The Tinley Manor Southbanks Coastal Development: Updated Estuarine Impact Assessment and Specialist Input for the Umhlali Estuary

Specialist Report for: Tongaat Hulett Developments

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Version 3

Tel: +27 (0) 87 350 6732
Email: catherine.meyer@rhdhv.com
19 Park Lane, The Boulevard, Umhlanga Rocks, 4319

Royal HaskoningDHV
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Cover Photograph: Umhlali Estuary mouth 2012. Courtesy of Gareth Earl Roberts of the Lower Tugela Biodiversity Project

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ABBREVIATIONS

amsl – Above Mean Sea Level

ha – Hectares

km – Kilometres

EIA – Environmental Impact Assessment

EDTEA – Department of Economic Development, Tourism and Environmental Affairs (KZN)

MAR – Mean Annual Run-off

NBA – National Biodiversity Assessment

NTU – Nephelometric Turbidity Units

PES – Present Ecological State

THD – Tongaat Hulett Developments

TMSCD – Tinley Manor Southbanks Coastal Development

1 INTRODUCTION

Tongaat Hulett Developments (THD) propose to develop a 485 ha site, located within the KwaDukuza Municipality, into a mixed-use coastal development including a large residential component, here onwards referred to as the Tinley Manor Southbanks Coastal Development (TMSCD).

The proposed development lies on the southern bank of the Umhlali Estuary, and thus an Estuarine Impact Assessment is required as part of the comprehensive Environmental Impact Assessment process currently being undertaken by Royal HaskoningDHV, as well as specialist coastal input for the development planning processes.

2 TERMS OF REFERENCE

The objective of this study is to undertake an Estuarine Impact Assessment, which will detail the potential impacts of the proposed development on the Umhlali Estuary. This will include the following:

- A literature review of existing information;
- Undertaking a field visit;
- Developing a map of the Umhlali Estuary which will identify different features, including sensitive habitats, and a potential buffer zone;
- Identify and assess the potential direct and indirect impacts of the proposed development on the Umhlali Estuary, with particular emphasis on the construction and operational phases of the proposed TMSCD; and
- Make recommendations and propose mitigation measures.

Additional specialist coastal input has, and is, being provided in respect to the exploration and production of a more refined development concept as well as the Block Layout Plan, which includes a framework for land use and a broad level landscape / townscape strategy for the study area. This additional specialist input is not reflected in this Estuarine Impact Assessment Report.

3 PROJECT DESCRIPTION

The proposed Tinley Manor Southbanks Coastal Development is centred upon the site's exceptional natural and physical attributes which includes, *inter alia*, 3.5 km of river frontage on the Umhlali Estuary (Figure 1). The proposed development capitalises on the undulating landscape, wetland areas, and coastal vegetation as part of an eco-centric design concept, which includes both direct and indirect interactions with the Umhlali Estuary, through the numerous drainage lines, wetland areas and the estuary shoreline. Special tourist, resort, leisure and recreational opportunities, together with upmarket and mixed densities of residential and limited commercial opportunities, are envisaged for this portion of the existing sugar plantation. The development will require new road and service infrastructure including electricity, sewer reticulation and water supply.

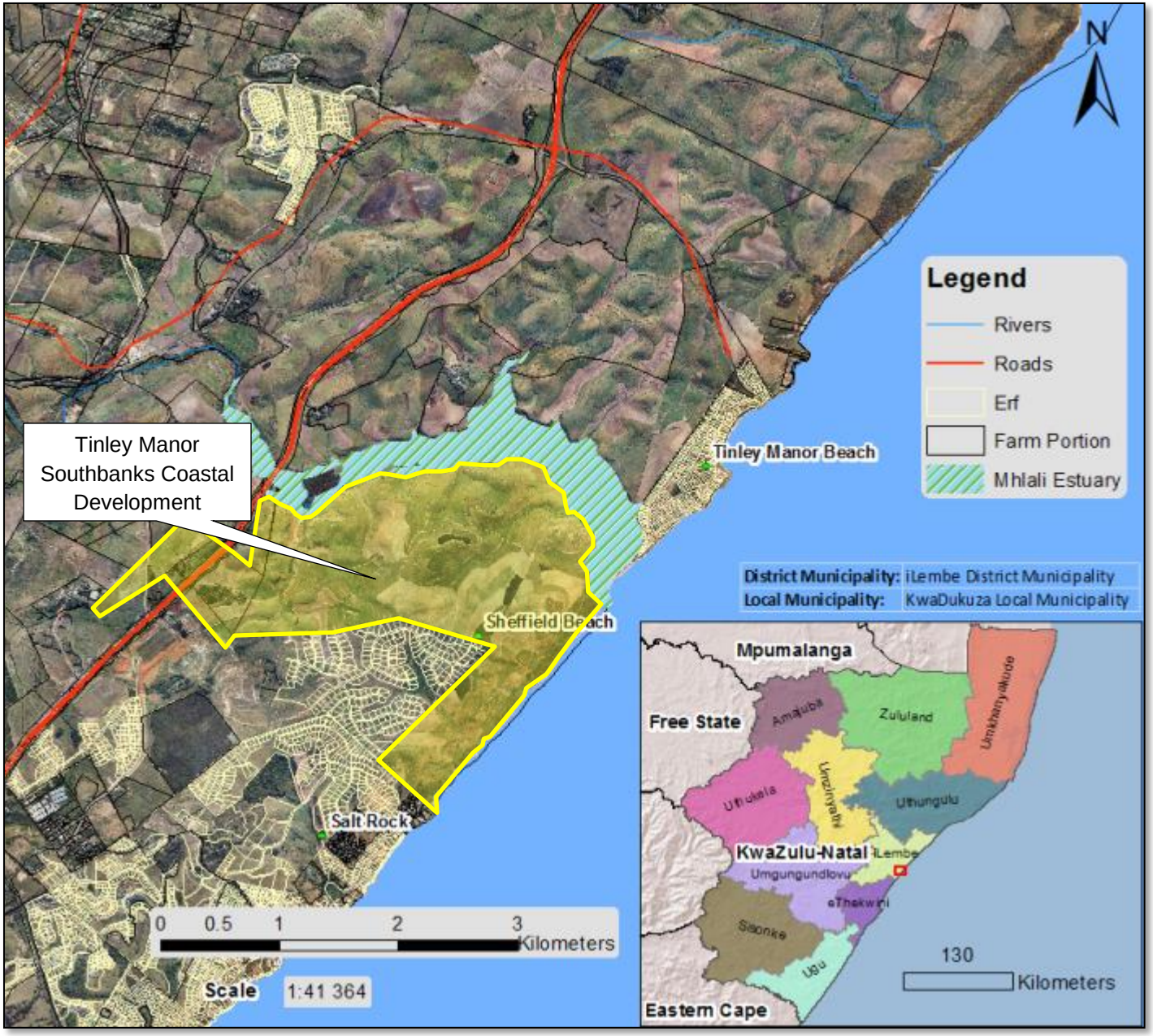

Figure 1. Location of the Tinley Manor Southbanks Coastal Development site and the Umhlali Estuary

4 CHANGES FROM THE FINAL EIAR TO THE AMENDED EIAR

4.1 Final EIAR Rejection

The all-inclusive final Environmental Impact Assessment Report (EIAR) for the Tinley Manor Southbanks Coastal Development was submitted to the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (EDTEA) in February 2016. In the Rejection Letter by EDTEA, dated the 8th of June 2016 the certain estuarine-related aspects were highlighted as requiring specific attention. These are summarised below and a response is provided:

- *Details of boardwalks [Comment 2.19]: The impacts associated with the installation and maintenance of the proposed boardwalks within the sensitive estuarine area must be provided.*

  The construction of the boardwalks and the maintenance of the boardwalks have since been addressed in the applicable sections of the Construction and Operational portion of this impact assessment.

- *Abstraction of water from the Umhlali River [Comment 2.20.7]: This mitigation measure is insufficient and in its current state cannot be rated as a medium impact, there must be accurate identification of impacts associated with this aspect and impact.*

  The abstraction of water from the Umhlali Estuary was not previously assessed. The potential impacts associated with this activity have since been addressed in this impact assessment.

- *The Sheffield WWTW [Comment 2.20.11; 2.20.12; 2.22]: All impacts related to the WWTW must be analysed by a specialist and mitigation measures presented.*

  The authorisation and construction of the Sheffield WWTW was approved through a formal Environmental Impact Assessment process, wherein the impacts associated with discharging treated waste water to the Umhlali Estuary were assessed. A Water Use License Application initiated by Siza Water is also in progress. Based on stringent water restrictions, Siza Water is seeking to reclaim as much water as possible from the incoming effluent for reuse. However, discharge into the estuarine environment must be anticipated.

  The impacts of treated waste water on the estuarine environment were assessed by the Estuarine Specialist as part of this EIA for the TMSCD. Specific mitigation measures have been provided in consultation with a Waste water Treatment Specialist for implementation at the Sheffield WWTW. However, management of the WWTW and implementation of these measures is the responsibility of Siza Water and not for THD.

  All the operational conditions of the WWTW must be added to the EMPr for the TMSCD once these are made available (i.e. via the pending Water Use License Application for the Sheffield WWTW).

- *A management plan must be considered as a mitigation measure to manage impacts caused by the utilization of the estuary [Comment 2.20.14].*

  The term ‘Management Plan’ must not be confused with a formal Estuarine Management Plan as required by Integrated Coastal Management Act (Act No. 24 of 2008, as amended) and the National Estuarine Management Protocol, which is the responsibility of the KwaDukuza District Municipality. Instead, best practice environmental management principles and estuarine-specific management controls have been provided and incorporated into the construction and post-construction/operational portions of the Environmental Management Programme.

4.2 Changes in the Block Layout

Since the submission of the final EIAR, changes to the proposed layout and engineering services have taken place through a detailed iterative design process. The details of the proposed land uses and their characteristics are provided in Table 1 and the updated Block Layout Plan is illustrated in Figure 2 (TMRP, 2017).

These changes, as well as changes to the engineering services (SMEC, 2017), and their applicability to the Umhlali Estuary are detailed in Table 2 below. Where necessary, the impact assessment (Section 24) has been updated.

Table 1. Details of the proposed land use types

	LAND USE	DETAILS	DENSITY (du/ha)	TOTAL SITE AREA (ha)	% OF TOTAL AREA	TOTAL NO UNITS
Residential	Special Residential	Special Residential 1500m^2	6	24.56	5%	147
	Special Residential	Special Residential 1000m^2	10	23.72	5%	237
	Special Residential	Special Residential 600 / 800m^2	12-16	18.55	4%	260
	Medium Density Residential	Planned Unit Development (25units/ha)	25	44.78	9%	1 120
	High Density Residential - Town Centre	Planned Unit Development (75 units/ha) with 10% commercial	75	3.56	1%	267
	High Density Residential	Planned Unit Development (75 units/ha)		14.66	3%	1 222
Resort	Resort / Hospitality	Hotel with Entertainment	-	12.00	2%	
Commercial	Retail 1	Mixed Retail, Office and Residential Node	-	20.46	4%	1 279
	Retail 2	Low Impact Retail and Entertainment Mixed Use for Beach Node	-	5.36	1%	-
Social	Community	FET College or School	-	12.43	3%	-
Open Space	Private Open Space	Parks within Residential Areas	-	5.50	1%	-
	Conservation	Wetlands, Estuary, Coastal Zones, Grasslands including buffers	-	246.35	51%	-
Utilities	Road	All roads	-	52.31	11%	-
	Grand Total		-	**484.23**	-	**4 531**

Figure 2. Updated Block Layout Plan for the Tinley Manor Southbanks Coastal Development

