# Environmental Impact Assessment for the Proposed Temo Coal Rail Loop, Road Diversion and Pipeline Project, near Lephalale, Limpopo Province

## Groundwater Report

**Project Number:**

NAM5335

**Prepared for:**

Temo Coal (Pty) Ltd

February 2019

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| **Report Type:** | **Groundwater Report** |
| **Project Name:** | **Environmental Impact Assessment for the Proposed Temo Coal Rail Loop, Road Diversion and Pipeline Project, near Lephalale, Limpopo Province** |
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| **Name** | **Responsibility** | **Signature** | **Date** |
|---|---|---|---|
| Robel Gebrekristos | Reporter | | February 2019 |

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# EXECUTIVE SUMMARY

Digby Wells Environmental was appointed by Temo Coal (Pty) Ltd to undertake a groundwater assessment for the proposed development of a Rail loop, Road and Pipeline in Lephalale, Limpopo. This report deals with the groundwater impact assessment and is conducted in support of the Integrated Environmental Authorisation (IEA) and Water Use License Application (WULA).

Temo is located approximately 60 kilometres (km) from Lephalale in the Limpopo Province. It currently has an approved mining right and proposes to extract coal using open pit mining method and the open pit will be situated entirely within the farm portion Verloren Valey 246 LQ. To support the operations, Temo proposes the construction of a diversion road, rail loop and water pipeline.

The construction of this infrastructure was not included or assessed in the original environmental authorisation of the Temo mine. This specialist groundwater study assesses the potential impacts and mitigation plans on the groundwater environment during the construction, operation and closure phases of the road, rail loop and water pipeline.

A total of 26 boreholes were surveyed during the hydrocensus within 5 km radius of the project area.

Out of the 26 boreholes identified:

- 3 boreholes are used for game watering only;
- 6 boreholes are used for livestock watering;
- 3 boreholes are used for human drinking and livestock watering;
- 7 boreholes are used for cattle and game watering; and
- The remaining 7 boreholes are unused.

The groundwater depth within the project area is approximately 20.7 m below ground surface, but ranges between 8.7 and 48.0 m. The natural groundwater flow direction within the project area is directed from south to north and north-west.

A total of 7 boreholes were sampled for the baseline assessment. Two boreholes (VLV1 and DKP1) are within the ideal quality standard, and therefore no threat to human health or the environment is expected. Three boreholes are classified with the acceptable quality. They contain slightly elevated levels of nitrate, chloride, and fluoride. The nitrate is likely to be associated with the farm fertiliser application or with the animal waste; while the chloride and fluoride are natural dissolution of the host rocks. At the current concentrations, the effects will be purely aesthetic, and no adverse health or environmental effects are expected.

Two boreholes (VLV3 and SARF2) contains high levels of fluoride and iron respectively, both exceeding the maximum allowable limits. This type of water is not suitable for domestic use. The elevated concentrations of iron and fluoride are suspected to be due to naturally elevated concentrations as derived from the natural erosional processes of the underlying formations.

Since the water table in the project area is approximately 20 m below the ground surface, all the proposed activities (rail loop, road, and pipeline) will take place above this and no impact on the groundwater is envisaged as a result. None of the activities will involve excavation to below the water table, hence there is no risk to the groundwater quantity and quality. Any hydrocarbon spillages are expected to volatilise before reaching the water table. However, the following are recommended to be implemented:

- Pipelines should be monitored for leakage. Cracked pipelines should be sealed.
- Diesel or other chemicals should not be spilled, and machinery should be properly maintained.
- Fuel and oil reservoirs must be in a bunded area.
- If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed of at an acceptable dumping facility. The excavation should be backfilled with soil of good quality.
- Monitoring boreholes located within the environs of the project area have to be monitored for both water level and quality.

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# 1 Introduction

Temo Coal Mining (Pty) Ltd (hereinafter Temo Coal), proposes to construct ancillary infrastructure associated with their approved coal mining operation, the Temo Coal Mine ("Temo Mine"), near Lephalale in the Limpopo Province ("the Project"). The proposed ancillary infrastructure includes a road diversion, rail loop and water pipeline.

Digby Wells Environmental (Digby Wells) was commissioned by Temo Coal to perform a fauna and flora field survey to compile a report for the inclusion in an Environmental Impact Assessment (EIA) for Environmental Authorisation for Listed Activities as detailed in the EIA Regulations, under the National Environmental Management Act No. 7 of 1998 (NEMA).

This report deals with the groundwater impact assessment and is conducted in support of the Integrated Environmental Authorisation (IEA) and Water Use License Application (WULA).

## 1.1 Project Background

Temo currently has an approved mining right (MR) which was authorised by the Department of Mineral Resources on 27 September 2013 (Reference Number: LP 30/5/1/2/2/199 MR). That Project was also authorised in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and the Environmental Impact Assessment (EIA) Regulations thereunder, dated 18 June 2010 (which have since been repealed). The Environmental Authorisation was granted by the Limpopo Department of Economic Development, Environment and Tourism (LEDET) on 13 July 2015 (Reference Number: 12/1/9/2-W55).

Temo Mine is located approximately 60km from Lephalale in the Limpopo Province. This project considers applying for Environmental Authorisation, in terms of NEMA, and a Water Use Licence (WUL) in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) to construct a rail loop, road diversion and pipeline.

The farm portions on which the Temo Mine is situated comprise Verloren Valey 246 LQ, Duikerpan 249 LQ, Japie 714 LQ, Hans 713 LQ and Kleinberg 252 LQ. Temo proposes to mine coal using open pit methods and the open pit will be situated entirely within the Farm Verloren Valey 246 LQ.

In reference to this assessment, Temo proposes to divert the dirt road (D175) around the approved mining right area for mining to continue, to construct a rail loop for transportation of coal and construct a water pipeline to service the Temo mine. As detailed below:

- **Diversion of road D175:** The approved open pit area has a road, the D175, which transects the south-western corner of the future pit area and continues to exit the Mining Right boundary near the north-western corner. To facilitate continued mining and maximise the minable area at the Temo Mine, Temo proposes that the D175 be diverted around the mining area;

- **Proposed Rail Loop:** The purpose of the rail loop is to allow Temo to transport export-grade coal product to the Richards Bay Coal Terminal (RBCT), as well as for domestic use. The rail loop will include a loading loop which will be within the approved Mining Right boundary of the Temo Mine; and
- **Proposed Bulk Water Pipeline:** Construction of a bulk water pipeline (for which three different pipeline routes are proposed) connecting the Temo mine.

The abovementioned proposed developments requires an EIA Report and Environmental Management Programme, in terms of the new EIA Regulations, published in GN R982 dated 04 December 2014 (as amended December 2017).

## 1.2 Topography and Drainage

Temo is located at an altitude of approximately 850 metres above mean sea level (mamsl). The topography is relatively flat, dipping at a very gentle slope towards the Limpopo River.

The Limpopo River forms the north-western border of A41E quaternary catchment and forms parts of the Limpopo Water Management Area (WMA). The main watercourse in the vicinity of the proposed mining area is the Limpopo River with smaller water courses such as the Matlabas and Mokolo Rivers located approximately 35 km to the southwest and towards the east respectively.

## 1.3 Climate

The project site is situated in rainfall zone A4B, which is characterised by a Mean Annual Precipitation (MAP) of 438 mm; Mean Annual Runoff (MAR) of 4.8 $Mm^3$ for the entire catchment; and Mean Annual Evaporation (MAE) of 1,950 mm. The ratio of runoff to precipitation in the A41E quaternary catchment is 1.3% (*Digby Wells, March 2011*).

The average maximum temperatures for the region are reached from November to January with temperatures reaching a maximum of 33°C. The average minimum temperatures are reached during June and July with a minimum temperature of 5°C.

