ELANDSPRUIT QUARRY

STORMWATER MANAGEMENT PLAN

September 2022, Ver. II

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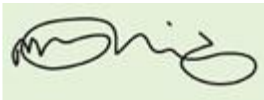
Reviewer	Hulisani T. Rananga (Pr. Nat. Sci)		September 2022

EXECUTIVE SUMMARY

Sustainable Drop Projects (Pty) Ltd was appointed to develop a stormwater management plan at the site of the proposed expansion of the Elandspruit Quarry near Ladysmith in Alfred Duma Local Municipality in KwaZulu-Natal Province. The site is extension of the existing quarry on a portion of the Remaining Extent of the farm Elands Spruit 5523 GS, Ladysmith District. The proposed project will entail the extension of the existing quarry pit through open-cast mining of the hard rock. The recovered material will then be crushed and screened to produce aggregate that can be used for road building purposes.

The planned activities intented to be conducted at the site include:

- stripping and stockpiling of the topsoil of the proposed mining footprint area;
- loosening of the hard rock through blasting and excavation;
- crushing and screening of the hard rock to reduce it to various size aggregate;
- stockpiling of the product until it is used.

Following the completion of a water balance assessment study, it was determined that the risk posed by the volume of the potential spill/overflow from the existing quarry as well as the runoff from the various planned stockpiles (i.e General topsoil, Quarry topsoil and the materials stockpiles) needs to be managed through the implementation of an approrpitare stormwater management plan. The appropriate stormwater management plan would address the potential impact of stormwater runoff generated the site:-

- on the planned quarrying operations and,
- on downstream receptors (catchments)

Development of the Storm Water Management Plan entailed the completion of the following tasks and activities: -

- A desktop-based investigation was undertaken which provided among others, the hydrological setting of the site as well as the wider region in which the site is located and review of the various development options, etc.
- A site investigation was undertaken to not only verify the findings of a desktop study but to also obtain additional relevant information. This included information regarding the presence and state of any existing stormwater infrastructure.
- Using the STRM 30 Digital Elevation Model (DEM), the site was sub-divided in sub-catchments that were considered homogenous with respect to topographical orientation.

- Using the Rational Formula and the proposed landuses for the respective sub-catchments as reflected in the respective development options, the design flood flow values were obtained.
- Recommendations for Stormwater management were then identified.

The proposed conceptual stormwater management plan for the entire site will consist of the following key features include:

- The only processing that is being planned for the site is the size reduction of the rock using the crusher plant; a process that does not involve the introduction of potentially pollutive materials to the site and downstream receptors. Nonetheless, a conservative approach has been taken whereby the plant area as well as the planned product, general topsoil and quarry topsoil stockpiles are considered parts of the dirty water system. As such it is recommended that perimeter berms be constructed around these components to contain any runoff that may be generated from therein.
- Given the site's size and the planned infrastructure layout and proposed activities, the analysis revealed that there would be a reduction in the runoff volumes generated between the pre-development and post development scenarios as a result of the need to contain the runoff (considered dirty) generated from the stockpiles and the plant area. For the pre-development scenario, the peak flows with recurrence intervals of 50 years and 100 years respectively were estimated as 1.928 m^3/s and 2.146 m^3/s while the corresponding estimates for the post-development scenario were 0.420 m^3/s and 0.468 m^3/s.
- An open channel will be constructed on along the northern boundary of the haul road that will run from the P263 road onto the site. This open channel, designed for a 1:50 year event, will drain into P263's existing stormwater drainage system. This will reduce the flood risk to the haul road thus minimizing the risk of disruption of operations and/or access.
- The planned general topsoil and quarry topsoil stockpiles will eventually have to be revegetated and any runoff from this will be classified as clean.
- During the lifespan of the planned quarrying operations at the site, there will need to be measure in place to minimise erosion of topsoil and/or material from the respective stockpiles. To this end, for each stockpile, a perimeter stormwater retention berm should be created to collect runoff and allow it to evaporate and/or infiltrate to ground.

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MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MAE	Mean Annual Evaporation
PFD	Process Flow Diagram
WB	Water Balance

1. INTRODUCTION

Sustainable Drop Projects (Pty) Ltd was appointed to develop a stormwater management plan at the site of the proposed expansion of the Elandspruit Quarry near Ladysmith in Alfred Duma Local Municipality in KwaZulu-Natal Province. The site is extension of the existing quarry on a portion of the Remaining Extent of the farm Elands Spruit 5523 GS, Ladysmith District. The proposed project will entail the extension of the existing quarry pit through open-cast mining of the hard rock. The recovered material will then be crushed and screened to produce aggregate that can be used for road building purposes.

The planned activities intended to be conducted at thee site include:

1. stripping and stockpiling of the topsoil of the proposed mining footprint area;
2. loosening of the hard rock through blasting and excavation;
3. crushing and screening of the hard rock to reduce it to various size aggregate;
4. stockpiling of the product until it is used.

1.1. Background

The Applicant, Raubex KZN (Pty) Ltd, applied for environmental authorisation and is required to submit a water balance assessment report as part of the application requirements. An accurate Water Balance is considered to be one of the most important and fundamental water management tools available to industry. This was drafted with the aim to provide Raubex KZN (Pty) Ltd with information that will help in deriving and defining their water management strategies. In addition, the assessment includes identifying and quantifying points of high-water consumption or wastage, while deriving vital water linkages within the site.

