

Specialist Report:
Ohlanga River and Estuary Impact Assessment
for the proposed Cornubia Mixed-use Development
ver 1.0



Nicolette Demetriades & Anthony Forbes
Marine & Estuarine Research

Report
to

Tongaat Hulett Developments

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MARINE & ESTUARINE RESEARCH

P.O. Box 417

Hyper-By-The-Sea

4053

ph: +27 31 572 2705

fax: +27 31 572 5171

Cell: +27 82 451 8078

email: estuary@mer.co.za

Completed Final: 26th October 2009

Contact Details:

Nicolette T. Demetriades

Marine & Estuarine Research

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Ohlangu River and Estuary Impact Assessment for the proposed Cornubia Mixed-use Development

Introduction

The Ohlangu river and estuary is situated immediately north of the coastal resort town of Umhlanga approximately 20 km north of Durban. The lower part of the estuary was proclaimed as an additional part of the Umhlanga Lagoon Nature Reserve in 1986 and includes the surface area of the lagoon up to the high water mark of the river, seaward of the provincial main road and up to the high water mark of the Indian Ocean.

A fair amount of historical (Begg 1978; Whitfield 1980; Begg 1984) and recent information (Perissinotto et al 2004; Graham, 2007, Forbes and Demetriades 2008) ecological information exists pertaining to the river and estuary and this information provided the basis for the description of the existing environment and assessment of present day conditions described in this report. This information was then used to identify and evaluate the issues and impacts resulting from the proposed development of the Cornubia Mixed Use Development.

Approach and limitations

The approach adopted for this investigation was carried out following the Integrated Environmental Management (IEM) Guidelines for Specialist Studies (DEAT 2002). This included the identification and assessment of potential issues and impacts on the section of the Ohlangu river and estuary from the proposed Cornubia development, and recommendations for mitigation. Existing and recent information from surveys conducted by the authors of the report and other literature relating to the receiving environments was used as the basis for this assessment and thus fulfils the requirements for the baseline studies required in the IEM guidelines.

The objectives of this investigation were to

- Describe the receiving environment and current conditions

- Identify, predict and evaluate issues and impacts associated with the development
- Provide relevant conclusions and recommendations for impact mitigation.

Given the amount of information and current understanding of this aquatic system the authors consider the limitations associated with the approach methodology to be negligible.

Description of the receiving environment and present conditions

Catchment Size, River Length, Estuarine and Riverine Boundaries

Estimates of the oHlanga catchment area range from 85 to 196 km² Begg (1978) but Perry (1989) and Cooper (1989) give a figure of 118 and Perissinotto *et al.* (2004) 80 km². River length (Perry 1989) is 28 km. The estuarine boundaries based on the position of the 5 m amsl contour are shown in Figure 1. The river boundaries for the river section within the limits of the proposed development are demarcated as the 1:100 yr floodline (Figure 2).



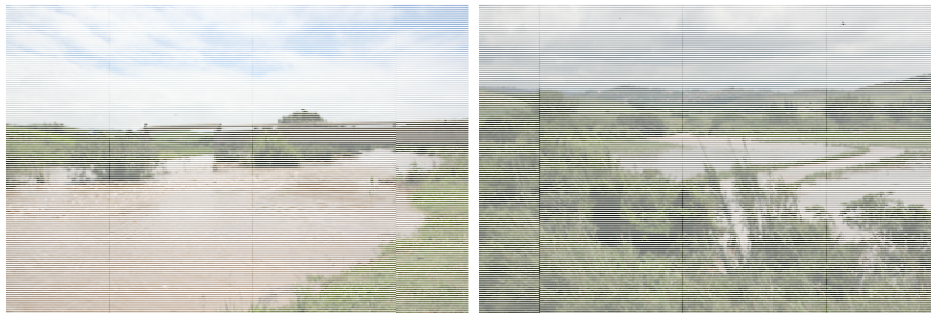
Figure 1: Ohlanga estuary with core estuarine area (blue shading) and key features.



Figure 2: Section of the Ohlanga river adjacent to the Cornubia development with 100 year floodline and riverine area indicated

Flow Records

Mean Annual Runoff estimates range from 19.7 to $29.5 \times 10^6 \text{m}^3$ with an intermediate of $26 \times 10^6 \text{m}^3$ (Cooper 1989) and a low of $12.6 \times 10^6 \text{m}^3$ (Perissinotto *et al.* 2004). There does not appear to be a good record of flood events but in January 1953, following 45 cm of rain overnight, water levels allegedly rose to 2.4 m higher than the normal high water mark. A small localised flood observed during February 2008 partly due to the bottleneck effect of the N2 bridge design resulted in flooding of sugar cane, roads and remaining wetland areas inland of the N2. The water was extremely turbid (See photographs below) indicating a high silt load.



Ohlanga estuary west of the N2 during a small localised flood event – note the inundation of inappropriately placed roads and cane fields.

