



**STORMWATER MANAGEMENT PLAN
FOR THE
SIBAYA PRECINCT**

Incorporating Policy, Regulations and Guidelines

**Version 1.3
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DRAFT

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STORMWATER MANAGEMENT PLAN

FOR THE

SIBAYA PRECINCT

1. INTRODUCTION

The proposed Sibaya Precinct is bounded by the Havaan Forest in the South, the N2 freeway in the west, Main Road 96 to the North and the coastal developments of Umdloti to the East. Central to the Node is the existing Sibaya Casino, which is located at the highest point on the watershed.

Most of the sub-catchments in the development area drain southwards to the Ohlanga River, but roughly one third of the area drains eastwards through existing developments in Umdloti. A small part of the area drains under the N2 and MR96 to the Umdloti River. Parts of the south-draining catchments, that incorporate the N2 drainage system, lie to the west of the N2.

This stormwater management plan applies to all new developments within the Sibaya Precinct and covers the impacts that developments may have on neighbouring catchments that must receive runoff from the Sibaya developments as well as impact of stormwater that must be received from neighbouring catchments.

2. OBJECTIVES

This stormwater management plan for the Sibaya Precinct has the following objectives:

1. To protect all life and property from damage by stormwater and floods
2. To prevent erosion of soil by wind and water
3. To improve the quality of life of the Sibaya Precinct and the affected downstream communities of Umdloti
4. To conserve the flora and fauna of the natural environment
5. To protect and enhance water resources in the catchments from pollution and siltation
6. To protect and enhance the local and downstream water courses and their eco-systems, in particular the Ohlanga River Estuary.

3. MAJOR RISKS

3.1. Erosion

The Berea Red soils and other alluvial sands found in the area vary from cohesive to non-cohesive, but are generally highly erodible and pose a constant and significant threat to the stability of the natural landforms. On the steeper slopes, erosion can take place extremely quickly once initiated, resulting in dongas and undermining structures. The damage to the watercourse will seriously impact not only on the site of the erosion but could damage neighbouring properties and any dams and wetlands located in the downstream valleys where the eroded sediment will be deposited. The cost of correcting the damages will be substantially more than the precautions required to avoid the damages.

3.2. Flooding

The proposed development will tend to reduce the natural rainfall infiltration and increase storm runoff. Downstream flood damage risks will therefore increase unless adequate attenuation of flood runoff is provided by the development either collectively and/or individually. The design of the major stormwater system must address this issue as far as possible, but it is important to note that each individual development and its associated infrastructure must be designed such that the downstream post-development flood risks are no greater than the pre-development flood risks.

This is particularly relevant in the case of developments that drain eastwards through the stormwater system infrastructure of Umdloti. A detailed analysis of the stormwater systems in the east-draining sub-catchments will be required to determine where stormwater attenuation measures can be implemented to meet the above conditions.

The analysis should also advise the degree to which individual developments will have to provide on-site attenuation to ensure that post-development runoff at the boundary with Umdloti developments remains the same, or is less than the pre-development runoff.

4. STORMWATER MANAGEMENT PHILOSOPHY

The major stormwater system consists of all natural water ways, including springs, streams, rivers, wetlands and dams. It includes detention and retention dams and other devices constructed to control stormwater. Roadways and their associated drainage structures are part of the major stormwater system if they result in a significant deflection of stormwater from its natural overland flow path.

The minor stormwater system consists of any measures provided to accommodate stormwater runoff within sites and road reserves and convey the runoff to the major stormwater system. These measures include gutters, conduits, berms, channels, road verges, small watercourses and infiltration constructions.

Stormwater runoff should not be concentrated to an extent that would result in any damage to the environment during storms with a probability frequency more than 1 in 10 years and would result in only minor, repairable damage in storms with a probability frequency more than 1 in 50 years. All elements of the built and natural environment must be able to withstand a 1 in 100 year storm event without significant consequential loss and risk to property and life.

Note that a "storm frequency" equates to a "probability of occurrence" of a storm event that should be used to assess the annual budget or insurance provision for remedial works, should the event occur.

In all catchments, the water courses and built stormwater infrastructure must be maintained in a clean state, free of any rubbish, debris and matter likely to pose any pollution threat to the lower reaches of the water courses.