The purpose of Sustainable Drop Project’s undertaking was to determine the required interventions to allow for the adequate management of stormwater within the project site. Stormwater management takes into consideration both quality and quantity of run-off to protect downstream water courses and ecosystems while ensuring that suitable mitigation measures for dealing with abnormal rainfall and flooding events are implemented.

As such the key objectives of a sound stormwater management plan are to:

- Protect the health and safety of the public and property from uncontrolled flooding hazards;
- Improve quality of life of affected communities and environments;
- Conserve water for community and environmental benefit;
- Preserve the natural environment;
- Create a sustainable environment while pursuing economic development.

These objectives should be achieved through a holistic planning approach which considers stormwater as part of the urban water cycle (Water Sensitive Urban Design (WSUD)) through sustainable drainage systems (SUDS).

1.2. Legal and Environmental Framework

The following Environmental and Legal Framework is considered relevant as far as the planned feasibility study and the conceptual stormwater management plan proposed here.

1.2.1. The Constitution of South Africa (1996)

The Constitution of South Africa (108 of 1996) is the supreme law in South Africa. Any laws must adhere to the Constitution including any environmental management acts, policies or planning documents. Section 24 of the Constitution addresses environmental rights such that "any person has the right to an environment that is not harmful to their health and is protected for future generations."

1.2.2. National Environmental Management Act (1998)

The National Environmental Management Act (NEMA) (107 of 1998) aims at the integration of environmental management into all development activities. It is the overarching Environmental Act in South Africa that manages the environment and guides the development of environmental frameworks, plans and policies.

With the potential for land degradation through the erosive power of stormwater runoff, the applicable section of the Act is Chapter 7 Section 28 (1) and (3) which deals with compliance, enforcement and protection, duty of care and prevention of pollution and environmental remediation:

(1) Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment

(3) The measures required in terms of subsection (1) may include measures to—
- *a. investigate, assess and evaluate the impact on the environment;*
- *b. cease, modify or control any act, activity or process causing the pollution or degradation;*
- *c. contain or prevent the movement of pollutants or the causant of degradation.*

1.2.3. National Water Act No 36 of 1998

The National Water Act (36 of 1998) requires that any new development takes cognisance of the 1 in 100 year return period flood level and that this floodline for the 1 in 100 year flood be indicated on the drawings. This is to ensure that all persons that may be affected by a major flood, have access to information regarding the likely flood levels.

1.2.4. Guidelines For Human Settlement Planning and Design

The CISR has developed a set of design guidelines for the development of infrastructure for townships and industrial developments. These Guidelines provide specific objectives for the design and operation of stormwater systems as follows:

> *"Prohibition against pollution is addressed in Clause 19 of the National Water Act, Act 36 of 1998. This section deals with pollution prevention, and in particular the situation where pollution of a water resource occurs or might occur as a result of activities on land. The person who owns, controls, occupies or uses the land in question is responsible for taking measures to prevent pollution of water resources. The dual drainage system for developed areas are defined as any man-induced developments which have changed the environment."*

The Guidelines provide specific design guidance for the sizing of stormwater systems in terms of the appropriate design return period is presented in Table 1-1 and Table 1-2.

Table 1-1: Design Flood Frequencies for Major Systems (Source: Table 6-1 of Guidelines for Human Settlement Planning and Design: Volume 2)

LAND USE	DESIGN FLOOD RECURRENCE INTERVAL
Residential	50 years
Institutional (e.g schools)	50 years
General Commercial and Industrial	50 years
High Value Central Business Districts	50 – 100 years

Table 1-2: Design Flood Frequencies for Minor Systems (Source: Table 6-2 of Guidelines for Human Settlement Planning and Design: Volume 2)

LAND USE	DESIGN FLOOD RECURRENCE INTERVAL
Residential	1 - 5 years
Institutional (e.g schools)	2 - 5 years
General Commercial and Industrial	5 years
High Value Central Business Districts	5 – 10 years

It is therefore considered appropriate to design the major system which includes overland flow routes, canals and detention ponds for the 1 in 50-year return period design flood recurrence interval while the piped underground stormwater system should be designed for the 1 in 5-year return period design flood recurrence interval.

2. LOCALITY AND SITE DESCRIPTION

The site is extension of the existing quarry on a portion of the Remaining Extent of the farm Elands Spruit 5523 GS, within Alfred Duma Local Municipality in KwaZulu Natal Province (Figure 2-1) In Figure 2-2, the planned layout of the site is shown. The topography is such that the site has a downward gradient in the southern direction. Towards the western boundary of the site is evidence of previous quarrying activity (Figure 2-3) and at the time of the site visit there was stagnant water visible within the pit. With the existing quarry included, the site covers an area of 41 284.90 m^2. It is understood that the site is underlain by a dolerite according to the 1:250 000 scale geological map of the area.

