Options Analysis for a Proposed River Diversion at Kudumane Mine, Northern Cape

Report Prepared for

Kudumane Manganese Resources (Pty) Ltd

Report Number 549507/Options Analysis

Report Prepared by

srk consulting

June 2020

Options Analysis for a Proposed River Diversion at Kudumane Mine, Northern Cape

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Executive Summary

SRK Consulting (South Africa) (Pty) Ltd. (SRK) was requested by Asia Minerals South Africa (Pty) Ltd. (AML) to conduct an options analysis and environmental gap analysis for a proposed river diversion at Kudumane Manganese Resources (Pty) Limited's (KMR) open pit mining operation, which AML is a shareholder and also the technical partner to KMR. The Kudumane mine site is a manganese resource that mines via two open pits. The project site is located in the Kgalagadi District in the northeast of the Northern Cape Province, about 60 km northwest of the regional town named Kuruman.

KMR is exploring the viability of extending the open pit mining operations in a westerly direction at the Hotazel Pit, beyond the 1:100-year floodline. The extension of the pits is restricted by a drainage channel of the Ga-Mogara River on the western side. Various diversion options were evaluated to identify the most feasible option to mine through the river.

Work programme

SRK proposed a 3 phased approach be followed for this project as listed below:

- Phase 1: An option analysis and environmental gap analysis;
- Phase 2: A detailed design of the selected option; and
- Phase 3: Environmental permitting.

The current study was conducted within the scope of Phase 1 and details are presented in the following chapters based on the evaluation of the different diversion options. Phase 2 and Phase 3 studies will be carried out as a result of the primary studies and at the request of the KMR. A schematic of the proposed approach of SRK is shown in Figure ES–1 and a high-level summary is presented in Table ES–1 below.

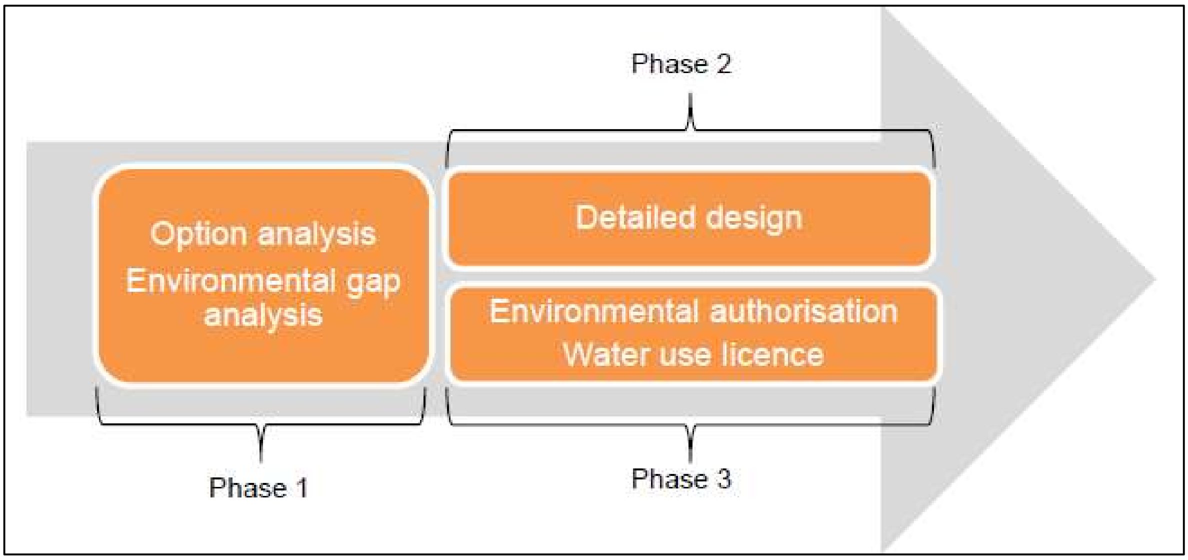


Figure ES-1: Schematic of Proposed Phased Approach

Table ES-1: High-Level Workplan

Phase	Objective	Deliverables
Phase 1: An option analysis and environmental gap analysis	To assess the various options to extend the extraction of ore beyond the 1:100 floodline and to confirm the environmental permitting requirements.	➢ An option analysis report; and ➢ An environmental gap analysis report.
Phase 2: A detailed design of the selected option	To provide a feasibility level detailed design of the chosen option presented in the option analysis report.	➢ A detailed design report.
Phase 3: Environmental permitting	To undertake the required environmental authorisation processes for the chosen option. Note: The detailed design phase (Phase 2) will run in parallel with the environmental permitting phase (Phase 3).	➢ An Environmental Management Programme; and ➢ A Water Use Licence Application.

Results

Various options were evaluated in the Hotazel and York Open Pit areas to divert possible floods away from the pit to allow mining to continue. Further options allowed the pits to flood but ensured that the safety of employees is met when flooding is expected. The possible diversion options include attenuation ponds, diversion channels with different alignments and the combination of the channels and ponds.

Six options were evaluated and described below:

- **Option-1:** The first and recommended option is to construct attenuation ponds along the Ga - Mogara River upstream of the site and store a certain portion of the flood water. It is not practical to store the 100-year flood water volume within the ponds. The number of dams and positions where selected being the most practical that can allow monitoring and controlling the flow in this semi-arid region;
- **Option-2 and Option-3:** These options include a combination of attenuation ponds and diversion channels. Although the diversion channels have been designed with sufficient capacity to hold 100-year peak flow rate, elevation difference between the river course and bank area is excessive. Therefore, attenuation ponds were considered to be done in conjunction with channels to store an initial portion of the flood and raise the water level to reduce the excavation volume of the channels. These options are prohibitively expensive and impractical; and
- **Option-4 to Option-6:** Single diversion channels were studied along the path of the York and Hotazel pits. Considering the excessive amount of excavation due to the distance and elevation difference, these options are not feasible.

In summary, Option-1 that includes two dams (Scenario-1) upstream of the pits and then allowing the potential flooding of the pit is recommended by SRK to move forward through the next phase of the project.

Table of Contents

List of Tables

List of Figures

Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by Asia Minerals South Africa Pty Ltd (AML). The opinions in this Report are provided in response to a specific request from AML to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

List of Abbreviations

AML	Asia Minerals South Africa (Pty) Ltd
a.s.l	Above Sea Level
DTM	Digital Terrain Model
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
HEC-RAS	Hydrologic Engineering Centre's River Analysis System
ISRIC	International Soil Reference and Information Centre
IWWMP	Integrated Water and Waste Management Plan
k	Thousand
Km	Kilometre
KMR	Kudumane Manganese Resources (Pty) Limited
LIDAR	Laser Imaging Detection and Ranging
LP DAAC	Land Processes Distributed Active Archive Centre
m	Metre
M	Million
m^3/s	Metre cube per second
MAP	Mean Annual Precipitation
mm	millimetre
MPRDA	Mineral and Petroleum Resources Development Act
n	Manning's Roughness Coefficient
NASA	National Aeronautics and Space Administration
NEMA	National Environmental Management Act
NLC	National Land Cover
NWA	National Water Act
R	Rand
RMF	Regional Maximum Flow
SLR	SLR Consulting
SRK	SRK Consulting (South Africa) (Pty) Ltd
UPD	Utility Programs for Drainage
WR	Water Resources of South Africa
WRD	Waste Return Dam
WUL	Water Use Licence
WULA	Water Use Licence Application

1 Introduction

Kudumane Manganese Resources (Pty) Limited (KMR) is a manganese open pit mining operation in the Kgalagadi District in the Northern Cape Province. Asia Minerals South Africa (Pty) Ltd (AML) is a 49% shareholder in KMR and acts as technical partner to KMR in terms of a Technical Services Agreement.

SRK Consulting (South Africa) (Pty) Ltd (SRK) was appointed by AML to conduct an options analysis and environmental gap analysis for a proposed river diversion at KMR. KMR is exploring the viability of extending the open pit mining operations in a westerly direction at the Hotazel Pit, beyond the 1:100-year floodline. The extension of the pits is restricted by a drainage channel of the Ga-Mogara River on the western side.

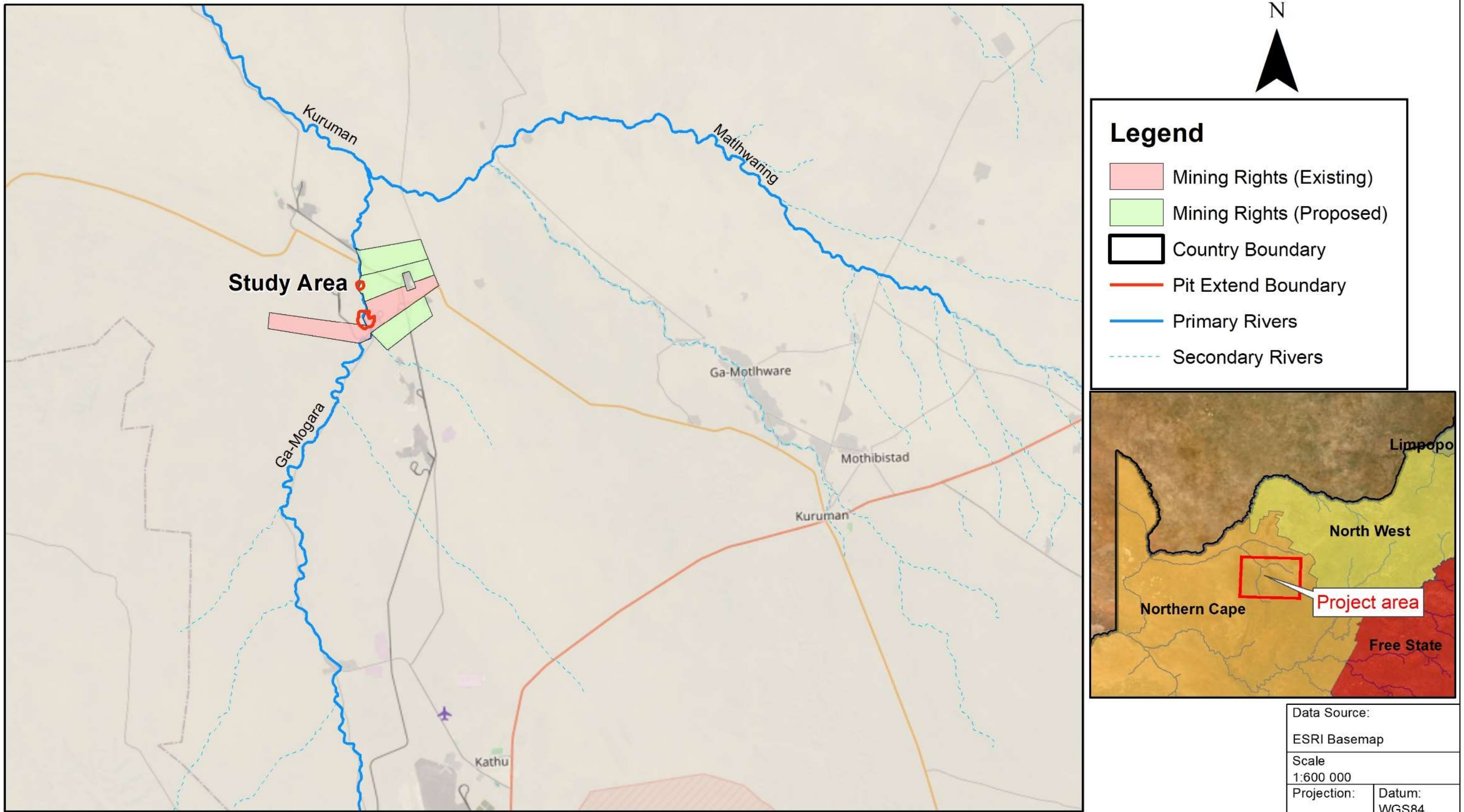
Open pit mining of the orebody beyond the 1:100-year floodline will trigger various environmental authorisations for the realignment of the river or will require an alternative engineering intervention to allow access to the ore reserves underneath the current drainage channel of the Ga-Mogara River.

SRK has investigated six options for the proposed diversion and undertook a gap analysis on the environmental authorisation process.

1.1 Project location

KMR is located approximately 5 km west of the R31 road that links Hotazel to the regional town of Kuruman, about 60 km south-east of Hotazel on the N14 to Upington (Figure 1-1).

The mine is located along the eastern edge of the Kalahari Manganese Field on the farms York A 279, Telele 312, Kipling 271, Devon 277 and Hotazel 280. The mine is part of the Lower Vaal Water Management and is located in the quaternary catchment D41K.



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KUDUMANE GAP ANALYSIS
LOCALITY MAP

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2 Scope of Work

2.1 SRK approach

Geological data underpinning the KMR mining right confirms that the manganese ore is extending in a westerly direction on the York, Hotazel and Kipling properties. Mineral extraction is however, restricted to the western side by the Ga-Mogara River. The 2017 Water Use Licence (WUL) amendment application sought authorisation to encroach within 100 m of the watercourse in the mining operations on the York and Hotazel Open Pit areas, extending these operations up to the 1:100-year floodline. The aim was to maximise the extraction of ore in a westerly direction.

KMR is now exploring the viability of possible further extension of the open pit mining operations in a westerly direction at the Hotazel Pit, beyond the 1:100-year floodline. SRK has been appointed to assess various options to divert the river away from the proposed pit expansion.

Open pit mining of the orebody beyond the 1:100-year floodline will trigger the requirement to obtain various environmental authorisations for the realignment of the river, or an alternative engineering intervention to allow access to the ore reserves underneath the current drainage channel of the Ga - Mogara River.

SRK will conduct a phased approach be followed for this project, namely:

- Phase 1: An options analysis and environmental gap analysis;
- Phase 2: A detailed design of the selected option; and
- Phase 3: Environmental permitting.

This report is presented within the scope of Phase 1 of the project and does not include any work for Phase 2 and 3, which requires a detailed scope and budget. SRK conducted a site on 26 February 2020 and a workshop was held at KMR on 27 February 2020 to discuss the options of diverting the Ga-Mogara River.

3 Project Objectives

KMR is now exploring the viability of a possible further extension of the open pit mining operations in a westerly direction at the Hotazel Pit, beyond the 1:100-year floodline. It is apparent that opencast mining of the orebody beyond the 1:100-year floodline will trigger the requirement to obtain various environmental authorisations for the realignment of the river, or an alternative engineering intervention to allow access to the ore reserves underneath the current drainage channel of the Ga-Mogara River.

To understand how the mine can best extract the ore between beyond the 1:100-year floodline, it is necessary to determine the options open to KMR, which will in turn inform the nature and purpose of the environmental authorisation process. SRK proposes that an option analysis be undertaken, taking into account mine planning, topography, hydrology and land ownership, amongst other aspects. Once a feasible option is chosen, environmental authorisation and detailed design can commence.

4 Environmental Gap Analysis

The current report summarizes the hydrological aspect of the project and option analysis. The Environmental gap analysis study carried out by SRK is presented as a separate report (SRK, 2020).

5 Baseline Hydrology

In order to evaluate the different diversion options of Ga-Mogara River in the vicinity of the York and Hotazel Open Pit areas, an understanding of the baseline hydrology and meteorological characteristics are required. This section presents a comprehensive review of the general hydrological characteristics of the study area and the representative catchment by using different information sources.

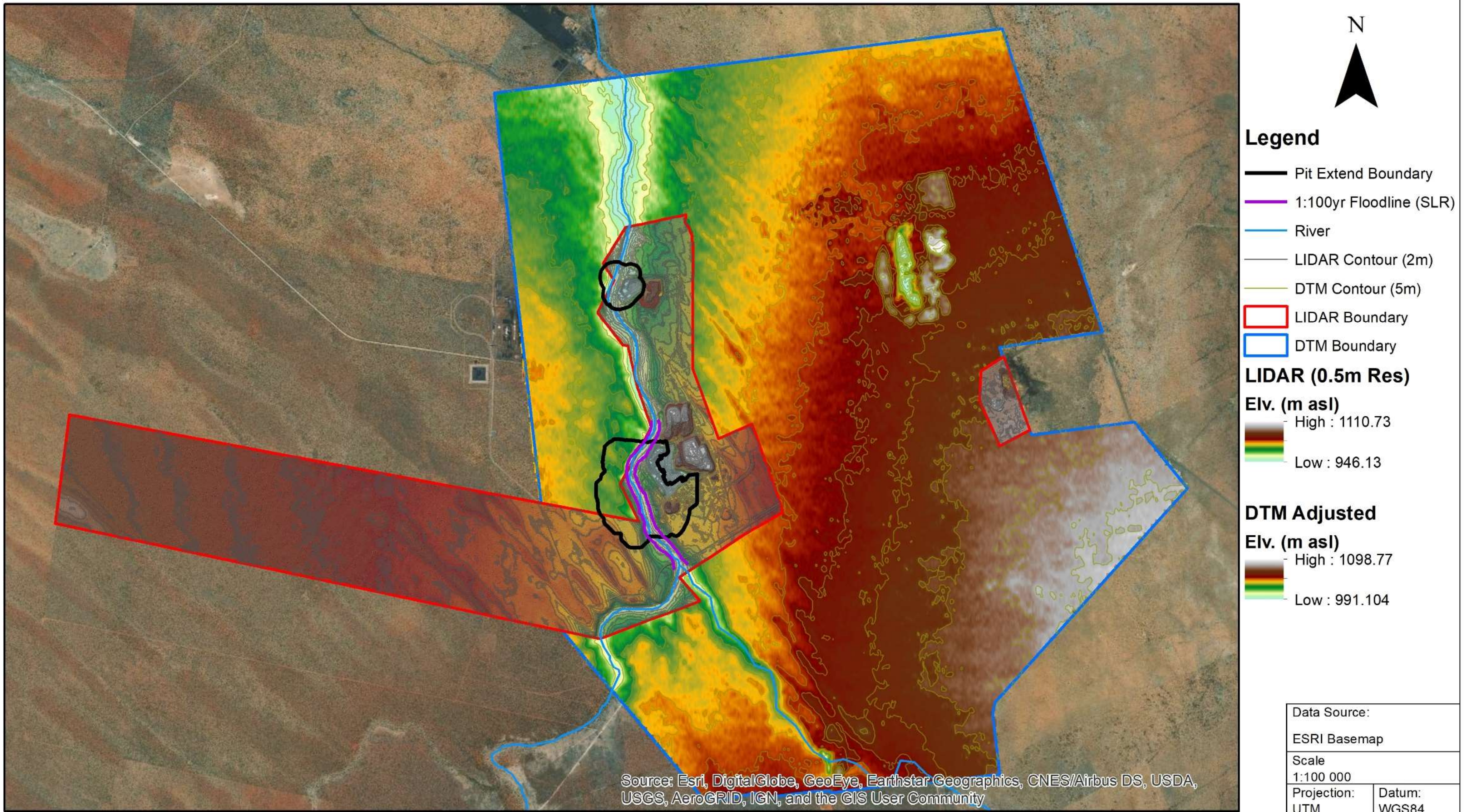
The project area is located in the Orange River Basin, in quaternary catchment D41K and downstream of D41J. The total catchment area of the ephemeral Ga-Mogara River is about 8000 km² and joins the Kuruman River at the north and downstream of the project site.