The Stormwater Management Philosophy for Sibaya Precinct encourages developers, their professional teams, contractors and property owners to do the following:

- Maintain adequate ground cover at all places and at all times to negate the erosive forces of wind, water and all forms of traffic.
- Prevent concentration of stormwater flow at any point where the ground is susceptible to erosion.
- Reduce stormwater flows as much as possible by the effective use of attenuating devices.
- Ensure that development does not increase the rate of stormwater flow above that which the natural ground can safely accommodate at any point in the sub-catchments.
- Ensure that all stormwater control works are constructed in a safe and aesthetic manner in keeping with the overall development theme for the area.

- Prevent pollution of water ways and water features by suspended solids and dissolved solids in stormwater discharges.
- Contain soil erosion, whether induced by wind or water forces, by constructing protective works to trap sediment at appropriate locations. This applies particularly during construction.
- Avoid situations where natural or artificial slopes may become saturated and unstable, both during and after the construction process.

5. STORMWATER MANAGEMENT POLICY

The following rules are to be observed by all developers, property owners, their professional teams, contractors and sub-contractors:

1. Designs for the buildings and site development in general must avoid concentration of stormwater runoff both spatially and in time and may be required to provide for on-site attenuation of stormwater runoff to limit peak flows to pre-development levels.
2. Detailed plans to control and prevent erosion by water must be agreed with prior to the commencement of any works, including site clearance, on any portion of the site.
3. Removal of vegetation cover must be carried out with care and attention to the effect, whether temporary or long term, that this removal will have on erosion potential.
4. Precautions shall be taken at all times on building sites to contain soil erosion and prevent any eroded material from being removed from the site.
5. Landscaping and re-vegetation of areas not occupied by buildings or paving shall be programmed to proceed immediately building works have been completed, or have reached a stage where newly established ground cover is not at risk from the construction works.
6. On-site stormwater control systems, such as swales, berms, soil fences and detention ponds are to be constructed before any construction commences on the site. As construction progresses, the stormwater control measures are to be monitored and adjusted to ensure complete erosion and pollution control at all times.
7. Earthworks on sites are to be kept to a minimum. Where embankments have to be formed, stabilisation and erosion control measures shall be implemented immediately.
8. Stormwater must not be allowed to pond in close proximity to existing building foundations.
9. Prior to any physical work proceeding on any site, stormwater control plans (SCPs) detailing the proposed stormwater control measures are to be submitted to the Design Review Committee of Moreland Developments, or their appointed representative. No work is to be undertaken without an approved SCP.
10. Stormwater Control Plans must describe what control measures are to be implemented before and during the construction period, as well as the final stormwater control measures required for the site on completion of site development. Plans must indicate who is responsible for the design of the control measures and who is, or will be, designated as the responsible person on site during each stage of the implementation of the control measures.
11. Stormwater Control Plans must show that all the provisions, regulations and guidelines contained in this document have been taken into account.

12. In the event of a failure to adequately implement the approved stormwater control plan, the owner/developer shall be responsible for making good all consequential environmental damage at his own cost. Owner/developers are therefore advised to ensure that all members of their professional teams and their contractors are competent to undertake the development work and are adequately insured.

6. MAJOR STORMWATER SYSTEMS

A plan of the sub-catchments is given in Figure 1, with details and possible stormwater impacts given for each sub-catchment in Appendix A to advise the planning process and highlight critical areas for attention during design.

In due course, the stormwater systems in each drainage basin will need to be identified and analysed to determine the requirements for new stormwater infrastructure to meet the objectives of this stormwater management plan. The results should be documented in a Stormwater Systems Report that advises designers on the hydraulic capacities of the major system and provides parameters for further detailed design at specific locations within the overall development.

The parameters should include:

- Allowable ranges for the percentage impervious for commercial and residential areas site
- Average depression storage values for pervious and impervious areas
- Initial and final infiltration rates and the appropriate Horton's decay constant
- Geotechnical data on infiltration rates for infiltration galleries
- Equivalent Rational Method coefficients and unit area runoffs for developments on the small sites

It is important that all building designs provide for maximum on-site stormwater attenuation and that the developers instruct their professional teams accordingly. It is important that level and near-level areas, such as building roofs and parking areas, are used to best advantage to attenuate storm runoff.

