

**PROPOSED FILLING STATION ALONG
NORTHBOUND CARRIAGEWAY OF
OLD VEREENIGING ROAD-R82 (K57)
ON PTN.38/ OLIFANTSVLEI 327-IQ**

STORMWATER MANAGEMENT REPORT

MAY 2017

K&T PROJECT REFERENCE: 6882A1

REVISION 0



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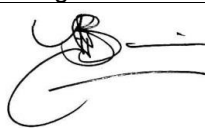
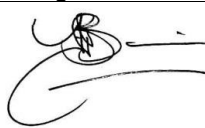
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The availability and positions of the existing services described in this report is based on the records of JRA, Johannesburg water and Johannesburg GIS.

As no SDP was available, a generic site plan has been used to describe the proposed services layout.

<i>For and on behalf of Kantey & Templer (Pty) Ltd</i>	
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EXECUTIVE SUMMARY

INTRODUCTION

Kantey & Templer Consulting Engineers (K&T) have been appointed by Great Sites investments (Pty) Ltd to compile a Stormwater Management Report in support of the proposed rezoning and development of the remainder of portion 36 of the farm Olifantsvlei 327-IQ for the purpose of two filling stations, one on the northbound carriageway of the R82 and the other on the southbound. The following was found with regards to Stormwater Management in terms of the filling station site on the northbound carriageway:

SITE AND STORMWATER

The site has an average slope of 42% to 11% in an easterly direction across the site. The site currently drains overland towards the northbound dual carriageway (Vereeniging Road-R82 (K57)) where the runoff is channelled along the road reserve in a southerly direction, by means of an existing concrete channel. The southbound carriageway site is affected by a wetland delineation and associated buffer zone. It is also affected by the 1:50 and 1:100 year floodlines.

PEAKFLOW ATTENUATION (JRA REQUIREMENTS)

The Johannesburg Roads Agency (JRA) requires on-site attenuation for developments larger than 8,500m² in area. Stormwater attenuation is not required for land given off for road reserve servitudes and undeveloped public and private open spaces.

Since the developable area of 18,645.6 m² for the proposed development is greater than the threshold, a stormwater attenuation facility will be required for this development.

ECOLOGICAL SYSTEM (COJ REQUIREMENTS)

- The attenuation ponds will also detain the water quality volume (WQV) over 24h and will be designed as partially wet ponds.
- The pond will have a forebay allowing for sedimentation of coarse material. The forebay will also reduce the energy of the inflowing water.
- Each pond will have a micropool providing for extended detention allowing the finer particles to settle down and reducing the peakflows. This will also reduce erosion downstream.
- The outlet structure will detain the runoff up to the WQV and Extended Detention volume.
 - In terms water quality, the following applies:
 - Pollution reduction through detention of WQV and Extended Detention
 - 80% reduction in suspended solids
 - 50% reduction in total phosphorus

The system will also include oil separators.

STORMWATER MANAGEMENT REPORT FOR PROPOSED FILLING STATION ALONG THE NORTHBOUND CARRIAGEWAY R82 ON PTN. 36/327-IQ

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6882A1 - SW-02-A – Site Surrounds and Services

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Annexure B: Olifantsfontein Floodline Study

Annexure C: Wetland Assessment Olifantsvlei

Annexure D: Runoff analysis – Rational Method: Pre and post development

Annexure E: Peak Flow attenuation calculations for

1 in 5 year event

1 in 25 year event

1 in 50 year event

Annexure F: Pre development runoff coefficient (C)

Annexure G: Post development runoff coefficient (C)

1. INTRODUCTION

1.1 BACKGROUND

Kantey & Templer Consulting Engineers (K&T) have been appointed by Great Sites Investments (Pty) Ltd to compile a Stormwater Management Report in support of the proposed rezoning and development of the remainder of portion 36 of the farm Olifantsvlei 327-IQ.

The project involves two proposed filling stations along the Old Vereeniging Road (R82), located about 3.5km south of the interchange between M1 & N12 Southern Bypass. A third part of the site, situated east of Wisane Road, will be developed in the future.

The site locality is shown on drawing no. **6882A1-SW-01-A: SITE LOCALITY** in **Annexure A**.

This report addresses the filling station situated on the **northbound carriageway** of the R82.

1.2 SCOPE OF REPORT

This report describes the stormwater management and attenuation plan for a proposed filling station development on the remainder of portion 36 of farm Olifantsvlei 327-IQ referred to as 'the site' and demonstrates how it complies with the requirements of:

- **JRA and the City of Johannesburg (CoJ)** in terms of **flood peak attenuation**.
- **JRA and the City of Johannesburg (CoJ)** in terms of **internal and external stormwater management**.
- **CoJ Environmental Planning** requirements for water quality, sedimentation and erosion management
- The design of the ecological system was done according to TP108 & TP10 of the Auckland Regional Council (ARC), New Zealand. These documents will be referred to in the document. The documents cover the following aspects of stormwater design:
 - TP108: 'Guidelines for stormwater modelling for the Auckland region' – deals with hydrological and environmental design. The hydrological design in these report was done for the conditions prevailing in South Africa & Johannesburg.
 - TP10: 'Design guideline manual stormwater' – deals with concepts and environmental stormwater devices

1.3 PROJECT TEAM

<i>Client:</i>	Great Site Investments (Pty) Ltd, Farhat Shaik
<i>Town planner:</i>	Ikanyeli Development (Pty) Ltd, Samuel Makhunga
<i>Architect:</i>	Not appointed yet. No SDP available, provisional SDP has been drawn by K&T.
<i>Civil engineer:</i>	Kantey & Templer (Pty) Ltd
<i>Transportation engineer:</i>	Kantey & Templer (Pty) Ltd

2. SITE DESCRIPTION

2.1 TOPOGRAPHY & LOCATION

	Northbound Filling Station	
<i>Location:</i>	Along northbound carriageway of R82 provincial road. 3.4 km south of interchange between M1 & N12 Southern Bypass. Between intersection with Pierpont & Angela road / Access to Quarry	
<i>Current Land Use Zoning:</i>	Agricultural	
<i>Existing structures:</i>	No buildings or access road – concrete stormwater channel outside the north eastern boundary of the site	
<i>Level & fall of terrain:</i>	Altitude of approximately 1 644 m to 1678 m above mean sea level. Slope falling from the northwest to southeast. Approximate gradient of 42% to 13% towards the east. Low point at south east corner	
<i>Vegetation:</i>	Short grass at the eastern part, many scattered shrubs and small trees at the western part.	
<i>Geology & soil:</i>	Residual soils on rock, presence of rock outcrops. Underlain by andesite and conglomerate of the Ventersdorp Group & Transvaal Supergroup. Soil potentially collapsible, consolidation might occur. Geotechnical investigation will be required.	
<i>Surrounding Land Use:</i>	North	Ptn.153/327-IQ; smallholding with dwellings and sheds used for agricultural purposes.
	East	Road reserve of R28 dual carriageway provincial road;
	South	Ptn.37/327-IQ; Vacant land.
	West	RE 323-IQ; Afrisam Eikenhof Quarry.

2.2 PROPOSED ZONING & LAND USE

	Northbound Filling Stations
<i>Proposed Land Use Zoning:</i>	Residential, (Low, medium and high density), Retail, Shops, Offices and business purposes, Drive thru, filling station, Financial institution, Motor agencies, Vehicle fitment centers, Transport facility, storage business, Place of public worship and warehousing
<i>Height Zone:</i>	3 Storey
<i>Coverage:</i>	60%.
<i>Floor Area Ratio (FAR):</i>	0.6 Permissible.
<i>Density:</i>	Floor area to be a minimum of 3000 m ²
<i>Servitudes:</i>	SDP to be submitted
<i>Parking:</i>	6 bays per 100m ² retail floor area, 4 bays per 100m ² office floor area

3. STORMWATER

The site has an average slope of 42% to 11% in an easterly direction across the site. The site currently drains overland towards the northbound dual carriageway (Vereeniging Road-R82 (K57)) where the runoff is channelled along the road reserve in a southerly direction, by means of an existing earth channel.

The Johannesburg Roads Agency (JRA) requires on-site attenuation for developments larger than 8,000m² in area. Stormwater attenuation is not required for land given off for road reserve servitudes and undeveloped public and private open spaces.

Since the developable area of **18,645.6 m²** for the proposed development is greater than the threshold, a stormwater attenuation facility will be required for this development.

3.1 EXISTING INFRASTRUCTURE

	Northbound Filling Station
<i>Internal:</i>	None
<i>External:</i>	3.8m Wide Stormwater channel 2 x 1.5m ϕ Existing Stormwater pipes
<i>Downstream Infrastructure for connection points:</i>	A natural grassed watercourse runs in a southerly direction along the eastern boundary of Proposed Site 1 and western boundary of Proposed Site 2. This watercourse runs parallel to the north/south bound (Vereeniging Road R82) in a south easterly direction. There is a presence of rocks with grassed vegetation along the watercourse.
<i>Upstream ingress runoff from upstream sources:</i>	The upstream boundary of the site is formed portion 153 of farm 327-IQ as well other portions of farm 327-IQ. The large majority of these portions are mainly agricultural land with no stormwater infrastructure. It can be assumed that all stormwater runoff from the site's upper catchment area will have to be catered for and managed past the site

4. FLOODLINES

The legislation regarding floodlines is described in Chapter 14, Part 3 of the National Water Act (Act 36 of 1998). An assessment of whether the site is affected by the 1:50 and 1:100 year floodlines is required in terms of the Town Planning and Townships Ordinance (Ordinance 15 of 1986). As per the Olifantsfontein Floodline Study, the northbound filling station is not affected by the 1:50 or the 1:100 year floodlines. This report can be found in **Annexure B**.

5. PRE-DEVELOPMENT FLOWS

The run-off for the pre-developed site was determined using the **Rational Method** for pre-developed conditions so as to determine the maximum allowable post development discharge for both the 1:5 and 1:25 year storms. The pre-developed runoff coefficient for the site as it currently exists is provided in **Annexure F**.

Using a mean annual precipitation of 750 mm/year and a time of concentration as shown below (with a minimum value of 15min) for peak rainfall intensity, a runoff from the site for each recurrence interval was determined. The pre-developed time of concentration for the site was determined using the **Kerby Method**, and the pre-developed analysis can be found in **Annexure D**.

PRE-DEVELOPMENT SUMMARY			
	Recurrence Interval		
	1:5 Year	1:25 Year	1:50 Year
Time of Concentration (minutes)	15	15	15
Peak Rainfall Intensity (mm/hour)	95	167	207
Peak Discharge (m ³ /second)	0.138	0.242	0.423

6. PROPOSED SERVICES

6.1 MINOR SYSTEM

The minor system refers to the internal stormwater infrastructure on the site and according to the Dept. of Housing, Guidelines for Human Settlement and Planning, 2000, (Red Book).

The minor system refers to the internal stormwater infrastructure on the site.

The following measures are proposed in terms of the design of the minor system:

- The run-off will be captured by **kerb inlets, grid inlets** and conveyed to an attenuation facility via an underground **stormwater pipe network**.
- The internal stormwater pipe network will be designed to **accommodate** the runoff generated by storm events with a **recurrence interval of up to 5 years**.
- An **oil/water separator** will be used to ensure that the natural water quality is not compromised.
- Two 600mmø culverts extending beneath the entrance and exit ramps and a 1m wide stormwater channel and headwall structure will be used to facilitate stormwater draining from the northern half of the site.

The layout of the proposed stormwater layout is shown on drawing **6882A1-SW-03-A**.

6.2 MAJOR SYSTEM

The major system acts as a backup emergency system in case of major storm events with a recurrence interval of greater than 5 years. Its function is to protect the properties and infrastructure from damage and flooding during such events.

The following measures are proposed in terms of the design of the major system:

- All runoff generated by the proposed development during the major system will drain overland towards the attenuation facility. All parking areas and internal road network will be designed accordingly.
- The attenuation structure on site will be designed to withstand the major flows. Erosion protection at the discharge points will be provided for in the form of gabions and reno mattresses.
- The outlet structures of the attenuation facility will overflow at recurrence of intervals of 1:25y and higher. Emergency overflows will be provided.
- The attenuation facility will be significantly robust and large enough to accommodate the 1:50 recurrence storm but will not attenuate for storms of this magnitude.

6.3 MANAGEMENT OF STORMWATER RUNOFF FROM UPSTREAM SOURCES

The site of the northbound filling station has an approximate catchment area of 408,172.81 m² which is mostly agricultural and undeveloped with a few dwelling houses. Runoff from the catchment drains in a south-easterly direction towards Vereeniging Road R-82 where it is channelled to flow along the road. Most of the run-off from this catchment flows into an existing 3.8m wide concrete channel located outside the north eastern boundary of the site parallel to Vereeniging Road R-(82) where it is diverted into two 1.5m ϕ stormwater pipes running under the road and into a natural watercourse on the eastern side of the road. Drawing **6882A1-SW-05** shows the catchment area of the both the northbound and southbound stations.

Runoff flowing directly towards the site will be diverted around the site by means of earth berms. The runoff coming towards the western boundary will be channelled to flow in a southerly direction then along the southern boundary where it will discharged into the existing 3.8m stormwater channel.

The runoff along the northern boundary will be channelled to flow toward the road where it will drain into an existing stormwater drain along the road.

6.4 POST-DEVELOPMENT FLOWS

Stormwater infrastructure internal to the site will be designed for runoff generated by the minor storms. Storms that exceed the minor storms will drain overland into the attenuation pond. The layout of the stormwater network for the site is shown on the drawing **6882A1-SW-03: Stormwater Layout and Details (Appendix A)** included in **Appendix A**. Stormwater infrastructure at the site will be designed such that the maximum allowable discharge for each recurrence interval will not exceed that of the pre-development discharge for the same recurrence interval up to and including the 1:25 year storm event.

Discharge from the pond will be controlled by two chambers and will be head dependent. The diameter of the orifice in each chamber will be sized for the maximum allowable discharge under the upstream head. An orifice in the wall of the first chamber will regulate the discharge from the site for the 1:5 year storm event. Should the storm exceed the 1:5 year event the first chamber shall be overtopped and the discharge from the pond will be regulated by an orifice in the second chamber. The orifice in the second chamber will be sized for the 1:25 year storm event.

The stage capacity of the pond and allowable discharge rate from the attenuation pond is controlled such that the post-development discharge does not exceed the pre-development outflow for the 1:5 year recurrence interval and 1:25 recurrence interval. The stage capacity and discharge under variable head from the attenuation ponds is reported in **Appendix E**.

Storms with varying duration were analysed to determine the worst case scenario at the site. The post development **time of concentration (Tc)** for the site with the greatest required attenuation volume was determined to be **15 minutes**. Using a mean annual precipitation of 750 mm/year and a time of concentration (Tc) of 15 minutes for peak rainfall intensity, the results for the attenuation are included in **Appendix D and C (1:5 / 1:25 / 1:50 Year Event)** and are summarised below:

ATTENUATION SUMMARY			
	Recurrence interval		
	1:5 year	1:25 year	1:50 year
Maximum Allowable Outflow to Match Pre-Development Flow	0.138 m ³ /s	0.242 m ³ /s	-
Outlet Diameter Required (mm)	2 x 200 uPVC	315 uPVC	675 Concrete
Maximum Water Depth	0.78 m	1.38 m	1.58 m
Attenuated Volume / Storage Required	291 m ³	510 m ³	-

6.5 DESIGN OF THE ATTENUATION POND AND DISCHARGE STRUCTURES

The following design philosophy has been incorporated into the detailed design of the attenuation pond:

1. The pond will remain empty (above the level of the permanent pool required for water quality purposes). During periods of rain, the level to which the pond shall fill will be dependent upon the intensity and duration of the storm. The physical volume storage capacity of the pond will be sufficient to contain the post-development runoff generated from a 1:25 year storm that is in excess of the 1:25 pre-development year storm.
2. Discharge from the pond will be controlled by two chambers. An orifice will be constructed at the base of each chamber to control discharge. Each orifice will control discharge dependent upon the upstream head. A hole in the wall of the first chamber will control the rate of discharge up to the 1:5 year storm event. For storms that exceed the 1:5 year recurrence interval the water will overtop the first chamber and discharge from the pond will be controlled by an orifice in the base of the second chamber.
3. A hole in the wall of the second chamber will control the rate of discharge up to the 1:25 year storm event. For storms that exceed the 1:25 year recurrence interval the water will overtop the second chamber and discharge from the pond will be controlled by an orifice in the base of the second chamber.
4. The crest of the second chamber will act as an overflow weir for storms that exceed the 1:25 year event.
5. An emergency spillway will be constructed on the crest of the pond as an alternative discharge pathway for storms which exceed a 1:50 year recurrence interval.
6. Discharge from the pond will be into the new headwall structure which in turn discharges into the natural drainage valley.
7. Access to the bottom of the chambers for maintenance purposes will be via manholes with step irons. The manholes will remain closed with a removable mentis grid.

