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STORMWATER MANAGEMENT PLAN

Tinley Manor South Banks

March 2017 Ref: DR2014/48

AUSTRALIA | ASIA | MIDDLE EAST | AFRICA | PACIFIC

Project Name:	Tinley Manor South
Project Number:	DR2014/48
Report for:	Stormwater Management Plan

REVISIONS

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EXECUTIVE SUMMARY

Tongaat Hulett Developments intends developing a 485 hectare mixed used development known as Tinley Manor South located within the iLembe District Municipality. SMEC South Africa has been appointed to provide civil engineering input to the EIA phase of this project including the provision of a Stormwater Management Plan.

The Stormwater Management Plan's objectives are to protect all life and property from damage by stormwater and floods, to prevent erosion of soil by wind and water, to conserve the flora and fauna of the natural environment, to protect and enhance water resources in the catchments from pollution and siltation and to protect and enhance the local and downstream water courses.

Based on preliminary Rational Method calculations, it is evident that one of the negative impacts of the development is a substantial increase in the peak stormwater runoff flows for both the 1 in 10 and 1 in 50 year return periods. Stormwater Management facilities are proposed as the primary mitigation to the increased run-off volumes and will be designed to reduce peak flows to pre-development levels.

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1. INTRODUCTION

The proposed Tinley Manor South development is located approximately 10km North East of Ballito (Dolphin Coast) on the Kwa-Zulu Natal North coast. The development is bounded by Sheffield beach to the south, the uMhlali River to the north, the N2 freeway to the west and the Indian ocean to the east (refer to Figure 1).

The project area is approximately 485ha in extent and is currently under sugarcane cultivation with pockets of indigenous vegetation predominantly along the coast. The project area drains to the uMhlali River to the north and the Indian Ocean to the east.

Tongaat Hulett Developments intend developing a mixed use development comprising

- Private Resorts,
- Special Residential
- High Density Residential
- Low impact use which offers a range of retail, offices, residential and community facilities
- Medium Density Residential

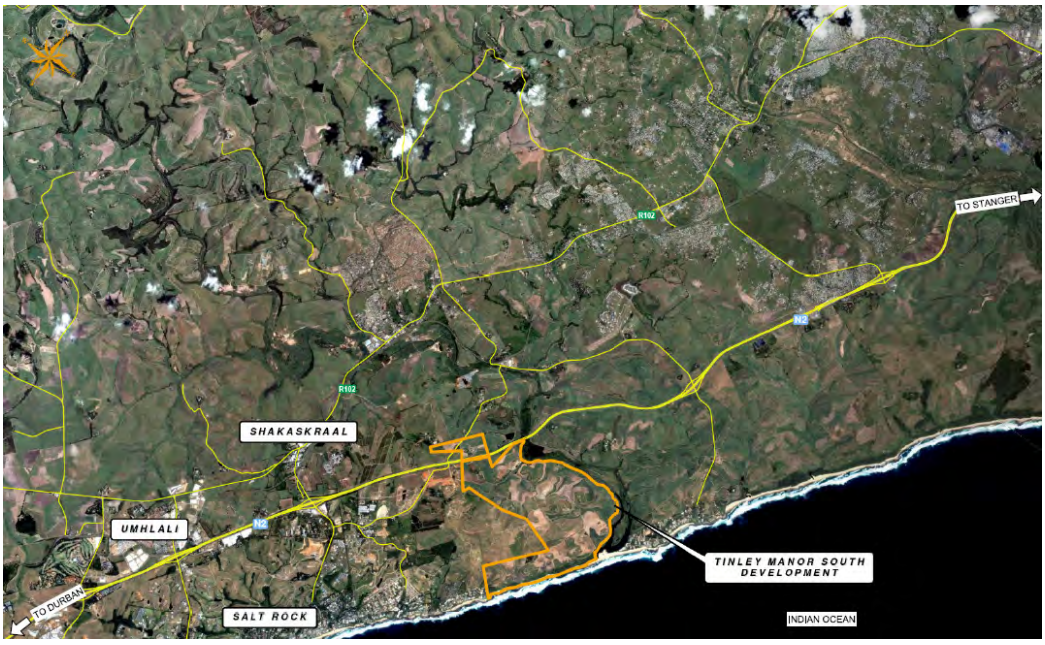


Figure 1: Locality Plan

2. STORMWATER MANAGEMENT PRINCIPLES

2.1 Potential impacts of development on existing catchments

The impacts of the proposed development on the environment will range from negative to positive depending on the degree of planning, design and methods of implementation. Measures put in place should contribute to the mitigation of the naturally negative impacts of development.

Expected consequences of unmitigated development include an increase in hardened areas, reduced infiltration, loss of vegetation and reduced evapo-transpiration potential. There will be an overall increase in surface runoff, an increase in the speed of runoff and peak flow rates in the watercourses.

2.2 Mitigation of development consequences

The following factors should be considered:

- Improved wetland functionality and zero net-loss approach regarding wetland areas.
- Protection of the natural watercourses to prevent pollution, erosion and retain runoff.
- Promotion of subsoil infiltration where possible.
- Provision of indigenous vegetation along watercourses and stabilisation of banks.
- Provision of in-stream installations at selected sites to trap first-flush pollution and non-soluble trash and litter entering the stormwater system.
- Attention to development of on-site, rainfall reuse attenuation or provisions for reducing runoff by in-catchment and on-site evaporation and evapo-transpiration.
- Local flood risk reduction by selection of appropriate design standards for road bridges, culverts and stormwater management facilities.
- Implementation of adequate on-site and localised stormwater management practices.
- Attenuation of flood peaks to predevelopment levels at the 2% (50-year) and the 10% (10-year) risk level.
- Providing new areas with sufficient flood attenuation and evaporation provisions.
- Rehabilitation and upgrading of open spaces following conversion from sugarcane.

- The parks and land scaping plan must take cognisance of the key issues and implement them in conjunction with the Stormwater Management Plan.

The Stormwater Management Plan described below lists many practical on-site controls to address these fundamental issues. However, this does not exclude any technology that can be shown to be effective in controlling runoff whilst supporting the proposed spatial development intensity levels and contributing positively to the environment.

To fully mitigate the negative impacts of development:

- The potential increase in flood peaks must be mitigated to at least pre-development levels by the provision of sufficient stormwater detention facilities at micro and macro levels.
- The potential increase in flood volumes must be mitigated where possible by subsoil infiltration, retention of runoff in on-site facilities for irrigation use and unsaturated wetland areas where evaporation and infiltration can help to reduce flood run off rates.
- Installations must be provided to contain pollution as close to source as possible and in a practical location for servicing by Department of Solid Wastes.

2.3 Objectives

This stormwater management plan has the following objectives:

- To protect all life and property from damage by stormwater and floods
- To prevent erosion of soil by wind and water
- To conserve the flora and fauna of the natural environment
- To protect and enhance water resources in the catchments from pollution and siltation
- To protect and enhance the local and downstream water courses

2.4 Stormwater management policy

The following rules are to be observed by the developer, the professional team, contractors and sub-contractors:

- 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.
- Detailed plans to control and prevent erosion by water must be agreed prior to the commencement of any works, including site clearance, on any portion of the site.

- 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 an erosion potential.
- 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.
- Landscaping and re-vegetation of areas not occupied by buildings or paving shall be programmed to proceed 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.
- On-site stormwater control systems, such as swales, berms, soil fences and detention facilities 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.
- 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.
- Stormwater must not be allowed to pond in close proximity to existing building foundations.
- Prior to any physical work proceeding on site, a stormwater control plan (SCP) detailing the proposed stormwater control measures are to be formulated. No work is to be undertaken without an approved SCP.
- The Stormwater Control Plan 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.
- Stormwater Control Plans must show that all the provisions, regulations and guidelines contained in this document have been taken into account.
- In the event of a failure to adequately implement the approved stormwater control plan, the contractor shall be responsible for making good all consequential environmental damage at his own cost. The developer is therefore advised to ensure that all members of the professional team and contractors are competent to undertake the development work and are adequately insured.

2.5 Major and minor stormwater systems

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 provides the hydraulic capacities of watercourses in the major system and other parameters required for further detailed design at specific locations within the overall development.

The parameters should include:

- Allowable ranges for the impervious percentage for commercial and residential areas.
- 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 the best advantage to attenuate storm runoff.

Appropriate provision must be made, wherever possible, for the removal of trash and litter from the major and minor stormwater systems. Stormwater trash collection stations must be conveniently located to facilitate trash collection and regular maintenance of the station.

2.6 Critical aspects

Stormwater drainage is a crucial aspect and will require careful planning, designing and managing and the critical aspects are.

- The stormwater management facilities should be designed for the 50-year storm event and should be located at an appropriately selected site. Site selection must take account of the necessary geotechnical, environmental and topographical conditions, including wetland conservation.
- In addition to macro stormwater measures, micro-stormwater measures should be implemented. The form of this attenuation will be dependent on a number of factors such as topography (natural and artificial slopes), the zoning of the site and soil conditions present.

- A limited stormwater pipe network should be provided for stormwater reticulation to safely convey minor stormwater runoff to the stormwater management facility.
- 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.
- The proposed development 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.
- A stormwater systems model should be developed to determine peak flood flow rates and flood levels and assess the collective impacts of development 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.
- For areas flowing into the development area, potential future development in these sub-catchments should be considered and any requirements for stormwater attenuation should be identified. Similarly, for stormwater flowing out of the development area may impact on the downstream watercourse and this must be considered and measures taken to ensure any upstream development does not result in an increased flood damage risk downstream.
- Areas within the proposed development that are bound on stormwater management facilities, 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 the stormwater management facility, plus an appropriate freeboard allowance.
- Overland flow may be encouraged where possible, but should be avoided in the specific areas identified. These are typically where roads 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.
- Steeper stormwater channels will require protection from erosion through the use of appropriate channel lining, or controlled drops to dissipate flow energy.

- 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.

2.7 Guidelines for developers

Developers will be required to control stormwater runoff in accordance with the stormwater management philosophy and policies of Kwadukuza Municipality. The following guidelines are intended to assist 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.

2.7.1 Stormwater runoff control

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

(a) Buildings

Any building will inevitably result in some degree of flow concentration, or deflection of flow around the building.

The developer/owner shall ensure that the flow path of the stormwater 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.

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.

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.

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.

(b) Roof Drainage

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.

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) Parking Areas and Yards

Any external parking area, yard or other paved area must be designed to attenuate stormwater runoff from a major storm to an acceptable degree.