7. CRITICAL ASPECTS

1. Preliminary assessment reports have highlighted the vulnerability and susceptibility of existing developments in Umdloti to the effects of stormwater runoff generated upstream by the proposed Sibaya Precinct. Stormwater drainage is hence a crucial aspect in the development of the Sibaya Precinct and will require careful planning, designing and managing.
2. The existing stormwater reticulation through Umdloti, particularly in the two primary watercourses, appears inadequate to handle the present upstream flows, which represent the pre-development flows from the Sibaya Precinct. Taking into account sensitive social and environmental considerations, upgrading of the existing stormwater systems and the provision of stormwater attenuation measures on a macro and micro scale should be included in development plans as far as possible.
3. The stormwater detention ponds should be designed for the 100-year storm event and should be located at appropriately selected sites in the primary watercourses. Site selection must take account of the necessary geotechnical, environmental and topographical conditions, including wetland conservation.
4. In addition to macro stormwater measures, micro-stormwater measures should be implemented on individual sites. The form of this attenuation will be dependant on a number of factors such as topography (natural and artificial slopes), the zoning of the site and soil conditions present. It is envisaged that in the steeper regions on-site attenuation

tanks will be the most suitable form of attenuation with outlets to the municipal pipe network, where provided, or appropriate flow spreaders.

5. In the less steep areas where soil conditions are favourable, infiltration measures will be the preferred form of on-site stormwater control and disposal. In certain instances infiltration devices may need to be supplemented with attenuation tanks with outlets to the municipal pipe network.
6. A limited stormwater pipe network should be provided for stormwater reticulation to safely convey minor stormwater runoff from properties and roads to and between the attenuation facilities. Hydraulic analysis is required to determine where existing elements of the major stormwater system are inadequate and how the problems can best be addressed.
7. To ensure that water quality is not compromised, silt and trash traps will need to be provided within the system. Where conditions permit, open ditches, drains and channels should be used instead of pipes. Attention must be given to the erodibility of channels where flow velocities are high and appropriate lining provided. Forms of lining will vary from natural vegetation to stone pitching and reinforced concrete linings.
8. While the stormwater management objective of the development should be to minimise the concentration of stormwater and attenuate flows as much as possible, roads and driveways cut into steeper slopes will cause storm runoff to be channelled and focused. Exit points should be located over flat ground, where sheet flow can be re-established or into culverts that convey the flow to a water body, or an energy-dissipating device.
9. In preparing the sub-catchment boundaries, account has been taken of the natural watersheds and the probable impact of proposed roads on the flow of stormwater runoff. Certain sub-catchment boundaries will be defined by proposed roadways that are likely to concentrate stormwater runoff in a formalised system. Within the development area, stormwater servitudes of adequate width will be required over properties straddling a natural watercourse, or where runoff is diverted for a specific reason. Lined conduits, either open channels or pipes, with outfall energy dissipaters must be provided wherever there is an assessed risk of erosion on slopes steeper than 2%.
10. The proposed developments should not adversely impact on the environments of the development node and surrounding areas in terms of erosion and sediment deposition, but the frequency of flooding and the total runoff volume will increase unless adequate provision can be made to maintain the current natural rate of stormwater retention and infiltration in the sub-catchments.
11. An overall stormwater systems model should be developed to determine peak flood flow rates and flood levels for the main watercourses and assess the collective impacts of developments on runoff patterns. The outputs from the modelling will provide the input data required for the design of culverts, channels and other stormwater infrastructure associated with the proposed developments.
12. Detailed hydraulic analysis will be required during the design stage to assess storm runoff and flood levels at specific locations, such as bridges, road culverts and where properties are affected by the 100-year flood. It is important to note that although a structure may be designed for a return period less than 1 in 100 years, the design analysis must still assess the consequences resulting from a 100-year storm event.
13. For sub-catchments flowing into the development area, potential future development in these sub-catchments should be considered and any requirements for stormwater detention should be identified. Similarly, for sub-catchments flowing out of the development area the impact on the downstream watercourse must be considered and measures taken to ensure any upstream development does not result in an increased flood damage risk downstream.
14. Sites within the proposed development that bound on stormwater detention areas, near road crossings, watercourse confluences and water features could be subject to flooding. In these situations no development should take place below the outfall levels of water detention areas, plus an appropriate freeboard allowance.

15. The proposed development layouts will impact on storm runoff to varying degrees. Adequate provision will have to be made for the management and disposal of stormwater runoff from the various internal developments as they are planned and this must be done in an integrated and coordinated process to avoid stormwater damage in the future.
16. Overland flow may be encouraged where possible, but should be avoided in the specific areas identified. These are typically where roads on steep slopes will capture and concentrate cross flows at the local low points in the roads. Plans must take into account probable impact of flow from these points of concentration on the downstream environment.
17. Steep watercourses will require protection from erosion through the use of appropriate channel lining, detention dams, or controlled drops to dissipate flow energy.
18. All natural and unlined channels should be inspected for adequate binding of soil by sustainable ground cover. Stone pitching should be used to reinforce channel inverts on steep slopes. Existing wetlands and stormwater detention areas should be protected from encroachment by the development.

