Lomoteng Mine: Hydrocensus and Groundwater Assessment Report, Northern Cape Province.

DMR Reference No – (NC) 240 MR

Report Prepared for

Huatian S.A. Mining and Investment (Pty) Ltd

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Lomoteng Mine: Hydrocensus and Groundwater Assessment of the area, Northern Cape Province.

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Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by M&S Consulting, Huatian SA Mining and Investment (Pty) Ltd, local property owners in the Lomoteng area and data obtained from the National Groundwater Archive (NGA). The opinions in this Report are provided in response to a specific request from M&S Consulting 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.

Glossary of Terms

Aquifer: A water-bearing geological formation capable of supplying economic quantities of groundwater to wells, boreholes and springs.

Aquitard: A saturated geological unit with a relatively low permeability that retards, but does not prevent the movement of water; while it may not readily yield water to boreholes and springs, it may act as a storage unit.

Aquiclude: A geological unit with a very low permeability that severely restricts groundwater movement. GRU boundaries are commonly formed by aquicludes, e.g. dykes.

Contamination: The introduction of any substance into the environment by the action of man.

Fractured-rock Aquifer: Aquifers where groundwater occurs within fractures and fissures in hard-rock formations.

Groundwater: Refers to the water filling the pores and voids in geological formations below the water table.

Groundwater Flow: The movement of water through openings and pore spaces in rocks below the water table i.e. in the saturated zone. Groundwater naturally drains from higher lying areas to low lying areas such as rivers, lakes and the oceans. The rate of flow depends on the slope of the water table and the transmissivity of the geological formations.

Groundwater Recharge: Refers to the portion of rainfall that actually infiltrates the soil, percolates under gravity through the unsaturated zone (also called the Vadose Zone) down to the saturated zone below the water table (also called the Phreatic Zone).

Groundwater Resource: All groundwater available for beneficial use, including by man, aquatic ecosystems and the greater environment.

Groundwater Resource Units: (GRU's) Represent provisional zones defined for the purposes of assessing and managing the groundwater resources of a region, in terms of large-scale abstraction from relatively shallow (depth < 300m) production boreholes. They represent areas where the broad geohydrological characteristics (i.e. water occurrence and quality, hydraulic properties, flow regime, aquifer boundary conditions etc.) are anticipated to be similar. Sometimes also called Groundwater Resource Units (GRU's).

Intergranular Aquifer: Aquifers where groundwater is contained in original intergranular interstices of sedimentary and weathered formations.

Karst: Topography geologically shaped by the dissolution of a layer or layers of soluble bedrock, usually carbonate rock such as limestone or dolomite. Many karst regions display distinctive surface features, with cenotes, sinkholes or dolines being the most common. However, distinctive karst surface features may be completely absent where the soluble rock is mantled, such as by glacial debris, or confined by superimposed non-soluble rock strata. Some karst regions include thousands of caves.

Major Aquifer System: Highly permeable formations, usually with a known or probable presence of significant fracturing and/or intergranular porosity; may be highly productive and able to support large abstractions for public supply and other purposes; water quality is generally very good.

Minor Aquifer System: Fractured or potentially fractured rocks that do not have a high primary permeability, or other formations of variable permeability; aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important both for local supplies and in supplying base flow for rivers.

Non-Aquifer: A groundwater body that is essentially impermeable, does not readily transmit water and/or has a water quality that renders it unfit for use.

Non-Aquifer Systems: formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities; water quality may also be such that it renders the aquifer unusable; groundwater flow through such rocks does take place and needs to be considered when assessing the risk associated with persistent pollutants.

Permeability: The ease with which a fluid can pass through a porous medium and is defined as the volume of fluid discharged from a unit area of an aquifer under unit hydraulic gradient in unit time (expressed as $m^3/m^2 \cdot d$ or m/d). It is an intrinsic property of the porous medium and is independent of the properties of the saturating fluid; not to be confused with *hydraulic conductivity*, which relates specifically to the movement of water.

Pollution: The introduction into the environment of any substance by the action of man that is, or results in, significant harmful effects to man or the environment.

Recharge: The addition of water to the zone of saturation, either by the downward percolation of precipitation or surface water and/or the lateral migration of groundwater from adjacent aquifers.

Saline Water: Water that is generally considered unsuitable for human consumption or for irrigation because of its high content of dissolved solids.

Saturated Zone: The subsurface zone below the water table where interstices are filled with water under pressure greater than that of the atmosphere

Specific Yield: Ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity from that mass.

Storativity (S): The volume of water released from storage per unit of aquifer storage area per unit change in head.

Unconfined Aquifer: An aquifer with no confining layer between the water table and the ground surface where the water table is free to fluctuate.

Unsaturated Zone: That part of the geological stratum above the water table where interstices and voids contain a combination of air and water; synonymous with *zone of aeration* or *vadose zone*.

Water Table: The upper surface of the saturated zone of an unconfined aquifer at which pore pressure is at atmospheric pressure, the depth to which may fluctuate seasonally.

List of Abbreviations

DMR	Department of Mineral Resources
DWA	Department of Water Affairs
EC	Electrical Conductivity (Salinity of water)
GA	General Authorisation
m	metres
mamsl	Metres above mean sea level
mbgl	Metres below ground level
mS/m	Milli-siemens per metre
m^3/a	Cubic metres per annum
mm	millimetres
m^3/m	Cubic metres per month
SRK	SRK Consulting
mg/ℓ	Milligrams per litre
Ma	Million years

1 Introduction and Scope of Report

During July 2011 SRK Consulting was requested by Mr. Hennie Posthumus of M&S Consulting to submit a cost proposal for the yield testing of two boreholes and a groundwater assessment report of the Lomoteng area. The groundwater abstracted from these boreholes will be used for mining activities at Lomoteng by Huatian SA Mining and Investment (Pty) Ltd. This company has obtained a mining right on the farms Remaining Extent of the Farm Lomoteng 669, Portion 1 (Fouross) of the Farm Lomoteng 669 and Portion 2 (Mineraal) of the Farm Lomoteng 669 which are sub divisions of the original cadastral farm Lomoteng 669. During the course of the project the scope of work has been extended to include the yield testing of an additional eight boreholes and the siting of additional exploration boreholes which can be used as future production boreholes to the mine.

The following final scope of work was provided and agreed upon by both parties:

1. Conduct a hydrocensus of Lomoteng and the surrounding farms. During this exercise all relevant geohydrological information (GPS coordinates, borehole status, depth, yield and equipment, groundwater level, field measured quality, etc.) will be collected.
2. Yield testing of ten boreholes by a reputable pump test contractor under control of a hydrogeologist.
3. The yield testing will consist of a Step Drawdown Test (CDT) consequently followed by a recovery test, a Constant Discharge Test (CDT) and again a recovery test.
4. These yield test data will be analysed and extrapolated by means of computer programmes to determine the long-term sustainable yield of each tested borehole. Parameters such as recharge from rainfall, abstraction from other nearby production boreholes and recharge will be taken into account when calculating the long-term sustainable yield of the tested boreholes.
5. The calculated sustainable yields will be compared with the groundwater potential of that area as indicated by the Groundwater Resource Assessment Phase 2 (GRA II) data of the Department of Water Affairs (DWA).
6. Siting of four exploration boreholes in the Lomoteng area based on lineament mapping results and local geological mapping of the surface.
7. Compile a conceptual groundwater model for the Lomoteng area. This model will indicate factors that control groundwater occurrence and general flow directions.
8. A final report will be compiled in which the results and recommendations will be summarized.

2 Project description

A manganese ore mine is in operation at Lomoteng. Water will be needed for the following actions of the mining process:

1. Ore washing to improve the grade
2. Dust control at the crusher
3. Dust control in open pit mine
4. Dust control on the numerous mine roads.

The annual water demand of the mine when in full production is approximately 100,000 m^3 with the maximum daily demand calculated at 300 m^3 (10 hours operation per day at a peak water consumption of 30 m^3/h).

3 Background

Lomoteng is located in the Northern Cape Province approximately 35 km north of Postmasburg and immediately west of the R325 route to Kathu (see **Figure 1**). Farms and small communities in the area are totally dependent on groundwater whilst the larger communities like Postmasburg, Beeshoek, Kathu, Olifantshoek and Dibeng use groundwater as well as surface water from the Vaal-Gamagara pipe line which runs along the R325 route.

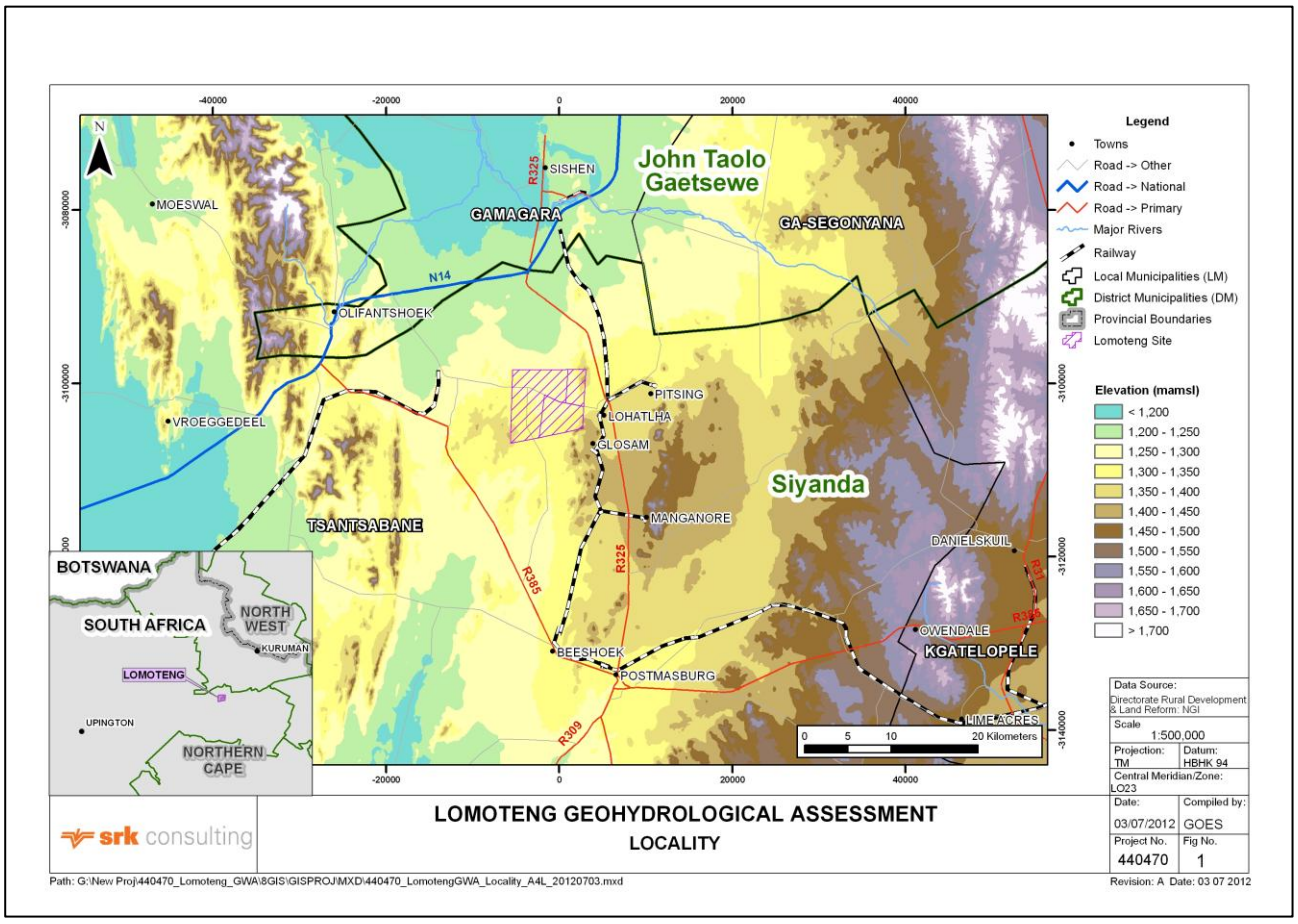


Figure 1: Locality of Lomoteng

4 Work Program

4.1 Purpose of the Report

The purpose of this Report is to provide an independent geohydrological assessment of the groundwater resources at Lomoteng and to advise the client about necessary precautions to be taken to protect groundwater resources of the area.

4.2 Work program

A hydrocensus of the boreholes on Lomoteng and adjacent properties was conducted on 14 September 2011. All available geohydrological information (borehole depth, yield, groundwater intersections, groundwater use and estimated abstraction, etc.) was collected from the owners during this visit. Boreholes were visited and the relevant geohydrological data (like groundwater levels, quality, equipment, etc.) were measured and noted. Simultaneously the local geology was

noted and red flag areas identified. Yield testing was conducted by Welltek Services in three phases during the periods 10 to 16 September 2011, 25 to 27 February 2012 and 26 April to 10 May 2012.

5 Physiography and Climate

Lomoteng Mine is located upon a North-South striking ridge formed by weather resistant quartzites of the Gamagara Formation. The areas east and west of this ridge are flat with a gentle slope to the north-west. In the area south-east of Lomoteng the average slope is 1:126 (0.8%) and in the area north-west thereof 1:144 (0.7%). Some insignificant, non-perennial drainage channels, which drain surface water in a north-westerly direction towards the Ga-Mogara River, occur in the area.

The elevation of the study area varies between 1,273 mamsl in the west and 1,488 mamsl at the south-eastern corner of the site. Hills on the eastern side of the site are rugged with relative steep slopes. The maximum slope in the study area occurs in the south-eastern corner thereof where it reaches ~1:3.4 (29%).

The climate of the area is typical of a semi-desert with very hot summers and cold winters. Temperature data for Postmasburg (as supplied by the South African Weather Service) for the period 1998-2011 is summarized in **Table 1** below. The data indicate that January is the hottest month with an average maximum daily temperature of 32.7^{o}C and July the coldest with an average maximum daily temperature of 19.5^{o}C. During June and July the average minimum daily temperature drops to <3^{o}C.

Table 1: Temperature data for Postmasburg (South African Weather Service)

Month	Ave Temp (^{o}C)	Max Temp (^{o}C)	Min Temp (^{o}C)	Ave Rain (mm)
Jan	23.7	32.7	16.1	40.8
Feb	22.8	31.7	16.1	79.1
Mar	21.3	30.3	14.6	29.3
Apr	17.0	26.4	11.0	22.0
May	11.9	22.2	5.5	9.3
Jun	8.9	20.0	2.3	5.2
Jul	8.4	19.5	1.3	1.1
Aug	11.3	22.3	3.5	3.2
Sep	15.7	26.5	7.0	7.8
Oct	19.7	29.7	10.9	17.9
Nov	21.7	31.4	12.9	15.0
Dec	23.8	33.3	15.5	23.6
Mean Annual Precipitation (mm)				**254.3**
Absolute min temp recorded (26/07/2004)				**-6.9^{o}**
Absolute max temp recorded (22/12/2009)				**39.8^{o}**

The table also indicates that the absolute maximum temperature recorded during this period was 39.8^{o}C and the lowest -6.9^{o}C.

The Lomoteng area falls within the summer rainfall area with a mean annual precipitation (MAP) of 385.3 mm for the farm. The average monthly precipitation and standard deviation (SD) values for Lomoteng, as provided by the South African Weather Service, are summarized in **Table 2** below.

Table 2: Precipitation statistics for Lomoteng (Source: South African Rain Atlas)

Average monthly precipitation for Lomoteng (Station Coordinates: S28°01' E023°01'													
	Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***	***Annual***
Mean (mm):	*62.1*	*71.5*	*74.9*	*41.9*	*16.4*	*5.4*	*3.9*	*5.5*	*10.8*	*20.1*	*29.7*	*43.1*	***385.3***
SD (mm):	*43.6*	*47.5*	*47.8*	*34.3*	*19.3*	*10*	*8.8*	*10.6*	*15.2*	*21.1*	*26.1*	*33.9*	***104.6***

The table indicates that ~84% of the mean annual precipitation occurs during the months November to April. This phenomenon is characteristic of a summer rainfall area. March is the wettest month with an average precipitation of ~75 mm whilst July is the driest with <4 mm.

The mean annual precipitation for this area is indicated in **Figure 2** over page. The figure indicates that MAP generally decreases from north to south and from east to west. A north-south striking band of higher rainfall occurs along the Langberge mountain range immediately west of Olifantshoek. The highest precipitation occurs in the mountainous areas of the Asbestos Hills. Here the mean annual precipitation is >600 mm. The lowest precipitation occurs west of the Langberge where it decreases to <350 mm/a. In the study area the highest rainfall occurs in the north-eastern part and the lowest in the south-western part thereof.

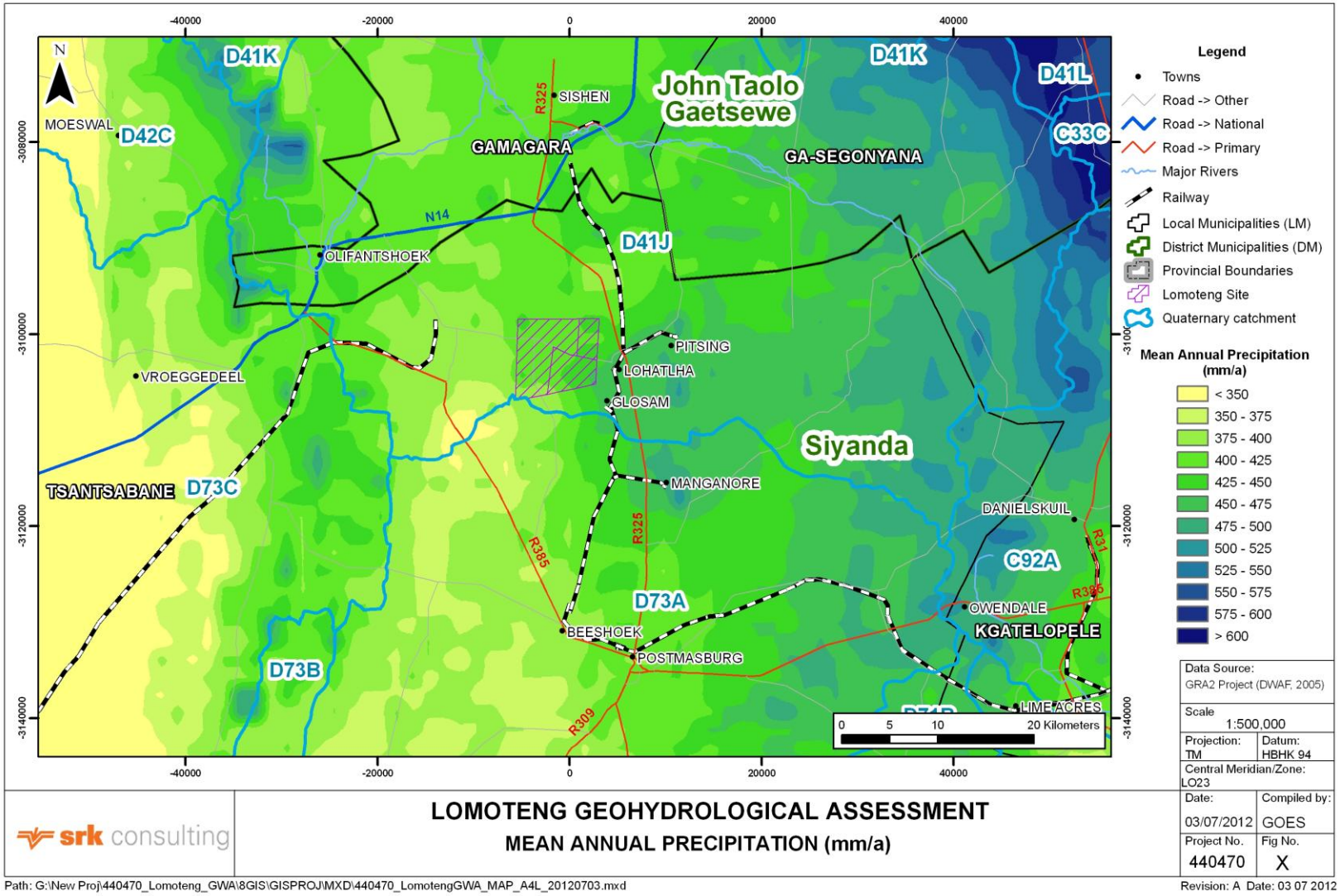


Figure 2: Mean annual precipitation of the Lomoteng area

6 Geology and Geohydrology

6.1 Geology

The geology of the study area, which is located on the western flank of the Maremane Anticline which strikes in a general north-south direction, is depicted in **Figure 3** over page. The geological map indicates that most of the central and western parts of the study area are covered by recent deposits of mainly windblown sand. These deposits occur along the flat plains in the area and are normally thin, seldom exceeding 15 m in vertical thickness. The general dip of the rocks is westwards (~10-15^{o}) with the oldest rock types outcropping in the east.

Dolomitic rocks of the upper Ghaap Plateau Formation outcrop immediately west of the mining area. These rocks consist mainly of dolomitic limestone with subordinate dolomite and chert. A prominent layer of chert breccia (Silica Breccia or Manganese Marker) occurs at the top of this Formation.

The far eastern part of the study area is underlain by hard rocks of the Gamagara Formation of the the lower Postmasburg Group which in turn forms part of the Griqualand West Sequence. These rocks consist mainly of quartzite and conglomerate with subordinate shale and flagstone and form the prominent hills on the eastern side of the farm.

The Makganyene Formation, which normally forms a well-defined aquifer, follows the Gamagara Formation in this area. Outcrops of this Formation occur in the southern part of the study area (south of the mining area). This Formation displays extreme thickness variations, from 3 m near the Orange River, to 70 m near Kuruman and to 500 m in a borehole near Postmasburg (Visser, 1971). The Makganyene Formation contains a variety of rock types including diamictites, sandstones, shales and banded ironstone. This Formation rests on an erosion unconformity in this specific area. The upper part of this Formation consists of a 1–3 m-thick tuffaceous unit that characteristically separates the diamictites of the Makganyene Formation from an overlying 900 m thick succession of basaltic andesites of the Ongeluk Formation.

The Ongeluk Formation, consisting of amygdaloidal andesitic lava with interbeds of tuff, agglomerate, chert and red jasper, rests conformably on the Makganyene Formation. This formation covers the extreme west of the study area and outside the mining site.

Several lineaments, faults and dykes are mapped in the area. A number of unmapped or partially mapped structures were mapped from Google Earth images. These lineaments are difficult to locate in the field due to weak outcrops and scattered large trees which limit sight (to observe tree lines associated with lineaments). Normally these structures have been intruded by dolerite dykes, but this could not be confirmed in this area due to lack of outcrops. It is also expected that the structures extend well beyond the mapped occurrences, but are obscured by the sand cover.

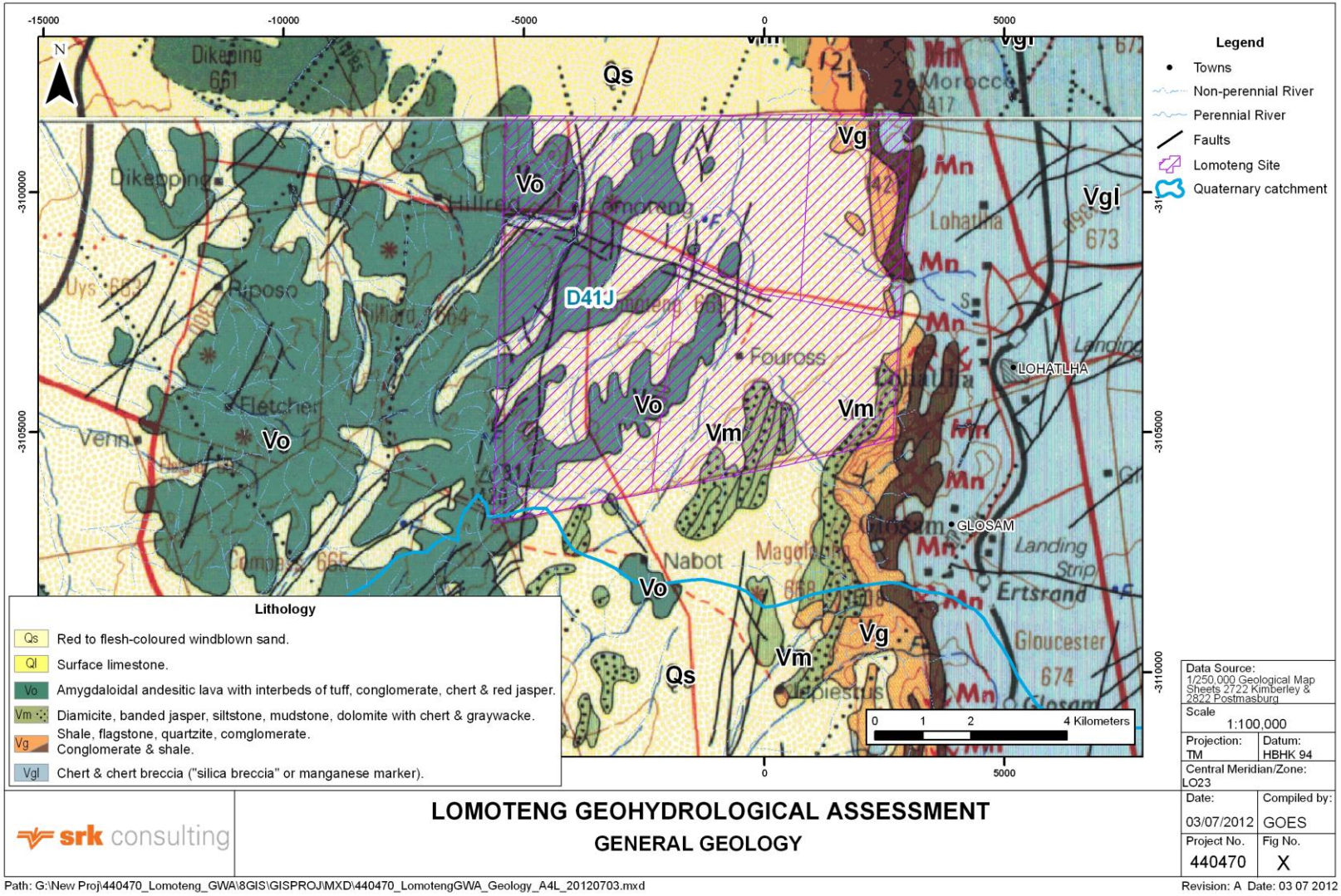


Figure 3: Geology of the Lomoteng area (after Council for Geoscience)

6.2 Geohydrology

Groundwater in this area occurs in both secondary (or fractured rock) aquifers and primary aquifers. The first is formed by jointing and fracturing of the otherwise solid bedrock. These fractures are formed by faulting, cooling of magma outflows, intrusion of dolerite dykes, folding and other geological forces. Generally the harder rocks (quartzite, jasper and lava) fracture more easily under stress to form superior aquifers compared to the softer sediments like shale which rather deform than fracture under stress.

Some examples of limited primary aquifers occur in the dolomitic area east of the site where the groundwater level rises within the weathered zone. Here the groundwater levels are shallow and within the weathered zone. Boreholes utilizing this aquifer are therefore shallow and only extract groundwater from a relative thin layer of weathered bedrock. All these result in a poorly developed primary aquifer that is very vulnerable to droughts. However, a more regional primary aquifer is formed in the sand covered area west of the mining site. Boreholes only intersecting this aquifer normally yield <0.5 ℓ/s, although yields can be significantly higher if fractures are intersected in the bedrock underneath. The aquifer types and expected yields of successful boreholes drilled in these aquifers are indicated in **Figure 4** over page.

The NGA data for this area is included in **APPENDIX 1** at the end of this report. An average borehole yield of 1.7 ℓ/s was calculated for the successful boreholes drilled in this area whilst the median yield is 0.6 ℓ/s. This indicates that the mean value is skewed by a few extraordinary high yielding boreholes and therefore the median yield is a better indication of the expected yield of successful boreholes drilled in this area. The average borehole depth is ~60 m with an average groundwater level of 27.5 mbgl.

Figure 5 on page 10 indicates the groundwater salinity of the Lomoteng area expressed as Electrical Conductivity in mS/m. The map indicates that the groundwater quality varies throughout the area with the best quality of groundwater occurring in the lavas on the western side of the site. However, the groundwater quality throughout the area is generally suitable for human consumption based on the field measured EC's. Noticeable anomalies in the field measured EC's can be expected near point pollution sources (e.g. kraals, soak away pits, etc.) in areas with shallow water levels. This is due to a rapid recharge and relative quick vertical infiltration.

The groundwater vulnerability of the Lomoteng area is indicated in **Figure 6** on page 11. This figure indicates that the groundwater sources of the central part of the site are highly vulnerable to contamination from surface sources. The groundwater vulnerability decreases from here towards the east and west with the lowest groundwater vulnerability occurring on the far western part of the study area. In the present mining area the groundwater vulnerability varies between low and low-medium, but it is high-medium at the locality of the processing plant and office buildings.

Figure 7 on page 12 indicates the mean annual recharge in the Lomoteng area. The highest recharge of ~10mm/a occurs in the south-eastern part of the study area. This includes the present mining area and the area south thereof. The lowest recharge occurs in the far south-western corner of the study area where it is ~7 mm/a.