Anthropogenic change

The earliest aerial photographs (1937) show an estuarine floodplain virtually entirely under sugarcane. There was some subsequent withdrawal of cane from the water's edge in the area downstream of the N2 but above the freeway the entire valley and the adjoining slopes as far upstream as the bridge on the R102 are under cane. Upstream of the R102 virtually the entire catchment is urban.

Depth and bathymetry

Earliest reported depths in the estuary ranged from "1.5 to 2 m" "in most places" with a maximum of 3.5 m below the M4 road bridge (at the mouth) and "depths of 3 m at several points in the lagoon"(Begg 1978). Whitfield (1980a) referred to a maximum depth of 3.2 m in 1978. Depths of 2.2 – 2.4 m were recorded in the mouth, mid and upper reaches during closed phases in 2007/2008.

Sandbar and mouth behaviour

Aerial photographs of the bar in 1937, 1953, 1967 and 1989 consistently indicated established dune vegetation in the central region of the bar and in 1967 this extended all along the northern half of the bar.

The bar has historically been subject to strong wave action, which can transport sediments into the estuary, while it can also be breached by high levels or flood events. The estimated breaching level (Perissinotto *et al.* 2004) is 3-3.4 m above mean sea level but could easily be higher without interference and influences from changes in water volume. Natural breaching will occur under high flow (flood) conditions but can also occur through strong seepage flows through the bar causing "sand-piping" which erodes the beach face and eventually triggers a slumping failure.

In recent years the normal pattern of extended closure which existed during the 80s has been progressively disrupted by the addition of treated waste water from the two treatment works in the catchment resulting in a greatly increased frequency of breaching, significant disruption of faunal communities and cycles and frequently low (lower than usual) water levels.

WATER CHEMISTRY

Estuary

There is greater documentation of conditions in the estuary than in the rest of the river. Begg (1984) described "extremely low salinity (as) a distinguishing feature of the oHlangu" estuary during closed

mouth periods. Following breaching in February 2008 the surface salinity remained low but there was strong layering and high bottom salinities due to input of sea water during high tides.

Reduced but not zero oxygen levels in the estuary were recorded in bottom waters and attributed to effluent discharge from the sewage works over 25 years ago (Begg 1984). The river above the estuary had indications of faecal pollution in 1964 and there was “considerable leakage” from “the old trunk sewer directly into the lagoon. . in January 1977.” “Increased loading of the system in the future remains. .of some considerable concern because of its closed nature” (Begg 1984a). . Harrison *et al.* (2000) subsequently rated the water quality as poor on a scale of good, moderate or poor thereby vindicating Begg’s (1984) forecast.

Oxygen determinations during 2007/2008 repeated the earlier pattern of depleted levels in the upper reaches due to organic decay, but day time super-saturation in the mid and mouth area occurred due to algal blooms in response to input of nutrients from the treatment works. Nutrient concentrations were generally highest in the upper reaches as were the bacterial levels. Nitrate and phosphate concentrations were particularly high during August 2007. These conditions are pushing the system into the eutrophic category and resulting in unstable cycles of low dissolved oxygen and super saturation due to algal blooms.

Bacterial levels were high during January 2008, particularly in the upper estuary, attenuating towards the mouth. The levels recorded suggested that either there is ineffective treatment of waste water upstream of the estuary or leaky infrastructure. This system opens far more frequently now than in the past and if a return to the more natural flow regime is implemented, as per the ecological reserve determination recommendations (Anon. 2003), then the factors influencing this water quality would have to be identified and given urgent and immediate attention.

River

Conditions in the river above the estuary have been described by Graham (2007) in the eThekweni State of Rivers Report which covered the years 2004-2007. Sampling was carried out at the Ottawa rail bridge, which is at the upstream limit of the proposed Cornubia development, and in proximity to the upstream treatment works, and also at the N2 road bridge which is at the downstream limit of the development. Physical and chemical conditions at both sites, particularly upstream, were indicative of major dumping and littering problems as well as high levels of nutrification, particularly in the case of soluble reactive phosphorus which was 14-25 times higher than recommended levels.

BIOTA

Estuary

Phytoplankton

These microscopic, single celled plants in the water column respond positively to nutrient additions. Their abundance is typically expressed in terms of chlorophyll levels. Levels during closed phases qualified as “dense phytoplankton blooms” (Perissinotto *et al.* 2004). Phytoplankton blooms were also evident during 2007/ 2008. The only factor preventing more severe water quality problems and fish kills is the unnaturally frequent breaching cycle.

Macrophytes

Begg (1984) strongly emphasised the uniqueness and biological value of the forested areas in the vicinity of the oHlanga estuary, viz. the Hawaan forest to the south and the coastal dune forest running north and south of the mouth. The estuary itself stood to improve following the withdrawal at that time by Natal Estates from the low-lying canefields and the re-establishment of the reed beds.

The current survey of the oHlanga suggests that not much change has occurred to the riparian and floodplain vegetation of the estuary since 1937. The historical pictures show a river meandering through broad areas of reed swamp with coastal forest on the southern bank. The integrity and conservation status of the adjacent coastal forest and the extent of the reed swamps make this a unique system in the KZN context. Invasive alien vegetation remains a problem, but this is mostly associated with man-made structures and disturbance caused by construction and maintenance.



