CURRENT & POST-DEVELOPMENT WETLAND ASSESSMENT REPORT

USING

WET-ECOSERVICES

Sibaya Precinct

Sagen Projects

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Disclaimer

WET-Ecoservices is a newly developed rapid assessment tool for the functional assessment of the benefits and services supplied by particular wetland systems. Any newly developed assessment system is likely to have shortfalls within a context in which it has not been extensively tested, such as, highly transformed wetland systems.

WET-Ecoservices, however, has been compiled based on international best practice and been compiled to apply to South African conditions. The tool has also undergone a peer review process during its development. This assessment tool should therefore be seen as the most appropriate tool for the assessment of wetland habitat at this time.

The results have been interpreted in light of these limitations. LRI have supplied this information in good faith and accept no liability or consequential liability for the utilisation of the results contained in this report.

Executive Summary

The wetland habitat within the development site covers an area of approximately 96ha and has generally been modified with the cultivation of sugarcane within many of the identified systems. The wetland habitat was assessed in terms of functioning using WET-Ecoservices to provide and indication of the benefits and services (ecoservices) supplied by these systems.

A functional assessment of the wetland habitats within the proposed Sibaya Precinct development site was carried out on behalf of Sagen Projects. The functional assessment was carried out for a post-development scenario to assist in identifying the positive and negative impacts on the wetland and riparian habitat associated with the proposed development.

Generally, the values recorded for the current ecological services of the wetland units were *Moderately Low* to *Intermediate.* The implementation of the proposed development layout, with the hydrological and vegetation components being rehabilitated, generally increase the values recorded for the various wetland ecoservices to *Intermediate*. The wetland units were ranked taking into consideration their size, linkage to the estuary and ecological services allowing the planning team to identify where to reduce potential impacts or increase buffering and connectivity. The *Ohlanga* floodplain (Unit A) was considered to be the most important system, with the riparian/wetland habitat (Unit D) draining southwards being the second-most important system.

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1. Introduction

Sagen Projects requested a report on the current and predicted post-development functionality of the wetland systems within the proposed Sibaya Precinct on the KwaZulu-Natal north coast. The functional assessment of the wetland habitats within the development site is outlined in this report. A functional assessment is a rapid assessment based primarily on readily described indicators, which would assist in identifying the important features and benefits provided by each wetland system. This report provides a means of identifying the importance and level of functioning of the wetlands present in relation to each other and within a regional context.

It should be noted that the majority of the wetland habitats scored highly for opportunities to improve the level of functioning of these systems with the re-vegetation and deactivation of the existing drainage canals. This study is therefore a means of quantifying the level of change in functioning within the wetland systems associated with the proposed development scenario.

2. A Provincial and Landscape Context

The proposed development site falls within the coastal belt of KwaZulu-Natal, an area that has been subjected to a particularly high level of wetland destruction (Kotze *et al.*, 1995). This is of concern given the importance of wetlands in enhancing water quality, regulating the flow of water, supporting biodiversity and providing other ecological goods and services (Kotze *et al*, 2005). Thus, based on the high level of cumulative loss of wetlands in this region, it is important that the developer attempt to protect the functioning of the wetland systems from further degradation, and enhance the functioning of these systems where possible. This could be facilitated by the 'no-nett-loss' approach with the improvement of wetland functionality onsite, or in those cases where this would not be possible to rehabilitate wetland areas offsite.

3. Methodology

3.1. Current Status

To provide an indication of the benefits and services, the wetland habitat within the project area was assessed utilizing the functional assessment technique, WET-EcoServices, developed by Kotze *et al* (2005). This technique consists of assessing a combination of desktop and infield criteria to determine the level of functioning of the systems. In order to provide useful information relating to those wetland systems within the development site, Level 2 assessments were conducted, of which the initial procedure is to assess the wetland habitat at a desktop level (*e.g*. identify hydrogeomorphic units).

The wetland boundary was determined during previous studies (LRI Report **L01616/050505/01**) utilising the wetland delineation principles outlined by DWAF (2005). The desktop exercise was carried out utilising imagery and contour data supplied by the professional team involved in the development project. For the purposes of the functional assessment the wetland area was split into individual hydrogeomorphic (HGM) units. A subsequent field trip was carried out to assess the functioning of the wetland habitat within the project area.

3.2. Post-Development Scenario

This study was carried out to predict the status of the wetland habitat within the proposed layout supplied by the client. The wetland habitat within the project area was assessed utilizing WET-Ecoservices for the anticipated post-development scenario.