6.6 ATTENUATION POND SUMMARY

One open attenuation pond is proposed for the site. This pond will require a 1:5 year attenuation capacity of 291 m³ and a total storage volume capacity of 510 m³ for the 1:25 year event. The actual total storage volume capacity of the pond that has been provided is 600 m³, with the berm embankment being 200 mm above the 1:25 year flood chamber, however the emergency spillway for storms exceeding the 1:25 year event is at the 1:25 flood level i.e. top of 1:25 year chamber.

The levels internal to the site have been designed such that all piped and overland stormwater flow will drain to these ponds without causing any flooding for the 50 year design storm.

The following table summarises the stormwater management plan for the proposed development:

ATTENUATION SUMMARY			
	Recurrence interval		
	<i>1:5 year</i>	<i>1:25 year</i>	<i>1:50 year</i>
Maximum Allowable Outflow to Match Pre-Development Flow	0.138 m ³ /s	0.242 m ³ /s	-
Outlet Diameter Required (mm)	2 x 200 uPVC	315 uPVC	675 Concrete
Maximum Water Depth	0.78 m	1.38 m	1.58 m
Attenuated Volume / Storage Required	291 m ³	510 m ³	-
Attenuated Volume / Storage Provided	291 m ³	510 m ³	-
Summary	156 m ³ /ha	274 m ³ /ha	-

We further recommend that the developer enter into a services agreement with the Johannesburg Metropolitan Council with regards to stormwater based on the following:

1. That the developer installs the proposed overland discharge infrastructure at the developers cost.
2. That the developer constructs the attenuation facilities as per the philosophy stipulated in this report.
3. That the developer pays the amount for bulk service contributions as calculated by the Johannesburg Metropolitan Council for stormwater.
4. Overland drainage paths across the site must remain unobstructed. K&T recommends that the developer protects the weepholes and overland drainage paths with servitudes such that the overland flow paths remain unobstructed.

7. ECOLOGICAL SYSTEM FOR COJ REQUIREMENTS

7.1 COJ ENVIRONMENTAL PLANNING REQUIREMENTS

- The CoJ's Catchment Management Policy includes the statement "Recognises the sustainable catchment management can only be achieved if environmental components of the system are not divorced from engineering components, and where natural and built systems are considered inextricably;"
- The document defines the stormwater system as is "the ecological system comprising the network of water courses and riparian zones that provide ecological linkages within the metropolitan area including water quality management ponds." The following three interlinked systems are identified:
 - Minor system
 - Major system
 - Environmental system
- In terms of stormwater runoff management, the document requires that four interrelated aspects need to be considered, namely:
 - Peak discharge
 - Discharge volume
 - Runoff frequency
 - Runoff water quality
- It also states that "appropriate water quality management measures, eg. 'Water Sensitive Urban Design' (WSUD), need to be identified and implemented for each catchment". In terms of land development, it stipulates "The quality of stormwater runoff from the proposed land developments shall be at least as good as runoff from the property before development. A range of stormwater quality improvement devices are available and the applicant shall submit details of how prevention and/or removal of contaminants from stormwater runoff will be achieved. Such measures shall be in accordance with Stormwater Management By-laws, once promulgated."
- The document further requires that "Construction site runoff should be such that no sediment laden or otherwise polluted runoff leaves the property up to the 2 year recurrence interval of any duration".
- The COJ's Catchments Management Policy requires the **integration** of environmental components with engineering components as part of **sustainable** catchment management.
- The document indicates that minor, major and **environmental systems** be interlinked to form an ecological system that prioritises **water quality management**.
- **Peak discharge, Discharge Volume, Runoff frequency** and water quality are to be considered during stormwater runoff management.
- The COJ requires that **water quality** preservation measures be implemented for surface runoff and attenuated stormwater.

7.2 DESIGN PARAMETERS

7.2.1 INTRODUCTION

- A single detention pond for all attenuation purposes (both JRA and Environmental requirements) is planned.

- The proposed design is based on the TP10 Stormwater Management document by the Auckland Council, New Zealand.
- The pond will be designed as a partially wet pond implicating that the runoff will be detained for a much longer time than the duration of the rainstorms and direct aftermath for smaller storms. By extending the detention time of the runoff will enable the settlement of contaminated particles and the reduction of downstream channel erosion.
- A part of the storage provided will be 'permanent' allowing for sedimentation and vegetation to be established.

7.2.2 WATER QUALITY VOLUME (WQV)

The average runoff, especially the first part of a storm, will be detained in order to remove the suspended solids from the runoff. It will either be permanently detained or released very slowly. This is referred to as the Water Quality Volume WQV.

- The Water Quality Volume (WQV) is quantified as 1/3 of the volume of a 1:2y storm with an average depth measured over 24h. This volume will be detained under the 1:5y orifice pipe of the outlet control structure.
- The WQV was calculated according to method described in 3.5.1 of TP108 using the hydrological data for Johannesburg. The calculations are enclosed in Annexure B.
- 50% of the WQV will be permanent storage. It will percolate down a filter bed and conveyed by a slotted subsoil pipe towards the outlet structure.
- 50% of the WQV will be released over a 24h period by means of pipes in the outlet structure. These pipes will be situated below the 1:5y outlet pipe.
- The detention of the WQV will allow for sedimentation of the Total Suspended Solids (TSS) The following objectives will be achieved:
 - Removal 80% of Total Suspended Solids (TSS) by sedimentation
 - Reduce Total Phosphorus Content to at least 45%
 - Reduction of pollutants such as phosphorus by aquatic vegetation in aquatic bench and permanently wet pool.
 - Downstream channel protection: attenuation of flood peak up to a 1:10 recurrence interval

7.2.3 EXTENDED DETENTION (ED)

For erosion protection of the downstream channels, the term extended detention is referred to in TP10. This is quantified as the runoff volume detained for a storm of a depth of 34.5mm.

Peak flow attenuation, as required by JRA, will reduce erosion downstream. The volume for the extended detention was thus compared with the volume required for JRA peak flow attenuation and the greater of these volumes was used as the total pond volume.

- The ponds will provide Sustainable Urban Drainage Design by detaining the runoff up to the Water Quality Volume (WQV) and extended detention (ED) and releasing it over a period of 24h.

8. ATTENUATION POND

8.1 DESCRIPTION

The pond will be situated at the south-eastern corner of the site. The pond will be cut into the steep face on the one side, and an earth embankment with a safe 1:1 slope on the shallower side, to create the depth required for the 1:25 year storage volume. The drawings for the attenuation pond can be found in **Annexure A**.

8.2 INLETS

One internal stormwater pipe will discharge into the pond. The internal roads and parkings will be falling towards the kerb & grid inlets which then channel the runoff into an attenuation pond thus providing an overland flow path for storms larger than 1:5y.

8.3 FOREBAYS

The runoff entering the ponds will firstly flow into the forebays.

The function of the forebays is to break the energy of the inflowing runoff and to reduce the velocity allowing sedimentation to take place. The relatively shallow depth of the forebays will facilitate the regular maintenance operations.

The floor of the forebays will either be constructed out of the following alternatives:

Bottom: Grassblocks or 300mm thick 150/300 stone pitching in order to facilitate the removal of the sediment.

On top of the floor a layer of 150/300 rip rap will be added to reduce the velocity of the water flowing through the forebays. However, the rocks need to be removed first in order to remove the sediment. After the removal of the sediment, the rip rap needs to be reinstated.

Alternatively, 300mm high transverse ridges can be created by the grassblocks or by gabions to lower the velocity of the water.

The depth of the forebay will be governed by the 1.0m high overflow. 50Ø outlet pipes below crest level will be provided near the bottom in the overflow weir.

The sidewalls will be constructed out of gabions.

8.4 AQUATIC BENCH

The runoff from the forebays will flow on to the aquatic bench once the excess energy has been dissipated.

The aquatic bench will be planted with emergent wetland vegetation.

The function will be purification of the runoff by biological processes. In addition debris will be trapped, pond safety and aesthetics will be enhanced.

The sidewalls will be constructed out of gabions.

8.5 MICRO POOL

Eventually the runoff flows from the aquatic bench into the micropool.

The floor of the micropool will be constructed out of Reno mattresses with a 400mm sandfilter layer and a sub soil drain underneath. The subsoil pipe will drain into the outlet control structure. The internal side slopes will be grassed at a 1:2 fall. The external slope next to the floodline will be constructed out of gabions.

8.6 OUTLET CONTROL STRUCTURE

- The outlet structure consists of 2 chambers: the lower chamber will cater for the 1:5 year storms and the higher chamber will attenuate for the 1:25 year storms.
- The outlet pipe attenuating the 1:5 year floods will be situated above the detained water quality volume.
- Half of the WQV will be released over a 24 h period by a few 40mm dia. outlet pipes
- The top of the emergency overflow will be 200mm above the top of the 1:25 year outlet structure

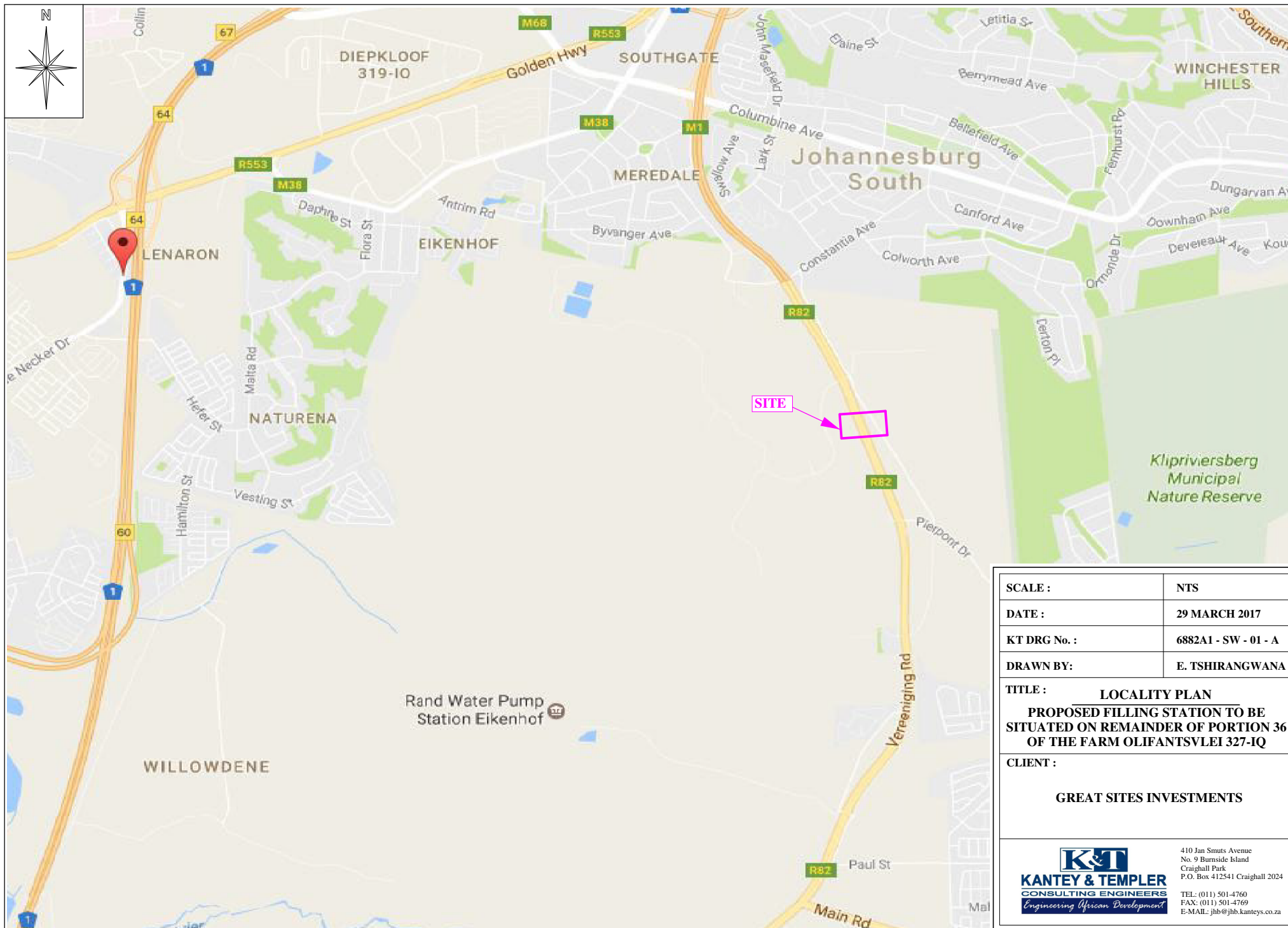
9. TREATMENT OF INFLOW FROM KERB INLETS

All stormwater runoff collected into kerb inlets will be passed through an internal pipe network then into an oil-water separator ensuring that no chemical contaminants are transported into the attenuation facility and ultimately discharged into the environment.

