APPENDIX 4.9(A)

SASOL MINING – MIDDELBULT (BLOCK 8)
SHONDONI PROJECT
ALTERNATIVES ASSESSMENT FOR
OVERLAND COAL CONVEYOR

FINAL

SASOL MINING
MIDDELBULT (BLOCK 8)
SHONDONI PROJECT

ALTERNATIVES ASSESSMENT
OVERLAND CONVEYOR

Date: 19 April 2010
JMA / 10391
Appendix to EIA

COMPILED FOR

SASOL MINING (Pty) Ltd
Middelbult Colliery
Shondoni Shaft

COMPILED BY

JMA Consulting (Pty) Ltd
Sustainable Environmental Solutions
through
Integrated Science and Engineering

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APPENDICES

1. INTRODUCTION

Sasol Mining operates a number of underground coal mines in the Secunda Area. Middelbult Colliery represents one of the underground mines and has been in operation since 1981. During its existence Middelbult Colliery has gone through several expansions. Whilst some of the original shafts have already been closed and rehabilitated, new shafts have been developed to access coal within the Middelbult Reserves.

As part of this ongoing development to ensure access to exploitable reserves, Sasol Mining is now investigating options to replace the existing West Shaft with a new shaft (Shondoni) in the Block 8 reserves in order to increase its reserve utilisation of the existing Middelbult operations (original Middelbult Reserves, Block 8 Reserves, Springbokdraai Reserves, Leeuwpan Reserves and Block 8 Northern Reserves).

The proposed expansions require Environmental Authorisations. As part of this, potential environmental impacts must be assessed and the Environmental Management Plan (EMP) must be amended in terms of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA). In order to achieve this, the current Environmental Impact Assessment (EIA) and Environmental Management Programme Report (EMPR) approved under the Minerals Act (Act 50 of 1991) must be amended.

Additionally, an Environmental Authorisation is required in terms of the National Environmental Management Act (NEMA) (Act 107 of 1998) for all listed activities related to the proposed expansion whilst an Integrated Water Use License Application (IWULA) is also required in terms of the National Water Act (NWA) (Act 36 of 1998) to authorize water uses related to the expansion.

The proposed expansion of the Middelbult operations, comprise one additional shaft complex (Shondoni Shaft) with associated infrastructure in the Block 8 Reserves and a **new overland conveyor to convey the coal to the Middelbult Main Shaft and then onto an existing conveyor to the Sasol Mining central coal stockpile area** (Sasol Coal Supply or SCS).

The proposed future mining activities will be conducted by means of underground mining operations, utilising the bord-and-pillar and high extraction methods to extract coal from the No.4 and No.2 Coal Seams. It is anticipated that approximately 8.5 to 9.5 million tons of coal per year will be mined. The increased utilisation of coal reserves will mean that Middelbult (Block 8) will continue mining (current schedule) for an additional 3 to 4 years.

The long-term plan for Middelbult-Shondoni (Block 8) is to maximise its life thereby ensuring optimal coal reserve utilisation. Existing personnel and equipment will be used in the mining of the No 4 and the No 2 Coal Seams by means of bord-and-pillar and high extraction.

This report represents a subdivision of the EIA report and deals with the selection of a preferred alternative overland conveyor route from three identified alternatives.

2. DESCRIPTION OF THE OVERLAND CONVEYOR

The ROM coal from the Shondoni operations will be transported along a surface coal conveyer from the Shaft Complex to Middelbult Main Shaft and then to the existing Sasol Coal Supply (SCS, the central coal stockpile area). In order to achieve this, a new overland conveyor of some 17 km in distance will be constructed to join up with the existing Middelbult Main Shaft conveyor.

2.1 SHONDONI MATERIALS HANDLING SYSTEM

Coal will be mined from both the No.4 seam and the No.2 seam by continuous miners, which will deliver the coal onto shuttle cars. The shuttle cars deliver the coal to feeder breakers and then into an underground crusher which sizes the coal to -150 mm lump size. From the crushers the coal goes onto section conveyers, then to trunk conveyors which deposit the coal into underground bunkers on the No.2 seam and the No.4 seam. On the No.2 seam, luffing chutes feed the coal from the bunker onto the interseam conveyor, which takes to it No.4 seam level.

From the main underground bunker on the No.4 seam, the coal goes onto the incline conveyor which transports the coal to surface and then through diverter chutes to either load onto the tripper conveyor, into the bypass bunker or onto the emergency stockpile conveyor.

The tripper conveyor receives coal from the incline conveyor and discharges via a moving tripper to the surface bunker. From the surface bunker coal is loaded through multiple luffing chutes onto the reclaim conveyor which travels beneath the surface bunker and which then loads the coal onto **Overland Conveyor 1**. After transporting the coal for some 12 km, overland conveyor 1 discharges the coal to **Overland Conveyor 2**, which some 6 km further joins up with the existing Middelbult Conveyor through a surge bin. The existing conveyor transports the coal to the central Sasol Coal Stockyard.

Figure 2.1(a): Typical Overland Conveyor with Associated Infrastructure

2.2 OVERLAND CONVEYOR 1

Overland Conveyor 1 will receive material from the Reclaim Conveyor, and travel approximately 11.95 km before discharging to Overland Conveyor 2.

The conveyor will incorporate horizontal curves to negotiate the terrain, residential areas and other building / structures. The detailed design of the conveyor including extended wing idlers, banking angle of idlers, and pitch of idlers in the horizontal curve areas will be carried out at the next phase to ensure proper tracking of the belt under all load conditions.

To **prevent carry back spillage** along the conveyor route, belt turnovers will be used, with one at the head en and one at the tail end. Belt turnovers ensure the dirty side of the belt is facing up for both top and bottom strands of the conveyor, such that residual material does not fall off the belt as it passes over idlers. Each belt turnover will be approximately 25m in length, suitable for 1200mm belt width.

The conveyor design rate is 2,000 t/h, with a volumetric capacity of 2,500 t/h for surge loads. This capacity is restricted at this stage by the rate of downstream conveying and stockyard equipment, however consideration should be paid to upgrading the capacity to allow for a higher annual throughput.

Overland Conveyor 1 uses 1200mm ST3150 steel cord belt with nomical 5 + 5mm Grade N covers.

Idlers will be 3 roll, Ø152 mm, 35°carry idlers, and 2 roll Ø152 mm, 5° return. All idlers structure will be ground mounted. Idler pitch will be nominally 3m pitch on the carry strand, and 6m on the return strand. Further optimisation of the idler pitch to ensure the correct balance between capital cost, and conveyor frictional resistances to minimise power consumption will be carried out at the next stage.

Three (3) 1000kW VVVF drives will be installed at the head end drive station. The drive pulley will use ceramic lagging, while non-drive pulleys will use rubber lagging. Two (2) external holdbacks will be provided to prevent run-back of the belt.

A gravity weight take up will be installed at the head end of the conveyor near the drive station.

Dust suppression sprays will be used at the transfer chute, and **all scrapings from the discharge pulley directed onto the downstream Overland Conveyor 2**.

2.3 OVERLAND CONVEYOR 2

Overland Conveyor 2 will receive material from Overland Conveyor 1, and travel approximately 5.7 km before discharging to the Surge Bin located part way along the existing 2202 Conveyor.

The Conveyor will incorporate horizontal curves to negotiate existing roads. As for Overland Conveyor 1, the final detailed design of the conveyor including extended wing idlers, banking angle of idlers and pitch of idlers in the horizontal curve areas will be crried out at the next.

Belt turnovers will be used, of similar design to Overland Conveyor 1, with one at the head end and one at the tail end.

The conveyor design rate is 2,000 t/h, with a volumetric capacity of 2,500 t/h for surge loads. This capacity is restricted at this stage by the rate of downstream conveying and stockyard equipment, however consideration should be paid to upgrading the capacity to allow for a higher annual throughput. This is discussed in more detail in the Dnamic Simulation Report.

Overland Conveyor 2 uses 1200mm ST3150 steel cord belt with nominal 5 + 5mm Grade N covers, identical to Overland Conveyor 1.

Idlers will be 3 roll, Ø152mm, 35° carry idlers, and 2 roll Ø152mm, 5° return. All idler structure will be round mounted. Idler pitch will be nomically 3m pitch on teh carry strand, and 6m on the return strand.

Two (2) 1000kW VVVF drives will be installed at the head end drive station on separate pulleys. The drive pulleys will use ceramic lagging, while non-drive pulleys will use rubber lagging. Two (2) external holdbacks will e provided to prevent run-back of the belt.

A gravity weight take up will be installed at the head end of the conveyor near the drive station.

Dust suppression sprays will be used at the transfer chute, and **all scrapings from the discharge pulley directed into the Surge Bin**.

2.4 CONVEYOR ITEMS OPTIMIZING ENVIRONMENTAL CONTROL

The items listed below are all incorporated into the conveyor designs from *inter alia* an environmental management perspective.

- Belt Turnovers have been specified on Overland Conveyors to prevent carry back spillage along the conveyor route by twisting the belt such that the dirty side of the belt faces upwards on the return streand. Turnovers are required to both ends of the conveyors, and require access platforms, and special idlers and structure. An alternative to belt turnovers is to install belt washing stations on the return strand near the head end of the conveyor. The belt washing station removes residual material remaining on the dirty side of the belt, preventing carry back spillage. Only one (1) belt washing station is required at the head end of each conveyor, and since the washing water is recycled, water consumption is low.

- Conveyor structure can be improved by using idlers supported on or hung from individual posts rather than on load bearing stringers. This will reduce the noise caused by vibration of stringers, and allow for easier adjustment of belt line, as each idler will be independently adjustable. By placing return idlers on the outbye side of the conveyor structure, any carry back dislodged by the idlers will be thrown clear of the cross members, rather than into them accelerating corrosion.

- The Overland Conveyor route passes residential areas where reduction of noise may be required. The installation of plastic idlers in these areas in place of steel shell idlers will reduce noise, and have the added benefit of lower weight for easier installation, improved life and lower rolling resistance which translates into lower energy consumption. The idlers are more expensive than standard steel rolls, and further investigation is required at the next stage into the quality of the sealing arrangement, and relative costs over the idler life.

Figure 2.4(a): Conveyors will use plastic idlers and will be covered to prevent rain wash, as well as dust and noise propagation

- Similarly, balanced idlers can be used to reduce noise at areas of the Overland Conveyors that are close to residential areas. Manufacturers have suggested noise can be reduced from 82dBA to 72dBA at 3m distance when using balanced idlers in place of standard idlers.

- The conveyor belts will be covered in order to prevent rain washing from the belts as well as to minimize dust and noise propagation.

- Magnets will be placed at strategic places to ensure metal objects will be removed from the belt thereby reducing the likelihood of blockages and damages the belt and equipment.

- Namur sensors or speed detectors will be installed on strategic non-drive pulleys to detect and calculate belt speed, and also to detect belt slip and tear.

- Along the length of the conveyor belt pull key systems will be installed so the belt can be stopped in case of an emergency at any place along the belt.

- An inter pull key intercom system will also be provided to enable personnel to communicate locally as well as to the pull key control station. This is very invaluable during fault finding and commissioning.

- A complete dust suppression system will be installed and controlled from the PLC in such a way that sprayers will be activated when the belts are running with coal.

- Vibration monitors will be installed on critical pulleys at the head and tail end of each drive to monitor vibration levels and act as an early warning signal to prevent catastrophic failure. When the vibration level exceeds an acceptable band, an alarm will be raised in the control room to trigger a maintenance inspection.

- At each transfer point there will be a High Definition Ethernet camera installed which will be displayed in the control room to facilitate the belts being run with minimum personnel.

2.5 ALTERNATIVE CONVEYOR ROUTES

Three alternative overland conveyor routes have been identified by Sasol Mining in collaboration with the project consulting engineers WorleyParsons. The three alternatives (West Route, Central Route and South-East Route) are shown on Figure 2.5(a).

2.6 SERVITUDES

Should only a portion of the properties across which the conveyors are to be constructed be purchased, a servitude for the conveyor and associated infrastructure will have to be registered over the remainder of the farm. The alternative conveyor routes are shown superimposed on the property delineation map in Figure 2.6(a)

For the west route alternative (preferred alternative from engineering and cost perspective), a new servitude will have to be registered from the surface bunker to provincial road R547 (point 17) over the farm Zandfontein 130 IS if surface rights for this farm is not obtained.

From this point 17 up to point 23 (4 km) on the conveyor route drawing the conveyor is planned within the road servitude. Approval will have to be obtained from the relevant authority, but no additional servitude will be required.

For the remainder of the proposed overland conveyor (a distance of 14 km) new servitudes will have to be registered over various properties. The servitudes will be some 43 m wide but the actual infrastructure will only take up some 10 m to 15 m.

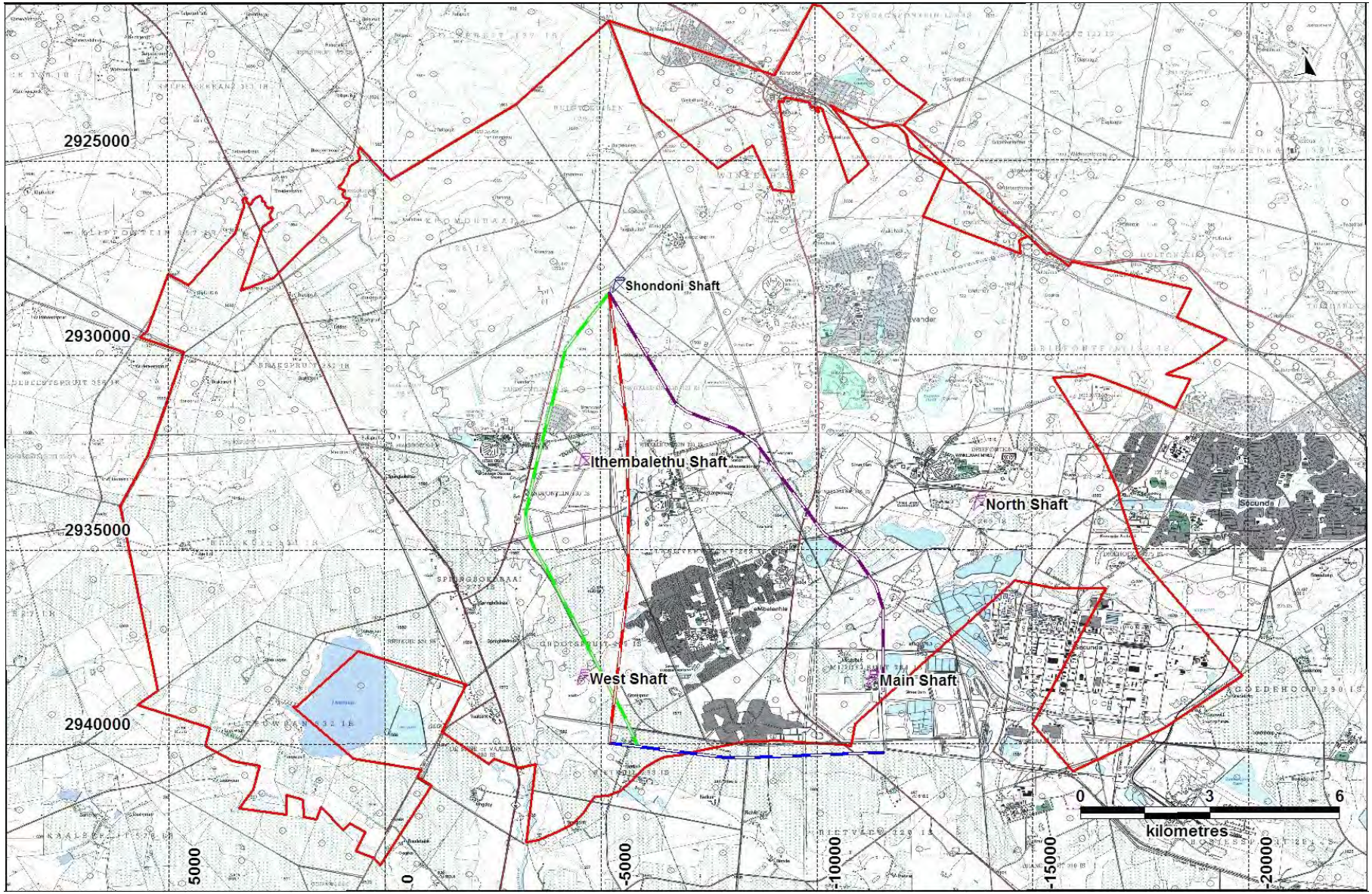


Figure 2.5(a) Alternative Conveyor Route (West Route, Central Route and South-East Route

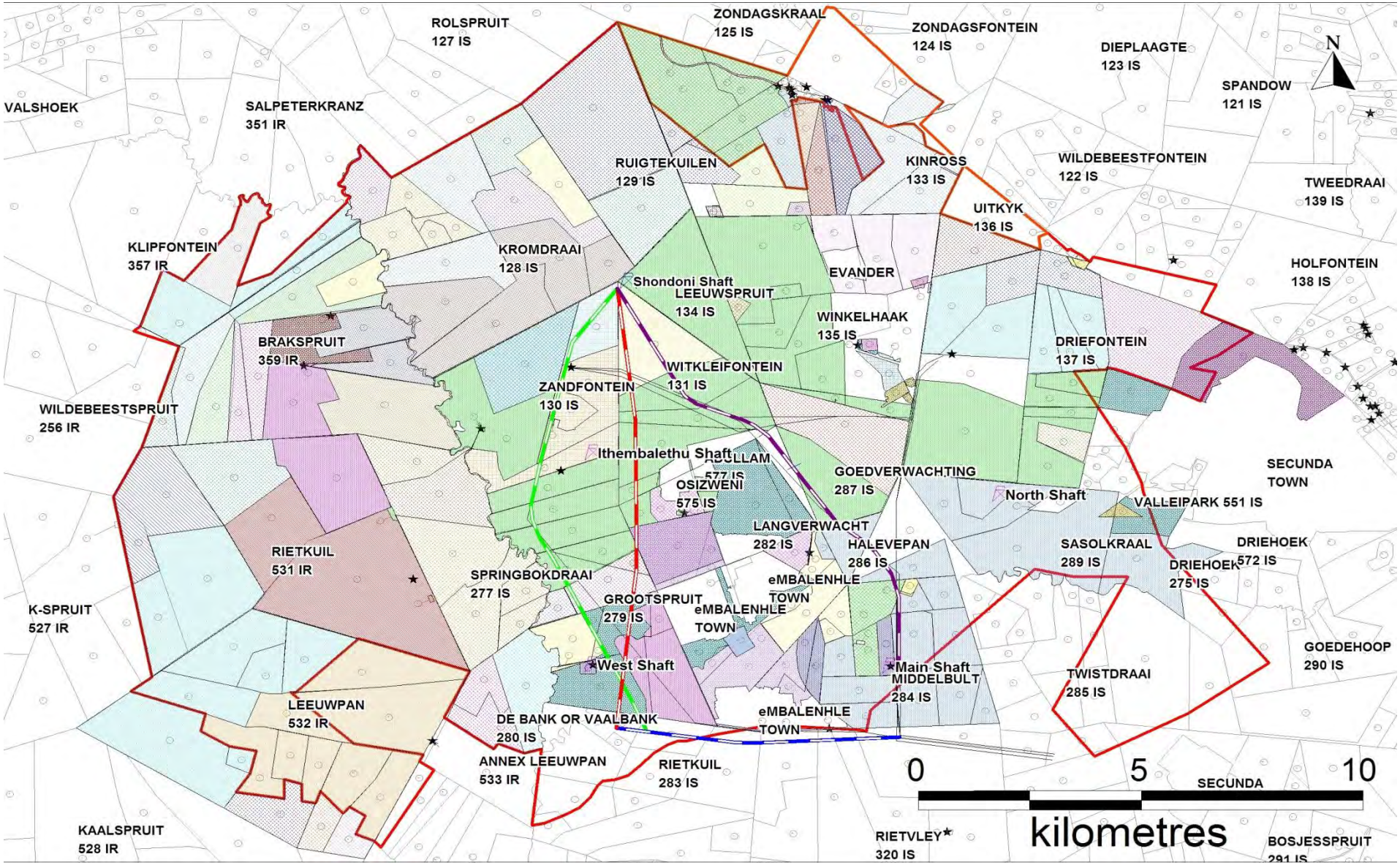


Figure 2.6(a): Alternative Conveyor Routes superimposed on Property Delineations

The proposed servitude will also make provision for other services and utilities as described in the engineering report. A typical required width for the servitude will be 43m. There will however be places where the servitude will have to be wider to allow for cut and fill. Crossing that will give property owners access to both sides of the conveyor will also have to be widened.

A list of properties covering the shaft complex as well as all three conveyor route options, is attached as APPENDIX 1 to this report.

The Table below summarizes the number of properties affected by the shaft and the three conveyor route options.

Development	Number of Affected Properties
Shondoni Shaft	**3**
West Conveyor Route	**13**
Central Conveyor Route	**14**
South-East Conveyor Route	**9**

3. CONVEYOR TRADE OFF STUDY

As part of the Techno-Economic Study performed by WorleyParsons on behalf of SASOL MINING, for the Shondoni Mine Project, a Conveyor Route Trade Off Study was undertaken (M3230-01-03 SHONDONI MINE PROJECT, Conveyor Route Trade Off Study, WorleyParsons Project Number : 1106, SASOL Mining Project Number M3230, 9 September 2009).

A copy of this report is attached as APPENDIX 2.

3.1 ASSESSMENT METHODOLOGY

Three potential conveyor route options were identified over a period of time and were evaluated by WorleyParsons form primarily an engineering perspective, although environmental related aspects concerned with river crossings and crossing of flooded land were incorporated, albeit primarily from an engineering, construction, operational and maintenance perspective.

WorleyParsons presented the three routes via a drawing review which was followed by a Qualitative Conveyor Route Trade Off Study. Some eighteen parameters had been selected by WorleyParsons. These were then rated in terms of their impacts on each selected route. Some additional parameters relating to the future expansion of the Harmony Slimes Dam, the Sakisizwe land area and the future Synfuels Ash Disposal area were requested to be included in the matrix.

WorleyParsons then also compiled a Quantitative Analysis based on the same parameters. The information generated was reviewed, assessed and discussed on a project Steering Committee meeting on 11th September 2009, which led to selection of the West Route as the preferred alternative from an engineering, operational and cost perspective.

3.2 OUTCOME OF STUDY

The outcome of the study is best summarized by the outcome of the Quantitative Analyses which used a parameter weighted numerical rating/scoring system to identify the preferred alternative. The following aspects formed part of the rating matrix:

- Conveyor length / cost
- Accessibility for maintenance
- Reliability
- Waterway crossings / seasonal flooding
- Environmental permitting
- Tar road crossings
- No. of conveyor elements / flights
- Coal spillage: Overland tracking
- No. of transfer points / Transfer towers
- Land wayleaves
- Noise pollution

- Security / Town / People proximity
- Power line crossings / Eskom permissions
- Through town proclaimed area
- Tar road crossings through culverts
- Farm road crossings through culverts
- Adjacent slimes dams
- Adjacent Harmony dam
- Adjacent future Synfuels ash disposal
- Adjacent Sakisizwe
- Adjacent explosives store
- Cattle crossings

The scoring, out of a possible 100, was as follows:

West Route	**77.7**
Central Route	**59.1**
South East Route	**49.6**

The **west route** was therefore identified from an engineering, operational and cost perspective as the **preferred alternative** by a significant numerical margin.

The full report is attached as APPENDIX 2.

4. ENVIRONMENTAL ASSESSMENT

Although the assessment performed by WorleyParsons and Sasol Mining did contain some environmental elements, JMA Consulting, as part their terms of reference and in support of the application for Environmental Authorizations, performed a route ranking exercise from a pure environmental perspective, neither including public acceptance, nor technical and financial considerations.

4.1 ASSESSMENT METHODOLOGY

The way in which the ranking is performed is straight forward. Each of the available alternative routes is ranked in order of preference for a specific aspect. For example the best route from a "Land Use" perspective would be ranked 1, the second best route 2, and so on. Should routes be deemed to be equal for a specific aspect, they will receive the same ranking.

The route with the **smallest score**, will represent the **preferred alternative route** from an environmental perspective.

From an environmental perspective the project is still within its scoping phase. It therefore implies that detailed environmental information has not yet been generated along any of the alternative overland conveyor routes and therefore the current assessment is based on existing available information. Information used were obtained from various sources including:

- Published 1: 50 000 topographical maps for the area.
- The approved EMPR for the Block 8 Reserves.
- The Mpumalanga Biodiversity Conservation Plan Handbook.

