grassy slopes, mountain slopes and plateaus. Appears to be drought and fire tolerant (Williams *et al.,* 2008). *Observed during the field survey within the grassland areas.*
APIACEAE	*Alepidea peduncularis* A.Rich.	DDT	-
EUPHORBIACEAE	Acalypha caperonioides Baill. var. *caperonioides*	DDT	-
HYACINTHACEAE	*Drimia elata* Jacq.	DDT	-
MYROTHAMNACEAE	*Myrothamnus flabellifolius* Welw.	DDT	-

Family	Species	Cons status	Notes
LAMIACEAE	*Salvia schlechteri* Briq.	DDD	-

Figure 11: *Hypoxis hemerocallidea* observed to be relatively common within the survey site.

The SANBI (POSA - Plants of southern Africa: A checklist) database was utilised in order to see if any protected tree species (that are nationally protected under the National Forests Act (Act No 84 of 1998) have been recorded from the survey area. It should be noted that a permit to remove or destroy protected species has to be sought from the national authority (DAFF) prior to the removal or destruction of these species. There were no species indicated or noted during the field survey.

4.2.4. Areas identified as ecologically sensitive for floral species of conservational concern

As mentioned above, there are no RDL species recorded from the region pertaining to the project that are thought to occur within the site, but this does not preclude the occurrence of any species that would be regarded as sensitive to environmental change or are conservationally significant. Much of the site has been transformed and shows degradation of the vegetation structures to varying levels. This means that a formal conservation initiative of the terrestrial-based grassland areas is not thought to be viable. Relatively little habitat remains that would support viable populations of any RDL species. Wetland habitat units do occur in association with the proposed site,

which is a habitat unit regarded as being inherently ecologically sensitive, regardless of present ecological state. These habitat units are also generally regarded as having the potential to support a proportionally larger biodiversity and therefore are considered the habitat units more likely to support species of conservational significance. The wetland zones associated with the project have therefore been regarded as ecologically sensitive, together with their respective 30 m conservation buffer zones.

4.3. Faunal features

The survey area includes open grasslands and a wetland unit, and therefore should support a wide biodiversity. The site, however, is considered to be ecologically isolated and is subject to varying degrees of habitat transformation and degradation, which limits this potential. The site therefore is expected to only support generalist and adaptable faunal species.

4.3.1. Mammals

There are 103 mammalian species that have been historically recorded from the region pertaining to the proposed development site. This includes all historical distribution data so unrealistic expectations of ungulates, and larger predators are not relevant to the site.

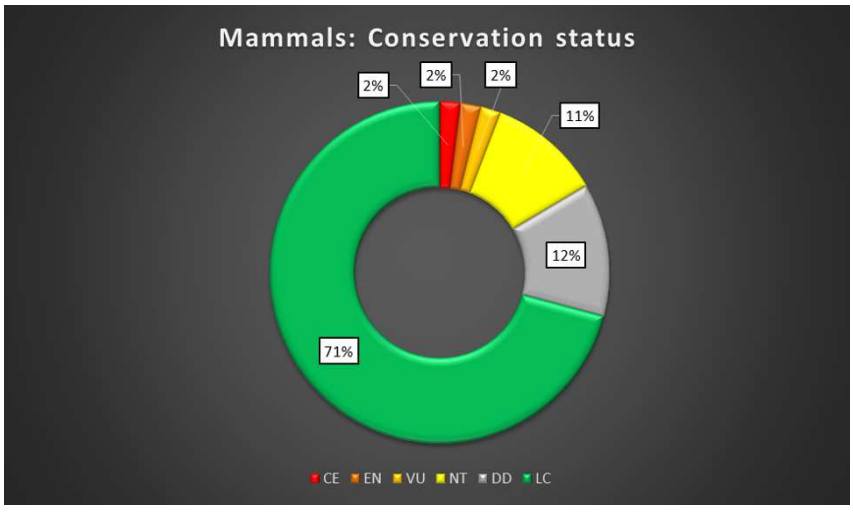


Figure 12: Conservation status of the mammalian species historically recorded from the region.

There are 30 species regarded as being of conservational significance (2 *critically endangered*, 2 *endangered*, 2 *vulnerable*, and 11 *near threatened*) and 13 as *data deficient*. The remaining 73 (71%) of the species are regarded as *least concern*. The conservation status of the mammalian species recorded from the region is presented in Figure 12. Those species that the proposed development activities would potentially impact are the mobile (mostly confined to smaller to medium species) that remain within the open areas and are free to migrate in or out of the region. All of the species of conservational concern are presented in Table 9.

Table 9: Mammalian species of conservational concern pertaining to the proposed development site.

Order	Species	Name	Status	POC*
RED LISTED SPEICES				
Chiroptera	*Cloeotis percivali*	Short-eared Trident Bat	CE	LOW
Insectivora	*Chrysospalax villosus subsp rufopallidus*	Rough-haired Golden Mole	CE	NONE
Artiodactyla	*Ourebia ourebi*	Oribi	EN	NONE
Rodentia	*Mystromys albicaudatus*	White-tailed Rat	EN	LOW
Artiodactyla	*Hippotragus niger niger*	Sable Antelope	VU	NONE
Chiroptera	*Rhinolophus blasii*	Peak-saddle Horseshoe Bat	VU	LOW
ORANGE LISTED SPECIES				
Carnivora	*Hyaena brunnea*	Brown Hyaena	NT	NONE
Carnivora	*Leptailurus serval*	Serval	NT	NONE
Carnivora	*Lutra maculicollis*	Spotted-necked Otter	NT	NONE
Carnivora	*Mellivora capensis*	Honey Badger	NT	NONE
Chiroptera	*Miniopterus schreibersii*	Schreibers' Long-fingered Bat	NT	LOW
Chiroptera	*Myotis tricolor*	Temminck's Hairy Bat	NT	LOW
Chiroptera	*Myotis welwitschii*	Welwitsch's Hairy Bat	NT	LOW
Chiroptera	*Pipistrellus rusticus*	Rusty Bat	NT	LOW
Chiroptera	*Rhinolophus clivosus*	Geoffroy's Horseshoe Bat	NT	LOW
Chiroptera	*Rhinolophus darlingi*	Darling's Horseshoe Bat	NT	LOW
Insectivora	*Atelerix frontalis*	South African Hedgehog	NT	LOW
Carnivora	*Poecilogale albinucha*	African Weasel	DD	NONE
Insectivora	*Crocidura cyanea*	Reddish-grey Musk Shrew	DD	MED
Insectivora	*Crocidura fuscomurina*	Tiny Musk Shrew	DD	MED
Insectivora	*Crocidura hirta*	Lesser Red Musk Shrew	DD	MED
Insectivora	*Crocidura mariquensis*	Swamp Musk Shrew	DD	MED
Insectivora	*Crocidura silacea*	Lesser Grey-brown Musk Shrew	DD	MED
Insectivora	*Myosorex varius*	Forest Shrew	DD	MED
Insectivora	*Suncus infinitesimus*	Least Dwarf Shrew	DD	MED
Insectivora	*Suncus varilla*	Lesser Dwarf Shrew	DD	MED
Rodentia	*Graphiurus platyops*	Rock Dormouse	DD	MED
Rodentia	*Lemniscomys rosalia*	Single-striped Mouse	DD	MED
Rodentia	*Tatera leucogaster*	Bushveld Gerbil	DD	MED
Macroscelidea	*Elephantulus brachyrhynchus*	Short-snouted Elephant-shrew	DD	MED

*** Probability of occurrence (*for naturally-occurring species*) – Distribution was based on historical records of species. Not all of these species would therefore occur within the area. Larger species would only be confined to fenced-off reserve and conservation areas.**

This analysis shows that there are no RDL mammalian species pertaining to the survey area that are thought to have a dependency on the habitat units available at the site and that would be

significantly impacted should the development take place. Any occurrences of the conservationally-significant bat species are thought to be potential fleeting occurrences and not dependency, as the proposed development site does not offer largely suitable habitat. No mammalian species, excepting domesticated and vermin (alien rats) species, were observed during the field survey.

The reminder of the species that are considered to have a low-medium probability of occurrence are limited to those small rodent and insectivorous species that are regarded as being *Data deficient*. These species are noted as having a relatively wide distribution range and cosmopolitan habitat preference. To effectively mitigate the negative impacts relating to these groups of species, attention needs to be given to reducing the general impacts on the habitat units (i.e. minimising the construction footprints, etc.). Even though disturbance factors will play a role in displacing certain more sensitive species, the proposed development activities are not thought to pose significant long-term impacts on the conservation of these species.

4.3.2. Avifauna

There are 406 avifaunal species recorded from the region, which includes two species that are regarded as being regionally extinct (Egyptian vulture *Neophron percnopterus* and African Skimmer *Rynchops flavirostris*). There are 31 species remaining that are regarded as being of conservational significance, which includes 5 (1%) endangered, 11 (3%) vulnerable and 15 (4%) near threatened. The remaining 372 species (92%) are regarded as being of least concern. Of the 5 species listed as endangered, only 2, namely African Marsh Harrier *(Circus ranivorus)* and Black Harrier *(Circus maurus)* have a chance of occurring at the site, albeit the probability of occurrence (POC) of each species is rated as low. An analysis of the conservation status of the avifaunal species recorded from the region is presented in Figure 13.

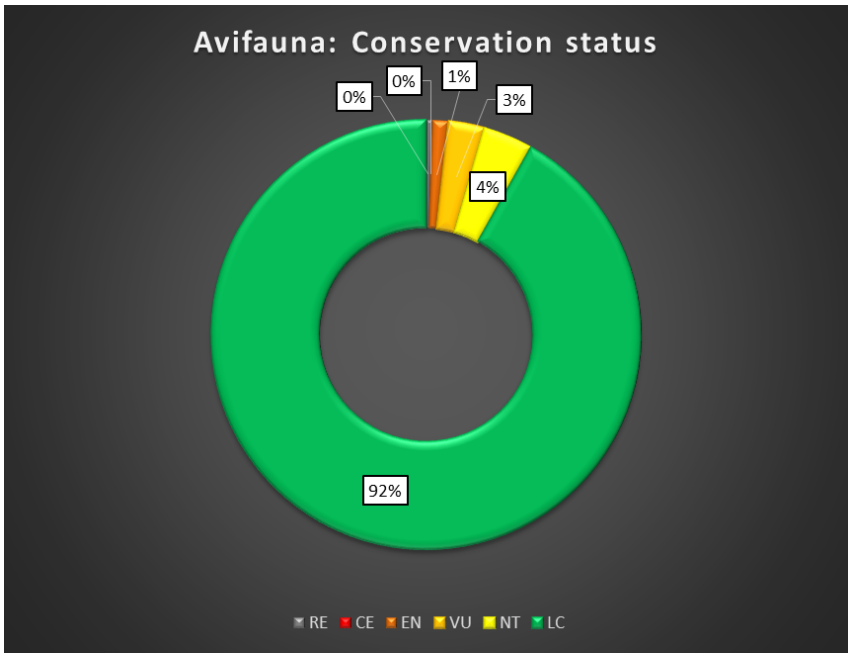


Figure 13: Conservation status of the avifaunal species historically recorded from the region.

All species of conservation significance with potential occurrence at the site and its immediate surrounds, which is largely due to habitat type availability and status, are presented in Table 10.

Table 10: Avifaunal species of conservational concern pertaining to the proposed development site.