The Kudumane Manganese Mine site falls within the Northern Steppe climatic zone as defined by the South African Weather Bureau. The general characteristics of the area is defined as a semi-arid region, which shows low rainfall, but high temperature and evaporation. Thus, the project site catchment is classified as endoreic with large areas, which do not contribute to runoff as the watercourses.

Figure 5-1: Typical View of Ga-Mogara Riverbed in the York Area

5.1 Topography

The topography and the available topographical data of the study area in vicinity of the mine site is presented in Figure 5-2. The diversion options and related analysis were performed by using two different elevation data sources. The biggest portion of the study was evaluated by using the most recent Laser Imaging Detection and Ranging (LIDAR) data, which data boundaries are illustrated below. The Digital Terrain Model (DTM) was evaluated with a 0.5 m resolution by using the LAS point cloud provided by KMR. Where the study extended to the area outside of the LIDAR boundaries, another DTM data source that was generated in 2007 was used. The DTM 2007 elevation model with the 30 m resolution was compared with the high resolute LIDAR data and elevated by 2.7 m, due to the average difference in the study area, to even out the elevation differences between the different sources.



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KUDUMANE GAP ANALYSIS
TOPOGRAPHY DATA

Besides the topographical data provided by KMR in the near vicinity of the mine site, the ASTER GDEM v3 Global Digital Elevation Model was provided by using the NASA's (National Aeronautics and Space Administration) Land Processes Distributed Active Archive Centre (LP DAAC). The ASTER dataset, which has 30 m resolution, was used in the current study to make assessments on a large scale of the study area.

5.2 Rainfall

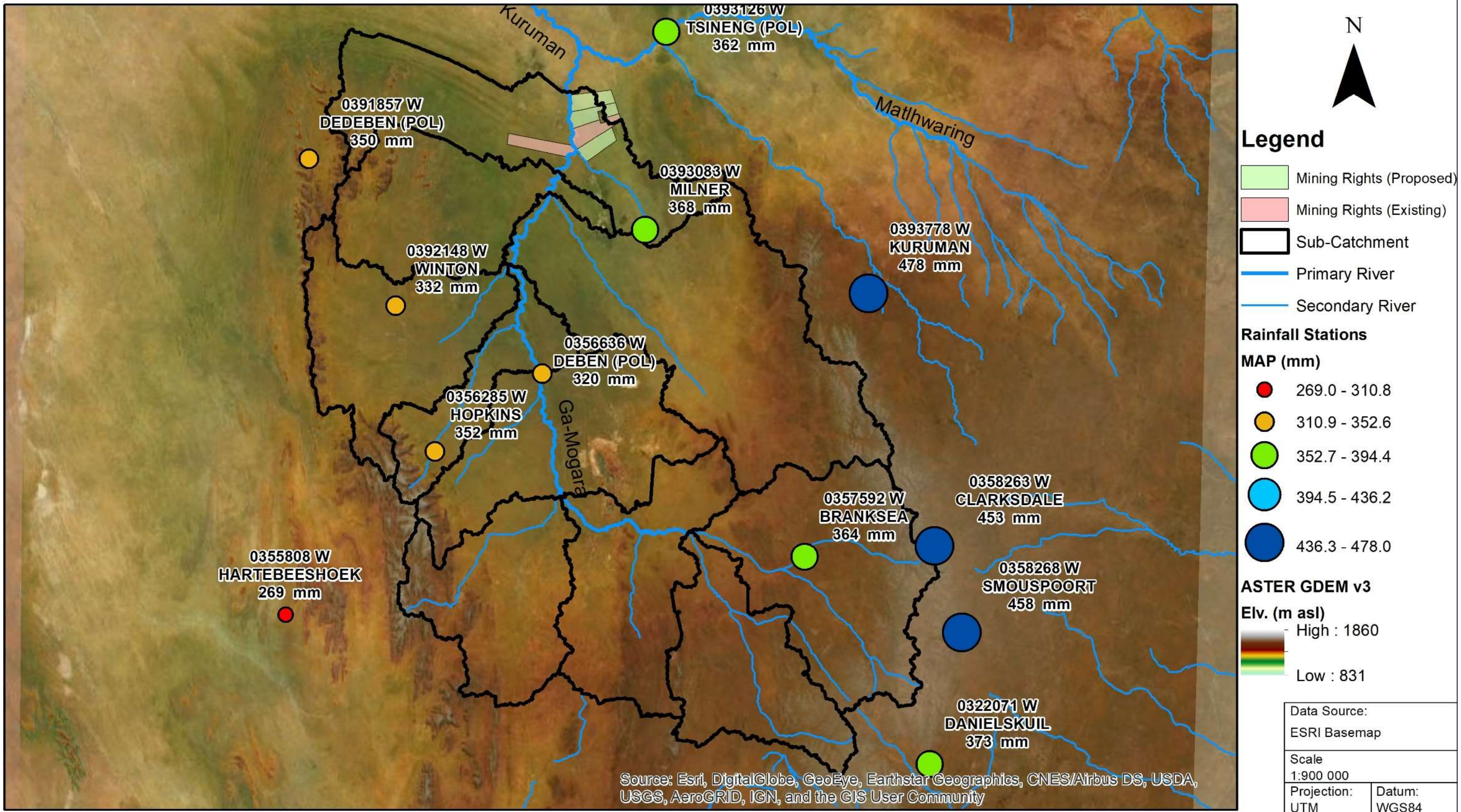
On-site specific rainfall record is not available on the Kudumane Mine Site. Since the Ga-Mogara River has approximately a 7678 km² catchment area, regional rainfall stations located in the upstream catchment were evaluated. The rainfall data was extracted from the Water Resources of South Africa 2012 (WR2012) database. The available rainfall station summary in vicinity of the project area and neighbouring river catchment is summarized in Table 5-1.

Table 5-1: Rainfall Station Summary Information (WR2012)

Station ID	Station Name	Latitude	Longitude	Elevation (m a.s.l)	MAP (mm)	YR_START	YR_END	Distance to Project Site (km)	Direction to Project Site
0393083 W	MILNER	-27.38	23.05	1118	368	1931	2009	19.2	SE
0428838 W	KARLSRUHE	-26.98	22.98	1050	322	1927	1960	29.5	N
0393126 W	TSINENG (POL)	-27.08	23.08	1049	362	1967	2009	31.26	NE
0356636 W	DEBEN (POL)	-27.6	22.88	1110	320	1925	2009	39.7	S
0392148 W	WINTON	-27.5	22.63	1180	332	1926	2009	41.1	SW
0391857 W	DEDEBEN (POL)	-27.28	22.48	1260	350	1931	2009	45	W
0393778 W	KURUMAN	-27.47	23.43	1320	478	1924	1976	55.3	SE
0430111 W	LONGHURST	-26.85	23.57	1120	350	1920	1950	76.8	NE
0427469 W	ONRUST	-26.77	22.25	950	228	1931	1972	85.8	NW

The closest rainfall station is Milner (0393083 W), which is located 19.2 km south-east of project area. The Milner station has a 368 mm Mean Annual Precipitation (MAP) record. According to the WR2012 database, the average MAP is calculated as 347 mm, with stations that where located in the catchment area.

Spatial distribution of the rainfall stations and MAP values are presented in Figure 5-3. A decrease in the MAP is prevalent from east to west. Western rainfall stations that are outside of the catchment boundary records more than 450 mm MAP, while it is less than 300 mm along the eastern boundary. Topographical patterns and elevation affect the spatial distribution of the rainfall characteristic.



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KUDUMANE GAP ANALYSIS
RAINFALL STATIONS / Mean Annual Precipitation

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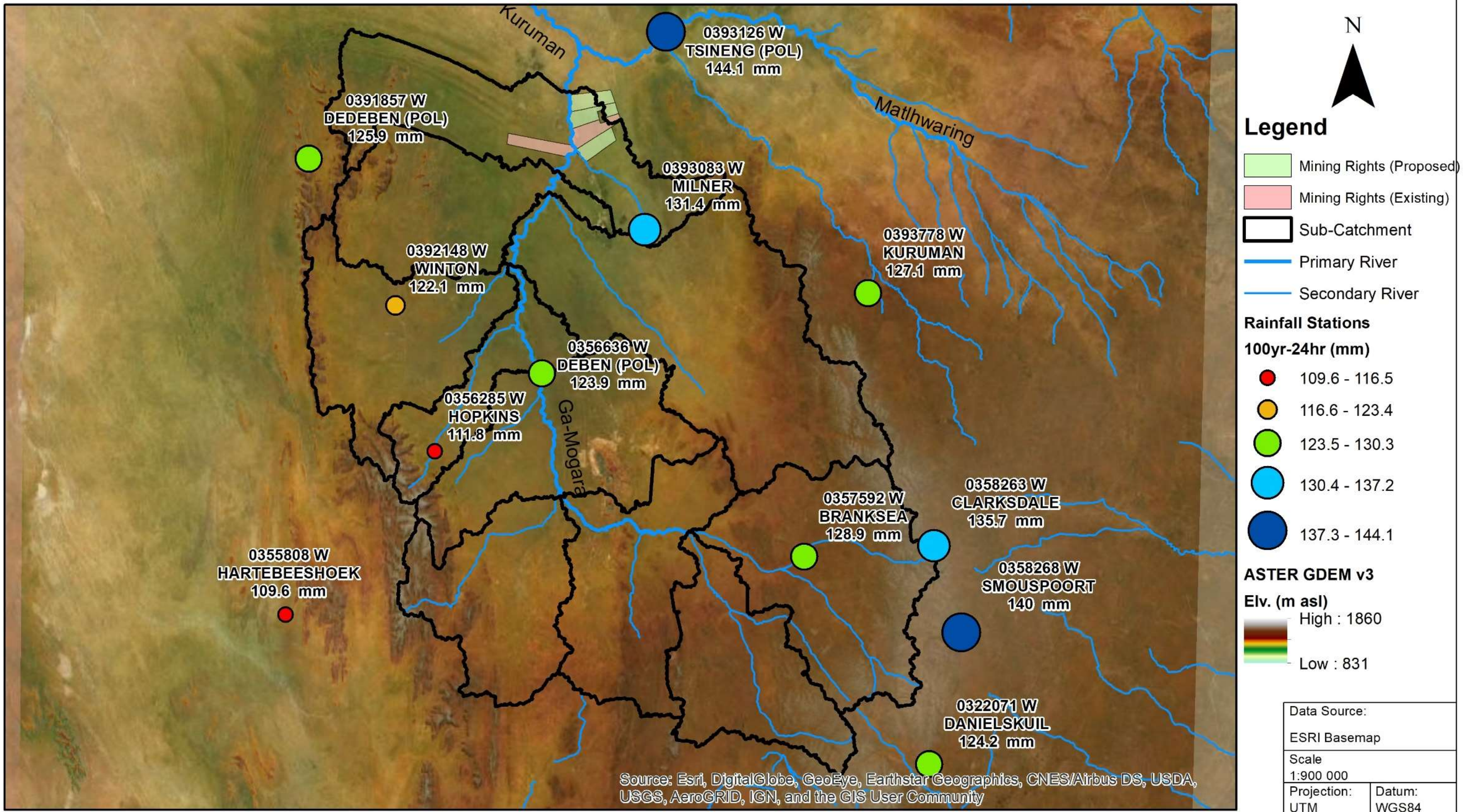
5.3 Design rainfall

In addition to the MAP, statistical characteristics of the rainfall records were evaluated in vicinity of the project area and related catchments. 100-year 24-hour Design rainfall distribution is presented in Figure 5-4.

The closest rainfall station, Milner (0393083 W) shows 131.4 mm design rainfall in 24-hour duration for 1:100-year Recurrence Interval storm. The highest design rainfall depth observed was at the Tsineng (POL) (0393126 W) station, which is located 31.3 km northeast of the project site.



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KUDUMANE GAP ANALYSIS

RAINFALL STATIONS / Design Rainfall (100yr-24hr)

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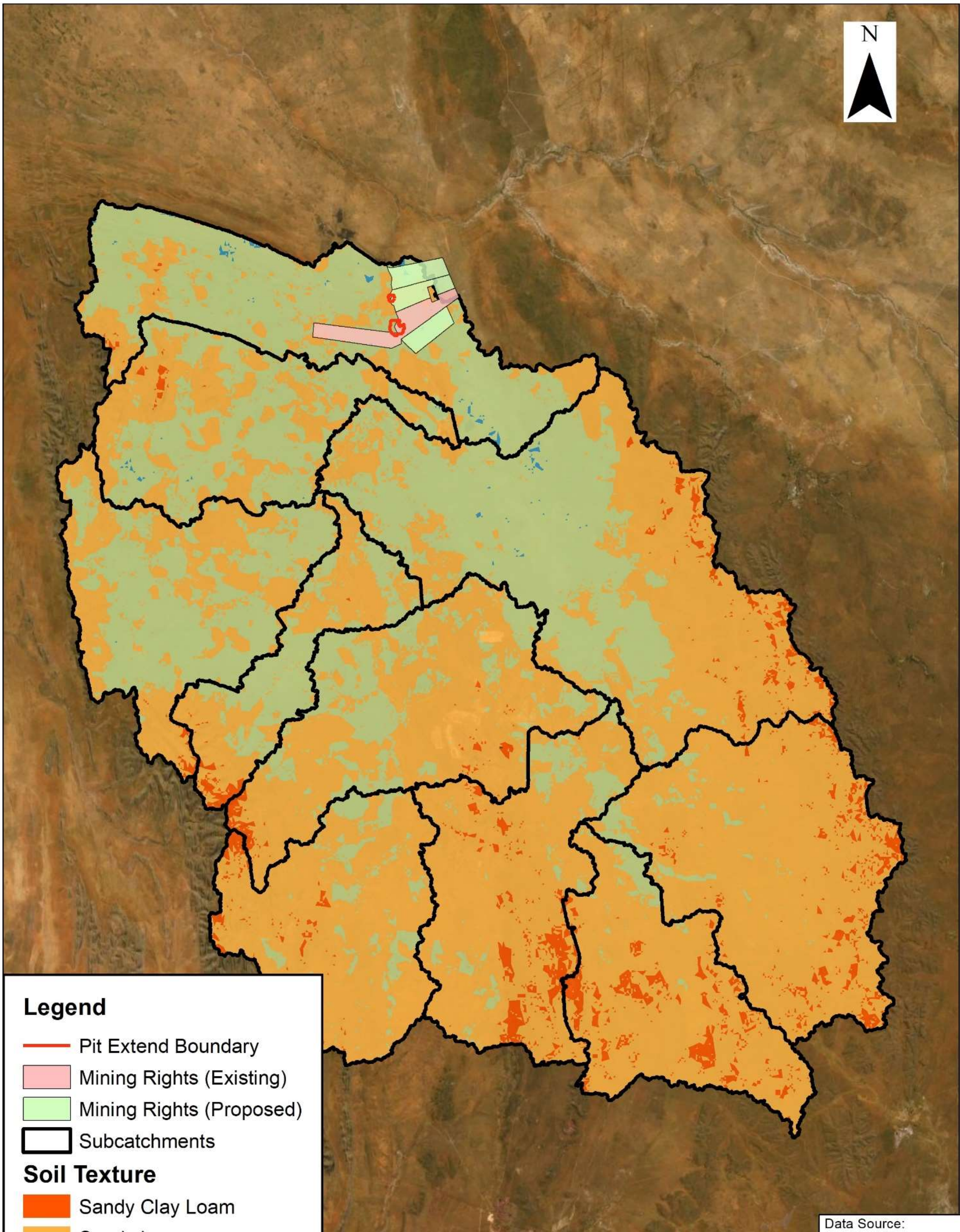
5.4 Soil and land cover characteristic

To develop a general understanding of soil characteristics and hydrological properties of the catchment of Ga-Mogara River, soil texture information is required. Soil texture data and spatial distribution was obtained from a remote sensing programme called SoilGrids 250 m Database of International Soil Reference and Information Centre (ISRIC, 2017). The general soil characteristics that affects the rainfall runoff relationship in this catchment area (Figure 5-5) is dominated by Sandy Loam and Loamy Sand. Some Sandy Clay Loam and Sand type of soil is also prevalent in the study area. In addition to the available data, the site observations also support that the catchment soil is formed with high sandy texture, that allows for a high infiltration rate and a low water holding capacity.

