FRESHWATER RESOURCE VERIFICATION AND OFFSET CALCULATIONS FOR THE PROPOSED DEVELOPMENT ON ERF 9445, IDAS VALLEY, STELLENBOSCH WESTERN CAPE

Prepared for

Asla Devco (Pty) Ltd

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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome - usually international in origin.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydromorphy:	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	The outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year.
Watercourse:	In terms of the definition contained within the National Water Act, 1998 (Act 36 of 1998) a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks.
Wetland:	"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 land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

1. INTRODUCTION

In July 2018 Scientific Aquatic Services (SAS) were requested to undertake a peer review of the specialist wetland assessment and risk matrix undertaken by Dr Dirk van Driel in 2015 for the proposed Idas Valley residential development on Erf 9445, Stellenbosch, Western Cape, hereafter referred to as the "study area". Following this, a field verification was undertaken to verify the delineation of the wetland as provided in Dr van Driel's report[1] and provide the relevant wetland ecoservice provision, Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) ratings and determine the impact caused by the proposed development. A desktop investigation was also undertaken where all relevant information as presented by SANBI's Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org) as well as the National Freshwater Ecosystem Priority Areas (NFEPA) database were compiled.

The study area is approximately 4,1 hectares in extent and is surrounded by residential dwellings (Idas Valley to the south east) and agricultural lands to the north (Figure 1 and 2). The proposed development will include 166 residential units as well as an internal road system and open space areas (Figure 3).

1.2 Assumptions and Limitations

- The ground-truthing and delineation of the freshwater resource boundaries and the assessment thereof, are confined to a single site visit undertaken in July 2018 which considered the wetlands within the study area and investigation zone. The river was not assessed as part of this investigation.
- All freshwater resources identified within the investigation area were delineated in fulfilment of Regulation GN509 of the NWA using various desktop methods including the use of topographic maps, historical and current digital satellite imagery and aerial photographs. These resources were not ground-truthed, however, the general surroundings were considered during the desktop assessment;
- Most areas surrounding the study area have undergone significant anthropogenic changes which have altered the geomorphic characteristics and vegetation composition. The freshwater resource delineations as presented in this report are regarded as a best estimate of the boundaries based on the site conditions present, as observed during a single site assessment. The results obtained are, however, considered sufficiently accurate to allow planning and decision making to take place;
- Global Positioning System (GPS) technology is inherently somewhat inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur, however, the delineations as provided in this report are deemed appropriately accurate to fulfil the authorisation requirements;
- Freshwater resources and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater resource boundaries may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results; and
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. However, the delineations as provided in this report are deemed appropriately accurate to provide guidance for any future development plans.

[1] Van Driel, D. 2015. Idas Valley, Stellenbosch, Erf 10866. Wetland Assessment.

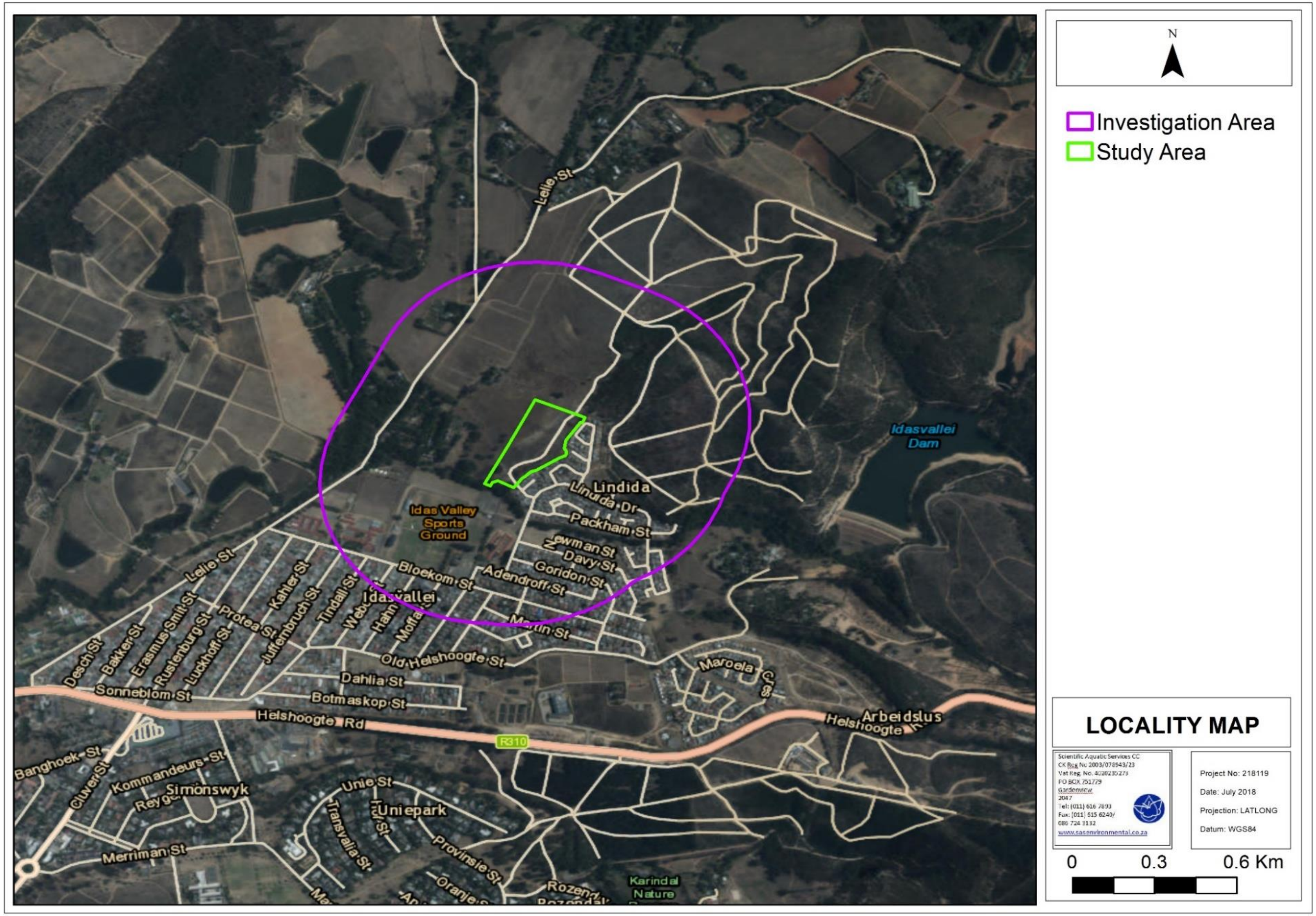

Figure 1: Digital satellite image depicting the study area in relation to the surrounding areas.

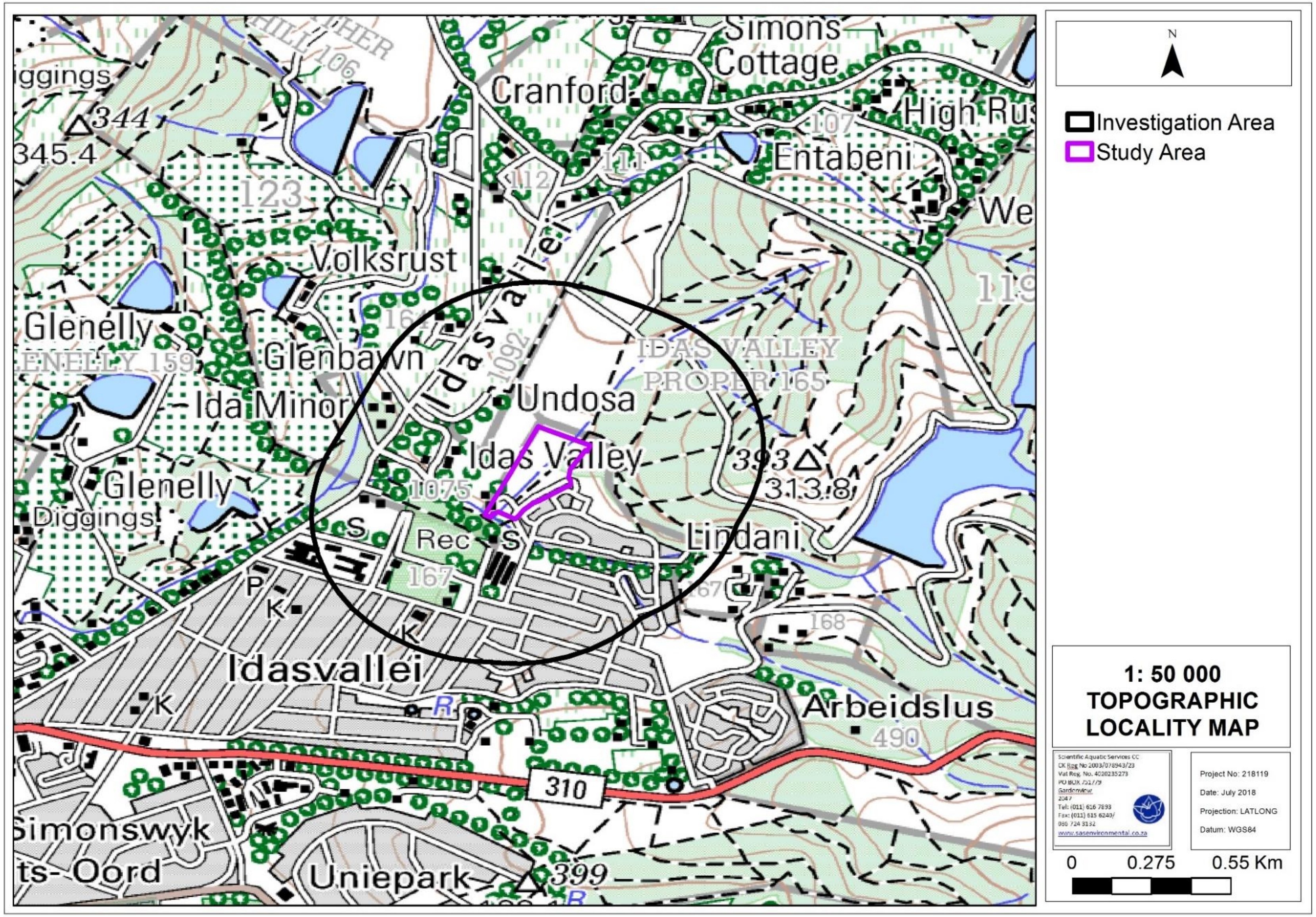

Figure 2: Location of the study area depicted on a 1:50 000 topographical map, in relation to surrounding areas.