Rob	English Name	Species	General Status	RDL Status	Habitats				POC
					Gr	Fa	Wa	To	
RED LISTED SPECIES									
90	Yellowbilled Stork	*Mycteria ibis*	NBM/R-LC	EN	0	0	1	0	None
122	Cape Vulture	*Gyps coprotheres*	E-LC	EN	1	1	0	0	None
140	Martial Eagle	*Polemaetus bellicosus*	R-U	EN	1	0	0	0	None
165	African Marsh Harrier	*Circus ranivorus*	R-C	EN	1	1	1	0	Low
168	Black Harrier	*Circus maurus*	E-U	EN	1	1	0	0	Low
49	Great White Pelican	*Pelecanus onocrotalus*	R-LC/R	VU	0	0	1	0	None
50	Pinkbacked Pelican	*Pelecanus rufescens*	R-LC/R	VU	0	0	1	0	Low
77	Whitebacked Night Heron	*Gorsachius leuconotus*	R-R	VU	0	0	1	0	Low
84	Black Stork	*Ciconia nigra*	R-U/R	VU	0	1	1	0	Low
118	Secretarybird	*Sagittarius serpentarius*	R-U	VU	1	1	0	0	Low
131	Black Eagle	*Aquila verreauxii*	R-U	VU	0	0	0	0	None
172	Lanner Falcon	*Falco biarmicus*	R-C	VU	0	1	0	1	Low
229	African Finfoot	*Podica senegalensis*	R-U	VU	0	0	1	0	None
233	Whitebellied Korhaan	*Eupodotis senegalensis*	E-U	VU	1	0	0	0	None
322	Caspian Tern	*Sterna caspia*	R-LC	VU	0	0	1	0	None
393	Grass Owl	*Tyto capensis*	R-U	VU	1	0	1	0	Low
ORANGE LISTED SPECIES									
85	Abdim's Stork	*Ciconia abdimii*	NBM-C	NT	1	1	1	0	None
89	Marabou Stork	*Leptoptilos crumeniferus*	R-R/LC	NT	0	0	1	0	None
96	Greater Flamingo	*Phoenicopterus ruber*	R(n)-LA	NT	0	0	1	0	Low
97	Lesser Flamingo	*Phoenicopterus minor*	R(n)-LA	NT	0	0	1	0	Low
117	Maccoa Duck	*Oxyura maccoa*	R-U	NT	0	0	1	0	None

Rob	English Name	Species	General Status	RDL Status	Habitats				POC
					Gr	Fa	Wa	To	
167	Pallid Harrier	*Circus macrourus*	NBM-R	NT	1	1	0	0	Low
179	Western Redfooted Kestrel	*Falco vespertinus*	NBM-R	NT	1	1	0	0	Low
208	Blue Crane	*Anthropoides paradisea*	E-U	NT	1	0	0	0	None
242	Greater Painted-snipe	*Rostratula benghalensis*	R-U	NT	0	0	1	0	Low
247	Chestnutbanded Plover	*Charadrius pallidus*	R-U	NT	0	0	1	0	Low
289	Eurasian Curlew	*Numenius arquata*	NBM-U	NT	0	0	1	0	None
305	Blackwinged Pratincole	*Glareola nordmanni*	NBM-LA	NT	1	0	0	0	None
346	Yellowthroated Sandgrouse	*Pterocles gutturalis*	R-LC	NT	1	1	0	0	None
430	Halfcollared Kingfisher	*Alcedo semitorquata*	R-U	NT	0	0	1	0	None
446	European Roller	*Coracias garrulus*	NBM-C	NT	1	1	0	0	None

The proposed development site incorporates a variety of habitat types that would be utilised by various avifaunal species. These include water/wetlands (Wa), grasslands (Gr), towns and gardens (To) and, to a lesser extent, farmlands (Fa). The avifaunal species of conservational concern are cross referenced with their geographical distribution, habitat type availability, connectivity with surrounding habitat, viability of the available and extent of the habitat types. This then allows for a probability of occurrence (POC) to be allocated to each species (Table 10). It can be seen that these species are considered to have a generally low probability of occurrence at the site. It can be seen that the wetland habitat unit plays an important role in providing habitat for many of these species, which reiterates its relative importance as a habitat type.

Avifaunal conservation is largely dependent on habitat availability and habitat integrity, which includes connectivity to surrounding habitat. The open grassland directly associated with the proposed development site are generally transformed, with degree of degradation increasing towards the northern areas. The status of the vegetation community structure improves toward the wetland zones and the central areas, but this is regarded as a relatively small area and therefore rendered largely irrelevant. The wetland unit and associated conservation buffer zones are considered important to avifaunal conservation in general within the development site (as well as within the local area) and therefore it is these areas that have been designated as ecologically significant. A list of the species observed during the field survey, is presented in Table 11.

Table 11: The list of avifaunal species observed during the field survey.

Rob	English Name	*Scientific*	General Status	RDL Status
63	Blackheaded Heron	*Ardea melanocephala*	R-C	LC
67	Little Egret	*Egretta garzetta*	R-C	LC
91	Sacred Ibis	*Threskiornis aethiopicus*	R-C	LC
93	Glossy Ibis	*Plegadis falcinellus*	R-U	LC
94	Hadeda Ibis	*Bostrychia hagedash*	R-A	LC

Rob	English Name	*Scientific*	General Status	RDL Status
102	Egyptian Goose	*Alopochen aegyptiacus*	R-A	LC
127	Blackshouldered Kite	*Elanus caeruleus*	R(n)-C	LC
200	Common Quail	*Coturnix coturnix*	R/BM/NBM-C	LC
203	Helmeted Guineafowl	*Numida meleagris*	R-VC	LC
255	Crowned Plover	*Vanellus coronatus*	R-C	LC
258	Blacksmith Plover	*Vanellus armatus*	R-VC	LC
260	Wattled Plover	*Vanellus senegallus*	R/BM-LC	LC
297	Spotted Dikkop	*Burhinus capensis*	R-C	LC
348	Feral Pigeon	*Columba livia*	R-A	LC
354	Cape Turtle Dove	*Streptopelia capicola*	R-VC	LC
355	Laughing Dove	*Streptopelia senegalensis*	R-VC	LC
373	Grey Lourie	*Corythaixoides concolor*	R-C	LC
386	Diederik Cuckoo	*Chrysococcyx caprius*	BM-VC	LC
415	Whiterumped Swift	*Apus caffer*	BM-VC	LC
417	Little Swift	*Apus affinis*	R/BM-VC	LC
421	Palm Swift	*Cypsiurus parvus*	R-C	LC
424	Speckled Mousebird	*Colius striatus*	R-C	LC
438	Eurasian Bee-eater	*Merops apiaster*	NBM/BM-C	LC
451	African Hoopoe	*Upupa africana*	R(n)-C	LC
464	Blackcollared Barbet	*Lybius torquatus*	R-C	LC
474	Greater Honeyguide	*Indicator indicator*	R-U	LC
494	Rufousnaped Lark	*Mirafra africana*	R-C	LC
506	Spikeheeled Lark	*Chersomanes albofasciata*	Er-C	LC
526	Greater Striped Swallow	*Hirundo cucullata*	BM-C	LC
548	Pied Crow	*Corvus albus*	R-A	LC
560	Arrowmarked Babbler	*Turdoides jardineii*	R-VC	LC
568	Blackeyed Bulbul	*Pycnonotus tricolor*	R-VC	LC
596	Stonechat	*Saxicola torquata*	R-VC	LC
631	African Marsh Warbler	*Acrocephalus baeticatus*	BM-C	LC
635	Cape Reed Warbler	*Acrocephalus gracilirostris*	R-C	LC
664	Fantailed Cisticola	*Cisticola juncidis*	R-VC	LC
666	Cloud Cisticola	*Cisticola textrix*	R-C	LC
677	Levaillant's Cisticola	*Cisticola tinniens*	R-C	LC
681	Neddicky	*Cisticola fulvicapillus*	R-C	LC
683	Tawnyflanked Prinia	*Prinia subflava*	R-C	LC
698	Fiscal Flycatcher	*Sigelus silens*	E-C	LC
713	Cape Wagtail	*Motacilla capensis*	R-C	LC
716	Grassveld Pipit	*Anthus cinnamomeus*	R-C	LC
727	Orangethroated Longclaw	*Macronyx capensis*	E-C	LC
732	Fiscal Shrike	*Lanius collaris*	R-C	LC
746	Bokmakierie	*Telophorus zeylonus*	Er-C	LC
758	Indian Myna	*Acridotheres tristis*	R-VC	LC
801	House Sparrow	*Passer domesticus*	R-VC	LC
803	Cape Sparrow	*Passer melanurus*	Er-VC	LC
814	Masked Weaver	*Ploceus velatus*	R-C	LC
824	Red Bishop	*Euplectes orix*	R-C	LC
826	Golden Bishop	*Euplectes afer*	R(n)-LC	LC
829	Whitewinged Widow	*Euplectes albonotatus*	R(n)-LC	LC
831	Redcollared Widow	*Euplectes ardens*	R(n)-LC	LC
832	Longtailed Widow	*Euplectes progne*	R(n)-C	LC
846	Common Waxbill	*Estrilda astrild*	R-C	LC
857	Bronze Mannikin	*Lonchura cucullata*	R-VC	LC
860	Pintailed Whydah	*Vidua macroura*	R(n)-C	LC

4.3.3. Reptiles

There are 25 known reptile species that have a distribution range that correlates to the proposed development site (SANBI, 2018), with no species recorded from the area being considered to be of conservational significance. One species not recorded during the recent reptile census but with an inferred distribution correlation due to historical records is *Homoroselaps dorsalis* (Striped harlequin snake). This species is regarded as near threatened, and is known to inhabit rocky Highveld grasslands, which is a habitat unit that has limited significance to the site. The site has a relatively low reptilian diversity, which is probably due to the urbanised nature of the area, and the transformed nature of the habitats. Although the presence of wetland habitat does increase the potential of the site to support a greater number of species. From species counts (ADU, 2018), the greatest densities of species are those that are particularly opportunistic and that have managed to exploit the urban environment as suitable habitat. These were four species noted during the field survey, namely *Trachylepis punctatissima* (Speckled rock skink), *Lagodactylus capensis capensis* (Common dwarf gecko), *Caesius rhombeatus* (Rhombic night adder) and *Hemachatus haemachatus* (Rinkhals). This is by no means an indication of the potential reptile diversity list for the property as this does not represent a long-term comprehensive reptile survey. This potential species list is therefore based on known historical distribution records, presented in Table 12.

Table 12: The reptilian species recorded from the region.

Family	Species	Common name	Red list category
Agamidae	*Agama aculeata distanti*	Distant's Ground Agama	Least Concern (SARCA 2014)
Agamidae	*Agama atra*	Southern Rock Agama	Least Concern (SARCA 2014)
Atractaspididae	*Aparallactus capensis*	Black-headed Centipede-eater	Least Concern (SARCA 2014)
Atractaspididae	*Atractaspis bibronii*	Bibron's Stiletto Snake	Least Concern (SARCA 2014)
Chamaeleonidae	*Bradypodion ventrale*	Eastern Cape Dwarf Chameleon	Least Concern (SARCA 2014)
Colubridae	*Boaedon capensis*	Brown House Snake	Least Concern (SARCA 2014)
Colubridae	*Crotaphopeltis hotamboeia*	Red-lipped Snake	Least Concern (SARCA 2014)
Colubridae	*Dasypeltis scabra*	Rhombic Egg-eater	Least Concern (SARCA 2014)
Colubridae	*Lamprophis aurora*	Aurora House Snake	Least Concern (SARCA 2014)
Colubridae	*Lycodonomorphus inornatus*	Olive House Snake	Least Concern (SARCA 2014)
Colubridae	*Lycodonomorphus rufulus*	Brown Water Snake	Least Concern (SARCA 2014)
Colubridae	*Lycophidion capense capense*	Cape Wolf Snake	Least Concern (SARCA 2014)
Colubridae	*Psammophis subtaeniatus*	Western Yellow-bellied Sand Snake	Least Concern (SARCA 2014)
Cordylidae	*Cordylus vittifer*	Common Girdled Lizard	Least Concern (SARCA 2014)
Elapidae	*Hemachatus haemachatus*	Rinkhals	Least Concern (SARCA 2014)
Gekkonidae	*Hemidactylus mabouia*	Common Tropical House Gecko	Least Concern (SARCA 2014)
Gekkonidae	*Lygodactylus capensis capensis*	Common Dwarf Gecko	Least Concern (SARCA 2014)
Gekkonidae	*Pachydactylus affinis*	Transvaal Gecko	Least Concern (SARCA 2014)
Gekkonidae	*Pachydactylus capensis*	Cape Gecko	Least Concern (SARCA 2014)
Gerrhosauridae	*Gerrhosaurus flavigularis*	Yellow-throated Plated Lizard	Least Concern (SARCA 2014)

Family	Species	Common name	Red list category
Pelomedusidae	*Pelomedusa subrufa*	Central Marsh Terrapin	Least Concern (SARCA 2014)
Scincidae	*Trachylepis capensis*	Cape Skink	Least Concern (SARCA 2014)
Scincidae	*Trachylepis punctatissima*	Speckled Rock Skink	Least Concern (SARCA 2014)
Scincidae	*Trachylepis varia*	Variable Skink	Least Concern (SARCA 2014)
Typhlopidae	*Afrotyphlops bibronii*	Bibron's Blind Snake	Least Concern (SARCA 2014)

Again, the wetland habitat unit is regarded as the most important to overall conservation of reptiles and therefore the impacts to this habitat feature and to the designated buffer zones should be limited as far as possible.

4.3.4. Amphibians

Habitat loss, in all its many forms, was cited as the most pervasive threat facing amphibians and was listed for all species during the analysis for the frog atlas project (Minter, *et al.*, 2004) and therefore habitat destruction should be limited to the absolute minimum throughout the survey area. This is especially pertinent to riparian and wetland habitat units. Amphibians have been shown to be steadily declining as a world-wide phenomenon. Care should therefore be practised in conserving all suitable habitats to aid in abating declines in amphibian numbers and diversity.

There are 11 amphibian species recorded from the area, with one species, namely the Giant bullfrog (*Pyxicephalus adspersus*) being of conservational significance (Minter, *et al*., 2004; du Preez & Carruthers, 2009 and ADU, 2018). The wetland associated with the proposed development site is again regarded as being important to amphibian species conservation within the area and should be considered to be part of the greenspace planning of the proposed development. The wetland zones associated with the wetland complex running through this section of the site, and further afield, should be observed as an ecologically sensitive habitat feature to support amphibian diversity in general.

4.3.5. Fish

Evaluation of the fish species within the proposed development site was not applicable to the project.

4.3.6. Invertebrates

The invertebrate taxa that are of conservational concern include the Mygalomorph spiders, scorpions, certain butterfly (Lepidoptera) and dragonfly and damselfly (Odonata) species.

