DRAFT INTEGRATED STORMWATER MANAGEMENT PLAN

Hartenbos Heuwels Residential Development (FINAL DRAFT)

Prepared for**:**

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SEF Project Code: 504342
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PROJECT SUMMARY	
Project Name	Proposed Residential Development on Erf 3122, Hartenbos Heuwels, Mossel Bay
Preferred Site	Erf 3122
Surveyor-General 21 Digit Code	Area not surveyed / NO DATA
Development Footprint	Approximately 60.5ha
Stormwater Flood Calculations	Refer to Appendix 1
Conceptual Engineering Design – Stormwater Management	Refer to Appendix 2
Confirmation of Supply:	
Water (Construction & Operational Phases)	Construction Phase = To be supplied by Contractor Operational Phase = 455kl/day Supplier: Mossel Bay Local Municipality
Sewage (Construction & Operational Phases)	Construction Phase = To be supplied by Contractor Operational Phase = 364m^3/day Supplier: Mossel Bay Local Municipality
Electricity (Construction & Operational Phases)	Construction Phase = To be supplied by Contractor Operational Phase = 1,850 kVA Supplier: Mossel Bay Local Municipality
Solid Waste (Construction & Operational Phases)	Construction Phase = To be supplied by Contractor Operational Phase = 1.5 ton per day Receiver: Mossel Bay Local Municipality landfill site

PROJECT TEAM MEMBERS

The following project team members are involved in this Draft Integrated Stormwater Management Plan:

Table 1: Project Team Members

Name	Organization	Project Role
Willie Howell	SEF	Project Manager
Willem Lubbe	SEF	Wetland Specialist
Gigi Nagy	Boston Associates	Planner
Chris Mynhardt	Axiom Consulting Engineers	Engineer

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SECTION 1: INTRODUCTION

1.1 PREAMBLE

The purpose of this report is to determine the parameters and proposed infrastructure to be implemented for the effective management of stormwater run-off from the development site for the proposed Hartenbos Heuwels Residential Development. The proposed residential development is planned to be located on Erf 3122 of Hartenbos Heuwels, Mossel Bay, Western Cape Province.

1.2 REQUIREMENTS

The management of stormwater run-off within the jurisdiction of the Western Cape Province falls under the management function of the **Western Cape Department of Roads and Public Works** (***Transport, Roads & Stormwater Directorate***).

The proposed development requirements adopted for the management of stormwater on site, are aimed at mitigating the negative impact of densification on the environment associated with the water courses and riparian zones.

The development requirements applied to all new development sites refers to the following:

- The stormwater management system for all new developments should have a design capacity which enables the system to safely contain floods up to the 1:50 year floodline without properties being flooded.
- Provision should also be made for 1:100 year flood event, to ensure that floor levels will not be inundated. Furthermore, the National Water Act (Act 36 of 1998) stipulates that the 1:100 year floodline must be indicated on the layout of all new residential developments.
- Discharge of stormwater from the site, or attenuation facility, is subject to the approval of the landowner located downstream from the site; and
- The Site Development Plan will only be approved if supported by an acceptable stormwater management strategy.

The stormwater system design objectives, that form the basis of this conceptual (draft) Integrated Stormwater Management Plan, are listed in the table below. It must be noted that both the Construction as well as the Operational Environmental Management Plans will serve as the main implementation documents for the management of the detailed stormwater system.

Symbol	Description
	**Flood Protection** Protect vulnerable areas against flooding, and locate development in areas which are not prone to flooding.
	**Volume** Minimise changes in the volume of runoff from the development. This will provide protection of human safety and property, as well as ecological resources.
	**Downstream Effects** Maintain the natural channel morphology and geometry of the receiving water body; where the system has been altered, the downstream effects and associated physical and ecological changes should be minimised.
	**Water Quality** Minimise negative impacts on water quality and improving, where possible, existing stormwater quality.
	**Velocity** Minimise the velocity of stormwater runoff and the likelihood of erosion of the catchment, including receiving water bodies.
	**Sedimentation** Minimise sedimentation of natural ecosystems by addressing erosion in the catchment or by trapping sediment. This will protect the natural ecosystems and help to prevent blockage of stormwater systems.
	**Peak** Minimise peak flows during storm events in order to mimic the natural pre-development condition.
	**Natural Habitats** Maximise the opportunities for the preservation, creation and/or rehabilitation of wetland and riverine habitats, by incorporating natural rivers/wetland into stormwater design where appropriate.
	**Multifunctionality** Maximise the use of resources in stormwater management by implementing multifunctional and dual-purpose strategies wherever possible.
	**Sustainability** Maximise the use of resources in stormwater management by considering both the long and short-term costs and implications of available design strategies. Strategies must be appropriate to their context, and be properly implemented and maintained.
	**Health & Safety** Minimise the risk of stormwater design and structures to humans and animals, through the appropriate choice of strategies and structures.
	**Maintenance** Design in such a way that the system will be effectively maintained and functional, and that the local community will appreciates its function, and where possible benefits in other ways, such as through creation of amenities.