Precipitation data presented in Figure 1-1 indicates that the highest average monthly rainfall (average 75 mm) is recorded in November, with the lowest rainfall occurring during winter (zero rainfall recorded).

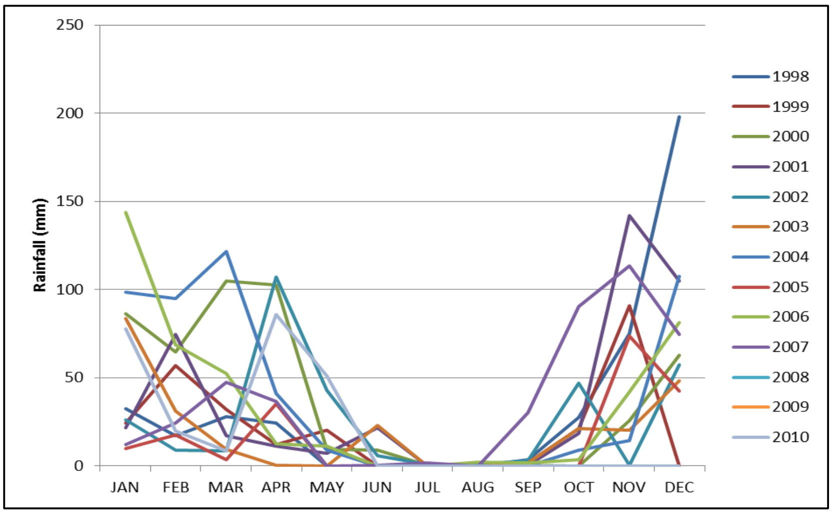


**Figure 1-1: Monthly rainfall at the Lephalale weather station**

## 1.4 Terms of Reference

The groundwater assessment was, therefore, conducted under the following legislative requirements:

- The assessment methodology is compiled in line with the National Environmental Management Act (Act 107 of 1998) (NEMA);
- The protection and use of water is legislated under the National Water Act (Act 36 of 1998) (NWA); and
- The use of water in mining is regulated under the NWA amendment of Regulation 704 (GN R 704) of 1999.

## 1.5 Study Objectives

The construction of this infrastructure (i.e. the road diversion, rail loop and pipeline) was not included or assessed in the original environmental authorisation of the Temo mine. This specialist groundwater study assesses the potential impacts and mitigation plans on the groundwater environment during the construction, operation and closure phases of this infrastructure.

The objectives of this study were to:

- Establish the current groundwater flow characteristics in the saturated zone, considering the aquifer hydraulic parameters, recharge and discharge areas;
- Investigate the current groundwater conditions (water levels and quality). This represents the baseline groundwater conditions for the site considered for potential future liability claims and preparation to final closure application;
- Estimate the likely impact of the proposed infrastructure on the groundwater resource; and

- Recommend groundwater monitoring, management and pollution mitigation methods to minimise any potential impacts associated with the proposed infrastructure.