Mygalomorph spiders as a taxon, includes various families of trapdoor and baboon spiders. This is a poorly-studied taxon nationally, making accurate distribution data difficult to source. The family of Theraphosidae (baboon spiders) are a nationally protected taxa under CITES, prohibiting collection, trade and destruction without the applicable permits (subject also to provincial legislation). Mygalomorphs are all generally sedentary in habit. The females establish variations of burrows where they generally remain throughout their lifetime. Males, especially during mating seasons, are generally free-roaming. The females are therefore especially vulnerable to habitat destruction and transformations as disturbances that destroy burrows often destroy the inhabitant, or, if displaced from the burrow, the females have difficulty in establishing new burrows or finding adequate refugia. Conservation of this taxon therefore relies on intact habitat functionality. Care should therefore be practised to minimise the construction footprints for each tower and not to cause undue destruction of habitat. Mygalomorph spiders inhabit virtually all the habitat types that are represented throughout the survey area, including transformed habitat. General habitat conservation is therefore the most viable mitigation measure to abate undue impacts on these species – as is applicable to all biodiversity within the region.

There are 75 butterfly species recorded from the region (ADU, 2018), with none of these species being regarded as Red Data Listed. As with all of the invertebrate taxa, conservation of the overall ecological integrity of the habitat units associated with the proposed development site is regarded as the most important factor to ensure ongoing conservation of butterfly species. Although limited viable natural habitat remains, it is proposed that indigenous gardens be encouraged and open greenspace be incorporated into the proposed development layout.

5. SURFACE WATER RESOURCES

5.1. General catchment & survey area condition

The survey area falls within a mixed-use residential/commercial area, with a rural component towards the northern section (where local residents have a dependency on the resources offered by the site). Over-capacitated services as well as a general lack of adequate services has led to largescale transformation and degradation of the wetland habitat units, which are viewed as disused open space for dumping of rubble, excess building material and domestic refuse. Water quality within the wetland units is also obviously poor due to contamination of the surface waters that often percolate through urban refuse, as well as contamination through untreated sewerage through failing infrastructure. This is especially true for the wetland units located further north of the site. In general, the wetland units within the area are regarded as being highly degraded, and the wetland zones have been generally transformed.

Landscaping through historical infrastructure development (e.g. sewerage pipelines) and associated landscaping has altered the surface hydrology and runoff patterns within the survey site and has modified hydrological functioning and has created impounding features where surface runoff water is inhibited from free drainage within the landscape. Surface water runoff carries sediments and silts which get trapped and settle within these areas. The finer-grained silts settle and eventually begin to inhibit percolation of the surface waters into the soil layers below and persistence of surface water is enhanced. This then provides the micro habitat that supports facultative wetland floral species. This occurs within sporadic and isolated areas where floral species occur within landscaped areas that are indicative of wetland conditions. Soil conditions within these areas are indicative of landscaping and therefore these areas are not regarded as functional wetland areas.

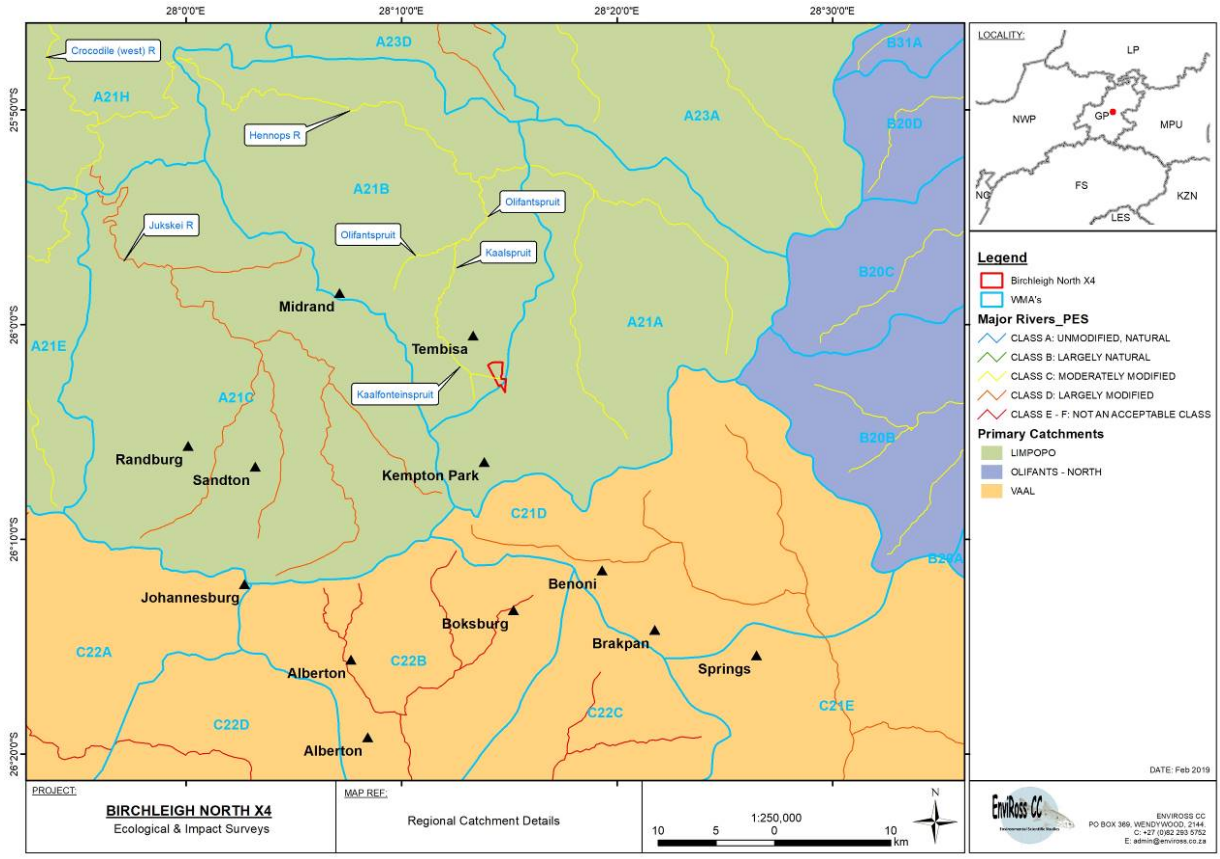


Figure 14: The catchment details for the regional area.

The site falls within the Limpopo (A) primary catchment, and within the A21B quaternary catchment area. The main watercourse draining this catchment to the northwest is the Hennops River, which eventually drains into the Crocodile (west) River that flows northwards towards the Limpopo River. The main watercourses within the catchment area are regarded as having a PES of C, which translates to moderately modified (Figure 14) (SANBI, 2014).

The local watercourse associated with the site drains into the Kaalfonteinspruit, which develops into the Kaalspruit further north. It confluences with the Olifantspruit before draining into the Hennops River. There are large wetland areas associated with the Kaalspruit located to the north of the site.

5.2. Wetland survey

5.2.5. Wetland forms associated with the site

The wetlands associated with the proposed development sites represent channelled and unchannelled valley-bottom wetlands that form a defined watercourse. These units are very often supplemented by stormwater runoff and drainage from surrounding roadways and urban areas. Failing water infrastructure (be it sewerage or potable water infrastructure) also intermittently increases the water volume within the wetland unit.

Table 13: The hydrogeomorphic wetland types of the regional wetlands associated with the site and the ecological services they provide within the landscape (*adapted from* Kotze, et al, 2007).

Wetland HGM type	Regulatory benefits potential provided by wetland							
	Flood attenuation		Stream flow regulation	Enhancement of water quality				
	Early wet season	Late wet season		Erosion control	Sediment trapping	Phosphates	Nitrates	Toxicants
Seep zones	Medium relevance	High relevance	Low relevance	Low relevance	Low relevance	Low relevance	Low relevance	Low relevance
Valley bottom – channelled	Medium relevance	Low relevance	Low relevance	High relevance	High relevance	Medium relevance	Medium relevance	Medium relevance

5.2.6. Ecological functionality & ratings

Wetlands within the surrounding area are impacted by various forms of development that has impacted the natural hydrological features of the wetland. Major roadways bisect the wetland units that impose limits on natural surface water drainage and lateral movement of soil water. The land use within the immediate surroundings and catchment area includes residential, commercial and some industry. Limited buffer zones are afforded the wetlands to allow for adequate conservation and functionality which area all factors that have led to degradation of the watercourse, transformation of the vegetation structures, hydrological and geomorphological functioning of the habitat units. Much of the wetland areas have, however, remained functional and the impacting features described above are largely limited to fringe areas.

5.2.6.1. WETLAND-IHI

The WETLAND-IHI scores are presented in Table 14, which places the overall integrity of both wetland complexes occurring at the survey area within a C category, which translates to a *moderately modified* system. This shows a wetland system that has retained functionality. The main impacting features of the wetland system are within the fringing areas. The vegetation within the wetland unit remains relatively good. The hydrological and geomorphological aspects have been impacted by catchment management and landscaping features both within and outside of the wetland units. Water quality issues were noted to emanate from within wetland areas (sewerage contamination) as well as from within the catchment area (surface water runoff, stormwater that includes contaminants, etc).

Table 14: Results from the WETLAND-IHI for the wetlands within the local area.

Site	Vegetation	Hydrology	Geomorphology	Water quality	Overall PES
Wetlands	84.9%	62.6%	57.5%	75.3%	**72.4%**
	B	**C**	**C/D**	**C**	**C**

5.2.6.2. Ecological Importance-Sensitivity (EIS)

The EIS was undertaken according to the methods outlined in WET-EcoServices (Kotze, *et al*, 2007). After application of the methods in WET-Ecoservices, the wetlands averaged out at 1.74 out of a possible 4 for both wetland complexes.

Table 15: The results of the WET-Ecoservices methodologies.

Wetland functional feature	Wetlands Totals
Flood attenuation	1.7
Stream flow regulation	2.0
Sediment trapping	2.0
Phosphate trapping	2.2
Nitrate removal	2.3
Toxicant removal	2.3
Erosion control	2.4
Carbon storage	1.3
Maintenance of biodiversity	2.5
Water supply for human use	0.8
Natural resources	0.6
Cultivated foods	0.8

Wetland functional feature	Wetlands Totals
Cultural significance	0.0
Tourism and recreation	0.6
Education and research	0.8
Runoff intensity from the wetland unit's catchment	1.5
Alteration of sediment regime	3.0
Alteration of nutrient/toxicant regime	2.0
Level of threat	3.0
Levels of opportunity	3.0
Overall ecological services rating	***1.74 (C)***

This translates to a wetland system that is currently supplying a *Moderate (C)* ecological service. The threat level to the habitat unit, however, remains high (scored 3 out of 4), but the levels of opportunity, which could be interpreted as the degree to which the wetland habitat units could perform these services, also scored at 3 out of 4 (Table 15).

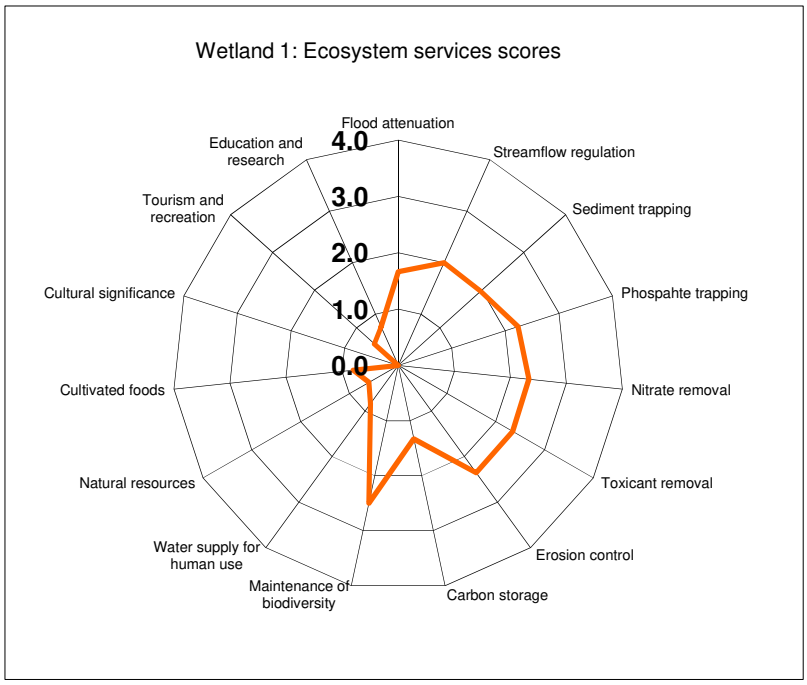


Figure 15: Scoring of the various aspects of ecological services provided for by the wetland habitat units present within the survey area.

The various input features and how they scored for both wetland units are presented in Figure 15. This shows which features (services) that are performed by the wetlands are currently scoring the highest, and which ones are ranked lower. It can be seen that the factors including the dependency on the resources offered by the wetlands to the surrounding communities are rated low. The wetland is also limited in extent and therefore the functionality of the wetland is comparatively

limited. The highest functions are designated to the actual physical wetland functioning groups, including toxicant removal, flood attenuation, stream flow regulation, and phosphate and nitrate removal from the water. The wetland features with a lower ranking include education and research and cultural significance and are therefore not viewed as the most significant contributing services of the wetlands. The wetland unit also has retained some functionality for maintenance of biodiversity.

5.2.7. Standard Wetland Delineation Indicators

It is important to note that not all of the four wetland indicators will necessarily be present at any particular site. Disturbance factors and landscaping often lead to the vegetation indicators being largely transformed and unreliable. Landscaping also often diverts surface water flow that often dries certain areas of the wetlands, leading to the loss of the soil wetness indicators. Therefore, the combination of all four unit indicators should be taken into consideration as well as a certain degree of "intuitive rationalisation" gained through experience when assessing the existence of wetland zones.