Phragmites sp. reeds lining the main river channel with the Hawaan forest as backdrop



Disturbance of the riparian zone

Zooplankton

Thirty two 32 taxa were recorded in the estuary, dominated by the euryhaline calanoid copepod *Pseudodiaptomus hessei* which typically contributed more than 90% of the zooplankton. The greatest abundances coincided with periods of prolonged mouth closure, a tendency noted in other temporary open/closed systems. (Perissinotto *et al.* 2004)

Benthic macroinvertebrates and epifauna

Whitfield (1980a) carried out grab sampling of the benthos and also sampled the epiphytic fauna on submerged stems of the reed *Phragmites mauritianus* in 1978. The zoobenthos was dominated by the amphipod *Corophium triaenonyx* and the polychaetes *Ceratonereis erythraensis* and *Dendronereis arborifera* which, in terms of energy content, constituted 94% of the grab sampled benthos. Two breaching periods during 1978, one in March and one in November, were estimated to have reduced the benthic biomass by 99% and 91% respectively on each occasion. Grab sampling did not collect the deep burrowing sand prawn *Callinassa kraussi* which was nevertheless estimated to contribute 33% of the total benthic biomass and would not have been equally affected by the breaches. The long term survival of this species in the oHlangu is indicative of periodic seawater intrusions and raised salinity levels as this species cannot breed in fresh water (Forbes 1978).

Benthic samples taken in August 2007 and January 2008 were dominated by the same polychaete species recorded in previous surveys but there has been an ongoing decline in benthic diversity and biomass.

Fish

Begg (1984) referred to fish netting in 1975 which showed that “juveniles of eight of the main species of estuarine fish in Natal were present in the oHlangu lagoon”. Earlier anecdotal records (Begg 1978) indicated that “all types of fish were plentiful” specifically “bream, grunter and rock salmon”. The intensive studies by Whitfield (1980a,b,c) in 1978, Begg (1984) in 1980 /1981, unpublished CSIR data from August 1990-May 1992, Harrison (unpublished) in the late 1990s and Perissinotto *et al.* (2004) in 2002-2003 have provided one of the best records of any of the temporary open/closed systems in the Durban area.

In a very broad sense there has been little change in terms of the major fish groups and the relative proportions. The major and most obvious exception was in the case of the roundherring *G. aestuaria* which is favoured by extended periods of mouth closure. Frequent breaches have become

a feature of the oHlanga and this would militate against a build-up in the roundherring population and also in the general carrying capacity of the system. According to Perissinotto *et al.* (2004) the fish diversity in the oHlanga has changed since the 1980s with a decline in the number of marine migrant species. This was attributed to the greater frequency of breaching due to increased freshwater flow from the sewage treatment works which results in a highly unstable environment. Quantification of fish abundance is extremely difficult but it is highly arguable in the context of the disrupted breaching regime and the known impact on the benthos that there has been a similar deleterious effect on the fish carrying capacity. This degradation is also apparent in the recent occurrence of fish kills which were unknown in this system 30 years ago.

Birds

In the earlier review Begg (1978) referred to anecdotal records of rarities such as flamingos *Phoenicopterus sp.*, white-backed night heron *Gorsachius leuconotus*, black heron *Egretta ardesiaca* and Peter's finfoot *Podica senegalensis*. In the later report (Begg 1984) the following species are listed, *viz.* white-breasted cormorant *Phalacrocorax carbo*, reed cormorant *Phalacrocorax africanus*, darter *Anhinga rufa*, grey heron *Ardea cinerea*, purple heron *Ardea purpurea*, black-crowned night heron *Nycticorax nycticorax*, Egyptian goose *Alopochen aegyptiaca*, African black duck *Anas sparsa*, yellow-billed duck *Anas undulata*, African fish eagle *Haliaeetus vocifer*, African purple swamphen *Porphyrio madagascariensis*, common moorhen *Gallinula chloropus*, kelp gull *Larus dominicanus*, grey-headed gull *Larus cirrocephalus*, swift tern *Sterna bergii*, pied kingfisher *Ceryle rudis* and giant kingfisher *Megaceryle maxima*.

Begg's (1978) rarities mentioned above, plus others such as African purple swamphen and common moorhen, are no longer features of the oHlanga system. The 2007/2008 surveys indicated a fairly diverse system as far as piscivores were concerned with 10 species ranging from malachite kingfishers to goliath herons, but in very low numbers as might be expected in such a small system. There was a very small addition of migrant waders in the form of wood sandpiper and ringed plover during summer which is in keeping with the small intertidal area and poor benthic fauna. The overall picture would appear to be one of a degree of maintenance of the more adaptable piscivorous species but the disappearance of shy or more specialised species such as white-backed night heron.