In many instances the values recorded for the system would be the same as those recorded in the original study (*e.g*. regional rainfall), but a number of the values were altered to account for:

- rehabilitation of the wetlands,
- increased buffering,
- increased connectivity, and
- replanting and establishment of natural vegetation.

NOTE:

The following should be noted with respect to the approach adopted in assessing the wetland habitat within the development site for the post-development scenario:

- The wetland habitat preserved within the development layouts would be rehabilitated using appropriate means to restore wetland vegetation and functioning.
- Alien invasive vegetation within the development site would be eradicated and controlled to allow the establishment of nature vegetation within the wetland and buffer zones.
- In those areas where no allowance was made to exclude the wetland/buffer zone from residential or developed areas indicated, the wetland would be filled and not provide any level of functioning.
- In those areas where a significant portion of the wetland was indicated as developed (in excess of 90% of the wetland area), then the wetland would be considered as providing no benefits or services.
- Road crossings would be designed so as to reduce the impoundment of water and the concentration of flow through culverts, maintaining hydrological connectivity and minimising the risk of erosion.
- The assessment of the alteration of wetland functioning within the proposed development excluded the proposed additional infrastructure, such as, boardwalks or cycle tracks.

4. Results

Fourteen hydrogeomorphic units were identified within the project area, ranging from **Unit A** to **Unit N** (**Map L02030/280207/01**). The general features of the wetlands were assessed in terms of functioning (**Appendix 1**) and the overall importance of each HGM unit was then determined at a landscape level. Generally, the values recorded for ecoservices for the various wetland systems were **Moderately Low** to **Intermediate** due to the modified and disturbed nature of these systems within the development site.

4.1. Current Status

The wetland habitat within the development site has generally been modified by the implementation of sugarcane cultivation activities and the infilling and hydrological impacts associated with the N2 and M4 roads.

The level of functioning supplied by the wetland units for various ecological services is shown in **Table 1**. A graphical representation of the following data is contained within **Appendix 2**.

Note: The ecoservices supplied by the wetland systems are ranked according to the following:

- 0 - Low
- 1 – Moderately Low
- 2 - Intermediate
- 3 – Moderately High
- 4 - High

From the below table it can be seen that the wetland systems within the development site are generally important from a water quality perspective with the trapping of sediment, toxicants and nutrients being prominent ecoservices supplied by the systems. The control of erosion and flood attenuation are also important ecoservices supplied by these wetland systems. These services are generally linked to the cultivation of sugarcane within the wetlands' catchments and the current development activities associated with Sibaya Casino.

Unit A has the highest score for 9 of the 15 ecosystem services examined and scored lowest for none of the ecosystem services. Units G and J scored a joint highest for 3 of the ecosystem services and scored lowest for 2 and 4 ecosystem services respectively. Unit D scored highest for 2 of the ecosystem services and lowest for one of the ecosystem services. Unit K scored highest for 1 of the ecosystem services and lowest for 2 of the ecosystem services. The remaining units generally do not score highest scores for ecosystem services and score lowest for a number of ecosystem services reducing their importance in the landscape.

Table 1. Importance rating of the individual wetland units

Condensed summary sheet	**Unit A**	**Unit B**	**Unit C**	**Unit D**	**Unit E**	**Unit F**	**Unit G**
Hydro-geomorphic setting	Floodplain	Channelled Valley-bottom	Hillslope Seepage feeding a watercourse	Channelled Valley-bottom	Channelled Valley-bottom	Hillslope Seepage not feeding a watercourse	Channelled Valley-bottom
Size (ha)	36.33*	2.41	12.61	16.29	1.13	0.46	7.09
	Overall score	**Overall score**	**Overall score**	**Overall score**	**Overall score**	**Overall score**	**Overall score**
Flood attenuation	**2.2**	**2.0**	**2.1**	**2.0**	**1.9**	**1.8**	**1.8**
Stream flow regulation	**2.5**	**2.0**	**2.0**	**2.5**	**1.8**	**1.3**	**2.3**
Sediment trapping	**3.0**	**2.1**	**2.1**	**2.5**	**2.1**	**2.1**	**3.5**
Phosphate trapping	**2.6**	**1.9**	**2.4**	**2.2**	**1.9**	**2.4**	**2.6**
Nitrate removal	**2.6**	**1.9**	**2.5**	**2.4**	**1.9**	**2.7**	**2.3**
Toxicant removal	**2.8**	**1.9**	**2.5**	**2.5**	**1.8**	**2.5**	**2.9**
Erosion control	**3.1**	**2.2**	**2.2**	**2.6**	**2.1**	**2.1**	**2.3**
Carbon storage	**2.3**	**0.3**	**0.3**	**2.0**	**0.0**	**0.3**	**1.0**
Maintenance of biodiversity	**2.4**	**1.2**	**1.7**	**1.9**	**1.8**	**1.7**	**1.8**
Water supply for human use	**1.6**	**0.8**	**0.8**	**1.6**	**0.5**	**0.6**	**1.3**
Natural resources	**0.8**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
Cultivated foods	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
Cultural significance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Tourism and recreation	**2.7**	**1.1**	**1.1**	**1.3**	**1.1**	**1.1**	**1.1**
Education and research	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