5.2.8. Terrain Unit Indicator (TUI)

The TUI (taken from topographical maps, GIS data and visual observations at the site) indicated that the terrain of the areas associated with this section of the proposed development site were topographically conducive to supporting wetlands. The wetland complexes within the area are typically confined to valley bottoms. The application of the other indicators was therefore applied to facilitate the determination of the limits of the wetland zones.

5.2.9. Soil Form Indicator (SFI)

Sampling pits were dug using a garden spade at strategic points in order to observe soil profiles *in situ*. Hydromorphic soils and associated mottling by both iron and magnesium were clearly observed within auger samples as well as within the soil profiles within areas that remain saturated with water (inundated) and therefore become anaerobic for prolonged periods of the year. Under these conditions, the iron within the soil is leached out, but cannot undergo reduction due to the lack of oxygen.

Figure 16: Examples of indications of ferrolysis (mottling) within the soils is a positive indication of hydromorphic conditions.

During periods when the water table recedes and oxygen is able to penetrate the soil, the iron undergoes reduction to iron oxide. This remains localised and tends to be visible in the form of reddish mottles within the soil profile. Iron deposits in the form of nodules were also readily observed throughout the wetland zones. The wetland soils were generally rich in clay, with a relatively low percolation rate within wetland zones. These soils also readily show the mottling effects of ferrolysis and therefore the utilisation of the SFI as an indicator of wetland zonation was considered reliable, but this was limited to certain areas as large-scale landscaping has occurred within the area. This has modified much of the soil profiles, which made the SFI unreliable in some areas. The SFI was therefore not utilised as the primary indictor of the occurrence of wetland conditions.

5.2.10. Soil Wetness Indicator (SWI)

The soil wetness indicator was also used as a factor that supported wetland soil conditions, and was used as an important indicator for determining the outer edges of the wetland zones. The SWI is also determined by using a soil auger to obtain a soil sample or by digging an inspection pit for viewing the soil profile.

5.2.11. Vegetation Indicator (VI)

Riparian vegetation has a floral species community structure that is dominated by species specifically adapted to inhabiting soils of varying degrees of water-logging. Various species are adapted to survive under varying periods of prolonged water saturated soils and therefore form distinct communities. This is largely true for undisturbed floral community structures associated with wetlands. The outer limits of the various wetland zones can therefore very often be determined by the changes in floral community structures. This unit indicator was found to be a useful tool as floral species indicative of the various wetland zones were observed. The proposed development areas have fringing associations with the adjacent units, and therefore limited permanent zones were noted during the survey. Stormwater outfalls were generally the only permanent source of water where vegetation structures indicative of permanent zones were present. The vegetation zonation was mostly therefore indicative of seasonal to temporary zonation. Wetland species indicative of permanent to seasonal zonation noted included *Typha capensis, Phragmites australis, Persicaria lapathifolia* and *Rorippa nasturtium-indica*, together with grass species such as *Leersia hexandra* and *Hermannia altissima*. Permanent wetland conditions were relatively rare, however. Seasonal zone indicators included *Imperata cylindrica, Agrostis lachnantha, Hemarthria altissima, Paspalum urvillei, Paspalum dilitatum, Helichrysum nudifolium* (dominant)*, Senecio coronatus* and *Senecio inornatus.* Opportunistic kikuyu (*Pennisetum clandestinum*) also occurred as a dominant feature within seasonal zones where it occurred. The temporary zones saw a decrease in density of the forb species and the incorporation of *Hyparrhenia hirta, Themeda triandra, Pennisetum clandestinum, Cynodon dactylon* and various *Aristida* and *Eragrostis* species. These are not regarded as being reliable wetland zone indicators, however, as they occur where wetland zones transition to terrestrial areas. *Stoebe vulgaris* was a noteworthy dominant species within terrestrial areas fringing wetland units, which is an indicator of disturbance features, and can probably be attributed to historical cattle grazing and trampling.

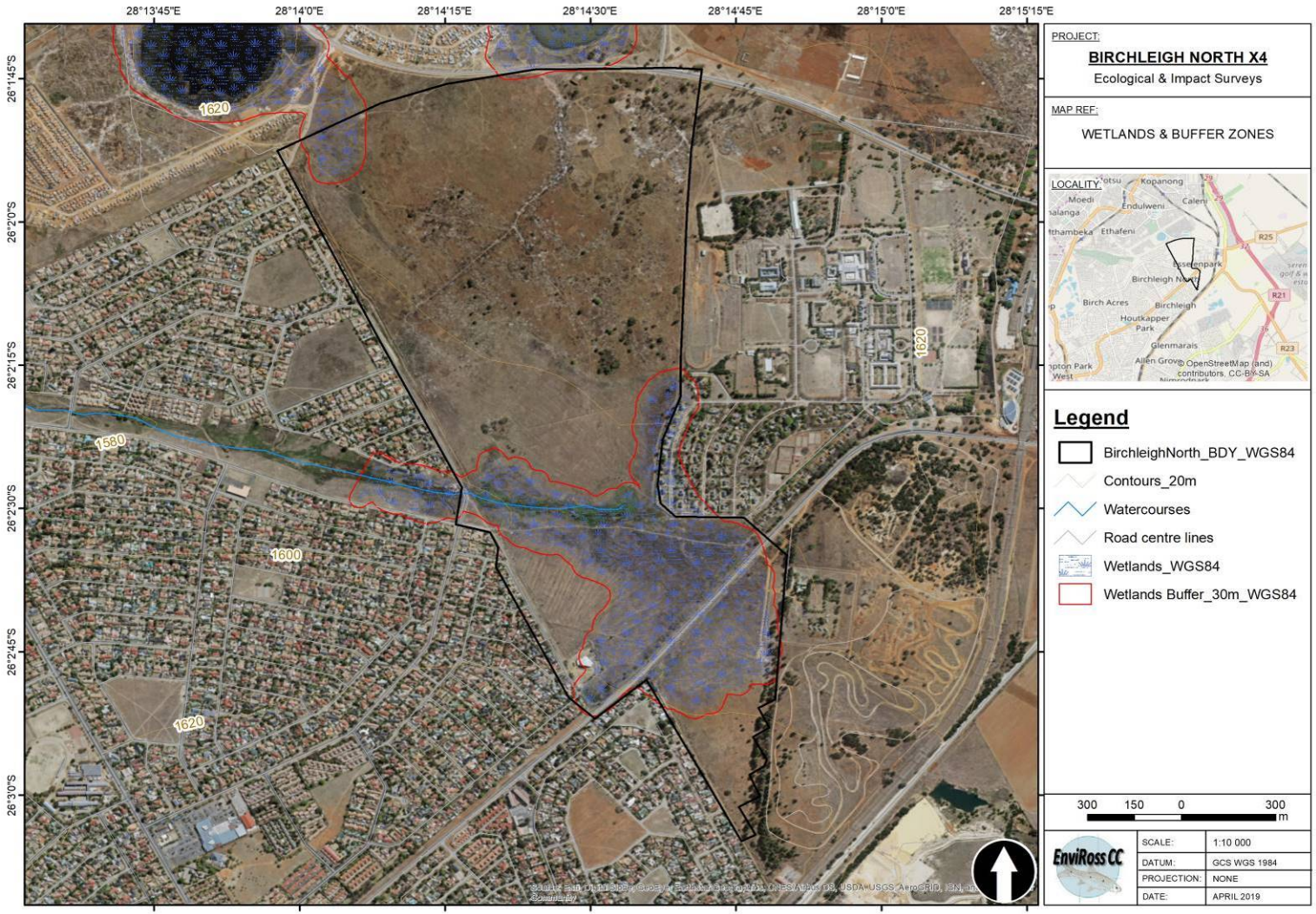


Figure 17: The wetland delineation and associated recommended 30 m conservation buffer zones for the site.

There are species which occur within the overlapping wetland zones, and so the density of communities, especially of opportunistic exotics, is also a useful indicator of the changing zonation of the wetlands. It should be noted that many of the wetland areas were regarded as being modified and therefore many of the wetland indicator species inhabiting the wetland soils are regarded as opportunistic generalist species. This was especially true for exotic species, such as *Verbena bonariensis*, as well as indigenous species such as *Helichrysum nudifolium*, which indicate the various wetland zones through changes in density rather than by their presence or absence.

5.3. Buffer Zones

The wetland habitat units associated with the proposed development area are subject to different pressures and drivers, which mostly emanate from the surrounding land use, historical infrastructure development, fringing encroachment of surrounding development and poor water quality. These wetlands do, however, perform vital functions within the landscape and should be regarded as being ecologically sensitive. Conservation of this habitat unit forms an integral part of the conservation of the surface water resources throughout the catchment area. Augmentation of the historical (natural) extent of the wetlands has occurred through stormwater management (outfalls from urban areas and roadways), which was observable most notably within the south-western section (just north of the R25 roadway). The development of roadways and pipelines that create embankments also tend to augment wetland conditions further that what would have historically occurred due to the modified surface water drainage patterns. This is most noteworthy within the road reserve areas.

According to GDARD (2010), the site falls within the urban edge. The wetlands associated with the site are therefore a 30 m buffer zone, which has been indicated in Figure 17.

5.4. DWS Risk Assessment Matrix

The Department of Water and Sanitation (DWS) has developed a risk assessment matrix for development activities within a wetland or watercourse. The wetland units associated with the project have all been delineated and the appropriate conservation buffer zones have been designated to the units. The risk assessment matrix is aimed at activities that are to take place within these areas. There are two alternatives for the bulk sewer pipeline proposed. One alignment will

have no impacts to the wetland features, whereas the alternative will require excavations through the wetland features. The former alternative will result in a low overall risk to the wetlands, and is therefore the preferred alternative. The latter will result in overall high risk to the wetland unit (as it requires excavations to occur within the wetland areas) and is therefore the least preferred alternative. The significance of the impacts is largely related to the scale and intensity of the wetland habitat that will be impacted. It can therefore can be greatly reduced by taking into consideration that wetland delineation mapping and associated conservation buffer zones. The calculations of the DWS Risk Assessment, detailing of the impacts and outline of the mitigation measures are provided as an Addendum to this report.

6. OVERALL ECOLOGICAL SENSITIVITY ZONING

As mentioned, the terrestrial habitat units have suffered varying degrees of ecological degradation and a formal conservation initiative to preserve the natural features of these areas is not thought viable. The terrestrial fauna and flora also did not show any particular dependency on the habitat features offered by these areas. Open space planning and green zone planning is, however, encouraged to provide some habitat for continued support of some of the terrestrial biodiversity. The wetland features are statutorily protected as ecologically sensitive habitat units, regardless of ecological state, and so these areas, together with the 30 m conservation buffer zones, are included as the areas of high ecological sensitivity. Therefore, the alignment alternatives that impose the least overall impact to these areas is considered to be the preferred alternative.

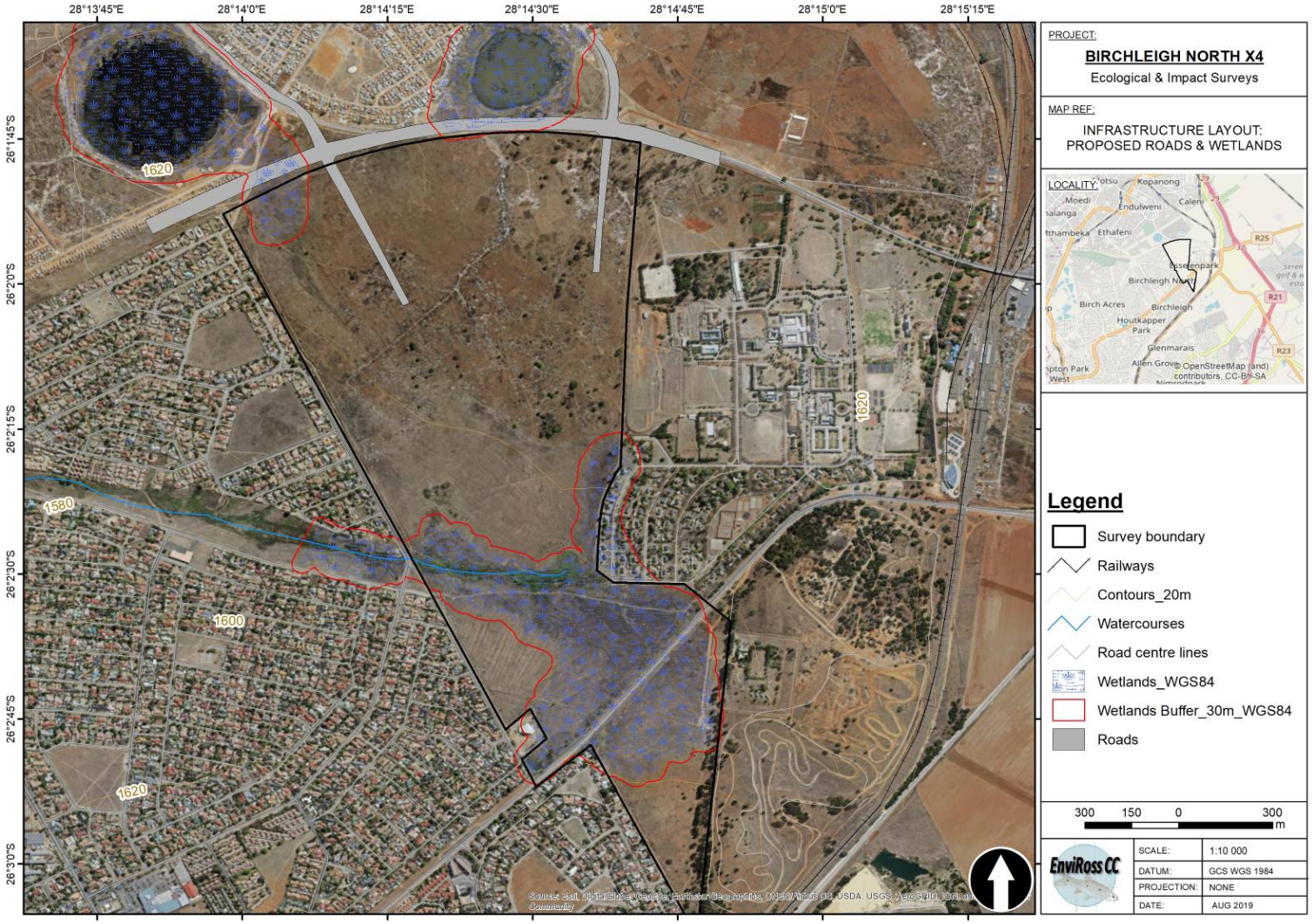


Figure 18: Wetland boundaries and the associated 30 m conservation buffer zones associated with the proposed road network development.

