

Afrimat Aggregates Operations (Pty) Ltd

Review of the 2021 Geohydrological Impact Assessment for the Bethlehem Quarry to Determine its Continued Applicability in Supporting the Proposed Amendment of the Environmental Management Programme (EMPr)

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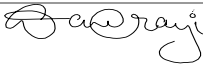
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Prepared for

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Principal Hydrogeologist

EXECUTIVE SUMMARY

This review exercise was conducted specifically to assess the validity of the original findings in supporting the proposed amendment of the Environmental Management Programme (EMPr) for Afimat Bethlehem Quarry. The original geohydrological impact assessment conducted in 2021 remains largely valid based on the April 30, 2026 site verification visit. Mining activities continue to occur above the water table, and no groundwater intersection or dewatering has taken place. Groundwater resources downstream of the quarry remain vulnerable to potential contamination from the unlined sump at the bottom of the quarry and from stormwater emanating from the mining area that escapes off site; the water quality of both is presently unknown

The findings of the follow-up site visit to the Bethlehem Quarry on April 30, 2026, are presented in an addendum to the original report, which remains unmodified with the exception of this Executive Summary.

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ADDENDUM SITE VERIFICATION AND VALIDITY CONFIRMATION (2026)

ACRONYMS

Amsl	Above mean sea level
CC	Close Corporation
DWS	Department of Water and Sanitation
EC	electrical conductivity
EMP	Environmental Management Plan
L/s	Litres per second
NGA	National Groundwater Archive
NWA	National Water Act
SABS	South African Bureau of Standards

1 INTRODUCTION

Afrimat Aggregates Operations (Pty) Ltd (hereinafter called Afrimat) appointed Waters Without Frontiers cc to conduct a geohydrological impact assessment in support of the updating of the Environmental Management Plan (EMP) for the ERF Number 4038 (Formerly subdivision 8) of Portion 7 of the Farm Wolhterskop 670 in Bethlehem. The quarry mines dolerite on a 65.8862 hectares of land.

The quarrying process involves the following activities:

- Drilling and blasting of dolerite and stockpiling,
- Loading and hauling the material out of the excavation to the crushing and screening plant,
- Crushing and screening the recovered material at the crusher plant in order to reduce it to various size aggregate,
- Stockpiling the aggregate at a stockpile area until it is collected by clients.

2 OBJECTIVE

The main objectives of the study were to establish baseline groundwater conditions at the site against which impacts of quarrying would be monitored; and to recommend management options to mitigate or remedy the impacts.

3 LEGAL CONSIDERATIONS

The proposed project is controlled by a number of legislative instruments that include:

3.1 CONSTITUTION OF THE REPUBLIC OF SOUTH AFRICA ACT, 1996 (ACT 108 OF 1996)

Section 24 of the Constitution provides that everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that:

- (i) prevent pollution and ecological degradation;
- (ii) promote conservation; and
- (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Afrimat shall ensure that these rights are not violated.

3.2 NATIONAL WATER ACT, 1988 (ACT 36 OF 1998)

In terms of section 4 of the NWA, water may only be used if it is authorised in terms of:

- **Schedule 1** - relatively small quantities of water, mainly for domestic and stock watering purposes, but also for emergency situations and certain recreational purposes.
- **General authorisation** - by which limited water use is conditionally allowed without a licence. Current general authorisations are described in Government Notice No. 1191, 8 October 1999.
- **Water use licence** - which are used to control water use that exceeds the limits imposed by Schedule 1 and general authorisations.
- **Compulsory licensing** - will apply if it is desirable that water use in respect of one or more water resources within a specific geographic area be licensed:
 - To achieve a fair allocation of water from a stressed water resource;
 - When it is necessary to review prevailing water use to achieve equity in allocations;
 - To promote beneficial use of water in the public interest;
 - To facilitate efficient management of the water resource and to protect water resource quality.

The Act recognises eleven water uses of which the following may be relevant to the current project:

- 21(a):- taking water from a water resource; - *relates to groundwater abstraction from a borehole.*
- 21(e):- engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1); - *relates to dust suppression.*
- 21(g):- disposing of waste in a manner which may detrimentally impact on a water resource; - *relates to disposal of industrial and domestic waste, sewage, and spillages of petroleum products.*
- 21(j):- removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; - *relates to potential dewatering should mining intersect the water-table.*

3.3 GOVERNMENT NOTICE NO. 704 (GN704)

In terms of this regulation, no person in control of a mine or activity may:

- (a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked;

- (b) except in relation to a matter contemplated in regulation 10, carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, whichever is the greatest;
- (c) place or dispose of any residue or substance which causes or is likely to cause pollution of a water resource, in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation; or
- (d) use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood-line of any watercourse or estuary.

The proposed quarrying activities do not require any exemptions from GN 704.

4 SITE DESCRIPTION

4.1 LOCATION

The site is situated approximately 3 kilometres south of the town of Bethlehem. The quarry falls under the Dihlabeng Local Municipalities of the Thabo Mofutsanyane District Municipality in the Free State Province. The site is accessible from Bethlehem by the R26 motorway leading to Fouriesburg near the northern border with Lesotho. The locality of the site is shown in Figure 4.1.

4.2 TOPOGRAPHY AND DRAINAGE

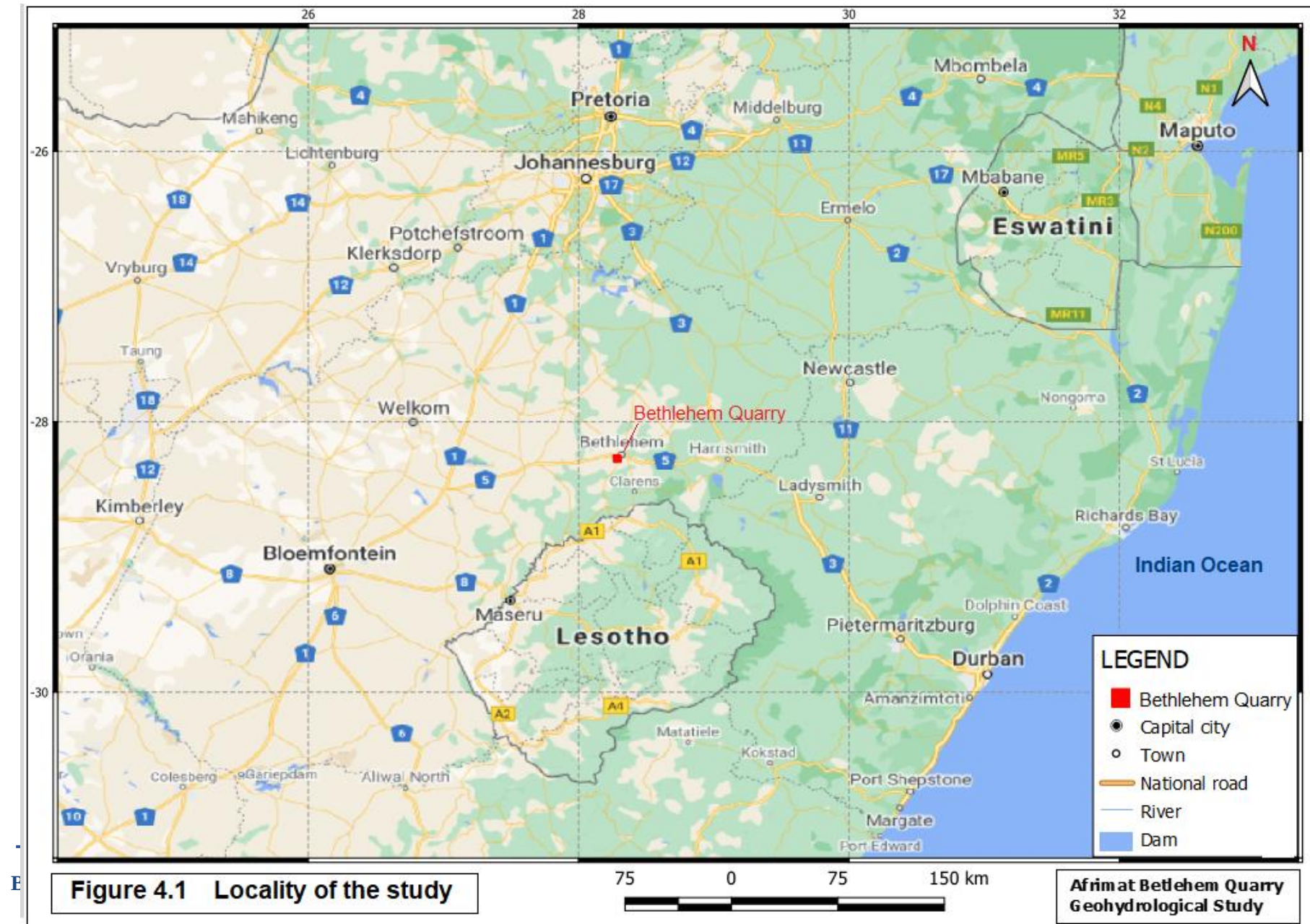
The study area is located in quaternary drainage catchment C83B of the Vaal Water Management Area. The site is characterised by moderate relief, with ground elevation rising from 1645 metres above mean sea level (amsl) at the perimeter of Loch Athlone Dam to about 1820 metres amsl at the peak of the dolerite ridge on whose side quarrying is taking place; a distance of about 2.3 kilometres. Quaternary catchment C83B is drained by the Jodaan River and a second river whose name is not indicated on available maps. Both rivers discharge into Loch Athlone Dam, which is situated east of the quarry. A significant wetland occurs between the dam and the site. Figure 4.2 shows the topography around the site, whilst Figure 4.3 shows the location of the wetland adjacent to the quarry.