Issues and Impacts – identification and evaluation

The Cornubia development is bounded in the north by the oHlanga river while the north bank and surrounds is largely under cane with some urbanisation upstream east of the R102 (Figure 3). The project proposes a mixed use area with high density residential to light industrial developments. The available plan (September 2009) does indicate a complex of open spaces covering 362 ha, or *ca.* 28% of the total area, which has the potential to provide possibly more valuable ecological habitat than exists at present under cane. This will, however, require substantial control of building activities, invasive alien plants and run-off during the construction and life of the development. Concrete lined drainage canals might speed run-off but this would be to the detriment of both the “green spaces” and the receiving river and estuary.

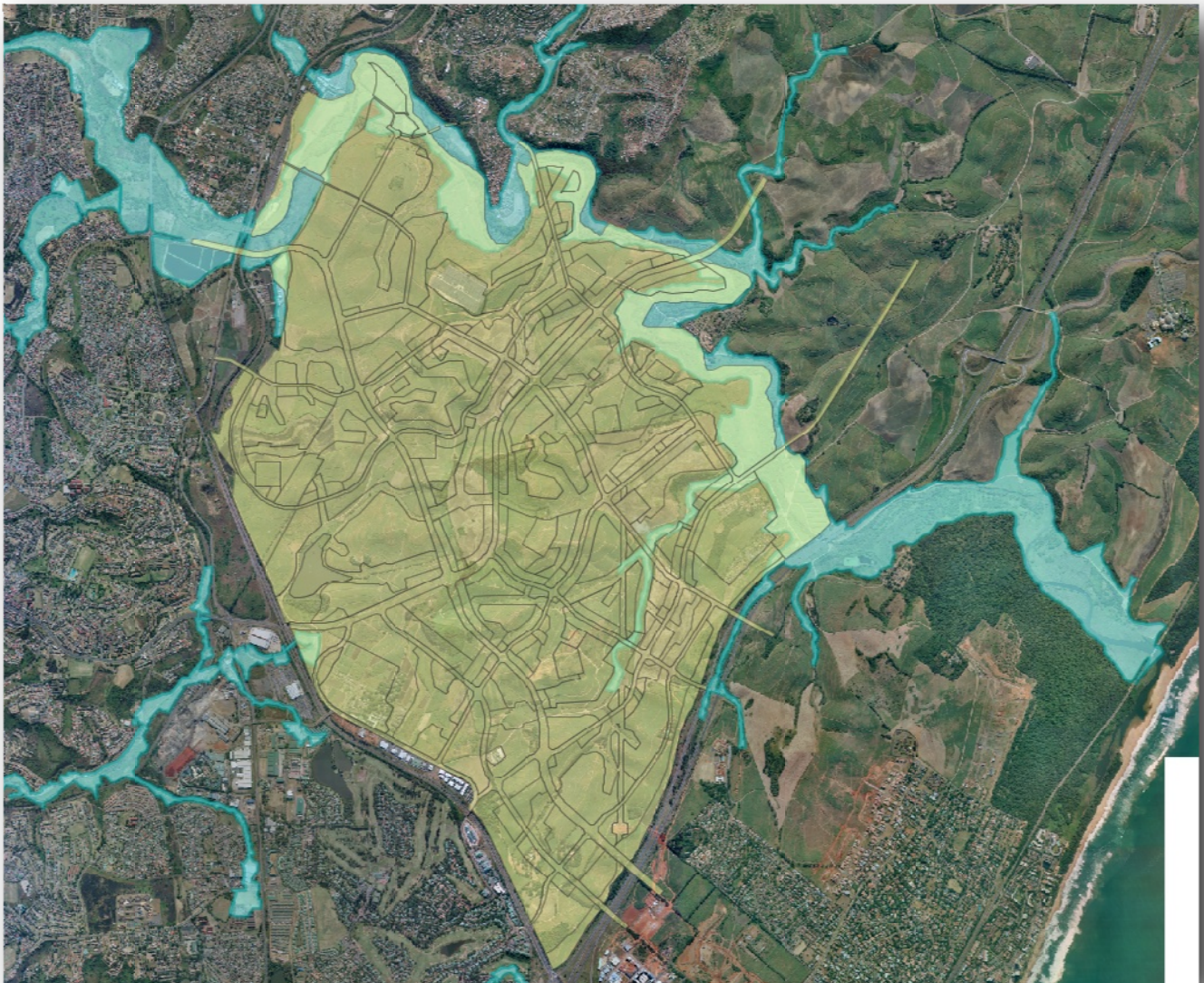


Figure 3: Cornubia Framework Plan (yellow) with oHlanga river and estuary boundaries (blue). Areas of overlap of Cornubia and ecological boundaries indicated in green

All of the issues and impacts discussed below are those considered to be potential future threats as a result of the Cornubia development and are assessed in terms of their direct and indirect influences on the adjacent river reach. It must be stressed that in addition to this these future impacts are assessed in the context of existing impacting activities to ensure that cumulative and long term impacts on downstream receiving environments are also taken into account. Various criteria have been suggested by the South African Department of Environmental Affairs and Tourism (DEAT 2002) for use in the specialist studies component of environmental impact assessments. These include the impact magnitude and significance, the extent or spatial scale, the intensity or severity, the duration, mitigatory potential, acceptability and degree of certainty. All were rated as either high, medium or low.