4.2 SELECTION OF ENVIRONMENTAL CRITERIA

The following criteria were selected with specific reference to the overland conveyor routes for the Shondoni Mine Project:

- Surface Water Quality (number of stream crossings)
- Surface Water Quality (length of stream crossings - floodlines)
- Noise (proximity to residential areas)
- Aquatic Ecology (number of crossing of wetland areas)
- Aquatic Ecology (extent of wetland areas)
- Land Capability (crossing of arable, grazing, compromised)
- Land Use (cultivation, grazing, compromised)
- Vegetation (high, moderate, low) – (hirta, triandra, transformed)
- Biodiversity (highly significant, important & necessary, least concern)
- Presence of heritage and cultural interest features

4.3 ENVIRONMENTAL SELECTION MATRIX

The matrix below was compiled specifically for the Middelbult Shondoni Overland Conveyor Route Selection. The weighting factor for each of the criteria is indicated in brackets:

Middelbult Shondoni Conveyor Route Selection	West Route	Central Route	South-East Route
Surface Water Quality (number of stream crossings)	1	2	3
Surface Water Quality (length of stream crossings - floodlines)	1	2	2
Noise (proximity to residential areas)	2	2	1
Aquatic Ecology (number of crossing of wetland areas)	1	3	2
Aquatic Ecology (extent of wetland areas)	1	2	3
Land Capability (crossing of arable, grazing, compromised	2	3	1
Land Use (cultivation, grazing, compromised	2	3	1
Vegetation (high, moderate, low) – (hirta, triandra, transformed)	1	2	3
Biodiversity (highly significant, important & necessary, least concern)	1	2	3
Presence of heritage and cultural interest features	2	1	2
Sum	14	22	21
Ranking	1	3	2

4.4 THE PREFERRED ENVIRONMENTAL ALTERNATIVE

The environmental ranking assessment confirms the **West Route** as the preferred alternative for the overland conveyor. The few river and wetland crossings most probably carry the most weight in this regard. The fact that this route will run alongside an existing road servitude for quite a significant part of its length, which implies minimal influence on agricultural land use, further benefitted the assessment.

One of the most critical potential impacts related to this west conveyor route probably relates to noise in close proximity to residential areas (Brendan Village and eMbalenhle).

5. CONSULTATION WITH LAND OWNERS

5.1 LAND OWNER FOCUS GROUP MEETING

A Land Owners focus group meeting was held on 19 March 2010 at 10:00am. The venue for the meeting was Brendan Lodge in Brendan Village. The purpose of the meeting was to inform the potential affected landowners of the selection process followed by Sasol Mining with regards to the selection of a preferred conveyor route, to afford them the opportunity to give inputs into the selection process if they so wish, and finally to facilitate agreement on the preferred alternative. All of the affected landowners were invited per formal letter that was distributed to them beforehand (Please refer Appendix 4 of this document for documentation relating to this meeting).

5.2 ISSUES AND CONCERNS

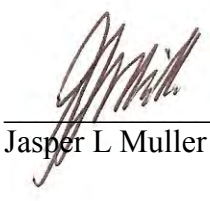
Several issues regarding the proposed location of the overland conveyor route were raised and among these the standout issues pertained to the following:

- Loss of agricultural land
- Access to properties
- Proximity of conveyor to residential areas (Noise, Visual aspects)
- Maintenance on conveyor route
- Cemetery to the south of eMbalenhle
- Safety zone for explosives magazine
- Some of the alternatives falls within the 1:100 year flood line

(Please refer to Appendix 4 of this report for the full register on issues and concerns that were raised)

The issues and concerns were noted and will be dealt with in the Plan of Study.

Respectfully submitted



Jasper L Muller (Pr.Sci.Nat.)

APPENDIX 1

LIST OF AFFECTED PROPERTIES

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
1.	Leeuwspruit 134 IS	Remaining Extent	Name	Evander Gold Mines Ltd	Agricultural	T0IS00000000013400000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander, 2280		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
2.	Witkleifontein 131 IS	Portion 1	Name	Sakhisiswe CPA	Agricultural	T0IS00000000013100001
			Contact Person	S Ndlovu		
			Postal Address	P.O. Box 818, Evander, 2280		
			Cellular	082 044 2820		
3.	Zandfontein 130 IS	Portion 4	Name	E.L. du Plooy	Agricultural	T0IS00000000013000004
			Contact Person	L du Plooy		
			Postal Address	P.O. Box 655, Evander, 2280		
			Cellular	082 492 7672		
Preferred Western Conveyor Option (Green)						
4.	Zandfontein 130 IS	Portion 4	Name	E.L. du Plooy	Agricultural	T0IS00000000013000004
			Contact Person	L du Plooy		
			Postal Address	P.O. Box 655, Evander, 2280		
			Cellular	082 492 7672		
5.	Zandfontein 130 IS	Portions 2, 5, 12	Name	Brendan Village	Portion 2 – Agricultural Portion 5 – Agricultural Portion 12 – Agricultural	Portion 2 – T0IS00000000013000002 Portion 5 – T0IS00000000013000005 Portion 12 – T0IS00000000013000012
			Contact Person	Carel Dirker		
			Postal Address	P.O. Box 3897, Witbank, 1035		
			Telephone	(013) 656 3816		
			Facsimile	(013) 656 5954		
			Cellular	082 325 6108		
			e-mail	carel@brendanvillage.com		
6.	Zandfontein 130 IS	Portions 8, 9	Name	Evander Gold Mines Ltd	Portion 8 – Agricultural Portion 9 – Agricultural	Portion 8 – T0IS00000000013000008 Portion 9 – T0IS00000000013000009
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
7.	Grootspruit 279 IS	Portions 3, 5, Remaining Extent	Name	Evander Gold Mines Ltd	Portion 3 – Agricultural Portion 5 – Agricultural Rem Ext – Agricultural	Portion 3 – T0IS00000000027900003 Portion 5 – T0IS00000000027900005 Rem Ext – T0IS00000000027900000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
8.	Grootspruit 279 IS	Portion 7	Name	J.C. Els	Agricultural	T0IS00000000027900007

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
			Contact Person	S van Niekerk		
			Postal Address	P.O. Box 35, Standerton,		
			Telephone	(017) 712 5211		
			Facsimile	086 614 1755		
			e-mail	svniekerk@ipsojure.co.za		
9.	Grootspruit 279 IS	Portions 12, 14	Name	Siyalinga Small Scale Farmers Co-Operative	Portion 12 - Agricultural Portion 14 – Agricultural	Portion 12 – T0IS00000000027900012 Portion 14 – T0IS00000000027900014
			Contact Person	Daniel Vilakazi		
			Cellular	076 095 673		
10.	Grootspruit 279 IS	Portions 2, 9, 10	Name	Govan Mbeki Local Municipality	Portion 2 – Agricultural Portion 9 – Agricultural Portion 10 – Agricultural	Portion 2 – T0IS00000000027900002 Portion 9 – T0IS00000000027900009 Portion 10 – T0IS00000000027900010
			Contact Person	Albert Olivier		
			Postal Address	Private Bag X 1017, Secunda, 2302		
			Telephone	(017) 620 6000		
			Facsimile	(017) 631 3599		
			e-mail	albert.o@govanmbeki.gov.za		
11.	Rietkuil 283 IS	Portion 8	Name	eMbalenhle Community Trust	Agricultural	T0IS00000000028300008
			Contact Person			
			Postal Address			
			Telephone			
			Facsimile			
			Cellular			
			e-mail			
12.	Rietkuil 283 IS	Portion 6	Name	J.F.N.T. Pistorius	Agricultural	T0IS00000000028300006
			Contact Person	Willem Pistorius		
			Postal Address	PO Box 599, Standerton 2280		
			Telephone	(017) 702 3033		
			Cellular	083 282 4132		
13.	Rietkuil 283 IS	Portion 5	Name	Republic of South Africa	Agricultural	T0IS00000000028300005
			Contact Person	Basil Louw		
			Postal Address	Private Bag X3, Braamfontein		
			Telephone	(011) 339 6442		
14.	Rietvley 320 IS	Portion 3, Remaining Extent	Name	Sasol Synfuels (Pty) Ltd	Portion 3 - Agricultural Rem Ext – Agricultural	Portion 3 – T0IS00000000032000003 Rem Ext – T0IS00000000032000000
			Contact Person	AS Potgieter		
			Postal Address	P O Box 699, Trichardt 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	ampie.potgieter@sasol.com		
15.	Rietvley 320 IS	Portion 4	Name	Sasol Mining (Pty) Ltd	Agricultural	T0IS00000000032000004
			Contact Person	AS Potgieter		
			Postal Address	P O Box 699, Trichardt 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
			e-mail	ampie.potgieter@sasol.com		
16.	Rietvley 320 IS	Portion 8	Name	Amos, Jiyana Buti	Agricultural	T0IS00000000032000008
			Contact Person	Amos Buti		
			Postal Address	9 Hulu Str Embalenthle		
			Cellular	072 120 8098		
Centre Conveyor Option (Red)						
17.	Witkleifontein 131 IS	Portion 1	Name	Sakhisiswe CPA	Agricultural	T0IS00000000013100001
			Contact Person	S Ndlovu		
			Postal Address	P.O. Box 818, Evander, 2280		
			Cellular	082 044 2820		
18.	Witkleifontein 131 IS	Portion 2, 3, 4, Remaining Extent	Name	Evander Gold Mines Ltd	Portion 2 – Agricultural Portion 3 – Agricultural Portion 4 – Agricultural Rem Ext – Agricultural	Portion 2 – T0IS00000000013100002 Portion 3 – T0IS00000000013100003 Portion 4 – T0IS00000000013100004 Rem Ext – T0IS00000000013100000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
19.	Langverwacht 282 IS	Portion 2	Name	Evander Gold Mines Ltd	Agricultural	T0IS00000000028200002
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
20.	Langverwacht 282 IS	Portion 11	Name	Hoëvelddrif Plaaslike Oorgangs Raad	Agricultural	T0IS00000000028200011
			Contact Person	Albert Olivier		
			Postal Address	Private Bag X 1017, Secunda, 2302		
			Telephone	(017) 620 6000		
			Facsimile	(017) 631 3599		
			e-mail	albert.o@govanmbeki.gov.za		
21.	Grootspruit 279 IS	Portion 4	Name	M.L. Wienand	Agricultural	T0IS00000000027900004
			Contact Person	M Wienand		
			Postal Address	P.O. Box 1911, Manaba Beach, 4276		
			Telephone	(012) 991 1666		
			Cellular	083 441 2733		
			e-mail	familysmit@telkonsa.net		
22.	Grootspruit 279 IS	Portion 7	Name	J.C. Els	Agricultural	T0IS00000000027900007
			Contact Person	S van Niekerk		
			Postal Address	P.O. Box 35, Standerton,		
			Telephone	(017) 712 5211		
			Facsimile	086 614 1755		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
			e-mail	svniekerk@ipsojure.co.za		
23.	Grootspruit 279 IS	Portions 9, 10	Name	Govan Mbeki Local Municipality	Portion 9 – Agricultural Portion 10 - Agricultural	Portion 9 – T0IS00000000027900009 Portion 10 – T0IS00000000027900010
			Contact Person	Albert Olivier		
			Postal Address	Private Bag X 1017, Secunda, 2302		
			Telephone	(017) 620 6000		
			Facsimile	(017) 631 3599		
			e-mail	albert.o@govanmbeki.gov.za		
24.	Grootspruit 279 IS	Portions 8, 20	Name	Republic of South Africa	Portion 8 – Agricultural Portion 20 - Agricultural	Portion 8 – T0IS00000000027900015 Portion 20 – T0IS00000000027900020
			Contact Person	Basil Louw		
			Postal Address	Private Bag X3, Braamfontein		
			Telephone	(011) 339 6442		
25.	Rietkuil 283 IS	Portion 8	Name	eMbalenhle Community Trust	Agricultural	T0IS00000000028300008
			Contact Person			
			Postal Address			
			Telephone			
			Facsimile			
			Cellular			
			e-mail			
26.	Rietkuil 283 IS	Portion 6	Name	J.F.N.T. Pistorius	Agricultural	T0IS00000000028300006
			Contact Person	Willem Pistorius		
			Postal Address	PO Box 599, Standerton 2280		
			Telephone	(017) 702 3033		
			Cellular	083 282 4132		
27.	Rietkuil 283 IS	Portion 5	Name	Republic of South Africa	Agricultural	T0IS00000000028300005
			Contact Person	Basil Louw		
			Postal Address	Private Bag X3, Braamfontein		
			Telephone	(011) 339 6442		
28.	Rietvley 320 IS	Portion 3, Remaining Extent	Name	Sasol Synfuels (Pty) Ltd	Agricultural	Portion 3 – T0IS00000000032000003 Rem Ext – T0IS00000000032000000
			Contact Person	AS Potgieter		
			Postal Address	P O Box 699, Trichardt 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	ampie.potgieter@sasol.com		
29.	Rietvley 320 IS	Portion 4	Name	Sasol Mining (Pty) Ltd	Agricultural	T0IS00000000032000004
			Contact Person	AS Potgieter		
			Postal Address	P O Box 699, Trichardt 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	ampie.potgieter@sasol.com		
30.	Rietvley 320 IS	Portion 8	Name	Amos, Jiyana Buti	Agricultural	T0IS00000000032000008
			Contact Person	Amos Buti		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
			Postal Address	9 Hulu Str Embalenthle		
			Cellular	072 120 8098		
Eastern Conveyor Option (Purple)						
31.	Witkleifontein 131 IS	Portion 1	Name	Sakhisiswe CPA	Agricultural	T0IS00000000013100001
			Contact Person	S Ndlovu		
			Postal Address	P.O. Box 818, Evander, 2280		
			Cellular	082 044 2820		
32.	Witkleifontein 131 IS	Portion 4, Remaining Extent	Name	Evander Gold Mines Ltd	Portion 4 – Agricultural Rem Ext – Agricultural	Portion 4 – T0IS00000000013100004 Rem Ext – T0IS00000000013100000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
33.	Adullam 577 IS	Remaining Extent	Name	Adullam Trust	Agricultural	T0IS00000000057700000
			Contact Person			
			Postal Address			
			Telephone			
			Facsimile			
			Cellular			
			e-mail			
34.	Goedverwachting 287 IS	Remaining Extent	Name	Evander Gold Mines Ltd	Agricultural	T0IS00000000028700000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
35.	Winkelhaak 135 IS	Portion 13	Name	Evander Gold Mines Ltd	Agricultural	T0IS00000000013500013
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
36.	Halvepan 286 IS	Remaining Extent	Name	Sasol Synfuels (Pty) Ltd	Agricultural	T0IS00000000028600000
			Contact Person	A Potgieter		
			Postal Address	P.O. Box 699,Trichardt, 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	anpie.potgieter@sasol.com		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
37.	Sasolkraal 289 IS	Portion 1	Name	Sasol Synfuels (Pty) Ltd	Agricultural	T0IS00000000028900001
			Contact Person	A Potgieter		
			Postal Address	P.O. Box 699,Trichardt, 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	anpie.potgieter@sasol.com		
38.	Middelbult 284 IS	Portion 23	Name	Eskom Holdings	Agricultural	T0IS00000000028400023
			Contact Person	E. Grunewald		
			Postal Address	P.O. Box 1491, Johannesburg, 2000		
			Telephone	011 800 5732		
			Facsimile	086 655 7036		
			Cellular	083 632 7668		
			e-mail	ernest.grunewald@eskom.co.za		
39.	Middelbult 284 IS	Portions 9, 12, 13	Name	Sasol Synfuels (Pty) Ltd	Portion 9 – Agricultural Portion 12 – Agricultural Portion 13 - Agricultural	Portion 9 – T0IS00000000028400009 Portion 12 – T0IS00000000028400012 Portion 13 – T0IS00000000028400013
			Contact Person	A Potgieter		
			Postal Address	P.O. Box 699,Trichardt, 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	anpie.potgieter@sasol.com		

APPENDIX 2

APPENDIX 4 – SPECIALIST REPORT

4.5 Conveyor Route Trade/Off Study
WORLEY PARSONS
M3230-01-03 SHONDONI MINE PROJECT
Techno Economic Study

M3230-01-03 SHONDONI MINE PROJECT

Conveyor Route Trade Off Study

WorleyParsons Project Number : 1106

SASOL Mining Project Number: M3230

Prepared by: D. G. Young Project Engineer, WorleyParsons

09 September 2009

SYNOPSIS

Disclaimer

This document / report has been prepared on behalf of and for the exclusive use of Sasol Mining, and is subject to and issued in accordance with the agreement between Sasol Mining and WorleyParsons. WorleyParsons accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

1. OVERVIEW

When the Sasol Mining selected Overland Conveyor Route (Central Route) was initially overlaid on the area topographical contour plan it was observed that certain sections of the conveyor transgressed over a number of areas which are subject to annual flooding. Elevating the conveyor above the flood levels drastically reduces maintenance access. Creating a backfill area substantial enough to support the conveyor as well as providing vehicular access alongside the conveyor was seen to be environmentally difficult. In addition the proximity of the Slimes Dam to the conveyor may be detrimental to conveyor reliability in the longer term. As part of an internal Value Engineering exercise WorleyParsons identified a potential alternative conveyor route, hence the West Route materialised.

The concept of an alternative conveyor route was first discussed with the Sasol Mining Project Team on **7th August 2009** and subsequently formed part of the Phase 1 deliverables.

The first formal review of the Overland Conveyor Routes, those being the Client selected Central Route and the WorleyParsons proposed West Route, were tabled at the Sasol Mining / WorleyParsons Risk Review held on **18th August 2009.**

Although not shown on the drawing a possible alternative route to the south, for the conveyor to run parallel with the planned Impumelelo overland conveyor was discussed. This had distinct advantages such as:

- Way leave permits in place,
- Better security,
- Improved safety i.e. away from habitation
- Power availability for transfer tower drives.

It was felt that the increase in capital cost due to the increased conveyor length did not justify further investigation of this possibility.

Although the WorleyParsons team had anticipated some pre - selection of a preferred route, a decision was deferred to a meeting held on **20th August 2009** when a larger team of mine related engineers could contribute to the decision making process. At this meeting the West and Central routes complete with route cross section contour profiles were reviewed.

Sasol Mining proposed that a further third route to the South East be investigated as this route was seen to be shorter. WorleyParsons stated that due to the adverse terrain of the South East route this would take some three to four working days to create the conveyor route with suitable conveyor curves and contour profiles. Sasol Mining requested that these drawings be finalised by **27th August 2009.** The drawings were handed to Sasol Mining on **28th August 2009** for overview by Sasol Mining in preparation for a further review meeting set up for **4th September 2009.**

The conveyor route review was held on **4th September 2009** and attended by the Sasol Mining and WorleyParsons project team members. WorleyParsons presented the three routes via a drawing review which was followed by a Qualitative Conveyor Route Trade Off Study. Some eighteen parameters had been selected by WorleyParsons. These were then rated in terms of their impact on each selected route. Some additional parameters relating to the future expansion of the Harmony Slimes Dam, the Sakisiswe land area and the future Synfuels ash disposal area were requested to be included in the matrix. These should also be indicated on an update of the conveyor route drawing. WorleyParsons would also compile a Quantitative Analysis based on the same parameters. The revised drawing and Trade Off Studies are to be available by **9th September 2009** in order that Sasol Mining Project Team can prepare for a presentation to the Steering Committee on **11th September 2009.**

Some four weeks of design project time have been expended in investigating the various conveyor routes (**18th August - 14th September 2009**). It is there for imperative that a final decision is taken at the Steering Committee Meeting such that more detailed conveyor layouts can proceed.

2. QUANTITATIVE AND QUALITATIVE ASSESSMENT

Notes are incorporated on the Qualitative Spread Sheet. These should be read in conjunction with the Trade Off.

The notes incorporated on the Quantitative Spread Sheet explain the basis on how the Analysis was compiled. With these types of Analyses the Option with the highest rating is always deemed to be the most favourable.

3. APPENDICES

1 off page Qualitative Analysis

1 off page Quantitative Analysis

1 off CD of Drawing No. 1106 000 GE DAL 0002 02 REV A Site Plan (Conveyor Routes)

CONVEYOR ROUTE TRADE OFF STUDY

SHONDONI OVERLAND CONVEYOR ROUTE QUANTITATIVE AND QUALITATIVE ASSESSMENT					
ID	PARAMETERS	Units	OPTION 1 CENTRAL ROUTE	OPTION 2 WEST ROUTE	OPTION 3 SOUTH EAST ROUTE
1	CONVEYOR LENGTH	Km	17.3	17.6	12.6
	CONVEYOR COST - STRAIGHT LINE Cost per metre	ZAR 28000	484,016,000	492,848,000	352,744,000
1	EARTHWORKS TO SUPPORT RAISED CONVEYORS Compacted backfill per m3	ZAR 200	36,000,000 (Length = 1800m x 100m2 area)	0	48,000,000 (Length = 2400m x 100m2 area)
	Estimated cost including earthworks	ZAR	521,016,000	492,848,000	400,744,000
1	Alternatively allow for raised conveyors on elevated sections Allow additional cost / m for steelwork and drainage	ZAR 10000	18,000,000 Length = 1800m	300,000 Length = 30m	24,000,000 Length = 2400m
	Estimated cost for raised conveyors without earthworks		502,016,000	492,848,000	376,744,000
1	Conceptual Annual Operating Cost Cost per Tonne per Kilometer	ZAR 0.15	36,691,200	28,367,040	18,141,120
	Delta vs lowest Annual Operating Cost		10,449,180	7,225,920	-
2	NO. OF CONVEYOR ELEMENTS/FLIGHTS		3	3	1
3	ACCESSABILITY FOR MAINTENANCE		Poor	Good	Very Poor
4	WATERWAY CROSSINGS/ SEASONAL FLOODING GANTRIES OVER MAIN STREAM CROSSINGS AND WETLAND		3 / High	1 / Low	4 / High
5	COAL SPILLAGE: OVERLOADING/TRACKING		Medium	Low	High
6	No. OF TRANSFER POINTS / TRANSFER TOWERS		3	3	1
7	ENVIRONMENTAL PERMITTING		High	Low	Very High
8	LAND WAYLEAVES		Medium	Medium / High	Very High
9	RELIABILITY		Average	Good	Average
10	NOISE POLLUTION		Poor	Poor	Poor
11	SECURITY / TOWN / PEOPLE PROXIMITY		Poor	Poor	Poor
12	POWER LINE CROSSINGS / ESKOM PERMISSIONS		4 / Yes	6 / Yes	6 Plus / Yes
13	TAR ROAD CROSSINGS THROUGH CULVERTS		3	7	4
14	TAR ROAD CROSSINGS ELEVATED		2	0	2
15	FARM ROAD CROSSINGS THROUGH CULVERTS		1	7	0
16	ADJACENT EXISTING SLIMES DAMS OR OTHER DAMS		1	1	2
17	ADJACENT PROPOSED HARMONY SLIMES DAM EXPANSION		No	No	Yes
18	ADJACENT FUTURE SYNFUELS ASH DISPOSAL		No	No	Yes
19	ADJACENT SAKISIWE (POTENTIALLY DIFFICULT NEGOTIATIONS)		No	No	Yes
20	THROUGH EXISTING TOWN PROCLAMATION		No	No	Yes
21	ADJACENT EXPLOSIVES STORE		Yes	No	No
22	CATTLE CROSSINGS REQUIRED + RAISED CULVERT ROAD		To be determined	To be determined	To be determined
	NOTES Conveyor lengths can be regarded as accurate for each route Bulk earthworks (earth quantity take offs and rate estimates) are unqualified i.e. they have been estimated Elevated conveyor gantry quantity take offs for supply and erection costs are unqualified i.e. they have been estimated Access for maintenance of conveyors and emergency events such as floods, belt breaks, belt spills & major spillage should be allowed for/dealt with route selection Environmental permitting for river crossings and wetland areas need to be taken cognisance of with route selection - comments by EIA Consultant				

4. QUANTITATIVE ANALYSIS

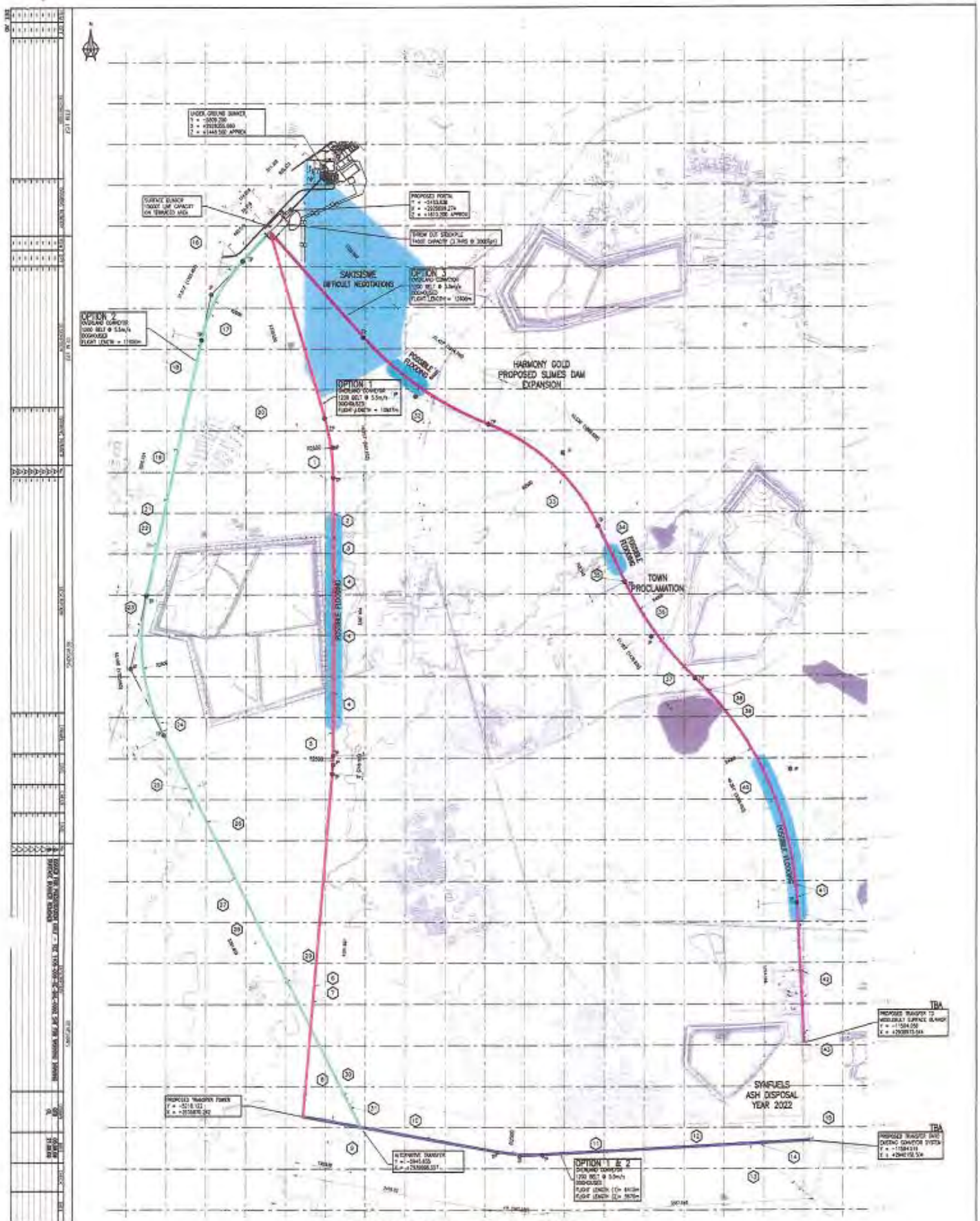
SHONDONI OVERLAND CONVEYOR ROUTE QUANTITATIVE ANALYSIS

The competing overland conveyor routes are rated on a score of 0 to 10 against the same series of parameters as in the analysis. Low values represent a poor fit with ranking parameters, higher values represent a better fit. Finally to facilitate decision making, the categories are weighted to reflect their perceived relative importance to Sasol Mining.