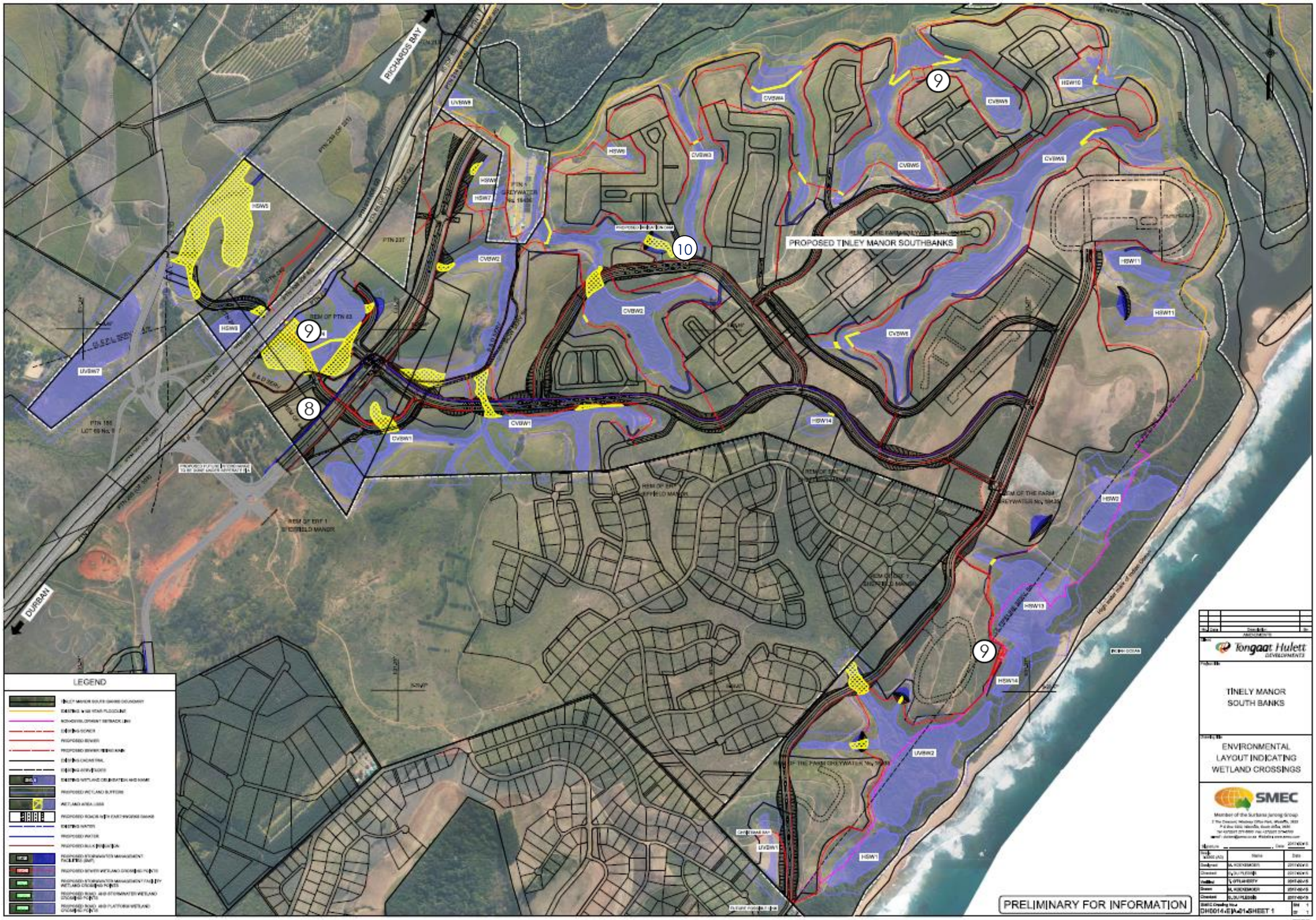

Figure 3. Tinley Manor Southbanks Coastal Development overall engineering services

Table 2. Description of changes to the layout and their applicability to the Umhlali Estuary

DOCUMENTED CHANGES	APPLICABILITY
LAND USE PLANNING: (See Figure 2)	
Road reserves for all major roads widened to accommodate latest road designs ①	Stormwater run-off will increase with increased area of hardened surface. However, this is deemed to be adequately addressed in the estuary impact report.
The road reserve in the south-east corner amended to provide for future access, pedestrian access and / or emergency access point to adjacent existing development ②	The risk of disturbance to the estuarine functional area and supporting habitats may increase and potentially increase steadily overtime with improved access to the area and estuary.
The coastal access road northwards from P228 through the site has been classified as a Class 3 road, therefore no access is permitted to adjacent sites. Accordingly, the Retail 1 site at corner of this access road and the proposed Primary Spine Road has been expanded southwards to accommodate road access off the Spine Road ③	N/A
Provision of additional indicative future road and / or pedestrian access and / or emergency access options to adjacent land or development④	The risk of disturbance to the estuarine functional area and supporting habitats may increase and potentially increase steadily overtime with improved access to the area and the estuary.
Coastal portion of the Secondary Spine Road widened and realigned to accommodate latest road designs ⑤	Stormwater run-off will increase with increased area of hardened surface. However, this is deemed to be adequately addressed in this estuary impact report.
Minor refinements to block outline based on preliminary design of roads and / or services networks ⑥	N/A - All design changes are maintained outside the 10m topographical contour which extends beyond the estuarine functional zone (5m contour)
Education site inland of N2 now called Community site ⑦	N/A
Yields amended to reflect more detailed work undertaken during the course of 2016 – the number of units therefore increases from 4,336 to 4,532	The increase in units will result in increased population numbers in the area in general. The risk of disturbance to the estuarine functional area and supporting habitats may increase.
ENGINEERING STRUCTURES: (See Figure 3 for 7, 8, 9) *Bulk Water Line -* The bulk waterline alignment changed from the Seaton Delaval Reservoir to the Tafeni reservoir. bulk water main will follow the alignment of the P228 and be constructed within the road reserve ⑧. The bulk water main does not form part of this application.	N/A
Sewer The number of sewer pump stations required was reduced from four to three pump stations. Subsequently, slight changes in the sewer network	N/A - All design changes are maintained outside the 10m topographical contour which extends beyond the estuarine functional zone (5m contour)

layout were made. ⑨	
Irrigation An irrigation network and dam have been added to the application ⑩.	The issue of freshwater abstraction (and abstraction from the estuary) is deemed to be adequately covered in this estuary impact report.
Stormwater Management Facilities (SWF) The stormwater management facilities layout was changed completely. Alternative solutions had to be found in order to minimise wetland losses. A number of swales have been included in the Storm Water Management Plan.	N/A – All design changes are maintained outside the 10m topographical contour which extends beyond the estuarine functional zone (5m contour). Changes to the SWF and the impact on the wetlands are captured in the wetland impact report. The issue of stormwater management is deemed to be adequately addressed in this estuary impact report.
Road Layout Slight modifications to the road layout (as also captured in the block layout). This includes: ▪ Possible cross connections into Seaton Delaval ④ ▪ Road reserve for possible extension of Colwyn drive to allow another access point ② ▪ Realignment of the beach road (this provides the 3rd possible access to Seaton Delaval) ⑤ ▪ Widening of road reserves to align with Traffic Impact Assessment ① ▪ Provision of wide enough road reserve for the KwaDukuza District Municipality future planned North South Link Road ①	N/A - All design changes are maintained outside the 10m topographical contour which extends beyond the estuarine functional zone (5m contour). Stormwater run-off will increase with increased area of hardened surface. However, this is deemed to be adequately addressed in the estuary impact report.

5 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This section describes the nature, extent and significance of the Umhlali Estuary's resources and functions in general and specific to the proposed development. In addition to historical references, this section draws on the ecological findings of research undertaken by Forbes & Demetriades (2009) over 16 weeks, between July and October 2008. A field inspection was undertaken, as per the Terms of Reference, on 18 October 2012 to obtain a current impression of the system, during which time the estuary mouth was open and water levels within the estuary were becoming progressively shallower. Observations made during this inspection are included where relevant.

5.1 Introduction

The Umhlali Estuary (29º27′36″S; 31°16′41″E) is situated approximately 68 km north-east of Durban and is classified as a subtropical, temporarily open/closed estuarine system (Whitfield, 2000). Estimations of the length of the Umhlali River range between 38 km and 55 km, draining a catchment area ranging between 256 km^2 and 331 km^2, and with a mean annual run-off between 49.85 and 59.76 $x10^6$ m^3 (Begg, 1978). Historically, the catchment area, and most of the land surrounding the estuary, was under sugar cane cultivation, which persists today.

The boundaries of the Umhlali Estuary are defined by the estuarine functional zone (Figure 1), that is, the area extending from the estuary mouth upstream to where the 5 m amsl contour crosses the river course, which is approximately 750 m upstream of the N2 bridge and laterally up to the up to the 5m topographical contour. This

area is 129 ha in extent and is 5 km long, The estuarine functional zone encompasses the natural features of an estuary, including the water body, the flood plain, estuarine habitats and vegetation, as well as the dynamic processes, such as backflooding and tidal fluctuations, which characterise the estuarine environment (Van Niekerk & Turpie, 2012).

The estuary comprises two channels, namely a northern and southern arm, separated by a large central island, a part of which is still planted with sugar cane. Saline intrusion in the main northern arm channel is, however, restricted by a weir, reducing the extent of the estuary to some 2.6 km upstream of the mouth (Forbes & Demetriades, 2009). Begg (1984) recorded a maximum depth of 1.3 m in the northern channel, presumably during open mouth conditions, while Forbes & Demetriades (2009) recorded a maximum depth of ca. 2.3 m during closed conditions in the northern channel.

5.2 Physico-chemical and sediment characteristics

5.2.1 Water Quality

Estuaries are the transitional point between saline marine water and land-derived freshwater. As such, the salinity of the Umhlali Estuary is strongly dependent on the state of the mouth, the amount of marine exchange that occurs, and the volume of freshwater input. Begg (1984) measured a range of salinities and marked layering and attributed this to tidal influences during open mouth conditions. During periods of mouth closure, accompanied by the rise in water level and stable conditions, Forbes & Demetriades (2009) recorded relatively low salinities[1] ranging between 5 and 10 throughout most of the system. During open mouth conditions, salinities rose to that of seawater (35) at the mouth and 28 in the southern channel, while strong salinity layering was noted in the northern channel with bottom water approximating seawater. The southern arm is known to retain salinities higher than that of the northern arm as it is does not receive the main river flow (Begg, 1984).

The amount of dissolved oxygen (measured as percentage saturation) is affected by water temperature, depth water turbulence, salinity and biological processes such as photosynthesis and decomposition. Eighty percent saturation is considered healthy for aquatic ecosystems. In the Umhlali Estuary, dissolved oxygen levels generally ranged between 50 and 100% saturation. However, following prolonged mouth closure, significant oxygen depletion was evident overtime, dropping to below 50% in the southern channel, and at depths greater than 1.2 m in the northern arm. Natural breaching of the estuary did alleviate low oxygen conditions of the main channel to some degree. The mouth region was less affected by closed conditions due to the predominantly shallow depth, prevalence of photosynthetic bottom algae and wind-induced mixing (Forbes & Demetriades, 2009).

Turbidity of the water column arises from fine particulate matter in suspension. Begg (1978) remarked that the northern channel was mostly muddy and turbid, while the southern arm retained clear water. Forbes & Demetriades (2009) described the Umhlali Estuary as a 'clear water' system as turbidity levels were typically low (<15 NTU[2]) at all sites and depths. Nonetheless, during the periodic opening of the system, turbidity increased as a result of turbulence generated by currents; and during the closed mouth period, turbidity decreased as suspended materials settled out from the water column with the onset of calmer conditions. During the 2012 field investigation, a rapid decrease in water level and turbid conditions (Figure 4) were evident throughout the estuary following recent rainfall within the catchment and the subsequent breaching of the estuary mouth.

Although natural to all aquatic ecosystems, high levels of nutrients (namely phosphorus and nitrogen) resulting mainly from stormwater runoff, agriculture practices, and discharges from wastewater treatment plants, negatively affect water quality, estuarine biota and ecological processes. Nutrient loading is generally an indication of environmental degradation. Similarly, a high bacterial concentration, typically arising from sewage contamination and agricultural and urban runoff, is indicative of poor water quality and is a threat to human health. Based on the

[1] Salinity is a ratio and therefore 'parts per thousand', or units of concentration no longer apply

[2] NTU - Nephelometric Turbidity Units

prescribed thresholds for phosphorus and nitrogen for aquatic ecosystems (DWAF, 1996), the Umhlali Estuary exhibits signs of nutrient enrichment with measurements ranging between <0.01–0.21 mg/L and <0.01–36 mg/L, respectively (Forbes & Demetriades, 2009). These are indicative of an meso- to eutrophic ecosystem, that is, a state where relatively high nutrient concentrations cause notable reductions in species diversity, and enhance primary production to a high enough level, so as to produce harmful algal blooms (DWAF, 1996).

Bacterial analyses by Forbes & Demetriades (2009) revealed that the Umhlali Estuary is faecally contaminated and that the recorded levels of bacteria were well above the recommended levels (often by orders of magnitude) for domestic (0-10 counts/100ml) or recreational use[3] (<1000 counts/ml) of the river and estuary. Faecal bacterial measurements in excess of 10 000 counts/ml, were likely attributed to flushing of the catchment surfaces and runoff generated by the spring rainfall period. Such high values were recorded mostly in the southern channel, rather than in the northern channel or at the mouth (Forbes & Demetriades, 2009), and are due to its marginalisation from the main channel of flow, and consequent reduction in flushing of any contaminants from this area. *Escherichia coli* (*E. coli*), the preferred indicator of human and animal faecal pollution, was prevalent throughout the survey.

5.2.2 Sediments and Sedimentation

Begg (1984, p. 47) described the Umhlali Estuary as "*in a badly silted condition due to agricultural malpractices immediately around and upstream of the estuary*". He found the sediments of the system to be characteristically firm and sandy (with areas of silt). During the open mouth state, extensive sand banks were exposed, particularly along the southern channel (as seen in Figure 6). At the mouth, the Umhlali Estuary was protected by dolerite outcrop and established dune thicket on the southern bank. This description remains unchanged as noted in the recent site inspection, where a thick layer of mud was encountered in the mouth region, which gave way to large expanses of firm river sand moving into the middle and upper reaches (see Figures 5 and 6). The northern arm functioned as the main channel of flow, while the south arm was virtually completely drained as a result of its visibly highly silted condition.

