NAAZ QUARRY

FLOODLINE STUDY AND STORMWATER MANAGEMENT PLAN

MARCH 2021

REVISION 00

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SYNOPSIS

Floodline Study and Stormwater Management Plan required as part of the Water Use Licence Application.

KEY WORDS:

Naaz Quarry, National Water Act 36 of 1998, General Notice 704, Best Practice Guidelines-A1

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO 9001: 2015 which has been independently certified by DEKRA Certification.

Verification	Capacity	Name	Signature	Date
By Author	Hydrologist	Jédine Govender	Jédine	31/03/2021
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NAAZ QUARRY
FLOODLINE STUDY AND STORMWATER MANAGEMENT PLAN REPORT

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1 INTRODUCTION

JG Afrika (Pty) Ltd were appointed by Greenmined Environmental Consulting (Pty) Ltd to undertake a series of hydrological specialist studies for the proposed Naaz Quarry located near Pietermaritzburg in KwaZulu-Natal. The proposed quarry site falls within Portion 0 (Remaining Extent) of the farm Thandisizwe No. 16691 in the uMshwathi Local Municipality. The hydrological specialist studies are required as part of a Water Use Licence Application (WULA) for the quarry, based on the requirements of the National Water Act (Act 36 of 1998), and include a baseline hydrological and impact assessment, floodline and a Stormwater Management Plan (SWMP). The following report presents methodologies applied and results obtained for the specialist floodline and SWMP studies.

The floodline analysis is based on the 1:50 and 1:100-year flood events and is based on the drainage line located adjacent to the eastern boundary of the property. The floodline delineation has been undertaken in line with the requirements of General Notice (GN 509) of the National Water Act (Act 36 of 1998). The floodline study is based on present day conditions. The process of floodline delineations includes initially calculating the 1:50 and 1:100-year return period peak discharge values, and thereafter hydraulically simulating the peak discharge value along the watercourses of interest. A typical floodline investigation requires detailed spatial information in the form of cross-sectional survey data and/or detailed contour information to produce accurate floodline delineations. Unfortunately, no detailed spatial information was available for this study. Therefore, freely available contour data at a resolution of five metres (5 m) was sourced from the Chief Surveyor General, Department of Land Affairs. This data was used to undertake the hydraulic modelling using HEC-RAS to simulate the 1:50 and 1:100-year design floods. The floodlines produced in this study are, thus, as accurate as the available spatial data applied in this study. The resultant floodlines delineated in this study are sufficient for planning and/or WULA purposes, but not for detailed design purposes.

The SWMP was developed in line with the requirements of General Notice (GN) 704 of the National Water Act (Act 36 of 1998) as outlined in the Department of Water and Sanitation (DWS), Best Practice Guidelines (BPGs) - A1 (2006).

A short description of the study area, analysis methodology, data used, and recommendations for stormwater management are summarised in the following report.

1.1 Declaration of Independence

It should be noted that JG Afrika have been appointed to undertake independent floodline and SWMP studies for the proposed Naaz Quarry. JG Afrika have undertaken this study in an objective manner, even if this results in views and findings that are not favourable to the Applicant or Client. JG Afrika have the expertise required to undertake the necessary studies and the resultant report presents the results in an objective manner. The main author of the report, Ms Jédine Govender is a qualified Hydrologist at JG Afrika with an MSc. in Hydrology. Ms Govender has undertaken this study under the guidance of Mr. Phillip Hull, who is an Associate and Senior Hydrologist at JG Afrika, has an MSc. in Hydrology, is professionally registered and has 14 years of relevant project experience.

2 SITE DESCRIPTION

2.1 Locality

The location of the proposed Naaz Quarry is presented in **Figure 2-1**. As depicted in this map, the study area is located approximately 10 km north east from the Pietermaritzburg city centre, within Portion 0 (Remaining Extent) of the farm Thandisizwe No. 16691 in the uMshwathi Local Municipality in KwaZulu-Natal. A site plan, of the proposed quarry is provided in **Figure 2-2**. As depicted in **Figure 2-2**, a small drainage line is located along the eastern boundary of the quarry site and is the focal area for the floodline analysis. This drainage line is a tributary of an unnamed non-perennial stream, which flows to the uMngeni River, located approximately 9.3 km downstream of the project site.

Hydrologically, the study area is located in the Mvoti to Umzimkhulu Water Management Area (WMA No. 11), in the U20G quaternary catchment. The study catchment Mean Annual Precipitation (MAP) is 895 mm and the Mean Annual Evaporation (MAE) is 1 200 mm. The land uses within the study catchment were identified using Google Earth aerial imagery and classed according to the South African National Landcover Database (NLC, 2018) which predominantly consisted of commercial agriculture (sugarcane) and to a lesser degree, grasslands.

2.2 Site Description

As part of the study JG Afrika undertook a site visit of the project area. The objectives of this site visit were to assess topographical, soil and land cover characteristics of the study area as well as to identify and generate an understanding of the characteristics of the drainage line, banks and their associated potential floodplains. These site characteristics form the basis for understanding the hydrology and hydraulics of the project area. The landcover characteristics of the study catchments were digitised using Google Earth aerial imagery, which predominantly consisted of thicket and bushland followed by grasslands as presented in **Plate 2-1** and **Plate 2-2**.

It is also important to account for any hydraulic structures (i.e. bridges and culverts) likely to impact upon the floodline delineations. It was noted that there are no culverts or bridges in the vicinity of the project area.

