TSWANA QUARRY

STORMWATER MANAGEMENT PLAN

August 2022
REVISION 01

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SYNOPSIS

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

KEY WORDS:

Tswana 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 ISO9001: 2008 which has been independently certified by DEKRA Certification under certificate number 90906882

Verification	Capacity	Name	Signature	Date
By Author	Hydrologist	Nkosinathi Dlamini	[signature]	August 2022
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TSWANA QUARRY
STORMWATER MANAGEMENT PLAN

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1 INTRODUCTION

JG Afrika (Pty) Ltd were appointed by Lafarge Industries South Africa (Pty) Ltd to undertake a stormwater management plan (SWMP) and General Notice 704 (GN704) audit for the Lafarge Tswana Quarry, located in the North West Province, in the year 2019. Subsequent to that study, JG Afrika have been appointed to update the stormwater management plan for the purposes of a Water Use Licence Application (WULA), and provide engineering drawings of stormwater infrastructure proposed during the initial study. The following stormwater management plan is therefore largely based on the findings of the General Notice 704 and stormwater management plan study undertaken in 2019.

Lafarge is committed to legal compliance in terms of environmental management and the philosophy of zero harm to the environment. This commitment is echoed in their Safety, Health and Environment (SHE) Policy, Lafarge values and corporate targets. To achieve full compliance, especially with regards to GN704 of the Water Act (NWA) (Act 36 of 1998), Lafarge has committed to the compilation of a comprehensive stormwater management plan.

Section 26 (1) of the NWA (Act No. 36 of 1998) provides for the development of regulations that:

- Require that the use of incoming and discharging water from a water resource be monitored, measured and recorded;
- Regulate or prohibit any activity in order to protect a water resource or in-stream or riparian habitat;
- Prescribe the outcome or effect that must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or deposited into or allowed to enter a water resource.

GN704 (Government Gazette 20118, 4 June 1999) was drawn up to address these issues in relation to mining activities. A summary of the principal conditions from GN704, upon which the proposed SWMP is based, includes:

- **Condition 4, which describes the location of infrastructure and mining activities.** Any residue deposit, dam, reservoir, together with any associated structure must not be located within the 1:100-year floodline or within 100m of any watercourse or borehole;
- **Condition 6, which deals with capacity requirements of clean and dirty water systems.** Clean and dirty water systems must be kept separate and must be designed, constructed, maintained and operated such that these systems do not spill into each other more than once in 50 years; and

- **Condition 7, which describes the measures which must be taken to protect water resources.** All dirty water or substances which cause or are likely to cause pollution of a water resource either through natural surface flow or by seepage must be contained.

As indicated above, Condition 6 of the Regulation requires containment of clean and dirty water systems so they cannot spill into each other more than once in 50 years. To assist in planning and efficient design, this condition has been interpreted (Department of Water and Sanitation [DWS], Best Practice Guidelines - A1 [2006]) as requiring the capacity for containment of a 1:50 year storm event, over and above mean operating levels.

1.1 Declaration of Independence

JG Afrika were appointed to undertake an independent SWMP study for the Tswana 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 study and the resultant report presents the results in an objective manner. The main author of the report, N. Dlamini, is hydrologist at JG Afrika and has an MSc. in Hydrology. Mr. Dlamini has undertaken the SWMP study under the guidance of Mr. Phillip Hull, who is an Executive Associate and Senior Hydrologist at JG Afrika, has an MSc. in Hydrology, is professionally registered and has an excess of 14 years of relevant project experience.

2 SITE DESCRIPTION

2.1 Locality

The location of the Tswana Quarry is presented in **Figure 2-1**. As depicted in this map, the quarry is located approximately 37 km northwest from Lichtenburg town, within the Ditsobotla Local Municipality of the North West Province. A site plan of the project site presenting the Tswana Quarry and Polfonteinspruit River are provided in **Figure 2-2**. As depicted in **Figure 2-1**, the Polfonteinspruit River flows adjacent to the northern boundary of the Tswana Quarry and drains into the Lotlhakane river, which eventually drains into the Molopo River.

