TSWANA QUARRY

BASELINE HYDROLOGY AND IMPACT ASSESSMENT

August 2022

REVISION 01

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SYNOPSIS

Specialist baseline hydrological study and impact assessment required as part of the Water Use Licence Application.

KEY WORDS:

Lichtenburg Lafarge, Tswana Quarry, National Water (Act 36 of 1998), Baseline Hydrology and Impact Assessment

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		August 2022
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1 INTRODUCTION

JG Afrika (Pty) Ltd were appointed by Lafarge Industries South Africa (Pty) Ltd to undertake a Baseline Hydrology and Impact Assessment for the Lafarge Tswana Quarry, located in the North West Province. The Tswana Quarry is located in Portion 0 of Driefontein Farm No 46 near Itsoseng. This hydrological specialist study is 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). The objectives of this baseline hydrological study are to:

- Describe the climatic, hydrological, landuse and topographical conditions of the study area by defining the general catchment conditions of the study site.
- Identify and delineate stream and river channels and their associated catchment areas in the vicinity of the quarry.
- Determine the Mean Annual Runoff (MAR) for the project area and any contributing catchments in the vicinity of the quarry.
- Undertake an impact assessment of the quarry, focusing on the potential risks associated with the site related specifically to local and regional hydrology. Using the impact assessment, mitigation measures have been provided to reduce the risks associated with the identified potential impacts.

1.1 Declaration of Independence

It should be noted that JG Afrika have been appointed to conduct an independent baseline and hydrological impact assessment for the Lafarge 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 necessary studies and the resultant report presents the results in an objective manner. The main author of the report, Ms Jédine Govender, is a professionally registered 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 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 tributary 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.