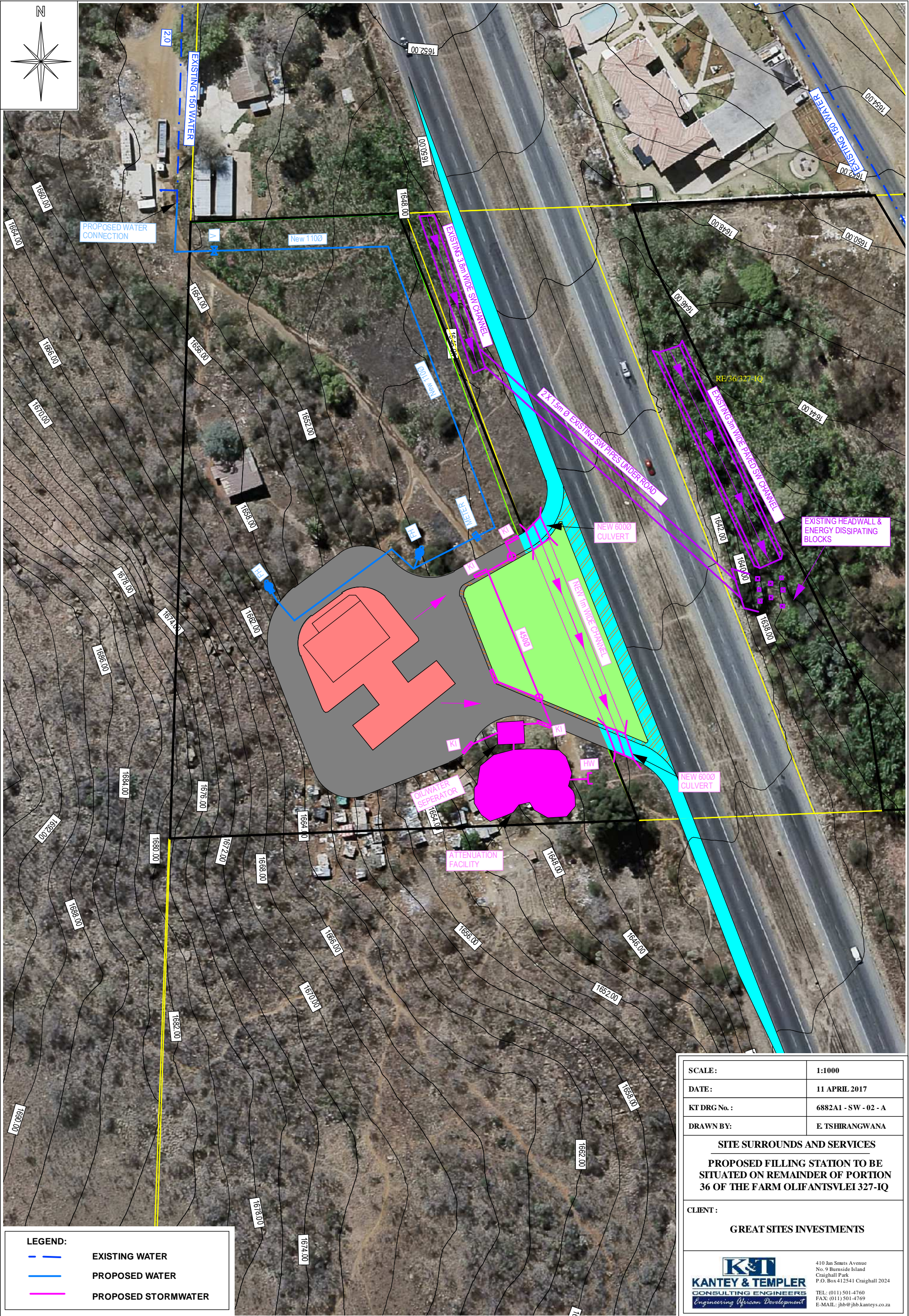
10. CONCLUSION

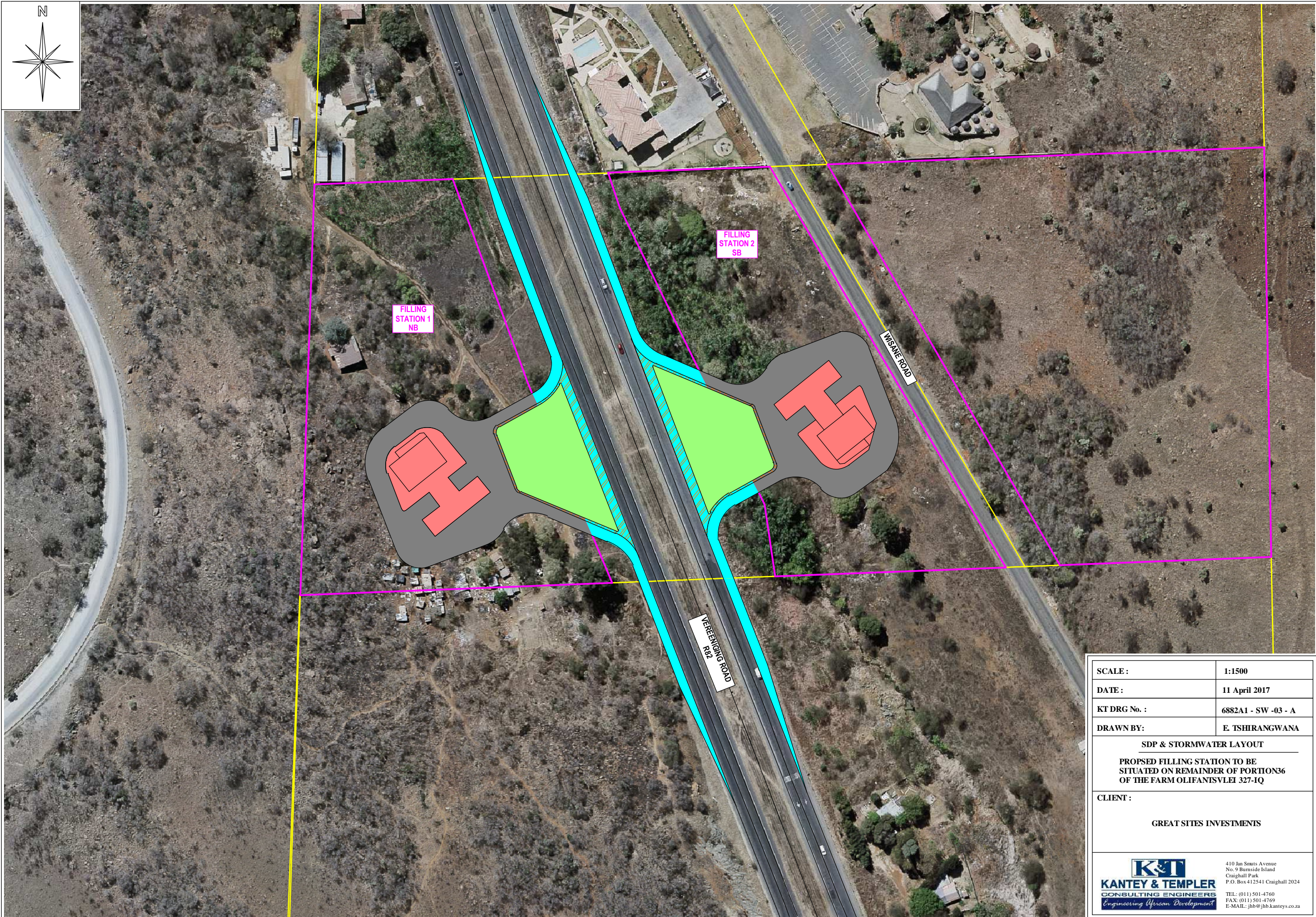
Provided the proposed infrastructure mentioned in this report is constructed, the increase in runoff produced by this development will be well managed. The development should be supported by the local authority as all measures have been taken to ensure that the increase in stormwater discharge does not negatively impact the surrounding environment.

Annexure A
DRAWINGS



SCALE :	NTS
DATE :	29 MARCH 2017
KT DRG No. :	6882A1 - SW - 01 - A
DRAWN BY:	E. TSHIRANGWANA
TITLE : LOCALITY PLAN PROPOSED FILLING STATION TO BE SITUATED ON REMAINDER OF PORTION 36 OF THE FARM OLIFANTSVLEI 327-IQ	
CLIENT : GREAT SITES INVESTMENTS	
<div>  <div> KANTLEY & TEMPLER CONSULTING ENGINEERS <i>Engineering African Development</i> </div> <div> 410 Jan Smuts Avenue No. 9 Burnside Island Craighall Park P.O. Box 412541 Craighall 2024 TEL: (011) 501-4760 FAX: (011) 501-4769 E-MAIL: jhb@jhb.kanteys.co.za </div> </div>	





SCALE :	1:1500
DATE :	11 April 2017
KT DRG No. :	6882A1 - SW -03 - A
DRAWN BY:	E. TSHIRANGWANA

SDP & STORMWATER LAYOUT

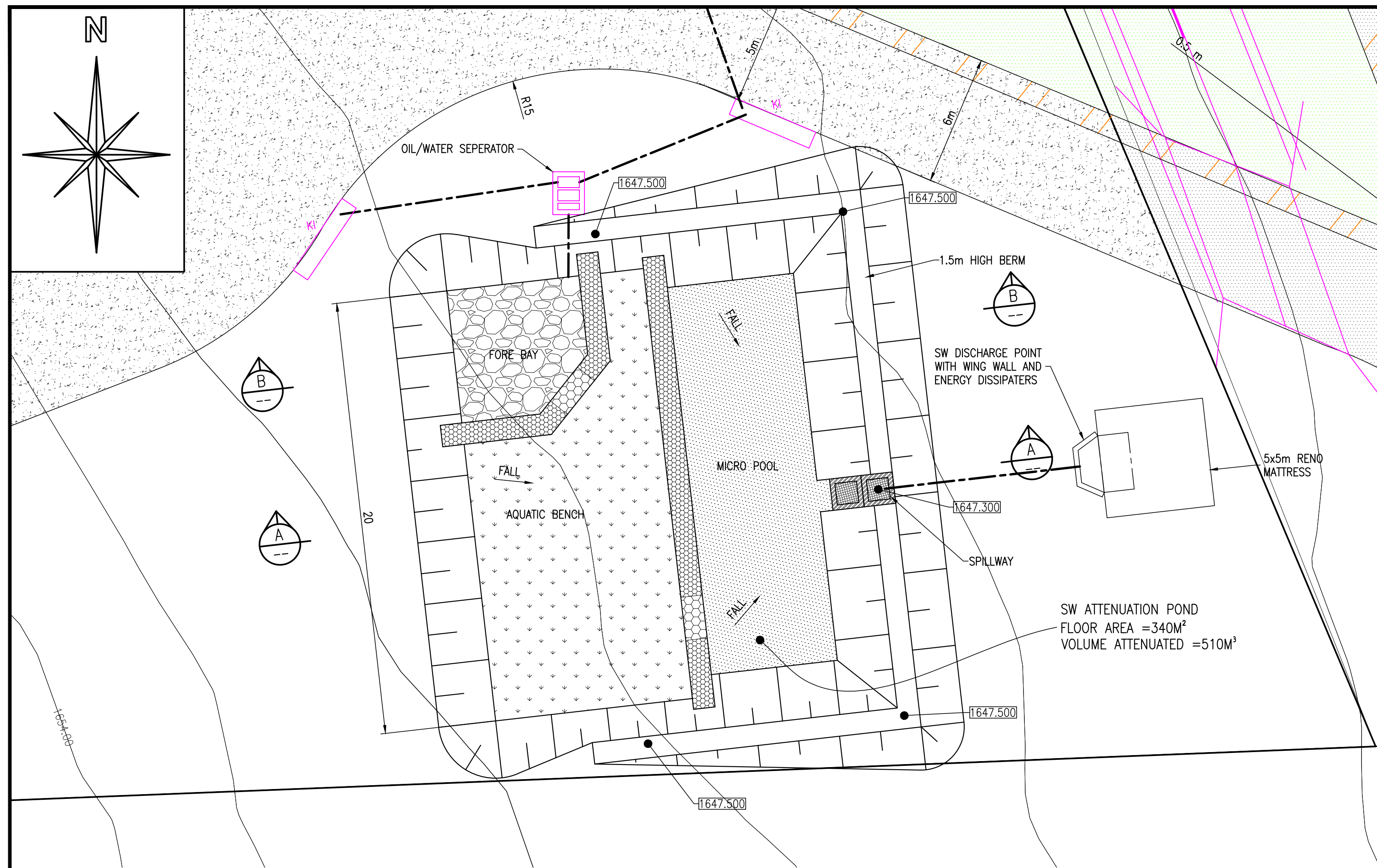
PROPOSED FILLING STATION TO BE
SITUATED ON REMAINDER OF PORTION36
OF THE FARM OLIFANTSVLEI 327-IQ

CLIENT :

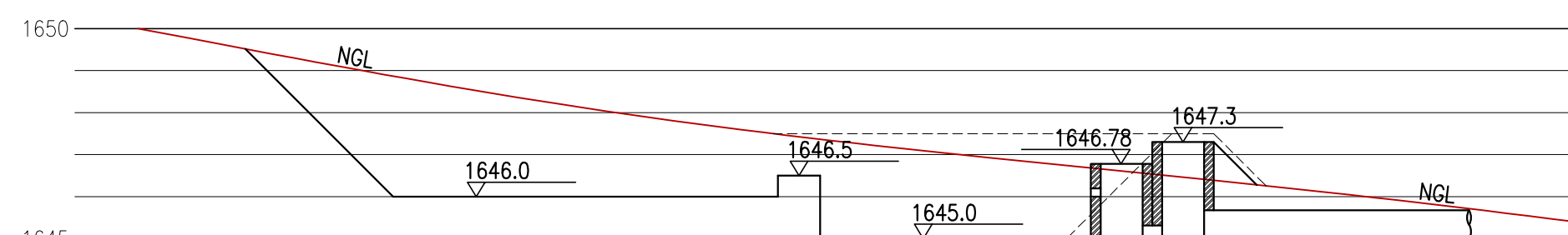
GREAT SITES INVESTMENTS



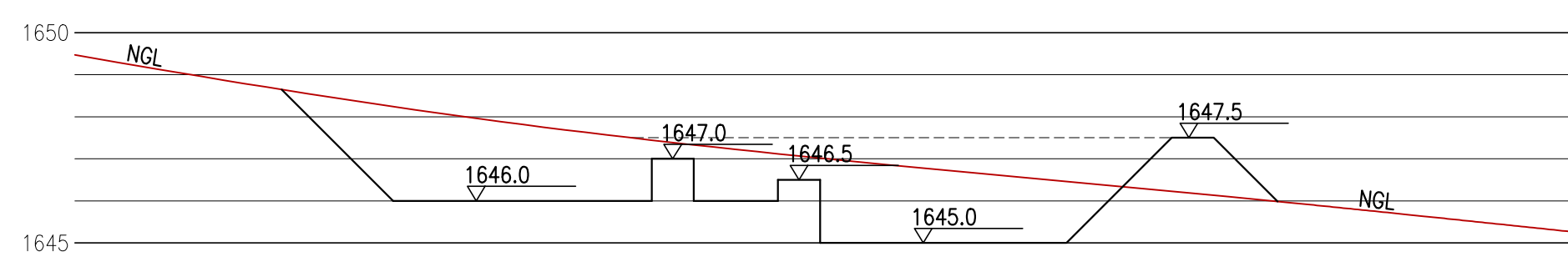
410 Jan Smuts Avenue
No. 9 Burnside Island
Craighall Park
P.O. Box 412541 Craighall 2024
TEL: (011) 501-4760
FAX: (011) 501-4769
E-MAIL: jhb@jhb.kanteys.co.za



