# P13050 GROOTEGELUK MINE

# STORMWATER REGIONAL MASTER PLAN

## REPORT

## REVISION 02

## APRIL 2015


**PREPARED FOR:**

exxaro
POWERING POSSIBILITY

**EXXARO**

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# 1 INTRODUCTION

## 1.1 BACKGROUND

Exxaro Resources (Ltd) is in the process of expanding its mining operations in the Lephalale district of the Limpopo Province. As part of the expansions, the Grootegeluk mine has been upgraded significantly to increase its production, and the Grootegeluk Medupi Expansion Project has seen major infrastructure upgrades already completed on the mine that is geared towards the main aim of producing 14.6 million tonnes of coal by 2014.

Infrastructure expansion in the Waterberg District is increasing to take full advantage of the major coal reserves of the area, and in addition to the Exxaro developments, there will be other major infrastructure developments in the region. These developments will have a major impact on the current and future stormwater run-off in the area, and will have a significant impact on the environmental surroundings.

Delta Built Environment Consultants (herein after referred to as Delta BEC) was appointed by Exxaro Resources (Ltd) to complete a study and report on the expected greater stormwater master plan pertaining to the Grootegeluk mining operations and its effect on the surrounding areas, as well as the dangers of flooding and infiltration of overland stormwater into the mining area.

## 1.2 PURPOSE OF REPORT

The details included in this report aims to provide a synthesized lookout on the stormwater management for the Grootegeluk mine and its surrounding areas. The report will provide clarity on the existing stormwater management systems in place for the internal operations of the mine, the expected regional stormwater flow regions, as well as the effect of the expected storm flow on the surrounds.

Areas will be classified in their appropriate categories to support the water use licence legislation and the report will act as guidance for possible future developments, problems and challenges associated with Grootegeluk mine and its immediate surrounding areas. The main purpose of this report is to enable Grootegeluk mine to effectively and pre-emptively plan for future flood occurrences.

## 1.3 STRUCTURE OF REPORT

The report comprises the following sections:

- Section 2: Hydrological characteristics
- Section 3: Stormwater run-off methodology
- Section 4: Site specific stormwater master plan
- Section 5: Conclusion.

# 2 HYDROLOGICAL CHARACTERISTICS

## 2.1 INTRODUCTION

Grootegeluk mine is situated in the Limpopo (A) primary drainage region. The majority of the stormwater run-off generated in this area drains into the Limpopo River, bordering the northern part of this region and spills out into the Indian Ocean. On a quaternary drainage level, the mine is situated in the A42J drainage basin as displayed in Figure 2-1 and Figure 2-2. The prominent river sections surrounding the site are the following:

- Sandloop River
- Mokolo River
- Limpopo River.

In this quaternary region, the Mokolo River is the major stormwater conveyance system.