If Cooper (1989) is to be believed, the geophysical nature of the oHlanga estuary did not change significantly in the 50 years preceding his study. In an endorsement of the sentiments expressed by Begg (1978) that “the “lagoon”, its floodplain, the Havaan forest and the dune forests be considered as one ecological unit and set aside as a nature reserve”, the Havaan forest on the south bank appears now to have become an accepted protected area, while the limited withdrawal of the sugar cane fields from the immediate edge of the north bank has allowed the re-establishment of reedbeds. However, incursions into the core estuarine area still dictate that manipulation of the mouth would result if the more natural flow regime was in place and mouth closure patterns approximated the historical situation. Similarly there are no hard structures in the floodplain which could become inundated during mouth closure although the roads under the N2 are particularly vulnerable. Water quality and latterly increased flow volumes emanating from the sewage works have arguably become the major problems. These features are reversible with appropriate management of the impacting activities and it should therefore be possible to maintain the system as one of the more functional estuaries in the Durban area and worthy of its description by Begg (1978) as a “gem” “when compared to other lagoons in Natal”.

As stated above, outflows from the treatment works strongly influence both river and estuary. The recovery capacity of the river is demonstrated by the consistent improvement in the health status between the upstream Ottawa rail bridge sampling site and the N2 bridge. The river then unfortunately encounters the outflow from the Umhlanga treatment works before entering the estuary which provides nutrient rich and high volume freshwater directly to the upper estuarine system.

In the absence of, at this stage, further development of the north bank, developments on the south bank stand to have the major new impacts on the adjoining river through changes in both the quantity, quality and run-off patterns due to the hardening of substantial areas which were formerly under cane or to a very small degree under natural vegetation. These represent both potential in-river and downstream direct, large long term and cumulative impacts on river and estuarine health and function if no mitigation measures are implemented

Water quantity, quality and flow distribution

Changes such as reclamation, hardening of shorelines and the removal of flood storage areas by the development of floodplains, all alter the dynamics of the system. Ironically schemes to protect fresh water habitats at the margin of estuaries are progressively having the same effect. Many of these anthropogenic changes can be likened to the various geological features that occur within estuary basins (such as variations in the underlying bed formation, some areas being relatively soft and erodible and other areas being hard and more resistant). Both serve to apply constraints on how an estuary evolves. As the estuary adjusts to these, particular features within the estuary, such as the extent or position of intertidal shores, sandbanks and deep pool areas will also change. It is important to recognise that the estuary will change in response to imposed constraints.

Urban run off

The development has the potential to change run-off patterns and the nature of materials transported into the river with possible negative implications for the estuary. Urban runoff transports a vast assemblage of pollutants into the aquatic environment, including sediment, nutrients such as nitrogen and phosphorus, organic carbon, trace metals such as copper, zinc, and lead, petroleum hydrocarbons, and pesticides (Schueler and Holland, 2000). The growth of plants in estuarine systems is generally controlled by the amount of available nitrogen. Consequently, additional nitrogen from coastal development can cause algal blooms. The subsequent decay of these organisms can reduce dissolved oxygen levels below the threshold needed by some species of fish and invertebrates. Additionally, overfertilization reduces water clarity and allows less light to penetrate below the water's surface. This damages seagrass beds, coral reefs, and other critical aquatic habitats. The primary sources of nitrogen in most developed watersheds are lawns and golf courses, along with significant contributions from municipal wastewater treatment plants.

The discharge of storm water with the associated run-off from urban streets mentioned above not only presents potential pollution problems but altered flow patterns may also result if not

adequately attenuated. These magnified “pulses” of runoff alter the stream flow patterns and, consequently, the shape of the stream channel. Streams in watersheds with more than ten percent hard surfaces become physically unstable, causing erosion and sedimentation (Booth, 1991; Booth and Reinelt, 1993). It is recommended that measures are put in place to reduce the pulse effect of this run-off as well as ‘scrub’ the water before it reaches the estuary. This may be achieved by the careful design of development sites to protect, or restore, the natural hydrology of the site so that the overall integrity of the watershed is protected. Storm water attenuation measures have been included as part of the design (Sagen 2005) and the impact of these structures is discussed below. Return water to the estuary post-development should emulate as far as possible the virgin MAR from the site.