* Size of this wetland unit only refers to the portion within the proposed development site, *i.e.* north of the *Ohlanga* River.

Condensed summary sheet	**Unit H**	**Unit I**	**Unit J**	**Unit K**	**Unit L**	**Unit M**	**Unit N**
Hydro-geomorphic setting	Channelled Valley-bottom	Channelled Valley-bottom	Unchannelled Valley-bottom	Channelled Valley-bottom	Unchannelled Valley-bottom	Channelled Valley-bottom	Unchannelled Valley-bottom
Size (ha)	0.44	0.38	4.7	6.43	0.77	4.1	0.4
	Overall score	**Overall score**	**Overall score**	**Overall score**	**Overall score**	**Overall score**	**Overall score**
Flood attenuation	**1.7**	**2.0**	**1.4**	**1.5**	**2.0**	**1.6**	**2.0**
Stream flow regulation	**2.0**	**2.0**	**2.5**	**2.0**	**0.7**	**1.3**	**0.2**
Sediment trapping	**2.0**	**2.1**	**2.0**	**2.8**	**1.4**	**1.2**	**1.5**
Phosphate trapping	**1.9**	**1.8**	**1.8**	**2.6**	**1.8**	**1.2**	**2.0**
Nitrate removal	**2.2**	**2.0**	**2.7**	**2.6**	**2.0**	**1.9**	**2.2**
Toxicant removal	**2.1**	**2.0**	**2.4**	**2.7**	**1.9**	**1.8**	**2.2**
Erosion control	**2.4**	**2.2**	**2.1**	**2.3**	**2.1**	**2.2**	**2.2**
Carbon storage	**0.3**	**0.3**	**1.3**	**1.3**	**0.0**	**1.3**	**0.7**
Maintenance of biodiversity	**1.9**	**1.8**	**1.8**	**2.2**	**1.8**	**1.8**	**2.0**
Water supply for human use	**0.8**	**0.8**	**1.6**	**1.5**	**0.2**	**1.3**	**0.3**
Natural resources	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
Cultivated foods	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
Cultural significance	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Tourism and recreation	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**
Education and research	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

4.2. Ranking of HGM Units

Unit A therefore stands out as the most important unit, followed by Units D, G, J and K. When distinguishing between units, however, it is useful to examine their value in the context of their size and spatial relationship to other wetland units and the estuary. The larger the wetland unit, the greater its importance, and all other factors being equal, the more directly connected the wetland is to the estuary, the more important it would be (a wetland immediately adjacent to an estuary would be "the last line of defence" in terms of trapping sediment and assimilating pollutants being carried into the estuary).

The following ranking attempts to show the relative importance in terms of wetland benefits and services of each of the HGM units within the Zimbali Lakes development site (**Map L02030/280207/02**) taking into consideration the following information:

- WET-Ecoservices Scores,
- Size, and
- Link to the Estuary

Table 2. Ranking of the HGM units

HGM Unit	Rank
Unit A	1
Unit D	2
Unit J & K	3
Unit C & G	4
Unit B	5
Unit H & I	6
Unit E, F, L, & M	7
Unit N	8

4.3. WET-Ecoservices Limitations

The current value of the wetlands for maintenance of biodiversity is likely to be lower than that reflected in the scores. This is owing to the fact that the complete removal of the native vegetation is considered by WET-Ecoservices as one of several averaged factors affecting the biodiversity value of wetlands. This does not fully account for the potential overriding influence that a high level of the removal of native vegetation (as is true for the Sibaya wetlands) has on diminishing the current biodiversity value of a wetland. It must be stressed, however, that given the particular landscape context (a high level of cumulative loss) and catchment context (strategic location adjacent to an estuary) the wetlands are of great potential value for both water quality enhancement and biodiversity support, and this potential could readily be realized through rehabilitation.