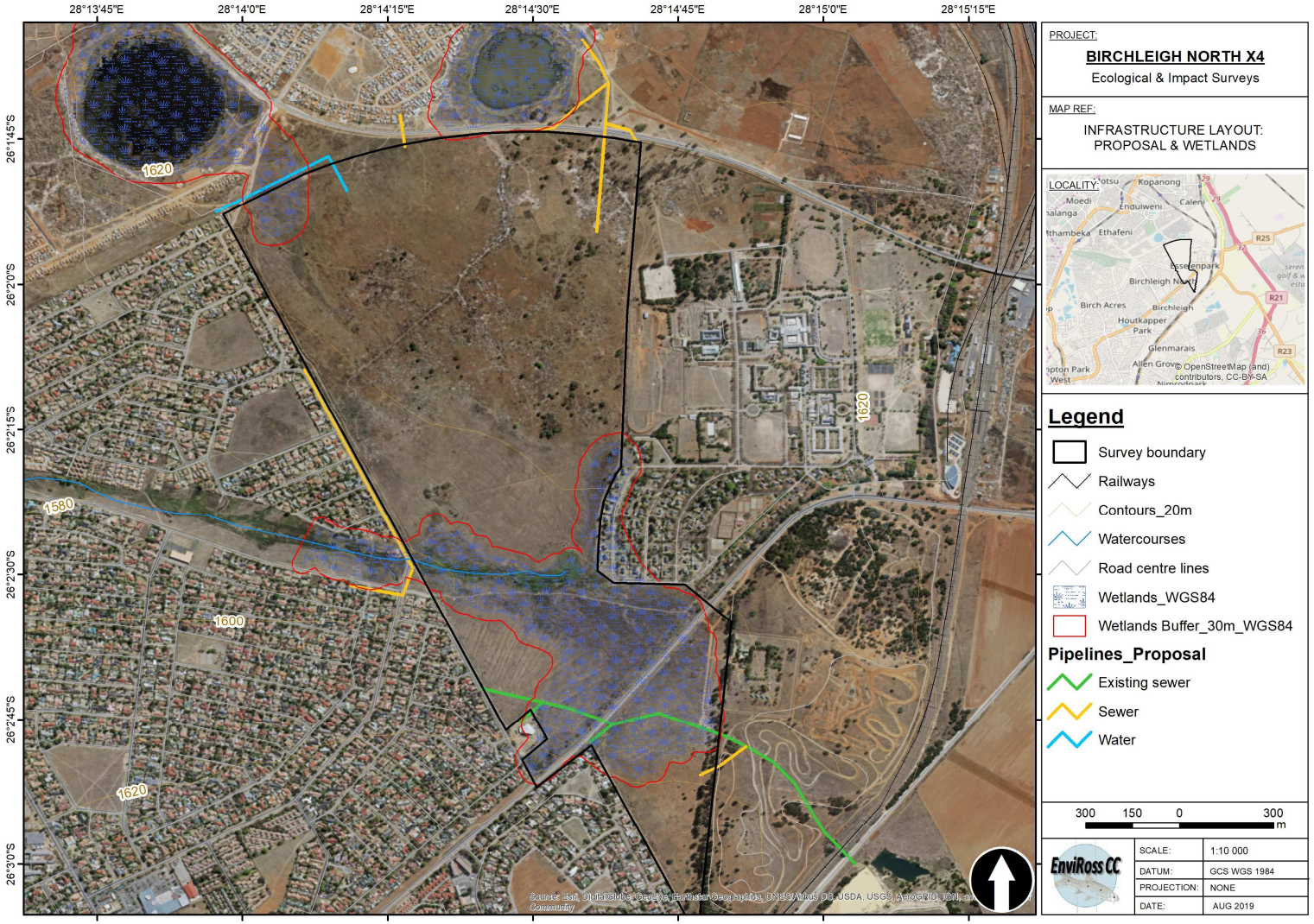


Figure 19: Wetland boundaries and the associated 30 m conservation buffer zones associated with the proposed pipeline development (Proposed option).

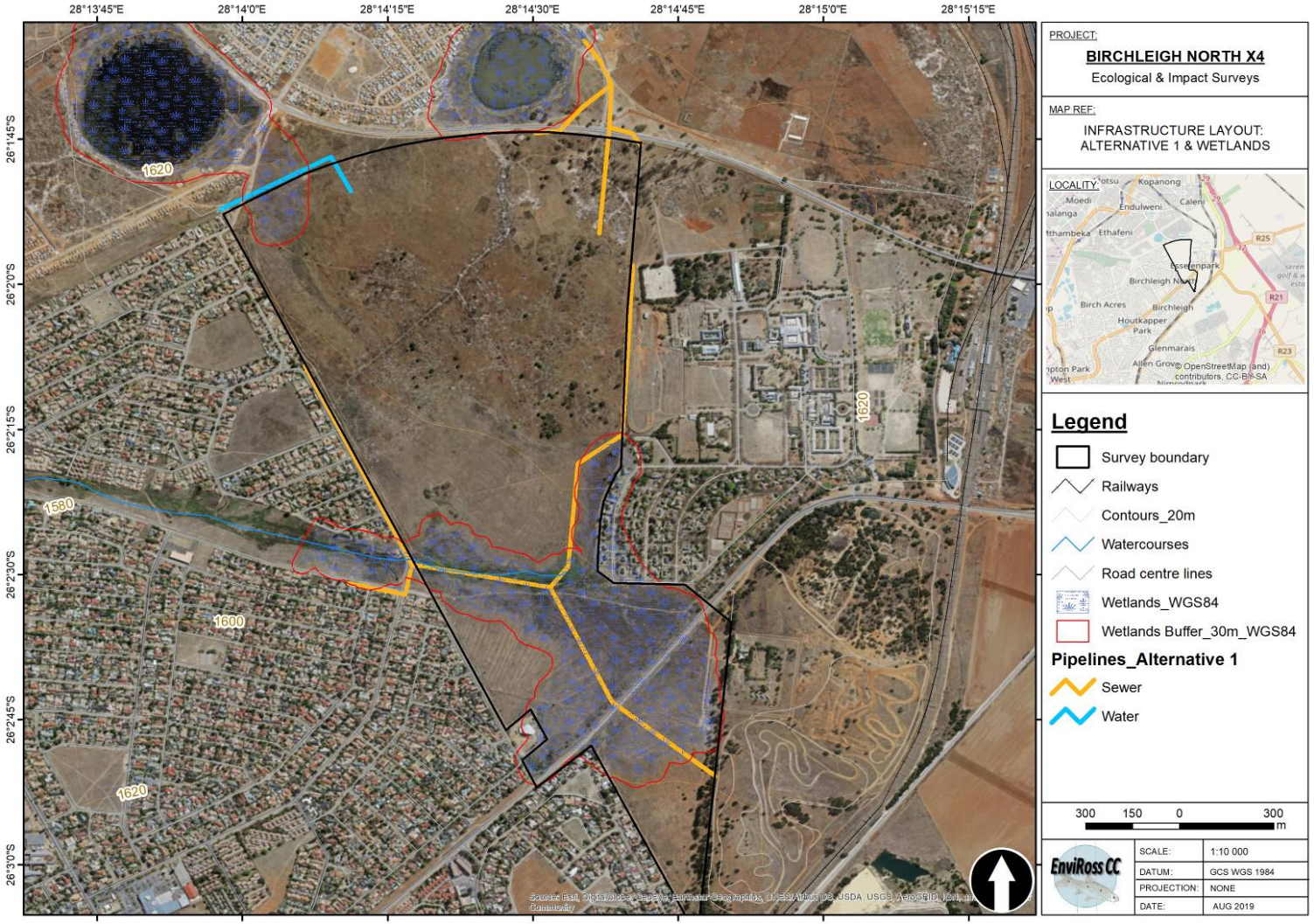


Figure 20: Wetland boundaries and the associated 30 m conservation buffer zones associated with the proposed pipeline development (Alternative option).

7. PREFERRED ALTERNATIVES

Two infrastructure layout plans have been presented that show two alternative pipeline (sewer and bulk water) alignments. Figure 18 presents the road alignment proposal (no alternatives were presented), whilst Figure 19 presents the proposed pipeline alignments and Figure 20 presents the alternative to the pipeline alignments. All three figures are presented within their association with the wetland habitat units associated with the site. The preferred pipeline alignment is the proposed option as it ties in with an existing sewer pipeline and therefore will require the least overall excavating within the wetland units. This alignment is shown to join to the existing ERWAT sewer line in the south-eastern boundary areas of the site. The alternative is an excavation to accommodate the sewer line that runs approximately parallel on the south side of the wetland. Lines running northwards, perpendicular to the wetland unit, will then require further excavations to occur within the wetland habitat, leading to a far greater disturbance impact and will also necessitate a substantial rehabilitation plan. This alternative is therefore not the preferred alternative due to the higher associated disturbance impacts.

8. SIGNIFICANCE RATINGS OF PERCEIVED ENVIRONMENTAL IMPACTS

The potential impacts pertaining to a development of this nature have been identified that could be deleterious to the overall long term ecological functionality and integrity of the proposed development area have been shown to be readily managed to within acceptable limits by the implementation of realistic and achievable mitigation measures. It should be noted, however, that the successful implementation of the mitigation measures and the long-term impacts on the overall ecological integrity at the development site can only be possible with the sincere efforts of the management and construction teams associated with the project. The ratings are calculated for the scenarios of both before and after the implementation of mitigation measures (Table 16 and Table 17). This was done in order to show how the degree of impacts can be reduced by careful planning and the following of relatively simple mitigation measures. The methodologies and ratings system are provided in Appendix A.

Table 16: The significance ratings both before and after implementation of mitigation measures of the main potential ecological impacts perceived to be associated to the proposed development activities pertaining to the construction phase.

PRE-CONSTRUCTION & CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likeli-hood**	**Rating**	**Mitigation***	**Interpretation**
Loss and/or displacement of sensitive faunal species.	<u>Direct Impact:</u>	Existing	1	4	1	0.1	0.6 - LOW	Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services); Unlikely to occur due to the transformed state of the site and immediate surrounding areas.	Thought to be insignificant due to the generally-transformed habitat at the site.
	Site disturbances and vegetation (habitat) loss may lead to the loss of faunal species that are sensitive to disturbances; The transformed nature of the footprint area assumes that only highly adaptable and generalist species would inhabit the site and therefore thought insignificant to the project.	Cumulative	2	4	2	0.5	0.4 - LOW		Displacement of sensitive faunal species due to habitat destruction eventually leads to loss of those species.
		Residual	1	4	1	0.1	0.6 - LOW		Insignificant residual impacts will remain as the site already suffers ecological transformation and degradation; The site will establish infrastructure within an area that had natural features before.
Destruction of nesting and/or roosting habitat for faunal species.	<u>Direct Impact:</u>	Existing	1	4	1	0.1	0.6 - LOW	Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services); Unlikely to occur due to the transformed state of site and immediate surrounding areas.	Thought to be insignificant due to the generally-transformed habitat at the site.
	Site clearing will remove vegetation (refugia habitat) to accommodate the infrastructure development; The transformed nature of the footprint area assumes that only highly adaptable and generalist species would inhabit the site and therefore thought insignificant to the project.	Cumulative	2	4	2	0.5	0.4 - LOW		Destruction of nesting habitat displaces the affected species eventually leads to loss of those species.
		Residual	1	4	1	0.1	0.6 - LOW		Insignificant residual impacts will remain as the site already suffers ecological transformation and degradation; The site will establish infrastructure within an area that had natural features before.
Destruction of ground-dwelling and/or sedentary fauna.	<u>Direct Impact:</u>	Existing	1	4	1	0.1	0.6 - LOW	Limit the footprint to only areas necessary for the construction process; Utilise single access roads only; Avoid indiscriminate destruction of	Thought to be insignificant due to the transformation of the habitat at the site.
	Site clearing will remove all vegetation and habitat to accommodate the	Cumulative	2	4	2	0.5	0.4 - LOW		Loss of habitat is the leading cause of species decline in general.