Hydrologically, the study area is located in Quaternary Catchment D41A, within the Lower Vaal Water Management Area (WMA No. 10). The Mean Annual Precipitation (MAP) of the study area is 601 mm and the Mean Annual Evaporation (MAE) of the study area is 1 952 mm, as per the Water Resources of South Africa 2012 (WR2012) study. The land uses within the local catchment area were identified using Google Earth aerial imagery and classed according to the South African National Landcover Database (NLC, 2018) which predominantly consisted of agriculture followed by formal and informal residential areas and grasslands and thickets.

2.2 Tswana Quarry Operations Description

It is JG Afrika's understanding that the Tswana Quarry operations involve mining limestone rock from opencast pits using conventional drilling and blasting methods. The topsoil and overburden are removed by means of trucks and relocated to an area near the open pit. The mined limestone material is loaded onto haul trucks by excavators and transported to the primary crusher. Following the crushing process, the materials are transported to the Lafarge Cement Plant via railway.

2.3 Site Assessment

JG Afrika conducted a site assessment of the Tswana Quarry in May of the year 2019. The objective of this site assessments was to undertake an SWMP Audit (in terms of the requirements of GN704) and to gain an understanding of the current state of stormwater management at the respective sites. This included recording the size and location of stormwater management infrastructure.