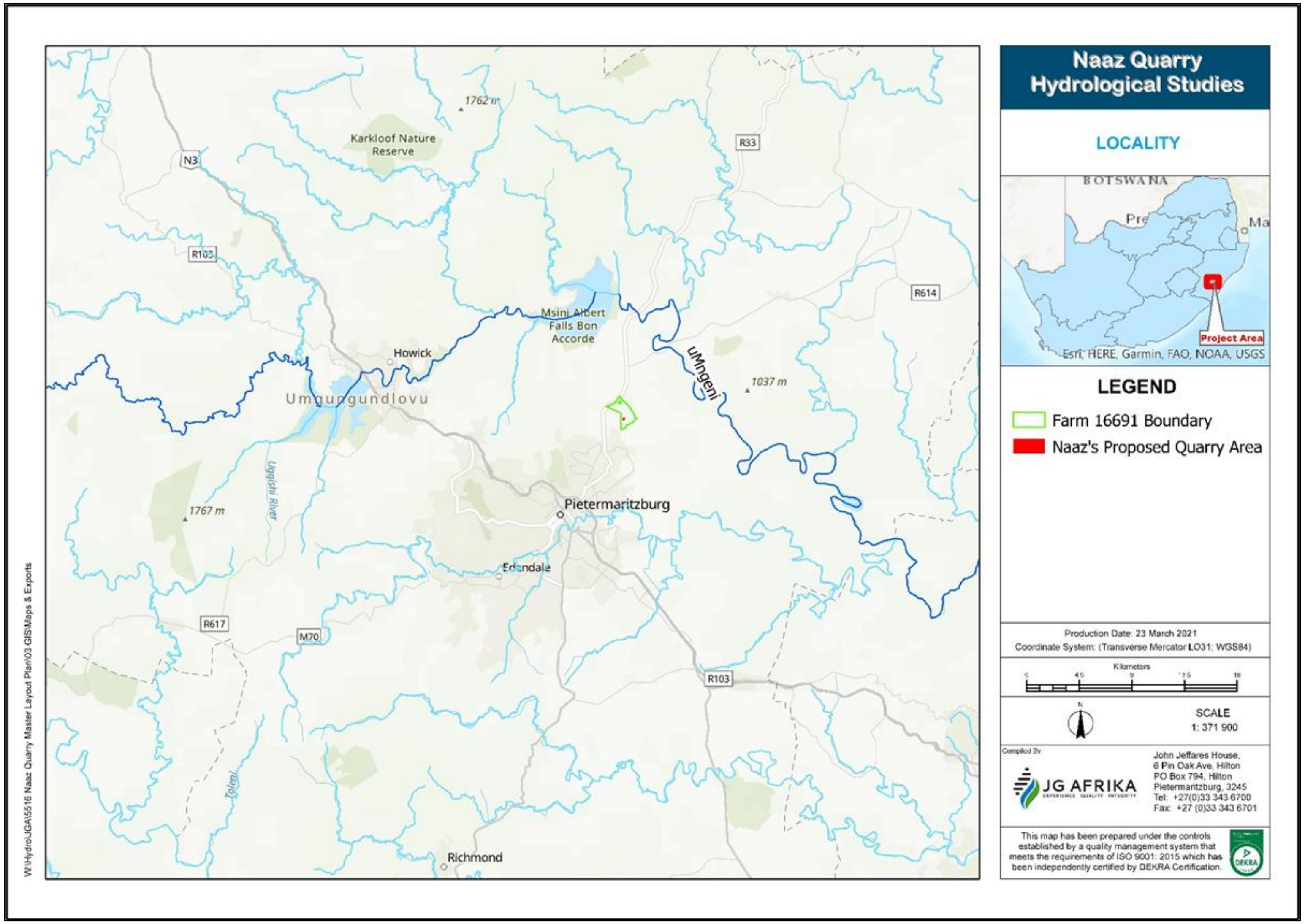

Figure 2-1 Naaz Quarry Locality Map

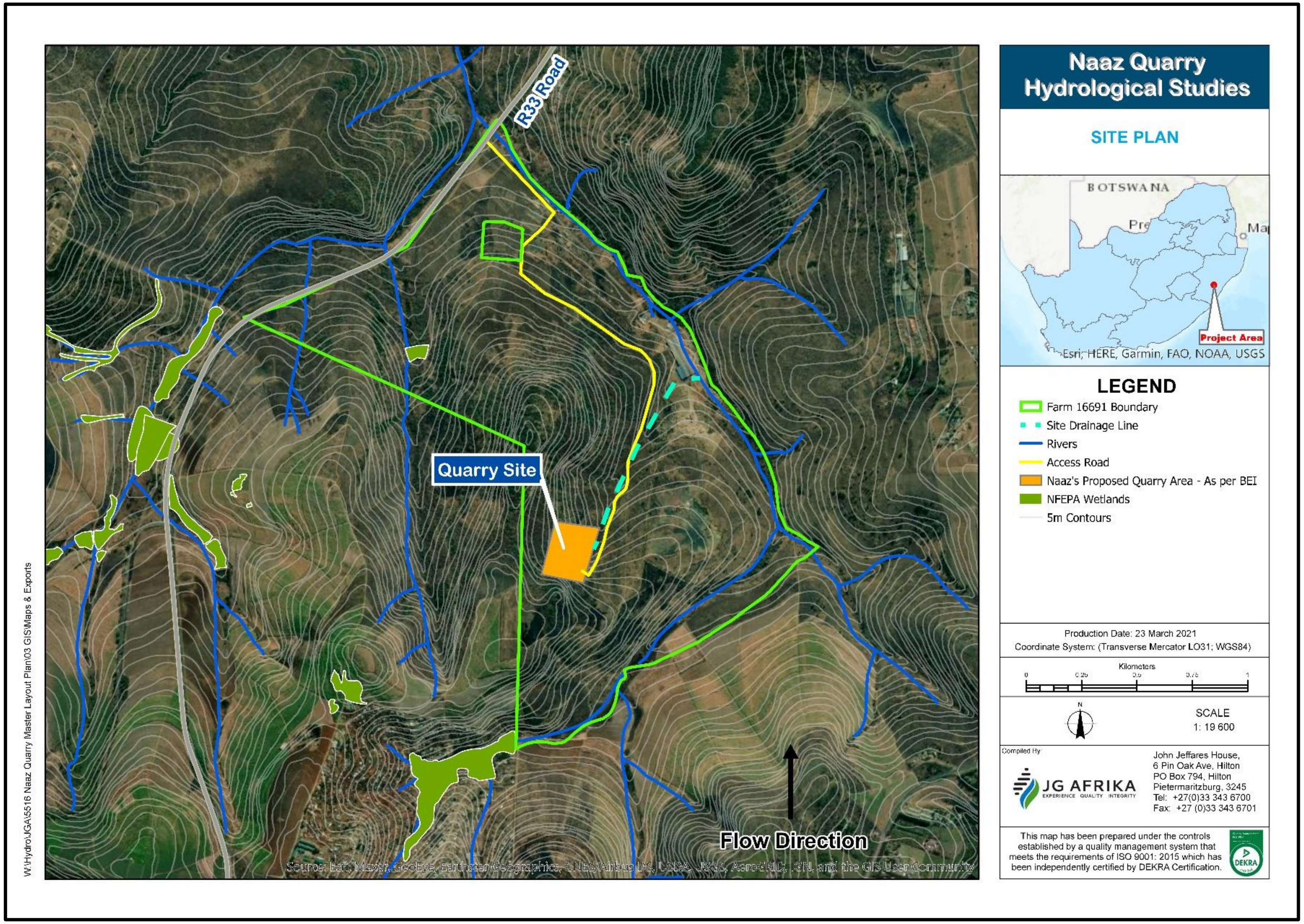

Figure 2-2 Naaz Quarry Site Plan

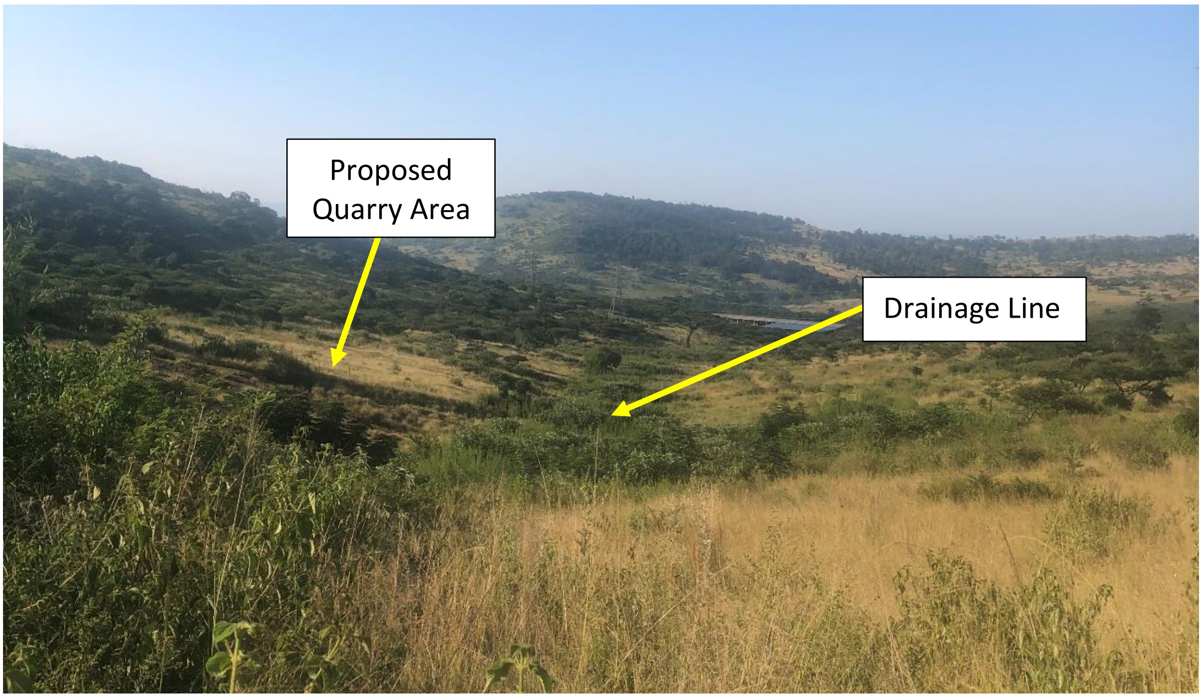

Plate 2- 1 General Depiction of the Study Site Land Cover Characteristics

Plate 2- 2 Start of the Identified Drainage Line

2.3 Proposed Naaz Quarry Mining Operations Description

The proposed Naaz Quarry operations will involve mining dolerite from one opencast pit on Portion 0 (Remaining Extent) of the farm Thandisizwe No 16691, using conventional drilling and blasting methods. The material will be removed by means of tipper trucks and relocated to a crushing plant to be screened to various sized stockpiles. The aggregate will be stockpiled until it is transported from the site. All mining related activities will be contained within the approved mining permit boundaries.

The proposed mining of dolerite will comprise of activities that can be categorised into three phases according to the Final Basic Assessment Report (2021):

1. Construction Phase – which will include demarcating the permitted mining area, vegetation removal, topsoil stripping and stockpiling, as well as the introduction of mining machinery and equipment onto site.
2. Operational Phase – which will involve the mining of dolerite from the permitted area using open cast mining methods. This will include blasting in order to loosen the hard rock. Thereafter, loosened material will be transported to the crushing and screening processing plant where it will be screen to various sized stockpiles before it is sold and transported from site to clients.
3. Decommissioning Phase – which includes the rehabilitation of the affected environment prior to the submission of a closure application to the Department of Mineral Resources and Energy (DMRE).

It has been noted, based on information provided by the Client, that infrastructure associated with the proposed quarry will be mobile. Therefore, for the purposes of this floodline and SWMP study, general locations of infrastructure have been provided. This is based on preliminary information from the Client and may change during the construction and/or operation phases of the project.

3 FLOODLINE DELINEATION

The methodology used to calculate the 1:50 and 1:~~100 year~~100-year design flood peak discharge values and the hydraulic model used to simulate the resultant floodlines are discussed in the following subsections.