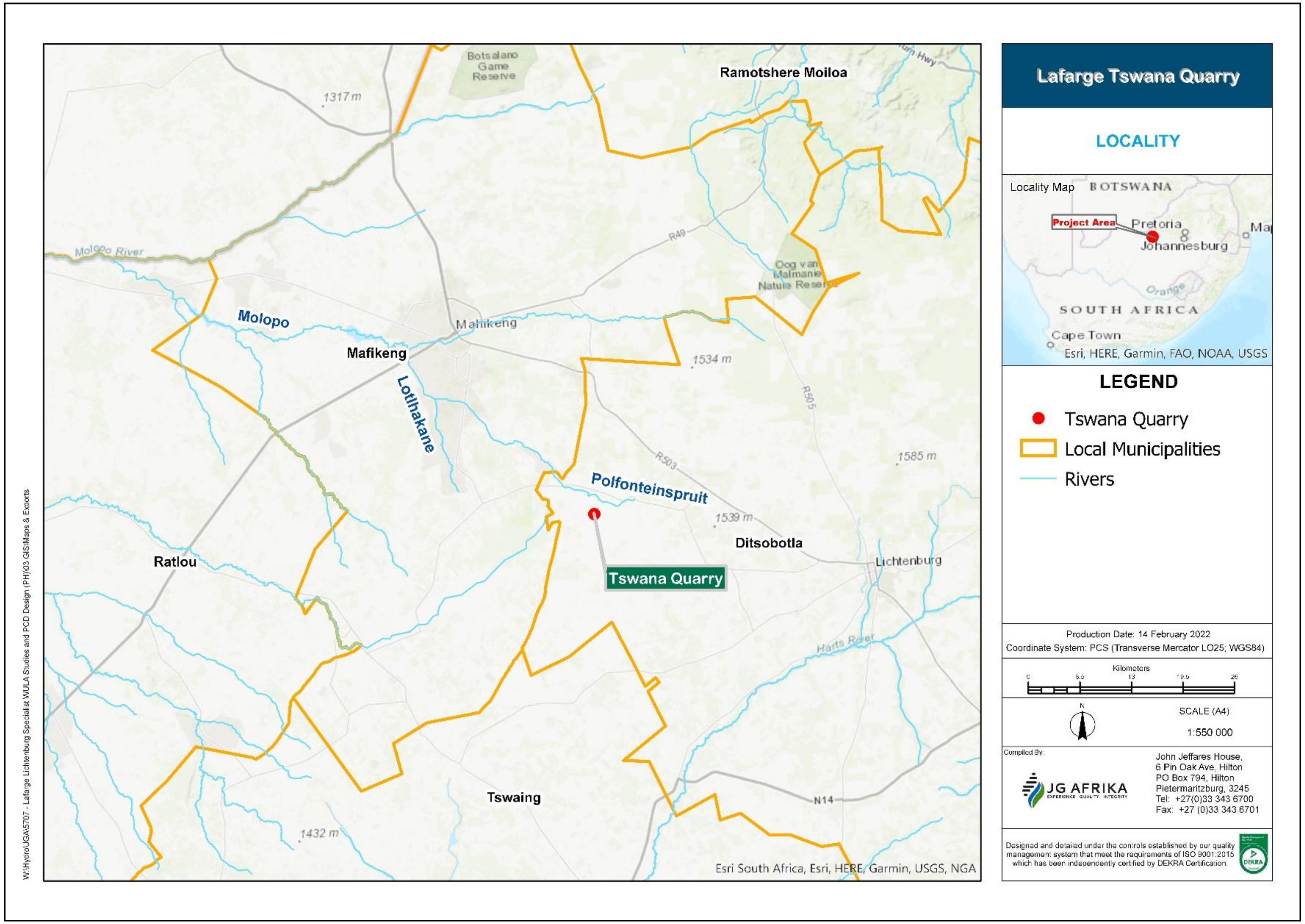

Figure 2-1 Tswana Quarry Locality Map

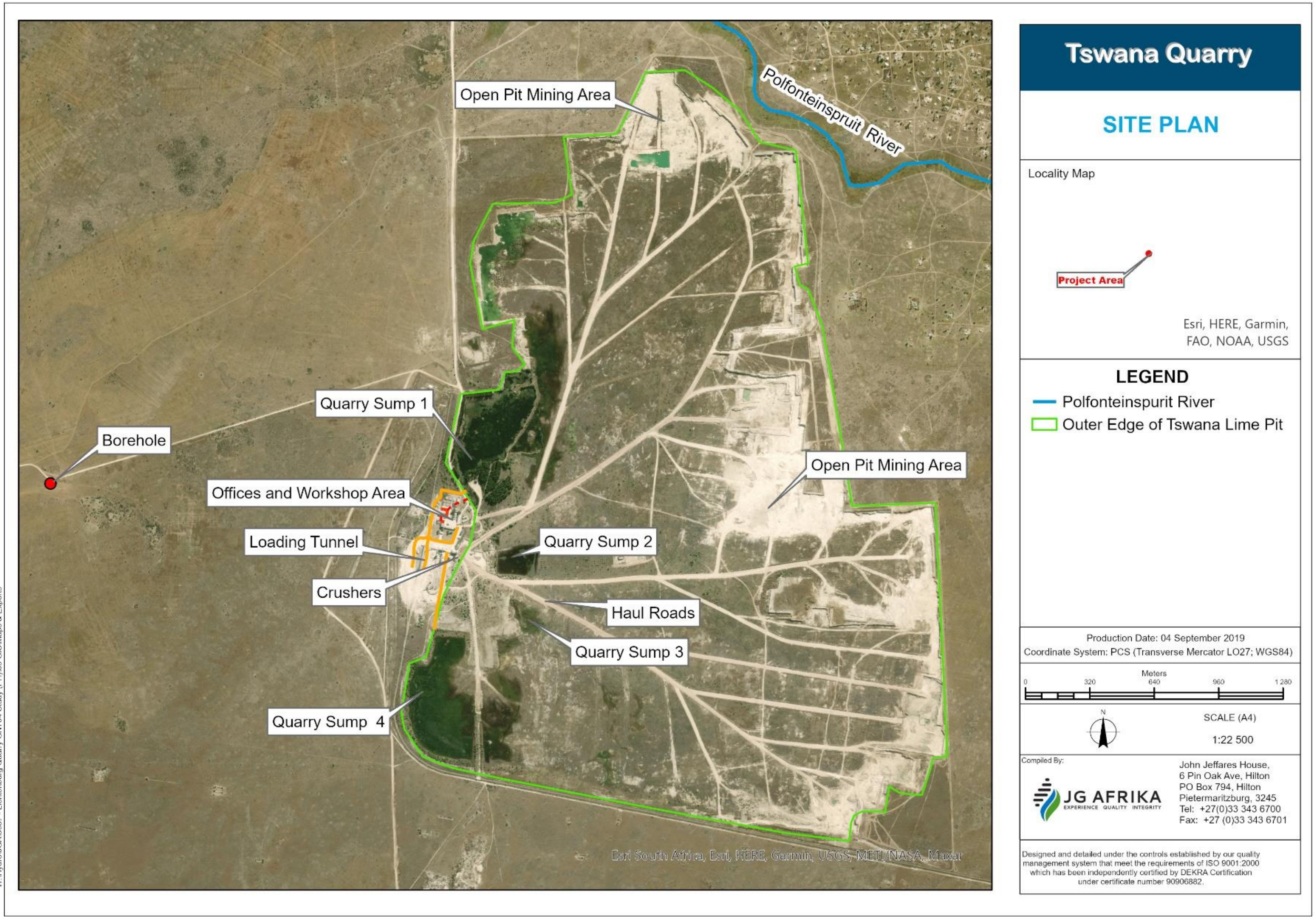

Figure 2-2 Tswana Quarry Site Plan

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 Climate Description

The Tswana Quarry lies within an arid to temperate climatic region (Köppen-Geiger Climate Classification Maps, 2018). Rainfall occurs mostly during the summer and the climate category can be described as dry and hot during the summer months and cold during the winter months.

Temperature data for the project area was obtained from the South African Weather Services (SAWS) meteorological station 0472280 A, as presented in **Table 2-1**. The monthly distribution of average daily maximum temperatures shows that the maximum temperatures range from 18.9°C in June to 28.7°C in January. The region is the coldest during June when the temperature drops to -0.4°C on average.