The applicable by-laws for Stormwater Management and Related Matters were consulted in the preparation of this draft Integrated Stormwater Management Plan. Please refer below to the applicable guidelines and policies that were consulted:

- (Draft) *Stormwater Management Planning and Design Guidelines for New Developments*; and
- *Integrated Metropolitan Environmental Policy for the Western Cape (2001)*.

The main focus of the documents listed above, is to prevent and mitigate the following:

(a) erosion and degradation of watercourses;
(b) sedimentation in ponds and watercourses;
(c) degradation of water quality and fish habitat;
(d) excess stormwater runoff onto a public road which may pose a danger to life or property or both;
(e) minimise threat of flooding;
(f) protect receiving water bodies;
(g) promote multi-functional use of stormwater management systems; and
(h) develop sustainable stormwater systems.

This document does not cover all aspects of a detailed engineering stormwater management plan / design; however it does consider the current and likely future activities of a development which may lead to the occurrence of stormwater impacts.

The following factors were considered as part of the methodology for the draft stormwater management plan:

- site characteristics;
- current ground / soil conditions;
- surrounding infrastructure;
- expected storm events ,and
- environmental concerns.

Taking into account the above listed factors, the best solution for effective management of stormwater run-off is the use of both conventional and attenuation methods to control and treat the stormwater run-off from the proposed development site.

The attenuation design allows for the maximum flow discharge of less than / equal to the pre-developed 1:5 year and 1:25 year flood events.

SECTION 2: SITE LOCATION

The study area is located on Erf 3122 of Hartenbos Heuwels (on the corner of Kameeldoring- and Geelhout Avenue) approximately 1.5km west of the centre of Hartenbos town, in the Mossel Bay Local Municipality, Western Cape Province. The N2 highway as well as the R102 provincial road between Hartenbos and Mossel Bay is situated to the east of the study area, while the R328 provincial road between Hartenbos and Oudshoorn is situated to the north of the study area (please refer to **Figure 1** below for the Locality Map).

The footprint of the proposed development is approximately 60.5 ha in extent. The current vacant land will be converted into a residential township that will include the following:

- Single residential;
- Retirement Village;
- Institution, Retirement Centre, Club House, Recreational and Sporting Facilities, Residential Building and Frail Care Centre.;
- Local Business;
- Local Government;
- Private and Public Streets;
- Private Open Space; and
- Special Zone: Conservation.

Please refer to **Table 1** below for a detailed breakdown of the proposed development components.

Table 1: Detailed breakdown of proposed development components

USE ZONE	ERF NO'S	NUMBER OF ERVEN	AREA IN m³	% OF DEVELOPMENT AREA
Single Residential	1 - 89 225 - 288	89 64 153	122 141	20%
Special zone: Retirement Village	91 - 161 165 - 224	71 60 131	51 409	8%
Special zone: Institution, Retirement Centre, Club House, Recreational and Sporting Facilities, Residential Buildings and Frail Care Centre	90 162 164	1 1 1 3	28 755	5%
Local Business	163	1	6 579	1%
Local Government	289	1	6 280	1%
Private Street			36 768	6%
Public Street			34 918	6%
Private Open Space	397 - 303	7	3 651	1%
Special Zone: Conservation	290 - 296	7	314 560	52%
TOTALS		**303**	**605 061**	**100%**