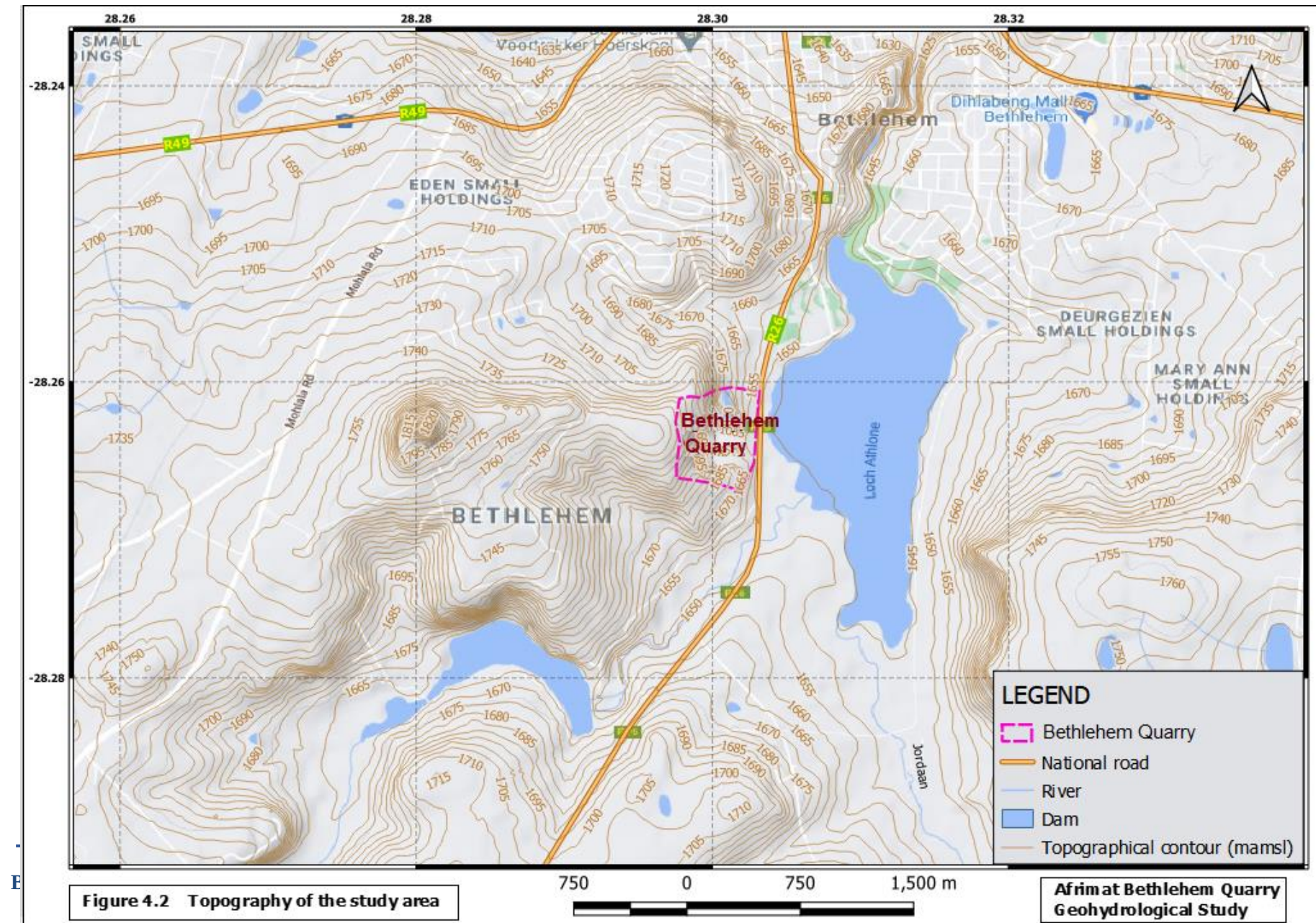
4.3 CLIMATE

The nearest weather station to the site is at Bethlehem. Bethlehem receives about 700mm of rain per year, with most rainfall occurring during summer. It receives the lowest rainfall (11mm) in June/July and the highest (10mm) in December/January. The average midday temperatures range from 7.8°C in July to 20.4°C in January. Bethlehem occasionally receives snow when temperatures plummet below 0°C.

4.4 LAND USE

The quarry is located in a transitional zone between urban setting and open farm land. The land around Bethlehem is classified as commercial dry farming.







5 GEOLOGICAL SETTING

5.1 REGIONAL GEOLOGY

The study area is underlain predominantly by the Karoo Supergroup which consists of a broad spectrum of Carboniferous to Jurassic strata. The Karoo Supergroup covers almost two thirds of the land surface of South Africa. The study area is located in the northeastern segment of the Karoo Basin. The Karoo Supergroup is lithostratigraphically subdivided from bottom upward into the Dwyka Group, Eccca Group and Beaufort Group. These strata are in turn overlain by the Molteno Formation, Elliot Formation, Clarens Formation and Drakensberg Formation. These subdivisions are shown in Table 5.1. Figure 5.1 shows a simplified geological of the study area.

The Dwyka Group consists of tillite, diamictites and reworked tillite and shales, overlain by sandstone. On the basis of lithological and paleocurrent data, the Eccca Group is divided into three formations: The Pietermaritzburg Formation; The Vryheid Formation and the Volksrust Formation. Large deposits of coal are associated with shales of the Eccca Group. The Beaufort Group overlying the Eccca Group consists predominantly of a sequence of mudstone alternating with sandstone and contains abundant flora and fauna remains.

The Karoo Supergroup was capped by an outpouring basaltic lava. Some of the magma did not reach the surface, but solidified at depth to form dolerite dykes and sills. The dykes and sills were later exposed at the surface by erosion.