Table 2-1 Temperature Recorded for Years 1950 – 1999 at SAWS 0472280 A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temperature (°C)	22.2	21.6	20.0	16.7	12.8	9.3	9.4	12.2	16.7	19.3	21.0	21.8
Min. Temperature (°C)	15.7	15.1	13.2	8.7	3.7	-0.4	-0.3	2.5	7.6	11.4	13.6	15.1
Max. Temperature (°C)	28.7	28.0	26.8	24.6	22.0	18.9	19.2	21.9	25.7	27.3	28.4	28.4

2.3.1 Rainfall and Evaporation

Rainfall data for the project area was obtained from the SAWS rainfall station 0471490 W. This rainfall station is located approximately 14.8 km southwest of the project site and was selected based on its record period and the reliability of the historical rainfall data. The details of this rainfall station are presented in **Table 2-2**. The mean monthly rainfall amounts over the period 1950 to 1999 are presented in **Table 2-3**. From **Table 2-3**, it is evident that most of the rainfall falls over the summer period (September to March). It is also noted that low rainfall values are recorded over the winter months (April to October).

Table 2-2 Rainfall Station Details

Station Number	Station Name	MAP (mm)	Years Assessed	Reliability (%)	Longitude	Latitude
0471490 W	Lusthof	601	1950 - 1999	99.7	25^{0} 47'	26^{0} 9'59"

Table 2-3 Average Rainfall Depths Recorded for Years 1950 – 1999 at Rainfall Station 0471490 W

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAP
Rainfall Depth (mm)	117.6	90.0	82.1	54.1	20.3	6.5	5.1	5.5	14.5	47.6	73.8	83.9	601

There is a high degree of variation in the annual rainfall in the data obtained from rainfall station 0471490 W. The lowest recorded annual rainfall value over the assessed period is 224.6 mm, recorded in the year 1984. **Table 2-4,** which presents the 10 wettest years over the 1950 to 2000 period, indicates the wettest recorded year over this period was 1 099.2 mm in 1967.

Table 2-4 Ten Wettest Years Recorded for Period 1950 – 1999

Ranking	Year	MAP (mm)
1	1967	1099.2
2	1975	943.6
3	1976	890.1
4	1996	780.5
5	1977	762.8
6	1956	724.3
7	1997	720.3
8	1981	696.7
9	1973	680.1
10	1978	673.7

While rainfall is generally variable on a month-to-month basis, this is not the case with evaporation. Evaporative demands do not vary significantly from one year to next (i.e. evaporation in one October-month, for example, is similar to evaporation in the next October-month). Therefore, it is generally considered to be acceptable to apply 12 average monthly evaporation values over the year. The evaporation data used for the Lafarge Cement Plant was obtained from Evaporation Zone 8A (Middleton and Bailey, 2008). Catchment evapotranspiration is calculated by applying 12 monthly evapotranspiration conversion factors, as presented in **Table 2-5**. Similarly, evaporation losses from an exposed water body are calculated by applying 12 monthly lake evaporation conversion factors, as presented in **Table 2-5**. The annual potential evaporation rate for the area is 1 952 mm (WR, 2012). From **Table 2-5**, the highest evaporation rates occur during the hotter summer months of September to March.

Table 2-5 Lafarge Cement Plant Potential Evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Evaporation Rate (mm)	216	174	164	128	107	87	98	135	179	218	219	226	1 952
Lake Evaporation Factor	0.84	0.88	0.88	0.88	0.87	0.85	0.83	0.81	0.81	0.81	0.82	0.83	
Evapotranspiration Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.80	0.80	0.80	1.00	1.00	

2.3.2 Design Rainfall

The 24-hour design rainfall depths (point rainfall) for the 1:2, 1:10, 1:20, 1:50, 1:100 and 1:200 year recurrence intervals were extracted using the Design Rainfall Estimation Utility (Smithers and Schulze, 2003) and are shown in **Table 2-6**, below.

Table 2-6 24-hour Design Rainfall Depths

Duration (hr)	Rainfall Depth (mm)						
	1:2	1:5	1:10	1:20	1:50	1:100	1:200
24	61.9	84.2	99.5	114.7	134.7	150.3	166.2

2.4 Hydrology

As presented in **Figure 2-3**, the project site is located in the Molopo River Catchment within the Quaternary Catchment D41A of the Lower Vaal Water Management Area (WMA No. 10). Based on Department of Water and Sanitation (DWS) river coverages and 5 m contours, the Polfonteinspruit flows alongside the northern boundary of the Tswana Quarry and flows into the Lotlhakane tributary which drains into the Molopo River (*cf*. **Figure 2-3**). The Molopo River is located approximately 42 km downstream of the project site.

The catchment area of the Polfonteinspruit within the vicinity of the Tswana Quarry (as depicted in **Figure 2-3**), is approximately 33 km^2. For the purposes of this study, this is considered the local catchment area. Quaternary Catchment D41A (considered as the regional catchment for the purposes of this study), within which the quarry is located, has a catchment area of 4 322 km^2 and a Mean Annual Runoff (MAR) of 5.03 million cubic meters (MCM). Details of the Quaternary Catchment D41A, including its associated MAR volume and MAR depth are provided in **Table 2-7** (WR, 2012).