Any area described above must discharge rainwater flowing over, or falling onto its surface, in a controlled manner either overland as sheet flow, or into a stormwater management facility, or infiltration gallery suitably sized to accommodate minor storm runoff.

(d) Driveways and Paths

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.

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.

Where the driveway joins the road, the driveway must not obstruct the flow in any open channel, whether lined or unlined, found along the road verge.

(e) Roads

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.

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.

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.

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.

(f) Stormwater Management Facilities

The sufficiency and effectiveness of on-site stormwater management facilities to meet stormwater attenuation requirements within the minor and major stormwater systems is the responsibility of the property owner.

Any stormwater management facility shall be integrated with the landscape on the site.

Stormwater management facilities shall be maintained in good condition and shall not be permitted to become a health hazard or nuisance.

The 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.

(g) Subsurface Disposal of Stormwater

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.

Infiltration structures should be integrated into the terrain so as to be unobtrusive and in keeping with the natural surroundings.

(h) Channels

Lined and unlined channels may be constructed to convey stormwater to a natural watercourse where deemed necessary and unavoidable.

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.

(i) Energy Dissipaters

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.

Stormwater management facility devices should be provided at the head of the energy dissipating structure if possible.

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.

(j) Flow Retarders

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.

All such constructions must be regularly maintained by the owner and may be inspected at any time by the Municipality or their appointed representatives.

2.7.2 Stormwater pollution control

All property owners and developers shall ensure 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 and wetlands.

Regular monitoring of the sites should be undertaken by the Municipality or their appointed representatives.

Any site that is required to store any substances that could be regarded as hazardous in terms of water pollution shall notify the Municipalities 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.

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.

2.7.3 Stormwater erosion control

The Municipality should inspect the development on a regular basis to:

- Determine the effectiveness of the stormwater management policies and amend policy as and when necessary to meet the objectives of the Stormwater Management Plan.
- Advise the property owner / manager of any repair, maintenance and improvement works required on the stormwater system control elements within their jurisdiction.

2.7.4 Safety

(a) Inundation of Property and Buildings

Any pre-development 1 in 100 year flood line shown on a development plan may not be altered by the development of the site, land-forming or other means, without the approval of the Municipality and confirmation by an appropriately qualified person that the alteration does not diminish the performance of the existing stormwater system and any stormwater management facilities.

All risk of inundation by flood water is carried by the owner of the property. No flood water may be diverted or concentrated such that a risk of flooding or inundation of any property or building is created.

(b) Structural Damage

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 Tinley Manor South.

The above includes the undermining of structures due to erosion of soil and/or the subsidence of structures due to saturation of the foundations by stormwater.

3. STORMWATER MANAGEMENT PHILOSOPHY

The major stormwater system consists of all natural water ways, including springs, streams, rivers, wetlands, dams and other devices constructed to control stormwater. Roadways and their associated drainage structures are also 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 the development 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 of more than 1 in 50 years.

All elements of the built and natural environment must be able to withstand a 1 in 50 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.

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 the development encourages the owner / developer, the professional teams and contractors to do the following:

- 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.
- Ensure that all stormwater control works are constructed in a safe and aesthetic manner in keeping with the overall development.
- 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.

3.1 Stormwater plan implementation procedures

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

3.1.1 Application for Permission to Build

A copy of the Stormwater Management Plan shall be obtained from Tongaat Hulett Developments or the Municipality.

3.1.2 Site Survey and Investigations

Anyone involved in site survey and investigation work shall be familiar with the contents of this Stormwater Management Plan.

3.1.3 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 Municipality must be obtained before commencing construction.

3.1.4 Construction

The contractor shall prepare a Stormwater Control Plan to ensure that all construction methods adopted on site and within the Tinley Manor South 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.

3.1.5 Certificate of Occupation

On completion of the works, the 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 Municipality.

3.1.6 Occupation Period

During occupation of any property, the 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 the Municipality.

3.2 Compliance with stormwater management policy

Within Tinley Manor South 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.

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 Tinley Manor South.

Approval of any plan or document, whether verbally or in writing, by the Municipality shall not be construed as absolving the owner or the professional team of this responsibility.

3.3 Major Risks

3.3.1 Erosion

Erosion is a major risk as identified in the REPORT TO TONGAAT HULETT DEVELOPMENT ON THE GEOTECHNICAL DESKTOP PHASE 1 ASSESSMENT FOR THE PROPOSED DEVELOPMENT OF TINLEY MANOR ESTATE SOUTH BANK, Ref m 23312, DRENNAN, MAUD AND PARTNERS, AND DECEMBER 2012, and the extract below.

Erosive Soils

The very loose to loose consistency, low cohesion between individual particles and fine to medium grained particle size of the Recent aeolian Dune sand, sandy Berea Formation and sandy colluvium results in these material being highly prone to erosion via wind and flowing storm water run-off, especially given the sloping nature of the site.

Furthermore, the likelihood of erosion will increase dramatically once the site is cleared of covering vegetation for the purpose of the development, which has a binding action on the underlying soils. As such, strict measures should be in place both during and after

construction to control storm water run-off across the site. Post construction all batters and unpaved areas should be vegetated in order to keep the erosion of upper soils to a minimum.

Due to the likely moderately high clay content within the more clayey colluvial and residual materials, these soils are not as susceptible to erosion; however, if subjected to concentrated surface flow, erosion is probable.

3.3.2 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. The design of the stormwater system must address this issue as far as possible and must be designed such that the downstream post-development flood risks are no greater than the pre-development flood risks.

As a guide to the degree of runoff attenuation required, pre-development and post development 50-year and 10 year flood estimates are given in the attached appendices.

4. HYDROLOGY AND HYDRAULICS

4.1 Rational Method

The Rational Method was used to estimate the peak stormwater runoff as a result of this development. The rational method calculation was done in accordance to EThekwini Municipality Stormwater Design Manual. The results of these calculations indicate that attenuation is required to accommodate the increase in stormwater runoff in a 1:10 and 1:50 year storms.

Due to the lack of rainfall data available, rainfall data for surrounding areas were used as an estimate. The rainfall data used was obtained from “Rainfall Statistics for Design Flood Estimation in South Africa" for the 1 in 10 and 1 in 50 year return periods was used in these calculations. A time of concentration (Tc) of 15 minutes was used to select a storm duration.

The Rational method calculations was done keeping the catchment boundaries the same for the pre-development and the post-development.

In the Rational Method, the pre-development C-factors are influenced by the steepness of the sub-catchment, the permeability of the soil and type of vegetal cover. The permeability of the soil is assumed to be semi-permeable and currently cultivated.

The post development C-factors were determined by measuring the area of each land use within a sub-catchment and then weighting the appropriate C-factors according to the ratio of land use versus overall area.

4.2 Stormwater Management System

The following key aspects will be implemented in doing the detailed design plan:

- All internal storm water reticulation will be designed with due cognizance accordance of the relevant guidelines.
- The use of the proposed road network will act as the primary stormwater collector with controlled discharge into stormwater management facilities.
- Overland flow routes are to be identified and maintained.
- The secondary system (pipe network) will be designed to accommodate the 1:3 and 1:10 year peak flow at critical points.
- Stormwater management facilities will be used to reduce runoff into the natural drainage system to the pre-development 1:10 and 1:50 year flood. Excess storm water will be attenuated on site and stormwater management facilities will be sized to accommodate the difference between the 1:50 pre and post development runoff volumes.

4.2.1 Proposed Stormwater Management Facilities

(Refer to Annexure C and Annexure D)

Dry Stormwater Management Facilities (SMF) are proposed as temporary storage facilities for the anticipated stormwater runoff. A total of 42 SMF's are proposed. The facilities for the development are a combination of constructed swales and dry attenuation structures. The decision of incorporating both these facilities was greatly affected by the position of the wetland.

The proposed swales will be constructed using Reno mattresses and gabion boxes, to prevent soil erosion. In addition to these stormwater management facilities, on site attenuation will be promoted on all sites. The combined attenuation volume for the proposed facilities is approximately 31 000m^3.

With these measures put in place, the attenuation volumes will meet the required attenuation for the development based on the Rational Method calculation (Annexure A). The table below provides a brief description of the SMF proposed and the volume that can be accommodated in each SMF (Refer to Annexure D):

Table 1: Summary of SMF

Name	SMF type	Depth (m)	Width (m)	Length (m)	Volume (m^3)
SMF 2	Dry attenuation structure	-	-	-	1380
SMF 3	Dry attenuation structure	-	-	-	900
SMF 4	Dry attenuation structure	-	-	-	970
SMF 5	Swale	1	2	114	228
SMF 6	Swale	1	4.5	154	693
SMF 7	Dry attenuation structure	-	-	-	1 730
SMF 9	Swale	1	8.5	292	2 485
SMF 10	Dry attenuation structure	-	-	-	1 470
SMF 11	Swale	1	6	89	522
SMF 12	Swale	1	6.5	365	2 375
SMF 13	Swale	1	4.5	257	1 156
SMF 15	Swale	1	4	160	640
SMF 16	Swale	1	1	146	146
SMF 17	Swale	1	2	180	360
SMF 18	Swale	1	2	120	240
SMF 19	Swale	1	2	115	230
SMF 20	Swale	1	2	500	1 000
SMF 21	Swale	1	2.5	78	195
SMF 22	Swale	1	2	160	320
SMF 23	Swale	1	2	100	200
SMF 24	Swale	1	4	150	600
SMF 25	Swale	1	2	119	238
SMF 26	Swale	1	2	250	500
SMF 27	Swale	1	2	80	160
SMF 28	Swale	1	1	160	160
SMF 29	Swale	1	2	160	320
SMF 30	Swale	1	2	40	80

Name	SMF type	Depth (m)	Width (m)	Length (m)	Volume (m^3)
SMF 31	Swale	1	4	55	220
SMF 32	Swale	1	8 and 4	220	1 280
SMF 33	Swale	1	6	120	720
SMF 34	Swale	1	4	60	240
SMF 35	Swale	1	2	90	180
SMF 36	Swale	1	2	80	160
SMF 37	Swale	1	4	90	360
SMF 38	Swale	1	2	160	320
SMF 39	Swale	1	4	10	40
SMF 40	Dry attenuation structure	-	-	-	2 000
SMF 41	Swale	1	4	600	600
SMF 43	Dry attenuation structure	-	-	-	1 700
SMF 44	Dry attenuation structure	-	-	-	1 000
SMF 45	Swale	1	10	200	2 000
SMF 46	Swale	1	3.5	200	700
SMF 47	Swale	1	6	260	1560
				TOTAL	**32 378**

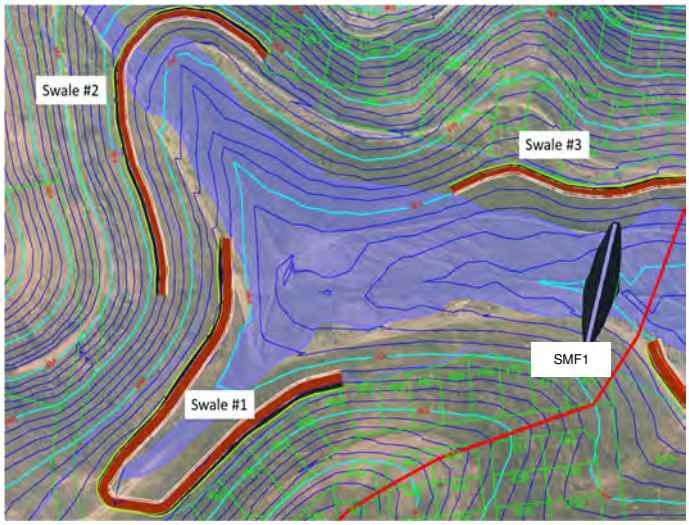
4.2.2 Alternative Stormwater Management Faculties

The proposed stormwater management facilities (Refer to 13.2.1) was assessed taking into the account the location of wetlands, the topography of the land and the extent of the proposed development. Various alternative solutions were investigated, but the proposed combination of dry attention structures and multiple swales was found to be the most feasible.