In addition to the soil characteristic, the land cover classification of the catchment was also evaluated by using the National Land Cover database (NLC, 2009). The majority of the catchment area is classified as a natural land cover of semi-arid scrub. Due to the dry climate condition of the site, plantation and cultivation areas is minimal. Secondary land cover classes are presented by mine sites and degraded areas. The land cover classification over the catchment is presented in Figure 5-6, below.



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KUDUMANE GAP ANALYSIS

SOIL TEXTURE

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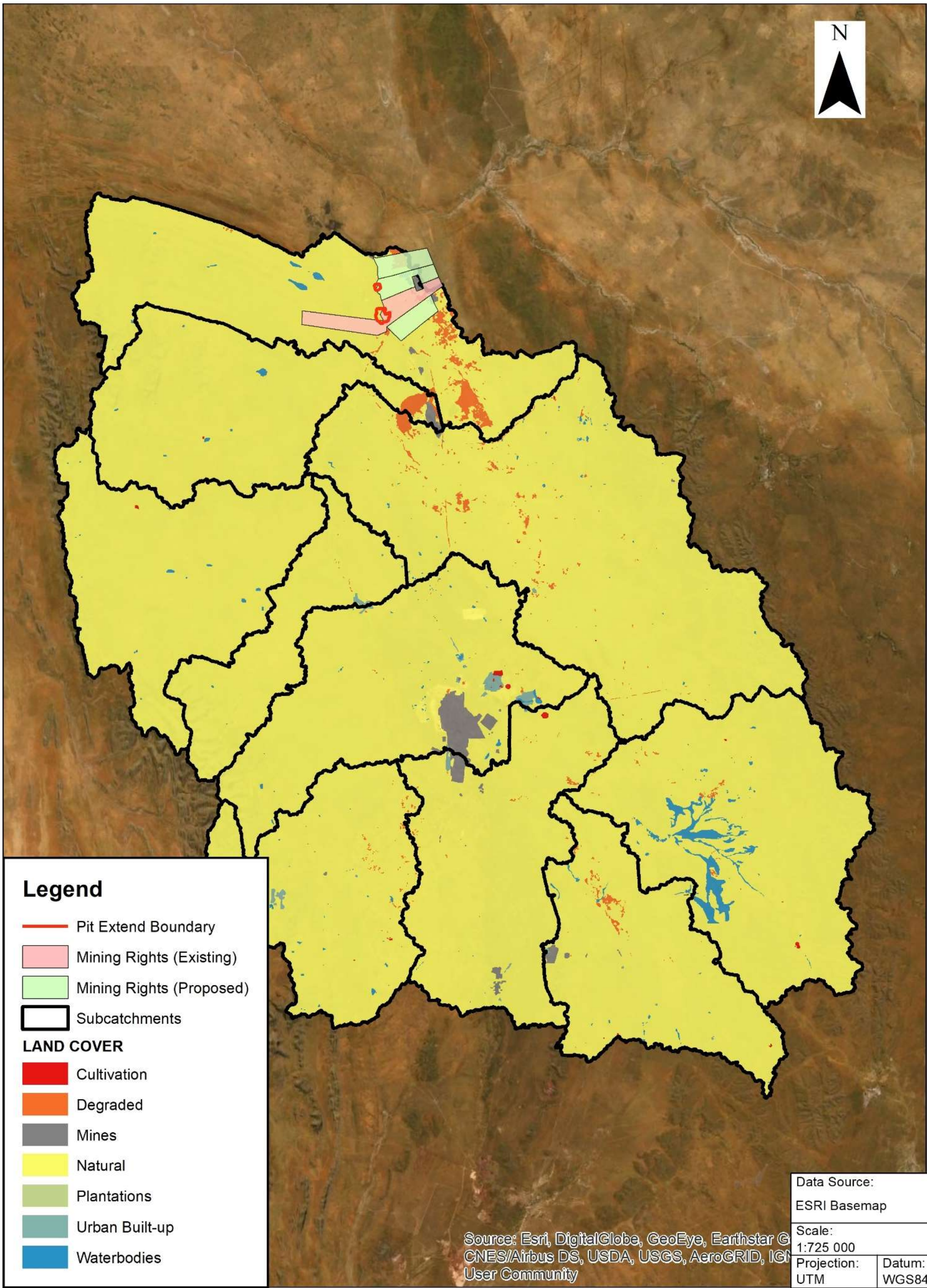

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KUDUMANE GAP ANALYSIS
LAND COVER

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5.5 Previous hydrology studies

The current study carried out by SRK to evaluate the different diversion options at Ga-Mogara River course for KMR does not cover any peak flow and floodline analysis. The design flow rate information was obtained from the previous hydrological studies as listed below:

- The Hydrological Assessment for the Proposed Kudumane Mine (Metago Environmental Engineers, 2010);
- The Integrated Waste and Water Management Plan (SLR Consulting, 2012);
- The New Mining Right Application for Devon, Kipling and Hotazel Surface Water Study, (SLR Consulting, 2014); and
- The Water Use Licence Application (WULA) Storm Water Management Design (SLR Consulting, 2015).

The initial hydrological assessment study carried out by Metago presents flood peak numbers that are determined by using the Regional Maximum Flood (RMF) method, as implemented in the Utility Programs for Drainage (UPD) software (SANRAL, 2006). Accordingly, 402.7 m^3/s was calculated for 1:50-year and 517.7 m^3/s for the 1:100-year design storm. Related floodlines were modelled by using the HEC-RAS software.

In the surface water study undertaken by SLR Consulring (2014), flood conditions were re-evaluated and included an estimation of peak flow in the Ga-Mogara River. Since the Ga-Mogaro River does not flow regularly, previous flow events based on anectodal evidence were evaluated. Notes from local farmers showed that notable flow at Ga-Mogara River occurred between 1974 and 1976 and again in 1988. A photo that was taken at a watercourse crossing at Kipling in 1976 year is presented in Figure 5-7.

Figure 5-7: Flood Event Occurred in 1976 at around Kipling Farm (SLR, 2014)

The probability of the flow in any one year is estimated to be 1:13 and the approximate peak flow was calculated as 35 m³/s at the cross section by developing a HEC-RAS model at the ungauged river.

In addition to the historical flood events based on farmers observation, the floodline study was supported by using the aerial images. 100 m³/s and 250 m³/s Floodlines were evaluated and a comparison was made based on the border of the darker brown alluvial soils and dense grass cover at the river banks. As a result, the largest peak flow is estimated to be likely less than 250 m³/s at the study area.

In addition to the flood assessment based on the historical flow observations in the ungauged catchment, SLR Consulting (SLR) also carried out peak flow analysis by using the RMF method, which is an emprical method based on maximum peak flow records all around Southern Africa. Due to recorded flood flow rates and catchments, a regional K Value was related through the catchments.

In the 2010 studies performed by Metago, the K value was taken as 2.8 with the result of 403 m³/s for a 1:50-year and 517.7 m³/s for the 1:100-year. Based on the peak flow estimations based on catchments C3H004 and C3H017, the K value was mentioned a better representation with 1.7. As a result of revised peak flow estimations by SLR, estimated flow rates are presented Table 5-2 where the numbers also participated in the WULAs.

Table 5-2: RMF Method Peak Flow Estimations (SLR, 2014)

Event	Peak Flow (m³/s)
	K=1.7
Regional Maximum Flow (RMF)	400
1:200	251
1:100	198
1:50	154

Regarding to the previous studies, the following diversion option studies are evaluated based on 1:100-year design flow of 198 m³/s calculated by SLR and presented in the previous Environmental Impact Assessment (EIA) and WULA reports.

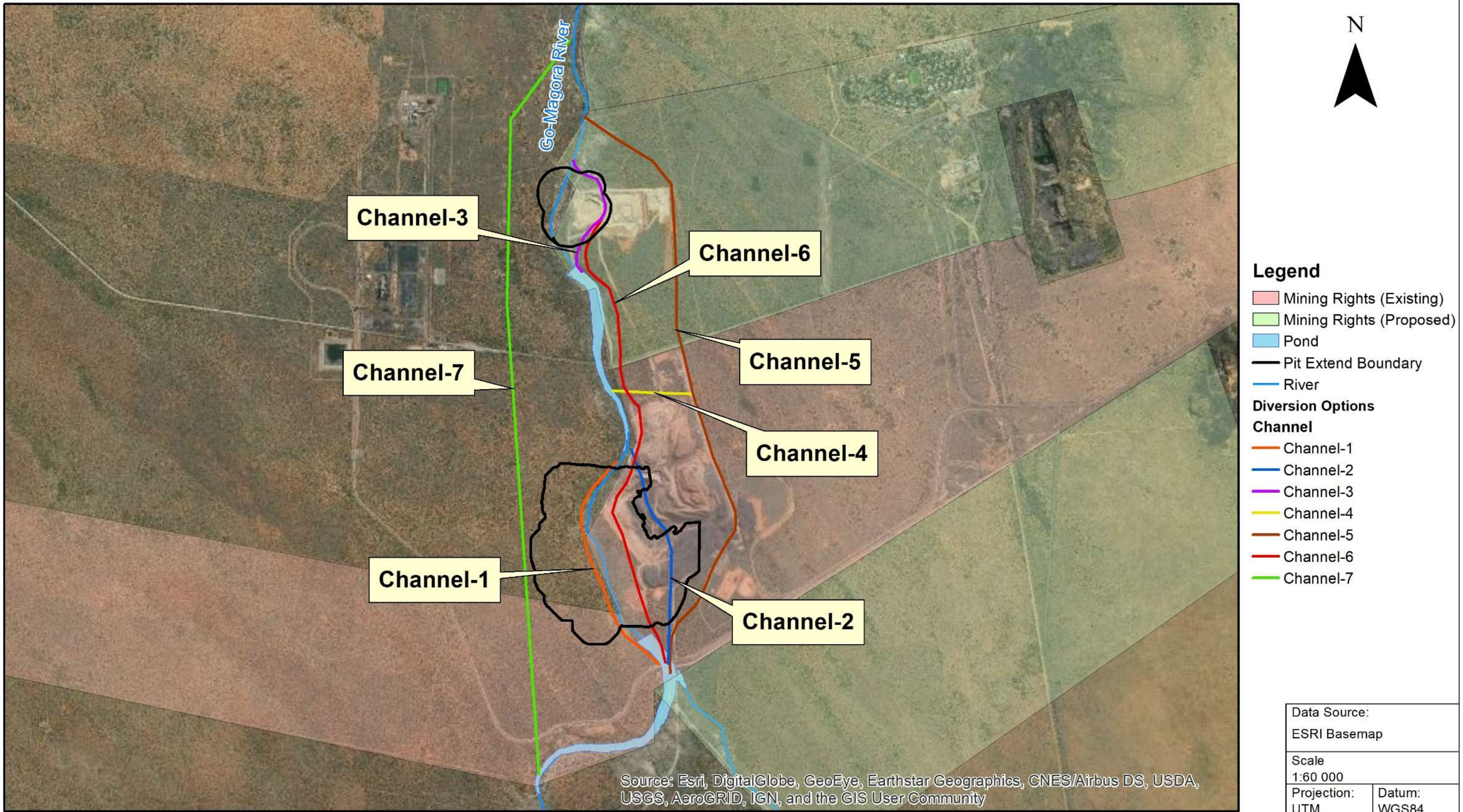
6 Options Analysis

Various options were evaluated in Hotazel and York Open Pit areas to divert possible floods away from the pit to allow mining to continue. Further options allowed the pits to flood, but ensured that safety parameters are met when flooding is expected. The possible diversion options include attenuation ponds, diversion channels with different alignments and the combination of the channels and ponds.

The general presentation of the option units evaluated in the following section of the current report are shown in Figure 6-1.

Each option was evaluated from a hydrological, hydraulic and cost point of view.

It should be noted that all rates and estimated option costs mentioned in the report are VAT exclusive.



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KUDUMANE GAP ANALYSIS
RIVER DIVERSION OPTIONS

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Pond and diversion channel options and capacities were evaluated by using the 1:100-year peak design criteria as 198 m³/s estimated by SLR by using the RMF method. Accordingly, a typical cross section that can handle the design flow rate was estimated to understand the minimum requirements of the diversion channel options around the mine facilities. The typical cross section is selected as a trapezoidal channel with a 5 m bottom width and 1:1.5 m/m side slopes, with 4.2 m normal depth under an average condition of 0.0015 channel slope through the channel route. Manning's n coefficient was taken as 0.015 that represents a clean channel. A summary of the information is given in Table 6-1 below.

The typical cross section details were presented in Figure 6-2. It should be noted that the dimensions of the typical cross section represent the minimum requirements to carry 198 m³/s design flow, especially the channel width and the normal depth. Since the river course and bank stations has approximately a 20 m to 30 m elevation difference along the mine site, the depth and excavation requirements were estimated due to topography for each individual channel. As a general approach, 5 m bottom width was applied for each of the diversion channel option.

Table 6-1: Diversion Channel Summary Information

Channel	Length (m)	Inlet Elevation (m a.s.l)	Outfall Elevation (m a.s.l)	Slope (m/m)	Option
Channel-1	2676.5	1032	1029	0.0011	Option-2
Channel-2	2480.9	1030	1026	0.0016	Option-2
Channel-3	1369.7	1025	1021	0.0029	Option-2, 3
Channel-4	4284.4	1030	1025	0.0012	Option-3
Channel-5	7081.2	1029	1019	0.0014	Option-4
Channel-6	5985.9	1029	1019	0.0017	Option-5
Channel-7	8402.5	1031	1018	0.0015	Option-6

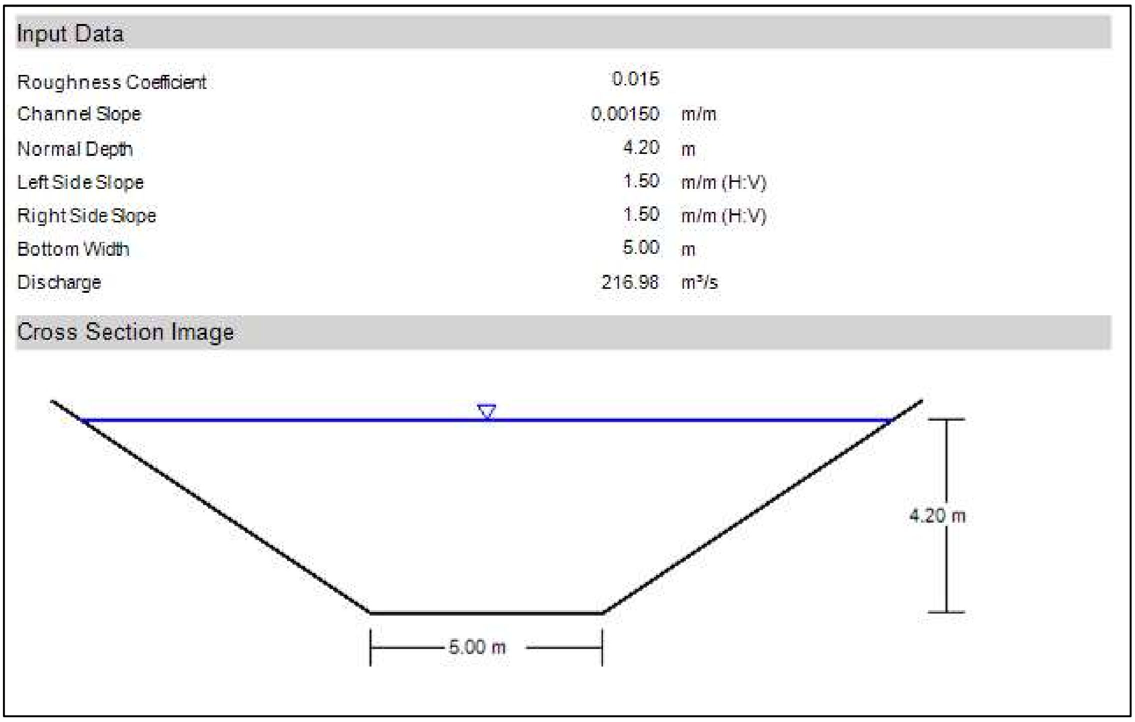


Figure 6-2: Typical Cross-Section of Diversion Channels

6.1 Option-1:

6.1.1 Description of option

Option-1 includes the construction of dams along the river course to attenuate the flow before reaching the open pit areas. In this option, there are no diversion channels.

Since the project area is located in the low-rainfall zone and the soil is very sandy, the rainfall-runoff is minimal in the vicinity of the project area. The most recent flow in the stream bed was observed in the late 1970s and 1980s. The capture and attenuation of the flowing upstream ponds is technically a good option and if the ponds overflow, the open pit operation can be suspended until the storm has abated. The mitigation measure will be to monitor upstream flows and give sufficient time to evacuate the pit. If the water flows into the pit, then the pit can be pumped dry and mining can commence.