Water quality

- High negative impact to water quality and physical characteristics of this estuary resulting in a disruption of ecological function
- Local to regional long term impact
- Reduction of pulsed water returns to the estuary using only essential storm water attenuation measures
- ‘Scrubbing’ of excess nutrients and biological filtering of the water prior to it reaching the Ohlanga estuary OR any of its tributaries *i.e.* creative solutions regarding the attenuation of storm water
- Return water to the estuary post-development should emulate as far as possible the virgin MAR (mean annual run-off)

Sanitation / sewage / solid waste disposal

All sewage facilities have the potential to cause a local decline in water quality if waste water is not adequately treated or is allowed to enter natural water bodies and change their nutrient status. In many instances, inadequate sewage treatment facilities have caused regional declines in the health of coastal ecosystems. The type of treatment provided, the location of the discharge, and the types of wastes collected by sewers are critically important to the impacts caused by these systems. It is the understanding of the authors that sewage produced within this development is to be dealt with as part of the existing sewage infrastructure and treated waste water will be routed to the Mgeni estuary once the construction of the diversion from the Ohlanga river is completed. It is essential that this diversion is completed and in effect before this development comes on-stream to prevent further degradation of this river system.

During construction increases in nutrients and bacterial loading may result from inadequate facilities for construction teams. The increased access to the area may also result in an increase in solid waste to the estuary. This would result in a low, local and medium term negative impact.

Mitigation is possible by provision of adequately designed and maintained sewage treatment facilities which effectively minimize contamination, both bacterial and nutrient, to the estuarine ecosystem. Adequate provision should also be made to ensure disposal of any solid waste to prevent this accumulating on the river's edge or in the estuary.

Contamination by runoff from construction materials, building equipment, heavy machinery and vehicular traffic may produce site-specific negative impacts. This can be obviated by ensuring storage, maintenance and leakages are managed in accordance with procedures detailed in the EMP.

Contamination of the river and estuary during construction can be easily mitigated by siting of construction camps as far away as possible from estuary and its tributary catchment areas.

Sanitation/sewage and solid waste disposal during construction

- Potential low negative impact influencing water quality, health of biota and the aesthetics of the estuary
- Local scale medium term impact
- Adequate facilities provided to construction crews
- Siting of construction camps far from estuary and tributary catchment areas
- Detailed methods for solid waste disposal need to be outlined in the EMP and monitored throughout construction

Increased sediment input to the estuary

An increase in the sediment loading of the estuary, via runoff or as windblown sediment, may result from the removal of existing vegetation, earthworks related to infrastructure development and building activities. This would result in sedimentation (infilling) and increased turbidities (muddiness) thereby negatively influencing the ecological and aesthetic value of the estuary which has up until now seemed to have been spared the fate of so many KZN systems. This may result in an accelerated shallowing of the system, may cover critical benthic (bottom) habitat and smother aquatic plants and animals. Increased suspended sediments in the water will reduce water clarity, thereby reducing light reaching phytoplankton and submerged plants. Metals and other toxic

materials, in this case, breakdown products of herbicides and pesticides, are frequently attached to sediments, and it is often through this affiliation that toxic materials are delivered to estuaries.

The scale of this **negative** impact is considered to be **high** at the local to regional scale given the importance and protected area status of this particular system. This impact can be significantly reduced by the application of appropriate mitigatory measures such as the incremental clearing of the project site to reduce erosion and siltation, preservation of riparian and wetland vegetation where this exists and extension and rehabilitation of these buffers along thin and degraded edges to assist in the prevention of sediment transport into the estuary. It is recommended that detailed methodology for mechanisms to reduce sedimentation must be included in a comprehensive Environmental Management Plan (EMP) for the activities on this site.

It is strongly recommended that monitoring is carried out to assess the effectiveness of erosion control measures. This should include the measurement of turbidity using *in-situ* methods in addition to laboratory measurements of total suspended solids. The current survey has provided some background turbidity levels and this will allow an evaluation of any impact or change to the system. It is strongly recommended that these measurements be taken at regular intervals prior to any site clearing as well as throughout the construction phase of the project and at less regular intervals for the life of the project to allow appropriate management intervention to be implemented if impact is occurring.

Sedimentation

- Potential high negative impact to water quality and clarity of the system leading to a change in biotic communities and reducing the functionality and aesthetics of the system
- Leading to an irreversible change in estuarine status
- Local to regional scale long term impact
- Significant erosion control measures needed and site clearing done in a phased manner
- Detailed methodology to mitigate this impact required in the EMP
- Monitoring of in situ turbidity and total suspended solids pre-construction, during construction and for life of development.

Buffer areas

Riparian habitat & corridor areas

It is the intention of the developers to rehabilitate much of the degraded wetland, occurring predominantly as drainage lines, which has been impacted by many years of sugar cultivation. It is recommended that this rehabilitation programme be extended to include the riparian edges of the upper estuary, river and tributaries. This will increase the potential habitat available and thereby the overall biodiversity of the site as well as provide additional protection against erosion and siltation of the riverine system. If done according to professional recommendations the restoration of these areas will significantly enhance the functioning of the lower river and estuary and reinstate links with other adjacent areas such as the significant forest patches downstream constituting a high positive impact on a regional scale. It is recommended that the protocol for this rehabilitation is described in detail in the EMP with reference to the species to be used, sourcing of the material and appropriate mechanisms to ensure successful rehabilitation.