ID	RANKING PARAMETERS	WEIGHTING %	OPTION 1 CENTRAL ROUTE		OPTION 2 WEST ROUTE		OPTION 3 SOUTH EAST ROUTE	
			RATING	WEIGHTED	RATING	WEIGHTED	RATING	WEIGHTED
1	CONVEYOR LENGTH / COST	20	8	16	8	16	10	20
3	ACCESSABILITY FOR MAINTENANCE	20	5	10	10	20	2	4
9	RELIABILITY	10	7	7	8	8	5	5
4	WATERWAY CROSSINGS / SEASONAL FLOODINGS	5	2	1	8	4	2	1
7	ENVIRONMENTAL PERMITTING	4	4	1.6	6	2.4	2	0.8
14	TAR ROAD CROSSINGS ELEVATED	4	3	1.2	5	2	3	1.2
2	NO. OF CONVEYOR ELEMENTS / FLIGHTS	3	5	1.5	5	1.5	10	3
5	COAL SPILLAGE: OVERLAND TRACKING	3	5	1.5	6	1.8	2	0.6
6	NO. OF TRANSFER POINTS / TRANSFER TOWERS	3	7	2.1	7	2.1	8	2.4
8	LAND WAYLEAVES	3	5	1.5	5	1.5	2	0.6
10	NOISE POLLUTION	3	4	1.2	7	2.1	7	2.1
11	SECURITY / TOWN / PEOPLE PROXIMITY	3	4	1.2	4	1.2	4	1.2
12	POWER LINE CROSSINGS / ESKOM PERMISSIONS	3	5	1.5	5	1.5	2	0.6
20	THROUGH TOWN PROCLAIMED AREA	3	10	3	10	3	3	0.9
13	TAR ROAD CROSSINGS THROUGH CULVERTS	2	5	1	5	1	5	1
15	FARM ROAD CROSSINGS THROUGH CULVERTS	2	5	1.2	6	1.2	8	1.6
16	ADJACENT SLIMES DAMS	2	2	0.4	7	1.4	2	0.4
17	ADJACENT HARMONY DAM	2	10	2	10	2	2	0.4
18	ADJACENT FUTURE SYNFUELS ASH DISPOSAL	2	10	2	10	2	2	0.4
19	ADJACENT SAKISISWE	2	10	2	10	2	2	0.4
21	ADJACENT EXPLOSIVES STORE	1	2	0.2	10	1	10	1
22	CATTLE CROSSINGS	Ignored						
	Total	100		59.1		77.7		49.6

CONCLUSIONS

On the basis of the above analysis Option 2, the West route should be selected as the preferred Overland Conveyor route. The conclusion is consistent with the comments, debate and final qualitative selection by the combined Sasol Mining and Worley Parsons Project Teams at the meeting held on 4th September 2009 at the Sasol Mining Offices.



SHONDONI MINE LAYOUT

SCALE 1:15000

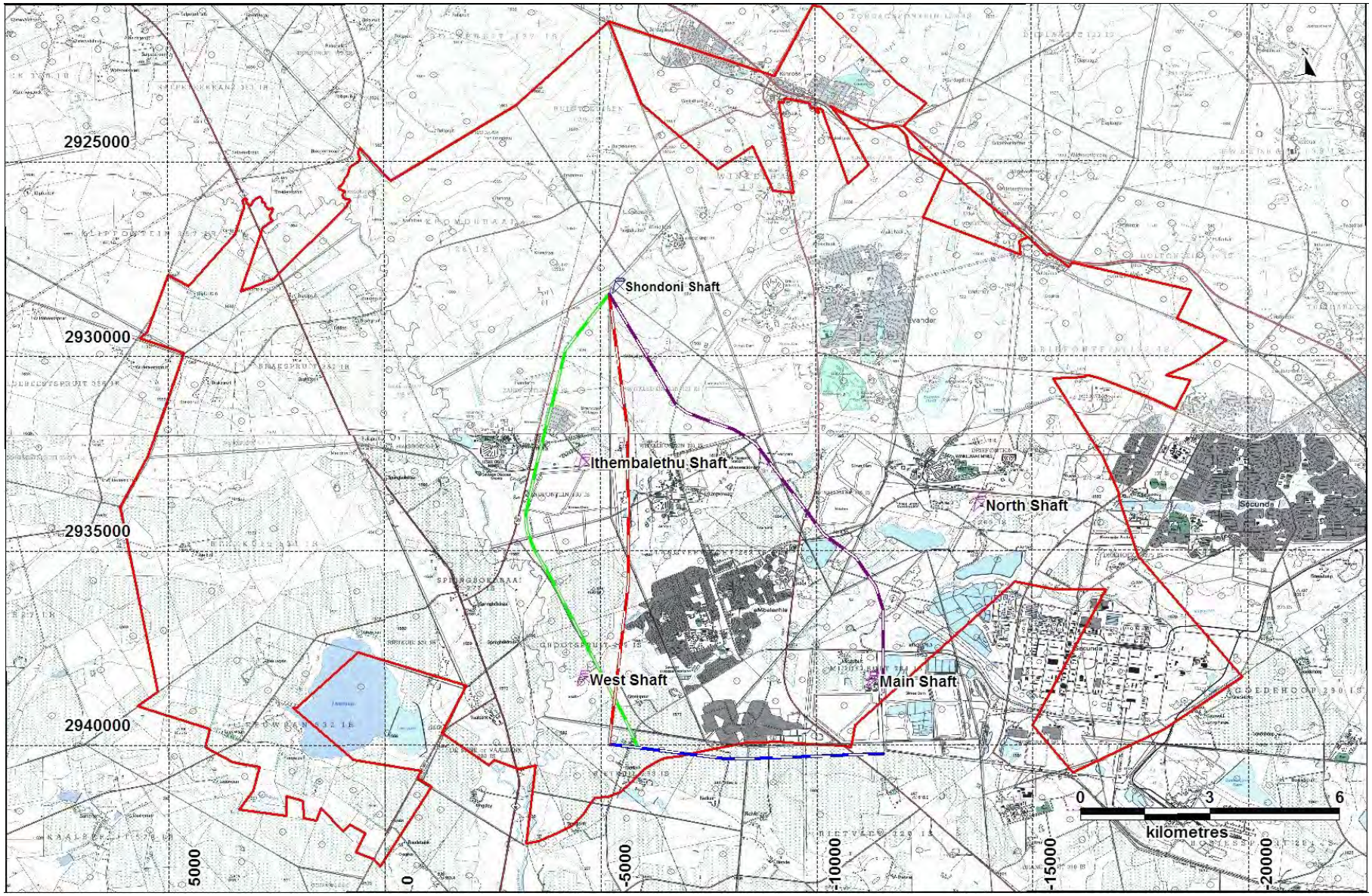
Sasol Mining (Pty) Ltd

WorleyParsons

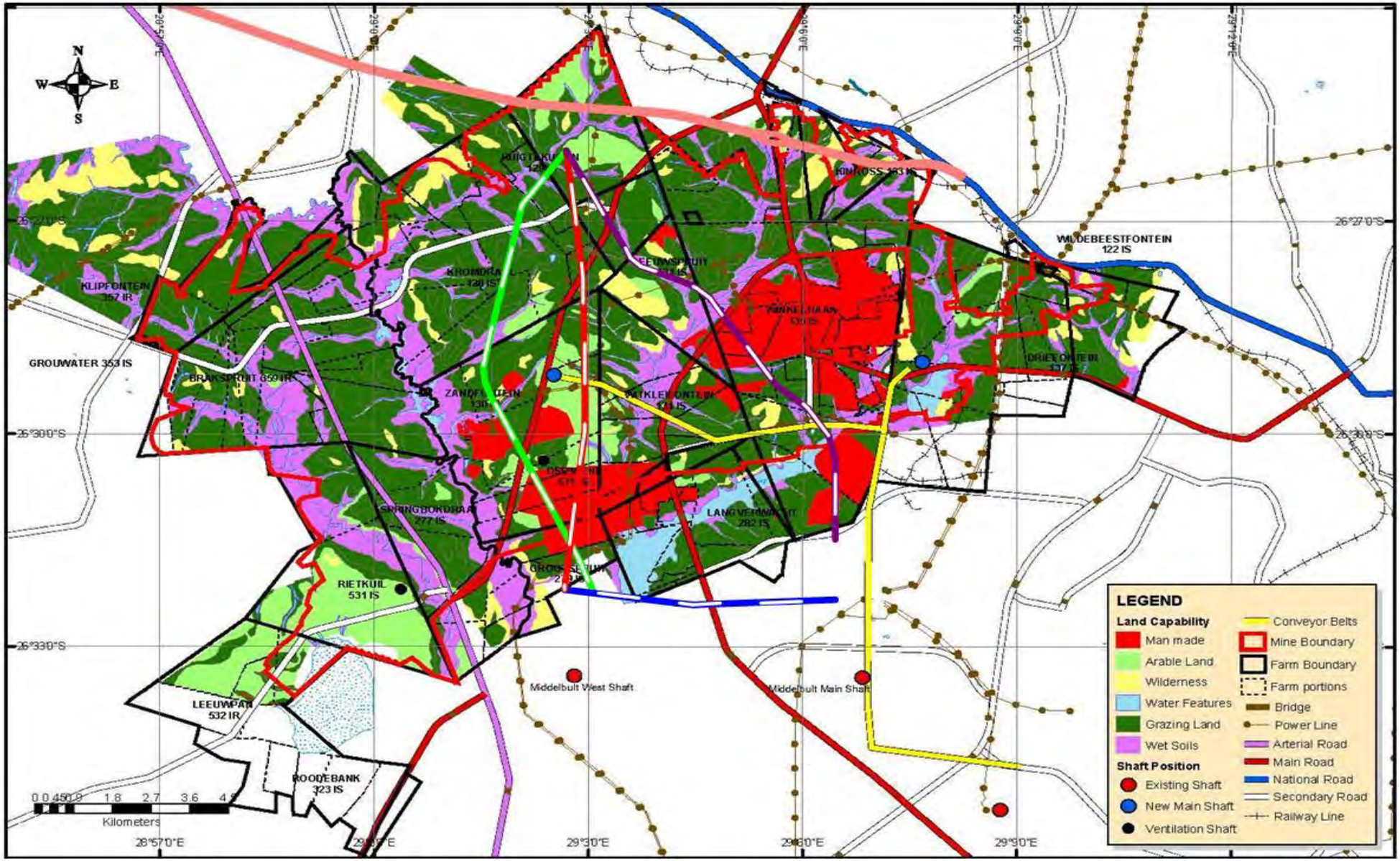
APPENDIX 3

ENVIRONMENTAL BASE MAPS

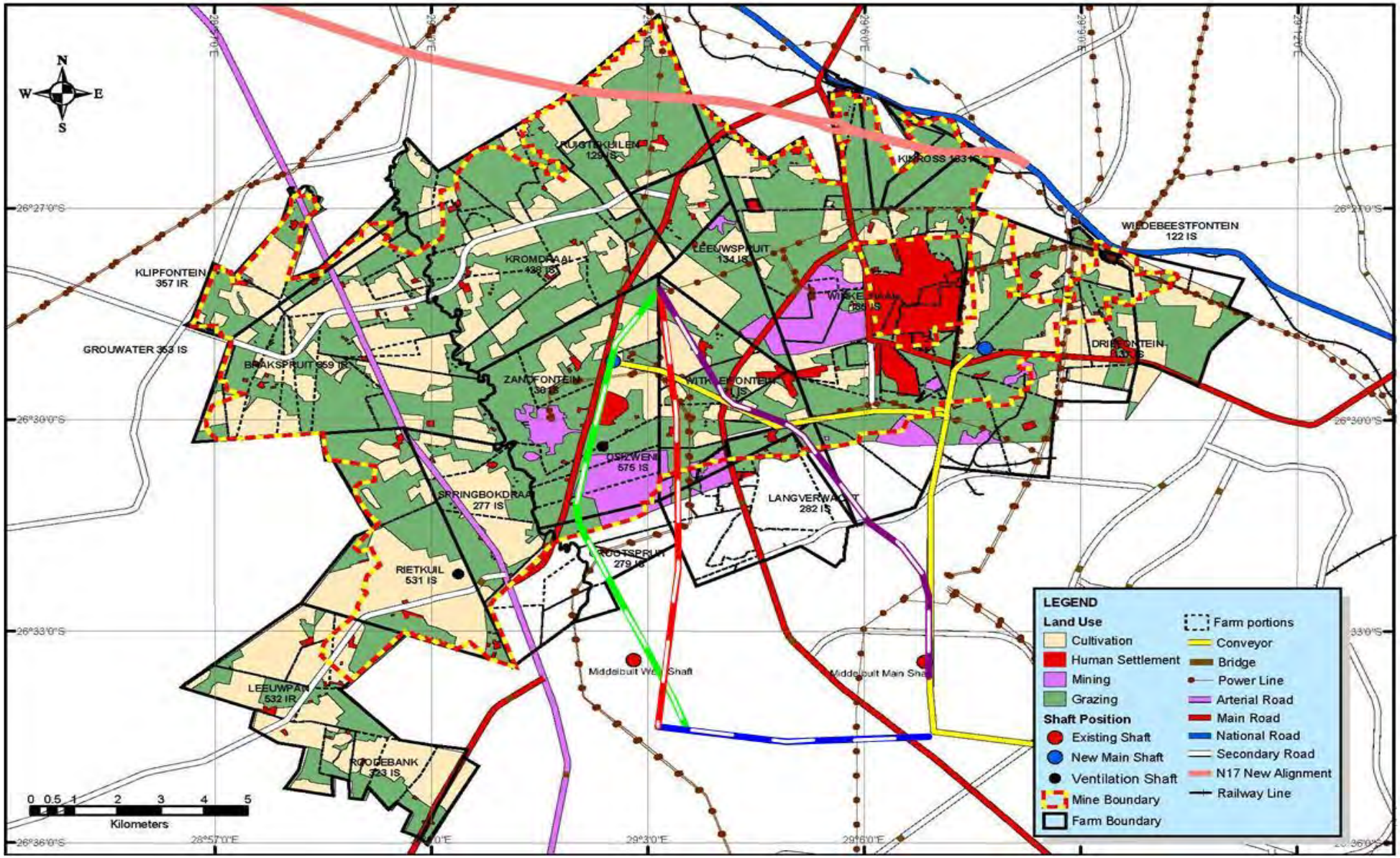
TOPOGRAPHIC MAP WITH SURFACE STREAMS



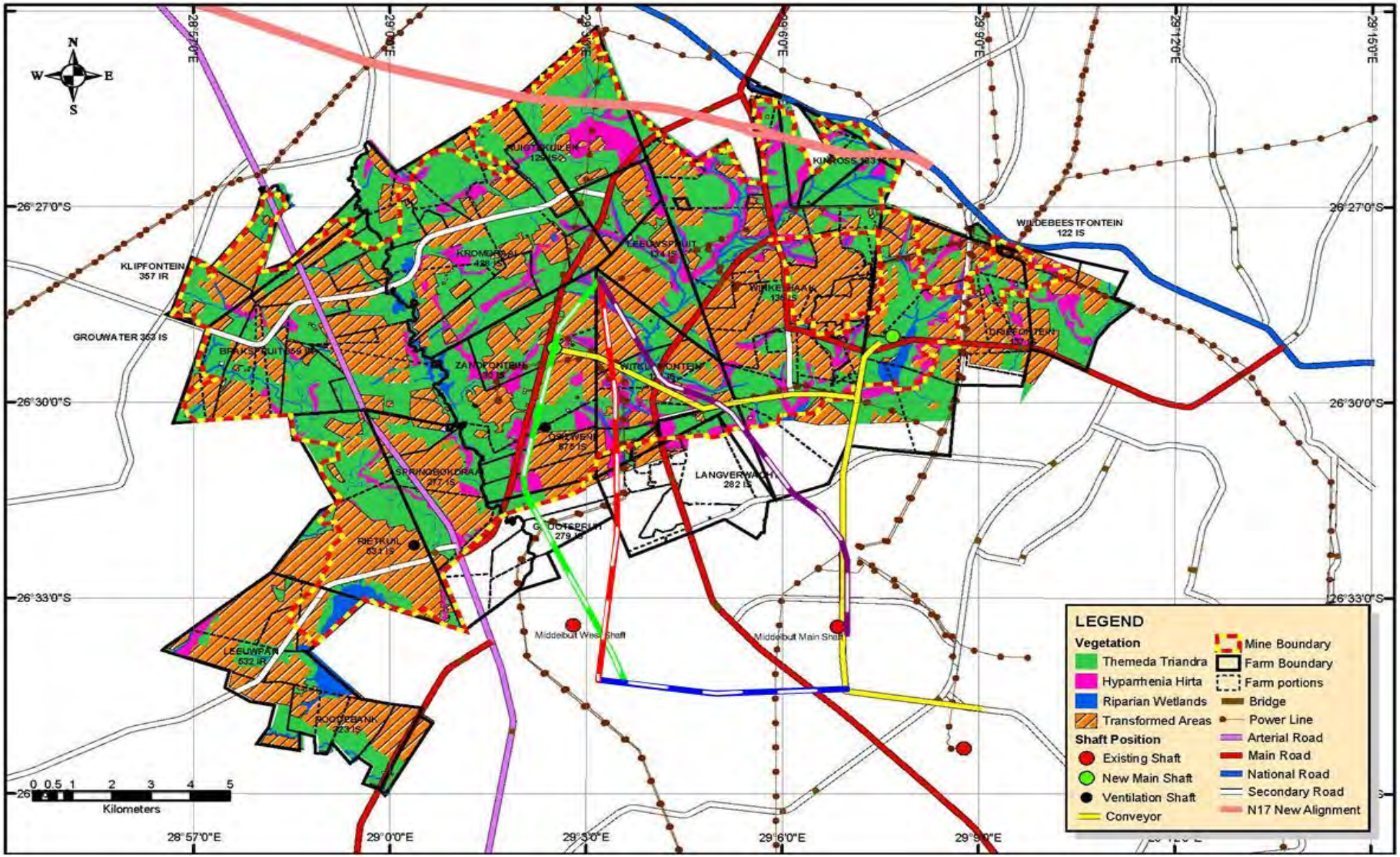
LAND CAPABILITY MAP (NOTE EXTENT OF WET SOILS WHICH INDICATE WETLAND AREAS)



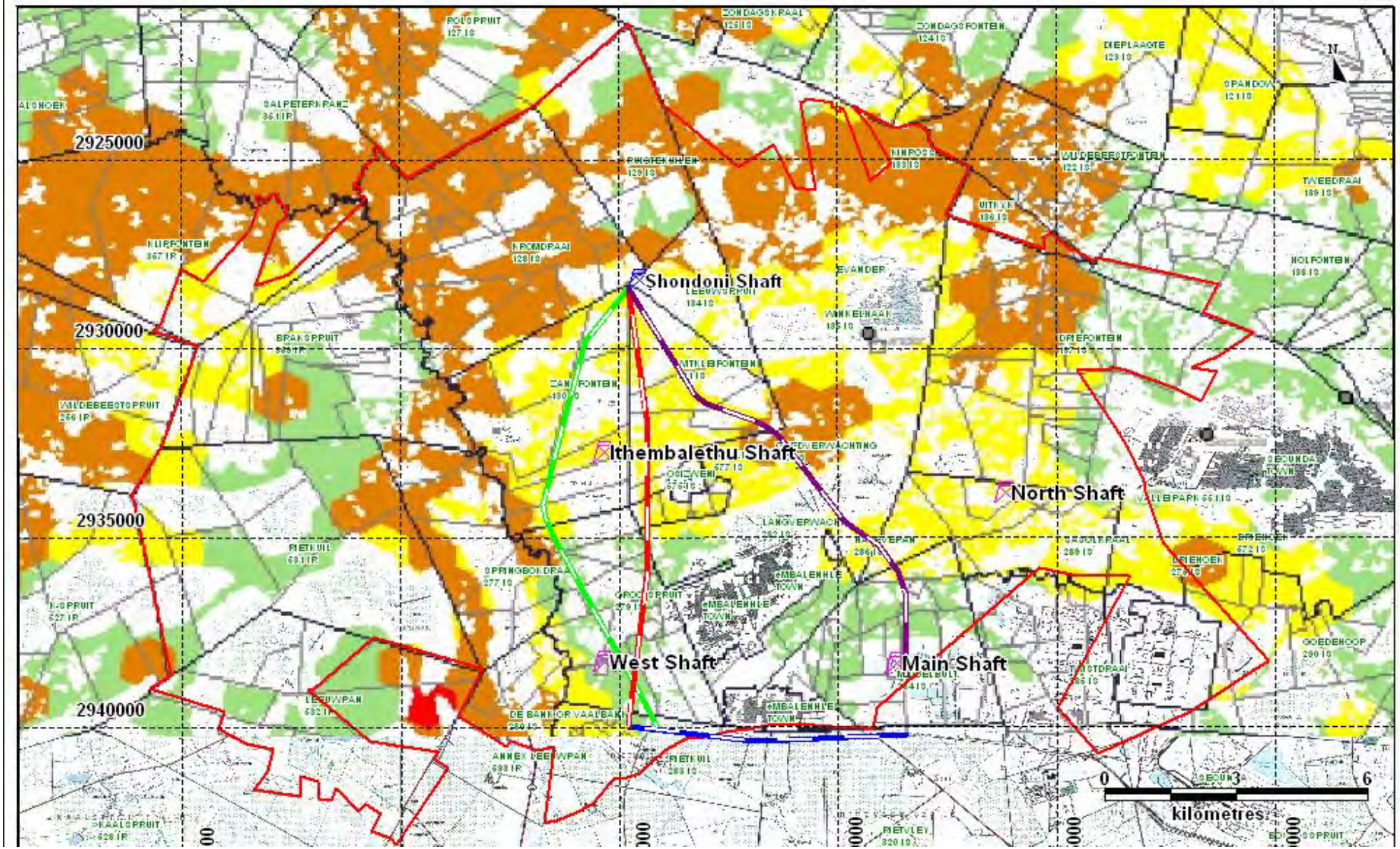
LAND USE MAP


N
W
E
S
KLIPFONTEIN 357 IR
GROUWATER 363 IS
BRAKSPRUIT 359 IR
KROMDRAAI 438 IS
ZANDFONTEIN 301 IS
LEEUWSPRUIT 134 IS
WILDEBEESTFONTEIN 122 IS
OSRWEN 575 IS
SPRINGBOKDRAAI 277 IS
LANGVERWACHT 282 IS
ROOTSPRUIT 279 IS
RIETKUIL 531 IS
LEEUWPAN 532 IR
RONDEBANK 323 IS
0 0.5 1 2 3 4 5
Kilometers
LEGEND
Land Use
Cultivation
Human Settlement
Mining
Grazing
Shaft Position
Existing Shaft
New Main Shaft
Ventilation Shaft
Mine Boundary
Farm Boundary
Farm portions
Conveyor
Bridge
Power Line
Arterial Road
Main Road
National Road
Secondary Road
N17 New Alignment
Railway Line