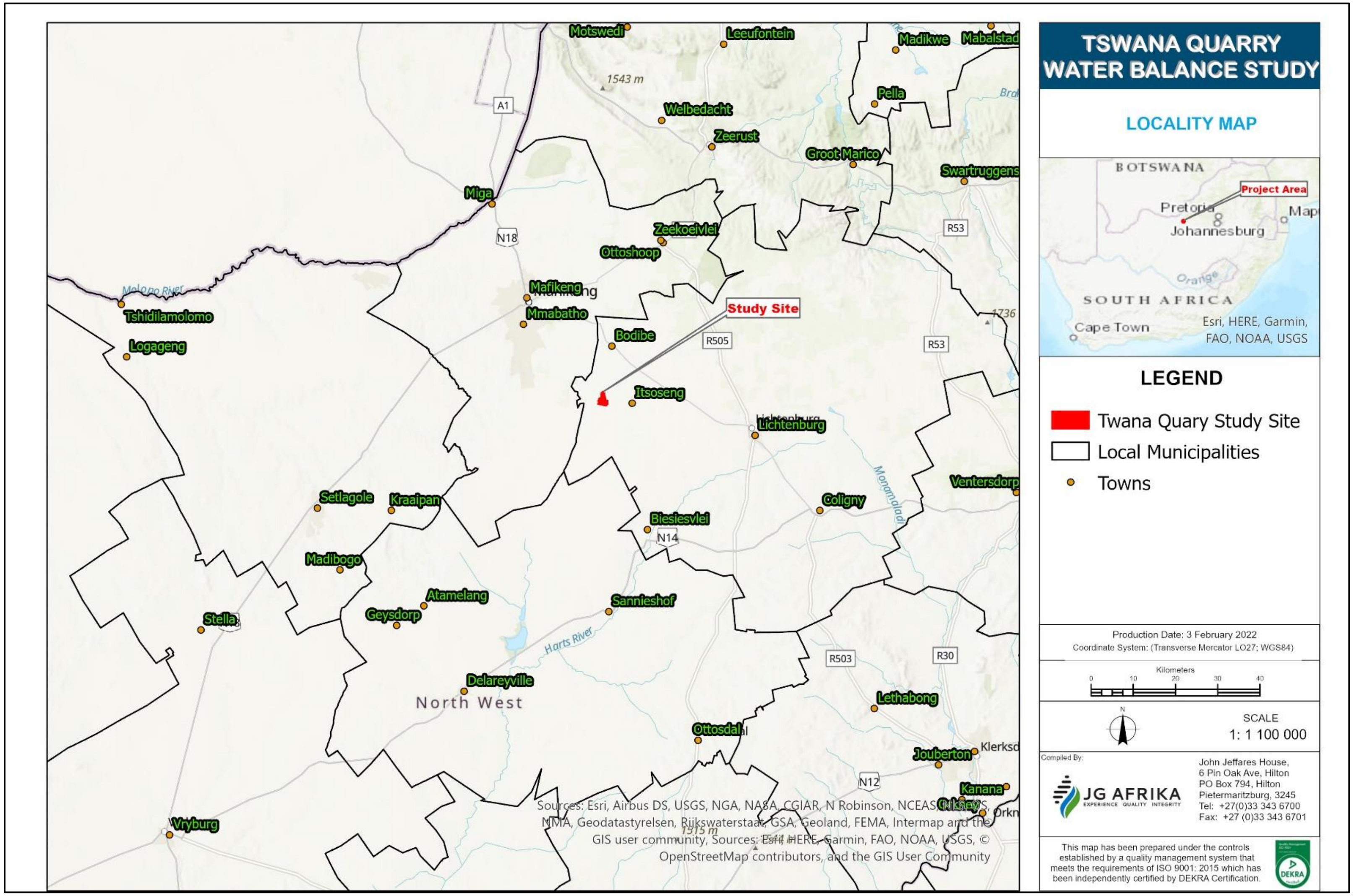

Figure 2-1 Tswana Quarry Locality Map

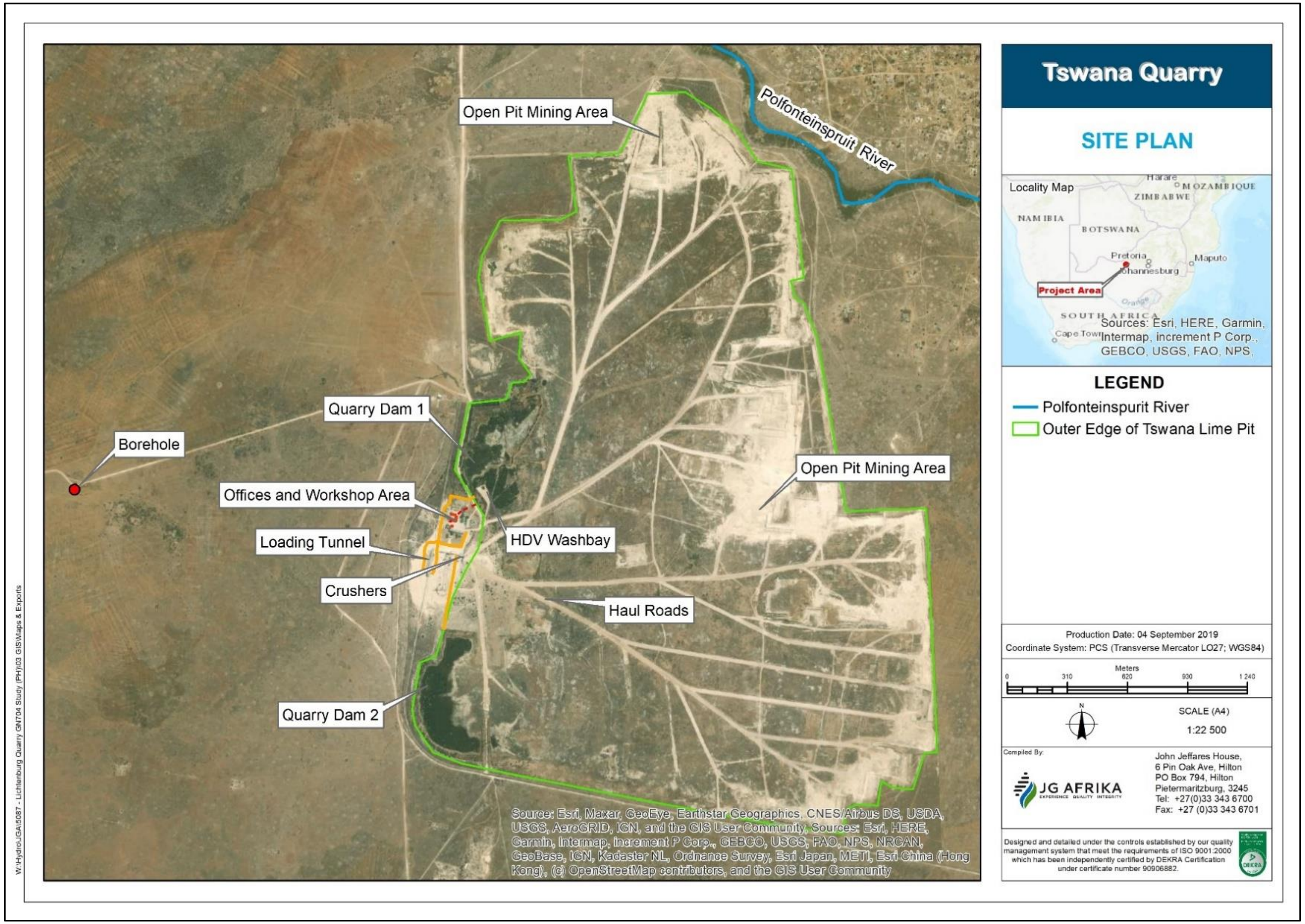

Figure 2-2 Tswana Quarry Site Plan

3 STORM WATER MANAGEMENT PLAN METHODOLOGY

An effective storm water management system is essential to ensure operations at the quarry are uninterrupted and to protect the downstream water resources. As presented previously, the main objective of the SWMP is to ensure that the risk of polluting water resources downstream of the Tswana Quarry site are minimised. This entails the management of dirty water generated at the crusher, stockpile areas, overburden stockpile areas and fuel and hydrocarbon stores.

The 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 the SWMP. These guidelines are based on the requirements of GN704. 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.

In order for the SWMP to be compliant with statutory requirements, the sizing of the stormwater management infrastructure was assessed based on the 1:50 year return period storm event. For this purpose, the Rational Method was used to calculate peak discharge values, used in the sizing of the stormwater infrastructure (i.e. diversion berms and channels), while the Soil Conservation Service – South Africa (SCS-SA) method was used to size the proposed pollution control dam at the Lafarge Cement Plant. One of the main inputs in Deterministic Methods for peak discharge calculations (such as the Rational and SCS-SA Methods) is design rainfall. The following section presents the design rainfall values used in this study.

3.1 Design Rainfall

Design rainfall for the 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 software returned similar design rainfall values at both sites. The design rainfall depths for various durations, used in the calculation of the 1:50 year return period design flood peaks, are presented in **Table 3-1**.