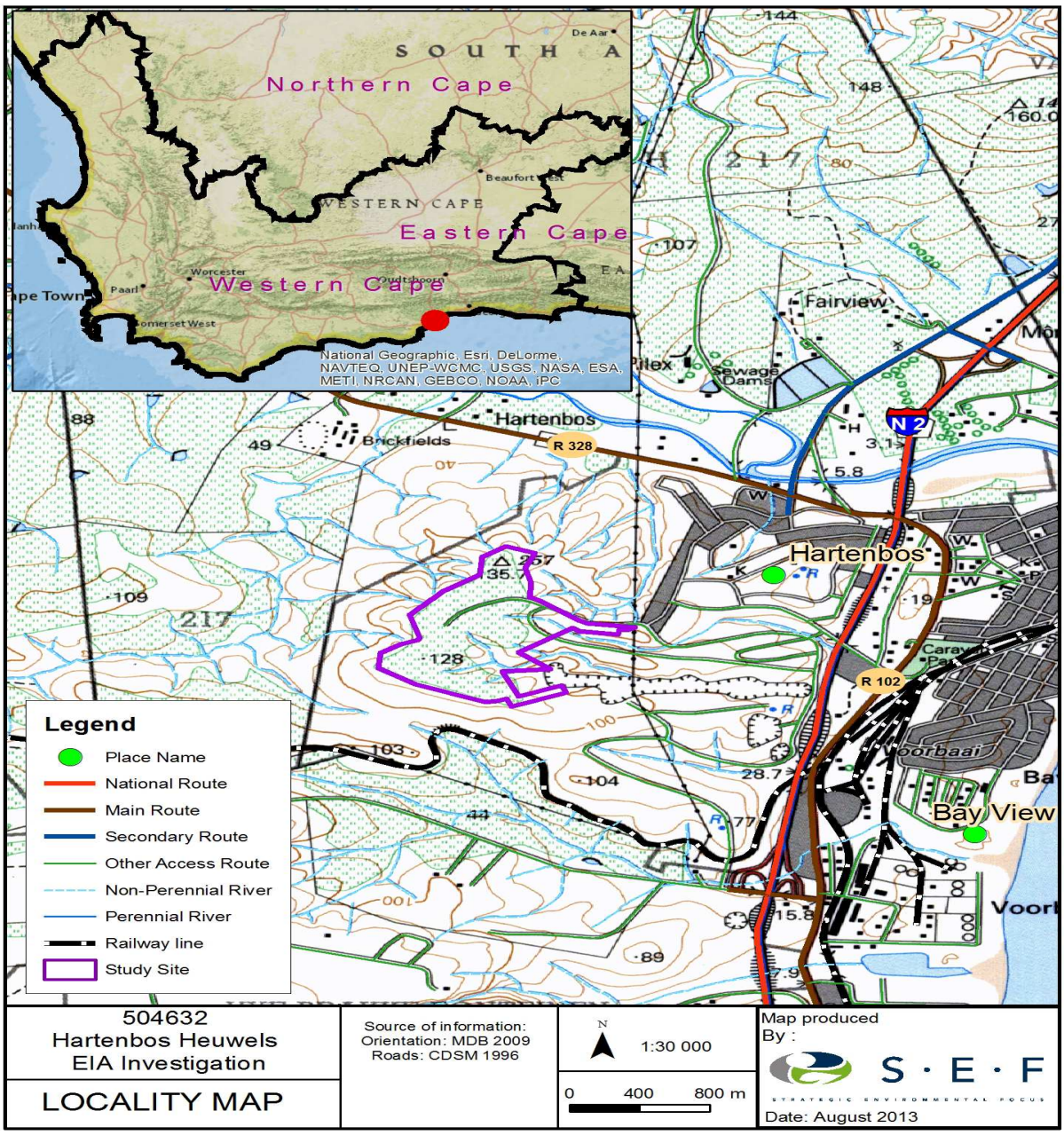

Figure 1: Locality Map

SECTION 3: SITE DESCRIPTION

3.1 EXISTING SITE DESCRIPTION

The site is currently void of any structures and the ground is covered with indigenous plant life commonly associated with the affected region. The site is hilly with well-defined natural waterways, which forms permanent wetlands. The stormwater runoff currently constitutes surface sheet flow, which flows into the well-defined natural waterways and into wetlands.

The proposed development size is 60.5 hectares and will consist of:

- Single residential;
- Retirement Village;
- Institution, Retirement Centre, Club House, Recreational and Sporting Facilities, Residential Building and Frail Care Centre.;
- Local Business;
- Local Government;
- Private and Public Streets;
- Private Open Space; and
- Special Zone: Conservation.

For the type of development envisaged, catchment will be confined to the site area itself. The overall site gradient varies between flat to steep gradients.