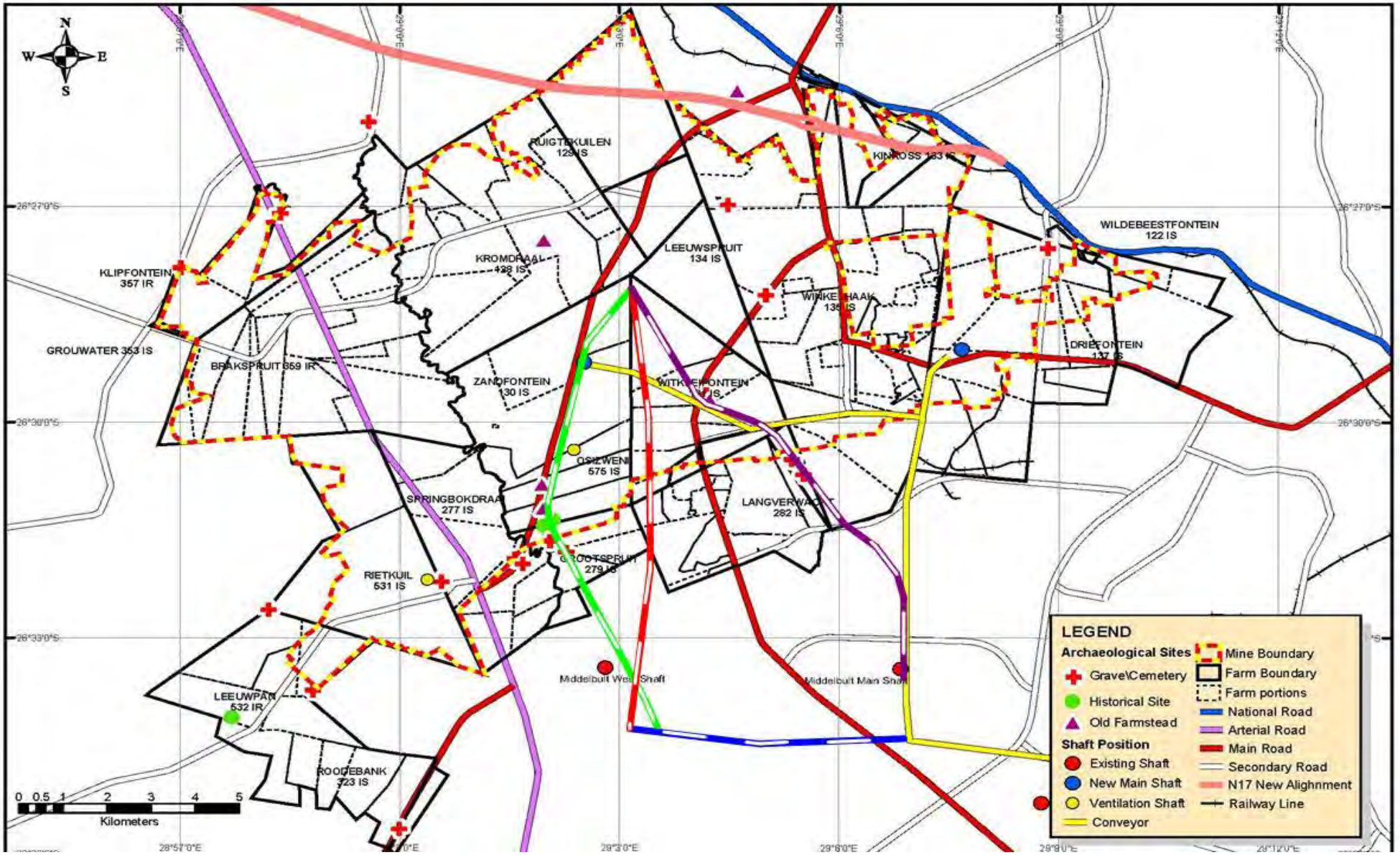
VEGETATION MAP



MPUMALANGA BIODIVERSITY CONSERVATION PLAN MAP



HERITAGE AND CULTURAL INTEREST FEATURES MAP



APPENDIX 4

CONSULTATION WITH LAND OWNERS

Invitation Letters
Agenda
Attendance Register
Presentation Handout
Minutes of Meeting
Comments Register
Landowner Consent Letter

JMA Consulting (Pty) Ltd

15 Vickers Street
Delmas
P O Box 883
Delmas, 2210
Tel (013) 665 1788
Fax (013) 665 2364

Sustainable Environmental Solutions through integrated Science and Engineering

JMA Projek Verwysingsnommer – **JMA/10391**

11 Maart 2010-03-11

VIR AANDAG: Grondeienaar

Geagte Mnr / Mev

SASOL MYNBOU – MIDDELBULT (BLOK 8) SHONDONI SKAG PROJEK – BEPLANDE VERVOERBAND ROETE FOKUS GROEP VERGADERING

Met verwysing na die bogenoemde projek, word u as „n geïdentifiseerde grondeienaar wat direk geaffekteer gaan word deur die ontwikkeling hiermee formeel uitgenooi om die fokus groep vergadering aangaande die ligging van die skag infrastruktuur en beoogde vervoerband roete en by te woon.

Tydens die genoemde vergadering sal lede van JMA Consulting (Pty) Ltd „n voordrag lewer waarin die motivering en besluitnemingsproses uitgestip sal word aangaande Sasol Mynbou se voorkeur opsie t.o.v. die ligging van die vervoerband roete, vanaf die nuwe skag area na Sasol Sentrale Steenkool Stoor Area. Gedurende die vergadering sal daar aan die geaffekteerde grond eienaars die geleentheid gebied word om enige bekommernis wat hul aangaande die vervoerband roete mag hê, te opper, asook „n geleentheid om vrae te vra i.v.m. enige groottes en/of dimensies van die vervoerband roete.

Die vergadering sal gehou word op Vrydag die 19de Maart 2010 om 10uur te Brenden Village. Hierdie vergadering word gesien as „n krities belangrike komponent van die formele publieke deelname proses. Dit dien ook die doel om alle geaffekteerde partye op hoogte te hou van die stand van sake wat betref die projek, deurdat effektiewe kommunikasie tussen die applikant, Sasol Mynbou, en die geaffekteerde partye onnodige misverstande verhoed en aanleiding gee tot „n effektiewe en professionele verhouding tussen alle partye wat betrokke is.

U teenwoordigheid by hierdie vergadering word hoog op prys gestel. Indien u dit moeilik of selfs onmoontlik sou vind om die vergadering by te woon word u vriendelik versoek om die ondergetekende, so gou as moontlik, in kennis te stel daarvan. Kontak besonderhede is beskikbaar in die briefhoof of u kan „n epos stuur aan R.Fourie@jmaconsult.co.za.

Vriendelike Groete

Riaan Fourie
(Cand.Sci.Nat)

LET 6512

JMA Consulting (Pty) Ltd

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Sustainable Environmental Solutions through integrated Science and Engineering

JMA Project Reference Number - **JMA / 10391**

09 March 2010

ATTENTION: Landowner

Dear Sir/Madam

SASOL MINING – MIDDELBULT (BLOCK 8) SHONDONI SHAFT PROJECT – PROPOSED CONVEYOR ROUTE FOCUS GROUP MEETING

With reference to the above mentioned project, as an identified affected landowner you are hereby cordially invited to attend the focus group meeting during which the proposed conveyor route site selection alternatives will be discussed.

During the meeting JMA will present the motivation and decision-making processes followed in choosing the Sasol Mining preferred conveyor route option. An opportunity will be given to affected landowners to raise concerns and/or to ask questions, which they may have regarding any aspect or dimensions of the proposed conveyor route.

This meeting will be held on the 19th of March 2010 at 10:00am at the Brendan Lodge in Brendan Village. This meeting presents a key component in the formal Interested & Affected Parties" engagement process. It is also an important informative discussion between Sasol Mining and stakeholders, such as yourself which is viewed as an essential tool to ensure that an effective professional relationship continues to exist between all parties involved.

Your attendance at this meeting will be greatly appreciated. If you, however, find it difficult or impossible to attend the meeting at the specified date, please inform the undersigned in writing as soon as possible. The contact details are appended in the letterhead or you can email R.Fourie@jmaconsult.co.za.

Regards

Riaan Fourie
(Cand.Sci.Nat)

LET 6512

SASOL MINING MIDDELBULT (BLOCK 8) SHONDONI PROJECT

OVERLAND CONVEYOR ROUTE – FOCUS GROUP MEETING
BRENDAN LODGE
BRENDAN VILLAGE

10:00
19 MARCH 2010

A G E N D A

1.	Welcome	Gail Nussey
2.	Purpose of Meeting	Jasper Müller
3.	Background to the Project	Jasper Müller
4.	Presentation on Route Selection	Jasper Müller
5.	Preferred Alternative	Jasper Müller
6.	Properties Affected	Riaan Fourie
7.	Landowners Consent	Riaan Fourie
8.	Discussion	Jasper Müller
9.	Way Forward	Jasper Müller
10.	Closure	Jasper Müller

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Sustainable Environmental Solutions through integrated Science and Engineering

ATTENDANCE REGISTER – SASOL MINING MIDDELBULT (BLOCK 8) SHONDONI CONVEYOR FOCUS GROUP MEETING– 19 MARCH 2010

NAME	COMPANY	CONTACT NO.	E-MAIL ADDRESS
JASPER MÜLLER	JMA CONSULTING (PTY) LTD	(013) 665 1788	jasper@jmaconsult.co.za
RIAAN FOURIE	JMA CONSULTING (PTY) LTD	"	r.fourie@jmaconsult.co.za
Gail Nussey	Sasol Mining (Env. Management)	017 614 2207	gail.nussey@sasol.com
Philani Mahaye	Sasol Mining - Middelbult	082 417 9418	philani.mahaye@sasol.com
Ignatius Matlou	Govan Mbeki Municipality	(017) 620 6200	ignatius.m@govanmbeki.gov.za
DRIES VENTER	BRENDAN VILLAGE	082 923 6073	brendanlodge@wol.co.za
Eugene' Du Plooy	Landowner.	0829402852	eugenedp@selectppe.co.za.
CAREL DIRKSE	BRENDAN VILLAGE	013-6563816	carel@brendanvillage.com.
MORNE COMBRINK	LANDOWNER	0823882150	MIKE.COMBRINK@HOTMAIL.COM
Hennie SCHOEMAN	SMRD	0824994374	hennie.schoeman1@sasol.com

SASOL MINING MIDDELBULT (BLOCK 8) SHONDONI PROJECT

OVERLAND CONVEYOR ROUTE – FOCUS GROUP MEETING
BRENDAN LODGE
BRENDAN VILLAGE

10:00
19 MARCH 2010

MINUTES OF THE MEETING

Jasper Müller (JM) opened the meeting by introducing himself and welcoming all of the members present. JM then explained that the purpose of the meeting was to inform the potential affected landowners of the selection process followed by Sasol Mining with regards to the selection of a preferred conveyor route, to afford them the opportunity to give inputs into the selection process if they so wish and finally to facilitate agreement on the preferred alternative.

JM then continued to give an explanation of the background to the project and also explaining the type of authorizations that are required. JM then discussed the process that was followed during route selection by stating that this process was based on a Techno Economic Study that was performed by WorleyParsons on behalf of Sasol Mining **(M3230-01-03 SHONDONI MINE PROJECT, Conveyor Route Trade Off Study, WorleyParsons Project Number : 1106, SASOL Mining Project Number M3230, 9 September 2009).** JM also mentioned that JMA Consulting (Pty) Ltd (JMA) had performed an Environmental Route Ranking Exercise to determine the preferred alternative from an Environmental Perspective and that a report thereupon have been compiled that will be subsequently finalized after the completion of the meeting. This report will then form part of the formal EIA process documentation that will be submitted to the authorities.

JM proceeded to give a more technical explanation of what exactly the proposed conveyor route will look like, all the components that it will comprise of, and, what measures can be undertaken to minimize the impact thereof on the surrounding environment.

JM further went on to discuss the trade off study that was undertaken by WorleyParsons to determine a preferred option with regards to location for the proposed conveyor route. JM explained that some 18 parameters were identified and they were then awarded a numerical rating according the impact thereof on the three different alternative routes. These eighteen parameters included the following:

- Security/Town/People Proximity
- Power line crossings / Eskom permissions
- Through town proclaimed area
- Tar road crossings through culverts
- Farm road crossings through culverts
- Adjacent slimes dams
- Adjacent Harmony dam
- Adjacent future Synfuels ash disposal
- Adjacent Sakisiswe
- Adjacent explosives store
- Cattle crossings
- Conveyor length/cost
- Accessibility for maintenance
- Reliability
- Waterway crossings/seasonal flooding
- Environmental permitting

- Tar road crossing
- No. of conveyor elements flights
- Coal spillage: overland tracking
- No. of transfer points/Transfer towers
- Land wayleave"s
- Noise pollution

JM stated that the results of this trade off study was that the proposed western route were the preferred alternative from an engineering, operational and cost perspective by a significant numerical margin.

JM then said that as part of their terms of reference in support of the application for Environmental Authorizations, JMA conducted a route ranking exercise from a pure environmental perspective, neither including public acceptance, nor technical and financial considerations. JM then explained the criteria that were selected for this route ranking exercise, with specific reference to the overland conveyor routes. These included:

- Surface Water Quality (number of stream crossings)
- Surface Water Quality (length of stream crossings – flood lines)
- Noise (proximity to residential areas)
- Aquatic Ecology (number of crossing of wetland areas)
- Aquatic Ecology (extent of wetland areas)
- Land Capability (crossing of arable, grazing, compromised)
- Land Use (cultivation, grazing, compromised)
- Vegetation (high, moderate, low) – (hirta, triandra, transformed)
- Biodiversity (highly significant, important & necessary, least concern)
- Presence of heritage and cultural interest features

JM discussed each of these criteria and stated that the results of this route ranking exercise confirmed that from an environmental perspective the western route is also the preferred alternative for the proposed overland conveyor route. JM indicated that the few river and wetland crossings most probably carry the most weight in this regard. Another reason this route benefited from the assessment is the fact that this route follows a road servitude for a significant part of its length which implies minimal influence on agricultural land use. JM however also stated that one of the most critical potential impacts of this western route probably relates to its close proximity to residential areas (Brendan Village & eMbalenhle).

Riaan Fourie (RF) then explained where servitudes for this conveyor will have to be negotiated by indicating all of properties that are to be affected by the western and centre conveyor route options. RF gave a description of the size and dimensions of these proposed servitudes. RF also raised the issue and importance of landowners consent to the future of the project and for the registration of servitudes.

JM then proceeded to the discussion phase on the agenda during which the focus group members were awarded the opportunity to ask questions, raise concerns or objections to topic at hand.

Carel Dirker (CD) started of by saying that the farmers in the surrounding area have a big concern regarding the security of their future water supply. CD stated that the proposed mining operations in the area will compromise the boreholes in the area which forms a critical part of farming operations in the area. CD mentioned that perhaps Sasol Mining could construct a reservoir to serve the area to be affected by a loss of ground water. CD also stated that future use will present a cost implication and raised the issue of compensation.

Hennie Schoeman and Gail Nussey explained that should it become evident that any borehole, of which the details was logged prior to the commencement of the mine, is affected detrimentally as a direct result to the mining operations taking place in the area, the owner of that borehole will be fully compensated for his loss based on historical use.

Eugené du Plooy (EdP) asked a question of exactly where the shaft infrastructure will be constructed. This was explained to her. CD then stated that the preferred western route will induce a loss of agricultural land currently being leased by Mike Combrink (MC) and that MC indicated to him that he is not interested in compensation for a conveyor servitude running through the land but that he rather just wants to continue his using the land in his efforts to produce food. CD also said that after discussion between the affected landowners they came up with a suggestion that the proposed conveyor route should rather follow the servitude just to the west of the Eskom line, more or less on par with the centre conveyor alternative. CD also vehemently stated that he is not in favour of the proposed western route which will run in close proximity to Brendan Village.

Ignatius Mathebula (IM) said that from the town planning division at Govan Mbeki Local Municipality‟s perspective they have got no problem with the preferred western route, but that the cemetery south of eMbalenhle should be kept in mind. IM also said that with regards to the centre route alternative, members of Extension 44 in eMbalanhle may have issues with dust, noise and visual aspects.

Harmony Gold mine were not present at the meeting but forwarded a list with concerns regarding the three alternatives to members of JMA. These are included in the Issues Register.

JM then concluded proceedings by saying that a final decision on what route to be taken for the overland conveyor will be taken after the ongoing negotiations between Sasol Mining Rights & Properties Department and the affected landowners have been completed. JM mentioned that JMA want to proceed with the formal EIA process in order to conduct specialist studies indicated in the Plan of Study Report, but also indicated that formal written consent will be needed to conduct these further specialist studies regarding the proposed conveyor route, e.g. Visual, Noise, and Heritage studies etc. JM said SMRD with the assistance of JMA will contact them in this regard.

These minutes for the record were compiled by:

Riaan Fourie
(**Cand.Sci.Nat**)

Register of Concerns – Focus Group – Overland Conveyor

LANDOWNER	CONCERNS
Carel Dirker (Brendan Village)	1. Stated that the preferred western route will induce a loss of agricultural land currently being leased by Mike Combrink (MC) and that MC indicated to him that he is not interested in compensation for a conveyor servitude running through the land but that he rather just wants to continue his using the land in his efforts to produce food. 2. After discussion between the affected landowners they came up with a suggestion that the proposed conveyor route should rather follow the servitude just to the west of the Eskom line, more or less on par with the centre conveyor alternative. 3. Stated that he is not in favour of the proposed western route which will run in close proximity to Brendan Village. 4. From a Brendan Village consideration concerns regarding the conveyor route include, noise, dust, aesthetics, impacts on property value. 5. How would maintenance be conducted on the conveyor belt?
Eugené du Plooy (Landowner)	1. Question of exactly where the shaft infrastructure will be constructed.
Ignatius Mathebula (Govan Mbeki Local Municipality – Town Planning Division)	1. From Town Planning division at Govan Mbeki Local Municipality‟s perspective they have got no problem with the preferred western route, but that the cemetery south of eMbalenhle should be kept in mind. 2. With regards to the centre route alternative, members of Extension 44 in eMbalanhle may have issues with dust, noise and visual aspects. 3. Was the eMbalenhle SDF considered when conveyor routes were planned? 4. The center conveyor route interferes with the eMbalenhle Evander corridor, has this been considered? 5. Wants to know whether eastern most conveyor route will interfere with the roads in the area near the crossroads going to Evander, eMbalenhle, and Secunda, and specifically whether this influences proposed Secunda West Developments? 6. The conveyor route (Eastern Most) is not recommended and supported by the Govan Mbeki Local Municipality. The conveyor route 3 is not in line with the Embalenhle and greater Secunda SLDF. The eastern part of Embalenhle is part of mixed use development and the northern part is proposed for urban development

Boet Conradie (Harmony – Evander Gold Mines)	**1. Purple conveyor option (Eastern Most Route)** • Requested for a description of the impact the conveyor belt will have on EGMs property during and after operation; • EGM plans to recycle all three the tailings dams. The belt falls in the position of the new planned tailings dam on the farm Witkleifontein 131 IS; • Entrance to the Winkelhaak tailings dam from the eastern side will be blocked. • In terms of the Certificate of Registration (COR 46) issued by the National Nuclear Regulator the belt will cross the COR 46 scope next to the Winkelhaak tailings dam and should adhere to requirements; • The belt will cross a few pipe lines and underground electrical power cables. **2. Red conveyor option (Centre Route)** • Requested for a description of the impact that the conveyor belt will have on EGMs land during and after operation; • The red conveyor option falls within the safety zone around explosive magazine. A permit for ± 2000 cases of explosives was issued for that magazine. A safety zone with a radius of approximately 1000 metres is required around the bunker. An exemption for the mine road was issued; • The current space between Bracken North Return Water dam spillway and the solution trench is 30 metres wide. Servitude maximum width is 40 metres. This will leave no road space next to solution trench, paddocks and pipe line for inspection purposes; • A portion of the belt construction east of the slime dam will fall within the 1:100 year flood line of the Grootspruit; • Requested for a discussion to be arranged about the water management plans regarding control of rain water runoff from the conveyor belt area next to the slime dam and the return water dams; • Raised a concern regarding the entrance to the Bracken Tailings dam from the eastern side that will be blocked due to the presence of the conveyor belt; • Informed the EIA consultants that plans to recycle the tailings dam is currently in progress. The Tailings dam will be mined from the eastern and western sides. Unrestricted access next to the slime dam will be required for the pumping arrangements; • There is a grave yard south of the south eastern corner of the slime dam; • In terms of the Certificate of Registration (COR 46) issued by National Nuclear Regulator the belt

	will cross the COR 46 scope next t to the Winkelhaak tailings dam and should adhere to requirements; and • The belt will cross a few pipe lines and underground electrical power cable. **3. Green conveyor option (Western Most Route)** • Requested for a description of the impact that the conveyor belt will have on EGMs property during and after operation; • The belt will cross a few underground water pipe lines and electrical power supply cables.
Mike Combrink (Landowner)	1. Asked if there was a more detailed map available showing the conveyor routes? 2. Raised concern about the centre conveyor route running through low lying area and the impact on the wetlands and water quality. 3. Final decision by Sasol on conveyor routes should be taken after consulting with the landowners. 4. Asked whether firebreaks will be done next to conveyor belts because this was important, and also asked whether the conveyor belts will be fenced in?

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JMA Projek Verwysingsnommer – JMA/10391

29 Maart 2010

VIR AANDAG: Grondeienaar

Geagte Mnr / Mev

SASOL MYNBOU – MIDDELBULT (BLOK 8) SHONDONI SKAG PROJEK – GRONDEIENAARS TOESTEMMING BENODIG VIR VERDERE STUDIES OM ONDERNEEM TE WORD TER ONDERSTEUNING VAN BESLUITNEMING WAT BETREF DIE LIGGING VAN DIE PROJEK SE VOORGESTELDE OPPERVLAK INFRASTRUKTUUR

Met verwysing na die bogenoemde projek was daar „n publieke vergadering gehou op die 10de November 2009, wat deel gevorm het van die formele publieke deelname proses. Tydens hierdie vergadering is daar aan al die geïntereseerde and geaffekteerde partye wat teenwoordig was verduidelik wat die hierdie projek in totaliteit behels. Gedurende hierdie vergadering was daar ook „n versoek gerig deur die grondeienaars, wat direk geaffekteer sou word deur die voorgestelde vervoerband roete, om in „n afsonderlike fokusgroep vergadering gekonsulteer te word, waartydens die metodologie van Sasol Mynbou se seleksie prosedure vir die voorgestelde vervoerband roete dan aan hulle verduidelik moes word.

„n Fokusgroep vergadering in hierdie verband is toe geskeduleer vir die 19de Maart 2010, te Brendan Village. Tydens die vergadering is die volgende onderwerpe bespreek:

- Agtergrond tot die Projek
- Roete Seleksie
- Voorkeur Opsie
- Geaffekteerde Eiendomme
- Grondeienaars toestemming tot verdere spesialis en impakstudies om onderneem te word.