Within the context of the Sibaya development site, the WET-Ecoservices does not account for the addition of nutrients and biocides applied directly onto the cultivated wetland, which is likely to reduce the current pollutant assimilative capacity of the wetland. Thus, under their current state, the effectiveness of the assessed wetlands for nitrate and toxicant assimilation is probably lower than reflected in the score.

The scores recorded for tourism and recreation should also be considered in a landscape context. The occurrence of the development site within the north coast of KwaZulu-Natal, a popular tourist destination, adds value to the wetland systems, although it is unlikely that the smaller wetland systems within the development site would be of recreational value in their current state.

4.4. Proposed Development Layout

The proposed development layout would maintain all fourteen hydrogeomorphic units as potentially functioning entities within the post-development landscape (**Map L02030/280207/03**). It should, however be noted that Unit E has been significantly modified by the existing access road for Sibaya Casino. The general features of the wetlands were assessed in terms of functioning and compared with the originally recorded levels.

Generally, the values recorded for the wetland ecoservices for the various wetland systems were ***Intermediate*** compared with the initial values which were ***Moderately Low*** *to* ***Intermediate.*** This is likely to be associated with the hydrological rehabilitation, revegetation with natural vegetation and increased buffering and connectivity. The rehabilitation of the wetland systems is anticipated to yield a significant increase in the various wetlands' contributions towards maintaining biodiversity within the landscape. It is important to note that in some instances the levels of ecological services supplied by the wetland habitat are reduced. This is generally associated with the reduction in the opportunity for the wetland to perform specific functions due to the removal of sugarcane and the completion of construction activities. The following table shows the level of functioning supplied by the wetland HGM units for various ecological services pre- and post-development. A graphical representation of the following data is contained within **Appendix 2**.

Table 3. Ecological Services supplied by individual wetland units within the proposed development (Pre- and Post-development)

Condensed summary sheet	Unit A			Unit B			Unit C			Unit D		
	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.
Flood attenuation	2.21	2.25	0.04	1.96	2.25	0.29	2.11	2.00	-0.11	2.00	2.21	0.21
Stream flow regulation	2.50	2.50	0.00	2.00	2.00	0.00	2.00	2.00	0.00	2.50	2.50	0.00
Sediment trapping	2.96	2.77	-0.19	2.06	1.97	-0.09	2.05	1.80	-0.25	2.47	1.54	-0.93
Phosphate trapping	2.65	2.74	0.09	1.86	2.24	0.38	2.44	2.25	-0.19	2.20	2.23	0.03
Nitrate removal	2.58	2.67	0.08	1.92	2.42	0.50	2.50	2.50	0.00	2.42	2.92	0.50
Toxicant removal	2.84	2.78	-0.07	1.95	2.28	0.33	2.52	2.50	-0.02	2.53	2.41	-0.12
Erosion control	3.11	3.39	0.29	2.23	2.93	0.70	2.21	2.79	0.57	2.59	3.23	0.64
Carbon storage	2.33	2.67	0.33	0.33	1.67	1.33	0.33	1.67	1.33	2.00	2.67	0.67
Maintenance of biodiversity	2.42	2.92	0.50	1.21	2.54	1.33	1.67	2.92	1.25	1.88	3.13	1.25
Water supply for human use	1.63	1.63	0.00	0.75	0.75	0.00	0.75	0.75	0.00	1.63	1.63	0.00
Natural resources	0.80	0.80	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00
Cultivated foods	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00
Cultural significance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tourism and recreation	2.71	3.29	0.57	1.14	1.71	0.57	1.14	1.86	0.71	1.29	2.00	0.71
Education and research	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00

Table 3 (cont.) Ecological Services supplied by individual wetland units within the proposed development (Pre- and Post-development)