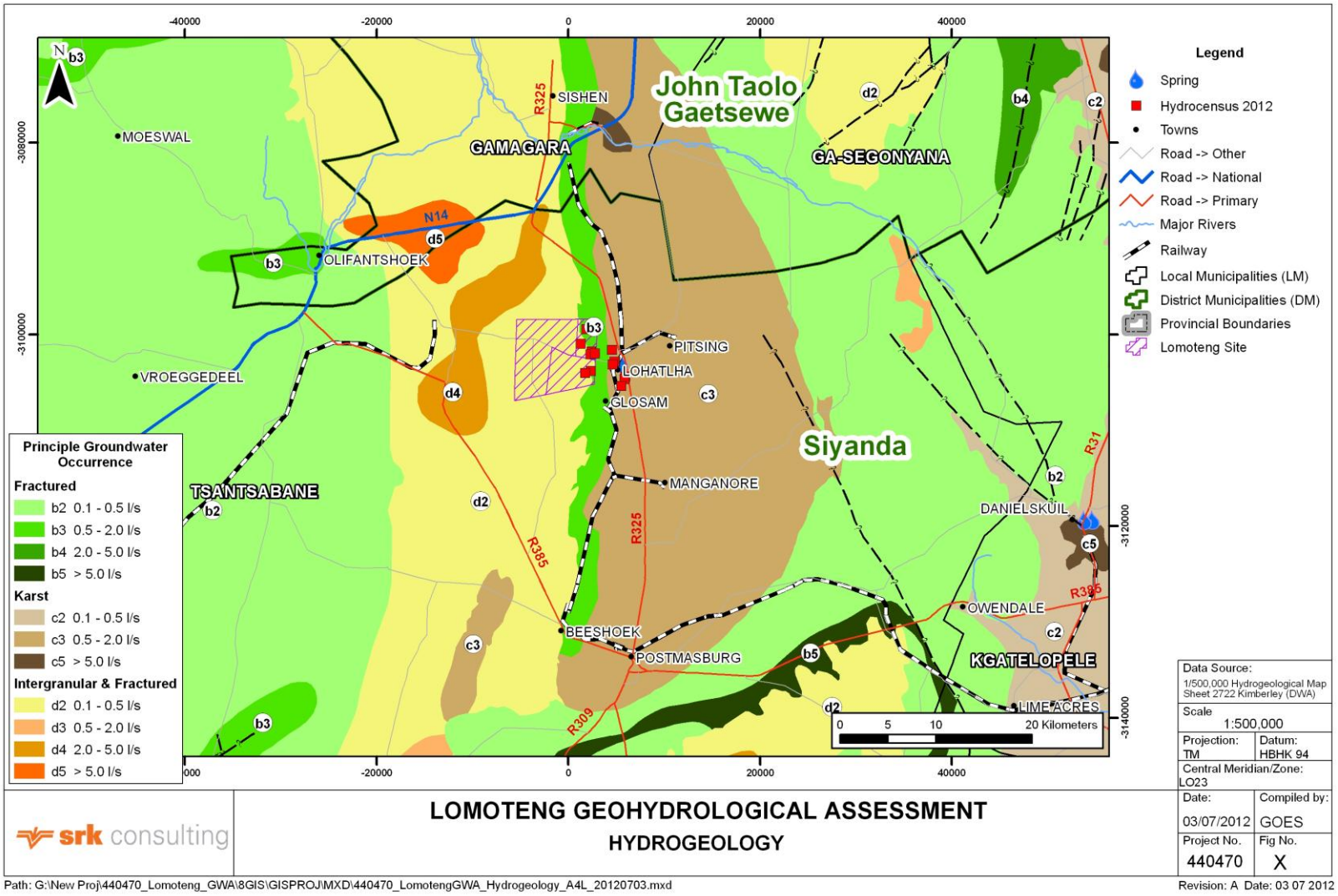


Figure 4: Aquifer types in the Lomoteng area

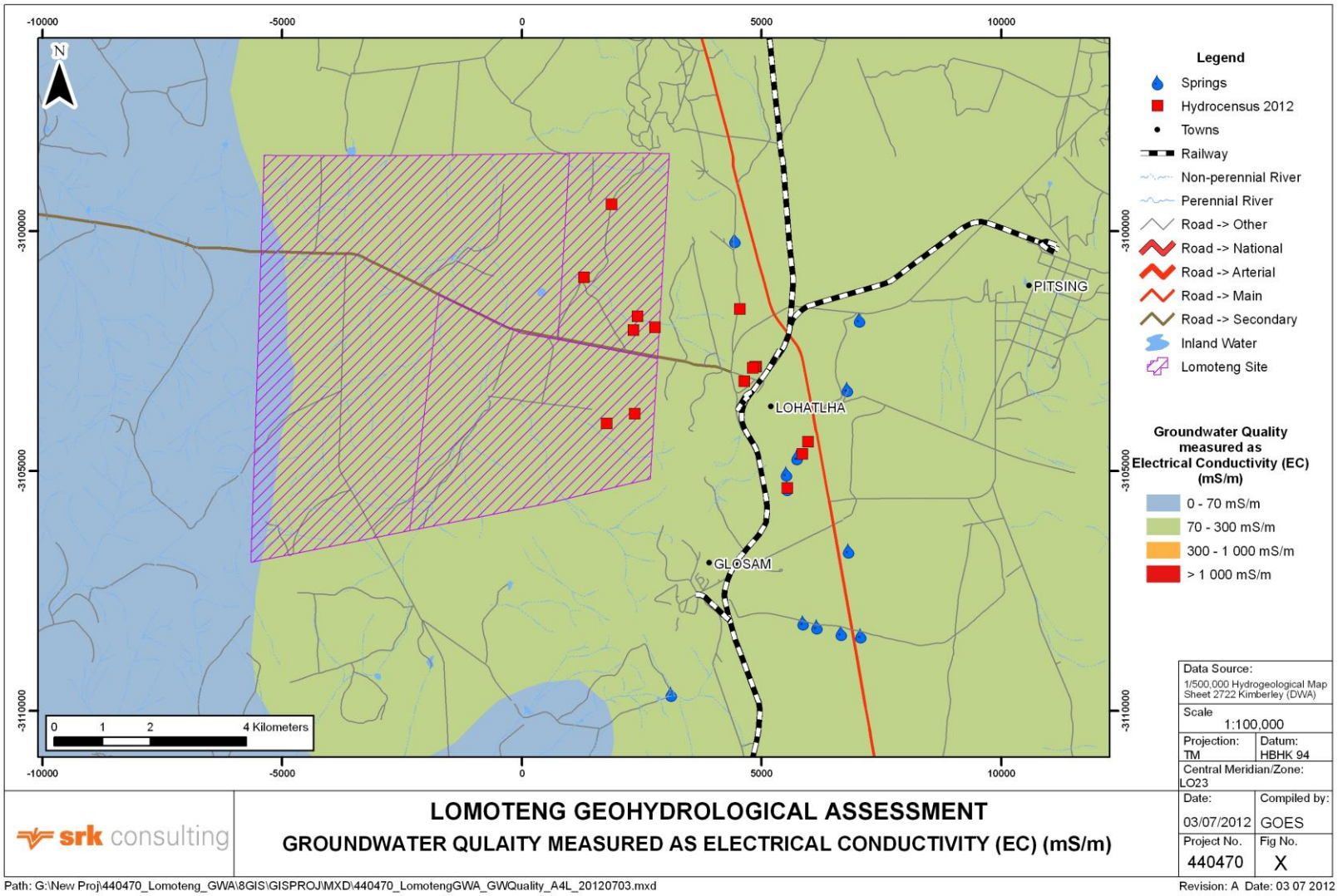


Figure 5: Groundwater quality of the Lomoteng area

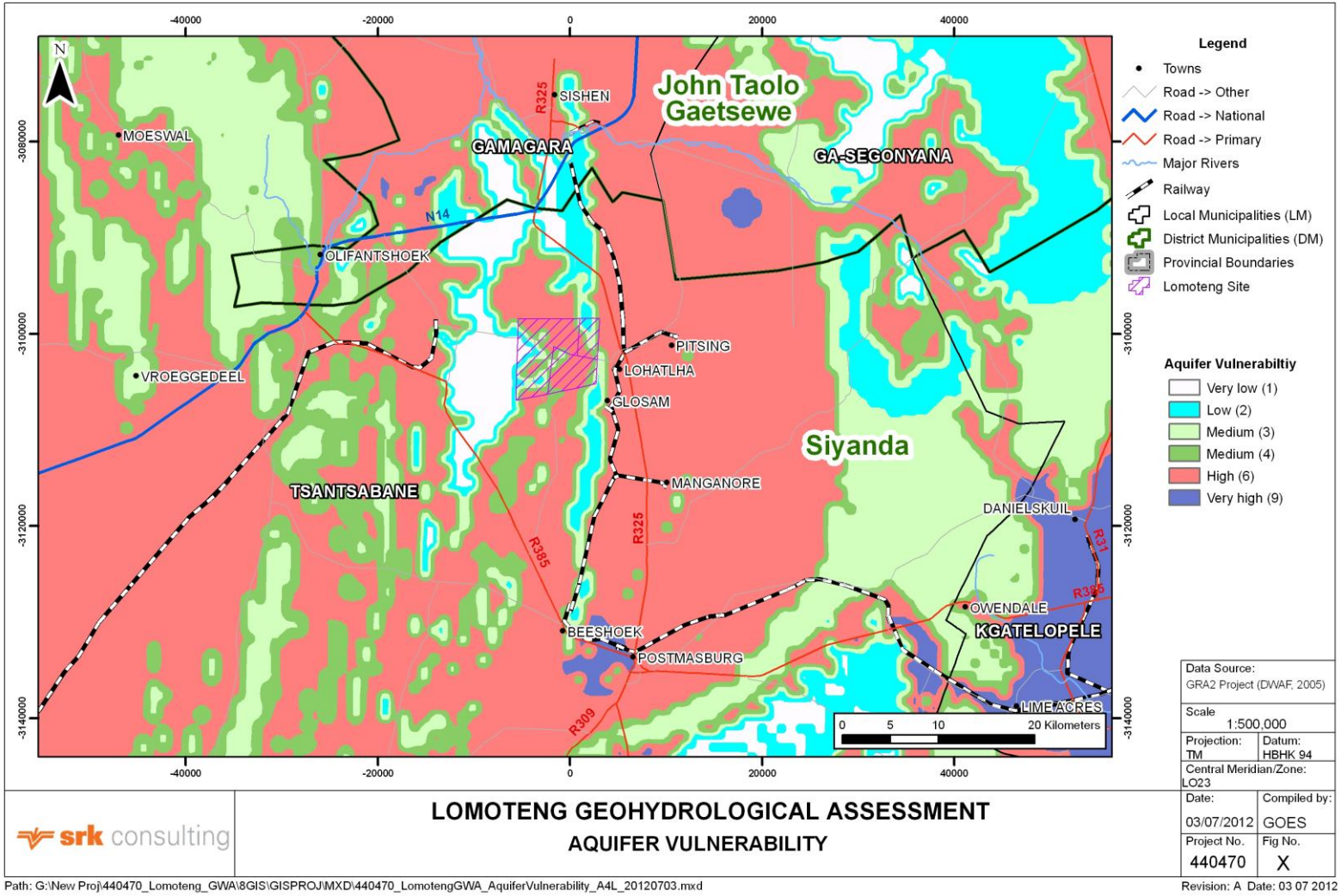


Figure 6: Groundwater vulnerability of the Lomoteng area

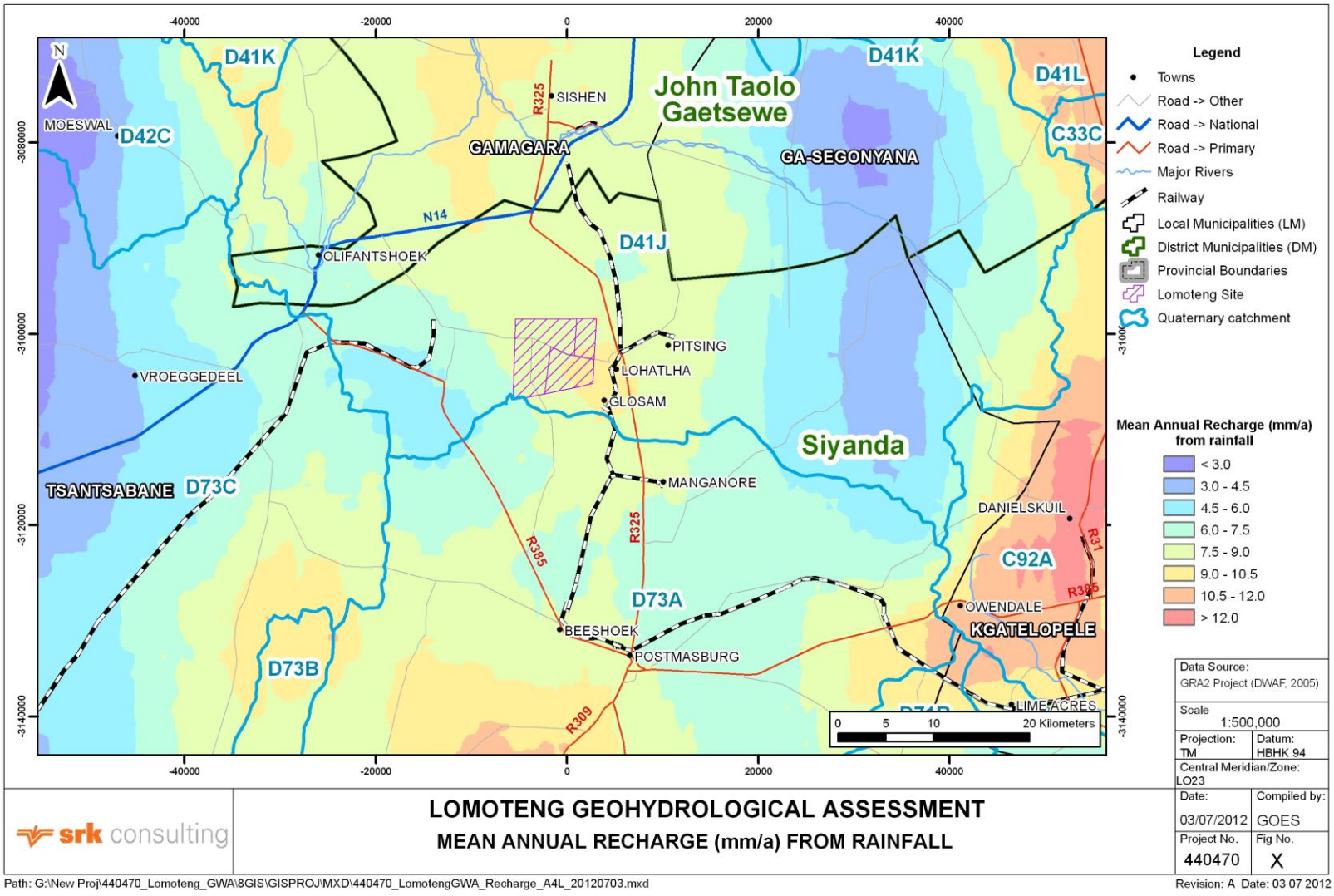


Figure 7: Mean Annual Recharge (mm/a) in the Lomoteng area

7 Program Results

7.1 Hydrocensus

The hydrocensus results are summarized in **Table 3** below with the localities of these boreholes indicated in **Figure 9** over page. A few relative high yielding boreholes were located in the area, i.e. boreholes 1, 4 and 10. These boreholes are located on or near mapped lineaments or the extensions thereof.

Table 3: Summary of hydrocensus results collected in the Lomoteng area.

Bh Nr	Date	Latitude	Longitude	Depth (mbgl)	Max Yield (ℓ/s)	Water level (mbgl)	Equipment	Pump intake (mbgl)	Use	Est Annual Abstr. (m^3/a)	pH	EC (mS/m)	Comments
Farm:	**Fouross 669/1**												
1	14/09/2011	-28.048236	23.023937	85	13.12	36.07	Submersible	66	Mine-main water supply	21,600	8.05	54	Generator
13	14/09/2011	-28.050157	23.017642			36.47	Solarpump		Stock	946	7.78	63	
Farm:	**Mineraal 669/2**												
2	14/09/2011	-28.032528	23.023934	145	0.99	20.92	No pump		None				
3	14/09/2011	-28.029910	23.024523	121	2.80	22.90	No pump		None				
4	14/09/2011	-28.031829	23.028064	120	2.60	5.44	No pump		None				
5	03/05/2012	-28.030560	23.025540	149	0.69	23.12	No pump		None				
6	03/05/2012	-28.035820	23.022690	62	0.54	26.57	No pump		None				
7	03/05/2012	-28.014640	23.017990	82	0.44	35.77	No pump		None				
8	03/05/2012	-28.030000	23.024580	21	1.41	37.20	No pump		None				
9	03/05/2012	-28.032620	23.023660	118	2.94	26.00	No pump		None				Future production borehole
10	03/05/2012	-28.022550	23.020290	104	7.61	19.53	No pump		None				Future production borehole
11	14/09/2011	-28.022756	23.012918			22.46	Submersible		Domestic and stock	5,913	7.45	89	
12	14/09/2011	-28.008792	23.018816			40.86	Windpump		None				Windpump not in use
Farm:	**Lohatlha 673**												
14	14/09/2011	-28.028334	23.045765				Monopump		Stock	2,628			With Lister engine
18	14/09/2011	-28.042172	23.047125				Submersible		Domestic	5,913	7.85	74	Generator
19	14/09/2011	-28.039731	23.049031			1.50	No pump		None				
20	14/09/2011	-28.039491	23.049542			1.20	No pump		None				
21	14/09/2011	-28.039482	23.049650			0.60	No pump		None				
Farm:	**Gloucester 674**												
15	14/09/2011	-28.062305	23.056346			12.00	Monopump		Maremane community main water supply	31,536	7.60	70	With Lister engine
16	14/09/2011	-28.055903	23.059562			0.00	No pump		None	6,307			Artesian
17	14/09/2011	-28.053589	23.060671			1.00	No pump		None				
			Mean	**100.6**	**3.31**	**19.45**					**7.75**	**70**	
			Median	**111.09**	**2.01**	**22.46**			**Total Annual Abstraction**	**74,843**	**m^3**		

One artesian borehole was surveyed on the farm Gloucester (bh no 16). The artesian flow of this borehole was ~0.2 ℓ/s during the site visit (see **Figure 8** below).

Figure 8: Artesian flow at Borehole 16, Gloucester Farm

The borehole is located on the south-eastern contact of a NE-SW striking dolerite dyke. Groundwater flow is restricted by the relative impermeable dyke and therefore it arises in the form of springs or artesian boreholes at low laying areas and on the upstream side of this dyke.

A very distinct decline in the groundwater level is noted on the eastern boundary of the property where the contact of the Ghaap Plateau Formation with the over laying clastic sediments of the Gamagara Formation outcrops. A likely explanation for this 15-20 m drop in the groundwater level is that the quartzites of the Gamagara Formation have a higher primary transmissivity than the dolomitic rocks of the Ghaap Plateau Formation. Therefore groundwater flows more rapidly from these rocks into the primary aquifer to the west which results in a decline in the groundwater level.

The average borehole yield of the surveyed boreholes is 3.31ℓ/s. This value is skewed by a few relative high yielding boreholes. Therefore the median borehole yield of 2.01 ℓ/s gives a much better indication of the borehole yield that can be expected from a successful borehole drilled in this area.

The average EC and pH values of the surveyed boreholes are 70 and 7.75 respectively and correlate well with the values obtained from the NGA data.

Table 4 indicates the estimated abstraction from the Lomoteng mining area and the surrounding properties. In the case of electric pumps, the estimates are based on pump yields and daily operating hours as reported by the owners. For wind pumps were assumed 24 h/d operation at 12% of the maximum yield (which is determined by the cylinder size). This assumption is based on personal experience in the Karoo area. The table indicates that the total annual abstraction from the study area is ~75,000 m^3. Approximately 29% of this volume is abstracted at Lomoteng exploration site whilst artesian borehole 16 contributes ~8.5% to the total abstraction. It is, however, expected that the artesian flow of this borehole increases significantly during rainy seasons and the total contribution is likely more than the calculated value.

No large scale irrigation occurs in the area and abstracted groundwater is exclusively used for the mining activities, stock watering and domestic use.

Table 4: Estimated groundwater abstraction in the Lomoteng area

Bh Nr	Date	Latitude	Longitude	Equipment	Use	Est Annual Abstr. (m^3/a)	Comments
Farm:	**Lomoteng 669/1**					**22,546**	
1	14/09/2011	-28.048236	23.023937	Submersible	Mine-main water supply	21,600	Generator
13	14/09/2011	-28.050157	23.017642	Solar pump	Stock	946	
Farm:	**Mineraal 669/2**					**5,913**	
11	14/09/2011	-28.022756	23.012918	Submersible	Domestic and stock	5,913	
Farm:	**Lohatlha 673**					**8,541**	
14	14/09/2011	-28.028334	23.045765	Mono pump	Stock	2,628	With Lister engine
18	14/09/2011	-28.042172	23.047125	Submersible	Domestic	5,913	Generator
Farm:	**Gloucester 674**					**37,843**	
15	14/09/2011	-28.062305	23.056346	Mono pump	Maremane community main water supply	31,536	With Lister engine
16	14/09/2011	-28.055903	23.059562	No pump	None	6,307	Artesian
					Total Annual Abstraction	**74,843**	

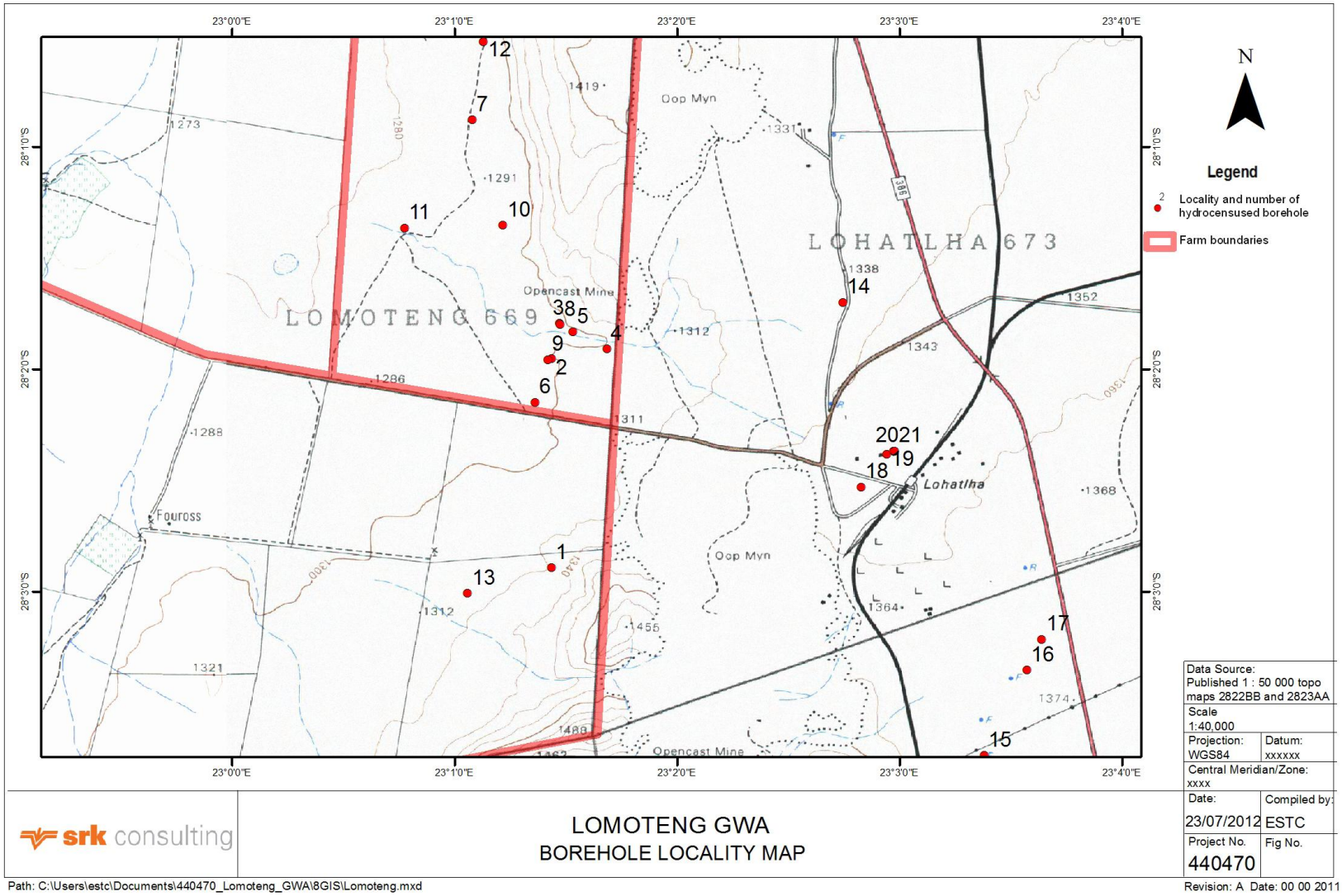


Figure 9: Localities of surveyed boreholes in the Lomoteng area

Borehole 4 is drilled on the dolomite/quartzite contact with Borehole 5 located 285 m downstream in the quartzites. The latter has intersected the quartzite/dolomite contact at 85 mbgl (data obtained from driller, Mr. Hermie Volgraaff). Taking the elevation difference of ~4 m into account it means that the sediments dip >17^{o} to the west at this locality. However, this apparent steeper dip is likely caused by the irregular karstic floor. Only small volumes of groundwater was intersected on the contact and in the dolomite below the quartzite, although this borehole is located very close to a visible NE-SW striking fault (approximately 20 m south-east of the hanging wall which dips ~75^{o} SE).

7.2 Groundwater flow direction

The hydrocensus data and data from the NGA were used to compile a groundwater elevation map with inferred groundwater flow directions. This map is presented in **Figure 10** over page. The map clearly indicates that groundwater at the site (Quaternary Catchment D41J) generally flows from south-east to north-west towards the Ga Mogara River. A surface watershed occurs south of the site and groundwater from this area (Quaternary Catchment D73A) flows to the south-west towards the Orange River.

7.3 Yield Testing

Boreholes 1 to 10 were yield tested during the periods described earlier. The yield test data were analysed by means of the FC-method, which has been specifically developed to determine sustainable yields of boreholes penetrating fractured-rock aquifers (Van Tonder & Xu, 1999), as well as other methods. A recharge value of 14.6 mm/a or 3.8% of the MAP (385 mm) was used. Available drawdown for each borehole was determined by the inflection point, where the rate of drawdown increases when plotted on a semi-log scale. The yield test data are summarized in **Table 5** below whilst the raw yield test data, diagnostic plots and sustainable yield analyses are indicated in **APPENDIX 3** to **APPENDIX 5** at the end of this report.

Table 5: Summary of yield test data

Bh No	Latitude (DD)	Longitude (DD)	Depth (mbgl)	RWL* (mbgl)	Discharge Rates (ℓ/s)				Pump suction Yield (ℓ/s)	Constant discharge test	Comments
					Step 1	Step 2	Step 3	Step 4			
Bh 01	-28.04824	23.02394	85.34	36.07	6.33	10.16	15.07		13.12	72h @ 8.12 ℓ/s	Pump suction after 3 min at last step
Bh 02	-28.03253	23.02393	144.79	20.92	1.55				0.99		No CDT, Yield too low
Bh 03	-28.02991	23.02452	121.07	22.90	1.09	2.31	3.16		2.80		Only calibration test. Pump suction after 5 min at last step.
Bh 04	-28.03183	23.02806	119.72	5.44	1.05	2.03	3.09	4.04	2.60		Max yield during calibration test = 6 ℓ/s, No CDT; yield too low
Bh 05	-28.03056	23.02554	148.51	23.12	1.02	2.05			0.69		No CDT, Yield too low
Bh 06	-28.03582	23.02269	62.00	26.57	0.24	0.42	0.72		0.54		No CDT, Yield too low
Bh 07	-28.01464	23.01799	81.54	35.77	0.20	0.41	0.61		0.44		No CDT, Yield too low
Bh 08	-28.03000	23.02458	144.79	20.92	0.21	0.41	0.93	1.11	1.41		No CDT, Yield too low
Bh 09	-28.03262	23.02366	118.48	26.00	0.21	0.58	1.21	2.58	2.94	72h @ 1.85 ℓ/s	
Bh 10	-28.02255	23.02029	103.70	19.53	0.44	0.82	1.65	5.14	7.61	72h @ 3.54 ℓ/s	Last step @ 7.61 ℓ/s - 37m DD

***RWL = Rest Water Level**

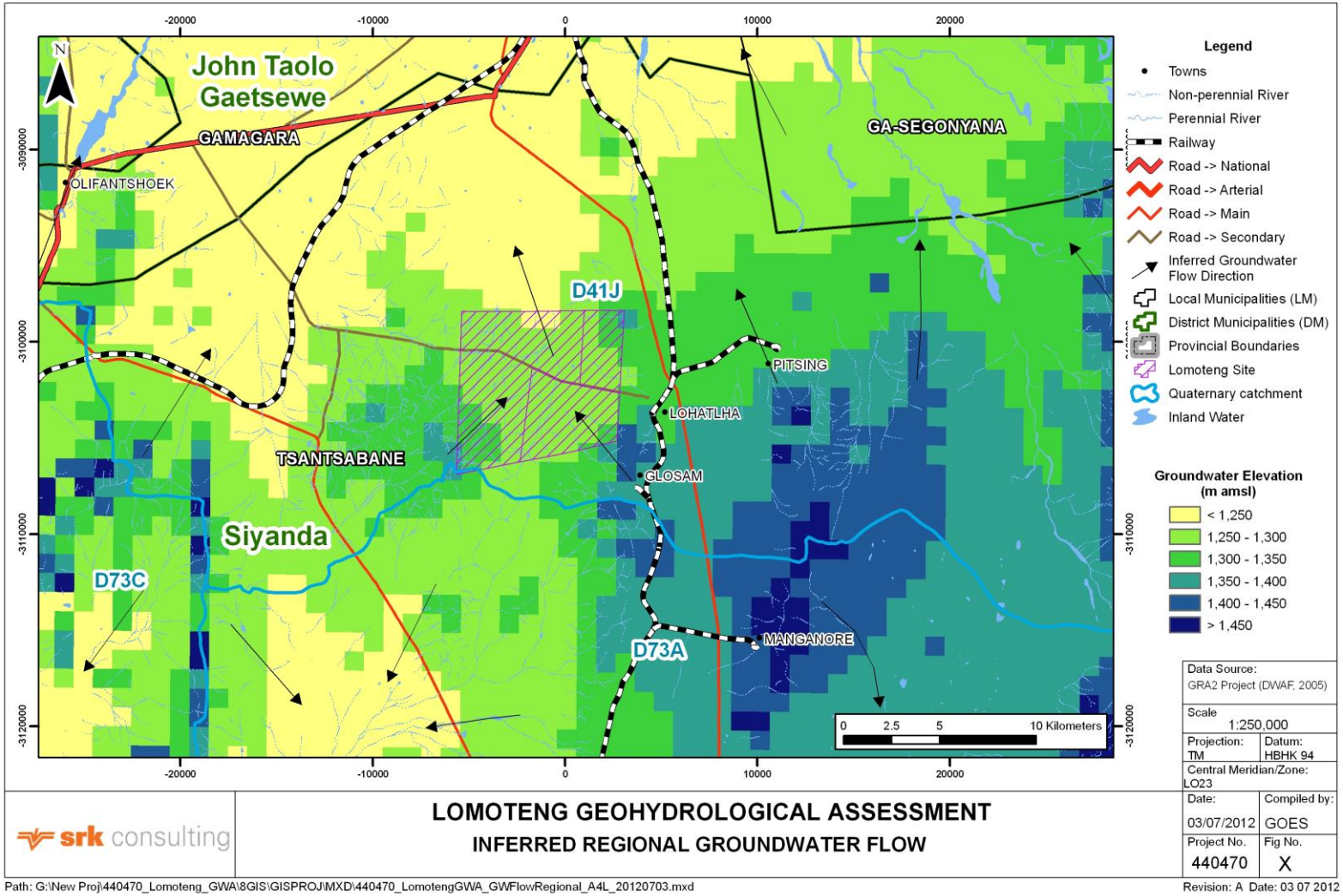


Figure 10: Inferred groundwater flow directions in the Lomoteng area

Only boreholes 01, 09 and 10 were submitted to a 72-hour CDT as the others had too low immediate yields to be considered as production boreholes. The results obtained with the FC- and recovery analyses are summarized in **Table 6** below.