An alternative solution included larger SMF's in the form of normally dry attenuation structures, situated within wetlands. Construction cost of these facilities would be considerably lower than the construction costs associated with the proposed swales.

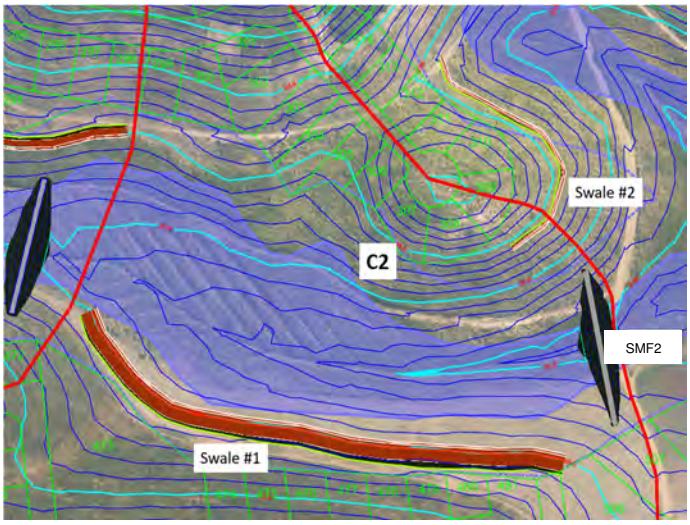
The wetland losses associated with the above mentioned alternative, and the costs associated with the wetland rehabilitation required to offset these losses, however rendered the alternative unfeasible.

A few examples of the larger alternative SMF's are depicted below:



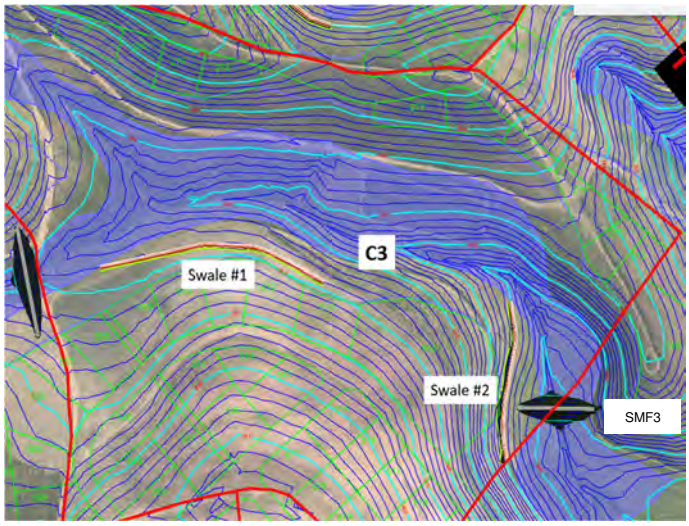
Proposed solution:
Swale 1, Area = 2 340m^2
Swale 2, Area = 729m^2
Swale 3, Area = 640m^2

Alternative Solution: SMF1
Area = 14 684m^2
Associated wetland los = 10 000m^3



Proposed solution:
Swale 1, Area = 2 465m^2
Swale 2, Area = 147m^2

Alternative Solution: SMF2
Area = 8 716m^2
Associated wetland loss= 10 000m^3



Proposed solution:
Swale 1, Area = 360m^2
Swale 2, Area = 729m^2

Alternative Solution: SMF3
Area = 2 533m^2
Associated wetland loss = 3 763m^3

5. CONCLUSION

It is evident from the Rational Method results that one of the negative impacts of the development is a substantial increase in the peak stormwater runoff flows for both the 1 in 10 and 1 in 50 year return periods.

The increase in peak runoff will primarily be mitigated by the introduction of stormwater management facilities as part of the stormwater network. These devices will be dry stormwater management facilities.

These stormwater management facilities will be required to reduce the post-development peak runoffs for the 1 in 10 and 1 in 50 year storms to pre-development levels. With this in mind, it is recommended that the hydraulic characteristics of the stormwater network is analysed (using EPASWMM or similar software) during the detail design part of the project. This analysis will accurately determine the attenuation volumes required and the outlet configuration in order to reduce the peak outflows to pre-development levels.

ANNEXURE A
STORMWATER RUNOFF ESTIMATES (RATIONAL METHOD)

Tinley Manor - Rational Method Summary & Attenuation Requirements (1:10 RI)

Catchment Name	Rational Method Calculation (1:10 Year RI)													
		Pre-Development						Post-Development						Attenuation Required (m^3)
	f_t	C	I (mm/hr)	A (Ha)	Q (m^3/s)	T_C (min.)	Storm Volume (m^3)	C	I (mm/hr)	A (Ha)	Q (m^3/s)	T_C (min.)	Storm Volume (m^3)	
C1	0.6	0.454	134.9	5.169	**0.528**	17	539	0.640	146.0	5.169	**0.805**	15	724	**221**
C2	0.6	0.550	119.0	10.473	**1.143**	21	1 440	0.644	146.0	10.473	**1.641**	15	1 477	**495**
C3	0.6	0.450	113.2	6.687	**0.568**	23	783	0.648	146.0	6.687	**1.055**	15	949	**456**
C4	0.6	0.565	122.4	3.344	**0.386**	20	463	0.672	146.0	3.438	**0.562**	15	506	**162**
C5	0.6	0.550	126.1	4.920	**0.569**	19	648	0.647	146.0	4.920	**0.774**	15	697	**185**
C6	0.6	0.450	146.0	3.661	**0.401**	15	361	0.535	146.0	3.661	**0.477**	15	429	**69**
C7	0.6	0.550	130.3	10.692	**1.277**	18	1 379	0.750	146.0	10.692	**1.952**	15	1 757	**546**
C8	0.6	0.550	126.1	5.213	**0.603**	19	687	0.763	146.0	5.213	**0.968**	15	871	**304**
C9	0.6	0.550	119.0	23.597	**2.575**	21	3 244	0.652	146.0	23.597	**3.745**	15	3 370	**1 150**
C10	0.6	0.550	126.1	9.911	**1.146**	19	1 306	0.714	168.6	9.911	**1.990**	10	1 194	**638**
C11	0.6	0.550	130.3	6.316	**0.754**	18	814	0.695	146.0	6.316	**1.068**	15	961	**257**
C12	0.6	0.546	108.2	11.843	**1.166**	25	1 748	0.734	146.0	11.843	**2.116**	15	1 905	**958**
C13	0.6	0.550	122.4	7.707	**0.865**	20	1 038	0.741	146.0	7.707	**1.390**	15	1 251	**457**
C14	0.6	0.550	146.0	3.643	**0.488**	15	439	0.577	146.0	3.643	**0.511**	15	460	**21**
C15	0.6	0.550	134.9	6.669	**0.825**	17	841	0.672	146.0	6.669	**1.090**	15	981	**210**
C16	0.6	0.550	146.0	1.861	**0.249**	15	224	0.584	146.0	1.861	**0.264**	15	238	**14**
C17	0.6	0.550	134.9	3.650	**0.451**	17	460	0.648	146.0	3.650	**0.575**	15	518	**99**
C18	0.6	0.556	140.1	3.215	**0.418**	16	401	0.655	146.0	3.251	**0.518**	15	466	**78**
C19	0.6	0.550	119.0	2.336	**0.255**	21	321	0.704	146.0	2.336	**0.400**	15	360	**135**
C20	0.6	0.550	146.0	7.113	**0.952**	15	857	0.662	146.0	7.113	**1.146**	15	1 032	**175**
C21	0.6	0.550	146.0	1.637	**0.219**	15	197	0.755	146.0	1.637	**0.301**	15	271	**74**
C22	0.6	0.550	140.1	4.288	**0.551**	16	529	0.654	146.0	4.288	**0.682**	15	614	**102**
C23	0.6	0.550	146.0	1.435	**0.192**	15	173	0.703	146.0	1.435	**0.245**	15	221	**48**
C24	0.6	0.435	134.9	3.855	**0.377**	17	385	0.679	146.0	3.855	**0.637**	15	573	**211**
C25	0.6	0.607	146.0	3.171	**0.468**	15	422	0.701	146.0	3.171	**0.541**	15	487	**65**
C26	0.6	0.532	130.3	5.219	**0.603**	18	651	0.673	146.0	5.219	**0.854**	15	769	**206**
C27	0.6	0.550	146.0	2.874	**0.385**	15	346	0.634	146.0	2.874	**0.443**	15	399	**53**
C28	0.6	0.550	146.0	2.140	**0.286**	15	258	0.674	146.0	2.140	**0.351**	15	316	**58**
C29	0.6	0.550	146.0	2.309	**0.309**	15	278	0.687	146.0	2.309	**0.386**	15	347	**69**
C30	0.6	0.550	146.0	1.027	**0.137**	15	124	0.700	146.0	1.027	**0.175**	15	157	**34**
C31	0.6	0.550	126.1	4.354	**0.503**	19	574	0.657	146.0	4.354	**0.696**	15	626	**171**
C32	0.6	0.552	116.0	8.120	**0.866**	22	1 143	0.728	168.6	8.120	**1.660**	10	996	**614**
C33	0.6	0.551	130.3	5.292	**0.633**	18	684	0.746	146.0	5.292	**0.960**	15	864	**264**
C34	0.6	0.550	140.1	2.631	**0.338**	16	324	0.732	146.0	2.631	**0.468**	15	421	**105**
C35	0.6	0.460	146.0	1.361	**0.152**	15	137	0.788	146.0	1.361	**0.261**	15	235	**98**
C36	0.6	0.550	146.0	0.647	**0.087**	15	78	0.698	146.0	0.647	**0.110**	15	99	**21**
C37	0.6	0.550	146.0	3.855	**0.516**	15	464	0.712	146.0	3.855	**0.668**	15	601	**137**
C38	0.6	0.550	126.1	3.641	**0.421**	19	480	0.684	146.0	3.641	**0.606**	15	546	**160**
C39	0.6	0.550	146.0	1.171	**0.157**	15	141	0.599	146.0	1.171	**0.171**	15	154	**13**
C40	0.6	0.460	146.0	6.060	**0.678**	15	610	0.734	146.0	6.060	**1.083**	15	975	**364**
C41	0.6	0.550	116.0	5.497	**0.584**	22	771	0.720	146.0	5.497	**0.964**	15	867	**360**
C42	0.6	0.550	126.1	8.046	**0.930**	19	1 060	0.774	146.0	8.046	**1.516**	15	1 365	**486**
C43	0.6	0.550	130.3	5.202	**0.621**	18	671	0.793	168.6	5.202	**1.159**	10	695	**376**
C44	0.6	0.460	146.0	4.387	**0.491**	15	442	0.789	168.6	4.387	**0.973**	10	584	**290**
C45	0.6	0.460	106.1	9.296	**0.756**	26	1 179	0.753	146.0	9.296	**1.704**	15	1 533	**908**
C46	0.6	0.460	146.0	4.540	**0.508**	15	457	0.758	146.0	4.540	**0.837**	15	754	**296**
C47	0.6	0.550	146.0	3.848	**0.515**	15	463	0.729	168.6	3.848	**0.788**	10	473	**186**
C48	0.6	0.550	146.0	1.462	**0.196**	15	176	0.720	168.6	1.462	**0.296**	10	178	**69**
C49	0.6	0.550	146.0	5.306	**0.710**	15	639	0.802	168.6	5.306	**1.196**	10	718	**311**
C50	0.6	0.550	146.0	1.207	**0.162**	15	145	0.600	146.0	1.207	**0.176**	15	159	**13**
C51	0.6	0.460	122.4	7.392	**0.694**	20	832	0.698	146.0	7.392	**1.256**	15	1 130	**476**
Total				**259.285**			**32 829**			**259.416**			**38 272**	**13 269**