8. GUIDELINES FOR OWNERS AND DEVELOPERS

All developments within the Sibaya Precinct will be required to control stormwater runoff in accordance with the stormwater management philosophy and policies of Moreland Developments and the Ethekwini Metro Municipality.

The following guidelines are intended to assist developers, owners and their professional teams with the planning of site layouts, the design of the major and minor stormwater systems infrastructure and to ensure that the objectives of this Stormwater Management Plan are met during the planning, design, construction and operational phases of all developments.

Where prescriptive wording is adopted, the guideline shall be accepted and implemented as a rule.

8.1. STORMWATER RUNOFF CONTROL

Formal surface and underground stormwater systems are provided in the overall development for the acceptance of stormwater drainage from private properties, but it is important that the peak runoff rate from private properties do not exceed the hydraulic capacities of the elements in the major stormwater system. The following are general guidelines for stormwater control from private properties.

Buildings

- a) Any building will inevitably result in some degree of flow concentration, or deflection of flow around the building.
- b) The developer/owner shall ensure that the flow path of the stormwater on his site is adequately protected against erosion and is sufficiently roughened to retard stormwater flow to the same degree, or more, as that found in the natural pre-development state of the site.
- c) Where the construction of a building causes a change in the natural flora of the site that might result in soil erosion, the risk of soil erosion by stormwater must be eliminated by the provision of approved artificial soil stabilisation devices, or alternative flora suited to the changed conditions on the site.
- d) Where a piped stormwater system exists, an on-site stormwater drainage system should be connected to this external system. Any inlet to a piped system shall be fitted with a screen, or grating to prevent debris and refuse from entering the

stormwater system. This must be done immediately on installation of the piped system.

- e) No building works, earthworks, walls or fences may obstruct or encroach on a watercourse inside or outside the site without approved plans that do not compromise the objectives of the Stormwater Management Plan.

Roof Drainage

- a) Building designs must adopt the One-Planet-Living-10 principles and rainfall runoff from roofing and other areas, not subjected to excessive pollution, must be efficiently captured for re-use where possible for on-site irrigation and non potable water uses.
- b) Where ground conditions permit, rainwater runoff that is not stored and utilised on site must be connected to infiltration galleries or trenches designed to maximise groundwater recharge. Infiltration facilities must be large enough to contain at least the first hour of a minor storm's runoff without overflowing.
- b) Infiltration trenches must be aligned along the contour on the downstream side of the property such that any spillage during major storms results in sheet overland flow.
- c) Where a piped stormwater system has been provided to a property, surplus runoff should be connected to this system. Garden and other debris must be trapped on screens or gratings before entering the municipal or local development's stormwater system.

Swimming Pools

- a) Unless municipal by-laws provide otherwise, back-wash from swimming pools must be discharged into a suitable soak-away or similar approved structure to ensure the flow is not concentrated without adequate attenuation.

Parking Areas and Yards

- a) Any external parking area, yard or other paved area must be designed to attenuate stormwater runoff from a major storm to an acceptable degree.
- b) Any area described in (a) must discharge rainwater flowing over, or falling onto its surface, in a controlled manner either overland as sheet flow, or into a detention facility, or infiltration gallery suitably sized to accommodate minor storm runoff.

Driveways

- a) Driveways shall not be constructed to deflect or channel runoff onto a roadway, or to concentrate runoff along a particular path that is not a natural water course, without prior consent.
- b) Driveways and paths should be designed and constructed such that the rate of flow of stormwater across and along the driveway or path is not increased when compared with the pre-development state.
- c) Where the driveway joins the road, the driveway must not obstruct the flow in any open channel, whether line or unlined, found along the road verge.

Private Roads

- a) The principle of overland flow should apply to roadways where possible and roads should be designed and graded to avoid concentration of flow along and off the road.
- b) Where flow concentration is unavoidable, measures to incorporate the road into the major stormwater system should be taken, with the provision of detention storage facilities at suitable points.
- c) Inlet structures at culverts must be designed to ensure that the capacity of the culvert does not exceed the pre-development stormwater flow at that point and detention storage should be provided on the road and/or upstream of the stormwater culvert.
- d) Outlet structures at a road culvert or a natural watercourse must be designed to dissipate flow energy and any unlined downstream channel must be adequately protected against soil erosion.