Table 6: Summary of Lomoteng Yield Test Analyses

Bh No	Coordinates (Decimal Degrees)		Bh Depth (mbgl)	Rest Water Level (mbgl)	Available Draw Down (m)	Max immediate bh yield (ℓ/s)	Fractal Dimension	Log Derivative	FC-Method Sustainable Yield		Recovery Safe Yield (m^3/d)	Recovery Safe Yield (ℓ/s @ 24h/d)	Ave S	Ave T (m^2/d)
	Latitude	Longitude							ℓ/s @ 24h/d	m^3/d				
LG1	-28.04838	23.02390	85.34	36.07	14.3	13.10	2.20	0.14	1.75	151.20	387.57	4.49	1.64E-03	13.7
LG9	-28.03262	23.02366	118.48	26.00	17.5	2.95	2.01	0.10	0.90	77.76	63.82	0.90	1.98E-03	8.3
LG10	-28.02255	23.02029	103.70	19.53	22.0	7.60	2.03	0.13	1.20	103.68	99.20	1.15	1.51E-03	7.7
								TOTAL	**3.9**	**332.6**	**550.6**	**6.37**	**1.71E-03**	**9.90**

The table indicates that the storativity value, S, is in the order of 1.7 x 10^{-3} for all three tested boreholes. Transmissivity (T) varies between 7.7 and 13.7 m^2/d for the fractured aquifer. The yield test data were also analysed with the recovery method to obtain the long term sustainable yields of the boreholes. This method calculates the long term sustainable yield of a borehole based on the recovering data as follows:

Q = V/((PT+RT)/1440), where

Q= Long term sustainable yield in m^3/d
V= Volume of groundwater abstracted during the yield test in m^3
PT= Pumping time in minutes
RT= Recovery time in minutes

These values are also indicated in **Table 6** above. For borehole 01 the recovery method yields a much higher sustainable yield than the FC-method (~2.5x) due to relative quick water level recovery after pump shutdown. However, the more conservative sustainable yield calculated by the FC-method is rather recommended. The recovery and FC-methods yield similar values for the other two boreholes.

The fractal dimension and log derivative values indicated in the table describes the fractured zones and groundwater flow regimes. Aquifers can be classified by the log derivative values as follows:

<0.25= Radial flow, homogeneous aquifer (very well developed fracture network, aquifer behaves like a primary aquifer with no preferred direction of groundwater flow)

0.25 - 0.50= Good fracture network with groundwater flow more prominent in one direction than the others

>0.50= Single fracture, limited fracture network with groundwater flow mainly in one direction along the fracture and very little or no groundwater flow perpendicular to the fracture.

The fractal dimension value indicates the type of groundwater flow as follows:

1= Linear flow: groundwater flows mainly in one direction only

1.5= Bi-linear flow: groundwater flow is more prominent in one direction than the others

2= Radial flow: groundwater does not flow in a preferred direction, but radial

Both the log derivative and fractal dimension values indicate radial flow at all three boreholes.

7.4 Groundwater chemistry

Groundwater samples for chemical analysis at M&L Laboratories were collected at the end of the three CDT's. The chemistry results were received from M&L laboratories on 1 October 2012 and are summarized **Table 7** below.

Table 7: Chemistry results of groundwater from boreholes at Lomoteng mine

BH NO:	LOM1	LOM9	LOM10	SANS (241 - 2006) Specifications for drinking water		
LAB NUMBER:	E02473	E02474	E02475			
SAMPLE DATE:	3-May-12	10-Jul-12	15-Jul-12	**Class 1 (Recom. limit)**	**Class 2 (Max. Allowed)**	**Class 2 water Consumption Period, Max.a**
Determinants (in mg/l unless stated otherwise)						
Potassium as K mg/L	3.9	23.0	0.7	<50	50 – 100	7 years
Sodium as Na mg/L	75.0	90.0	136.0	<200	200 – 400	7 years
Calcium as Ca mg/L	39	17.3	7.7	<150	150 – 300	7 years
Magnesium as Mg mg/L	49	27	0.38	<70	70 – 100	7 years
Sulphate as SO4 mg/L	89	90	7.6	<400	400 – 600	7 years
Chloride as Cl mg/L	116	77	93	<200	200 – 400	7 years
Total Hardness	299	154	21	Not Specified - Not a health issue		
Total Alkalinity as CaCO3 mg/L	242	244	161	Not Specified - Not a health issue		
Nitrate as N mg/L	6.8	4.0	0.1	<10	10 – 20	7 years
Fluoride as F mg/L	0.40	1.40	17.40	<1.0	1.0 – 1.5	7 years
Iron as Fe mg/L	0.02	0.02	0.11	<0.2	0.2 – 2.0	7 years
Manganese as Mn mg/L	0.001	0.001	0.001	<0.1	0.1 - 1.0	
Conductivity mS/m (25°C)	91.5	79.4	66.4	<150	>150 – 370	7 years
pH (Lab) (25°C)	8.2	8.2	7.8	5.0 – 9.5	4.0 - <5.0; >9.5 - 10.0	No health effect
Total Dissolved Solids	540	468	390	<1000	1000 - 2400	7 years
Nitrate , NO3	30	17.6	0.1	<45	45 - 90	7 years
Bicarbonate, HCO3	295	297	196	Not Specified - Not a health issue		
Aluminium, Al	0.05	0.04	0.017	<0.3	0.3 - 0.5	1 year
Copper, Cu	0.030	0.020	0.003	<1	1 - 2	1 year
Sum of Anions meq/L	10.464	9.278	6.913	Not Specified - Not a health issue		
% Error	-5.670	-10.020	-4.253	Not Specified - Not a health issue		
Sum of Cations meq/L	9.341	7.588	6.394	Not Specified - Not a health issue		
Overall Classification	**1**	**2**	**3**			

[a] The limits for the consumption of class 2 water are based on the consumption of 2 ℓ of water per day by a person of mass 70 kg over a period of 70 years.

The table indicates that the general groundwater quality is very good except for high concentrations of Fluoride in the groundwater from boreholes LOM9 and LOM10. The Fluoride concentration in the groundwater from borehole LOM10 is extremely high and uncommon for this area. This groundwater is unsuitable for human consumption based on the high Fluoride content. Otherwise this borehole yields the best quality of groundwater. The hardness of this groundwater is very low and it is recommended that this groundwater is used for washing and showering as it will cause very little scaling in geysers and other hot water equipment. It will also decrease the amount of soap needed for washing purposes. The Fluoride content of the groundwater from borehole LOM9 renders it only suitable for short term human consumption (maximum continuous consumption of 7 years). Therefore it is recommended that the groundwater from Borehole LOM1 is used for drinking purposes.

8 Conceptual Model

Figure 11 below illustrates a 2D-groundwater model of the Lomoteng area. Transmissivity (T) values were calculated from yield test data and geohydrological data from other nearby localities. The model indicates the decline in groundwater level across the dolomite/quartzite contact and the higher T values obtained for the latter which causes the decline. Though the dolomitic rocks are known for high borehole yields, the T value in the non-fractured and –leached rocks are low. In contrast the Gamagara Formation has a higher primary transmissivity than the dolomite.

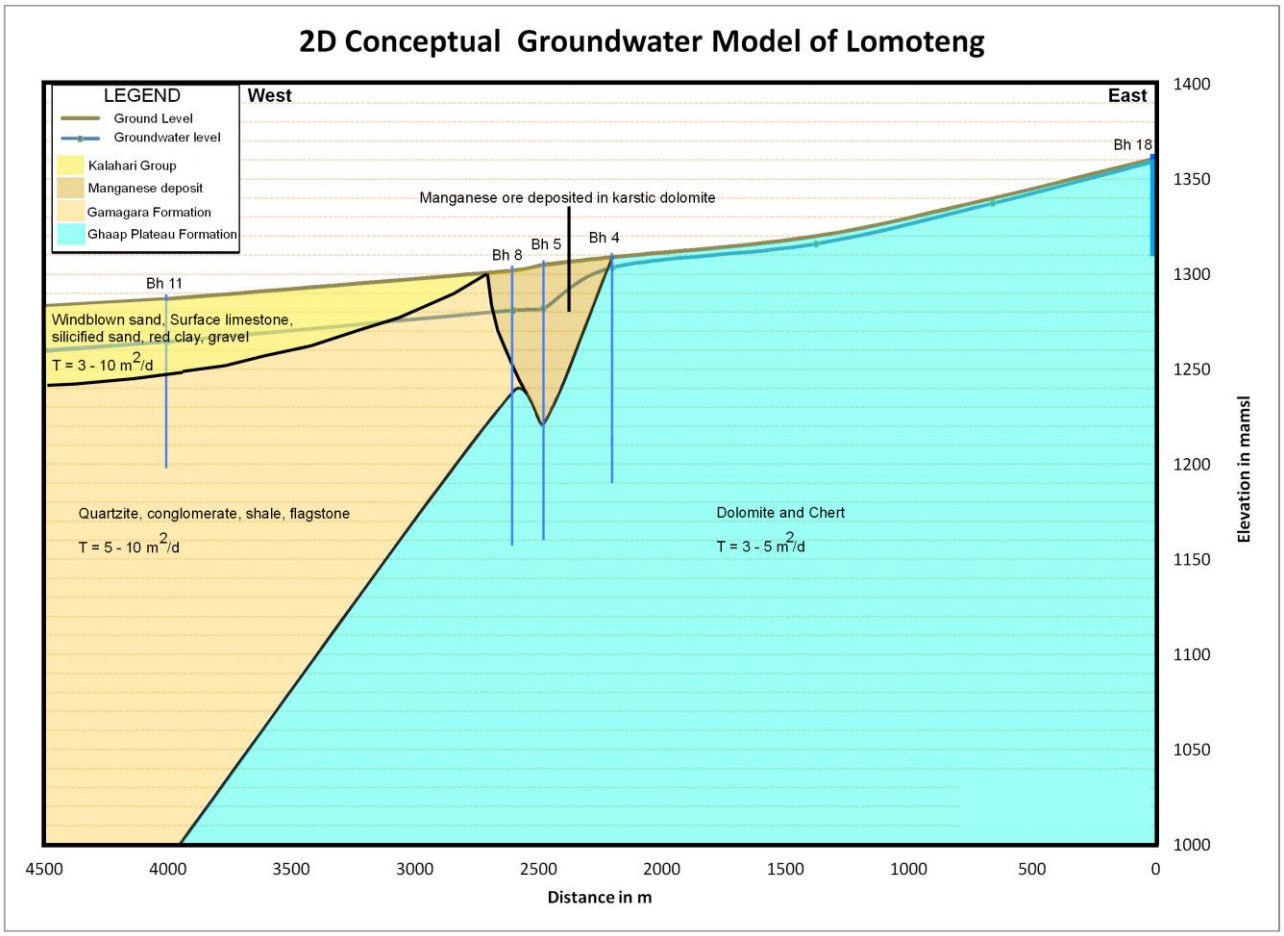


Figure 11: Conceptual 2D groundwater model of the Lomoteng area

9 Groundwater Balance

The site area falls on the southern boundary of the Quaternary Drainage Region D41J (see **Figure 10**) for which the amount of water available under General Authorisation is listed under Zone A of the Groundwater Taking Zones, where no water may be taken from this drainage regions except as set

out under Schedule 1[1] and small industrial users[2] (DWAF, 2004). Therefore, if the water demand of the mine is to be satisfied from the groundwater resources, a Water Use Licence Application will have to be submitted.

Subordinate Groundwater Resource Units (GRU's) for this area were defined based on the three properties. Areas of the GRU's were calculated and used together with the rainfall and recharge percentages from the GRAII data to determine the total annual recharge for each Unit. Boreholes cannot intersect all the available recharge for several reasons. Therefore an exploitability factor was used to calculate the volume of groundwater that can actually be abstracted through boreholes. For the study are this value was slightly adjusted based on the hydrocensus information (few dry and very low yielding boreholes were reorted). Furthermore, a potability factor was used to determine the volume of potable groundwater that can be abstracted through boreholes. Current abstraction was based on the hydrocensus data and subtracted from this value to determine the Utilisable Potable Groundwater Exploitation Potential (UPGEP) based on recharge. These calculated values are indicated in **Table 8** below.

Table 8: Groundwater exploitation potential of the Lomoteng area

Quaternary Catchment	Area (ha)	Average Water-level (mbgl)	Exploita-bility Factor	Pota-bility Factor	Annual Abstrac-tion (m^3/a)	Mean Annual Potential Recharge (m^3/a)				Groundwater Exploitation Potential Based on Recharge (m^3/a)		Utilisable Potable Groundwater Exploitation Potential (m^3/a)	
						Wet Season		Dry Season		Wet Season	Dry Season	Wet Season	Dry Season
			Ef	Pf	At	Re (wet)	% of MAP	Re (dry)	% of MAP	GEP (wet)	GEP (dry)	UPGEP (wet)	UPGEP (dry)
D41J	387,363	29.37	0.408	0.957	1,924,240	27,606,700	2.0%	18,295,600	1.3%	25,682,460	16,371,360	10,036,653	6,765,290
Lomoteng	6,425	19.45	0.500	1.000	12,772	618,374	2.5%	371,025	1.5%	605,602	358,253	302,801	179,126
D73A	323,486	20.09	0.427	0.837	3,084,160	27,823,300	2.7%	18,219,500	1.7%	24,739,140	15,135,340	8,834,265	5,404,780

The table indicates that for the Lomoteng GRU the average UGEP is ~241,00 m^3/a. For the D41J quaternary catchment the value is ~ 8,400,000 m^3/a. The maximum water demand at the mine will be 300 m^3/d or 109,500 m^3/a if operated continuously for one year. This volume is ~45% of the UPGEP of the Lomoteng GRU. This means that, with mining in full production, no negative impact on groundwater levels should be noted outside the three properties where Huatian has mining rights.

10 Possible impacts and mitigation measures

Table 9 over page indicates possible groundwater impacts during the construction, operation and decommission phases of the manganese mine without any mitigation measures taken. Mitigation measures need to be implemented to minimise identified impacts during all phases of the project life-cycle (construction, operation and decommissioning). These measures are also indicated in this table. **Table 10** indicates the severity of the impacts with the proposed mitigation measures applied.

[1] Not taking more than 10 cubic metres from groundwater on any given day.

[2] •"Small industrial users" mean water users who qualify as work creating enterprises that do not use more than twenty cubic metres per day (i.e. 20 000 litres/day) and identified in the Standard Industrial Classification of All Economic Activities (5th edition), published by the Central Statistics Service, 1993, as amended and supplemented, under the following categories:-

a) 1: food processing;
b) 2: prospecting, mining and quarrying;
c) 3: manufacturing;
d) 5: construction

Table 9: Possible groundwater impacts without mitigation measures

Construction Phase: Groundwater impacts

	Status of Impacts		Spatial Scale of Impacts		Temporal scale of impacts		Probability of Impacts		Severity of Impacts		Significance of impacts	
Impact description	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating
Oil and Fuel spills	Negative	-	Low	1	Low	1	Probable	2	Average	2	Medium	6
Waste Water contamination	Negative	-	Low	1	Low	1	Probable	2	Average	2	Low	6

Essential mitigation measures:

- Place oil traps under stationary machinery, Only re-fuel machines at fuelling station, Construct structures to trap fuel spills at fuelling station, Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only
- Ensure that waste water is properly handled, install oil traps at workshop, place soak away pits at suitable localities
- A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.
- Ensure vehicles and equipment are in good working order and drivers and operators are trained.
- Ensure that good housekeeping rules are applied.

Operational Phase: Groundwater impacts

	Status of Impacts		Spatial Scale of Impacts		Temporal scale of impacts		Probability of Impacts		Severity of Impacts		Significance of impacts	
Impact description	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating
Groundwater abstraction	Negative	-	Low	1	Low	1	Probable	2	Minor	1	Low	5
Oil and Fuel spills	Negative	-	Low	1	Low	1	Probable	2	Average	2	Medium	6
Contamination from manganese ore spills and mine heaps	Negative	-	Low	1	Low	1	Improbable	1	Minor	1	Low	4
Waste Water contamination	Negative	-	Low	1	Low	1	Probable	2	Average	2	Low	6
Contamination from explosives used to mine ore	Negative	-	Low	1	Low	1	Improbable	1	Minor	1	Low	4

Essential mitigation measures:

- Minimise waste water by the appropriate engineering design and re-use for other purposes where possible.
- A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.
- Ensure vehicles and equipment are in good working order and drivers and operators are trained.
- Place oil traps under stationary machinery, Only re-fuel machines at fuelling station, Construct structures to trap fuel spills at fuelling station, Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only
- Oil traps must be installed at the workshop and fuelling station. Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only
- A groundwater monitoring system must be implemented to monitor groundwater quality and water levels.
- Sewage tanks and/or infiltration pits must be constructed far away from permeable formations and significant aquifer systems.
- Ensure that good housekeeping rules are applied.

Decommisioning Phase: Groundwater impacts

	Status of Impacts		Spatial Scale of Impacts		Temporal scale of impacts		Probability of Impacts		Severity of Impacts		Significance of impacts	
Impact description	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating
Oil and Fuel spills	Negative	-	Low	1	Low	1	Probable	2	Average	2	Medium	6
Contamination from abandoned mine heaps	Negative	-	Low	1	Low	1	Unlikely	1	Minor	1	Low	4

Essential mitigation measures:

- A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.
- Ensure vehicles and equipment are in good working order and drivers and operators are trained.
- Place oil traps under stationary machinery, Only re-fuel machines at selected re-fuelling points, construct structures to trap fuel spills at re-fuelling points, Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only
- Mine heaps and the mining site must be rehabilitated with vegetation to limit erosion and contamination.
- Sewage tanks and/or infiltration pits must be rehabilitated.
- Ensure that good housekeeping rules are applied.

Table 10: Possible groundwater impacts with mitigation measures

Construction Phase: Groundwater impacts												
	Status of Impacts		Spatial Scale of Impacts		Temporal scale of impacts		Probability of Impacts		Severity of Impacts		Significance of impacts	
Impact description	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating
Oil and Fuel spills	Negative	-	None	0	None	0	Improbable	1	Minor	1	Low	2
Waste Water contamination	Negative	-	None	0	None	0	Improbable	1	Minor	1	Low	2
Operational Phase: Groundwater impacts												
	Status of Impacts		Spatial Scale of Impacts		Temporal scale of impacts		Probability of Impacts		Severity of Impacts		Significance of impacts	
Impact description	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating
Groundwater abstraction	Negative	-	Low	1	Low	1	Probable	2	Minor	1	Low	5
Oil and Fuel spills	Negative	-	None	0	None	0	Improbable	1	Minor	1	Low	2
Contamination from manganese ore spills and mine heaps	Negative	-	None	0	Low	1	Improbable	1	Minor	1	Low	3
Waste Water contamination	Negative	-	None	0	Low	1	Improbable	1	Minor	1	Low	3
Contamination from explosives used to mine ore	Negative	-	None	0	None	0	Improbable	1	Minor	1	Low	2
Decommisioning Phase: Groundwater impacts												
	Status of Impacts		Spatial Scale of Impacts		Temporal scale of impacts		Probability of Impacts		Severity of Impacts		Significance of impacts	
Impact description	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating	Rating	Quan-tative Rating
Oil and Fuel spills	Negative	-	None	0	None	0	Improbable	1	Minor	1	Low	2
Contamination from abandoned mine heaps	Negative	-	None	0	None	0	Improbable	1	Minor	1	Low	2

It is clear that these measures significantly reduce the risk of groundwater contamination. Therefore it is essential that these measures be implemented as part of the normal plant operation.

11 Conclusions

Based on the information discussed in this report the following can be concluded regarding the groundwater conditions at Lomoteng:

- Local geological observations during the hydrocensus and lineament mapping from Google Earth images indicate numerous lineaments in the area. Many of these are partially covered by windblown sand and rather hard to identify in the field.
- The area west of the mining area is largely covered by recent sediments which obscure most lineaments in this area. These sediments and the weathered bedrock underneath it form a significant primary aquifer.
- Maximum immediate yields of successful boreholes drilled in the area are generally <4 ℓ/s. Boreholes drilled away from structures in solid bedrock normally yield <0.5 ℓ/s. Boreholes only intersecting the primary aquifer normally also yield <0.5 ℓ/s
- High yielding boreholes 01, 04 and 10 are all linked to fracture zones or the extensions thereof.
- Groundwater levels vary largely through the area from artesian to >40 mbgl. A distinct decline in the groundwater level is noted at the dolomite/quartzite contact on the far eastern side of the mining area.
- Relative little groundwater is abstracted from this area and groundwater on adjacent properties is exclusively used for stock watering and domestic purposes. No irrigation occurs in the surveyed area.
- Most of the calculated groundwater abstraction occurs at the proposed mining area.
- The amount of water available under General Authorisation for this Quaternary Drainage Region (D41J) is listed under Zone A of the Groundwater Taking Zones. Therefore, if the water demand of the mine is to be satisfied from the groundwater resources, a Water Use Licence Application will have to be submitted.
- Groundwater quality in the surveyed area is generally good to very good and only deteriorates near pollution sources like kraals, soak away pits, etc. The best quality groundwater occurs near the higher laying recharge areas.
- From a groundwater point of view the proposed mining site is favourable as long as possible sources of groundwater pollution are kept away from lineaments and the shallow groundwater levels of the dolomitic areas along the far eastern boundary of the prospecting area. The groundwater level in the area west of the mine pit varies between 21 and 41 mbgl.
- The yield test data indicate that transmissivity values range between 7.7 and 13.7 m^2/d.
- Storativity values for the three yield tested boreholes vary little between 1.51×10^{-3} (borehole 10) and 1.98×10^{-3} (borehole 09) with an average value of 1.7×10^{-3}.
- Groundwater recharge calculations indicate that the expected water demand from the proposed mine is only ~45% of the UPGEP of the Lomoteng GRU. Therefore the proposed abstraction will likely not have a significant negative influence on groundwater levels in the area.
- The following mitigation measures have to implemented during the construction phase in order to limit the impact on groundwater sources:

    a) Place oil traps under stationary machinery, only re-fuel machines at fuelling station, Construct structures to trap fuel spills at fuelling station, Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only.

b) Ensure that waste water is properly handled, install oil traps at workshop, place soak away pits at suitable localities.

c) A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.

d) Ensure vehicles and equipment are in good working order and drivers and operators are trained.

e) Ensure that good housekeeping rules are applied.

- During the operation phase the following mitigation measures are desirable:

a) Minimise waste water by the appropriate engineering design and re-use for other purposes where possible.

b) A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.

c) Ensure vehicles and equipment are in good working order and drivers and operators are trained.

d) Place oil traps under stationary machinery. Only re-fuel machines at fuelling station. Construct structures to trap fuel spills at fuelling station. Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only.

e) Oil traps must be installed at the workshop and fuelling station. Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only.

f) A groundwater monitoring system must be implemented to monitor groundwater quality and water levels.

g) Sewage tanks and/or infiltration pits must be constructed far away from permeable formations and significant aquifer systems.

h) Ensure that good housekeeping rules are applied.

- The following mitigation measures are required during the decommissioning phase:

a) A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.

b) Ensure vehicles and equipment are in good working order and drivers and operators are trained.

c) Place oil traps under stationary machinery, Only re-fuel machines at selected re-fuelling points, construct structures to trap fuel spills at re-fuelling points, Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only.

d) Mine heaps and the mining site must be rehabilitated with vegetation to limit erosion and contamination.

e) Sewage tanks and/or infiltration pits must be rehabilitated.

f) Ensure that good housekeeping rules are applied.

12 Recommendations

Based on the discussions in this report the following is recommended for the proposed Lomoteng manganese ore mine:

1. The workshops, washing bays and sewage tanks and/or infiltration pits should be placed west of the shallow groundwater levels of the dolomitic areas.
2. All existing boreholes must be properly sealed at the surface to prevent surface pollution of the groundwater. This measure will also prevent bees from invading the borehole.
3. Boreholes 01, 09 and 10 can be utilized as production boreholes and managed as indicated in **Table 11** below:

Table 11: Recommended operation of production boreholes

Bh No	Coordinates		Bh Depth (mbgl)	Rest Water Level (mbgl)	Available Draw Down (m)	Recom pump intake (mbgl)	Max Pumping Water Level (mbgl)	Recom Sustainable Yield	
	Latitude	Longitude						ℓ/s @ 24h/d	m^3/d
Bh 01	-28.04838	23.02390	85.34	36.07	14.3	66	55.0	1.75	151.20
Bh 09	-28.03262	23.02366	118.48	26.00	17.5	66	58.0	0.90	77.76
Bh 10	-28.02255	23.02029	103.70	19.53	22.0	66	56.5	1.20	103.68
							Total	**3.9**	**332.6**

4. Boreholes 02, 04, 08 and 10 must be utilized as groundwater quality monitoring boreholes where groundwater samples must be taken bi-annually. These must be analysed by a SANS accredited laboratory for macro-chemical and micro-biological constituents and metals.
5. Water levels must be measured monthly at all the production boreholes and boreholes 13, 06, 04, 03, 11 and 12.
6. Simultaneously abstracted volumes must be recorded at the production boreholes.
7. Rainfall must be recorded on a daily basis at the site.
8. These data must be analysed by a qualified hydrogeologist at least on a yearly basis in order to identify red flag situations timeously and take the necessary preventative measures;
9. The following mitigation measures must be employed in order to limit the possibility of groundwater pollution:
    - Minimise waste water by the appropriate engineering design and re-use for other purposes where possible.
    - A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.
    - Ensure vehicles and equipment are in good working order and drivers and operators are trained.
    - Place oil traps under stationary machinery, only re-fuel machines at fuelling station, construct structures to trap fuel spills at fuelling station, immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only.
    - Place plastic sheets on surface where salt is up- or unloaded to collect spilled salt.

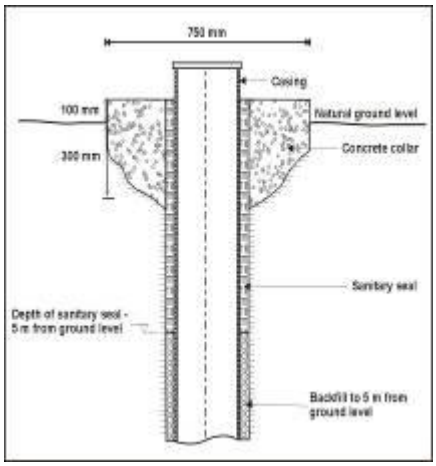
- Effluent and waste water from the plant must be deposited in evaporation ponds. These ponds must be constructed away from vulnerable areas, fault zones and permeable formations to prevent ponding and ingress of contaminated water. The ponds must be properly lined to prevent vertical infiltration of contaminated water.
- A groundwater monitoring system must be implemented to monitor groundwater quality and water levels.
- Sewage tanks and/or infiltration pits must be constructed far away from permeable formations and significant aquifer systems.
- Ensure that good housekeeping rules are applied.
- At decommissioning the mine area must be rehabilitated. Contaminated material must be disposed at a suitable, licensed waste disposal site. Sewage tanks and/or infiltration pits must also be rehabilitated.

10. In order to safeguard the groundwater supplies from contamination and equipment from theft and damage, two zones of protection must be established around each production borehole:

Inner protection Zone

The inner protection zone is an area of at least 50m x 50m, centred on the actual borehole. The following measures must be applied in this protection zone:

- No pit latrines, VIP's, soak-aways or septic tanks – to prevent effluent from percolating into the aquifer and borehole;
- No storage of fuel, lubricants or other hazardous substances without a leak prove;
- Production boreholes for domestic use must be equipped with a sanitary seal – to prevent contaminated surface water and spilled fuel from percolating down the casing into the borehole;
- The concrete collar around borehole casing must be at least 100mm higher than the floor or surface level to prevent spilled fuel, water from leakages, wash water, etc to enter the borehole;
- No ponding of surface water must be allowed, i.e. the area must be sloped for surface water to drain away from this zone;



- Vegetation, other than trees and large bushes, should be maintained in this zone – Note: Roots of bushes and trees growing near boreholes often grows into the borehole where it can cause considerable problems;
- The borehole and pumping equipment must be housed in a lockable pump house. For this purpose a removable cage manufactured out of galvanised steel mesh and corrugated steel sheets is recommended. This cage, rather than a brick building, is recommended as it can be readily removed in case the borehole is damaged or if it needs to be re-developed and cleaned.
- The production boreholes, as well as other monitoring boreholes in the area, must be properly sealed to prevent entry of reptiles, insects, birds and small rodents.

- The entire area should be properly fenced with a lockable gate to prevent unauthorised entry and to exclude animals. The gate must be positioned and of such a type that allows easy vehicle access.
- A signboard must be erected on the gate warning people of the dangers and that unauthorised entry is not allowed.

Outer protection Zone

The outer protection zone should cover an area of at least 500 m x 500 m and the following measures should be applied within this zone:

- No water-borne sewage, soak-aways or new pit latrines;
- No new stock watering points or pens;
- No abattoirs and other hazardous industries such as workshops, metal plating factories, petrol filling stations, etc;
- No cemeteries or disposal of solid waste or sewage;
- Existing pit latrines and septic tanks with 100 m of the borehole must be properly sealed; and
- If possible no new housing or industry developments should be allowed in this zone.

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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.