In order to determine the cost efficiency of the pond option, two different scenarios were evaluated.

Scenario-1:

- Scenario-1 represents two bigger dams;
- Total storage volume of Scenario-1 dams are 739 453.6 m³;
- The upstream pond will be constructed with a crest elevation 1032 m a.s.l and will be able to store 430 260.8 m³, which is enough volume to attenuate a runoff event with 10.2 m³/s; and
- The downstream ponds that are located between the open pits will be constructed with a crest elevation up to 1025 m a.s.l and have a storage volume of 309 192.8 m³, which is able to store a single runoff event with 7.34 m³/s peak flow.

Scenario-2:

- Scenario-2 represents the smaller dams along the riverbed immediately upstream of the pits;
- Total storage volume of Scenario-1 dams are 273 761.0 m³;
- Two ponds were simulated upstream of York Open Pit area with a total storage volume of 176 712 m³. A flood event with 4.2 m³/s peak flow in 24-hours can be captured at upstream ponds; and
- Two ponds were evaluated between the open pits considering the civil structures along the river course. Accordingly, a total of 97 048 m³ volume will be sufficient to handle 2.3 m³/s flood peak in 24-hours.

A summary of the design information of the ponds for Option-1's Scenario-1 and Scenario-2 are presented in Table 6-2.

Table 6-2: Option-1 Pond Summary Information

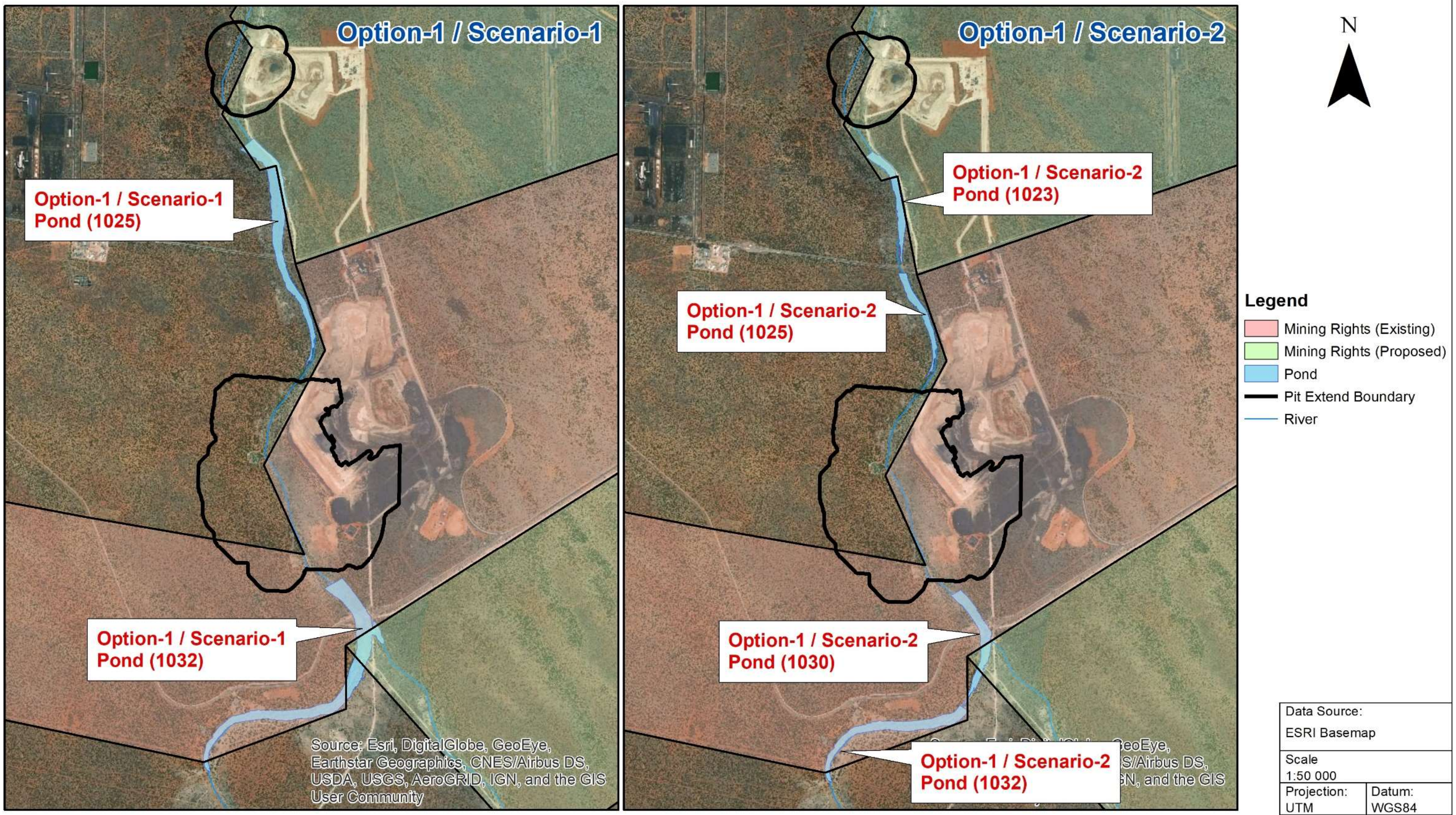
Dam Scenario	Pond ID	Crest Elv. (m a.s.l)	Dam Length (m)	Pond Surface Area (m²)	Storage Volume (m³)	Location
1	Dam_Opt1_1025	1025	163.1	199125.8	309192.8	Between the York and Hotazel Open Pits
1	Dam_Opt1_1032	1032	184.9	301434.0	430260.8	Upstream of York Open Pit
2	Dam_Opt2_1023	1023	90.2	68534.4	59542.1	Between the York and Hotazel Open Pits
2	Dam_Opt2_1025	1025	75.1	51655.5	37506.2	Between the York and Hotazel Open Pits

Dam Scenario	Pond ID	Crest Elv. (m a.s.l)	Dam Length (m)	Pond Surface Area (m²)	Storage Volume (m³)	Location
2	Dam_Opt2_1030	1030	109.1	87492.4	73122.6	Upstream of York Open Pit
2	Dam_Opt2_1032	1032	91.4	126041.5	103590.1	Upstream of York Open Pit

Pond maximum elevations were determined considering the civil structures, such as road crossings and bridges, as well as existing farms and houses. Option-1 evaluated larger dams and as a result larger pond volumes and storage capacities. Although Scenario-1 has a higher storage capacity, the main road transition between the York and Hotazel Open Pits needs to be increased in height to a 1025 m a.s.l crest elevation in order to prevent the back filling of the York pit at upstream.

In Scenario-2, smaller dam bodies are evaluated by considering the surface structures. The pond volumes calculated with the LIDAR topography indicates that the small dams are able to contain less storage volume.

A comparison of the options is presented in Figure 6-3. The dam cross section details of Option-1's Scenario-1 and Scenario-2 are presented in Figure 6-4 and Figure 6-5, respectively.



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OPTION-1

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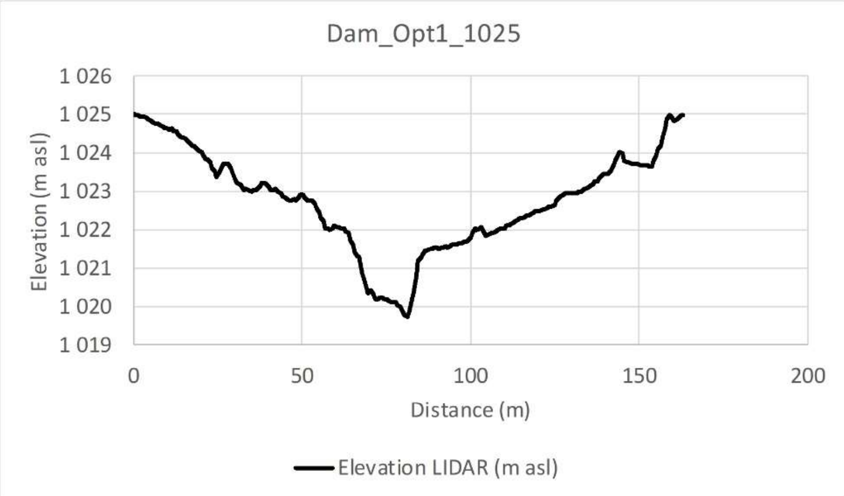

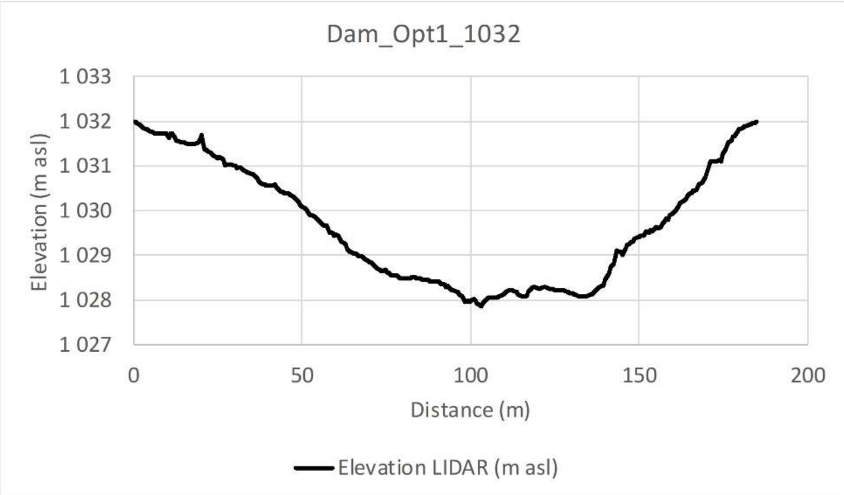

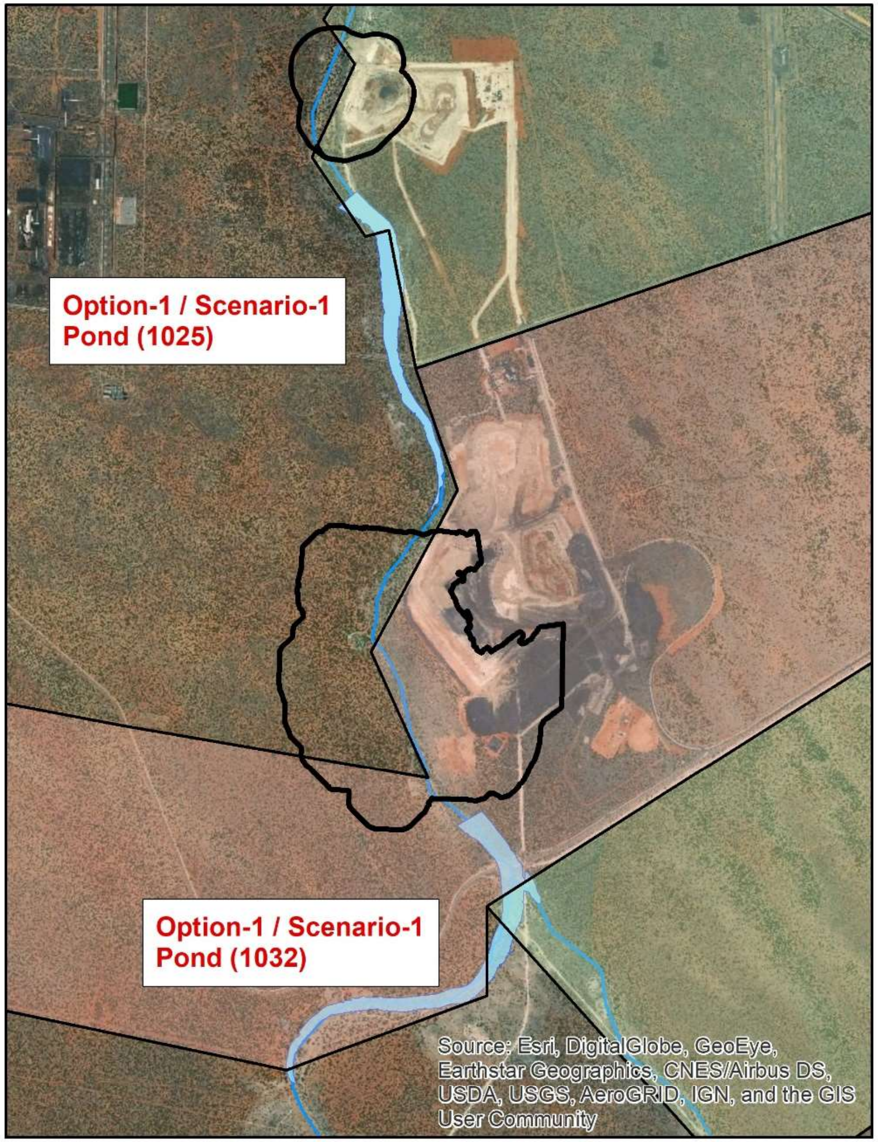

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Legend

- Mining Rights (Existing)
- Mining Rights (Proposed)
- Pond
- Pit Extend Boundary
- River

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OPTION-1 / Scenario-1

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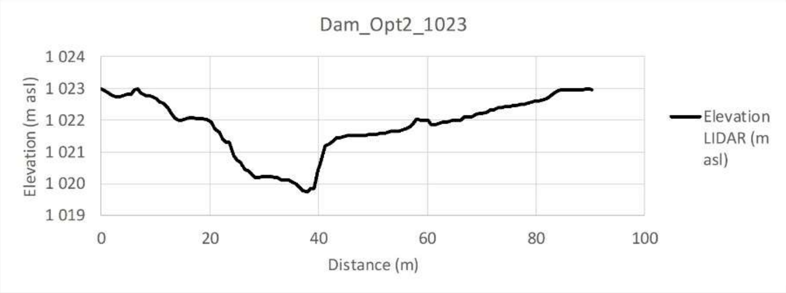