5.2 LOCAL GEOLOGY

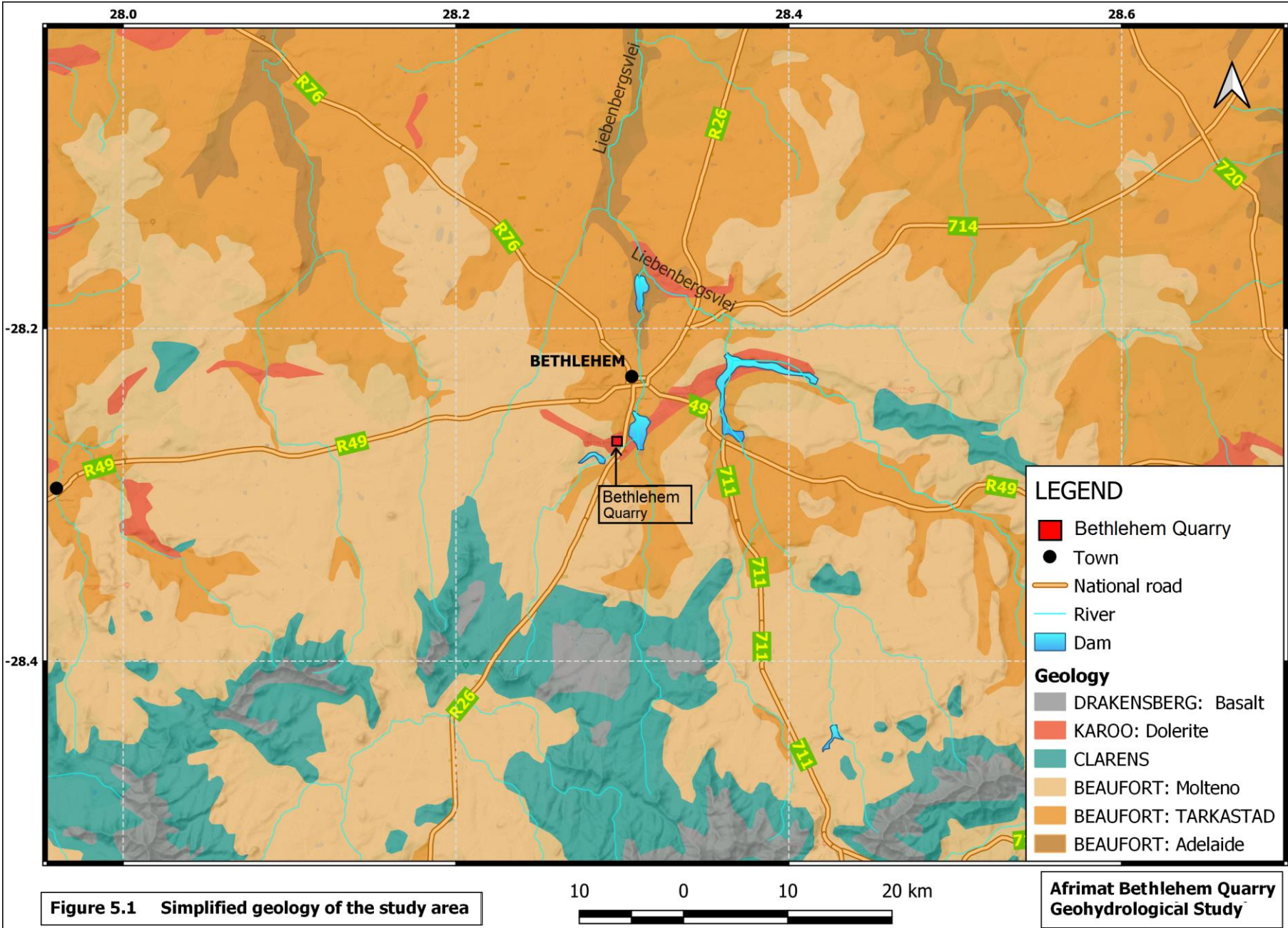
At local level, the study area is dominated by the middle to the upper layers of the Karoo Supergroup. These layers consist of the Beaufort Group, represented by the Tarkastad Subgroup at the site. The Tarkastad consists predominantly of mudstone interbedded with subordinate sandstone.

Dolerite dyke and sills are abundant in the study, and due to their superior resistance to weathering and erosion than the mudstone and sandstone, they form hills that are widespread in the area. Bethlehem quarry is extracting dolerite from one of these hills.

Table 5.1 Lithostratigraphical succession in the study area

Complexes: Super-group	System	Group: Suite; Complex	Subgroup	Formation	Lithology
Karoo	Jurassic	Drakensberg		Extrusive	Basalt
		Karoo dolerite		Intrusive Rock	Dolerite
	Triassic	Clarence			Sandstone
		Elliot			Mudstone & sandstone interbeds
		Molteno			Mudstone & sandstone
	Permian/ Triassic	Beaufort	Tarkastad		Mudstone & subordinate sandstone
			Adelaide		Shale/mudstone & subordinate sandstone
		Ecca		Volksrust	Sandstone, Shale and Coal
				Vryheid	Shale, coal & sandstone
				Pietermaritzburg	
	Carboniferous	Dwyka			Tillite, Mudstone, Sandstone and Shale