Table 3-1 1:50 Year Return Period Design Rainfall Values

Duration	1:50 Year Design Rainfall Depths (mm)
5 min	20.3
10 min	30.2
15 min	38.0
30 min	48.2
45 min	55.3
1 hour	61.0
1.5 hour	70.0
2 hour	77.2
4 hour	90.2
6 hour	98.8
8 hour	105.4
10 hour	110.9
12 hour	115.5
16 hour	123.2
20 hour	129.6
24 hour	135.0
2 day	138.1
3 day	155.8
4 day	169.0
5 day	180.0
6 day	189.5
7 day	198.0

3.2 Rational Method Description

The Rational Method is widely used throughout the world for both small rural and urban catchments (Alexander, 2001; Pilgrim and Cordery, 1993) and is the most widely used method of estimating design flood peak discharge values. The peak flow equation is based on a runoff coefficient (C), average rainfall intensity (I) and the effective area of the catchment (A).

The Rational formula is defined as:

$$Q = 0.278(CIA) \quad \textbf{Equation 1}$$

Where:

Q	=	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)

The Rational formula has the following assumptions:

- The rainfall has a uniform spatial distribution across the total contributing catchment;
- The rainfall has a uniform time distribution for at least a duration equal to the time of concentration;
- The peak discharge occurs when the total catchment contributes to the flow occurring at the end of the critical storm duration, or time of concentration;
- C remains constant for the storm duration, or the time of concentration; and
- The return period of the peak flow, T, is the same as that of the corresponding rainfall intensity.

Catchment C Factors, required as input into the Rational Method, are determined by accounting for a combination of catchment landcover types (C_v), soils (C_p) and slope (C_s). Catchment C Factors applied to each respective catchment area is provided in **Section 4**.