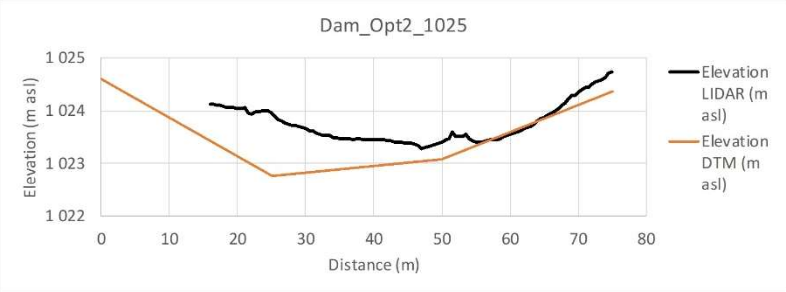

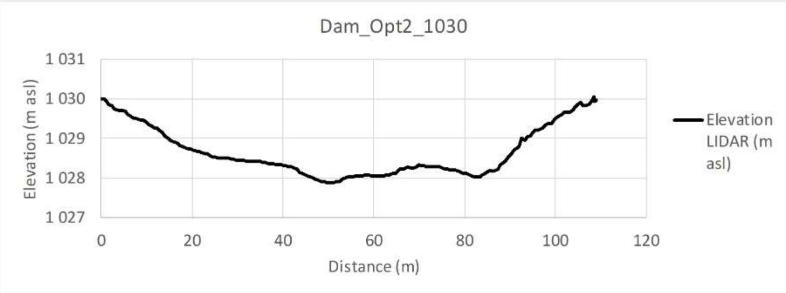

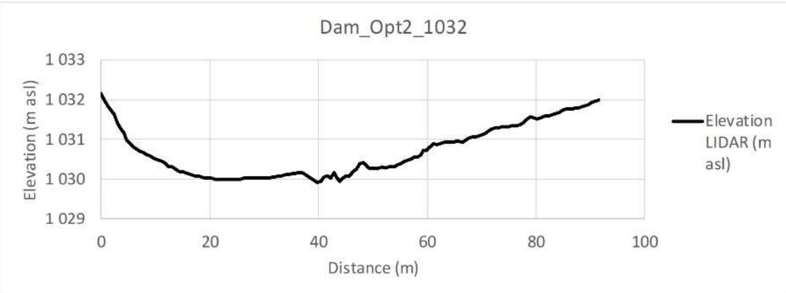

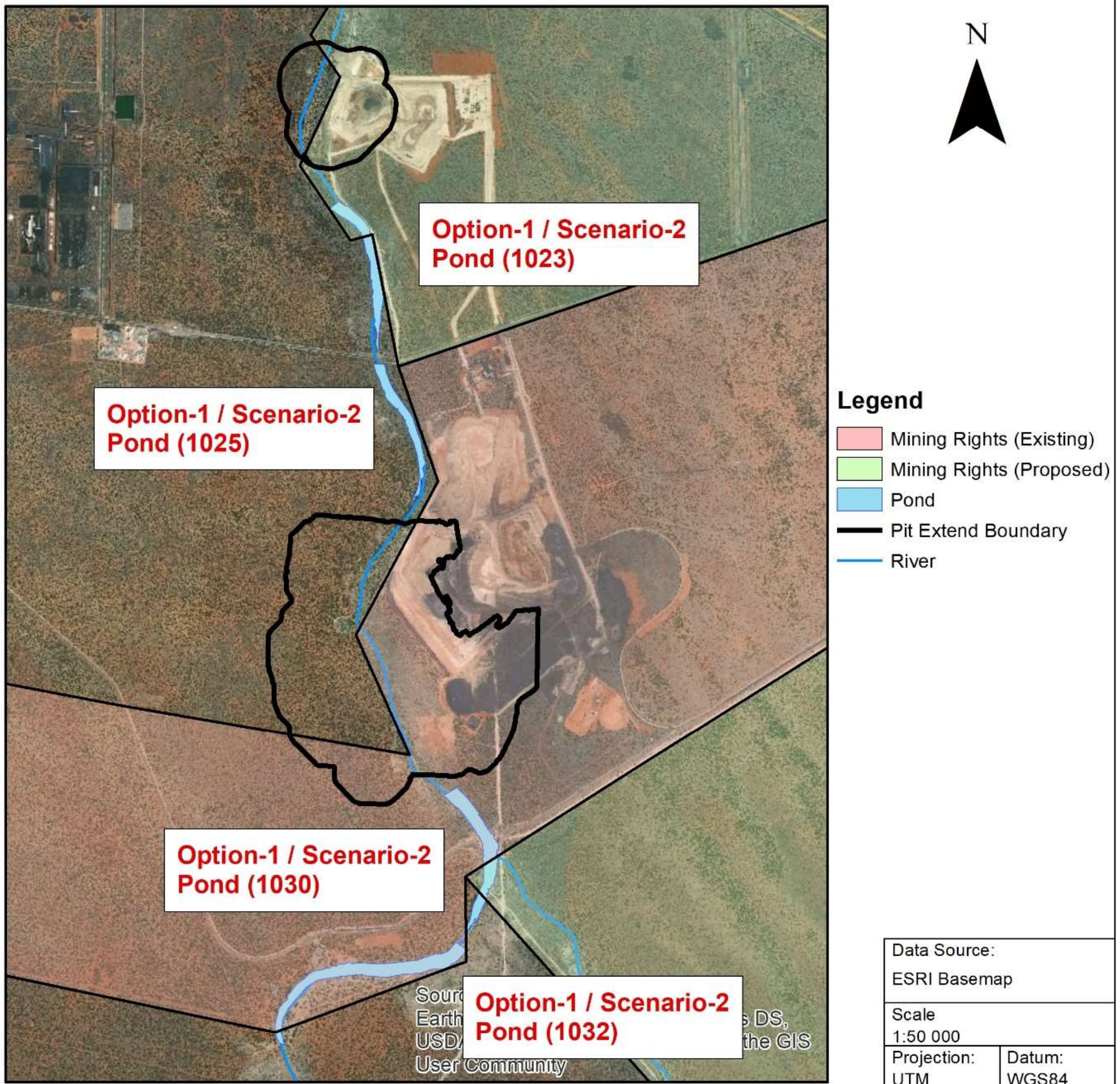

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KUDUMANE GAP ANALYSIS

OPTION-1 / Scenario-2

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6.1.2 Pros and cons

Pros:

- Less disturbance of biodiversity and environmental impact;
- Reduced erosion;
- It can be combined with the diversion channels;
- Since there is no diversion channel and excavation this is the cheapest option;
- Attenuating the flow will delay the flow into the open pit area and will give time to evacuate the pit if necessary; and
- By reducing the amount of discharge, it allows for smaller structures downstream.

Cons:

- It will impact the downstream water users, as water will not flow in the river below the pits;
- Increased sedimentation due to ponding of water;
- Change in biodiversity due to the increase ponding of water;
- During high rainfall events and a flow rate above the thresholds mentioned above, the flow might end up at the pit area and can cause a temporary closure of the operations;
- Upstream of the pond area has private properties that are located within the river basin; and
- Permissions required to authorise this option will be the least likely to be accepted, but with proper motivation this should be investigated.

6.1.3 Scheduling

Construction of the upstream ponds at the York Open Pit area can be scheduled within the time that the pit boundary reaches to Ga-Mogara River boundary. Downstream options can be considered with regards to KMR’s decision and future mining plans of the Hotazel Open Pit in case of expanding the pit boundaries across the river course.

6.1.4 Cost estimate

The cost estimation was evaluated for both the pond scenarios of Option-1 by considering the site clearance, earthwork, material import, topsoil and grassing process and earth dam works. Accordingly, Option-1 cost estimated in range of R 5 million to R 10 million.

6.1.5 Discussion

Since the project area is located in semi-arid zone with low rainfall and high temperature characteristics, the site observations indicate that the Ga-Mogara River does not produce any significant flow. Considering the environmental and cost saving advantages of building dams along the river course will provide an efficient flood risk management. In case of where the flow will occur in the project area, Option-1 Scenario-1 with large dams can store a flood event up to 10.2 m^3/s.

As a result of the general study, SRK believes that Option-1 Scenario-1 is the best option for mining through the Ga-Mogara River and recommends moving forward with the pond options by controlling the river flow with attenuation ponds without any diversion structures.

6.2 Option-2:

6.2.1 Description of option

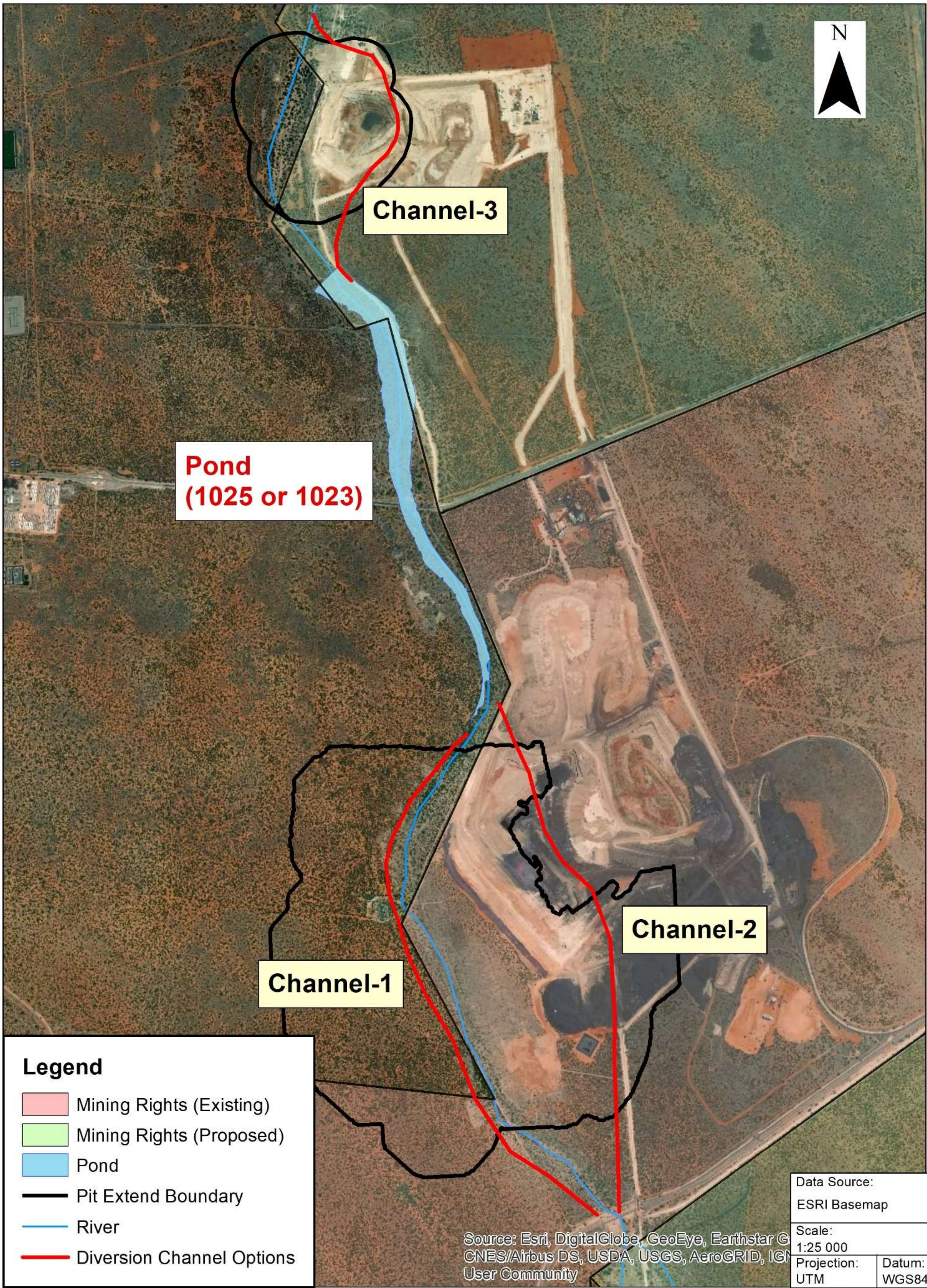
Option-2 is combination of three relatively short diversion channels (Channel-1, Channel-2, and Channel-3) and an attenuation pond. Channel-1 and Channel-2 is planned for the York Open Pit area. Channel-3 will divert the water around the Hotazel Open Pit area. The general layout of Option-2 is presented in Figure 6-6 below.

The York Open Pit is planned to be expanded west, across the 1:100-year floodline. This scenario entails the construction of Channel-1 initially. Channel-1 is 2676.5 m long and designed from 1032 m a.s.l inlet elevation to 1029 m a.s.l outfall elevation. Channel-1 is located on the western side of Ga-Mogara River and crossing through the extended pit boundary. When the pit boundary reaches the river course, Channel-2 will be constructed and placed over a portion of the rehabilitated pit.

Channel-2 diverts water on the eastern side of water course and is constructed over a portion of the pit that is rehabilitated. Channel-2 is 2481 m long and designed from 1030 m a.s.l inlet elevation to 1026 m a.s.l outfall elevation. Re-organising the existing benches will be required. In addition, since Channel-2 is located downstream of the Waste Dump area, contaminated water as runoff from the Waste Return Dam (WRD) should be separated from the natural flow. Long sections of Channel-1 and Channel-2 are presented in Figure 6-7 and Figure 6-8, respectively.

If the Hotazel Open Pit is extended, then Channel-3 will be used to divert the flow over a portion of the rehabilitated pit. Channel-3 is 1370 m long and designed from 1025 m a.s.l inlet elevation to 1021 m a.s.l outfall elevation. The long section of Channel-3 is shown in Figure 6-9. The topography difference is up to 20 m. An attenuation pond should be considered at the inlet part of the channel to increase the water level offtake area.

In order to evaluate a better option for the crest elevation of the pond and related inlet elevation, two different scenarios were studied. The first case represents a higher dam body and a channel inlet at 1025 m a.s.l that cause a larger dam body, but less excavation and construction costs on the channel route. The second case represents the dam body and channel inlet at 1023 m a.s.l, which will require a 2 m deeper channel construction.



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OPTION-2

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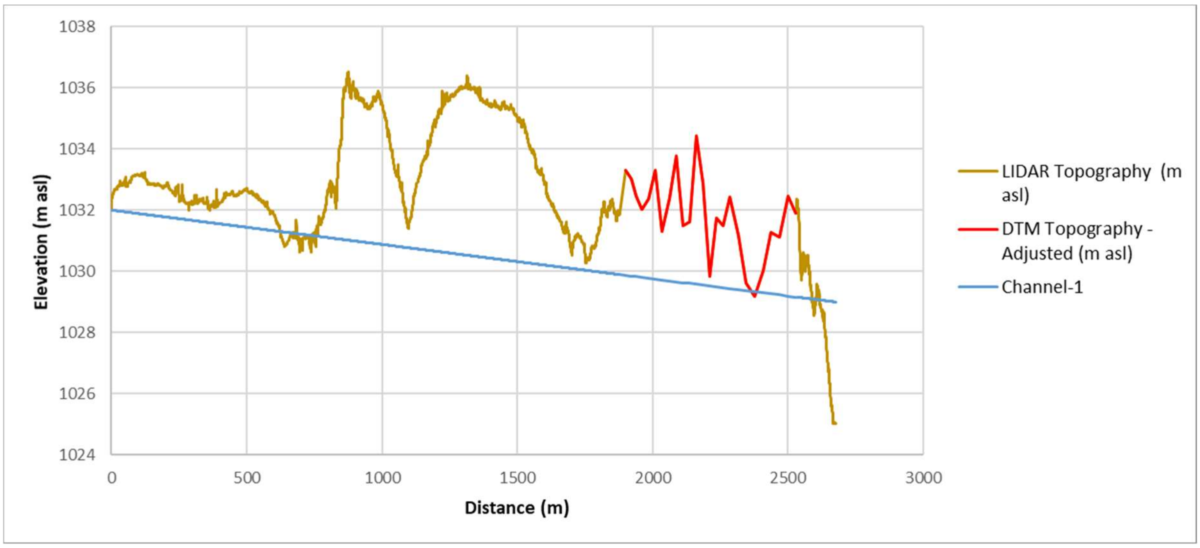


Figure 6-7: Channel-1 Long Section

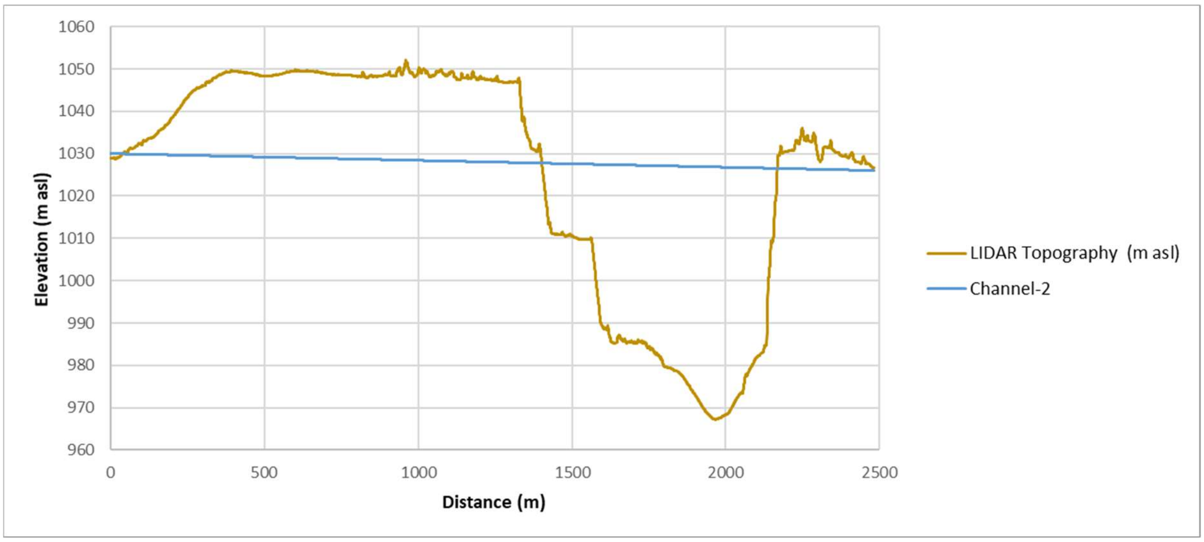


Figure 6-8: Channel-2 Long Section

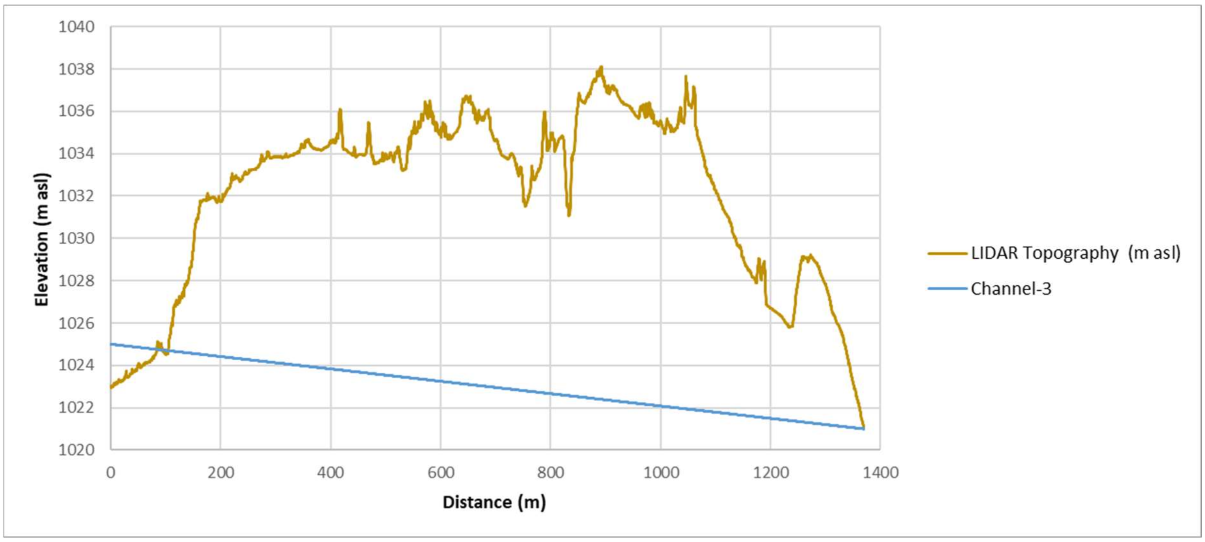


Figure 6-9: Channel-3 Long Section

6.2.2 Pros and cons

Pros:

- Relatively short distance between the other diversion options;
- Relatively less excavation volume, therefore less soil disturbance;
- Less disturbance of biodiversity (rehabilitated);
- Using the company properties; and
- Full capture of the flood flow and dry open pit.