In 2009, the sediments comprised predominantly well-sorted, medium-grained sand (0.25 mm particle size) (Forbes & Demetriades, 2009). The depositional nature of the mouth region, following the summer rainfall period, was evident in the mixture of medium- to very fine-grained sand (0.063 mm), with a mud component making up more than 50% of the sediment sample (Forbes & Demetriades, 2009) (Figure 7). The organic content of sediment was highest at this time, comprising 1.22 - 2.74% of the sediment composition. After the breaching of the estuary and scouring of most of the very fine-grained material and mud, the estuary sediments at all sites were almost uniformly medium- to fine-grained sand (0.125 mm). This was possibly attributed to low flow conditions, which may have also resulted in the deposition of mud and organic matter in the northern channel, constituting approximately 15% and between 0.76-1.28% of the sediment sample, respectively.

[3] The recommended level for full contact recreation (e.g. swimming) is <130 counts/ml, and intermediate contact (e.g. canoeing) is <1000 counts/ml.

Figure 4. Turbid waters of the upper reaches of the northern channel, above the weir – facing north

Figure 5. The Umhlali Estuary mouth and dolerite outcrop – facing south east

Figure 6. Extensive sand banks exposed in the northern channel during open mouth conditions – facing north west

Figure 7. Thick layer of mud and fine sediment in the lower region of the Umhlali Estuary

5.3 Ecology

5.3.1 Flora

5.3.1.1 Algal forms

There are no historical measurements of algae for the Umhlali Estuary apart from the mention of a mild bloom of the algae *Chaetomorpha* provided by Begg (1984). Algal growth is influenced by nutrient availability and turbidity and abstraction of chlorophyll-*a* from phytoplankton is used as an indicator of water quality based on the quantity of algae in the water column (Forbes & Demetriades, 2009).

An average chlorophyll-*a* concentration of 1.8 $\mu g.L^{-1}$ (range 1.2 – 3.4 $\mu g.L^{-1}$) was recorded in the headwaters entering the Umhlali Estuary in 2009, which was similar to that measured in the southern channel, of 1.9 $\mu g.L^{-1}$ (range 1.1 – 3.3 $\mu g.L^{-1}$). Chlorophyll-*a* levels in the northern channel and near the mouth were slightly higher at 2.9 $\mu g.L^{-1}$ (range 1.0 – 5.4 $\mu g.L^{-1}$) and 2.1 $\mu g.L^{-1}$ (range 0.6 – 5.5 $\mu g.L^{-1}$), respectively (Forbes & Demetriades, 2009). The authors suggest that although these levels were not high, they were still indicative of some nutrient

enrichment relative to other KwaZulu-Natal estuaries. In comparison with the urban estuaries of the eThekwini Metropolitan Area (Forbes & Demetriades, 2010), these levels are considered to be minimal. Although no measurements were taken during the 2012 field investigation, microphytobenthos was visible on recently drained sediment in both estuary channels.

5.3.1.2 Riparian and estuarine vegetation

The historical accounts of the vegetation of the Umhlali Estuary refer to the occurrence of *Hibiscus tiliaceous* (lagoon/freshwater hibiscus), *Barringtonia racemosa* and *Phragmites* reed beds lining the Umhlali Estuary (Begg, 1978). A substantial portion of the *H. tiliaceous* fringe was removed from the estuary edge in 1981 to expand sugar cane plantations. The extent of this species, and other riparian vegetation, was further reduced due to harvesting for firewood (Begg, 1984). Part of the central island was also planted with sugar cane.

Evidently, the peripheral vegetation of the Umhlali Estuary has been greatly impacted by cane encroachment as Begg (1978) described the system as 'unimportant' in terms of botanical value. Currently, a narrow strip of *H. tiliaceous* and *B. racemosa* swamp forest remains along both the southern bank and northern banks (Figure 8), the latter forming a large stand on the northern channel and becoming particularly dense near the weir (Figure 9). The central island is vegetated with clumps of *B. racemosa* and *H. tiliaceous,* as well as *Phragmites* spp. *Juncus kraussi*, *Phoenix reclinata*, *Cyperus* spp. and other hygrophilious grasses (Figure 10). Farther upstream, sugar cane is grown in the interior portion of the island, which is fringed by *B. racemosa*.

There appears to be significant reed encroachment from the southern bank, where extensive reed beds have developed, possibly as a result of silting of the southern channel (Figure 11). *Echinocloa* grass is well established in the upper reaches of the estuary. At the mouth, the sand bar is stabilised by dune pioneer species and grasses, as well coastal dune forest species, such as *Strelizia nicolai*, *Brachylaena discolour*, and *Mimusops caffra*.

Invasive alien plants and weeds are abundant in the upper reaches of the system on both the northern and southern banks, specifically in the vicinity of the wastewater treatment works. Numerous species were noted including *Lantana camara*, *Chromalaena odorata*, *Melia azedarach* (Syringa), *Schinus terebinthifolius* (Brazilian pepper tree), and *Solanum mauritianum* (Bugweed). Exotic gum trees (*Euclaytpus grandis*) and bamboo (*Bambusa vulgaris*) also occur in this area.

Figure 8. *H. tiliaceous* and *B. racemosa* fringe on the southern bank of the Umhlali Estuary – facing west

Figure 9. Dense *B. racemosa* swamp forest on the northern channel – facing north west

Figure 10. Mixed vegetation of the eastern portion of the central island – facing south west

Figure 11. Large *Phragmites* reed bed on the southern channel of the Umhlali Estuary – facing north west (photo courtesy of G.E. Roberts, Lower Tugela Biodiversity Project)

It is important to note that *B. racemosa* and *M. caffra* are protected tree species under the National Forests Act (Act no 84 of 1998). While the *M. caffra* is sparse along the estuary, a large portion of the estuary margin, including the central island, is fringed with *B. racemosa*. This protected status may have implications for the proposed development, such that protected species may not be cut, disturbed, damaged or destroyed except without a license from the Department of Agriculture, Forestry and Fisheries. Furthermore, special conditions of the license will also have to be fulfilled, if issued.

5.3.2 Fauna

5.3.2.1 Benthic invertebrates

Benthic invertebrates are those organisms found living in or on the sediment surface. They are an important component of estuarine ecosystems reaching high diversity, density and biomass in healthy environments. Begg (1984) recorded 11 species of prawns and 7 species of crabs collected during trawling of the Umhlali Estuary. A large proportion of the catch (58%) comprised penaeid prawns, predominantly *Penaeus indicus*, which indicated the important function of the Umhlali system as a nursery ground for marine prawn species.

Soft-sediment sampling by Forbes & Demetriades (2009) produced a total of 23 taxa dominated by polychaete worms and amphipod crustaceans. The densities of the amphipods increased significantly in the spring season from 3 027 to 40 672 individuals/m^2. The presence of the polychaete species, *Capitella capitata*, a well-known indicator species of organic pollution, was negligible. The most conspicuous feature of the benthos was the wide distribution of the burrowing prawn, *Callianassa kraussi*, where burrows were visible mainly in the lower and middle reaches. However, the abundance of this species

Figure 12. High density occurrence of *C. kraussi* (top) and *T. granifera* (bottom) as green band, in the Umhlali Estuary

was not assessed as the burrows extend deeper than that of the surface sampling technique that was used. In addition, the presence of the alien invasive snail, *Tarebia granifera*, was particularly noteworthy. This species reached a maximum density of 10 848 individuals/m^2 in the southern channel (Forbes & Demetriades, 2009). While *T. granifera* is present in numerous estuaries across KwaZulu-Natal (Forbes & Demetriades, 2010; (Meyer, 2011), the exceedingly high abundance in the Umhlali Estuary is cause for concern, as invasive species typically outcompete native species for critical resources, which results in a loss of diversity.

The high occurrence of both *C. kraussi* and *T. granifera* was confirmed during the 2012 field inspection, where the latter were densely clustered, appearing as narrow green mats in shallow areas (Figure 12).

5.3.2.2 Fish fauna

Early intensive sampling of the fish community of the Umhlali Estuary using beam trawling, yielded 37 species, 21 of which occurred consistently throughout the sampling period (Begg, 1984). Harrison (unpublished, cf. Forbes & Demetriades, 2009), using seine and gill netting, collected some 30 species, 15 of which were regularly occurring. More recent sampling using the same technique yielded 13 identified species. Only six of these were common (i.e. more than five individuals), namely *Liza dumerilii*, *L. alata*, and *Valamugil cunnesius* (three mullet species), *Rhabdosargus holubi*, *R. sarba* (two stumpnose species) and *Abassis natalensis* (Slender glassy) (Forbes & Demetriades, 2009). The most abundant group was mullet, comprising 80% of the total catch.

In comparison with Harrison's records, there were several species that did not appear (or appeared in very low numbers) in the most recent samples, namely, *A. ambassis*, *Oreochromis mossambicus*, *Pomadasys commersonnii*, *Terapon jarbua* and the mullet species, *Myxus capensis* and *Mugil cephalus* (Forbes & Demetriades, 2009). While Harrison et al. (2000) rated the fish community of the Umhlali Estuary as 'Good', the results by the latest survey suggest a decline in species diversity and population numbers, which is indicative of the reduced capacity of the Umhlali Estuary as favourable fish habitat (Forbes & Demetriades, 2009). During the 2012 field inspection, there was heightened fish activity (leaping fish), specifically in shallow sections of the estuary where shoals became concentrated as the system continued to drain through the open mouth.

5.3.2.3 Birds

Begg (1984) refers to some 1500 terns of various species, predominantly the Arctic Tern (*Sterna macrura*), utilising the Umhlali Estuary as a roosting area, specifically the extensive sandbanks which become exposed during low tide, open mouth conditions. Forbes & Demetriades (2009) did not record such numbers during their survey, presumably due to closed mouth conditions. They documented 20 species of water-associated birds, with the greatest number of species (13) and individuals (42) recorded in July, in comparison with to October (10 species, 29 individuals). The overall abundance of water- associated birds was relatively low.

During the 2012 field inspection when the estuary mouth was open, large numbers of birds were also not observed. However, wading bird species including Common Greenshank, Little Egret, and White Fronted Plovers were seen foraging on the exposed sandbanks and in the shallows (Figure 13). Other bird species noted were Spurwing Goose, White breasted Cormorant, Reed Cormorant, Pied Kingfisher, Fish Eagle, and Woolly necked storks.

Figure 13. Common Greenshank seen foraging on the exposed sand banks in the lower reaches of the Umhlali Estuary

5.4 Health Status and Importance

5.4.1 Health Status

Harrison et al. (2000) rated the condition of the Umhlali Estuary as good in all aspects, including ichthyofauna, water quality and aesthetics. Whitfield (2000) rated the overall condition of the estuary as fair, although information on the system was limited/poor. The 2011 National Biodiversity Assessment (NBA) (Van Niekerk & Turpie, 2012), provides *inter alia* an updated assessment of the health status of estuaries in South Africa. The health condition of each estuary (also known as the Present Ecological State (PES) was provisionally determined at the *desktop* level using the Estuarine Health Index, in which the current conditions of various abiotic and biotic components are rated as a percentage of the probable pristine condition (Table 3). The resultant health score was then assigned to one of six categories, ranging from natural (A) to critically modified (F) (Van Niekerk & Turpie, 2012). The Umhlali Estuary was given an estuarine health score of ***64***, corresponding to a ***Category C*** provisional PES, i.e. a ***Moderately Modified*** system (Table 4) where a loss of natural habitat and biota is recognised, but the basic ecosystem functions and processes are still predominantly unchanged.

Table 3. Estuarine Health Index (EHI) scores allocated to the Umhlali Estuary (Van Niekerk & Turpie, 2012)

ESTUARINE COMPONENT	WEIGHT	SCORE	GRADING	WEIGHTED SCORE
HABITAT ASSESSMENT				
Hydrology	25	75	Fair	18.7
Hydrodynamics & mouth condition	25	80	Good	20
Water quality	25	44	Fair	11
Physical habitat alteration	25	60	Fair	15
HABITAT SCORE				**65**
BIOLOGICAL ASSESSMENT				
Microalgae	20	58	Fair	11.6
Macrophytes	20	60	Fair	12
Invertebrates	20	70	Fair	14
Fish	20	55	Fair	11
Birds	20	70	Fair	14
BIOLOGICAL SCORE				**63**
ESTUARINE HEALTH SCORE (*average of habitat & biotic scores*)				**64**
PROVISIONAL PRESENT ECOLOGICAL STATE				**C**

Table 4. Correlation between the EHI Score and the Present Ecological State

EHI SCORE	PRESENT ECOLOGICAL STATE	GENERAL DESCRIPTION
91 – 100	A	Unmodified, natural
76 – 90	B	Largely natural with few modifications
61 – 75	**C**	**Moderately modified**
41 – 60	D	Largely modified
21 – 40	E	Highly degraded
0 – 20	F	Extremely degraded

The status of the Umhlali Estuary was recently updated as part of the Water Resources Classification Study for the Umzimkulu-Mvoti Water Management Area (DWA, 2014). The revised EHI score was estimated to be ***57***, translating into a lower PES of ***Category D***, i.e. ***Largely Modified***. This is largely ascribed to non-flow related impacts, specifically the depressed biotic health scores for all of the biotic components. Addressing poor water quality was considered to be of highest priority in order to improve the health of the system. High nutrient inputs resulted in increased plant growth, and subsequent loss of open intertidal riparian habitat, while low oxygen levels resulted in reduced invertebrate abundance and reduced nursery functionality (DWA, 2014).