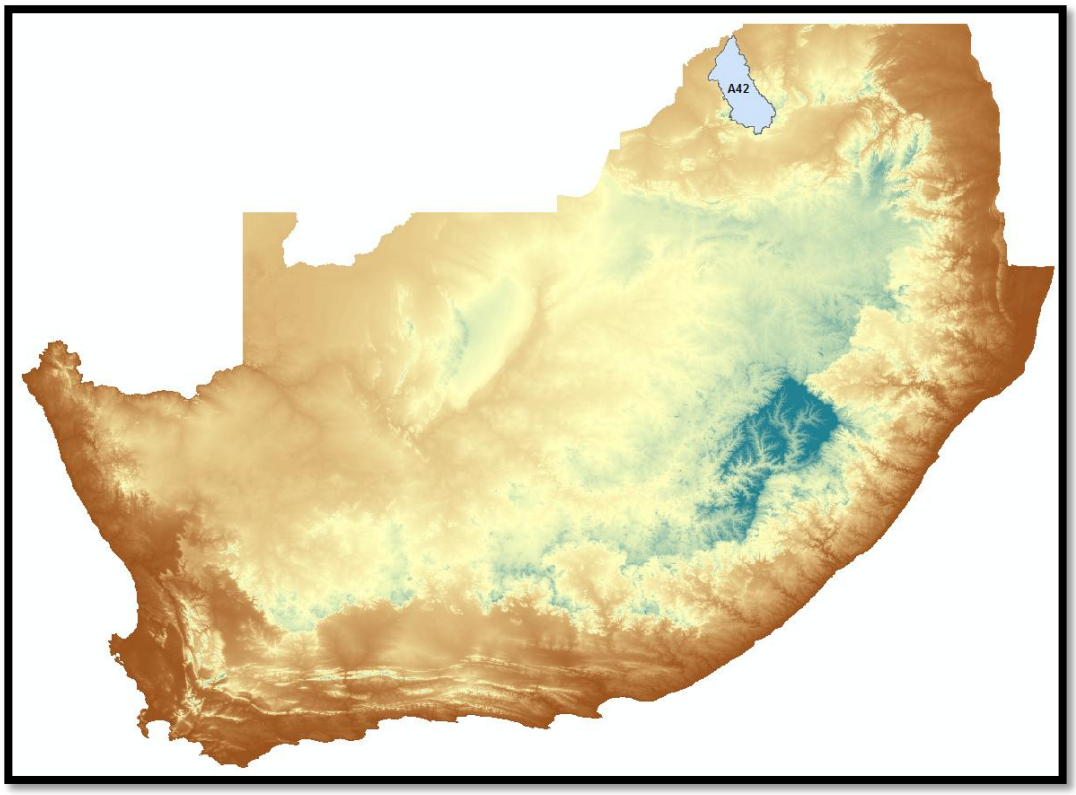


**Figure 2-1 Quaternary catchment location on RSA map**

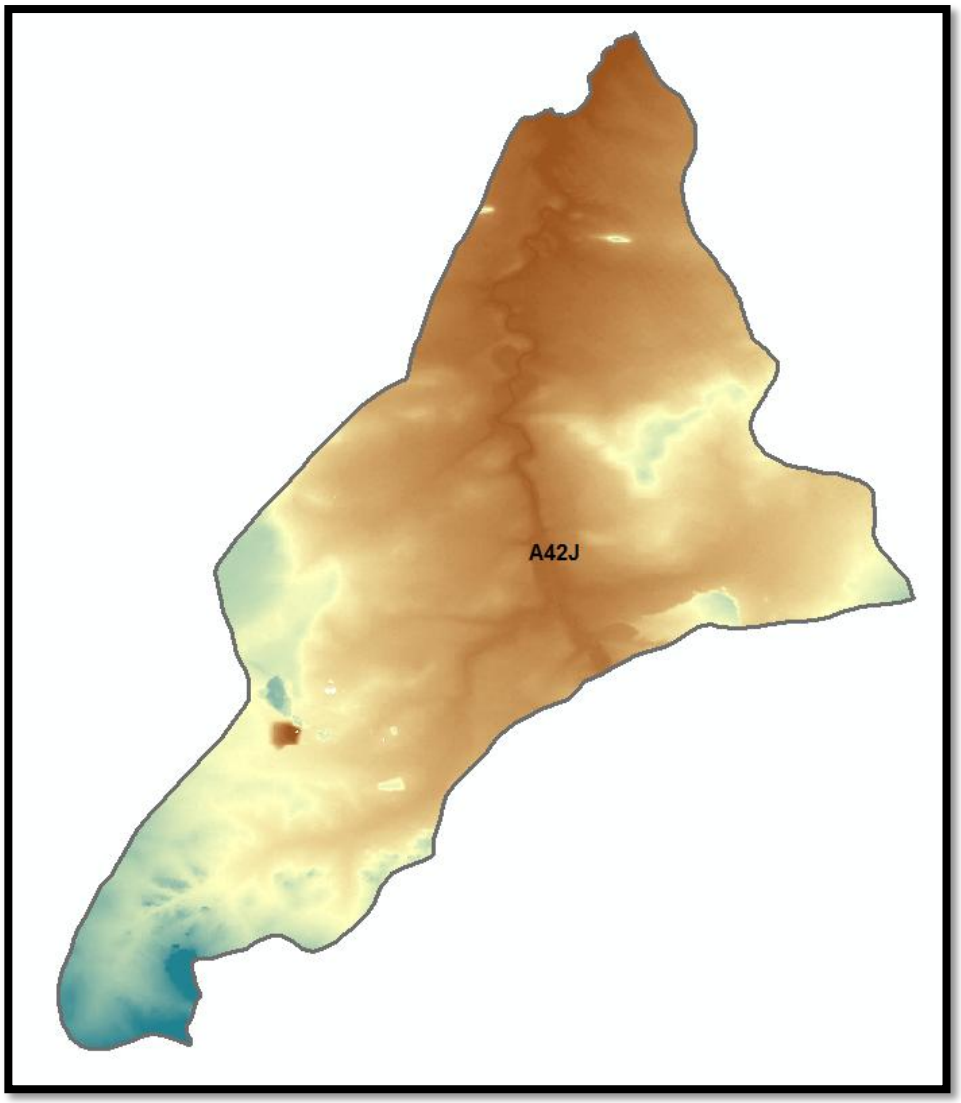


**Figure 2-2 Quaternary catchment**

The stormwater run-off from the Lephalale area surrounding the mine can be described as a flat drainage basin with the area renowned for the underground movement of water and rivers. The permeable soil type, relatively low yearly rainfall as well as the topography of the area results in very few distinct perennial water streams running through the area.

## 2.2 REGIONAL TOPOGRAPHY

The region has a uniform relief, relatively flat with a slope of about 0.8% (1 m vertical variation in a horizontal distance of 127 m). The regional contour plan received from GIS data indicated a variation in level of 1 200 m to 781 m above mean sea level for the study area as seen in Figure 2-3.

As seen in the figure below, the terrain is of a very flat nature. The contours displayed are at 10 m intervals.