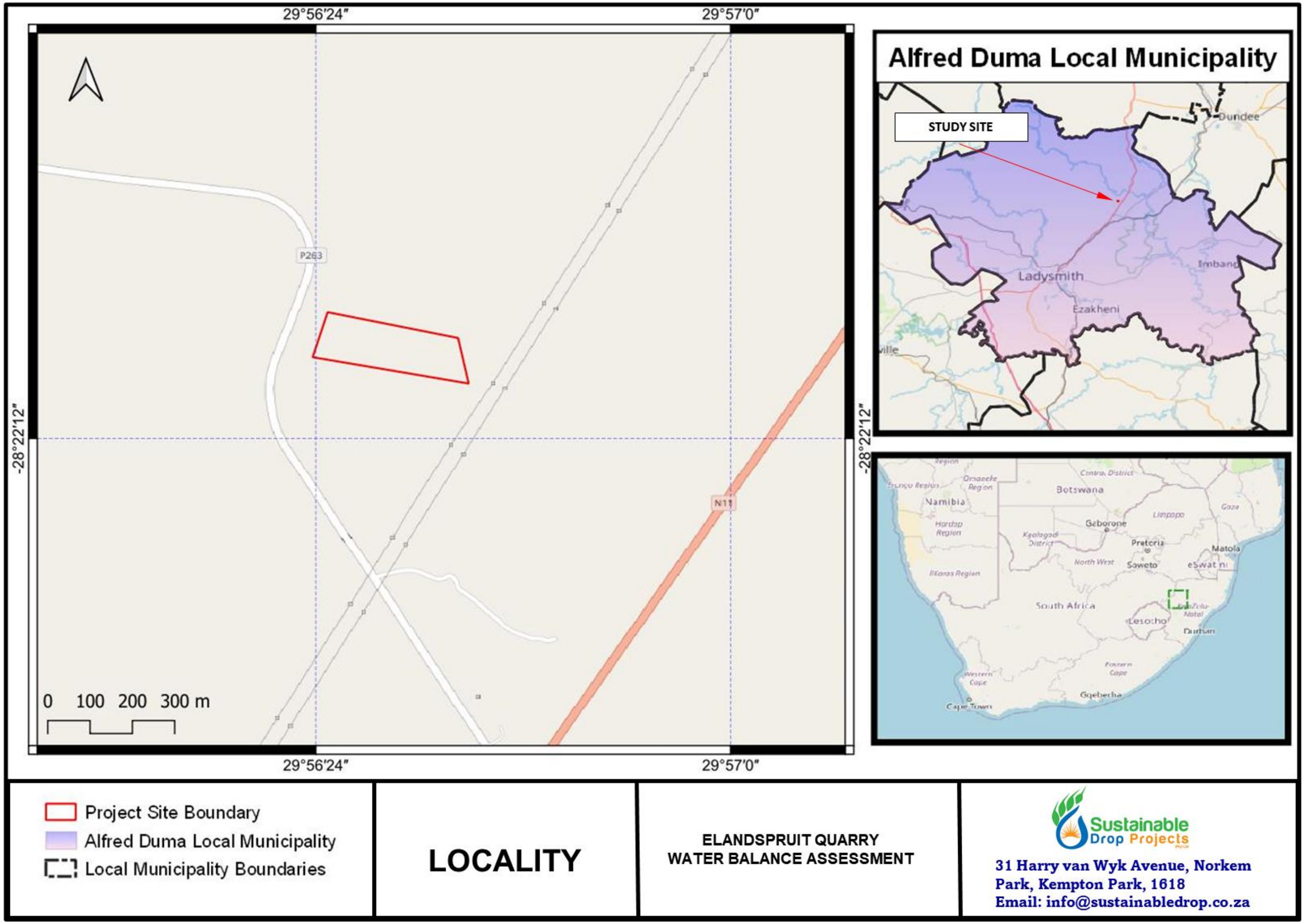

Figure 2-1: Location of the Elanspruit quarry site

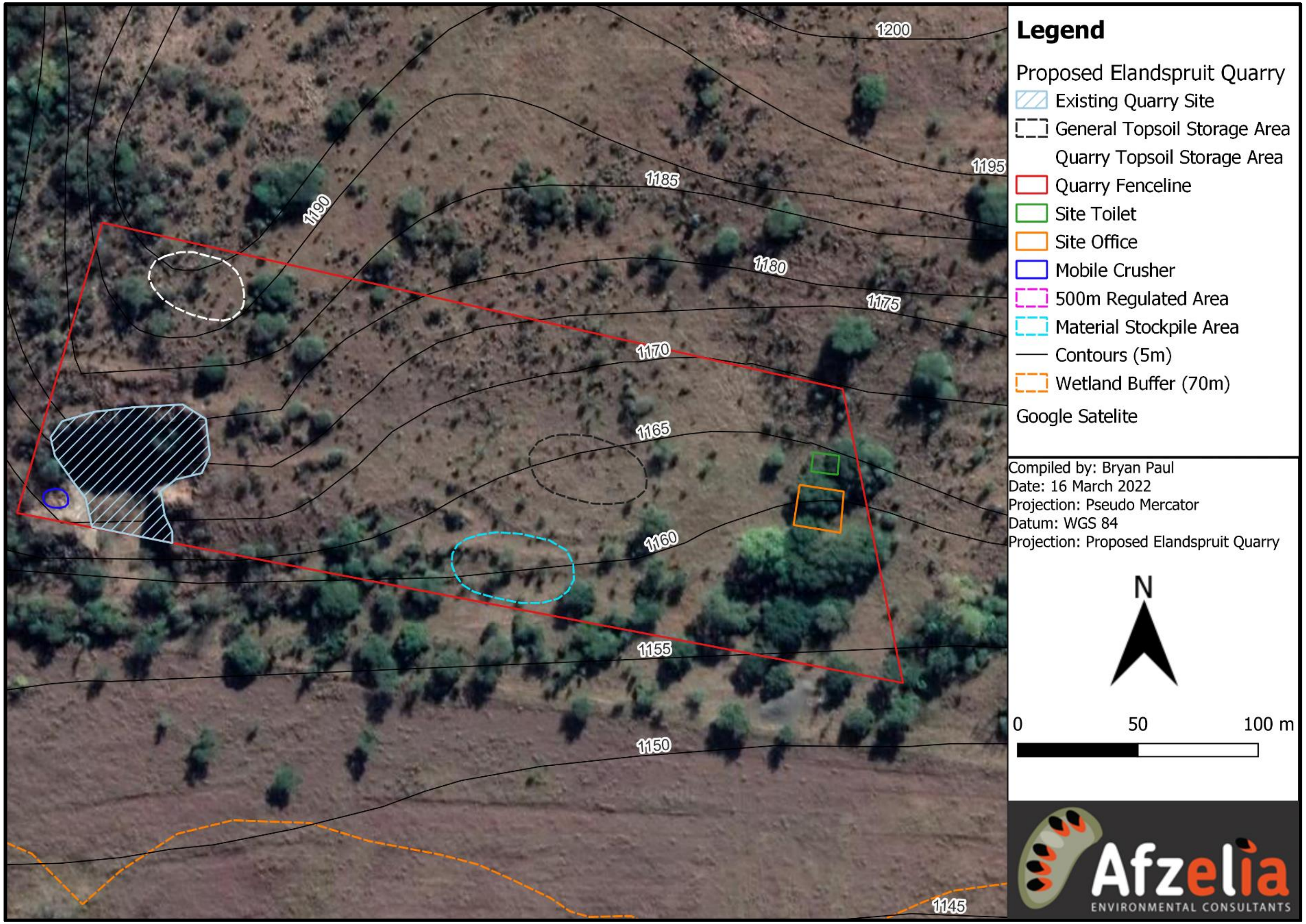

Figure 2-2: Planned Layout and Infrastructure for the Site (Source: Afzelia Environmental Consultants)

Figure 2-3: Location of existing quarry within the site boundary

3. METHODOLOGY

Development of the Storm water Management plan entailed the completion of the following activities:-

I. A desktop-based investigation was undertaken which provided among others, the hydrological setting of the site as well as the wider region in which the site is located and review of the various development options, etc.
II. A site investigation was undertaken to not only verify the findings of a desktop study but to also obtain additional relevant information. This included information regarding the presence and state of any existing stormwater infrastructure.
III. Using the STRM 30 Digital Elevation Model (DEM), the site was sub-divided in sub-catchments that were considered homogenous with respect to topographical orientation.
IV. Using the Rational Formula and the proposed landuses for the respective sub-catchments as reflected in the respective development options, the design flood flow values were obtained.
V. Recommendations for Stormwater management were then identified.

VI. **Reporting –** Following the completion of the plan, a report documenting the proposed plan was prepared (this report) and provided to the client for review and comment before it could be finalised.

4. HYDROLOGICAL SETTING

The site is located within quaternary catchment V60C which is part of the uThukela Water Management Area. Quaternary catchment V60C covers an area of 361 km^2, has a mean annual precipitation (MAP) of 726 mm, a mean annual evaporation (Symon's Pan) of 1500 mm and a mean annual runoff of 21.31 million m^3.