Stormwater Storage Facilities

- a) The sufficiency and effectiveness of on-site detention and retention storage to meet stormwater attenuation requirements within the minor and major stormwater systems is the responsibility of the property owner.
- b) Any detention pond shall be integrated with the landscape on the site and maintained in good condition.
- c) Retention ponds shall be maintained in good condition and shall not be permitted to become a health hazard or nuisance.
- d) Moreland, or the eThekweni Municipality, shall have the right to inspect any stormwater drainage control facility at any time and issue instructions for repair and maintenance works deemed to be necessary, which instructions must be carried out within the prescribed time period.

Subsurface Disposal of Stormwater

- a) Any construction providing for the subsurface disposal of stormwater should be designed to ensure that such disposal does not cause slope instability, or areas of concentrated saturation or inundation.
- b) Infiltration structures should be integrated into the terrain so as to be unobtrusive and in keeping with the natural surroundings.

Channels

- a) Lined and unlined channels may be constructed to convey stormwater to a natural watercourse where deemed necessary and unavoidable.
- b) Channels must be constructed with rough artificial surfaces, or lined with suitable, hardy vegetation, to be non-erodible and to provide maximum possible energy dissipation to the flow.

Energy Dissipators

- a) Measures should be taken to dissipate flow energy wherever concentrated stormwater flow is discharged down an embankment or erodible slope and the resulting supercritical flow poses a significant risk to the stability of the waterway.
- b) Attenuation dams should be provided at the head of the energy dissipating structure if possible.
- c) A means of dissipating energy must be provided at the outfall of any drop structure to ensure stormwater flow is returned to a safe sub-critical state, or to disperse the flow.

Flow Retarders

- a) Stormwater flow should be retarded wherever possible through the use of surface roughening or other flow restricting devices, provided these are designed and built to avoid blockages that could result in environmental and structural damage.
- b) All such constructions must be regularly maintained by the owner and may be inspected at any time by Moreland, or the eThekweni Municipality, or their appointed representatives.

8.2. STORMWATER POLLUTION CONTROL

- a) All property owners and developers shall ensure that no materials, fluids or substances are allowed to enter the stormwater system that could have a detrimental effect on the flora, fauna and aquatic life in the water courses, wetlands and dams.
- b) Regular monitoring of sites within the catchments should be undertaken by Moreland, the eThekweni Municipality, or their appointed representatives.
- c) The owner of any site that is required to store any substances that could be regarded as hazardous in terms of water pollution, shall notify the eThekweni Municipality and shall take measures to ensure spillages of the substance(s) can be adequately contained to prevent contamination of the water resources within the development area and particularly the Ohlanga River Estuary.
- d) No stormwater, wash water, or waste water may be directed towards any permanent water body or wetland without the installation of a suitable filtration system to prevent pollution, including silt, from entering such water body.

8.3. STORMWATER EROSION CONTROL

Moreland or the eThekweni Municipality may, at its discretion, inspect the individual properties within in the Sibaya Node precincts on a regular basis to:

- a) determine the effectiveness of the stormwater management policies and amend policy as and when necessary to meet the objectives of the Stormwater Management Plan.
- b) advise property owners of any repair, maintenance and improvement works required on the stormwater system control elements within their jurisdiction.

8.4. SAFETY

Inundation of Property and Buildings

- a) No new buildings are to be constructed below the 1:100 year flood line.
- b) The 1:100 year flood line may not be altered by the development of the site, land-forming or other means, without the approval of Moreland and/or the eThekweni Municipality, in case this interferes with the performance of existing stormwater management facilities.
- c) All risk of inundation by flood water is carried by the owner of the property.
- d) No flood water may be diverted or concentrated such that a risk of flooding or inundation of any property or building is created.

Structural Damage

- a) The diversion or concentration of stormwater, whether on the surface or underground, must not increase the risk of structural damage to any development within the Sibaya Precinct.
- b) The above includes the undermining of structures due to erosion of soil by stormwater.