Na die aanbieding wat gedoen is deur JMA Consulting, was daar aan die grondeienaars teenwoordig, die geleentheid gegee om enige besware of bekommernisse aangaande die voorgestelde vervoerband roete te opper. Voorstelle is gemaak deur van die grondeienaars vir alternatiewe roetes wat die vervoerband moontlik sou kon volg. Al die besware en voorstelle was genotuleer en was ingesluit in die finale Bestekopname (Scoping) Verslag, en sal tot „n verdere mate ondersoek word.

Vir die bogenoemde ondersoeke om te kan plaasvind, moet daar addisionele spesialis studies onderneem word deur die applikant, Sasol Mynbou. Hierdie studies sluit ondermeer in opnames wat gedoen moet word t.o.v. impakstudies vir Visuele- en Geraas geassosisieerde impakte, spesifiek van toepassing op die voorgestelde vervoerband roete. Alvorens Sasol Mynbou die bogenoemde spesialis studies kan onderneem, moet die

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Bestekopname Verslag en Beplanning vir verdere Studies tesame met die relevante omgewing impak studie aansoek vorm by die Departement van Ekonomiese Ontwikkeling, Omgewing & Toerisme ingedien word. Na indiening moet die dokumente goedgekeur word deur die departement alvorens daar na die volgende fase van ondersoek beweeg kan word. Tydens hierdie volgende fase word spesialis studies onderneem ter ondersteuning van die optrek van die omgewings impak studie verslag en die omgewings bestuursplan vir die projek.

Hierdie is die proses wat normaalweg gevolg word tydens „n omgewings impakstudie, waar al die bekommernisse en besware i.v.m. voorgestelde projek tydens die bestekopname fase geïdentifiseer word. Hierna word al die besware en bekommernisse in ag geneem, en word daar dan „n Beplanning vir Verdere Studies verslag saamgestel. Hierdie verslag bevat al die spesialis studies, soos reeds vroeër genoem, wat onderneem moet word in die volgende fase van ondersoek. Die spesialis ondersoeke word dan voltooi en die resultate van hierdie ondersoeke word dan aan die Geïntereseerde en Geaffekteerde partye meegedeel tydens die 2de fase van publieke deelname.

Tesame met die indiening van die Bestekopname- en Beplanning vir Verdere Studies verslae, benodig die Sasol Mynbou „n toestemmingsbrief van die grondeienaars wat aan hul die nodige toestemming sal verleen om met die Shondoni projek voort te gaan. Hiermee dan die funksie van hierdie brief. Hierdie brief sal aan die departement aandui dat die grondeienaars wel gekonsulteer is in die bestekopname proses en dat die grondeienaars se menings wel ingewin is. Hierdie brief sal Sasol Mynbou dan in staat sal stel om voort te gaan met verdere ondersoeke op grond van besware en bekommernisse soos geïdentifiseer tydens die bestekopname fase.

Neem asseblief deeglik kennis dat hierdie toestemmingsbrief nie aan Sasol Mynbou die toestemming gee om „n finale besluit te maak t.o.v. watter roete vir die voorgestelde vervoerband gebruik gaan word nie. „n Finale besluit kan slegs gemaak word deur Sasol Mynbou nadat alle studies voltooi is en die nodige onderhandelinge met die geaffekteerde grondeienaars afgehandel is. Hierdie onderhandelinge met grondeienaars sal deur Sasol Mynregte en Eiendomme Departement gedoen word. Die finale uitkoms van hierdie onderhandelinge sal wees in die vorm van „n serwituut ooreenkoms, wat sal insluit die nodige kondisies van gebruik, asook die nodige kompensasie ooreenkomste. Hierdie serwituut ooreenkoms sal dan deur beide partye onderteken moet word.

In lig van die bogenoemde, dui hierdie brief aan dat die grondeienaars erkenning gee, en toestemming verleen aan Sasol Mynbou om verdere spesialis studies te onderneem ter ondersteuning van verdere besprekings en onderhandelinge om plaas te vind tussen die betrokke partye.

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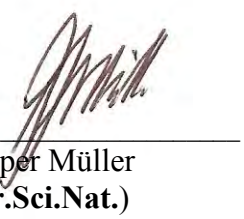
Indien daar enige verdere onsekerheid bestaan i.v.m. hierdie brief moet asseblief nie huiwer om die ondertekende te kontak nie.

Vriendelike Groete



Jasper Müller
(**Pr.Sci.Nat.**)

LET 6518

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TOESTEMMINGSBRIEF: SASOL MYNBOU – MIDDELBULT (BLOK 8)
SHONDONI SKAG PROJEK

Ek _____,

Eienaar van die eiendom _____ porsie(s)_____,

verleen hiermee toestemming aan Sasol Mynbou om die verdere en nodige studies te onderneem, ter ondersteuning van besluitneming in die seleksie van die ligging van oppervlak infrastruktuur vir die Sasol Mynbou Middelbult (Blok 8) Shondoni Skag Projek.

_____
Handtekening

_____ _____
Datum Place

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JMA Project Reference Number - **JMA / 10391**

29 March 2010

ATTENTION: Landowner

Dear Sir/Madam

SASOL MINING – MIDDELBULT (BLOCK 8) SHONDONI SHAFT PROJECT – LANDOWNERS CONSENT REQUIRED FOR FURTHER STUDIES TO BE UNDERTAKEN AS PART OF SURFACE INFRASTRUCTURE SITE SELECTION PROCESS

With reference to the project mentioned above, a public meeting was held as part of the formal public participation process on 10 November 2009 in Evander, where the entire project was presented and explained to all identified I&APs that attended the meeting. During this meeting a number of the affected landowners requested to be consulted on a individual basis during a focus group meeting, regarding the site selection of the proposed overland conveyor route.

A focus group meeting regarding the site selection of the proposed overland conveyor was subsequently held on 19 March 2010, at the Brendan Lodge in Brendan Village. During this meeting a presentation was given discussing the following topics:

- Background to the Project;
- Route Selection;
- Preferred Alternative;
- Properties Affected; and
- Landowners‟ Consent to conduct specialist studies and impact assessments.

After the presentation made by JMA Consulting, the opportunity was given to the landowners present at the meeting to raise any issues and concerns they have regarding the proposed site selection of the overland conveyor route. Furthermore, alternative suggestions were made by some of the landowners proposing slight changes to the route to be followed by the overland conveyor. All of these concerns/suggestions were noted and included in the Scoping Report and will be investigated to a further extent.

For the above to transpire, additional specialist studies need to be undertaken. These aforementioned specialist studies include, among others, assessments for Visual and Noise related impacts to be undertaken specifically for the proposed overland conveyor route. In order for the applicant, Sasol Mining, to conduct these studies the Scoping Report and Plan of Study for this project must be submitted, along with the relevant EIA Application Form, to

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the relevant authority for approval. In this case, the authority being consulted is the Department of Economic Development, Environment & Tourism (DEDET). Once approval of the Scoping Report & Plan of Study is granted by DEDET, the process moves into the next phase of investigation where all specialist studies are conducted. This next phase is called the EIA/EMP investigative phase

This is the procedure normally followed in the formal EIA process, whereby all issues regarding the project are investigated and discussed with the I&APs during the Scoping Phase of the project. All concerns regarding the project is noted and a Plan of Study is subsequently drawn up which consist of all specialist studies to be undertaken during the next phase of the formal EIA process. This next phase is the EIA/EMP investigation phase. During this phase, all the issues raised during the scoping have to be investigated and feedback on the results of these studies needs to be given to all I&APs during the second round of public participation.

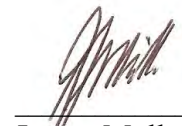
However, before the Scoping Report & Plan of Study can be submitted for approval, Sasol Mining has to obtain a letter stating that the landowners give consent to the proposed Shondoni project to be undertaken. This consent letter will indicate to DEDET that Sasol Mining did indeed engage with the affected landowners and provide Sasol Mining with the necessary authorization to undertake the above mentioned specialist studies and investigations that are needed to address the issues raised by I&APs during the Scoping Phase.

Please take cognizance understood that this letter of consent does not provide Sasol Mining with the authorization to make a final decision on what route to be used for the overland conveyor. A final decision on the site selection can only be made by Sasol Mining, once all studies have been completed and the necessary negotiations with affected landowners have been completed. These negotiations will be conducted by Sasol Mining Rights & Properties Department (SMRD). The outcome of these negotiations will be in the form of a servitude agreement between the parties involved which will include the appropriate conditions of use and compensation incentives.

In light of the above, this letter shows landowners acknowledgement and consent to Sasol Mining to initiate specialist studies in order for further discussions and negotiations to take place.

If any uncertainty regarding this letter of consent exists please do not hesitate to contact the undersigned.

Regards



Jasper Müller
(**Pr.Sci.Nat.**)
Lead Environmental Assessment Practitioner LET6517

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LETTER OF CONSENT: SASOL MINING – MIDDELBULT (BLOCK 8)
SHONDONI SHAFT PROJECT

I _____,

owner of the property _____ portions _____,

hereby give consent to Sasol Mining to undertake the further and necessary studies to assist in the decision making of the site selection process for proposed surface infrastructure for the Sasol Mining Middelbult (Block 8) Shondoni Shaft Project.

_____
Signature

_____ _____
Date Place

APPENDIX 5.3(A)

SPECIALIST REPORT
SOILS, LAND CAPABILITY
&
LAND USE

Project No: JMA.SASOL.MB8.S.09.11.077

SASOL Mining Middelbult (Block 8) Shondoni Project

EMP/EIA Upgrade
Specialist Soils, Land Capability and Land Use Study

Compiled on Behalf of

JMA Consulting (Pty) Ltd

23rd July 2010

REPORT

Sustaining the Environment

Stonecap Trading 14 (Pty) Ltd

Our Ref: JMA.SASOL.MB8.S.09.11.077
Your Ref: 10391/JM/lvn

23rd July 2010

JMA Consulting (Pty) Ltd
P.O. Box 883
Delmas
2210

Attention: Mr. Jasper Muller/Jaco van der Berg

Re: SASOL Mining Middelbult (Block 8) Shondoni Project
Baseline Specialist Soils, Land Capability and Land Use Studies

Dear Jasper,

In line with the ToR submitted to Earth Science Solutions (Pty) Ltd by JMA Consulting (Pty) Ltd, ESS (Pty) Ltd was requested to provide a scope of work, methodology and budget estimate for the specialist baseline soils, land capability and land use studies as part of the greater EIA and EMPR required in terms of the MRPDA requirements for any mining project.

Herewith attached please find our Final specialist report for the soils, land capability and land use studies undertaken.

Thanking you

Yours sincerely,
Earth Science Solutions (Pty) Ltd

Ian Jones B.Sc. (Geol) Pr.Sci.Nat EAP Certified
Director

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SHONDONI PROJECT

Compiled for

SASOL MINING

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Title	**Name**	**Capacity**	**Signature**	**Date**
Author	Ian Jones	Project Pedologist		23rd July 2010
Project Director	Jasper Muller	EAP		
Technical Review				

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Declaration

This specialist report has been compiled in terms of Regulation 33.3 of the National Environmental Management Act 107/1998 (R. 385 of 2006), and forms part of the overall impact assessment, both as a standalone document and as supporting information to the overall impact assessment for the proposed development.

The Specialist Soils, Land Capability and Land Use Baseline and Impact Assessment Studies, were managed and signed off by Ian P.C. Jones (Pr.Sci.Nat 400040/08) and Certified EAP, an Earth Scientist with 34 years of experience in these specialist fields.

I declare that both, Ian Jones, and Earth Science Solutions (Pty) Ltd, are totally independent in this process, and have no vested interest in the project.

The objectives of the study were to:

- **Provide a permanent record of the present soil resources in the area that are potentially going to be affected by the proposed development – Pre construction environment,**
- **Assess the nature of the site in relation to the overall environment and its present and proposed utilization, and determine the capability of the land in terms of agricultural utilization, and**
- **Provide a base plan from which long-term ecological and environmental decisions can be made, impacts of construction can be determined, and mitigation and rehabilitation management plans can be formulated.**

The Taxonomic Soil Classification System and Chamber of Mines Land Capability Rating Systems in combination with the Canadian Land Inventory were used as the basis for the soils and land capability investigations respectively. These systems are recognized nationally.

Signed: **20th July 2010 at Nelspruit**

Ian Jones B.Sc. (Geol) Pr.Sci.Nat. 400040/08, (EAP Certified)

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GLOSSARY OF TERMS

Alluvium: Refers to detrital deposits resulting from the operation of modern streams and rivers.

Base status: A qualitative expression of base saturation. See base saturation percentage.

Black turf: Soils included by this lay-term are the more structured and darker soils such as the Bonheim, Rensburg, Arcadia, Milkwood, Mayo, Sterkspruit, and Swartland soil forms.

Buffer capacity: The ability of soil to resist an induced change in pH.

Calcareous: Containing calcium carbonate.

Catena: A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage.

Clast: An individual constituent, grain or fragment of a sediment or sedimentary rock produced by the physical disintegration of a larger rock mass.

Cohesion: The molecular force of attraction between similar substances. The capacity of sticking together. The cohesion of soil is that part of its shear strength which does not depend upon inter-particle friction. Attraction within a soil structural unit or through the whole soil in apedel soils.

Concretion: A nodule made up of concentric accretions.

Crumb: A soft, porous more or less rounded ped from one to five millimetres in diameter. See structure, soil.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Denitrification: The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0,25-0,1mm in diameter.
(2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction.

Fine textured soils: Soils with a texture of sandy clay, silty clay or clay.

Hardpan: A massive material enriched with and strongly cemented by sesquioxides, chiefly iron oxides (known as ferricrete, diagnostic hard plinthite, ironpan, ngubane, ouklip, laterite hardpan), silica (silcrete, dorbank) or lime (diagnostic hardpan carbonate-horizon, calcrete). Ortstein hardpans are cemented by iron oxides and organic matter.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics.
(2) In South Africa it has been used as a map unit denoting land, mapable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Mottling: A mottled or variegated pattern of colours is common in many soil horizons. It may be the result of various processes *inter alia* hydromorphy, illuviation, biological activity, and rock weathering in freely drained conditions (i.e. saprolite). It is described by noting (i) the colour of the matrix and colour or colours of the principal mottles, and (ii) the pattern of the mottling. The latter is given in terms of abundance (few, common 2 to 20% of the exposed surface, or many), size (fine, medium 5 to 15mm in diameter along the greatest dimension, or coarse), contrast (faint, distinct or prominent), form (circular, elongated-vesicular, or streaky) and the nature of the boundaries of the mottles (sharp, clear or diffuse); of these, abundance, size and contrast are the most important.

Nodule: Bodies of various shapes, sizes and colour that have been hardened to a greater or lesser extent by chemical compounds such as lime, sesquioxides, animal excreta and silica. These may be described in terms of kind (durinodes, gypsum, insect casts, ortstein, iron-manganese, lime, lime-silica, plinthite, salts), abundance (few, less than 20% by volume percentage; common, 20 – 50%; many, more than 50%), hardness (soft, hard meaning barely crushable between thumb and forefinger, indurated) and size (threadlike, fine, medium 2 – 5mm in diameter, coarse).

Overburden: A material which overlies another material difference in a specified respect, but mainly referred to in this document as materials overlying weathered rock

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedocutanic diagnostic B-horizon: The concept embraces B-horizons that have become enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic B-horizon, the transition to the overlying A-horizon is clear or abrupt.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Slickenslides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickenslides. They occur in clayey materials with a high smectite content.

Sodic soil: Soil with a low soluble salt content and a high exchangeable sodium percentage (usually EST > 15).

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand subseparates.

Vertic, diagnostic A-horizon: A-horizons that have both, a high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

EXECUTIVE SUMMARY

Soils, Land Capability and Land Use Baseline Investigation, Impact Assessment and Management Planning

The proposed Middelbult Block 8 Shondoni Coal Mining Project is situated to the south of Kinross and west of Trichardt/Secunda on the Mpumalanga highveld/province of South Africa.

The Middelbult Block 8 Shondoni Project covers a large number of commercial farms and co-operative farming ventures (Refer to Figure 1.1 – Locality Plan), the list of which is contained in Figure 1.2. The proposed development covers significant areas of land that fall within the Greater Olifants River catchment. The Olifants River flows from north to the south and south east through the area of concern dividing the landscape into distinct catchments with their associated floodplain environs and distinctive river channel, terraces and impoundments, with significant secondary and tertiary catchments, all of which are very significant in understanding the complex of hydromorphic soils within these land forms. The geomorphology of this site will play a large role in the possible impacts that any development might have, with the interactions of landform, climate, topography, aspect and geology producing a complex inter-relationship that is basic to the soil forming processes and resultant soil characteristics.

The combination of open cast and underground mining that has been completed and the underground mining that is proposed for the expansion, with all of the proposed support infrastructure requires a specialised approach and a full understanding of the baseline conditions before any detailed planning can be considered.

The impacts of the proposed/planned underground and opencast mining and the associated processing and support infrastructure on the soils and land capability and the tabling of appropriate management and mitigation strategies to minimise the impacts will be essential if the sustainability of this area and the long term project is to be realised.

A scoping assessment was completed, and has been used as the basis for the detailed assessment going forward. In terms of the reference given to ESS, it is understood that the mining plan will include:

- One additional shaft complex (Shondoni Shaft) with associated infrastructure in the Block 8 Reserves
- A new overland conveyor to convey the coal to the Middelbult Main Shaft and then onto an existing conveyor to the Sasol Mining central coal stockpile area (Sasol Coal Supply or SCS);
- The underground workings for the additional reserve blocks (Block 8 Northern Reserves, the Springbokdraai Reserves and the Leeuwpan Reserves;

The proposed future mining activities will be conducted by means of underground mining operations, utilising the bord-and-pillar and high extraction methods to extract coal from the No.4 and No.2 Coal Seams.

It is anticipated that approximately 8.5 to 9.5 million tons of coal per year will be mined. The increased utilisation of coal reserves will mean that Middelbult (Block 8) will continue mining (current schedule) for an additional 3 to 4 years.

The long-term plan for Middelbult-Shondoni is to maximise its life thereby ensuring optimal coal reserve utilisation. Existing personnel and equipment will be used in the mining of the No 4 and the No 2 Coal Seams by means of bord-and-pillar and high extraction.

Although no actual figures are quoted for the areas to be disturbed by the proposed operations, an estimate has been made based on the mine plan tabled and the relative tonnages that are estimated to be mined.

With the background information available, it is incumbent on the developer to obtain a full understanding of the impacts that this overall project could have on the environment. It was imperative that a full understanding of the baseline conditions and environmental aspects of the site that is to be disturbed and affected was obtained and recorded prior to the implementation of any mining or related activities taking place.

Apart from the more obvious environmental studies (Fauna and Flora, Surface Water etc.) that need to be undertaken prior to the implementation of any new development, it has become increasingly apparent that the soils need to be investigated in detail if a comprehensive base line of information is to be available for future reference.

In compliance with the NEMA and MPDRA, a comprehensive pedological investigation at various scales (depending on the degree of disturbance to be implemented), coupled with an interpretation, and understanding of the land capability for the area to be disturbed has been undertaken as part of the overall Environmental Impact Assessment. In addition, and as part of the overall understanding and detail of record, the pre-construction and or mining land use has been noted. The actual economics of the farming and/or industrial activities is a matter for the socio economic studies that are to be undertaken separately of this study.

The pedological assessment revealed a strong correlation between the underlying lithologies and weathering of the in-situ materials, and the accumulation of depositional materials within the lower lying areas as colluvial and/or alluvial deposits, the result of movement of materials downslope and along the drainage ways. The result of these geomorphological interactions has resulted in a complex of soil forms and families, with a general trend from moderately shallow to shallow sandy loams and silty clay loams associated with the Ecca sediments and the highly structured and clay rich materials derived from the intrusive volcanics that make up a significant proportion of the soils in the areas mapped.

The complexity of the lower midslopes and lower slopes adjacent to the bottomlands and riverine environments is noted in the number of differing soil forms that make up the hydromorphic catena in the area.

The accumulation of colluvial materials in the transition zone are reflected in the sandy clays and clay loams that vary in depth, water holding capabilities and drainage characteristics, with the development of inhibiting iron rich layers, shallow outcrop in the weathering profile, and some deep gleycutanic horizons associated with the lower slope positions. The presence of dolerite and diabase intrusives complicates the situation, with the presence of iron, magnesium and calcium having an influence on both the chemical and physical characteristics of the alluvial materials that are found as much younger soil materials within the river channels (flood plain deposits).

These materials tend to be more highly structured, return much higher clay contents and are inherently more difficult to work with. Each of these soil groups (sandy loams, silty clay loams and gleyed materials) will need to be managed differently and if possible separately, while the end use should be matched to the soil qualities and their ability to be stored, managed and re-worked.

Successful rehabilitation of the sensitive and more structured soils will require significant management input if a sustainable vegetative cover is to be re-established and the project is to obtain a standalone status at closure.

Significant economic gain can be achieved by getting the stripping and storage of utilizable materials correct as part of the overall mine planning, with successful rehabilitation and ease of closure being achieved more readily if the materials are available and a conceptual plan made.

The outcomes for the soil study for the Middlebult Shondoni Block 8 Coal Mining Project are summarised as follows:

The major soil types encountered on the areas that are proposed for the expansion project comprise the hydromorphic form - Avalon, Westleigh, Bonheim, Katspruit and Longlands with significant areas of Rensburg and Arcadia Form soils. Other soil forms of significance that were mapped during the original study of the greater Middelbult Block 8 area comprise those of the orthic phase Hutton, Clovelly, Griffin, Glenrosa and Mispah Forms, the more structured Valsrivier, Swartland, Sterkspruit and Mayo Forms associated with the younger intrusive lithologies, while the hydromorphic materials that make up a significant portion of this particular area comprise predominantly Glencoe, Dresden, Avalon, Pinedene, Bainsvlei, Westleigh, Bloemdal, Longlands, Kroonstad, Katspruit, Willowbrook and Sepane Forms, with areas of deep colluvial materials that returned extremely high clay contents and massive structure (Vertic and gleycutanic) in the form of Rensburg and Arcadia Form soils.

The land capabilities range from moderately small areas with good arable and agricultural potential, to moderate and very poor quality arable materials that are generally associated with shallow and wet based soils, and areas of moderate to low economic potential that rate as wilderness/conservation land capability. In addition, and of significance is the proportion of the total area that rates as transition zone wetlands and wetland status.

The strong correlation between soil depth, soil structure and the capability of the land is evident across the study area, with the shallow and sensitive soils being confined to low intensity grazing and wilderness/conservation activities, and the deeper and less sensitive soils being utilized for better quality (higher density) grazing and cultivation of annual crops.

Physical Characteristics

- Topsoil clay percentages range from as low as 10% on the sandy and silty loams, to more than 25% depending on the host/parent geology from which they are derived, and their position in the topography (Crest Slopes versus colluvial and/or alluvial bottom slope deposits);
- Subsoil clays that range from 15% to greater than 65%,
- Moderate to very low in-situ permeability rates (0.60m/day to 2.10m/day) on the sandy clay loams and structured clay rich (gleycutanic) form soils respectively,
- Poor to very poor intake (infiltration) rates (4mm/m to 6 mm/m, depending on the type of clay present,
- Moderate to good (60 to 160mm/m) water holding capacities, and
- Moderate to poor agricultural potential (nutrient status).

The physical characteristics are highly influenced by the parent materials from which the soils are derived, and to a lesser extent by their position in the topography.

The structure of the soils varies from single grained and apedel for the most part, with minor areas of weak crumby to blocky structure on the clay loams and gleycutanic materials.

Chemical Characteristics

The chemistry of the soils is typical of the sedimentary lithologies that make up the major part of the study area, with some distinctive differences associated with the relatively much younger intrusive/volcanic lithologies that occur within and cross cutting the bedded/layered sedimentary lithologies.

The soils are characteristically:

- Variable in pH with strongly alkali returns for the sedimentary derived soils, of between 4,25 and 7.5, and slightly acidic to neutral pH on the intrusive derived soils of between 6.5 and 7.5;
- A generally good supply of calcium and magnesium in a ratio of 3:1;
- Under subscribed with potassium and phosphorous and in places zinc, and
- Low to very low organic carbon matter content (0.045 – 0.45 C%)

Overall, and as a generalised statement, these soils require significant amounts of nutrient input if they are to be used for commercial farming ventures on a full rotation system. Grazing of livestock on the natural pastures requires good management, and larger areas of land to accommodate the low number of animals that can be grazed per hectare (between 2 and 5 livestock units per hectare).