In order to provide further context to the proposed development site, a description of the surrounding land uses in the four (4) cardinal directions have been provided in **Table 2** below

Table 2: Surrounding Land Use

Direction	Land Use	Description and distance
North	Residential	Sonskyn Valley (north)
	Road Infrastructure	R328 (highway/main road) – **944m**
	Mining	2 Operations: **1079m** and **2739m** respectively
North-east	Residential	Hartenbos city centre - **1590m**
	Residential	Monte Cristo low-density estate
East	Electrical Infrastructure	Runs adjacent to the site
	Residential	Existing Hartenbos Heuwels Residential Development - **772m**
	Road Infrastructure	N2 highway - **1063m**
	Residential	Bay View - **3270m**
	Steam Locomotive Yard (cultural land)	**2170m**
South	Residential land	Menkenkop and Seemeeupark
	Farming land	Aalwyndal smallholding area
West	Agriculture/Cultivation land	Directly adjacent

Please refer to **Figure 2** for the proposed Hartenbos Heuwels Development Layout Plan.

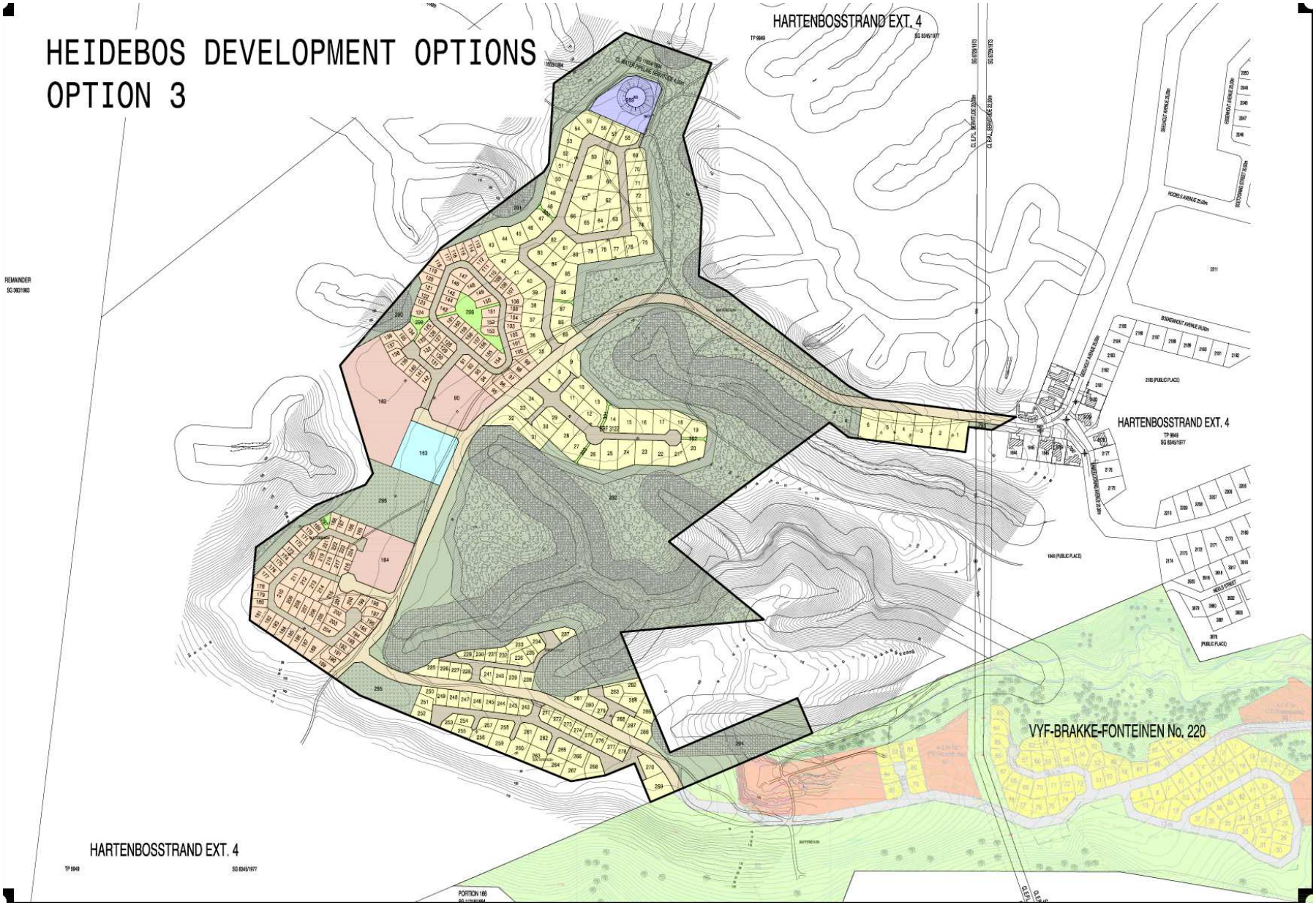

Figure 2: Proposed Hartenbos Heuwels Development Layout Plan

SECTION 4: NATURAL RIVERS SYSTEMS AND FLOODLINES

A Wetlands Assessment Report was undertaken by Strategic Environmental Focus (Pty) Ltd (SEF) in **October 2014**. The assessment phase of the investigation identified that wetland areas with well-defined natural waterways, will be impacted upon by the proposed development. The affected wetlands are formed by tributaries extending through the area, and further defined by the 1:100 year flood line events and buffer zones. It is important to note that no development will take place within the 1:100 year floodline zone.

Furthermore, the wetland impact assessment has identified the following major potential impacts on the receiving riparian features, as a result of the proposed development:

- Destruction of wetland habitat;
- Surface water pollution (including sedimentation); and
- Increased erosion of the study area.

The above listed potential impacts may result from reshaping and construction activities associated with the proposed residential development; implementation of roads and stormwater infrastructure; as well as increased surface runoff due to larger hard/ compacted surface areas. Several mitigation measures have however been identified which will serve to limit the severity and extent of the impacts on the sensitive wetland and riparian features. These mitigation measures include attenuation features, diffuse release infrastructure as well as a wetland rehabilitation program. The wetland rehabilitation programme further includes specific measures associated with the design and placement of infrastructure within sensitive riparian features, as well as alien vegetation control.

From the assessment undertaken, it was identified that the Mean Annual Precipitation (MAP) for the affected area ranges between 400-600 mm per annum (South African Road Agency, 2006). With this being said, an average of 500 mm was used to calculate the stormwater run-off for the proposed development on erf 3122 of Hartenbos Heuwels, Mossel Bay, Western Cape Province.

Please refer to **Figure 3** below for the identified wetland and riparian features, along with the location of the rehabilitation gabion structures.