3.1 Peak Discharge Calculation

The design flood peak discharge value (Q_p) for a site can be calculated using various methodologies. The appropriate methodology to be applied in calculating peak discharge values depends largely on the size of the contributing catchment and the level of hydrological data available (for example, gauged streamflow values and design rainfall data) for a particular catchment. The catchment area of the site drainage line is approximately 0.27 km^2. Based on the size of the catchment, and a lack of available gauged streamflow data, it was decided that the Rational Method is the most appropriate method to calculate the peak discharge values.

The Rational Method is widely used throughout the world for both rural and urban catchments (Alexander, 2001; Pilgrim and Cordery, 1993) and it is the most commonly used method of estimating design flood peak discharge values. The method is sensitive to design rainfall intensity and the selection of the runoff coefficient (C factor). The method assumes that the peak discharge occurs when the duration of the rainfall event is equal to the Time of Concentration (Tc), and that the rainfall intensity is distributed uniformly over the catchment. As a consequence of these assumptions, the Rational Method is best suited to catchments with areas of less than 100 km^2 (HRU, 1972). The final peak discharge values (Q_p) were derived from the Rational Equation (cf. **Equation 1**) and are presented in **Table 3-1**.

$$Q_p = 0.278(CIA) \qquad \textbf{Equation 1}$$

Where:

Q_p = peak flow (m^3/s)

C = run-off coefficient (dimensionless)

I = average rainfall intensity over catchment (mm/hour)

A = effective area of catchment (km^2)

Design rainfall is required as an input into the Rational Method for calculating design flood peak discharge values associated with various recurrence interval storm events (floods). Design rainfall for the study site was obtained from the Design Rainfall Estimation Program (Smithers and Schulze, 2003).

This Design Rainfall Estimation software calculates the design rainfall depths using a regionalised L-moment Algorithm and scale invariance at any 1′ × 1′ grid interval in South Africa. The design rainfall depths for the 1:50 and 1:100-year return period used in calculating the design peak discharge calculations are presented in **Table 3-1**.