PRE-CONSTRUCTION & CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likeli-hood**	**Rating**	**Mitigation***	**Interpretation**
	infrastructure development. Ground-dwelling fauna (e.g. Mygalomorph spiders) or ground-nesting birds may be included when vegetation is stripped, suffering loss of individuals; Thought to have a low probability, however, due to the already-transformed nature of the proposed development site.	Residual	1	4	1	0.1	0.6 - LOW	habitat.	Insignificant residual impacts will remain as the site already suffers ecological transformation and degradation; The site will establish infrastructure within an area that had natural features before.
Destruction of sensitive habitat (Terrestrial areas).	<u>Direct Impact:</u>	Existing	1	4	1	0.1	0.6 - LOW	Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services); Erosion and runoff from the site could impact the nearby watercourse, so mitigation to control erosion and runoff must be in place during all phases of the proposed development activities; Impacts to other sensitive ecological features are unlikely to occur due to the transformed state of the proposed construction footprint and immediate surrounding areas.	Thought to be insignificant due to the generally-transformed habitat at the site.
	The proposed development site has already suffered ecological and physical transformation and therefore this is thought to be an insignificant impact; Erosion and runoff from the site could impact nearby watercourses due to the topography of the site and stormwater management/disposal.	Cumulative	2	4	2	0.5	0.4 - LOW		Cumulative loss of sensitive habitat is relatively high within the region.
		Residual	1	4	1	0.1	0.6 - LOW		Insignificant residual impacts will remain should adequate erosion control measures be put into place; The site will establish infrastructure within an area that had natural features before.
Destruction of sensitive habitat (Surface water ecosystems).	<u>Direct Impact:</u>	Existing	1	4	1	0.1	0.6 - LOW	Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services);	Thought to be insignificant due to the generally-transformed habitat at the site.
	Some development activities (such as the inevitable utilisation of wetland areas for	Cumulative	2	4	2	0.5	0.4 - LOW		Cumulative loss of sensitive habitat is relatively high within the region.

PRE-CONSTRUCTION & CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likeli-hood**	**Rating**	**Mitigation***	**Interpretation**
	services) will take place close to the wetland unit, which could lead to loss of functionality; This is not thought to be highly significant as existing infrastructure is already within the wetland areas.	Residual	1	4	1	0.1	0.6 - LOW	Erosion and runoff from the site could impact the nearby watercourse, so mitigation to control erosion and runoff must be in place during all phases of the proposed development activities; Impacts to other sensitive ecological features are unlikely to occur due to the transformed state of the proposed construction footprint and immediate surrounding areas.	Insignificant residual impacts will remain should adequate erosion control measures be put into place; The site will establish infrastructure within an area that had natural features before.
Disturbance features that alter the vegetation structures	<u>Indirect Impact:</u>	Existing	2	4	4	1	10 - High	Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services); Exotic vegetation already dominates the site and therefore encroachment and recruitment of exotics will be enhanced following further site disturbances. This will require active management.	Exotic vegetation already dominates the site and therefore this impact will be enhanced following further site disturbances. This will require active management; Also true for the perimeter areas that will be continually maintained to avert fire risk; Continued maintenance means that this impact is easily mitigated.
	Disturbances of soils will lead to altered state of vegetation structures. This will often lead to establishment of exotic invasive species; This is especially true for wetland areas. This is an aspect that is however readily managed.	Cumulative	2	4	4	1	10 - High		Cumulative loss of primary vegetation features is relatively high within the region and therefore should be avoided.
		Residual	1	4	1	0.1	0.6-LOW		Insignificant residual impacts are expected to occur as it is an impact that is readily mitigated for.
Impacts on water quality within nearby surface water ecosystems.	<u>Direct Impact:</u>	Existing	1	1	1	0.1	0.3 - LOW	Spillages must be cleared immediately and the ECO on site informed so that clean-up operations can commence. Polluted soils must be removed and disposed of at a registered disposal site; Erosion must be actively managed during all phases of the proposed development activities in order to	The distance from the site to the nearest watercourse reduces the likelihood of contaminations entering into the system; There is also existing infrastructure between the site and the nearest wetland units that further buffer any potential impacts from occurring.

PRE-CONSTRUCTION & CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likeli-hood**	**Rating**	**Mitigation***	**Interpretation**
	Impacts to water quality include accidental fuel/oil spills from poorly maintained equipment; Silts emanating from erosion carried to the watercourse via runoff will also impact the water quality of the watercourse; Thought to be an insignificant impact.	Cumulative	2	1	1	0.5	2.0 - LOW	abate the impact of silts being transported to the watercourse.	Water quality degradation is a common feature throughout the vast majority of the watercourses throughout the province.
		Residual	1	1	1	0.1	0.3 - LOW		Insignificant residual impacts will remain if appropriate erosion management is in place at all time.
Soil erosion	<u>Direct Impact:</u>	Existing	1	4	1	0.1	0.6 - LOW	Erosion management procedures must be in place during all phases of the proposed development activities, which would include the use of silt traps, silt fencing, hay bale fences, etc to protect the wetland areas.; Topsoil stockpiles should be protected from erosion.	Soil erosion could result in a significant risk if not managed appropriately.
	Soil erosion will take affect any unprotected soils that have suffered disturbances, including unprotected stockpiles of stored topsoil. Soil stripping, soil compaction and vegetation removal will increase rates of erosion and entry of sediment into the general environment and surrounding watercourses; Stockpiled soils will also be at risk of dispersal; This is a feature that is readily managed.	Cumulative	2	4	2	0.5	0.4 - LOW		Soil erosion is of national concern and is one of the leading causes of ecological degradation.
		Residual	1	4	1	0.1	0.6 - LOW		Insignificant residual impacts will remain if managed appropriately.

Table 17: The significance ratings both before and after implementation of mitigation measures of the main potential ecological impacts perceived to be associated to the proposed development activities pertaining to the operations and management phase.

OPERATIONS PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likeli-hood**	**Rating**	**Mitigation***	**Interpretation**
Erosion created through poorly designed stormwater infrastructure	Direct & Indirect Impact:	Existing	3	2	4	0.2	1.4 - LOW	Stormwater attenuation features must be designed for controlled release into the environment. Outfalls must be designed to dissipate the energy of high-velocity water and therefore reduce the scouring effect that will result in erosion; Erosion must be monitored for and rectified if concerns arise.	Erosion at outfall sites could become problematic, but not viewed as significant at the site.
	Stormwater is usually conveyed through concrete channels or underground pipe networks and have an outfall into the nearby wetlands/watercourses or to stormwater attenuation ponds. These ponds also usually have outflows. Poorly-designed outflows will create erosion if not designed appropriately.	Cumulative	3	3	2	0.75	6.0 - MOD		Cumulative degradation of watercourse integrity within urban settings is high due to poor water outfall designs, and erosion is riverbanks is common.
		Residual	1	1	1	0.2	0.6 - LOW		Insignificant residual impacts will remain if adequately designed and implemented.
Vegetation transformation for areas that are routinely maintained.	Indirect Impact:	Existing	1	3	1	0.1	0.5 - LOW	The wetland areas already suffer significant exotic vegetation inclusion, which is a general driver of ecological change throughout urban watercourses; Recruitment of exotic vegetation should be controlled throughout all phases of the development.	This will have a limited impact to the site.
	Disturbances of vegetation persisting from the construction phase will result in perpetual encroachment of pioneering and exotic/invasive floral species; The relatively small spatial scale tends to render this impact insignificant.	Cumulative	2	3	2	0.5	3.5 - MOD		Cumulative vegetation transformation through invasion of exotic vegetation is a nationwide concern.
		Residual	1	2	1	0.1	0.4 - LOW		Little to no residual impacts should remain if managed appropriately.

8.1. Pre-Construction & Construction Phase

The pre-construction and construction phases of the proposed development activities will include the site preparation, which will include the stripping of vegetation, landscaping, and compaction of soils. This will have the inevitable impacts of loss of habitat and loss of vegetation, which will influence the biodiversity within the area. The significance of this impact will vary according to the present ecological state of the site, the conservation status of the vegetation type and whether the vegetation present at the site can be considered to be representative of primary vegetation structure, the scale of the site to be cleared, the use of heavy earthmoving equipment that may require to impact an area larger than the ultimate development footprint (site offices, equipment and mateirals storage yards, access roads) and whether the site has an association with other sensitive ecological features such as surface water ecosystems. The significance is also influenced by the present land use. The significance is also determined by what impacting features can be mitigated for and how successful those mitigation measures are expected to be in the long term. By keeping the footprint of the impacts reduced to a minimum through only allowing heavy machinery to operate on designated access roadways and by avoiding the indiscriminate destruction of habitat within areas adjacent to the actual construction areas, the ecological impacts can be greatly reduced. This is especially pertinent for activities that are to take place adjacent to the wetland areas and associated conservation buffer zones.

An overall low rating of impact significance is expected to occur due to the already-transformed nature of the proposed area set within an urban landscape. Provided that the proposed mitigation measures outlined above are considered and the impact footprint remains within the ultimate footprint area, then the overall significance of the associated impacts can be negated.

8.1.1. Red Data Listed biodiversity impacts

No RDL species were noted to occur at the site during the field survey and, due to the close proximity to existing infrastructure that results in the site suffering relative ecological isolation, no RDL faunal or floral species are thought to occur within the impact footprint area. This impact is therefore regarded as being insignificant. Orange listed floral species (*Hypoxis hemerocallidea*) listed as nationally declining, do occur within the area and individuals should be removed and replanted within green zones if applicable. Being bulbous, the success rate of replanting individuals is high.

8.1.2. Floral community structures

The disturbance of soils and vegetation enhances the growth of opportunistic pioneering species. These species can be indigenous, but are most often exotic in origin that grow rapidly, colonising an area through aggressive encroachment and will out-compete the indigenous counterparts in most cases. The proposed development footprint has already been subject to historical disturbances and therefore the floral community structures have already been altered. Exotic vegetation inclusion is already regarded as high within some areas and therefore aggressive invasion/recruitment of exotic floral species could be expected following soil disturbances. An effort to control and manage future requirement should be implemented throughout all phases of the development.

8.1.3. Faunal community structures

The construction phase of a development of this nature requires the use of heavy machinery, earthmoving equipment and large teams of construction crews who are very often accommodated in construction camps (although this is unlikely for this particular development). This means that disturbance features typically increase. This could lead to displacement of sensitive species, especially ground-dwelling and ground-nesting species. Direct impacts to habitat will also lead to destruction of suitable nesting and foraging areas. This is thought to be of minor significance to the project though as the proposed development footprint area is located within an urbanised setting, within a poorly-managed catchment area. The faunal species associated with the site are therefore thought to be limited to generalist and adaptable species. The proposed development activities are therefore seen to be of minor ecological significance.

8.1.4. Soil features

Soil erosion emanating from disturbed areas and soil stockpiles could smother surrounding habitat and silts could reach aquatic and wetland systems. This will displace faunal biota from those areas that are transformed through this impact. Although easily mitigated, this is regarded as being a prominent impacting feature that requires active management throughout all phases of the proposed development activities due to the association the site has with the wetland unit.

8.1.5. Impacts associated with the proposed road development to the north of the site

The proposed road alignments are largely associated with existing informal and formal roadways and therefore the area has already been exposed to most of the perceived ecological impacts that would emanate from new roads. The construction of the new roads will require the importing of foundation materials to raise the road levels as a measure to avoid flooding. This material is typically compacted and therefore allows limited flow through of soil water. This limits hydrological interaction between the established wetland units to the north of the road and the peripheral wetland zones located to the south of the road. It is therefore recommended that drains and culverts be placed within the low points of the natural topography to allow for freedom of surface water flow.

The alignments do fall within wetland zones and the associated buffer areas and therefore specific mitigation measures do apply (see section 9 for more detail). The establishment of new roads within this area will not, however, have a significant impact on the terrestrial nor wetland ecological integrity due to the high level of ecological degradation that these habitat units are already exposed to from the local catchment management.

8.2. Management/Operations Phase

The operations phase of the proposed development refers to the everyday activities and those impacts that are thought to perpetuate from the construction phase such as exotic vegetation encroachment or erosion.

Management of soil erosion as well as exotic vegetation will be important to the management/operations phase and should be monitored for routinely, especially in areas associated with the wetland unit. Any emerging concerns must be dealt with immediately. Stormwater runoff must also be monitored for as this is often a source of emerging erosion.

9. PROPOSED REHABILITATION MEASURES

Excavations and other infrastructure development within wetland habitat requires the application of specific rehabilitation measures. Continues wetland functionality relies on an interplay between correct soil grades and layering, vegetation structures and the continued supply of a water resource. Excavations within a wetland unit that disturb soil layering tends to inhibit the movement of sub-surface water through

the soil with the result that the associated section of the wetland unit loses its source of water and/or other section receive unnaturally high levels of water due to diversions. The loss of the water resource to previously-inundated soils results in the loss of wetland-supported biodiversity and soil destabilisation. The destabilisation of the soils leads to erosion and the opportunity for the encroachment of exotic vegetation. The severity of these impacts is dependent on various factors such as the scale of the impact area, the ecological condition and sensitivity of the wetland unit, the hydrogeomorphic form of the wetland unit, and the degree of wetland development (the severity of the impacts reduce with distance from the permanent zones toward the outer limits of the temporary zones).