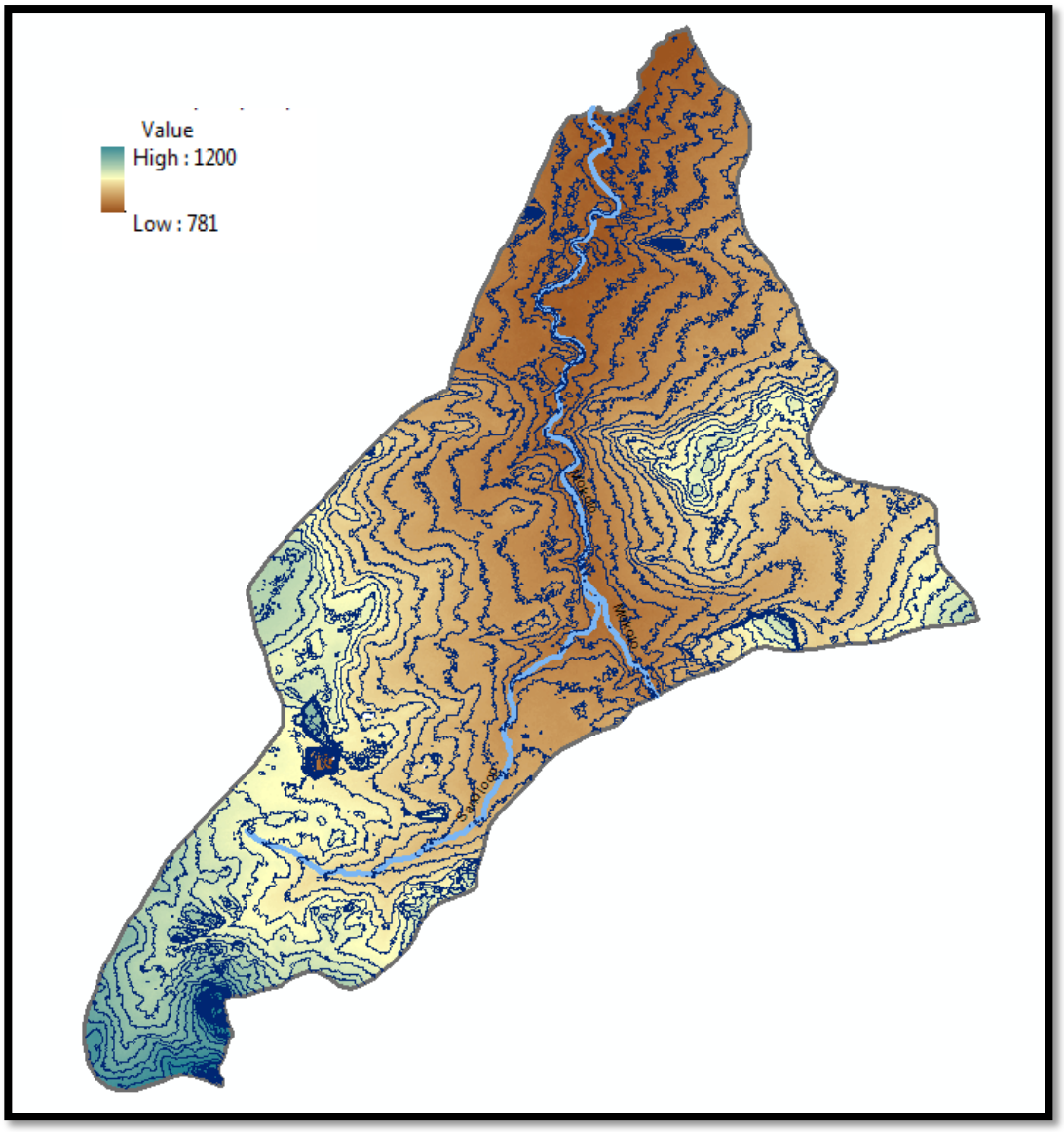


**Figure 2-3 Quaternary area displaying contours**

The drainage basin has a watershed that separates it into two distinct east-west drainage areas, with very little evidence from the contour map of concentrated flows in the form of defined streams. The deep, unconsolidated sands of 2 m – 3 m would lead to high infiltration rates and thus low surface water run-off, mostly in the form of sheet flow. Where there are identified river streams, they are of a distinct perennial nature and flow only occurs after a major storm event.

A drawing indicating the four major drainage basins with the associated watersheds are included in Appendix A.

## 2.3 GEOLOGY

The site is predominantly underlined with Basalts of the Letaba formation and Aeolian. Due to the fine red sand covering the majority of the top layer of the site, the absorption of stormwater into the ground occurs at a high rate. Some areas are being subjected to heavy build-up of coal fragments and fines result.

## 2.4 METEOROLOGY

The site is situated in the larger catchment area of the Limpopo and Mogol Rivers, in the drier western part of the Limpopo province. The Mean Annual Precipitation (MAP) of the region is 451 mm and the Mean Annual Evaporation (MAE) 1 950 mm.