4 GN704 AUDIT AND CONCEPTUAL STORMWATER MANAGEMENT PLAN

The following chapter has been subdivided into two main sections, presenting the results of the GN704 audit and conceptual SWMP for the Tswana Quarry. As presented previously, all recommendations pertaining to the size and capacity of stormwater infrastructure has been based on the 1:50 year design flood. The method used to calculate the 1:50 year peak discharge values was the Rational Method, as described in **Section 3.2**.

The Tswana Quarry site is characterised by a very flat topography, particularly in the area of the crushers, offices and workshop. This has resulted in flooding/pooling of stormwater runoff in a number of areas. Due to the low flow velocities associated with flat channels, sediment deposition in stormwater channels is an issue identified at the site.

Tswana Quarry – GN704 Assessment

As mentioned previously, a site assessment of the quarry focusing on aspects of GN704 was undertaken in May 2019. It was noted during the site assessment that sources of hydrocarbon contamination are generally contained in the immediate vicinity of the potential source of contamination (i.e. the diesel tank is bunded, there are oil separators to separate out hydrocarbons from water emanating from the service bay, the workshop area is roofed and any sources of hydrocarbons in this area are bunded), as depicted in **Plate 4-1**. Two oil separators were identified during the site assessment. These included the oil separator located adjacent to the Service Bay, and the one located to the north east of the Workshop Area. Stormwater emanating from the Workshop Area (and therefore through the oil separator) reports to the Quarry Sump 1 located to the northeast of the workshop area, as depicted in **Figure 4-1**. It was noted that the vehicle Wash Bay is located within the Quarry pit, therefore water used for washing purposes is recycled through the sump. The Tswana Quarry pit and associated four sumps are endorheic (there are no surface water discharge points). During the site assessment, no signs of hydrocarbon contamination were noted in the vicinity of the wash bay or along the banks of the quarry sumps.

The main concern from a GN704 requirement perspective relates to the capacity of the stormwater management infrastructure, particularly considering the issues surrounding sedimentation of the stormwater channels. In order to reduce the likelihood of flooding/pooling of water in areas associated with the quarry (i.e. the crusher area) it is recommended that regular maintenance (which includes excavation of sediment) of the stormwater infrastructure is implemented. It was also noted that there were a number of areas where sediment build-up had occurred due to spillages from conveyor belts or similar (as depicted in **Plate 4-2**). It is recommended that these areas are cleared prior to the sediment being eroded and deposited in the stormwater channels.

Plate 4-1 Examples of Appropriate Hydrocarbon Management at the Tswana Quarry Site

Plate 4-2 Examples of Areas Where Sediment Deposition May Impact Upon Stormwater Management