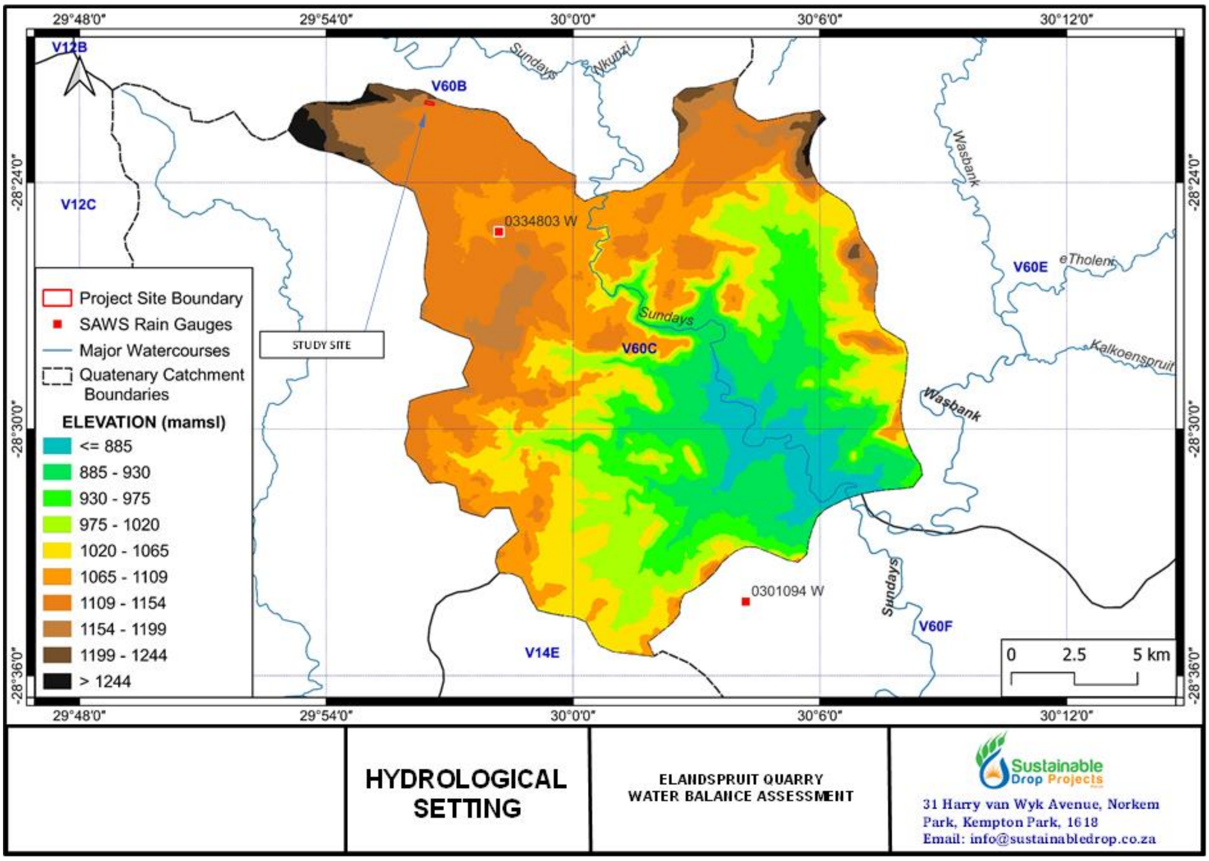

Figure 4-1: Hydrological Setting of Project Site

4.1. Long-term trends of average monthly rainfall and evaporation

To understand the precipitation and evaporation patterns for the project area, the statistics of these hydrological and meteorological variables were obtained for the quaternary catchment V60C and these are presented in Table 4-1.**Error! Reference source not found.**

Table 4-1: Mean monthly rainfall and evaporation distribution

Month	Rainfall (mm/month)	Symons Pan Evaporation (mm/month)
Jan	161.00	128.44
Feb	140.00	108.98
Mar	135.00	83.55
Apr	108.00	36.07
May	90.00	15.93
Jun	75.00	9.60
Jul	83.00	10.07
Aug	107.00	17.08

Sep	126.00	33.67
Oct	148.00	68.50
Nov	155.00	98.88
Dec	166.00	113.44

(Source: WRSM2000)

It is apparent from Table 4-1 that the catchment lies within a summer rainfall part of the country since the months of November to March are when most rainfall is received. The period April to September experiences low rainfall.

4.2. Regional Temperatures

The regional temperature data (Table 4-2) was obtained from Climate-Data.Org. For this study, the temperature data for Ladysmith was used.

Table 4-2: Project Site Monthly Temperatures (https://en.climate-data.org/africa/south-africa/kwazulu-natal/ladysmith-947/)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temperature °C	21.6	21.5	20.2	17.3	14.2	11.1	10.8	13.8	17	18.6	19.8	21.2
Min. Temperature °C	16.3	16.4	14.8	11.5	7.3	3.9	3.3	6.2	9.4	11.9	13.7	15.4
Max. Temperature °C	27.7	27.5	26.4	23.7	21.7	19.2	19.1	22.2	25.3	26.2	27	27.9

A plot of the regional monthly temperatures, evaporation and rainfall data was prepared and is shown in Figure 4-2. It is clear from the plot that on average evaporation exceeds rainfall throughout the year.