The area falls in the summer rainfall region, with the biggest percentage of rainfall historically occurring in the December and January months, with an average of 39% of the yearly rainfall occurring in these two months. The SANWS at Grootegeluk mine's rainfall data is presented in Table 2-1:

**Table 2-1 Grootegeluk rainfall statistics**

| MONTH | AVG RAINFALL (mm) | % OF YR RAINFALL | AVG NO RAIN DAYS | MAXIMUM RAINFALL (mm) | DATE OF MAXIMUM RAIN |
|---|---|---|---|---|---|
| **JAN** | 88.4 | 19.6% | 6.3 | 104 | 2004/01/19 |
| **FEB** | 76.4 | 16.9% | 5.8 | 99 | 1978/02/14 |
| **MAR** | 58.2 | 12.9% | 4.6 | 134 | 2004/03/07 |
| **APR** | 32.3 | 7.2% | 2.5 | 136 | 2002/04/14 |
| **MAY** | 6.8 | 1.5% | 0.9 | 30.5 | 1997/05/25 |
| **JUN** | 5.1 | 1.1% | 0.8 | 44 | 2002/06/01 |
| **JUL** | 0.9 | 0.2% | 0.3 | 6.2 | 1983/07/03 |
| **AUG** | 1.1 | 0.2% | 0.4 | 27.3 | 1979/08/26 |
| **SEP** | 5.9 | 1.3% | 1.1 | 4.5 | 1977/09/28 |
| **OCT** | 33.1 | 7.3% | 3.9 | 57 | 1992/10/29 |
| **NOV** | 54.9 | 12.2% | 6.2 | 71 | 1989/11/05 |
| **DEC** | 88.2 | 19.5% | 6.2 | 100 | 1995/12/17 |

A graphical presentation of the yearly rainfall distribution is presented in Figure 2-4:

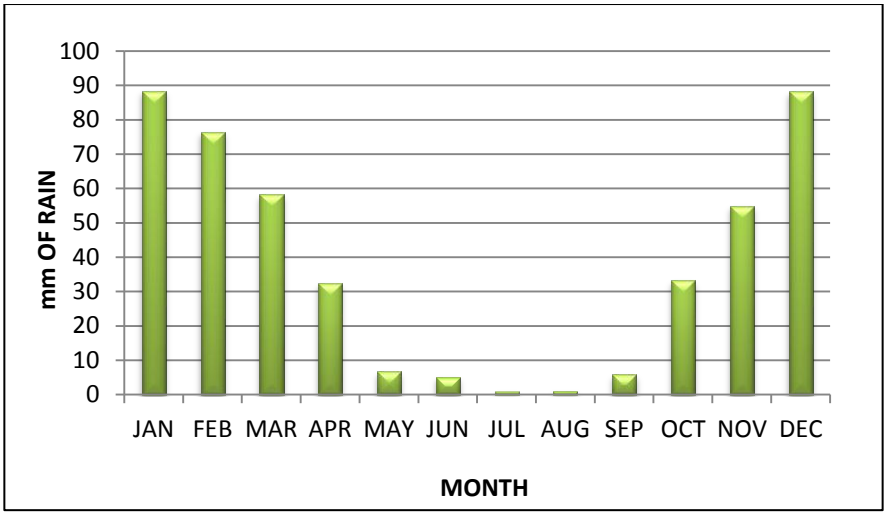


**Figure 2-4 Grootegeluk rainfall distribution**

# 3 STORMWATER RUN-OFF METHODOLOGY

## 3.1 HYDROLOGY

Run-off calculation techniques used in South Africa are inadequate and often based on unverified catchment and rainfall data (Watson, 1981). The use of various models should be used to derive most probable values and to ensure that gross errors in estimation are eliminated.

The most widely used method of calculation in South Africa is the Rational Method. This method has in past yielded very accurate estimations when compared to the corresponding measured catchment flows. It does, however, have limitations when the catchments become rather large, and as such it is good practice to verify the calculated results with two additional estimation methods.

For the size of this study it was decided to utilise the Standard Design Flood method as well as the Empirical Method. Each method's background and calculation methodology is briefly explained in the following sections:

### 3.1.1 RATIONAL METHOD

Since its inception in 1851, the Rational Method has become one of the most widely used methods for determining peak flows from small catchments. The basis of the relationship is the conservation of mass and the premise that the flow rate is directly proportional to the size of the contributing area and rainfall intensity. Rainfall intensity is a function of the return period. Peak flow is obtained by the following relationship:

$$Q = \frac{CIA}{3.6}$$

Where:

Q = peak flow ($m^3/s$)
C = run-off coefficient
I = average rainfall intensity over catchment (mm/hour)
A = effective area of catchment ($km^2$)
3.6 = conversion factor.

Despite the Rational Method's shortcomings and widespread criticism, it provides realistic results, especially in combination with other run-off estimation models. Disadvantages of the method include that reliable hydrographs cannot be calculated and the method is of limited use in flood routing calculations. As mentioned, its results are less accurate if catchment sizes are greater than 25 $km^2$.

### 3.1.2 STANDARD DESIGN FLOOD METHOD

The standard design flood method (SDF) was developed in 2002, to provide a uniform approach to flood calculations (Alexander, 2002). This method is based on calibrated discharge coefficients for return periods of 2 and 100 years that are summarised from 29 primary identified drainage basins in South Africa.