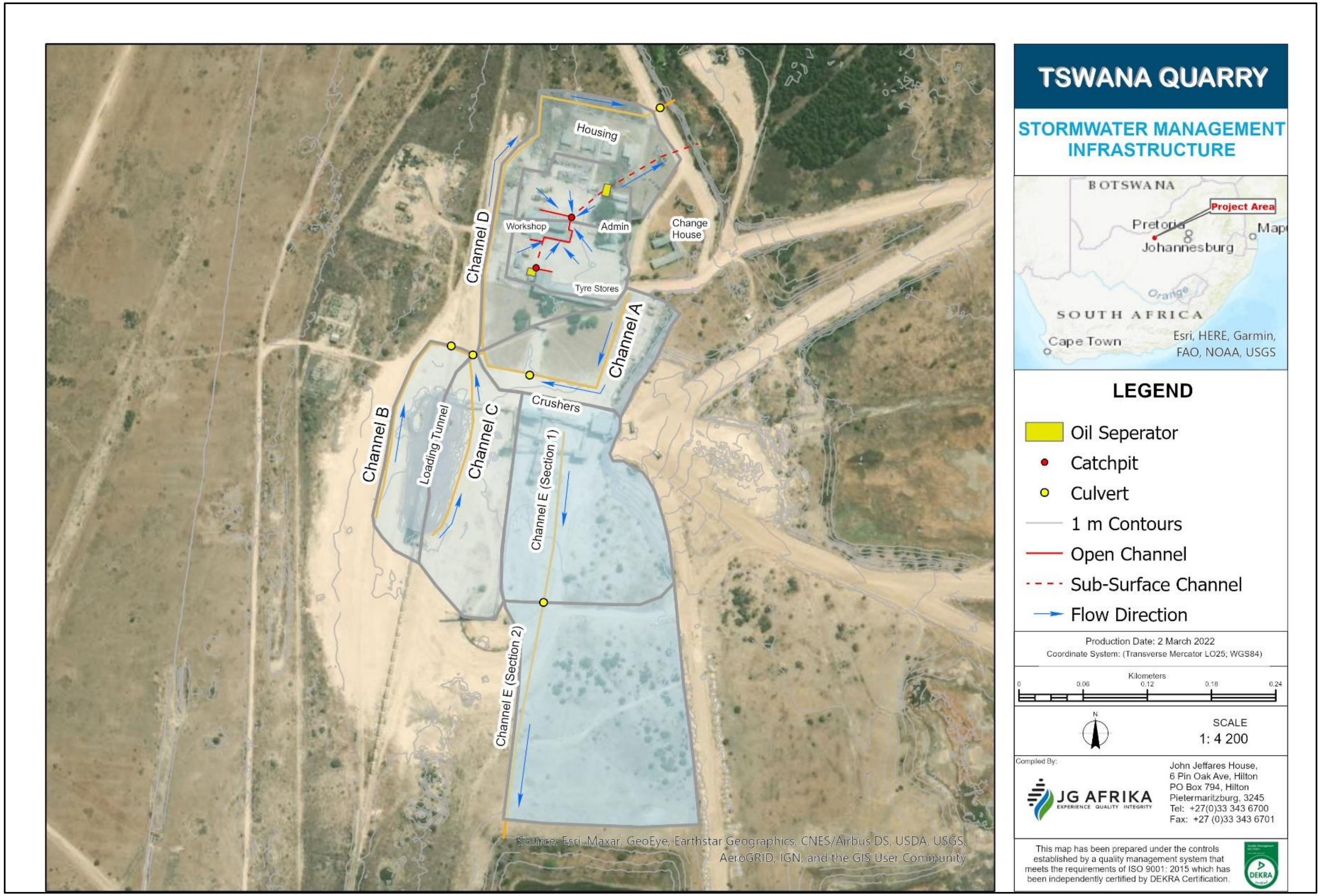

Figure 4-1 Tswana Quarry Stormwater Management Infrastructure

Tswana Quarry – SWMP Assessment

It should be noted, based on the recommendations provided in this report, preliminary level designs of proposed stormwater channels have been detailed in an engineering design report (*5707 - Lichtenburg Lafarge Cement Plant and Tswana Quarry Stormwater Infrastructure and Pollution Control Dams Preliminary Design Report*). Engineering Drawings of the proposed stormwater infrastructure are also included in **Annexure A**.

As part of the stormwater management assessment, the location and dimensions of stormwater management infrastructure were documented. The identified stormwater channels associated with the Tswana Quarry are presented in **Figure 4-1**. Due to the extremely flat nature of the project site, no clean stormwater diversion requirements were identified during the site assessment. The current stormwater channels were mainly identified in the vicinity of the workshop area (as depicted by red lines in **Figure 4-1**).

A summary of the catchment characteristics contributing flows to each of the channels identified during the site assessment are presented in **Table 4-1**. Based on the calculated 1:50 year peak discharge values, a compliance assessment of the respective channels is presented in **Table 4-2**. If channels were found to be inadequate, recommended channel dimensions are presented in **Table 4-3**. The recommended culvert size for Channel D and Channel E (Section 1) is presented in **Table 4-4** and **Table 4-5**, respectively.