5.4.2 National and Regional Importance of the Umhlali Estuary

Turpie et al. (2002) prioritised South African estuaries based on their conservation importance derived from various factors including size, type, biogeographical zone, habitat and biodiversity (plants, invertebrates, fish and birds). The updated prioritisation (Turpie & Clark, 2007) ranks the Umhlali Estuary as the 71st most important estuary out of 256 systems in South Africa. In comparison with other temporarily open/closed estuaries of the iLembe District Municipality, it is the second most important system after the Zinkwasi Estuary (Table 5), particularly in terms of its biodiversity and the ecological habitat it provides.

Table 5. Desktop estuary important scores for the Umhlali Estuary in a regional context with other estuaries of the iLembe District Municipality

	Umhlali	Matigulu / Nyoni	Zinkwasi	Thukela	Mdlotane	Tongati	Mvoti	Nonoti	Seteni
Estuary Type*	TOCE	POE	TOCE	RM	TOCE	TOCE	RM	TOCE	TOCE
Size	60	90	80	80	60	70	60	60	10
Habitat Importance	90	70	90	50	90	80	30	60	80
Rarity of Type	10	30	10	70	10	10	70	10	10
Biodiversity Importance	80	89	80	71	65	54.5	80.5	74.5	37.5
Overall Importance Score	***67.5***	*78.8*	*75.5*	*69.3*	*63.8*	*62.6*	*58.6*	*58.6*	*34.4*
National Rank	***71***	*39*	*48*	*66*	*80*	*83*	*95*	*96*	*184*

* TOCE = Temporarily open/closed estuary, POE = Permanently open estuary; RM = River mouth

Through a more detailed specialist workshop, the functional importance of the Umhlali Estuary was determined (under the Water Resources Classification Project, DWA, 2014) and incorporated into the above estuary importance score. The functional importance score was estimated to be 70, rendering the overall estuarine importance score as **63**, inferring that the system is regionally ***Important*** (Table 6).

Of critical relevance is the fact that the Umhlali Estuary is ***one of the core estuarine systems to be protected in order to reach the national estuarine biodiversity conservation targets***. Thus, suitable protection of the estuary must established and appropriate management interventions and mitigation measures applied towards reaching this improved condition. Ideally, the system should be afforded partial no-take protection, and 50% of the estuarine margin should remain undeveloped (Van Niekerk & Turpie, 2012; DWA, 2014).

Table 6. Description of Estuary Importance Score

IMPORTANCE SCORE	DESCRIPTION
Protected Status	Protected
80 – 100	Highly Important
60 – 80	**Important**
0 – 60	Of average importance

5.4.3 Recommended Ecological Flow Requirements

Based on the updated PES and the overall importance, the Recommended Ecological Category (i.e. the target for protection and management) for the Umhlali Estuary is ***Category B*** (i.e. a ***largely natural system with few modifications***). The recommended Ecological Flow Requirement scenario to achieve the Category B status is Scenario 5, i.e. the present day flow (51.26 x $10^6 m^3$), without abstractions or WWTW inputs and without the current system impacts. The following management interventions are required to attain a B Category:

- Reduce the nutrient input from the WWTW and catchment to control growth of reeds and aquatic invasive plants;

- Remove the sugar cane from the EFZ (below 5 m contour) to allow for a buffer against human disturbance and the development of a transitional vegetation ecotone between estuarine and terrestrial ecosystems;
- Removal of vegetation from main river channel in upper reaches, including invasive aliens plants and stands of Eucalyptus (using CoastCare programme);
- Ensure that the estuary is not artificial breached; and
- Remove the old saltwater weir from middle reaches of system (DWA, 2014).

5.4.4 Importance of Estuarine Habitats

As previously mentioned, the Umhlali Estuary has been moderately modified from its original natural condition, mostly by sugar cane encroachment, which has reduced the extent of available estuarine habitat through accelerated sedimentation, draining of wetlands, clearing of marginal swamp forest and construction of the weir. Nonetheless, sensitive estuarine habitats still exist (Table 7) (Van Niekerk & Turpie, 2012). The bifurcated channel constitutes the greatest area of available habitat (21 ha), the health of which is essential for all life in the estuary. The calm water environment provided by an estuary provides essential nursery habitat and feeding grounds for juvenile fish and invertebrates. The estuary water body also serves to dilute, assimilate and transport pollutants and nutrients to the marine environment. The mouth sandbar itself, provides protection against marine storms.

Table 7. Type and estimated extent of existing estuarine habitats in the Umhlali Estuary

	Extent of Habitat (ha)
Length (km)	2.6
Open Water	19
Type of Habitat	
Intertidal salt marsh	
Supratidal salt marsh	
Submerged Macrophytes	
Reeds & Sedges	6
Mangroves	
Sand / mud banks	8
Channel	21
Rocks	
Swamp forest	7
TOTAL	**42**

The sand/mud banks and swamp forest constitute 8 ha and 7 ha, respectively, however the extent of the sand/mud banks varies depending on the open/closed state of the mouth, river flow and tides during open periods. During exposure, sand/ mud banks become important feeding areas for birds (Figure 13 above). The relative extent of reed and sedge coverage in the Umhlali is noteworthy and arguable attributed to significant sedimentation of the southern channel. The swamp forest, reed beds and riparian vegetation perform the valuable functions of wildlife refugia, flood regulation, erosion protection (bank stabilisation), water filtration, sediment retention and carbon storage, and generation of organic food sources.

Figure 14 (overleaf) depicts a conceptual habitat map, indicating the various estuarine habitats in the Umhlali Estuary that are most likely to be impacted on by the proposed coastal development. As the development will occupy the land parcel up to the N2 bridge, almost the entire Umhlali Estuary could potentially be affected.

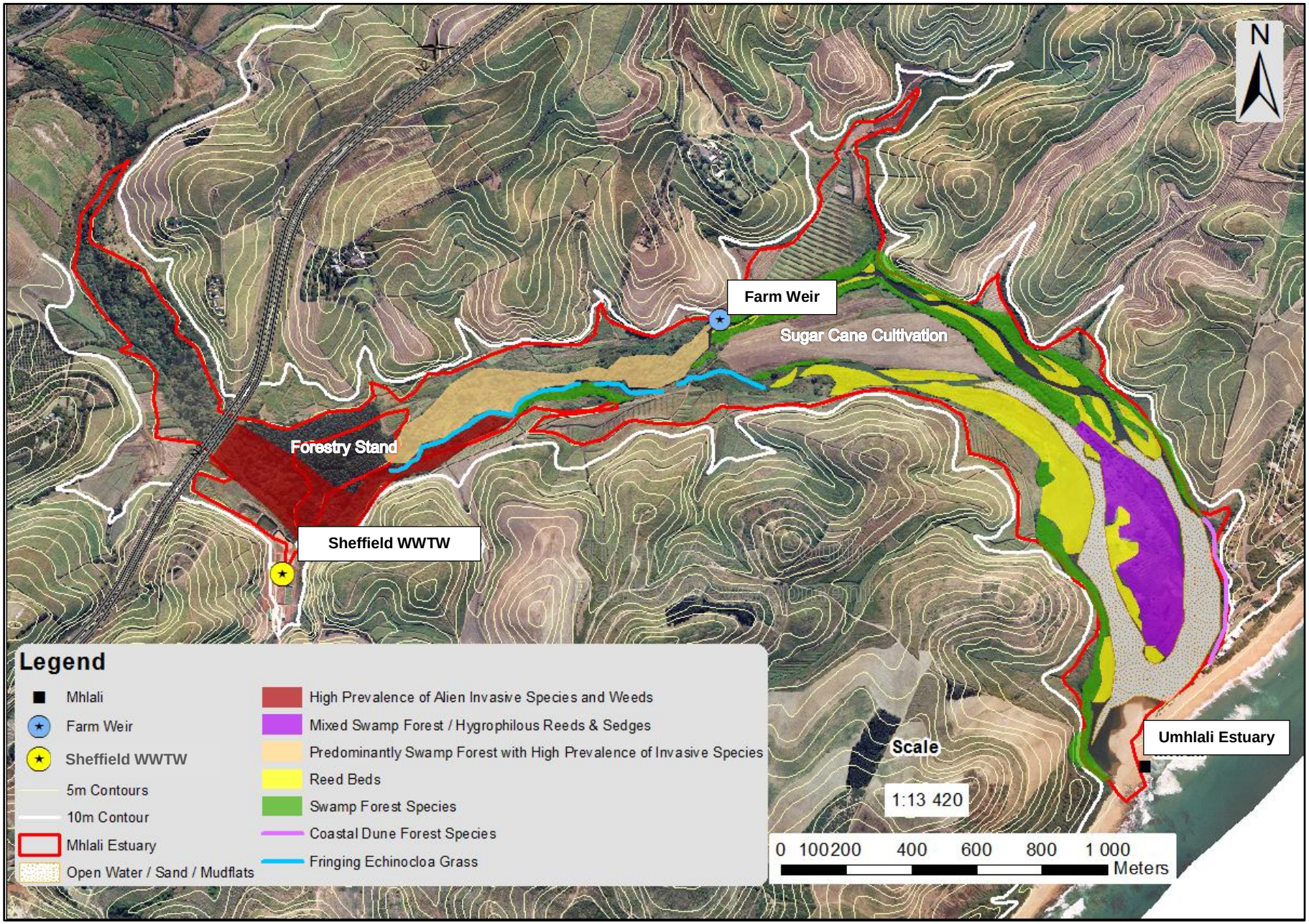

Figure 14. Conceptual habitat map for the Umhlali Estuary in relation to the proposed Tinley Manor Southbanks Coastal Development

6 POTENTIAL IMPACTS OF PROPOSED DEVELOPMENT

6.1 Legal Requirements

6.1.1 National Environmental Management Act

According to the National Environmental Management Act (Act 107 0f 1998) (as amended) (NEMA), environmental authorisation must be obtained from the relevant competent authority, in this case the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (EDTEA), for the proposed development and associated listed activities[4] through an Environmental Impact Assessment (EIA) process. The purpose of an EIA is to determine whether there are any fundamental negative impacts which may result from the proposed development activity and which cannot be effectively mitigated. The report is then submitted to the competent authority to inform their decision to grant/not grant approval for the project, as well as specific conditions to mitigate negative impacts, should authorisation be granted.

6.1.2 National Water Act

In terms of the National Water Act (Act No 36 of 1998) (NWA), a Water Use License Application must be lodged with the Department of Water and Sanitation for various water uses listed under Section 21. In the context of the proposed development, the following water uses may be applicable:

(a) taking water from a watercourse;

(i) altering the bed, banks, course or characteristics of a watercourse; and

(f) discharging waste or water containing waste into a water resource through a pipe, canal,…or other conduit.

These activities will impact numerous aspects or components of the Umhlali Estuary.

6.2 Current Impacts

Historically, the Umhlali Estuary has been subject to severe siltation, caused by poor agricultural practices (Begg, 1978). It is also suggested that the total area and volume have been reduced over time due to this accelerated sedimentation (Forbes & Demetriades, 2009). As a sediment-rich system, sandwinning has been and is still prevalent in the Umhlali River above the estuary (Demetriades, An inventory of sandmining operations in KwaZulu Natal estuaries: Mtamvuna to Thukela. Investigational Report of CoastWatch, WESSA KZN, 2007). This has additional negative impacts, which influence the estuarine environment, including disturbance and downstream transportation of fine sediment, modification of the river course and flow patterns, destruction of riparian habitat and potential introduction of pollution.

Apart from the broader impacts of sugar cane farming, namely increased sedimentation and nutrient input, direct anthropogenic impacts on the estuary itself have been relatively limited because of its remote location and extensive plantation surroundings. The most significant impact, in terms of estuarine function, is the presence of the weir, which was originally constructed for irrigation purposes. By preventing saline intrusion and acting as a barrier, the weir has effectively decreased available estuarine habitat and restricted natural estuarine processes and faunal movement.

The existence of the weir and adjacent pumping station indicates the abstraction of water from the immediate estuarine functional zone. While there are no major dams on the Umhlali River, water abstraction from the greater

[4] Listing Notice 1 Activities (GNR. 544 of 2010), Listing Notice 2 Activities (GNR. 545 of 2010) and Listing Notice 3 Activities (GNR 546 of 2010)

catchment is highly probable given that agriculture is the dominant land use. However, abstraction does not appear to be having an adverse effect on the state of the mouth, as the system is mostly open (for approximately 55% of the year; Ezemvelo 2011) and as described by both Begg (1984) and Harrison et al. (2000). Nonetheless, it is arguable that the duration of mouth closure has increased (Forbes & Demetriades, 2009).

The Umhlali Estuary has history of artificial breaching which was allegedly undertaken by sugar cane farmers to prevent flooding and damage to fields (Begg, 1978), but also prolonged by locals to enable the collection of bait organisms (*C. kraussi* and *Upogebia africana*) (Begg, 1984). In the last 20 years, the number of *known* artificial breaching events was limited to two (Ezemvelo, 2011) but it is possible that more undocumented breaching events have taken place. The collection of bait organisms still occurs (Forbes & Demetriades, 2009).