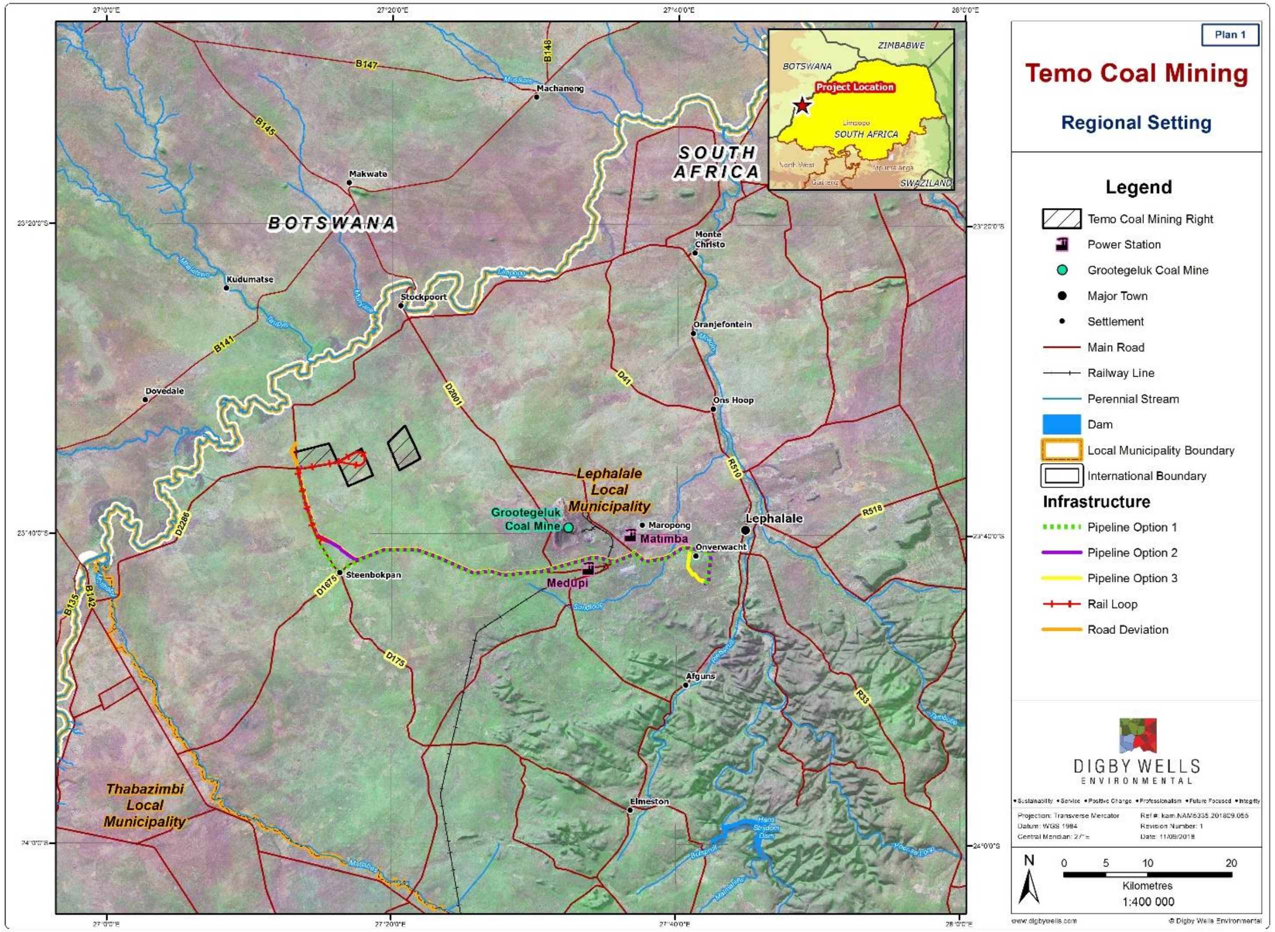


**Figure 1-2: Regional setting**

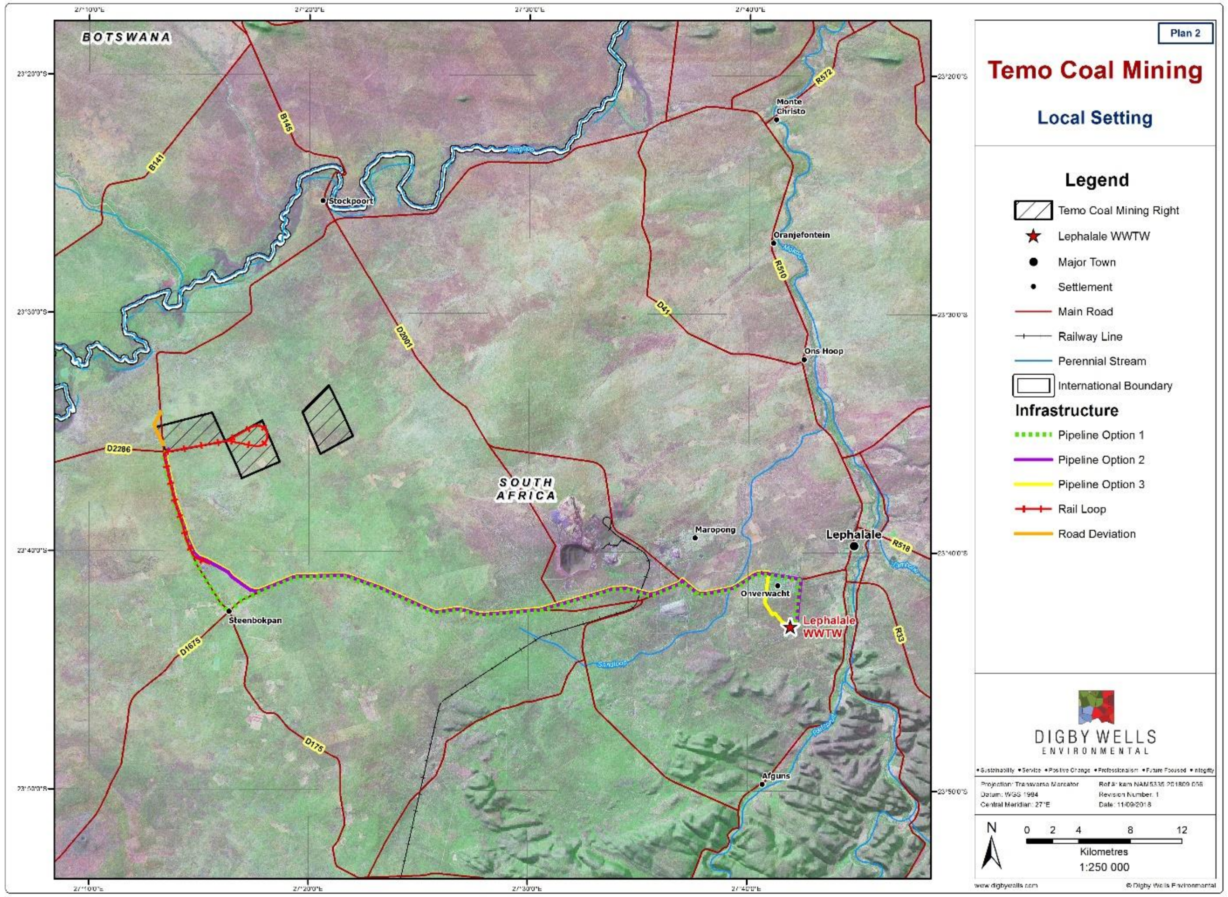


**Figure 1-3: Local setting**

# 2 Details of the Specialist

The groundwater impact assessment was conducted by Dr Robel Gebrekristos. Robel is a senior groundwater modeller and the hydrogeology manager at Digby Wells, with more than 17 years of experience, both as a corporate consultant and as researcher. He achieved his Doctorate in Hydrogeology in 2007 from the University of the Free State.

Robel's experience with groundwater modelling includes using finite difference (Modflow) and finite element (FEFLOW, SUTRA) software packages, tailings seepage modelling (using SEEP/W), water balance evaluations (using GoldSim or Excel Spreadsheet), hydrogeological database management, appraisals of mining and industrial impact assessments, and monitoring and analysis of contaminants (both organic and inorganic) in groundwater.

Robel has solid background on GIS mapping and is familiar with QGIS, Surfer, Global Mapper, ArcGIS, Map Source, WISH and Voxler 3D modelling. He is competent in VB.net and C++ computer programming and is able to design databases. Robel has written more than 20 papers and documents on his field of expertise.

Recent assignments include various hydrogeological specialist and EIA investigations for mining and industrial projects in South Africa and other African countries. Robel was the principal groundwater modeller for the EIA study of Temo Coal Mine in 2014 and 2016.

# 3 METHODOLOGY

The methodology followed to investigate the groundwater impact assessment is as follows:

- Desktop study: This phase involved a review of available hydrogeological, geotechnical, geochemical, geochemical, conceptual and numerical reports. Available data was selected and stored into a Water Interpretation System for Hydrogeologists (WISH) database. This was later used to develop a site conceptual model that was used for numerical modelling, impact assessment and mitigation planning.
- Hydrocensus: A site visit that included a hydrocensus of existing boreholes (community and/or private boreholes) was conducted following the desktop study. This was carried out to initiate the project and define the baseline groundwater usage in the area, as well as to collect information on activities and general groundwater related infrastructures.
- Impact Assessment: The potential impact of the proposed infrastructure on the groundwater was conducted following the desktop study and hydrocensus. In this

phase, the environmental impacts were rated based on their significance scoring before and after mitigation methods are implemented.

- Impact Mitigation: The recommended mitigation and management options to further minimise environmental impacts on the groundwater environment are addressed in this phase.

# 4 Baseline Hydrogeological Conditions

## 4.1 Current Groundwater Usage

A hydrocensus was conducted by Digby Wells previously as part of the Temo Coal project. A total of 26 boreholes were surveyed within 5 km radius of the project area as listed in Table 4-1.

Out of the 26 boreholes identified:

- 3 boreholes are used for game watering only;
- 6 boreholes are used for livestock watering;
- 3 boreholes are used for human drinking and livestock watering;