9. STORMWATER PLAN IMPLEMENTATION PROCEDURES

The following procedures are to be followed by owners, developers, appointed agents, professional teams and contractors:

1. **Application for Permission to Build**
A copy of the Stormwater Management Plan shall be obtained from Moreland.
2. **Site Survey and Investigations**
Anyone involved in site survey and investigation work shall be familiar with the contents of the Stormwater Management Plan.
3. **Design Stage**
The professional team shall take into account the stormwater management requirements contained in this document and shall clearly indicate on all plans and in any contract document where and how measures have been provided in the design to ensure the stormwater management requirements are implemented. Approval from the eThekweni Municipality must be obtained before commencing construction.
4. **Construction**
The contractor shall prepare a Stormwater Control Plan to ensure that all construction methods adopted on site and within the Sibaya Precinct precincts do not cause, or precipitate, soil erosion and shall take adequate steps to ensure that the requirements of the Stormwater Management Plan are met before, during and after construction. The designated responsible person on site, as indicated in the stormwater control

plan (usually the contractor) shall ensure that no construction work takes place before the stormwater control measures are in place.

5. Certificate of Occupation

On completion of the works, the eThekweni Municipality, or their appointed professional person will inspect the site for compliance with the stormwater management requirements, prior to the issuing of a certificate of occupation by the eThekweni Municipality.

6. Occupation Period

During occupation of any property, Moreland or the eThekweni Municipality may undertake periodic inspections, to ensure the stormwater management policy is being correctly implemented, and may serve notice on occupants to undertake remedial work, which is deemed necessary in the opinion of Moreland and/or the eThekweni Municipality.

10. COMPLIANCE WITH STORMWATER MANAGEMENT POLICY

1. Within the jurisdiction of a site specifically and the Sibaya Precinct precincts in general, the owner and his professional team, including the contractor, shall be responsible for ensuring that the requirements of this Stormwater Management Plan are met.
2. The owner and his professional team shall be responsible for the performance of all stormwater control measures implemented on a site under their jurisdiction and the impact such works may have on downstream property within the Sibaya Umdlotti Development precincts.
3. Approval of any plan or document, whether verbally or in writing, by the eThekweni Municipality shall not be construed as absolving the owner or the professional team of this responsibility.

11. References

- 1 "Sibaya Development Node – Preliminary Assessment for Stormwater Catchment Management Plan", 19 May 2006, VelaVKE Consulting Engineers (Pty) Ltd..
- 2 "Preliminary Assessment of the Stormwater Catchment for the Umdloti South Development", 13 July 2006, Goba Moahloli Keeve Steyn (Pty) Ltd.
- 3 "Sibaya Umdloti Development Node - East of MR 398 (M4): Summary of Bulk Civil Services", 10 May 2006, Goba (Pty) Ltd.

12. Figures

Figure 1 Plan of the catchments affected by Sibaya Precincts

Issued by:

Moreland Developments (Pty) Ltd.

Date:

INSERT FIGURE 1 HERE

Appendix A: Sub-Catchment Stormwater Details

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Catchments Located East of MR 4

The relevant sub-catchments are A to E shown in Figure 1. The approximate sizes of the catchments are tabulated below.

Catchment	Overall Size	Portion Within Proposed Development
A	28.91 ha	16.90 ha
B	11.26 ha	6.67 ha
C	4.9ha	0.81 ha
D	87.67ha	83.16 ha
E	177.76 ha	80.43 ha

Catchment A

The proposed Hotel/Lodge site falls into this catchment. A limited piped stormwater system is present along the existing roads below the site, but has been implemented on an ad-hoc basis. The pipes are small diameter with a number of discharge points onto the beach.

The strip of coastal bush and trees performs an important role in retarding the stormwater runoff from the cultivated lands. The proposed town planning scheme has taken into account this strip of coastal forest.

Subject to the findings of the geotechnical investigation, it is important that on-site stormwater infiltration measures be implemented on the Hotel/Lodge site. The on-site stormwater measures will most likely need to be supplemented by a piped system discharging to existing stormwater drainage along the roads and which may need upgrading.

Catchments B & C

The existing army base occupies most of this area and the small portion that does drain onto the site could most likely be re-routed into the adjacent catchments.

Catchment D

This is a significant catchment with some 83.16ha of the development falling into this catchment which stretches from Umdloti to some 250m west of the M4.

In the existing cultivated lands the watercourse is relatively well defined however it tends to disappear as it enters the band of coastal bush at the interface with Umdloti. The watercourse is extremely overgrown and the stormwater appears to be piped from the property above the road (the existing ski-boat club site) to an outlet on the beach next to the sewer pump station.

The proposed town planning takes into account the existing watercourse, but some refinement may be required depending on the extent of the seepage zones that will

be determined from the geotechnical investigation and floodline analysis. More accurate contours along the watercourse are required for the analysis.