Green shade highlights rocks present in the study area

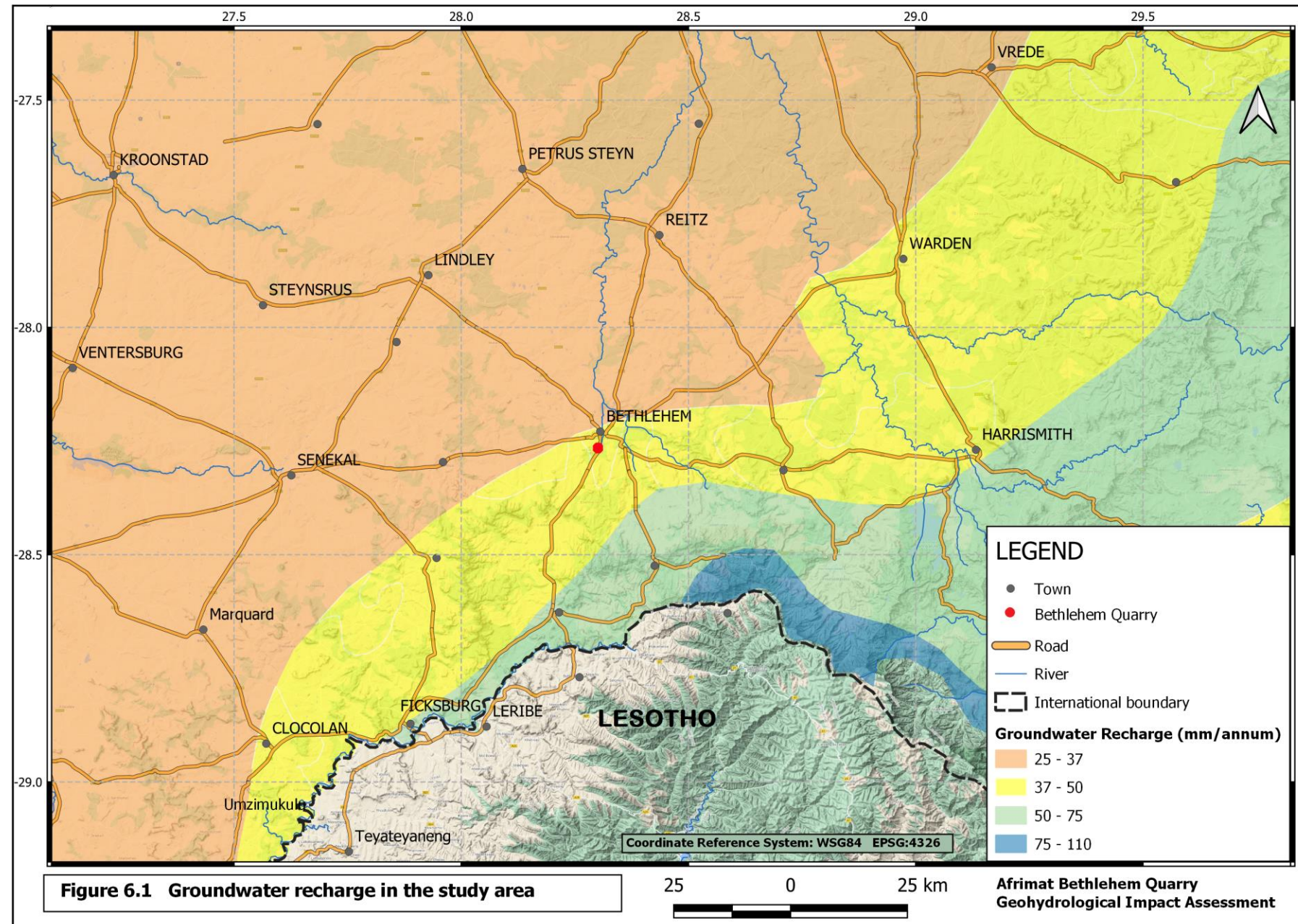


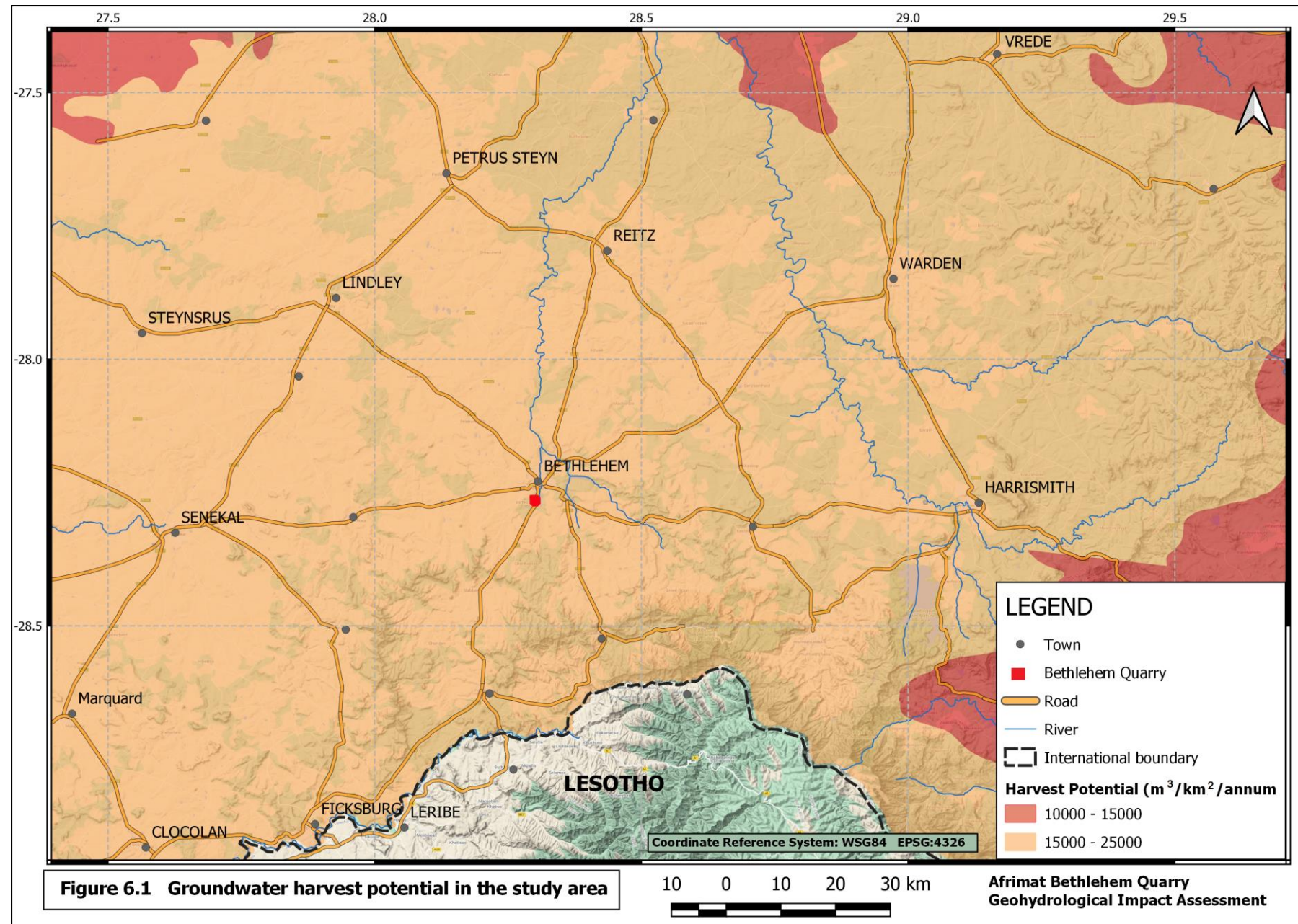
6 GEOHYDROLOGICAL SETTING

The study area is underlain by sedimentary rocks of the Karoo Super-group as described above. Besides the thin veneer of the quaternary deposits, the rocks in the study area are consolidated masses, and generally have very little, if any, primary porosity and permeability. Their water storage and transmission properties arise as a result of secondary processes of fracturing, faulting and weathering. Fracturing develops due to a number of factors that include tectonic movement in the earth crust, pressure relief due the erosion of overburden and shrinking during cooling of the rock mass. Weathering involves the breaking down of the rock mass into loose grains with the help of rainwater which acts as a weak acid after dissolving carbon dioxide in the atmosphere and in the soil. The groundwater potential in the area is classified as low with an average borehole yield of less than 0.5 L/s (1.8m³/h), (King, 1998). However, higher yields are not uncommon and are associated with major faults and fractured dolerite dyke margins.

Groundwater recharge in the study area ranges from 25 to 37mm per annum (Vegter, 1995). Figure 6.1 shows the distribution of groundwater recharge in the area. The groundwater harvest potential, which defines the amount of groundwater that can be sustainably abstracted from a square kilometre of an area per annum, is estimated at between 15 000 and 25 000 m³/km²/annum (Saymour and Seaward, 1995). The distribution of groundwater harvest potential is shown in Figure 6.2.

Groundwater quality is generally good and suitable for human consumption; however pockets of poor water quality do occur. Electrical conductivity (EC) is a useful parameter for evaluating water quality as it reflects the total dissolved solids in the water. The average EC in the area is estimated at less than 70 mS/m (King, 1998), which is ideal water for human consumption.





7 INVESTIGATION

The study was based entirely on the evaluation of existing information, complemented by limited field work comprising a hydrocensus.

The following activities were undertaken:

7.1 DESKTOP STUDY

The investigation commenced with a desktop study in which existing data and information pertaining to groundwater characteristics at the site were gathered and analysed. Sources of information and data included the following:

- National Groundwater Archive (NGA) of the Department of Water Affairs,
- Published geological reports and maps,
- Published geohydrological reports and maps,
- Consultant's reports provided by the client,

7.2 HYDROCENSUS

The desktop study was complemented by a hydrocensus in which existing boreholes and other groundwater related features such as springs and wetlands were sought. The hydrocensus thus sought to:

- Familiarise project team with the project area.
- Identify existing groundwater features (boreholes, springs, wetlands, etc.) in the area.
- Assess groundwater use in the study area.
- Where accessible, measure water levels in existing boreholes

7.3 INTERVIEWS

During the hydrocensus, interviews were conducted with groundwater users around the quarry to establish issues relating to groundwater resources in the area.

8 DISCUSSION OF FINDINGS

8.1 GROUNDWATER CHARACTERISATION

Groundwater characterisation was based on the evaluation of data from existing boreholes. A total of five boreholes were identified, comprising four boreholes from the National Groundwater Archive, NGA; and one from the adjacent property inside which Loch Athlone dam is located. The latter borehole used to supply water to the quarry in the past, but has since been abandoned. The boreholes range in distance from less 100 metres to 3.6 kilometres from the quarry. Data on the existing boreholes are given in Table 8.1. Most of the boreholes have incomplete, but nevertheless useful information. The location of the boreholes is shown in Figure 8.1.

Available information confirms the low groundwater supply potential classification of the area with the only borehole (2828AD00058) that has yield information having 0.4 L/s (1.4m³/h). Water was struck at a depth of 24 metres in this borehole. The lithologies intersected in the existing boreholes include sandstone, dolerite, tillite and shale. The dolerite exposed in the quarry is highly fractured, Plate 8.1.