Urban encroachment is relatively low, apart from the towns of Tinley Manor and Shakaskraal, located on the northern bank of the Umhlali Estuary and River, at the mouth and 7 km upstream, respectively. Begg (1984) refers to the inappropriate development of Tinley Manor on the "*vegetatively sensitive and highly unstable*" sand bar, followed by resultant slumping of the estuary-facing slopes.

There are two wastewater treatment works (WWTW) located along the Umhlali River and Estuary, namely the Shakaskraal WWTW and the newly constructed Sheffield WWTW located in the estuarine functional zone adjacent to the proposed development site, approximately 8 km and 3.6 km upstream, respectively. Only the Shakaskraal Works is currently discharging 0.8 Ml/day into the Umhlali River (DWA, 2014), while discharge from the Sheffield WWTW will only commence once the first stages of development are complete (planned for 2015) and is estimated to add 6.75 Ml/day into the system (SMEC, 2014). The discharge of treated wastewater invariably contributes to the nutrient status of system, and serves as source of added freshwater input and potential faecal contamination. In addition, Begg (1978) refers to the use of the Etete River (a tributary of the Umhlali River located 6.4 km upstream of the mouth) for bathing and laundry, resulting in an "*enormously enriched and faecally polluted*" state. It is quite possible that these conditions still exist to some degree, and cascade into the Umhlali Estuary as indicated by recent bacterial results (Forbes & Demetriades, 2009).

Human-induced threats to the Umhlali Estuary are summarised in Table 8 below.

Table 8. Human-induced threats to the Umhlali Estuary (adapted from Forbes & Demetriades, 2009; 2010)

THREATS	NOTES
1. Habitat Loss	Construction of weir, agriculture plantation in the floodplain, draining of marginal wetlands, and firewood collection have caused significant habitat loss for the system
2. Eutrophication	Relatively low provided mouth status is maintained
3. Freshwater diversions	Unknown levels of abstraction for irrigation purposes, and added treated wastewater input from WWTW. Additional input anticipated from Sheffield WWTW.
4. Sewage	Daily discharge of treated water from WWTW, contaminated runoff from settlements
5. Chemical contamination	Runoff containing agricultural pesticides is likely entering the system
6. Litter/debris	Contaminated runoff from settlements
7. Introduced species	High densities of the invasive snail, *Tarebia granifera.* Potential to influence benthic communities but impact is yet unknown
8. Sea-level rise	Estuarine setback proposed at the 10 m amsl[5] as a result of sea level rise (Mather & Swart, 2010)

[5] Mather & Swart (2010) delineated the estuarine boundary at the 6m amsl contour, with an environmental buffer to the 10m amsl contour

9. Overexploitation	Bait collection and fishing effort is low

6.3 Assessment Methodology

An impact can be described as the consequence of a particular action or activity on the environment, generally identified by a change in a specific feature or characteristic of the environment concerned. By nature, the impact can be positive or negative, or neutral.

A *direct impact* is caused directly by the specific action and generally occurs at the same time and place. An *indirect impact* is an induced change caused by the action and is generally expressed later in time or farther removed in distance, but is still reasonably foreseeable. A *cumulative impact* is the impact on the environment, which results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions on the same area. A cumulative impact can result from actions considered minor in isolation, yet collectively significant, taking place over a period of time (CEE, 2012).

The following factors were considered during the predication of the potential environmental impacts associated with the project. The associated criteria are provided in

Table 9 (SSI Environmental, 2011).

- the nature of the impact (Status), i.e. positive, negative, neutral, direct, indirect, and/or cumulative;
- the location and extent of the impact (Extent), i.e. the area over which the impact will be expressed (maximum area considered);
- when the impact will be experienced, i.e. during construction, operation, and/or decommissioning phases;
- the duration of the impact (Duration), i.e. short-, medium-, long-term, and/or permanent;
- the likelihood of the impact actually occurring (Probability);
- the intensity of the impact in respect to affecting functions and processes (Intensity);
- the importance of the impact and the level of mitigation required (Significance);
- the potential irreversibility of the impact; and
- the nature of potential cumulative impacts.

An ecosystem approach was adopted in assessing the potential impacts, i.e. acknowledging that all estuarine functions, processes, habitats and organisms are intricately connected. Therefore, the construction-related potential impacts will not necessarily be limited to the construction site(s) but will more likely indirectly affect the entire downstream estuarine environment, with possible implications for upstream habitats and environments as well.

**It is important to note, that the impact ratings provided are scored prior to or without mitigation measures.

Table 9. Criteria used to assess the potential impacts of the proposed construction adjacent to the Umhlali Estuary

CRITERIA	DESCRIPTION			
Status	***Positive*** A benefit	***Negative*** A loss	***Neutral***	
Extent	***Site (1)*** Within immediate construction site	***Local (2)*** Within a radius of 2 km of the construction site	***Regional (3)*** Affecting the region as a whole (provincial or parts of other provinces)	***National (4)*** Affecting the whole of South Africa
Duration	***Short term (1)*** The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase	***Medium term (2)*** The impact will last for the period of the construction phase, where after it will be entirely negated	***Long term (3)*** The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter. The only class of impact which will be non-transitory	***Permanent (4)*** Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient
Probability of occurrence	***Improbable (1)*** Low likelihood of impact materialising	***Probable (2)*** The impact may occur	***Highly Probable (3)*** Most likely to occur	***Definite (4)*** Impact will certainly occur
Intensity	***Low (1)*** Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected; Management is not required	***Moderate (2)*** Affected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way; Management may be required	***High (3)*** Natural, cultural and social functions and processes are temporarily altered or cease; Management is required to reduce negative impacts	***Very High (4)*** Natural, cultural and social functions and processes are altered to extent that they permanently cease; Development is not feasible if negative impacts cannot be mitigated/reduced; Management is critical

6.4 Impact Assessment

Although estuarine ecosystems are considered key environmental assets, they are one of the most threatened habitats in the country. The Umhlali estuarine system will undoubtedly experience a degree of interference or disturbance, as a result of the proposed development, particularly those habitats closest to the proposed construction site(s) and physical development. Based on the current state of the system and existing impacts and pressures, it is therefore imperative that potential impacts on the Umhlali Estuary be assessed in order to minimise environmental degradation of the natural elements of the system and to formulate and implement appropriate mitigation measures. With proactive management, the impacts can be avoided or will be greatly reduced in terms of the extent, duration and overall significance. In this section, the potential impacts are assessed in terms of their potential direct and indirect effects on the Umhlali Estuary, and as a worst-case scenario (i.e. undertaking of the proposed development without mitigation). Mitigation measures to minimise the potential negative impacts are provided.

6.4.1 Construction Phase

6.4.1.1 Erosion

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	Site (1)	Long term (3)	Probable (2)	High (3)

Nature of Impact:

The construction of the residential units, resorts, facilities and associated infrastructure will necessitate the clearing of land and major earthworks. This will lead to soil exposure with the potential for erosion and consequent loss of topsoil. While agricultural practises have already depleted this soil component (Geoff Nichols[6], pers. com), healthier soils will still exist in the remaining pockets of indigenous vegetation. Eroded material may be transported from the site via surface water runoff into the estuary. Topsoil contains nutrients essential for plant growth but is problematic for estuaries and other aquatic habitats, as nutrient enrichment will lead to eutrophication[7] and subsequent oxygen depletion. The potential for erosion is high, given that the prospective land is currently used for farming, the steepness of the landscape adjacent to the estuary and the sparseness of well-established vegetation communities (e.g. forests, grasslands, wetlands) to stabilise the soil. Similarly, the construction of low-impact structures within the estuarine functional zone may increase erosion potential within this dynamic environment also through removal of binding vegetation and exposure of soils.

Proposed Mitigation:

On-site erosion as a result of land clearing and construction activities must be prevented as much as possible. The developer must follow best-practise construction methods to reduce erosion, particularly in steep areas and close to the estuary. This potential impact can be easily and significantly reduced if the following mitigation measures are implemented:

- The development layout must take the natural drainage patterns of the site into account, such that the flow path around buildings and other infrastructure is adequately protected against erosion and is sufficiently roughened to retard stormwater flow (specifically during high rainfall events);
- Sustainable urban drainage methods, such as porous paving techniques and vegetated swales, must be incorporated into the design concept to assist in flow attenuation for the life-span of the development;
- Before any construction commences on the site, stormwater control systems, such as swales, berms, soil fences and detention facilities are to be constructed. As construction progresses, the stormwater control measures are to be monitored and adjusted to ensure complete erosion and pollution control at all times;
- Earthworks on sites are to be kept to a minimum. Where embankments have to be formed, stabilization and erosion control measures shall be implemented immediately;
- Topsoil must be conserved and re-used for rehabilitation purposes;
- Soil stockpiles must be positioned at least 50m away from the estuary, watercourse and stormwater drains, and not on steep slopes;
- Unnecessary removal of indigenous vegetation, especially on steep areas, must be avoided;
- The removal of vegetation should only occur just prior to construction;
- Cleared areas must not be left exposed, and should be promptly rehabilitated/vegetated with indigenous plants immediately after building works have been completed, or have reached a stage where newly established ground cover is not at risk from the construction works;

[6] Mr. Geoff Nichols, expert horticulturalist. Geoff Nichols Horticultural Services

[7] Eutrophication is a state of nutrient enrichment in a water body caused by excess phosphorous and nitrogen, which stimulates excessive plant growth, such as algal blooms, that in severe cases have devastating consequences for aquatic biota.

- Landscaping and re-vegetation must take place perpendicular to the slope to reduce flow velocities and minimise erosion;
- Post construction, all areas disturbed by construction, including the site camp area, must be rehabilitated;
- Indigenous vegetation removal for the construction of the eco-friendly structures, i.e. boardwalks, is not permissible. However, sympathetic pruning may be undertaken.
- Installation of these structures must not be undertaken in the high rainfall, late spring summer months, and preferably when water levels are low following a natural breaching event.

No development may be constructed below the 1:100 year floodline or the recommended 10 amsl contour (whichever is intercepted first from the point of development), as these areas are susceptible to erosion during storm events, flooding, and natural back flooding of the estuary. This may result in damage/loss of property and negatively impact on estuarine functioning (detailed below). In the case of permissible low impact structures within the EFZ, these will be considered sacrificial (See details in Section 6.4.1.5 below). To further reduce runoff velocities and the chances of erosion, wetlands and riparian habitats may be reconstructed/reinstated/rehabilitated where appropriate as directed by a wetland expert. Flow attenuation must be implemented using dry storm water management facilities (e.g. swales, etc), prior to directed flow entering such wetlands and the estuary, to prevent scouring and exacerbated erosion.

6.4.1.2 Sedimentation

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**Local to National (4)**	**Long term (3)**	**Probable (2)**	**High (3)**

Nature of Impact:

Sedimentation (caused predominantly by agriculture) is one of the leading causes of the poor condition of many KwaZulu-Natal estuaries (Begg, 1978).The severely silted nature of the Umhlali Estuary has been largely attributed to sugar cane farming and poor agricultural practises, as well as numerous sand mining operations located above the estuary. The increased erosion of soil (detailed above) and subsequent deposition within the estuary can have severe negative impacts on the estuarine environment, including:

- exacerbation of the already shallow nature of the system (particularly the southern channel) leading to reduced aquatic habitat, and reed and terrestrial vegetation encroachment;
- increased turbidity which reduces light penetration thereby impairing photosynthesis and primary productivity;
- reduced oxygen concentration in the water column and benthic habitat;
- smothering of benthic invertebrates and aquatic plants resulting in reduced food resources; and
- modification of current sediment characteristics, thereby altering the distribution and composition of benthic invertebrate communities and aquatic plants.

Overall, the impact of sedimentation on aquatic habitats associated with the estuary will be highly significant with long-term, and often irreversible repercussions.

This impact is rated at a local to national scale, as excessive sedimentation will affect the natural functioning of the estuary, all biota (both plants and animals), and the provision of certain ecosystem services, which would decrease the overall condition and importance of the system for conserving estuarine biodiversity. Heavily silted and muddy conditions reduce the aesthetic value of an estuary.

Proposed Mitigation:

Sedimentation is directly related to increased erosion, thus the above-mentioned mitigation measures will reduce the probability of this impact. In addition, maximum vegetation cover should be maintained outside of construction areas, particularly in the drainage lines/riparian areas, as these will serve as sediment traps. This will require additional planting, landscaping and rehabilitation of such as areas where indigenous vegetation has been replaced by sugar cane. Similarly, no indigenous vegetation along the estuary margin must be removed. However strategic/sensitive pruning will be permitted for creating space for the boardwalks. This will serve to maintain the natural ecological functioning of the riparian and estuarine areas as well as function as an ecological corridor between terrestrial and aquatic environments.

6.4.1.3 Conservation areas

Status	Extent	Duration	Probability of occurrence	Intensity
Positive	**Regional (3)**	**Long term (3)**	**Highly Probable (3)**	**High (3)**

Nature of Impact:

The eco-centric design concept of the coastal development proposes to *inter alia*, conserve and enhance the remaining natural elements of the surrounding landscape, as well as rehabilitate (and recreate) the degraded wetland areas that have been damaged by the sugar cane plantations. This will increase the amount of available habitat, thereby enhancing the biodiversity of the area. Furthermore, the preservation of natural areas and corridors allows for the migration of species and interconnection between terrestrial, estuarine and freshwater ecosystems. The reinstatement of these habitats will also assist with erosion protection, and reducing sedimentation and contamination of the estuary. Essentially, the overall ecological state and functioning of the Umhlali Estuary may potentially be improved and this has regional significance.