INTRODUCTION AND TERMS OF REFERENCE

JM A Consulting (Pty) Ltd commissioned Earth Science Solutions (Pty) Ltd (Order No. 10391/JM/lvn dated 17th May 2010) to undertake the specialist Soils (Pedological), Land Capability and Land Use Baseline Studies, Impact Assessment and Mitigation Management Planning for the areas that are to be disturbed by the proposed/planned SASOL Middelbult (Shondoni Block 8 Expansion Project. The project aims to expand the existing underground mining and its associated support infrastructure.

These activities and the associated construction and operation of infrastructure are proposed as part of the expansion to the underground mining of the "Shondoni Coal Resource" proven in the area south of Kinross and west of Secunda/Trichardt. The prospect has been drilled and assessed in terms of its economic viability and resource worth by SASOL Mining.

The initial site evaluation was undertaken during May and June of 2010, the Scoping Study of the area of concern having been compiled by J.M.A Consulting in April 2010. Subsequent investigations and studies around the mine planning have culminated in the detailed specialist investigations being commissioned as part of this phase of the mining right application process.

The project involved the undertaking of a reconnaissance pedological survey, land capability and land use study as part of the greater EMPR amendment, the studies being undertaken so as to satisfying the requirements of the National Environmental Management Act (NEMA) as well as the Mineral and Petroleum Resource Development Act (MRPDA), with the underlying assurance that the studies would meet the best practise methodology and standards of the Equator Principles. To this end, a number of soil parameters were mapped, recorded and interpreted.

A total area of approximately 4,600 ha has been investigated in the course of the soils and land capability studies undertaken.

This document deals with the Soils, Land Capability and Land Use assessments for the overall area that is planned for underground mining (Total Extraction and Bord and Pillar methods) and/or the development of the required surface infrastructure inclusive of the haulage ways, access roads, soil and soft overburden stockpiles, ROM Stockpiles and the conveyancing of the raw product to the beneficiation area.

The proposed Coal Mining Project can be found on several properties on the Mpumulanga Highveld, south and west of Kinross and Trichardt – collectively called the SASOL Middelbult (Shondoni) Block 8 Project.

The proposed infrastructure development area is still to be finally decided. However, the best alternative has been tabled as part of the interim mine plan, and has been used in the detailed assessment investigation. If these positions are to be changed based on the findings of this and other specialist studies, or the method of mining is altered in any way, the new alternative might need to be assessed in detail (Refer to Figure 1b).

The study has been structured so as to satisfy the requirements of the overall Environmental Management Programme as required in terms of the MPRDA (20 of 2002), as well as complying with the regulations as directed by the NEMA and the EIA requirements as a listed activity.

To this end, a number of soil parameters were mapped and classified using the standard *Taxonomic Soil Classification System for South Africa (Mac Vicar et al, 2nd edition* 1991**)** and the Chamber of Mines Land Classification System of rating.

The objectives of the study were to:

- Provide a permanent record of the present soil resources in the areas that are potentially going to be affected by the proposed developments;
- Assess the nature of the sites in relation to the overall environment and its present and proposed utilisation, to determine the capability of the land in terms of agricultural utilization, and
- To provide a base plan from which long-term ecological and environmental decisions can be made, impacts of construction and operation can be determined and planned, and mitigation and rehabilitation management plans can be formulated.

Historically, the Shondoni – Middelbult Block 8 mining area has been confined to cultivation of annual crops and low intensity grazing of livestock with a significant amount of coal mining and some gold mining at depth. A significant amount of light and heavy industry has also taken root in Kinross, Trichardt and Secunda as support structures to the mining and agricultural industries.

The expansion to the existing (expansive) coal mining in this particular area has been mooted for many years as part of the SASOL Expansion Project, and the possibility of mining for coal resources has been known to exist. This area is the major supplier of coal to the South African power generation industry. The proposed underground mining of coal will require that limited but significant surface area is affected, with the utilization of haulage ways, the potential for hydrocarbon impacts, coal spillage and soil loss as a result being a negative impact for the duration of the project.

The land proposed for the expansion to the support infrastructure and any expansion to beneficiation facilities is existing farmland that has been zoned as such and is already disturbed by these activities. The proposed linear features (conveyer lines, haulage ways, pipelines and electrical reticulation will traverse a number of differing land and soil types, with the majority of the length of the features being planned over existing agricultural land (arable and grazing), while the soil stockpiles and materials handling facilities are generally associated with farmlands that are being utilized for either livestock grazing or associated agriculture (Refer to Figure 1b).

Mining and the development of support infrastructure is a feature of the landscape in the vicinity, and mining as an activity in the Kinross – Trichardt area has been accepted as a way of life for generations and has coexisted with farming successfully to date.

However, with the ever-increasing competition for land, it has become imperative that the full scientific facts for any particular site are known, and the effects on the land to be used by any other proposed enterprise must be evaluated, prior to the new activity being implemented (NEMA).

This document describes the in-field methods used to classify and describe the *in-situ* soils, using a well documented rating system to classify and rank the land capability based on the soils assessment, regional climate information and topographic variables, and records the pre mining/construction land use as a baseline to the proposed planning.

This information will be invaluable in determining the END LAND USE and rehabilitation plans for the closure phase of the developments.

The findings of this investigation are based on a pedological survey involving a number of specialists in differing fields of expertise and the interpretation of the resulting data.

This study was aimed at describing the physical and chemical properties of the soils that are to be disturbed, to identify the soil forms and characterise the pedological status of the areas that are to be utilized for development, and to determine the effect that the proposed underground mining will have on the land capability and sustainability of the area.

This includes an evaluation of the hydromorphic nature of the soils, their effective rooting depths, nutrient status, the potential erodibility, and the soil utilisation potential. In addition, the investigation required that the impacts be assessed, and mitigation methods recommended where possible, and the status of the proposed mining area understood.

The area under consideration for the proposed mining operation (Middelbult Shondoni Block 8) is situated within the Evander/Kinross area, extending to the south of the Leandra - Trichardt main road,(Refer to Figure 1a - Locality Map). The area of concern includes the Springbokdraai Reserve, the Leeuwpan Reserve and the Block 8 Northern Reserve.

Figure 1a General Locality Plan

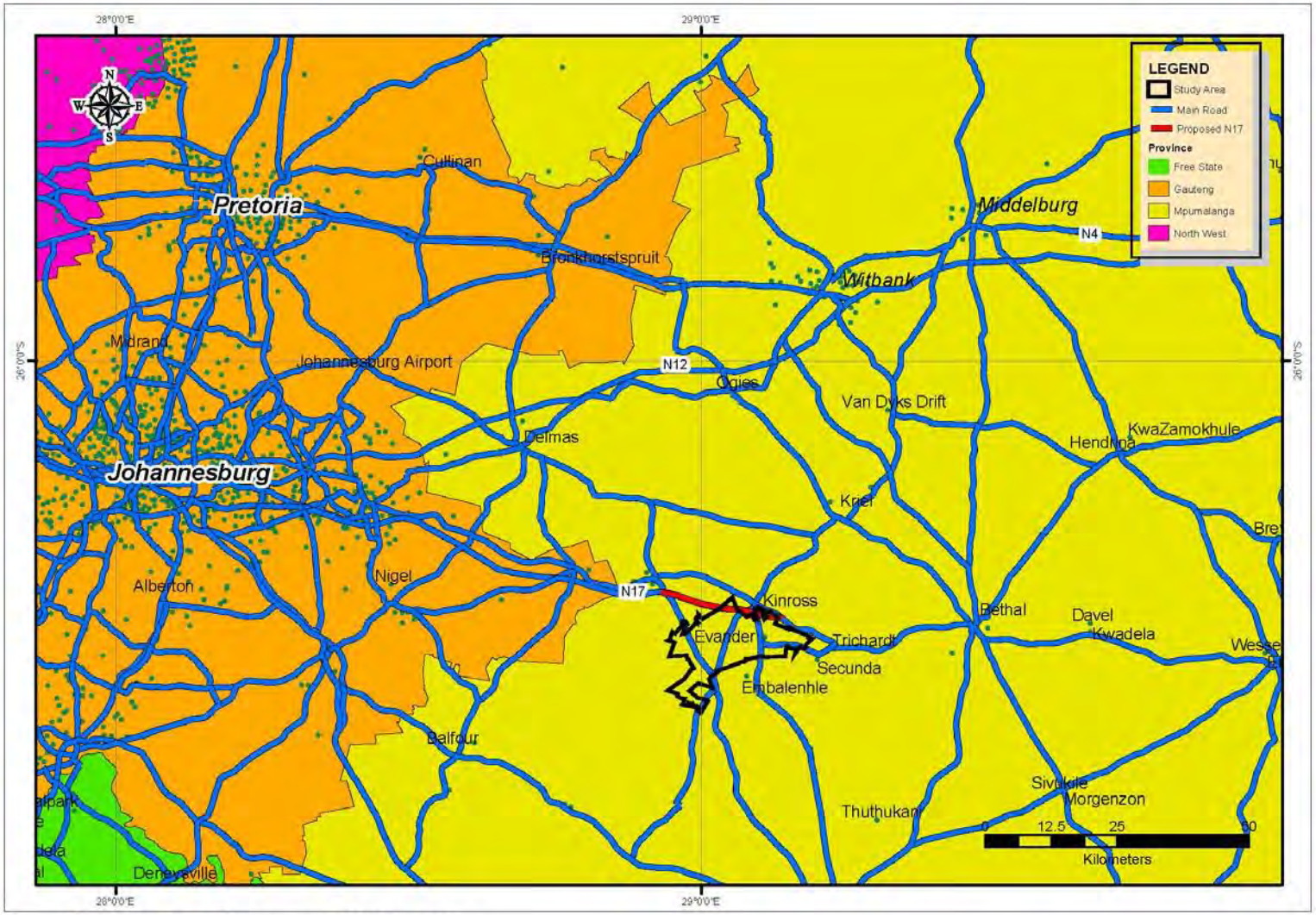


Figure 1.5.1: Location of the proposed Block 8 area.

Figure 1b - New Reserve Blocks (Block 8 Northern Reserves, Springbokdraai and Leeuwpan)

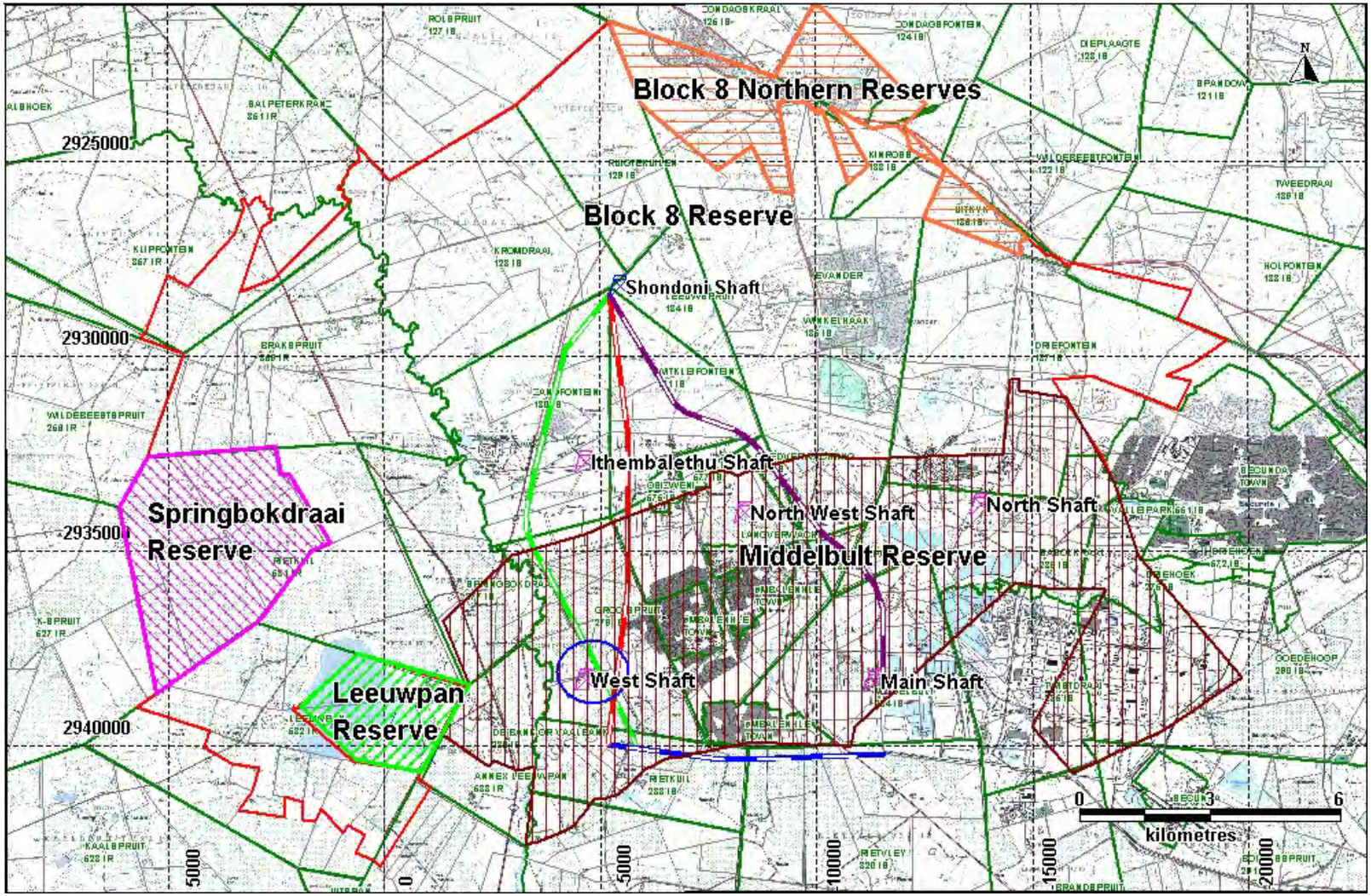
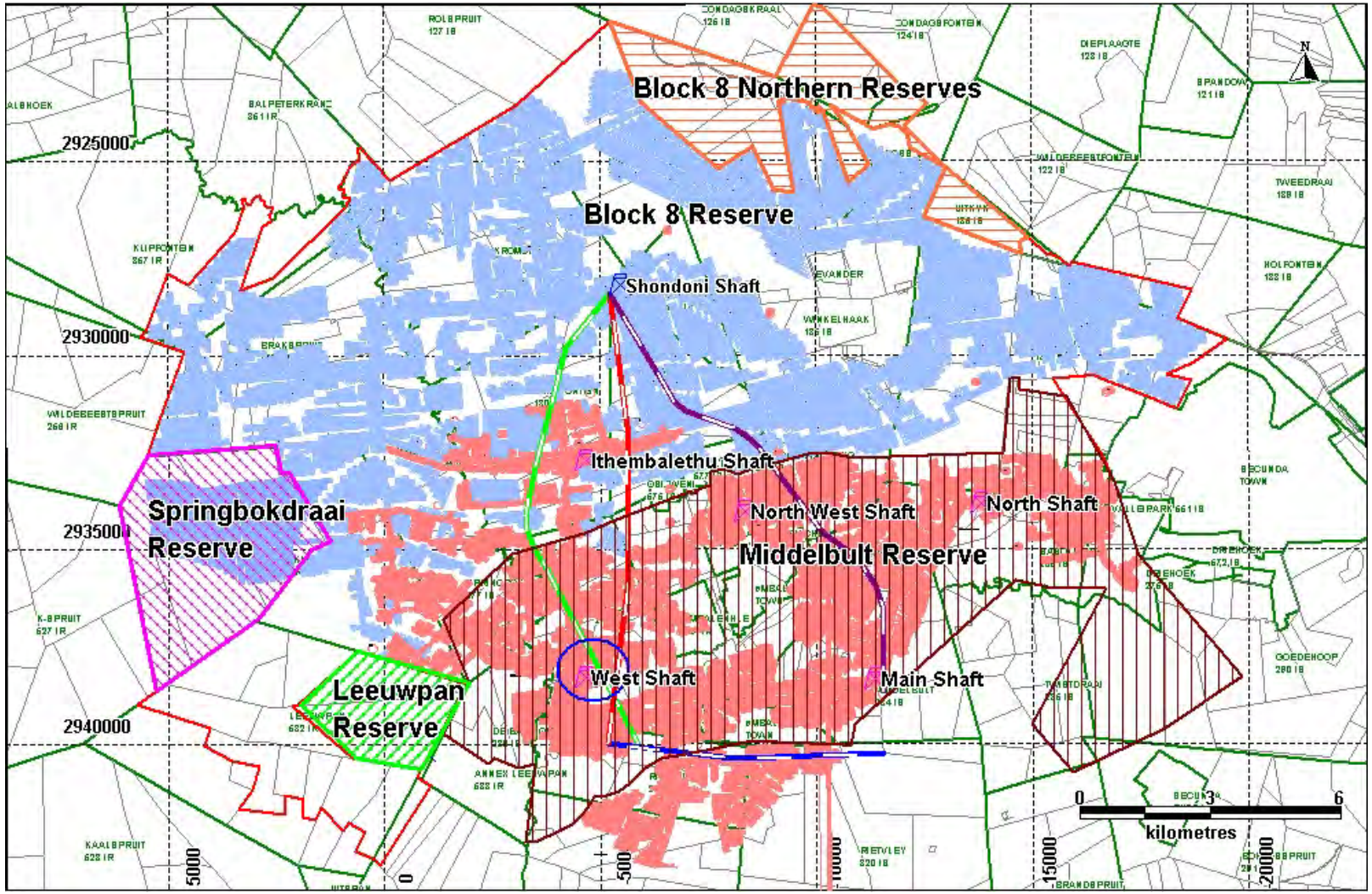


Figure 1c - The Middelbult Shondoni Underground Mining Plan



DESCRIPTION OF THE PRE-MINING/CONSTRUCTION ENVIRONMENT

5.3 Soils

5.3.1 Data Collection

Review of Published Reports and Maps

The area proposed for development is in close proximity to a number of existing mining ventures, and forms part of the greater coal mining regions of the eastern and central highveld coal fields of South Africa. Extensive geological and geotechnical information is available for this area and a substantial amount of existing socio economic and environmental work has been undertaken. The geology and geochemistry of the sedimentary formations that make up the major portion of the materials that are to be affected by mining or infrastructure development are well known and understood. SASOL Coal has undertaken detailed economic and geological/geotechnical investigations over the area of prospect, and has a proven resource that underlies the area.

With the economic viability of the resource understood, and with a mine plan on the table, it remains only for the socio economic and environmental aspects of the site to be assessed and the impacts understood. The general characteristics of the soils of this area are well understood. However, the subtle changes and localised changes in characteristics is important baseline information required if sustainability of rehabilitation and closure are to be achieved, and if a realistic management plan for the soils and land capability are to be achieved during the operational phase. These detailed specialist investigations will add to the baseline information required as part of the planning, operational and rehabilitation phases that are proposed for the Middlebult (Shondoni) Block 8 Project.

In addition, ESS have used any exploration data, drilling logs where available and the reconnaissance scoping report to better understand the basic characteristics of the soils and the lay of the land, to obtain information about the parent geology that has contributed to the soil formation that cover the area of study and to extrapolate chemical and physical attributes to the soil classification. The Land Type Mapping of S.A. (1:250000 scale), the Geological Map of S.A. and local knowledge of the soils and land capability where made available to the study. However, no existing detailed mapping was available.

The Department of Agriculture is concerned, and has voiced its concerns regarding the impact of further mining activities on the agricultural potential of the soils in the South Africa in general, and this region in particular. The Land Type Maps are the only information that could be supplied by this department however. In addition, significant comment and concerns were received from the local communities.

The maps available during scoping were of a small scale, and have been compiled using basic aerial photographic interpretation of the area with limited field interpretation. They are a good first approximation, and in combination with the geological maps (1:250,000) were useful as a baseline from which to work.

Of significance to the study is the underlying geology, with a moderately complex suite of rocks that make up the sequence. In its simplicity, the major portion of the area studied is underlain by the Ecca sediments that have been intruded by a complex of younger dykes and sills of differing ages and orientation.

It is these complexes of lithologies combined with the topography that produce the complex of differing soil polygons noted across the study site.

Field Work

The pedological study of the Middlebult (Shondoni) Block 8 site was performed based on a variable grid bases with the understanding that surface features will affect the surface to a greater degree than the underground mining (Bord and Pillar), and required a detailed assessment, while balance of the area (underground mining) was covered on a reconnaissance grid base.

The soil classification/characterisation and mapping has delineated the broad soil patters for the total mining right area. The survey was undertaken during May and June of 2010. .

In addition to the grid point observations, a representative selection of the soil Forms mapped was sampled to determine the chemistry and physical attributes of the soils. The soil mapping was undertaken on a 1:10,000 scale (Refer to Figures 5.3.1a, b, c and d – Soil Polygon Mapping) .

A total area of approximately 4,600ha was covered in the course of this study.

The majority of observations used to classify the soils were made using a hand operated Bucket Auger and Dutch (clay) augers with any and all natural exposures (road cuttings etc.) being used to obtain a better understanding of the in-situ characteristics of the soils. Where possible, and if the characterisation of the soils required, an observation pit was dug so as to obtain better information. However, due to the limited time available for these studies, only a limited number of observation pits were dug.

In all cases, the observation points were excavated to a depth of 1,500mm or until refusal was obtained. Immediately after completing the classification of the profiles, the excavations (Pits and Auger Holes) were backfilled for safety reasons.

Standard mapping procedures and field equipment were used throughout the survey. Initially, geological map of scale 1:250,000 and top cadastral maps at a scale of 1:50,000 were used to provide an overview of the area, while Ortho photographs at a scale of 1:10,000 being used as the base map for the soil survey.

The fieldwork comprised a site visit during which profiles of the soil were examined and observations made of the differing soil extremes. Relevant information relating to the climate, geology, wetlands and terrain morphology were also considered at this stage. This information was obtained from the client or from other consultants involved in these areas of speciality.

The pedological study was aimed at investigating/logging and classifying the soil profiles. Terrain information, topography and any other infield data of significance was also recorded, with the objective of identifying and classifying the area in terms of:

- The soil types to be disturbed/rehabilitated;
- The soil physical and chemical properties;
- The soil depth;
- The erodibility of the soils;
- Pre-construction soil utilisation potential, and
- The soil nutrient status.

Soil Profile Identification and Description Procedure

The identification and classification of soil profiles were carried out using the *Taxonomic Soil Classification System (Mac Vicar et al, 2nd edition 1991*)

The Taxonomic Soil Classification System is in essence a very simple system that employs two main categories or levels of classes, an upper level or general level containing Soil Forms, and a lower, more specific level containing Soil Families. Each of the soil Forms in the classification is a class at the upper level, defined by a unique vertical sequence of diagnostic horizons and materials. All Forms are subdivided into two or more families, which have in common the properties of the Form, but are differentiated within the Form on the basis of their defined properties.

In this way, standardised soil identification and communication is allowed by use of the names and numbers given to both Form and Family.

The procedure adopted in field when classifying the soil profiles is as follows:

i. Demarcate master horizons (Refer to Figure 5.3.1)
ii. Identify applicable diagnostic horizons by visually noting the physical properties such as:
    - Depth (below surface)
    - Texture (Grain size, roundness etc.)
    - Structure (Controlling clay types)
    - Mottling (Alterations due to continued exposure to wetness)
    - Visible pores (Spacing and packing of peds)
    - Concretions (cohesion of minerals and/or peds)
    - Compaction (from surface)

iii. Determine from i) and ii) the appropriate Soil Form
iv. Establishing provisionally the most likely Soil Family

Sampling of representative areas of each of the Soil Forms were carried out and submitted for analysis.

Factors that were considered in the laboratory included:

- Determination of the pH
- Exchangeable bases
- C.E.C. (cation exchange capacity)
- Texture (% clay)
- Nutrient status and
- Any potential pollutants

The methods employed in the determination of the above variables are:

- The Spectro Atomic Analyser for the determination of the basic elements
- The titration method for the determination of Organic Carbon contents, and
- The use of a density meter for the determination of the clay contents.

Analytical results are given for the extractable quantities available from the soil, the results having been obtained from the actual soil sample.

