Stormwater Management Plan Report

Compiled for:

Mr. Abdulla Parker

On behalf of the City of Cape Town

Catchment Stormwater and River Management

Compiled by:

OWS Civils (Pty) Ltd

Date:

17 September 2019

Terms of Reference

The task provided to OWS Civils (Pty) Ltd was to investigate and design a stormwater management plan for the proposed new development on Erf 511 located along Blomhof Avenue in Wetton.

OWS Civils (Pty) Ltd was required by the Client to perform the following tasks with regard to the management of the stormwater network:

- Investigate the effects of the proposed development on the existing stormwater network.
- Propose a management plan that can effectively and efficiently drain water flows during the prescribed storm events.
- Design the network to be as cost-effective as possible and can be easily maintained in the future.

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STORMWATER MANAGEMENT PLAN REPORT

Proposed New Development on ERF 511, Wetton

SUBMITTED TO:

CITY OF CAPE TOWN

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Report Details

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00	Initial Submission
01	Accommodation of Doig Road Run-off Excluded, Revised Layout

1. Introduction

Erf 511 in Wetton, which is situated adjacent to Blomhof Avenue, consists of a 4365m^2 open area. The developer and/or owner intend constructing proposed new low rise apartments on the respective erf.

This report provides an in-depth description of the design process followed for the proposed stormwater management plan. This will include the design procedure followed, all calculations and assumptions made, and recommendations for possible design improvements for the management plan. The designing of the system will be in accordance with the current statutory regulations and standards prescribed by the City of Cape Town and based on the existing stormwater infrastructure in the area.

2. Site Analysis

2.1 Site Location

Erf 511 is located approximately ±16.9km from the Cape Town CBD. Access to the site is from Blomhof Avenue, off Old Strandfontien Road in Wetton. The approximate centre of the existing network system and proposed development as depicted in Figure 2.1 below, is located at

- WGS 84 Coordinates: **X – 44 508.59, Y – 3 764 292.22** and
- Latitude and Longitude coordinates: **34° 00’ 17” S, 18° 31’ 05” E**.

Figure 2.1: Location of Erf 511 Wetton, Cape Town

2.2 Description of Site

The project requires the design of a stormwater management plan that will adequately service the proposed development of the **nineteen (19)** low rise apartments.

Refer to Figure 2.2 below for diagrammatic representation of the site with the proposed development.

Figure 2.2: Description of Site with Proposed Development

2.3 Existing Services Infrastructure

2.3.1 Water Reticulation

A 100mm diameter watermain is located on the western verge of Old Strandfontein Road, which has a 50mm diameter pipe leading off this main into Blomhof Avenue.

It is proposed that the 50mm diameter pipe be replaced with at least a 100mm diameter pipe in order to service the proposed development intended for construction on Erf 511.

Refer to Figure 2.3.1 below for diagrammatic representation of the proposal.