- 7 boreholes are used for cattle and game watering; and
- The remaining 7 boreholes are unused.

**Table 4-1: Summary of the groundwater usage**

| Site ID | Cartesian X (m) | Cartesian Y (m) | Type | Farm and Farm Portion | Groundwater Level | Equipment | Use |
|---|---|---|---|---|---|---|---|
| VLV1 | -2609990 | 24437 | Borehole | Verloren Valley 246-LQ | 21.08 | Submersible pump | Drinking water and Livestock watering |
| VLV2 | -2609328 | 25641 | Borehole | Verloren Valley 246-LQ | No access | Mono pump | Livestock watering |
| VLV3 | -2608203 | 25392 | Borehole | Verloren Valley 246-LQ | 19.52 | None | None |
| VLV4 | -2608960 | 22518 | Borehole | Verloren Valley 246-LQ | No access | Windpump | None |
| DKP1 | -2609875 | 29318 | Borehole | Duikerpan 249-LQ | 24.65 | Windpump | Livestock watering |
| DKP2 | -2611437 | 29943 | Borehole | Duikerpan 249-LQ | 41.92 | Windpump | None |
| DKP3 | -2612257 | 29150 | Borehole | Duikerpan 249-LQ | 21.84 | Mono pump | Livestock watering |
| SARF1 | -2605481 | 37535 | Borehole | Kleinberg 252 LQ, Hans 713 LQ & Japie 714 LQ | 27.14 | Submersible pump | Drinking water and Livestock watering |
| SARF2 | -2610791 | 34888 | Borehole | Kleinberg 252 LQ, Hans 713 LQ & Japie 714 LQ | 14.02 | None | None |
| SARF3 | -2606719 | 36124 | Borehole | Kleinberg 252 LQ, Hans 713 LQ & Japie 714 LQ | 19.59 | Submersible pump | None |
| SARF4 | -2609395 | 36085 | Borehole | Kleinberg 252 LQ, Hans 713 LQ & Japie 714 LQ | 11.82 | Windpump | None |
| SARF5 | -2609885 | 34992 | Borehole | Kleinberg 252 LQ, Hans 713 LQ & Japie 714 LQ | No access | Windpump | Game watering |
| SARF6 | -2609886 | 35039 | Borehole | Kleinberg 252 LQ, Hans 713 LQ & Japie 714 LQ | 12.61 | Windpump | None |
| TP01 | -2611600 | 24825.48 | Borehole | Twispan 265 LQ | Unable to measure | Submersible pump | Cattle and game watering |
| TP02 | -2610835 | 26985.54 | Borehole | Twispan 265 LQ | Unable to measure | Submersible pump | Cattle and game watering |
| TP03 | -2611989 | 27312.31 | Borehole | Twispan 265 LQ | Unable to measure | Submersible pump | Game watering |
| TP04 | -2613245 | 27677.05 | Borehole | Twispan 265 LQ | Unable to measure | Submersible pump | Game watering |
| TP05 | -2613045 | 25229.85 | Borehole | Twispan 265 LQ | Unable to measure | Submersible pump | Cattle and game watering |
| WP01 | -2609107 | 40122 | Borehole | Wolwepan 253 LQ | Unable to measure | Submersible pump | Cattle and game watering |
| WP02 | -2608725 | 38677 | Borehole | Wolwepan 253 LQ | Unable to measure | Wind pump | Cattle and game watering |
| WP03 | -2608701 | 38735 | Borehole | Wolwepan 253 LQ | 22.54 | Wind pump | Cattle and game watering |
| WP04 | -2608447 | 38435 | Borehole | Wolwepan 253 LQ | 19.29 | Solar pan with submersible pump | Cattle and game watering |
| GRUIS 1 | -2608856 | 27794 | Borehole | Gruisfontein 230 LQ | 19.40 | submersible pump and external generator | Domestic and livestock |
| GRUIS 2 | -2607017 | 26860 | Borehole | Gruisfontein 230 LQ | 17.20 | submersible pump and external generator | Livestock |
| GRUIS 3 | -2606024 | 27779 | Borehole | Gruisfontein 230 LQ | 14.61 | submersible pump and external generator | Livestock |
| GRUIS 4 | -2606264 | 29288 | Borehole | Gruisfontein 230 LQ | 17.25 | submersible pump and external generator | Livestock |