It follows the same procedure as the Rational Method, with the exception of the run-off coefficient (C) for the catchment. In the conventional Rational Method, the run-off coefficient is determined by giving numerical values to the catchment characteristics that influence the run-off, and is based on user-dependant input parameters. In the SDF method the run-off coefficient is a calibrated single value for the specific drainage basin, and is based on historical statistical analysis of the various catchments included in the SDF method (SANRAL, 2013). There are 29 different calibrated drainage basins, covering the entire drainage area of South Africa.

### 3.1.3 EMPIRICAL RUN-OFF CALCULATION

Empirical methods are mostly based on simple correlation between peak flow rates and other catchment characteristics derived from general regional parameters. The peak discharges calculated with these methods are relatively inaccurate when compared with other deterministic methods, due to the undetailed, generic approach taken. It is, however, a quick and useful tool to use when working with relatively large catchments, as it ensures gross errors in estimation are avoided.

For this study, the empirical deterministic relationship developed by Midgley & Pittman was used:

$$Qt = .0377 K_T P A^{0.6} C^{0.2} \qquad \text{Where:} \qquad C = \frac{A \times \sqrt{S}}{L \times L_c}$$

And where:

$Q_t$ = Peak flow for “t” return period ($m^3/s$)
$K_T$ = Calibrated constant value for “T” return period
A = Size of the catchment ($m^2$)
P = Mean annual rainfall over the catchment area (mm per annum)
S = Average slope of the stream (m/m)
L = Hydraulic length of the catchment (km)
$L_c$ = Length from the outlet to the catchment centroid (km).

## 3.2 SUB-CATCHMENT DELINEATION

With the partial focus of the master plan study being the influence of storm flow patterns specifically affecting the operations of Grootegeluk mine, the study area was divided into various sub-catchments upstream and downstream of the mine. Watersheds were identified using contour intervals spaced at 20m, as indicated on the regional GIS layout plans. There were four main catchments identified that might influence, or be influenced by the operations of Grootegeluk Mine. A detailed drawing indicating the catchments and their respective watersheds are indicated in Appendix A.

The four main sub-catchments are as follows:

**Table 3-1 Identified catchments of interest**

| NAME | ORIENTATION TO MINE | SIZE ($km^2$) | Avg SLOPE (%) | DESCRIPTION |
|---|---|---|---|---|
| **CA-01** | Upstream | 159 | 0.42% | • Catchment is located far south of the mining area<br>• Run-off contributes directly to CA-02<br>• Run-off mostly affected by new Medupi Power station |
| **CA-02** | Upstream/ Downstream | 130 | 0.40% | • Catchment includes southern portion of mine operations<br>• Perennial stream flowing in western direction towards Mogol River<br>• Contains possible dirty water from mining operations |
| **CA-03** | Downstream | 193 | 0.32% | • Catchment includes northern portion of mine operations<br>• Run-off from slime dams and operations west of D2001<br>• Perennial stream flowing in western direction<br>• Joins Mogol River directly to the west<br>• Contains possible dirty water from mining operations |
| **CA-04** | Downstream | 191 | 0.39% | • No direct influence from mining operations<br>• Joins Mogol River directly to the west |

## 3.3 CATCHMENT PEAK FLOW CALCULATIONS

For the purposes of this report, the expected maximum flow rates for the 1:20, 1:50 and 1:100 floods were estimated, and detailed calculations are added in Appendix B at the back of this document. The following sections describe the methodology followed in greater detail.

### 3.3.1 RAINFALL DEPTH

In order to determine surface water run-off, probabilistic relationships between the average daily rainfall, rainfall intensity, duration and return period are required. These relationships were estimated by using a regional scale invariance approach, developed by Smithers and Schulze (2003). Design rainfall was estimated at a spatial resolution of 1-minute x 1-minute. The project area is located at Latitude 23°39'S and Longitude 27°32'E with an altitude of 910 m above mean average sea level (masl). The mean annual precipitation (MAP) is estimated at 451 mm per annum. The following weather stations were utilised to calculate the mean rainfall within the project area:

- Tambootivlei 0673636_W
- Zyferbult 0673645_W
- Ellisras (POL) 0674400_W
- Oranjefontein 0718327_W
- Sterkfontein 0674207_W

Design rainfall depths, calculated for various recurrence intervals and storm durations are presented in Table 3-2 below:

**Table 3-2 Design rainfall depths**

| STORM DURATION | RECURRENCE INTERVAL (YEARS) AND RAINFALL DEPTH (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2** | **5** | **10** | **20** | **50** | **100** | **200** |
| **1 h** | 29.9 | 42.2 | 51.1 | 60.1 | 72.6 | 82.5 | 93.1 |
| **2 h** | 40.4 | 57.1 | 69 | 81.2 | 98.1 | 111.6 | 125.8 |
| **4 h** | 45.8 | 64.7 | 78.2 | 92 | 111.2 | 126.5 | 142.6 |
| **6 h** | 49.3 | 69.6 | 84.2 | 99 | 119.6 | 136.1 | 153.5 |

### 3.3.2 PEAK RUN-OFF VOLUMES

The topography of the investigation area as well as the type of veld cover, contributes to the flow patterns during a typical rainfall event. The flat nature of the topography (with slopes of 4% and under) results in plate flow velocity patterns that are extremely low, and estimated velocities area only accurately estimated from 0.5% and steeper (Schulze & Arnold, 1979). It is, however, expected that velocities in the range of 0.4 – 0.65 m/s will be encountered throughout.