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APPENDIX 1: NGA Data for Lomoteng Area

Identifier	Type	Latitude	Longitude	Accuracy (m)	Elevation (mamsl)	WL Date & Time	Wlevel (mbgl)	Bh Depth (mbgl)	Water Strike (mbgl)	Discharge Rate (ℓ/s)
2823AA00130	Borehole	-28.24979	23.21973		1390	11/02/1994 15:45	53.73	53.73		
2823AA00124	Borehole	-28.23924	23.18278		1370	11/02/1994 9:05	9.00	75		
2823AA00125	Borehole	-28.23785	23.18251		1370	11/02/1994 9:15	9.47	60		
2823AA00129	Borehole	-28.23757	23.23834		1400	11/02/1994 15:25	48.20	48.2		
2823AA00123	Borehole	-28.23646	23.20251		1380	11/02/1994 8:50	25.14	116		
2823AA00098	Borehole	-28.22924	23.10695		1400	09/04/1994 13:00	15.34	36.57	24.38	
2823AA00133	Borehole	-28.22813	23.06695		1390	11/01/1994 16:25	19.53	19.53		
2823AA00131	Borehole	-28.22674	23.20639		1380			79.24		
2823AA00061	Borehole	-28.22537	23.23278		1400			84.73		
2823AA00059	Borehole	-28.22535	23.23275		1400			80.77		
2823AA00057	Borehole	-28.22535	23.23278		1400	06/27/1969 8:00	60.96	124.66	119.17	0.11
2823AA00058	Borehole	-28.22535	23.23278		1400			134.42	122.52	0.90
2823AA00062	Borehole	-28.22535	23.23278		1400	08/19/1975 8:00	51.00	137	121	1.83
2823AA00063	Borehole	-28.22535	23.23278		1400	01/25/1956 8:00	54.86	83.51	76.2	0.20
2823AA00060	Borehole	-28.22535	23.23279		1400			50.6		
2823AA00128	Borehole	-28.22341	23.24472		1400					
2823AA00122	Borehole	-28.22258	23.16612	100	1390	11/02/1994 9:50	15.30	15.3		
2823AA00127	Borehole	-28.22146	23.24417		1400	11/02/1994 14:20	45.57	45.57		12.00
2823AA00132	Sinkhole	-28.21646	23.19528		1380	11/01/1994 14:10	27.00			
2823AA00099	Dug Well	-28.21591	23.12029		1400	09/04/1994 13:20	9.06			
2823AA00119	Borehole	-28.21591	23.21751		1380			60.96		
2823AA00106	Borehole	-28.21563	23.08972		1390	10/04/1994 9:25	15.49	15.49		
2823AA00104	Borehole	-28.21563	23.09306		1400	10/04/1994 9:40	13.77	13.77		
2823AA00103	Borehole	-28.21535	23.09000		1390	10/04/1994 9:20	14.18	14.18		
2823AA00105	Borehole	-28.21285	23.07695		1400	10/04/1994 10:00	12.33	12.33		
2823AA00095	Borehole	-28.20924	23.11362		1450	09/04/1994 12:15	14.50	30.48		
2823AA00094	Borehole	-28.20896	23.11362		1400	09/04/1994 12:10	14.56	30.48		
2823AA00074	Borehole	-28.20868	23.14945		1400	07/19/1955 8:00	27.43	60.96	45.11	0.10
2823AA00120	Borehole	-28.20868	23.21028		1380	11/01/1994 13:00	13.59	13.59		
2823AA00096	Borehole	-28.20674	23.11195		1400			76.2		
2823AA00097	Borehole	-28.20396	23.08889		1400	09/04/1994 12:40	15.52	73.15		
2823AA00078	Borehole	-28.20037	23.19945		1380			52.73		
2823AA00075	Borehole	-28.20035	23.19945		1380	11/21/1969 8:00	23.77	49.68	43.28	2.00
2823AA00076	Borehole	-28.20035	23.19945		1380	08/02/1958 8:00	3.66	29.56	21.33	0.30
2823AA00077	Borehole	-28.20035	23.19945		1380	10/05/1954 8:00	24.38	78.02	64	0.32
2823AA00111	Borehole	-28.19674	23.20806		1390	11/01/1994 10:20	26.07	36.5		
2823AA00112	Borehole	-28.19285	23.20973		1390	11/01/1994 10:35	17.56	76.2		
2823AA00121	Borehole	-28.19007	23.19750		1390	11/01/1994 13:30	5.75	5.75		
2823AA00118	Borehole	-28.18313	23.22501		1390	11/01/1994 12:20	11.63	11.63		
2823AA00117	Borehole	-28.18160	23.23945		1390	11/01/1994 12:00	21.85	21.85		
2823AA00116	Borehole	-28.18132	23.23945		1390	11/01/1994 12:00	19.25	19.25		
2823AA00110	Borehole	-28.17924	23.09667		1430	10/04/1994 11:05	37.78	37.78		
2823AA00126	Borehole	-28.17869	23.23972		1390	11/02/1994 12:55	17.18	17.18		
2823AA00109	Borehole	-28.17591	23.09417		1430					
2823AA00101	Borehole	-28.17480	23.12723		1430	10/04/1994 14:05	41.75	41.75		

2823AA00100	Dug Well	-28.17452	23.12029		1440	10/04/1994 13:50	8.97			
2823AA00115	Borehole	-28.17091	23.23278		1390	11/01/1994 11:35	13.32	13.32		
2823AA00107	Borehole	-28.16952	23.07556		1410	10/04/1994 11:30	17.11	17.11		
2823AA00108	Borehole	-28.16341	23.09639		1430	10/04/1994 10:45	47.38	47.38		
2823AA00114	Borehole	-28.16229	23.22723		1390					
2823AA00102	Borehole	-28.16202	23.14250		1430	10/04/1994 14:30	11.73	11.73		
2823AA00113	Borehole	-28.15979	23.21417		1400	11/01/1994 11:15	3.26	41.5		
2823AA00072	Borehole	-28.15868	23.19945		1420	11/01/1965 8:00	82.29	167.94	146.3	0.64
2823AA00073	Borehole	-28.15868	23.19946		1420			40.78		
2823AA00064	Borehole	-28.15591	23.03278		1420	11/30/1983 8:00	21.00	48	24	14.77
2823AA00065	Borehole	-28.15591	23.03278		1420	09/17/1935 8:00	3.66	47.55	25.9	0.30
2823AA00067	Borehole	-28.15591	23.03278		1420	04/07/1982 8:00	30.00	114	79	0.07
2823AA00068	Borehole	-28.15591	23.03278		1420	02/06/1984 8:00	23.00	76	76	4.30
2823AA00069	Borehole	-28.15591	23.03278		1420	07/30/1982 8:00	15.00	30	18	1.60
2823AA00071	Borehole	-28.15591	23.03278		1420	07/27/1982 8:00	12.00	36	28	16.00
2823AA00066	Borehole	-28.15591	23.03279		1420			48		
2823AA00070	Borehole	-28.15591	23.03281		1420			79		
2823AA00040	Borehole	-28.13369	23.01612		1380			18.29		
2823AA00039	Borehole	-28.13368	23.01612		1380	11/06/1942 8:00	20.72	30.78	23.16	0.80
2823AA00055	Borehole	-28.13091	23.21612		1400	02/10/1970 8:00	10.66	115.82	49.37	
2823AA00056	Borehole	-28.13091	23.21612		1400	03/13/1970 8:00	15.85	51.2	15.85	0.23
2823AA00092	Borehole	-28.12908	23.01477		1340	09/22/1994 13:00	39.49	39.49		
2823AA00091	Borehole	-28.12886	23.00350		1320					
2823AA00090	Borehole	-28.12633	23.00233		1320					
2823AA00053	Borehole	-28.11702	23.11612		1500	09/27/1961 8:00	45.12	72.25	60.96	3.20
2823AA00054	Borehole	-28.11702	23.11612		1500	10/13/1936 8:00	88.39	103.63	88.39	0.45
2823AA00089	Borehole	-28.11168	23.01464		1330	09/22/1994 12:00	30.44	30.44		
2823AA00084	Borehole	-28.10702	23.00196		1340	03/01/1943 8:00	44.20	89.92	44.2	
2823AA00083	Borehole	-28.10701	23.00195		1340			61.26	22.86	
2823AA00087	Borehole	-28.10266	23.01424		1340					
2823AA00093	Borehole	-28.10265	23.00506		1350					
2823AA00086	Borehole	-28.10237	23.00118		1330	09/22/1994 9:25	27.72	27.72		
2823AA00085	Borehole	-28.10174	23.00047		1330	07/31/2003 12:00	24.14	999		
2823AA00088	Borehole	-28.09856	23.02572		1360					
2823AA00024	Borehole	-28.09619	23.10778		1440			97		
2823AA00022	Borehole	-28.09618	23.10778		1440			198		
2823AA00025	Borehole	-28.09618	23.10778		1440	04/24/1975 8:00	5.00	120	79	0.12
2823AA00023	Borehole	-28.09618	23.10779		1440			127		
2823AA00036	Borehole	-28.08368	23.06612		1400			60.96		
2823AA00037	Borehole	-28.08368	23.06612		1400	06/01/1938 8:00	25.29	42.67	35.35	2.52
2823AA00038	Borehole	-28.08368	23.06612		1400	04/07/1938 8:00	24.38	88.39	45.72	0.50
2823AA00034	Borehole	-28.07952	23.08278		1400	08/08/1975 8:00	101.00	138	118	1.60
2823AA00021	Borehole	-28.06702	23.14945		1420	09/21/1971 8:00	27.43	60.96	30.48	0.08
2823AA00026	Borehole	-28.06702	23.18278		1440	02/18/1939 8:00	28.04	51.51	40.54	3.78
2823AA00079	Borehole	-28.04795	23.01480		1300					
2823AA00080	Borehole	-28.03856	23.04806		1340					
2823AA00004	Borehole	-28.03368	23.04945		1340			129		

2823AA00082	Borehole	-28.03016	23.05360		1340					
2823AA00081	Borehole	-28.02836	23.04571		1340					
2823AA00002	Borehole	-28.02536	23.04945		1340			78.99		
14013	Borehole	-28.02535	23.04945		1340	09/01/1973 8:00	3.00	30	30	6.10
2823AA00001	Borehole	-28.02535	23.04945		1340	05/19/1937 8:00	25.30	87.47	60.96	0.38
2823AA00041	Borehole	-28.02535	23.04945		1340			85		2.53
2823AA00042	Borehole	-28.02535	23.04945		1340			95		3.54
2823AA00043	Borehole	-28.02535	23.04945		1340			55		2.65
2823AA00044	Borehole	-28.02535	23.04945		1340			43		0.51
2823AA00045	Borehole	-28.02535	23.04945		1340			61		0.76
2823AA00046	Borehole	-28.02535	23.04945		1340			56	24	3.79
2823AA00047	Borehole	-28.02535	23.04945		1340			70		0.13
2823AA00049	Borehole	-28.02535	23.04945		1340			65		0.13
2823AA00050	Borehole	-28.02535	23.04945		1340			61		0.76
2823AA00051	Borehole	-28.02535	23.04945		1340	09/01/1973 8:00	1.80	37	37	1.14
2823AA00052	Borehole	-28.02535	23.04945		1340	09/01/1973 8:00	25.30	97.15	61	0.38
2823AA00003	Borehole	-28.02535	23.04946		1340			84.73		
2823AA00134	Borehole	-28.02535	23.05778	100	1330					
2823AA00007	Borehole	-28.01703	23.16612		1380			46.02		
2823AA00005	Borehole	-28.01702	23.16612		1380			91.74		
2823AA00009	Borehole	-28.01702	23.16612		1380	11/07/1961 8:00	11.58	29.87	18.29	0.47
2823AA00010	Borehole	-28.01702	23.16612		1380	11/01/1961 8:00	30.48	56.08	39.62	1.26
2823AA00011	Borehole	-28.01702	23.16612		1380	12/07/1961 8:00	30.48	75.59	60.96	1.04
2823AA00012	Borehole	-28.01702	23.16612		1380	11/18/1955 8:00	45.72	73.45	57.91	4.54
2823AA00013	Borehole	-28.01702	23.16612		1380	01/16/1962 8:00	8.23	46.33	38.1	0.12
2823AA00014	Borehole	-28.01702	23.16612		1380	08/08/1963 8:00	32.30	91.74	82.29	1.89
2823AA00015	Borehole	-28.01702	23.16612		1380	07/31/1967 8:00	3.66	94.49	82.29	0.30
2823AA00016	Borehole	-28.01702	23.16612		1380	11/01/1961 8:00	9.14	34.74	20.72	1.26
2823AA00017	Borehole	-28.01702	23.16612		1380	08/27/1932 8:00	28.95	46.02	33.53	0.38
2823AA00018	Borehole	-28.01702	23.16612		1380	10/14/1932 8:00	8.84	36.88	12.19	0.38
2823AA00019	Borehole	-28.01702	23.16612		1380	03/25/1950 8:00	21.33	85.03	79.25	0.11
2823AA00020	Borehole	-28.01702	23.16612		1380	06/29/1938 8:00	11.88	36.57	16.76	0.25
2823AA00006	Borehole	-28.01702	23.16613		1380			60.65		
2823AA00008	Borehole	-28.01702	23.16614		1380			78.33		
2822BB00228	Borehole	-28.24951	22.86298		1220	04/24/1996 8:00	24.00	42	24	1.11
2822BB00122	Dug Well	-28.24904	22.85774		1230	03/16/2006 13:15	7.42			
2822BB00128	Borehole	-28.24843	22.90428		1260	03/16/2006 13:15	30.51			
2822BB00127	Borehole	-28.24841	22.90424		1260	03/16/2006 14:00	31.00	74.7		
2822BB00048	Borehole	-28.24840	22.85909		1220			42.37		
2822BB00049	Borehole	-28.24840	22.85909		1220	10/07/1968 8:00	39.62	110.64	71.32	0.36
G00108NC	Borehole	-28.24602	22.85987	10	1230	05/31/2004 12:00	6.97	150		
2822BB00219	Borehole	-28.24229	22.78548		1310	11/29/1994 15:25	49.00	49		
2822BB00124	Dug Well	-28.23979	22.87047		1230	03/16/2006 13:15	6.62			
2822BB00125	Borehole	-28.23950	22.87232		1220					
2822BB00230	Borehole	-28.23924	22.82482	100	1252					
2822BB00101	Borehole	-28.23901	22.96777	100	1290	09/20/1994 15:40	10.00	46.9		
2822BB00126	Borehole	-28.23839	22.82540		1240					

2822BB00102	Borehole	-28.23764	22.91795		1300	09/20/1994 16:00	54.00	85.3		
2822BB00220	Borehole	-28.23710	22.78650		1300	03/14/2006 15:15	68.70	75		
2822BB00059	Borehole	-28.23368	22.78853		1300	05/19/1954 8:00	67.06	125.58	68.88	0.05
2822BB00060	Borehole	-28.23368	22.78853		1300	07/14/1954 8:00	68.88	85.65	81.08	0.40
2822BB00061	Borehole	-28.23368	22.78853		1300	07/29/1954 8:00	50.29	55.78	50.29	0.36
2822BB00224	Borehole	-28.23316	22.78854		1310	03/14/2006 12:30	43.85	50.47		
2822BB00221	Borehole	-28.23146	22.78687		1310			95		
2822BB00213	Borehole	-28.22285	22.89270		1240	06/08/2004 12:00	19.90	41	20	3.78
2822BB00121	Borehole	-28.21885	22.96920	100	1290	09/21/1994 8:55	10.95	10.95		
2822BB00223	Borehole	-28.21869	22.75631		1300	06/08/2004 12:00	71.41	75		
2822BB00225	Borehole	-28.21841	22.75243		1300	11/30/1994 16:55	83.45	83.45		
2822BB00002	Borehole	-28.21702	22.98270		1300	05/04/1976 8:00	54.00	120	72	0.64
2822BB00222	Borehole	-28.21646	22.80270		1340	06/08/2004 12:00	79.22	130	108	0.05
2822BB00226	Borehole	-28.21452	22.75131		1300	11/30/1994 17:05	84.55	128		
2822BB00215	Borehole	-28.21396	22.88132		1240	06/08/2004 12:00	8.78	18.28		
2822BB00067	Borehole	-28.21341	22.96243		1280			96		
2822BB00068	Borehole	-28.21341	22.96244		1280			72.18		
2822BB00117	Borehole	-28.21185	22.96181	100	1280	09/21/1994 8:45	9.17	30	25	
2822BB00119	Borehole	-28.21125	22.96268	100	1280	09/21/1994 9:50	7.06	7.06		
2822BB00120	Borehole	-28.21053	22.96256	100	1280	09/21/1994 9:40	7.59	7.59		
2822BB00214	Borehole	-28.20507	22.87993		1240	06/08/2004 12:00	10.90	30.48		
2822BB00216	Borehole	-28.20368	22.91548		1260			48.76		
2822BB00118	Borehole	-28.20092	22.95786	100	1270	09/21/1994 9:15	11.22	11.22		
2822BB00217	Borehole	-28.19729	22.92882		1260	06/08/2004 12:00	26.60	30	15	1.38
2822BB00212	Borehole	-28.19479	22.89687		1250	06/08/2004 12:00	13.75	39.62		
2822BB00211	Borehole	-28.18812	22.89048		1250	12/08/1994 12:15	13.82	39.62		
2822BB00097	Borehole	-28.17535	22.77215	1000	1280			90		
2822BB00142	Dug Well	-28.16919	22.86316	100	1260	06/08/2004 12:00	12.37		10.6	
2822BB00144	Borehole	-28.16802	22.87204	100	1250	08/01/2003 12:00	9.76	36.57	18.28	
2822BB00046	Borehole	-28.16702	22.86270		1260	12/19/1969 8:00	54.86	107.59	67.06	0.58
2822BB00047	Borehole	-28.16702	22.86270		1260	11/25/1969 8:00	55.78	109.73	51.82	0.33
2822BB00143	Borehole	-28.16679	22.87284	100	1250	06/08/2004 12:00	10.62	24.38	12.1	0.00
2822BB00147	Borehole	-28.16542	22.81996	100	1300	09/07/1994 8:00	40.06	91.4	73.15	
2822BB00148	Borehole	-28.16390	22.80165	100	1340	09/07/1994 8:00	43.34	106.68	91.44	
2822BB00146	Borehole	-28.16193	22.86340	100	1260	09/07/1994 8:00	4.57	24.38	4.57	
2822BB00218	Borehole	-28.16140	22.76966		1320	11/29/1994 13:00	76.34	100		
2822BB00114	Borehole	-28.15953	22.97483	100	1290	09/21/1994 10:45	10.93	35		
2822BB00050	Borehole	-28.15952	22.90215		1280			90		
2822BB00113	Borehole	-28.15604	22.97150	100	1300	09/21/1994 10:30	18.34	75	70	
2822BB00149	Dug Well	-28.15550	22.85629	100	1260	06/08/2004 12:00	13.14		11.58	
2822BB00069	Borehole	-28.15341	22.91910	1000	1280			50		
2822BB00227	Borehole	-28.15140	22.76438	100	1290	11/29/1994 13:15	58.27	73		
2822BB00209	Borehole	-28.14810	22.86021	100	1260	08/17/1994 8:00	8.62	42.6	15.2	9.47
2822BB00208	Borehole	-28.14806	22.86188	100	1260			42.6	15.2	9.47
2822BB00210	Borehole	-28.14667	22.86188	100	1260	08/17/1994 8:00	9.40	45.7	15.2	6.31
2822BB00145	Borehole	-28.14660	22.83163	100	1290			91.4	70.1	
2822BB00100	Borehole	-28.14640	22.75077	100	1270	09/08/1994 10:20	53.80	60.9		

2822BB00115	Borehole	-28.14471	22.98306	100	1300	09/21/1994 10:55	12.09	21.33		
2822BB00206	Borehole	-28.14365	22.85549	100	1260	08/17/1994 8:00	9.42	60.9	15.2	
2822BB00205	Dug Well	-28.14361	22.85549	100	1260				12.19	
2822BB00207	Borehole	-28.13584	22.87438	100	1270	08/17/1994 8:00	16.58	42.6	15.2	
2822BB00116	Borehole	-28.13396	22.98446	100	1300	09/21/1994 11:05	28.68	50		
2822BB00138	Borehole	-28.13225	22.90355	100	1280	09/11/1994 10:00	13.42	13.42		
2822BB00106	Dug Well	-28.12796	22.98734		1300	09/13/1994 10:30	14.33		12.19	
2822BB00112	Dug Well	-28.12790	22.96194	100	1300	09/21/1994 11:35	14.04			
2822BB00189	Borehole	-28.12779	22.78577	100	1300	08/22/1994 8:00	41.80	6.5		
2822BB00109	Dug Well	-28.12674	22.98915		1300	09/13/1994 10:45	13.37		12.19	
2822BB00139	Borehole	-28.12591	22.89090	100	1290	09/11/1994 10:15	18.11	18.11		
2822BB00108	Dug Well	-28.12525	22.98973		1300	09/13/1994 10:50	15.34			
2822BB00129	Borehole	-28.12401	22.93677		1300	09/11/1994 10:00	5.87	12.19	6.09	
2822BB00137	Borehole	-28.12365	22.96075	100	1280	09/11/1994 10:45	11.90	45.7		
2822BB00194	Borehole	-28.12313	22.85770	100	1290	08/15/1994 8:00	12.19	31		
2822BB00141	Borehole	-28.12158	22.93516	100	1290	09/11/1994 11:00	17.84	17.84		
2822BB00107	Borehole	-28.12121	22.98623		1300	09/13/1994 11:15	12.84	30.48		
2822BB00111	Borehole	-28.12029	22.99024	100	1300	09/13/1994 11:25	15.13	15.13		
2822BB00099	Borehole	-28.11807	22.77716	100	1300	09/08/1994 11:30	56.86	100	76.2	
2822BB00187	Borehole	-28.11695	22.82633	100	1300	08/22/1994 8:00	46.39	106.68		0.22
2822BB00130	Borehole	-28.11652	22.94556	100	1280					
2822BB00188	Borehole	-28.11334	22.82855	100	1290	08/22/1994 8:00	32.71	67	36.5	6.31
2822BB00110	Borehole	-28.11136	22.96692		1300	09/13/1994 12:00	12.33	33.52		1.01
2822BB00191	Borehole	-28.11035	22.87104	100	1290	08/15/1994 8:00	17.37	94.4		
2822BB00140	Borehole	-28.10835	22.90897	100	1300	09/11/1994 10:30	16.97	38		
2822BB00195	Borehole	-28.10785	22.87687	100	1300	08/15/1994 8:00	17.00	18.2		0.63
2822BB00190	Borehole	-28.10785	22.87854	100	1300	08/15/1994 8:00	17.98	31	18.2	
2822BB00192	Borehole	-28.10674	22.87687	100	1300	08/15/1994 8:00	21.30	92		
2822BB00198	Borehole	-28.10338	22.89048	100	1310			45.7		
2822BB00197	Borehole	-28.10334	22.89270	100	1310			45.7		
2822BB00193	Borehole	-28.10146	22.85298	100	1280	08/15/1994 8:00	32.00	78.3	32	
2822BB00078	Borehole	-28.09896	22.95993	1000	1300			71		0.13
2822BB00156	Borehole	-28.09886	22.99843	100	1330	09/22/1994 9:35	37.18	37.18		
2822BB00074	Dug Well	-28.09757	22.96882	1000	1360	09/06/1973 8:00	16.90			
2822BB00073	Dug Well	-28.09618	22.97993	1000	1310	06/09/1973 8:00	13.10			
2822BB00196	Borehole	-28.09306	22.89353	100	1310			24.3		
2822BB00201	Borehole	-28.09306	22.89353	100	1310	08/16/1994 8:00	12.71	12.71		
2822BB00200	Borehole	-28.09171	22.88881	100	1300					
2822BB00199	Borehole	-28.09167	22.88742	100	1300	08/16/1994 8:00	16.04	42.6		7.57
2822BB00136	Borehole	-28.09066	22.93373	100	1330	09/11/1994 10:30	27.16	27.43		
2822BB00176	Borehole	-28.09000	22.76772	100	1360	08/23/1994 8:00	85.30	137.16	121.9	0.75
2822BB00098	Borehole	-28.08507	22.89381	1000	1310	10/21/1991 8:00	18.00	54	18	4.00
2822BB00071	Borehole	-28.08507	22.97354	1000	1310			56		1.26
2822BB00001	Borehole	-28.08368	22.89937		1320	12/13/1985 8:00	21.00	53	37	3.00
2822BB00070	Borehole	-28.08368	22.97521	1000	1310			37		1.26
2822BB00076	Borehole	-28.08285	22.94520	1000	1340			74		0.63
2822BB00075	Borehole	-28.08230	22.95409		1320			40	24	

2822BB00072	Borehole	-28.08230	22.97798		1310			71	35	0.95
2822BB00202	Borehole	-28.08084	22.89909	100	1320	08/16/1994 8:00	16.31	16.31		
2822BB00175	Borehole	-28.07917	22.76355	100	1400	08/23/1994 8:00	59.86	121.9	76.2	1.26
2822BB00174	Borehole	-28.07785	22.78631	100	1370	08/23/1994 8:00	83.30	121.9	115.8	0.00
2822BB00055	Borehole	-28.07760	22.78270		1420			144		
2822BB00051	Borehole	-28.07758	22.78270		1420	07/30/1942 8:00	36.58	60.96	56.08	0.20
2822BB00052	Borehole	-28.07758	22.78270		1420	09/30/1954 8:00	78.64	152.7	93.57	0.10
2822BB00053	Borehole	-28.07758	22.78270		1420	08/17/1921 8:00	27.43	63.4	45.72	0.05
2822BB00054	Borehole	-28.07758	22.78270		1420	12/17/1936 8:00	55.47	91.44	55.47	0.03
2822BB00173	Borehole	-28.07702	22.78687	100	150	08/23/1994 8:00	67.09	152.4	137.16	0.63
2822BB00157	Borehole	-28.07649	22.99727		1330	09/22/1994 10:00	57.32	57.32		
2822BB00172	Borehole	-28.07591	22.78937	100	1340	08/23/1994 8:00	64.50	137.16	70.1	2.02
2822BB00077	Borehole	-28.07508	22.98520	1000	1330			56		
2822BB00204	Borehole	-28.07251	22.92104	100	1340					
2822BB00203	Borehole	-28.06807	22.89909	100	1340	08/16/1994 8:00	27.88	27.88		
2822BB00155	Borehole	-28.06740	22.82211	100	1290	09/06/1994 12:30	30.55	30.55		
2822BB00062	Borehole	-28.06702	22.84937		1260	02/10/1971 8:00	45.72	79.86	46.94	7.95
2822BB00063	Borehole	-28.06702	22.84937		1260	07/30/1955 8:00	18.29	28.96	18.29	0.38
2822BB00064	Borehole	-28.06702	22.84937		1260			43.89	28.35	3.79
2822BB00065	Borehole	-28.06702	22.84937		1260	07/30/1955 8:00	49.07	123.29	74.98	0.36
2822BB00066	Borehole	-28.06702	22.84939		1260			122.22		
2822BB00153	Borehole	-28.05756	22.86297	100	1280	09/06/1994 12:00	26.68	50		
2822BB00151	Borehole	-28.05687	22.86815	100	1290	09/06/1994 11:15	16.65	35		
2822BB00091	Borehole	-28.05662	22.98258		1300					
2822BB00090	Borehole	-28.05639	22.98365		1300					
2822BB00152	Borehole	-28.05576	22.86545	100	1280	09/06/1994 11:30	27.14	50		3.78
2822BB00150	Borehole	-28.05504	22.86724	100	1290	09/06/1994 11:00	22.10	35		2.52
2822BB00007	Borehole	-28.05454	22.88520		1320			85		
2822BB00003	Borehole	-28.05452	22.88520		1320	02/19/1942 8:00	23.62	35.81	24.38	1.26
2822BB00004	Borehole	-28.05452	22.88520		1320	04/14/1942 8:00	26.21	42.06	39.01	2.30
2822BB00005	Borehole	-28.05452	22.88520		1320	09/15/1977 8:00	8.00	45	15	
2822BB00006	Borehole	-28.05452	22.88520		1320	09/15/1977 8:00	20.00	75	24	0.15
2822BB00008	Borehole	-28.05452	22.88523		1320			70		
2822BB00135	Borehole	-28.05167	22.88631	100	1320	08/15/1994 8:00	13.15	13.15		
2822BB00089	Borehole	-28.05093	22.98696		1300					
2822BB00134	Borehole	-28.05028	22.88631	100	1310	08/15/1994 8:00	10.18	10.18		
2822BB00133	Borehole	-28.04949	22.88409	100	1310	08/15/1994 8:00	10.01	10.01		
2822BB00132	Borehole	-28.04948	22.88409	100	1310	08/15/1994 8:00	9.57	9.57		
2822BB00131	Borehole	-28.04945	22.88409	100	1310	08/15/1994 8:00	9.68	9.68		
2822BB00154	Borehole	-28.04836	22.82089	100	1280	09/06/1994 12:15	63.75	63.75		
2822BB00088	Borehole	-28.04786	22.99631		1300					
2822BB00087	Borehole	-28.04588	22.99275		1300					
2822BB00086	Borehole	-28.04484	22.99367		1300					
2822BB00042	Borehole	-28.04340	22.96187	1000	1300			40	20	1.89
2822BB00095	Borehole	-28.04335	22.96219		1300					
2822BB00009	Borehole	-28.03368	22.93270		1320	09/09/1982 8:00	21.00	71	60	1.97
2822BB00010	Borehole	-28.03368	22.93271		1320			30		

2822BB00082	Borehole	-28.03232	22.88215	1000	1300			44		0.13
2822BB00080	Borehole	-28.03231	22.88215	1000	1300			50		0.13
2822BB00079	Borehole	-28.03230	22.88215	1000	1300			47		0.13
2822BB00081	Borehole	-28.03230	22.88216	1000	1300			47		0.13
2822BB00083	Borehole	-28.03230	22.88217	1000	1300			44		0.13
2822BB00014	Borehole	-28.03063	22.93409	1000	1310			93	37	0.50
2822BB00013	Dug Well	-28.03063	22.93548	1000	1310	09/01/1973 8:00	19.50			
2822BB00045	Borehole	-28.02952	22.97298	1000	1290			48		
2822BB00044	Borehole	-28.02952	22.98132	1000	1280			48		
2822BB00179	Borehole	-28.02911	22.93520	100	1310	08/12/1994 8:00	14.82	91.4		
2822BB00183	Borehole	-28.02911	22.93520	100	1310	08/12/1994 8:00	15.71	15.71		
2822BB00056	Borehole	-28.02896	22.88520		1300	01/03/1928 8:00	33.53	77.42	73.76	0.47
2822BB00057	Dug Well	-28.02896	22.88521	1000	1300	09/05/1973 8:00	7.90			
2822BB00164	Borehole	-28.02890	22.88243	100	1290					
2822BB00185	Borehole	-28.02785	22.78687	100	1280	08/11/1994 8:00	57.20	121.9		
2822BB00184	Borehole	-28.02785	22.78937	100	1280	08/11/1994 8:00	43.09	121.9		0.12
2822BB00167	Borehole	-28.02727	22.88243	100	1290	08/12/1994 8:00	21.81	21.81		
2822BB00166	Borehole	-28.02725	22.88243	100	1290					
2822BB00165	Borehole	-28.02723	22.88243	100	1290					
2822BB00168	Borehole	-28.02720	22.88520	100	1290	08/12/1994 8:00	9.74	9.74		
2822BB00084	Borehole	-28.02535	22.86882	1000	1260			50		0.63
2822BB00085	Borehole	-28.02341	22.83798	1000	1250	09/05/1973 8:00	24.40	50		0.63
2822BB00170	Borehole	-28.02195	22.85827	100	1260	08/12/1994 8:00	28.59	28.59		
2822BB00169	Borehole	-28.02195	22.86966	100	1270					
2822BB00171	Borehole	-28.02057	22.83882	100	1240	08/12/1994 8:00	16.81	16.81		
2822BB00015	Borehole	-28.01980	22.90798		1300			50	30	0.13
2822BB00017	Borehole	-28.01980	22.90854	1000	1300			101		
2822BB00096	Borehole	-28.01935	22.98574		1280					
2822BB00186	Borehole	-28.01841	22.78631	100	1260	08/11/1994 8:00	11.64	11.64		
2822BB00177	Borehole	-28.01828	22.90798	100	1290	08/12/1994 8:00	30.48	40.2		
2822BB00040	Borehole	-28.01711	22.95798		1280			40		
2822BB00038	Dug Well	-28.01710	22.95798	1000	1290	09/05/1973 8:00	18.60			
2822BB00036	Borehole	-28.01709	22.95798	1000	1280			33		0.25
2822BB00034	Borehole	-28.01708	22.95798	1000	1280			30		
2822BB00030	Borehole	-28.01706	22.95798	1000	1290			37		
2822BB00026	Borehole	-28.01705	22.95798		1280			114		
2822BB00024	Borehole	-28.01704	22.95798		1280			72		
2822BB00022	Borehole	-28.01703	22.95798		1280			73		
2822BB00019	Borehole	-28.01702	22.75687		1300	12/18/1954 8:00	56.08	127	96.93	0.56
2822BB00058	Borehole	-28.01702	22.81604		1260			90	63.5	1.20
2822BB00011	Borehole	-28.01702	22.93132		1300	08/28/1945 8:00	18.29	35.36	32.92	0.40
2822BB00012	Borehole	-28.01702	22.93132		1300			31	20	0.05
2822BB00018	Borehole	-28.01702	22.93132	1000	1300			98	22	0.96
2822BB00028	Borehole	-28.01702	22.94798	1000	1300			86	27	
2822BB00020	Borehole	-28.01702	22.95798		1280			32		
2822BB00023	Borehole	-28.01702	22.95798		1280	06/09/1982 8:00	21.00	33	22	2.56
2822BB00027	Borehole	-28.01702	22.95798		1280	09/22/1986 8:00	23.00	84	63	0.06