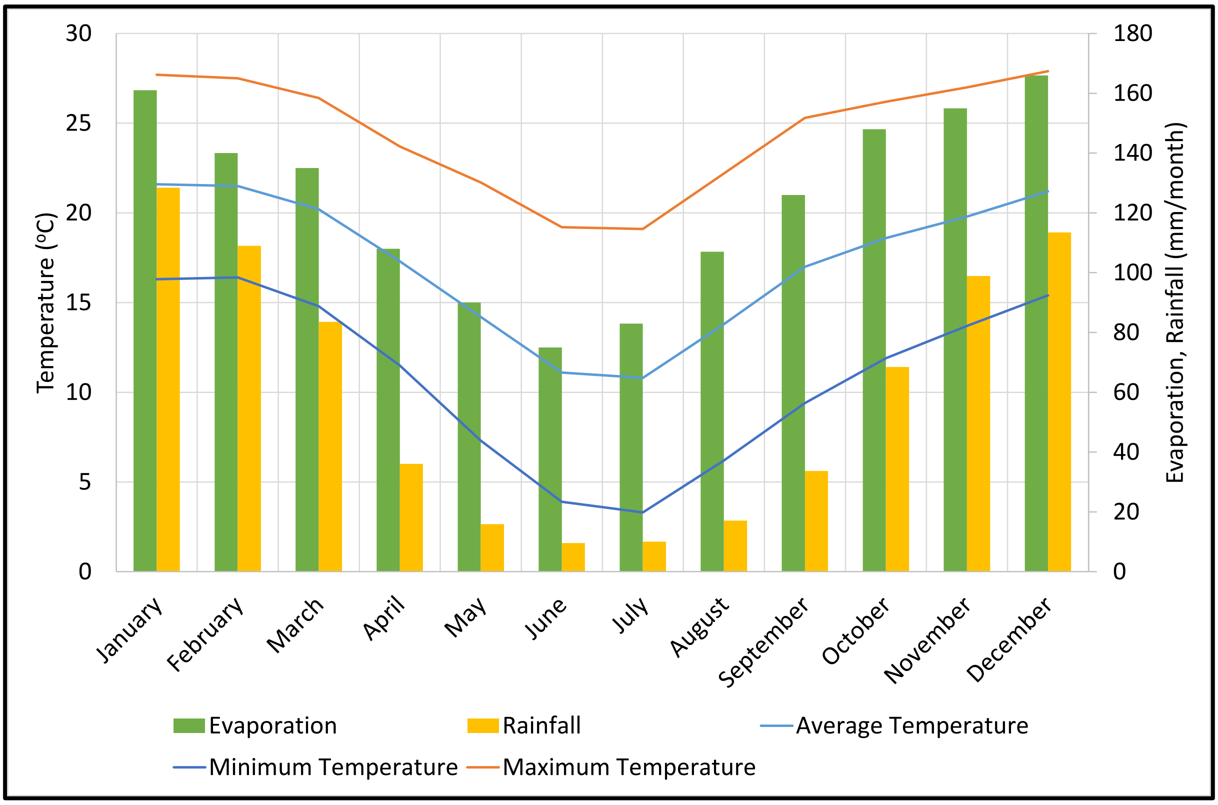

Figure 4-2: Plot of monthly Evaporation vs Rainfall and regional temperatures for the Project Site

The plot clearly indicates that the seasonal pattern of evaporation and temperatures is nearly identical to the seasonal rainfall pattern. It is also apparent that the Mean Annual Evaporation (MAE) exceeds the Mean Annual Rainfall (MAP) on account of the mean monthly values of evaporation for all months being greater than the corresponding monthly rainfall values.

4.3. Design Rainfall Depths

Design storm estimates for various return periods and storm durations were sourced from the Design Rainfall Estimation Software for South Africa, developed by the University of Natal in 2002 as part of a WRC project K5/1060 (Smithers and Schulze, 2002). This method uses a Regional L-Moment Algorithm in conjunction with a Scale Invariance approach to provide site specific estimates of Design Rainfall depths for specified durations at various recurrence intervals. Table 4-3 presents the design rainfall depths that were derived from the Smithers and Schulze method based for Station No. 0334825_W (Latitude -28.25; Longitude - 29.97), the closest rain gauge station, in the database to the project site.

Table 4-3: 1-day Design Rainfall Depths (mm)

Station Name	SAWS No.	MAP (mm)	Altitude (m)	Duration	Recurrence Interval (Years)			
					5	20	50	100
BALBROGIE	**0334825_W**	907	1244	1 day	86.2 mm	115.9 mm	135.8 mm	151.1 mm

5. CONCEPTUAL STORMWATER MANAGEMENT PLAN

Mining operations have the potential to impact upon the baseline water quality of an area and, if not managed correctly, stormwater may pose a risk of flooding to project infrastructure. The aim of stormwater management measures is to mitigate these impacts by fulfilling the requirements of the National Water Act (Act 36 of 1998) and more particularly GN 704.

The following definitions from GN 704 are appropriate to the classification of catchments and design of stormwater management measures at the Elandspruit Quarry:-

- **Clean water system:** includes any dam, other forms of impoundment, canal, works, pipeline and any other structure or facility constructed for the retention or conveyance of unpolluted (clean) water;
- **Dam:** includes any settling dam, slurry dam, evaporation dam, catchment or barrier dam and any other form of impoundment used for the storage of unpolluted water or water containing waste (i.e. dirty water);
- **Dirty area:** means any area at a mine or activity which causes, has caused or is likely to cause pollution of a water resource;
- **Dirty water system:** This includes any dirty water diversion bunds, channels, pipelines, dirty water dams or other forms of impoundment, and any other structure or facility constructed for the retention or conveyance of water containing waste (i.e. dirty water); and
- **Activity:** means any mining related process on the mine including the operation of washing plants, mineral processing facilities, mineral refineries and extraction plants; the operation and the use of mineral loading and off-loading zones, transport facilities and mineral storage yards, whether situated at the mine or not; in which any substance is stockpiled, stored, accumulated, dumped, disposed of or transported.

In addition to the above, the Department of Human Settlements, Water and Sanitation (then Department of Water and Forestry) developed Best Practice Guidelines for the mining industry, which should inform the design and operation of the Elandspruit Quarry expansion project.