The peak regional flow rates, to be read in conjunction with the layout drawing provided in Appendix A, is provided in Table 3-3:

**Table 3-3 Peak run-off volumes**

| CATCHMENT | CALCULATION METHOD | DESIGN PERIOD FLOW ($m^3/s$) | | |
|---|---|---|---|---|
| | | 20 | 50 | 100 |
| CA-01 | Rational Method | 65.86 | 98.57 | 135.14 |
| | SDF Method | 113.25 | 169.39 | 216.90 |
| | Empirical | 91.79 | 127.21 | 161.03 |
| CA-02 | Rational Method | 59.57 | 89.15 | 122.24 |
| | SDF Method | 125.65 | 187.93 | 240.65 |
| | Empirical | 88.54 | 122.72 | 155.34 |
| CA-03 | Rational Method | 73.75 | 110.37 | 151.32 |
| | SDF Method | 120.23 | 179.83 | 230.26 |
| | Empirical | 112.29 | 155.64 | 197.01 |
| CA-04 | Rational Method | 75.59 | 113.13 | 155.10 |
| | SDF Method | 127.21 | 190.28 | 243.64 |
| | Empirical | 108.28 | 150.07 | 189.96 |

# 4 SITE SPECIFIC STORMWATER MASTER PLAN

## 4.1 INTRODUCTION

The need for a stormwater master plan depicting the stormwater management network of the mine is a critical part of the stormwater system. The following requirements are referred to in the Exxaro Stormwater Policy:

*The key concept is to prepare and to maintain a Master Storm Water Drainage Plan that reflects the integration of storm water runoff and drainage systems for all Waterberg Region business units. Information reflected on the Master Storm Water Drainage Plan shall be endorsed by Storm Water Design Reports from the various business unit storm water sub-catchment areas.*

During this section of the report, a brief summary is provided of the stormwater projects completed subsequent to design requests of the Grootegeluk stormwater system.

## 4.2 GROOTEGELUK STORMWATER PROJECTS

Recent expansions of the mining operations, as well as the need for better use of water resources had necessitated the upgrading of the existing stormwater infrastructure for the mine and surrounding areas. Various consultant companies were involved in the design of the upgraded stormwater system. The following consultants formed part of the design teams and can be reached for further information at the following contact details:

| CONSULTANT | ADRESS | CONTACT |
|---|---|---|
| **Delta BEC** | Rynlal Building,2nd Floor,<br>Suite 24, 320 The Hillside Rd<br>Lynnwood<br>Gauteng, 0181 | 012 368 1850 |
| **ARUP** | Joe Strydom<br>10 High Street<br>Melrose Arch<br>Johannesburg | 011 218 7600 |
| **Nurizon** | Route 21 Corporate Park<br>118 Sovereign Drive<br>Irene<br>Pretoria | 012 345 3649 |
| **BVI** | Menlyn Corporate Park<br>Garsfontein Road (M30)<br>Menlyn<br>Pretoria, South Africa | 012 940 1111 |
| **LSL** | Justitia House<br>78 B Republic Road<br>Ferndale<br>Randburg 2194 | 011 789 8138 |

Appended to this document is a drawing outlining the various stormwater projects on the Grootegeluk mine, with their associated boundaries and extremities indicated. These upgrades (both completed and in process) will be discussed in more detail in the following sections.

### 4.2.1 GROOTEGELUK STORMWATER UPGRADE PHASE 1 – DELTA BEC

As part and parcel of this phase of the upgrades, Delta BEC was appointed to design and oversee the cleaning and refurbishment of existing stormwater systems around the plant area. The details included:

- Removing pipes and cables in trenches and stormwater pipes
- Cleaning of stormwater network of silt, grit and sedimentation problems
- Relocation of services to avoid stormwater interference.

The project was implemented successfully, and all stormwater infrastructure is currently operating at the predicted level of service.

For details on the calculations and implemented elements, please refer to *GROOTEGELUK MEDUPI EXPANSION AND GROOTEGELUK MINE PROJECT: DESIGN REPORT FOR: UPGRADE OF THE STORM WATER SYSTEM FOR GG1-6*

### 4.2.2 GROOTEGELUK STORMWATER UPGRADE PLANT GG 7 AND GG 8 AREA – ARUP AND LSL

The construction of the new plant infrastructure of the GMEP project resulted in additional stormwater run-off being generated due to the increase in impermeable surfacing and the redirection of the surface run-off though the main N1 canal running through all the various plant areas. Messrs Arup consulting engineers were responsible for the design and implementation of the stormwater upgrades in this area of Grootegeluk mine.