Table 3-1 1:10, 1:50 and 1:100 Year Return Period Design Rainfall Values

Duration	1:10 Year Design Rainfall Depths (mm)	1:50 Year Design Rainfall Depths (mm)	1:100 Year Design Rainfall Depths (mm)
5 min	20.90	33.8	41.1
10 min	27.90	45.3	55.0
15 min	33.10	53.7	65.2
30 min	41.90	67.8	82.5
45 min	48.00	77.8	94.6
1 hour	52.90	85.8	104.3
1.5 hour	60.70	98.4	119.6
2 hour	66.90	108.5	131.8
4 hour	77.90	126.3	153.5
6 hour	85.20	138.1	167.8
8 hour	90.80	147.1	178.8
10 hour	95.30	154.5	187.7
12 hour	99.20	160.8	195.4
16 hour	105.70	171.3	208.2
20 hour	111.00	179.9	218.6
24 hour	115.50	187.3	227.6
2 day	124.40	201.6	245.1
3 day	143.10	231.8	281.8
4 day	154.60	250.6	304.5
5 day	164.20	266.1	323.4
6 day	172.50	279.5	339.7
7 day	179.80	291.4	354.1

Catchment C factors, required as an input into the Rational Method, are determined by accounting for a combination of catchment landcover types (Cv), soil types (Cp) and catchment slopes (Cs). The land uses of the contributing catchment areas were classed as rural. The land cover of the study catchments were identified using Google Earth aerial imagery and classed according to the South African National Landcover Database (NLC, 2018) which predominantly consisted of commercial agriculture (sugarcane) and to a lesser degree, grasslands.

The soils of the contributing catchments were classified predominantly as semi-permeable. The surface slopes for the catchment were estimated from a Digital Elevation Model (DEM), created from 5 m contour data of the project area. The surface slopes were classed according to the threshold slopes of < 3%, 3 – 10%, 10 – 30% and >30%. The majority of the study catchments had steep slopes resulting in a higher C-factor. The study site catchments C-Factor calculation inputs are presented in **Table 3-2**. A summary of the input variables used in the Rational Method and the resultant 1:50 and 1:100-year peak discharge values are presented in **Table 3-3**.

Table 3-2 Catchment C-Factor Calculation Inputs

Catchment Slope Distribution (%)				Catchment Soil Permeability Distribution (%)	Vegetation Distribution (%)		Final C-Factor Value
>3	0-10	10-30	> 30	Semi-Permeable	Light Bush	Grasslands	
3.44	28.01	61.31	7.24	100	20	80	0.49

Figure 3-1 Summary Inputs for Peak Discharge Calculation and Resultant Peak Discharge Values

Catchment	Site Drainage Line
Catchment Area (km^2)	0. 268
Longest Water Course (km)	0.76
Average Water Course Slope (m/m)	0.10
Time of Concentration (hours)	0.48
1:50 Point Rainfall Intensity (mm)	130.26
1:100 Point Rainfall Intensity (mm)	158.49
1:50 Catchment C-Factor	0.47
1:100 Catchment C-Factor	0.49
1:50 Year Peak Discharge (m^3/s)	**4.52**
1:100 Year Peak Discharge (m^3/s)	**5.79**

3.2 Hydraulic Simulations

The HEC-RAS Model (US Army Corp of Engineers) was used to undertake one-dimensional hydraulic modelling to determine the extent of the floodlines corresponding to the 1:50 and 1:100-year return periods. The following sections present inputs to the hydraulic model for simulation purposes.

3.2.1 Survey Data

The hydraulic modelling was based on freely available 5 m contour information. Accurate contour information is important for accurate floodline delineations., however more detailed survey information was not available. The reason for topographical information being so important is illustrated in Error! Reference source not found., which indicates that detail in the cross-sectional information can be lost due to coarse spatial information (red line). Detailed spatial information (purple line) represents the actual cross-sectional topography (blue line) far more accurately. Therefore, it is of the view of JG Afrika that the resultant floodlines, based on more detailed spatial information, would be more accurate. The 5 m contours were used to create a DEM of the study site, which in turn allowed for cross-sectional elevations and other topology to be extracted for the project area utilising RAS Mapper. This data was subsequently used for hydraulic modelling of the previously calculated peak discharge values.

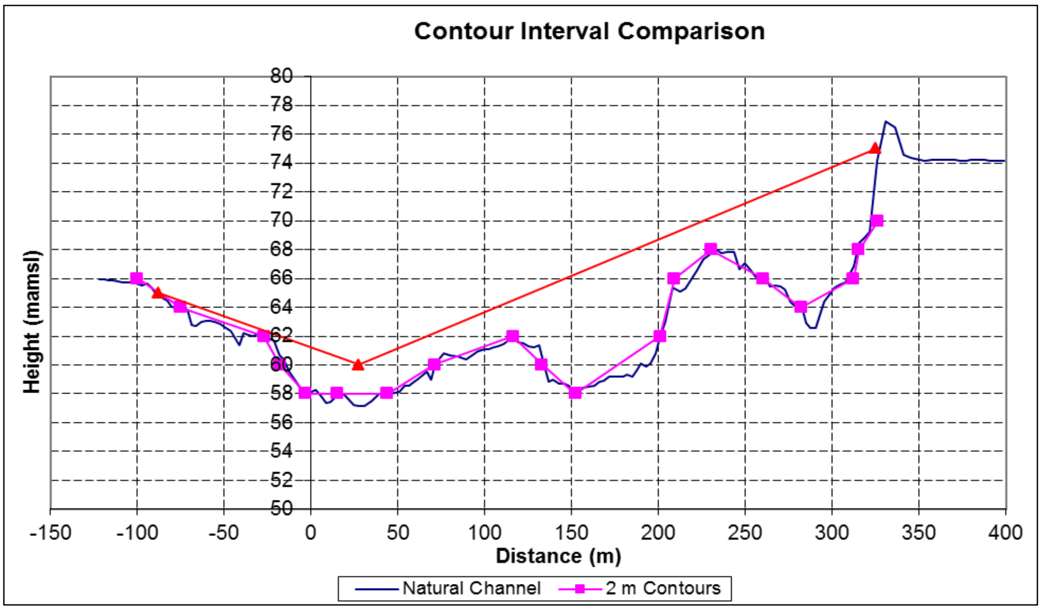

Figure 3-2 Illustration of Contour Information Representation (example)

3.2.2 Manning's Values

The roughness of the channel and floodplain surface needs to be accounted for within the hydraulic model. In this case, Manning's n values (Chow, 1959) were used to describe the surface roughness within HEC-RAS. The Manning's values were based on aerial imagery (Google Earth Imagery) of the project site as well as the site visit observations. **Table 3-3** presents the range of Manning's n values used to describe the roughness of the river channels and floodplains of each study catchment. There is a lot of homogeneity within the catchments with regards to the channel and floodplain roughness, and hence, the Manning's n values were similar.