Table 2-7 Quaternary Catchment Details

Quaternary Catchment	Catchment Area (km^2)	Evaporation Zone	Rain Zone	Water Management Area	MAR (MCM)	MAR Depth (mm)
D41A	4 322	8A	D4A	10	5.03	1.16

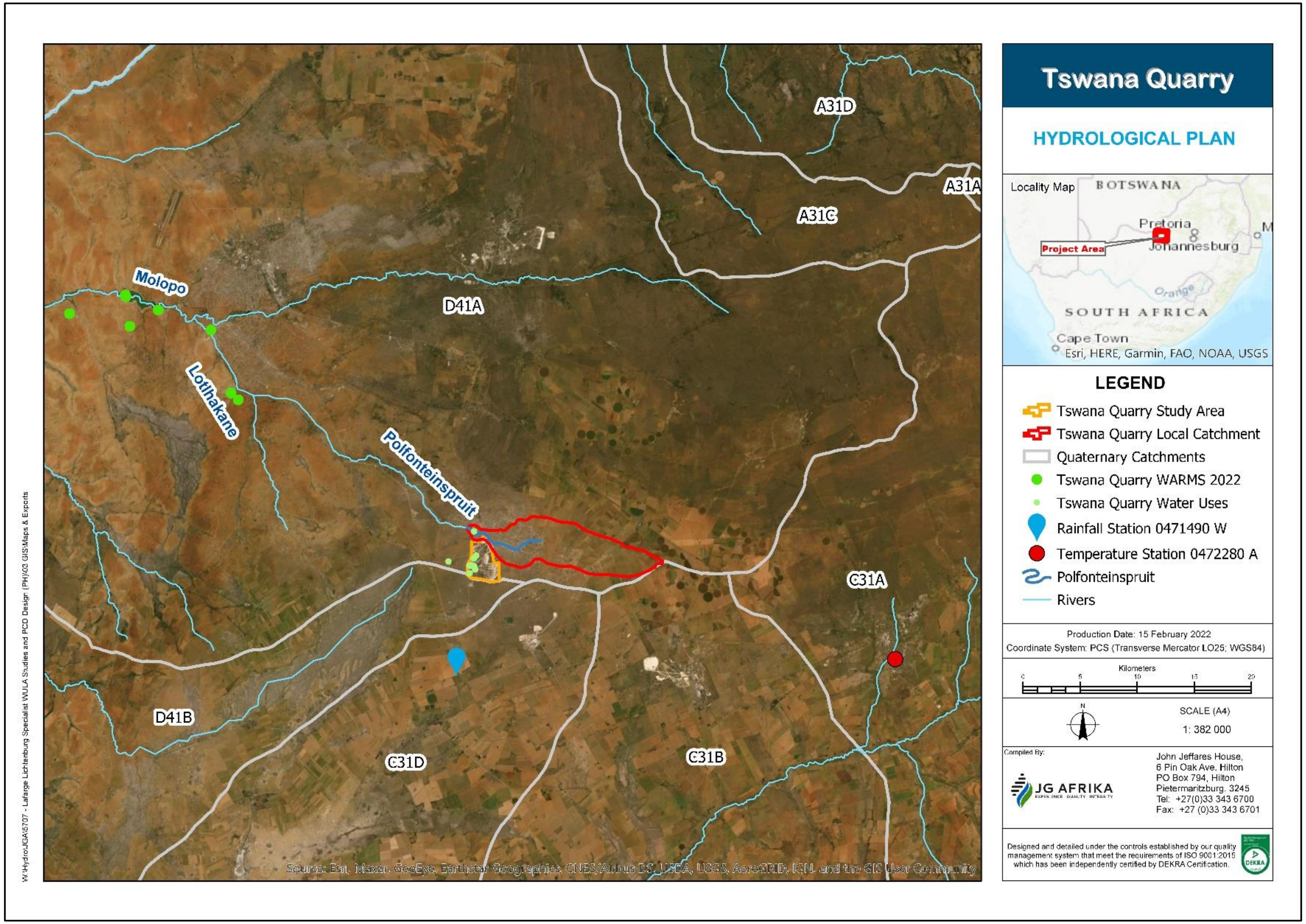

Figure 2-3 Hydrological Plan of the Tswana Quarry Site

3 HYDROLOGICAL IMPACT ASSESSMENT

3.1 Risk Assessment Methodology

In order to be compliant with statutory requirements, a hydrological impact assessment was undertaken as per the DWS Risk Assessment Matrix (2016).

The risk rating matrix methodology used is based on the following quantitative measures:

- The severity of each impact.
- The spatial extent or geographic sense of each impact occurring.
- Duration of occurrence.
- The frequency of each activity.
- The frequency of each impact.
- Legal issues of the activity.
- Detection of the impact.