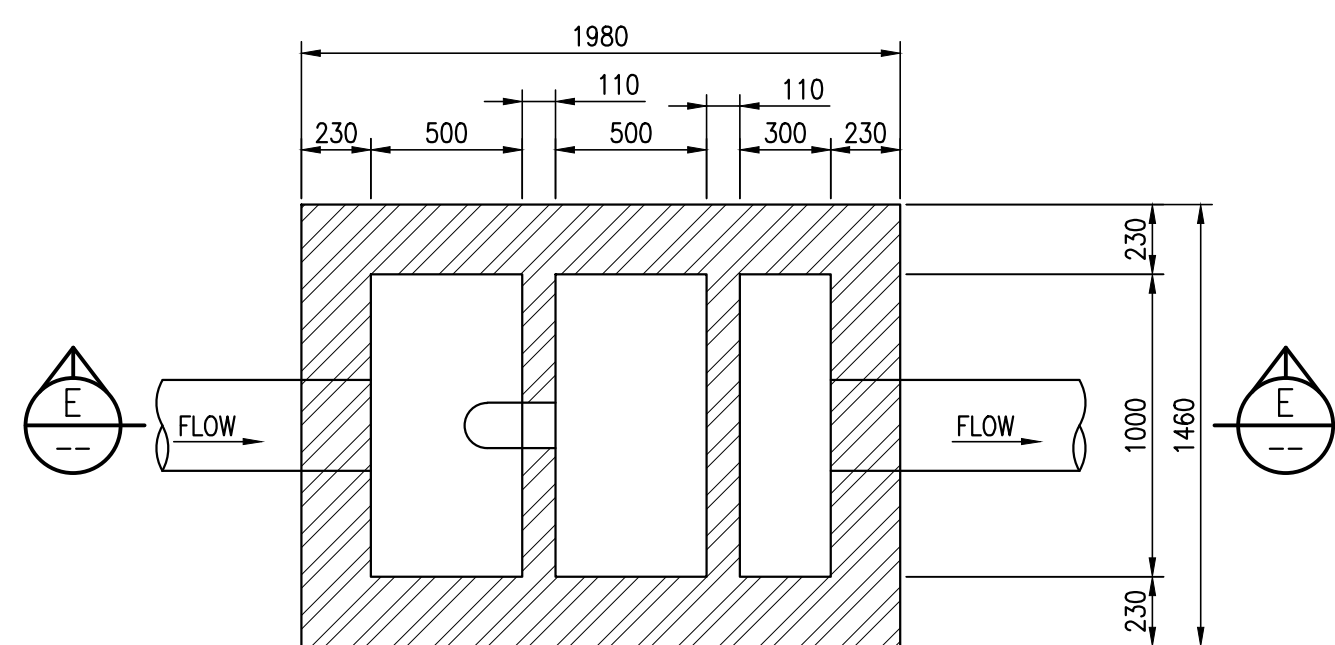
ATTENUATION POND LAYOUT
SCALE 1:150



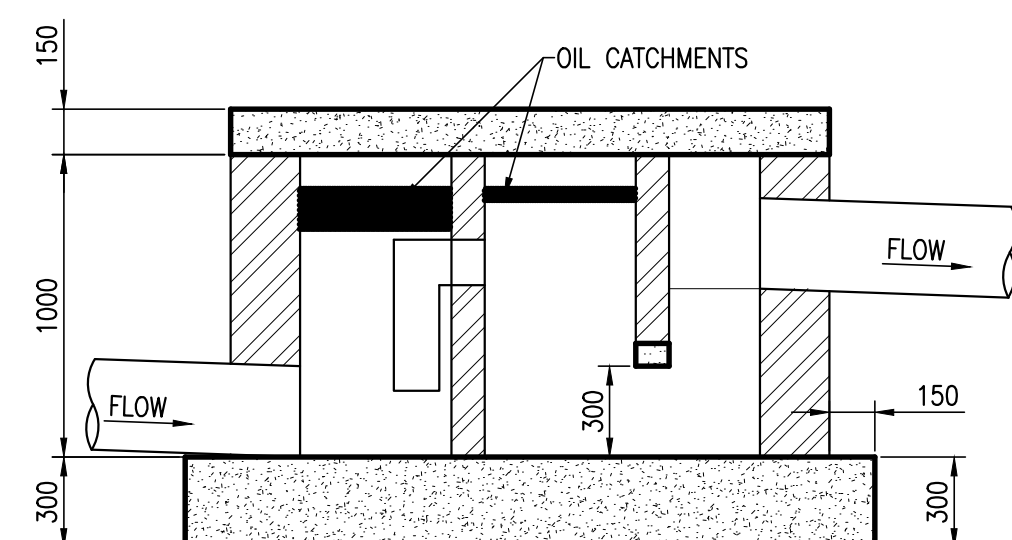
SECTION A-A
SCALE 1:150



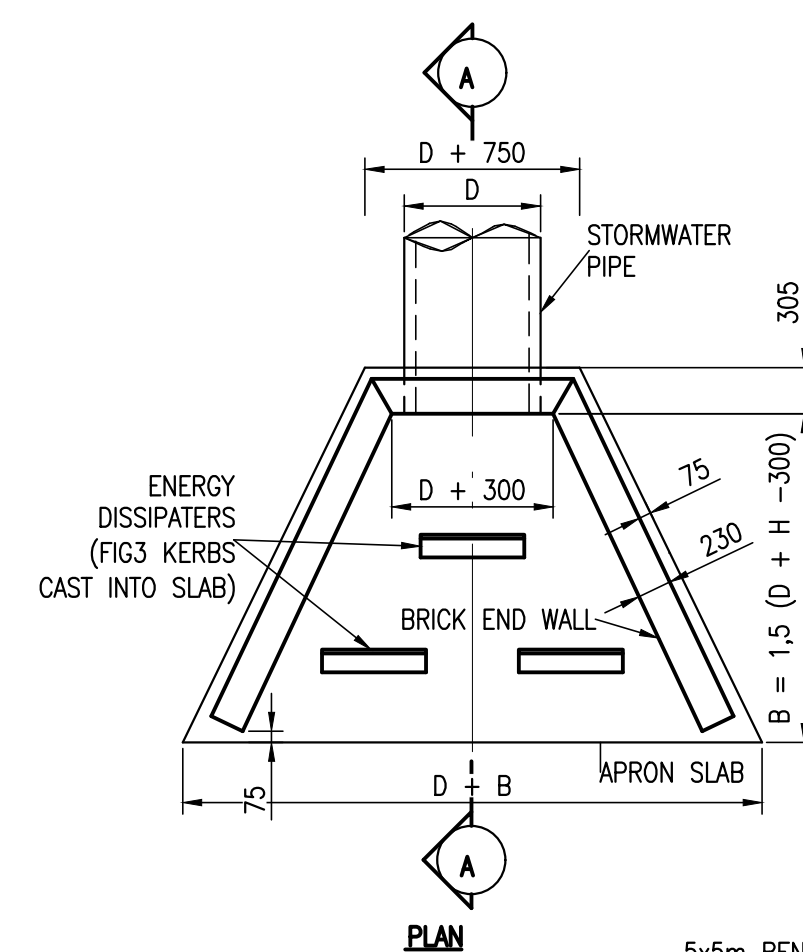
SECTION B-B
SCALE 1:150



TYPICAL OIL SEPARATOR PLAN
SCALE 1:25

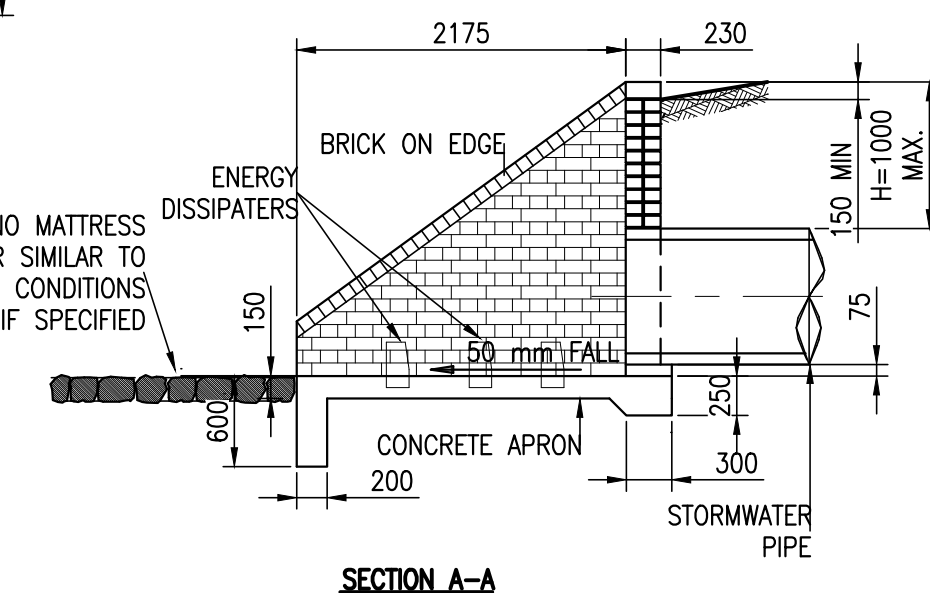


SECTION E-E
SCALE 1:25

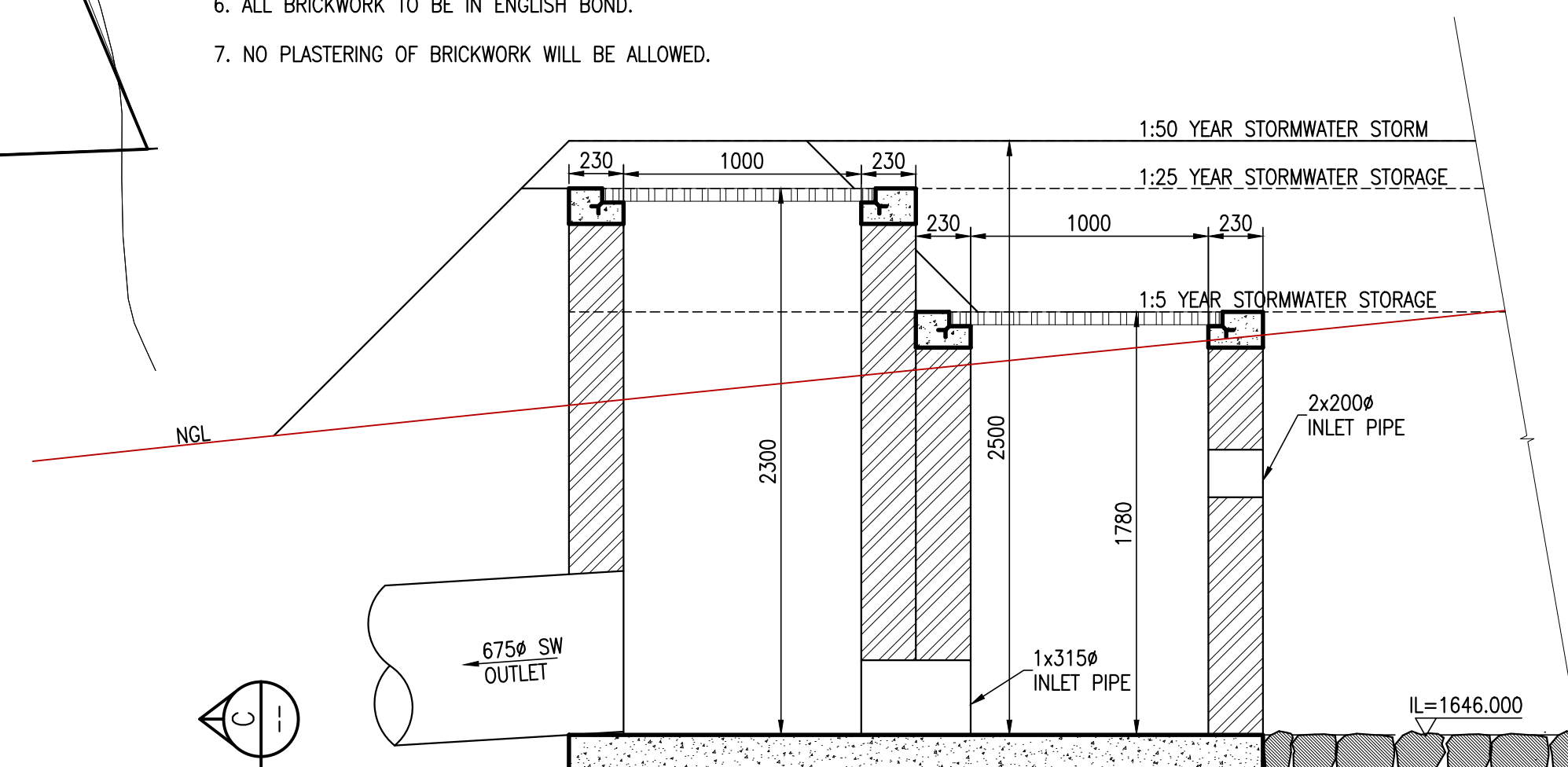


NOTES

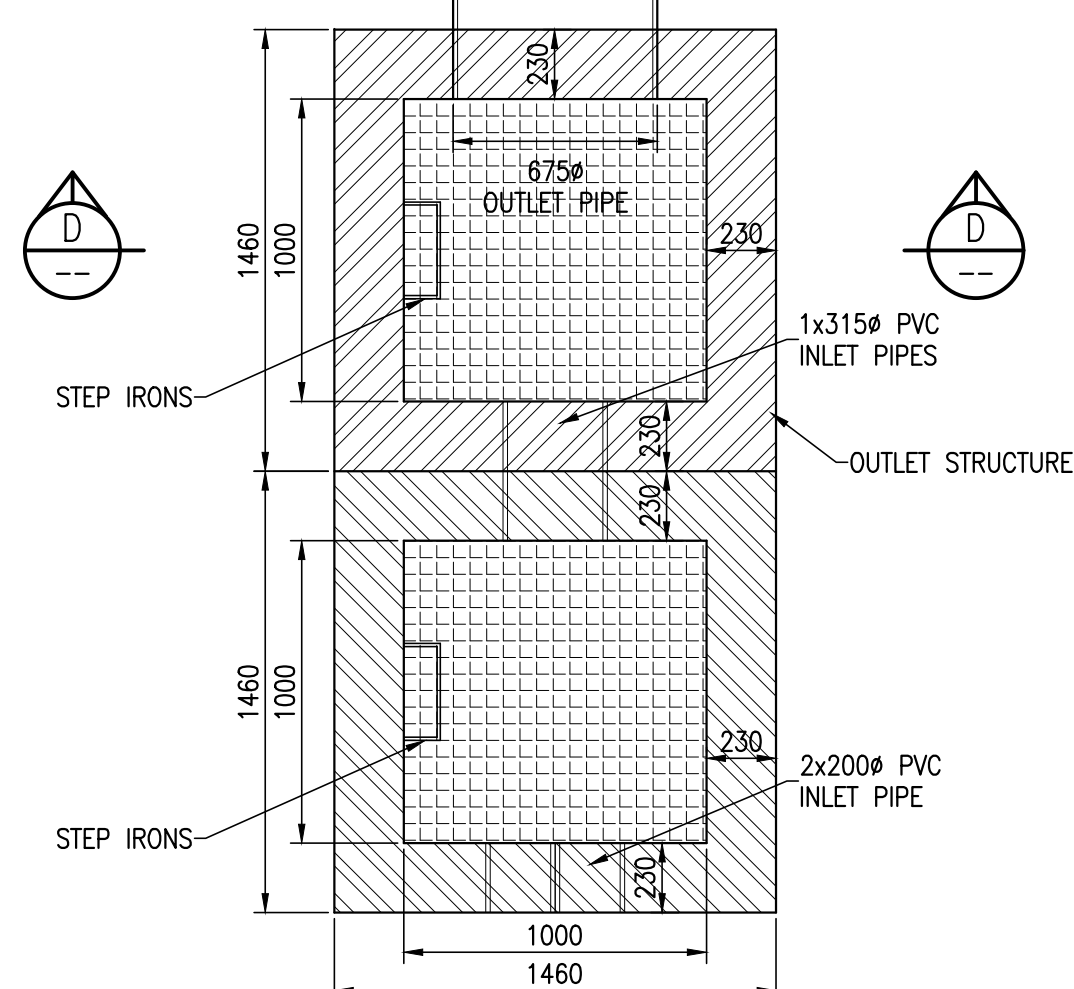
1. THE MATERIAL FOR A DEPTH OF 150mm UNDER THE APRON SLAB MUST BE COMPACTED TO A MINIMUM DENSITY OF 90 % OF THE MOD. AASHTO DENSITY.
2. ALL CONCRETE TO BE CLASS 20/19.
3. ENERGY BREAKERS MUST BE PROVIDED ACCORDING TO DRG JRA-SD-S018 WHEN REQUIRED BY THE ENGINEER
4. THIS OUTLET STRUCTURE ONLY TO BE USED WHEN PIPE SIZE IS LESS THAN 600 mm dia. REFER TO JRA-SD-S018
5. ALL BRICKS TO BE OF QUALITY FBSE30 TO SABS 227-1986 WITH WATER ABSORPTION <14% AND EFFLORESCENCE <10.
6. ALL BRICKWORK TO BE IN ENGLISH BOND.
7. NO PLASTERING OF BRICKWORK WILL BE ALLOWED.



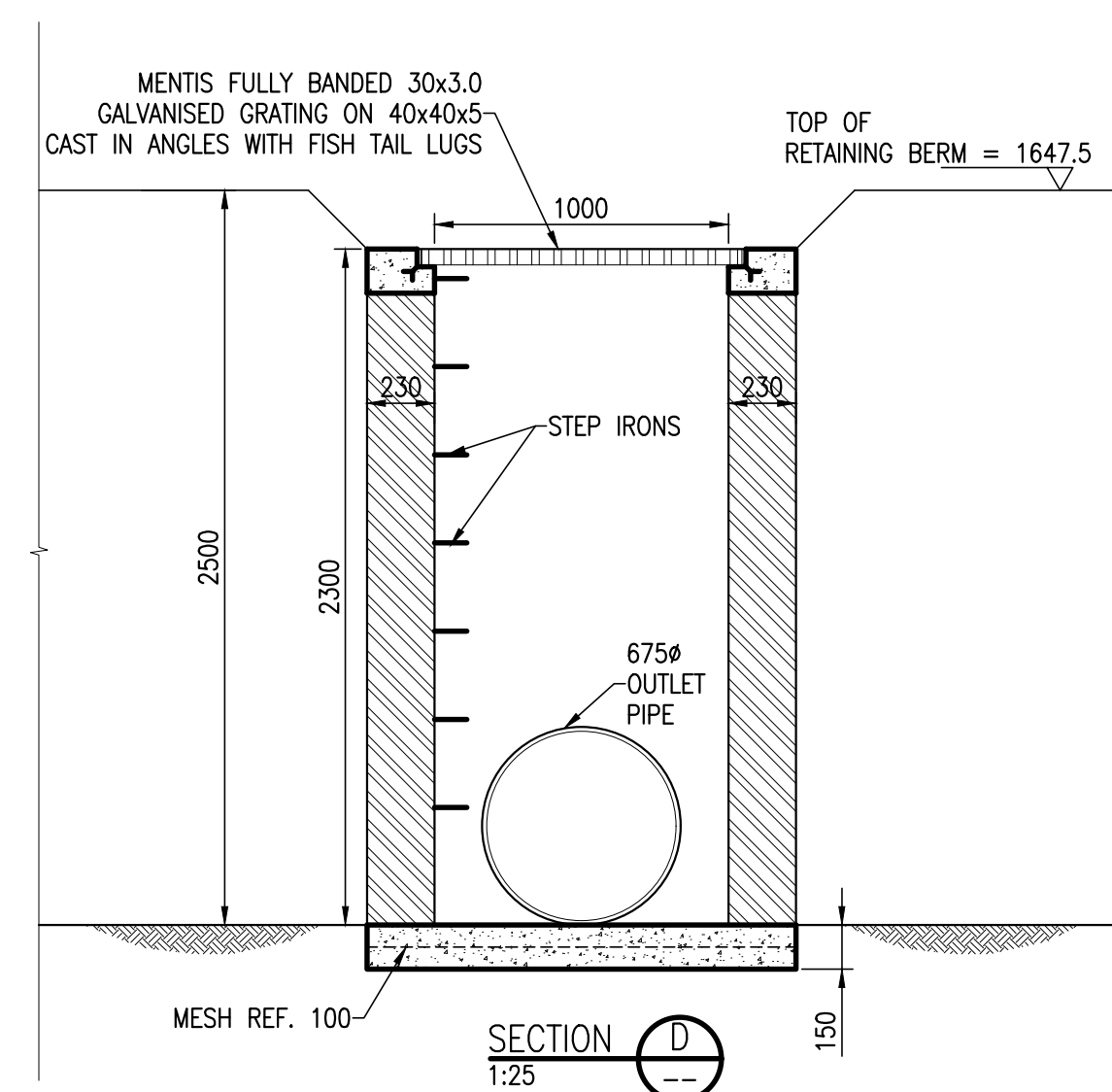
SECTION A-A



SECTION C-C
SCALE 1:25



PLAN OF OUTLET STRUCTURE
SCALE 1:25



SECTION D-D
SCALE 1:25

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GENERAL NOTES

- * ALL BUILDING WORK AND BUILDING REQUIREMENTS ARE TO BE CARRIED OUT IN STRICT ACCORDANCE WITH THE REQUIREMENTS OF THE NATIONAL BUILDING REGULATIONS AND BUILDING STANDARDS ACT (No 103 OF 1977).
- * THIS DRAWING IS NOT TO BE SCALED. USE FIGURED DIMENSIONS ONLY.
- * ALL DIMENSIONS AND LEVELS, ETC., TO BE CHECKED ON SITE, BEFORE ANY WORK IS COMMENCED.
- * ANY DISCREPANCIES, QUERIES, ETC., RELATED TO THIS DRAWING ARE TO BE REFERRED TO ENGINEERS BEFORE ANY WORK IS COMMENCED.
- * SETTING OUT OF GRID LINES TO ARCHITECTS DRAWINGS.