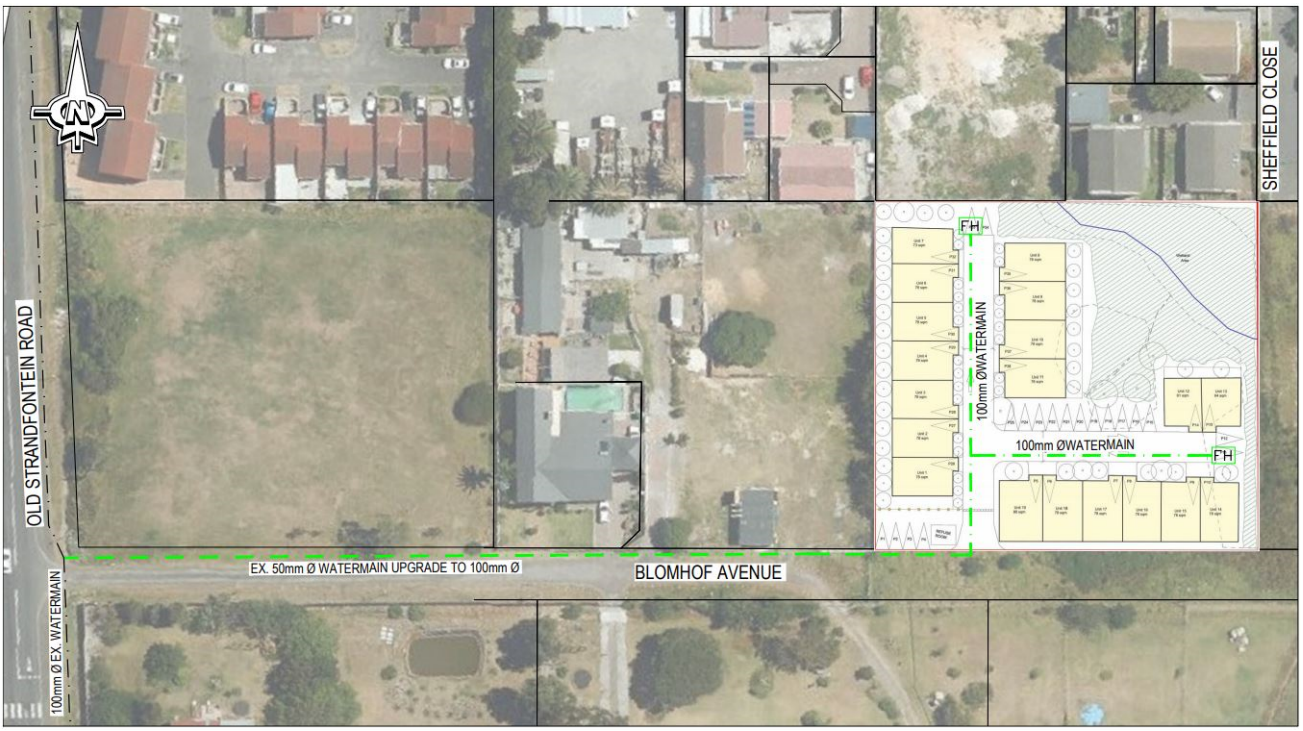

Figure 2.3.1: Proposed Water Reticulation System

2.3.2 Sewer Reticulation

There are two (2) sewer connection points, which is located in Old Strandfontein Road and Thistle Road. However, the cover levels of the existing manholes are higher than the average height of Erf 511. In order to provide adequate drainage of sewer effluent, the erf needs to be filled to a maximum of approximately ±0.5m along the northern boundary and ±1.0m along the southern boundary. Furthermore, retaining structures are required along the northern and western boundaries of the erf.

The proposed location of the sewer connection is in Sheffield Road, which in turn has an existing connection originating from Doig Road.

Refer to Figure 2.3.2 below for diagrammatic representation of the proposal.

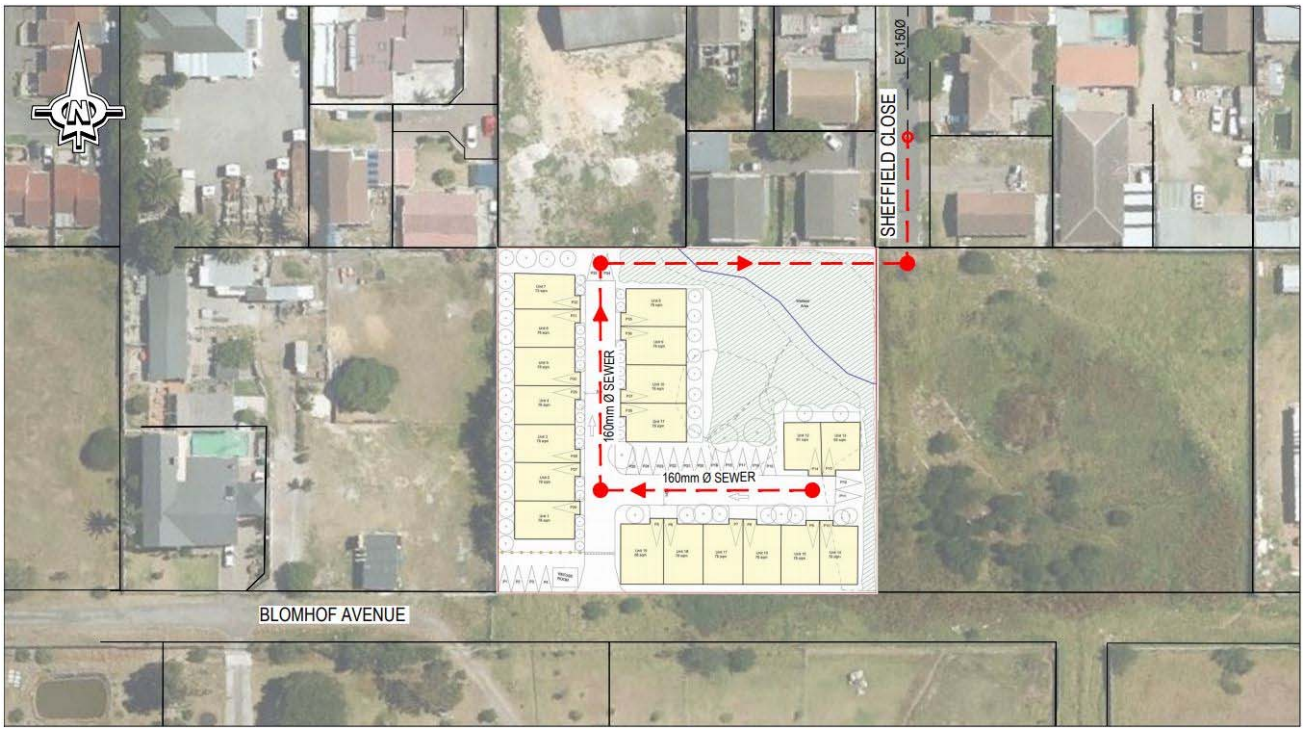

Figure 2.3.2: Proposed Sewer Reticulation System

2.3.3 Stormwater

A fresh water area exists on the north eastern side of the Erf 511. A detention pond is proposed for construction in the north east corner of the erf, which will subsequently discharge into the adjacent fresh water pond area.

The accommodation of the stormwater run-off from Erf 511, Doig Road is no longer required as plans are in place to redevelop this erf and to construct apartments as well as to grade the site from the southern boundary into Doig Road.

Refer to Figure 2.3.3 below for diagrammatic representation of the proposal.