Table 5.3.1 Typical Arrangement of Master Horizons in Soil Profile

SOLUM (Zone in which the soil forming processes are maximally expressed)		O		O1	Loose leaves and organic debris, largely undecomposed
				O2	Organic debris, partially decomposed or matted
		A		A1	Dark coloured due to admixture of humified organic matter with the mineral fraction
				A2 or E	Light coloured mineral horizon
				A3	Transitional to B but more like A than B
		G	B	B1	Transitional to A but more like B than A
				B2	Maximum expression of B-horizon character
				B3	Transitional to C
			C		Unconsolidated material
		R			Hard rock
Arrangement of master horizons					

Figure 5.3.1a Soil Polygon Map - Leeuwpan

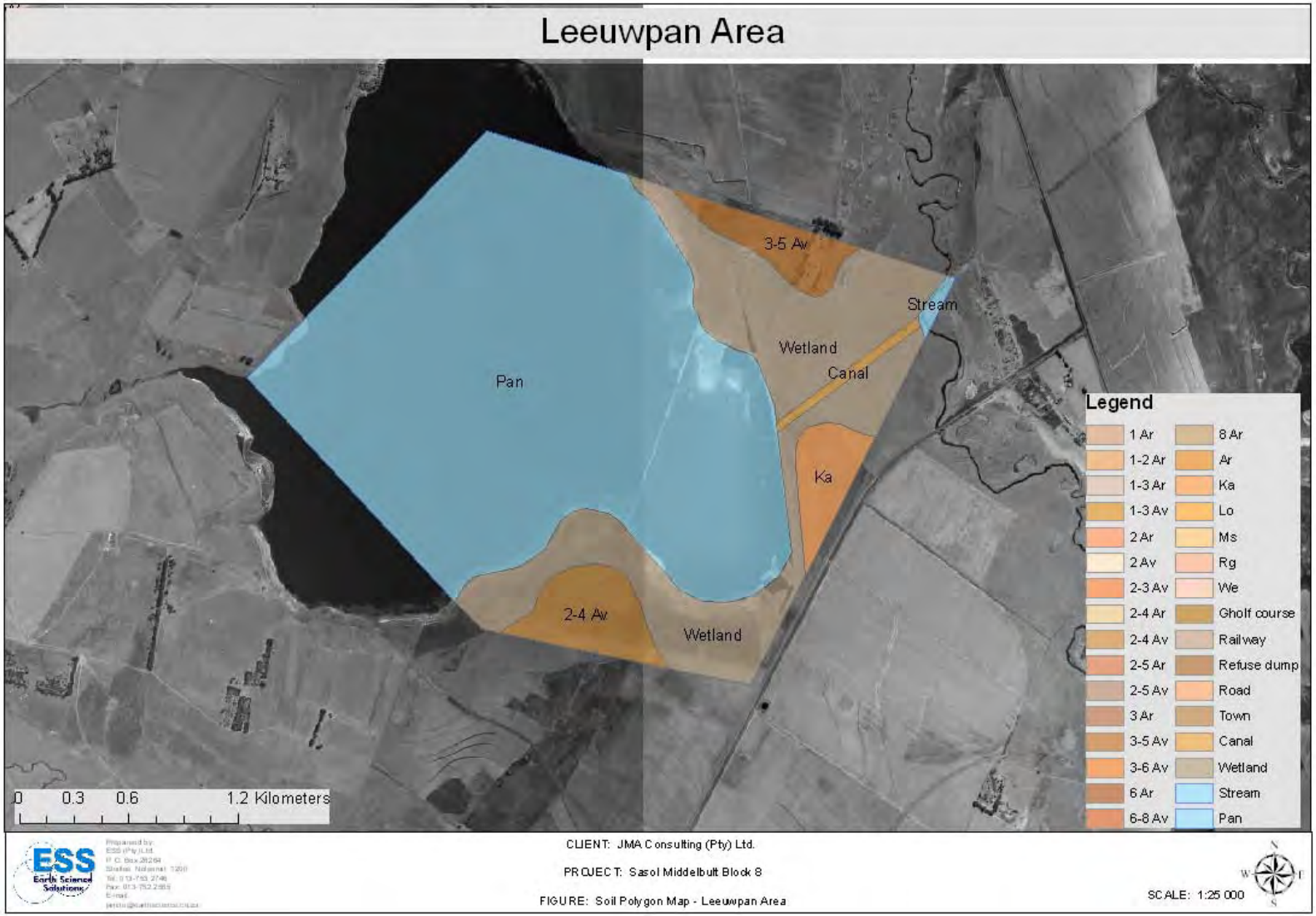


Figure 5.3.1b Soil Polygon Map - Springbokdraai

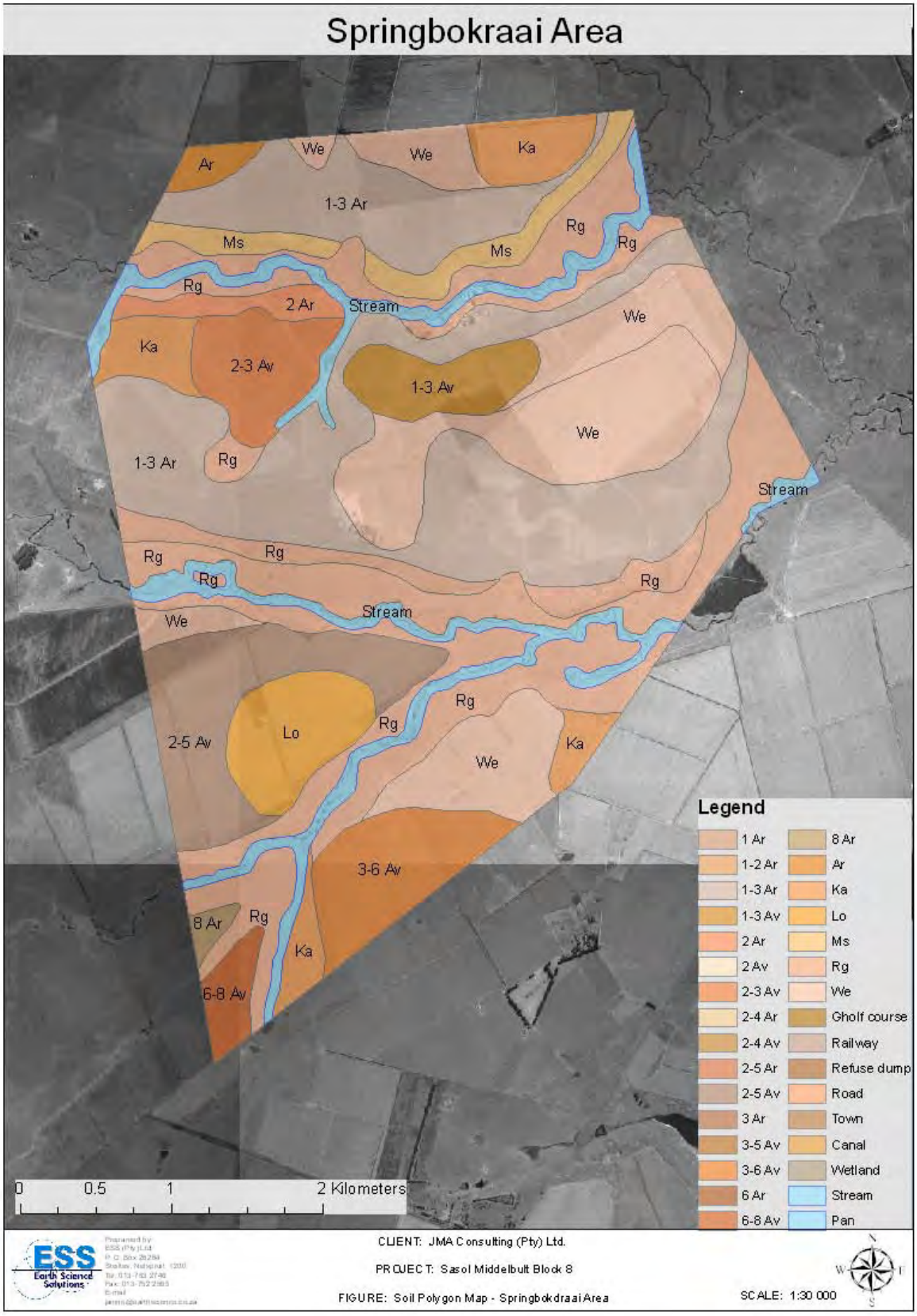


Figure 5.3.1c Soil Polygon Map – Northern Block

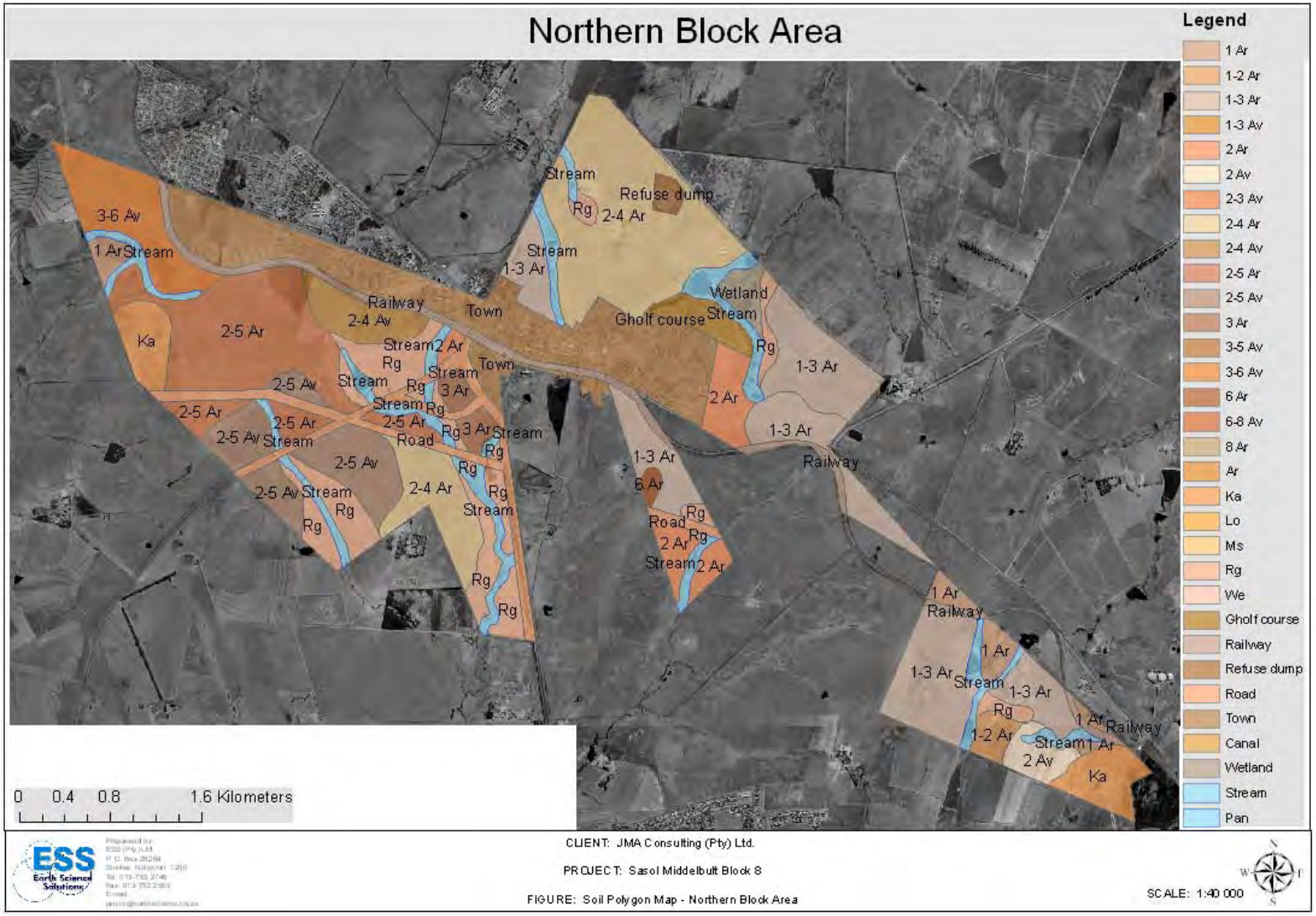
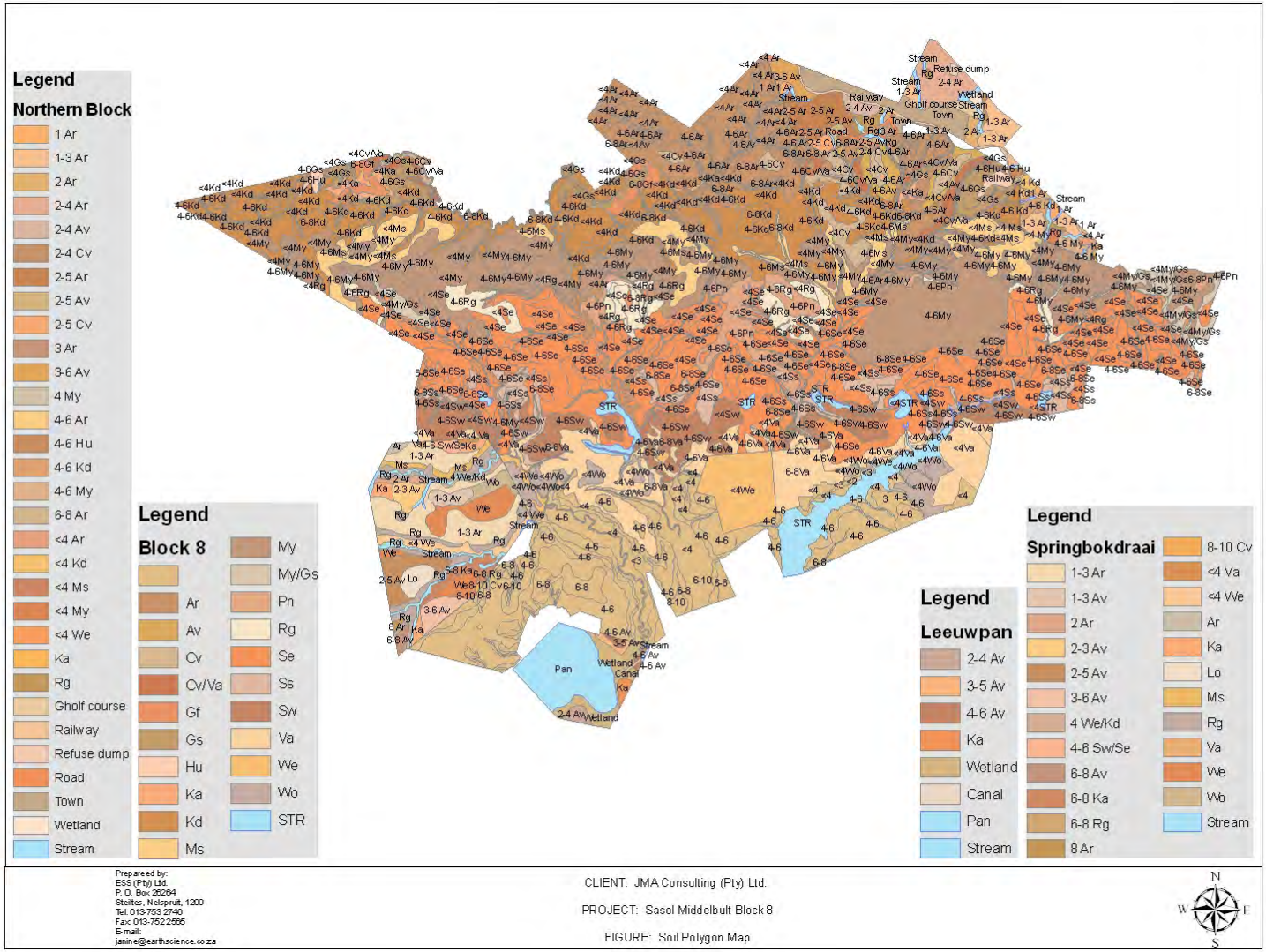


Figure 5.3.1d Soil Polygon Map – Complete Area



5.3.2 Description

Soil Forms Identified

The "major" soil types mapped during the most recent (June 2010) site assessment comprise shallow structured and wet based soils that include the Avalon, Westleigh, Longlands, Katspruit and Rensburg Forms, with significantly large areas of Arcadia Form soils in the Northern Block. Of the total area included in the SASOL Middelbult (Shondoni) Block 8 study area are a number of other soil forms. The major forms mapped across the study site include those of the orthic phase Hutton, Clovelly, Griffin, Shortlands of varying depth, with areas of shallow Mispah, Mayo and Glenrosa Form soils which cover small but significant portions of the study area, while minor and less significant areas of structured materials occur associated with the much younger and basic dolerite and in places diabase intrusives.

The hydromorphic form soils are extremely prevalent and of significance to the EIA, the generally slight topographic slope and resulting wide expansive drainage lines that characterise the study area resulting in proportionately large areas of transition zone wetland and wet based soils. These areas comprise a large variety of soils, varying from deep transition zone Glencoe, Avalon, Pinedene, Bainsvlei and Bloemdal forms to the more shallow wetland soils including the sandy loams and sandy clay loams in the form of the Westleigh, Longlands, Avalon and Dresden forms, and the more structured to highly structured Willowbrook, Sepane, Kroonstad, Katspruit and Rensburg forms, with areas of Arcadia.

The hydromorphic soils are primarily associated with the riverine areas and its tributaries, the terrace slopes and change in topography holding a strong correlation to the change is soil types. The horizontal bedding of the sedimentary lithologies that underlie a significant portion of the site and the presence of significant hard sandstone partings have resulted in large areas of hard plinthic horizons both in the lower lying drainage ways and wetland areas, as well as relic land forms at lower midslope and even midslope positions in the topography.

The various catena described for this area reflect the strong erosion environment on the crest and upper slopes, with large open floodplain deposits associated with the riverine environment, the distinctive soils associated with colluvial deposition, and variations on cumulative environments in between. These catena are tempered and altered by the complex lithological associations and geological formations that make up the sedimentary pile and its intrusives with which the coal deposits are associated. It is this complex of interactions combined with the complex of topography, climate and geomorphology that complicate the soil pedogenisis and that result in the complex of soil forms mapped.

All relevant soils and related spatial information (inclusive of waterways) in the study area has been captured in a GIS format with the land capability having been ranked/rated according to a combination of the Chamber of Mines Land Capability Rating System and the Canadian Land Inventory System. The utilization of the soil classification information and related geomorphological characteristics has been

combined with the local climatic information in obtaining a reliable rating for the land capability potential.
The spatial distribution and size of the different soil types has been captured in a soil map and tabled as a percentage of the total study area. Please refer to Table 5.3.2 a to d for the soil areas, and in Figure 5.3.1a to c for the map (Soil Polygon Maps).

A short description of the major soil forms that have been characterised and mapped during the expansion study are given below, with the salient features of each soil being discussed in some detail. Of significance to the outcomes from these studies is the significant physical and chemical attributes of each soil form. These are important in understanding how the different soils will react to being disturbed, handled and stored (stockpiled), and will have a bearing on the ease or difficulty of handling of the soils at the time of stripping, hauling and/or rehabilitation. The management plan and resultant ease of mitigation of impacts are dependent on the knowledge of these soil properties.

A table (Refer to 5.3.2d) reflects the combined studies for the complete Shondoni Block 8 Project area.

Table 5.3.2a Soil Coverage – Leeuwpan

Leeuwpan Soil Polygon Table

Soil Code	Soil Name	Soil Depth	Comment	Area (Ha)	% of Area
2-4 Av	Avalon	2-4	(We) 15-20% Clay	28.12	3.94%
3-5 Av	Avalon	3-5	20-25% Clay	20.40	2.86%
Canal	Canal			4.86	0.68%
Ka	Katspruit		(We) 40-60% Clay, Soil Sample	19.24	2.69%
Pan	Pan			475.37	66.58%
Stream	Stream			2.62	0.37%
Wetland	Wetland			163.40	22.88%
			Total Area (Ha)	714.02	100.00%

Table 5.3.2b Soil Coverage – Springbokdraai

Springbokdraai Soil Polygon Table

Soil Code	Soil Name	Soil Depth	Comment	Area (Ha)	% of Area
1-3 Ar	Arcadia	1-3		453.98	23.96%
1-3 Av	Avalon	1-3	(We) 15-20% Clay	49.04	2.59%
2 Ar	Arcadia	2		22.71	1.20%
2-3 Av	Avalon	2-3	(We) 15-20% Clay	58.19	3.07%
2-5 Av	Avalon	2-5	(We) 20-25% Clay	119.59	6.31%
3-6 Av	Avalon	3-6	(We/Lo) 25-30% Clay	76.82	4.05%
6-8 Av	Avalon	6-8		21.25	1.12%
8 Ar	Arcadia	8		6.93	0.37%
Ar	Arcadia		Ms	12.73	0.67%
Ka	Katspruit		We	86.66	4.57%
Lo	Longlands		(Ka) 20-25% Clay	63.14	3.33%
Ms	Mispah		Ar 1	52.38	2.76%
Rg	Rensburg			430.28	22.71%
We	Westleigh			312.19	16.47%
Stream	Stream			129.13	6.81%
			Total Area (Ha)	1895.02	100.00%

Table 5.3.2c Soil Coverage – Northern Block

Northern Block Soil Table

Soil Code	Comment	Soil Name	Soil Depth	Area (Ha)	% of Area
1 Ar		Arcadia	1	34.82	1.99%
1-2 Ar	Ms	Arcadia	1-2	13.14	0.75%
1-3 Ar		Arcadia	1-3	341.20	19.51%
2-4 Ar		Arcadia	2-4	242.83	13.88%
2-4 Av	20-25% Clay	Avalon	2-4	35.59	2.04%
2-5 Ar		Arcadia	2-5	177.18	10.13%
2-5 Av		Avalon	2-5	88.06	5.04%
3 Ar		Arcadia	3	17.66	1.01%
3-6 Av	(We) (Lo) 10-15% Clay	Avalon	3-6	72.57	4.15%
6 Ar		Arcadia	6	4.78	0.27%
Ka		Katspruit		61.40	3.51%
Rg		Rensburg		140.69	8.04%
Stream		Stream		112.51	6.43%
Wetland		Wetland		14.77	0.84%
Town		Town		234.79	13.42%
Road		Road		75.69	4.33%
Railway		Railway		52.28	2.99%
Gholf course		Gholf course		21.56	1.23%
Refuse dump		Refuse dump		7.44	0.43%
			Total Area (Ha)	1748.95	100.00%

Table 5.3.2d – Soil Coverage – 2002 Assessment

Soil Form	Soil Depth (cm)	Soil Area (Ha)	% of Total Area (Ha)
Willowbrook (Wo)	<40	182.90	0.91
Valsrivier/Swartland (Va/Sw)	<40	73.90	0.37
Valsrivier (Va)	80-100	189.80	0.94
Valsrivier (Va)	60-80	446.10	2.21
Valsrivier (Va)	40-60	820.70	4.07
Swartland (Sw)	40-60	886.80	4.40
Swartland (Sw)	80-100	8.20	0.04
Swartland (Sw)	60-80	669.40	3.32
Sterkspruit (Ss)	60-80	111.60	0.55
Sterkspruit (Ss)	40-60	1,783.50	8.85
Sepane (Se)	60-80	201.30	1.00
Sepane (Se)	40-60	1,867.70	9.27
Sepane (Se)	<40	658.30	3.27
Rensburg (Rg)	40-60	456.20	2.26
Rensburg (Rg)	<40	293.60	1.46
Pinedene (Pn)	<80	7.10	0.03
Mayo (My)	40-60	556.90	2.76
Mayo (My)	<40	1,056.20	5.24
Mispah (Ms)	<40	226.70	1.13
Kroonstad (Kd)	40-60	44.50	0.22
Kroonstad (Kd)	<40	2,130.30	10.57
Katspruit (Ka)	<40	198.30	0.98
Hutton (Hu)	60-80	148.20	0.74
Glenrosa (Gs)	40-60	61.10	0.30
Glenrosa (Gs)	<40	35.60	0.18
Griffin (Gf)	80-100	4.70	0.03
Griffin (Gf)	60-80	139.00	0.69
Clovelly (Cv)	80-100	10.80	0.05
Clovelly (Cv)/Valsrivier (Va)	60-80	271.30	1.36
Clovelly (Cv)	80-100	6.40	0.03
Clovelly (Cv)	40-60	9.10	0.06
Avalon (Av)/Westleigh (We)	<40	10.70	0.06
Avalon (Av)	60-80	16.10	0.08
Arcadia (Ar)	60-80	177.00	0.88
Arcadia (Ar)	40-60	3,904.30	19.38
Arcadia (Ar)	<40	37.00	0.18
Disturbed Areas		299.00	1.48
Oos		1,040.50	5.17
Streams		1,002.10	4.98
Water		99.50	0.50
Total Area		**20,142.40**	**100.00**

Hutton (Hu)

The Hutton Form soils mapped in the area comprise predominantly fine grained sandy, to silty loams or fine to medium grained sandy clay loams (depending on the lithological unit from which they are derived), and generally exhibit an apedel to single grained structure. These soils generally returned pale red/brown to orange/red colours in the topsoil's, and fine to medium grained sandy clay and clay loams, with dark orange reds and dark red colours in the subsoil horizons.