In order to determine the significance of each identified potential impact, a numerical value has been linked to the respective factor. **Table 3-1** provides the ranking scales used in this assessment.

Table 3-1 Risk Rating Matrix

RISK ASSESSMENT KEY (Referenced from DWA RISK-BASED WATER USE AUTHORISATION APPROACH AND DELEGATION GUIDELINES)	
RATINGS	
SEVERITY	
Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
SPATIAL SCALE	
Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5
DURATION	
One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5

RISK ASSESSMENT KEY (Referenced from DWA RISK-BASED WATER USE AUTHORISATION APPROACH AND DELEGATION GUIDELINES)	
RATINGS	
FREQUENCY OF THE ACTIVITY	
Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5
FREQUENCY OF THE INCIDENT/IMPACT	
Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5
LEGAL ISSUES	
No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
DETECTION	
Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Based on the ranking scales presented in **Table 3-1**, the significance of each impact is calculated using the following formula:

Significant Value = (Severity + Spatial Scale + Duration) x (Frequency of Activity + Frequency of Incident + Legal Issues + Detection).

The risk significance rating has been subdivided into three categories, as presented in **Table 3-2**. This ranking system is based on the DWS risk assessment requirements and has therefore been used to determine risk significances in this study.

Table 3-2 Risk Assessment Significance Value

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

3.2 Impact Assessment

The following potential hydrological impacts were identified to be associated with the Tswana Quarry and, therefore, included as part of this impact assessment:

- Changes in catchment water resources;
- Changes in catchment water quality; and
- Changes in catchment flood hydrology.

Table 3-3 presents the results of the significance ratings attributed to each of the identified potential impacts for both the pre- and post-mitigation scenarios.

Table 3-3 Significance Ratings of Identified Potential Impacts

Nature of Impact	Severity	Spatial Scale	Duration	Frequency of Activity	Frequency of Incident	Legal Issues	Detection	Significance Score	Significance / Mitigation Measure
Pre-Mitigation									
Changes in Catchment Water Resources due to:									
An Increase in Impervious Areas	1	2	4	1	3	1	1	**42**	**Low**. The area associated with any impervious surfaces is insignificant compared to the local and regional catchment areas. Therefore, the significance rating for changes in water resources as a result of an increase in impervious areas is insignificant.
Abstractions	1	2	4	1	1	1	1	**28**	**Low**. Water for domestic and operational purposes are abstracted from a Borehole. Drinking water is brought in from an external source. The main use of water from Tswana Quarry Sump 1 is for dust suppression. There are currently no abstractions from the Polfonteinspruit River. Therefore, the associated significance of the identified impact is low.
Limiting Flow to the downstream environment	2	2	4	5	5	1	1	**96**	**Moderate**. Any rainfall and runoff within the open pit will remain within the pit. Due to the relatively large area associated with the open pit, there will most likely be a reduction in water resources (rainfall and runoff) to the downstream catchment area.
Reduction in Catchment Water Quality due to:									
Erosion from disturbed open ground	1	1	4	2	2	1	2	**42**	**Low**. Open and disturbed areas are predominantly located within the open pit area. Therefore, any erosion or transport of sediment will be limited to within the open pit. It is unlikely that sediment will be transported to the downstream environment, which means this identified potential impact is associated with a low significance.

Nature of Impact	Severity	Spatial Scale	Duration	Frequency of Activity	Frequency of Incident	Legal Issues	Detection	Significance Score	Significance / Mitigation Measure
Discharging waste or contaminated water (Hydrocarbon spills, pit dewatering and sewage spills)	3	1	1	2	3	5	2	60	**Moderate**. Although reducing water quality for downstream users/eco-systems is associated with a high significance, the likelihood of contamination from the quarry site to the downstream environment is limited. This is largely due to most of the stormwater runoff from the site discharging into the open pit (which cannot discharge to the downstream environment). Possible sources of contamination were identified at the workshop area of the quarry, were hydrocarbon stores are located. These hydrocarbon stores still pose a threat to the ecosystems present in the open pit and Quarry Sump 1. Management of these sources of potential contamination are therefore still associated with a high importance.
Changes in Flood Hydrology due to:									
An increase in impervious areas	1	1	4	1	1	1	2	30	**Low**. As mentioned previously, the area associated with impervious surfaces is insignificant. Further to this, any stormwater runoff from the project site will be into the open pit, which means that there will be no increase in the discharge rate or downstream flood hydrology as a result of the quarry.
Altering the bed, banks, course or characteristics of a water course	1	1	1	1	2	5	1	24	**Low**. A floodline study of the Polfonteinspruit River in the vicinity of the open pit has indicated that the open pit is located outside of the 1:100-year floodlines. Therefore, the impact of altering the bed, banks, course or characteristics of a water course (i.e. the Polfonteinspruit River) as a result of the open pit, is associated with a low significance.
Post-Mitigation									
Changes in Catchment Water Resources due to:									
An increase in impervious areas	1	2	1	1	2	5	1	36	**Low**. No mitigation measures are required (refer to **Section 3.2.1**)
Abstractions	1	1	1	1	1	5	1	24	**Low**. No mitigation measures required (refer to **Section 3.2.1**)
Limiting Flow to the downstream environment	2	2	2	2	3	5	2	72	**Moderate**. It is noted that an application for the discharge of water stored in the open pit to the Polfonteinspruit River, has been included in the current Water Use Licence Application (as presented in **Table 3-5**). If this is approved, then the impact of a reduction in the catchment water resources will be negated. See **Section 3.2.1** for more details on the catchment water resources impact of the open pit on the local and regional catchment hydrology.