EARTHWORKS NOTES:

1. ALL EARTHWORKS TO COMPLY WITH SABS 1200 AND ANY AMENDMENTS THEREOF.
2. DUE CARE TO BE TAKEN TO PROTECT ALL EXCAVATIONS, BANKS etc FROM STORMWATER INGRESS. ALL LAYER WORKS THAT ARE CONTAMINATED WITH RAINWATER MUST BE REWORKED TO ACHIEVE THE CORRECT COMPACTION BEFORE BEING COVERED WITH THE FINAL SURFACE.
3. ALL EXCAVATION TO BE INSPECTED BY THE ENGINEER PRIOR TO CASTING ANY CONCRETE.
4. ALL COMPACTION RESULTS OF LAYERWORKS TO BE FORWARDED TO THE ENGINEERS OFFICE AS SOON AS POSSIBLE FOR APPROVAL.
5. TESTING REQUIREMENTS FOR THE COMPACTION OF THE EARTHWORKS TO BE DONE STRICTLY ACCORDING TO SABS 1200 UNLESS ORDERED OTHERWISE BY THE ENGINEER.
6. STOCKPILE G7 OR BETTER QUALITY MATERIAL ON SITE.
7. POSITION AND QUANTITY OF STOCKPILES TO BE CONFIRMED.
8. LEVELS INDICATED ON THIS DRAWING ARE FINISHED ROAD OR FLOOR LEVELS. REFER TO SECTIONS FOR BULK EARTHWORKS LEVELS.
9. BATTER SLOPES TO BE DETERMINED ON SITE BY CONTRACTOR AND APPROVED BY ENGINEER.

DRG. No. DESCRIPTION

REFERENCE DRAWINGS

REV	DESCRIPTION	DR.	APP.	DATE
A	ISSUED FOR APPROVAL	JW	FB	05/06/2017

	INITIALS	SIGN	DATE
DESIGNED	M. GONELLI		05/06/2017
DRAWN	J. VD WANT		05/06/2017
PROJECT ENG.	E. TSHIRANGWANA		05/06/2017
APPROVED	F. BAIN		05/06/2017

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CLIENT

PROJECT
PROPOSED FILLING STATION TO
BE SITUATED ON REMAINDER
OF PORTION36 OF THE FARM
OLIFANTSVLEI 327-IQ

TITLE
LAYOUT & SECTIONS OF
ATTENUATION POND

SCALE AS SHOWN

DRAWING No. 6882A1-SW-04

REV
A

Annexure B

Olifantsfontein Floodline Study

HYDROLOGICAL INVESTIGATION

OLIFANTSVLEI 1:100Y INDICATIVE FLOODLINES

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Engineering Consultant
For: Gestion Engineering
and Project Consultants (Pty) Ltd**

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3. RAINFALL INFORMATION	5
4. DESIGN FLOOD DETERMINATION.....	6
5. INDICATIVE FLOODLINE DETERMINATION.....	7
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INDICATIVE FLOODLINE INVESTIGATION

OLIFANTSVLEI

1. INTRODUCTION

1.1. Terms of Reference

Gestion Engineering and Project Consultants was appointed for an indicative hydrological and floodline study. The study is required as part of the project report for the proposed fuel facility on a portion of Olifantsvlei, located on Wisane Street, approximately 750 m North-East from Afrisam Eikenhof Quarry, Gauteng. The purpose of the study is the estimation of the design flood run-off values for the catchment, and the investigation of the influence of the proposed improvements on the floodplain.

1.2. Study Area

The study area is located on the remainder of portion 36 of the farm Olifantsvlei no 327-IQ, approximately 750 m North-East of Afrisam Eikenhof Quarry, Gauteng, on Wisane Street. The referenced GPS location is:

26°17'28.54"S

27°59'39.63"E

An artificial watercourse traverse the site, mainly draining north to south, and originating in the catchment area to the north. The watercourse consists of constructed earth and concrete drains, and was probably constructed as part of the R 82 (Vereeniging Road) stormwater management. The catchment area eventually drains into the Kliprivier, South of the site and forms part of natural watercourses which eventually discharges into the Vaal River, which drains eastwards up to the Vaal Dam. The locality is shown on Figure 1 below.

Relevant maps:

- 1:50 000 topographic map (WGS2530DB)
Chief Directorate National Geo-spatial Information of South Africa
- Google Earth satellite/aerial photograph
© Google

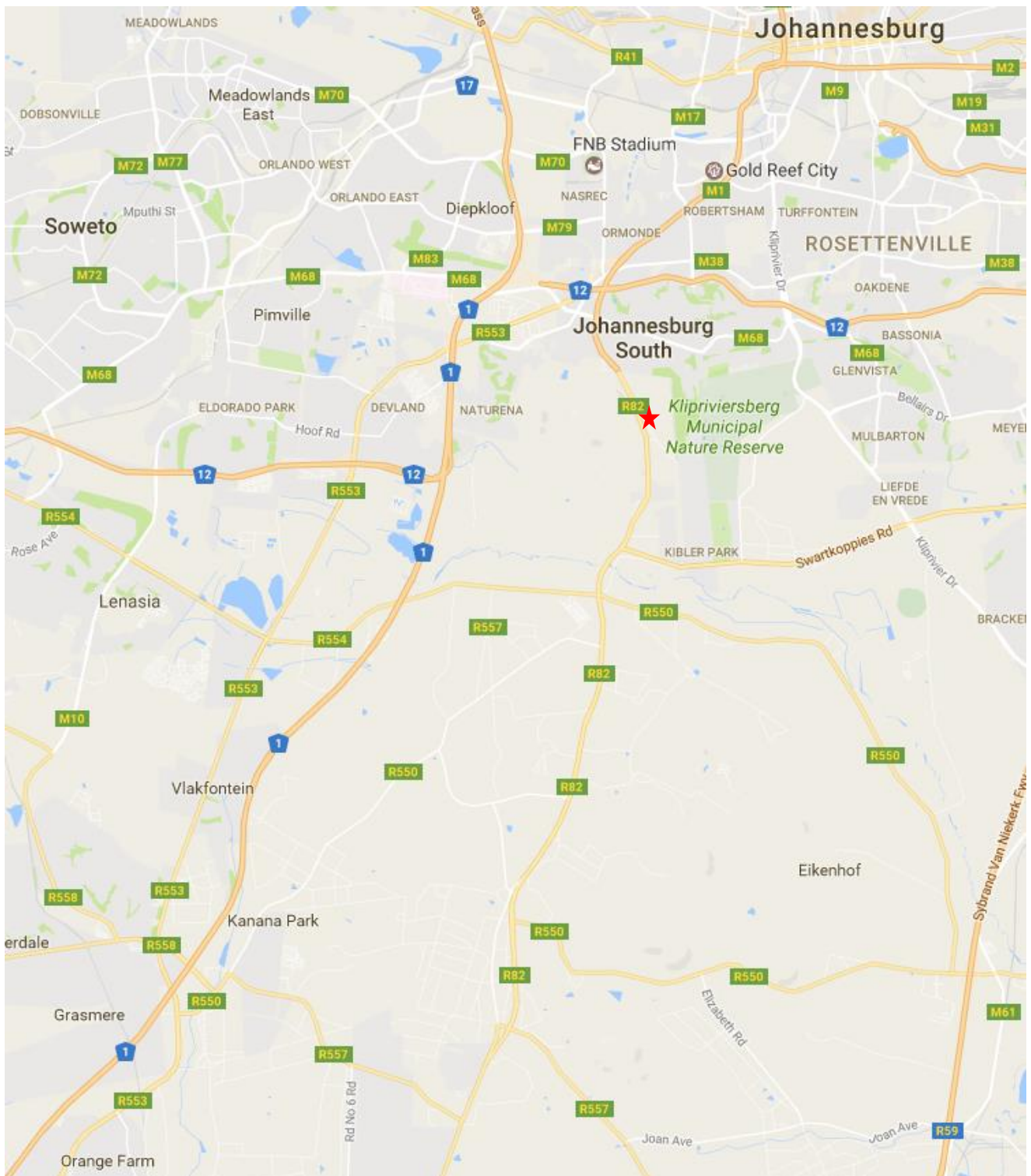


Figure 1: Locality

2. CATCHMENT INFORMATION

2.1. Catchment Area

The artificial watercourse flowing through the site is draining the catchment area from Kliprivierberg Nature Reserve, Johannesburg South, Kanana Park, Vlakfontein and Elandsfontein ($H_{\max} = 1799$ m.a.m.s.l). The catchment area is relatively small, with no defined perennial watercourses this early in the catchment. The watercourse through the site is artificially created as part of the R82 construction stormwater management plan. The catchment area eventually drains into the Kliprivier, South of the site and forms part of natural watercourses which eventually discharges into the Vaal River, which drains eastwards up to the Vaal Dam. The outlet of the catchment for this specific site is at a height of 1653 m.a.m.s.l. Run-off from this catchment continues in a Southerly direction, through formal stormwater management systems and eventually discharges into the Kliprivier.

There is only one contributory area to this site. The Catchment is relatively small, relatively steep

Catchment delineation was based on a surface model grid extracted from Google Earth, and the available 1:50 000 topographical maps. A summary of the relevant catchment characteristics is given below in Table 1.

2.2. Topography

Table 1: Catchment characteristics

Characteristic	Catchment
Area, A (km ²)	0.52
Height at highest point (m)	1799
Height at catchment outlet (m)	1653
Height at 10% of watercourse length, $H_{10\%}$ (m)	1680
Height at 85% of watercourse length, $H_{85\%}$ (m)	1780
Maximum height difference, H_{\max} (m)	146
Maximum watercourse length, L (km)	0.849
Average catchment slope, S_{avg} (m/m)	0.157
Distance between catchment outlet, and centroid of catchment, L_o (km)	0.360
Average time of concentration, T_c (hours)	0.500

3. RAINFALL INFORMATION

Historic rainfall data was sourced from the nearest South African weather station site (Johannesburg Botanical Gardens).

Rainfall data has also been gathered from the nearest five weather stations (in a total 86 kilometre radius) to compile statistical representative information (refer to table 2 below).

Table 2: Rainfall station details

Weather station name	Weather station number	Distance (km)	MAR (mm)
Vereeniging	0438784 3	35.55	559
JHB Botanical Gardens	0475879 0	14.45	543
JHB International	0476399 0	29.27	543
Springs	0476762A3	46.55	586
Grand Central	0513239 0	34.90	723
Potchefstroom	0437104A4	103.20	507

The mean annual rainfall is calculated as 704 mm/year.

4. DESIGN FLOOD DETERMINATION

4.1. Outline of strategy

A downstream control point was chosen at which point the design run-off is calculated. Control points are generally at confluence points, at the catchment outlet, and the middle of extensive river reaches, preferably at control flow points.

4.2. Peak flood estimation

The following deterministic methods for calculating the peak discharges were used to estimate a final expected discharge at each control point:

- Rational method;
- Alternative rational method;
- Empirical Method

5. INDICATIVE FLOODLINE DETERMINATION

5.1. Cross-sections

Based on the surface elevations obtained from Google Earth, an indicative surface model was constructed in a GIS environment (*ESRI ArcMap 10.1*), allowing the extracting of suitable cross-sectional information (using the *HEC-GeoRAS* extension for ArcMap). In the absence of specific detailed cross-sectional surveys, these extracted indicative cross-sections were used for the flood simulations.

The maximum spacing for cross sections was determined to be on average 30m.

Based on this, cross-sections were designed using this maximum indicated cross-section spacing, as well as the following factors:

- Change in average bed slope of the stream;
- Change in bank descriptions and general roughness values;
- Sudden change in plan geometry;
- Obstructions;

A total of 12 indicative cross-sections were extracted, and exported as part of the applicable HECRAS model.

5.2. Flow profile calculation

5.2.1 Method

A one dimensional steady flow (gradual-varied) analysis model was designed using HEC-RAS software. The software computation is based on the solution of the one-dimensional energy equation based on Manning's roughness values. In order to analyse a mixed flow regime for the different flow profiles, flow controls needs to be defined for each tributary, or flow reach. A flow control is a section of the flow channel where the relationship between flow rate (Q) and flow depth (y_n) is known. In the absence of control structures (such as culverts or weirs), a section with constant and known slope is selected, where the water surface is expected to be at a critical energy depth.

5.2.2 Flow depth calculation

The flow profile for the 1:50 year (50% recurrence) up to the 1:100 year (0,5% recurrence) was modelled, with the anticipated flow depths for each profile being known at each cross-section. With the final expected water level known for each cross section, the water levels are projected on the extracted surface model, resulting in an expected area of inundation. The outer extent of this inundation region forms the final floodline profile. Refer to **Annexure A** for final floodline layout.

It must be highlighted that the computed floodline layout is indicative only. The layout will approximate an actual designed layout, but in the absence of surface or control section surveys it remains a planning tool. It is however useful to investigate the hydrological functioning of the floodplain, and its sensitivity to change.

6. DISCUSSION AND CONCLUSION

The study area is located on the remainder of portion 36 of the farm Olifantsvlei no 327-IQ, approximately 750 m North-East of Afrisam Eikenhof Quarry, Gauteng, on Wisane Street

The watercourse consists of constructed earth and concrete drains, and was probably constructed as part of the R 82 (Vereeniging Road) stormwater management. The catchment area eventually drains into the Kliprivier, South of the site and forms part of natural watercourses which eventually discharges into the Vaal River, which drains eastwards up to the Vaal Dam.

A detailed hydrological catchment analysis was performed in order to calculate design run-off values to be used for floodline calculation. Various deterministic and empirical methods were used in the calculation, taking into account the various constraints of each method.

Since no specific geotechnical information is available, the SCS-SA method was omitted as part of this study. The empirical method utilising Q_T/Q_{RMF} ratios resulted in above-average flow values, and these results were subsequently also omitted from the final mean averages.

The flood analysis model was used to investigate the influence of the proposed weir structures on the floodplain, including the velocity distribution surrounding the proposed improvements.

The final results indicated a good correlation between the final design values and the resulting design flows can therefore be used with confidence.

The 1:100 year indicative floodline model indicated that the proposed improvements will not have an adverse or detrimental effect on the floodplain.

7. REFERENCES

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3. Lurie, J., *South African geology for mining, metallurgical, hydrological and civil engineering 9th Ed.*, Lupon Publishing, 2004.
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6. Smithers, J.C., Schulze, W.E., *Design rainfall and flood estimation in South Africa*, Water Research Commission Report No: K5/1060, University of Natal, 2002.
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9. Thompson, D.B., the *Rational Method*, Civil Engineering Department, Texas Tech University, 2006.