The proposed link road between the M4/Sibaya Casino traffic circle and the Main Access Road (MR96) to Umdloti can be used for stormwater attenuation where it crosses the watercourse. To maximize the amount of stormwater attenuation in the open spaces the level of the adjacent residential properties will need to be raised.

Downstream of the link road the watercourse is steeper and channel protection will be required. A depressed area on the western fringe of the coastal forest requires investigation to ascertain the extent of attenuation that can be provided in this area immediately above the boundary with Umdloti.

Although stormwater attenuation in the open spaces is provided in the town planning layout, on-site stormwater control and disposal methods should still be implemented on the individual properties. The stormwater protection measures of the watercourse through the coastal forest must take particular cognisance of the Environmental Impact assessment.

Existing stormwater servitudes over the properties along the main watercourse need to be verified.

Catchment E

Catchment E is some 178 hectare in extent. It stretches up to the N2 in the West and is bisected by the Main Road (MR96) to Umdloti. The proposed Development comprises some 80 hectares of this catchment.

An open drainage channel, portions of which are protected with gabions runs along the Main Road (MR96) to Umdloti. The open channel starts at the farm access intersection East of the M4 interchange where it picks up stormwater runoff from the Northern and Southern side of the Main Road. This open drain, which is very overgrown with vegetation, runs along the northern side of the Main Road to just before the intersection with Bellamont Road, at which point it is piped to the southern side of the road where it continues as an open channel before being piped under the traffic circle to the stormwater outlet on the beach.

At the entrance to Umdloti a number of pipe culverts have been provided across the open channel for the property accesses off the Main Road. Preliminary calculations show that the capacity of the system is very limited in terms of the size of the catchment that drains into this watercourse. A detailed survey will be required to assess the capacity of the drainage system and to determine the measures required to accommodate the additional runoff from the proposed development.

Catchments Located West of MR 4

Catchments west of MR4 have identification numbers from 1 to 16. Where the development area bisects a catchments, the sub-areas inside and outside the development area are identified by "a" or "b" suffixes.

Catchment 1a

Catchment 1a is 26 ha in extent and drains the North-East quarter of the Sibaya Casino complex, before flowing southwards into Catchment 2a through a culvert under the access road to the casino and commercial area. Runoff from Catchment 1b flows through a culvert under the M4 to join the Catchment 1a water course above the culvert linking to Catchment 2a. The casino site has an attenuation dam on its boundary.

The catchment is relatively steep and the main concern will be erosion during development. Risk of flooding should be considered for developments near the watercourse in the commercial areas.

Catchment 2a

The catchment is 93 ha in extent and the main watercourse draining southwards to the Ohlanga River floodplain picks up runoff from relatively steep slopes east and west. The eastern slopes and the watercourse fall into the conservation zone. Development of entertainment and residential areas on the western slopes could significantly increase storm runoff and protection against erosion is recommended for all steep valley lines.

Proposed road alignments will impact on the direction and concentration of runoff in this catchment. Detention storage and energy dissipation along the main watercourse should be provided.

Runoff from the 4 ha Catchment 2b located outside the development node enters the main watercourse at the circle on the M4.

Catchment 3

Catchment 3 is 35 ha in extent and drains south into the flood plain of the Ohlanga River. It has steep sides to both the east and west. Development on the watershed above this catchment should be carefully planned to avoid, or minimise, concentrated runoff down the steep slopes. There is a high potential for erosion damage in this catchment.

Catchment 4

Catchment 4 is a very steep 7 ha catchment draining to the Ohlanga River flood plain. The same comments given for Catchment 3 apply with respect to development in this catchment. Extreme care will be required to deal with any concentrated runoff. Special care will be required to prevent or control erosion during and after construction.

Catchment 5

The Catchment 5 catchment drains from the north-east to the south-west. The sides are generally steep. The valley curves from a southerly direction to a westerly direction and displays sections that are relatively flat, which could be used for stormwater attenuation. The impact on storm runoff of the proposed road(s) through the catchment should be assessed in relation to potential flow attenuation sites.

The lower sections of the watercourse are steep and may require special attention to prevent erosion due to increased runoff volumes. Protective vegetation must be retained at all times. Catchment 5 drains into Catchment 7 where there appears to be a wetland area within the defined conservation space.