The additional operation water generated also contributed to a higher constant flow being transported through the entire plant area's stormwater network.

The implementation was completed successfully, and in short entailed the following:

- Construction of new concrete stormwater channels and conduits
- Separation of dirty and clean stormwater elements
- Upgrading of existing stormwater networks in the area, including tie-in to the existing GG 6 plant area stormwater network.

For details on the calculations and implemented elements, please refer to: *GROOTEGELUK MEDUPI EXPANSION AND GROOTEGELUK MINE PROJECT: DESIGN REPORT FOR: GG7 AND GG8 STORMWATER SYSTEM (REPORT NAME TO BE OBTAINED FROM RESPONSIBLE MINE PROJECT MANAGER)*

### 4.2.3 GROOTEGELUK STORMWATER UPGRADE PHASE 2 – DELTA BEC

The upgrading of the new GG 7 and 8 plant areas resulted in a greater concentration of run-off from the mine process plant areas being added to the existing stormwater run-off. All spilled process water was also directed to these canals. Coupled with the siltation problems associated with the major stormwater conduits in the plant process area, it was a definite requirement to upgrade the major stormwater channels in the plant area to accommodate maintenance procedures and silt transportation. The implementation was completed utilising a phased approach:

- **Phase 2A** entailed the upgrading of the 'N1' channel, transporting water from the current plant areas to WP Slime dams situated on the south-western side of the GG 3 and 4 process plants
- **Phase 2B** requires the construction of the new Channel-to-pit stormwater canal, transporting water from the WP Slime dams to the pit area.

For details on the calculations and implemented elements, please refer to: *GROOTEGELUK MEDUPI EXPANSION AND GROOTEGELUK MINE PROJECT: DESIGN REPORT FOR: UPGRADE OF THE STORM WATER SYSTEM FOR GG1-6*

### 4.2.4 OVERALL UPGRADING OF GG STORMWATER SYSTEMS – DELTA BEC

Delta BEC was appointed to design and implement the upgrading of the greater Grootegeluk stormwater system, encompassing various sections and areas on the mine.

A lack of maintenance, aging of infrastructure and additional infrastructure developments resulted in the capacity of the existing stormwater system falling below the required level of service in certain areas, thereby necessitating the upgrading and addition of new infrastructure to the existing stormwater system. With the stringent application laws for the Mining Water Use Act and regulation 704, the need for these upgrades were also emphasised.

Some of the upgrading entailed the following:

- Refurbishment and upgrading of stormwater channels and networks in the GG 1 to 6 process plants
- Stormwater cut-off berms and trenches around the slime dams, to ensure Regulation 704 compliance
- Integration of stormwater and borehole systems around the drying beds, to reduce groundwater problems and spillages of dirty water into clean water areas
- General upgrading and refurbishment of stormwater surrounding office areas and clear separation of the different water category areas
- Refurbishment and upgrading of the stormwater systems associated with the pit service station.

For details on the calculations and the implemented stormwater elements, please refer to the following documents:

- *Stormwater Drainage System Upgrade: GG1-6 Plant AREA*
- *Stormwater Drainage System Upgrade: clean water area east of stockpiles*
- *Stormwater Drainage System Upgrade: pit service station*
- *Stormwater Drainage System Upgrade: slime dams*
- *Stormwater Drainage System Upgrade: stockpile area*

#### 4.2.5 GROOTEGELUK ENTRANCE GATE

Delta BEC was appointed to design and implement the new entrance gate of Grootegeluk mine. The construction of this project consisted of the following:

- New road network
- Additional paved parking areas
- New buildings and operational structures
- Reshaped open areas
- Additional land scaping.

All the aforementioned contributed to the required modification of the surrounding stormwater management, since successful drainage of these areas are off extreme importance to ensure the effective operation of the facilities.

For details on the calculations and the implemented stormwater elements, please refer to the following documents: *GROOTEGELUK COAL MINE NEW ENTRANCE GATE AND CARPORTS DESIGN REPORT*

## 4.3 INFORMATION STILL TO BE INCORPORATED INTO THE MASTER PLAN

During the compilation of the stormwater master plan all available information was utilised to achieve the most complete stormwater master plan possible. However, due to some outstanding information, some areas were only partially detailed in the master plan. These areas and their relevant information are to be incorporated into the drawings and the report by the responsible person from the mine as soon as the information is obtained from the various consultants.

The following projects can be listed as incomplete:

#### 4.3.1 GG 7-8 STORMWATER PROJECT – ARUP AND LSL

ARUP consulting and LSL was appointed by Exxaro to design the required stormwater system for the expansion of the Grootegeluk mine, with specific reference to GG 7 and 8 within the plant area.

Information for certain elements of this stormwater network were available at the time this report was compiled. However, this stormwater system is extensive and

a lot of information is required to deem this area as being completely covered in the stormwater master plan.

It can be proposed that an appointment be made to capture the required information and incorporate it into the relevant sections of this report and the stormwater master plan drawings.