2822BB00032	Borehole	-28.01702	22.95798	1000	1290	09/05/1973 8:00	18.30	42	23	0.51
2822BB00035	Borehole	-28.01702	22.95798	1000	1280			40	17	1.89
2822BB00037	Borehole	-28.01702	22.95798	1000	1280			37	26	0.10
2822BB00041	Borehole	-28.01702	22.95798		1270			37	18	2.53
2822BB00043	Dug Well	-28.01702	22.95798		1280					
2822BB00021	Borehole	-28.01702	22.95799		1280			27		
2822BB00025	Borehole	-28.01702	22.95801		1280			114		
2822BB00031	Borehole	-28.01702	22.95803	1000	1290			33		
2822BB00033	Borehole	-28.01702	22.95804	1000	1290			25		
2822BB00039	Borehole	-28.01702	22.95807	1000	1280			26		
2822BB00094	Borehole	-28.01677	22.94985		1300					
2822BB00093	Borehole	-28.01672	22.95737		1280					
2822BB00092	Borehole	-28.01668	22.95737		1280					
2822BB00178	Borehole	-28.01661	22.90826	100	1290			91.4		
2822BB00016	Dug Well	-28.01563	22.92854	1000	1300	09/01/1973 8:00	21.00			
2822BB00182	Borehole	-28.01442	22.92993	100	1300	08/12/1994 8:00	16.21	35.35	21.3	
2822BB00180	Borehole	-28.01438	22.92993	100	1300	08/12/1994 8:00	20.18	20.18		
2822BB00181	Borehole	-28.01438	22.92993	100	1300	08/12/1994 8:00	19.56	21.3		
2822BB00029	Borehole	-28.01341	22.95076	1000	1300			86	31	0.13
2822BB00162	Borehole	-28.01245	22.88520	100	1270	08/11/1994 8:00	15.94	15.94	14.6	5.05
2822BB00161	Borehole	-28.01244	22.88520	100	1270					
2822BB00103	Borehole	-28.01086	22.90029	100	1280	09/13/1994 14:15	13.10	30.48		
2822BB00159	Borehole	-28.00970	22.88520	100	1270	08/11/1994 8:00	23.40	23.4		4.16
2822BB00158	Borehole	-28.00966	22.88520	100	1270	08/11/1994 8:00	24.06	34.1	24.3	
2822BB00160	Borehole	-28.00961	22.88520	100	1270	08/11/1994 8:00	23.73	23.73		
2822BB00163	Borehole	-28.00938	22.88270	100	1270	08/11/1994 8:00	26.37	26.37		
2822BB00104	Borehole	-28.00587	22.89702	100	1280	09/13/1994 14:30	13.14	36.5	18.28	
2822BB00105	Borehole	-28.00126	22.89689	100	1260			30.48		
2822BB00228	Borehole	-28.24951	22.86298		1220	04/24/1996 8:00	24.00	42	24	1.11
2822BB00122	Dug Well	-28.24904	22.85774		1230	03/16/2006 13:15	7.42			
2822BB00128	Borehole	-28.24843	22.90428		1260	03/16/2006 13:15	30.51			
2822BB00127	Borehole	-28.24841	22.90424		1260	03/16/2006 14:00	31.00	74.7		
2822BB00048	Borehole	-28.24840	22.85909		1220			42.37		
2822BB00049	Borehole	-28.24840	22.85909		1220	10/07/1968 8:00	39.62	110.64	71.32	0.36
G00108NC	Borehole	-28.24602	22.85987	10	1230	05/31/2004 12:00	6.97	150		
2822BB00219	Borehole	-28.24229	22.78548		1310	11/29/1994 15:25	49.00	49		
2822BB00124	Dug Well	-28.23979	22.87047		1230	03/16/2006 13:15	6.62			
2822BB00125	Borehole	-28.23950	22.87232		1220					
2822BB00230	Borehole	-28.23924	22.82482	100	1252					
2822BB00101	Borehole	-28.23901	22.96777	100	1290	09/20/1994 15:40	10.00	46.9		
2822BB00126	Borehole	-28.23839	22.82540		1240					
2822BB00102	Borehole	-28.23764	22.91795		1300	09/20/1994 16:00	54.00	85.3		
2822BB00220	Borehole	-28.23710	22.78650		1300	03/14/2006 15:15	68.70	75		
2822BB00059	Borehole	-28.23368	22.78853		1300	05/19/1954 8:00	67.06	125.58	68.88	0.05
2822BB00060	Borehole	-28.23368	22.78853		1300	07/14/1954 8:00	68.88	85.65	81.08	0.43
2822BB00061	Borehole	-28.23368	22.78853		1300	07/29/1954 8:00	50.29	55.78	50.29	0.36
2822BB00224	Borehole	-28.23316	22.78854		1310	03/14/2006 12:30	43.85	50.47		

2822BB00221	Borehole	-28.23146	22.78687		1310			95		
2822BB00213	Borehole	-28.22285	22.89270		1240	06/08/2004 12:00	19.90	41	20	3.78
2822BB00121	Borehole	-28.21885	22.96920	100	1290	09/21/1994 8:55	10.95	10.95		
2822BB00223	Borehole	-28.21869	22.75631		1300	06/08/2004 12:00	71.41	75		
2822BB00225	Borehole	-28.21841	22.75243		1300	11/30/1994 16:55	83.45	83.45		
2822BB00002	Borehole	-28.21702	22.98270		1300	05/04/1976 8:00	54.00	120	72	0.64
2822BB00222	Borehole	-28.21646	22.80270		1340	06/08/2004 12:00	79.22	130	108	0.05
2822BB00226	Borehole	-28.21452	22.75131		1300	11/30/1994 17:05	84.55	128		
2822BB00215	Borehole	-28.21396	22.88132		1240	06/08/2004 12:00	8.78	18.28		
2822BB00067	Borehole	-28.21341	22.96243		1280			96		
2822BB00068	Borehole	-28.21341	22.96244		1280			72.18		
2822BB00117	Borehole	-28.21185	22.96181	100	1280	09/21/1994 8:45	9.17	30	25	
2822BB00119	Borehole	-28.21125	22.96268	100	1280	09/21/1994 9:50	7.06	7.06		
2822BB00120	Borehole	-28.21053	22.96256	100	1280	09/21/1994 9:40	7.59	7.59		
2822BB00214	Borehole	-28.20507	22.87993		1240	06/08/2004 12:00	10.90	30.48		
2822BB00216	Borehole	-28.20368	22.91548		1260			48.76		
2822BB00118	Borehole	-28.20092	22.95786	100	1270	09/21/1994 9:15	11.22	11.22		
2822BB00217	Borehole	-28.19729	22.92882		1260	06/08/2004 12:00	26.60	30	15	1.38
2822BB00212	Borehole	-28.19479	22.89687		1250	06/08/2004 12:00	13.75	39.62		
2822BB00211	Borehole	-28.18812	22.89048		1250	12/08/1994 12:15	13.82	39.62		
2822BB00097	Borehole	-28.17535	22.77215	1000	1280			90		
2822BB00142	Dug Well	-28.16919	22.86316	100	1260	06/08/2004 12:00	12.37		10.6	
2822BB00144	Borehole	-28.16802	22.87204	100	1250	08/01/2003 12:00	9.76	36.57	18.28	
2822BB00046	Borehole	-28.16702	22.86270		1260	12/19/1969 8:00	54.86	107.59	67.06	0.58
2822BB00047	Borehole	-28.16702	22.86270		1260	11/25/1969 8:00	55.78	109.73	51.82	0.33
2822BB00143	Borehole	-28.16679	22.87284	100	1250	06/08/2004 12:00	10.62	24.38	12.1	0.0002
2822BB00147	Borehole	-28.16542	22.81996	100	1300	09/07/1994 8:00	40.06	91.4	73.15	
2822BB00148	Borehole	-28.16390	22.80165	100	1340	09/07/1994 8:00	43.34	106.68	91.44	
2822BB00146	Borehole	-28.16193	22.86340	100	1260	09/07/1994 8:00	4.57	24.38	4.57	
2822BB00218	Borehole	-28.16140	22.76966		1320	11/29/1994 13:00	76.34	100		
2822BB00114	Borehole	-28.15953	22.97483	100	1290	09/21/1994 10:45	10.93	35		
2822BB00050	Borehole	-28.15952	22.90215		1280			90		
2822BB00113	Borehole	-28.15604	22.97150	100	1300	09/21/1994 10:30	18.34	75	70	
2822BB00149	Dug Well	-28.15550	22.85629	100	1260	06/08/2004 12:00	13.14		11.58	
2822BB00069	Borehole	-28.15341	22.91910	1000	1280			50		
2822BB00227	Borehole	-28.15140	22.76438	100	1290	11/29/1994 13:15	58.27	73		
2822BB00209	Borehole	-28.14810	22.86021	100	1260	08/17/1994 8:00	8.62	42.6	15.2	9.47
2822BB00208	Borehole	-28.14806	22.86188	100	1260			42.6	15.2	9.47
2822BB00210	Borehole	-28.14667	22.86188	100	1260	08/17/1994 8:00	9.40	45.7	15.2	6.31
2822BB00145	Borehole	-28.14660	22.83163	100	1290			91.4	70.1	
2822BB00100	Borehole	-28.14640	22.75077	100	1270	09/08/1994 10:20	53.80	60.9		
2822BB00115	Borehole	-28.14471	22.98306	100	1300	09/21/1994 10:55	12.09	21.33		
2822BB00206	Borehole	-28.14365	22.85549	100	1260	08/17/1994 8:00	9.42	60.9	15.2	
2822BB00205	Dug Well	-28.14361	22.85549	100	1260				12.19	
2822BB00207	Borehole	-28.13584	22.87438	100	1270	08/17/1994 8:00	16.58	42.6	15.2	
2822BB00116	Borehole	-28.13396	22.98446	100	1300	09/21/1994 11:05	28.68	50		
2822BB00138	Borehole	-28.13225	22.90355	100	1280	09/11/1994 10:00	13.42	13.42		

2822BB00106	Dug Well	-28.12796	22.98734		1300	09/13/1994 10:30	14.33		12.19	
2822BB00112	Dug Well	-28.12790	22.96194	100	1300	09/21/1994 11:35	14.04			
2822BB00189	Borehole	-28.12779	22.78577	100	1300	08/22/1994 8:00	41.80	6.5		
2822BB00109	Dug Well	-28.12674	22.98915		1300	09/13/1994 10:45	13.37		12.19	
2822BB00139	Borehole	-28.12591	22.89090	100	1290	09/11/1994 10:15	18.11	18.11		
2822BB00108	Dug Well	-28.12525	22.98973		1300	09/13/1994 10:50	15.34			
2822BB00129	Borehole	-28.12401	22.93677		1300	09/11/1994 10:00	5.87	12.19	6.09	
2822BB00137	Borehole	-28.12365	22.96075	100	1280	09/11/1994 10:45	11.90	45.7		
2822BB00194	Borehole	-28.12313	22.85770	100	1290	08/15/1994 8:00	12.19	31		
2822BB00141	Borehole	-28.12158	22.93516	100	1290	09/11/1994 11:00	17.84	17.84		
2822BB00107	Borehole	-28.12121	22.98623		1300	09/13/1994 11:15	12.84	30.48		
2822BB00111	Borehole	-28.12029	22.99024	100	1300	09/13/1994 11:25	15.13	15.13		
2822BB00099	Borehole	-28.11807	22.77716	100	1300	09/08/1994 11:30	56.86	100	76.2	
2822BB00187	Borehole	-28.11695	22.82633	100	1300	08/22/1994 8:00	46.39	106.68		0.22
2822BB00130	Borehole	-28.11652	22.94556	100	1280					
2822BB00188	Borehole	-28.11334	22.82855	100	1290	08/22/1994 8:00	32.71	67	36.5	6.31
2822BB00110	Borehole	-28.11136	22.96692		1300	09/13/1994 12:00	12.33	33.52		1.01
2822BB00191	Borehole	-28.11035	22.87104	100	1290	08/15/1994 8:00	17.37	94.4		
2822BB00140	Borehole	-28.10835	22.90897	100	1300	09/11/1994 10:30	16.97	38		
2822BB00195	Borehole	-28.10785	22.87687	100	1300	08/15/1994 8:00	17.00	18.2		0.63
2822BB00190	Borehole	-28.10785	22.87854	100	1300	08/15/1994 8:00	17.98	31	18.2	
2822BB00192	Borehole	-28.10674	22.87687	100	1300	08/15/1994 8:00	21.30	92		
2822BB00198	Borehole	-28.10338	22.89048	100	1310			45.7		
2822BB00197	Borehole	-28.10334	22.89270	100	1310			45.7		
2822BB00193	Borehole	-28.10146	22.85298	100	1280	08/15/1994 8:00	32.00	78.3	32	
2822BB00078	Borehole	-28.09896	22.95993	1000	1300			71		0.13
2822BB00156	Borehole	-28.09886	22.99843	100	1330	09/22/1994 9:35	37.18	37.18		
2822BB00074	Dug Well	-28.09757	22.96882	1000	1360	09/06/1973 8:00	16.90			
2822BB00073	Dug Well	-28.09618	22.97993	1000	1310	06/09/1973 8:00	13.10			
2822BB00196	Borehole	-28.09306	22.89353	100	1310			24.3		
2822BB00201	Borehole	-28.09306	22.89353	100	1310	08/16/1994 8:00	12.71	12.71		
2822BB00200	Borehole	-28.09171	22.88881	100	1300					
2822BB00199	Borehole	-28.09167	22.88742	100	1300	08/16/1994 8:00	16.04	42.6		7.57
2822BB00136	Borehole	-28.09066	22.93373	100	1330	09/11/1994 10:30	27.16	27.43		
2822BB00176	Borehole	-28.09000	22.76772	100	1360	08/23/1994 8:00	85.30	137.16	121.9	0.75
2822BB00098	Borehole	-28.08507	22.89381	1000	1310	10/21/1991 8:00	18.00	54	18	4
2822BB00071	Borehole	-28.08507	22.97354	1000	1310			56		1.26
2822BB00001	Borehole	-28.08368	22.89937		1320	12/13/1985 8:00	21.00	53	37	3
2822BB00070	Borehole	-28.08368	22.97521	1000	1310			37		1.26
2822BB00076	Borehole	-28.08285	22.94520	1000	1340			74		0.63
2822BB00075	Borehole	-28.08230	22.95409		1320			40	24	
2822BB00072	Borehole	-28.08230	22.97798		1310			71	35	0.95
2822BB00202	Borehole	-28.08084	22.89909	100	1320	08/16/1994 8:00	16.31	16.31		
2822BB00175	Borehole	-28.07917	22.76355	100	1400	08/23/1994 8:00	59.86	121.9	76.2	1.26
2822BB00174	Borehole	-28.07785	22.78631	100	1370	08/23/1994 8:00	83.30	121.9	115.8	0.0003
2822BB00055	Borehole	-28.07760	22.78270		1420			144		
2822BB00051	Borehole	-28.07758	22.78270		1420	07/30/1942 8:00	36.58	60.96	56.08	0.2001

2822BB00052	Borehole	-28.07758	22.78270		1420	09/30/1954 8:00	78.64	152.7	93.57	0.1001
2822BB00053	Borehole	-28.07758	22.78270		1420	08/17/1921 8:00	27.43	63.4	45.72	0.05
2822BB00054	Borehole	-28.07758	22.78270		1420	12/17/1936 8:00	55.47	91.44	55.47	0.03
2822BB00173	Borehole	-28.07702	22.78687	100	150	08/23/1994 8:00	67.09	152.4	137.16	0.63
2822BB00157	Borehole	-28.07649	22.99727		1330	09/22/1994 10:00	57.32	57.32		
2822BB00172	Borehole	-28.07591	22.78937	100	1340	08/23/1994 8:00	64.50	137.16	70.1	2.02
2822BB00077	Borehole	-28.07508	22.98520	1000	1330			56		
2822BB00204	Borehole	-28.07251	22.92104	100	1340					
2822BB00203	Borehole	-28.06807	22.89909	100	1340	08/16/1994 8:00	27.88	27.88		
2822BB00155	Borehole	-28.06740	22.82211	100	1290	09/06/1994 12:30	30.55	30.55		
2822BB00062	Borehole	-28.06702	22.84937		1260	02/10/1971 8:00	45.72	79.86	46.94	7.95
2822BB00063	Borehole	-28.06702	22.84937		1260	07/30/1955 8:00	18.29	28.96	18.29	0.38
2822BB00064	Borehole	-28.06702	22.84937		1260			43.89	28.35	3.79
2822BB00065	Borehole	-28.06702	22.84937		1260	07/30/1955 8:00	49.07	123.29	74.98	0.36
2822BB00066	Borehole	-28.06702	22.84939		1260			122.22		
2822BB00153	Borehole	-28.05756	22.86297	100	1280	09/06/1994 12:00	26.68	50		
2822BB00151	Borehole	-28.05687	22.86815	100	1290	09/06/1994 11:15	16.65	35		
2822BB00091	Borehole	-28.05662	22.98258		1300					
2822BB00090	Borehole	-28.05639	22.98365		1300					
2822BB00152	Borehole	-28.05576	22.86545	100	1280	09/06/1994 11:30	27.14	50		3.78
2822BB00150	Borehole	-28.05504	22.86724	100	1290	09/06/1994 11:00	22.10	35		2.52
2822BB00007	Borehole	-28.05454	22.88520		1320			85		
2822BB00003	Borehole	-28.05452	22.88520		1320	02/19/1942 8:00	23.62	35.81	24.38	1.26
2822BB00004	Borehole	-28.05452	22.88520		1320	04/14/1942 8:00	26.21	42.06	39.01	2.3001
2822BB00005	Borehole	-28.05452	22.88520		1320	09/15/1977 8:00	8.00	45	15	
2822BB00006	Borehole	-28.05452	22.88520		1320	09/15/1977 8:00	20.00	75	24	0.15
2822BB00008	Borehole	-28.05452	22.88523		1320			70		
2822BB00135	Borehole	-28.05167	22.88631	100	1320	08/15/1994 8:00	13.15	13.15		
2822BB00089	Borehole	-28.05093	22.98696		1300					
2822BB00134	Borehole	-28.05028	22.88631	100	1310	08/15/1994 8:00	10.18	10.18		
2822BB00133	Borehole	-28.04949	22.88409	100	1310	08/15/1994 8:00	10.01	10.01		
2822BB00132	Borehole	-28.04948	22.88409	100	1310	08/15/1994 8:00	9.57	9.57		
2822BB00131	Borehole	-28.04945	22.88409	100	1310	08/15/1994 8:00	9.68	9.68		
2822BB00154	Borehole	-28.04836	22.82089	100	1280	09/06/1994 12:15	63.75	63.75		
2822BB00088	Borehole	-28.04786	22.99631		1300					
2822BB00087	Borehole	-28.04588	22.99275		1300					
2822BB00086	Borehole	-28.04484	22.99367		1300					
2822BB00042	Borehole	-28.04340	22.96187	1000	1300			40	20	1.89
2822BB00095	Borehole	-28.04335	22.96219		1300					
2822BB00009	Borehole	-28.03368	22.93270		1320	09/09/1982 8:00	21.00	71	60	1.97
2822BB00010	Borehole	-28.03368	22.93271		1320			30		
2822BB00082	Borehole	-28.03232	22.88215	1000	1300			44		0.13
2822BB00080	Borehole	-28.03231	22.88215	1000	1300			50		0.13
2822BB00079	Borehole	-28.03230	22.88215	1000	1300			47		0.13
2822BB00081	Borehole	-28.03230	22.88216	1000	1300			47		0.13
2822BB00083	Borehole	-28.03230	22.88217	1000	1300			44		0.13
2822BB00014	Borehole	-28.03063	22.93409	1000	1310			93	37	0.5001

2822BB00013	Dug Well	-28.03063	22.93548	1000	1310	09/01/1973 8:00	19.50			
2822BB00045	Borehole	-28.02952	22.97298	1000	1290			48		
2822BB00044	Borehole	-28.02952	22.98132	1000	1280			48		
2822BB00179	Borehole	-28.02911	22.93520	100	1310	08/12/1994 8:00	14.82	91.4		
2822BB00183	Borehole	-28.02911	22.93520	100	1310	08/12/1994 8:00	15.71	15.71		
2822BB00056	Borehole	-28.02896	22.88520		1300	01/03/1928 8:00	33.53	77.42	73.76	0.47
2822BB00057	Dug Well	-28.02896	22.88521	1000	1300	09/05/1973 8:00	7.90			
2822BB00164	Borehole	-28.02890	22.88243	100	1290					
2822BB00185	Borehole	-28.02785	22.78687	100	1280	08/11/1994 8:00	57.20	121.9		
2822BB00184	Borehole	-28.02785	22.78937	100	1280	08/11/1994 8:00	43.09	121.9		0.12
2822BB00167	Borehole	-28.02727	22.88243	100	1290	08/12/1994 8:00	21.81	21.81		
2822BB00166	Borehole	-28.02725	22.88243	100	1290					
2822BB00165	Borehole	-28.02723	22.88243	100	1290					
2822BB00168	Borehole	-28.02720	22.88520	100	1290	08/12/1994 8:00	9.74	9.74		
2822BB00084	Borehole	-28.02535	22.86882	1000	1260			50		0.63
2822BB00085	Borehole	-28.02341	22.83798	1000	1250	09/05/1973 8:00	24.40	50		0.63
2822BB00170	Borehole	-28.02195	22.85827	100	1260	08/12/1994 8:00	28.59	28.59		
2822BB00169	Borehole	-28.02195	22.86966	100	1270					
2822BB00171	Borehole	-28.02057	22.83882	100	1240	08/12/1994 8:00	16.81	16.81		
2822BB00015	Borehole	-28.01980	22.90798		1300			50	30	0.13
2822BB00017	Borehole	-28.01980	22.90854	1000	1300			101		
2822BB00096	Borehole	-28.01935	22.98574		1280					
2822BB00186	Borehole	-28.01841	22.78631	100	1260	08/11/1994 8:00	11.64	11.64		
2822BB00177	Borehole	-28.01828	22.90798	100	1290	08/12/1994 8:00	30.48	40.2		
2822BB00040	Borehole	-28.01711	22.95798		1280			40		
2822BB00038	Dug Well	-28.01710	22.95798	1000	1290	09/05/1973 8:00	18.60			
2822BB00036	Borehole	-28.01709	22.95798	1000	1280			33		0.25
2822BB00034	Borehole	-28.01708	22.95798	1000	1280			30		
2822BB00030	Borehole	-28.01706	22.95798	1000	1290			37		
2822BB00026	Borehole	-28.01705	22.95798		1280			114		
2822BB00024	Borehole	-28.01704	22.95798		1280			72		
2822BB00022	Borehole	-28.01703	22.95798		1280			73		
2822BB00019	Borehole	-28.01702	22.75687		1300	12/18/1954 8:00	56.08	127	96.93	0.56
2822BB00058	Borehole	-28.01702	22.81604		1260			90	63.5	1.2
2822BB00011	Borehole	-28.01702	22.93132		1300	08/28/1945 8:00	18.29	35.36	32.92	0.4001
2822BB00012	Borehole	-28.01702	22.93132		1300			31	20	0.05
2822BB00018	Borehole	-28.01702	22.93132	1000	1300			98	22	0.96
2822BB00028	Borehole	-28.01702	22.94798	1000	1300			86	27	
2822BB00020	Borehole	-28.01702	22.95798		1280			32		
2822BB00023	Borehole	-28.01702	22.95798		1280	06/09/1982 8:00	21.00	33	22	2.56
2822BB00027	Borehole	-28.01702	22.95798		1280	09/22/1986 8:00	23.00	84	63	0.06
2822BB00032	Borehole	-28.01702	22.95798	1000	1290	09/05/1973 8:00	18.30	42	23	0.51
2822BB00035	Borehole	-28.01702	22.95798	1000	1280			40	17	1.89
2822BB00037	Borehole	-28.01702	22.95798	1000	1280			37	26	0.1001
2822BB00041	Borehole	-28.01702	22.95798		1270			37	18	2.53
2822BB00043	Dug Well	-28.01702	22.95798		1280					
2822BB00021	Borehole	-28.01702	22.95799		1280			27		

2822BB00025	Borehole	-28.01702	22.95801		1280			114		
2822BB00031	Borehole	-28.01702	22.95803	1000	1290			33		
2822BB00033	Borehole	-28.01702	22.95804	1000	1290			25		
2822BB00039	Borehole	-28.01702	22.95807	1000	1280			26		
2822BB00094	Borehole	-28.01677	22.94985		1300					
2822BB00093	Borehole	-28.01672	22.95737		1280					
2822BB00092	Borehole	-28.01668	22.95737		1280					
2822BB00178	Borehole	-28.01661	22.90826	100	1290			91.4		
2822BB00016	Dug Well	-28.01563	22.92854	1000	1300	09/01/1973 8:00	21.00			
2822BB00182	Borehole	-28.01442	22.92993	100	1300	08/12/1994 8:00	16.21	35.35	21.3	
2822BB00180	Borehole	-28.01438	22.92993	100	1300	08/12/1994 8:00	20.18	20.18		
2822BB00181	Borehole	-28.01438	22.92993	100	1300	08/12/1994 8:00	19.56	21.3		
2822BB00029	Borehole	-28.01341	22.95076	1000	1300			86	31	0.13
2822BB00162	Borehole	-28.01245	22.88520	100	1270	08/11/1994 8:00	15.94	15.94	14.6	5.05
2822BB00161	Borehole	-28.01244	22.88520	100	1270					
2822BB00103	Borehole	-28.01086	22.90029	100	1280	09/13/1994 14:15	13.10	30.48		
2822BB00159	Borehole	-28.00970	22.88520	100	1270	08/11/1994 8:00	23.40	23.4		4.16
2822BB00158	Borehole	-28.00966	22.88520	100	1270	08/11/1994 8:00	24.06	34.1	24.3	
2822BB00160	Borehole	-28.00961	22.88520	100	1270	08/11/1994 8:00	23.73	23.73		
2822BB00163	Borehole	-28.00938	22.88270	100	1270	08/11/1994 8:00	26.37	26.37		
2822BB00104	Borehole	-28.00587	22.89702	100	1280	09/13/1994 14:30	13.14	36.5	18.28	
2822BB00105	Borehole	-28.00126	22.89689	100	1260			30.48		
						Mean	**27.53**	**59.65**	**44.38**	**1.71**
						Median	**20.00**	**47.78**	**32.46**	**0.63**

APPENDIX 2: Lomoteng Hydrocensus Data

Bh No	Coordinates	Use	Description	Photo
01	23°1'26.174"E 28°2'53.649"S	Mine's main water supply	Locality: Lomoteng 669/1 Depth: 84m Water Level: 36m Comments: Submersible with generator	
02	23°1'26.161"E 28°1'57.101"S	None	Locality: Miniraal 669/2 Depth: 90m Water Level: 27m Comments: No pump	
03	23°1'28.284"E 28°1'47.676"S	None	Locality: Miniraal 669/2 Depth: 90m Water Level: 24m Comments: No pump	
04	23°1'41.031"E 28°1'54.585"S	None	Locality: Miniraal 669/2 Depth: 114m Water Level: 5m Comments: No pump, Shed	
11	23°0'46.503"E 28°1'21.92"S	Domestic and stock watering	Locality: Miniraal 669/2 Depth: ? Water Level: 25m Comments: Submersible at kraal/homestead	
12	23°1'7.736"E 28°0'31.652"S	None	Locality: Miniraal 669/2 Depth: ? Water Level: ? Comments: Windpump, not in use	
13	23°1'3.512"E 28°3'0.564"S	Stock watering	Locality: Lomoteng 669/1 Depth: ? Water Level: ? Comments: Solar pump	

14	23°2'44.755"E 28°1'42.001"S	Stock watering	Locality: Lohatlha 673 Depth: ? Water Level: ? Comments: Mono pump with Lister engine	
15	23°3'22.847"E 28°3'44.297"S	Maremane Community's main water supply	Locality: Gloucester 674 Depth: ? Water Level: 12m Comments: Mono pump with Lister engine	
16	23°3'34.423"E 28°3'21.251"S	None	Locality: Gloucester 674 Depth: ? Water Level: Artesian Comments: No pump	
17	23°3'38.414"E 28°3'12.919"S	None	Locality: Gloucester 674 Depth: ? Water Level: 1m Comments: No pump	
18	23°2'49.649"E 28°2'31.82"S	Chambua's security	Locality: Lohatlha 673 Depth: ? Water Level: ? Comments: Submersible with generator	
19	23°2'56.51"E 28°2'23.032"S	None	Locality: Lohatlha 673 Depth: ? Water Level: 1.5m Comments: No pump	
20	23°2'58.351"E 28°2'22.167"S	None	Locality: Lohatlha 673 Depth: ? Water Level: 1.2m Comments: No pump	
21	23°2'58.74"E 28°2'22.136"S	None	Locality: Lohatlha 673 Depth: ? Water Level: 0.6m Comments: No pump	

APPENDIX 3: Lomoteng raw yield test data

Borehole testing and associated projects

Department of Water Affairs Minimum Standards and Guideline: FORM 5 E BOREHOLE TEST RECORD SHEET

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE NO:	1	CO-ORDINATES:		PROVINCE:	NORTHERN CAPE
ALT BH NO:	0	LATITUDE [S]:	28.04838	DISTRICT:	POSTMASBURG
		LONGITUDE [E]:	23.0239	SITE NAME:	LEMOTENG MINE
BOREHOLE DEPTH [mbgl]:	85.34	DATUM LEVEL ABOVE CASING (m):	0.88	EXISTING PUMP:	SUBMERSIBLE
WATER LEVEL [mbgl]:	36.07	CASING HEIGHT (magl):	0.16	CONTRACTOR:	WELLTEK SERVICES
DEPTH OF PUMP [m]:	63.00	DIAM OF CASING AT TOP (mm)	225	TEST PUMP TYPE:	GW 9002

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 — RPM — DATE: 10/09/2011 — TIME: 14H01

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	2.95		1	
2	4.27		2	
3	5.40	6.33	3	
5	6.72		5	
7	7.55		7	
10	8.27		10	
15	8.65	6.31	15	
20	8.99		20	
30	9.31		30	
40	9.77	6.34	40	
50	10.45		50	
60	10.90		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	

DISCHARGE RATE 2 — RPM — DATE: 10/09/2011 — TIME: 15H01

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	13.59		1	
2	15.03		2	
3	15.94	10.15	3	
5	16.54		5	
7	17.01		7	
10	17.34		10	
15	17.60	10.15	15	
20	17.73		20	
30	18.00		30	
40	18.02	10.17	40	
50	18.63		50	
60	18.97		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	

DISCHARGE RATE 3 — RPM — DATE: 10/09/2011 — TIME: 16H01

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	21.45		1	
2	23.32	15.07	2	
3	24.50		3	
4	24.50	14.21	5	
5	24.50	13.12	7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	

DISCHARGE RATE 4 — RPM — DATE: — TIME:

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	
			240	
			300	
			360	

DISCHARGE RATE 5 — RPM — DATE: — TIME:

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	
			240	
			300	
			360	

DISCHARGE RATE 6 — RPM — DATE: — TIME:

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	19.80
2			2	14.53
3			3	10.91
5			5	6.75
7			7	5.20
10			10	3.55
15			15	2.12
20			20	1.61
30			30	1.19
40			40	0.94
50			50	0.77
60			60	0.67
70			70	0.58
80			80	0.52
90			90	0.48
100			100	0.44
110			110	0.41
120			120	0.33
			150	0.30
			180	0.23
			210	0.18
			240	0.15
			300	
			360	

WAS SAND PUMPED ?	NO	WAS THE WATER CLEAN ?	YES
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST?	36.22		

Borehole testing and associated projects

Department of Water Affairs Minimum Standards and Guideline: FORM 5 F BOREHOLE TEST RECORD SHEET

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE NO: 1	CO-ORDINATES:	PROVINCE:	NORTHERN CAPE
	LATITUDE [S]: 28.04838	DISTRICT:	POSTMASBURG
ALT BH NO: 0	LONGITUDE [E]: 23.0239	SITE NAME:	LEMOTENG MINE

BOREHOLE DEPTH [mbgl]:	85.34	DATUM LEVEL ABOVE CASING (m):	0.88	EXISTING PUMP:	SUBMERSIBLE
WATER LEVEL [mbgl]:	36.07	CASING HEIGHT (magl):	0.16	CONTRACTOR:	WELLTEK SERVICES
DEPTH OF PUMP [m]:	63.00	DIAM OF CASING AT TOP (mm)	225	TEST PUMP TYPE:	GW 9002

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				TEST COMPLETED					
DATE:	11/09/2011	TIME:	08H17	DATE:	16/09/2011	TIME:	08H17	TYPE OF PUMP:	GW 9002

					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3		
					NR:			NR:			NR:		
DISCHARGE BOREHOLE					Distance:			Distance:			Distance:		
TIME	DRAWDOWN	YIELD	TIME	Recovery	TIME:	DRAWDOWN	Recovery	TIME:	DRAWDOWN	Recovery	TIME:	DRAWDOWN	Recovery
(MIN)	(M)	(L/S)	MIN	(m)	(min)	(M)	(m)	(min)	(M)		(min)	(M)	(m)
1	1.40	8.10	1	13.10	1			1			1		
2	4.43		2	10.36	2			2			2		
3	5.32	8.10	3	9.07	3			3			3		
5	6.91		5	7.85	5			5			5		
7	7.99	8.11	7	7.09	7			7			7		
10	9.13		10	6.54	10			10			10		
15	10.27	8.13	15	5.97	15			15			15		
20	10.80		20	5.63	20			20			20		
30	11.26	8.12	30	5.53	30			30			30		
40	11.56		40	5.35	40			40			40		
60	11.92	8.10	60	5.04	60			60			60		
90	12.13		90	4.74	90			90			90		
120	12.30	8.10	120	4.52	120			120			120		
150	12.35		150	4.45	150			150			150		
180	12.44	8.11	180	4.36	180			180			180		
210	12.53		210	4.35	210			210			210		
240	12.58	8.10	240	4.29	240			240			240		
300	12.66		300	4.24	300			300			300		
360	12.68	8.10	360	4.19	360			360			360		
420	12.69		420	4.13	420			420			420		
480	12.70	8.11	480	4.05	480			480			480		
540	12.84		540	3.95	540			540			540		
600	13.07	8.10	600	3.86	600			600			600		
720	13.50		720	3.72	720			720			720		
840	13.79	8.11	840	3.44	840			840			840		
960	13.80		960	3.02	960			960			960		
1080	13.82	8.10	1080	2.88	1080			1080			1080		
1200	13.85		1200	2.69	1200			1200			1200		
1320	13.89	8.13	1320	2.50	1320			1320			1320		
1440	13.95		1440	2.42	1440			1440			1440		
1560	14.04	8.12	1560	2.36	1560			1560			1560		
1680	14.07		1680	2.27	1680			1680			1680		
1800	14.10	8.11	1800	2.05	1800			1800			1800		
1920	14.20		1920	1.91	1920			1920			1920		
2040	14.31	8.13	2040	1.72	2040			2040			2040		
2160	14.86		2160	1.51	2160			2160			2160		
2280	15.40	8.11	2280	1.30	2280			2280			2280		
2400	15.60		2400	1.19	2400			2400			2400		
2520	15.64	8.10	2520	0.98	2520			2520			2520		
2640	15.66		2640	0.82	2640			2640			2640		
2760	15.69	8.12	2760	0.74	2760			2760			2760		
2880	15.72		2880	0.63	2880			2880			2880		
3000	15.78	8.11	3000		3000			3000			3000		
3120	15.85		300		3120			3120			3120		
3240	15.91	8.12	3240		3240			3240			3240		
3360	16.00		3360		3360			3360			3360		
3480	16.10	8.13	3480		3480			3480			3480		
3600	16.20		3600		3600			3600			3600		
3720	16.47	8.13	3720		3720			3720			3720		
3840	16.95		3840		3840			3840			3840		
3960	17.28	8.14	3960		3960			3960			3960		
4080	17.52		4080		4080			4080			4080		
4200	18.01	8.15	4200		4200			4200			4200		
4320	18.52		4320		4320			4320			4320		
Total time pumped(min):				4320		W/L			W/L				
Average yield (l/s):				8.12									

BOREHOLE NO:	BH 2	WATER LEVEL [mbdl]:	21.38	WATER DEPTH [mbgl]:	20.59	AVAILABLE DRAWDOWN [m]:	11.25

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE & TIME		04/28/2012 16:00			DATE & TIME		04/28/2012 17:00			DATE & TIME		04/28/2012 18:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	1.28		1		1	1.72		1		1	3.61		1	
2	1.30	0.21	2		2	1.87		2		2	4.17	0.93	2	
3	1.34		3		3	1.91	0.41	3		3	4.52		3	
5	1.36		5		5	2.18		5		5	5.20		5	
7	1.38		7		7	2.45		7		7	5.61		7	
10	1.41		10		10	2.86		10		10	5.94		10	
15	1.45		15		15	3.02		15		15	6.86		15	
20	1.54		20		20	3.02		20		20	7.15		20	
30	1.60		30		30	3.06		30		30	7.32		30	
40	1.64		40		40	3.09		40		40	7.34		40	
50	1.64		50		50	3.12		50		50	7.38		50	
60	1.66		60		60	3.13		60		60	7.40		60	
			70					70					70	
			80					80					80	
			90					90					90	
			100					100					100	
			110					110					110	
			120					120					120	
			150					150					150	
Average Yield (l/s):		0.21	180		Average Yield (l/s):		0.41	180		Average Yield (l/s):		0.93	180	
Drawdown (%):		14.76	210		Drawdown (%):		27.82	210		Drawdown (%):		65.78	210	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE & TIME		04/28/2012 19:00			DATE & TIME		04/28/2012 19:00			DATE & TIME		04/28/2012 19:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	8.77		1		1			1		1			1	6.55
2	9.66	1.11	2		2			2		2			2	4.78
3	10.43		3		3			3		3			3	3.91
5	11.08		5		5			5		5			5	2.55
7			7		7			7		7			7	1.73
10			10		10			10		10			10	1.27
15			15		15			15		15			15	0.90
20			20		20			20		20			20	0.71
30			30		30			30		30			30	0.57
40			40		40			40		40			40	0.46
50			50		50			50		50			50	0.41
60			60		60			60		60			60	0.37
			70					70					70	0.34
			80					80					80	0.31
			90					90					90	0.29
			100					100					100	0.28
			110					110					110	0.27
			120					120					120	0.26
			150					150					150	0.19
			180					180					180	0.13
			210					210					210	0.06
			240					240					240	0.02
Average Yield (l/s):		1.11	300		Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300	
Drawdown (%):		98.49	360		Drawdown (%):			360		Drawdown (%):			360	

DATUM LEVEL ABOVE GROUND [m]:	0.79	WAS SAND PUMPED ?	NO
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST [mbdl]:	21.38	WAS THE WATER CLEAN?	YES

STEPPED DRAWDOWN SUMMARY

STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]	STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]
1	60	1.66	14.76	0.21				5		0.00		0.00			
2	60	3.13	27.82	0.41				6		0.00		0.00			
3	60	7.40	65.78	0.93				7							
4	60	11.08	98.49	1.11				8							
DATE & TIME END:		04/28/2012 20:00						TOTAL:	240.00	11.08	98.49		0	0.00	0.00
COMMENTS:															

ESTABLISHMENT

ESTABLISHMENT DATE:	2012/04/28

SITE MOVE FROM:	BOREHOLE	VILLAGE	MOVE TO:	BOREHOLE	VILLAGE	DISTANCE BETWEEN BOREHOLES [km]	0.00
	0	0		BH 2	LEMOTENG MINE		

Borehole testing and associated projects

Department of Water Affairs Minimum Standards and Guideline: FORM 5 E BOREHOLE TEST RECORD SHEET

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE NO:	3	CO-ORDINATES:		PROVINCE:	NORTHERN CAPE
ALT BH NO:	0	LATITUDE [S]: 28.02999		DISTRICT:	POSTMASBURG
		LONGITUDE [E]: 23.02458		SITE NAME:	LEMOTENG MINE
BOREHOLE DEPTH [mbgl]:	121.07	DATUM LEVEL ABOVE CASING (m):	0.31	EXISTING PUMP:	NONE
WATER LEVEL [mbgl]:	22.90	CASING HEIGHT (magl):	0.37	CONTRACTOR:	WELLTEK SERVICES
DEPTH OF PUMP [m]:	80.00	DIAM OF CASING AT TOP (mm)	180	TEST PUMP TYPE:	GW 9002

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE: 17/09/2011		TIME: 13.17			DATE:		TIME:			DATE:		TIME:		
TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	4.45	1.09	1		1	10.93	2.31	1		1	41.52	3.16	1	
2	5.86		2		2	13.67		2		2	46.20		2	
3	6.92		3		3	17.08		3		3	50.60		3	
5	8.06		5		5	22.56		5		5	54.46		5	
7	8.69		7		7	26.30		7		7			7	
10	9.27		10		10	29.85		10		10			10	
15	9.86		15		15	36.85		15		15			15	
20			20		20			20		20			20	
30			30		30			30		30			30	
40			40		40			40		40			40	
50			50		50			50		50			50	
60			60		60			60		60			60	
70			70		70			70		70			70	
80			80		80			80		80			80	
90			90		90			90		90			90	
100			100		100			100		100			100	
110			110		110			110		110			110	
120			120		120			120		120			120	
			150					150					150	
			180					180					180	
			210					210					210	
DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE:		TIME:			DATE:		TIME:			DATE:		TIME:		
TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1		1			1		1			1	44.38
2			2		2			2		2			2	33.65
3			3		3			3		3			3	26.61
5			5		5			5		5			5	15.91
7			7		7			7		7			7	9.06
10			10		10			10		10			10	3.53
15			15		15			15		15			15	2.35
20			20		20			20		20			20	1.60
30			30		30			30		30			30	1.06
40			40		40			40		40			40	0.86
50			50		50			50		50			50	0.77
60			60		60			60		60			60	0.70
70			70		70			70		70			70	0.65
80			80		80			80		80			80	0.61
90			90		90			90		90			90	0.58
100			100		100			100		100			100	0.56
110			110		110			110		110			110	0.55
120			120		120			120		120			120	0.54
			150					150					150	0.53
			180					180					180	0.50
			210					210					210	0.48
			240					240					240	0.36
			300					300					300	
			360					360					360	

WAS SAND PUMPED ?	NO	WAS THE WATER CLEAN ?	NO
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST?	23.26		

Borehole testing and associated projects

Department of Water Affairs Minimum Standards and Guideline: FORM 5 E BOREHOLE TEST RECORD SHEET

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE NO:	2	CO-ORDINATES:		PROVINCE:	NORTHERN CAPE
ALT BH NO:	0	LATITUDE [S]: 28.03209		DISTRICT:	POSTMASBURG
		LONGITUDE [E]: 23.02825		SITE NAME:	LEMOTENG MINE
BOREHOLE DEPTH [mbgl]:	119.72	DATUM LEVEL ABOVE CASING (m):	0.85	EXISTING PUMP:	NONE
WATER LEVEL [mbgl]:	5.44	CASING HEIGHT (magl):	0	CONTRACTOR:	WELLTEK SERVICES
DEPTH OF PUMP [m]:	80.00	DIAM OF CASING AT TOP (mm)	180	TEST PUMP TYPE:	GW 9002

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 — RPM — DATE: 16/09/2011 — TIME: 7H18

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	(M)
1	1.35		1	
2	1.64	0.82	2	
3	1.84		3	
5	2.09		5	
7	2.44	1.05	7	
10	2.83		10	
15	3.15	1.05	15	
20	3.43		20	
30	3.82		30	
40	4.08	1.05	40	
50	4.30		50	
60	4.45		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	

DISCHARGE RATE 2 — RPM — DATE: 16/09/2011 — TIME: 08H18

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	4.77	1.63	1	
2	5.14		2	
3	5.52	2.03	3	
5	6.00		5	
7	6.03		7	
10	6.12		10	
15	8.60	2.03	15	
20	9.67		20	
30	11.35	2.03	30	
40	12.59		40	
50	13.64		50	
60	14.50		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	

DISCHARGE RATE 3 — RPM — DATE: 16/09/2011 — TIME: 09H18

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	15.55		1	
2	16.36	2.70	2	
3	17.23	3.17	3	
5	19.54		5	
7	20.95		7	
10	22.42	3.00	10	
15	24.13		15	
20	25.30		20	
30	27.14		30	
40	28.58		40	
50	29.78		50	
60	31.20		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	

DISCHARGE RATE 4 — RPM — DATE: 16/09/2011 — TIME: 10H18

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	32.78		1	
2	35.17	4.04	2	
3	37.87		3	
5	40.34	4.04	5	
7	42.61		7	
10	46.00		10	
15	50.57	4.03	15	
20	55.56		20	
30	63.01	4.04	30	
40	65.36		40	
50	70.29		50	
60	73.00		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	
			240	
			300	
			360	

DISCHARGE RATE 5 — RPM — DATE: 16/09/2011 — TIME: 11H18

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	73.02		1	
2	73.03	2.60	2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
			150	
			180	
			210	
			240	
			300	
			360	

DISCHARGE RATE 6 — RPM — DATE: — TIME:

TIME (MIN)	DRAWDOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	62.80
2			2	60.85
3			3	58.43
5			5	53.50
7			7	45.74
10			10	37.50
15			15	28.24
20			20	25.00
30			30	20.91
40			40	18.74
50			50	17.49
60			60	16.52
70			70	15.68
80			80	15.04
90			90	14.49
100			100	13.95
110			110	13.47
120			120	12.94
			150	11.38
			180	9.62
			210	7.64
			240	4.96
			300	
			360	

WAS SAND PUMPED ?	NO	WAS THE WATER CLEAN ?	YES
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST?	10.44		

BOREHOLE NO:	BH 05	WATER LEVEL [mbdl]:	21.35	WATER DEPTH [mbgl]:	20.50	AVAILABLE DRAWDOWN [m]:	79.08

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE & TIME		02/27/2012 13:48			DATE & TIME		02/27/2012 13:48			DATE & TIME		02/27/2012 13:48		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	9.07		1		1			1		1			1	
2	11.38	1.55	2		2			2		2			2	
3	19.79		3		3			3		3			3	
5	33.72	2.14	5		5			5		5			5	
7	40.82		7		7			7		7			7	
10	49.25	2.15	10		10			10		10			10	
15	57.90		15		15			15		15			15	
20	71.35		20		20			20		20			20	
30	77.50	2.14	30		30			30		30			30	
40	77.50	0.86	40		40			40		40			40	
50	77.50	0.72	50		50			50		50			50	
60	77.50	0.69	60		60			60		60			60	
			70					70					70	
			80					80					80	
			90					90					90	
			100					100					100	
			110					110					110	
			120					120					120	
			150					150					150	
Average Yield (l/s):		1.07	180		Average Yield (l/s):		0.00	180		Average Yield (l/s):		0.00	180	
Drawdown (%):		98.00	210		Drawdown (%):			210		Drawdown (%):			210	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE & TIME		02/27/2012 13:48			DATE & TIME		02/27/2012 13:48			DATE & TIME		02/27/2012 13:48		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1			1		1			1		1			1	66.49
2			2		2			2		2			2	59.65
3			3		3			3		3			3	48.66
5			5		5			5		5			5	43.91
7			7		7			7		7			7	34.62
10			10		10			10		10			10	32.59
15			15		15			15		15			15	29.64
20			20		20			20		20			20	26.97
30			30		30			30		30			30	20.84
40			40		40			40		40			40	18.07
50			50		50			50		50			50	14.00
60			60		60			60		60			60	10.04
			70					70					70	6.74
			80					80					80	3.72
			90					90					90	2.64
			100					100					100	1.99
			110					110					110	1.63
			120					120					120	1.21
			150					150					150	1.02
			180					180					180	0.89
			210					210					210	0.76
			240					240					240	0.54
Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300	0.32
Drawdown (%):			360		Drawdown (%):			360		Drawdown (%):			360	0.19

DATUM LEVEL ABOVE GROUND [m]:	0.85	WAS SAND PUMPED ?	NO
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST [mbdl]:	21.35	WAS THE WATER CLEAN?	YES

STEPPED DRAWDOWN SUMMARY

STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]	STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]
1	60	77.50	98.00	1.07				5		0.00		0.00			
2		0.00		0.00				6		0.00		0.00			
3		0.00		0.00				7							
4		0.00		0.00				8							
DATE & TIME END:		02/27/2012 14:48						TOTAL:	60.00	77.50	98.00		0	0.00	0.00

COMMENTS:

ESTABLISHMENT

ESTABLISHMENT DATE:	2012/02/27

SITE MOVE FROM:	BOREHOLE	VILLAGE	MOVE TO:	BOREHOLE	VILLAGE	DISTANCE BETWEEN BOREHOLES [km]	392.00
	0	0		BH 05	LEMOTENG MINE		

BOREHOLE NO:	BH 6	WATER LEVEL [mbdl]:	26.88	WATER DEPTH [mbgl]:	26.57	AVAILABLE DRAWDOWN [m]:	32.73

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE & TIME		04/26/2012 12:00			DATE & TIME		04/26/2012 13:00			DATE & TIME		04/26/2012 14:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	2.06		1		1	9.41		1		1	11.91		1	
2	2.87		2		2	9.54		2		2	12.25		2	
3	4.02	0.24	3		3	9.80	0.42	3		3	12.52	0.72	3	
5	4.68		5		5	10.12		5		5	13.81		5	
7	5.97		7		7	10.48		7		7	15.88		7	
10	7.22		10		10	10.68		10		10	18.92		10	
15	8.02		15		15	10.98		15		15	23.22		15	
20	8.44		20		20	11.20		20		20	26.63		20	
30	8.61		30		30	11.53		30		30	32.46		30	
40	8.77		40		40	11.56		40		40			40	
50	9.02		50		50	11.58		50		50			50	
60	9.12		60		60	11.60		60		60			60	
			70					70					70	
			80					80					80	
			90					90					90	
			100					100					100	
			110					110					110	
			120					120					120	
			150					150					150	
Average Yield (l/s):		0.24	180		Average Yield (l/s):		0.42	180		Average Yield (l/s):		0.72	180	
Drawdown (%):		27.86	210		Drawdown (%):		35.44	210		Drawdown (%):		99.18	210	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE & TIME		04/26/2012 14:00			DATE & TIME		04/26/2012 14:00			DATE & TIME		04/26/2012 14:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1			1		1			1		1			1	28.92
2			2		2			2		2			2	25.45
3			3		3			3		3			3	21.90
5			5		5			5		5			5	16.41
7			7		7			7		7			7	10.72
10			10		10			10		10			10	5.45
15			15		15			15		15			15	0.89
20			20		20			20		20			20	0.70
30			30		30			30		30			30	0.59
40			40		40			40		40			40	0.00
50			50		50			50		50			50	
60			60		60			60		60			60	
			70					70					70	
			80					80					80	
			90					90					90	
			100					100					100	
			110					110					110	
			120					120					120	
			150					150					150	
			180					180					180	
			210					210					210	
			240					240					240	
Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300	
Drawdown (%):			360		Drawdown (%):			360		Drawdown (%):			360	

DATUM LEVEL ABOVE GROUND [m]:	0.31	WAS SAND PUMPED ?	NO
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST [mbdl]:	26.88	WAS THE WATER CLEAN?	YES

STEPPED DRAWDOWN SUMMARY

STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]	STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]
1	60	9.12	27.86	0.24				5		0.00		0.00			
2	60	11.60	35.44	0.42				6		0.00		0.00			
3	60	32.46	99.18	0.72				7							
4		0.00		0.00				8							
DATE & TIME END:		04/26/2012 15:00						TOTAL:	180.00	32.46	99.18		0	0.00	0.00

COMMENTS:

ESTABLISHMENT

ESTABLISHMENT DATE:	2012/04/26						
SITE MOVE FROM:	BOREHOLE	VILLAGE	MOVE TO:	BOREHOLE	VILLAGE	DISTANCE BETWEEN BOREHOLES [km]	0.00
	0	0		BH 6	LEMOTENG MINE		

BOREHOLE NO:	BH 7	WATER LEVEL [mbdl]:	36.22	WATER DEPTH [mbgl]:	35.77	AVAILABLE DRAWDOWN [m]:	40.03

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE & TIME		04/27/2012 12:00			DATE & TIME		04/27/2012 13:00			DATE & TIME		04/27/2012 14:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	2.38		1		1	7.84		1		1	31.66		1	
2	2.89	0.20	2		2	9.00		2		2	33.90	0.61	2	
3	3.08		3		3	9.57	0.41	3		3	36.42		3	
5	3.09		5		5	11.07		5		5	37.09		5	
7	3.13		7		7	12.49		7		7	38.41		7	
10	3.20		10		10	14.34		10		10	39.66		10	
15	3.37		15		15	19.31		15		15			15	
20	3.47		20		20	19.93		20		20			20	
30	6.42		30		30	22.09		30		30			30	
40	6.87		40		40	23.35		40		40			40	
50	7.01		50		50	26.80		50		50			50	
60	7.52		60		60	29.68		60		60			60	
			70					70					70	
			80					80					80	
			90					90					90	
			100					100					100	
			110					110					110	
			120					120					120	
			150					150					150	
Average Yield (l/s):		0.20	180		Average Yield (l/s):		0.41	180		Average Yield (l/s):		0.61	180	
Drawdown (%):		18.79	210		Drawdown (%):		74.14	210		Drawdown (%):		99.08	210	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE & TIME		04/27/2012 14:00			DATE & TIME		04/27/2012 14:00			DATE & TIME		04/27/2012 14:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1			1		1			1		1			1	31.05
2			2		2			2		2			2	26.79
3			3		3			3		3			3	24.56
5			5		5			5		5			5	22.21
7			7		7			7		7			7	20.80
10			10		10			10		10			10	19.65
15			15		15			15		15			15	17.87
20			20		20			20		20			20	16.06
30			30		30			30		30			30	12.80
40			40		40			40		40			40	10.19
50			50		50			50		50			50	8.08
60			60		60			60		60			60	6.44
			70					70					70	5.10
			80					80					80	4.07
			90					90					90	3.04
			100					100					100	2.60
			110					110					110	2.02
			120					120					120	1.61
			150					150					150	1.30
			180					180					180	1.07
			210					210					210	0.85
			240					240					240	0.69
Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300	
Drawdown (%):			360		Drawdown (%):			360		Drawdown (%):			360	

DATUM LEVEL ABOVE GROUND [m]:	0.45	WAS SAND PUMPED ?	NO
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST [mbdl]:	36.22	WAS THE WATER CLEAN?	YES

STEPPED DRAWDOWN SUMMARY

STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]	STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]
1	60	7.52	18.79	0.20				5		0.00		0.00			
2	60	29.68	74.14	0.41				6		0.00		0.00			
3	60	39.66	99.08	0.61				7							
4		0.00		0.00				8							
DATE & TIME END:		04/27/2012 15:00						TOTAL:	180.00	39.66	99.08		0	0.00	0.00

COMMENTS:

ESTABLISHMENT

ESTABLISHMENT DATE:	2012/04/27

SITE MOVE FROM:	BOREHOLE	VILLAGE	MOVE TO:	BOREHOLE	VILLAGE	DISTANCE BETWEEN BOREHOLES [km]	0.00
	0	0		BH 7	LEMOTENG MINE		

BOREHOLE NO:	BH 08	WATER LEVEL [mbdl]:	24.05	WATER DEPTH [mbgl]:	23.12	AVAILABLE DRAWDOWN [m]:	76.79

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE & TIME		02/25/2012 14:05			DATE & TIME		02/25/2012 15:05			DATE & TIME		02/25/2012 15:05		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	7.13		1		1	36.27		1		1			1	
2	8.35	1.01	2		2	39.69	2.08	2		2			2	
3	10.60		3		3	42.02		3		3			3	
5	14.20		5		5	46.26	2.05	5		5			5	
7	20.35	1.02	7		7	54.54		7		7			7	
10	25.91		10		10	61.33		10		10			10	
15	27.66		15		15	69.00	2.05	15		15			15	
20	28.06	1.01	20		20	76.25		20		20			20	
30	28.76		30		21	76.25	1.55	30		30			30	
40	29.09		40		22	76.25	1.52	40		40			40	
50	29.26	1.02	50		23	76.25	1.41	50		50			50	
60	29.56		60		.			60		60			60	
			70					70					70	
			80					80					80	
			90					90					90	
			100					100					100	
			110					110					110	
			120					120					120	
			150					150					150	
Average Yield (l/s):		1.02	180		Average Yield (l/s):		1.63	180		Average Yield (l/s):		0.00	180	
Drawdown (%):		38.49	210		Drawdown (%):		99.30	210		Drawdown (%):			210	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE & TIME		02/25/2012 15:05			DATE & TIME		02/25/2012 15:05			DATE & TIME		02/25/2012 15:05		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1			1		1			1		1			1	70.25
2			2		2			2		2			2	65.31
3			3		3			3		3			3	61.21
5			5		5			5		5			5	57.86
7			7		7			7		7			7	52.11
10			10		10			10		10			10	48.76
15			15		15			15		15			15	42.13
20			20		20			20		20			20	38.30
30			30		30			30		30			30	33.39
40			40		40			40		40			40	30.34
50			50		50			50		50			50	25.93
60			60		60			60		60			60	18.56
			70					70					70	13.22
			80					80					80	9.57
			90					90					90	7.00
			100					100					100	4.14
			110					110					110	2.69
			120					120					120	1.96
			150					150					150	1.48
			180					180					180	1.22
			210					210					210	1.12
			240					240					240	1.05
Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300		Average Yield (l/s):		0.00	300	0.98
Drawdown (%):			360		Drawdown (%):			360		Drawdown (%):			360	0.9

DATUM LEVEL ABOVE GROUND [m]:	0.93	WAS SAND PUMPED ?	NO
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST [mbdl]:	24.05	WAS THE WATER CLEAN?	YES

STEPPED DRAWDOWN SUMMARY

STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]	STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]
1	60	29.56	38.49	1.02				5		0.00		0.00			
2	23	76.25	99.30	1.63				6		0.00		0.00			
3		0.00		0.00				7							
4		0.00		0.00				8							
DATE & TIME END:		02/25/2012 15:28						TOTAL:	83.00	76.25	99.30		0	0.00	0.00

COMMENTS:

ESTABLISHMENT

ESTABLISHMENT DATE:	2012/02/25

SITE MOVE FROM:	BOREHOLE	VILLAGE	MOVE TO:	BOREHOLE	VILLAGE	DISTANCE BETWEEN BOREHOLES [km]	
	0	0		BH 08	LEMOTENG MINE		

BOREHOLE NO:	BH 9	WATER LEVEL [mbdl]:	26.36	WATER DEPTH [mbgl]:	25.78	AVAILABLE DRAWDOWN [m]:	60.30

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE & TIME		04/29/2012 13:00			DATE & TIME		04/29/2012 14:00			DATE & TIME		04/29/2012 15:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	0.31		1		1	1.21		1		1	3.15		1	
2	0.46	0.20	2		2	1.33		2		2	3.40	1.15	2	
3	0.48		3		3	1.44	0.55	3		3	3.55		3	
5	0.52	0.21	5		5	1.50		5		5	3.67	1.21	5	
7	0.53		7		7	1.59	0.58	7		7	3.75		7	
10	0.56	0.20	10		10	1.62		10		10	3.82	1.20	10	
15	0.58		15		15	1.62	0.57	15		15	3.87		15	
20	0.66	0.22	20		20	1.62		20		20	3.89	1.22	20	
30	0.73		30		30	1.62	0.58	30		30	3.92		30	
40	0.73	0.21	40		40	1.62		40		40	3.95	1.21	40	
50	0.78		50		50	1.63	0.58	50		50	3.98		50	
60	0.80	0.2	60		60	1.67		60		60	4.04	1.22	60	
			70					70					70	
			80					80					80	
			90					90					90	
			100					100					100	
			110					110					110	
			120					120					120	
			150					150					150	
Average Yield (l/s):		0.21	180		Average Yield (l/s):		0.58	180		Average Yield (l/s):		1.21	180	
Drawdown (%):		1.33	210		Drawdown (%):		2.77	210		Drawdown (%):		6.70	210	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE & TIME		04/29/2012 16:00			DATE & TIME		04/29/2012 17:00			DATE & TIME		04/29/2012 17:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	4.41		1		1	12.52		1		1			1	37.09
2	4.60		2		2	14.19	5.08	2		2			2	31.82
3	6.40	2.56	3		3	19.16		3		3			3	25.47
5	7.46		5		5	21.73	5.09	5		5			5	12.64
7	7.97	2.57	7		7	25.68		7		7			7	5.22
10	8.51		10		10	29.12	5.10	10		10			10	2.60
15	9.30	2.58	15		15	32.86		15		15			15	1.46
20	9.76		20		20	48.36	5.09	20		20			20	1.25
30	9.9	2.57	30		30	59.66	3.27	30		30			30	1.03
40	10.1		40		32	59.66	2.99	40		40			40	0.92
50	10.56	2.59	50		34	59.66	2.94	50		50			50	0.83
60	10.9		60					60		60			60	0.74
			70					70					70	0.70
			80					80					80	0.62
			90					90					90	0.61
			100					100					100	0.58
			110					110					110	0.55
			120					120					120	0.51
			150					150					150	0.45
			180					180					180	0.39
			210					210					210	0.27
			240					240					240	0.25
Average Yield (l/s):		2.58	300		Average Yield (l/s):		3.63	300		Average Yield (l/s):		0.00	300	0.19
Drawdown (%):		18.08	360		Drawdown (%):		98.94	360		Drawdown (%):			360	0.13

DATUM LEVEL ABOVE GROUND [m]:	0.58	WAS SAND PUMPED ?	NO
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST [mbdl]:	26.36	WAS THE WATER CLEAN?	YES

STEPPED DRAWDOWN SUMMARY

STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]	STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]
1	60	0.80	1.33	0.21				5	34	59.66	98.94	3.63			
2	60	1.67	2.77	0.58				6		0.00		0.00			
3	60	4.04	6.70	1.21				7							
4	60	10.90	18.08	2.58				8							
DATE & TIME END:		04/29/2012 17:34						TOTAL:	274.00	59.66	98.94		0	0.00	0.00