## 4.2 Water Level and Flow Direction

The groundwater depth within the project area is approximately 20.7 m below ground surface, but ranges between 8.7 and 48.0 m. The water level at various monitoring boreholes is shown in Figure 4-1.

The natural groundwater flow direction within the project area is directed from south to north and north-west as shown in Figure 4-2. The flow direction is towards the Limpopo River. The maximum hydraulic head is found in the southern part of the project site, at an elevation of 870 metres above mean sea level (mamsl). The lowest hydraulic head is found in north-western part of the project site at an elevation of 830 mamsl. The maximum hydraulic difference along a northwest-south profile is therefore 40 m (i.e. 870 – 830 m).

The distance between the north-western and southern boundary of the project area is approximately 13200 m. This would mean that the hydraulic gradient along the groundwater flow direction is 0.003.

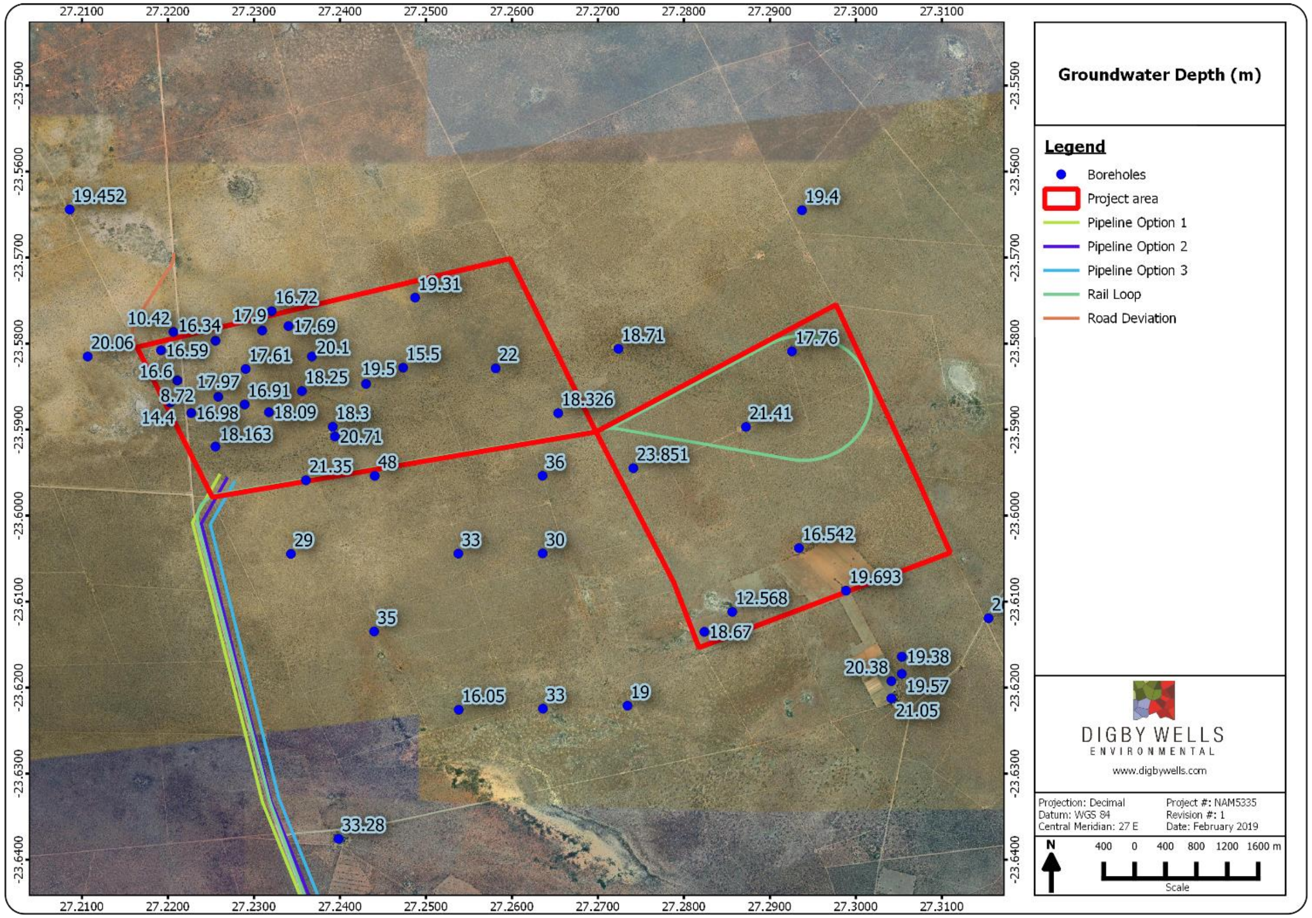


Figure 4-1: Groundwater depth

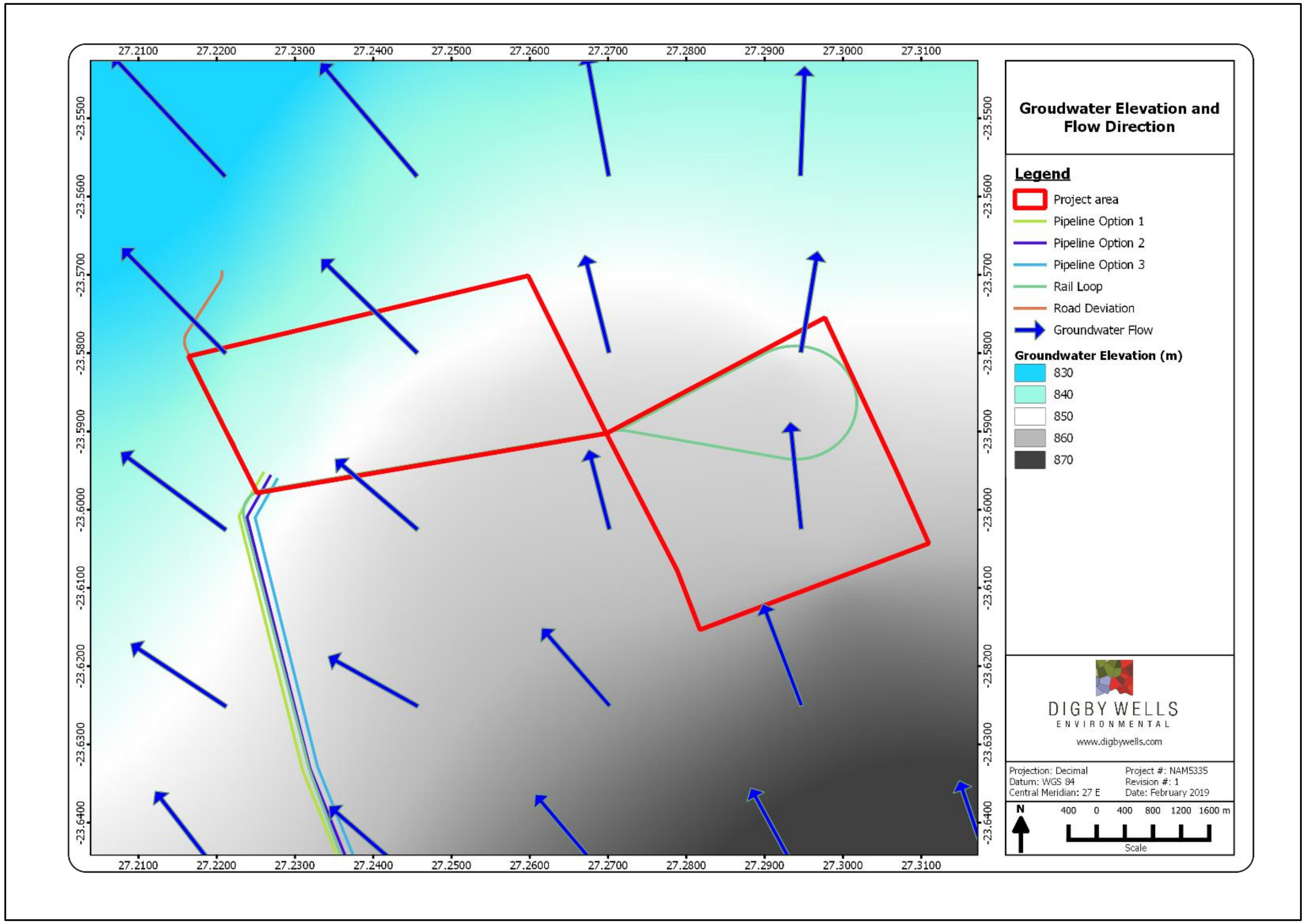


**Figure 4-2: Groundwater elevation and flow direction**

## 4.3 Baseline Groundwater Quality

The groundwater quality was evaluated by comparing the borehole samples with the South African Water Quality Guidelines (SAWQG, 1996) for human drinking. A total of 7 boreholes were sampled for the baseline assessment.

Boreholes VLV1 and DKP1 are within the ideal quality standard, and therefore no threat to human health or the environment is expected. The rest of the boreholes, except for SARF2 and VLV3, are classified with the acceptable quality. They contain slightly elevated levels of nitrate, chloride, and fluoride. The nitrate is likely to be associated with the fertiliser application, while the chloride and fluoride are natural dissolution of the host rocks. At the current concentrations, the effects will be purely aesthetic, and no adverse health or environmental effects are expected.

Boreholes VLV3 and SARF2 contains high levels of fluoride and iron respectively, both exceeding the maximum allowable limits. This type of water is not suitable for domestic use. The elevated concentrations of iron and fluoride are suspected to be due to naturally elevated concentrations as derived from the natural erosional processes of the underlying formations.

## Table 4-2: Water quality results as compared with the South African drinking standards

| Sample ID | | Total Dissolved Solids | Nitrate NO3 as N | Chlorides as Cl | Total Alkalinity as CaCO3 | Sulphate as SO4 | Calcium as Ca | Magnesium as Mg | Sodium as Na | Potassium as K | Iron as Fe | Manganese as Mn | Conductivity at 25° C in mS/m | pH-Value at 25° C | Aluminum as Al | Ammonia as N | Fluoride as F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class 0 | (Ideal) | <450 | <6.0 | <100 | N/S | <200 | <80 | <30 | <100 | <25 | <0.01 | <0.05 | <70 | 6.0-9.0 | <0.15 | N/S | <0.5 |
| Class I | (Acceptable) | 450-1000 | 6.0-10.0 | 100-200 | N/S | 200-400 | 80-150 | 30-70 | 100-200 | 25-50 | 0.01-0.2 | 0.05-1.0 | 70-150 | 5-6 or 9.0-9.5 | 0.15-0.3 | N/S | 0.5-1 |
| Class II | (Max. Allowable) | 1000-2400 | >10-20 | >200-600 | N/S | >400-600 | >150-300 | >70-100 | 200-400 | 50-100 | >0.2-2 | >0.1-1 | >150-370 | 4-5 or 9.5-10 | >0.3-0.58 | N/S | 1-1.5 |
| Class III | (Exceeding) | >2400 | >20 | >600 | N/S | >600 | >300 | >100 | >400 | >100 | >2 | >1 | >370 | <4 or >10 | >0.58 | N/S | >1.5 |
| VLV1 | | 641.00 | 0.26 | 151.30 | 293.50 | 64.31 | 65.31 | 36.15 | 137.26 | 10.33 | 0.01 | 0.01 | 138.40 | 7.48 | -0.01 | -0.02 | 0.58 |
| DKP1 | | 494.00 | 7.21 | 105.50 | 280.90 | 13.74 | 39.86 | 24.19 | 132.93 | 2.49 | 0.08 | 0.05 | 109.10 | 7.20 | -0.01 | 0.03 | 0.60 |
| VLV2 | | 731.00 | **14.43** | 199.70 | 279.10 | 59.10 | 76.07 | 38.39 | 166.56 | 9.45 | 0.02 | 0.01 | **158.90** | 7.51 | -0.01 | -0.02 | 0.74 |
| SARF2 | | 621.00 | -0.06 | 194.20 | 289.40 | 4.59 | 56.30 | 33.54 | 154.19 | 4.53 | **2.52** | 0.11 | 136.20 | 7.12 | -0.01 | -0.02 | 0.74 |
| SARF3 | | 746.00 | 9.94 | **205.20** | 290.70 | 54.58 | 60.93 | 33.78 | 197.42 | 10.08 | 0.02 | 0.02 | **161.90** | 7.83 | -0.01 | -0.02 | **1.38** |
| SARF4 | | 791.00 | -0.06 | 136.20 | 582.70 | -0.13 | 69.91 | 35.48 | 182.68 | 17.25 | 0.05 | 0.59 | **158.60** | 7.73 | -0.01 | 5.88 | **1.25** |
| VLV3 | | 831.00 | -0.06 | 199.60 | 436.40 | 56.63 | 108.73 | 54.30 | 140.05 | 9.77 | 0.02 | 0.25 | **165.30** | 7.79 | -0.01 | 0.08 | **2.17** |

## 4.4 Aquifer Characterisation

A percussion borehole (Borehole TCD1) was drilled by Digby Wells in the project area. The borehole log is given in Figure 4-3.

The drilling was conducted to a depth of 100 m and showed that:

- The borehole was almost dry, with a seeping water strike encountered at a depth of 33 m.
- There was no measurable final blow yield (estimated to be at less than 0.5 L/s).
- The top 8 m is composed of sand with intermittent calcrete;
- Between 8 and 25 m is mudstone; and
- Between 25 and 100 m is carbonaceous mudstone.