### 4.3.2 THREE SILT TRAPS – NURIZON

Nurizon was appointed by Exxaro to complete the designs required for several silt traps within the mining premises. The silt traps will be located at the following facilities:

- Pool workshop
- Diesel workshop
- Pit Service Station

These silt traps will play a large role in the mine's compliance with the relevant mining and water legislation. These silt traps will provide the required infrastructure to ensure separation of the clean and dirty water areas and effective removal of oil from the contaminated water.

The silt trap positioned at the pit service station will have a direct connection to the outfall channel from the plant to the pit, as discussed in Section 4.2. The flow values generated by the overflow of the silt trap will not occur regularly and will not have a large impact but should nevertheless be incorporated within the scope of this report.

### 4.3.3 GG 6 EXPANSION PROJECT – BVI (APPOINTED UNDER LSL)

BVI was appointed under LSL to complete a feasibility study for the expansion of the GG 6 plant area. This project is still in a very early stage but should be incorporated into the stormwater master plan if the development of the specific area results in a large increase of generated run-off.

Once this project reached implementation stage, the stormwater values should be scrutinised and integrated if necessary.

### 4.3.4 PIT UPGRADING PROJECT

The utilisation of the mining pit is cardinal to the functioning of the stormwater system as a whole, since all the mining plant stormwater drains to this point. From the pit the water is pumped back to the plant area to be reused.

Taking this into consideration the pit can be seen as the heart of the stormwater system and it is therefore critical that this element of the network be monitored, maintained and operated with the utmost of care.

The flow of stormwater from the mining plant to the pit is included in the stormwater master plan but some information is still required to complete a

thorough water balance for this element. This would require evaporation, infiltration and recycling (pumping) volumes of the water present in the pit. Further studies can be implemented to gain the required knowledge to complete this section of the stormwater network.

## 4.4 STORMWATER MASTER PLAN DRAWINGS

The Stormwater Master Plan Report serves as a supporting document to the drawings (Appendix C), which is the primary tool for the stormwater master plan. The drawings contain all the information required to make quick decisions regarding projects or planned developments.

The following drawings form part of the stormwater master plan:

- **Area classifications drawing** – Specifying the areas which have been subject to contamination and the areas that are currently not impacted.
- **Stormwater management network** – This drawing will contain all the main stormwater elements to which new developments will connect.
- **Catchment areas** – This drawing will illustrate the division of areas into the different catchment areas.

For the detailed calculations of these drawings, please refer to the relevant detail design report, as stated in Section 4.2.

### 4.4.1 AREA CLASSIFICATION DRAWINGS

This drawing takes into consideration all the changes recently planned during the designs of the General Grootegeluk Stormwater Upgrade. However, the areas not affected by the aforementioned designs were categorised as specified in the SRK Audit Report titled: *Regulation GN704 Audit and Conceptual Design of Surface Water Management Controls.*

The categories used in the drawing is summarised below:

- Dirty Stormwater Areas
- Clean Stormwater Areas
- Open Pit Area
- Waste Rock Dumps
- Rehabilitation Possible.

### 4.4.2 STORMWATER MANAGEMENT NETWORK

A large amount of data was available to utilise and incorporate into the aforementioned drawing. However, some of the areas on the mine are not included on the drawing due to the lack of information. This can, however, be superimposed on the drawing once obtained.

From the available data, not all the elements of the stormwater network were incorporated into the drawing. Some elements were omitted to provide adequate clarity on a drawing of such a large scale. All large stormwater elements were included. For the complete stormwater network of a specific area, the construction drawings can be obtained for the relevant area.

The following information is provided in the drawing:

- Larger stormwater canals
    - Sizes and shapes
    - Capacity
    - Generated flow during following recurrence:
        - 1:20 rainfall event
        - 1:50 rainfall event
        - 1:100 rainfall event
- Background image displaying:
    - Buildings
    - Roads.

Some areas will not have the information stated above, due to the availability of data. Projects completed by Arup and BVI will not be included if the information was not distributed to Delta BEC.

At some areas the width of the canals will be specified (as measured from the block plan). Storm flow calculations and capacity calculation could not be completed due to the lack of information regarding the following:

- Canal depth
- Canal slope
- Layout of smaller stormwater network dividing the catchment areas.

### 4.4.3 CATCHMENT AREAS

P13050-CC-06-SW-004 will display the separate stormwater catchment areas and the general flow direction of the generated flows. Areas with unknown detail will be shown as one large catchment.

# 5 CONCLUSION

It has to be clearly stated that this document is in no way the final revision and that these drawings should be seen as a live document and a work tool that has to be utilised and modified for it to serve its true purpose. The drawings will have to be updated regularly and concurrent with the developing of the mine's stormwater system. This will ensure that a proper summary of the existing stormwater network is available at all times, containing specific information relevant to decision making in terms of development.

It is advised that this document should be updated with the construction drawings and designs of ARUP and BVI projects, to ensure an all encapsulating document.

# APPENDIX A – REGIONAL LAYOUT AND WATERSHEDS

# APPENDIX B – REGIONAL CALCULATIONS

# APPENDIX C – STORMWATER MASTER PLAN DRAWINGS