COMMENTS:

ESTABLISHMENT

ESTABLISHMENT DATE:	2012/04/29

SITE MOVE FROM:	BOREHOLE	VILLAGE	MOVE TO:	BOREHOLE	VILLAGE	DISTANCE BETWEEN BOREHOLES [km]	0.00
	0	0		BH 9	LEMOTENG MINE		

BOREHOLE NO:	BH 9				WATER LEVEL [mbdl]:	26.36					WATER LEVEL [mbgl]:	25.78	
CONSTANT DISCHARGE TEST & RECOVERY													
DISCHARGE BOREHOLE					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3		
TEST STARTED					WATER LEVEL [mbcl]:		N/A	WATER LEVEL [mbcl]:		N/A	WATER LEVEL [mbcl]:		N/A
DATE & TIME:	04/30/2012 7:00				CASING HEIGHT [m]:		N/A	CASING HEIGHT [m]:		N/A	CASING HEIGHT [m]:		N/A
TEST COMPLETED					CASING DIAMETER [m]:		N/A	CASING DIAMETER [m]:		N/A	CASING DIAMETER [m]:		N/A
DATE & TIME:	05/06/2012 7:00				DISTANCE [m]:		N/A	DISTANCE [m]:		N/A	DISTANCE [m]:		N/A
TIME [min]	DRAWDOWN [m]	YIELD [l/s]	TIME [min]	RECOVERY [m]	TIME: [min]	DRAWDOWN [m]	RECOVERY [m]	TIME: [min]	DRAWDOWN [m]	RECOVERY [m]	TIME: [min]	DRAWDOWN [m]	RECOVERY [m]
1	3.00		1	6.86	1			1			1		
2	4.02	1.56	2	4.99	2			2			2		
3	4.39		3	4.90	3			3			3		
5	4.86	1.82	5	4.83	5			5			5		
7	5.74		7	3.96	7			7			7		
10	6.21		10	3.96	10			10			10		
15	6.37	1.84	15	3.92	15			15			15		
20	6.45		20	3.84	20			20			20		
30	6.48		30	3.73	30			30			30		
40	6.51	1.83	40	3.64	40			40			40		
60	6.53		60	3.53	60			60			60		
90	6.67		90	3.39	90			90			90		
120	6.79	1.84	120	3.24	120			120			120		
150	6.85		150	3.14	150			150			150		
180	6.94		180	3.03	180			180			180		
210	7.01	1.85	210	2.99	210			210			210		
240	7.07		240	2.88	240			240			240		
300	7.18		300	2.80	300			300			300		
360	7.26	1.82	360	2.69	360			360			360		
420	7.44		420	2.55	420			420			420		
480	7.53		480	2.44	480			480			480		
540	7.64	1.83	540	2.35	540			540			540		
600	7.69		600	2.27	600			600			600		
720	7.76	1.84	720	2.17	720			720			720		
840	7.78		840	2.00	840			840			840		
960	7.92		960	1.91	960			960			960		
1080	7.97	1.85	1080	1.80	1080			1080			1080		
1200	8.23		1200	1.73	1200			1200			1200		
1320	8.41		1320	1.71	1320			1320			1320		
1440	8.52	1.84	1440	1.57	1440			1440			1440		
1560	8.58		1560	1.46	1560			1560			1560		
1680	8.60	1.85	1680	1.42	1680			1680			1680		
1800	8.68		1800	1.34	1800			1800			1800		
1920	8.69		1920	1.28	1920			1920			1920		
2040	8.76	1.84	2040	1.24	2040			2040			2040		
2160	8.82		2160	1.18	2160			2160			2160		
2280	8.85	1.86	2280	1.13	2280			2280			2280		
2400	8.87		2400	1.11	2400			2400			2400		
2520	8.89		2520	1.07	2520			2520			2520		
2640	8.95	1.84	2640	1.03	2640			2640			2640		
2760	8.98		2760	1.00	2760			2760			2760		
2880	9.08		2880	0.98	2880			2880			2880		
3000	9.13	1.85	3000	0.92	3000			3000			3000		
3120	9.14		3120	0.88	3120			3120			3120		
3240	9.18		3240	0.83	3240			3240			3240		
3360	9.21	1.84	3360	0.81	3360			3360			3360		
3480	9.24		3480	0.79	3480			3480			3480		
3600	9.26		3600	0.77	3600			3600			3600		
3720	9.40	1.86	3720	0.72	3720			3720			3720		
3840	9.44		3840	0.66	3840			3840			3840		
3960	9.46		3960	0.62	3960			3960			3960		
4080	9.51	1.85	4080	0.59	4080			4080			4080		
4200	9.51		4200	0.53	4200			4200			4200		
4320	9.53		4320	0.48	4320			4320			4320		
DURATION TOTALS [min]		CDT:	4320		RECOVERY:	4320		OBS 1:	0		OBS 2:	0	OBS 3: 0
DRAWDOWN / RECOVERY [m]		CDT:	9.53		RECOVERY:	0.48		OBS 1:	0.00		OBS 2:	0.00	OBS 3: 0.00
DRAWDOWN / RECOVERY [%]		CDT:	15.80		RECOVERY:	94.96		OBS 1:	0.00		OBS 2:	0.00	OBS 3: 0.00
AVERAGE YIELD [l/s]		CDT:	1.85		COMMENTS:								
GENERAL ITEMS AND MAINTENANCE													
TRAVELING FOR VERIFICATION [km]:					SAMPLE TRANSPORTATION [km]:						TRANSPORT EXISTING EQUIPMENT [km]:		

BOREHOLE NO:	BH 10	WATER LEVEL [mbdl]:	19.85	WATER DEPTH [mbgl]:	19.46	AVAILABLE DRAWDOWN [m]:	75.77

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE & TIME		05/03/2012 13:00			DATE & TIME		05/03/2012 14:00			DATE & TIME		05/03/2012 15:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	0.55		1		1	2.12		1		1	4.88		1	
2	0.66		2		2	2.21		2		2	5.11	1.63	2	
3	0.79	0.42	3		3	2.28	0.65	3		3	5.31		3	
5	0.98		5		5	2.44		5		5	5.60	1.64	5	
7	1.10	0.43	7		7	2.50	0.81	7		7	5.82		7	
10	1.19		10		10	2.81		10		10	6.06	1.63	10	
15	1.34	0.44	15		15	3.23	0.82	15		15	6.28		15	
20	1.45		20		20	3.43		20		20	6.48		20	
30	1.62	0.43	30		30	3.77	0.81	30		30	6.85	1.65	30	
40	1.79		40		40	3.93		40		40	7.08		40	
50	1.82	0.44	50		50	4.12	0.82	50		50	7.26	1.64	50	
60	1.90		60		60	4.24		60		60	7.55		60	
			70					70					70	
			80					80					80	
			90					90					90	
			100					100					100	
			110					110					110	
			120					120					120	
			150					150					150	
Average Yield (l/s):		0.44	180		Average Yield (l/s):		0.81	180		Average Yield (l/s):		1.64	180	
Drawdown (%):		2.51	210		Drawdown (%):		5.60	210		Drawdown (%):		9.96	210	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE & TIME		05/03/2012 16:00			DATE & TIME		05/03/2012 17:00			DATE & TIME		05/03/2012 17:00		
TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)	TIME (min)	DRAWDOWN (m)	YIELD (l/s)	TIME (min)	RECOVERY (m)
1	10.48		1		1	26.87		1		1			1	30.18
2	12.85	5.08	2		2	27.90	7.58	2		2			2	26.63
3	14.33		3		3	28.66		3		3			3	23.87
5	16.38	5.14	5		5	29.71	7.59	5		5			5	20.64
7	17.53		7		7	30.43		7		7			7	17.55
10	19.00	5.13	10		10	31.39	7.61	10		10			10	15.98
15	20.86		15		15	32.55		15		15			15	12.97
20	21.06		20		20	33.38	7.59	20		20			20	11.22
30	21.99	5.15	30		30	34.66		30		30			30	9.68
40	22.48		40		40	35.74	7.6	40		40			40	8.49
50	24.63		50		50	36.48		50		50			50	7.26
60	26.23	5.13	60		60	37.15	7.61	60		60			60	6.33
			70					70					70	4.83
			80					80					80	4.00
			90					90					90	3.92
			100					100					100	3.80
			110					110					110	3.22
			120					120					120	2.84
			150					150					150	2.48
			180					180					180	2.09
			210					210					210	1.86
			240					240					240	1.66
Average Yield (l/s):		5.14	300		Average Yield (l/s):		7.60	300		Average Yield (l/s):		0.00	300	1.42
Drawdown (%):		34.62	360		Drawdown (%):		49.03	360		Drawdown (%):			360	1.19

DATUM LEVEL ABOVE GROUND [m]:	0.39	WAS SAND PUMPED ?	NO
STATIC WATER LEVEL AFTER STEPPED DISCHARGE TEST [mbdl]:	19.85	WAS THE WATER CLEAN?	YES

STEPPED DRAWDOWN SUMMARY

STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]	STEP	DURATION [min]	DRAWDOWN [m]	DRAWDOWN [%]	AVERAGE YIELD [l/s]	RECOVERY [min]	RECOVERY [m]	RECOVERY [%]
1	60	1.90	2.51	0.44				5	60	37.15	49.03	7.60			
2	60	4.24	5.60	0.81				6		0.00		0.00			
3	60	7.55	9.96	1.64				7							
4	60	26.23	34.62	5.14				8							
DATE & TIME END:			05/03/2012 18:00					TOTAL:	300.00	37.15	49.03		0	0.00	0.00

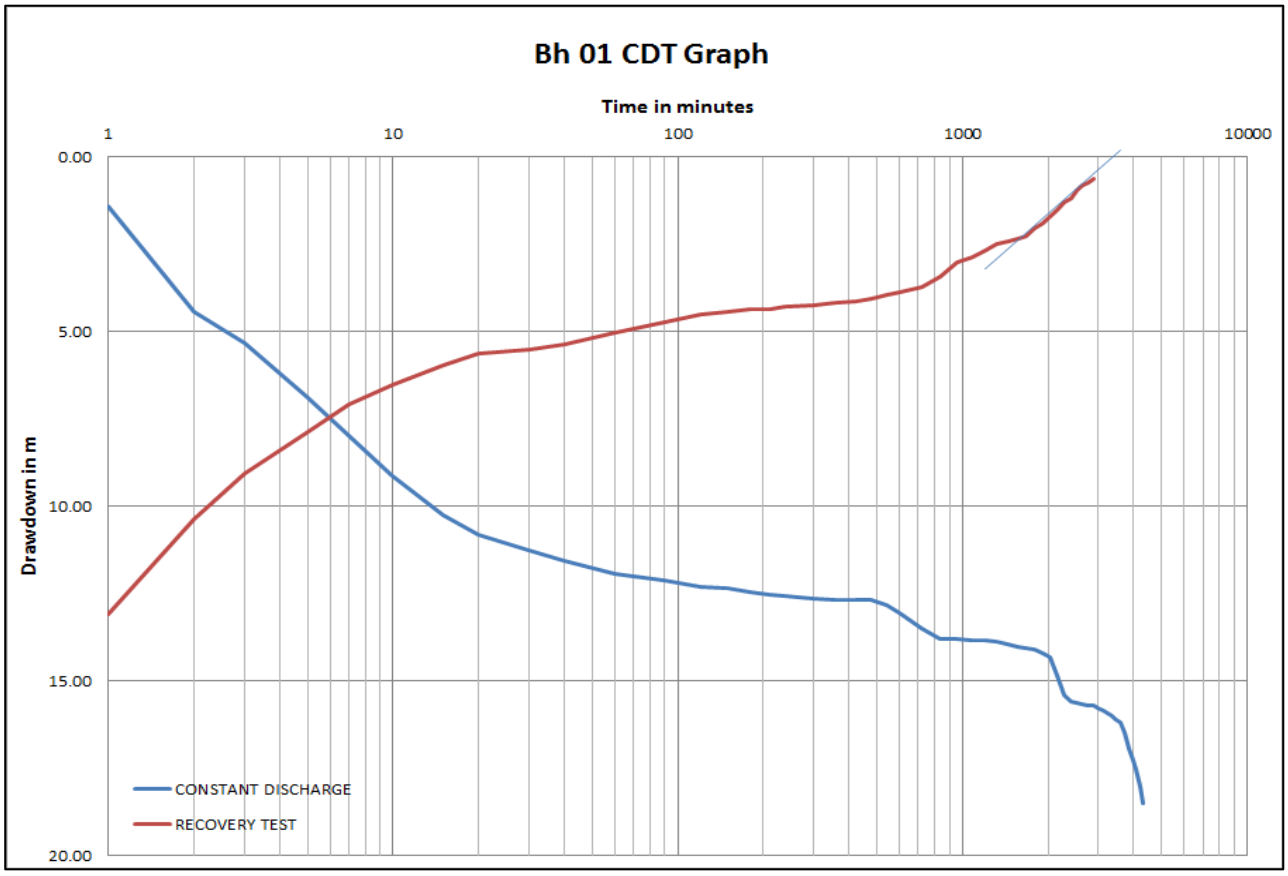
COMMENTS:

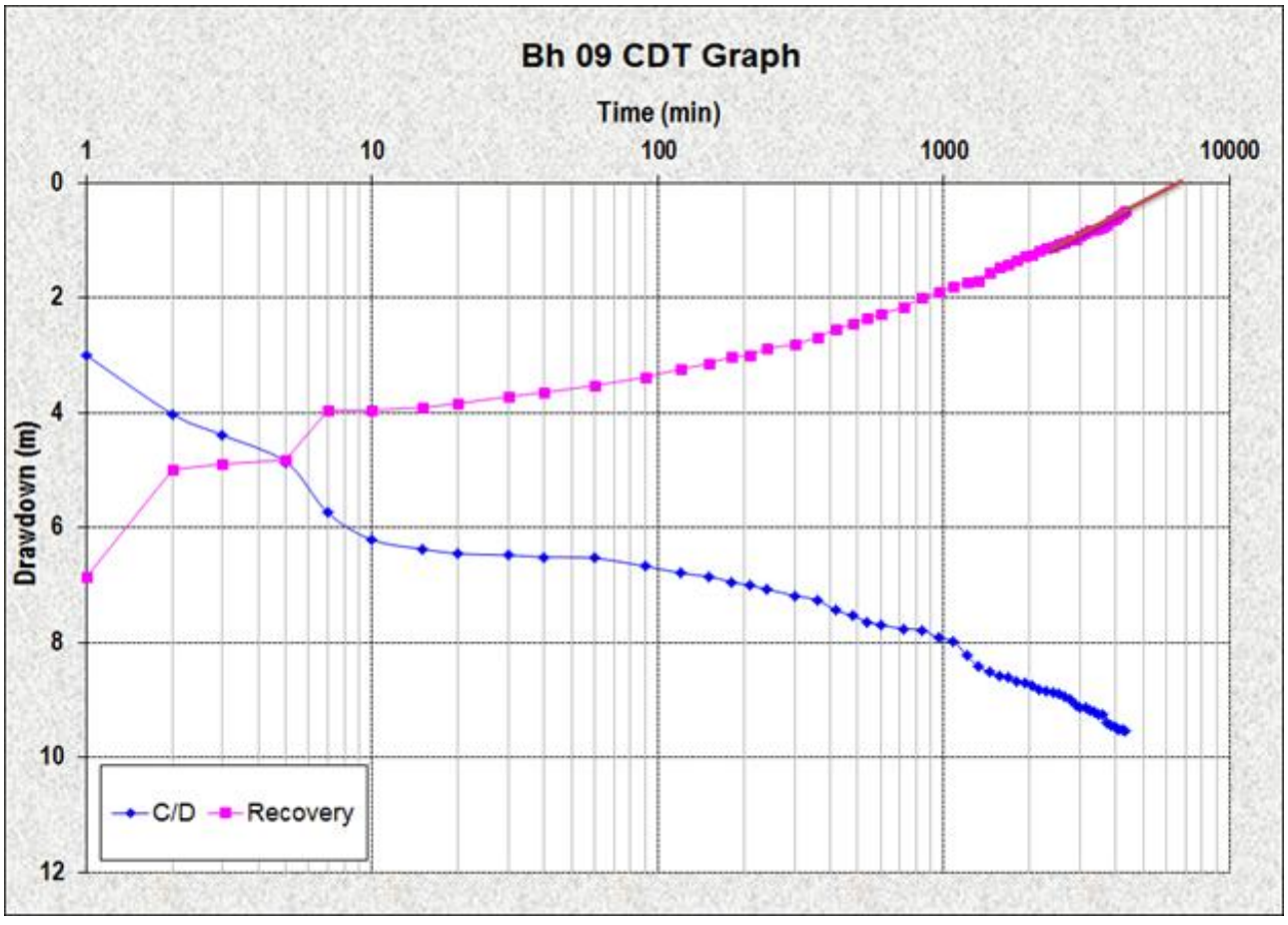
ESTABLISHMENT

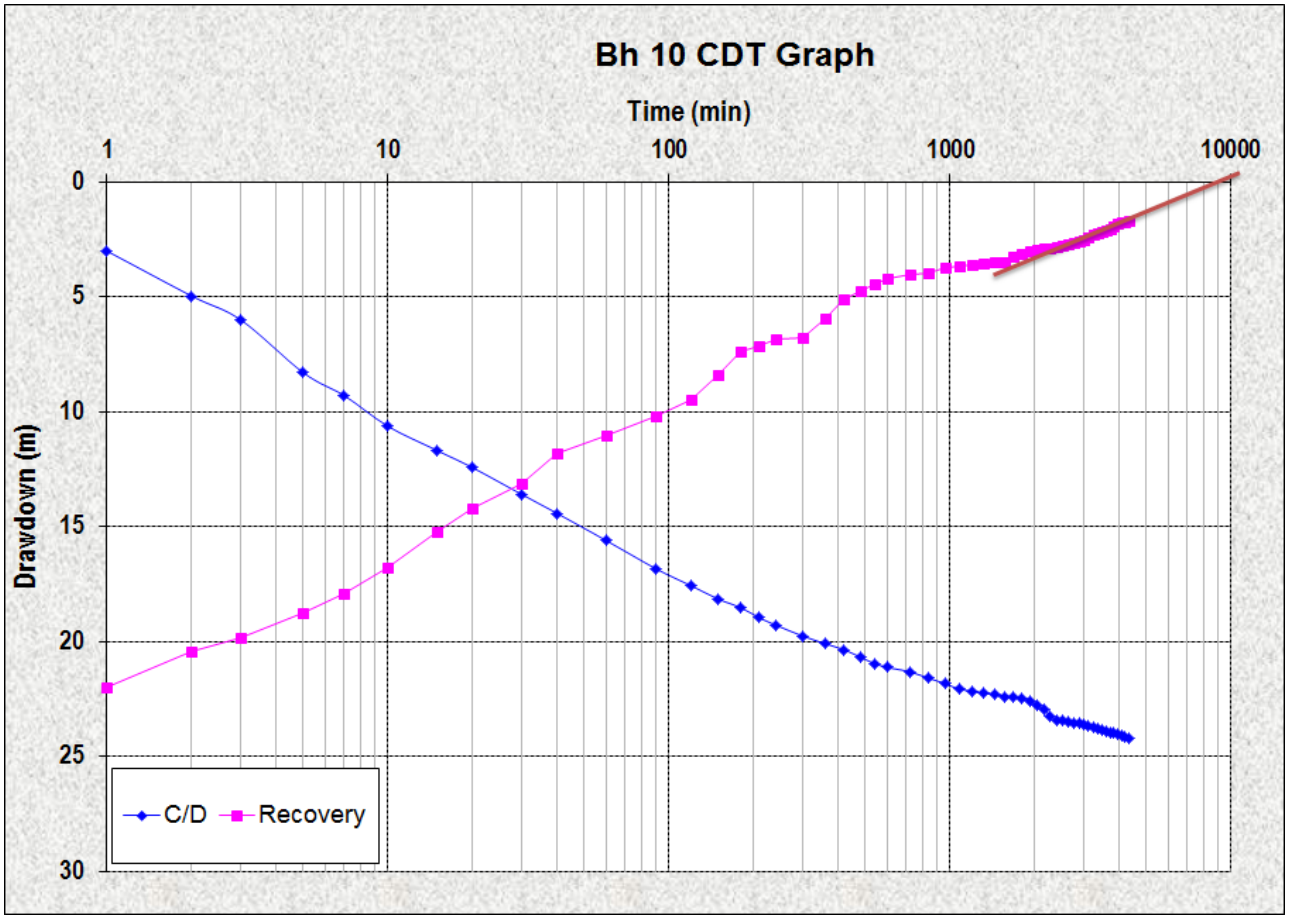
ESTABLISHMENT DATE:	2012/05/03

SITE MOVE FROM:	BOREHOLE	VILLAGE	MOVE TO:	BOREHOLE	VILLAGE	DISTANCE BETWEEN BOREHOLES [km]	0.00
	0	0		BH 10	LEMOTENG MINE		

BOREHOLE NO:	BH 10				WATER LEVEL [mbdl]:	19.85				WATER LEVEL [mbgl]:	19.46	
CONSTANT DISCHARGE TEST & RECOVERY												
DISCHARGE BOREHOLE					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3		
TEST STARTED					WATER LEVEL [mbcl]:	N/A		WATER LEVEL [mbcl]:	N/A		WATER LEVEL [mbcl]:	N/A
DATE & TIME:	05/04/2012 7:00				CASING HEIGHT [m]:	N/A		CASING HEIGHT [m]:	N/A		CASING HEIGHT [m]:	N/A
TEST COMPLETED					CASING DIAMETER [m]:	N/A		CASING DIAMETER [m]:	N/A		CASING DIAMETER [m]:	N/A
DATE & TIME:	05/10/2012 7:00				DISTANCE [m]:	N/A		DISTANCE [m]:	N/A		DISTANCE [m]:	N/A
TIME [min]	DRAWDOWN [m]	YIELD [l/s]	TIME [min]	RECOVERY [m]	TIME: [min]	DRAWDOWN [m]	RECOVERY [m]	TIME: [min]	DRAWDOWN [m]	RECOVERY [m]	TIME: [min]	DRAWDOWN [m]	RECOVERY [m]
1	3.01		1	21.97	1			1			1		
2	4.96	3.46	2	20.46	2			2			2		
3	6.01		3	19.86	3			3			3		
5	8.30	3.52	5	18.75	5			5			5		
7	9.30		7	17.90	7			7			7		
10	10.63		10	16.78	10			10			10		
15	11.69	3.53	15	15.20	15			15			15		
20	12.43		20	14.21	20			20			20		
30	13.60	3.52	30	13.10	30			30			30		
40	14.42		40	11.79	40			40			40		
60	15.61		60	11.01	60			60			60		
90	16.83	3.50	90	10.20	90			90			90		
120	17.57		120	9.47	120			120			120		
150	18.15	3.53	150	8.40	150			150			150		
180	18.52		180	7.37	180			180			180		
210	18.96		210	7.12	210			210			210		
240	19.28	3.54	240	6.82	240			240			240		
300	19.76		300	6.79	300			300			300		
360	20.09	3.52	360	5.95	360			360			360		
420	20.35		420	5.13	420			420			420		
480	20.67		480	4.74	480			480			480		
540	20.96	3.53	540	4.47	540			540			540		
600	21.12		600	4.20	600			600			600		
720	21.31	3.54	720	4.04	720			720			720		
840	21.59		840	3.94	840			840			840		
960	21.82		960	3.72	960			960			960		
1080	22.07	3.52	1080	3.65	1080			1080			1080		
1200	22.15		1200	3.59	1200			1200			1200		
1320	22.25		1320	3.53	1320			1320			1320		
1440	22.28	3.53	1440	3.50	1440			1440			1440		
1560	22.38		1560	3.48	1560			1560			1560		
1680	22.40		1680	3.24	1680			1680			1680		
1800	22.44	3.54	1800	3.10	1800			1800			1800		
1920	22.57		1920	3.02	1920			1920			1920		
2040	22.79		2040	2.96	2040			2040			2040		
2160	22.93	3.55	2160	2.92	2160			2160			2160		
2280	23.24		2280	2.87	2280			2280			2280		
2400	23.40		2400	2.81	2400			2400			2400		
2520	23.42	3.52	2520	2.77	2520			2520			2520		
2640	23.47		2640	2.71	2640			2640			2640		
2760	23.52		2760	2.65	2760			2760			2760		
2880	23.56	3.53	2880	2.60	2880			2880			2880		
3000	23.62		3000	2.51	3000			3000			3000		
3120	23.67		3120	2.43	3120			3120			3120		
3240	23.71	3.54	3240	2.31	3240			3240			3240		
3360	23.79		3360	2.24	3360			3360			3360		
3480	23.84	3.52	3480	2.19	3480			3480			3480		
3600	23.92		3600	2.14	3600			3600			3600		
3720	23.95		3720	2.04	3720			3720			3720		
3840	23.99	3.55	3840	1.95	3840			3840			3840		
3960	24.04		3960	1.82	3960			3960			3960		
4080	24.09	3.54	4080	1.78	4080			4080			4080		
4200	24.13		4200	1.74	4200			4200			4200		
4320	24.20		4320	1.69	4320			4320			4320		
DURATION TOTALS [min]			CDT:	4320	RECOVERY:	4320		OBS 1:	0	OBS 2:	0	OBS 3:	0
DRAWDOWN / RECOVERY [m]			CDT:	24.20	RECOVERY:	1.69		OBS 1:	0.00	OBS 2:	0.00	OBS 3:	0.00
DRAWDOWN / RECOVERY [%]			CDT:	31.94	RECOVERY:	93.02		OBS 1:	0.00	OBS 2:	0.00	OBS 3:	0.00
AVERAGE YIELD [l/s]			CDT:	3.53	COMMENTS:								
GENERAL ITEMS AND MAINTENANCE													
TRAVELING FOR VERIFICATION [km]:					SAMPLE TRANSPORTATION [km]:					TRANSPORT EXISTING EQUIPMENT [km]:			


Bh 01 CDT Graph
Time in minutes
1
10
100
1000
10000
0.00
5.00
10.00
15.00
20.00
Drawdown in m
CONSTANT DISCHARGE
RECOVERY TEST

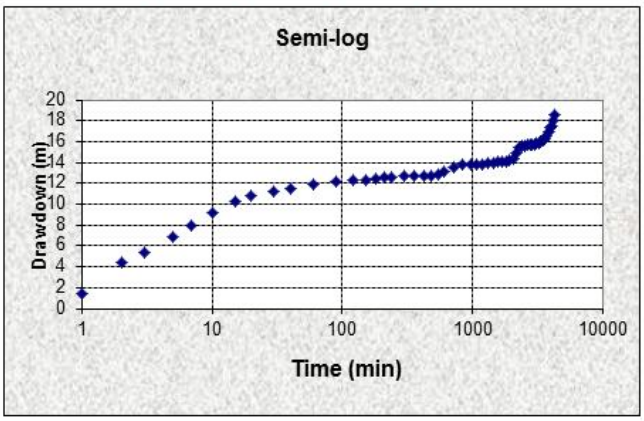

Bh 09 CDT Graph
Time (min)
1
10
100
1000
10000
0
2
4
6
8
10
12
Drawdown (m)
C/D
Recovery

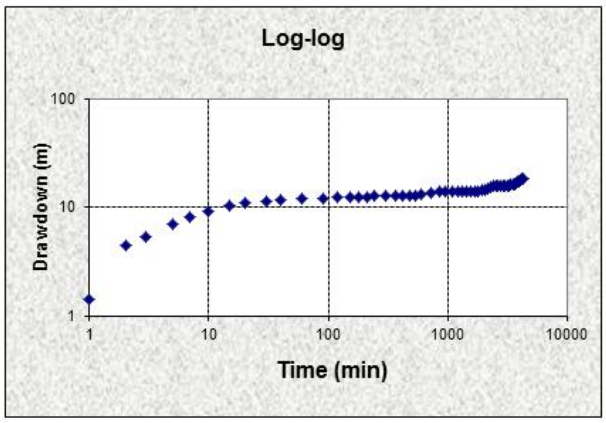

Bh 10 CDT Graph
Time (min)
1
10
100
1000
10000
0
5
10
15
20
25
30
Drawdown (m)
C/D
Recovery

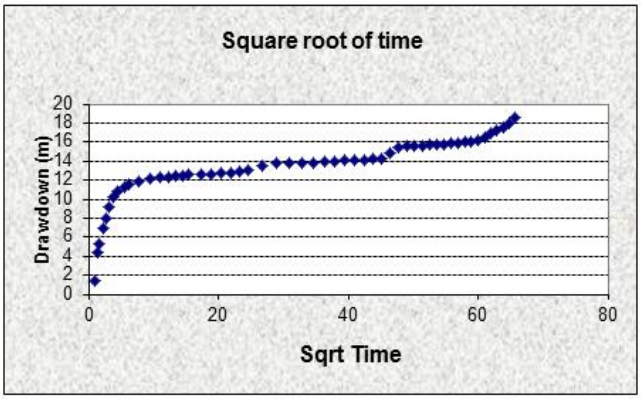
APPENDIX 4: Lomoteng FC diagnostic plots