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Tinley Manor - Rational Method Summary & Attenuation Requirements (1:50 RI)

Catchment Name	Rational Method Calculation (1:50 Year RI)													
		Pre-Development						Post-Development						Attenuation Required (m^3)
	f_t	C	I (mm/hr)	A (Ha)	Q (m^3/s)	T_C (min.)	Storm Volume (m^3)	C	I (mm/hr)	A (Ha)	Q (m^3/s)	T_C (min.)	Storm Volume (m^3)	
C1	0.83	0.454	210.6	5.169	**1.140**	17	1 163	0.640	228.0	5.169	**1.739**	15	1 565	**478**
C2	0.83	0.550	185.8	10.473	**2.468**	21	3 110	0.644	228.0	10.473	**3.544**	15	3 190	**1 071**
C3	0.83	0.450	176.7	6.687	**1.226**	23	1 691	0.648	228.0	6.687	**2.278**	15	2 050	**985**
C4	0.83	0.565	191.1	3.344	**0.833**	20	1 000	0.672	228.0	3.438	**1.214**	15	1 093	**350**
C5	0.83	0.550	196.9	4.920	**1.229**	19	1 401	0.647	228.0	4.920	**1.673**	15	1 506	**401**
C6	0.83	0.450	228.0	3.661	**0.866**	15	779	0.535	228.0	3.661	**1.030**	15	927	**148**
C7	0.83	0.550	203.4	10.692	**2.758**	18	2 978	0.750	228.0	10.692	**4.216**	15	3 795	**1 180**
C8	0.83	0.550	196.9	5.213	**1.302**	19	1 484	0.763	228.0	5.213	**2.091**	15	1 882	**656**
C9	0.83	0.550	185.8	23.597	**5.560**	21	7 006	0.652	228.0	23.597	**8.090**	15	7 281	**2 486**
C10	0.83	0.550	196.9	9.911	**2.475**	19	2 821	0.714	263.4	9.911	**4.300**	10	2 580	**1 380**
C11	0.83	0.550	203.4	6.316	**1.629**	18	1 759	0.695	228.0	6.316	**2.307**	15	2 077	**555**
C12	0.83	0.546	169.0	11.843	**2.517**	25	3 775	0.734	228.0	11.843	**4.572**	15	4 114	**2 071**
C13	0.83	0.550	191.1	7.707	**1.868**	20	2 241	0.741	228.0	7.707	**3.003**	15	2 703	**986**
C14	0.83	0.550	228.0	3.643	**1.053**	15	948	0.577	228.0	3.643	**1.104**	15	994	**46**
C15	0.83	0.550	210.6	6.669	**1.781**	17	1 817	0.672	228.0	6.669	**2.355**	15	2 120	**454**
C16	0.83	0.550	228.0	1.861	**0.538**	15	484	0.584	228.0	1.861	**0.571**	15	514	**30**
C17	0.83	0.550	210.6	3.650	**0.975**	17	994	0.648	228.0	3.650	**1.242**	15	1 118	**213**
C18	0.83	0.556	218.8	3.215	**0.902**	16	866	0.655	228.0	3.251	**1.119**	15	1 007	**169**
C19	0.83	0.550	185.8	2.336	**0.550**	21	694	0.704	228.0	2.336	**0.864**	15	777	**291**
C20	0.83	0.550	228.0	7.113	**2.057**	15	1 851	0.662	228.0	7.113	**2.477**	15	2 229	**378**
C21	0.83	0.550	228.0	1.637	**0.473**	15	426	0.755	228.0	1.637	**0.650**	15	585	**159**
C22	0.83	0.550	218.8	4.288	**1.190**	16	1 142	0.654	228.0	4.288	**1.474**	15	1 326	**221**
C23	0.83	0.550	228.0	1.435	**0.415**	15	373	0.703	228.0	1.435	**0.530**	15	477	**104**
C24	0.83	0.435	210.6	3.855	**0.814**	17	831	0.679	228.0	3.855	**1.376**	15	1 238	**456**
C25	0.83	0.607	228.0	3.171	**1.012**	15	911	0.701	228.0	3.171	**1.168**	15	1 051	**141**
C26	0.83	0.532	203.4	5.219	**1.302**	18	1 406	0.673	228.0	5.219	**1.845**	15	1 661	**444**
C27	0.83	0.550	228.0	2.874	**0.831**	15	748	0.634	228.0	2.874	**0.958**	15	862	**114**
C28	0.83	0.550	228.0	2.140	**0.619**	15	557	0.674	228.0	2.140	**0.759**	15	683	**126**
C29	0.83	0.550	228.0	2.309	**0.667**	15	601	0.687	228.0	2.309	**0.834**	15	750	**150**
C30	0.83	0.550	228.0	1.027	**0.297**	15	267	0.700	228.0	1.027	**0.378**	15	340	**73**
C31	0.83	0.550	196.9	4.354	**1.087**	19	1 239	0.657	228.0	4.354	**1.503**	15	1 352	**369**
C32	0.83	0.552	181.0	8.120	**1.871**	22	2 469	0.728	263.4	8.120	**3.588**	10	2 153	**1 328**
C33	0.83	0.551	203.4	5.292	**1.368**	18	1 477	0.746	228.0	5.292	**2.074**	15	1 867	**571**
C34	0.83	0.550	218.8	2.631	**0.730**	16	701	0.732	228.0	2.631	**1.012**	15	910	**227**
C35	0.83	0.460	228.0	1.361	**0.329**	15	296	0.788	228.0	1.361	**0.564**	15	508	**211**
C36	0.83	0.550	228.0	0.647	**0.187**	15	168	0.698	228.0	0.647	**0.238**	15	214	**45**
C37	0.83	0.550	228.0	3.855	**1.115**	15	1 003	0.712	228.0	3.855	**1.444**	15	1 299	**296**
C38	0.83	0.550	196.9	3.641	**0.909**	19	1 036	0.684	228.0	3.641	**1.310**	15	1 179	**346**
C39	0.83	0.550	228.0	1.171	**0.338**	15	305	0.599	228.0	1.171	**0.369**	15	332	**27**
C40	0.83	0.460	228.0	6.060	**1.465**	15	1 319	0.734	228.0	6.060	**2.339**	15	2 105	**787**
C41	0.83	0.550	181.0	5.497	**1.262**	22	1 666	0.720	228.0	5.497	**2.082**	15	1 873	**778**
C42	0.83	0.550	196.9	8.046	**2.009**	19	2 290	0.774	228.0	8.046	**3.275**	15	2 948	**1 051**
C43	0.83	0.550	203.4	5.202	**1.342**	18	1 449	0.793	263.4	5.202	**2.504**	10	1 502	**813**
C44	0.83	0.460	228.0	4.387	**1.061**	15	955	0.789	263.4	4.387	**2.102**	10	1 261	**626**
C45	0.83	0.460	165.6	9.296	**1.632**	26	2 546	0.753	228.0	9.296	**3.681**	15	3 313	**1 963**
C46	0.83	0.460	228.0	4.540	**1.098**	15	988	0.758	228.0	4.540	**1.809**	15	1 628	**640**
C47	0.83	0.550	228.0	3.848	**1.112**	15	1 001	0.729	263.4	3.848	**1.703**	10	1 022	**402**
C48	0.83	0.550	228.0	1.462	**0.423**	15	380	0.720	263.4	1.462	**0.640**	10	384	**149**
C49	0.83	0.550	228.0	5.306	**1.534**	15	1 381	0.802	263.4	5.306	**2.585**	10	1 551	**672**
C50	0.83	0.550	228.0	1.207	**0.349**	15	314	0.600	228.0	1.207	**0.381**	15	343	**29**
C51	0.83	0.460	191.1	7.392	**1.498**	20	1 798	0.698	228.0	7.392	**2.713**	15	2 442	**1 028**
Total				**259.285**			**70 907**			**259.416**			**82 681**	**28 675**

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ANNEXURE B
CALCULATIONS FOR TIME OF CONCENTRATION

SMEC
Local People. Global Experience.