Cons:

- Steep topography at inlet part;
- Reclamation will be required at the York Open Pit area before the diversion with Channel-2;
- Increase in erosion and sedimentation;
- Unstable banks;
- Lined channel will be required over the rehabilitated York Open Pit (potential to affect baseflow);
- More detailed stormwater management infrastructure will be required to separate the dirty water runoff from the mining operations;
- Surface Water quality contamination, due to runoff from the mining operations; and
- Expensive option compared to the construction of attenuation ponds.

6.2.3 Scheduling

The diversion schedule of Option-2 is based on the extension program of the York Open Pit and the advancing speed through the west. Based on the site investigations, the York Open Pit boundary is about to reach the 1:100-year floodline borders soon. Considering the current condition, Channel-1 construction can start right after the required environmental permissions have been authorised. As the York Open Pit extends, preparation of Channel-2 can begin.

Downstream options at the Hotazel Open Pit can be considered once KMR's decision and future mining plans are finalised.

6.2.4 Cost estimate

A cost estimation was performed for all the surface water structures, diversion channels and ponds for the Option-2. Site Clearance, earthworks, bulk excavation, importing of the materials, gabion and pitching items were considered for the three diversion channels and earth work costs for the pond.

Considering the Channel-3 inlet will begin at elevation of 1025 m a.s.l with a higher earth dam at Hotazel Open Pit area, the total cost of Option-3 is estimated as R 225 million.

As a second scenario with smaller dam and lower inlet part at 1023 m a.s.l, it will cost an extra R 4.3 million, that will make the total cost about R 229.3 million.

The cost estimation details of Option-2 is presented in Appendix A.

6.2.5 Discussion

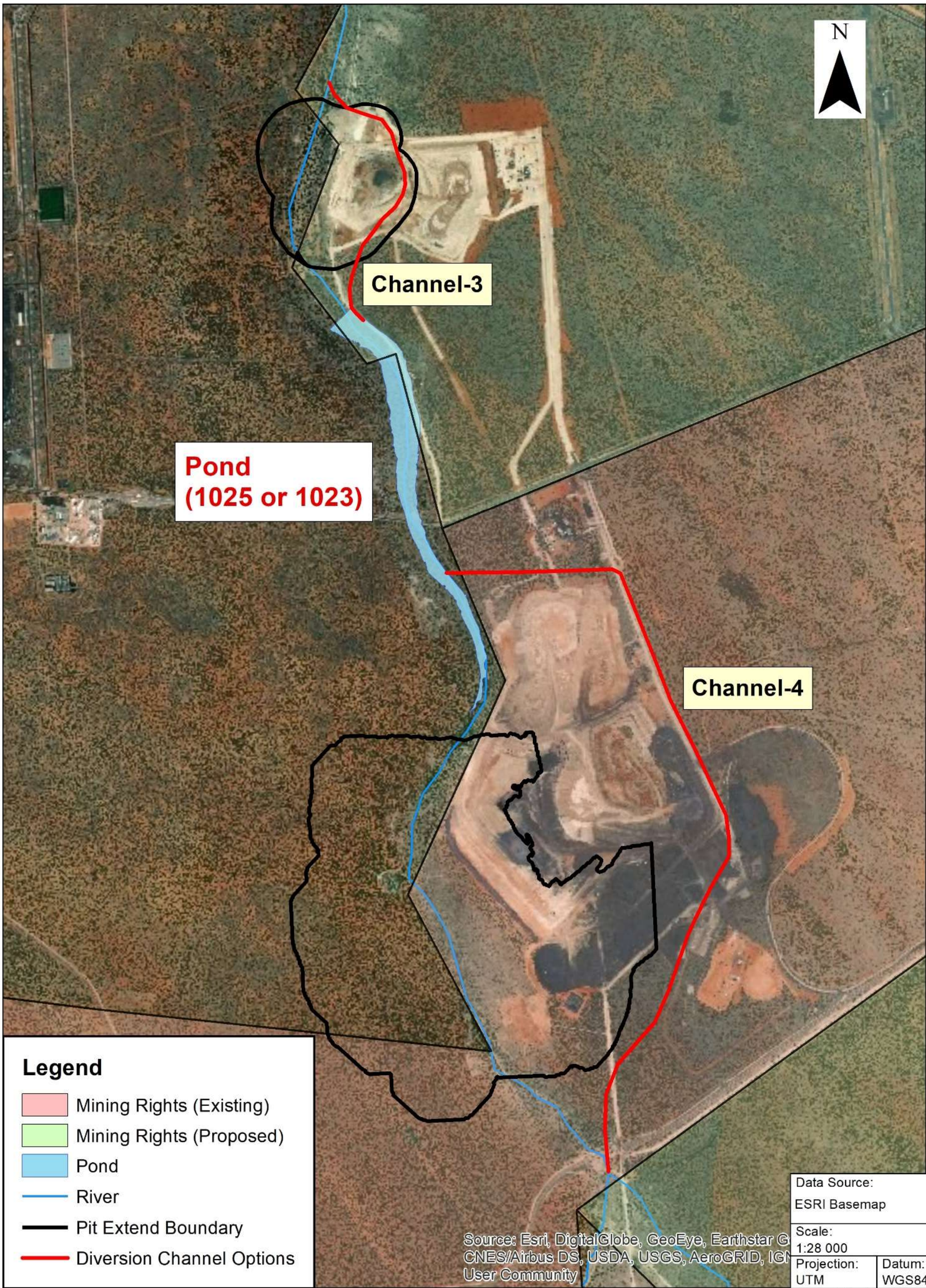
Apart from Option-1 with ponds, Option-2 is the second cheapest one of the options with diversion channels (Option-2 to Option-6). Though, diversion channels provide the opportunity to mine in a dry environment.

6.3 Option-3:

6.3.1 Description of option

Option-3 is combination of 2 diversion channels (Channel-3 and Channel-4) and a pond. The same diversion and pond combination as at the Hotazel Open Pit area are described in Option-2, are also included in this option. In addition, only one channel, which is Channel-4, will divert the runoff east past the York Open Pit area. The Hotazel Open Pit will be prevented from being flooded with a pond and Channel-3. The general layout of Option-3 is presented in Figure 6-10 below.

Channel-4, with a length of 4284 m, will divert the surface runoff around the open pit and mine facilities to the east. The diversion channel will not cross through either the open pit or WRD area. The channel is designed from 1030 m a.s.l inlet elevation to 1025 m a.s.l outfall elevation. However, the surface topography at the flat area is reaching to 1050 m, which makes more than a 20 m elevation difference with the Ga-Mogara River course. A long section of Channel-4 is presented in Figure 6-11.



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OPTION-3

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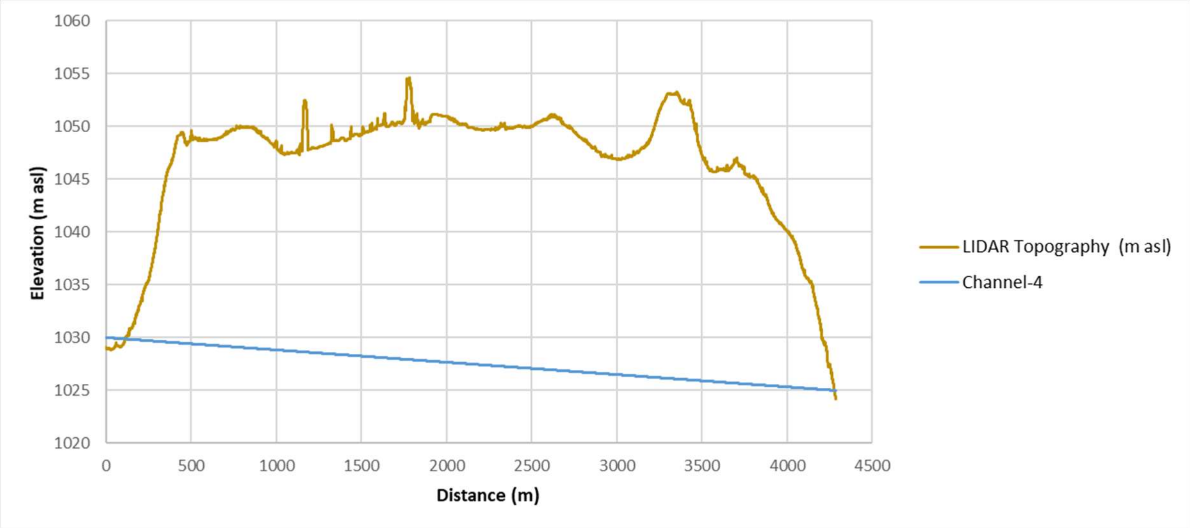


Figure 6-11: Channel-4 Long Section

6.3.2 Pros and cons

Pros:

- Relatively short distance;
- Less disturbance of biodiversity (rehabilitated); and
- Using the company properties.

Cons:

- Steep topography at inlet part;
- Limited space to create natural, meandering channel;
- Surface water quality contamination, due to runoff from the mining operations;
- More detailed stormwater management infrastructure will be required to separate the dirty water runoff from the mining operations; and
- Excavation volume and cost is high.

6.3.3 Scheduling

According to the current pit boundary at the York operation, construction of Option-3 is required to start right after the required authorization process.

Downstream options at the Hotazel Open Pit can be considered with regards to KMR's decision and future mining plans in case of expanding the pit boundaries across the river course.

6.3.4 Cost estimate

A cost estimation was performed for all the surface water structures, diversion channels and ponds for Option-3. Site clearance, earthworks, bulk excavation, importing of the materials, gabion and pitching items were considered for the three diversion channels and earth work costs for the pond. Accordingly, the total cost of Option-3 is estimated as R 255 million.

The cost estimation details of Option-3 is presented in Appendix A.

6.3.5 Discussion

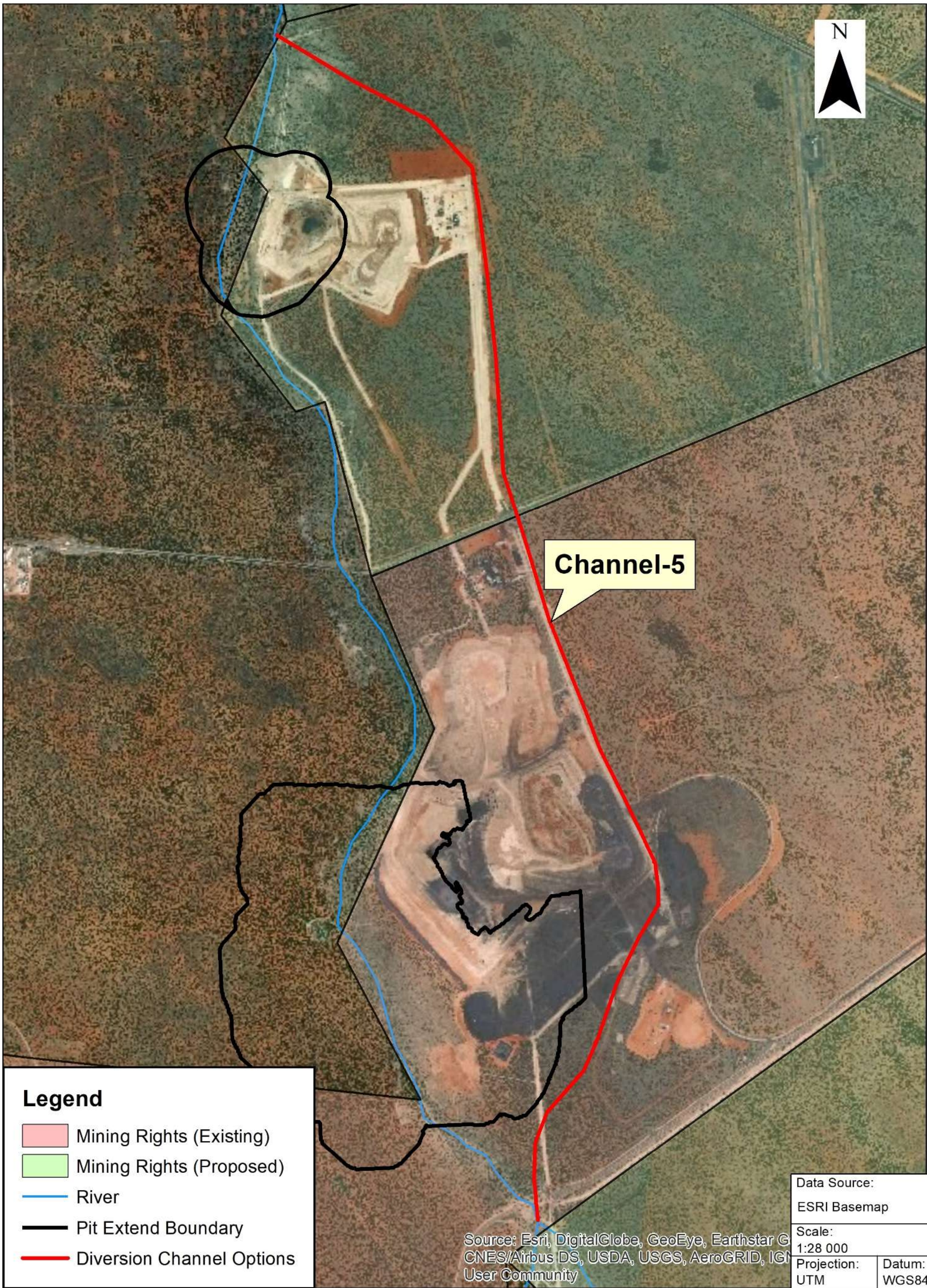
This is an expensive option that cannot be entertained due to the deep canal in close proximity to mine infrastructure.

6.4 Option-4:

6.4.1 Description of option

Option-4 consists of only one diversion channel (Channel-5) that starts diverting from upstream of York Open Pit to downstream of Hotazel Pit area along the east part of mine facilities. Channel-5 is not crossing any mine facility such as the open pit or waste dump area. However, a major road crossing exists in the area between the York and Hotazel Open Pits. General layout of Option-4 is presented in Figure 6-12 below.

Channel-5 is about 7 km length and designed from 1039 m a.s.l inlet elevation to 1019 m a.s.l outfall elevation. The long section of it is presented in Figure 6-13. Once the channel reaches to the flatter area in the east, the elevation difference changes between 20 m to 25 m, which will cause extreme excavation volume and cost.



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KUDUMANE GAP ANALYSIS
OPTION-4

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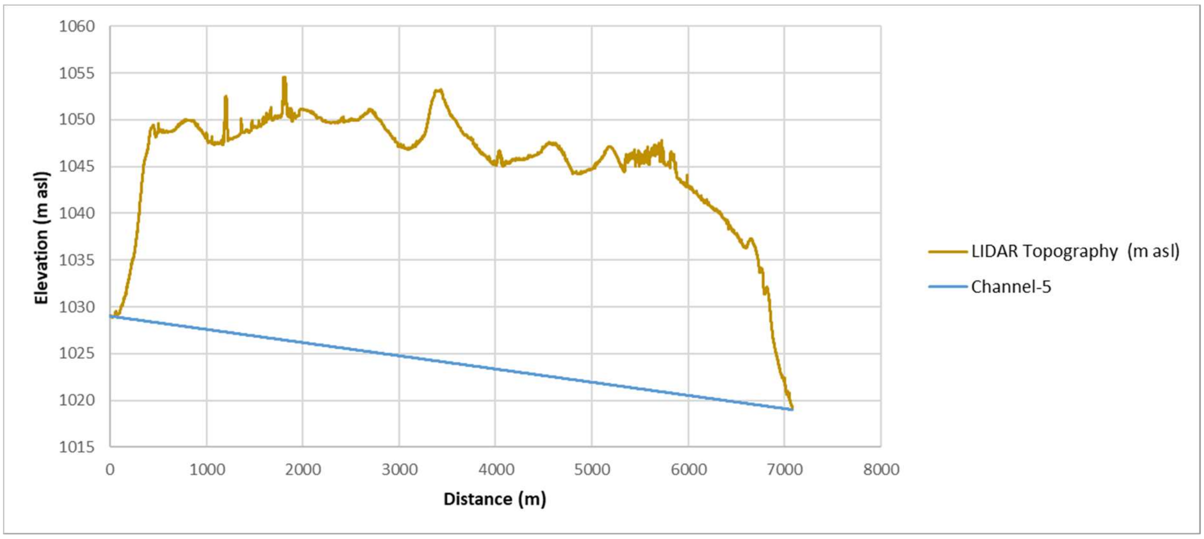


Figure 6-13: Channel-5 Long Section

6.4.2 Pros and cons

Pros:

- Using the company properties; and
- Single construction and easy to maintain.

Cons:

- Steep topography at inlet part;
- Excavation volume is high;
- Major and minor road crossing and other services;
- More detailed stormwater management infrastructure is required to separate the dirty water runoff from the mining operations;
- Limited space to create natural, meandering channel;
- Surface water quality contamination, due to runoff from the mining operations; and
- Grave location.

6.4.3 Cost estimate

A cost estimation was performed for Channel-5 and for Option-4. Site clearance, earthworks, bulk excavation, importing of the materials, gabion and pitching items were considered for the cost estimation.

Considering that the Channel-5 inlet will begin at an elevation of 1029 m a.s.l, excavation depth might increase up to 25 m and also largen the width at the top. Considering the length and depth of the channel; the total cost of Option-4 is estimated as R 448 million that will make it the most expensive option so far.

The cost estimation details of Option-4 is presented in Appendix A.