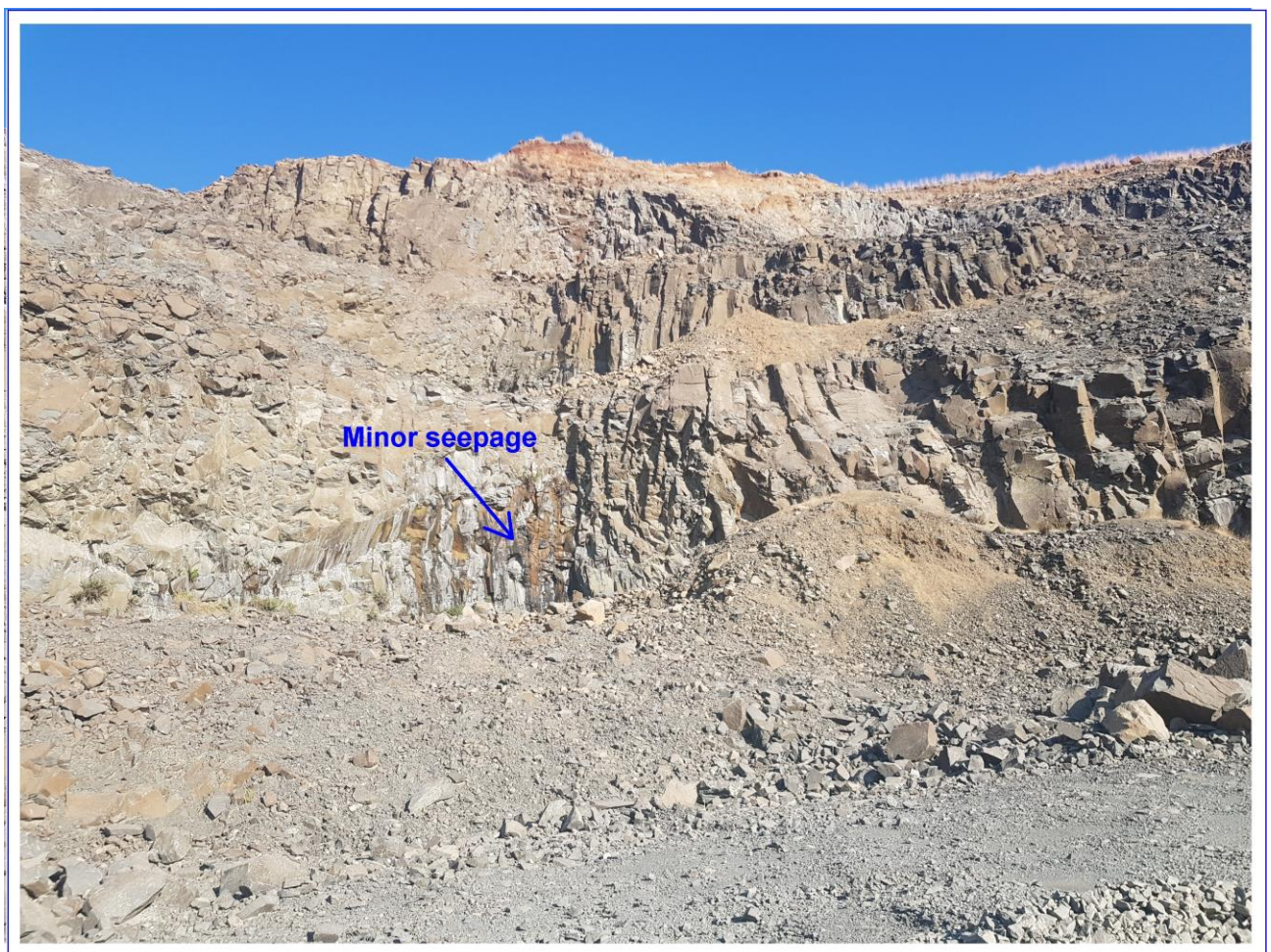


Plate 8.1 Fractured dolerite exposed in the quarry

No major water strikes or groundwater inflows have been encountered in the quarry. Some minor seepage into the quarry from fractures is reported during and after the rain season. This, however, is attributed to drainage from the soil layer which acts as sponge; soaking in water during the rainfall season and releasing it later into underlying fractures. Storm water is collected in sumps in the lower lying areas of the quarry and used for mining activities.

8.2 GROUNDWATER LEVEL

Groundwater level data were evaluated with a view to determining the background water levels at the site, and to determine groundwater flow direction. Available data indicates that groundwater level in the area is around 9 to 10 metres below ground surface. The boreholes nearest to the quarry (BH1) could not be accessed during the field visit, and no information on it could be found. The borehole is located at the edge of the wetland.

The next nearest borehole (2828AD00058) to the quarry is on private property about 0.45 kilometres from the quarry. The borehole is equipped with an electric submersible pump. The water level in the borehole, based on NGA data, is about 10.22 metre below ground surface. The surface elevation at the location of the borehole is estimated to be about 1657 metres above mean seal level (amsl). The elevation of the water-table at the same location is estimated to be 1647 metres amsl. The water level elevation in the nearby wetland is estimated to be between 1640 and 1645 metres amsl. These calculations indicate that there is a shallow water-table gradient from the borehole to the wetland and ultimately to Loch Athlone Dam. This suggests that groundwater contributes baseflow into the wetland. Figure 8.3 shows a schematic vertical cross-section from west to east cutting through the quarry.

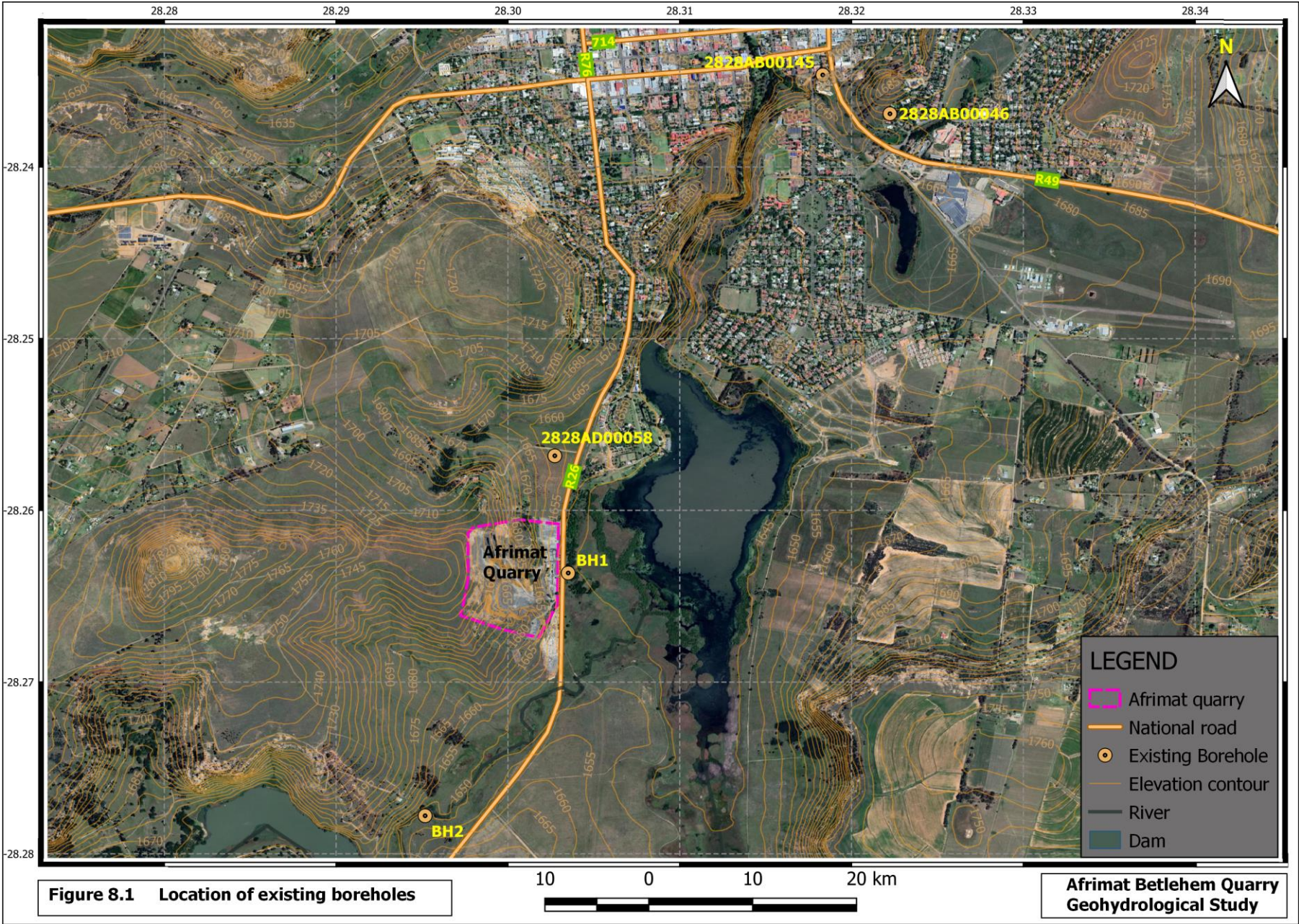
Table 8.1 Information on existing boreholes

Borehole ID	Latitude	Longitude	Distance from site (m)	BH Depth (m)	Water-strike (m)	Blow-yield (L/s)	Water-level (m)	EC mS/m	Geology
BH1	-28.263647	28.303513	< 100						
BH2	-28.277785	28.295182	1.6						
2828AD00058	-28.256820	28.302730	0.5				10.22	47	
2828AB00145	-28.234640	28.318330	3.6	41.45	24.38	0.4	9.4		Sandstone, shale, dolerite
2828AB00046	-28.236900	28.322240	3.5	8.77					dolerite, siltstone & shale

Lack of adequate groundwater level data precluded the creation of a piezometric surface map to depict groundwater flow patterns at the site. Under these circumstances the principle that the water-table mimics surface topography in hard rock environments was adopted. Figure 8.2 shows the inferred groundwater flow directions at the site. Loch Athlone Dam is final receptor of groundwater in the area.

8.3 GROUNDWATER QUALITY

No groundwater quality data could be found for the quarry. Borehole 2828AD00058 from NGA indicates an average electrical conductivity of 47 m/Sm, which is good quality for drinking.