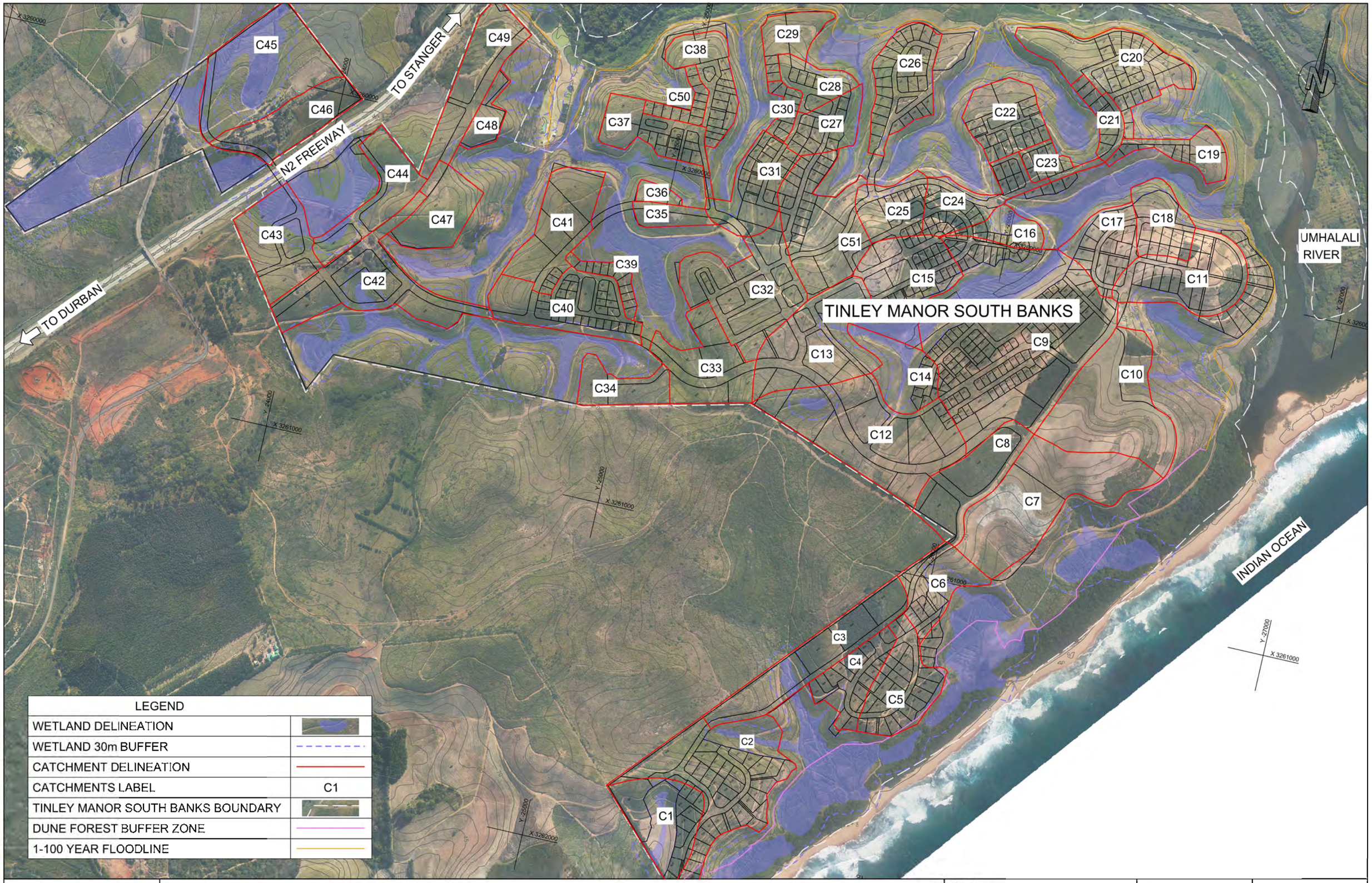
Tinley Manor - Pre-Dev Input

Catchment Name	Catchment Area (Ha)	Catchment Land Use (used to determine min. T_C)	Time of Concentration, Tc (min.)																DWA Method with MAP > 900mm - Runoff Coefficient, C_f (enter areas in Ha)															Rainfall Depth (mm)	
			Overland Flow						Streamflow						Mannings								Steepness/Slope, C_s					Permeability, C_p					Vegetal Growth, C_v							
			r-factor	Length, L (m)	Height, z_1 @ 10% of L from discharge point	Height, z_2 @ 85% of L from discharge point	Slope, S (m/m)	Tc_{OF} (min.)	Length, L (m)	Height, z_1 @ 10% from discharge point	Height, z_2 @ 85% from discharge point	Slope, S (m/m)	Tc_{SF} (min.)	Length, L (m)	Absolute Minimum Velocity, v (m/s)	Tc_{M} (min.)	Tc_{PD} (Tc_{OF} + Tc_{SF} + Tc_{M}) (min.)	Minimum Tc_{PD} (min.)	Chosen Tc_{PD} (min.)	*<3% C_s=0.05*	*3-10% C_s=0.11*	*10-30% C_s=0.20*	*>30% C_s=0.30*	C_s	*Very perm (dunes) C_p=0.05*	*Perm (light soil) C_p=0.10*	*Semi (most soils) C_p=0.20*	*Imperm (rock / paving) C_p=0.30*	C_p	*Dense bush, forest C_v=0.05*	*Cult land, sparse bush C_v=0.15*	*Grassland C_v=0.25*	*Bare surface C_v=0.30*	C_v	C_r	1:10 RI	1:50 RI
C1	5.1685	Residential	0.40	200.000	75.000	44.895	0.201	16.103	25.397	44.804	44.000	0.042	0.796			0.000	17	15	17			5.2588		0.20			5.1685		0.20	5.2588				0.05	0.45	38.2	59.7
C2	10.4733	Residential	0.40	200.000	86.000	59.305	0.178	16.561	321.608	56.670	31.393	0.105	3.960			0.000	21	15	21			10.4733		0.20			10.4733		0.20		10.4733			0.15	0.55	41.7	65.0
C3	6.6868	Residential	0.40	200.000	69.000	50.578	0.123	18.060	286.145	48.491	37.000	0.054	4.687			0.000	23	15	23			6.6868		0.20			6.6868		0.20	6.6868				0.05	0.45	43.4	67.7
C4	3.3438	Residential	0.40	200.000	53.000	36.578	0.109	18.551	88.202	35.515	28.000	0.114	1.418			0.000	20	15	20			3.4380		0.21			3.4380		0.21		3.4380			0.15	0.57	40.8	63.7
C5	4.9199	Residential	0.40	200.000	58.000	30.504	0.183	16.447	166.301	29.248	19.000	0.082	2.617			0.000	19	15	19			4.9199		0.20			4.9199		0.20		4.9199			0.15	0.55	39.9	62.4
C6	3.6606	Residential	0.40	191.584	69.000	30.431	0.268	14.747					0.000			0.000	15	15	15			3.6606		0.20			3.6606		0.20	3.6606				0.05	0.45	36.5	57.0
C7	10.6924	Residential	0.40	200.000	52.000	32.000	0.133	17.716	23.047	31.772	30.135	0.095	0.541			0.000	18	15	18			10.6924		0.20			10.6924		0.20		10.6924			0.15	0.55	39.1	61.0
C8	5.2129	Residential	0.40	200.000	72.000	55.614	0.109	18.560	41.568	55.385	53.000	0.077	0.925			0.000	19	15	19			5.2129		0.20			5.2129		0.20		5.2129			0.15	0.55	39.9	62.4
C9	23.5965	Residential	0.40	200.000	74.000	51.438	0.150	17.225	246.220	48.757	37.519	0.061	3.974			0.000	21	15	21			23.5965		0.20			23.5965		0.20		23.5965			0.15	0.55	41.7	65.0
C10	9.9108	Residential	0.40	200.000	78.000	53.541	0.163	16.903	212.386	51.839	30.000	0.137	2.594			0.000	19	15	19			9.9108		0.20			9.9108		0.20		9.9108			0.15	0.55	39.9	62.4
C11	6.3157	Residential	0.40	200.000	47.000	25.000	0.147	17.326	21.463	24.915	24.541	0.023	0.880			0.000	18	15	18			6.3157		0.20			6.3157		0.20		6.3157			0.15	0.55	39.1	61.0
C12	11.8425	Residential	0.40	200.000	86.000	76.630	0.062	21.148	336.261	71.293	43.000	0.112	3.992			0.000	25	15	25		11.8425	5.0655		0.20			11.8425		0.20		11.8425			0.15	0.55	45.1	70.4
C13	7.7073	Residential	0.40	200.000	86.000	67.000	0.127	17.930	183.363	65.299	50.740	0.106	2.559			0.000	20	15	20			7.7073		0.20			7.7073		0.20		7.7073			0.15	0.55	40.8	63.7
C14	3.6428	Residential	0.40	77.414	55.740	41.626	0.243	9.885					0.000			0.000	10	15	15			3.6428		0.20			3.6428		0.20		3.6428			0.15	0.55	36.5	57.0
C15	6.6692	Residential	0.40	200.000	75.000	44.000	0.207	15.993	48.501	43.690	40.813	0.079	1.028			0.000	17	15	17			6.6692		0.20			6.6692		0.20		6.6692			0.15	0.55	38.2	59.7
C16	1.8612	Residential	0.40	87.722	45.000	35.000	0.152	11.693					0.000			0.000	12	15	15			1.8612		0.20			1.8612		0.20		1.8612			0.15	0.55	36.5	57.0
C17	3.6495	Residential	0.40	186.222	47.000	29.000	0.129	17.272					0.000			0.000	17	15	17			3.6495		0.20			3.6495		0.20		3.6495			0.15	0.55	38.2	59.7
C18	3.2150	Residential	0.40	194.503	47.000	15.000	0.219	15.568					0.000			0.000	16	15	16			3.2514		0.20			3.2514		0.20		3.2514			0.15	0.56	37.4	58.3
C19	2.3359	Residential	0.40	200.000	41.000	26.000	0.100	18.947	122.802	25.833	16.665	0.100	1.924			0.000	21	15	21			2.3359		0.20			2.3359		0.20		2.3359			0.15	0.55	41.7	65.0
C20	7.1132	Residential	0.40	183.094	41.000	12.000	0.211	15.269					0.000			0.000	15	15	15			7.1132		0.20			7.1132		0.20		7.1132			0.15	0.55	36.5	57.0
C21	1.6374	Residential	0.40	113.835	41.280	28.551	0.149	13.266					0.000			0.000	13	15	15			1.6371		0.20			1.6371		0.20		1.6371			0.15	0.55	36.5	57.0