8. MAP AND SOFTWARE RESOURCES

1. 1:50 000 topographic map. WGS2530DB. *Chief Directorate National Geo-spatial Information of South Africa*;
2. Google Earth satellite/aerial photograph, © Google, <http://www.google.com/>
3. Planet GIS Professional 4.0, <http://www.planetgis.co.za>
4. Mpumalanga 5m contours, <http://www.planetgis.co.za>
5. Stormwater Management Model (SWMM) V5.0.022. *United States Environmental Protection Agency (EPA)*. <http://www.epa.gov/nrmrl/wswrd/wq/models/swmm/>
6. Hydrologic Engineering Centers River Analysis System (HEC-RAS) V4.1.0. US Army Corps of Engineers. <http://www.hec.usace.army.mil/software/hec-ras/>

ANNEXURE A: Schematic catchment layout and contour map



SCALE 1 : 500

STORMWATER CATCHMENT LAYOUT
SCALE 1 : 500

LEGEND

1 : 50
1 : 100

Q 1 : 50 = 14m²/s
Q 1 : 100 = 18m²/s

NOTES / LEGEND

DO NOT SCALE DRAWING
IF IN DOUBT, REFER TO DRAWING OFFICE

CLIENT PLAN NUMBER

REFERENCE DRAWINGS

NUMBER	REVISION	DRAWING DESCRIPTION
187-001	A	FLOODLINES

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT REG. NO. DATE

AMENDMENTS CODE

A-Y / : REPORT/DESIGN/TENDER	A : BY CLIENT
0-99 / : CONSTRUCTION	B : BY ARCHITECT
Z / : AS BUILT	C : BY MECHANICAL / ELECTRICAL
	D : BY GESTION
	E : BY OTHER ()

DATE	INITIAL	CODE	REVISION DESCRIPTION
2017/04/07	WJR	A	ISSUED FOR APPROVAL

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Reg. No. 2012/056982/07

CLIENT

PROJECT

REMAINDER OF PORTION
36 OLIFANTSVLEI 327-IQ

DRAWING TITLE

FLOODLINES

APPROVED BY GESTION

ENGINEER/TECHNOLOGIST REG. NO. DATE

SCALE	AS SHOWN	DRAWN	WJR
DESIGNED	WJR	CHECKED	WMS
PLAN NUMBER	REVISION NO.	DATE SAVED	

187-001

A

19/05/2017

A1

Annexure C

Wetland Assessment Olifantsvlei



Wetland Assessment for the proposed Olifantsvlei Service Station

Gauteng

May 2017

REFERENCE

Olifantsvlei

CLIENT



Prepared for:

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Report Name	Wetland Assessment for the proposed Olifantsvlei Service Station	
Reference	Olifantsvlei	
Submitted to	Gestion	
Report writer	Wayne Jackson	
Report Reviewer	Andrew Husted	



EXECUTIVE SUMMARY

The Biodiversity Company was commissioned to conduct a wetland assessment as part of the Basic Assessment (BA) environmental authorisation process and Water Use Licence Application (WULA) for the proposed service station in Olifantsvlei, Gauteng. A single site visit was conducted in April 2017, this would constitute a wet season survey.

The aim of the study was to complete a wetland assessment for the project area, ensuring that all legislative and provincial requirements are achieved.

Deliverable	Yes / No	Comment
Wetlands within 500m of the project area	Yes	Channelled valley bottom
Presence of NFEPA wetlands	No	
Present Ecological State (PES) of the wetlands determined	Yes	HGM1 = D – Largely Modified
Eco-Services that were rated as moderately-high or very high.	Yes	<ul style="list-style-type: none"> Flood attenuation.
EIS assessment with results of A or B.	No	Highest rating was a C for HGM 1

One (1) HGM unit was identified within the 500m project assessment boundary. The channelled valley bottom wetland drains from the north to the south on the eastern portion of the main road. There is a small wetland portion on the western side of the road which drains under the road to the main wetland. The area has been significantly altered by the main road and erosion is evident on the channel banks. The catchment is steep and any runoff generated will result in a sharp hydrograph. The dominant soils are shallow rocky soils on the slopes with Rensburg soils in the valley bottom.

The PES results for the channelled valley bottom wetland was determined to be largely modified. The channelled Valley Bottom (HGM 1) had an overall intermediate level of service, with flood attenuation being the only service rated as high.

HGM 1 showed a Moderate (C) level of importance for the Ecological Importance & Sensitivity as well as for the Hydrological Importance respectively. The Direct Human benefits were rated to be Low with a (D) rating.

A buffer zone of 15m during the construction and the operational phase is recommended for the wetland areas, this buffer is calculated assuming mitigation measures are applied.

The proposed service station and associated infrastructure (roads) do pose a risk on the identified wetland system, with the level of risk determined to vary from low to moderate, without mitigation. The highest risks identified for the construction phase, were those associated with the clearing of areas, the construction of infrastructure, and possible crossings and stabilisation of wetlands. These moderate risks can be reduced to low risks if the mitigation measures are implemented.



Olifantsvlei

The operational phase shows moderate risk for all aspects however these are on the border of being low risks and with mitigation can be successfully reduced to low. These risks are mainly associated with increased flow volumes and peaks into the receiving environment as well as possible contamination of the system.



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I, Wayne Jackson declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.



Wayne Jackson

Wetland Ecologist

The Biodiversity Company

8 May 2017



1 INTRODUCTION

The Biodiversity Company was commissioned to conduct a wetland assessment as part of the Basic Assessment (BA) environmental authorisation process and Water Use Licence Application (WULA) for the proposed service station in Olifantsvlei, Gauteng. A single site visit was conducted in April 2017, this would constitute a wet season survey.

1.1 Objectives

The aim of the assessment is to provide information to guide the development of the proposed service station with respect to the current state of the wetland systems in the area of study. This was achieved through the following:

- The delineation and assessment of wetlands within 500m of the project area;
- A risk assessment for the proposed development; and
- The prescription of mitigation measures and recommendations for identified risks.

2 KEY LEGISLATIVE REQUIREMENTS

2.1 National Water Act (NWA, 1998)

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (NWA) (Act No. 36 of 1998) allows for the protection of water resources, which includes:

- The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;
- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The NWA recognises that the entire ecosystem, and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS.

For the purposes of this project, a wetland area is defined according to the NWA (Act No. 36 of 1998): "Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".



Wetlands have one or more of the following attributes to meet the NWA wetland definition (DWAF, 2005):

- A high water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50 cm of the soil;
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils; and
- The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

2.2 National Environmental Management Act (NEMA, 1998)

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in April 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact.

3 PROJECT AREA

The project area is situated just south of Johannesburg (Figure 1) of the M1 highway.



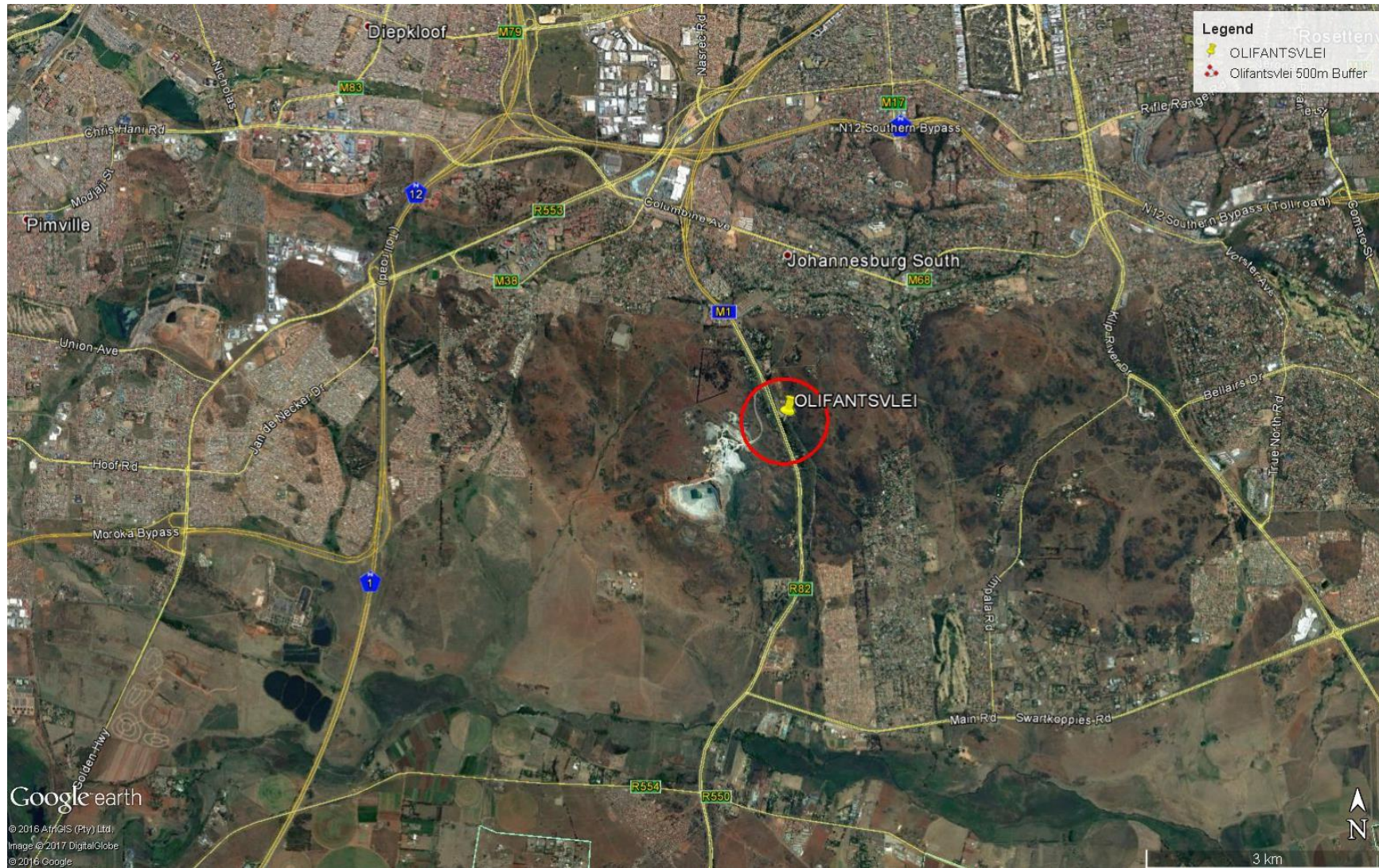


Figure 1: Locality map showing the general setting in relation to the proposed project area



4 LIMITATIONS

The following aspects were considered as limitations for the water resource assessment;

- The GPS used for wetland delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side.
- Wetland systems identified at desktop level within 500 m of the project area were considered for the identification and desktop delineation, with wetland areas within the project area being the focus for ground truthing.
- The information regarding the activities to be completed on the site, allowed us to do a general assessment on the impacts and the buffer requirement.
- The exact layout has not been given so we cannot assess whether the infrastructure will encroach on the wetland or not.



5 METHODOLOGY

5.1 Wetland Assessment

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) will be considered for this study. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels, and also then includes structural features at the lower levels of classification (Ollis, Snaddon, Job, & Mbona, 2013).

5.1.1 Wetland Classification System

A distinction is made between four Landscape Units for Inland Systems on the basis of the landscape setting in which a HGM is situated, which broadly considers (Ollis, Snaddon, Job, & Mbona, 2013):

- Slope;
- Valley floor;
- Plain; and
- Bench.

The HGM Units, which are defined primarily according to:

- Landform, which defines the shape and localised setting of a wetland;
- Hydrological characteristics, which describe the nature of water movement into, through and out of the wetland; and
- Hydrodynamics, which describe the direction and strength of flow through the wetland.

Seven primary HGM units are recognised for Inland Systems on the basis of hydrology and geomorphology (Ollis, Snaddon, Job, & Mbona, 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvium (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.



The above terms have been used in order to ensure consistency with the wetland classification terms in South Africa.

5.1.2 Desktop assessment

The following information sources were considered for the desktop assessment;

- Information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (<http://bgis.sanbi.org>);
- Aerial imagery (Google Earth Pro);
- Land Type Data (Land Type Survey Staff, 1972 - 2006);
- The National Freshwater Ecosystem Priority Areas (Nel, et al., 2011);
- Contour data (5m).

5.1.3 Wetland Delineation

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 2. The outer edges of the wetland areas were identified by considering the following four specific indicators:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The soil forms (types of soil) found in the landscape were identified using the South African soil classification system namely; Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991);
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

Vegetation is used as the primary wetland indicator. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role.



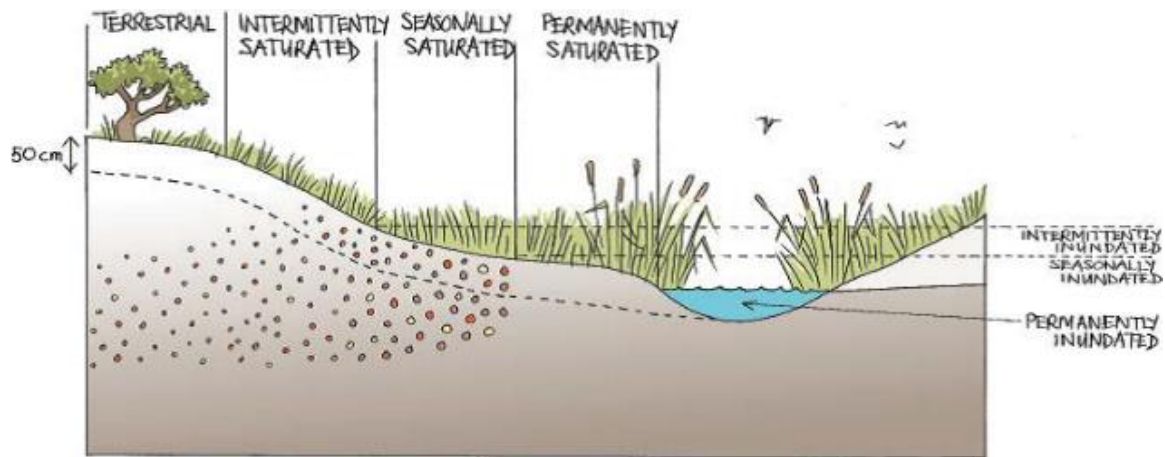


Figure 2: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis, Snaddon, Job, & Mbona, 2013)

5.1.4 Present Ecological Status (PES)

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society (ecosystem services). Management of these systems is therefore essential if these attributes are to be retained within an ever-changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing promote their conservation and wise management.

Level of Evaluation

WET-Health provides two levels of assessment:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where many wetlands need to be assessed at a very low resolution; or
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom and whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled).

Quantification of Present Ecological State (PES) of a Wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a PES score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The impact scores and Present State categories are provided in Table 1 and Table 2.



Table 1: The magnitude of impacts on wetland functionality (Macfarlane, et al., 2009)

Impact Category	Description	Score
None	No Discernible modification or the modification is such that it has no impacts on the wetland integrity	0 to 0.9
Small	Although identifiable, the impact of this modification on the wetland integrity is small.	1.0 to 1.9
Moderate	The impact of this modification on the wetland integrity is clearly identifiable, but limited.	2.0 to 3.9
Large	The modification has a clearly detrimental impact on the wetland integrity. Approximately 50% of wetland integrity has been lost.	4.0 to 5.9
Serious	The modification has a highly detrimental effect on the wetland integrity. More than 50% of the wetland integrity has been lost.	6.0 to 7.9
Critical	The modification is so great that the ecosystem process of the wetland integrity is almost totally destroyed, and 80% or more of the integrity has been lost.	8.0 to 10

Table 2: The PES categories (Macfarlane, et al., 2009)

Impact Category	Description	Impact Score Range	Present State Category
None	Unmodified, natural	0 to 0.9	A
Small	Largely Natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1.0 to 1.9	B
Moderate	Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2.0 to 3.9	C
Large	Largely Modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4.0 to 5.9	D
Serious	Seriously Modified. The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable.	6.0 to 7.9	E
Critical	Critical Modification. The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.0 to 10	F

Overall Health of the Wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole is calculated. Since hydrology, geomorphology and vegetation are interlinked their scores are aggregated to obtain an overall PES health score using the following formula (Macfarlane, et al., 2009):

$$\text{Health} = ((\text{Hydrology score}) \times 3 + (\text{Geomorphology score}) \times 2 + (\text{Vegetation score}) \times 2) \div 7$$



5.1.5 Wetland Ecosystem Services

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze, Marneweck, Batchelor, Lindley, & Collins, 2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (

Table 3):

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

Table 3: Classes for determining the likely extent to which a benefit is being supplied (Kotze, Marneweck, Batchelor, Lindley, & Collins, 2009)

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

5.1.6 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWS (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 4.



Table 4: Description of EIS categories

EIS Category	Range of Mean	Recommended Ecological Management Class
Very High	3.1 to 4.0	A
High	2.1 to 3.0	B
Moderate	1.1 to 2.0	C
Low Marginal	< 1.0	D

5.2 Risk assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines. The matrix assesses impacts in terms of consequence and likelihood. Consequence is calculated based on the following formula:

$$\text{Consequence} = \text{Severity} + \text{Spatial Scale} + \text{Duration}$$

Whereas likelihood is calculated as:

$$\text{Likelihood} = \text{Frequency of Activity} + \text{Frequency of Incident} + \text{Legal Issues} + \text{Detection}.$$

Significance is calculated as:

$$\text{Significance \ Risk} = \text{Consequence} \times \text{Likelihood}.$$

The significance of the impact is calculated according to Table 5.