It is important to note that limited low impact development, namely boardwalks, will be installed along and inside the estuary margin and will be for passive recreational use and appreciation of the conservation areas/open spaces (See details in Section 6.4.1.5 below).

Additional recommendations:

The conservation area should include the entire Umhlali Estuary (i.e. below the 5m amsl contour), as well as the remaining area below the 10 m amsl contour (described in detail below), which constitutes a horizontal buffer area between 16 m (in severe case) and 257 m wide depending on topographical constraints. No further transformation of this land for development or removal of natural vegetation should be permitted (apart from invasive alien vegetation removal and sensitive pruning along the boardwalks).

The reinstatement and rehabilitation of natural areas must be undertaken according to expert recommendations, using local/indigenous species. Consideration should be given to extending the rehabilitation programme to upstream riparian areas and tributaries, and other ‘green’ areas of the Tongaat Hulett Holdings (i.e. northern bank). The design of the development perimeter fencing should consider the movement of animals (e.g. antelope) between the estuary and the conservation areas.

6.4.1.4 Freshwater Abstraction

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**National (4)**	**Medium term (2)**	**Highly Probable (3)**	**High (3)**

Nature of Impact:

Reduced freshwater inflow (mostly through abstraction) is a major threat facing South African estuaries, including the Umhlali Estuary, where dam construction and known abstraction occurs for irrigation purposes in the catchment area of the Umhlali River. Additional freshwater may be abstracted from the Umhlali River above the head of the estuary to supply construction activities for the TMSCD, which is also likely to include wetland rehabilitation activities.

The hydrodynamic functioning and ecological state of an estuary are critically dependent on fluvial input. The degree of impact on the downstream estuarine environment will depend on the volume, frequency and timing of water abstraction. In the context of the Umhlali, the cumulative impact of farm dams and direct abstraction of significant volumes of freshwater during the current drought-stressed conditions may result depressed in baseflows and aseasonal and/or prolonged closure of the estuary mouth with knock-on effects for the ecology of the system. Overall reduction in flow will also result in reduction of estuarine habitat. Conversely, over an extended period, the gradual accumulation of water will lead to backflooding and prolonged inundation of littoral habitats, with potential shifts in vegetation community assemblages.

While the discharge of treated wastewater from the nearby WWTWs may be thought of as a means to augment the depressed mean annual runoff or offset freshwater abstraction, the concomitant increase in nutrients related to the discharge will produce a highly negative impact (DWA, 2014). Furthermore, treated effluent discharged from WWTWs becomes the primary constituent of river flow where natural baseflows have been greatly reduced through abstraction and impoundments, combined with drought conditions. This can have severe consequences in terms of eutrophication of the downstream environment, such as estuaries. This risk must be considered given the severe drought conditions currently being experienced in KZN and in the context of the proposed phased construction approach.

Moreover, the recommended Ecological Flow Requirement (EFR) to achieve the Recommended Ecological Category is the present day flow (51.26 $x10^6$ m^3) but without abstractions or WWTW inputs, and without the current system impacts. Additional abstraction from the system, together with increased nutrient loading, will undoubtedly result in deterioration of the system (DWA, 2014).

This potential impact is rated at a national scale, as continual abstraction of large volumes of water that erode the ecological reserve will affect estuarine health and functioning, and all biota (both plants and animals), which would decrease the overall importance of the system for conserving estuarine biodiversity.

Proposed Mitigation:

It is strongly recommended that water abstraction from the Umhlali River and estuary not be permitted in view of the Category D Present Ecological State, the Recommended Ecological Category of B, the prescribed recommended EFR, and the current impacts threatening the system.

An alternative water supply must be sought. A water conservation strategy should be compiled between Siza Water, as owner of the Sheffield WWTW, and Tongaat Hulett Development to recover water of a suitable standard from the Sheffield WWTW for possible use during construction, rehabilitation and potentially potable use within the TMSCD complex. Failing this, further investigation into alternative water supply will be required.

6.4.1.5 Disturbance of the estuarine functional area and supporting habitats

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**Local (2)**	**Medium term (2)**	**Definite (4)**	**Moderate (2)**

Nature of Impact:

The establishment of green spaces/conservation areas in the current design offers residents and visitors the opportunity to engage with the environment, particularly with the estuarine environment. The potential thus exists for low impact structures, such as wooden boardwalks, to be constructed along the edge of the estuary, and across other supporting habitats, such as wetlands and streams/drainage lines. These structures will enable controlled access to the estuary margin, reduce trampling of important habitats, and would serve as a means to educate users about the estuarine ecosystem. If approved, they must ensure strictly controlled / directed access to these sensitive environments. This will have a positive impact in terms of generating environmental awareness, however the construction process will still impact negatively on the natural vegetation through trampling, potential small scale vegetation removal and potential contamination.

The EIA regulations maintain that estuaries are 'sensitive areas' and environmental authorization must be obtained before development within the estuarine boundary (i.e. below the natural 5m amsl contour) may proceed. Any development below the 5m contour will have a significant long-term negative impact on the estuary and riparian/wetland areas (Van Niekerk & Turpie, 2012). By limiting development to outside the estuarine boundary, damage to the estuarine biota is reduced, and the natural functioning and processes of an estuary are preserved. The current layout of the proposed development respects the estuarine boundary, apart from the proposed boardwalks. It is anticipated that wooden boardwalks constructed within the estuarine area will be damaged during periodic (severe) floods, but due to their low impact on the environment, low costs of construction and maintenance/repair and the infrequency of floods, this is considered acceptable, in comparison to major development.

A new access road and river crossing is proposed in the long term to provide a link to the northern bank of the Umhlali Estuary. An assessment of the potential impacts associated with this development is beyond the scope of this report, but will need to be undertaken in detail prior to obtaining specific environmental authorisation at a detailed design stage. Nonetheless, it is safe to say, that the construction of a bridge will have significant short to long-term effects on the Umhlali Estuary.

Proposed Mitigation:

The Umhlali estuarine boundary plus an environmental buffer up to the 10 m amsl contour (Mather & Swart, 2010) should be used to determine the boundary of the development footprint, and not the current extent of the sugar cane plantations. All buildings and infrastructure, such as sewer pipelines and roadways of the proposed development, must be set back from the 5m contour as an absolute minimum. Artificial environments such as lawns and sports grounds should also be restricted by the estuary boundary. Any clearing of vegetation within this area for improved vistas may not take place, and will require approval if considered necessary. Areas that were previously planted with sugar cane within the estuarine functional zone must be rehabilitated to reflect the natural supporting habitats of the estuary (e.g. swamp forest, reed beds, wetlands, riverine habitats). The infilling of wetlands and estuarine habitat, and any other methods to reduce such environments, cannot be supported.

Although the wooden boardwalks will be constructed within the estuarine boundary, the design must ensure the unobstructed/unimpeded flow of water, the least disturbance to sensitive habitats, the shortest span, and that the least harmful materials and methods are used, to ensure minimal impact on the aquatic environment. The construction of *solid structure (e.g. concrete)* jetties and slipways, and other hard edges, on the estuary must not

be allowed. The number of access points and wooden structures (boardwalks, viewing area) should be limited to a single boardwalk along the southern bank of the estuary and two points of access.

As recommended for other estuaries where boardwalks were to be constructed, possible mitigation measures are as follows:

- The design of the boardwalks must be such to avoid and reduce disturbance to sensitive areas (e.g. reed beds and dense swamp forests, and protected plant species, e.g. *B. racemosa*);
- The boardwalks must follow landscape contours and existing cane tracks, except where providing direct access to the waters edge;
- The number and length of boardwalks in the estuarine environment should be kept to a minimum;
- In terms of construction, strict erosion control measures must be implemented to ensure erosion does not occur; and
- In terms of stabilization and rehabilitation, the disturbed and damaged areas must be rehabilitated immediately using only local indigenous plant species and any invasive alien vegetation must be removed.

In general, the developer must take all reasonable measures to ensure:

- All 'hard' buildings and infrastructure are located above the 5m contour, the 1:100 year flood line and beyond the recommended 10 m amsl estuarine buffer;
- Only eco-friendly structures, namely the boardwalks, are permitted in this area;
- The stability of the water course must not be detrimentally affected;
- Scouring, erosion and sedimentation of the estuary is prevented; and
- Rehabilitation of the watercourse is undertaken immediately when disturbance to the estuarine functional zone first becomes apparent.

The developer must follow acceptable and sustainable construction, maintenance and operational practices to prevent unnecessary disturbance to the estuarine area and to ensure its sustainable use. Specifically, earth moving equipment/plant is not permitted within the estuarine functional zone for the construction of wooden structures and natural indigenous vegetation may not be removed to accommodate these structures; pruning of vegetation is permitted. All work must be undertaken under the guidance of a vegetation specialist and monitored by an Environmental Control Officer (ECO).

If the boardwalks are damaged during a storm or flood event, damage needs to be assessed and appropriate measures taken to remove all debris from the estuary and re-construct the damaged boardwalk, if deemed viable and appropriate.

6.4.1.6 Solid waste contamination

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**Site to Local (2)**	**Medium term (2)**	**Probable (2)**	**Moderate (2)**

Nature of Impact:

Solid waste will be generated by construction activities and may include concrete rubble and bricks, material off-cuts and surplus. If not properly managed and contained, these items may find their way into drainage lines, wetlands, and the estuarine environment where they will not only pollute, but also impede flow and the ecological functioning of these habitats. Unwanted vegetation off-cuts, including large tree stumps, will also pose a threat to such habitats through physical damage, if not handled correctly, or through decomposition, which will result in nutrient enrichment. Materials deposited in the estuary and riparian areas may lead to the accumulation of sediment and debris, and cause consequent blockage and back flooding.

Proposed Mitigation:

A minimum number of site construction camps should be established. All site camps and storage areas for any development must be sited outside of the estuarine boundary and away from drainage lines and steep slopes. Most importantly, construction and associated activities must be undertaken according to a site-specific approved Environmental Management Programme and must be monitored daily by an on-site environmental officer. All solid waste must be removed as soon as possible from each construction point and the broader development site to an appropriate disposal facility. Every effort must be made to prevent construction waste entering the estuary and supporting habitats. Dumping of vegetation off-cuts in aquatic habitats is not recommended. Regular visual surveys of the estuary must be undertaken and any accumulated waste removed and disposed of at an appropriate disposal facility.

6.4.1.7 Liquid waste contamination

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**Site-Local (2)**	**Medium term (2)**	**Probable (2)**	**High (3)**

Nature of Impact:

Liquid pollution may result from accidental spillage of fuels, oils, cement–laden water, curing compounds, sealants, paints and other chemicals. This will be transported as contaminated runoff into the estuary or occur via seepage, which pollutes the soil and groundwater. Once in the estuary, contaminants will be transported downstream and out to sea if the mouth is open. However, accumulation to lethal concentrations, in both the water column and in the sediment, may occur during closed mouth conditions. In addition, inadequate ablution facilities for construction workers during the construction phase will also contribute to faecal and nutrient contamination of the surrounding environment.

Proposed Mitigation:

A minimum number of site construction camps should be established. Sufficient ablution facilities must be provided for construction personnel and these must be frequently cleared (preferably weekly). All site camps and storage areas for any development must be sited outside of the estuarine boundary and away from drainage lines and steep slopes. Most importantly, construction and associated activities must be undertaken according to an approved site-specific Environmental Management Programme and must be monitored daily by an on-site environmental officer.

A method statement in respect to the use, handling, storage and disposal of all chemical and contaminated waste must compiled and submitted as part of any Environmental Management Programme. All chemicals must be stored in specifically demarcated and secured areas, which are bunded to avoid any contamination.

An Emergency Response Plan for accidental spillages of chemical substances must also be developed. Every effort must be made to prevent the spillage of any pollutants, such as fuels, cements, concrete, lime, and chemicals into any aquatic habitats. In the event of a spill from any construction contractor, resident or hotel operator, a penalty should be issued and the ‘polluter pays’ principle should be applied for clean-up operations and rehabilitation, if necessary. Regular water quality monitoring of all water courses, wetlands and the estuary must be undertaken for the early detection of harmful substances

6.4.2 Operational Phase

6.4.2.1 Water Quality

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**National (4)**	**Permanent (4)**	**Definite (4)**	**Very High (4)**

Nature of Impact:

The water quality of the Umhlali Estuary is already impaired due to nutrient and faecal inputs from existing WWTWs, surrounding farmlands, contaminated runoff from rural settlements, and seepage from possible septic tanks located in the floodplain (Begg, 1978; 1984; Forbes & Demetriades, 2009). The Sheffield WWTW was constructed, as approved through a formal EIA process to service future development in the surrounding area, including the proposed TMSCD, and proposes to discharge additional treated wastewater (6.75Ml/day at 0.07m^3/s) into the system with a maximum output of 18Ml/day at 0.21m^3/s once at full capacity (B. Sambo, pers. comm., DWA, 2014; SMEC, 2014)[8]. The estimated discharges for nitrates, ammonia and phosphates from the Sheffield WWTW are 1500 ug/L, 1000 ug/L and 7000 ug/L, respectively. While there are no water quality guidelines or standards for estuaries, treated wastewater will certainly elevate the current nutrient status of the Umhlali Estuary beyond estimated levels for this estuarine type and the ocean along the KwaZulu-Natal coastline definitely (DWA, 2014).