5.1. Principles for Overall Stormwater Management

The GN 704 requires the following:

- **Capacity:** dirty water systems are to be designed, constructed, maintained and operated so that they are not likely to spill into a clean water system or the environment more frequently than once in 50 years.
- **Conveyance:** all water systems are to be designed, constructed, maintained and operated so that they convey a 1:50 year flood event.

- **Freeboard:** as a minimum, any dirty water dams are to be designed, constructed, maintained and operated to have 0.8m freeboard above full supply level.
- **Collect and Re-Use:** ensure that dirty water is collected and re-used as far as practicable.
- **Diversion:** minimise flow of any surface water or floodwater into mine workings.

Informed by a review of the site setting, a series of design principles for site wide stormwater management have been developed to ensure compliance with the requirements of GN 704 and Best Practice Guidelines.

Table 5-1: Aerial Footprint of Planned and Existing Components for the Project Site

Process Unit	Footprint (m^2)	Catchment Area (m^2)	Direct Rainfall (m^3/annum)	Evaporation (m^3/annum)	Runoff (m^3/annum)
Existing Quarry	2 526	72 301.38	1 833.88	3 789.00	15 747.24
General Topsoil Storage Area	1 091	55 202.14	792.07	1 636.50	12 023.03
Quarry Topsoil Storage Area	850	41 576.11	617.10	1 275.00	9 055.28
Materials Stockpile Area	1 189	51 274.40	863.21	1 783.50	11 167.56

The proposed conceptual stormwater management plan for the entire site is presented on **Figure 5-1**.

The key features include:

- The only processing that is being planned for the site is the size reduction of the rock using the crusher plant; a process that does not involve the introduction of potentially pollutive materials to the site and downstream receptors. Nonetheless, a conservative approach has been taken whereby the plant area as well as the planned product, general topsoil and quarry topsoil stockpiles are considered parts of the dirty water system. As such it is recommended that perimeter berms be constructed around these components to contain any runoff that may be generated from therein.
- An open channel will be constructed on along the northern boundary of the haul road that will run from the P263 road onto the site. This open channel, designed for a 1:50 year event, will drain into P263's existing stormwater drainage system. This will reduce the flood risk to the haul road thus minimizing the risk of disruption of operations and/or access.
- The planned general topsoil and quarry topsoil stockpiles will eventually have to be revegetated and any runoff from this will be classified as clean.
- During the lifespan of the planned quarrying operations at the site, there will need to be measure in place to minimise erosion of topsoil and/or material from the respective stockpiles. To this end, for each stockpile, a perimeter stormwater retention berm should be created to collect runoff and allow it to evaporate and/or infiltrate to ground.

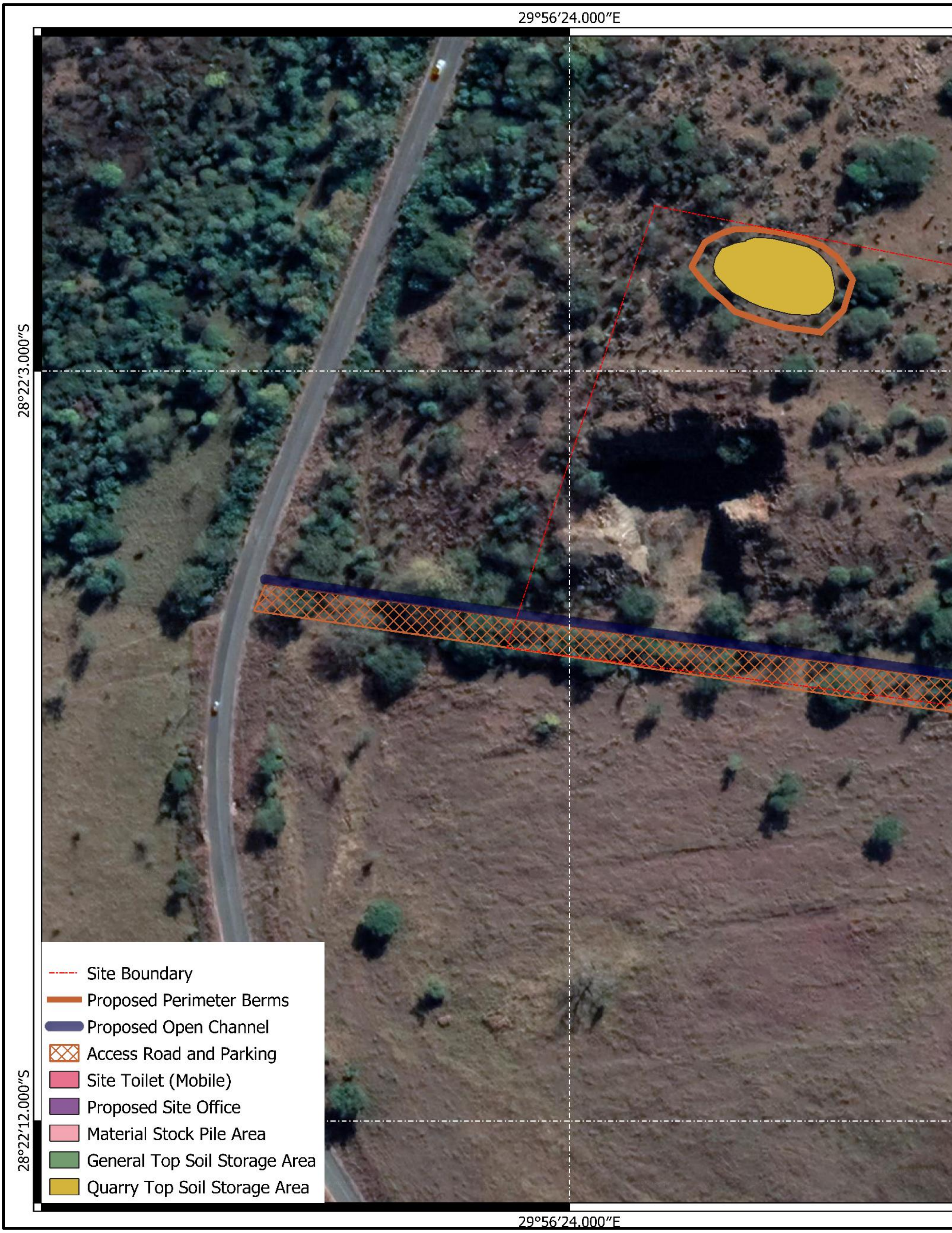
29°56′24.000″E
28°22′3.000″S
28°22′12.000″S
Site Boundary
Proposed Perimeter Berms
Proposed Open Channel
Access Road and Parking
Site Toilet (Mobile)
Proposed Site Office
Material Stock Pile Area
General Top Soil Storage Area
Quarry Top Soil Storage Area
29°56′24.000″E