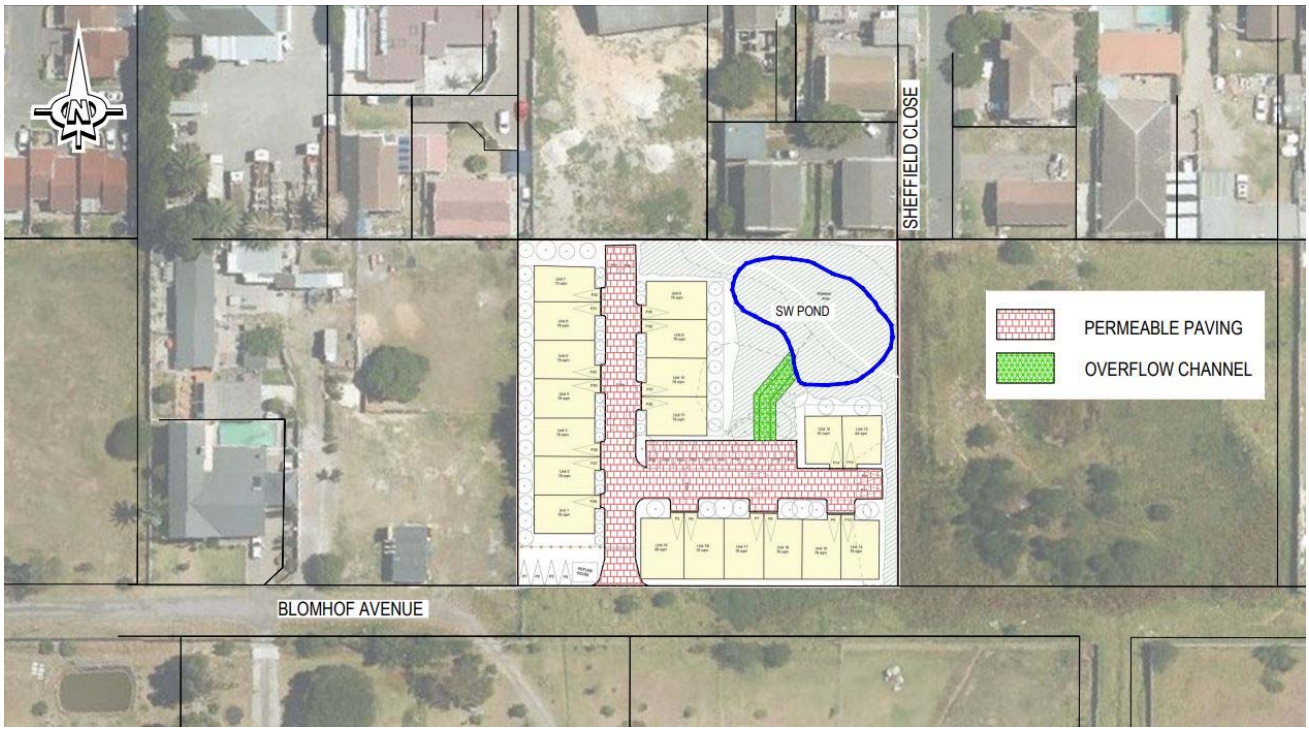

Figure 2.3.3: Proposed Stormwater System

3. Background

3.1 Stormwater Policy Requirements

The City of Cape Town Management of Urban Stormwater Impacts Policy (2009) indicates the criteria for the recurrence and duration of the design storm event for a site in accordance with the following:

- Size of the catchment.
- Nature of the site with respect to it being a Greenfield (new development) or Brownfield (existing development) project.

The provision of infrastructure on site suggests that the proposed project will be considered as a Greenfield project with a total area estimated to be **± 4365m^2**. The designing of the network system is in accordance with current regulations and standards as set out in the City of Cape Town Management of Urban Stormwater Impacts Policy (2009) and the requirements that need to be complied with for the control of quantity and rate of runoff is described below.

3.1.1 Rate of Runoff

- The protection of stability in downstream channels requires a 24-hour extended detention of stormwater runoff for a 1-year recurrence interval, 24-hour storm event.
- The protection of the downstream properties from fairly frequent nuisance floods requires the reduction of a 10-year recurrence interval post-development peak flow to a pre-development peak flow level.
- The protection of the floodplain developments and floodplains from adverse impacts of extreme floods requires the reduction of a 50-year recurrence interval post-development peak flow to existing pre-development peak flow levels. The evaluation of the effects of the 100-year recurrence interval storm event on the stormwater management system, adjacent properties and downstream facilities and downstream properties. The impacts need to be managed through detention controls and/or flood plain management.

3.1.2 Water Quality

In terms of water quality, the City of Cape Town Management of Urban Stormwater Impacts Policy (2009) has criteria for achieving sustainable urban drainage system objectives in various development scenarios. The water quality target for the provision of the described infrastructure on the area of interest for Greenfield sites more than 4000m^2 include:

- The removal of 80% of Suspended Solids (SS) and
- 45% of Total Phosphates (TP) produced on site as a result of post-development stormwater runoff or
- To reduce to existing catchment levels; whichever requires a higher level or treatment.
- In addition, all litter, grease and oil need to be trapped at the source.

In terms of the City of Cape Town Management of Urban Stormwater Impacts Policy (2009), the Water Quality Volume will be treated for **½ year Recurrence Interval, 24-hour storm**.