The borehole was subsequently pump tested and yielded a limited rock permeability of $1.95 \times 10^{-3}$ m/d.

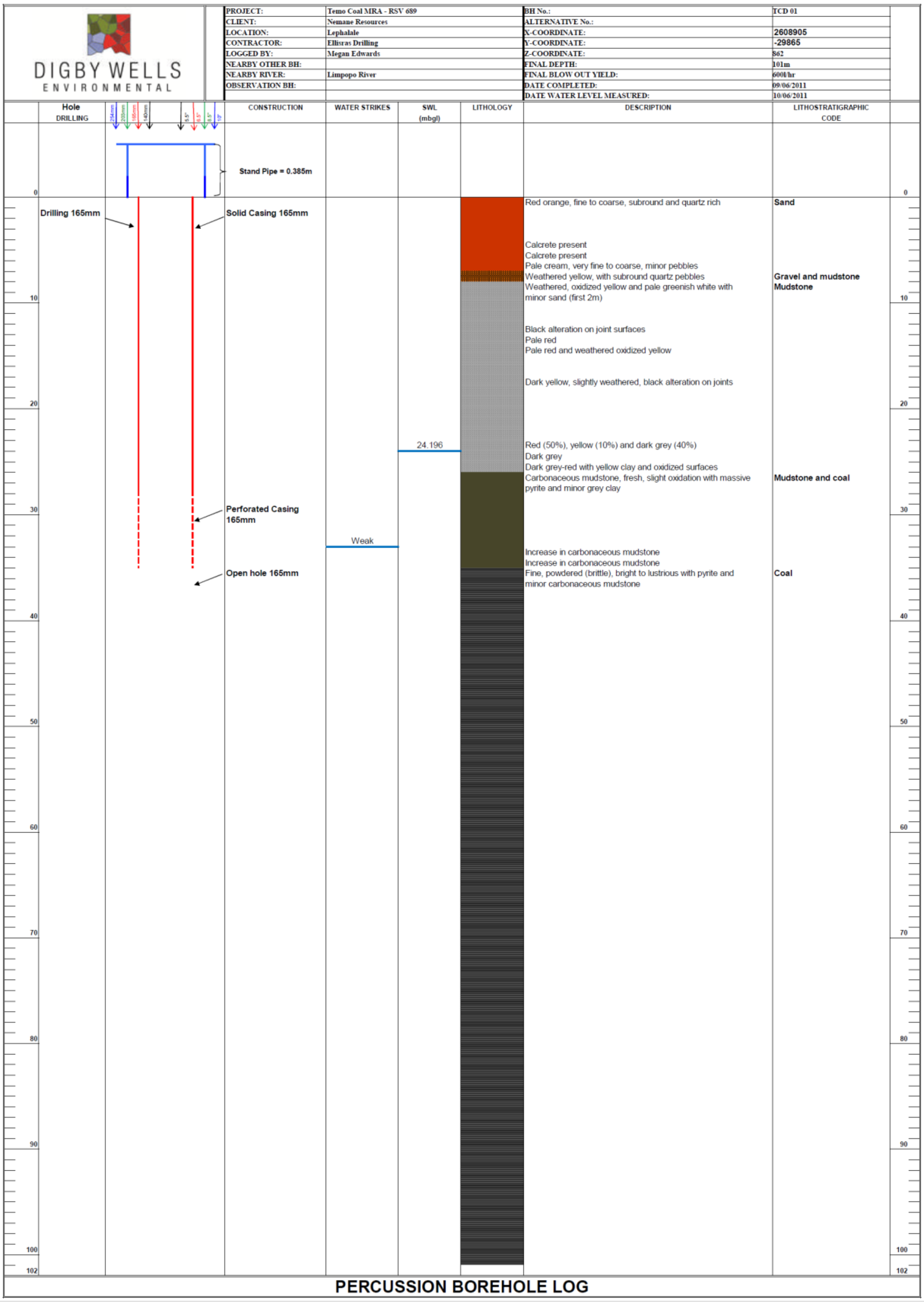


**Figure 4-3: Hydrogeological log of borehole TCD1**

# 5 Impact Assessment and Management Planning

The impacts are assessed based on the impact's magnitude, as well as the receiver's sensitivity, culminating in an impact significance which identifies the most important impacts that require management.

Based on international guidelines and South African legislation, the following criteria are taken into account when examining potentially significant impacts:

- Nature of impacts (direct/indirect, positive/ negative);
- Duration (short/medium/long-term, permanent(irreversible) / temporary (reversible), frequent/seldom);
- Extent (geographical area, size of affected population/habitat/species);
- Intensity (minimal, severe, replaceable/irreplaceable);
- Probability (high/medium/low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

| **Significance** = Consequence x Probability x Nature |
|---|

Where

| **Consequence** = Intensity + Extent + Duration |
|---|

And

| **Probability** = Likelihood of an impact occurring |
|---|

And

| **Nature** = Positive (+1) or negative (-1) impact |
|---|

**Note:** In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 5-1. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 5-2, which is extracted from Table 5-1. The description of the significance ratings is discussed in Table 5-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

**Table 5-1: Impact Assessment Parameter Ratings**

| RATING | INTENSITY/REPLACABILITY | | EXTENT | DURATION/REVERSIBILITY | PROBABILITY |
|---|---|---|---|---|---|
| | **Negative impacts** | **Positive impacts** | | | |
| 7 | Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order. | Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline. | International<br>The effect will occur across international borders. | Permanent: The impact is irreversible, even with management, and will remain after the life of the project. | Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability. |
| 6 | Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order. | Great improvement to the overall conditions of a large percentage of the baseline. | National<br>Will affect the entire country. | Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management. | Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability. |
| 5 | Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items. | On-going and widespread benefits to local communities and natural features of the landscape. | Province/ Region<br>Will affect the entire province or region. | Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management. | Likely: The impact may occur. <65% probability. |

| RATING | INTENSITY/REPLACABILITY | | EXTENT | DURATION/REVERSIBILITY | PROBABILITY |
|---|---|---|---|---|---|
| | **Negative impacts** | **Positive impacts** | | | |
| 4 | On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance. | Average to intense natural and / or social benefits to some elements of the baseline. | Municipal Area<br>Will affect the whole municipal area. | Long term: 6-15 years and impact can be reversed with management. | Probable: Has occurred here or elsewhere and could therefore occur. <50% probability. |
| 3 | On-going natural and / or social issues. Discernible changes to natural or social baseline. | Average, on-going positive benefits, not widespread but felt by some elements of the baseline. | Local<br>Local extending only as far as the development site area. | Medium term: 1-5 years and impact can be reversed with minimal management. | Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability. |
| 2 | Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline. | Low positive impacts experience by a small percentage of the baseline. | Limited<br>Limited to the site and its immediate surroundings. | Short term: Less than 1 year and is reversible. | Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability. |
| 1 | Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline. | Some low-level natural and / or social benefits felt by a very small percentage of the baseline. | Very limited<br>Limited to specific isolated parts of the site. | Immediate: Less than 1 month and is completely reversible without management. | Highly unlikely / None: Expected never to happen. <1% probability. |