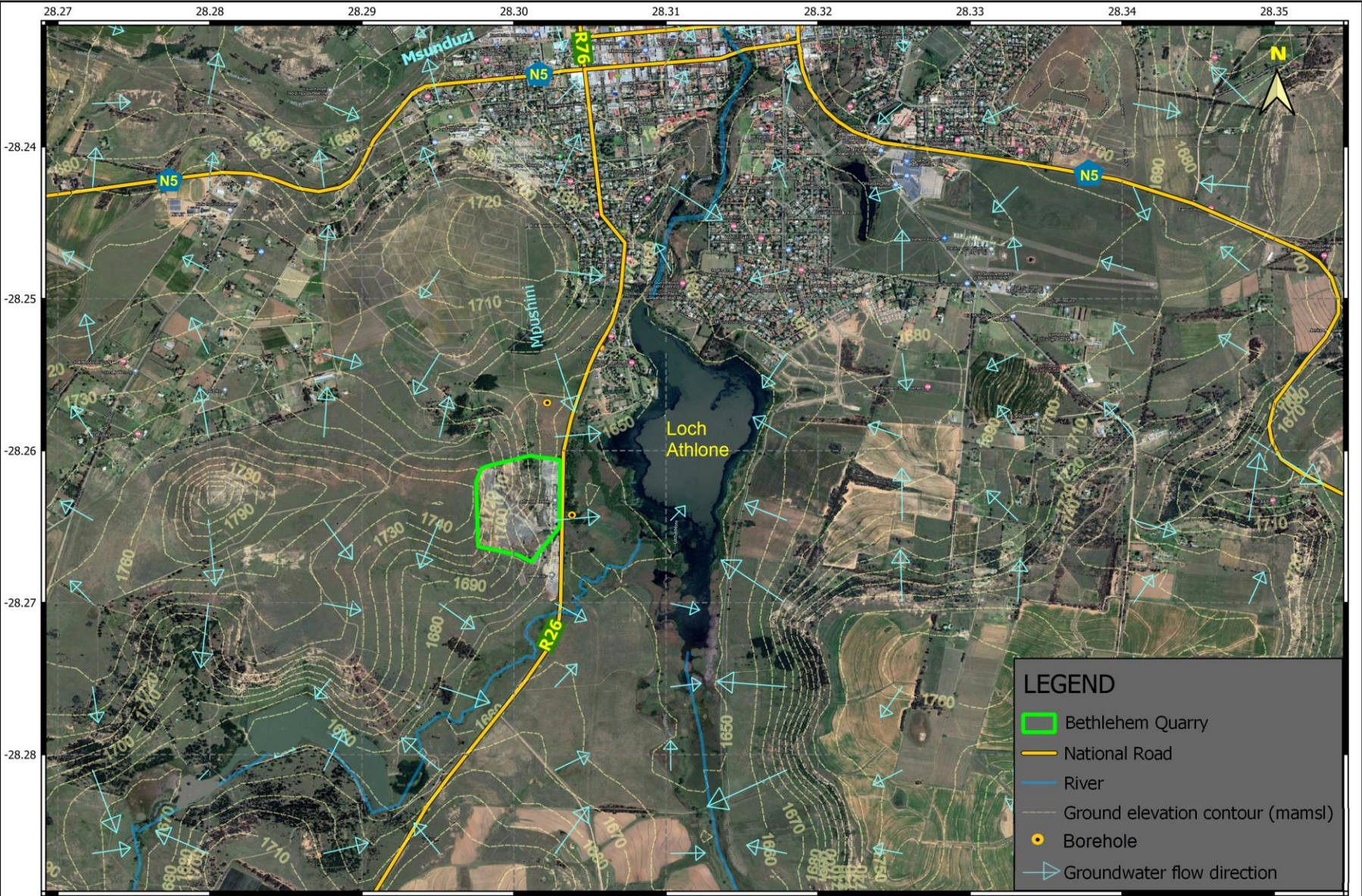
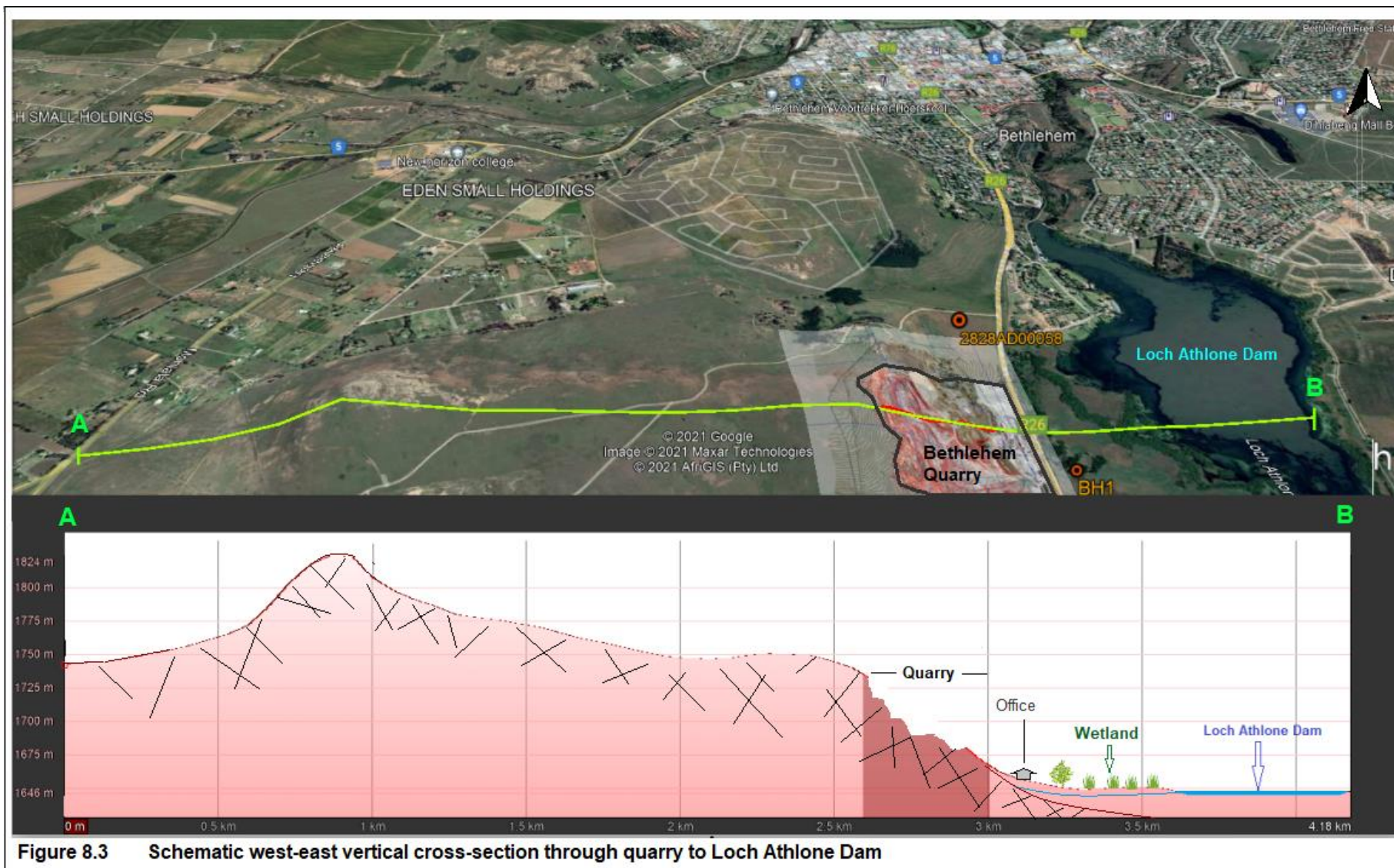


Figure 8.2 Groundwater flow pattern at the site

Afrimat Bethlehem Quarry
Geohydrological Impact Assessment



9 IMPACT ASSESSMENT

The potential impact posed by the Bethlehem Quarry on the integrity of groundwater resources at the site were evaluated according to the Department of Water and Sanitation's "Best Practice Guidelines For Water Resource Protection In the South African Mining Industry, BPG4: Impact Prediction" published by the SABS in 2008. The guidelines dictates that the impacts be evaluated for all the different phases of the project life cycle, which comprise the following:

1. Feasibility
2. Construction phase
3. Operational phase
4. Decommissioning and closure phase
5. Post closure phase (management of post closure residual and latent impacts).

For the current project, the feasibility and construction phases have passed. The impact assessment therefore begins at the operation phase to the post closure phase.