4. Climate

The Cape Town Cape Flats receives an average of approximately 724mm of rainfall per annum, which falls mainly in the winter months and is therefore recognized as a Mediterranean climatic area. The proposed development is located in Wetton. The chart below shows the average rainfall values for the Cape Flats per month where the highest value of 133mm and lowest value of 11mm occur in June and February respectively.

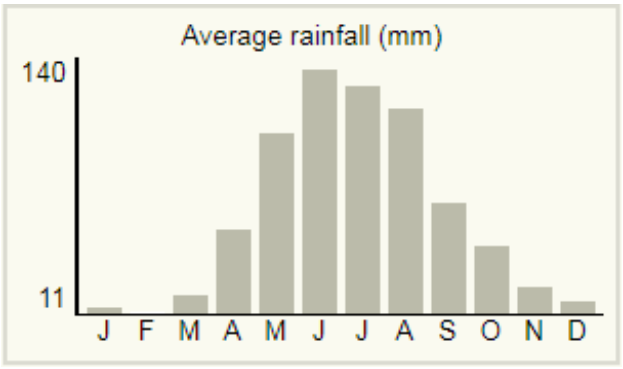

Figure 4-1: Average Rainfall Temperature (˚C) for Cape Flats (SA Explorer, 2017)

The monthly distribution of average daily maximum temperatures indicates that the average midday temperatures for Muizenberg ranges from a minimum of 16.5°C in July to a maximum of 26.8°C in February.

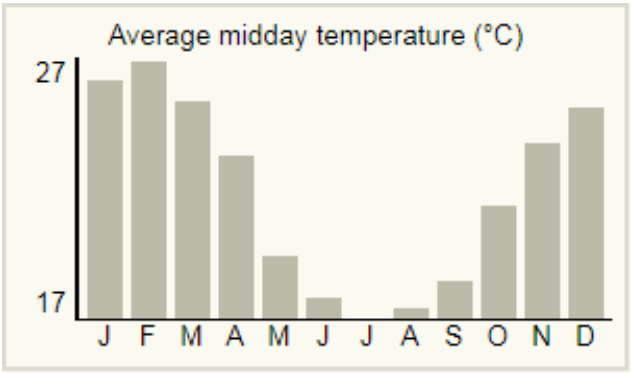

Figure 4-2: Average Midday Temperature (˚C) for Cape Flats (SA Explorer, 2017)

The region is the coldest during July when the mercury drops to 7.5°C on average during the night.

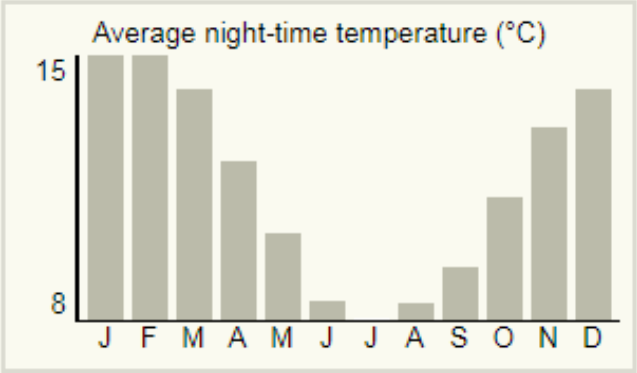

Figure 4-3: Average Night-Time Temperature (˚C) for Cape Flats (SA Explorer, 2017)

5. Findings and Discussions

5.1 Intensity

The data for intensity of rainfall and rainfall depths were derived from the City of Cape Town 2010 Rainfall Grid (adjusted for climate change). The nearest synthesized data point was chosen (-34° 0' LAT, 18° 34' LONG). The synthesized station is located ± 546.102m from Erf 511. The local weather station is the Groenvlei Weather Station, which is located approximately ± 982.46m from Erf 511.

The rainfall depth for the following recurrence intervals was calculated as follows:

- **24-Hour Storm Duration**

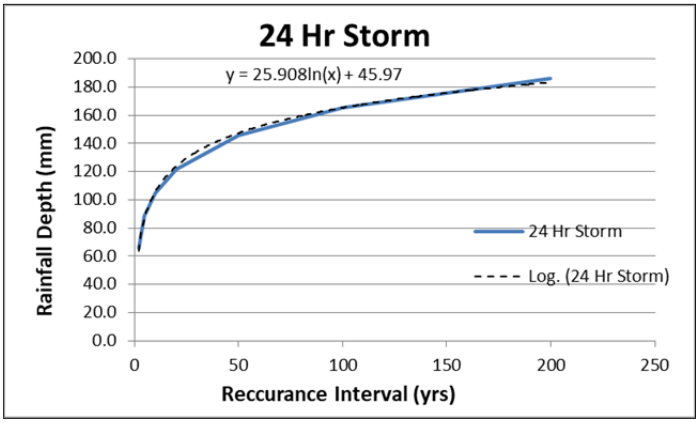

Figure 5.1-1: 24-Hour Storm Duration

Table 5.1-1: 24-Hour Storm Duration

	24 Year Storm								
	Years	0.5	1	2	5	10	20	50	100
Calculated	Rainfall Depth	28.0	46.0	63.9	87.7	105.6	123.6	147.3	165.3
synthethised				65.8	88.2	104.5	121.6	145.6	165.0
Local weather station		45.6	52.8	64.8	84	112.8	136.8		