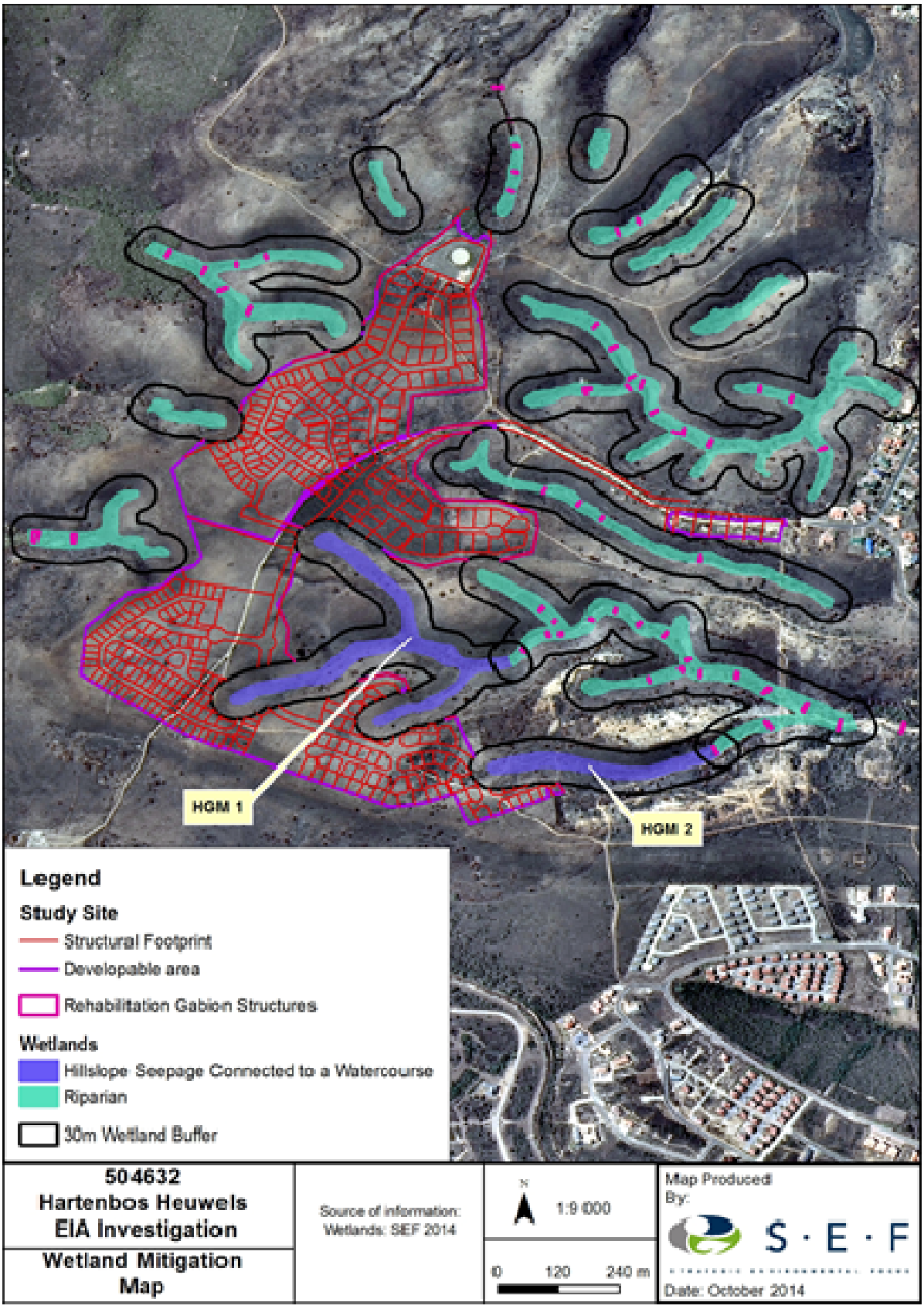

Figure 3: Wetlands Mitigation Map

SECTION 5: PROPOSED STORMWATER METHODOLOGY

4.1 PRE-DEVELOPMENT SITE CHARACTERISTICS

The pre-development characteristic of the development site has been classified as “rural”.

The stormwater run-off for the site can be summarised as follows:

Size of Catchment	0.605061 km² (60.5 ha)
Longest Watercourse	0.153 km
Average Slope	2.09 %
Roughness Coefficient	0.3

Please refer to **Table 3** below for the runoff calculation of the pre-developed site:

Table 3: Rational Method Pre-Development Runoff

Return Period	Coefficient C	Intensity I mm/hr	Area km2	Flow Q m3/s
1:5	0.504	36.1	0.605061	**3.06**
1:10	0.536	45.2	0.605061	**4.07**
1:25	0.573	53.7	0.605061	**5.54**
1:50	0.599	72.4	0.605061	**7.29**
1:100	0.630	88.2	0.605061	**9.34**

4.2 POST-DEVELOPMENT SITE CHARACTERISTICS

The proposed Hartenbos Heuwels Development will consist of the following:

- Single Residential units;
- Retirement Village;
- Institution;
- Retirement Centre;
- Club House;
- Recreational and Sporting Facilities;
- Local Business;
- Local Government;
- Various roads (Private and Public);
- Private Open Space; and
- Conservation area.

The stormwater run-off for the proposed Hartenbos Heuwels Development can be summarised as follows:

Size of Catchment	0.605061 km²
Longest Watercourse	0.7307 km
Average Slope	1.78 %
Time of Concentration	defined watercourse
Roughness Coefficient	0.353