6.4.4 Discussion

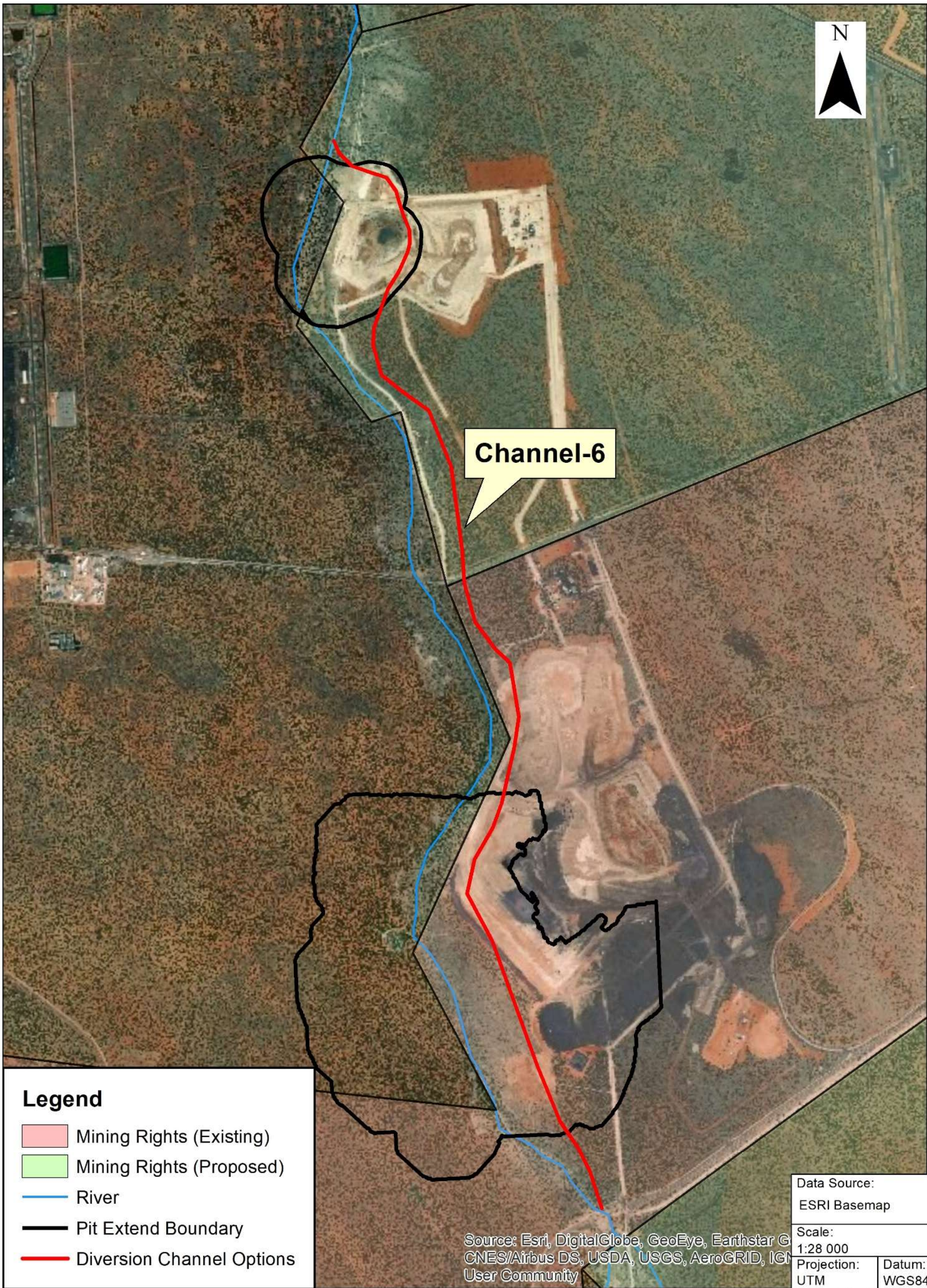
The elevation difference and related excavation volume in the vertical and horizontal access of the diversion channel for 7 km is not a feasible option. In addition, crossing the major civil structures such as roads, will increase the design complexity and environmental aspect of it.

6.5 Option-5:

6.5.1 Description of option

Option-5 consists of only one channel (Channel-6) that starts diverting the Ga-Mogara River from upstream of the York Open Pit. The channel alignment is located on the right bank of the river. Channel-6 passes through the York Open Pit boundary area and reaches the Hotazel Pit area between the open pit and waste dumps. As the channel interacts with waste dumps in both pit areas, a detailed design is required for preventing the contamination of fresh water. A general layout of Option-5 is presented in Figure 6-14.

Channel-6 is about 6 km in length and designed from 1029 m a.s.l inlet elevation to 1019 m a.s.l outfall elevation. A long section of it is presented in Figure 6-15. In order to construct Channel-6, the initial site preparation will be required in the York Open Pit area.



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OPTION-5

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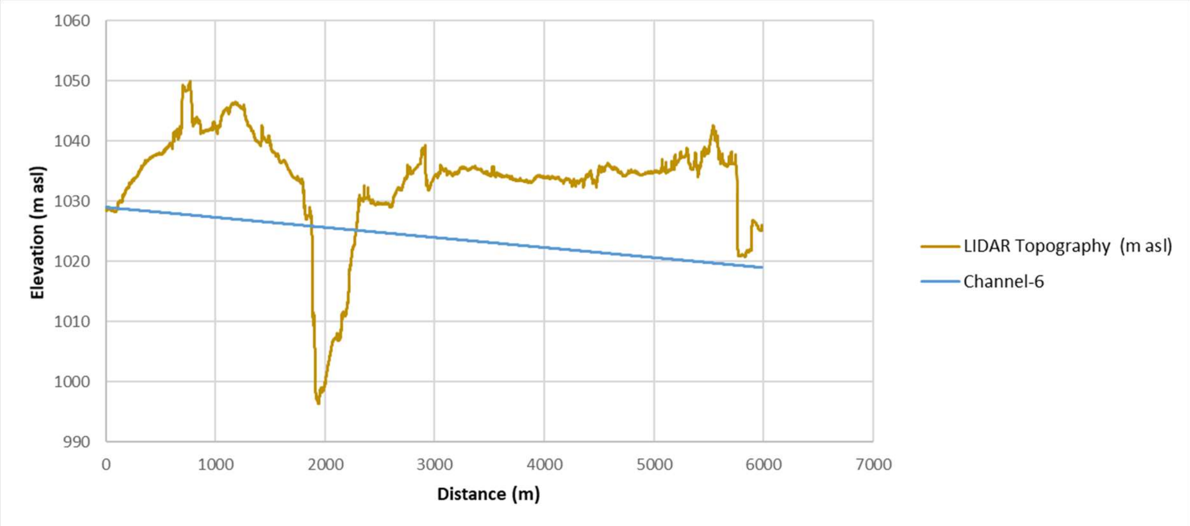


Figure 6-15: Channel-6 Long Section

6.5.2 Pros and cons

Pros:

- Relatively less excavation volume therefore less soil disturbance;
- Less disturbance of biodiversity (rehabilitated); and
- Using the company properties.

Cons:

- Steep topography at inlet part;
- Excavation volume is high;
- Major and minor road crossing and other services;
- Limited space to create natural, meandering channel;
- Reclamation will be required at the York Open Pit area before diversion with Channel-6;
- Increase in erosion and sedimentation;
- A lined channel will be required over the rehabilitated York Open Pit (potential to affect baseflow);
- Surface water quality contamination, due to runoff from the mining operations; and
- More detailed stormwater management infrastructure required to separate the dirty water runoff from the mining operations.

6.5.3 Scheduling

If considered, the Channel-6 design should be finalised due to the final open pit design and initial site rehabilitation, which will be required for the benches. The timeline of the construction of Option-5 is also dependent on the York Open Pit's advancement schedule.

6.5.4 Cost estimate

A cost estimation was performed for Channel-6 for Option-5. Site Clearance, earthworks, bulk excavation, importing of the materials, gabion and pitching items were considered for the cost estimation.

Considering that the Channel-5 inlet will begin at an elevation of 1029 m a.s.l, excavation volume is relatively less than the other diversion channel options. The total elevation difference will be between 10 m to 15 m range, due to the alignment in the bank of river and not rising through the east. Considering the length and depth of the channel; the total cost of the Option-5 is estimated at about R 144 million. Comparing the cost of Option-5 with the rest, it's the second cheapest option.

The cost estimation details of Option-5 is presented in Appendix A.

6.5.5 Discussion

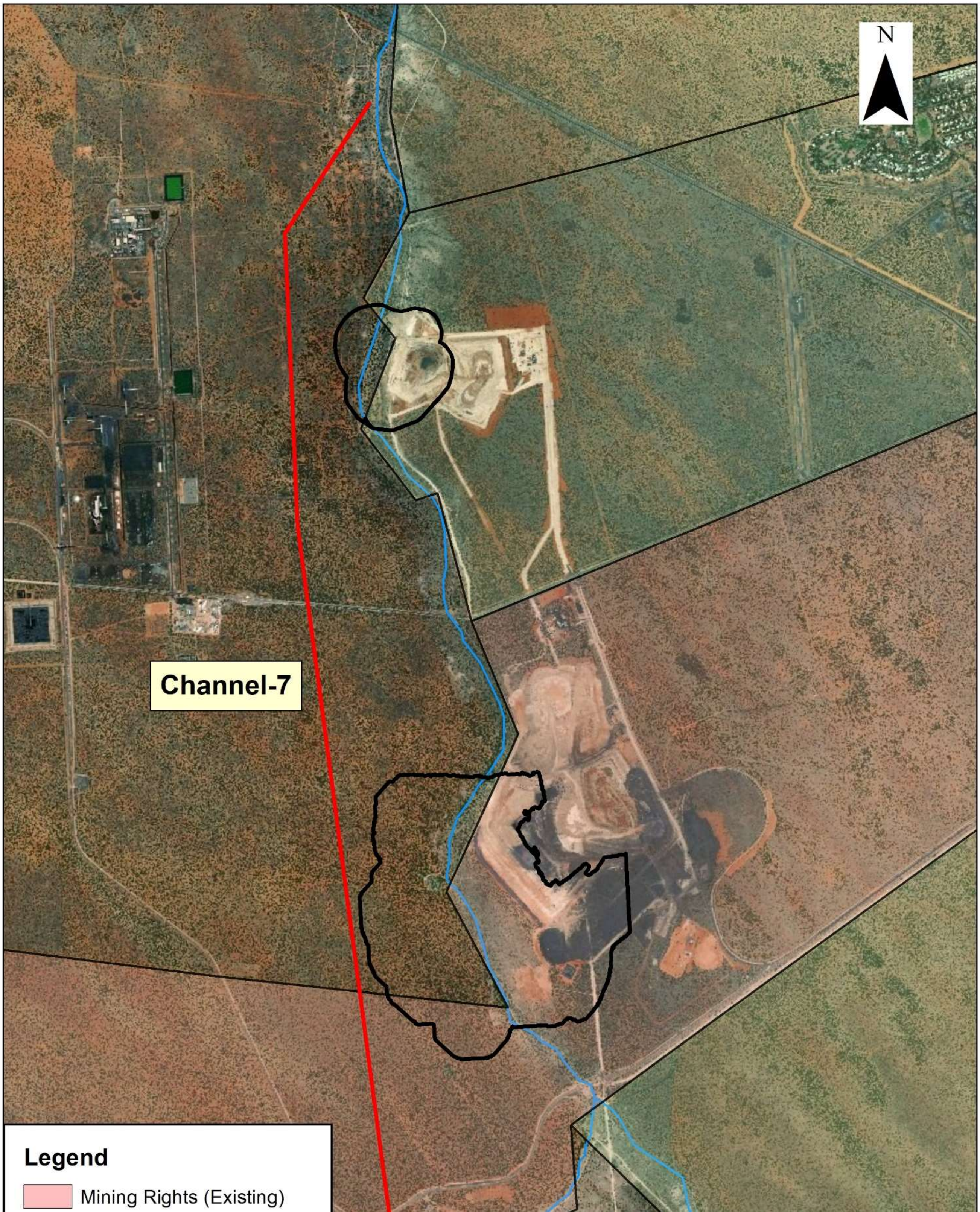
This is not feasible.

6.6 Option-6:

6.6.1 Description of option

Option-6 is the last diversion option with a single channel (Channel-7). Channel-7's conceptual design is located at the left side of the riverbank by starting from the very upstream of the Ga-Mogara River. The alignment goes through the north, at a left-hand side of the river and outside of the York and Hotazel Open Pit areas. However, Channel-7's alignment passes through the outside of mine's boundaries and also the site boundaries of the Kalagadi Manganese Mine Site. The layout of Option- 6 is shown in Figure 6-16.

Channel-7 is about 8.5 km in length and is designed from 1031 m a.s.l inlet elevation to 1018 m a.s.l outfall elevation. At the inlet of the channel, the topography has an immediate rise from 20 m to 25 m with an invert elevation of the channel, which keeps the average elevation distance along the channel aligned. Therefore, an additional pond can be considered to elevate the water at the inlet to reduce excavation volume and the cost of construction. The long section of it is presented in Figure 6-17.



Data Source: ESRI Basemap		
Scale: 1:40 000		
Projection: UTM	Datum: WGS84	
Central Meridian/Zone: 34 South		
Date: 27/05/2020	Compiled by: OZKM	
Project No. 549507	Fig No. 6-16	

srk consulting

KUDUMANE GAP ANALYSIS
OPTION-6

Path: J:\Proj\549507_KUDUMANE GAP ANALYSIS\8GIS\GISPROJ\MXD\REV2\549507_A4P_Kudumane_Option-6_REV2_20200527.mxd

Revision: 2 Date: 27 05 2020

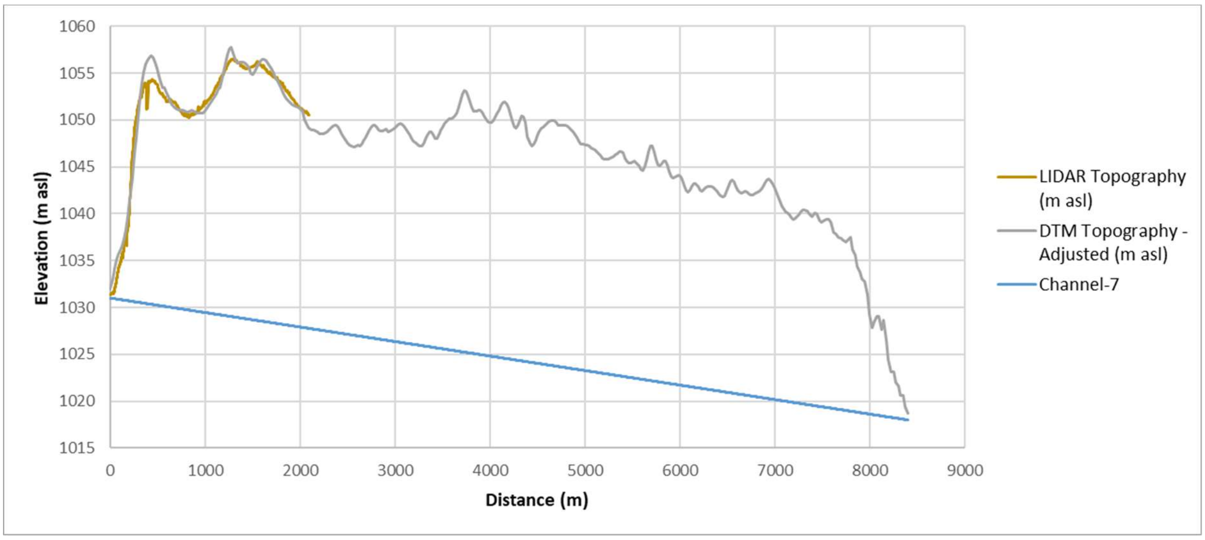


Figure 6-17: Channel-7 Long Section

6.6.2 Pros and cons

Pros:

- Hydraulically a good option;
- Sufficient space to create a meandering diversion;
- Can be combined with a pond at the inlet part; and
- No interruption with the existing services (except Kalagadi).

Cons:

- Steep topography at inlet part;
- Long distance, therefore, excavation volume is high;
- Loss of soil resources due to excavation;
- Major and minor road crossing;
- Increase in erosion and sedimentation;
- Very sandy along diversion route;
- Unstable banks; and
- All infrastructure on land not owned by mine.

There is the possibility to build a dam upstream and take the risk of flooding and rise water elevation at the inlet to reduce excavation volume.

6.6.3 Scheduling

According to the current pit boundary at the York Operation, construction of Option-6 needs an immediate start after the required authorization process. The reason for the recommendation of the early start for constructing the diversion channel, is because of the long distance of about 8.5 km and that construction will take significant time and effort to build, to create a dry working environment at the York Open Pit area.

6.6.4 Cost estimate

A cost estimation was performed for Channel-7 for Option-6. Site clearance, earthworks, bulk excavation, importing of the materials, gabion and pitching items were considered for the cost estimation.

Considering that the Channel-5 inlet will begin at an elevation of 1031 m a.s.l, excavation depth will be in a range of 20 m to 25 m and largen the width at the top. The total cost of Option-6 is estimated as R 354 million, which will make it the second most expensive option.

The cost estimation details of Option-6 is presented in Appendix A.

6.6.5 Discussion

Considering the elevation difference and related excavation volume in the vertical and horizontal access of the diversion channel and the 8.5 km distance, it is not a feasible option. Crossing major civil structures, such as roads will also increase the design complexity and environmental aspect of it. In addition, the channel alignment will be reaching to Kalagadi Manganese Mine boundaries and will require an agreement between the companies.