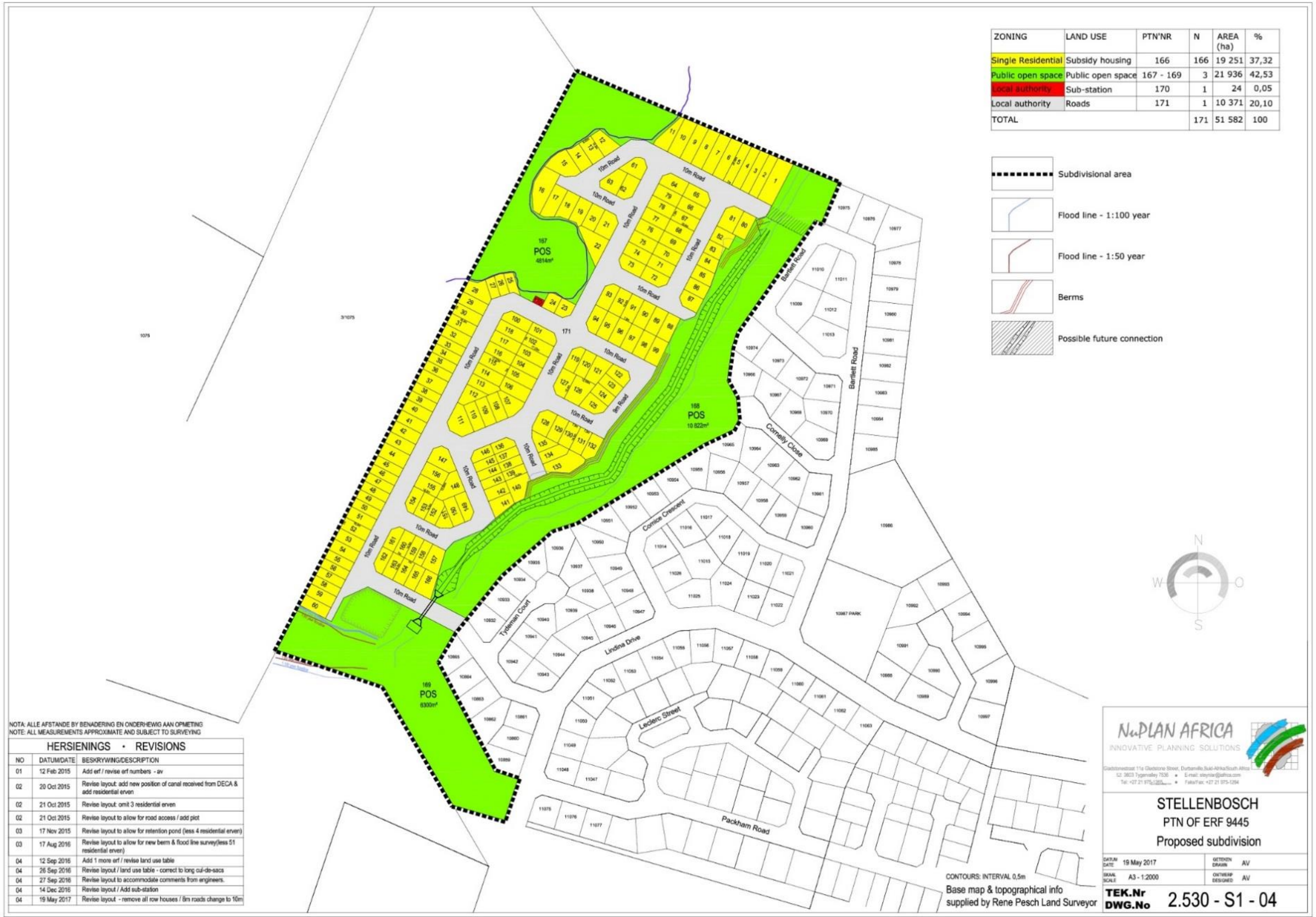

Figure 3: Proposed development layout plan.

2. RESULTS

2.1. Desktop Findings

Use was made of aerial photography, digital satellite imagery, and available provincial and national wetland databases to identify points of interest prior to the field survey. Wetland features often display a diversity of digital signatures that can be used to assist the field verification.

On comparison of the historical imagery dating back to 1938 with the available digital satellite imagery obtained for 2018, it is clear that the entire study area was historically utilised for agricultural purposes. It is further noted that the historical imagery indicated a channel bordering the western boundary to the study area which is no longer present under the current site conditions (Figure 4). Furthermore, there has been a marked increase in anthropogenic activity in the surrounding area, with more road and structural developments and less agricultural activities.

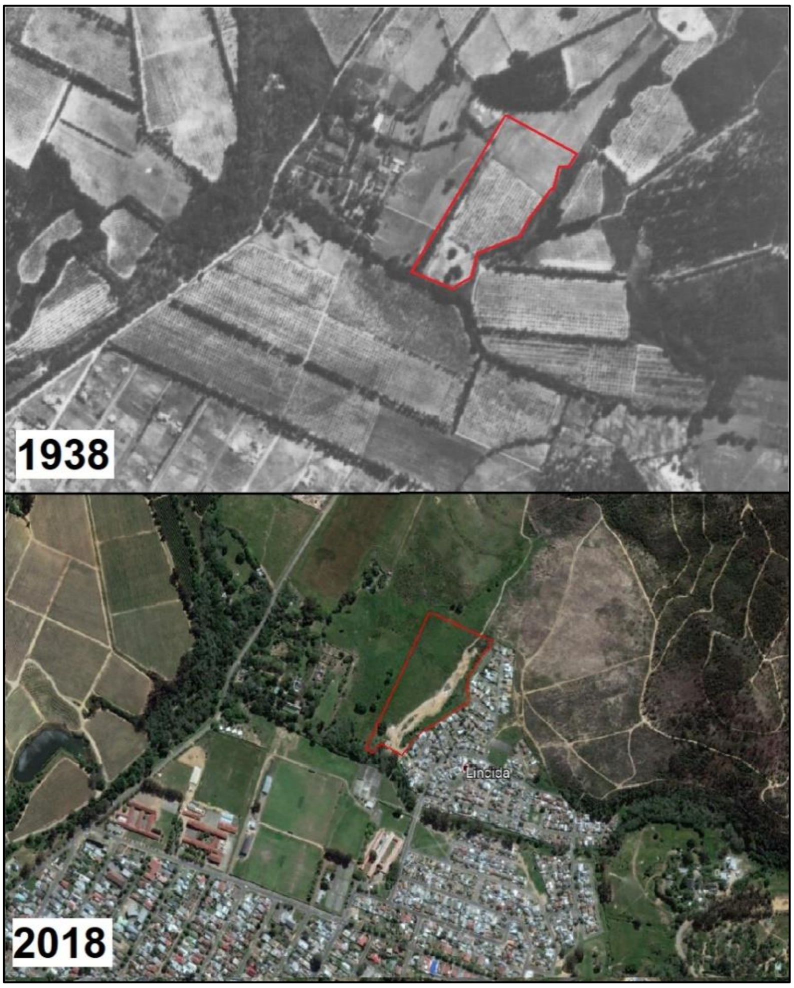

Figure 4: Historical imagery of the study area (Estimated location of the study area indicated by red block (Flight Plan 12286 of Job 120)) (top) and digital satellite imagery from 2018 (bottom).

The following table contains data accessed as part of the desktop assessment and presented as a "dashboard style" report below (Table 1). It is important to note that although all data sources used provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the subject property's actual site characteristics at the scale required to inform the environmental authorisation and/or water use authorisation processes, however, this information is considered to be useful as background information to the study. This data was therefore used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance during the site-specific field verification survey.

Table 1: Desktop data relating to the characteristics of the wetlands associated with the study area.

Aquatic ecoregion and sub-regions in which the study area is located	
Ecoregion	South Western Coastal Belt
Catchment	Berg
Quaternary Catchment	G22G
WMA	Berg
subWMA	Greater Cape Town
Dominant characteristics of the South Western Coastal Belt Ecoregion Level II (24.06) (Kleynhans *et al.*, 2007)	
Level II code	24.06 (Southern portion)
Dominant primary terrain morphology	Hills, Plains
Dominant primary vegetation types	Mountain Fynbos, Sand Plain Fynbos
Altitude (m a.m.s.l)	100 – 1100
MAP (mm)	500 to 800
Coefficient of Variation (% of MAP)	<20 to 30
Rainfall concentration index	30 to 55
Rainfall seasonality	Winter
Mean annual temp. (°C)	14 – 18 °C
Winter temperature (July)	6 – 18 °C
Summer temperature (Feb)	14 – 28°C
Median annual simulated runoff (mm)	100 to >250

Detail of the study area in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database	
FEPACODE	The study area is located within a sub-quaternary catchment currently not considered important in terms of fish or freshwater resource conservation.
NFEPA Wetlands	According to the NFEPA Database there are no wetland features situated within the study area, nor within the immediate vicinity (500m radius). The closest wetland feature is situated approximately 690m south of the study area and is considered artificial.
Wetland Vegetation Type	The study area is situated within the critically endangered Southwest Granite Fynbos wetland vegetation type.
NFEPA Rivers	There are no rivers associated with the study area, nor are there any within close proximity to the study area (within a 1km radius).
Importance of the study area according to the Western Cape Biodiversity Spatial Plan (WCBSP, 2017) (Figure 5)	
According to the WCBSP (2017) the study area is situated within the Stellenbosch Local Municipality. The study area comprises Category 2 Ecological Support Areas (ESA). ESAs are areas that are not essential for meeting biodiversity targets; however, they play an important role in supporting the functioning of protected areas / CBAs and are often vital for delivering ecosystem services. ESA 2 areas are considered to be severely degraded or have no natural cover remaining and therefore require restoration where feasible.	

Ecological Status of the most proximal sub-quaternary reach (DWS, 2014)	
Sub-quaternary reach	G22G – 09120 (Klippies River)
Proximity to study area	Approximately 3.6km southwest of the study area
Assessed by expert?	Yes
PES Category Median	D (Largely modified)
Mean Ecological Importance (EI) Class	Moderate
Mean Ecological Sensitivity (ES) Class	High
Stream Order	1
Default Ecological Class based on median PES and highest EI or ES mean	B (High)

CBA = Critical Biodiversity Areas; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; m.a.m.s.l = Meters Above Mean Sea Level; MAP = Mean Annual Precipitation; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State; WMA = Water Management Area