Nature of Impact	Severity	Spatial Scale	Duration	Frequency of Activity	Frequency of Incident	Legal Issues	Detection	Significance Score	Significance / Mitigation Measure
Reduction in Catchment Water Quality due to:									
Erosion from disturbed open ground areas	1	1	3	1	2	5	1	**45**	**Low.** Although the anticipated impact is low, it is still recommended that erosion control measures are implemented, as detailed in **Section 3.2.2.**
Discharging Waste or contaminated water into a water resource through a sewer or other conduit (pit dewatering and sewer waste)	1	1	4	1	1	5	1	**48**	**Low.** It is recommended that mitigation measures outlined in **Section 3.2.2** are implemented on site to reduce the risk of contamination of surface water resources.
Changes in Flood Hydrology due to:									
An increase in impervious areas	1	1	4	1	1	5	1	**48**	**Low.** The potential impact of an increase in peak discharge rates are associated with a low likelihood and impact.
Altering the bed, banks, course or characteristics of a water course (quarry within 100m of watercourse)	1	1	4	1	1	5	1	**48**	**Low**. No mitigation measures are recommended. More details are provided in **Section 3.2.3**.

3.2.1 Changes in Catchment Water Resources

A hydrological analysis of the local (Polfonteinspruit adjacent to the quarry) and regional (D41A quaternary catchment) catchments hydrology was undertaken to determine the potential impact of the quarry on the local and regional hydrology. The hydrological analysis consisted of assessing catchment Mean Annual Evaporation (MAE), MAP and MAR, based on results obtained from the Water Resources of South Africa Study (WR2012) undertaken in 2012. Furthermore, an analysis of the licensed water abstractions downstream of the quarry, within the D41A Quaternary Catchment was undertaken using the 2022 DWS Water Authorisation and Registration Management System (WARMS) database. The database indicated that there were seven licenced water users which mostly included water users for water supply services, located downstream of the study area, between the quarry and the Molopo River, as shown in **Figure 2-3**. Details of the licenced water users are presented in **Table 3-4**. In addition to the current licenced water users downstream of the quarry, it is noted that Lafarge are in the process of applying for a licences for a number of water uses for the quarry. These are detailed in **Table 3-5** and indicated in **Figure 2-3**.

Table 3-4 Water Users Downstream of Tswana Quarry (WARMS 2022)

Registration/ Water Use No.	Sector	Volume m³/year	Source	Quaternary	Location
26020341/3	Water Supply Service	62	Molatedi Dam	D41A	-25.8561 S ; 25.50842 E
26020341/4	Water Supply Service	0.8	Pella Dam	D41A	-25.8561 S ; 25.5084 E
26020341/5	Water Supply Service	2	Madikwe Dam	D41A	-25.8807 S ; 25.5113 E
26033621/3	Water Supply Service	3650000	Scheme	D41A	-25.8572 S ; 25.5089 E
26038234/2	Industry (Non-Urban)	3326	Molopo River	D41A	-25.8864 S ; 25.5817 E
26048937/2	Mining	300	Molopo River	D41A	-25.9365 S ; 25.5969 E
26057310/5	Industry (Urban)	5300000	Scheme	D41A	-25.8572 S ; 25.5089 E

Table 3-5 Summary of Lafarge Tswana Lime Water Use Licence Application

Water use	Water source	Quaternary Catchment	Location	Quantity	Sector
Section 21 a Taking water from water resource	Tswana Quarry Borehole 1	D41A	26° 4.571'S 25° 46.819'E	25 769m³ per year. Amount based on usage at Tswana Quarry.	Domestic and process water. Drinking water is bought and not used from the borehole.
Section 21 b Taking water from water resource	Tswana Quarry Sump	D41A	26° 4'28.64"S 25°48'8.43"E	Sump storage capacity : 480 000m³	Water used for Dust suppression- Water will be collected by a truck for dust suppression.
Section 21 j Removing, discharging or disposing of water found underground	Tswana Quarry	D41A	26°04'20.53"S 25°48'17.14"E	1 681 m³/year	Sump 1 Dust suppression along haul roads
Section 21 (f) Discharging waste or water containing waste into a water resource	Tswana Quarry	D41A	26°3'11.94"S 25°48'13.09"E	700 000m³/ annum	Discharging water into the Polfonteinspruit.
Section 21 (c) Impeding or diverting the flow of water in a watercourse.	Tswana Quarry	D41A	26° 3'11.94"S 25°48'13.09"E	700 000m³/ annum	Discharging water into the Polfonteinspruit.
Section 21 (i) Altering the bed, banks, courses or characteristics of a watercourse.	Tswana Quarry	D41A	26° 3'11.94"S 25°48'13.09"E	700 000m³/ annum	Discharging water into the Polfonteinspruit.
Section 21 g Waste discharge related water use	Tswana Quarry	D41A	26°07'99.2"S 25°80'02.9"E	24 528 m³/annum (Dust suppression at Crushers) 1 681 m³/annum (Tankers Dust Suppression on Roads)	Dust suppression at crushing plant and along haul roads
Section 21 g Waste discharge related water use	Tswana Quarry - Limestone stockpile	D41A	26° 4.807'S 25° 47.917'E	8000/tons	Limestone Loading Tunnel stockpile