- **15-MinuteStorm Duration**

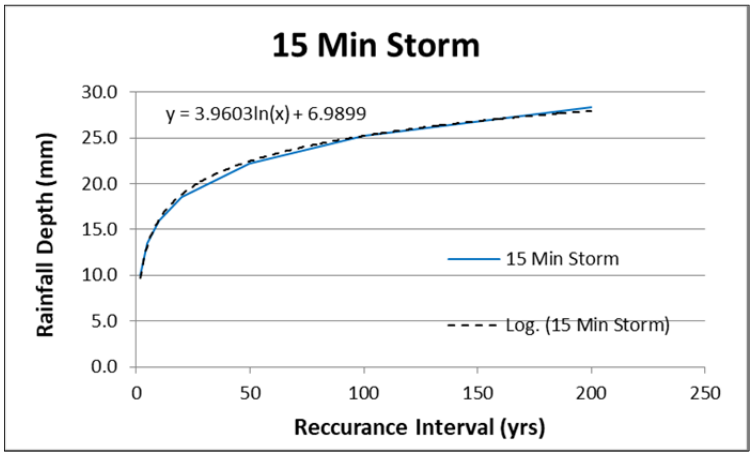

Figure 5.1-2: 15-Minute Storm Duration

Table 5.1-2: 15-Minute Storm Duration

	15 Min Storm								
	Years	0.5	1	2	5	10	20	50	100
Calculated	Rainfall Depth	4	7	10	13	16	19	22	25
Synthethised				10.0	13.5	16.0	18.5	22.2	25.2
Local weather station		7.8	9.6	12	15.5	18	21		

Long storm durations such as 2-hour storm events have greater rainfall depths than a storm event of 15-minutes (0.25-hour) duration but have a lower intensity and therefore require greater detention volumes; while shorter duration events such as a 0.25-hour storm event have greater intensity and hence greater peak flows.

The rainfall intensity can be calculated as the depth of rainfall falling over the time of concentration. The 24-hour storm can be assumed to have a triangular distribution with the peak rainfall intensity occurring at 12-hours.