Figure 5-1: Site Wide Stormwater Management

5.2. Pre- and Post-Development Runoff Estimates

Considering the site extent and its catchment area, the Rational Formula was selected for the determination of the runoff estimates for both the pre-development scenario and the for the post-development scenario. The runoff estimates from the site in the pre-development scenario (in which only the existing quarry is accounted for) are presented in Table 5-2.

Table 5-2: Pre-development peak flow estimates

Contributing Catchment Area (m^2)	Peak Flow	
	1:50 year	1:100 year
189 337.55	1.928	2.146

The post-development scenario takes into account the office area, the stockpiles (product, general and) and plant area as well as the fact that the runoff from the stockpiles is to be contained and prevented from leaving the site. The resulting peak flow estimates from the changes in the contributing catchment area are presented in Table 5-3.

Table 5-3: Post-development peak flow estimates

Contributing Catchment Area (m^2)	Peak Flow	
	1:50 year	1:100 year
41 284.90	0.420	0.468

5.3. Sizing of Drainage Channels and Berms

The 1:50 year peak flow estimate i.e. 0.420 m^3/s, was used for the sizing of the cleanwater channel with the recommended channel design reflected in Figure 5-2.

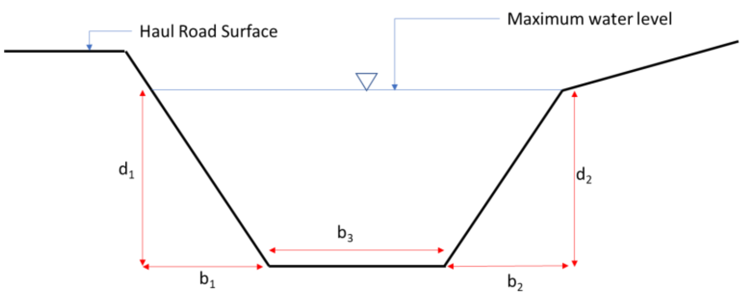

Figure 5-2: Cleanwater Diversion Channel Sizing

Drainage Channel	Design Flow (m^3/s)	Channel Dimension (meters) (refer to Figure 5-2)				
		b_1	d_1	b_2	d_2	b_3
Cleanwater Diversion Channel	0.420	0.6	0.6	0.6	0.6	0.6

6. CONCLUSIONS AND RECOMMENDATIONS

This study was undertaken to complement a water balance assessment study that was conducted in May 2022. Following observations by the team while on site as well as the recommendations arising from the said water balance assessment, this proposed stormwater plan has been developed to minimise the impact of flood events on the planned quarrying operations as well as on downstream receptors and its key features are the following:-

- The only processing that is being planned for the site is the size reduction of the rock using the crusher plant; a process that does not involve the introduction of potentially pollutive materials to the site and downstream receptors. Nonetheless, a conservative approach has been taken whereby the plant area as well as the planned product, general topsoil and quarry topsoil stockpiles are considered parts of the dirty water system. As such it is recommended that perimeter berms be constructed around these components to contain any runoff that may be generated from therein.
- The analysis revealed that there would be a reduction in the runoff volumes generated between the pre-development and post development scenarios as a result of the need to contain the runoff (considered dirty) generated at stockpiles.
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- During the lifespan of the planned quarrying operations at the site, there will need to be measure in place to minimise erosion of topsoil and/or material from the respective stockpiles. To this end, for each stockpile, a perimeter stormwater retention berm should be created to collect runoff and allow it to evaporate and/or infiltrate to ground.

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