Table 4-1 Tswana Quarry Stormwater Channel Design Flood Calculation Results

Channel	Catchment Area (km^2)	Time of Concentration (hrs)	Catchment C Factor	1:50 Year Design Rainfall (mm)	1:50 Year Peak Discharge (m^3/s)
Channel A	0.0130	0.25	0.33	135	0.18
Channel B	0.0083	0.25	0.39	135	0.14
Channel C	0.0120	0.25	0.39	135	0.20
Channel D	0.0150	0.25	0.42	135	0.50
Channel E (Section 1)	0.024	0.25	0.43	135	0.42
Channel E (Section 2)	0.034	0.25	0.43	135	0.44
Workshop Area	0.007	0.25	0.50	135	0.13

Table 4-2 Tswana Quarry Stormwater Channel Size and Compliance Assessment

Channel	Shape	Top Width (m)	Bottom Width (m)	Depth (m)	Channel Capacity (m3/s)	Compliance
Workshop Area Channels	Rectangular	0.85	0.85	0.30	0.16	Compliant

Table 4-3 Tswana Quarry Recommended Stormwater Channel Dimensions

Channel	Shape	Channel Slope (m/m)	Top Width (m)	Bottom Width (m)	Depth (m)	Lining Material
Channel A	Trapezoidal	0.005	1.20	0.60	0.20	Concrete
Channel B	Trapezoidal	0.005	1.20	0.60	0.20	Concrete
Channel C	Trapezoidal	0.006	1.20	0.60	0.20	Concrete
Channel D	Trapezoidal	0.005	1.62	0.60	0.35	Concrete
Channel E (Section 1)	Trapezoidal	0.005	1.35	0.60	0.25	Concrete
Channel E (Section 2)	Trapezoidal	0.007	2.64	0.60	0.34	Earth

Table 4-4 Proposed culvert sizing

Culvert	Shape	Pipe Diameter (m)	Deck Height (m)	Number of Openings	Discharge Capacity (m^3/s)	Required Discharge (m^3/s)
Channel D	Pipe	0.525	0.60	2	0.54	0.50

Table 4-5 Proposed culvert sizing

Channel	Shape	Span (m)	Rise (m)	Pipe Diameter (m)	Deck Height (m)	Openings	Capacity (m^3/s)	Required Peak (m^3/s)
A	Box	0.60	0.30	-	0.06	1	0.20	0.18
B	Box	0.45	0.30	-	0.06	1	0.15	0.14
B + C	Box	0.45	0.30		0.09	3	0.45	0.43
D	Pipe	-	-	0.75	0.15	1	0.71	0.50
E (Section 1)	Box	0.45	0.30	-	0.09	3	0.45	0.42

5 CONCLUSION AND RECOMMENDATIONS

Based on a GN704 audit undertaken in 2019, the SWMP for the Lafarge Tswana Lime Quarry was updated for the purposes of a WULA for the quarry. In the GN704 study undertaken in 2019, it was noted that all sources of hydrocarbon contamination are contained in the immediate vicinity of the potential source of contamination (i.e. the diesel tank is bunded, there are oil separators to separate out hydrocarbons from water emanating from the service bay, the workshop area is roofed and any sources of hydrocarbons in this area are bunded). Therefore, the main focus of this study was on the stormwater management infrastructure at the quarry. In order to reduce the likelihood of flooding/pooling of water in areas associated with the quarry (i.e. the crusher area) several stormwater channels are recommended to be constructed. These channels were sized based on the 1:50 year design flood event, in accordance with GN704 requirements. In addition to the proposed stormwater infrastructure, it is recommended that regular maintenance (which includes excavation of sediment) of the stormwater infrastructure is implemented. The requirement for regular maintenance is largely as a result of the flat topography of the project site.

6 REFERENCES

Department of Water Affairs and Forestry. 2006. Best Practice Guideline A1 Storm Water Management.

DWAF. (1998). The South African National Water Act (36 of 1998). DWAF.

Government Notice No.704, 1999: Regulations on Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources, dated June 1999, under the National Water Act, 1998, (Act 36 of 1998).

Kunz, R (2004). Daily Rainfall Data Extraction Utility, Version 1.4.

Smithers, J.C., Schulze, R.E., 2003. Design rainfall and flood estimation in South Africa. WRC Report No. 1060/01/03, Water Research Commission, Pretoria, RSA.

ANNEXURE A – PRELIMINARY DESIGN DRAWINGS OF PROPOSED STORMWATER INFRASTRUCTURE