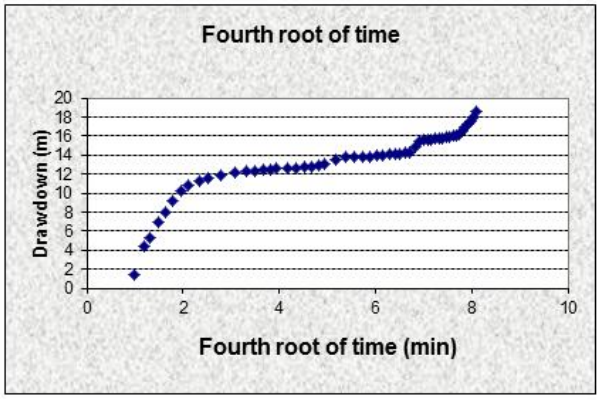
DIAGNOSTIC PLOTS Main Data

Borehole 01

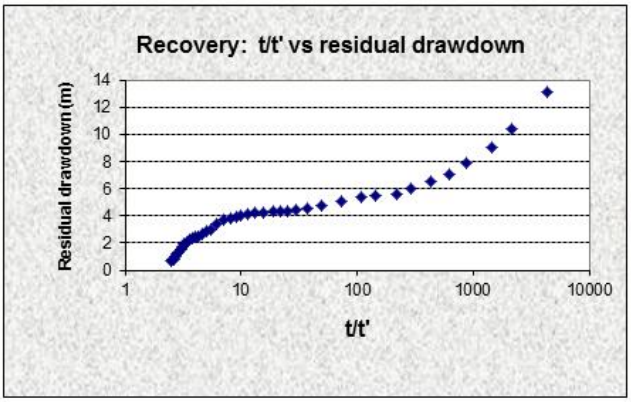


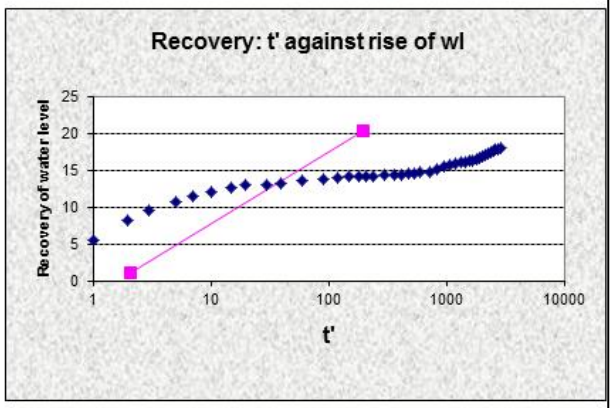


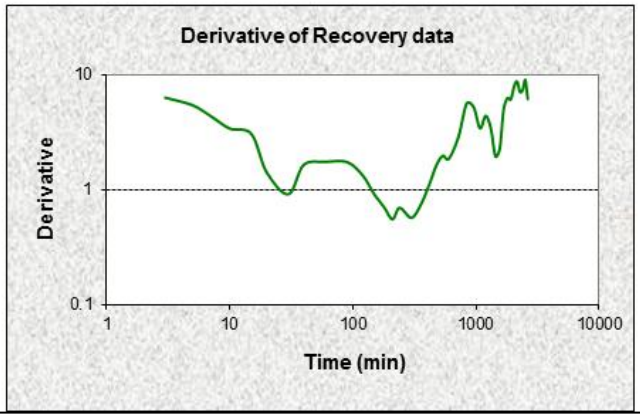


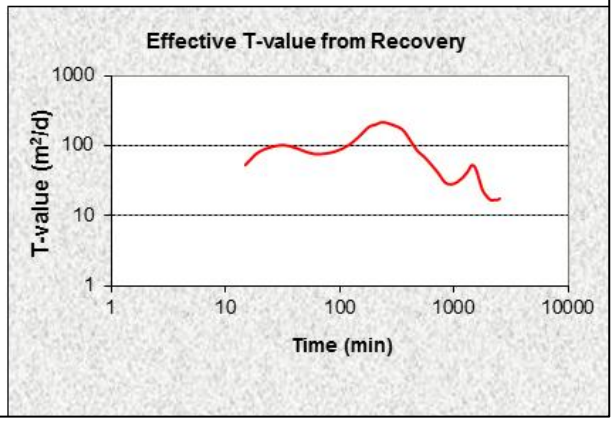


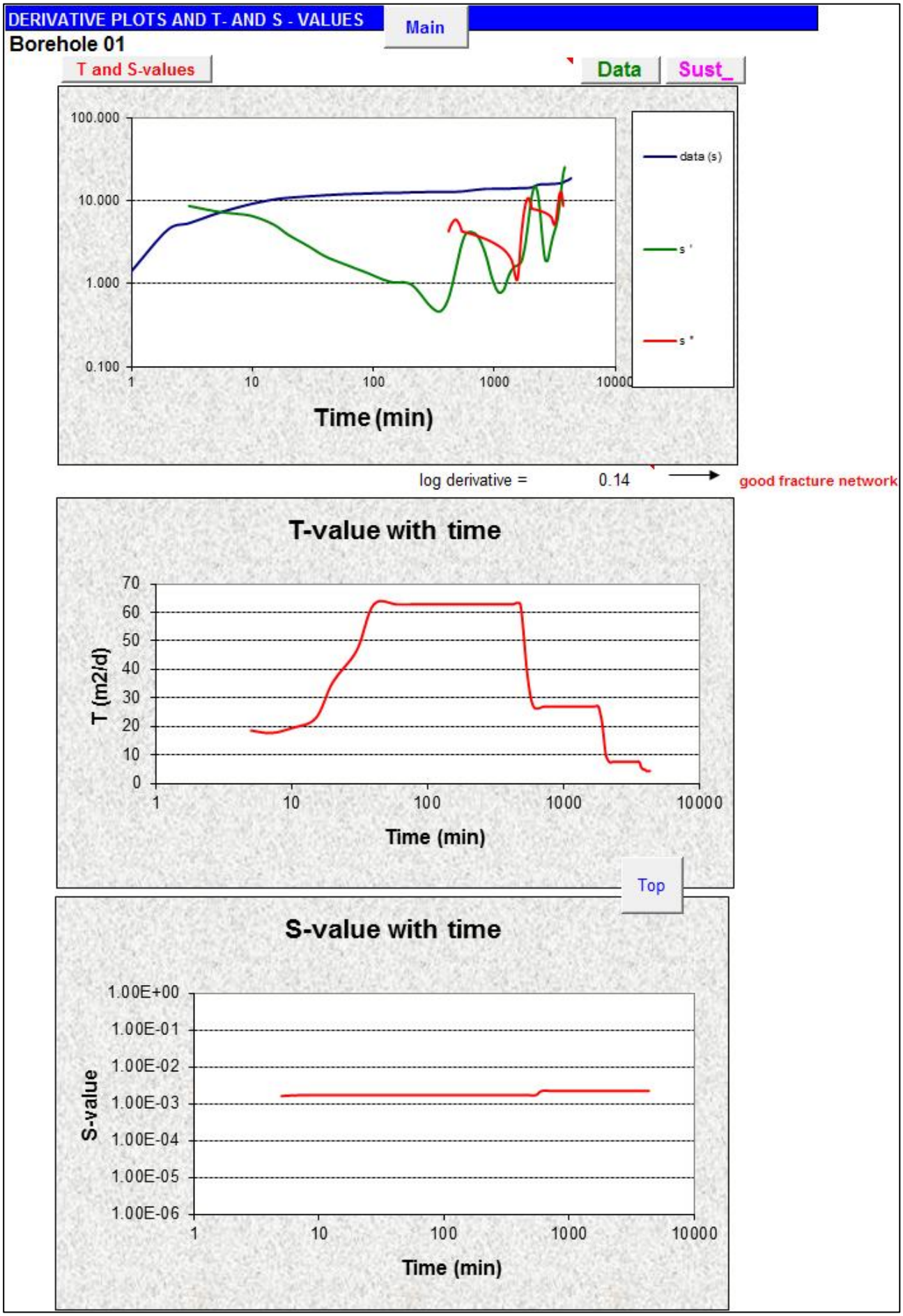
T = 13.2





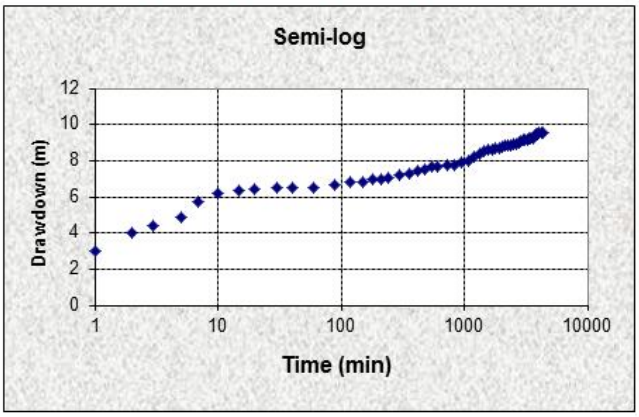


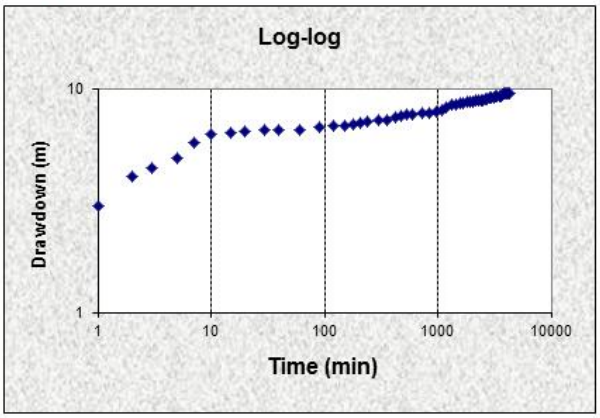


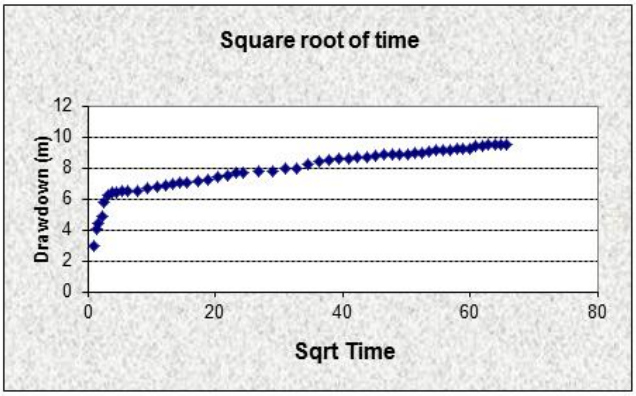

DERIVATIVE PLOTS AND T- AND S - VALUES
Main
Borehole 01
T and S-values
Data
Sust_
100.000
10.000
1.000
0.100
1
10
100
1000
10000
data (s)
s '
s "
Time (min)
log derivative = 0.14
good fracture network
T-value with time
70
60
50
40
30
20
10
0
T (m2/d)
1
10
100
1000
10000
Time (min)
Top
S-value with time
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
S-value
1
10
100
1000
10000
Time (min)

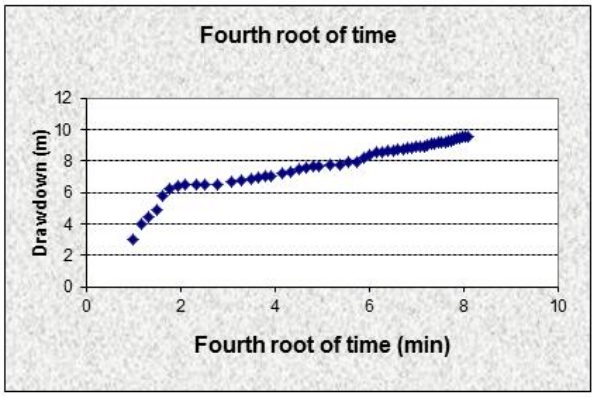
DIAGNOSTIC PLOTS Main Data

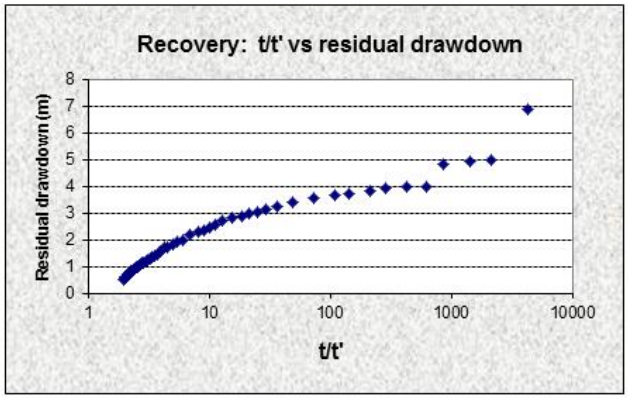
BH09

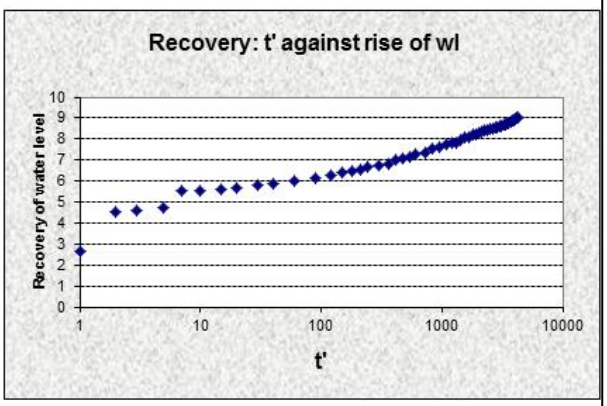


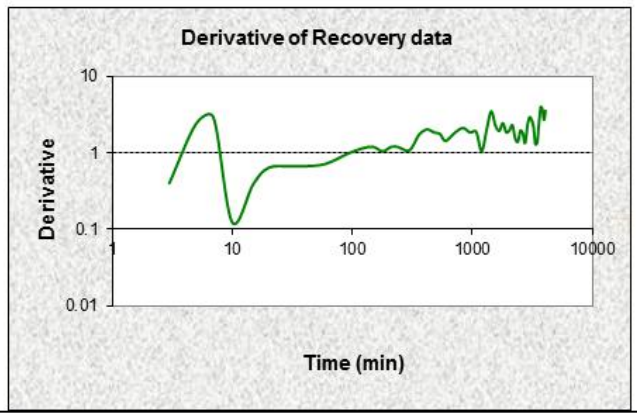


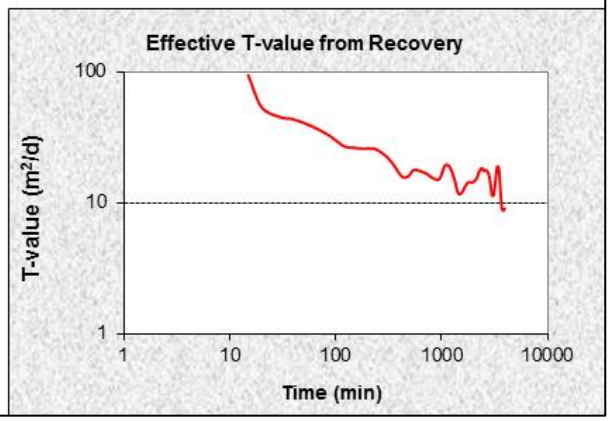


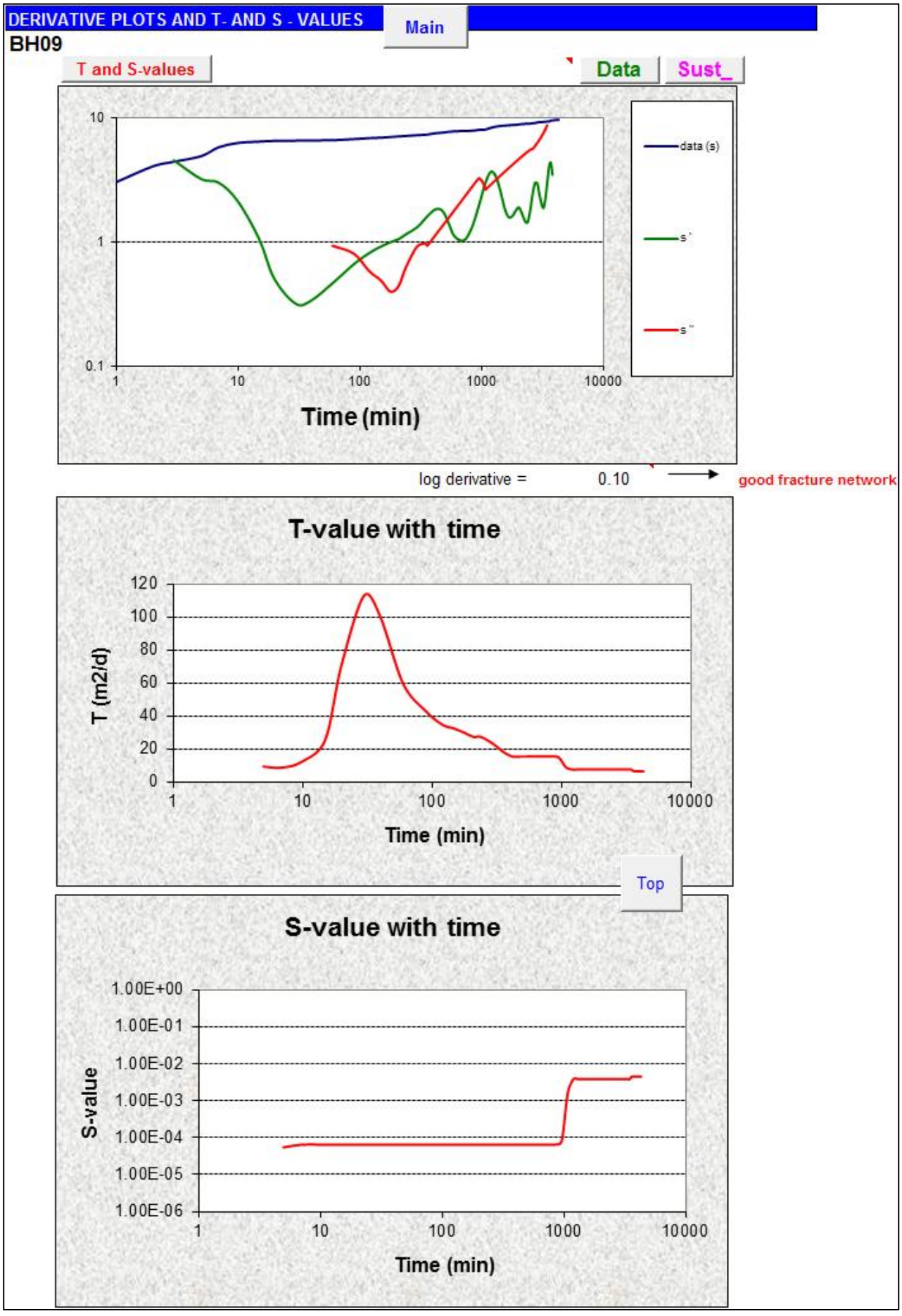






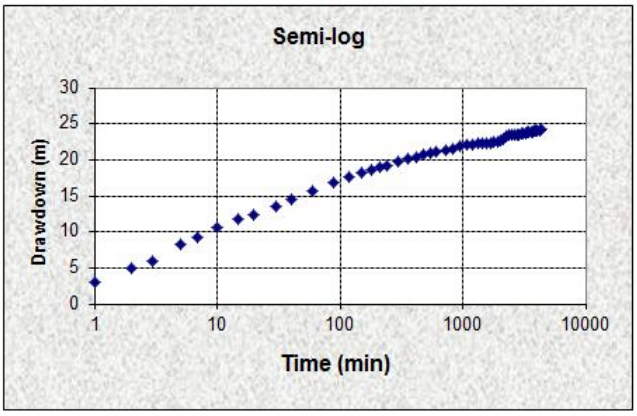


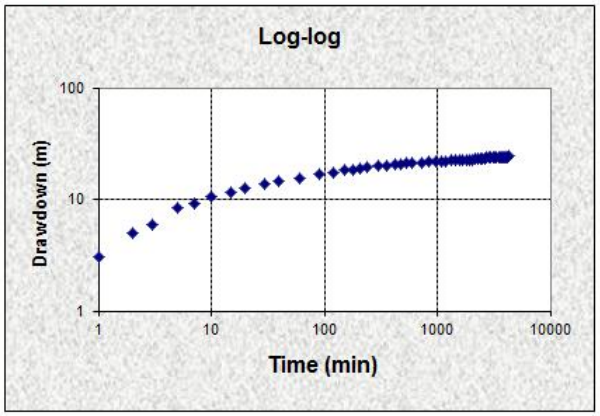


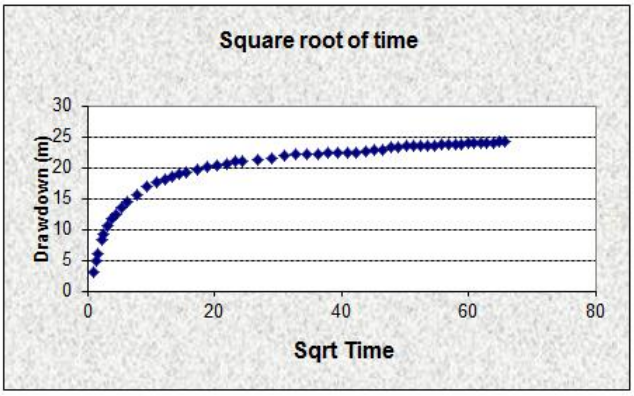

DERIVATIVE PLOTS AND T- AND S - VALUES
Main
BH09
T and S-values
Data
Sust_
10
1
0.1
1
10
100
1000
10000
Time (min)
data (s)
s'
s''
log derivative = 0.10
good fracture network
T-value with time
120
100
80
60
40
20
0
T (m2/d)
1
10
100
1000
10000
Time (min)
Top
S-value with time
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
S-value
1
10
100
1000
10000
Time (min)

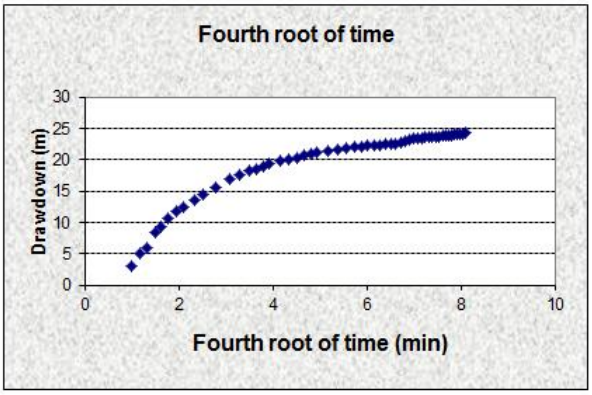
DIAGNOSTIC PLOTS Main Data

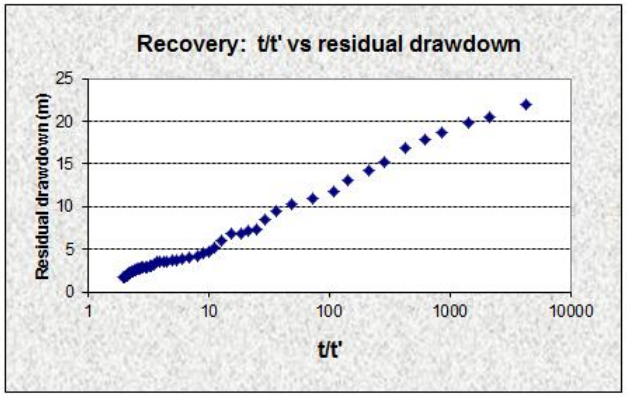
BH10

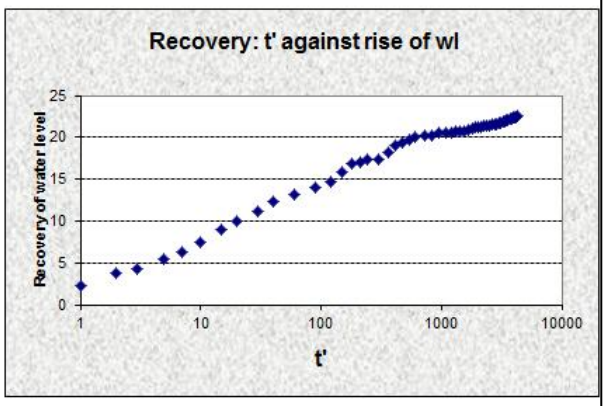


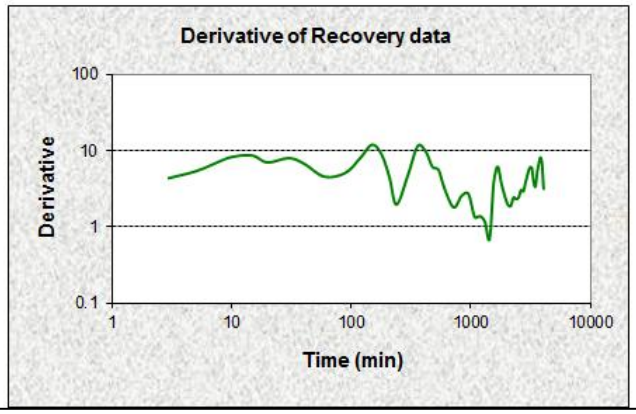


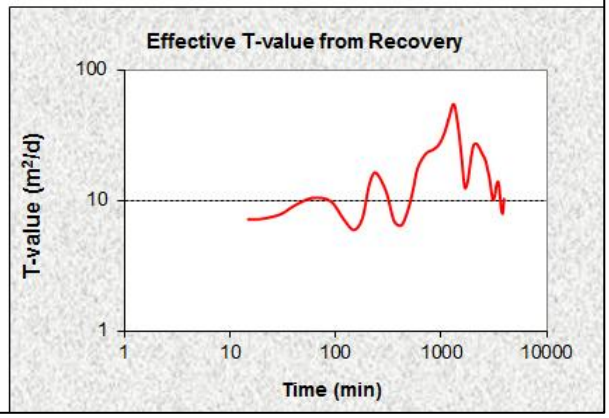


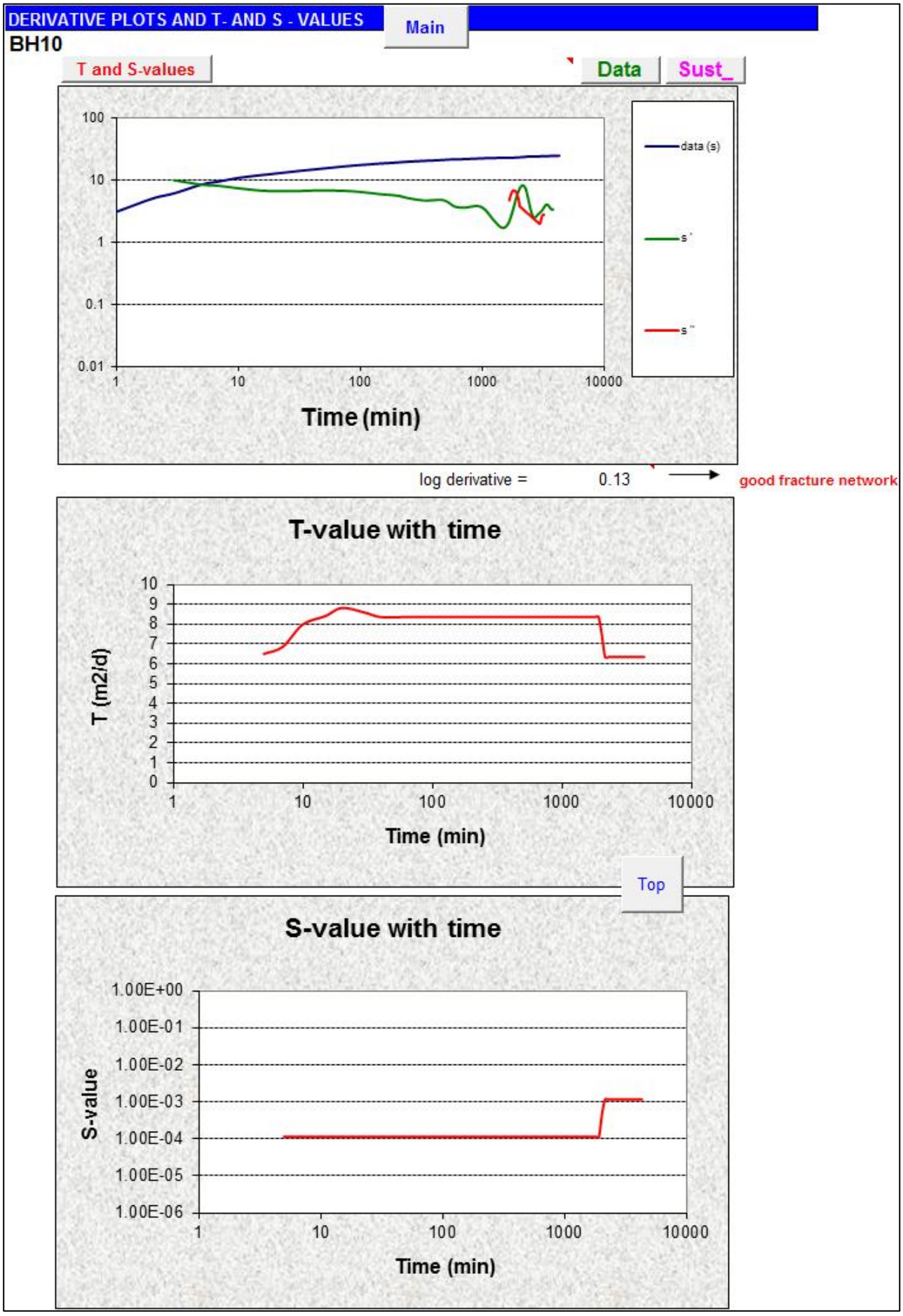











DERIVATIVE PLOTS AND T- AND S - VALUES
Main
BH10
T and S-values
Data
Sust_
100
10
1
0.1
0.01
1
10
100
1000
10000
Time (min)
data (s)
s'
s''
log derivative = 0.13
good fracture network
T-value with time
T (m2/d)
10
9
8
7
6
5
4
3
2
1
0
1
10
100
1000
10000
Time (min)
Top
S-value with time
S-value
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1
10
100
1000
10000
Time (min)

APPENDIX 5: Lomoteng FC analyses

Summary	Main	Borehole 01						
Applicable	Method	Sustainable yield (l/s)	Std. Dev	Early T (m^2/d)		Late T (m^2/d)	S	AD used
☑	Basic FC	1.28	0.94	129		4.7	2.20E-03	14.3
☐	Advanced FC			129		4.7	1.00E-03	14.3
☑	FC inflection point	1.31	0.87					14.3
☑	Cooper-Jacob	2.34	1.51			31.8	2.66E-03	14.3
☑	FC Non-Linear	2.12	1.87	26.0			1.00E-03	14.3
☑	Barker	1.73	2.33	K_f =	60	S_s =	1.32E-03	14.3
	Average Q_sust (l/s)	1.76	0.47	b =	0.16	Fractal dimension n =	2.20	

Recommended abstraction rate (L/s)	1.75	for 24 hours per day		
Hours per day of pumping 10	2.71	L/s for	10	hours per day
Amount of water allowed to be abstracted per month	4536	m^3		
Borehole could satisfy the basic human need of	6048	persons		

Summary	Main	BH09						
Applicable	Method	Sustainable yield (l/s)	Std. Dev	Early T (m^2/d)		Late T (m^2/d)	S	AD used
☑	Basic FC	0.65	0.36	2925		6.8	4.40E-03	11.0
☐	Advanced FC			2925		6.8	4.40E-03	11.0
☑	FC inflection point	0.69	0.31					9.6
☑	Cooper-Jacob	0.67	0.44			11.4	4.85E-04	11.0
☑	FC Non-Linear	0.63	0.56	10.0			1.02E-03	11.0
☑	Barker	0.71	0.50	K_f =	329	S_s =	2.00E-03	11.0
	Average Q_sust (l/s)	0.67	0.03	b =	0.04	Fractal dimension n =	2.01	

Recommended abstraction rate (L/s)	0.65	for 24 hours per day		
Hours per day of pumping 12	0.92	L/s for	12	hours per day
Amount of water allowed to be abstracted per month	1684.8	m^3 or	55.4	m^3/day
Borehole could satisfy the basic human need of	2246	persons		

Summary	Main	BH10						
Applicable	Method	Sustainable yield (l/s)	Std. Dev	Early T (m^2/d)		Late T (m^2/d)	S	AD used
☑	Basic FC	1.19	0.59	8		6.9	2.20E-03	22.0
☐	Advanced FC			8		6.9	2.20E-03	22.0
☑	FC inflection point	1.67	0.60					22.5
☑	Cooper-Jacob	1.00	0.65			9.3	1.15E-04	22.0
☑	FC Non-Linear	1.16	1.03	6.0			1.02E-03	22.0
☑	Barker	1.14	0.63	K_f =	186	S_s =	2.00E-03	22.0
	Average Q_sust (l/s)	1.23	0.25	b =	0.04	Fractal dimension n =	2.03	

Recommended abstraction rate (L/s)	1.20	for 24 hours per day		
Hours per day of pumping 12	1.70	L/s for	12	hours per day
Amount of water allowed to be abstracted per month	3110.4	m^3 or	102.3	m^3/day
Borehole could satisfy the basic human need of	4147	persons		

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