C22	4.2881	Residential	0.40	200.000	54.000	21.000	0.220	15.761	22.901	20.670	18.396	0.132	0.473			0.000	16	15	16			4.2881		0.20			4.2881		0.20		4.2881			0.15	0.55	37.4	58.3
C23	1.4349	Residential	0.40	130.718	56.000	37.000	0.194	13.310					0.000			0.000	13	15	15			1.4349		0.20			1.4349		0.20		1.4349			0.15	0.55	36.5	57.0
C24	3.8554	Residential	0.40	200.000	67.000	41.677	0.169	16.766	14.529	41.389	39.543	0.169	0.303			0.000	17	15	17		3.6456			0.10			3.6456		0.19		3.6456			0.14	0.43	38.2	59.7
C25	3.1707	Residential	0.40	196.475	75.000	40.000	0.238	15.354					0.000			0.000	15	15	15			3.4994		0.22			3.4994		0.22		3.4994			0.17	0.61	36.5	57.0
C26	5.2188	Residential	0.40	200.000	40.000	18.651	0.142	17.448	49.827	18.000	11.898	0.163	0.794			0.000	18	15	18		1.0438	4.1750		0.18			5.2188		0.20		5.2188			0.15	0.53	39.1	61.0
C27	2.8735	Residential	0.40	169.000	58.000	30.000	0.221	14.555					0.000			0.000	15	15	15			2.8735		0.20			2.8735		0.20		2.8734			0.15	0.55	36.5	57.0
C28	2.1403	Residential	0.40	140.678	48.000	25.000	0.218	13.402					0.000			0.000	13	15	15			2.1403		0.20			2.1403		0.20		2.1403			0.15	0.55	36.5	57.0
C29	2.3085	Residential	0.40	142.732	30.000	11.000	0.177	14.156					0.000			0.000	14	15	15			2.3085		0.20			2.3085		0.20		2.3085			0.15	0.55	36.5	57.0
C30	1.0272	Residential	0.40	77.236	51.000	38.000	0.224	10.060					0.000			0.000	10	15	15			1.0272		0.20			1.0272		0.20		1.0272			0.15	0.55	36.5	57.0
C31	4.3536	Residential	0.40	200.000	64.000	44.156	0.132	17.749	48.078	44.000	41.000	0.083	1.002			0.000	19	15	19			4.3536		0.20			4.3536		0.20		4.3536			0.15	0.55	39.9	62.4
C32	8.1195	Residential	0.40	200.000	77.000	62.000	0.100	18.947	179.755	58.672	47.574	0.082	2.777			0.000	22	15	22			8.1492		0.20			8.1492		0.20		8.1492			0.15	0.55	42.5	66.4
C33	5.2919	Residential	0.40	200.000	85.000	51.898	0.221	15.750	101.933	51.381	49.000	0.031	2.608			0.000	18	15	18			5.3034		0.20			5.3034		0.20		5.3034			0.15	0.55	39.1	61.0
C34	2.6308	Residential	0.40	163.603	71.000	52.000	0.155	15.576					0.000			0.000	16	15	16			2.6308		0.20			2.6308		0.20		2.6308			0.15	0.55	37.4	58.3
C35	1.3608	Residential	0.40	58.861	51.000	42.680	0.188	9.230					0.000			0.000	9	15	15		1.3608			0.11			1.3608		0.20		1.3608			0.15	0.46	36.5	57.0
C36	0.6471	Residential	0.40	60.364	50.000	39.000	0.243	8.802					0.000			0.000	9	15	15			0.6471		0.20			0.6471		0.20		0.6471			0.15	0.55	36.5	57.0
C37	3.8550	Residential	0.40	110.118	56.000	39.504	0.200	12.200					0.000			0.000	12	15	15			3.8552		0.20			3.8552		0.20		3.8552			0.15	0.55	36.5	57.0
C38	3.6406	Residential	0.40	200.000	54.591	34.000	0.137	17.596	84.661	33.000	23.418	0.151	1.231			0.000	19	15	19			3.6406		0.20			3.6406		0.20		3.6406			0.15	0.55	39.9	62.4
C39	1.1707	Residential	0.40	40.575	55.000	48.000	0.230	7.405					0.000			0.000	7	15	15			1.1707		0.20			1.1707		0.20		1.1707			0.15	0.55	36.5	57.0
C40	6.0599	Residential	0.40	71.183	56.000	46.000	0.187	10.101					0.000			0.000	10	15	15		6.0599			0.11			6.0599		0.20		6.0599			0.15	0.46	36.5	57.0
C41	5.4968	Residential	0.40	200.000	70.000	55.527	0.096	19.106	177.243	53.218	42.000	0.084	2.720			0.000	22	15	22			5.4968		0.20			5.4968		0.20		5.4968			0.15	0.55	42.5	66.4
C42	8.0455	Residential	0.40	200.000	86.000	65.000	0.140	17.516	88.030	63.000	52.000	0.167	1.221			0.000	19	15	19			8.0455		0.20			8.0455		0.20		8.0455			0.15	0.55	39.9	62.4
C43	5.2023	Residential	0.40	200.000	85.574	53.000	0.217	15.809	99.204	52.000	48.527	0.047	2.186			0.000	18	15	18			5.2023		0.20			5.2023		0.20		5.2023			0.15	0.55	39.1	61.0
C44	4.3874	Residential	0.40	127.293	67.000	56.466	0.110	14.994					0.000			0.000	15	15	15		4.3874			0.11			4.3874		0.20		4.3874			0.15	0.46	36.5	57.0
C45	9.2960	Residential	0.40	200.000	63.506	55.405	0.054	21.879	286.601	53.297	32.000	0.099	3.703			0.000	26	15	26		9.2960			0.11			9.2960		0.20		9.2960			0.15	0.46	46.0	71.7
C46	4.5395	Residential	0.40	128.290	61.000	40.000	0.218	12.833					0.000			0.000	13	15	15		4.5395			0.11			4.5395		0.20		4.5395			0.15	0.46	36.5	57.0
C47	3.8477	Residential	0.40	110.392	76.000	53.000	0.278	11.309					0.000			0.000	11	15	15			3.8477		0.20			3.8477		0.20		3.8477			0.15	0.55	36.5	57.0
C48	1.4622	Residential	0.40	104.777	67.000	50.000	0.216	11.700					0.000			0.000	12	15	15			1.4622		0.20			1.4622		0.20		1.4622			0.15	0.55	36.5	57.0
C49	5.3055	Residential	0.40	193.990	60.000	21.000	0.268	14.838					0.000			0.000	15	15	15			5.3055		0.20			5.3055		0.20		5.3055			0.15	0.55	36.5	57.0
C50	1.2072	Residential	0.40	70.020	55.000	44.000	0.209	9.766					0.000			0.000	10	15	15			1.2072		0.20			1.2072		0.20		1.2072			0.15	0.55	36.5	57.0
C51	7.3924	Residential	0.40	200.000	67.000	45.826	0.141	17.482	111.928	44.000	40.402	0.043	2.479			0.000	20	15	20		7.3924			0.11			7.3924		0.20		7.3924			0.15	0.46	40.8	63.7