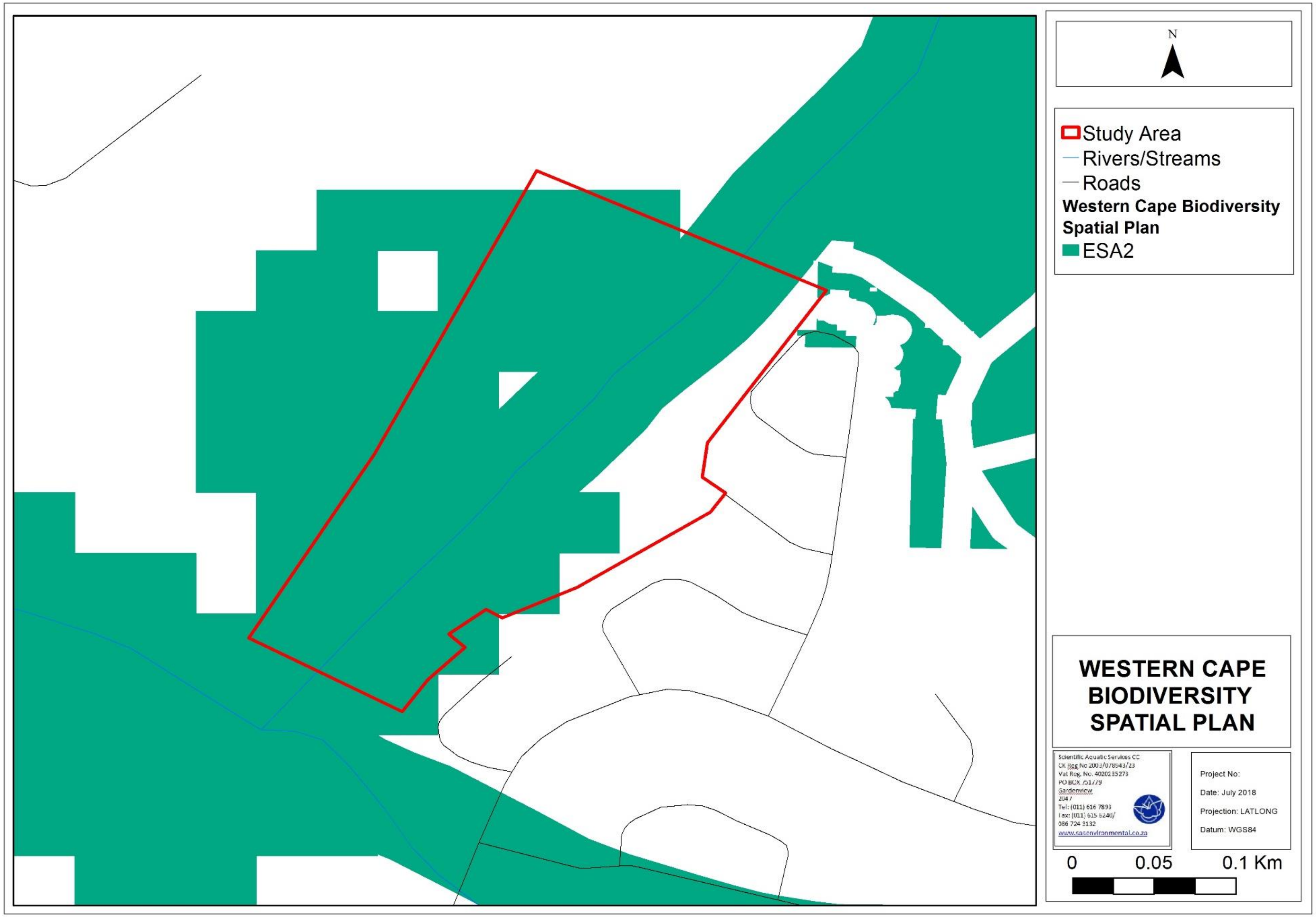

Figure 5: Wetland and ESAs according to the Western Cape Biodiversity Spatial Plan (2017).

2.2. Site Verification Results

A site visit was undertaken on the 16th of July 2018, during which the presence of any areas representing with wetland characteristics as defined by the DWAF (2008) as defined by the National Water Act, 1998 (Act 36 of 1998) were identified. The following indicators assist in determining the presence of a wetland within the study area:

- Terrain units are used to determine in which parts of the landscape a watercourse (including wetlands) was most likely to occur;
- Obligate and facultative wetland species such as *Typha capensis, Pennisetum macrourum* or *Phragmites australis* could be used in conjunction with terrain units as well as the point where a distinct change in the vegetation composition was observed in order to determine the various wetland boundaries. Obligate species are almost always found in a freshwater feature (>99% of occurrences) while facultative species are usually found in a freshwater feature (76%-99% of occurrences) but are also occasionally found in areas not associated with wetlands or rivers and often in areas of disturbance;
- Surface water and/or saturated soils can be used to determine if there is a permanent zone and to define the outer boundaries (temporary zone) of the wetland; and
- Soil form indicators are used to determine the presence of soils that are associated with prolonged and frequent saturation and a fluctuating water table within 50 cm of the land surface.

It should be noted that in order for an area to be identified as a wetland, at least two (2) of the above indicators should be present (*Pers Comm Prof. F. Ellery*).

3. KEY OBSERVATIONS

1. The study area is located on a fairly uniform slope, with an average slope ranging between 4,3% in the northern reaches and 0,3% with a southernly decent, towards the river that borders the study area to the south.

2. A large Seep Wetland with an extent of 2,31 hectares was identified extending from the northern most corner of the study area into the adjacent property. The Seep Wetland was predominantly dominated by *Pennisetum macrourum* with areas also hosting, *Imperata cylindrica, Zantedeschia aethiopica* and various moisture loving weeds such as *cotula tubinata* (Figure 6).

Figure 6: (Left) Seep Wetland within study area. The permanent zone is dominated by *Pennisetum macrourum* and *Zantedeschia aethiopica.*

3. The soil profile was investigated with the use of a hand auger in order to determine the outer boundary of the Seep wetland (Figure 7). Surface water was observed within the permanent zone.

Figure 7: (Top Left); Soil sample taken from temporary zone indicating mottling; (Top Right) Soil sample taken within the permanent zone indicating soil saturation; (Bottom) surface water identified within the Seep wetland.

4. A smaller Seep wetland was identified in the north-eastern section of the study area with an extent of 0,25 hectares. This seep was dominated by *Pennesteum macrourum* (Figure 8) and was isolated from the larger Seep and the river along the eastern boundary due to anthropogenic disturbances on the site, including a gravel road to the east and soil deposits to the west.

Figure 8: (Left) soil sample taken within smaller seep; (Right) *Pennisetum macrourum* within the smaller Seep Wetland.

5. On review of the delineation as provide in the previous wetland report (van Driel. 2015) it was noted that this delineation included only the permanent zone of the wetland within the study area and did not consider the temporary zone or the larger wetland falling outside of the study area. It was

concluded that in fact 0,78 hectares of the large Seep wetland and 0,1 hectares of the small Seep wetland falls within the study area (Figure 9).

Figure 9: (Left) delineation of wetland habitat with the study area according to van Driel. 2015; (Right) Wetland delineation undertaken by SAS. 2018 indicating the outer boundary of the temporary zone. The green indicates the large Seep Wetland and the blue indicates the smaller Seep Wetland.

Figure 10 provides visual representation of all freshwater features within the study area and surroundings while Table 2 below summarises the findings of the field verification in terms of relevant aspects (hydrology, geomorphology and vegetation components) of the riparian ecology of the Seep Wetlands. It should be highlighted that wetland habitat will be lost as part of the development and therefore an offset investigation was required (Section 4).

The details pertaining to the methodology used to assess the various assessments are available in **Appendix A** of this report.

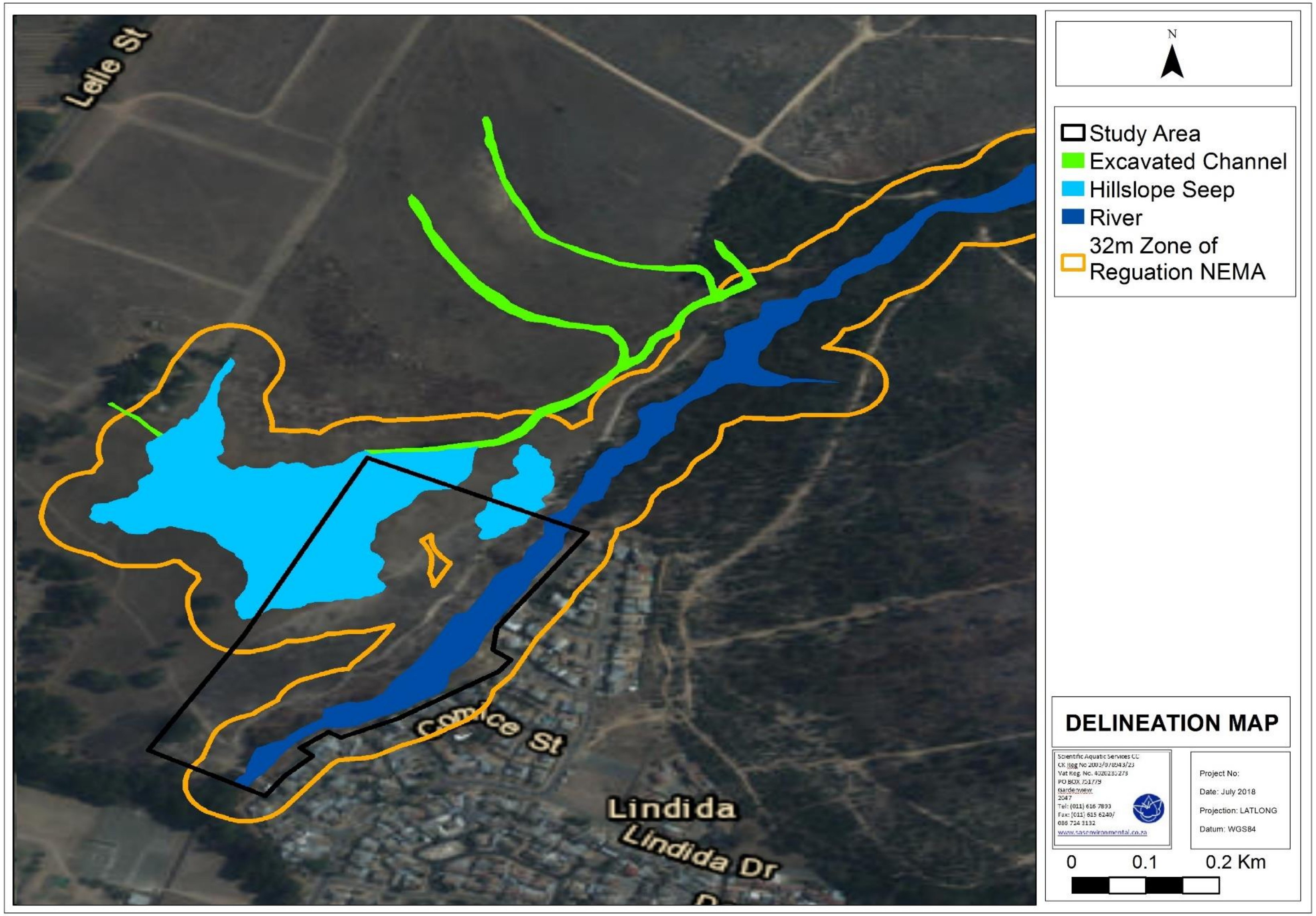

Figure 10: Delineation map and applicable Zones of Regulation for the Seep Wetlands and River within the study area.

Table 2: Summary of the assessment of the identified natural drainage line associated with the subject property.