Corridor areas in the current design allow for movement and linkage between the 'open' areas of the resort and the estuary and these should be carefully managed to allow their use by the greatest diversity of species. In addition, consideration should be given to the elimination of any fencing between the open areas and / or a fence designed to allow the movement of both small and larger mammals between the downstream sections of the river.

Riparian habitat, wetland & corridor areas

- High positive impact as a result of rehabilitation of riparian edges, wetland and the provision of ecological corridors leading to increased biodiversity value of the river and estuary and protection of the estuary from associated land based activities
- Local to regional long term impact particularly if upper estuary is rehabilitated
- Corridor areas designed for movement and linkages between the open space areas and the upper river catchment and the coast.
- No fences should be erected which act as a barrier to this movement

The establishment of the development will result in increased disturbance along this river reach. In order to fully realise the potential positive effects of rehabilitated riparian zone, floodplain and other corridor areas the impact of adjacent activities and access by people needs to be controlled. The lower river and estuary is a refuge for a number of aquatic birds including the rare and localised African finfoot, *Podica senegalensis* and this refuge status could be severely compromised by

increased disturbance. Access to the river should be avoided to prevent partitioning of the corridor and, if proposed, would need to be assessed on an individual site basis. As a general principle it is recommended that individual lots are prevented from incorporating decks, jetties and any access points to the river's edge as part of their individual development plans.

Disturbance

- High negative impact – disturbance and utilisation of the area as a result of an increase in the numbers of people resulting in disturbance of riparian corridor
- Local to regional long term impact
- Corridor and buffer areas need to be designed to facilitate movement and linkages between the open space areas and the upper river catchment and the coast.
- Corridor and buffer areas also need to be designed to minimize negative impacts both direct and indirect which may result from runoff and disturbance
- No fence should be erected between the estate and the estuary

Extent of buffers

There are no detailed methods for defining buffer width areas as yet within South Africa. However, several decades of scientific research around the world have highlighted the importance of establishing, maintaining, and enhancing buffers along streams, rivers, wetlands and estuaries (WCAGP undated). The authors of this report have drawn on the guidelines and literature available to compile best practice guidelines for the buffer areas adjacent to this development. Aquatic buffers provide important ecological benefits, but they also provide significant social and economic benefits. Healthy buffers are now considered important **natural capital** that adds complexity and resiliency to our important and essential life sustaining systems such as rivers. Research has identified the importance of maintaining the connectivity and complexity of aquatic buffers to sustain and regenerate the dynamic interaction between aquatic and terrestrial landscapes.

Thus, aquatic buffers offer a large array of ecological, sociological, and economic benefits to communities. In urban and suburban settings, it can be challenging to balance these benefits with the need for public living spaces and services. Often, engineered solutions are pursued that allow for increased development intensity and density adjacent to aquatic resources. Unfortunately, these expensive structural solutions can have limited effectiveness, can exacerbate undesirable conditions adjacent and downstream, and may simply transfer a problem to another location. **In the long term, the most ecological, sociological, and economical approach is to set aside an appropriately sized vegetated buffer around aquatic resources.**

Riparian buffer widths can vary depending on factors such as the size and slope of the stream/river and the quality of the stream. In the KZN situation forested riparian buffers are more typical and are preferred over grassed buffers because they provide a broader range of benefits. Good urban aquatic buffers are defined by three primary characteristics – width, vegetative composition, and allowable uses. The most effective buffers are commonly structured with three zones (inner/waterside, middle, and outer), where each zone has a specified width, vegetative composition, and set of allowable uses. Minimum criteria can be established to maintain basic buffer functions and avoid encroachment or abuse.

A substantial body of research exists that correlates aquatic buffer width with ecological function or value (Figure 4). Establishment of buffers must balance these functions with the constraints found in urban and suburban settings. Buffer widths can begin with a minimum width based on certain baseline criteria and then be increased (and perhaps decreased) based on site-specific considerations and the goals and objectives of the buffer, e.g., protection of water quality, habitat, etc. Recommended minimum riparian buffers are provided in Table 1.