9.1 DESCRIPTION OF ACTIVITIES

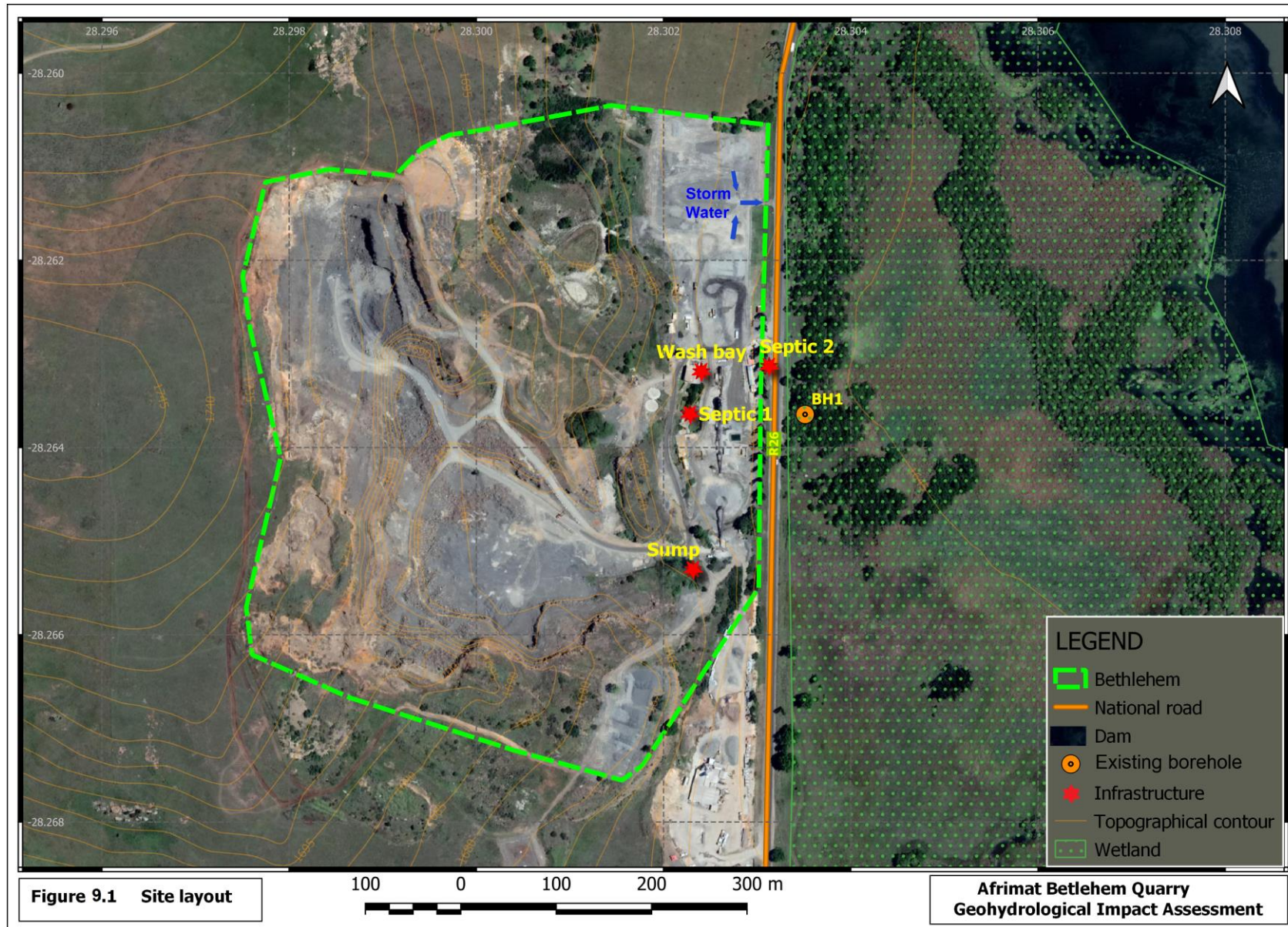
Mining operations at Bethlehem Quarry are on-going. The site layout, highlighting features of interest for the current study, is shown in Figure 9.1. The following activities are currently taking place:

- Drilling and blasting to extract the desired rock. It is reported that excavation will not go below the current lowest elevation, estimated at 1660 metres above mean sea level.
- Loading and hauling the material out of the excavation to the crushing and screening plant,
- Crushing and screening the recovered material at the crusher plant in order to reduce it to various size aggregate. The processing area has been compacted by the haulage trucks.
- Stockpiling the aggregate at a stockpile area until it is collected by clients.

The potential **receptors** of impacts from the quarry include:

- Loch Athlone Dam.
- Wetland associated with Loch Athlone Dam.
- Neighboring groundwater users.

Presently there are no groundwater monitoring boreholes to track potential impacts of mining activities on groundwater at the quarry.



9.2 OPERATION PHASE

This phase represents the period during which quarrying takes place at the site. Installation of all supporting infrastructure will have been completed.

9.2.1 Impact on groundwater Levels

The main concern relates to the potential drying up of the adjacent wetland due to dewatering of the quarry. In other words water will be drawn from the wetland towards the quarry as a result of dewatering. This is not going to happen as explained below:

The excavation of the quarry has reached its lowest intended vertical elevation, and extraction of dolerite is now progressing laterally. Mining is taking place way above the water-table. Available ground elevation data show that the lowest point in the excavated area is at 1660 metres amsl. The water level in the borehole near the quarry and in the wetland are estimated to be between 1640 and 1647 metres amsl. Quarrying is therefore not expected to intersect the water-table. Groundwater level will not be affected by mining operations.

9.2.2 Impact on groundwater quality

The main concern relates to possible contamination of groundwater by waste generated from mining activities. The potential for groundwater contamination is considered low as explained below:

The processing of rock material consists of crushing and screening, and temporarily stockpiling at the site before sale. The entire process is a physical one, with no toxic chemical additives used. The process therefore does not generate any potential sources of groundwater contamination. No waste facilities such as tailings dams or evaporation dams exist at the site. No significant groundwater contamination is anticipated from the main activities.

Potential sources of groundwater contamination include:

- Septic tanks and associated ablution facilities,
 - Vehicle wash bay and associated oil separator,
 - Incidental fuel and oil leaks/spillages from vehicles and equipment,
 - Explosives used for blasting taint the rocks with residual chemicals, particular nitrates. These chemicals get washed off the rocks by rain in the quarry and stockpile area, and find their way into the underlying aquifers,
 - Dust suppression,
 - Storm water from processing and stockpile areas.
- All the above potential sources of groundwater contamination represent low contaminant load. The septic tanks, vehicle wash bay and oil separator are bunded and therefore present the least threat to groundwater quality.

- The rock processing and aggregate stockpile areas have been compacted by heavy haulage trucks over the years to the extent that very little surface water is expected to seep into the ground.
- Presently storm water from these areas is directed out of the property through a dedicated spillway. The quality of the storm water is not tested prior to disposal outside the property. An ecologically sensitive wetland lies a short distance down gradient of the discharge point, a situation of serious concern.
- Presently there is no groundwater quality monitoring being conducted at the quarry. There are two existing boreholes that could potentially be used for groundwater monitoring. These are BH1 located next to, and downstream of the quarry; and BH 2828AD00058 located less than 500 metres north of the quarry on private land. The latter will require permission from the owner. Should these boreholes not be available for monitoring purposes, then a new borehole downstream of the quarry will be required.

9.3 DECOMMISSIONING PHASE

The decommissioning phase represents the period leading to the total cessation of mining operations. During this phase, the status quo from the operation phase persists until all activities stop.

9.3.1 Impact on groundwater Levels

No impact is expected during this phase

9.3.2 Impact on groundwater Quality

Residual impacts from the earlier phases may persist for some time after closure.

9.4 POST MINE CLOSURE PHASE

This represents the period after of all mining activities have come to a complete halt.

9.4.1 Groundwater Levels

No impact on groundwater levels is expected.

9.4.2 Groundwater Quality

Residual impacts from the earlier phases may persist for some period after closure.