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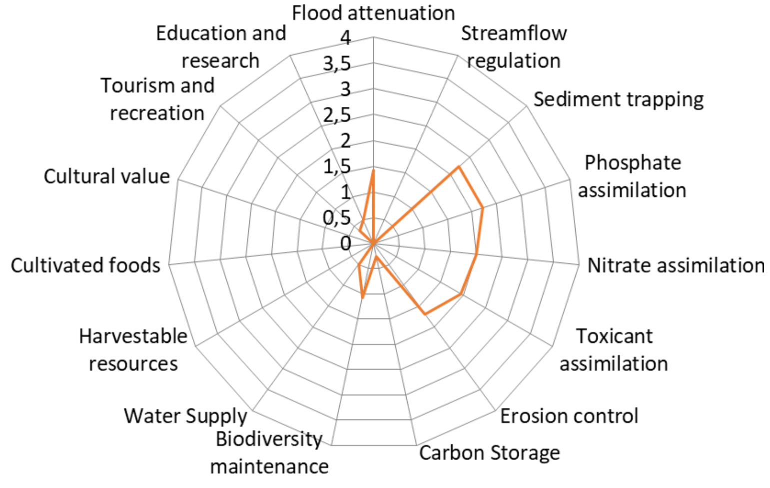
<tr><td colspan="2">Resource: Wetland</td><td colspan="2" rowspan="2"> </td></tr>
<tr><td colspan="2">Ecological & socio-cultural service provision graph:

</td></tr>
<tr><td colspan="2"></td><td>Photograph notes</td><td>Seep wetlands mainly comprising of Pennisetum macrourum, Zantedeschia aethiopica and common weed species such as Oxalis purpurea and Cotula tubinata. An excavated channel was noted extending from the upper reaches into the Seep wetland, likely excavated historically when the land was under cultivation.</td></tr>
<tr><td>Feature HGM Unit Description</td><td>Seep Wetland - located on gently to steeply sloping land and dominated by colluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope. Seeps are often located on the side-slopes of a valley, but they do not, typically, extend onto a valley floor.</td><td colspan="2" rowspan="3"><u>Watercourse characteristics</u>:

a) Hydraulic regime (Category D – Largely Modified)
The hydrological functioning of the Seep Wetlands has been largely modified due to surrounding agricultural and anthropogenic activities, including various excavated channels, likely excavated when the land was actively cultivated. These drains and deposited materials creating berms within and surrounding the Seeps have changed the pattern, direction and timing of runoff within the system.
 </td></tr>
<tr><td>PES discussion</td><td>PES Category: D (Largely Modified)
The hydrology of the Wetland Seeps has been largely modified through historical agricultural activities. This is especially true on review of the historical imagery. Similarly, the historical agricultural activities resulted in complete loss of all indigenous vegetation and, although has not been cultivated for many years, resulted in the proliferation of alien plant and weed species. Furthermore, the wetland has been impacted by excavation works and deposition of soils, altering the geomorphology.</td></tr>
<tr><td>Ecoservice provision</td><td>Ecoservice: 0,9 (Moderately Low)
The wetland seeps are considered to be of moderately high importance for sediment trapping, phosphate, nitrate and toxicant assimilation. The Seep Wetlands are considered of moderately low value for biodiversity maintenance due to the low diversity of indigenous species as well as the surrounding urbanisation and limited buffer area. The Seeps are not</td></tr>
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<tr>
<td></td>
<td>considered important for harvestable resources, cultivated foods or have any cultural value.</td>
<td rowspan="3">

Figure A: (Left) Excavated channel north of the Seep Wetlands; (right) berms within system changing the flood patterns.

b) Water quality

Due to a low buffer zone around the Seep wetlands, as well as historical agricultural activities and the surrounding anthropogenic activities, the water quality can be considered to be of moderate quality.

c) Geomorphology and sediment balance (Category C – Moderately Modified)

The geomorphology of the Seep wetlands is considered moderately modified due to excavation works and deposition of materials observed within the wetland. This has resulted in loss of organic matter and impacted on the dispersal of water across the HGM unit.

Figure B: (Left) excavation holes identified within the Seep Wetlands showing the water table depth at the time of assessment; (Right) one of various depositional mounds identified within the Seep Wetland.

d) Habitat and biota (Vegetation: Category E – Severely Modified)

The vegetation composition of both Seep wetlands has been critically modified through the removal of indigenous wetland species during the historical agricultural activities and through the proliferation of alien and invasive plant species such as *Acacia saligna* and *Pennsietum clandistenum* as well as a large variety of other weed and grass species indicative of disturbed areas. No endangered species were identified during the site visit, but the system may provide suitable breeding habitat for various common avifaunal and amphibian species.
</td>
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<tr>
<td>EIS discussion</td>
<td>EIS Category: Moderate
The Wetland Seeps are considered to be of moderate ecological importance and sensitivity, mainly due to their status as an Ecological Support Area (identified on the Western Cape Biodiversity Spatial Plan (2017) database in Figure 5) as well as its location within the Critically Endangered Southwest Granite Fynbos Wetland Vegetation Type (although no remnants were observed).</td>
</tr>
<tr>
<td>Impact Significance and Business Case</td>
<td>HIGH – 0,88 hectares of wetland will be lost (Figure 11)

Although the development layout plan (as presented in Figure 3 of this report) includes an open space area for the wetland, this is based on the delineation as provided by van Driel (2015) and only includes a portion of the permanent zone of the large Seep wetland and not the temporary zone as delineated in this report. Furthermore, the open space area does not include the smaller Seep wetland.

Based on the above, it can be concluded that an additional 15m from the edge of the study area will be lost as a result of edge effects associated with the construction activities. Factoring in this buffer, it is concluded that 0,77 hectares of the large Seep Wetland and 0,11 hectares of the smaller Seep wetland will be permanently lost as a result of this residential development. It is therefore required that an offset investigation be undertaken to ascertain the functional habitat hectare equivalents that must be conserved by the proponent to account for the above mentioned residual wetland loss.</td>
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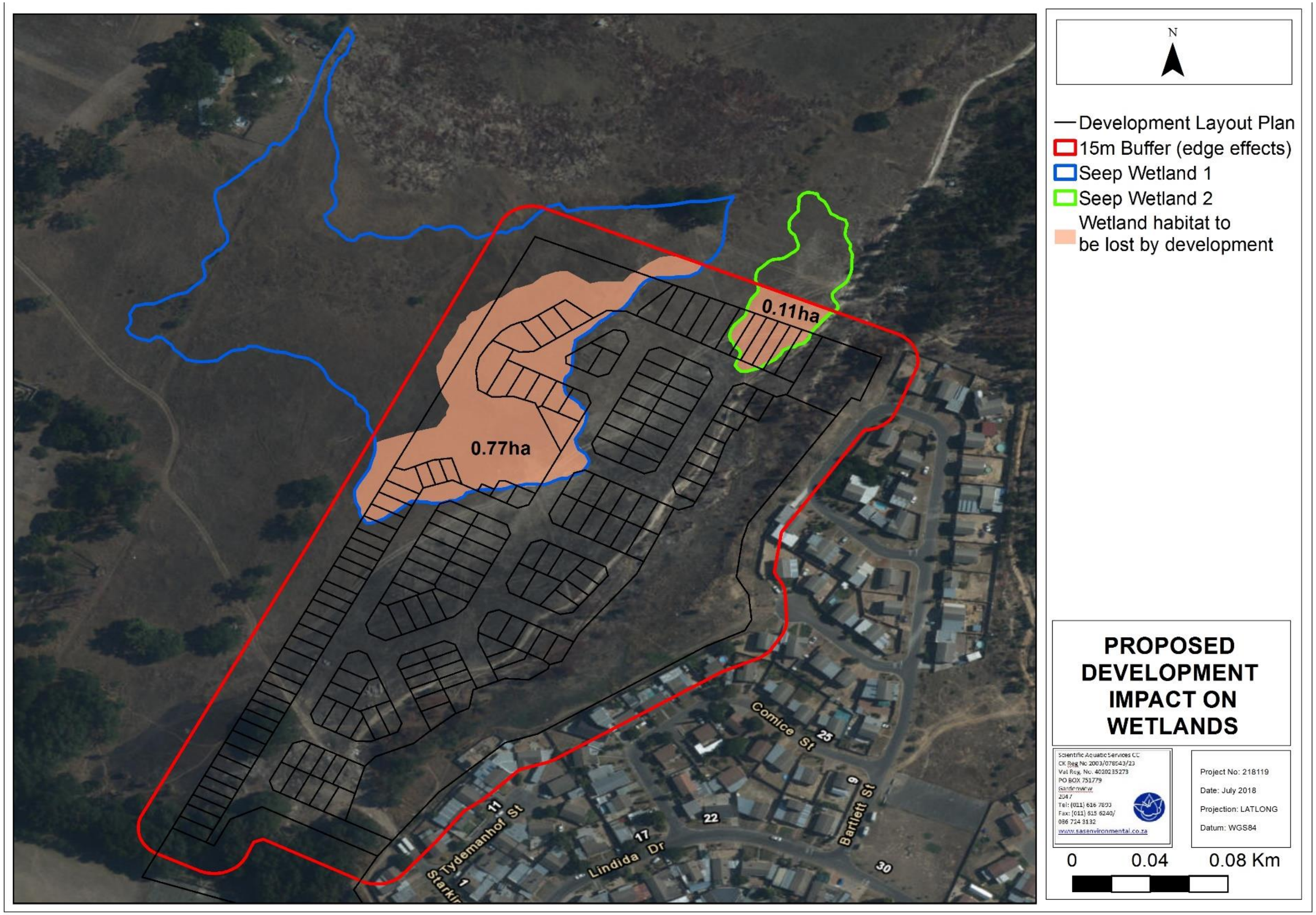

Figure 11: Map indicating development footprint, 15 m buffer included as edge effects and the anticipated loss of wetland habitat.

4. OFFSET INVESTIGATION

4.1. Mitigation Hierarchy

Offsets are applied within a mitigation hierarchy and are only aimed at mitigating or compensating for residual impacts of project development on the environment (often called “compensatory mitigation”) after all appropriate and feasible steps have first been taken to avoid/prevent, minimize/reduce and remediate/rehabilitate impacts (Macfarlane D. *et al* 2014).

- First, the proposed development should try to **avoid or prevent** negative impacts on biodiversity and ecosystem services by seeking alternative types of development, or alternative locations, different scales of development, different layouts and siting of development components, etc.;
- Secondly if the above-mentioned alternatives have been exhausted, every effort should be made to **minimize negative impacts** and to rehabilitate or remediate affected areas;
- ‘Residual impacts’ are what will remain after **minimizing impacts and rehabilitation**. These residual impacts would then need to be compensated for, and this may involve the specific application of an offset.

4.2. General Offset Guidelines

The South African National Biodiversity Institute (SANBI, 2004) defines biodiversity offsets as “*measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken*.”[2]

In terms of the Provincial Guideline on Biodiversity Offsets (Western Cape; 2007), the significance of residual impacts should be identified on a regional as well as national scale when considering biodiversity conservation initiatives. If the residual impacts lead to irreversible loss of irreplaceable biodiversity, the residual impacts should be considered to be of *very high significance* and when residual impacts are considered to be of *very high significance*, offset initiatives are not considered an appropriate way to deal with the magnitude and/or significance of the biodiversity loss. In the case of residual impacts determined to have *medium to high significance*, an offset initiative may be investigated. If the residual biodiversity impacts are considered of *low significance* no biodiversity offset is required.[3]

During 2005 the Department of Environmental Affairs and Development Planning (DEA&DP) started a process to develop a guideline on biodiversity offsets. Currently, in South Africa, only the Western Cape and KwaZulu Natal have provincial guidelines on biodiversity offsets. No guidelines or regulations relating to biodiversity offsets are formally written for the remainder of the South African provinces. Nonetheless, biodiversity offset strategies are starting to increase in number within South Africa and although thought of as a “last resort” to counteract the cumulative impacts on biodiversity, do have the potential to increase the future value of biodiversity within a region. The increase in attempts to offset residual impact, ultimately led to the release of a *Provincial Guideline on Biodiversity Offsets* in October 2007 for the Western Cape. Recently the *Draft Best Practice Guideline for South Africa* specifically focused on wetland offsets was released by Department of Water and Sanitation (DWS) in collaboration with SANBI (Macfarlane D. *et al* 2014).

The significance of a residual negative impact on biodiversity is heavily influenced by the characteristics of the receiving environment, for example, if an area is identified in a bioregional plan or fine scale

[2] Business and Biodiversity Offsets Programme (BBOP). 2009. *Biodiversity Offset Design Handbook*. BBOP, Washington, D.C.
[3] Provincial Guideline on Biodiversity Offsets, Western Cape, 2007.

biodiversity plan as a Critical Biodiversity Area (CBA), a priority site, a listed protected area, a threatened ecosystem or habitat containing threatened species or special habitat (Macfarlane D. *et al* 2014).