5.2 Catchment Areas

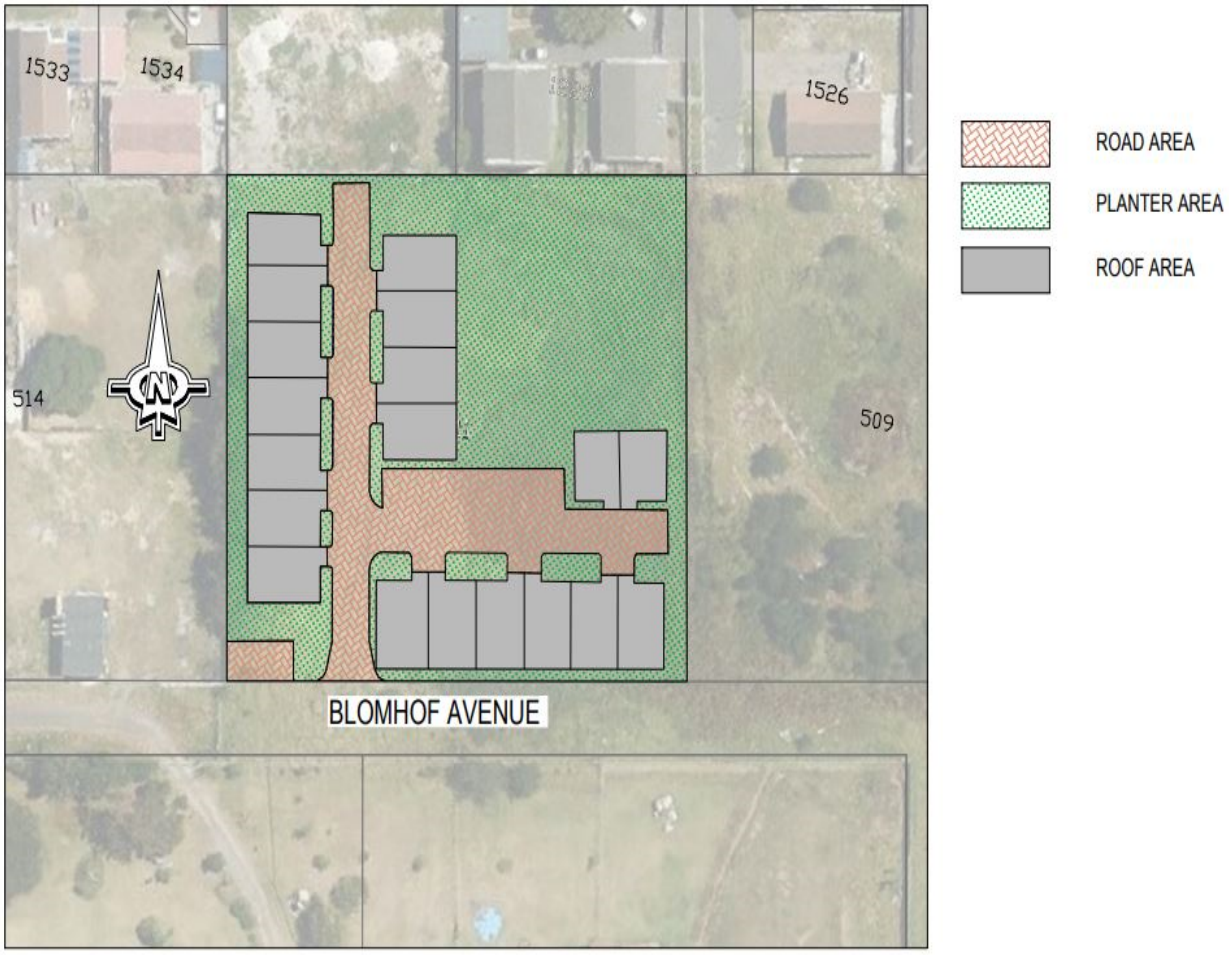

Figure 5.2.1: Catchment Areas for Erf 511

For the purposes of this report, the total ERF area of ± **4365 m²** will be considered as runoff requiring detention and treatment. The catchment area will be raised (filled) and 'platformed' in order to drain from the south western corner to the north eastern corner of the erf. The access road and parking areas will be constructed with permeable paving.

The catchment runoff characteristics are as follows:

Table 5.2-1: Catchment Characteristics

Roofs	Road & Parking	Soft	Total
m^2	m^2	m^2	m^2
1485	850	2030	4365

Table 5.2-2: Effective Runoff Areas (CA)

Impermeable		Permeable	Effective Runoff Area
(Runoff Factor = 0.8)		(Runoff Factor = 0.4)	
m^2	m^2	m^2	m^2
Roofs	Roads & Parking	Soft	
1280	672	772	2724

5.3 Peak Runoffs

The tables that follow compare the pre-development and post-development runoff scenarios.

Table 5.3-1: Peak Runoff Discharge (24-Hour Storm)

RI	Storm Duration	Depth Intensity	Pre-Development			Post Development		
			Runoff Area	Discharge Volume	Peak Discharge	Runoff Area	Discharge Volume	Peak Discharge
yrs	h	mm	m^2	m^3	m^3/h	m^2	m^3	m^3/h
0.5	24	28	1748	49	4.08	2724	76	6.36
1	24	46	1748	80	6.70	2724	125	10.44
2	24	64	1748	112	9.31	2724	174	14.51
5	24	88	1748	153	12.77	2724	239	19.90

The post-development volume requirement is **56% more** than the pre-development volume requirement.

Table 5.3-2: Peak Runoff Discharge (15-Minute Storm)

RI	Storm Duration	Depth Intensity	Pre-Development			Post Development		
			Runoff Area	Discharge Volume	Peak Discharge	Runoff Area	Discharge Volume	Peak Discharge
yrs	h	mm	m^2	m^3	m^3/s	m^2	m^3	m^3/s
10	0.25	16.1	1748	28	0.03	2724	44	0.05
20	0.25	18.9	1748	33	0.04	2724	51	0.06
50	0.25	22.5	1748	39	0.04	2724	61	0.07
100	0.25	25.2	1748	44	0.05	2724	69	0.08

5.4 Proposed Stormwater Management

5.4.1 Water Quality

In terms of water quality, the City of Cape Town Management of Urban Stormwater Impacts Policy (2009) has criteria for achieving sustainable urban drainage system objectives in various development scenarios.

The water quality target for the *Proposed New Development on Erf 511* as a Greenfield site is the removal of **80% of Suspended Solids (SS) and 45% of Total Phosphates (TP)** produced on site as a result of post-development stormwater runoff or to reduce to undeveloped catchment levels; whichever requires a higher level or treatment. In addition, all litter, grease and oil need to be trapped at the source.

The water quality will be treated by percolating the water through a permeable paving layer that is drained by a subsurface perforated pipe system, which will subsequently discharge into the storage tank. This will allow for the reduction of Total Suspended Solids (TSS) and the reduction of Total Phosphates (TP).

In terms of the City of Cape Town Management of Urban Stormwater Impacts Policy (2009), the Water Quality Volume is to be treated for a ½ year Recurrence Interval, 24-hour storm.

Table 5.4.1 - Water Quality Discharge Volume

RI	Storm Duration	Depth Intensity		Pre-Development				Post Development		
				Runoff Area	Discharge Volume	Peak Discharge		Runoff Area	Discharge Volume	Peak Discharge
yrs	h	mm		m^2	m^3	m^3/h		m^2	m^3	m^3/h
0.5	24	28		1748	49	4.08		2724	76	6.36

The total depth of run-off for the ½ year Recurrence Interval, 24-hour storm was estimated to be 28 mm.

5.4.2 Permeable Paving Specification

It is proposed to treat the runoff from the whole site by passing the runoff through a permeable paving area (see detail of Permealock™ CEL permeable pavers in Annexure A).