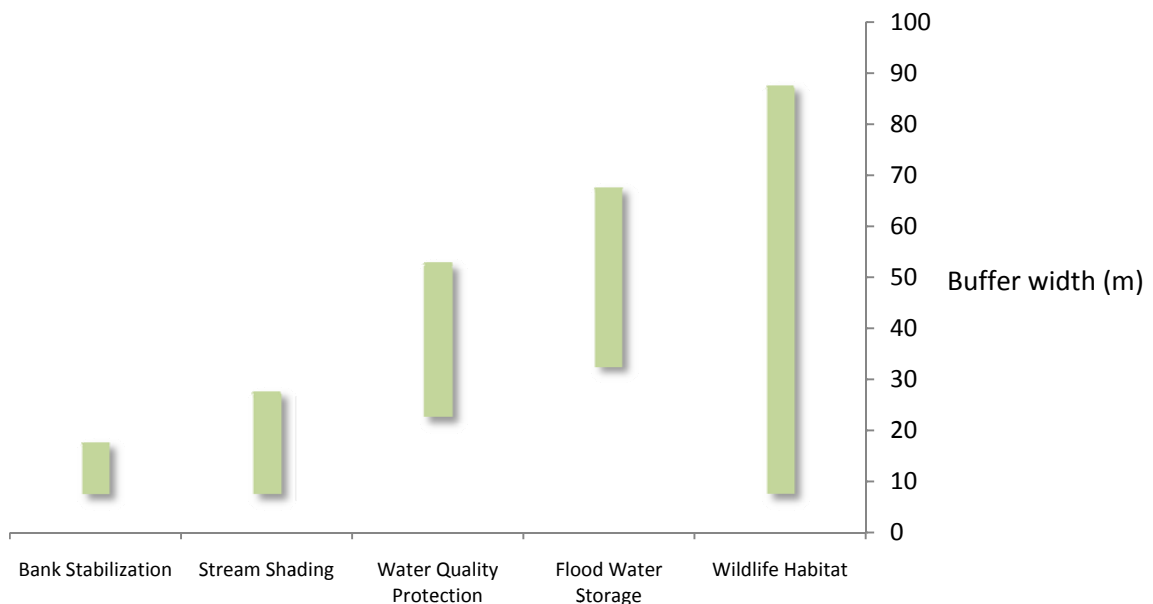


Figure 4: Aquatic buffer functions associated with buffer width (Adapted from USDA Natural Resources Conservation Service. Where the Land and Water Meet: A Guide for Protection and Restoration of Riparian Areas First Edition. USDA NRCS, September 2003)

Table 1. Recommended Minimum Riparian Buffer Widths (m) from ecological core boundaries

Stream order	Sensitive streams	Restorable streams	Impacted streams
1	25	20	15
2	40	35	25
3+	50	40	30

Notes:

1. Stream order refers to a classification system for stream networks, where low order (e.g., 1st and 2nd order) are smaller streams and high order are progressively larger streams. When two 1st order streams meet, they become a 2nd order stream, and so on.
2. Stream classification refers to the condition or quality of the stream. Stream classification may already exist in a community or can be initially determined using certain indicators such as watershed impervious cover.
3. Buffer widths are total widths measured from the 100 year floodline.
4. Widths may be expanded to include site-specific considerations, such as steep slopes (e.g., >15%), flood zones, critical habitat, etc.

Adapted from City of Lenexa, KS: Successful Implementation of Riparian Buffer Programs. Stormwater. Nov/Dec 2006 issue.

Consideration of the oHlanga river and estuary as a sensitive stream of order 3+ suggests that recommended buffer width is in the order of 50m from the ecological boundary (100 year floodline). Methods for the restoration of these buffer area must be described in detail as part of the EMP.

Buffers
<ul style="list-style-type: none"> • Buffer width recommended to be 50 m from the river's ecological boundary • No development of any kind should be allowed within this buffer area • Methods for restoration of the buffer to be drawn up by a specialist and form part of the EMP

Conclusions and recommendations

The assessment of impact to the riverine and estuarine environment (including associated buffer areas) has been considered for both phases of the project (construction and operation) and highlights both the negative and positive impacts; possible mitigation and recommended monitoring. For almost all identified negative impacts described, mitigation alternatives have been recommended which allow avoidance or minimization of the impact. This means that if implemented correctly and in accordance with a detailed EMP adverse impacts may be avoided altogether through design or other related interventions. In addition to the positive impacts identified, it should be noted that restoration of lost habitat is considered a mitigation activity particularly if a former wetland, riparian zone or floodplain is re-established and a high level functionality is achieved.

In terms of the DEAT (2002) criteria the “impact magnitude and significance” of the proposed development to the river and riverine environment above the N2 bridge and the estuary downstream of the bridge could be described as **medium** in that the **impact is real but not substantial in relation to other impacts** that might arise in the same general area. **Mitigation is both feasible and fairly easily possible**; however modification of the project design or alternative action may be required to achieve this. The extent or spatial scale would be rated as medium as there is a very real possibility of impacts beyond the site boundary. The intensity or severity would also be rated as medium because there is a real potential for disturbance of areas that have potential conservation value or are of use as a resource. **A complete change in species occurrence or variety** is also a possibility. The duration of the impact would be rated as high because the potential for impacts extends beyond the period of construction into the operational phase which would be the life of the development. This would exceed the DEAT criterion of 15 years and render the impact “long term”. The mitigatory potential is medium in that there is the “potential to mitigate negative impacts. However, the implementation of mitigation measures may still not prevent some negative effects. In the Cornubia context there is a very real possibility and potential for rehabilitation of presently degraded catchment areas through the installation of appropriate buffers and control of run-off in the broad sense into the river and estuary. The acceptability of impacts would be medium or “manageable” predicated on the “regulatory controls” alluded to in the previous sentence and the commitment of the project’s proponents. DEAT (2002) also refer to criteria for the degree of certainty of impacts, based on more than 90% certainty (definite), more than 70% (probable), more than 40% (possible) and less than 40% (unsure). On this basis the above assessments can be described as **definite**.