Table 5: Significance ratings matrix

Rating	Class	Management Description
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

5.3 Buffer Determination

A buffer zone is defined as “A strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another.” (Macfarlane, *et al.*, 2014).

Buffer zones protect water resources in a variety of ways, such as;

- Maintenance of basic aquatic and wetland processes;
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- The reduction of impacts on water resources from activities and adjoining land uses;
- The provision of habitat for aquatic and semi-aquatic species;
- The provision of habitat for terrestrial species; and
- The provision of societal benefits.

The “Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries” (Macfarlane, *et al.*, 2014) was used to determine the appropriate buffer zone for the proposed activity.



6 RESULTS & DISCUSSIONS

6.1 Desktop Assessment

6.1.1 Geology & Soils

The geology of the area is mainly Ventersdorp lava, breccia and tuff.

According to the land type database (Land Type Survey Staff, 1972 - 2006) the development falls within the Ib43 land type. It is expected that, the dominant soils in the crest and midslope positions will be soils of the shallow Glenrosa and Mispah forms. The soils that dominated the footslopes and the valley bottoms are Rensburg and Bonheim soil forms.

6.1.2 Wetland NFEPA's

There were no wetland NFEPA's identified within the project area.

6.1.3 City of Johannesburg wetlands

A wetland audit was completed for the City of Johannesburg (2009) with the intention of locating wetland areas that may then be considered for spatial planning. The available dataset was considered in order to identify any possible wetland areas in close proximity to the project area. The dataset does indicate the presence of channelled valley bottom wetland within 500m of the project area (Figure 3).





Figure 3: The CoJ (2009) wetlands within project area



6.2 Wetland Assessment

The survey included assessing all the wetland indicators as well as assessing the Present Ecological Score (PES) or health of the wetland, the wetland's ability to provide goods and services (Eco-Services) and the Ecological Importance and Sensitivity (EIS) of the wetlands.

The wetland delineation and HGM units are shown in Figure 4. The wetland classification as per SANBI guidelines (Ollis, Snaddon, Job, & Mbona, 2013) in Table 6.





Figure 4: Project overall wetland delineation



One (1) HGM unit was identified within the 500m project assessment boundary, namely;

- Channelled Valley Bottom (HGM 1).

Table 6: Wetland classification as per SANBI guideline (Ollis, Snaddon, Job, & Mbona, 2013)

UNIT	LEVEL 1	LEVEL 2		LEVEL 3	LEVEL 4		
	System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	4A (HGM)	4B	4C
HGM 1	Inland	Highveld	Central Bushveld Group 1	Valley Floor	Channelled Valley Bottom	N/A	N/A

6.2.1 Channelled Valley Bottom (HGM 1)

The channelled valley bottom wetland drains from the north to the south on the eastern portion of the main road. There is a small wetland portion on the western side of the road which drains under the road to the main wetland. The area has been significantly altered by the main road and erosion is evident on the channel banks. The catchment is steep and any runoff generated will result in a sharp hydrograph. The dominant soils are shallow rocky soils on the slopes with Rensburg soils in the valley bottom.



Figure 5: The channelled valley bottom within the project area



6.3 Present Ecological State (PES)

The PES results are described in the sections below with the results presented in Table 7.

HYDROLOGY

The catchment area is very steep with shallow rocky outcrops. The area has been developed with large roads and the natural hydrology has been seriously altered (E) by the drainage lines that have been installed as well as all the impervious areas that are present.

GEOMORPHOLOGY

The geomorphology of the systems has been altered by the drainage channels that have been installed as well as the increased runoff from impervious areas. The main road has been developed on a possible wetland areas which has reduced the wetland size in the area.

VEGETATION

Alien vegetation has established across the wetland system with the existing infrastructure also altering the vegetation component.

Table 7: The PES results for the project area

Wetland	Area (ha)	Hydrology		Geomorphology		Vegetation	
		Rating	Score	Rating	Score	Rating	Score
HGM 1	0.64	E: Seriously Modified	6.0	D: Largely Modified	4.2	D: Largely Modified	4.8
Overall PES Score		5.2		Overall PES Class		D: Largely Modified	

6.4 Ecosystem Services Assessment

The Ecosystem services provided by the HGM unit present at the site were assessed and rated as per Table 8 using the WET-EcoServices method (Kotze, Marneweck, Batchelor, Lindley, & Collins, 2009). The summarised results for the HGM units are shown in Table 9. The HGM units were classified according to the HGM type in order to perform the WET-EcoServices assessment.

The Channelled Valley Bottom (HGM 1) had an overall intermediate level of service with the following showing Moderately High levels of services;

- Flood attenuation.

The remaining services for the HGM unit were scored as intermediate or lower.

Table 8: Eco-Services rating of likely extent to which a benefit is being supplied

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low



1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

Table 9: The Eco-Services being provided by the wetlands

Wetland Unit					HGM 1	
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		2.5	
			Streamflow regulation		1.7	
			Water Quality enhancement benefits	Sediment trapping		2.0
				Phosphate assimilation		1.5
				Nitrate assimilation		1.2
				Toxicant assimilation		1.8
				Erosion control		2.0
				Carbon storage		1.3
	Direct Benefits	Biodiversity maintenance			0.9	
		Provisioning benefits	Provisioning of water for human use		0.6	
			Provisioning of harvestable resources		0.0	
			Provisioning of cultivated foods		0.0	
		Cultural benefits	Cultural heritage		0.0	
			Tourism and recreation		1.3	
			Education and research		1.0	
Overall					17.8	
Average					1.2	



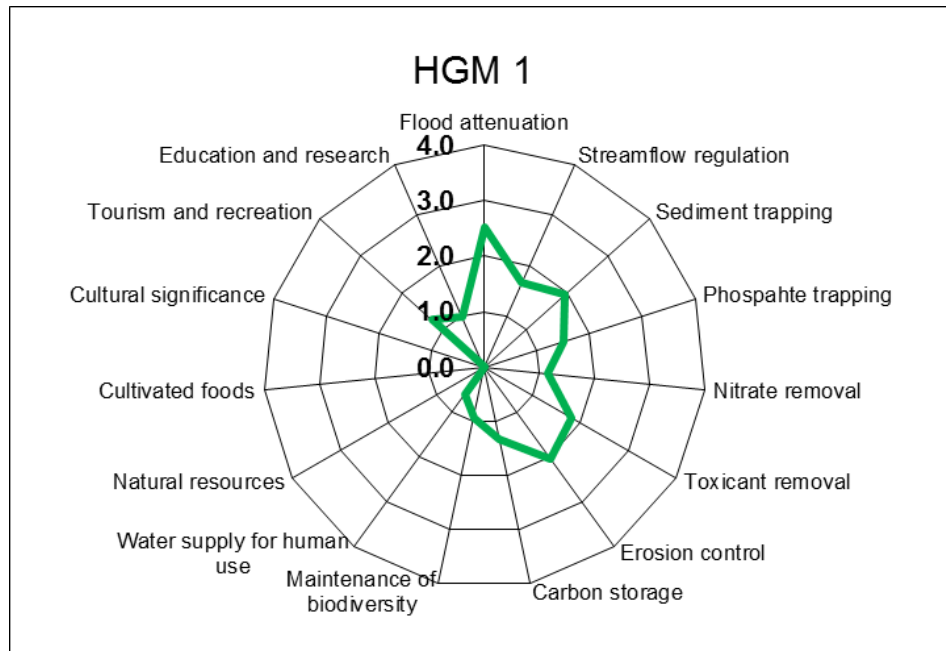


Figure 6: The spider diagram for Eco-Services rendered by the HGM unit

6.5 Ecological Importance & Sensitivity (EIS)

The EIS assessment was applied to the HGM units described in the previous section in order to assess the levels of sensitivity and ecological importance of the wetland. The results of the assessment are shown in Table 10.

HGM 1 showed a Moderate (C) level of importance for the Ecological Importance & Sensitivity as well as for the Hydrological Importance respectively. The Direct Human benefits were rated to be Low with a (D) rating.

Table 10: The EIS results for the project

WETLAND IMPORTANCE AND SENSITIVITY	
HGM 1	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	2.0
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	1.8
DIRECT HUMAN BENEFITS	0.5

6.6 Buffer Zones

The wetland buffer zone tool was used to calculate the appropriate buffer required for the proposed service station. The model shows that the largest risk (High) posed by the project during the construction phase is that of “increased sediment inputs and turbidity”.



During the operational phase a high risk was identified to the alteration of flow volumes, where moderate risks were posed by the possible inputs of nutrients, toxins and heavy metals, and also the input of pathogens.

These risks are based on what could threaten the wetland and what buffer would be required at a desktop level.

After conducting the field investigations buffer zones were suggested for the identified wetlands to address the vulnerability of the wetlands to impacts. A buffer zone of 15m during the construction and the operational phase is recommended for the wetland areas, as presented in Table 11, this buffer is calculated assuming mitigation measures are applied.

Table 11: The risk results from the wetland buffer model for the project

Threat Posed by the proposed land use / activity		Rating
Construction Phase	1. Alteration to flow volumes	VL
	2. Alteration of patterns of flows (increased flood peaks)	L
	3. Increase in sediment inputs & turbidity	H
	4. Increased nutrient inputs	VL
	5. Inputs of toxic organic contaminants	VL
	6. Inputs of toxic heavy metal contaminants	L
	7. Alteration of acidity (pH)	N/A
	8. Increased inputs of salts (salinization)	N/A
	9. Change (elevation) of water temperature	VL
	10. Pathogen inputs (i.e. disease-causing organisms)	VL
Operational Phase	1. Alteration to flow volumes	M
	2. Alteration of patterns of flows (increased flood peaks)	H
	3. Increase in sediment inputs & turbidity	L
	4. Increased nutrient inputs	M
	5. Inputs of toxic organic contaminants	M
	6. Inputs of toxic heavy metal contaminants	M
	7. Alteration of acidity (pH)	VL
	8. Increased inputs of salts (salinization)	VL
	9. Change (elevation) of water temperature	VL
	10. Pathogen inputs (i.e. disease-causing organisms)	M
Construction Phase		15
Operational Phase		15



7 RISK ASSESSMENT

The proposed project is for the development of a new service station facility. The risk assessment considered aspects that may impact directly, or indirectly as a result of the project, which is located on the periphery of wetland systems.

Findings from the DWS aspect and impact register / risk assessment are provided in Table 12, Table 13, and Table 14.

Table 12: Impacts assessed for the proposed project

Activity	Aspect	Impact
Construction and operation of a service station including additional infrastructure	Construction of new infrastructure	Impeding the flow of water Loss of aquatic habitat Siltation of watercourse. Erosion of watercourse. Sedimentation of the watercourse. Flow sediment equilibrium change Water quality impairment
	Clearing areas	
	Watercourse crossings	
	Road Construction & Maintenance	
	Stream Channel Stabilisation	
	Land Management	
	Site Drainage	
	Settling Ponds	
	Stormwater Management	
	Erosion and sedimentation control	
	Pollution Control	
	Installation of new tanks & oil traps	
	Operation of machinery & equipment	
	Temporary infrastructure	
	Staff ablutions	
	Operation of service station	



Table 13: DWS Risk Impact Matrix for the proposed project

Severity								
Aspect	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence
Construction Phase								
Construction of new infrastructure	3	3	3	3	3	2	4	9
Clearing areas	4	4	3	3	3.5	2	3	8.5
Watercourse crossings	4	3	3	3	3.25	2	3	8.25
Road Construction & Maintenance	3	3	3	3	3	2	3	8
Stream Channel Stabilisation	3	2	2	2	2.25	1	3	6.25
Land Management	2	2	2	2	2	2	2	6
Site Drainage	3	3	3	2	2.75	1	3	6.75
Settling Ponds	3	4	3	2	3	1	3	7
Stormwater Management	3	3	3	2	2.75	2	3	7.75
Erosion and sedimentation control	2	3	3	3	2.75	2	2	6.75
Pollution Control	0	5	0	4	2.25	1	2	5.25
Installation of new tanks & oil traps	3	3	3	3	3	2	4	9
Operation of machinery & equipment	0	5	0	4	2.25	1	2	5.25
Temporary infrastructure	2	3	3	3	2.75	2	2	6.75
Staff ablutions	0	5	0	4	2.25	1	2	5.25

Operational Phase								
Drainage patterns change due to road extent and levels	2	1	2	1	1.5	3	4	8.5
Site Management	2	1	1	1	1.25	3	4	8.25
Storm water management	2	2	1	2	1.75	2	4	7.75
Traffic / vehicle activity	1	2	1	2	1.5	2	4	7.5
Operation of service station	3	2	2	2	2.25	2	4	8.25



Table 14: DWS Risk Impact Matrix for the proposed project continued

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Without Mitigation	With Mitigation
Construction Phase								
Construction of new infrastructure	1	4	1	2	8	72	Moderate*	Low
Clearing areas	1	4	1	2	8	68	Moderate*	Low
Watercourse crossings	1	3	5	1	10	82.5	Moderate*	Low
Road Construction & Maintenance	1	4	1	2	8	64	Moderate*	Low
Stream Channel Stabilisation	1	2	5	2	10	62.5	Moderate*	Low
Land Management	1	1	1	1	4	24	Low	Low
Site Drainage	1	3	1	2	7	47.25	Low	Low
Settling Ponds	1	2	1	2	6	42	Low	Low
Stormwater Management	1	2	1	2	6	46.5	Low	Low
Erosion and sedimentation control	1	2	1	2	6	40.5	Low	Low
Pollution Control	1	2	1	2	6	31.5	Low	Low
Installation of new tanks & oil traps	1	2	1	1	5	45	Low	Low
Operation of machinery & equipment	1	3	1	2	7	36.75	Low	Low
Temporary infrastructure	1	2	1	1	5	33.75	Low	Low
Staff ablutions	1	2	1	2	6	31.5	Low	Low
Operational Phase								
Drainage patterns change due to road extent and levels	3	2	1	1	7	59.5	Moderate*	Low
Site management	3	1	1	1	6	49.5	Moderate*	Low
Storm water management	3	1	1	1	6	46.5	Moderate*	Low
Traffic / vehicle activity	4	2	1	1	8	60	Moderate*	Low
Operation of service station	4	1	1	1	7	57.75	Moderate*	Low

(*) denotes - In accordance with General Notice 509 "Risk is determined after considering all listed control / mitigation measures. Borderline Low / Moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures detailed below."



The proposed service station and associated infrastructure (roads) do pose a risk to the identified wetland system, with the level of risk determined to vary from low to moderate, without mitigation. The highest risks identified for the construction phase, were those associated with the clearing of areas, the construction of infrastructure, and possible crossings and stabilisation of wetlands. These moderate risks can be reduced to low risks if the mitigation measures are implemented.

The operational phase shows moderate risk for all aspects however these are on the border of being low risks and with mitigation can be successfully reduced to low. These risks are mainly associated with increased flow volumes and peaks into the receiving environment as well as possible contamination of the system.

7.1 Project mitigation measures

The following specific mitigation measures are provided:

- The new tanks should be double walled steel tanks which consist of a primary steel inner tank shell and a secondary containment steel outer shell which are separated by a continuous interstitial space between the two shells;
- All steel tanks and coatings must comply with the requirements of the South African National Standard (SANS 1535);
- The drainage lines feeding the wetlands are to be protected and no contaminants are allowed to enter these drains. These drainage lines must be vegetated to act as some form of constructed / biological system to reduce flow and polish water;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- A suitable storm water plan must be compiled for the property. This plan must attempt to displace and divert storm water from the Shell service station, and discharge the water into adjacent areas without eroding the receiving areas. It is preferable that run-off velocities be reduced and flows discharged into the local watercourses

7.2 General mitigation measures

The following general mitigation measures are provided:

- The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access;
- Laydown yards, camps and storage areas must be beyond the water resources. Where possible, the construction of the road and crossings must take place from the existing dirt road and not from within the aquatic systems;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;
- Temporary storm water channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion;
- Prevent uncontrolled access of vehicles through the river system that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;



- All chemicals and toxicants to be used for the road upgrade must be stored outside the channel system and in a bunded area;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);
- Have action plans on site, and training for contractors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;
- Erosion and sedimentation into the channel must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed banks;
- Temporary and permanent erosion control methods may include silt fences, flotation silt curtains, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching;
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil;
- Large trees and other debris often collect upstream against the culverts, damming up the channel with risk of flooding and damaging the river crossing and its banks. This debris should be cleared routinely with appropriate disposal of the debris. Timber can be sold or donated to local communities;
- No dumping of construction material on-site may take place;
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported;
- Due to the potential increase of pedestrians using the new road, it is suggested that waste bins are installed and maintained at the end of the new road to reduce solid waste disposal into the stream. Signage discouraging littering of the system can also be erected;
- Quarterly vegetation rehabilitation surveys need to be conducted of the vegetation within the project footprint for a period of at least a year after construction has been completed to assess vegetation regrowth and recovery; and
- An alien invasive plant management plan needs to be compiled and implemented post construction to control current invaded areas and prevent the growth of invasives on cleared areas.