Biodiversity offsets generally target features or areas with similar biodiversity ("like for like" concept) as that residually impacted by development but may target features or areas with biodiversity of higher conservation significance. According to "*Towards a best-practice guideline for wetland offsets in South Africa*" (Macfarlane D. *et al* 2014) the goals of wetland offsets in South Africa are as follows:

- Provide appropriate and adequate compensation for residual impacts on key water ecosystem services and contribute to achieving water resource objectives (including both Water Resource Management and Water Resource Quality Objectives) by:
  - Ensuring "no net loss" in the overall wetland functional area by providing gains in wetland area and/or conditions equal to or greater than the losses due to residual impacts;
  - Directing offset activities that will improve key regulating and supporting services towards those wetlands where these specific services can best be enhanced, and where these offset activities will contribute best to achieving water resource objectives including both Water Resource Management and Quality Objectives;
  - Providing 'in kind' services through offset activities, or substitute services acceptable to affected communities, for residual impacts on direct (provisioning or cultural) services, to ensure that these communities are at least as well off as prior to the development taking place;
- Secure formal protection of wetland systems in a good condition so as to contribute to meeting national biodiversity and protection targets for the representation and persistence of different wetland types, thereby ensuring that cumulative impacts of increased water use, development authorisation and land use change do not jeopardize the ability to meet the country's targets; and
- Adequately compensate for residual impacts on threatened or otherwise important (e.g. wetland dependent) species through appropriate offset activities that support and improve the survival and persistence of these species.

4.3. Wetland Specific Offset Guidelines

The offset ratios as defined by DEA&DP (2011) were refined in the draft wetland offset calculator specifically pertaining to wetland offsets (Macfarlane D. *et al* 2014). The wetland offset calculator was designed to guide the criteria and importance of wetland habitat in terms of water resource and ecosystem value, ecosystem conservation and presence of species of conservation concern, at the end providing hectare equivalents representative of the wetland that requires an offset. The wetland offset calculator was used during the determination of this development offset.

Hectare Equivalents: To enable the quantification of an appropriate offset, it is important to establish a unit or measurement that will allow for losses (due to the proposed impacts) and gains (due to the proposed offset) in wetland / biodiversity values to be assessed. This is central to the concept of offsets, and the goal of achieving no net loss. In the past, the area of wetland affected (as measured in hectares, for example) was a commonly used 'currency' and is still used in many instances. However, the approach taken in these guidelines which is based international best practice, shows that a more refined "currency" that better incorporates a measure of ecological function, quality, and/or integrity. The basic "hectare equivalents" used in these guidelines are a combination of area impacted and the change in condition or functionality. These basic values are modified based on the significance of the feature being impacted (in the case of the calculation of the required offset) or the quality of the offset achieved (in the case of the offset receiving calculation). This currency ('hectare equivalents') is used as a surrogate for residual loss and has been adopted as the primary currency for evaluating impacts to wetlands as a result of the proposed development.

Where a wetland offset is deemed appropriate, various actions may be used to deliver the required outcomes. These actions can be broadly grouped into the different categories listed below as provided by Macfarlane D. *et al* 2014.

- **Protection**: This refers to the implementation of legal mechanisms (e.g. declaration of a Protected Environment or Nature Reserve under the National Environmental Management: Protected Areas

Act (Act No. 21 of 2014), a legally binding conservation servitude, or a long term Biodiversity Agreement under National Environmental Management Act (Act No. 10 of 2004) and putting in place appropriate management structures and actions. This may include setting appropriate water reserve determinations and specifying protection measures within DWA planning instruments. Furthermore, inclusion of offset sites into appropriate land use zones and land use plans, including provincial and local conservation plans, ensure that conservation outcomes are secured and maintained in the long-term. In light of the high regional rate of loss of wetlands and associated biodiversity, protection is necessary for any wetland offset, irrespective of the means used to deliver the “no net loss” outcome (i.e. rehabilitation, or other activities that compensate for wetland degradation or loss). It is important to recognize that increased protection (especially at a catchment level) greatly improves the chance of long term persistence of wetland function and biodiversity, and therefore contributes to “no net loss” objectives. As protection increases the current "value" of a wetland system, it is important that the offset mechanism fully recognises the benefits associated with increased protection in reducing potential for long term loss and adding to the overall conservation estate, in line with national conservation goals and targets;

- **Averted loss*:*** This refers to physical activities which prevent the loss or degradation of an existing wetland system, its ecosystem services and its biodiversity, where there is a clearly demonstrated threat of decline in the system’s condition, ability to provide ecosystem services or support overall Water Resource Objectives (both quality and quantity). This would apply in situations where a wetland head-cut[4] is stabilised to prevent an erosion gully from propagating further into the wetland, where excessive sediment inputs are prevented from entering a wetland through the stabilization of erosion dongas alongside the wetland or by creating structures to trap such sediment before reaching the wetland, or where there is significantly improved management of a wetland (e.g. reduced grazing pressure or control of invasive aliens impacting on wetland ecosystem functioning). These actions can therefore count as ‘gains’ which contribute to achieving a “no net loss” outcome for key wetland services. Although, it can be argued that protection mechanisms measured against the regional background rate of wetland / biodiversity loss are part of ‘averted loss’;
- **Rehabilitation**: Rehabilitation results in an improvement in wetland condition, function, and associated biodiversity. Rehabilitation involves the manipulation of the physical, chemical, or biological characteristics of a degraded wetland system in order to repair or improve wetland integrity and associated ecosystem services. This could involve actions such as removing obstructions to flow or assisting the regeneration of the natural vegetation. By increasing the condition of a wetland system and its biodiversity, a positive contribution is made towards the goal of “no net loss”;
- **Establishment**: This involves the development (i.e. creation) of a new wetland system where none existed before by manipulating the physical, chemical, or biological characteristics of a specific site. Successful establishment would result in ‘gains’ in wetland area, functions and biodiversity values. It is important to note however, that while selected ecosystem services may quite readily be created through establishment, many ecological values – let alone whole intact systems - are very difficult if not impossible to create. In general, establishment as a mechanism for delivering an offset should therefore be avoided, or only used in exceptional circumstances, where it is known (based on research and demonstrated experience) that a particular system or service that has been lost can be reliably created elsewhere. Sites would also need to be located such that they do impact on important terrestrial resources (e.g. intact natural grasslands);
- **Direct compensation**: Direct compensation involves directly compensating affected parties for the ecosystem services lost as a result of development activities. This is ideally done by providing an equivalent substitute form of offset or in some cases may take the form of monetary compensation. This form of offset action is generally most relevant to direct services (e.g. loss of grazing land) but may occasionally be applied to compensate for losses of regulating and supporting services (e.g. through the direct treatment of polluted water).

[4] Erosion occurring upstream of a specific point.

5. OFFSET REQUIREMENTS

Taking the above into consideration and on reflection of the findings as presented in Table 2 of this report, offset requirements were defined for the Idas Valley Residential Development. The identification of required wetland offsets is divided into three key themes, namely **water resources and ecosystem services, ecosystem conservation, and species of conservation concern**. As per the key observations listed in Section 3 of this report, it was noted that no Species of Conservation Concern were identified and therefore this theme was excluded from the offset requirements.

The remaining two themes must be evaluated in the specific context of the impacted wetland to ensure that the residual impacts associated with the wetland are included when assessing proposed impacts and deciding on adequate mitigation measures, including offsets (Macfarlane D. *et al* 2014). All results as obtained in Section 2 and 3 of this report were used to address the two key themes and determine the residual impact that will result due to the proposed development. The sections below provide a summary of characteristics and findings considered for each of the themes.

5.1. Wetland Functional Services

The Seep wetlands were determined to be of moderately low importance in terms of wetland function and service provision (refer to Table 2) for which the highest scores were calculated for nitrate, phosphate and toxicant assimilation, mainly as a result of the locality of the features in a quaternary catchment in which urban development and agricultural activities are dominate, followed by importance in terms of erosion control and flood attenuation from the upper mountain reaches. The remainder of the function and services assessed scored either a low score or 0.

No evidence of connected surface flow was encountered during the field assessment between the depressions and the river to the east of the study area. However, the geotechnical investigation (Core Geotechnical Consultants. 2014) indicated a high water table and that the residual granite dominating the site has a low permeability, resulting in a perched water table. This is likely the main hydrological driver for the Seep wetlands identified, as sub-surface water moves in a southern direction towards the stream along the southern boundary. It is further anticipated that the excavated drainage lines in the upper reaches of the site, likely excavated when the site was under active cultivation, further provide surface water inputs into the larger Seep Wetland.

5.2. Ecosystem Conservation

Ecosystem conservation ratios are calculated based on a suite of wetland characteristics that are regarded as important in determining conservation value. These include (i) ecosystem status; (ii) regional and national conservation context and (iii) local site attributes.

In the absence of more appropriate measures, the vegetation module of WET-Health can be used as a surrogate measure for habitat intactness pre- and post-development. This is regarded as a more appropriate measure than the integrated PES score as the suitability of a wetland to support biodiversity is most strongly linked to vegetation attributes. The Wet-Health vegetation module (refer to section 4.3) for the Seep Wetlands calculated scores falling within Category E (Vegetation composition has been severely altered and introduced; alien and/or increased weed species occur in a greater abundance to the characteristic indigenous wetland species). However, in a regional conservation context the seep wetlands fall within an indicated ESA area (Figure 5 in Section 2.1 above) and are also indicated to fall within the Southwest Granite Fynbos wetland vegetation group according to the National Freshwater Ecosystem Priority Areas (NFEPA) WetVeg database and are therefore listed as critically endangered. Local site attributes considered included the transformed nature of the buffer presently around the features due to surrounding urbanisation and agricultural activities.

The need and desirability of a wetland offset was also considered. Taking into consideration the total loss of habitat associated with wetlands – **0,88 hectares** as indicated in Table 2 and Figure 11 above, which includes a 15 m edge effect buffer– with the development of the proposed residential estate, an offset to compensate for loss of habitat may be insisted upon by the relevant regulating authorities.

On-site mitigation is deemed practical as there is sufficient remaining wetland available – **1,69 hectares** after factoring in the losses associated with the development and edge effects - within the neighbouring property (Figure 12).