Condensed summary sheet	Unit E			Unit F			Unit G			Unit H		
	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.
Flood attenuation	1.92	1.83	-0.08	1.75	1.63	-0.13	1.75	2.33	0.58	1.67	1.92	0.25
Stream flow regulation	1.83	1.83	0.00	1.33	1.33	0.00	2.33	2.33	0.00	2.00	2.00	0.00
Sediment trapping	2.11	1.89	-0.23	2.05	1.25	-0.80	3.46	2.06	-1.40	1.97	1.86	-0.11
Phosphate trapping	1.88	1.95	0.07	2.44	2.25	-0.19	2.61	2.36	-0.25	1.90	2.11	0.20
Nitrate removal	1.92	2.00	0.08	2.67	2.67	0.00	2.33	2.83	0.50	2.17	2.33	0.17
Toxicant removal	1.83	1.82	-0.01	2.52	2.25	-0.27	2.95	2.73	-0.21	2.06	2.23	0.17
Erosion control	2.14	2.71	0.57	2.14	2.71	0.57	2.29	3.14	0.86	2.36	2.93	0.57
Carbon storage	0.00	1.33	1.33	0.33	1.67	1.33	1.00	2.33	1.33	0.33	1.67	1.33
Maintenance of biodiversity	1.79	2.17	0.38	1.67	2.67	1.00	1.83	2.75	0.92	1.92	2.92	1.00
Water supply for human use	0.46	0.46	0.00	0.58	0.58	0.00	1.33	1.33	0.00	0.75	0.75	0.00
Natural resources	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00
Cultivated foods	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00
Cultural significance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tourism and recreation	1.14	1.43	0.29	1.14	1.29	0.14	1.14	1.71	0.57	1.14	1.71	0.57
Education and research	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00

Table 3 (cont.) Ecological Services supplied by individual wetland units within the proposed development (Pre- and Post-development)

Condensed summary sheet	Unit I			Unit J			Unit K			Unit L		
	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.
Flood attenuation	2.00	2.25	0.25	1.42	2.13	0.71	1.46	2.04	0.58	2.00	2.00	0.00
Stream flow regulation	2.00	2.00	0.00	2.50	2.50	0.00	2.00	2.00	0.00	0.67	0.67	0.00
Sediment trapping	2.09	1.97	-0.11	2.00	2.00	0.00	2.77	1.57	-1.20	1.40	1.17	-0.23
Phosphate trapping	1.79	2.15	0.37	1.75	2.33	0.58	2.57	2.49	-0.08	1.83	1.82	-0.01
Nitrate removal	2.00	2.33	0.33	2.67	3.17	0.50	2.58	3.33	0.75	2.00	2.00	0.00
Toxicant removal	1.96	2.28	0.32	2.36	2.86	0.50	2.70	2.56	-0.14	1.86	1.85	-0.01
Erosion control	2.21	2.93	0.71	2.07	2.98	0.91	2.27	3.13	0.86	2.07	2.68	0.61
Carbon storage	0.33	1.67	1.33	1.33	2.67	1.33	1.33	2.67	1.33	0.00	1.33	1.33
Maintenance of biodiversity	1.75	2.92	1.17	1.83	2.42	0.58	2.21	2.58	0.38	1.83	2.17	0.33
Water supply for human use	0.75	0.75	0.00	1.63	1.63	0.00	1.50	1.50	0.00	0.17	0.17	0.00
Natural resources	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00
Cultivated foods	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00
Cultural significance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tourism and recreation	1.14	1.71	0.57	1.14	1.86	0.71	1.14	1.86	0.71	1.14	1.71	0.57
Education and research	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00

Table 3 (cont.) Ecological Services supplied by individual wetland units within the proposed development (Pre- and Post-development)

Condensed summary sheet	Unit M			Unit N		
	Current	Post-Dev	Diff.	Current	Post-Dev	Diff.
Flood attenuation	1.63	1.83	0.21	2.00	2.09	0.09
Stream flow regulation	1.33	1.33	0.00	0.17	0.17	0.00
Sediment trapping	1.17	1.03	-0.14	1.50	1.10	-0.40
Phosphate trapping	1.15	1.26	0.11	2.04	1.63	-0.42
Nitrate removal	1.92	2.00	0.08	2.17	2.00	-0.17
Toxicant removal	1.78	1.94	0.16	2.18	1.96	-0.21
Erosion control	2.23	2.96	0.73	2.21	2.82	0.61
Carbon storage	1.33	2.67	1.33	0.67	1.67	1.00
Maintenance of biodiversity	1.79	2.42	0.63	2.00	3.00	1.00
Water supply for human use	1.33	1.33	0.00	0.29	0.29	0.00
Natural resources	0.33	0.33	0.00	0.33	0.33	0.00
Cultivated foods	0.33	0.33	0.00	0.33	0.33	0.00
Cultural significance	0.00	0.00	0.00	0.00	0.00	0.00
Tourism and recreation	1.14	1.57	0.43	1.14	1.57	0.43
Education and research	1.00	1.00	0.00	1.00	1.00	0.00

5. Proposed Development Recommendations

It is understood that the proposed development layout has been informed by the location and extent of wetland and riparian habitat within the development site. It is assumed that the wetland habitat within the development site would generally be protected within the landscape and be rehabilitated and managed in accordance with the recommendations included in LRI Report **L01616/050505/01**. In many instances the proposed development layout makes allowances for the wetland systems and a buffer zone within the landscape.