Please refer to **Table 4** below for the runoff calculation of the post-developed site:

Table 4: Rational Method Post-Development Runoff

Return Period	Coefficient C	Intensity I mm/hr	Area km2	Flow Q m3/s
1:5	0.353	38.6	0.605061	**2.29**
1:10	0.353	50.0	0.605061	**2.97**
1:25	0.353	66.6	0.605061	**3.95**
1:50	0.353	90.1	0.605061	**5.34**
1:100	0.353	97.9	0.605061	**5.81**

4.3 STORMWATER ATTENUATION & RUNOFF

The effects of surface water from the main component / focus of the stormwater management plan as it is directly discharged by rainfall events and has a more immediate impact on the surface conditions, as compared to groundwater which receives water through seepage/infiltration from surface water.

Surface water may also refer to waters found in the streams, wetlands and ponds with less distinction to 'stormwater'. Surface water features such as sensitive streams, wetland and ponds which functions as a receiving water body (receptor) needs to be protected from exposure to untreated stormwater. Untreated stormwater may contain various contaminants such as greases or oil from parking or road areas, where exposure to this will reduce the surface water quality. Therefore, the design of stormwater features need to include (but not be limited to) the following:

- Effective conveyance channels;
- Impervious ponds;
- Treatment facility where necessary;
- Water re-use where feasible; and
- Stormwater retarders.