Table 3-3 Manning's "n" Values Used in the Hydraulic Modelling (Chow, 1959)

Location	Manning's n	Description
Channels	0.050	Very weedy reaches, brush, dense grass
Floodplains	0.045	Medium to dense brush and trees

3.3 Floodline Delineation Results

Delineated floodlines for the drainage line adjacent to the proposed quarry property are presented in **Figure 3-3**. As presented in this map, it is likely that a portion of the project site will be inundated during both the 1:50 and 1:100-year flood events. It is noted that the floodlines presented in **Figure 3-3** start within the property area. Upstream of the delineated floodlines, it is expected that runoff will be in the form of sheet flow. It is only from the approximate area of where the floodlines have been delineated that sheet flow becomes defined flow, as runoff is more confined to the drainage line.

It should be noted that the simulations undertaken are for the pre-development conditions only. If a culvert were to be positioned as suggested in **Figure 3-3** this will have an impact on the flooding conditions experienced at the site. It may widen the floodline upstream of the culvert and reduce it on the downstream side.

It is also noted that the 1:50 and 1:100-year floodlines are delineated relatively close together. This is as a result of the coarse nature of the topographic information used in the simulations as the relatively steep nature of the project area.

It is recommended that all mining related infrastructure (including workshops, offices, and parking areas) are located outside of the delineated floodlines.

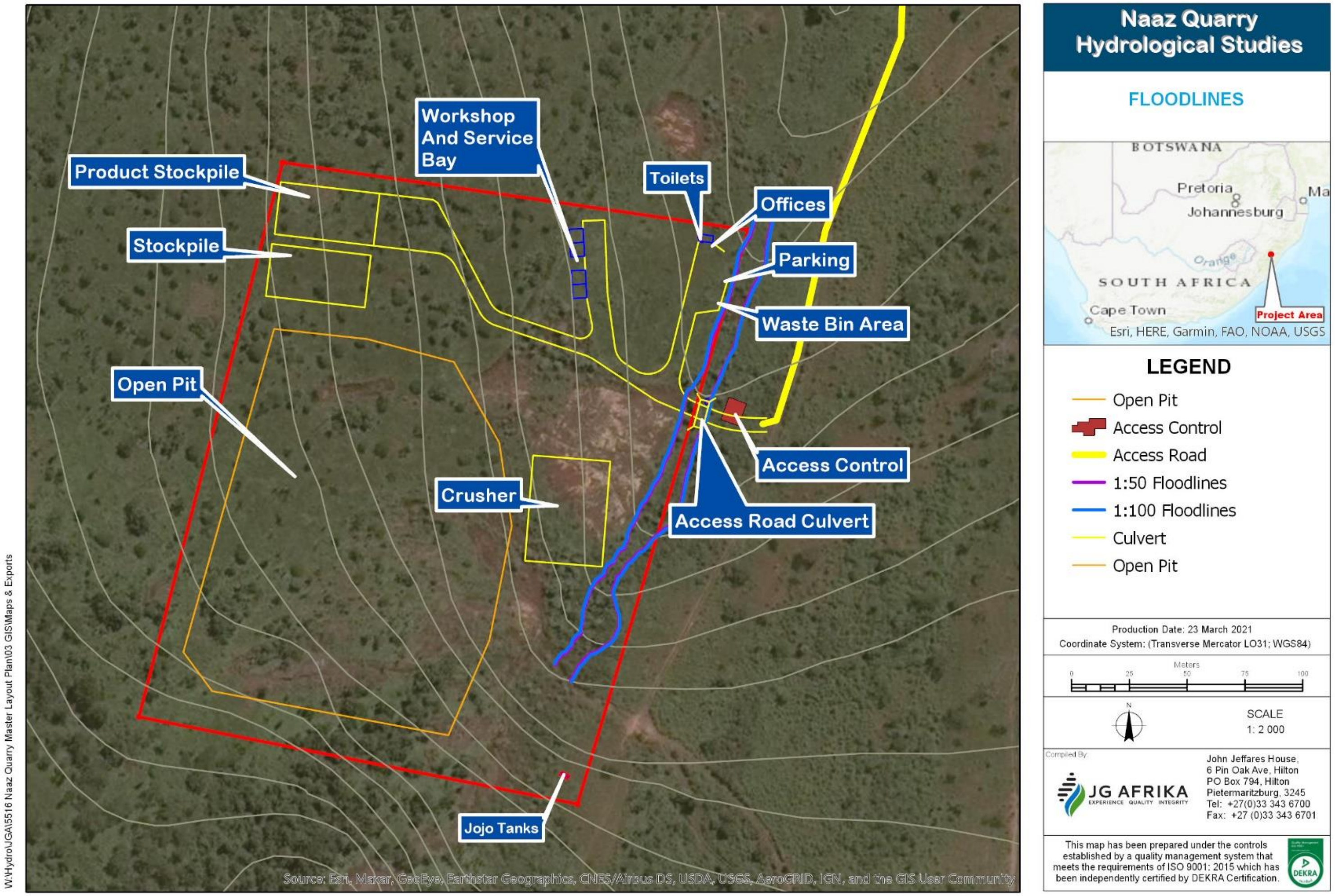

Figure 3-3 1:50 and 1:100 Year Floodlines for the Naaz Quarry Drainage Line

4 STORMWATER MANAGEMENT PLAN

An effective storm water management system is essential to ensure operations at the quarry are uninterrupted and to protect the downstream water resources and ecosystems. The main purpose of this SWMP is to ensure that the risk of polluting water resources downstream of the Naaz Quarry site is minimised. This entails the management of dirty water generated at the crusher plant, overburden stockpile areas, product stockpile and fuel and hydrocarbon stores.

The Department of Water and Sanitation (DWS) Best Practice Guidelines (BPGs)-A1 (2006), which were developed specifically for stormwater management in small-scale mining, was used as a basis for the development of this SWMP. These guidelines are based on the requirements of General Notice 704 (GN 704) of the National Water Act (Act 36 of 1998). The basic principles of a SWMP, which were followed in this study, are outlined below:

1. Clean water must be kept clean and be routed to a natural watercourse by a system separate from the dirty water system, while preventing, or minimising, the risk of spillage of clean water into dirty water systems.
2. Dirty water must be collected and contained in a system separate from the clean water system and the risk of spillage, or seepage, into clean water systems must be minimised.
3. The SWMP must be sustainable over the life cycle of the dirty areas, over different hydrological cycles and it must incorporate principles of risk management.
4. The statutory requirements of various regulatory agencies and the interests of stakeholders must be considered and incorporated.

The following SWMP has been divided into two parts, namely, that dealing with clean stormwater runoff and secondly that dealing with dirty stormwater management.

4.1 Clean Stormwater Runoff Management

As per principal one of the BPG - A1 (Small Scale Mining), clean stormwater runoff must be kept clean and be routed to a natural watercourse by a system separate from the dirty water system, while preventing or minimising the risk of mixing clean and dirty stormwater runoff. In order to accomplish this at the Naaz Quarry site, two clean water diversion berms are proposed, as presented in **Figure 4-1**. These include:

- Berm 1, which is proposed to divert clean stormwater runoff around the western and northern boundary of the project site; and
- Berm 2, which is proposed to divert clean stormwater runoff around the southern boundary of the project site.