Establishment of pipelines within a wetland unit requires a linear excavation. Sewer lines tend to require deeper excavations (due to the reliance of gravity-induced flow) than water pipelines and therefore the associated impacts tend to be more significant. Linear excavations tend to impose the more significant impact severity than local developments as linear developments can potentially isolate larger areas of a wetland unit. Again, this depends on relative locality to the wetland unit.

Rehabilitation measures include the following:

- As excavating requires the use of heavy earth-moving machinery, the potential to compact wetland soils is high. Access into wetland zones must be via a single access route and vehicular movement outside of the designated access routes must be prohibited;
- The impact area must be limited to the infrastructure zones as well as the immediate support and service areas (i.e. access roads). Indiscriminate habitat destruction through storage of materials, and driving vehicles outside of designated access routes must be avoided;
- All activities and storage of mateirals that can take place outside of the wetland and buffer zones should preferable not be undertaken within wetland areas;
- Soils that are removed from wetland zones during excavation should be stored within their respective layers and, once the pipelines have been established, reinstated in reverse order. This is done in order to conserve the correct soil layering within the wetland zones;
- Soils should be stored next to the trench on a layer of shade cloth (or similar material) that will allow for the complete removal of soils from the storage area. This will allow for the quick and spontaneous rejuvenation of the underlying vegetation that would otherwise be smothered by persistent soil. This is, however, applicable only to short-term storage of soils. If the excavation is expected to remain open for a prolonged period, then it is recommended that soils be stored outside of the wetland zones;

- Once the excavation has been filled, the surface must be landscaped to mimic the natural topography. This is to ensure proper surface water drainage and the avoidance of gulley erosion formation;
- Impact areas should be revegetated with wetland plants that can be harvested from the existing wetland. Harvesting should be done from a wide area in order to limit the impact to the donor areas;
- If the topography of the site is such that erosion is a concern from surface water runoff, then a geotextile should be utilised to further stabilise soils;
- Soils can be further stabilised through the use of straw bales that can be anchored in place by hammering a wooden stake through the centre into the ground. A line of anchored straw bales is regarded as being very effective in curbing soil erosion. They are also preferable over the use of synthetic materials as they can be left in place as they will either be burnt during the flowing veld fire cycle or rot in place over time;
- Wetland zones that have suffered compaction during the construction process must be shallow-ripped, landscaped and re-vegetated with wetland species found within adjacent wetland areas.

Following these rehabilitation recommendations, a monitoring plan should be put into place that focuses on the early identification of erosion concerns, the success of the re-vegetation procedures as well as the potential recruitment of exotic vegetation. If any of these emerging features are observed, then remediation action must be implemented.

10. CONCLUSIONS & RECOMMENDATIONS

Following the wetland survey, the following conclusions were drawn:

- A watercourse and associated wetland zones were observed within the impact areas of the proposed development site and therefore these wetland zones were delineated (according to DWAF, 2008 guidelines) and the 30 m obligatory conservation buffers were designated (according to GDARD, 2014 guidelines);
- Two sewer line alignment alternatives have been presented for evaluation. The alternative that seeks to join up with the existing sewer network at the eastern side of the site is preferred as it will require no excavations, and therefore disturbances, within the wetland habitat;

- The overall ecological integrity of the terrestrial habitat units was shown to be relatively low, with very limited representation of primary grassland features remaining. A formal conservation initiative to preserve these areas is not thought to be viable;
- One of the most pertinent impacting features to the wetland unit will be that of soil erosion and the associated siltation of the wetland and watercourse. Silt traps and silt fencing must be used to stop sediments being transported to the wetland areas and smothering the habitat units;
- No dumping of any excess building material or other wastes or litter should be allowed within any wetland and buffer areas;
- Exotic vegetation recruitment was observed as an impacting feature within the wetlands. It is recommended that an exotic vegetation management strategy be developed to manage the present and future emergent exotic vegetation;
- Subsistence hunting or harvesting of fauna or flora within the wetland zones should be prohibited.

It should be noted that, in order to conserve the ecological structures within the region, a holistic habitat conservation approach should be adopted. This includes keeping general habitat destruction and construction footprints to an absolute minimum within the terrestrial habitat as well. Conserving the habitat units will ultimately conserve the species communities that depend on it for survival. This can only be achieved by the efforts of the contractor during the various processes of the construction phase.

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APPENDIX A – IMPACT SIGNIFICANCE RATING METHODOLOGIES & CALCULATIONS

A1. Impact Assessment Methodology

The impacts will be ranked according to the methodology described below. Where possible, mitigation measures will be provided to manage impacts. In order to ensure uniformity, a standard impact assessment methodology will be utilised so that a wide range of impacts can be compared with each other. The impact assessment methodology makes provision for the assessment of impacts against the following criteria, as discussed below.

A2. Nature of the impact

Each impact should be described in terms of the features and qualities of the impact. A detailed description of the impact will allow for contextualisation of the assessment.

A3. Extent of the impact

Extent intends to assess the footprint of the impact. The larger the footprint, the higher the impact rating will be. The table below provides the descriptors and criteria for assessment.

Table 18: Criteria for the assessment of the extent of the impact.

Extent Descriptor	Definition	Rating
Site	Impact footprint remains within the boundary of the site.	1
Local	Impact footprint extends beyond the boundary of the site to the adjacent surrounding areas.	2
Regional	Impact footprint includes the greater surrounds and may include an entire municipal or provincial jurisdiction.	3
National	The scale of the impact is applicable to the Republic of South Africa.	4
Global	The impact has global implications	5

A4. Duration of the impact

The duration of the impact is the period of time that the impact will manifest on the receiving environment. Importantly, the concept of reversibility is reflected in the duration rating. The longer the impact endures, the less likely it is to be reversible. See Table 19for the criteria for rating duration of impacts.

Table 19: Criteria for the rating of the duration of an impact.

Duration Descriptor	Definition	Rating
Construction / Decommissioning phase only	The impact endures for only as long as the construction or the decommissioning period of the project activity. This implies that the impact is fully reversible.	1
Short term	The impact continues to manifest for a period of between 3 and 5 years beyond construction or decommissioning. The impact is still reversible.	2
Medium term	The impact continues between 6 and 15 years beyond the construction or decommissioning phase. The impact is still reversible with relevant and applicable mitigation and management actions.	3
Long term	The impact continues for a period in excess of 15 years beyond construction or decommissioning. The impact is only reversible with considerable effort in implementation of rigorous mitigation actions.	4
Permanent	The impact will continue indefinitely and is not reversible.	5

A5. Potential intensity of the impact

The concept of the potential intensity of an impact is the acknowledgement at the outset of the project of the potential significance of the impact on the receiving environment. For example, SO_2 emissions have the potential to result in significant adverse human health effects, and this potential intensity must be accommodated within the significance rating. The importance of the potential intensity must be emphasised within the rating methodology to indicate that, for an adverse impact to human health, even a limited extent and duration will still yield a significant impact.

Within potential intensity, the concept of irreplaceable loss is taken into account. Irreplaceable loss may relate to losses of entire faunal or floral species at an extent greater than regional, or the permanent loss of significant environmental resources. Potential intensity provides a measure for comparing significance across different specialist assessments. This is possible by aligning specialist ratings with the potential intensity rating provided here. This allows for better integration of specialist studies into the environmental impact assessment. See Table 20 and Table 21 below.

Table 20: Criteria for impact rating of potential intensity of a negative impact.

Potential Intensity Descriptor	Definition of negative impact	Rating
High	Significant impact to human health linked to mortality/loss of a species/endemic habitat.	16
Moderate-High	Significant impact to faunal or floral populations/loss of livelihoods/individual economic loss.	8
Moderate	Reduction in environmental quality/loss of habitat/loss of heritage/loss of welfare amenity	4

Potential Intensity Descriptor	Definition of negative impact	Rating
Moderate-Low	Nuisance impact	2
Low	Negative change with no associated consequences.	1

Table 21: Criteria for the impact rating of potential intensity of a positive impact.

Potential Intensity Descriptor	Definition of positive impact	Rating
Moderate-High	Net improvement in human welfare	8
Moderate	Improved environmental quality/improved individual livelihoods.	4
Moderate-Low	Economic development	2
Low	Positive change with no other consequences.	1

It must be noted that there is no HIGH rating for positive impacts under potential intensity, as it must be understood that no positive spinoff of an activity can possibly raise a similar significance rating to a negative impact that affects human health or causes the irreplaceable loss of a species.

A6. Likelihood of the impact

This is the likelihood of the impact potential intensity manifesting. This is not the likelihood of the activity occurring. If an impact is unlikely to manifest then the likelihood rating will reduce the overall significance. Table 22 provides the rating methodology for likelihood.

The rating for likelihood is provided in fractions in order to provide an indication of percentage probability, although it is noted that mathematical connotation cannot be implied to numbers utilised for ratings.

Table 22: Criteria for the rating of the likelihood of the impact occurring

Likelihood Descriptor	Definition	Rating
Improbable	The possibility of the impact occurring is negligible and only under exceptional circumstances.	0.1
Unlikely	The possibility of the impact occurring is low with a less than 10% chance of occurring. The impact has not occurred before.	0.2
Probable	The impact has a 10% to 40% chance of occurring. Only likely to happen once in every 3 years or more.	0.5
Highly Probable	It is most likely that the impact will occur and there is a 41% to 75% chance of occurrence.	0.75
Definite	More than a 75% chance of occurrence. The impact will occur regularly.	1

A7. Cumulative Impacts

Cumulative impact are reflected in the in the potential intensity of the rating system. In order to assess any impact on the environment, cumulative impacts must be considered in order to determine an accurate significance. Impacts cannot be assessed in isolation. An integrated approach requires that cumulative impacts be included in the assessment of individual impacts.

The nature of the impact should be described in such a way as to detail the potential cumulative impact of the activity.

A8. Significance Assessment

The significance assessment assigns numbers to rate impacts in order to provide a more quantitative description of impacts for purposes of decision making. Significance is an expression of the risk of damage to the environment, should the proposed activity be authorised.

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, which takes cognisance of extent, duration, potential intensity and likelihood.

Impact Significance = (extent + duration + potential intensity) x likelihood

Table 23 provides the resulting significance rating of the impact as defined by the equation as above.

Table 23: Significance rating formulas.

Score	Rating	Implications for Decision-making
< 3	Low	Project can be authorised with low risk of environmental degradation
3 - 9	Moderate	Project can be authorised but with conditions and routine inspections. Mitigation measures must be implemented.
10 - 20	High	Project can be authorised but with strict conditions and high levels of compliance and enforcement. Monitoring and mitigation are essential.
21 - 26	Fatally Flawed	Project cannot be authorised

APPENDIX B – OBSERVED PLANT LIST FOR THE SITE

Table 24: The floral species observed during the field survey.

Family	Naturalised	*Species*	Threat status
ACANTHACEAE		*Barleria obtusa Nees*	LC
ACANTHACEAE		*Crabbea acaulis N.E.Br.*	LC
ACANTHACEAE		*Crabbea angustifolia Nees*	LC
ACANTHACEAE		*Hypoestes forskaolii (Vahl) R.Br.*	LC
ACANTHACEAE		*Justicia anagalloides (Nees) T.Anderson*	LC
AGAVACEAE	*	*Agave americana L. subsp. americana var. americana*	Not Evaluated
AMARANTHACEAE	*	*Amaranthus deflexus L.*	Not Evaluated
AMARANTHACEAE	*	*Amaranthus hybridus L. subsp. hybridus var. hybridus*	Not Evaluated
AMARANTHACEAE		*Amaranthus thunbergii Moq.*	LC
AMARANTHACEAE	*	*Gomphrena celosioides Mart.*	Not Evaluated
AMARYLLIDACEAE		*Haemanthus humilis Jacq. subsp. hirsutus (Baker) Snijman*	LC
AMARYLLIDACEAE		*Nerine angustifolia (Baker) Baker*	LC
ANACARDIACEAE		*Searsia lancea (L.f.) F.A.Barkley*	LC
ANACARDIACEAE		*Searsia pyroides (Burch.) Moffett var. pyroides*	LC
APIACEAE		*Centella asiatica (L.) Urb.*	LC
APOCYNACEAE		*Asclepias adscendens (Schltr.) Schltr.*	LC
APOCYNACEAE		*Gomphocarpus fruticosus (L.) Aiton f. subsp. fruticosus*	LC
APOCYNACEAE		*Xysmalobium undulatum (L.) Aiton f. var. undulatum*	LC
ASPARAGACEAE		*Asparagus laricinus Burch.*	LC
ASPHODELACEAE		*Aloe greatheadii Schönland var. davyana (Schönland) Glen & D.S.Hardy*	LC
ASPHODELACEAE		*Bulbine abyssinica A.Rich.*	LC
ASTERACEAE		*Berkheya insignis (Harv.) Thell.*	LC
ASTERACEAE		*Berkheya radula (Harv.) De Wild.*	LC
ASTERACEAE		*Berkheya setifera DC.*	LC
ASTERACEAE	*	*Bidens pilosa L.*	Not Evaluated
ASTERACEAE	*	*Cirsium vulgare (Savi) Ten.*	Not Evaluated
ASTERACEAE	*	*Conyza bonariensis (L.) Cronquist*	Not Evaluated
ASTERACEAE	*	*Conyza canadensis (L.) Cronquist*	Not Evaluated
ASTERACEAE		*Conyza podocephala DC.*	LC
ASTERACEAE	*	*Coreopsis lanceolata L.*	Not Evaluated
ASTERACEAE	*	*Cosmos bipinnatus Cav.*	Not Evaluated
ASTERACEAE		*Cotula anthemoides L.*	LC
ASTERACEAE		*Dicoma anomala Sond. subsp. anomala*	LC
ASTERACEAE	*	*Galinsoga parviflora Cav.*	Not Evaluated
ASTERACEAE		*Helichrysum acutatum DC.*	LC
ASTERACEAE		*Helichrysum aureonitens Sch.Bip.*	LC
ASTERACEAE		*Helichrysum caespititium (DC.) Harv.*	LC
ASTERACEAE		*Helichrysum cephaloideum DC.*	LC
ASTERACEAE		*Helichrysum dregeanum Sond. & Harv.*	LC
ASTERACEAE		*Helichrysum kraussii Sch.Bip.*	LC
ASTERACEAE		*Helichrysum nudifolium (L.) Less. var. nudifolium*	LC
ASTERACEAE		*Helichrysum rugulosum Less.*	LC
ASTERACEAE		*Helichrysum setosum Harv.*	LC
ASTERACEAE	*	*Hypochaeris radicata L.*	Not Evaluated
ASTERACEAE		*Nidorella anomala Steetz*	LC
ASTERACEAE	*	*Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt*	
ASTERACEAE	*	*Schkuhria pinnata (Lam.) Kuntze ex Thell.*	Not Evaluated
ASTERACEAE		*Senecio affinis DC.*	LC
ASTERACEAE		*Senecio barbertonicus Klatt*	LC
ASTERACEAE		*Senecio coronatus (Thunb.) Harv.*	LC
ASTERACEAE		*Senecio inornatus DC.*	LC