8 CONCLUSIONS

One (1) HGM unit was identified within the 500m project assessment boundary. The channelled valley bottom wetland drains from the north to the south on the eastern portion of the main road. There is a small wetland portion on the western side of the road which drains under the road to the main wetland. The area has been significantly altered by the main road and erosion is evident on the channel banks. The catchment is steep and any runoff generated will result in a sharp hydrograph. The dominant soils are shallow rocky soils on the slopes with Rensburg soils in the valley bottom.

The PES results for the channelled valley bottom wetland was determined to be largely modified. The channelled Valley Bottom (HGM 1) had an overall intermediate level of service, with flood attenuation being the only service rated as high.

HGM 1 showed a Moderate (C) level of importance for the Ecological Importance & Sensitivity as well as for the Hydrological Importance respectively. The Direct Human benefits were rated to be Low with a (D) rating.

A buffer zone of 15m during the construction and the operational phase is recommended for the wetland areas, this buffer is calculated assuming mitigation measures are applied.

The proposed service station and associated infrastructure (roads) do pose a risk on the identified wetland system, with the level of risk determined to vary from low to moderate, without mitigation. The highest risks identified for the construction phase, were those associated with the clearing of areas, the construction of infrastructure, and possible crossings and stabilisation of wetlands. These moderate risks can be reduced to low risks if the mitigation measures are implemented.

The operational phase shows moderate risk for all aspects however these are on the border of being low risks and with mitigation can be successfully reduced to low. These risks are mainly associated with increased flow volumes and peaks into the receiving environment as well as possible contamination of the system.



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Annexure D

Runoff analysis – Rational Method: Pre and post development

	PRE AND POST DEVELOPMENT FLOWS			
	Date:	05/06/2017	By:	M. GONELLI
	Job Number:	6882A1	Client:	GREAT SITE INVESTMENTS

PRE DEVELOPMENT RURAL					
CATCHMENT AREA 1					
R =	5 Years	25 Years	50 Years		Return Period Design Storm
L =	0.1	0.1	0.1	km	Longest watercourse pre-development
H =	36	36	36	m	Height difference
r =	Sparse Grass Over Fairly Rough Surface	Sparse Grass Over Fairly Rough Surface	Sparse Grass Over Fairly Rough Surface		Roughness coefficient
	0.3	0.3	0.3	(-)	
S =	0.36	0.36	0.36	m/m	Slope
	36.0	36.0	36.0	%	
Defined Watercourse?	N	N	N	Y/N	Defined Watercourse (YES): $T_c = \left(\frac{0.87L^2}{1000S} \right)^{0.385}$
					Defined Watercourse (NO): $T_c = 0.604 \left(\frac{rL}{S^{0.5}} \right)^{0.467}$
Tc =	0.250	0.250	0.250	h	Time of Concentration (= Duration of Storm)
	15.00	15.00	15.00	min	
	900	900	900	sec	
A =	18645	18645	18645	m2	Catchment Area
	1.8645	1.8645	1.8645	ha	
	0.018645	0.018645	0.018645	km2	
MAP =	750	750	750	mm/y	Mean Annual Precipitation
Inland? (else Coastal)	Y	Y	Y	Y/N	Regional Factor (YES) = $\frac{217.8}{(1 + 4.779t)^{0.8832}}$
					Regional Factor (NO) = $\frac{122.8}{(1 + 4.779t)^{0.7372}}$
Regional Factor =	108.78	108.78	108.78	(-)	
MAP Factor =	1.46	1.46	1.46	(-)	MAP Factor = $\frac{18.79 + 0.17xMAP}{100}$
Frequency Factor =	0.60	1.05	1.30		
i =	95.5	167.1	206.9	mm/h	$i = (Frequency\ Factor)(MAP\ Factor)(Regional\ Factor)$
C =	0.280	0.280	0.280	(-)	Runoff Coefficient
Q =	0.138	0.242	0.423	m³/s	Flood Discharge (Rational Method)
	138.5	242.3	423.0	l/s	


POST DEVELOPMENT URBAN					
CATCHMENT AREA 1					
R =	5 Years	25 Years	50 Years		Return Period Design Storm
L =	0.17	0.17	0.17	km	Longest watercourse post-development
H =	10	10	10	m	Height difference
r =	Paved Areas	Paved Areas	Paved Areas		Roughness coefficient
	0.02	0.02	0.02	(-)	
S =	0.059	0.059	0.059	m/m	Slope
	5.9	5.9	5.9	%	
Defined Watercourse?	N	N	N	Y/N	Defined Watercourse (YES): $T_c = \left(\frac{0.87L^2}{1000S} \right)^{0.385}$
					Defined Watercourse (NO): $T_c = 0.604 \left(\frac{rL}{S^{0.5}} \right)^{0.467}$
Tc =	0.250	0.250	0.250	h	Time of Concentration (= Duration of Storm, with a minimum of 15 minutes)
	15.00	15.00	15.00	min	
	900	900	900	sec	
A =	18645	18645	18645	m2	Catchment Area
	1.8645	1.8645	1.8645	ha	
	0.018645	0.018645	0.018645	km2	
MAP =	750	750	750	mm/y	Mean Annual Precipitation
Inland? (else Coastal)	Y	Y	Y	Y/N	Regional Factor (YES) = $\frac{217.8}{(1 + 4.779t)^{0.8832}}$
					Regional Factor (NO) = $\frac{122.8}{(1 + 4.779t)^{0.7372}}$
Regional Factor =	108.78	108.78	108.78	(-)	
MAP Factor =	1.46	1.46	1.46	(-)	MAP Factor = $\frac{18.79 + 0.17xMAP}{100}$
Frequency Factor =	0.6	1.05	1.3		
i =	95.5	167.1	206.9	mm/h	$i = (Frequency\ Factor)(MAP\ Factor)(Regional\ Factor)$
C =	0.935	0.935	0.935	(-)	Runoff Coefficient
Q =	0.462	0.809	1.002	m³/s	Flood Discharge
	462.4	809.1	1001.8	l/s	

Increase in Run Off	323.9	566.8	578.8	l/s
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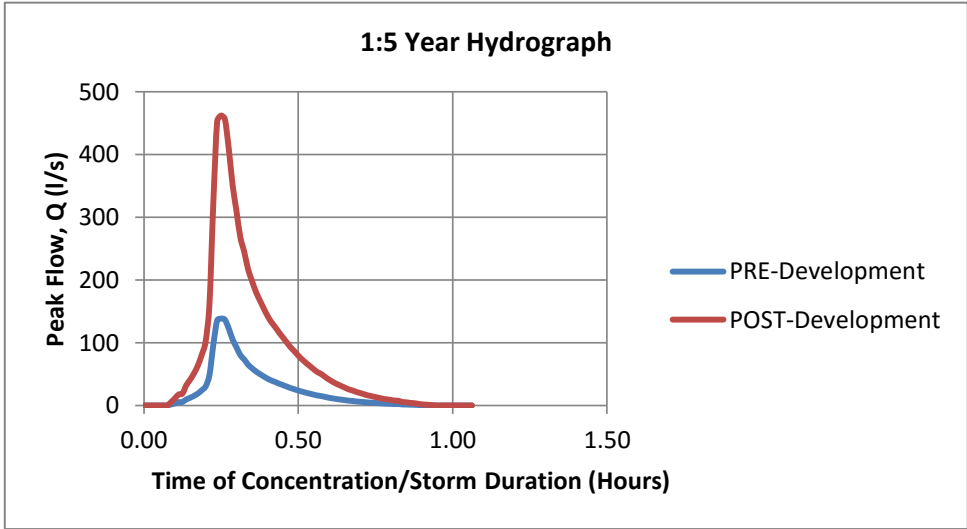
Annexure E

Peak Flow attenuation calculations for:

**1 in 5 year event
1 in 25 year event
1 in 50 year event**

	SUMMARY	
	Date:	05/06/2017
	Job Number:	6882A
	By:	M. GONELLI
	Client:	GREAT SITE INVES.

1:5 Year Storm



PRE-Development peak flow	= 138 l/s
	= 0.138 m3/s
POST-Development peak flow	= 462 l/s
	= 0.462 m3/s

Volume of stormwater runoff required to be attenuated to match PRE-development flows	= 291184 litres
	= 291 m3

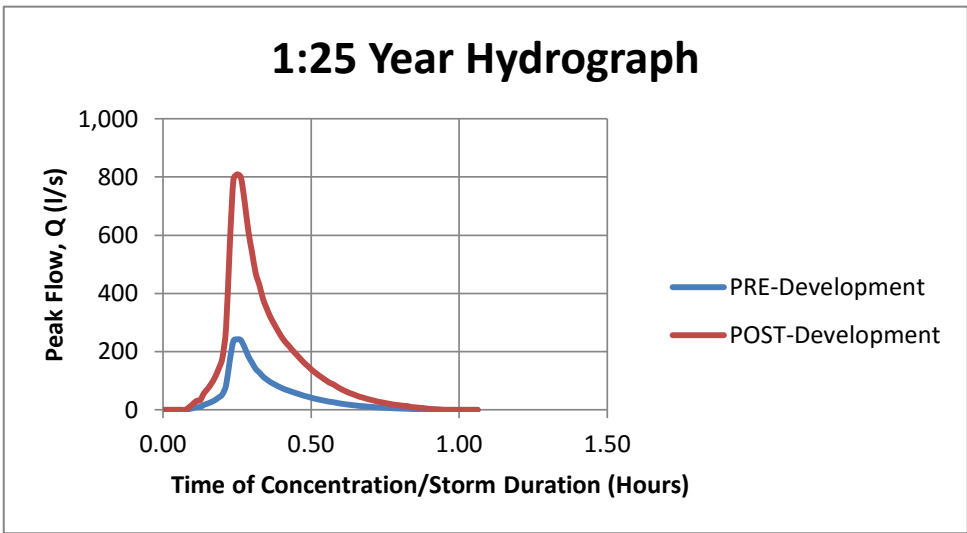
Site Area	= 18645 m2
	= 1.865 ha

Storage Capacity	= 291 m3 / 1.865 ha
	OR
	= 156 m3 / ha

Attenuated runoff that will be discharged from site	PRE	= 0.138 m3/s
	POST	= 0.138 m3/s

OK

1:25 Year Storm



PRE-Development peak flow	= 242 l/s
	= 0.242 m3/s
POST-Development peak flow	= 809 l/s
	= 0.809 m3/s

Volume of stormwater runoff required to be attenuated to match PRE-development flows	= 510022 litres
	= 510 m3

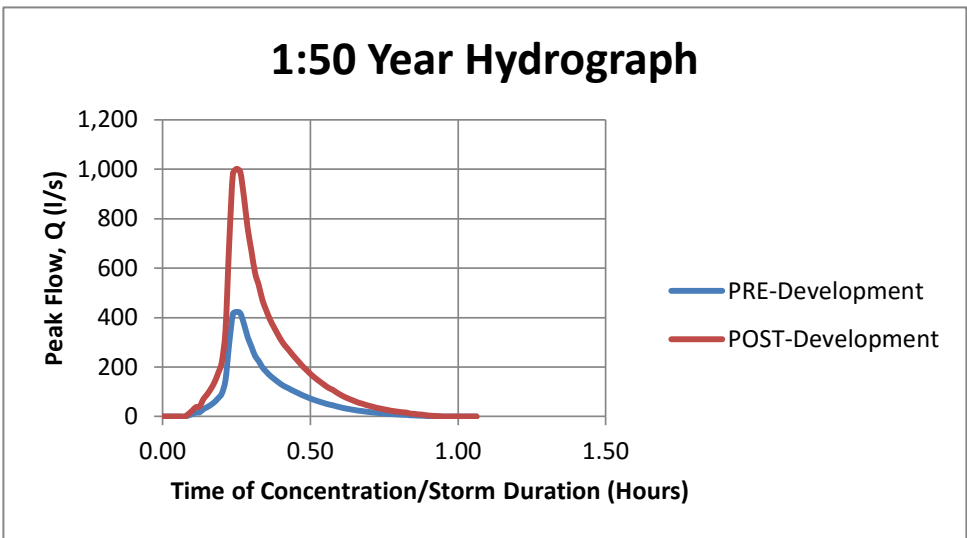
Site Area	= 18645 m2
	= 1.865 ha

Storage Required	= 510 m3 / 1.865 ha
	OR
	= 274 m3 / ha

Attenuated runoff that will be discharged from site	PRE	= 0.242 m3/s
	POST	= 0.221 m3/s

OK

1:50 Year Storm



PRE-Development peak flow	= 423 l/s
	= 0.423 m3/s
POST-Development peak flow	= 1002 l/s
	= 1.002 m3/s

Volume of stormwater runoff generated above pre-development flows for storm duration	= 521100 litres
	= 521 m3

Site Area	= 18645 m2
	= 1.865 ha

Storage Required	= 521 m3 / 1.865 ha
	OR
	= 279 m3 / ha

Actual storage provided based on final attenuation tank size	Overflows through 1:25 emergency spillway
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Annexure F

Pre development runoff coefficient (C)

PRE DEVELOPMENT								
RURAL C1								
			Mean Annual Rainfall (mm)					
			600-900					
Component	Classification	%	<600	600-900	>900	Factor	% x factor	
Surface slope Cs	Vleis and pans <3%		0.01	0.03	0.05	0.03		0.53
	Flat areas 3 to 10%		0.06	0.08	0.11	0.08		
	Hilly 10 to 30%	70	0.12	0.16	0.2	0.16	0.11	
	Steep areas >30%	30	0.22	0.26	0.3	0.26	0.08	
Permeability Cp	Very permeable (Gravel, coarse sand)		0.03	0.04	0.05	0.04		0.12
	Permeable (Sandy, sandy loam)	50	0.06	0.08	0.1	0.08	0.04	
	Semi-permeable (Silt, loam, clayey sand)	50	0.12	0.16	0.2	0.16	0.08	
	Impermeable (Clay, peat rock)		0.21	0.26	0.3	0.26		
Vegetation Cv	Thick bush and plantation		0.03	0.04	0.05	0.04		0.16
	Light bush and farm lands	50	0.07	0.11	0.15	0.11	0.06	
	Grasslands	50	0.17	0.21	0.25	0.21	0.11	
	No vegetation		0.26	0.28	0.3	0.28		
						Total	0.47	
1:5						Ft	0.70	
						C1	0.33	
1:25						Ft	0.80	
						C1	0.38	
1:50						Ft	0.90	
						C1	0.42	

The JRA Stormwater Management Policy Statement states that for a pre-development run off factor (C1) of greater than 0.28, special motivation is required. The pre-development run off factor (C1) obtained using the current pre-development site conditions yields a C1 value greater than 0.28. This is due to the very steep nature of this particular site. However in light of a more conservative estimate and not submitting special motivation for this run off factor, an upper limit cap of 0.28 will be used for the purposes of this calculation to satisfy the JRA requirements. This will yield a slightly bigger attenuation tank volume and hence more stormwater runoff attenuated before being discharged at pre-development flows.

1:5	C1	0.28
1:25	C1	0.28
1:50	C1	0.28

Adjustment factor Ft for Soil Saturation (C)						
Flat and permeable (Slope less than 30%)						
Catchment characteristic	1:2	1:5	1:10	1:25	1:50	1:100
Steep and <i>impermeable</i>	0.75	0.80	0.85	0.91	0.95	1.00
Flat and permeable	0.50	0.55	0.60	0.70	0.83	1.00
Chosen		0.70		0.80	0.90	

Annexure G

Post development runoff coefficient (C)

URBAN C-FACTOR - POST-DEVELOPMENT					
Component	%	Use	Factor	Factor	% x factor
Lawns	10	Sandy, flat <2%	0.05-0.1	0.35	0.035
		Sandy, steep >7%	0.15-0.20		
		Heavy soil, flat <2%	0.13-0.17		
		Heavy soil, steep >7%	0.25-0.35		
Residential areas		Houses	0.30-0.50	0.3	0.000
		Flats	0.50-0.70	0	0.000
Industry		Light industry	0.50-0.80	0	0.000
		Heavy industry	0.60-0.90		
Business	90	City centre	0.70-0.95	1	0.900
		Suburban	0.50-0.70		
		Streets	0.70-0.95		
		Maximum flood	1.00		
	100				0.935