In order to meet with statutory requirements, clean stormwater diversion infrastructure needs to be sized to accommodate the 1:50 year design flood event. The method used to calculate the 1:50 year peak discharge used to provide recommendations pertaining to the dimensions of the clean diversion berms was the Rational Method, as described in **Section 3.2**. Due to the size of the catchment areas, a minimum time of concentration of 15 minutes was used for all catchments.

In addition to the diversion berms, a culvert is also required along the access road to the project site. Due to the culvert not being associated with the diversion infrastructure, it is not required to be sized to convey the 1:50 year peak discharge rate. Instead, the culvert was sized based on the 1:10 year design flood peak discharge rate.

Catchment characteristics of areas contributing flow to the proposed stormwater diversion berms and proposed culvert, including catchment C Factors and resultant peak discharge values are presented in **Tables 4-1** and **Table 4-2**. Based on the calculated 1:50 year peak discharge values, dimensions of the proposed stormwater management infrastructure are presented in **Table 4-3** (diversion berms) and **4-4** (access road culvert) As presented in **Table 4-3**, significant flow velocities are expected along both of the diversion channels/berms. It is therefore recommended that erosion protection measures are implemented along the bed and walls of the channels. This may include rocks from the mining operations, imbedded along the channel bed and/or concrete lining along the respective channels. The lining mechanism should be confirmed during the detailed design phase of the project.

Table 4-1 Diversion Berms and Culvert Catchment Characteristics

Catchment	Catchment Area (km^2)	Stream Length (m)	Slope (m/m)	Time of Concentration (hrs)
Diversion Berm 1	0.16	0.35	0.17	0.25
Diversion Berm 2	0.07	0.44	0.15	0.25
Access Road Culvert	0.16	0.37	0.19	0.25

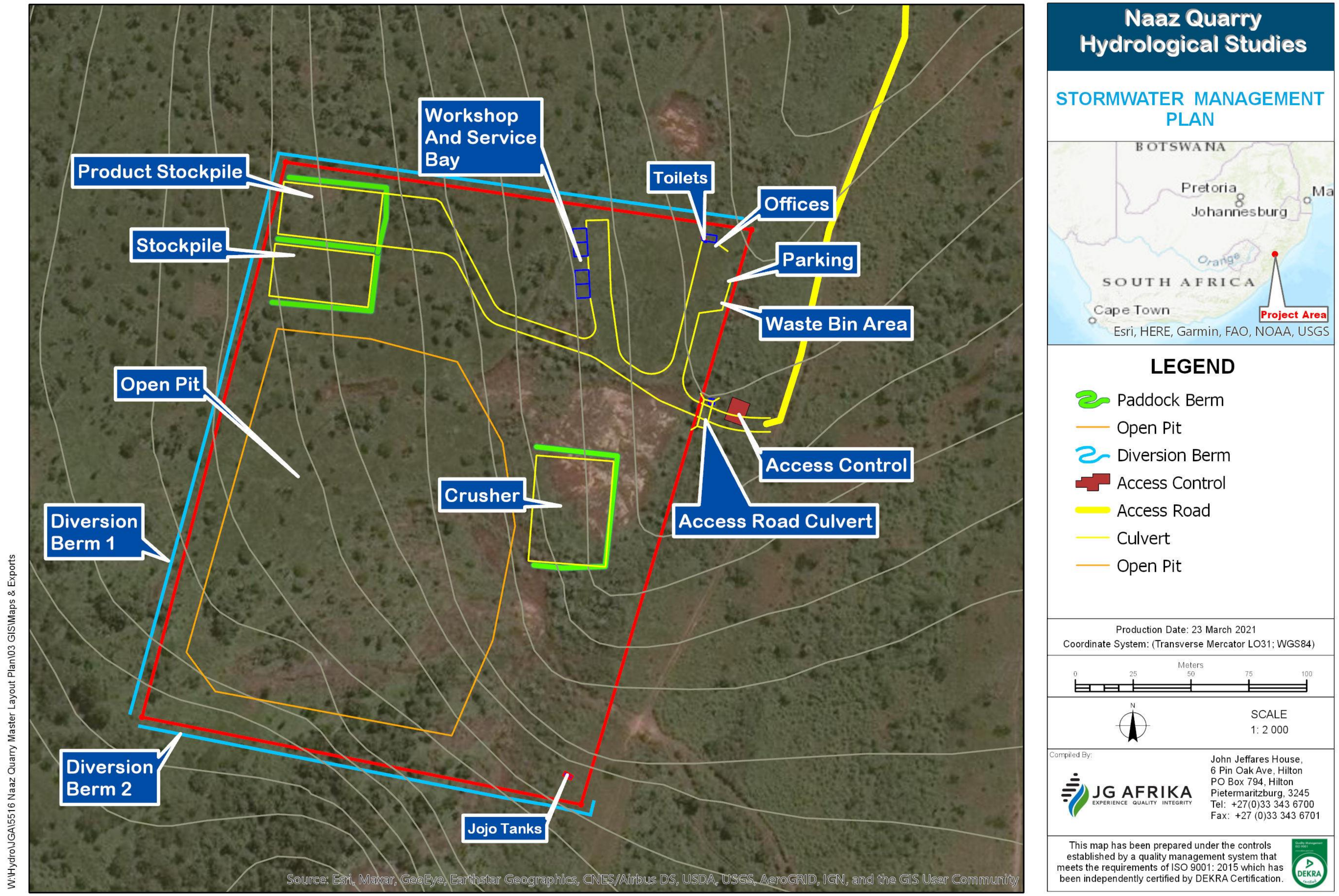

Figure 4-1 Naaz Quarry Proposed SWMP Infrastructure

Table 4-2 Clean Stormwater Management Infrastructure Peak Discharge Calculation Results

Channel Name	1:50 Year Average Rainfall Intensity (mm) (PI), Based on Tc of 15 minutes	Catchment C Factor	1:10 Year Peak Discharge (m^3/s)	1:50 Year Peak Discharge (m^3/s)
Diversion Berm 1	214.80	0.48	**Not Applicable**	**4.28**
Diversion Berm 2	214.80	0.51		**1.94**
Access Road Culvert	214.80	0.48	**2.40**	**Not Applicable**

Table 4-3 Proposed Clean Stormwater Diversion Berm Dimensions

Channel Name	Type*	Slope (m/m)**	Height/Depth (m)	Side Slopes of Channel	Flow Velocity (m/s)
Diversion Berm 1	V-Drain/ Embankment	0.08	**0.65**	**1:3**	**3.5**
Diversion Berm 2B	V-Drain/ Embankment	0.09	**0.50**	**1:3**	**2.9**