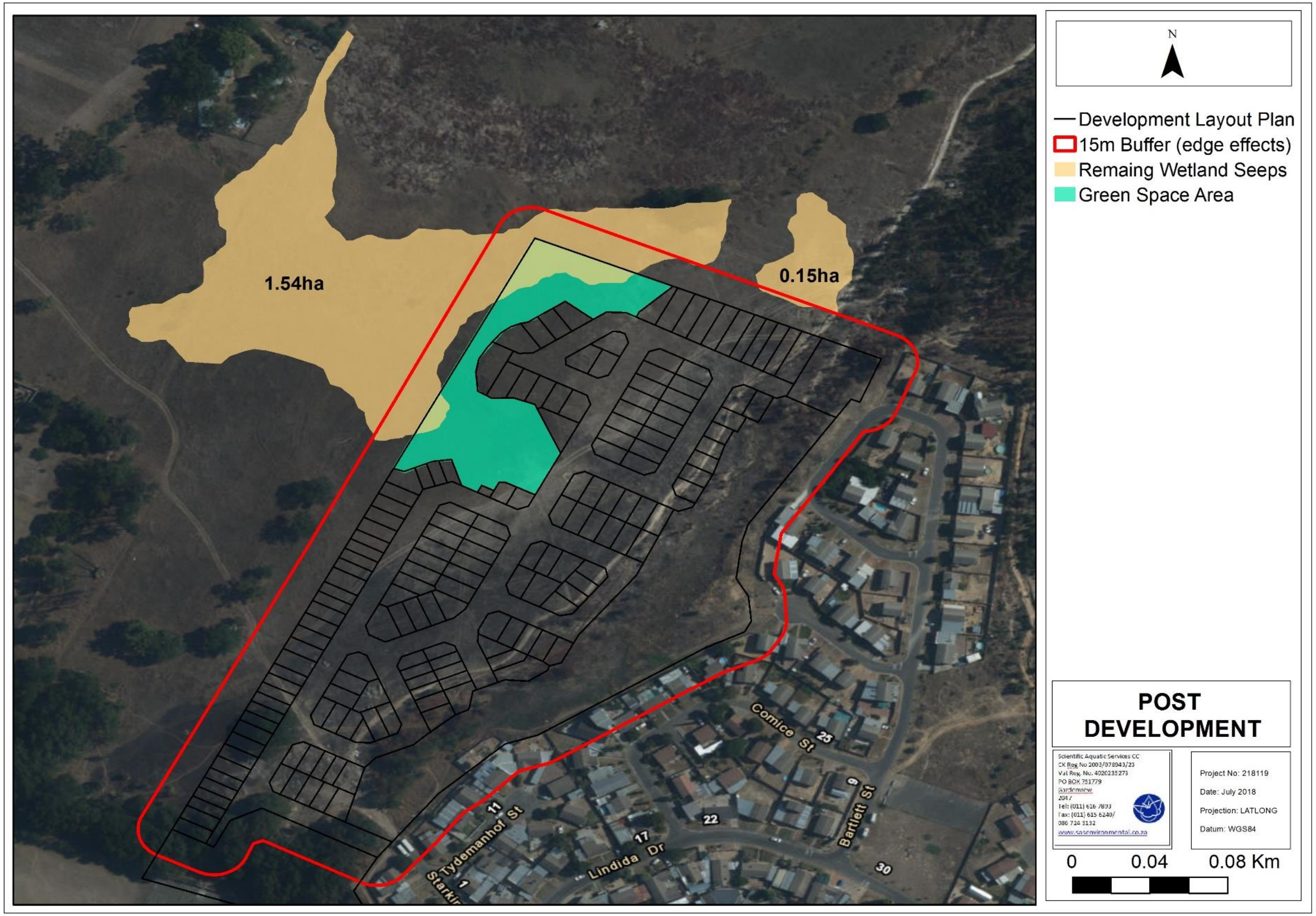

Figure 12: Map indicating the remaining wetland available to meet the offset requirements.

6. WETLAND OFFSET CALCULATION

Macfarlane D. *et al* (2014) as part of the attempt to develop a national standard, developed a tool for the calculation of wetland offset requirements by making use of risks and threat statuses in conjunction with the consideration of extent of the wetland and the PES and the perceived state of the wetland before and after development to define the required wetland offset necessary to meet the offset targets.

The wetland offset calculator was used to calculate the functional hectare equivalents as well as the habitat hectare equivalents for the themes ecosystem services and ecosystem conservation, respectively. These results are presented in Tables 3 and 4 below. The wetland features are not considered important in terms of species of conservation concern therefore the calculation was not included in the assessment.

Furthermore, since there is remaining wetland on site (1,69 hectares as indicated in Figure 12), the wetland offset calculator for assessing the potential gains for the offset receiving area – in this case the neighbouring property – were also calculated and the results are presented in Tabled 5 and 6 below.

From the below assessment it is evident that 0,4 functional hectare equivalents and 0,3 habitat hectare equivalents of wetland area needs to be conserved to offset the loss of 0,88 hectares of wetland ecoservices and ecosystem conservation value in the catchment (Table 3 and 4). Following this, it is clear from Table 6 that one habitat hectare equivalent is available in the neighbouring property which can be utilised for the offset. As indicated above, there is 1,69 hectares of wetland habitat available, therefore ample wetland s available to meet the offset requirements. This wetland will need to be improved by 30% in order to meet the functional hectare equivalent requirements, meaning that the remaining wetland will need to be improved from the Current PES Category D (Largely modified) to a Category B/C (Moderately modified).

Table 3: Functional area equivalents calculated for the Seep Wetlands to be affected.

Wetland Functionality Targets			
Impact Assessment	Prior to development	Wetland size (ha)	2,56
		Functional value (%)	53
	Post development	Functional value (%)	47
		Change in functional value (%)	10
	Key Regulating and Supporting Services Identified		
	Development Impact (Functional hectare equivalents)		0,3
Offset calculation	Offset Ratios	Triggers for potential adjustment in exceptional circumstances	Wetlands in areas of high water stress (e.g. a water stressed catchment as designated by DWA)
		Functional Importance Ratio	1,5
	Functional Offset Target (Functional hectare equivalents)		0,4

Table 4: Ecosystem Conservation Targets for the Seep Wetlands to be affected.

Ecosystem Conservation Targets				
Impact Assessment	Prior to development	Wetland size (ha)	2,56	
		Habitat intactness (%)	33	
	Post development	Habitat intactness (%)	25	
		Change in habitat intactness (%)	8	
	Development Impact (Habitat hectare equivalents)		0,2048	
Determining offset ratios	Ecosystem Status	Wetland Vegetation Group (or type based on local clasification)	Southwest Granite Fynbos	
		Threat status of wetland	Threat status	CR
			Threat status Score	15
		Protection lev el of wetland	Protection lev el	Well Protected
			Protection lev el Score	0,25
			Ecosystem Status Muliplier	3,75
	Regional and National Conservation context	Priority of wetland as defined in Regional and National Conserv ation Plans	Moderate Importance	0,75
			Regional & National Context Multiplier	0,8
	Local site attributes	Uniqueness and importance of biota present in the wetland	Low biodiv ersity v alue	0,5
		Buffer zone integrity (within 500m of wetland)	Buffer compatability score	0,5
		Local connectiv ity	Low connectiv ity	0,5
			Local Context Multiplier	0,5
			Ecosystem Conservation Ratio	1,41
Offset Calculation	Development Impact (Habitat hectare equivalents)		0,2	
	Ecosystem Conservation Ratio		1,4	
	Ecosystem Conservation Target (Habitat hectare equivalents)		0,3	

Table 5: Contributing Wetland Functionality Targets for the Offset.

Contribution Towards Wetland Functionality Targets				
Wetland attributes	Wetland Reference		**Idas Seep**	
Alignment with site selection guidelines	**Criterion**	**Relevance**	**Site attributes**	**Acceptability Guidelines**
	Wetland type	Targeted wetlands should typically be of the same type to ensure that similar serv ices to those impacted are improv ed through offset activ ities.	Wetland is of the same type as the impacted wetland.	Ideal
	Key serv ices targeted	Targeted wetlands should be prioritised and selected based on their ability to compensate for key regulating and supporting serv ices impacted by the proposed dev elopment.	Selected wetland is reasonably placed to improv e key regulating and supporting serv ices identified.	Acceptable
	Offset site location relativ e to impacted wetland	Targeted wetlands should ideally be located as close to the impacted site as possible.	Selected wetland is located within the same local catchment as the impacted wetland.	Ideal
	Overall comment on alignment with site selection guidelines			
Preliminary Offset Calculation	**Prior to offset activities**	Wetland size (ha)	1,7	
		Functional v alue (%)	40	
	Following sucessful offset implimentation	Functional v alue (%)	50	
		Change in functional v alue (%)	10	
	Preliminary Offset Contribution (Functional hectare equivalents)		**0,2**	
Final Offset Calculation	**Criterion**	**Relevance**	**Offset activity**	**Adjustment factor**
	Types of offset activ ities proposed	The risk of offset failure is linked to the type of offset activ ity planned with wetland establishment considered less preferable and more risky than rehabilitation or av erted loss activ ities.	Establishment & Protection	0,33
	Final Offset Contribution (Functional hectare equivalents)		**0,1**	

Table 6: Contributing Ecosystem Conservation Targets for the Offset.

Contribution Towards Ecosystem Conservation Targets				
Wetland attributes	Wetland Reference		Idas Seep	
	Wetland Vegetation Group (or type based on local clasification)		Southwest Granite Fynbos	
	Threat status of wetland		Threat status	**CR**
Alignment with site selection guidelines	**Criterion**	**Relevance**	**Site attributes**	**Acceptability Guidelines**
	Like for Like	Targeted wetlands should be aligned with "like-for-like" criteria to ensure that gains associated with wetland protection are commensurate with losses.	Wetland is of the same wetland type within the same wetland vegetation group	Ideal
	Landscape planning	To what degree is wetland selection aligned with Regional and National Conservation Plans	Wetlands have been identified as moderately important in landscape planning	Acceptable
	Wetland condition	The habitat condition of the wetland should ideally be as good / better that that of the impacted site prior to development (or at least B PES Category in the case of largely un-impacted wetlands)	Final habitat condition is likely to be as good as that of the impacted wetland.	Acceptable
	Local biodiversity value	Wetlands that are unique or that are recognised as having a high local biodiversity value should be prioritised for wetland protection.	The wetland is charachterised by habitat and / species of moderate biodiversity value.	Acceptable
	Viability of maintaining conservation values	Connectivity and consolidation with other intact ecosystems together with the potential for linkage between existing protected areas is preferable.	The wetland is well connected to other intact natural areas	Acceptable
	Overall comment on alignment with site selection guidelines	The offset will occur within the same wetland system. A small portion of wetland will be lost by the development, but the offset will occur by expanding the wetland habitat southwards, towards the river.		
Preliminary Offset Calculation	Wetland areas to be secured	Wetland size (ha)	**1,7**	
		Habitat intactness (%)	**40**	
		Wetland habitat contribution (hectare equivalents)	**0,7**	
	Buffer zones to be secured	Area of wetland buffer zone included in the wetland offset site	**40**	
		Integrity of buffer zone	**0,5**	
		Buffer zone hectare equivalents	**5,0**	
		Buffer zone contribution (hectare equivalents)	**0,3**	
Final Offset Calculation	**Criterion**	**Relevance**	**Site attributes**	**Adjustment factor**
	Security of tenure	Offset activities that formally secure offset sites for longer than the minimum requirement are more likely to be maintained in the long-term and are therefore preferred.	Minimum acceptable security of tenure for shortest acceptable period	1
	Offset Contributions	Wetland habitat contribution (hectare equivalents)	0,7	
		Buffer zone contribution (hectare equivalents)	0,3	
		Functional Offset Contribution (hectare equivalents)	**1,0**	

7. CONCLUSIONS AND WAY FORWARD

Based on the findings of the study, the following is can be summarised:

1. Given the findings of this investigation, it is noted that the delineation of the wetland provided by van Driel (2015) was only of the permanent zone and did not consider the temporary zone of the Seep Wetland. It was concluded that in fact the large Seep wetland had a total extent of 2,31 hectares, of which 0,78 hectares fell within the study area and a smaller Seep wetland was also identified with a total extent of 0,25 hectares, of which 0,1 hectares fell within the study area.
2. Although the development layout plan (as presented in Figure 3 of this report) includes an open space area for the wetland, this is based on the delineation as provided by van Driel (2015) and only includes a portion of the permanent zone of the large Seep wetland and not the temporary zone as delineated in this report. Furthermore, the open space area does not include the smaller Seep wetland.
3. Based on the above, and with the inclusion of an additional 15m from the edge of the study area that can be assumed will be lost as a result of edge effects associated with the construction activities, it was calculated that 0,77 hectares of the large Seep Wetland and 0,11 hectares of the smaller Seep wetland will be permanently lost as a result of this residential development.
4. An offset investigation was therefore undertaken to ascertain the functional hectare equivalents and the habitat hectare equivalents required in order to offset the anticipated 0,88 hectare loss of wetland. It was determined that 0,4 functional hectare equivalents and 0,3 habitat hectare equivalents of wetland area needs to be conserved to offset this loss.
5. Following this, one habitat hectare equivalent must be made available in the neighbouring property for the offset. This wetland will need to be improved by 30% (conservative approach) in order to meet the functional hectare equivalent requirements, meaning that the remaining wetland will need to be improved from the Current PES Category D (Largely modified) to a Category B/C (Moderately modified) which equates to 1ha equivalent in terms of conservation targets and 0.1 hectare equivalents in terms of functional hectare equivalents.
6. In order for this offset to be successful the land will need to be zoned for conservation purposes and no future developments will be allowed. Furthermore, a rehabilitation and implementation plan must be compiled indicating what actions must be undertaken, both during construction and for the operational phase to improve this Seep wetland to a Category B/C and maintain it as such for the life of the development (30 years).