The internal stormwater drainage system will be designed for a five (5) year return period and the main drain designed for a 25 year return period. The designs will be done in accordance with the requirements stipulated in the report below:

- Guidelines for Human Settlement Planning and Design Compiled under the patronage of the Department of Housing by CSIR Building and Construction Technology (also known as the New Red Book).

The stormwater runoff will occur as surface sheet flow and the proposed roads (public and private) will be utilised as stormwater channels. The roads will be designed with a cross fall with kerbs and concrete gutters at the lower side of the roads, which will accommodate the stormwater runoff to the various outlet points as determined in the final design stage of the project.

The kerb inlets of various lengths will collect the stormwater runoff and convey the stormwater runoff to the attenuation dams at the end of the 450 mm diameter concrete pipe. A total of eight stormwater attenuation dams will be constructed to accommodate the water in excess of the 1:5 year flood. The stormwater attenuation dams will be constructed using geotextile material (erosion protection), gabions for the walls and "Reno" mattresses for the floor. Finger subsoil drains will be installed perpendicular with the stormwater outlet pipe.

The attenuation structure's depth will be deeper at a minimum depth of 0.4m below the invert of the stormwater pipe outlet. The subsoil finger drains will be installed at least 0.4 m below the invert of the stormwater outlet. Furthermore, the subsoil finger drains will be installed level at a distance as indicated on the construction drawings. The pipe size for the subsoil finger drains is 160 mm diameter.

The purpose of the attenuation dams with subsoil finger drains accommodates the regeneration of the wetlands. Its other purpose is to limit the concentration flow of the stormwater runoff at one point of discharge. Please refer to **Figure 4** below for the location of attenuation ponds and finger drains.

Furthermore, the extent of surface runoff will also be limited on site by means of implementing engineering designs, such as the following:

- Flow retarders;
- Concrete lined channels (to be used only where flow velocities cannot be restricted)
- Rock lining;
- Well vegetated buffer strips;
- Unlined artificial channels for uncontaminated stormwater;
- Unlined sheet flow;
- Energy dissipaters;
- Planting; and
- Dry and/or wet ponds.

All stormwater will be directed by means of channels, shaping or swales to the attenuation ponds located along the affected drainage lines. The detailed specifics need to be attended to during the detailed design stage of the proposed development.

It is also important to note that a stormwater maintenance plan will be implemented as part of the proposed development, as to ensure the long term functionality of the system. Please refer below for the summarised functions that will form part of the stormwater maintenance plan:

- Regular inspection of the attenuation dams and accumulated debris removed;
- Regular inspection of the subsoil finger drains openings and to ensure the openings are clean from all debris;
- Any damage to the gabions and structures to be repaired immediately; and
- Maintenance plan for stormwater structures and channels.