9.5 SUMMARY OF THE IMPACT ASSESSMENT

A summary of the impact assessment is given in Table 9.1

Table 9.1 Summary of the impact assessment

Phase	Description of activities	Impacts	Recommendation/remediation
Operation	- Extraction and processing of rock. - Disposal of industrial and domestic waste. - Dust suppression. - Monitoring of impacts.	- Quarrying has reached its lowest intended elevation which is higher than the adjacent dam and associated wetland. No impact on groundwater levels expected. - Blasted rock may be tainted with nitrate explosives with potential to contaminate groundwater. - Accidental fuel and oil spillages may contaminate groundwater. - Dust suppression may wash contaminants from surface to underlying aquifers. - Processing and stockpile areas have been compacted by heavy trucks over the year; hence surface water infiltration will be minimal.	- Water free of potential contaminants should be used for dust suppression, - Test water quality of storm water from processing and stockpile areas prior to disposal outside the property. - Use boreholes BH1 and 2828AD00058 for groundwater monitoring. Should these boreholes not be available, then drill another borehole next to BH1. Pump test the borehole to determine hydraulics parameters required for groundwater modelling. - Develop a groundwater flow model to simulate groundwater flow behavior at the site. - Commence groundwater monitoring immediately after monitoring boreholes become available. - Storm water management should ensure no water lingers on the surfaces; hence prevent seepage into the subsurface.

Phase	Description of activities	Impacts	Recommendation/remediation
Closure and decommissioning	- Cessation of operations and cleaning up. - Monitoring of impacts.	- No impact on groundwater levels expected. - Residual groundwater contamination may continue	- Continue groundwater monitoring. - Fine tune the groundwater flow model
Post closure	- Mine rehabilitation continued. - Monitoring of impacts.	- No impact on groundwater levels expected - Residual groundwater contamination may continue	Continue groundwater monitoring until it complies with RQOs embedded in the Water Use Licence.

10 CONCLUSION

The study sought to assess potential negative impacts emanating from the mining activities at Bethlehem Quarry just outside Bethlehem in the Free State Province. The following findings were derived from the study:

10.1 GROUNDWATER LEVEL AND QUANTITY

- Very little to no negative impact on groundwater level is expected as mining excavation is taking place way above the water-table at the site. Mining excavation has reached the intended lowest elevation, which is estimated at 1660 metres amsl. The quarry will go not below this level; hence will not intersect the water table which is estimated to be below 1647 metre amsl. Dewatering will not take place.
- The study area has very low borehole yield potential, characterised by borehole yields of less than 0.5 L/s (1.8m³/h). However, higher yields are possible where good fractures or faults are intersected.
- Groundwater level monitoring is presently not conducted.

10.2 GROUNDWATER QUALITY

- The processing of dolerite aggregate is a physical process that does not use any chemicals. The potential for negative impacts on groundwater quality from the main activities is considered very small.
- Potential sources of groundwater contamination include:
 - Septic tanks and associated ablution facilities,
 - Oil separator
 - Dust suppression:
 - Incidental spillage of fuel and oil
 - Residual chemicals on blasted rocks in the processing and stockpile areas.
- All the above potential sources of groundwater contamination represent low contaminant load.
- The septic tanks, vehicle wash bay and oil separator are bunded and therefore present very low risk to groundwater quality.
- The rock processing and aggregate stockpile areas have been compacted by heavy haulage trucks over the years to the extent that minimal surface water is expected to percolate into the underlying aquifers.
- Presently storm water from these areas is directed out of the property through a dedicated spillway. The quality of the storm water is not tested prior to disposal outside the property. This leaves an ecologically sensitive wetland immediately down gradient of the discharge point exposed and vulnerable.

- There is one groundwater user (BH 2828AD00058) that may be potentially at risk of ground water contamination.

11 RECOMMENDATIONS

The recommendations seek to ensure that Bethlehem Quarry complies with the relevant government legislation, particularly the National Water Act of 1998 (Act 36 of 1998).

To this end, the following recommendations are made:

- Groundwater monitoring should commence immediately. Groundwater monitoring provides early warning of possible negative impacts on groundwater resources; leading to timely intervention.
- Two existing boreholes (Figure 8.1) should be investigated for possible use for groundwater monitoring:
 - BH1 located directly down gradient of the quarry. The borehole may require rehabilitation. Should the borehole not be usable, then a replacement borehole next to it should be drilled.
 - BH 2828AD00058 located less than 500 metres north of the quarry on private land. This will require permission from the owner.
- Borehole BH1 or its replacement should be pump-tested to determine hydraulic properties of the aquifer(s) at the site.
- A groundwater flow model should be developed using hydraulic parameters from above to simulate groundwater flow behaviour at the site; hence predict potential impacts on water quality.
- Groundwater quality sampling should be conducted quarterly; whilst monitoring of groundwater level should be carried out monthly.
- Water quality parameters to be monitored should include, but not limited to those for drinking water as given in Table 11.1.
- Baseline groundwater quality should be established in the first 24 months of continuous collection of water quality data from the monitoring borehole(s). This will provide a robust long-term groundwater quality baseline that will be used to detect any changes in groundwater quality during operation and post mine closure.
- Groundwater quality monitoring should continue after mine closure until the water quality complies with the Resource Quality Objectives (RQOs) embedded in the water use licence for a period of 24 months. RQOs are determined by the Department of Water and Sanitation for the quaternary catchment in which the quarry is located, in this case quaternary catchment C83B.
- Ideally the aggregate stockpile and processing areas should be lined with low permeability material or bunded to reduce the risk of groundwater contamination. However, due to the extent of the existing facilities, the cost of retro-fitting the liners or bunding would be

astronomical. It is therefore recommended that effort be made to manage storm water in a manner that reduces its residence time in these areas to minimise the chances of it seeping into the subsurface.

- The disposal of storm water outside the property without prior water quality testing is of major concern, considering the presence of a wetland immediately downstream of the quarry. However, this falls in the realm of surface water management; hence is left to be appropriately addressed there.
- Water used for dust suppression should be free of potential contaminants.

Table 11.1 Parameters to be monitored

Electrical conductivity, EC.	Potassium, K.	Chloride, Cl.
Total dissolved solids, TDS.	Iron, Fe.	Sulphate, SO ₄ .
Acidity/alkalinity, pH.	Manganese, Mn.	Fluoride, F.
Turbidity	Copper, Cu.	Nitrate, NO ₃ as N.
Colour	Lead, Pb.	Phosphate, PO ₄ .
Calcium, Ca.	Zinc, Zn.	Total alkalinity, CaCO ₃ .
Magnesium, Mg.	Cadmium, Cd.	Hydrogen carbonate, HCO ₃
Sodium, Na.	Chromium, Cr.	Faecal Coliform.

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ADDENDUM

SITE VERIFICATION AND VALIDITY CONFIRMATION (2026)

ADDENDUM: SITE VERIFICATION AND VALIDITY CONFIRMATION (2026)

1 INTRODUCTION

A follow-up site visit to the Bethlehem Quarry was conducted on April 30, 2026 to verify whether conditions described in the 2021 Geohydrological Impact Assessment (Report Ref: 2021013) remain valid. This exercise was undertaken to confirm the continued applicability of the original findings, in support of the amendment of the Environmental Management Programme (EMPr) for the Bethlehem Quarry.

2 OBJECTIVE

The objective of the site visit was to:

- Assess any changes in site conditions since 2021.
- Verify the validity of the original conceptual hydrogeological model.
- Identify any new or emerging risks to groundwater resources.
- Confirm whether previous conclusions and recommendations remain applicable.

3 SUMMARY OF SITE OBSERVATIONS (2026)

No significant changes in site layout, mining activities, or infrastructure were observed compared to the 2021 assessment.

- The elevation of the quarry floor remains unchanged and continues to be above the regional water table.
- No evidence of groundwater intersection by mining activities was observed.
- Increased water accumulation in the lower sump was noted, attributed to recent rainfall.
- Stormwater from mining operational area and sump water continue to be discharged off-site toward the dam and wetland.
- No groundwater monitoring infrastructure has been installed.

4 INTERPRETATION OF FINDINGS**4.1 Groundwater Levels and Quantity**

The original conclusion that mining activities occur above the water table remains valid. Increased sump water is rainfall-driven, not groundwater ingress. No impact on groundwater levels is expected.

4.2 Groundwater Quality and Surface Water Interaction

Groundwater resources downstream of the quarry are vulnerable to potential contamination from the unlined sump at the bottom of the quarry and from stormwater emanating from the mining area; the water quality of both is presently unknown.

5 CONCLUSION

The 2021 report remains valid. However, several recommendations from that assessment are still outstanding. These include the commencement of groundwater monitoring and the quality analysis of water collecting in the quarry sump.

6 UPDATED RECOMMENDATIONS

- The quality of the water collecting in the sump should be determined.
- Stormwater management should be strengthened; presently, stormwater emanating from mining operational areas escapes into the downstream wetland and dam.
- Groundwater monitoring should be implemented using the two existing boreholes identified in the report for this purpose.