Tinley Manor - Post-Dev Input

Catchment Name	Catchment Area (Ha)	Catchment Land Use (used to determine min. T_C)	Time of Concentration, Tc (min.)																DWA Method with MAP > 900mm - Runoff Coefficient, C_f (enter areas in Ha)												Rainfall Depth (mm)	
			Overland Flow						Streamflow					Mannings					Urban											Pre/Rural	Area Weighting Factors			1:10 RI	1:50 RI
			r-factor	Length, L (m)	Height, z_1 @ 10% of L from discharge point	Height, z_2 @ 85% of L from discharge point	Slope, S (m/s)	Tc_{OF} (min.)	Length, L (m)	Height, z_1 @ 10% from discharge point	Height, z_2 @ 85% from discharge point	Slope, S (m/s)	Tc_{SF} (min.)	Length, L (m)	Absolute Minimum Velocity, v (m/s)	Tc_{M} (min.)	Tc_{PD} (Tc_{OF} + Tc_{SF} + Tc_{M}) (min.)	Minimum Tc_{PD} (min.)	Chosen Tc_{PD} (min.)	*Lawn sandy <2% C=0.08*	*Lawn sandy >7% C=0.18*	*Lawn heavy <2% C=0.15*	*Lawn heavy >7% C=0.30*	*Residential single C=0.60*	*Flats/dense townships C=0.70*	*Light industrial C=0.65*	*Heavy industrial C=0.70*	*Business local C=0.75*	*Business CBD C=0.85*	*Streets / roofs C=0.95*	C_{urban}	$C_{pre/rural}$	Urban	Rural	C_T		
C1	5.1685	Residential	0.02	200.000	75.000	44.895	0.201	3.975	25.397	44.804	44.000	0.042	0.796			0.000	5	15	15					1.5416	1.2969					0.8401	0.72	0.45	71%	29%	0.64	36.5	57.0
C2	10.4733	Residential	0.02	200.000	86.000	59.305	0.178	4.088	321.608	56.670	31.393	0.105	3.960			0.000	8	15	15					5.4368	1.4008					1.2502	0.67	0.55	77%	23%	0.64	36.5	57.0
C3	6.6868	Residential	0.02	200.000	69.000	50.578	0.123	4.458	286.145	48.491	37.000	0.054	4.687			0.000	9	15	15						3.0559					1.1220	0.77	0.45	62%	38%	0.65	36.5	57.0
C4	3.4380	Residential	0.02	200.000	53.000	36.578	0.109	4.579	88.202	35.515	28.000	0.114	1.418			0.000	6	15	15					2.4201						0.7346	0.68	0.57	92%	8%	0.67	36.5	57.0
C5	4.9199	Residential	0.02	200.000	58.000	30.504	0.183	4.060	166.301	29.504	19.000	0.084	2.592			0.000	7	15	15					3.8128						0.7155	0.66	0.55	92%	8%	0.65	36.5	57.0
C6	3.6606	Residential	0.02	191.584	69.000	30.431	0.268	3.640				0.000	0.000			0.000	4	15	15					0.9242						0.3484	0.70	0.45	35%	65%	0.54	36.5	57.0
C7	10.6924	Residential	0.02	200.000	52.000	32.000	0.133	4.373	23.047	31.772	30.135	0.095	0.541			0.000	5	15	15										10.7020		0.75	0.55	100%	0%	0.75	36.5	57.0
C8	5.2129	Residential	0.02	200.000	72.000	55.614	0.109	4.581	41.568	55.385	53.000	0.077	0.925			0.000	6	15	15						3.4954					1.4648	0.77	0.55	95%	5%	0.76	36.5	57.0
C9	23.5965	Residential	0.02	200.000	74.000	51.438	0.150	4.252	246.220	48.757	37.519	0.061	3.974			0.000	8	15	15				1.1516	8.4953	3.8068					4.2604	0.69	0.55	75%	25%	0.65	36.5	57.0
C10	9.9108	Comm./Industrial	0.02	200.000	78.000	53.541	0.163	4.172	212.386	51.839	30.000	0.137	2.594			0.000	7	10	10										8.1459		0.75	0.55	82%	18%	0.71	28.1	43.9
C11	6.3157	Residential	0.02	200.000	47.000	25.000	0.147	4.277	21.463	54.915	24.541	1.887	0.162			0.000	4	15	15				0.0985	2.3507	1.5900					1.4604	0.72	0.55	87%	13%	0.69	36.5	57.0
C12	11.8425	Residential	0.02	200.000	86.000	76.630	0.062	5.220	336.261	71.293	43.000	0.112	3.992			0.000	9	15	15					0.2481	7.0978					2.7847	0.77	0.55	86%	14%	0.73	36.5	57.0
C13	7.7073	Residential	0.02	200.000	86.000	67.000	0.127	4.426	183.363	65.299	50.740	0.106	2.559			0.000	7	15	15						3.5682				0.8258	1.9328	0.78	0.55	82%	18%	0.74	36.5	57.0
C14	3.6428	Residential	0.02	77.414	55.740	41.626	0.243	2.440				0.000	0.000			0.000	2	15	15					0.7040						0.1540	0.66	0.55	24%	76%	0.58	36.5	57.0
C15	6.6692	Residential	0.02	200.000	75.000	44.000	0.207	3.948	48.501	43.690	40.813	0.079	1.028			0.000	5	15	15					2.1585	1.5470					1.1820	0.72	0.55	73%	27%	0.67	36.5	57.0
C16	1.8612	Residential	0.02	87.722	45.000	35.000	0.152	2.886				0.000	0.000			0.000	3	15	15					0.6269						0.0783	0.64	0.55	38%	62%	0.58	36.5	57.0
C17	3.6495	Residential	0.02	186.222	47.000	29.000	0.129	4.263				0.000	0.000			0.000	4	15	15					2.4579						0.5836	0.67	0.55	83%	17%	0.65	36.5	57.0
C18	3.2514	Residential	0.02	194.503	47.000	15.000	0.219	3.843				0.000	0.000			0.000	4	15	15					1.3396	0.8878					0.3422	0.68	0.56	79%	21%	0.65	36.5	57.0
C19	2.3359	Residential	0.02	200.000	41.000	26.000	0.100	4.677	122.802	25.833	16.665	0.100	1.924			0.000	7	15	15					0.6369	1.3298					0.3182	0.71	0.55	98%	2%	0.70	36.5	57.0
C20	7.1132	Residential	0.02	183.094	41.000	12.000	0.211	3.769				0.000	0.000			0.000	4	15	15				0.2118	1.7415	3.1460					0.7332	0.69	0.55	82%	18%	0.66	36.5	57.0
C21	1.6371	Residential	0.02	113.835	41.000	28.863	0.142	3.311				0.000	0.000			0.000	3	15	15						1.2283					0.3788	0.76	0.55	98%	2%	0.76	36.5	57.0
C22	4.2881	Residential	0.02	200.000	54.000	21.000	0.220	3.891	22.948	20.670	18.396	0.132	0.474			0.000	4	15	15				0.3245	1.9201	1.5011					0.5128	0.65	0.55	99%	1%	0.65	36.5	57.0
C23	1.4349	Residential	0.02	130.718	56.000	37.000	0.194	3.286				0.000	0.000			0.000	3	15	15					1.1017						0.4096	0.69	0.55	105%	-5%	0.70	36.5	57.0
C24	3.8554	Residential	0.02	200.000	67.000	41.677	0.169	4.139	14.529	41.389	39.543	0.169	0.303			0.000	4	15	15					2.2279						1.1126	0.72	0.43	87%	13%	0.68	36.5	57.0
C25	3.1707	Residential	0.02	196.475	75.000	40.000	0.238	3.790				0.000	0.000			0.000	4	15	15				0.2274	0.9392	0.7043					0.8986	0.71	0.61	87%	13%	0.70	36.5	57.0
C26	5.2188	Residential	0.02	200.000	40.000	18.651	0.142	4.307	49.827	18.000	11.898	0.163	0.794			0.000	5	15	15				0.1513	3.7971						1.2224	0.67	0.53	99%	1%	0.67	36.5	57.0
C27	2.8735	Residential	0.02	169.000	58.000	30.000	0.221	3.593				0.000	0.000			0.000	4	15	15				0.1366	1.5158						0.5007	0.66	0.55	75%	25%	0.63	36.5	57.0
C28	2.1403	Residential	0.02	140.678	48.000	25.000	0.218	3.308				0.000	0.000			0.000	3	15	15				0.2221	0.6975	0.1391					0.6646	0.70	0.55	81%	19%	0.67	36.5	57.0
C29	2.3085	Residential	0.02	142.732	30.000	11.000	0.177	3.494				0.000	0.000			0.000	3	15	15					0.2929	2.0111						0.69	0.55	100%	0%	0.69	36.5	57.0
C30	1.0272	Residential	0.02	77.236	51.000	38.000	0.224	2.483				0.000	0.000			0.000	2	15	15						1.0272						0.70	0.55	100%	0%	0.70	36.5	57.0
C31	4.3536	Residential	0.02	200.000	64.000	44.156	0.132	4.381	48.078	44.000	41.000	0.083	1.002			0.000	5	15	15				0.1962	1.8706	0.8272					0.7384	0.68	0.55	83%	17%	0.66	36.5	57.0
C32	8.1195	Comm./Industrial	0.02	200.000	77.000	62.000	0.100	4.677	179.755	58.672	47.574	0.082	2.777			0.000	7	10	10				1.2250		2.6809			1.3155		2.7086	0.73	0.55	98%	2%	0.73	28.1	43.9
C33	5.2919	Residential	0.02	200.000	85.000	51.898	0.221	3.888	101.933	51.381	49.000	0.031	2.608			0.000	6	15	15						4.2870					0.9791	0.75	0.55	100%	0%	0.75	36.5	57.0
C34	2.6308	Residential	0.02	163.603	71.000	52.000	0.155	3.845				0.000	0.000			0.000	4	15	15						2.2867					0.3363	0.73	0.55	100%	0%	0.73	36.5	57.0
C35	1.3608	Residential	0.02	58.861	51.000	42.680	0.188	2.278				0.000	0.000			0.000	2	15	15						0.8856					0.4780	0.79	0.46	100%	0%	0.79	36.5	57.0
C36	0.6471	Residential	0.02	60.364	50.390	36.237	0.313	2.048				0.000	0.000			0.000	2	15	15						0.6404						0.70	0.55	99%	1%	0.70	36.5	57.0
C37	3.8552	Residential	0.02	110.118	56.000	39.504	0.200	3.011				0.000	0.000			0.000	3	15	15				0.1236	1.1730	1.5744					0.9057	0.72	0.55	98%	2%	0.71	36.5	57.0
C38	3.6406	Residential	0.02	200.000	54.591	34.000	0.137	4.343	84.661	33.000	23.418	0.151	1.231			0.000	6	15	15				0.1199	1.4766	1.5025					0.5499	0.68	0.55	100%	0%	0.68	36.5	57.0
C39	1.1707	Residential	0.02	40.575	55.000	48.000	0.230	1.828				0.000	0.000			0.000	2	15	15					1.1547							0.60	0.55	99%	1%	0.60	36.5	57.0
C40	6.0599	Residential	0.02	71.183	56.000	46.000	0.187	2.493				0.000	0.000			0.000	2	15	15				0.3815	2.1704	1.1859					2.3172	0.73	0.46	100%	0%	0.73	36.5	57.0
C41	5.4968	Residential	0.02	200.000	70.000	55.527	0.096	4.716	177.243	53.218	42.000	0.084	2.720			0.000	7	15	15						4.4296					0.6803	0.73	0.55	93%	7%	0.72	36.5	57.0
C42	8.0455	Residential	0.02	200.000	86.000	65.000	0.140	4.324	88.030	63.000	52.000	0.167	1.221			0.000	6	15	15				0.7719		1.0158			2.4419		3.3952	0.79	0.55	95%	5%	0.77	36.5	57.0
C43	5.2023	Comm./Industrial	0.02	200.000	85.574	53.000	0.217	3.902	99.204	52.000	48.527	0.047	2.186			0.000	6	10	10										4.0945		1.1080	0.79	0.55	100%	0%	0.79	28.1	43.9
C44	4.3874	Comm./Industrial	0.02	127.293	67.000	56.532	0.110	3.707				0.000	0.000			0.000	4	10	10										3.5762		0.8281	0.79	0.46	100%	0%	0.79	28.1	43.9
C45	9.2960	Residential	0.02	200.000	63.506	55.405	0.054	5.401	286.601	53.297	32.000	0.099	3.703			0.000	9	15	15										8.5119		0.5250	0.76	0.46	97%	3%	0.75	36.5	57.0
C46	4.5395	Residential	0.02	128.290	61.000	40.000	0.218	3.168				0.000	0.000			0.000	3	15	15										4.0228		0.3804	0.77	0.46	97%	3%	0.76	36.5	57.0
C47	3.8477	Comm./Industrial	0.02	110.392	76.000	53.000	0.278	2.791				0.000	0.000			0.000	3	10	10										3.4368			0.75	0.55	89%	11%	0.73	28.1	43.9
C48	1.4622	Comm./Industrial	0.02	104.777	67.000	50.000	0.216	2.888				0.000	0.000			0.000	3	10	10										1.2458			0.75	0.55	85%	15%	0.72	28.1	43.9
C49	5.3055	Comm./Industrial	0.02	193.990	60.000	21.000	0.268	3.663				0.000	0.000			0.000	4	10	10										3.7566		1.4673	0.81	0.55	98%	2%	0.80	28.1	43.9
C50	1.2072	Residential	0.02	70.020	55.000	44.000	0.209	2.411				0.000	0.000			0.000	2	15	15					1.2181							0.60	0.55	101%	-1%	0.60	36.5	57.0
C51	7.3924	Residential	0.02	200.000	67.000	45.826	0.141	4.315	111.928	44.000	40.241	0.045	2.437			0.000	7	15	15				0.2042	1.7884	4.0359					1.1731	0.70	0.46	97%	3%	0.70	36.5	57.0