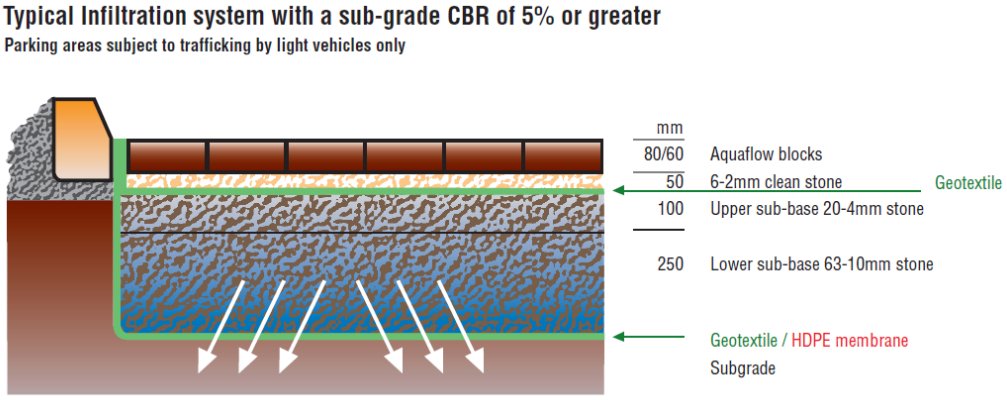

Figure 5.4.2-1: Permeable Paving Specification

The following specification was provided by the supplier as follows:

- **Void ratio** = 30% (refer to Appendix B)
- **Infiltration rate** = 13 000 liters/hour

This equates to a rate of 0.004m^3 per second (i.e. 3.611litres per second).

Depth of Stone Layers (mm)		Size of Stone
50		2mm to 6mm
150		4mm to 20mm
250		10mm to 63mm
Total Depth	**450**	

Volume per square meter = 0.400 x 30% = 0.12m^3 per m^2.

Storage capacity in permeable paving area = 1930 x 0.12 = 231.61m^3.

The storage capacity of the permeable paving layers is more than the required water quality discharge volume of 76m^3.

5.4.3 Run-Off Quantity

5.4.3.1 The 1-Year Recurrence Interval, 24-Hour Storm

The stormwater is envisaged to be discharged onto permeable paving within the main parking area and access road; the stormwater is aimed to percolate through the sub-surface layer works.

The storage capacity available is 231.6m^3. The maximum amount of storage required at any stage for the 1-Year, 24-Hour storm is 125m^3. The peak discharge for the 1-Year, 24 hour storm is 10.44m^3/hr. This equates to 2.90 l/s, which is 0.711 l/s less than the infiltration rate of 3.611 l/s.

Using Bernoulli's Equation, the maximum velocity in the outlet pipe is 2.80m/s. Restricting the subsoil pipe to 100mm diameter, the water will take a further ± 20hrs after the storm and thereby retarding the storm discharge to ± 44hrs.

The sub-surface drain will discharge into a detention pond before discharging into the adjacent fresh water pond area.

$\gamma = 9810$

$g = 9.81\ m/s^2$

$v_1 = initial\ velocity$

$v_2 = discharge\ velocity$

$h = depth\ of\ Permeable\ Paving\ System$

Assumptions

$v_1 = 0$

Using Manning's formula for the sub-surface drainage, the following hydrographs were prepared.