## Table 5-2: Probability/Consequence Matrix

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Significance | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| -147 | -140 | -133 | -126 | -119 | -112 | -105 | -98 | -91 | -84 | -77 | -70 | -63 | -56 | -49 | -42 | -35 | -28 | -21 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 84 | 91 | 98 | 105 | 112 | 119 | 126 | 133 | 140 | 147 |
| -126 | -120 | -114 | -108 | -102 | -96 | -90 | -84 | -78 | -72 | -66 | -60 | -54 | -48 | -42 | -36 | -30 | -24 | -18 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 | 78 | 84 | 90 | 96 | 102 | 108 | 114 | 120 | 126 |
| -105 | -100 | -95 | -90 | -85 | -80 | -75 | -70 | -65 | -60 | -55 | -50 | -45 | -40 | -35 | -30 | -25 | -20 | -15 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 |
| -84 | -80 | -76 | -72 | -68 | -64 | -60 | -56 | -52 | -48 | -44 | -40 | -36 | -32 | -28 | -24 | -20 | -16 | -12 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 64 | 68 | 72 | 76 | 80 | 84 |
| -63 | -60 | -57 | -54 | -51 | -48 | -45 | -42 | -39 | -36 | -33 | -30 | -27 | -24 | -21 | -18 | -15 | -12 | -9 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 57 | 60 | 63 |
| -42 | -40 | -38 | -36 | -34 | -32 | -30 | -28 | -26 | -24 | -22 | -20 | -18 | -16 | -14 | -12 | -10 | -8 | -6 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 |
| -21 | -20 | -19 | -18 | -17 | -16 | -15 | -14 | -13 | -12 | -11 | -10 | -9 | -8 | -7 | -6 | -5 | -4 | -3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| -21 | -20 | -19 | -18 | -17 | -16 | -15 | -14 | -13 | -12 | -11 | -10 | -9 | -8 | -7 | -6 | -5 | -4 | -3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Consequence | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## Table 5-3: Significance Rating Description

| Score | Description | Rating |
|---|---|---|
| 109 to 147 | A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change | Major (positive) (+) |
| 73 to 108 | A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment | Moderate (positive) (+) |
| 36 to 72 | A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment | Minor (positive) (+) |
| 3 to 35 | A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment | Negligible (positive) (+) |
| -3 to -35 | An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment | Negligible (negative) (-) |
| -36 to -72 | A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment | Minor (negative) (-) |
| -73 to -108 | A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes. | Moderate (negative) (-) |
| -109 to -147 | A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable. | Major (negative) (-) |

## 5.1 Impacts Assessed

Potential impacts are assessed considering the construction, operational and closure phases of the proposed road diversion, rail loop and pipeline. The objective of this section is to rate the significance of the potential impacts pre- and post-mitigation.

The project activities and infrastructure that could potentially impact the groundwater environment are listed in Table 5-4.

**Table 5-4: Project activities assessed that are relevant to the groundwater study**

| Construction phase activities |
|---|
| Site clearing for the proposed infrastructure |
| **Operation phase activities** |
| Rail loop |
| Pipeline |
| Road diversion |
| **Decommissioning phase activities** |
| Not applicable as none of the proposed infrastructure will be left behind on the site after closure |

## 5.2 Construction Phase

The main activities during the construction phase that could result in groundwater impacts are associated with the site clearing and construction of the infrastructure. The interaction and impact during the construction phase is listed in Table 5-5.

The water table in the project area is approximately 20 m below the ground surface. All activities are expected to take place above this and no impact on the groundwater is envisaged as a result. None of the activities will involve excavation to below the water table, hence there is no risk to the groundwater quantity and quality.

**Table 5-5: Interactions and impacts during the construction phase**

| Interaction | Impact |
|---|---|
| Site clearing for infrastructure placement | No impact on the groundwater is anticipated during this phase. All site clearing activities will take place above the water table. |

The following are management objectives during the construction phase:

- There will be no impact if the activities take place above the water table;

- Site clearance should be kept to a minimum;
- Areas cleared of vegetation for construction activities should be limited to those of absolute necessity;
- Ensure that all construction activities take place above the water table. The water table is 20 m deep and there is sufficient space for the construction activities to take place without reaching the aquifer;
- Conduct groundwater monitoring.

The significance rating of the potential impacts before and after mitigation is provided in Table 5-6.

### Table 5-6: Potential impacts during the construction phase

| **Activity & Interaction: Site clearing for the development of surface infrastructure through the removal of the topsoil and weathered rocks** | | | |
|---|---|---|---|
| **Dimension** | **Rating** | **Motivation** | **Significance** |
| **Impact Description: Lowering of the water table** | | | |
| ***Prior to mitigation/ management*** | | | |
| **Duration** | Short term (2) | Soil clearing, and development of infrastructure should take place in a relatively short duration. | Negligible (negative) – 4 |
| **Extent** | Very limited (1) | Site clearing will only occur within and immediately around the project site | |
| **Intensity x type of impact** | Minor - negative (-1) | No dewatering is anticipated during the construction phase. | |
| **Probability** | Probable (1) | It is highly unlikely that any construction activities will take place below the water table (25 m) | |
| ***Mitigation/ Management actions*** | | | |
| ▪ Avoid constructing below the water table as far as possible.<br>▪ In the unlikely scenario where the foundation of structures is to be installed below the water level, dewatering of the aquifer to locally lower the water table can be considered. The abstracted water can be utilised for dust suppression, vegetation or discharged to the pollution control dams.<br>▪ Install long term monitoring boreholes. | | | |
| ***Post- mitigation*** | | | |
| **Duration** | Immediate (1) | Any impact on the groundwater (if any) is expected to recover due to natural processes in a short-time | Negligible (negative) – 3 |
| **Extent** | Very limited (1) | Only the area in the site clearing area will be affected (if at all) | |
| **Intensity x type of impact** | Minimal - negative (-1) | Considering that the construction phase will be for a short period, the intensity will be minimal | |
| **Probability** | Probable (1) | It is highly unlikely that any construction activities will take place below the water table (25 m) | |

## 5.3 Operation Phase

### 5.3.1 Impact Description

All the proposed operations will take place on ground surface with no or limited interaction with the groundwater, which is 20 m below the surface.

The pipeline will transport water from the Lephalale waste water treatment works (WWTW) to Temo Mine. The water is of good quality as it is transported after treatment, hence, any seepage will not have negative environmental impact. The pipeline is also in continuous monitoring and maintenance hence no or limited seepage is expected. Any seepage from the pipeline will also first interact with the local wetlands and surface water bodies before impacting the groundwater.

Any liquid waste that may be generated after treatment is not within the scope of this study as the WWTW is in Lephalale and any brine waste generated is expected to be in a solidified state and transported offsite for disposal.

**Table 5-7: Potential impact of the infrastructure during operation**

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Impact Description: Groundwater contamination due to seepage from the pipeline and hydrocarbons during vehicle movement** | | | |
| ***Prior to mitigation/ management*** | | | |
| **Duration** | Project Life (5) | Seepage of water from the pipeline or hydrocarbons from vehicles and storage tanks during operation could occur | Negligible (negative) – 30 |
| **Extent** | Local (3) | The impact is expected to be local | |
| **Intensity** | Minor (2) | The contamination will be minor (if any) as it will be on surface, above the aquifer. | |
| **Probability** | Probable (3) | Seepage from the pipelines or fuel storage tanks are unlikely to contaminate the groundwater considering the aquifer depth | |
| **Nature** | Negative | | |
| ***Mitigation/ Management actions*** | | | |
| ▪ Pipelines should be monitored for leakage. Cracked pipelines should be sealed.<br>▪ Diesel or other chemicals should not be spilled, and machinery should be properly maintained.<br>▪ Fuel and oil reservoirs must be in a bunded area.<br>▪ If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed of at an acceptable dumping facility. The excavation should be backfilled with soil of good quality. | | | |

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| ▪ Monitoring boreholes located within the environs of the project area have to be monitored for both water level and quality. | | | |
| ***Post- mitigation*** | | | |
| **Duration** | Short term (2) | With the above stated mitigation measures, any leakage from pipelines or fuel storage tanks is expected to be for the short-term | Negligible (negative) – 8 |
| **Extent** | Very limited (1) | The seepage is expected to be limited to the specific parts of the site | |
| **Intensity** | Minimal (1) | With the implementation of the above stated mitigation measures, the impact is not expected to affect the receiving ecosystem | |
| **Probability** | Rarely (2) | Impact to the groundwater outside the project area is unlikely | |
| **Nature** | Negative | | |

## 5.4 Decommissioning and Post-closure Phase

The closure phase is characterised by the decommissioning of the rail loop, road, and water pipeline. None of the infrastructure will be left behind and will not contaminate the groundwater after closure.