6.7 General option comparisons

In this sub head of the report, a comparison is presented of the different options on aspects of the general cost estimates, pros and con summaries that are summarised above.

The cost comparison of all the options were evaluated in Table 6-3. Advantages of each option compared in Table 6-4, and disadvantages and concerns are compared in Table 6-5 below.

Table 6-3: Cost Comparison of the Options

Option	Option Description	Cost Estimate (Rand)
Option-1 / Sc-1	Two large ponds with higher dam bodies.	5 – 10 M
Option-1 / Sc-2	Four smaller ponds with lower dam bodies.	5 – 10 M
Option-2	Three diversion channel and a large pond.	225 M
Option-3	Two diversion channel and a large pond.	255 M
Option-4	Single diversion channel on long distance.	448 M
Option-5	Single diversion channel on long distance.	144 M
Option-6	Single diversion channel on long distance.	354 M

Note - M: million

Table 6-4: Pros Comparison of the Options

Option	Option-1	Option-2	Option-3	Option-4	Option-5	Option-6
Pros	• Less disturbance of biodiversity and environmental impact; • Reduced erosion; • Can be combined with the diversion channels; • Since there is no diversion channel and excavation, it is the cheapest option; • Attenuating the flow will delay the flow into the open pit area and will give time to evacuate the pit if necessary; and • By reducing the amount of discharge, allows for smaller structures downstream.	• Relatively short distance between other diversion options; • Relatively less excavation volume, therefore less soil disturbance; • Less disturbance of biodiversity (rehabilitated); • Using the company properties; and • Full capture of the flood flow and dry open pit.	• Relatively short distance; • Less disturbance of biodiversity (rehabilitated); • Using the company properties.	• Using the company properties; and • Single construction and easy to maintain.	• Relatively less excavation volume, therefore less soil disturbance; • Less disturbance of biodiversity (rehabilitated); and • Using the company properties.	• Hydraulically a good option; • Sufficient space to create a meandering diversion; • Can be combined with pond at inlet part; and • No interruption with existing services (except Kalagadi).

Table 6-5: Cons Comparison of the Options

Option	Option-1	Option-2	Option-3	Option-4	Option-5	Option-6
Cons	• Impact downstream water users, as water will not flow in the river below the pits; • Increased sedimentation due to ponding of water; • Change in biodiversity, due to increase ponding of water; • During high rainfall events and a flow rate above the thresholds mentioned, the flow might end up at pit area and can cause a temporary closure of operations; • Upstream of the pond area has private properties that are located within the river basin; and • Permissions required to authorise this. This option will be the least likely to be accepted, but with proper motivation this should be investigated.	• Steep topography at inlet part; • Reclamation will be required at the York Open Pit area before diversion with Channel-2; • Increase in erosion and sedimentation; • Unstable banks; • Lined channel required over rehabilitated York Open Pit (potential to affect baseflow); • More detailed stormwater management infrastructure required to separate dirty water runoff from the mining operations; • Surface Water quality contamination, due to runoff from the mining operations; and • Expensive option compared to the construction of attenuation ponds.	• Steep topography at inlet part; • Limited space to create natural, meandering channel; • Surface water quality contamination, due to runoff from the mining operations; • More detailed stormwater management infrastructure required to separate dirty water runoff from the mining operations; and • Excavation volume and cost is high.	• Steep topography at inlet part; • Excavation volume is high; • Major and minor road crossing and other services; • More detailed stormwater management infrastructure required to separate dirty water runoff from the mining operations; • Limited space to create natural, meandering channel; • Surface water quality contamination due to runoff from the mining operations; and • Grave location.	• Steep topography at inlet part; • Excavation volume is high; • Major and minor road crossing and other services; • Limited space to create natural, meandering channel; • Reclamation will be required at the York Open Pit area before diversion with Channel-6; • Increase in erosion and sedimentation; • Lined channel required over rehabilitated York Open Pit (potential to affect baseflow); • Surface water quality contamination, due to runoff from the mining operations; and • More detailed stormwater management infrastructure required to separate dirty water runoff from the mining operations.	• Steep topography at inlet part; • Long distance, therefore, excavation volume is high; • Loss of soil resources due to excavation; • Major and minor road crossing; • Increase in erosion and sedimentation; • Very sandy along diversion route; • Unstable banks; and • All infrastructure on land not owned by mine.

7 Conclusions and Recommendations

The preferred technical option is Option 1, where upstream dams are constructed, and the workings are exposed. The monitoring of floods will be the best mitigation measures to evacuate the river in time. This option will be difficult to approve from a water licensing and mining authorisation perspective.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

8 References

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Appendices

Appendix A: Cost Estimate Details

OPTION 2

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
		SECTION C: OPTION 2					
C.1	SANS 1200 C	**SITE CLEARANCE**					
	8.2.1	*Clear and grub:*					
C.1.1		Channel base, including slope footprint	ha	32.4	29,250.51	947,716	52
C.2	SANS 1200 D	**EARTHWORKS**					
C.2.1	8.3.1.2	Remove topsoil to nominal depth 150 mm, stockpile required fill amount and maintain, or dispose surplus material to dump site, within 2 km freehaul distance, as instructed by the Engineer	m³	48,578.0	35.43	1,721,118	54
	8.3.2	**BULK EXCAVATION**					
	8.3.2 (a)	*Excavate in soft to intermediate material and stockpile or use for channel fill using selected material (G7/G8 material, incl. mechanical modifications), compacted in 150 mm thick layers to 98% MOD AASHTO density @ 0% to +2% of O.M.C., as instructed by the Engineer, for:*					
C.2.2		Channel base	m³	207,570.8	74.87	15,540,825	80
C.2.3		Channel sloped section	m³	1,151,703.3	74.87	86,228,026	07
	8.3.2 (a)	*Excavate in hard rock material (blasting) and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
C.2.4		Channel base and sloped section	m³	203,891.1	125.30	25,547,554	83
	8.3.4	**IMPORTING OF MATERIALS**					
		Selected material (G7/G8 material, incl. mechanical modifications) from stockpile , compacted in 150 mm thick layers to 98% MOD AASHTO density @ 0% to +2% of O.M.C. for:					
C.2.5		Channel base	m³	151,556.0	39.96	6,056,177	76
C.2.6		Channel sloped section	m³	1,366,076.0	39.96	54,588,396	96
C.3	SANS 1200 DE	**SMALL EARTH DAMS**					
	8.3.4	**PREPARATION OF EXPOSED SURFACES**					
		Rip and recompact in-situ material, 150 mm thick layer to 98% MOD AASHTO density @ 0% to +2% of O.M.C. for:					
C.3.1		Channel base	m²	32,635.0	6.22	202,989	70
C.4	SANS 1200 DK	**GABIONS AND PITCHING**					
		PITCHING					
Total Carried Forward						190,832,806	18

OPTION 2

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						190,832,806	18
	8.2.5	*Supply and install 100 mm thick ordinary pitching for:*					
C.4.1		Channel base	m²	32,635.0	228.32	7,451,223	20
	8.2.5	*Supply and install 200 mm thick ordinary pitching for:*					
C.4.2		Channel sloped section	m²	58,379.3	456.64	26,658,323	55
Total Carried Forward To Summary						224,942,352	93

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
		SECTION B: OPTION 3					
D.1	SANS 1200 C	**SITE CLEARANCE**					
	8.2.1	*Clear and grub:*					
D.1.1		Channel base, including slope footprint	ha	40.6	29,250.51	1,187,570	71
D.2	SANS 1200 D	**EARTHWORKS**					
D.2.1	8.3.1.2	Remove topsoil to nominal depth 150 mm, stockpile required fill amount and maintain, or dispose surplus material to dump site, within 2 km freehaul distance, as instructed by the Engineer	m³	60,945.7	35.43	2,159,306	15
	8.3.2	**BULK EXCAVATION**					
	8.3.2 (a)	*Excavate in soft to intermediate material and stockpile or use for channel fill using selected material (G7/G8 material, incl. mechanical modifications), compacted in 150 mm thick layers to 98% MOD AASHTO density @ 0% to +2% of O.M.C., as instructed by the Engineer, for:*					
D.2.2		Channel base	m³	944.0	74.87	70,677	28
D.2.3		Channel sloped section	m³	424.0	74.87	31,744	88
	8.3.2 (a)	*Excavate in soft to intermediate material and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
D.2.4		Channel base	m³	466,414.5	34.91	16,282,530	20
D.2.5		Channel sloped section	m³	3,662,808.8	34.91	127,868,655	21
	8.3.2 (a)	*Excavate in hard rock material (blasting) and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
D.2.6		Channel base and sloped section	m³	619,588.7	125.30	77,634,464	11
D.3	SANS 1200 DE	**SMALL EARTH DAMS**					
	8.3.4	**PREPARATION OF EXPOSED SURFACES**					
		Rip and recompact in-situ material, 150 mm thick layer to 98% MOD AASHTO density @ 0% to +2% of O.M.C. for:					
D.3.1		Channel base	m²	28,270.0	6.22	175,839	40
D.4	SANS 1200 DK	**GABIONS AND PITCHING**					
		PITCHING					
Total Carried Forward						225,410,787	94

OPTION 3

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						225,410,787	94
	8.2.5	*Supply and install 100 mm thick ordinary pitching for:*					
D.4.1		Channel base	m²	28,270.0	228.32	6,454,606	40
	8.2.5	*Supply and install 200 mm thick ordinary pitching for:*					
D.4.2		Channel sloped section	m²	50,570.9	456.64	23,092,695	78
Total Carried Forward To Summary						254,958,090	12

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
		SECTION C: OPTION 4					
E.1	SANS 1200 C	**SITE CLEARANCE**					
	8.2.1	*Clear and grub:*					
E.1.1		Channel base, including slope footprint	ha	63.9	29,250.51	1,869,107	59
E.2	SANS 1200 D	**EARTHWORKS**					
E.2.1	8.3.1.2	Remove topsoil to nominal depth 150 mm, stockpile required fill amount and maintain, or dispose surplus material to dump site, within 2 km freehaul distance, as instructed by the Engineer	m³	95,838.0	35.43	3,395,540	34
	8.3.2	**BULK EXCAVATION**					
	8.3.2 (a)	*Excavate in soft to intermediate material and stockpile or use for channel fill using selected material (G7/G8 material, incl. mechanical modifications), compacted in 150 mm thick layers to 98% MOD AASHTO density @ 0% to +2% of O.M.C., as instructed by the Engineer, for:*					
E.2.2		Channel base	m³	7.0	74.87	524	09
E.2.3		Channel sloped section	m³	0.2	74.87	14	97
	8.3.2 (a)	*Excavate in soft to intermediate material and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
E.2.4		Channel base	m³	749,067.3	34.91	26,149,939	44
E.2.5		Channel sloped section	m³	6,807,592.6	34.91	237,653,057	67
	8.3.2 (a)	*Excavate in hard rock material (blasting) and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
E.2.6		Channel base and sloped section	m³	1,133,500.1	125.30	142,027,562	53
E.3	SANS 1200 DE	**SMALL EARTH DAMS**					
	8.3.4	**PREPARATION OF EXPOSED SURFACES**					
		Rip and recompact in-situ material, 150 mm thick layer to 98% MOD AASHTO density @ 0% to +2% of O.M.C. for:					
E.3.1		Channel base	m²	35,405.0	6.22	220,219	10
E.4	SANS 1200 DK	**GABIONS AND PITCHING**					
		PITCHING					
Total Carried Forward						411,315,965	73

OPTION 4

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	AMOUNT c
Brought Forward						411,315,965	73
	8.2.5	*Supply and install 100 mm thick ordinary pitching for:*					
E.4.1		Channel base	m²	35,405.0	228.32	8,083,669	60
	8.2.5	*Supply and install 200 mm thick ordinary pitching for:*					
E.4.2		Channel sloped section	m²	63,334.4	456.64	28,921,020	42
Total Carried Forward To Summary						448,320,655	75

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
		SECTION D: OPTION 5					
F.1	SANS 1200 C	**<u>SITE CLEARANCE</u>**					
	8.2.1	*Clear and grub:*					
F.1.1		Channel base, including slope footprint	ha	31.5	29,250.51	921,391	07
F.2	SANS 1200 D	**<u>EARTHWORKS</u>**					
F.2.1	8.3.1.2	Remove topsoil to nominal depth 150 mm, stockpile required fill amount and maintain, or dispose surplus material to dump site, within 2 km freehaul distance, as instructed by the Engineer	m³	47,225.0	35.43	1,673,181	75
	8.3.2	**BULK EXCAVATION**					
	8.3.2 (a)	*Excavate in soft to intermediate material and stockpile or use for channel fill using selected material (G7/G8 material, incl. mechanical modifications), compacted in 150 mm thick layers to 98% MOD AASHTO density @ 0% to +2% of O.M.C., as instructed by the Engineer, for:*					
F.2.2		Channel base	m³	35,504.0	74.87	2,658,184	48
F.2.3		Channel sloped section	m³	299,926.0	74.87	22,455,459	62
	8.3.2 (a)	*Excavate in soft to intermediate material and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
F.2.4		Channel base	m³	280,629.5	34.91	9,796,775	85
F.2.5		Channel sloped section	m³	1,375,185.5	34.91	48,007,725	81
	8.3.2 (a)	*Excavate in hard rock material (blasting) and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
F.2.6		Channel base and sloped section	m³	298,686.8	125.30	37,425,456	04
F.3	SANS 1200 DE	**<u>SMALL EARTH DAMS</u>**					
	8.3.4	**PREPARATION OF EXPOSED SURFACES**					
		Rip and recompact in-situ material, 150 mm thick layer to 98% MOD AASHTO density @ 0% to +2% of O.M.C. for:					
F.3.1		Channel base	m²	29,930.0	6.22	186,164	60
F.4	SANS 1200 DK	**<u>GABIONS AND PITCHING</u>**					
		PITCHING					
Total Carried Forward						123,124,339	22

OPTION 5

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						123,124,339	22
	8.2.5	*Supply and install 100 mm thick ordinary pitching for:*					
F.4.1		Channel base	m²	29,930.0	228.32	6,833,617	60
	8.2.5	*Supply and install 200 mm thick ordinary pitching for:*					
F.4.2		Channel sloped section	m²	29,930.0	456.64	13,667,235	20
Total Carried Forward To Summary						143,625,192	02

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT	
						R	c
		SECTION G: OPTION 6					
G.1	SANS 1200 C	**<u>SITE CLEARANCE</u>**					
	8.2.1	*Clear and grub:*					
G.1.1		Channel base, including slope footprint	ha	29.3	29,250.51	857,039	94
G.2	SANS 1200 D	**<u>EARTHWORKS</u>**					
G.2.1	8.3.1.2	Remove topsoil to nominal depth 150 mm, stockpile required fill amount and maintain, or dispose surplus material to dump site, within 2 km freehaul distance, as instructed by the Engineer	m³	43,935.0	35.43	1,556,617	05
	8.3.2	**BULK EXCAVATION**					
	8.3.2 (a)	*Excavate in soft to intermediate material and stockpile or use for channel fill using selected material (G7/G8 material, incl. mechanical modifications), compacted in 150 mm thick layers to 98% MOD AASHTO density @ 0% to +2% of O.M.C., as instructed by the Engineer, for:*					
G.2.2		Channel base and sloped section	m³	350.0	74.87	26,204	50
	8.3.2 (a)	*Excavate in soft to intermediate material and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
G.2.3		Channel base and sloped section	m³	5,724,827.0	34.91	199,853,710	57
	8.3.2 (a)	*Excavate in hard rock material (blasting) and dispose of surplus / unsuitable material to dump site, within 2 km freehaul distance, as instructed by the Engineer, for:*					
G.2.4		Channel base and sloped section	m³	858,724.1	125.30	107,598,129	73
G.3	SANS 1200 DE	**<u>SMALL EARTH DAMS</u>**					
	8.3.4	**PREPARATION OF EXPOSED SURFACES**					
		Rip and recompact in-situ material, 150 mm thick layer to 98% MOD AASHTO density @ 0% to +2% of O.M.C. for:					
G.3.1		Channel base	m²	42,010.0	6.22	261,302	20
G.4	SANS 1200 DK	**<u>GABIONS AND PITCHING</u>**					
		PITCHING					
	8.2.5	*Supply and install 100 mm thick ordinary pitching for:*					
G.4.1		Channel base	m²	42,010.0	228.32	9,591,723	20
Total Carried Forward						319,744,727	19

OPTION 6

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT R	c
Brought Forward						319,744,727	19
	8.2.5	*Supply and install 200 mm thick ordinary pitching for:*					
G.4.2		Channel sloped section	m²	75,149.8	456.64	34,316,404	67
Total Carried Forward To Summary						354,061,131	86

SUMMARY OF SECTIONS

SECTION	DESCRIPTION	AMOUNT (RAND)
C	OPTION 2	224,942,352.93
D	OPTION 3	254,958,090.12
E	OPTION 4	448,320,655.75
F	OPTION 5	143,625,192.02
G	OPTION 6	354,061,131.86
Total Carried Forward To Summary Of Schedules		1,425,907,422.68

KUDUMAN

SUMMARY OF SCHEDULES

SCHEDULE	DESCRIPTION	AMOUNT (RAND)
1	EARTH WALL DAMS	720,741.02
2	CHANNELS	1,425,907,422.68
	SUBTOTAL	1,426,628,163.70
	Add 15% VAT	213,994,224.56
Total		1,640,622,388.26