The relative importance of the wetland units within the landscape needs to be considered during the finalisation of the development layout, especially with regards to Units A, D, J and K, which are ranked as the most important systems in the development site. In these areas the development layout should attempt to

- minimise encroachment; and
- maximise the buffering and connectivity associated with these areas.

It is recommended that the following recommendations be considered during the finalisation of the development layout.

5.1. Wetland Rehabilitation

The wetland/riparian habitat within the development site should be rehabilitated to restore the integrity of the hydrological and vegetative components of the systems by means of:

- the deactivation of the drainage network, preferably by infilling of the drains or the placement of interventions at least at 'top-to-toe' intervals; and
- the removal of sugarcane and alien invasive vegetation followed by the active replanting of indigenous wetland species.

The hydrological rehabilitation would need to be planned so as to restore unchannelled valley-bottom characteristics to a number of the wetland systems. It is important that the objectives of the rehabilitation be carefully considered to ensure that the systems are restored to 'near-natural' conditions rather than the implementation of operations that are likely to result in artificial hydrological conditions. In order to achieve this, the rehabilitation plan would need to include the plugging of the drains within the wetland to at least top-to-toe specifications to ensure adequate improvements in wetland hydrological functioning/integrity. Ideally, the rehabilitation of the drainages canals would involve the infilling of the

drainage canals to totally restore hydrological functioning, but this is often limited by the lack of appropriate fill material.

5.2. Wetland Buffers

The wetlands have been protected within the landscape through the adoption of a 20m buffer zone across the majority of the site. There is planned encroachment into isolated areas of the wetland buffer, but these are likely to be offset by the following aspects of the development layout:

- The buffer zone adjacent to the wetland in some cases extends beyond 20m due to other site constraints;
- The development has been planned to increase connectivity between the natural areas;
- The development has generally been planned so that encroachment into the buffer zone coincides with existing infrastructure or disturbed areas; and
- The development would include the rehabilitation and long-term management of the wetland and riparian habitat in accordance with best practices.

The offset of the potential impacts of the proposed development on the wetland habitat is illustrated by the post-development assessment showing a general increase in the level of ecosystem delivery by the wetland units.

While it is recognised that wetlands provide benefits and services in terms of water purification and attenuating storm flows, it is important that a precautionary approach be adopted, with mitigation activities being implemented to reduce the potential impacts from the proposed development on the receiving freshwater ecosystems. The following recommendations should be considered in the detailed design phase of the development to assist in reducing the impacts on the wetland and riparian ecosystems.

This scale of development is likely to require large amounts of earthworks and landscaping, potentially generating substantial quantities of sediment in the land adjacent to the wetlands. It is recommended that the wetlands be buffered before construction/landscaping commences, in order to trap this sediment before it reaches the wetland habitat. It is suggested that an incremental approach to landscaping be adopted, to spread the potential sediment source over time, and revegetation be actively promoted as soon after landscaping as possible to further reduce the potential for sediment to be washed into the wetland.

5.3. Buffer Composition

The most effective buffer is considered to be a multilayered, undisturbed vegetative community (Vermont Dept. of Environmental Conservation, 1999). A multilayered community refers to the presence of a variety of vegetative growth forms including grass, shrubs and trees. Within the Sibaya Precinct the buffer is likely to comprise of historically disturbed vegetative cover due to the level of historical cultivation within the wetland and buffer areas. It is therefore recommended that the developer should actively plant trees and grasses in those areas characterised by poor vegetative cover adjacent to the wetland.

Ideally buffers should be maintained as natural vegetation, but if required portions can be maintained as lawn, without exposed areas, such as flower beds. The height of the vegetation within the buffer, however, should be maintained at 15cm (Dillaha *et al*. 1986), as this affects the surface roughness for sediment retention. It is, however, recommended that at least 10-15m of natural vegetation be maintained adjacent to the wetlands depending on the importance of the wetland. This should only be considered adjacent to those wetlands considered to be lees important within the landscape and not directly linked to the floodplain and estuary.