Catchment 6

Catchment 6 drains into the most westerly portion of Catchment 7 where a proposed major road crosses the valley. The catchment has relatively steep sides and contains a main lower valley and two side valleys. The main valley is relatively flat and receives runoff from Catchment 10. A proposed road follows the water course to a tee junction at the catchment boundary with Catchment 7. This road may assist in creating upstream flood attenuation areas in the conservation zones. This would affect the road and culvert designs, in particular at the boundary interface with Catchment 7 (see below).

Catchment 7

Catchment 7 is steep-sided, except for the valley bounding on the Ohlanga River floodplain. Upstream catchments draining into Catchment 7 are Catchment 5 and Catchment 6. In the vicinity of the Ohlanga floodplain, development should take note of the 100 year flood line and encroachment onto the flood plain where permitted by the EIA should be limited.

The steep fall in the stream bed below the road tee junction at the catchment boundary with Catchment 6 is a potential area of concern. Further investigation of the valley is required to determine the erodibility and general stability of this section of the water course. The impact of the road on stormwater drainage and flood attenuation at the junction should be assessed and upstream attenuation storage provided in the main valley of Catchment 6.

Catchment 8

The Catchment 8 catchment is small, has no watercourse and drains onto the Ohlanga River flood plain to the South. The slopes are steep and special precautions will be required to prevent erosion and concentration of stormwater by any development.

Catchment 9a & Catchment 9b

Catchment 9a is east of the N2 within the development node and Catchment 9b is west of the N2. Runoff in both catchments is controlled by the existing N2 freeway drainage system. There is little potential for flood attenuation, other than that already provided by the freeway drainage system, and the main concern will be the conveyance of storm runoff down steep slopes and the control of erosion during and after development.

The status of the watercourse and the capacity of culverts under the N2 and elsewhere along the watercourse may require evaluation to determine if any protective measures are required.

Catchment 10a & Catchment 10b

Catchment 10a is east of the N2 within the development node and Catchment 10b is outside to the west of the N2 freeway. Most of Catchment 10a is steep, except along the main watercourse that runs south parallel to the N2. The main watercourse receives flow from Catchment 11a and Catchment 10b.

A proposed road located through Catchment 10a will impact on storm runoff distribution, in particular a small dam in the middle of the catchment. This interface will require careful analysis. The impact of the proposed internal roads on storm runoff should be covered in the stormwater management plan.

Catchment 10b is outside the development node and is zoned for business developments, while Catchment 10a is zoned entertainment, residential and commercial. Consideration should be given to flood attenuation on the west of the N2, as well as any water quality controls that could be introduced to protect the water quality in the main watercourse.

Catchment 11a & Catchment 11b

Catchment 11a receives runoff under the N2 from Catchment 11b and discharges the combined runoff into the main watercourse of Catchment 10a. The steep west-facing slopes pose a risk of erosion similar to the other catchments. Attenuation and water quality controls should be applied in Catchment 11b on the western side of the N2.

Catchment 12

Catchment 12 is located in the Northwest of the development node. Slopes are relatively gentle slopes compared to elsewhere and runoff flows west under the N2. No specific stormwater related issues are identified.

Catchment 13

Catchment 13 faces the uMdloti/N2 interchange. It is relatively steep and has no watercourse. Runoff from development on the watershed to the N2 freeway drainage system will require careful control to avoid erosion of the steep slopes.

Catchment 14a & Catchment 14b (upper parts of catchment E)

Runoff from Catchment 14a west of the M4 into Catchment 14b east of the M4 is controlled by the drainage system of the M4. The catchment is relatively small and its development should have minimum impact on the larger downstream catchments. An assessment should be made and, if required, flow controls could be put in place where the watercourse crosses under the M4.

Catchment 15a & Catchment 15b (upper parts of catchment D)

Catchment 15a drains to a proposed traffic circle on the M4 before crossing under the road into the top of Catchment 15b. Both are part of Catchment D. The catchment slopes are relatively mild, but with the anticipated development on the east-facing slopes, provision should be made for the additional runoff to be attenuated on the western side of the traffic circle. This will minimise the impact on Catchment 15b, where any space for stormwater attenuation will be required to address the problems that additional runoff from developments could cause lower down in Catchment D.

Catchment 16

Catchment 16 is a long narrow strip of vegetated land draining from the watershed to the M4. The road drainage system should be adequate to accommodate existing runoff from this catchment, but any proposed developments on the ridge should be assessed to determine the best way to handle additional runoff. It is possible that the ridge is sufficiently permeable that all runoff could be disposed of by infiltration.

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