Details of the local catchment (Polfonteinspruit within the vicinity of the quarry) and regional catchment (Quaternary Catchment D41A) hydrology are presented in **Table 3-5**. Based on the respective catchment areas and information provided in the WR2012 study, the MAR of the local catchment (i.e. which includes the Polfonteinspruit catchment area), in the vicinity of the quarry equates to 0.04 MCM (million cubic meters), and the MAR of the regional catchment (D41A) equates to 5.03 MCM. This is based on an average runoff depth of 1.16 mm/annum for the respective catchments. In order to determine the anticipated impact of the quarry on the catchment water resources (volume of water), the catchment area of the overall quarry site was compared to the local and regional catchment areas. Based on this, the quarry site, with an area of approximately 7.62 km^2, comprises approximately 15.76 % of the local catchment area and approximately 0.18 % of the regional quaternary catchment area (D41A). The resulting impact on local and regional catchment resources is 15.76 % and 0.18 %, respectively. Based on this, the anticipated impact of the quarry on the local and regional catchment water resources (from a water volume perspective), as a result of r limiting flow in the downstream channels (capturing of contaminated stormwater), will be limited. It is noted that the volume of water captured in the open pit (which would convert to runoff to the Polfonteinspruit River under natural conditions) equates to 8 868 m^3/annum. It is also noted that the volume of water that is being applied for to discharge to the Polfonteinspruit River far exceeds this volume. Therefore, if the licence is granted, the quarry will contribute more water to the downstream environment than that which would have occurred under natural conditions.

Table 3-6 Comparison of Regional to Local Catchment Hydrology

	Local Catchment	**D41A Quaternary Catchment**
Catchment Area (km^2)	48.34	4 322.00
MAR (MCM/annum)	0.06	5.03
Average Quaternary Runoff Depth (mm/annum)	1.16	
Catchment Area of Tswana Quarry (km^2)	7.62	
Percentage of Quaternary Catchment Affected by the Tswana Quarry	15.76	0.18
Flow Volume falling into the Quarry Site that would ordinarily result in streamflow contributions to the Polfonteinspruit (m^3/annum)	8 868	

Water requirements at the quarry include domestic water (for showers and cleaning purposes for example), potable water for human consumption, operational water (for washdowns for example) and water required for dust suppression. This water is obtained from the following sources:

- Borehole 1, located at the Tswana Quarry. Water is pumped from the borehole to a Jojo Tank, which is then used to supply water for domestic and operational purposes.
- External source. Potable water is sourced externally and used on site, strictly for human consumption.
- Tswana Quarry Sump 1. Water from the sump is used for dust suppression at the crushers as well as for cleaning machinery at the wash bay located adjacent to the quarry sump.

No water is abstracted from Polfonteinspruit and therefore there is no impact associated with reducing catchment water resources as a result of abstractions from this drainage line.

3.2.2 Reduction in Catchment Water Quality

Currently stormwater runoff from the crushers, stockpile and office areas associated with the Tswana Lime Quarry is directed back into the open pit, mostly to the Quarry Sumps. As mentioned previously, part of the Water Use Licence Application is to pump water from the Quarry Sump 1 into the Polfonteinspruit. It is therefore important to ensure that the quality of water in the Quarry Sump 1 is sufficiently good to allow this water to be pumped to the Polfonteinspruit River and downstream environment. As presented in **Section 3.2.1**, there are a number of licenced water users located on Lotlhakane and Molopo Rivers, downstream of the quarry. These abstractions include four licenced abstractions for water supply services, and three for industrial water supply (one non-urban, one urban and one for mining purposes). Any reduction in water quality for these licenced water users is associated with a high significance level. Potential types and sources of surface water contamination are as follows:

- Sediment – which may potentially enter the quarry sump and downstream environment from the crushing plant and associated infrastructure, overburden stockpiles and disturbed bare surfaces (sediment).
- Hydrocarbons – which may occur from spillages around fuel and hydrocarbon stores, workshop areas and scrap yards.
- Sewage – which includes spillages of untreated sewage to the downstream environment.

In order to mitigate against these identified potential sources of contaminated runoff, the following is proposed:

- Berms upslope and downslope of areas likely to be a source of sediment contamination should be implemented. Upslope berms will ensure limited surface flows through areas associated with sediment loss. Downslope berms will ensure that sediments eroded from areas associated with sediment loss will be trapped, therefore reducing the impact to the downstream receiving environment. It is recommended that the berms are constructed out of a non-erodible material.