***** See design drawing in Annexure A***
*****Based on the lowest gradient along the channel***

Table 4-4 Proposed Clean Stormwater Diversion Berm Dimensions

Channel Name	Type*	Slope (m/m)**	Diameter (m)	Number of Pipes
Access Road Culvert	Concrete Pipe	0.01	**0.75**	**4**

***** See design drawing in Annexure A***
*****Based on the lowest gradient along the channel***

4.2 Dirty Stormwater Runoff Management

As per principle two of the BPGs - A1 (Small-Scale Mining), dirty water must be collected and contained in a system separate from the clean water system and the risk of spillage or seepage into the clean water systems must be minimised. In line with this, the main objectives of the dirty SWMP includes the following:

- Ensure all sources of hydrocarbon contamination are contained at the source of the pollutant. Hydrocarbons (oils and fuels) are considered hazardous to the downstream environment. Therefore, it is a requirement of GN704 that no hydrocarbons emanate from the project site into the downstream environment or infiltrate into the groundwater stores.

- Limit the volume of fine sediments discharging from quarry site and entering the downstream environment. Although sediments are not a hazardous pollutant, it is still considered detrimental to the downstream environment and therefore considered as dirty water.

As presented previously, the design philosophy of infrastructure associated with the quarry is that all infrastructure will be mobile. Therefore, recommendations towards dirty stormwater management presented in this report are mostly generic in nature. Once details around specific areas (such as the workshop and service bay for example) of the quarry have been confirmed (i.e. during detailed design), more detail pertaining to specific sizes of bunds and oil traps, specifically for hydrocarbon management, can be developed.

The following sections present recommendations towards prevention of the contamination of the downstream environment. This has been sub-divided into the management of areas containing hydrocarbons, and secondly, areas likely to be a source of sedimentation.

4.2.1 Management of Areas Containing Hydrocarbons

It is recommended that the following is considered for stormwater management around all areas likely to be a source of hydrocarbon contamination (i.e. the workshop, service bay, fuel and oil stores, waste disposal facilities and parking areas for Heavy Duty Vehicles):

- Areas used to store hydrocarbons and/or fuels should be concrete lined, bunded (wall constructed around the perimeter of the storage area) and roofed if possible. The capacity of the area within the bund walls should, at a minimum, have sufficient capacity to contain the volume of fuel or oil being stored within the bunded area. This will ensure that if the integrity of a storage container is compromised, there is sufficient storage capacity in the bunded area to ensure that there will be no spillage to the downstream environment.
- Workshop areas and service bays should be located on a concrete lined area and should be roofed. Due to the high likelihood of hydrocarbon spills associated with workshop areas, it is important to ensure that the risk of seepage of hydrocarbons into the ground is minimised. This will be achieved though concrete lining of the area. Further to this, though ensuring that these areas are located under roofed areas, the likelihood of rainfall and runoff mixing with hydrocarbons will also be minimised.
- Construction of an oil sump at the workshop and service bay area. It is good practice to have all areas from within the workshop and service bay area draining towards an oil sump. This will ensure the effective management of hydrocarbons in this area. Oil collected in the oil

sumps should be appropriately disposed of through pre-approved service providers that are able to deal with discarded hydrocarbons.

- Diversion channels should be constructed around the workshop and service bay areas, if required. This will ensure that these areas are not flooded though stormwater runoff from upstream of the respective facilities.
- It is recommended that drip trays are placed under each of the mining vehicles at the end of each day. This will ensure that any leaks from the vehicles will be captured on the drip trays and not directly onto open ground.

4.2.2 Management of Areas Likely to be a Source of Sedimentation

An effective means of management of sediments associated with quarry sites, is the construction of permeable berms downstream of areas likely to be a source of sediments. The berms are constructed from fine aggregate from the crushing plant. The rock aggregate berms allow water to filter through the berm, and through this process capture sediments on the upstream side of the berm. The advantage of permeable berms is that they are able to be implemented and relocated as the dynamics of quarry (location of stockpiles for example) change over time. As presented in **Figure 4-1**, three berms have been proposed to be constructed for the Naaz Quarry. These include:

- Paddock Berm 1, which is proposed to control and collect dirty stormwater runoff from the Crusher area;
- Paddock Berm 2, which is proposed to control and collect dirty stormwater runoff from the Stockpile area; and
- Paddock Berm 3, which is proposed to control and collect dirty stormwater runoff from the Product Stockpile area.

Although there are no specific requirements on the dimension of the berms (apart from the fact that they should be effective in trapping sediment), it is recommended that a minimum berm height of 0.5 m is used for all of the above-mentioned areas.

5 CONCLUSION

JG Afrika (Pty) Ltd were appointed by Greenmined Environmental to undertake a SWMP and Floodline analysis for the proposed Naaz Quarry, located near Pietermaritzburg in KwaZulu-Natal. The proposed quarry site falls within Portion 0 (Remaining Extent) of the farm Thandisizwe No. 16691 in the uMshwathi Local Municipality. These hydrological specialist studies form part of a WULA for the quarry, based on the requirements of the National Water Act (Act 36 of 1998).

The floodline analysis was undertaken for the 1:50 and 1:100-year flood events and was based on a drainage line located adjacent to the eastern boundary of the proposed mining area. The floodline delineation was been undertaken in line with the requirements of General Notice (GN 509) of the National Water Act (Act 36 of 1998). The floodline study was based on present day conditions.

In order to undertake floodline delineations, initially the 1:50 and 1:100-year return period peak discharge values were estimated using the Rational Method. Peak discharge rates of approximately 4.5 m^3/s and 5.8 m^3/s for the 1:50 and 1:100-year flood events respectively were estimated. Based on this, the peak discharge rates were hydraulically simulated using the HEC-RAS Model. A typical floodline investigation requires detailed spatial information in the form of cross-sectional survey data and/or detailed contour information to produce accurate floodline delineations. Unfortunately, no detailed spatial information was available for this study. Therefore, freely available contour data at a resolution of five metres (5 m) was sourced from the Chief Surveyor General, Department of Land Affairs. This data was used to undertake the hydraulic modelling to simulate the flood water extents associated with the 1:50 and 1:100-year design floods. The floodline analysis results indicated that portions of the quarry site are inundated during both the 1:50 and 1:100-year flood events. It was therefore recommended that all infrastructure associated with the proposed quarry is located outside of the delineated floodlines.