It is understood that the development layout requires the installation of services, especially sewerage pipes, in the lower areas of the landscape and it is likely that these services may encroach into the buffers. In these instances, the associated excavation would be temporary and the adoption of the following best management practices may assist in reducing the potential impacts:

- Excavated soil to be placed upslope of the trench;
- Incremental excavation to avoid long-term exposure of soil in close proximity to the wetland; and
- Closure and active re-vegetation of pipeline to promote the re-establishing of a vegetated buffer, prior to the initiation of construction adjacent to the wetland.

5.4. Wetland and Buffer Zone Management

The wetland habitats and buffer zones within the development site would need to be managed following the implementation of rehabilitation and re-vegetation of these areas. A detailed environmental management plan, including the management of the wetland habitat, would assist in ensuring that the following activities take place frequently and at the correct times:

- Removal of emerging alien invasive vegetation;
- Defoliation of herbaceous wetlands;
  (The buffer area should ideally be burnt every 2-3 years, otherwise mowing can be adopted as a substitute. The mowing, however would need to be higher (> 15cm) and less frequent than lawn or recreational areas (Valparaiso City, 2004);
- Maintenance of rehabilitation structures;
- Maintenance of storm water attenuation structures and removal of excessive sediment accumulation within the buffer zone; and
- Monitoring of wetland habitat and receiving areas of the buffer zone for scour and erosion from excessive runoff.

Kotze and Breen (2000) outlined general wetland management guidelines for wetland areas within South Africa.

5.5. Storm Water Management

Buffer zones are only effective in reducing velocity of flow and filtering sediment and pollutants from storm water runoff when flow occurs as diffuse flow. Flow through the buffer zone should be via diffuse flow and concentrated flow should be avoided (Cornelius-Carolina, 2004; Valparaiso City, 2004). The runoff entering the buffer zone should not exceed 1.5m/sec as flow velocities less than this are considered optimal to reduce the pollutant removal performance of the buffer area (Valparaiso City, 2004).

Buffer areas should be inspected following runoff-producing rainfall events, with re-vegetation taking place if necessary (Valparaiso City, 2004). Monitoring of these areas should include checks that the distribution of flow has been maintained as diffuse and that no erosion is evident within the area. Should there be evidence of erosion and concentrated flow adequate measures should be taken to restore diffuse flow through the buffer area. The management of storm water runoff from the proposed development is considered critical in terms of reducing impacts on the receiving wetland habitat.

Generally, the following guidelines should be considered during the planning of the proposed attenuation structures:

- Encourage re-infiltration of runoff into the soil decreasing overland flow by managing it onsite with the incorporation of porous pavements and 'soft zones' within the proposed development nodes.
- It is recommended that the following recommended mitigation activities supplied be adopted where possible:
  - Detention ponds within the system prior to discharge;
  - Preference for overland diffuse flow as opposed to hydraulically efficient solutions;
  - Maintaining porous surfaces and reducing impervious structures; and
  - Maintaining vegetation cover to increase interception and evapotranspiration.
- Should attenuation structures be required, these should preferably be located outside of the wetland to avoid the direct loss of wetland habitat associated with the construction of the structure;
- In some instances storm water attenuation may need to occur within the wetland/riparian habitat. In these cases it is preferable that the structures be designed as 'dry-ponds' to reduce the loss of wetland habitat upstream associated with flooding. Generally, in-stream detention structures should be constructed as permeable barriers allowing a continual flow to escape the structure;
- The positioning of these structures should attempt to minimize impacts on the receiving environment, focusing in those areas that have limited or highly modified natural vegetation;
- Positioning of roads outside of the buffer zones, with the incorporation of scour protection and velocity reduction structures for storm water runoff;
- Discharge of diffuse flow from storm water outlets outside of the recommended buffer zones; and
- Establishment of dense vegetative cover within the wetland and buffer should take place prior to the implementation of construction activities to ensure that the buffer vegetation is able to filter runoff before it enters the wetland habitat (Valparaiso City, 2004).

The development layout, generally, makes use of attenuation structures located outside of the wetlands, but in some instances, storm water attenuation is planned within the wetland units (Units D, G, J, K & L - **Map L02030/120508/01** and **Appendix 3**). It is understood that in these instances, the attenuation/detention structures would be designed as 'dry ponds'. Correspondence with Vela VKE, the project engineers, highlighted

that the gabion detention weirs would be designed to leak and would maintain flow directly through the structure, with small diameter pipes also being provided to maintain low flows. In higher intensity storms, the structure will attenuate larger volumes but flow will continue at the pipes and gabions maximum permeable rate. Based on the assumption that the attenuation structures are designed in this manner, the impacts on the wetland systems are likely to the limited to the direct impacts associated with the size of the intervention. In this instance it is likely that the structures can be designed to compliment the rehabilitation of the wetland systems within the landscape.