- All stormwater runoff from areas likely to be a source of sediment contamination should be directed to a sediment trap, where sediment will be deposited rather than entering into the receiving environment.
- Machinery should be regularly (at least daily) checked for oil leaks. During periods where the machinery is not in use, drip trays should be placed under the machinery to contain any spillages.
- The likelihood of dust being produced should be reduced. Dust suppression methods include:
  - Limiting the speed of all mining equipment/vehicles to 40 km/h on the internal haul roads.
  - Site management are to ensure denuded areas (dust source) are kept to a minimum.
  - Strips of used conveyor belts can be attached to the drop end of the crusher plant where crushed material falls onto the stockpiles. This will lessen the distribution of fine particles from the minerals.
  - Compacted dust collected by the crusher plant should be cleaned weekly to eliminate it as a dust source.
- The sizing and positioning of “dirty” stormwater channels and recommendations on bunding around areas containing potential for surface water contamination should be designed such that:
  - Dirty stormwater channels and bunding walls will contain runoff generated during the 1:50 year storm event, as per the requirements stipulated in General Notice 704 (GN704) of the National Water Act (Act 36 of 1998).
- Areas that may result in the contamination to groundwater should be sufficiently lined to meet with regulatory requirements.
- The sizing and positioning of clean stormwater diversion channels or berms so as to keep “clean” stormwater runoff from mixing with “dirty” stormwater runoff should be designed such that:
  - “Clean” stormwater runoff diversion infrastructure will be sized to divert runoff generated during the 1:50 year storm event as per the GN704 requirements.

- All domestic waste should be regularly removed from the quarry site on a regular basis and dumped in appropriate waste handling facilities.
- Long-term sewage containment management and/or treatment facilities implemented at the quarry should be sufficiently sized, such that spillages of untreated sewage to the environment are unlikely.
- Fuels and hydrocarbon stores should be lined and bunded such that spills from the store areas will not enter the receiving environment.
- Water downstream of quarry should be monitored to ensure no degradation of water quality occurs.

3.2.3 Changes in Flood Hydrology

As previously stated, all stormwater runoff from the quarry site, including the crusher area and offices, flows towards the Quarry Sumps. The quarry sumps has no discharge point. Therefore, the likelihood of an increase in peak discharge rates from the quarry and its associated infrastructure is very low.

It is noted that the Tswana Lime open pit is located relatively close (approximately 100 m) to the Polfonteinspruit River along its northern boundary. However, a recent floodline study has confirmed that the Tswana Lime Pit and any associated infrastructure is located outside of the 1:100 year floodline. Therefore, there is no obvious impact of the mine on the banks or floodplain of the Polfonteinspruit River.

4 DISCUSSIONS AND CONCLUSION

As part of this assessment, a general hydrological characterisation of the area in which the Lafarge Tswana Quarry is located was undertaken. This included defining the MAP, MAR and MAE for the project site. In order to determine the potential impact of the quarry and its associated infrastructure on the local and regional hydrology, the catchment areas corresponding to these regions were defined. The local catchment area was defined as the catchment area of the Polfonteinspruit in the vicinity of the quarry. The regional catchment area was defined as the Quaternary Catchment D41A, in which the quarry is located.

In addition to the hydrological characterisation of the quarry site, an impact assessment of the quarry on the local and regional hydrology was undertaken. Mitigation measures to reduce the significance of the identified potential impacts were provided. The potential impacts and mitigation measures identified included:

- Changes in catchment water resources. Based on the assessment undertaken, it was found that the potential impact of the quarry on catchment water resources (volume of water available to downstream users) is moderate. This is largely due to the rainfall and runoff that is captured in the open pit, therefore reducing contributions to the Polfonteinspruit River (compared to what would occur naturally). It is, however, noted that as part of the Water Use Licence Application, a licence to pump water stored in the quarry sump has been applied for. If this is granted, the impact of a reduction downstream water resources as a result of the open pit will largely be mitigated against.
- Changes in catchment water quality. The potential sources of contamination to the downstream environment were identified as sediment (from the crushing plant and stockpiles), hydrocarbon spills (through fuel stores and machinery on site) and raw sewage. In order to reduce the risk of surface water contamination, numerous recommendations were made, largely with respect to management of contaminants at their source.
- Changes in catchment flood hydrology. It was noted that the likelihood of changes in flood hydrology in the local and regional catchment context as a result of the quarry and its associated infrastructure, is low. The location of the open pit was, however, noted to be in a close proximity to the Polfonteinspruit River. However, a recent floodline study has confirmed that the Tswana Lime Pit and any associated infrastructure are located outside of the 1:100 year floodline. Therefore, there is no obvious impact of the mine on the banks or floodplain of the Polfonteinspruit River.

It is concluded that if the Lafarge Tswana Quarry is compliant with the various regulations guiding the management and protection of water resources (as outlined in this report), the impact of the quarry on the local and regional hydrology will be low.

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