We trust we have interpreted your requirements correctly. Please do not hesitate to contact us if there are aspects of this document that you would like to discuss further.

Yours Faithfully,

Digital Documentation Not Signed for Security Purposes

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Pr. Sci. Nat 117137/17

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APPENDIX A: Method of Assessment

1. Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and ecostatus of the larger aquatic system within which the freshwater resources and drainage line features present in close proximity of the proposed development are located. Aspects considered as part of the literature review are discussed in the sections that follow.

1.1 National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), DWA, South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present in the vicinity of the proposed development.

1.2 Department of Water and Sanitation (DWS) Resource Quality Information Services Present Ecological State / Ecological Importance and Sensitivity (PES/EIS) Database (2014)

The PES/EIS database as developed by the DWS RQIS department was utilised to obtain background information on the project area. The PES/EIS database has been made available to consultants since mid-August 2014. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, EWR sites and Hydro WMS sites. The results obtained serve to summarise this information as a background to the conditions of the watercourse traversed by the proposed linear development.

2. Classification System for Wetlands and other Aquatic Ecosystems in South Africa (2013)

All wetland or riparian features encountered within the study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the "Classification System" (Ollis et. al., 2013). A summary on Levels 1 to 4 of the classification system are presented in the tables below.

Table C1: Classification System for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	**LEVEL 2: REGIONAL SETTING**	**LEVEL 3: LANDSCAPE UNIT**
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table C2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)

FUNCTIONAL UNIT		
LEVEL 4: **HYDROGEOMORPHIC (HGM) UNIT**		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems

From the classification system, Inland Systems are defined as **aquatic ecosystems that have no existing connection to the ocean**[5] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but **which are inundated or saturated with water, either permanently or periodically.** It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included in Level 2 of the classification system is that of the DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et. al.,* 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups' vegetation types across the country, according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

Level 3: Landscape Setting

At Level 3 of the classification system for Inland Systems, a distinction is made between four Landscape Units (Table C1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et. al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

[5] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table C2), on the basis of hydrology and geomorphology (Ollis *et. al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et. al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et. al*., 2009).

3. Wet-Ecoservices (2009)

“The importance of a water resource, in ecological, social or economic terms, acts as a modifying or motivating determinant in the selection of the management class” (DWA, 1999). The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table C3: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

4. Index of Habitat Integrity (IHI)

To assess the PES of the riparian / wetland feature, the Index of Habitat Integrity (IHI) for South African floodplain and channelled valley bottom wetland types (DWAF Resource Quality Services, 2007) was used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (table below), and provide a score of the PES of the habitat integrity of the riparian system being examined.

Table C4: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

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 natural habitat, biota and basic ecosystem functions has occurred. 20-40% Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
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.

5. WET-Health

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing to promote their conservation and wise management.

Level of Evaluation

Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; or
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems above.

Quantification of Present State of a wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial *extent* of the impact of individual activities and then separately assessing the *intensity* of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores, and Present State categories are provided in the table below.

Table C5: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognisable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been completely modified with an almost complete loss of natural habitat and biota.	8-10	F

Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (table below).

Table C6: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

Overall health of the wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

6. Ecological Importance and Sensitivity (EIS) (Rountree & Kotze, 2013)

The purpose of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term (Rountree & Kotze, 2013).

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWA (now the DWS) used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, *et, al,* 2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWA and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, taking into consideration water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of socio-cultural benefits, including the subsistence and cultural benefits provided by the wetland system.

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C7) of the wetland system being assessed.

Table C7: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999).

EIS Category	Range of Mean	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.	>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.	>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.	>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.	>0 and <=1	D

7. Recommended Ecological Category (REC)

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure" (DWA, 1999).

The REC (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above), and is followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.
A wetland may receive the same class for the PES as the REC if the wetland is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the wetland feature.

Table C8: Description of REC classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

8. Wetland Delineation

For the purposes of this investigation, a wetland is defined in the National Water Act (1998) as "land which is transitional between terrestrial and aquatic systems where the water table is at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".
The wetland zone delineation took place according to the method presented in the DWAF (2005) document "A practical field procedure for identification and delineation of wetlands and riparian areas.

An updated draft version of this report is also available and was therefore also considered during the wetland delineation (DWAF, 2008). The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The position in the landscape, which will help identify those parts of the landscape where wetlands are more likely to occur;
- The type of soil form (i.e. the type of soil according to a standard soil classification system), since wetlands are associated with certain soil types;
- The presence of wetland vegetation species; and
- The presence of redoxymorphic soil feature, which are morphological signatures that appear in soils with prolonged periods of saturation.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF, 2005 and 2008). Riparian and wetland zones can be divided into three zones (DWAF, 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant periods of wetness (at least three months of saturation per annum) and the temporary zone surrounds the seasonal zone and is only saturated for a short period of saturation (typically less than three months of saturation per annum), but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

APPENDIX B: Calculations from the Wetland Assessment

PRESENT ECOLOGICAL STATE (PES), ECOSERVICES AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table B1: Presentation of the results of the Socio-cultural and Ecoservice provision

Ecosystem service	Seep
Flood attenuation	1,4
Streamflow regulation	0,0
Sediment trapping	2,2
Phosphate assimilation	2,2
Nitrate assimilation	2,0
Toxicant assimilation	1,9
Erosion control	1,7
Carbon Storage	0,3
Biodiversity maintenance	1,1
Water Supply	0,5
Harvestable resources	0,0
Cultivated foods	0,0
Cultural value	0,0
Tourism and recreation	0,4
Education and research	0,5
SUM	**14,2**
Average score	**0,9**

Table B2: Presentation of the results of the PES assessment (WET-Health) applied to the Wetland Seeps

HGM Unit	Ha	Extent (%)	Hydrology		Geomorphology		Vegetation	
			Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
1	2,30	100	4,0	0	3,7	0	7,0	-1
Area weighted impact scores*			4,0	-1,0	3,7	0,0	7,0	-1,0
PES Category (See Table 5.29)			D	↓	C	→	E	↓

Table E3: Presentation of the EIS assessment applied to Seep Wetlands

Ecological Importance and Sensitivity	Score (0-4)	*Confidence (1-5)*
Biodiversity support	A (average)	(average)
	0,33	3,00
Presence of Red Data species	0	3
Populations of unique species	0	3
Migration/breeding/feeding sites	1	3
Landscape scale	B (average)	(average)
	1,20	4,00
Protection status of the wetland	1	4
Protection status of the vegetation type	2	4
Regional context of the ecological integrity	1	4
Size and rarity of the wetland type/s present	1	4
Diversity of habitat types	1	4
Sensitivity of the wetland	C (average)	(average)
	1,00	2,00
Sensitivity to changes in floods	1	2
Sensitivity to changes in low flows/dry season	1	2
Sensitivity to changes in water quality	1	2
ECOLOGICAL IMPORTANCE & SENSITIVITY	**(max of A,B or C)**	*(average of A, B or C)*
Fill in highest score:	**B**	**1,20**

Hydro-Functional Importance			Score (0-4)	*Confidence (1-5)*
Regulating & supporting benefits	**Flood attenuation**		1	4
	Streamflow regulation		0	4
	Water Quality Enhancement	***Sediment trapping***	2	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		0	4
HYDRO-FUNCTIONAL IMPORTANCE			**(average score)**	**(average confidence)**
			1	4

Direct Human Benefits		Score (0-4)	*Confidence (1-5)*
Subsistence benefits	***Water for human use***	0	3
	Harvestable resources	0	4
	Cultivated foods	0	4
Cultural benefits	***Cultural heritage***	0	4
	Tourism and recreation	1	4
	Education and research	1	4
DIRECT HUMAN BENEFITS		(average score)	(average confidence)
		0,33	4

APPENDIX C: Details, Expertise and Curriculum Vitae of Specialists

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden	MSc (Environmental Management) (University of Johannesburg)
Kim Marais	BSc (Hons) Zoology (Herpetology) (University of the Witwatersrand)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Johannesburg, 2007		
Postal code:	1401	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist, Aquatic Ecologist
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)

Accredited River Health practitioner by the South African River Health Program (RHP)

Member of the South African Soil Surveyors Association (SASSO)

Member of the Gauteng Wetland Forum

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2002
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2000
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	1999

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces

Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe

Eastern Africa – Tanzania

West Africa – Ghana, Liberia, Angola, Guinea Bissau

Central Africa – Democratic Republic of the Congo

SELECTED PROJECT EXAMPLES

Development compliance studies

- Project co-leader for the development of the EMP for the use of the Wanderers stadium for the Ubuntu village for the World Summit on Sustainable Development (WSSD).
- Environmental Control Officer for Eskom for the construction of an 86Km 400KV power line in the Rustenburg Region.
- Numerous Environmental Impact Assessment (EIA) and EIA exemption applications for township developments and as part of the Development Facilitation Act requirements.
- EIA for the extension of mining rights for a Platinum mine in the Rustenburg area by Lonmin Platinum.
- EIA Exemption application for a proposed biodiesel refinery in Chamdor.
- Compilation of an EIA as part of the Bankable Feasibility Study process for proposed mining of a gold deposit in the Lofa province, Liberia.

- EIA for the development of a Chrome Recovery Plant at the Two Rivers Platinum Mine in the Limpopo province, South Africa.
- Compilation of an EIA as part of the Bankable Feasibility Study process for the Mooihoek Chrome Mine in the Limpopo province, South Africa.
- Mine Closure Plan for the Vlakfontein Nickel Mine in the North West Province.

Specialist studies and project management

- Development of a zero discharge strategy and associated risk, gap and cost benefit analyses for the Lonmin Platinum group.
- Development of a computerised water balance monitoring and management tool for the management of Lonmin Platinum process and purchased water.
- The compilation of the annual water monitoring and management program for the Lonmin Platinum group of mines.
- Analyses of ground water for potable use on a small diamond mine in the North West Province.
- Project management and overview of various soil and land capability studies for residential, industrial and mining developments.
- The design of a stream diversion of a tributary of the Olifants River for a proposed opencast coal mine.
- Waste rock dump design for a gold mine in the North West province.
- Numerous wetland delineation and function studies in the North West, Gauteng and Mpumalanga Kwa-Zulu Natal provinces, South Africa.
- Hartebeespoort Dam Littoral and Shoreline PES and rehabilitation plan.
- Development of rehabilitation principles and guidelines for the Crocodile West Marico Catchment, DWAF North West.