The SWMP was developed in line with the requirements of General Notice (GN) 704 of the National Water Act (Act 36 of 1998) as outlined in the Department of Water and Sanitation (DWS), Best Practice Guidelines (BPGs) - A1 (2006). The objective of this study was to develop a conceptual stormwater management plan for Naaz Quarry. As per principal one of the DWS, BGPs - A1, clean stormwater runoff must be kept clean and be routed to a natural watercourse by a system separate from the dirty water system, while preventing or minimising the risk of mixing clean and dirty stormwater runoff. Based on this principle two clean stormwater runoff diversion berms were recommended. Each of the berms were sized based on the 1:50 year storm event. Based on the hydraulic analysis used to size the proposed diversion berms, it was noted that flow velocities associated with the berms were high. It was therefore recommended that erosion protection measures are implement along the proposed diversion berms. The specific means of erosion protection should be confirmed during detailed design. However, this could include the lining of the channels with concrete or rock discard embedded in the channel bed.

In order to ensure that the integrity of the downstream environment is not compromised through the operation of the proposed quarry, several recommendations towards the management of areas containing hydrocarbons and sources of fine sediment were provided. Management of areas containing hydrocarbons predominantly included the following:

- Areas used to store hydrocarbons and/or fuels should be concrete lined, bunded (wall constructed around the perimeter of the storage area) and roofed if possible. The capacity of the area within the bund walls should, at a minimum, have sufficient capacity to contain the volume of fuel or oil being stored within the bunded area.
- Workshop areas and service bays should be located on a concrete lined area and should be roofed.
- An oil sump should be constructed at the workshop and service bay area. Further to this, oil collected in the oil sumps should be appropriately disposed of through pre-approved service providers that are capable of dealing with discarded hydrocarbons.
- Diversion channels should be constructed around the workshop and service bay areas, if required (depending on the final location of the workshop and service bay areas).
- Drip trays should be placed under each of the mining heavy duty vehicles at the end of each day.

In order to ensure fine sediments from stockpile and crusher areas are effectively managed, it was recommended that permeable berms are constructed downstream of areas likely to be a source of sediments. The berms should be constructed from fine aggregate from the crushing plant. In theory, rock aggregate berms allow water to filter through the berm while capturing sediments on the upstream side of the berm.

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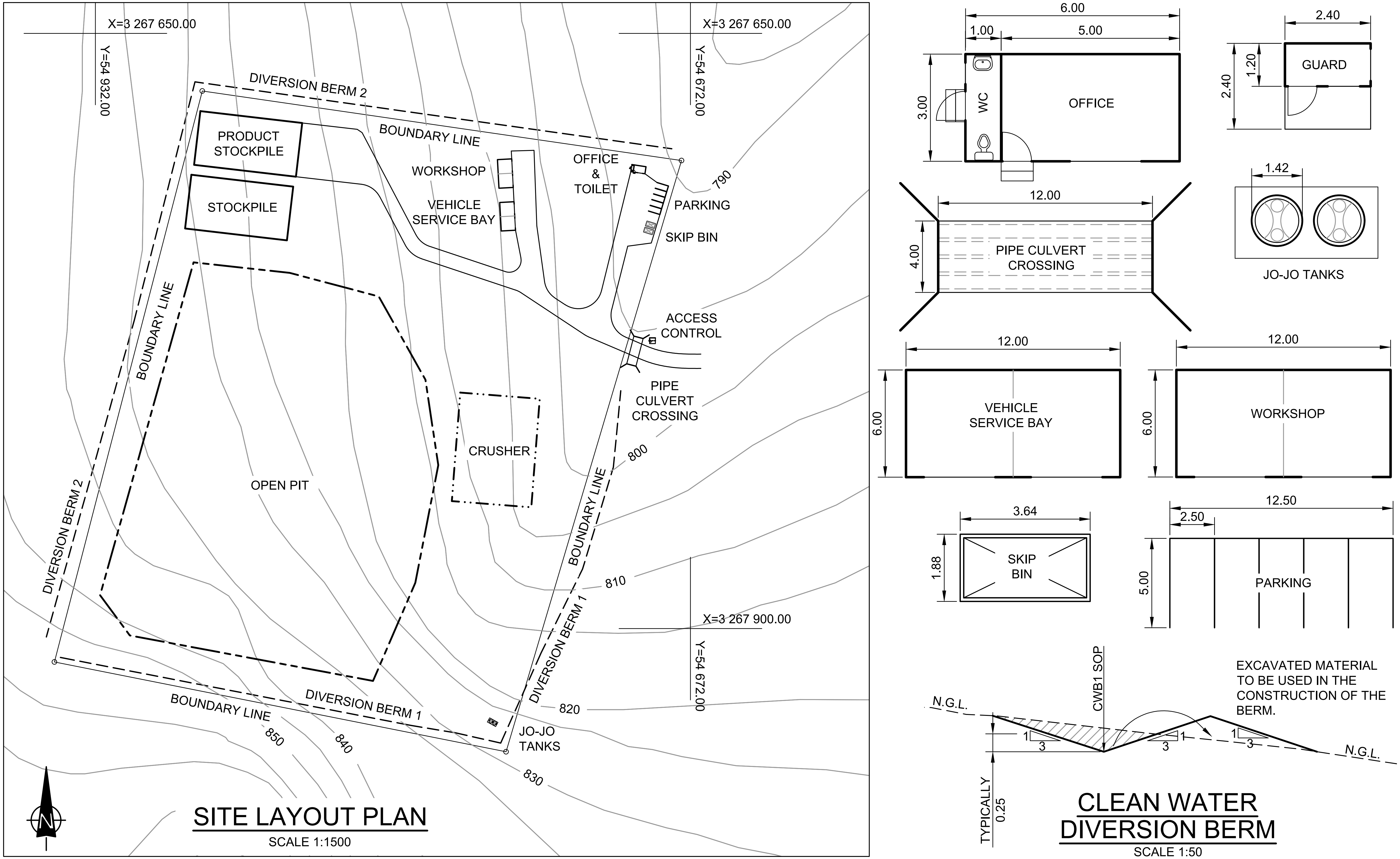
Annexure A

Stormwater Management Infrastructure Preliminary Design Drawing



DESIGNED	P.HULL	DRAWN	P.PELSER
CHECKED	P.HULL	CHECKED	P.HULL

REV	NATURE OF REVISION	DATE	SIGNED
0	ISSUED FOR APPROVAL	01-04-21	

DESIGN APPROVED:
JG AFRIKA (Pty) Ltd
S. JANGALI 01-04-2021
NAME DATE

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CLIENT
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PROJECT
NAAZ QUARRY
HYDROLOGICAL STUDIES

DRAWING TITLE
INFRASTRUCTURE LAYOUT

ISSUED FOR APPROVAL

SHEET 1 OF 1	SCALE: SCALE (2.5mm)	SIZE: A3

CLIENT DRAWING No.

JG AFRIKA (Pty) Ltd. DRAWING No: 5516-HYD-01
REVISION: 0