5.6. Road Network and Road Crossings

Due to the development site being a commercial sugarcane farm an extensive road network already exists within the site. Generally, it is considered best practice to align the required road network within the development site with the existing systems in an attempt to minimise impacts on the receiving environment.

Within the Sibaya Precinct, the road network within the development layout, attempts to make use of the existing main haulage route and loading zones within the sugarcane farm to facilitate access in the proposed development (**Map L02030/120508/02**). It should be noted that in some instances this does result in the road alignment being located within the wetland habitat's buffer distance. Careful consideration should be given to the following recommendations in an attempt to minimise the hydrological impacts of these roads:

- Unit A
  - The existing the road would be maintained for management and recreational purposes. The following recommendations should be considered:
    - the crossings of the tributaries should be re-designed to:
      - account for diffuse flow in area associated with the flow characteristics of the rehabilitated tributaries; and
      - reduce the risk of impoundment or concentration of flow where tributaries drain into the *Ohlanga* River.
    - the road be maintained as a grass track rather than bare soil/quarry material.
- Units B & C
  - Access to the development node on the hill adjacent to the floodplain will be along the ridge, mostly along an existing sugarcane management track which would be upgraded

- It should be noted that the wetland habitat in this area was noted as being artificially extended due to earthworks and the loss of topsoil in the area.

- Unit D
  - the road proposed on the eastern side of the system should be aligned to ensure that cut/fill operations do not encroach further than the existing road footprint
  - the impacts associated with the toxins in the runoff water directly entering the wetland should be minimised
  - the lower reaches of this road would be maintained for management and recreational purposes and should be maintained as a grass track rather than bare soil/quarry material
- Unit G
  - the road on the south-eastern side of the system would be maintained for management and recreational purposes and should be maintained as a grass track rather than bare soil/quarry material
  - the road crossing the upper reaches of the system would involve the upgrading of the existing haulage route across the wetland
- Unit K
  - the road proposed on the eastern side of the system should be aligned to ensure that cut/fill operations do not encroach further than the existing road footprint
  - the road crossing at the head of the system should be re-aligned to occur outside of the wetland.
  - the impacts associated with the toxins in the runoff water directly entering the wetland should be minimised
- Unit M
  - the road proposed on the eastern side of the system should be aligned to ensure that cut/fill operations do not encroach further than the existing road

- Road alignments should attempt to reduce the crossing distance through the wetland areas, in order to minimise potential impacts.
- Road crossings should be planned to minimise the hydrological impacts on the wetland systems, with preference being given to bridges or multiple box-culverts during design.

6. References

CORNELIUS-CAROLINA, 2004. Land Development Code. Chapter 9: Environmental Protection. North Carolina.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (2005). A Practical Field Procedure for Identification and Delineation of Wetland and Riparian areas. Edition 1, September 2005. DWAF, Pretoria.

DILLAHA, TA; SHERRARD, JH; AND LEE, D. 1986. Long-Term Effectiveness and Maintenance of Vegetative Filter Strips. Bulletin 153. Virginia Water Resources Research Center, Blacksburg.

KOTZE D C, and BREEN C M, 2000. WETLAND-USE, a wetland management decision support system for South African freshwater palustrine wetlands. Department of Environmental Affairs and Tourism, Pretoria.

KOTZE D C, BREEN C M, and QUINN N, 1995. Wetland losses in South Africa. In: COWAN G I (ed.) *Wetlands of South Africa*. Department of Environmental Affairs and Tourism

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.S. AND COLLINS, N.B. 2005. Wet-Esoservices: A technique for rapidly assessing ecosystem services supplied by wetlands. May 2005. Mondi Wetlands Project.

VALPARAISO CITY. 2004. Stimson Drain Guidebook. Best Management Practice No. 18 – Filter Strips. Indiana.

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION. 1999. Wetlands Fact Sheet. Topic: Wetland Buffer Zones. Water Quality Division – Wetland Office, Waterbury.

7. Appendices

Appendix 1

Wetland units' functioning within the current setting.

Appendix 2

Graphical representation of the wetland units functioning within the current setting and proposed development.

Appendix 3

The following shows the proposed layout and storm water management system within the Sibaya Precinct development site supplied by Vela VKE.

Appendix 4

The following maps show the proposed development layouts within the Sibaya Precinct development site.