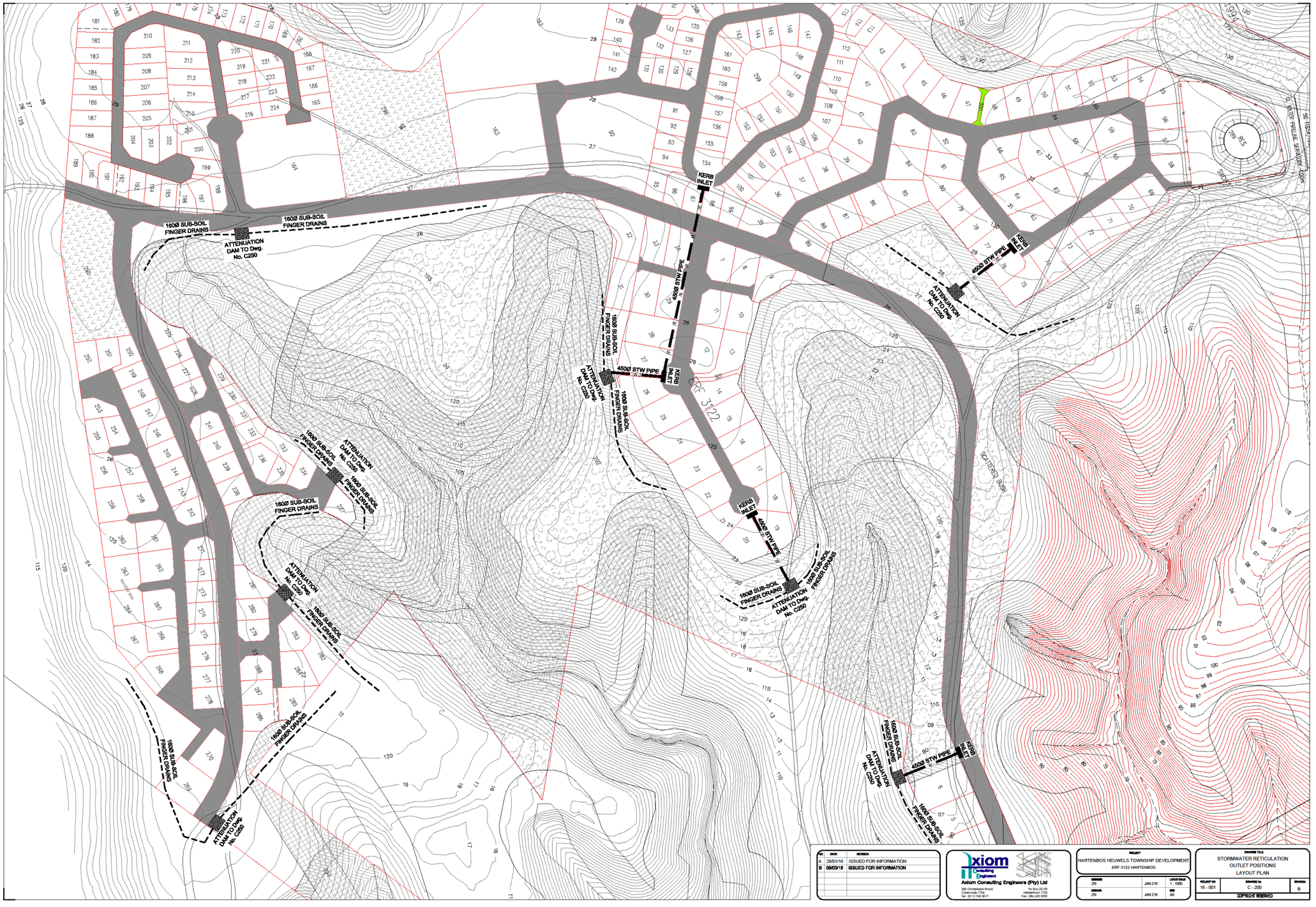

Figure 4: Location of Attenuation ponds and finger drains

4.4 STORMWATER EROSION CONTROL

Stormwater erosion is one of the most challenging factors of stormwater management as it happens quickly and destructively. With the slopes in the study area being fairly steep, surface runoff on bare soil could have negative impacts on the receiving environment due to transportation of salt to the storage (attenuation close) ponds. Should erosion occur, the eroded soil may need to be replaced to reinstate the integrity of the slopes and banks. In doing so, awareness will be necessary to prevent the use of unsuitable soil in replacing the eroded soil.

It is possible to make use of sand bags / straw bales to prevent erosion during the construction phase of the development, before stabilizing vegetation is established. Following the construction phase, it is recommended that rapidly growing grasses be planted on site as this will serve to stabilize disturbed soil as well as retard sheet flow.

4.5 STORMWATER POLLUTION CONTROL

Sewer reticulation within the development must be designed in such a way as to obviate blockages and possible overtopping of manholes. The blockage or leakage of any sewer may pose considerable pollution threats to both surface and groundwater resources.

Furthermore, in areas where potentially high concentrations of hydrocarbon spillages can be expected (i.e. parking areas), the introduction of porous paving to serve as a filter for surface water before it enters underground systems, will be encouraged.

SECTION 6: CONCLUSIONS AND RECOMMENDATIONS

This document has been compiled in accordance with the applicable and relevant South African legislation and by-laws, prior to the commencement of any construction activities. It should however be noted that a revised engineering stormwater management plan (detailed) may need to be undertaken after completing the relevant engineering designs, to provide for incorporation of the finalized designs and changes made (if any).

Furthermore, a monitoring plan will need to be included in the contract documentation (for the appointment of a site developer) to supplement the standard operating procedures which form part of this document. It is important that energy dissipaters and measures associated with the control of volumes and velocity of flow be effectively implemented as to limit surface erosion.

Lastly, the Engineer that is to be appointed by the Developer to undertake and manage the detailed design component and development of the site, must incorporate the information of this report into the planning of any building, roadways and drainage structures on the site. This aid in the achievement of the proposed stormwater management proposals, and in particular, to comply with the requirements stipulated in the Construction and Operational Environmental Management Plan.