This is somewhat ameliorated by estuarine habitats, and associated wetlands and riparian habitats, which perform free ecosystems services, such as filtration ('polishing') and entrapment of sediment and contaminants. However, recent assessments have indicated that poor water quality remains a significant threat to the health of the Umhlali Estuary (DWA, 2014). While the system may be resilient to the small volumes of initial effluent input, effluent discharge at full capacity (effectively tripling the impact) will tip the estuary into the 'Highly Degraded' PES category, which is unacceptable given the conservation importance of the Umhlali Estuary.

The sewer reticulation system could deteriorate over time unless properly managed and well maintained. This could have very severe negative impacts on the Umhlali Estuary, such as contamination of soils, ground and surface waters in the event of a leak, pump station overflow or failure.

Despite the generally open mouth conditions which enables the continuous removal of most contaminants, increased inputs of treated wastewater and potential sewer problems will have devastating effects on the estuary, particularly during periods of low base flow and closed mouth conditions (e.g. oxygen depletion resulting in fish kills), progressing as a steady decline in ecological condition.

This potential impact is rated at a national scale, as sewage and nutrient input will affect all biota (both plants and animals), estuarine health and functioning, and the provision of ecosystems, which would decrease the overall importance of the system for conserving estuarine biodiversity.

Proposed Mitigation:

Siza Water is urgently investigating effluent recycling and reuse from all of its WWTW in light of the current drought and associated water restrictions. To this end, the primary mitigation measure would be to prevent or remove all discharge to the estuary for water reclamation. Consequently a reduction in treated effluent discharge to the estuary will be greatly beneficial in reducing nutrient inputs to the system. Given the current stringent water restrictions, the likelihood of no discharge is very high (Mr. J. Ellis, pers. comm.[9]). Effective means of disposal or reuse of the concentrated sludge need to be investigated, e.g. agricultural applications. Concentrated sludge must

[8] Ms Bongiwe Sambo, Department of Water Affairs, Water Quality Management Division

[9] Mr. J. Ellis, Function Manager, Urban Development, SMEC, 27/06/2016

not be discharged to the Umhlali Estuary under any circumstances. However, in the event of drought relief and the lifting of water restrictions, effluent discharge to the estuary must be controlled and comply with specific standards, in terms of water quality and discharge volumes. In terms of water quality, the Reserve Determination Study for the Umhlali Estuary (Water Resources Classification Study; DWA, 2014) established that average nutrient levels within the estuary should not exceed 200 ug/l N for nitrates/nitrites, 20 ug/l N for ammonia, and 10 ug/l P for phosphates.

At a minimum, the discharge standards set for the WWTW (as negotiated between DWS and DEA) as a condition of the Environmental Authorisation and discharge permit ***must*** be adhered to, as well as all mitigation and contingency measure identified as part of the EIA process for the WWTW. However, past case studies on estuaries, which receive treated wastewater discharge that is compliant with the prescribed standards, have illustrated that nutrient loading is still prevalent and detrimental to the estuarine environment. Thus only special water quality standards should be implemented for the discharge of treated wastewater to the system.

Mechanical and or biochemical processes to remove nutrients to the said standards need to be investigated, for example, the addition of alum for the precipitation and removal of phosphates, or the processes of bio-electrochemical denitrification or electrocoagulation, the latter produces less sludge and is cost-effective for removal both nitrates and phosphates. In brief, the following options could be scrutinised by Siza Water to assess their feasibility and applicability at the Sheffield WWTW (Mr. M. Kerstholt, pers. comm.[10]):

- Phosphate reduction within the WWTW:
  - Introduction of biological phosphorous removal in the existing treatment works;
  - Introduction of phosphate removal in the sludge return liquors, such as struvite or calcium phosphate precipitation (only applicable if digesters are installed at the works);
  - Chemical phosphate removal with ferric or aluminium; and
  - Advanced control on bio-Phophorous removal and chemical phosphate removal including sensor and automatization.
- As post-treatment for phosphate removal:
  - Chemical phosphate removal in the effluent with ferric or aluminium. To remove the formed sludge sand filters can be applied.
- Nitrate reduction within the WWTW:
  - Inclusion of denitrification basin into the design (if the current design doesn't allow for denitrification);
  - Upgrading the recirculation flow over the denitrification basin (under the condition that sufficient COD is available for denitrification);
  - Introduction of nitrogen removal from the sludge return liquors (anammox, babe, air/steam stripping etc.) (only applicable if digesters are installed at the works);
  - Addition of external carbon source in denitrification basin (only applicable if the denitrification is COD limited); and
  - Advanced control on aerators/oxygen set point to stimulate simultaneous denitrification.
- As post-treatment for nitrate
  - Denitrification basin + Carbon source addition; and
  - Denitrifying sand filters + Carbon source addition.

Apart from the existing WWTW, the entire sewer network must be located outside of the estuarine boundary (i.e. the 5m topographical contour) and the stormwater system must be kept separate from the sewer system. It is imperative that the sewer reticulation system and WWTW are properly managed and well maintained to prevent environmental contamination and the associated risks to human health. Emergency overflow facilities must be

[10] Mr. M. Kerstholt, Water Technology Specialist, Royal HaskoningDHV, 27/07/2016

considered for each pump station and an overall Site Contingency Plan must be developed to address unforeseen problems. Regular maintenance and inspections, and on-going water quality monitoring of the estuary and selected sites within the development complex, are required.

6.4.2.2 Water Quantity

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**National (4)**	**Long term (3)**	**Definite (4)**	**High (3)**

Nature of Impact:

Reduced freshwater inflow (mostly through abstraction) is another major threat facing South African estuaries, including the Umhlali Estuary. The system currently receives approximately 0.8Ml of treated wastewater per day from the Shakaskraal WWTW, which will be increased to approximately 7.55Ml/day with the commissioning of the Sheffield WWTW. When operating at full capacity, approximately 20Ml/d will be added to the estuary in total. The discharge of treated wastewater from the Sheffield WWTW may be thought of as a means of augmenting the depressed mean annual runoff or offset freshwater abstraction, which would have a positive effect on estuarine health and function. However, the estuary is predicted to deteriorate significantly when the WWTWs are operating at full capacity and maximum discharge due to the concomitant increase in nutrients related to the discharge, and the overall impact will be highly negative (DWA, 2014).

Water quality impacts aside, increased volumes of freshwater input will affect mouth dynamics and functioning of the system. The open or closed state of the estuary mouth is regulated by both marine and fluvial processes. For temporarily open/closed systems (such as the Umhlali Estuary), which fluctuate between these two states, the closed state is a time of nutrient accumulation and assimilation, heightened productivity and when estuary nursery function is highly effective. However, elevated flow volumes and flow velocities will alter sediment erosion/deposition patterns, sediment habitat properties (e.g. removal of muddy material), water column characteristics (e.g. salinity stratification) and will generally lead to increased frequency and duration of mouth openings through erosion of the sand bar, and ultimately reduction of the productive growth period. Overall, changes in the estuary mouth dynamics will affect changes to the abiotic and biotic ecosystem components and estuarine functioning relative to the temporarily open/closed template.

Abstraction for on-site irrigation is also required and provisions for an irrigation storage facility within the development are being investigated. The land uses that will require irrigation are open spaces, resorts, educational and selected verges and medians. The anticipated total irrigation surface area is approximately 225 000 m^2 which requires a total weekly irrigation volume of 7.75 Ml or 1.55 Ml/day over 5 days. An 8 hour nightly irrigation time is proposed particularly to reduce losses due to evaporation. Although estuarine water above the salt weir will be largely fresh, abstraction of water from the Umhlali River and/or the estuary for any purpose is strongly not supported. As previously stated, the Recommended Ecological Category requires the present day flow conditions, i.e. without additional abstractions or WWTW inputs, and without the current system impacts. Reduced freshwater input generally results in prolonged mouth closure, during which time prolific algal growth may occur, followed by low oxygen conditions may develop, and when contaminants can accumulate to toxic levels.

This potential impact is rated at a national scale, as large scale changes in water quantity within the estuary will affect estuarine functioning, ecological processes, all biota (both plants and animals), and the provision of ecosystems, which would decrease the overall importance of the system for conserving estuarine biodiversity.

Proposed Mitigation:

Given that the Ecological Flow Requirement is the estuary 'ideal', and that this estuarine impact assessment is being conducted in light of obtaining Environmental Authorisation for a development project, the following mitigation measures are recommended in circumstances where the 'ideal' is unattainable (i.e. no discharge of treated water). No untreated effluent or wastewater discharge should be permitted to enter the Umhlali Estuary under any circumstances. Every effort must be made to reduce the level of nutrients introduced to the Umhlali Estuary through treated wastewater disposal and special water quality standards must be set for the discharge of treated wastewater to the system (See Section 5.4.2.1 above). Maximum discharge from the WWTWs is not recommended and should be capped at a level to prevent exceedence of the natural flow volume for the estuary (MAR 56.31 $x10^6 m^3$). Any abstraction from the estuary functional zone should be discontinued.

It is likely that artificial breaching will be considered when flow volumes are not sufficient to open the mouth and water quality within the system declines to concerning levels. Artificial breaching is strongly not recommended, and that at this early development stage, that the quality of the wastewater be improved prior to considerations of artificial breaching. If the pressure arises to implement artificial breaching, an estuary mouth Maintenance Management Plan *must* be developed in consultation with the EDTEA and Ezemvelo KZN Wildlife before such action is taken.

6.4.2.3 Stormwater runoff and contamination

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**Local (2)**	**Permanent (4)**	**Probable (2)**	**Moderate (2)**

Nature of Impact:

Open soil will be replaced by hardened surfaces through the construction process, which will result in increased surface runoff with high erosion potential. An effective stormwater management system will be required. However, the 'first flush' emanating from run-off directed through a stormwater system carries many contaminants, particularly oils, fuels and heavy metals from roads, vehicle parking areas and general traffic, as well as litter and debris. If this is allowed to be discharged directly into the estuary, without prior treatment or screening, nutrients, toxic substances and solid waste will contaminate the estuary, which in turn will have significant long-term impacts for the biota of the system. Furthermore, without flow attenuation, the 'first flush' or 'pulse' of stormwater input has the potential to alter river flow, erosion and deposition patterns, and ultimately river channel morphology, as well as the state of the estuary mouth and nutrient status of the system.

Proposed Mitigation:

Stormwater design needs to ensure that stormwater runoff from the new hardened surfaces is cleaned and that flows are attenuated prior to reaching the estuary. Creative means of 'scrubbing' and removing sediment, litter and debris from the runoff must be implemented, such as silt and trash traps. The developer proposes to enhance the vegetation along several drainage lines and restore certain wetland areas to capitalise on the natural ecosystem services of filtration ('polishing' of contaminants) and flood control (slowing flow velocities and promoting percolation) prior to entering the estuary. Direct stormwater discharge into the Umhlali Estuary must not be permitted, and any potential influences on the natural functioning of the estuary mouth must be prevented.

6.4.2.4 Chemical contamination

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**Local (2)**	**Long term (3)**	**Probable (2)**	**Moderate (2)**

Nature of Impact:

The draft design concept indicates the conservation of natural areas along the estuary margin and drainage lines, as well as the reinstatement of wetland habitats. These areas will be interspersed with a "flexible open space system" which may comprise active recreation areas (sports grounds) and passive recreation areas (boardwalks, seating areas, viewing points), where conditions are suitable. In such instances, fertilizers and insecticides may be applied, as well as in landscaping and resort gardens. Certain chemicals (e.g. some organophosphates like Chlorpyrifos and Diazinon), are known to adversely affect aquatic biota, particularly fish. Pesticides are largely indiscriminate, resulting in the die-off of numerous organisms. These would likely enter watercourses through surface run-off. The use of such chemicals to manage and maintain the vegetation, including lawns, is thus strongly discouraged. Local vegetation and grass species should rather be planted as part of the landscaping scheme, as these are adapted to local conditions and would not require chemical maintenance.

Proposed Mitigation:

Pesticides should not be applied to the grounds of the proposed development. If the use of chemicals is deemed necessary, a trained aquatic scientist and horticulturalist should be consulted in order to determine what chemicals can be used, in what quantities and during which seasons. The use of fertilizers should be kept to a minimum, as contaminated run-off will contribute to nutrient enrichment and potential eutrophication if it reaches the estuary.