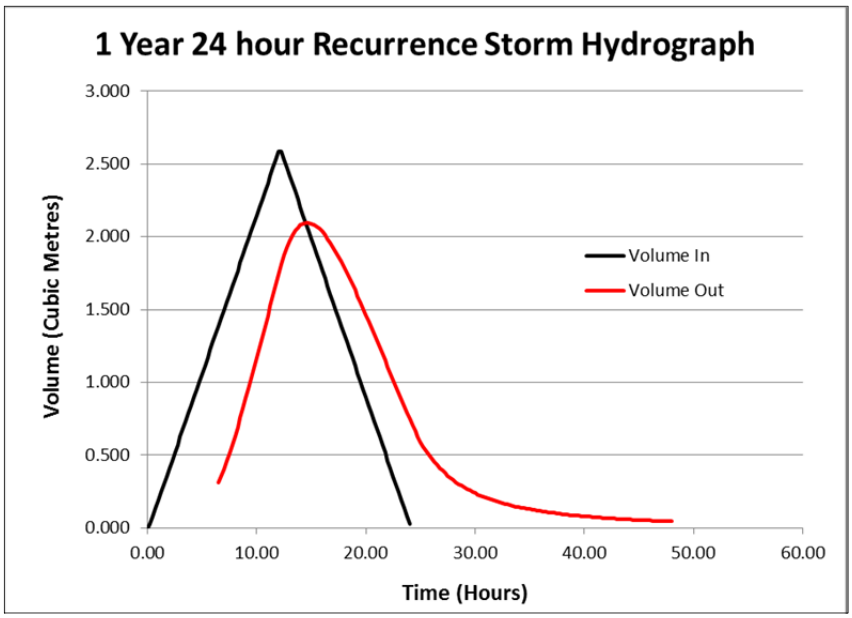

Figure 5.4.3.1-1: 1-Year 24-Hour Recurrence Storm Hydrograph

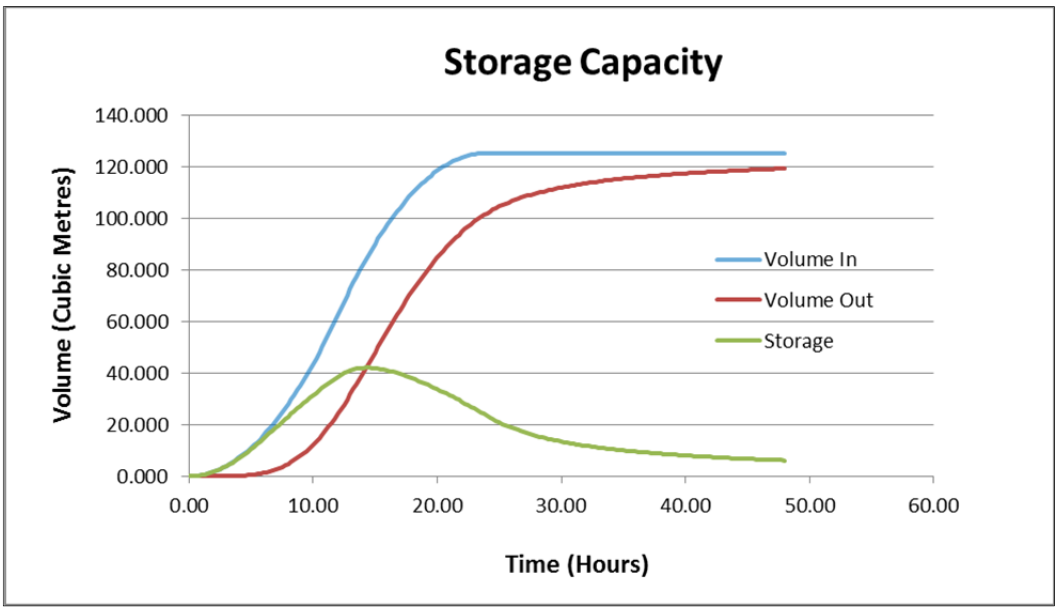

Figure 5.4.3.1-2: Storage Capacity

The Hydrograph indicates ± 6.5m^3 water left in the system after 48-Hours using a 100mm diameter sub-soil drain at a grade of 1 in 200 (i.e. 0.5%).

5.4.3.2 The **10-year, 50-year and 100-year Recurrence Interval, 15-minute Storm**

The quoted infiltration rate of the system is 3.611 l/s (0.004m^3/s). The excess run-off will be directed into the adjacent detention pond via an overland surface channel. The minimum volume of the detention pond is 70m^3 to accommodate the 1 in 100-Year storm event. A detention facility (pond) of 0.75m deep, which will accommodate a volume of 225m^3, will be provided.

6. Operation Management Plan (OMP)

There needs to be constant supervision by the maintenance team of the proposed development. The maintenance section needs to ensure that there is at least one dedicated worker for the OMP supervised by a maintenance foreman. The aforementioned OMP will fall under the ambit of the Body Corporate.

The maintenance tasks include weeding, litter control, sweeping, grit removal and cleaning of the subsurface drain. Refer to Appendix A for recommended maintenance operations. Signage must be installed to convey to the User Client or Residents that the permeable paving performs a vital stormwater management function, and as such should not be tampered with. The proposed wording for the signage that should essentially be displayed at the new development is as follows:

"THE PERMEABLE PAVING YOU SEE IN THIS DEVELOPMENT PERFORMS AN IMPORTANT STORMWATER MANAGEMENT FUNCTION AND AS SUCH SHOULD BE PROTECTED FROM VANDALISM. PERMEABLE PAVERS ARE AN ENVIRONMENTALLY RESPONSIBLE SURFACE AND FORMS PART OF THE BROADER WSUD (WATER SENSITIVE URBAN DESIGN) PHILOSOPHY WITHIN THE CITY OF CAPE TOWN"

Team

A dedicated worker should be allocated to ensure that regular maintenance is done.

Permeable Paving
Maintenance Schedule

The primary objective of the maintenance schedule is to keep the surface draining voids clear. These voids, over time, fill with general dirt and debris.

Each maintenance schedule is site specific and potential problems should be identified early in order to inform the procedures and frequency of cleaning (e. g. windblown sand on most sites in Cape Town).

Inspection of the site should occur frequently in the period after construction, especially after rain events.

Organic material and sand are to be brushed or swept off the paving at least once a month.

Particular attention should be given to any open channels or downpipes discharging onto the paving as sand (especially sand in suspension) will quickly clog the slots between the pavers.

Experience has shown that clogging occurs predominantly in the top 1m of the surface slots.

More vigorous cleaning should therefore take place at least twice a year:

- Conventional street sweepers with vacuums, brushes and water.
- Low pressure hosing or washing as necessary.

Additional aggregate (3mm grit) may be required to refill surface slots.

We suggest that after every five (5) years, a test area of pavers is to be lifted and inspected in order to investigate or assess what deterioration (if any) has occurred.

The worst case scenario would be clogging of the upper voids and even clogging of the upper Fibertex^{TM} Geofabric. The geofabric would need to be replaced when necessary.

Although the design of the paver systems takes into account irreplaceable loss in permeability of the pavers, regular maintenance can certainly extend the pavers functional life.

7. Conclusion

The investigations and calculations indicate that the provision of permeable paving (i.e. Permealock™ CEL permeable pavers) in the parking areas and access road can adequately manage the post-development runoff to mimic the pre-development runoff.

Discharging the stormwater onto the permeable paving, which subsequently drains into the detention pond, attenuates and cleans the stormwater discharge within acceptable levels.

8. Recommendations

The following recommendations are made for the adequate stormwater management for the Proposed New Development on Erf 511:

a) The runoff from the proposed development be discharges and attenuated by the permeable paving (i.e. Permealock™ CEL permeable pavers).
b) The water quality of the discharge to be improved by the attenuation of the flow and filtration thereof through a permeable paving and subsequent layer works.