There will be no contamination plume or lowering of the water table after closure. The significance rating of the potential impacts during the decommissioning and post-closure is displayed in Table 5-8.

**Table 5-8: Potential impacts after mine closure**

| **Activity and Interaction: Closure of the rail loop, road diversion and water pipeline** | | | |
|---|---|---|---|
| **Dimension** | **Rating** | **Motivation** | **Significance** |
| **Impact Description: Groundwater contamination** | | | |
| ***Prior to mitigation/ management*** | | | |
| **Duration** | Immediate (1) | All the infrastructure will be removed and rehabilitated. Any impact (if at all) will be immediate and for the short period | Minimal (negative) – 3 |
| **Extent** | Very limited (1) | No groundwater contamination from the infrastructure is foreseen. | |

| Activity and Interaction: Closure of the rail loop, road diversion and water pipeline | | | |
|---|---|---|---|
| **Dimension** | **Rating** | **Motivation** | **Significance** |
| **Intensity x type of impact** | Minimal - negative (-1) | Minor natural impacts are expected with little change to the baseline | |
| **Probability** | Highly unlikely (1) | The impact from the ash dump is expected to be likely | |
| ***Mitigation/ Management actions*** | | | |
| ▪ Rehabilitation of the decommissioned infrastructure. | | | |
| ***Post- mitigation*** | | | |
| **Duration** | Immediate (1) | All the infrastructure will be removed and rehabilitated | Negligible (negative) – 3 |
| **Extent** | Very limited (1) | No groundwater contamination from the infrastructure is foreseen. | |
| **Intensity x type of impact** | Minimal - negative (-1) | Minor natural impacts are expected with little change to the baseline | |
| **Probability** | Highly unlikely (1) | The impact is expected to be highly unlikely | |

# 6 Cumulative Impacts

The Temo Coal mine is located within the proposed infrastructure area. The pit and associated discard dumps are more likely to contaminate the groundwater than the proposed rail loop, diversion road and water pipeline.

The closeness of the pit to the infrastructure means that the lowering of the water table at the pit area is likely to affect the groundwater system underlying the proposed infrastructure. After mine closure and decommissioning of the dewatering programme, the water level will start to recover. The impact of dewatering is therefore at its maximum at the end of mine operation.

The only active mine in the proximity of the proposed infrastructure is Exxaro's Grootegeluk mine. Grootegeluk is, however, approximately 25 km from the project site and no direct hydraulic interaction is expected, and therefore no cumulative impact is foreseen.

There are several power plants and mines that are planned to be operational in the Waterberg Coalfield. The currently known land tenure in the vicinity of the project site include:

- Dalyshope mine and IPP which is approximately 3 km to the north;
- Boikarabelo mine and IPP which is approximately 4 km to the southwest; and
- Mafutha mine which is approximately 4 km to the east.

The mines are fairly close to the proposed infrastructure and the impact of dewatering activities and contamination plume from the nearby mines could potentially reach them. Integrated inter-mine hydrogeological studies are required to quantify the cumulative impacts and to strategize a large-scale management plan during operation and after closure.

# 7 Unplanned Events and Low Risks

The unplanned events that may happen at the project site and the proposed mitigation plan are listed in Table 7-1.

### Table 7-1: Unplanned Events, Low Risks and their Management Measures

| Unplanned event | Potential impact | Mitigation / Management / Monitoring |
|---|---|---|
| Hydrocarbon spills from storage tanks, vehicles and heavy machinery or hazardous materials or waste storage facilities. | ▪ Hydrocarbon contamination of the groundwater | ▪ Hydrocarbons and hazardous materials must be stored in bunded areas and refuelling should take place in contained areas;<br>▪ Ensure that oil and silt traps are well maintained;<br>▪ Vehicles and heavy machinery should be serviced and checked in a demarcated area on a regularly basis to prevent leakages and spills;<br>▪ Hydrocarbon spill kits must be available on site at all locations where hydrocarbon spills could take place;<br>▪ Monitoring boreholes, particularly those located within the construction area, have to be monitored for both water level and quality to detect any changes in quality; and<br>▪ If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed of at an acceptable dumping facility. The excavation should be backfilled with soil of good quality. |
| Spills / leaks from the pipeline. | ▪ Contamination of groundwater | ▪ Regular inspections of the pipeline for any leaks. Seeping pipeline should be sealed; and<br>▪ Ensure that storm water management structures are put in place to capture all spills and to convey to the pollution control dams. |

# 8 Conclusion and Recommendation

Temo is located approximately 60 kilometres (km) from Lephalale in the Limpopo Province. Temo currently has an approved mining right and proposes to extract coal using open pit mining method and the open pit will be situated entirely within the farm portion Verloren Valey 246 LQ. To support the operations, Temo proposes the construction of a diversion road, rail loop and water pipeline.

The construction of this infrastructure was not included or assessed in the original environmental authorisation of the Temo mine. This specialist groundwater study assesses the potential impacts and mitigation plans on the groundwater environment during the construction, operation and closure phases of this infrastructure.

## 8.1 Baseline Hydrogeological Conditions

A hydrocensus was conducted by Digby Wells previously as part of the Temo Coal project. A total of 26 boreholes were surveyed within 5 km radius of the project area.

Out of the 26 boreholes identified:

- 3 boreholes are used for game watering only;
- 6 boreholes are used for livestock watering;
- 3 boreholes are used for human drinking and livestock watering;
- 7 boreholes are used for cattle and game watering; and
- The remaining 7 boreholes are unused.

The groundwater depth within the project area is approximately 20.7 m below ground surface, but ranges between 8.7 and 48.0 m. The natural groundwater flow direction within the project area is directed from south to north and north-west.

A total of 7 boreholes were sampled for the baseline assessment. Boreholes VLV1 and DKP1 are within the ideal quality standard, and therefore no threat to human health or the environment is expected. The rest of the boreholes, except for SARF2 and VLV3, are classified with the acceptable quality. They contain slightly elevated levels of nitrate, chloride, and fluoride. The nitrate is likely to be associated with the farm fertiliser application or with the animal waste; while the chloride and fluoride are natural dissolution of the host rocks. At the current concentrations, the effects will be purely aesthetic, and no adverse health or environmental effects are expected.

Boreholes VLV3 and SARF2 contains high levels of fluoride and iron respectively, both exceeding the maximum allowable limits. This type of water is not suitable for domestic use. The elevated concentrations of iron and fluoride are suspected to be due to naturally elevated concentrations as derived from the natural erosional processes of the underlying formations.

## 8.2 Impact Assessment

The water table in the project area is approximately 20 m below the ground surface. All the proposed activities (rail loop, road, and pipeline) are expected to take place above this and no impact on the groundwater is envisaged as a result. None of the activities will involve excavation to below the water table, hence there is no risk to the groundwater quantity and quality. However, the following are recommended to be implemented:

- Pipelines should be monitored for leakage. Cracked pipelines should be sealed;
- Diesel or other chemicals should not be spilled, and machinery should be properly maintained;

- Fuel and oil reservoirs must be in a bunded area;
- If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed of at an acceptable dumping facility. The excavation should be backfilled with soil of good quality; and
- Monitoring boreholes located within the environs of the project area have to be monitored for both water level and quality.