6.4.2.5 Increased disturbance, fishing and bait collecting pressure on the estuary

Status	Extent	Duration	Probability of occurrence	Intensity
Negative	**National (4)**	**Permanent (4)**	**Highly Probable (3)**	**High (3)**

Nature of Impact:

Previously, the limited access to the extensive sugar cane plantations enclosing the estuary (apart from a portion at Tinley Manor at the mouth) restricted the recreational use of the Umhlali Estuary, including fishing and bait harvesting. The recorded history of bait harvesting in the system is noted. By increasing the residential capacity of the area, marketing the proposed development as a holiday destination and creating linkages with surrounding settlements, accessibility of the estuary as a recreational resource will be greatly improved. This is likely to result in increased footfall in the area, fishing and bait collection in the system and in the beach zone, as well as increased disturbance to sensitive habitats (e.g. sand/mud flats, marginal swamp forest, buffer zones and corridor). This is however likely to be seasonal based on peak holiday periods.

As discussed previously, the diversity and abundance of commonly occurring fish species appear to have decreased. Increased fishing pressure may significantly reduce fish populations through the removal of adults as well as young individuals that have not yet reached reproductive maturity. Increased bait harvesting will not only reduce the populations of sand and mudprawns, but will also result in trampling of important estuarine habitat and disturbance to wading birds, which also utilise these areas. Such activities, and increased human presence and vehicular traffic in general, will contribute to elevated disturbance for the estuarine system, and will in turn adversely impact fish, birds and other animals' distributions.

These potential impacts are rated at a local to national scale as decimation of fish populations, disturbance to bird communities and damage to estuarine habitat through intensive activity would decrease the biodiversity, functioning and overall conservation importance of the system.

Proposed Mitigation:

It is vitally important that an Estuary Management Plan be developed for the Umhlali Estuary to regulate the use of resources and activities within the system, to minimize user conflict and to ensure sustained estuarine health. However, this is a legislative requirement in terms of the Integrated Coastal Management Act (No 24 of 2008) (ICM Act), and is the responsibility of the KwaDukuza Municipality and not the developer, as per the National Estuarine Management Protocol.

In the interim, following sections and management recommendations for use of the Umhlali Estuary must be included in the operational portion of the EMPr:

Table 10. Management recommendations and associated responsibilities for the Operational Phase

Structures in and adjacent to the Estuarine Functional Zone	Responsibility
▪ The construction of solid concrete jetties and slipways on the estuary must not be allowed as these reduce estuarine habitat, and impede and alter water flow.	THD
▪ All structures within the EFZ (wooden boardwalks, viewing areas, fencing) and up to 100m of the EFZ (roads, stormwater structures, fencing) must be regularly maintained (annual basis), taking cognisance of the sensitive environment, to prevent any environmental damage or pollution.	THD – End-User Developers / Tenants
▪ The EFZ must be considered a no-go area for vehicles and earthmoving machinery as these will result in compaction of soils, damage to estuarine habitats and disturbance to wildlife.	THD
▪ Maintenance plans must be drawn up for each development sub-complex to ensure that buildings and other infrastructure near the estuary are adequately maintained to prevent any environmental damage or pollution.	THD – End-User Developers / Tenants
Exploitation of Living Resources	
▪ Regulations with respect to harvesting of natural resources (fish and bait) must be enforced. This is within the ambit of DAFF monitoring officials, in accordance with the Marine Living Resources Act (Act No. 18 of 1998).	DAFF supported by KwaDukuza Municipality environmental branch
Access	
▪ Access to the estuary must be formalised (e.g. via elevated boardwalks) to prevent the impacts of trampling and habitat disturbance.	THD
▪ The number of access points and wooden structures (boardwalks) should be limited to a single boardwalk along the southern bank and maximum of two (2) access points.	THD
▪ Although the Umhlali Estuary is naturally shallow, the use of motorized boats during the deeper closed mouth phase should not be permitted, and other low impact recreational activities, such as canoeing, are preferred.	KwaDukuza Municipality End-User Developers / Tenants
Pollution Control	
▪ Suitable waste receptacles must be provided at strategic points, and regular clean-up operations must be undertaken to ensure that solid waste is contained and removed from conservation/green areas and waterways (including vegetated stormwater channels, wetlands and the estuary).	THD & KwaDukuza Municipality

▪ Maintenance work for structures within and adjacent to the EFZ must not result in pollution, including solid or liquid contamination, of the surrounding environment. Strict supervision and operating procedures are required.	THD End-User Developers / Tenants
Control of Invasive Alien Plant Species	
▪ Through a dedicated Invasive Alien Plant eradication programme, any alien invasive vegetation and weeds that are introduced and become established as a result of habitat disturbance must be removed, and regularly controlled.	THD
Environmental Awareness	
▪ The sensitivity of the estuarine ecosystem, its supporting habitats and associated biota, fishing and bait collecting regulations, and susceptibility of the estuary to overexploitation must be communicated to all residents and visitors. This could possibly be achieved through the establishment of an information/visitors centre, the distribution of informative brochures and posters, and strategic placement of educational signboards throughout the development complex and along the boardwalks	KwaDukuza Municipality & End-User Developers / Tenants

7 CONCLUSION AND RECOMMENDATIONS

Despite the very high significance of some of the predicated impacts resulting from the proposed TMSCD, the majority of the above-mentioned potential impacts can be reduced to low disturbance and/or avoided, if the mitigation measures detailed are implemented and incorporated into a detailed Environmental Management Programme. However, water quality and quantity impacts remain critical and will require significant management interventions.

Given the national conservation importance of the Umhlali Estuary, a strong opportunity exists to reverse, to some degree, the past maltreatments of the surrounding landscape (sugar plantations, salt weir etc.) and current impacts on the system. This would contribute to the improved ecological state of the Umhlali Estuary. Furthermore, the design concept of the proposed development, as it currently stands, accommodates the preservation of the estuary and its supporting habitats. This essentially denotes the first step to achieving some form of conservancy status, with the greater goal of achieving formal protected area status in future.

In order to preserve the ecological functioning and conservation status of the Umhlali Estuary, the aforementioned mitigation measures and the following recommendations to minimise potential impacts on the estuary must be implemented, should the development be approved.

7.1 Establish estuarine and riparian buffers

One of the most significant impacts of the proposed development is disturbance to the estuarine environment and impacts on its ecological functioning. It is therefore of utmost importance that adequate buffers are implemented to reduce disturbance from within and adjacent to the Umhlali Estuary, surrounding drainage lines and wetlands. It is critical that the development be setback from the estuary to a minimum of the 5 m contour, however the 10 m contour is preferred, as it provides for an environmental buffer between the estuary and the proposed development (Mather & Swart, 2010), which constitutes approximately 16m - 257m horizontal buffer distance, depending on the topography.

Under no circumstances should artificial breaching be permitted (apart from acute threats to human health and with necessary approvals), for example, to prevent flood damage to ill-placed development. Artificial breaching interferes with natural estuarine functioning, specifically the natural scour of accumulated sediments and the flushing of contaminants, which may otherwise build up within the system, with significant implications for the ecology of the estuary. Reinstatement of appropriate, indigenous vegetation should be encouraged, and indigenous vegetation removal / trimming prevented, to promote connectivity between terrestrial and aquatic environments and to maintain services such as erosion prevention, and sediment and pollution trapping. In addition, alien invasive species and weeds should be eradicated using appropriate methods. Sugar cane should be removed from the floodplain and replaced appropriate indigenous vegetation.

The establishment of a development setback line (based on the 10 m amsl contour) is particularly important for the Umhlali Estuary given the high potential for wetland rehabilitation and reinstatement of ecological corridors and linkages between the estuary and the surrounding wetlands and riparian areas. Furthermore, the Umhlali Estuary is the major draw card and an invaluable natural asset to the proposed development contributing to the 'sense of place' and aesthetic appeal of the area. Most importantly, restricting disturbance and impacts to outside the estuarine boundary will also contribute to improving the ecological condition of the Umhlali Estuary.

7.2 Sustaining water quality

The health of the Umhlali Estuary can be significantly improved by addressing water quality of incoming water (DWA, 2014). The proposed development will link directly with the Sheffield WWTW. This Works must be maintained in good working condition, such that the quality of the wastewater discharge complies with accepted / required special standards. Nutrients must be adequately removed from wastewater by means of mechanical, chemical or biological processes, prior to disposal into the estuarine environment (to special standards for the estuarine environment where possible). Any pump stations and other sewage infrastructure must be located above the 10 m contour buffer, out of the estuary functional zone. Compliance monitoring at the Works and monitoring of water quality within the estuary are within the ambits of DWS and EDTEA.

In addition, contamination by runoff containing other harmful urban substances, such as fuels, grease and soaps, should be prevented by installing suitable traps or filtering methods, before being released to the natural environment. By adopting a 'Working-with-Nature' approach, the reinstatement and/or retention of wetlands, riparian and estuarine vegetation to fulfil their natural functions can assist with final substance removal before entering the Umhlali Estuary or other water bodies.

A monitoring program should be implemented for all water features (wetlands, drainage line and streams), including the estuary, to assess the level of nutrient input and to ensure timely implementation of mitigation/emergency measures.

7.3 Maintaining water quantity and flow

Abstraction of water from the estuarine functional zone is strongly not recommended, while applications for abstraction above the estuary by means of the water use license application process must be carefully considered in light of altering estuarine functioning. This affects the mean annual runoff reaching the estuary, and subsequently the volume of water in the estuary, the natural flow patterns and mouth dynamics. Rain water harvesting can implemented to substitute abstractions from wetlands and the estuary.

The salt weir in the middle reaches of the Umhlali Estuary represents a major hindrance to flow and natural estuarine processes, and is consequently one of the elements affecting the health of the system. Removal of the weir is viewed as warranted towards restoring natural processes, increasing the extent of estuarine habitat and overall improvement of the core estuarine area. The removal will require engagements with DWS and EDTEA.

Further disruption to the flow of the Umhlali Estuary and natural drainage lines should be avoided as much as possible, by limiting new road crossings, infrastructure, boardwalks, bridges or any other structures, which may be required to cross wetlands, streams, tributaries or parts of the estuary itself. If these are deemed necessary, the design must ensure unobstructed/unimpeded flow of water, the least disturbance to sensitive habitats, the shortest span, and that the least harmful materials and methods are used, to ensure minimal impact on the aquatic environment. Limited elevated boardwalks are the preferred design options as they are known to have low environmental impacts (Figure 15).

The design of lake features or additional wetlands must ensure sustained baseflow to natural drainage lines and the estuary. Alien invasive plant species should be eradicated as part of a formal programme for the development area, as they contribute significantly water use/loss from natural water resources. In the future, this should include removal the eucalyptus stand adjacent to the N2 road bridge. Stormwater discharge must be controlled to reduce erosion and 'first flush' impacts. While these activities may be considered minor on the relatively large Umhlali Estuary, the greater impact is incremental/cumulative, which may affect the state of the mouth and the overall functioning of the system.

Figure 15. Examples of low impact footbridge options

7.4 Sustainable stormwater management

The conversion of agricultural land to holiday/residential developments will result in increased runoff entering the system with the potential for erosion. Sustainable urban drainage methods, such as porous paving techniques and swales, should be adopted as well as other solutions for flow attenuation for the development complex as a whole and at the site level wherever possible. In addition, any irrigation systems must incorporate an effective and well-maintained stormwater/runoff management system which promotes the entrapment and polishing of nutrient-enriched water before release to the natural environment.

7.5 Implementing monitoring programmes

Regular monitoring of the water quality of the Umhlali Estuary should be undertaken on a monthly basis, including general physic-chemical parameters and bacterial levels, particularly if increased human contact through recreational activities such as swimming and canoeing, is anticipated. In terms of the ecological functioning of the estuary, nutrients (namely nitrates and phosphates) derived from wastewater or fertilizers, should also be monitored. The periodic monitoring of both the Etete tributary and the Umhlali River, in terms of chemical and bacterial levels, is also recommended to evaluate catchment-related inputs into the estuary. Moreover, the ecological health of these feeder rivers could be rapidly and easily assessed using SASS-5 (South African

Scoring System, Version 5), designed specifically for flowing freshwater riverine environments (Demetriades & Forbes, 2007).

7.6 Implementing management plans

In line with the Integrated Coastal Management Act and the draft National Estuarine Management Protocol, an Estuary Management Plan must be developed for each estuary throughout the country. This is a consultative process and is dependent on the regional prioritization of estuarine systems. While the development of an Estuarine Management Plan (EMP) is not the responsibility of the developer, basic estuarine management principles to minimise disturbance to the Umhlali Estuary and ensure a healthy and well-functioning system, should be adopted under the site Environmental Management Programme (EMPr). Representatives of the TMSCD should be actively involved in the proposed Umhlali Estuary Advisory Forum once the EMP has been completed.

As per the EIA Regulations of the National Environmental Management Act (Act 107 of 1998, as amended), an EMPr for the proposed development has been compiled and must be implemented. The EMPr lists appropriate actions for each of project phase (viz. pre-construction, construction & rehab/operations), and assigns responsibility for those actions to ensure that any impacts resulting from construction activities of the proposed TMSCD are avoided, minimised and rectified. This EMPr contains environmental management controls specific to the Umhlali Estuary which must be strictly adhered to. Importantly, the development site emergency response plan (once developed) may not, under any circumstances, involve discharge of contaminated water (e.g. polluted or nutrient enriched water trapped in stormwater management facilities, or sewerage, etc.) to the estuary. In addition, an environmental agreement / memorandum of understanding could be drawn up to be signed by all property owners/managers, both residential and resort based, to comply with a set of specially formulated regulations for the protection of the natural assets of the development complex.

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