Aquatic and water quality monitoring and compliance reporting

- Development of the Resource Quality Objectives for the Local Authorities in the Upper Crocodile West Marico Water management Area.
- Development of the 2010 State of the Rivers Report for the City of Johannesburg.
- Development of an annual report detailing the results of the Lonmin Platinum groups water monitoring program.
- Development of an annual report detailing the results of the Everest Platinum Mine water monitoring program.
- Initiation and management of a physical, chemical and biological monitoring program, President Steyn Gold Mine Welkom.
- Aquatic biomonitoring programs for several Xstrata Alloys Mines and Smelters.
- Aquatic biomonitoring programs for several Anglo Platinum Mines.
- Aquatic biomonitoring programs for African Rainbow Minerals Mines.
- Aquatic biomonitoring programs for several Assmang Chrome Operations.
- Aquatic biomonitoring programs for Petra Diamonds.
- Aquatic biomonitoring programs for several coal mining operations.
- Aquatic biomonitoring programs for several Gold mining operations.
- Aquatic biomonitoring programs for several mining operations for various minerals including iron ore, and small platinum and chrome mining operations.
- Aquatic biomonitoring program for the Valpre bottled water plant (Coca Cola South Africa).
- Aquatic biomonitoring program for industrial clients in the paper production and energy generation industries.
- Aquatic biomonitoring programs for the City of Tshwane for all their Waste Water Treatment Works.
- Baseline aquatic ecological assessments for numerous mining developments.
- Baseline aquatic ecological assessments for numerous residential commercial and industrial developments.
- Baseline aquatic ecological assessments in southern, central and west Africa.
- Lalini Dam assessment with focus on aquatic fish community analysis.
- Musami Dam assessment with focus on the FRAI and MIRAI aquatic community assessment indices.

Wetland delineation and wetland function assessment

- Wetland biodiversity studies for three copper mines on the copper belt in the Democratic Republic of the Congo.
- Wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Terrestrial and wetland biodiversity studies for developments in the mining industry.
- Terrestrial and wetland biodiversity studies for developments in the residential commercial and industrial sectors.
- Development of wetland riparian resource protection measures for the Hartbeespoort Dam as part of the Harties Metsi A Me integrated biological remediation program.
- Priority wetland mammal species studies for numerous residential, commercial, industrial and mining developments throughout South Africa.

Terrestrial ecological studies and biodiversity studies

- Biodiversity Action plans for numerous mining operations of Assmang Chrome throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Xstrata Alloys and Mining throughout South Africa in line with the NEMBA requirements.

- Biodiversity Action plan for the Nkomati Nickel and Chrome Mine Joint Venture.
- Terrestrial and wetland biodiversity studies for three copper mines on the copperbelt in the Democratic Republic of the Congo.
- Terrestrial and wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Numerous terrestrial ecological assessments for proposed platinum and coal mining projects.
- Numerous terrestrial ecological assessments for proposed residential and commercial property developments throughout most of South Africa.
- Specialist Giant bullfrog (*Pyxicephalus adspersus*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist Marsh sylph (*Metisella meninx*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Project management of several Red Data Listed (RDL) bird studies with special mention of African grass owl (*Tyto capensis*).
- Project management of several studies for RDL Scorpions, spiders and beetles for proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist assessments of terrestrial ecosystems for the potential occurrence of RDL spiders and owls.
- Project management and site specific assessment on numerous terrestrial ecological surveys including numerous studies in the Johannesburg-Pretoria area, Witbank area, and the Vredefort dome complex.
- Biodiversity assessments of estuarine areas in the Kwa-Zulu Natal and Eastern Cape provinces.
- Impact assessment of a spill event on a commercial maize farm including soil impact assessments.

Fisheries management studies

- Tamryn Manor (Pty.) Ltd. still water fishery initiation, enhancement and management.
- Verlorenkloof Estate fishery management strategising, fishery enhancement, financial planning and stocking strategy.
- Mooifontein fishery management strategising, fishery enhancement and stocking programs.
- Wickams retreat management strategising.
- Gregg Brackenridge management strategising and stream recalibration design and stocking strategy.
- Eljira Farm baseline fishery study compared against DWAF 1996 aquaculture and aquatic ecosystem guidelines.

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF KIM MARAIS

PERSONAL DETAILS

Position in Company	Consultant
Date of Birth	28 February 1989
Nationality	The Netherlands
Languages	English, Afrikaans
Joined SAS	2015 – Present

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Natural Scientist with the South African Council for Natural Scientific Professions
Member of the South African Wetlands Society

EDUCATION

Qualifications

Short course in Tools for Wetland Assessment (Rhodes) (Passed with Distinction)	2018
Certificate in Environmental Law for Environmental Managers (CEM)	2014
Certificate for Introduction to Environmental Management (CEM)	2013
BSc (Hons) Zoology (Herpetology) (University of the Witwatersrand)	2012
BSc (Zoology and Environment, Ecology and Conservation) (University of Witwatersrand)	2011

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces

West Africa – Uganda

PREVIOUS EMPLOYMENT

Position	Junior Environmental Scientist
Company	ILISO Consulting (Pty) Ltd
Employment	2013 - 2015

SELECTED PROJECT EXAMPLES

Wetland Delineation and Wetland Function Assessment
Various Freshwater Assessments, including:

- Wetland Offset Plan for the Cape Town International Airport, Cape Town.
- Freshwater Assessment for the Swartklip Site as part of the Cape Town International Airport Wetland Offset requirements, Cape Town.
- Freshwater Assessment for the proposed Heuningklip Solar Farm, Vredenburg, Western Cape.
- Freshwater screening for the proposed Doornfontein Solar Farm, Velddrift, Western Cape.
- Freshwater Screening for the proposed Valentia underground shooting range, Paarl, Western Cape.

- Freshwater Assessment for the proposed Baden Powell Industrial development, Western Cape.
- Freshwater Assessment for the decommissioning of five landfill sites within the Drakenstein Municipality, Western Cape.
- Freshwater Assessment for the proposed De Hoop Residential Development, southern Paarl, Western Cape.
- Freshwater assessment for the proposed Vredenburg Wind Energy Facility, Vredenburg, Western Cape.
- Wetland Assessment for the proposed Excelsior Wind Energy Farm and associated powerline infrastructure, Swellendam, Western Cape.
- Wetland Assessment for the sewage Bulk Service System for the Drakenstein Municipality, Paarl, Western Cape.
- Freshwater screening for the proposed Vendome residential Development, Paarl, Western Cape.
- Wetland Assessment for the Riverclub Development for the Val de Vie development, Paarl, Western Cape.
- Wetland Assessment for the Riverfarm Development for the Val de Vie development, Paarl, Western Cape.
- Wetland Assessment for the development of three agricultural dams for irrigation of crops, Cape Farms, Western Cape.
- Wetland Assessment for the Willow Wood Estate Sewage pipeline upgrade, D'Urbanvale, Western Cape.
- Wetland Assessment for the rectification of infilling of a freshwater feature, D'Urbanvale, Western Cape.
- Freshwater Assessment for the stabilisation of the Franschhoek River embankment, Leeu Estates, Franschhoek, Western Cape.
- Freshwater Assessment for the proposed Helderburg Hospital, Somerset West, Western Cape.
- Freshwater Assessment for the Vergenoegd Wine Estate, Cryodon, Western Cape.
- Freshwater assessment for the proposed upgrade of the community school, Elandsdift farm, Sir Lowry's Pass, Western Cape.

Various Freshwater Rehabilitation and Management Plans, including:

- Detailed Method Statement for the rehabilitation and Maintenance of the wetland associated with the Gentleman's Estate Plots, Val de Vie, Paarl, Western Cape.
- Detailed method statement for the rectification and rehabilitation of a storm water system, D'Urbanvale, Western Cape.
- Rehabilitation Plan for the proposed de Hoop Residential Development, Paarl, Western Cape.
- Rehabilitation Plan for the proposed abstraction and storage of water from the Diep River in a 500,000m^3 dam, Durbanville, Western Cape.
- Rehabilitation Plan for the proposed bulk water pipeline over the Kuils River, Belhar, Western Cape.

Water Use Authorisations and ECO input

- WUA for the SANRAL N3 De Beers Pass Section within the Free State and KwaZulu-Natal.
- Assistance with the WULA for the Mzimvubu Water Project, Eastern Cape.
- WUA for the Excelsior Wind Energy Farm and associated powerline infrastructure, Swellendam, Western Cape.
- WUA for the Golden Valley Phase II Wind Energy Facility, Eastern Cape.
- WUA for the Sewage Bulk Service system for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
- WUA for the Riverfarm Development for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
- WUA for the Pearl Valley II Development for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
- WUA for the Levendal Village for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
- WUA for a residential Development, Klapmuts, Western Cape.
- WUA for the Riverclub Development for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
- WUA for the proposed Copperton Wind Energy Facility, Northern Cape.
- WUA for the proposed bulk water pipeline crossing over the Kuils River, Bellville, Western Cape.
- WUA for the proposed Vergenoegd Village residential development near Crydon, Western Cape.
- Validation and Verification process of three farms in Franschhoek, Western Cape.
- Validation and Verification process for Farm 1165 in Durbanville, Western Cape.
- WUA for the De Hoop Lifestyle Estate, Paarl, Western Cape.
- WUA for the proposed Platrug Dam with storage capacity of 500,000m^3, Western Cape.
- WUA for the proposed Boland Park residential development, Western Cape.

Specialist Environmental Control Work

- ECO of WUL conditions for the proposed bridge and access road over the Berg River, Val de Vie Estate, Paarl.
- ECO of WUL conditions for the proposed bulk water pipeline over the Kuils River, City of Cape Town, Belhar, Western Cape.
- ECO of WUL conditions for the proposed Riverclub residential development, Paarl, Western Cape.
- Various specialist freshwater input into EMP's and landscape plans, Western Cape.

Faunal Assessments

- Faunal Screening for the proposed Brand se Baai Abalone Farm, Tronox Namakwa Sand's Mine, Western Cape.
- Faunal Assessment for the proposed Vergenoegd Village residential development near Crydon, Western Cape.
- Faunal Baseline Study for the proposed wetland offset Study at Denel Swartklip, Cape Town international Airport, Western Cape.

Public Participation and Environmental Impact Assessments

- Public Participation for the Environmental Impact Assessment for the Eskom Photovoltaic Plant at Arnot and Duvha Power Station.
- Eskom Hendrina to Gumeni sub-stations 400 kV Powerline. Co-ordination of Heritage and Ecological Assessment and updating the Construction and Operation Environmental Management Plan.
- Public Participation Team Leader for the Mzimvubu Dam Environmental Impact Assessment.
- Public Participation Process for Eskom Exemption from and Postponement of Air Emission Licence Applications.
- EIA for Eskom Vierfontien to Wawielpark 22 kV Transmission line refurbishing.
- Junior Environmental Scientist for the Hartbeespoort Waste Charge Discharge System.
- Public Participation Process for City of Tshwane's Bus Rapid Transit from Pretoria Station to Rainbow Junction.
- EIA for the Rwengaaju Model Village Irrigation Scheme in Kabarole District, Uganda.
- EIA for tte Water supply and Sanitation system in Moroto, Bugaddem Kacheri-Lokona, Nakapelimoru and Kotido, Uganda.
- EIA for the Farm Income Enhancement and Forestry Conservation Project: Irrigation Scheme for Katete, Kibimba and Mubuku II, Uganda.