Family	Naturalised	*Species*	Threat status
ASTERACEAE		*Senecio oxyriifolius DC. subsp. oxyriifolius*	LC
ASTERACEAE		*Senecio venosus Harv.*	LC
ASTERACEAE		*Sonchus dregeanus DC.*	LC
ASTERACEAE	*	*Tagetes minuta L.*	Not Evaluated
ASTERACEAE	*	*Taraxacum officinale Weber*	Not Evaluated
ASTERACEAE		*Vernonia galpinii Klatt*	LC
ASTERACEAE	*	*Xanthium spinosum L.*	Not Evaluated
BRASSICACEAE	*	*Capsella bursa-pastoris (L.) Medik.*	Not Evaluated
BRASSICACEAE	*	*Nasturtium officinale R.Br.*	Not Evaluated
BUDDLEJACEAE		*Buddleja salviifolia (L.) Lam.*	LC
BUDDLEJACEAE		*Gomphostigma virgatum (L.f.) Baill.*	LC
CARYOPHYLLACEAE		*Dianthus mooiensis F.N.Williams subsp. mooiensis var. mooiensis*	Not Evaluated
CELASTRACEAE		*Gymnosporia buxifolia (L.) Szyszyl.*	LC
CELTIDACEAE		*Celtis africana Burm.f.*	LC
CHENOPODIACEAE	*	*Chenopodium album L.*	Not Evaluated
CHRYSOBALANACEAE		*Parinari capensis Harv. subsp. capensis*	LC
COMBRETACEAE		*Combretum erythrophyllum (Burch.) Sond.*	LC
CONVOLVULACEAE		*Ipomoea crassipes Hook. var. crassipes*	LC
CONVOLVULACEAE	*	*Ipomoea purpurea (L.) Roth*	Not Evaluated
CUCURBITACEAE		*Cucumis africanus L.f.*	LC
CUCURBITACEAE		*Cucumis hirsutus Sond.*	LC
CUCURBITACEAE		*Cucumis zeyheri Sond.*	LC
CYPERACEAE		*Bulbostylis humilis (Kunth) C.B.Clarke*	LC
CYPERACEAE		*Cyperus congestus Vahl*	LC
CYPERACEAE		*Cyperus esculentus L. var. esculentus*	LC
CYPERACEAE		*Eleocharis dregeana Steud.*	LC
CYPERACEAE		*Kyllinga alba Nees*	LC
CYPERACEAE		*Pycreus macranthus (Boeckeler) C.B.Clarke*	LC
CYPERACEAE		*Pycreus nitidus (Lam.) J.Raynal*	LC
CYPERACEAE		*Schoenoplectus brachyceras (Hochst. ex A.Rich.) Lye*	LC
EBENACEAE		*Diospyros lycioides Desf. subsp. guerkei (Kuntze) De Winter*	LC
EBENACEAE		*Euclea crispa (Thunb.) Gürke subsp. crispa*	LC
EUPHORBIACEAE		*Euphorbia clavarioides Boiss. var. truncata (N.E.Br.) A.C.White, R.A.Dyer & B.Sloane*	LC
EUPHORBIACEAE	*	*Ricinus communis L. var. communis*	Not Evaluated
FABACEAE		*Acacia karroo Hayne*	LC
FABACEAE	*	*Acacia mearnsii De Wild.*	Not Evaluated
FABACEAE		*Chamaecrista comosa E.Mey. var. capricornia (Steyaert) Lock*	LC
FABACEAE		*Elephantorrhiza elephantina (Burch.) Skeels*	LC
FABACEAE		*Erythrina zeyheri Harv.*	LC
FABACEAE		*Indigofera alternans DC. var. alternans*	LC
FABACEAE		*Indigofera dimidiata Vogel ex Walp.*	LC
FABACEAE		*Indigofera hirsuta L. var. hirsuta*	Not Evaluated
FABACEAE		*Indigofera zeyheri Spreng. ex Eckl. & Zeyh.*	LC
FABACEAE	*	*Medicago sativa L.*	Not Evaluated
FABACEAE	*	*Robinia pseudoacacia L.*	Not Evaluated
FABACEAE	*	*Sesbania punicea (Cav.) Benth.*	Not Evaluated
GERANIACEAE		*Monsonia angustifolia E.Mey. ex A.Rich.*	LC
HYACINTHACEAE		*Dipcadi viride (L.) Moench*	LC
HYACINTHACEAE		*Ledebouria cooperi (Hook.f.) Jessop*	LC
HYACINTHACEAE		*Ledebouria ovatifolia (Baker) Jessop*	LC
HYACINTHACEAE		*Ledebouria revoluta (L.f.) Jessop*	LC
HYPOXIDACEAE		*Hypoxis argentea Harv. ex Baker var. argentea*	LC
HYPOXIDACEAE		*Hypoxis filiformis Baker*	LC
HYPOXIDACEAE		*Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.*	Declining
HYPOXIDACEAE		*Hypoxis iridifolia Baker*	LC
HYPOXIDACEAE		*Hypoxis rigidula Baker var. rigidula*	LC
LAMIACEAE		*Leonotis leonurus (L.) R.Br.*	LC

Family	Naturalised	*Species*	Threat status
LOBELIACEAE		*Monopsis decipiens (Sond.) Thulin*	LC
MALVACEAE		*Dombeya rotundifolia (Hochst.) Planch. var. rotundifolia*	LC
MALVACEAE		*Hermannia depressa N.E.Br.*	LC
MALVACEAE	*	*Hibiscus trionum L.*	
MALVACEAE		*Sida rhombifolia L. subsp. rhombifolia*	LC
MELIACEAE	*	*Melia azedarach L.*	Not Evaluated
NYCTAGINACEAE	*	*Mirabilis jalapa L.*	Not Evaluated
OROBANCHACEAE		*Striga elegans Benth.*	LC
OXALIDACEAE	*	*Oxalis corniculata L.*	Not Evaluated
PAPAVERACEAE	*	*Argemone ochroleuca Sweet subsp. ochroleuca*	Not Evaluated
PINACEAE	*	*Pinus patula Schltdl. & Cham. var. patula*	Not Evaluated
PLANTAGINACEAE		*Plantago lanceolata L.*	LC
POACEAE		*Agrostis lachnantha Nees var. lachnantha*	LC
POACEAE		*Alloteropsis semialata (R.Br.) Hitchc. subsp. semialata*	LC
POACEAE		*Andropogon appendiculatus Nees*	LC
POACEAE		*Andropogon eucomus Nees*	LC
POACEAE		*Aristida adscensionis L.*	LC
POACEAE		*Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter*	LC
POACEAE		*Aristida congesta Roem. & Schult. subsp. congesta*	LC
POACEAE		*Aristida stipitata Hack. subsp. graciliflora (Pilg.) Melderis*	LC
POACEAE		*Arundinella nepalensis Trin.*	LC
POACEAE	*	*Arundo donax*	Not Evaluated
POACEAE		*Brachiaria serrata (Thunb.) Stapf*	LC
POACEAE	*	*Bromus catharticus Vahl*	Not Evaluated
POACEAE		*Chloris pycnothrix Trin.*	LC
POACEAE		*Chloris virgata Sw.*	LC
POACEAE	*	*Cymbopogon pospischilii (K.Schum.) C.E.Hubb.*	Not Evaluated
POACEAE		*Cynodon dactylon (L.) Pers.*	LC
POACEAE		*Digitaria eriantha Steud.*	LC
POACEAE		*Diheteropogon amplectens (Nees) Clayton var. amplectens*	LC
POACEAE		*Elionurus muticus (Spreng.) Kunth*	LC
POACEAE		*Eragrostis chloromelas Steud.*	LC
POACEAE		*Eragrostis curvula (Schrad.) Nees*	LC
POACEAE		*Eragrostis gummiflua Nees*	LC
POACEAE		*Eragrostis plana Nees*	LC
POACEAE		*Eragrostis racemosa (Thunb.) Steud.*	LC
POACEAE		*Heteropogon contortus (L.) Roem. & Schult.*	LC
POACEAE		*Hyparrhenia dregeana (Nees) Stapf ex Stent*	LC
POACEAE		*Hyparrhenia hirta (L.) Stapf*	LC
POACEAE		*Imperata cylindrica (L.) Raeusch.*	LC
POACEAE		*Loudetia simplex (Nees) C.E.Hubb.*	LC
POACEAE		*Melinis repens (Willd.) Zizka subsp. repens*	LC
POACEAE		*Monocymbium ceresiiforme (Nees) Stapf*	LC
POACEAE		*Panicum maximum Jacq.*	LC
POACEAE		*Panicum natalense Hochst.*	LC
POACEAE	*	*Paspalum dilatatum Poir.*	Not Evaluated
POACEAE		*Paspalum distichum L.*	LC
POACEAE	*	*Paspalum urvillei Steud.*	Not Evaluated
POACEAE	*	*Pennisetum clandestinum Hochst. ex Chiov.*	Not Evaluated
POACEAE	*	*Poa annua L.*	Not Evaluated
POACEAE		*Pogonarthria squarrosa (Roem. & Schult.) Pilg.*	LC
POACEAE		*Schizachyrium sanguineum (Retz.) Alston*	LC
POACEAE		*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. sphacelata*	LC
POACEAE		*Sporobolus africanus (Poir.) Robyns & Tournay*	LC
POACEAE		*Themeda triandra Forssk.*	LC
POACEAE		*Trachypogon spicatus (L.f.) Kuntze*	LC

Family	Naturalised	*Species*	Threat status
POACEAE		*Urochloa panicoides P.Beauv.*	
POLYGONACEAE		*Persicaria decipiens (R.Br.) K.L.Wilson*	LC
POLYGONACEAE	*	*Persicaria lapathifolia (L.) Gray*	Not Evaluated
POLYGONACEAE	*	*Rumex crispus L.*	Not Evaluated
POLYGONACEAE		*Rumex lanceolatus Thunb.*	LC
RHAMNACEAE		*Ziziphus mucronata Willd. subsp. mucronata*	LC
RHAMNACEAE		*Ziziphus zeyheriana Sond.*	LC
SINOPTERIDACEAE		*Cheilanthes involuta (Sw.) Schelpe & N.C.Anthony var. obscura (N.C.Anthony) N.C.Anthony*	LC
SOLANACEAE	*	*Datura ferox L.*	Not Evaluated
SOLANACEAE	*	*Datura stramonium L.*	Not Evaluated
SOLANACEAE	*	*Physalis viscosa L.*	Not Evaluated
SOLANACEAE	*	*Solanum chenopodioides Lam.*	Not Evaluated
SOLANACEAE	*	*Solanum mauritianum Scop.*	Not Evaluated
SOLANACEAE	*	*Solanum pseudocapsicum L.*	Not Evaluated
SOLANACEAE		*Solanum retroflexum Dunal*	LC
SOLANACEAE	*	*Solanum sisymbriifolium Lam.*	Not Evaluated
TYPHACEAE		*Typha capensis*	LC
VERBENACEAE	*	*Lantana camara L.*	Not Evaluated
VERBENACEAE		*Lippia javanica (Burm.f.) Spreng.*	LC
VERBENACEAE	*	*Verbena aristigera S.Moore*	Not Evaluated
VERBENACEAE	*	*Verbena bonariensis L.*	Not Evaluated