ANNEXURE C
CATCHMENT DELINEATION



LEGEND	
WETLAND DELINEATION	
WETLAND 30m BUFFER	
CATCHMENT DELINEATION	
CATCHMENTS LABEL	C1
TINLEY MANOR SOUTH BANKS BOUNDARY	
DUNE FOREST BUFFER ZONE	
1-100 YEAR FLOODLINE	

SMEC
Member of the Surbana Jurong Group

TINLEY MANOR SOUTH BANKS

CATCHMENTS DELINEATION BOUNDARY

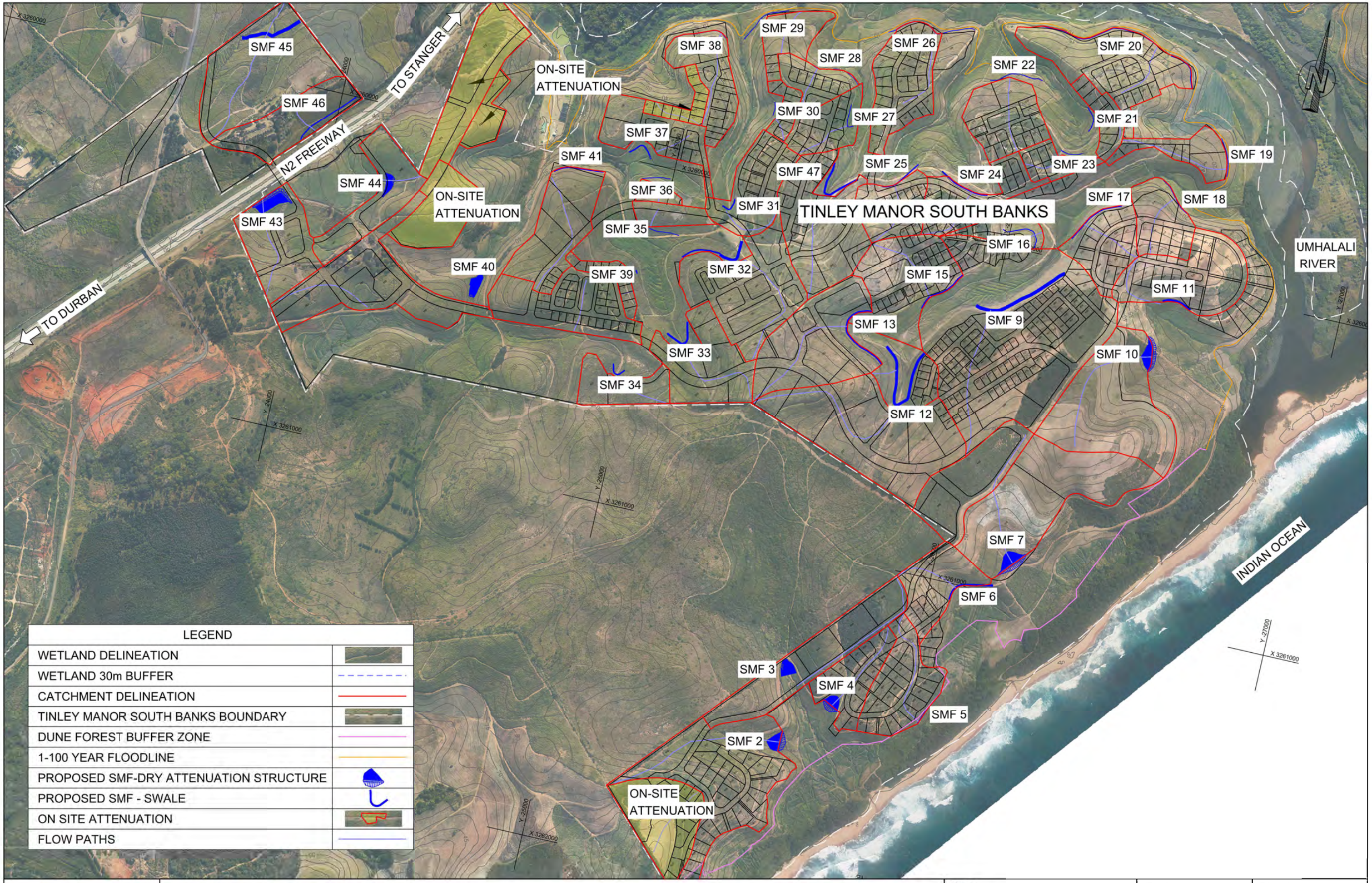
Client: Tongaat Hulett DEVELOPMENTS

Scale: 1:10 000

Sheet: 1

Drawing No: DH0014-TINMAN-SW-01

ANNEXURE D
PROPOSED STORMWATER MANAGEMENT FACILITIES



LEGEND	
WETLAND DELINEATION	
WETLAND 30m BUFFER	
CATCHMENT DELINEATION	
TINLEY MANOR SOUTH BANKS BOUNDARY	
DUNE FOREST BUFFER ZONE	
1-100 YEAR FLOODLINE	
PROPOSED SMF-DRY ATTENUATION STRUCTURE	
PROPOSED SMF - SWALE	
ON SITE ATTENUATION	
FLOW PATHS	

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TINLEY MANOR SOUTH BANKS

PROPOSED STORMWATER MANAGEMENT FACILITIES

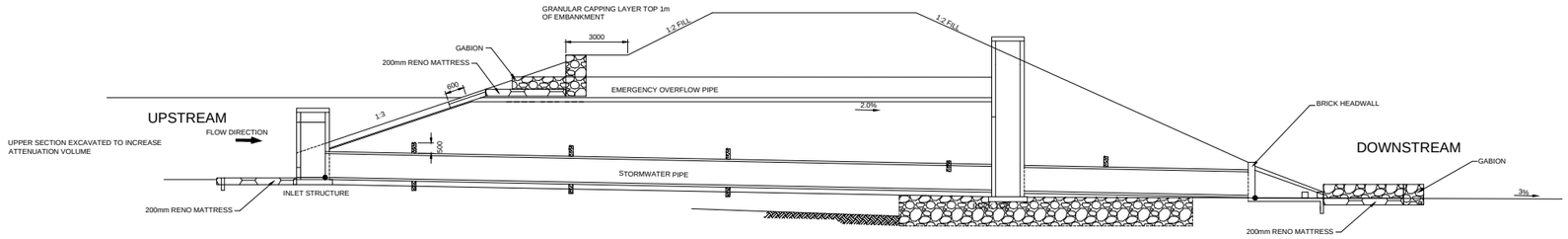
Client: Tongaat Hulett DEVELOPMENTS

Scale: 1:10 000

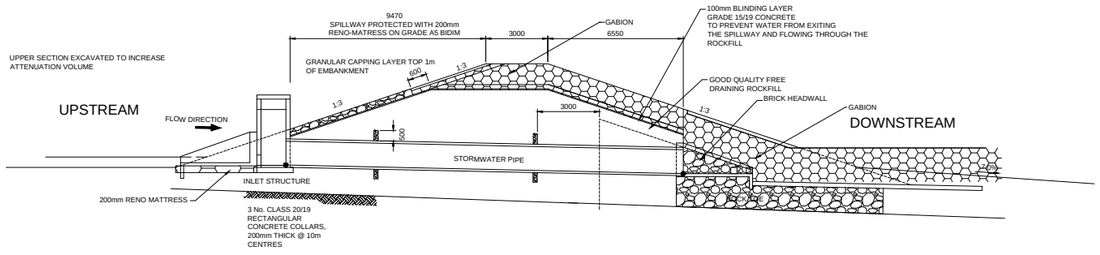
Sheet: 1

Drawing No: DH0014-TINMAN-SW-02

ANNEXURE E
PROPOSED STORMWATER MANAGEMENT FACILITY TYPICAL DETAILS



STORMWATER MANAGEMENT
FACILITY 1
SCALE 1:100



STORMWATER MANAGEMENT
FACILITY 2

SMEC
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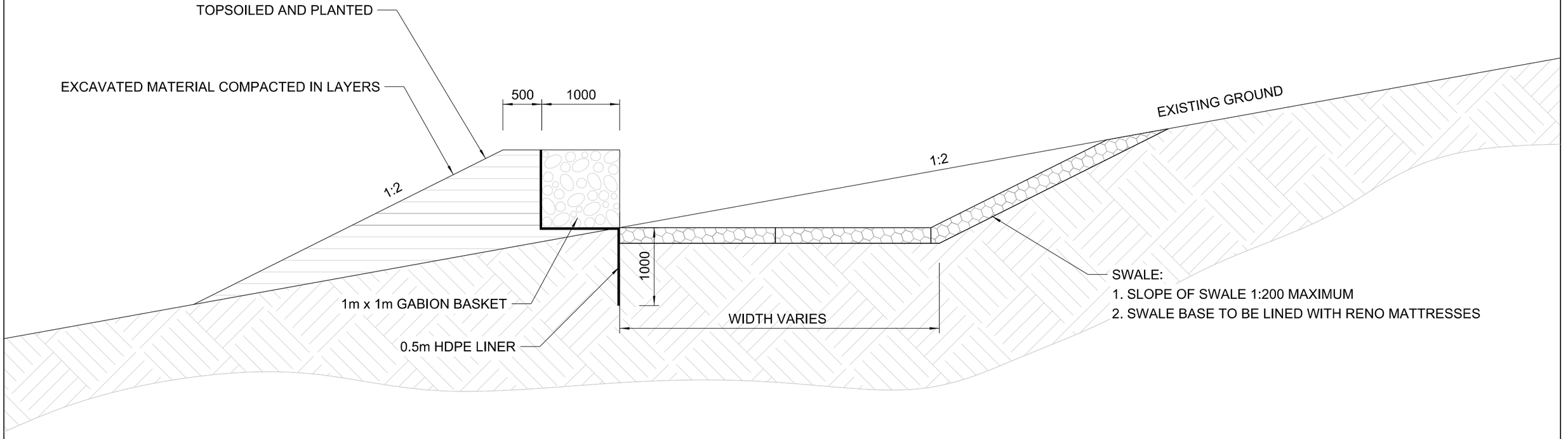
TINLEY MANOR
TYPICAL STORMWATER MANAGEMENT FACILITY DETAILS

SCALE	SHEET
AS SHOWN	1 OF 1

DRAWING NO
DH0014-SW-DET-02



SWALE DETAIL

SCALE 1:50

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TINLEY MANOR
STORMWATER SWALE DETAIL

Client
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Scale	Sheet
1:50 (A3)	1

Drawing No
DH0014-SW-DET-SWALE-01