Clay contents vary from as low as 10% and 15% in the sandy topsoil's of the soils derived from the sediments, rising as high as 25% in some instances where the soils are associated with more basic lithologies.

In the topographically lower lying areas, the high clay contents are associated with the fine to very fine grained colluvial derived materials.

The subsoil clay percentages range from about 15% to 45% depending on the position that they occupy in the topographic sequence and the host geology from which they are derived.

In almost all cases mapped, the soils classify as having a mesotrophic leaching status (moderately leached) and are luvic in character. This implies that the soils are only moderately leached. These soil forms generally occupy the upper and upper midslopes, and returned effective rooting depths (ERD) that vary from as shallow as 400mm to greater than 1,200mm.

Chemically, these soils are of the more productive soil forms in the area. However, the chemical analysis undertaken on the composite samples returned only moderate reserves of Ca and Mg, with lower than required reserves of P, Zn and K. Supplements of these nutrients will be needed if the soils are to be utilized for anything other than natural low intensity grazing of livestock. Additions of fertilizers are required if economically sustainable farming is to be undertaken on a long-term and sustainable basis.

Clovelly (Cv) and Griffin (Gf)

Soils of the Clovelly and Griffin Form have very similar characteristics to the Hutton Form described above and are generally derived from the same parent materials. The major differences are observed is the degree of leaching that has occurred. These soils returned physical and chemical characteristics very similar to the Hutton described, varying in physical characteristics from a very fine to medium grained sandy and/or silty loam, with pale grey brown to yellow brown colours and a single grained orthic topsoil ("A" horizon), on a yellow to yellow/red dystrophic "B", to those with a more clay rich sandy clay loam, displaying much darker yellow reds and less leached colours. These soils exhibit a predominantly mesotrophic leaching status and luvic characteristics.

Generally, these soils were noted to interface directly on a hard rock contact with only a thin saprolitic layer. This phenomenon is due mainly to the horizontal or sub horizontal bedding of the parent material from which they are derived.

These sandy to-sandy-clay loams are confined predominantly to the midslope and upper midslope positions and often exhibit a thin plough pan layer at approximately 300mm, an indication of the depth to which the soils have previously been compacted or worked (ploughed). The effective rooting depths vary from as little as 400mm to 900mm in places where they are inhibited by physical or chemical barriers.

Compaction and erosion are physical hazards to be aware of and catered for when working with these soil types. Chemically, these soils returned results similar to the Hutton soils described above.

Swartland (Sw) and Sterkspruit (Ss)

The Swartland Form along with its more extreme version – the Sterkspruit - is defined by an orthic "A" horizon on a pedocutanic B, or an orthic "A" on a prismacutanic "B" respectively. The structure of the "B" horizon is the defining feature between these soils Forms, the Sterkspruit having a stronger structure than the Swartland.

These soils are widespread over the mid and upper midslope positions where the soils are associated with the more basic parent host material (Dolerite and/or Diabase) or on the scree slopes below the dolerite dykes that were encountered in the southern portions of the area mapped.

Clay percentages range from 20% to 28% in the topsoils, and between 35% and 65% in the subsoils. These soils returned moderate to good water holding capabilities due to the high clay contents. However, not all of this moisture is available to the plant as the two to one swelling nature of the clays has a strong electrical bond on the water particles. Total Available Moisture (TAM) levels are thus lower than would otherwise be expected. These soils show only moderate drainage characteristics and are moderately susceptible to salinity problems if not managed correctly. Drainage and surface water management are essential for good economic return of agriculture on these soils.

Both the Swartland and Sterkspruit forms are susceptible to compaction in the wet state, and erosion is a major problem due to the dispersive nature of the soil particles. Chemically, these soils are prone to solution weathering, the sodium and calcium being easily taken into solution. These soils will need extremely good management, and protection during stockpiling as well as during the rehabilitation process.

Valsrivier (Va)

The Valsrivier Forms mapped can be divided into two categories, based on their colour and degree of structure. Those with a predominantly red colour are on average less structured and can be grouped with the Hutton Form with regards to their land capability, irrigation potential and general workability. In contrast, the brown Valsrivier Form has a stronger structure verging on strong blocky, and is more closely aligned to the Swartland Form soils in character.

Chemically, both soil families are very similar, returning moderate to good levels of most nutrients (Ca, Mg and K), the brown Valsrivier returning higher levels of Sodium (Na) (in the updated areas), resulting in a greater potential for salinity/sodicity problems in the brown soils than in the red.

Structurally the brown Valsrivier forms are more difficult to work, and they are generally shallower (400-600mm).

These soils are generally associated with the dolerite derived parent materials.

Better than average management of both erosion as well as compaction will be needed to retain the usability of these soils during the rehabilitation process.

Glenrosa (Gs) Dresden (Ds) and Mispah (Ms)

The Glenrosa, Dresden, and Mispah soil forms returned effective rooting depths of between 150mm and 400mm. The major constraint envisaged with these soils will be tillage, sub surface hindrance and erosion. The restrictive layer associated with these soils is a hard lithocutanic layer in the form of weathered parent material (Gs), hard plinthite (Dr) or rock (Ms).

The effective soil depth is restricted, resulting in reduced soil volumes and as a result, depletion in the water holding capacity as well as nutrient availability.

Geophysical characteristics of these soils include moderate clay percentages (12% to 20%), moderate internal drainage and low water holding capabilities.

These materials are of the poorer land capability units mapped. It is imperative that good management of these soils is implemented, both from the erosion as well as the compaction perspective.

Glencoe (Gc)

The Glencoe soil form is generally confined to the lower mid-slope, lower slope and bottom land positions, and is found associated with the transition zone and wetland areas that are regularly influenced by the soil water and regional groundwater table. These soil forms are indicative of a persistent wetting of the subsoil, and the formation of a hard plinthic horizon at the base of the profile. These soils are also associated with lithologies that are rich in iron and magnesium.

These soils are characterised by a hard plinthic (*ouklip*) layer at the base of the profile, and are classified as wet soil types. It should be noted however that these soil forms are sometimes found in mid, and in some cases, upper midslope positions, as residual, or old land forms.

Physically these soils returned fine to medium grained, pale red to brown, apedel structure in the topsoil's ("A" horizon), with moderate to low clay contents (12% – 18%) and moderate to low water holding capabilities (40 – 60 mm/m). The subsoil is generally pale yellow/red to pale red in colour, returning moderate clays (12% – 22%), fine to very fine-grained sand fractions, with a concretionary layer at the interface between the "B" horizon and the hard plinthic "C" horizon.

Chemically, the soils are similar to the Avalon, Pinedene and Westleigh soil Forms described herein.

Hazards to be managed on these soils include the impeded drainage caused by the hard plinthic layer, compaction in the wet state, and erosion.

Bainsvlei (Bv), Bloemdal (Bd), Pinedene (Pn) and Avalon (Av)

The Bloemdal and Pinedene form soils are found associated with the deeper profiled Bainsvlei and Avalon Forms that have been mapped as part of the transition zone terrace slopes that occur upslope of the wetland environ. These soils are characterised by hydromorphic features (soft plinthic – mottled horizons of varying intensity at depth ("C" horizon).

These soils are most often found associated with but upslope of the Westleigh and Kroonstad soils and comprise the major "hydromorphic" category of soil classified on the site, and are of the more sensitive materials that will potentially need to be worked and handled during the construction and rehabilitation phases. Better than average management of these materials will be needed.

Chemically, these soils (characteristics are similar within these same forms) are moderately well leached returning significantly lower amounts of Ca and Mg than the dryer soils, as well as depleted amounts of Na, K and P. The leaching of the nutrients from these soils is significant and the pale colours are evidence of the movement of water within the profile.

By definition, these soils vary in the degrees of wetness at the base of their profile. i.e. the soils are influenced by a rising and falling water table, hence the mottling within the lower portion of the profile and the pale background colours.

Depths of utilizable agricultural soil (to top of mottled horizon) vary from 400mm to over 700mm. The deeper rooting depths (>700mm) are considered potentially utilizable soils, with those less than 500mm being considered to have a wetland or wilderness/conservation status. In general, these soils are high in transported clay in the lower "B" horizon with highly leached topsoil's and pale denuded horizons at shallow depths. The nutrient status is variable, but due to excessive leaching is generally low.

These materials will be more difficult to work due to the wetness factor, both during the construction phase and operation, as well as on rehabilitation. Compaction is a problem to contend with if these soils are to be worked during the wet months of the year. Stockpiling of these soils should be done separately from the dry soils and greater care is needed with the management of erosion problems during storage. Any strong structure that develops during the stockpiling stage will need to be dealt with prior to the use of this material for rehabilitation.

Westleigh (We)

The Westleigh soil form is by definition a soil with strong hydromorphic characteristics. It exhibits strong indications of wetness at shallow depths in the form of strong red to yellow/red mottling on a grey (gleyed) background.

In general, these soils are high in transported clay in the lower "B" horizon with highly leached topsoil's and pale denuded horizons at shallow depths. The nutrient status is generally low.

These soils will be more difficult to work due to the wetness factor, both during the construction and operation of the facility.

Compaction is a problem to contend with if these soils are to be worked during the wet months of the year.

Stockpiling of these soils should be done separately from the dry soils and greater care is needed with the management of erosion problems during storage.

Any strong structure that develops during the stockpiling stage will need to be dealt with prior to the use of this material for rehabilitation.

Kroonstad (Kd), and Katspruit (Ka)

The Kroonstad and Katspruit soil Forms are found associated exclusively with the wetland and vlei areas alongside the rivers and prominent pan features. The hydromorphic nature of these soils renders them highly susceptible to compaction and erosion.

Re-working of these soils for rehabilitation purposes will need to be undertaken during the dry months of the year, and will require that the structure is broken down if these soils are to be used for topdressing of areas prior to replanting.

Longlands (Lo)

The Longlands soil Form is found associated exclusively with the wetland and vlei areas within the floodplain environment and alongside the rivers and around the prominent pan features. The hydromorphic nature of these soils renders them highly susceptible to compaction and erosion.

Re-working of these soils for rehabilitation purposes will need to be undertaken during the dry months of the year, and will require that the structure is broken down if these soils are to be used for topdressing of areas prior to replanting.

Arcadia (Ar) and Rensburg (Rg)

The Rensburg and Arcadia soils are characterised by high clay contents, of a swelling variety (2:1 Swelling – Smectite clay) that produce strongly structured blocky and vertic fabric, are generally pale in colour (grey to grey brown), highly leached, and are, in almost all cases associated with the bottomland floodplain alluvial deposits, were accumulations of transported materials and soils make up the majority of the soil pedogenisis.

The vertic structure is the distinctive feature of these soils, the Arcadia by definition being a vertic horizon on soft rock base, while the Rensburg Form comprises a vertic "A" horizon on a gleyed G-horizon, with its distinctive greyish-yellow mottling due to direct contact with the water table. In the Arcadia Forms there are slight colour variations that differentiate the soil series' from one another, ranging from black to red.

Chemically, both soil Forms are very similar, returning moderate to poor levels of most nutrients (Al, P and N materialisation capacity). Conversely the salts (K and Zn) return as higher levels, resulting in a greater potential for salinity and/or sodicity problems (moderate to severe).

Physically these soils have very high clay contents (> 40%) with moderate to high moisture holding capabilities. The intake rates range from moderate to poor with poor drainage characteristics and a high erosion hazard index.

Structurally both of these soil forms are difficult to work, the Arcadia often being associated with a shallow water table.

Better than average management of both erosion as well as compaction will be needed to retain the usability of these soils during the rehabilitation process.

5.3.3 Soil Chemical and Physical Characteristics

A suite of composite and representative samples from the differing soil forms/types were taken and sent for analyses for both chemical as well as physical constituents (Refer to Table 5.3.3.1a (Latest Results) and 5.3.3.1b (Previous/Original Mapping) for the results). A select number of samples were submitted, each sample containing a number of sub samples from a particular soil polygon/type which is representative of the area in question, thus forming a composite sample, which in turn is representative of the soil polygon rather than just the point sampled.

5.3.3.1: Soil Chemical Characteristics

Sampling of the soils for nutrient status was confined where possible to areas of uncultivated land. However, some of the land being used for grazing may have been fertilized in the past, and thus these results may not be truly representative of the soils in their natural state.

These results will be useful in understanding the pre mining/construction conditions, and will give a baseline from which to compare the soils at closure. However, due to the possible loss of nutrients from the soils during stockpiling and storage, additional sampling and analysis of the soils will be needed prior to their use for rehabilitation.

Table 5.3.3.1a - Analytical Soils Results – June 2010 Study

SASOL Middlebult (Shondoni) Block 8 Expansion																	
Sample No	**Obs Pt**	**pH (Water)**	**Res (ohms)**	**Ca mg/kg**	**Mg mg/kg**	**K mg/kg**	**Na mg/kg**	**P (Bray1)**	**Al mg/kg**	**Ca/Mg**	**Ca+Mg/K**	**Zn mg/kg**	**C%**	**Org Mat%**	**Sand%**	**Silt%**	**Clay%**
1548	**Leeuwpan A**	5.02	1400	1626	470	322	132	0.6	11	3.46	6.51	1.25	1.19	2.04	60	16	24
1549	**Uitkyk A**	5.65	2100	3089	1327	220	21	0.3	10	2.33	20.07	4.29	2.52	4.33	62	14	24
1550	**SBD 2 A**	5.93	840	3632	1473	217	171	0.5	9	2.47	23.53	3.52	1.01	1.73	60	6	34
1551	**NP 1 A**	4.96	500	537	149	225	8	10.7	51	3.60	3.05	2.92	1.01	1.73	82	4	14
1552	**NP 1 B**	5.33	990	734	373	107	61	0.3	15	1.97	10.35	1.25	0.86	1.49	68	12	20
1553	**SBD 1 A**	4.2	940	353	85	253	4	43.7	177	4.15	1.73	5.52	1.44	2.48	77	3	20
1554	**SBD 1 B**	5.08	890	986	284	104	5	0.5	16	3.47	12.21	1.44	0.5	0.87	60	10	30
1555	**SB1**	6.85	842	1946	728	12	20	7	1.2	2.67	222.83	1.10	0.33	NA	55	6	39
1556	**SB2**	4.7	622	122	34	12	3	7	6	3.59	13.00	0.90	0.04	NA	74	24	2
1557	**SB3**	7.55	1147	2775	215	4	10	7	0.8	12.91	747.50	1.20	0.32	NA	68	13	19
1558	**SB4**	7.2	1050	2060	733	11	23	8	0.1	2.81	253.91	2.00	0.26	NA	55	12	33
1559	**SB5**	4.75	985	134	33	12	9	8	4.4	4.06	13.92	1.50	0.10	NA	72	26	2

Table 2.1.3.1b – Soil Analytical Results – April 2010 Study

Determinants	Units	KS5	KS10	KS11	KS18	KS28	KS40	KS55	KS62	KS69	KS76	KS102	KS109	KS119	KS121	KS126	KS140	KS170	KS184	KS201	KS220
PH		0.25	5.8	4.9	6.8	6.65	6.9	5.85	5.75	3.8	5.6	5.15	5.55	5.85	4.95	6.55	7	5.2	6.48	7.8	7.15
Ca	mg/kg	200	3178	30	904	683	441	603	653	395	774	1446	1045	2806	893	2209	1489	1380	2156	3720	1345
Mg	mg/kg	60	1338	22	513	235	218	733	116	162	206	405	169	1273	289	1518	994	647	433	950	578
K	mg/kg	138	176	80	1090	631	69	25	178	111	130	208	296	161	257	145	81	208	216	89	68
Na	mg/kg	5	170	5	149	119	15	2	8	15	3	10	9	169	10	120	143	10	42	72	68
"S" Value (CEC)	me%	4.9	28.2	8.6	12.3	7.5	4.3	9.2	4.7	5.7	5.9	11.2	7.4	25.7	7.6	24.5	16.5	12.9	8.2	6.2	5.2
P	Amb.1mg/kg	117	12	123	170	150	7	6	10	13	5	7	19	3	5	2	5	5	2	3	5
Zn	mg/kg	2.7	0.5	2.7	4.9	3.3	12.2	24.3	1.4	4.4	0.9	0.7	1.6	0.4	0.4	1.5	1.1	2	2.2	11.8	3.2
Clay	%	20	57	22	18	15	9	12	24	23	30	21	30	46	20	24	6	24	26	25	22
Org Mat	C%	0.03	0.21	0.02	0.81	0.41	0.11	0.21	0.52	0.88	0.55	0.7	0.45	0.87	0.23	0.72	0.88	0.62	0.52	0.31	0.3

Determinants	Units	KS226	KS238	KS250	KS272	KS284	KS300	KS311	KS321	KS328	KS345	KS376	KS386	KS379	KS400	KS402	KS338	KS292	KS368
PH		7.53	7.8	6.48	7.04	5.83	6.69	7.46	6.03	8.2	7.09	7.32	8.24	7.81	6.76	7.06	6.2	6.92	7.35
Ca	mg/kg	1323	7660	2125	1361	1103	1641	3336	1568	6890	3409	1367	2858	1913	3003	1807	1297	1543	2680
Mg	mg/kg	413	567	433	430	377	514	1016	657	1050	1590	270	596	820	592	467	284	655	750
K	mg/kg	152	58	216	142	143	255	438	423	233	326	109	183	145	244	419	121	62	58
Na	mg/kg	68	95	42	204	34	33	210	80	109	111	8	4	50	1	43	66	70	39
"S" Value (CEC)	me%	3.8	7.5	8.8	5.9	1.9	5.6	10.3	7.8	5.3	9.3	1.7	3.2	2.7	3.1	5.9	2.5	6.3	4.1
P	Amb.1mg/kg	10	2	2	117	11	190	33	27	17	17	9	1	3	12	4	3	3	2
Zn	mg/kg	2.1	2	4.4	1.8	2.9	6.7	4.9	4.3	6.2	6.3	2.4	0.7	1.5	3.8	2	4.1	2.7	3.2
Clay	%	16	18	26	20	26	34	44	38	24	32	10	21	24	26	24	20	22	18
Org Mat	C%	0.22	0.45	0.42	0.33	0.05	0.45	0.65	0.47	0.41	0.51	0.03	0.35	0.32	0.05	0.42	0.1	0.34	0.13

The results of the analysis returned moderate to light textured soils with a range of pH (KCl) values of between 3.8 and 7.5, a base status ranging from 2.0me% to 10.8me%, and nutrient levels reflecting generally acceptable concentrations of calcium and magnesium, but deficiencies in the levels of potassium, phosphorous and zinc, with predictably low organic carbon matter.

The structured and basic derived soils returned values that are indicative of the higher reserves of calcium and magnesium. They are inherently low in potassium reserves, and returned lower levels of zinc and phosphorous for economically acceptable agricultural growth.

The nutrient status indicates a need for fertiliser applications of “Zn” “P” and “K”.

It should be noted however, that the addition of “P”, “K” and “Zn” in the form of commercial fertilisers are potential pollutants to the riverine and groundwater environment if added in excess. This must be taken into account when applying these additives. Small amounts of fertilizer should be added on a regular/more frequent basis, rather than adding large quantities in one application.

5.3.3.1.1 Soil acidity/alkalinity

In general, it is accepted that the pH of a soil has a direct influence on plant growth. This may occur in a number of different ways, which include:

- The direct effect of the hydrogen ion concentration on nutrient uptake;
- Indirectly through the effect on major trace nutrient availability; and by
- Mobilising toxic ions such as aluminium and manganese, which restrict plant growth.

A pH range of between 6 and 7 most readily promotes the availability of plant nutrients to the plant. However, pH values below 3 or above 9, will seriously affect, and reduce the nutrient uptake by a plant.

The dominant soils mapped in this area are neutral to slightly acid (4.20 to 7.60), generally within the accepted range for good nutrient mobility. However, some of the soils derived from intrusive material will tend to be more alkaline than indicated by these results due to the potential buffering capacity of the moderately high levels of calcium carbonate. This may affect the pH of the soils to some extent. It is unlikely however, that they will be dramatically impaired.

5.3.3.1.2 Soil Salinity/Sodicity

In addition, to the acidity/alkalinity of a soil, the salinity and/or sodicity are of importance in a soils potential to sustain growth.

Highly saline soils will result in the reduction of plant growth caused by the diversion of plant energy from normal physiological processes, to those involved in the acquisition of water under highly stressed conditions. Salinity levels of <60mS/m will have no effect on plant growth. From 60 – 120mS/m salt sensitive plants are affected, and above 120mS/m growth of all plants is severely affected.

In addition soil salinity may directly influence the effects of particular ions on soil properties. The sodium adsorption ratio (SAR) is an indication of the effect of sodium on the soils. At high levels of exchangeable sodium, certain clay minerals, when saturated with sodium, swell markedly.

With the swelling and dispersion of a sodic soil, pore spaces become blocked and infiltration rates and permeability are greatly reduced. The critical SAR for poorly drained (grey coloured) soils is 6, for slowly draining (black swelling as found in this site) clays it is 10 and for well drained, (red and yellow) soils and recent sands, 15.

Generally, the soils mapped in this area tend toward being non saline in character, but could become susceptible to an increase in salinity if their water regime is not well managed, particularly on the more clay rich materials (Rensburg and Arcadia).

5.3.3.1.3 Soil Fertility

The soils mapped in this area returned at best only moderate concentrations of the nutrients required for good plant growth, with Zn, P and K generally lower than the optimum required, and the soil depths are inhibiting due to the extreme soil structure.

Significantly large areas of soil with an acceptable level of plant nutrition where mapped on soils that are not generally considered to be of an arable rating. These results can possibly be ascribed to either a natural anomaly in nutrient levels within the soil profile sampled, or to residual levels of fertiliser within the soil due to farming activities in the area.

In general however, there is phosphorus and zinc deficiency in the soils, and the organic carbon content is lower than the optimum.

Calcium levels are generally high to very high. This would normally have the capacity to restrict magnesium uptake. However, as the ratio between calcium and magnesium is approximately 3:1 a magnesium deficiency in the soils is unlikely.

There are no indications of any toxic elements that are likely to limit natural plant growth in the soils mapped within the study area.

Fairly standard fertiliser treatments will be needed for optimum agricultural production of crops on areas that have previously been planted, with exceptionally good water management being of paramount importance on both dryland as well as irrigated lands.

5.3.3.1.4 Nutrient Storage and Cation Exchange Capacity (CEC)

The potential for a soil to retain and supply nutrients can be assessed by measuring the “cation exchange capacity” (CEC) of the soils.

The low organic carbon content is balanced to some extent by the relatively high clay content which naturally provides exchange sites that serve as nutrient stores. These conditions will result in a moderate retention and supply of nutrients for plant growth.

Low CEC values are an indication of soils lacking organic matter and clay minerals. Typically a soil rich in humus will have a CEC of 300 me/100g (>30 me/%), while a soil low in organic matter and clay may have a CEC of 1-5 me/100g (<5 me/%).

Generally, the CEC values for the soils mapped in the area are moderate to low, due to the moderate clay contents but poor organic matter content.

5.3.3.1.5 Soil organic matter

The organic matter content of the soils is low to moderate, with values raging from 0.2-0.8%. “Normal” soils have an organic matter content of 1-2%. Within the range of 0-4%, soil erodibility tends to decrease appreciably as organic matter increases, and the magnitude of organic matter effect is related to texture. Organic matter content of a soil is important in determining the soil erodibility factor K and the N mineralisation potential.

5.3.3.2 Soil Physical Characteristics

A significant proportion of the soils mapped exhibit apedel to weak structure, moderate clay contents and mesotrophic to dystrophic characteristics.

Due to the texture and structure inherent in these soils, compaction within the "A" horizon is likely to occur if heavy machinery is used during the wet summer months over unprotected ground, while the sensitivity of the soils to erosion is a factor to be considered during the rehabilitation process (refer to section on Soil Handling and Removal and Mitigation and Management Measures)

A large proportion of the overall area to be affected by the construction operations and its associated infrastructure is underlain by soils with a more sensitive nature to heavy traffic. This will affect both compaction and erosion of the materials if not well managed

The area is flat to undulating, with wide open drainage lines and active water ways. The natural movement of eroded materials has resulted in the distribution of differing soils associated with the midslopes and lower midslope positions. The upper slopes and midslopes are dominated by erosion platforms and old land surfaces, while the lower slopes are dominated by recent accumulations of transported materials (colluvial) from the upslope positions in the alluvial floodplains of the major rivers and their tributaries.

The end result is a complex of differing soil forms within a relatively small spatial area.

5.3.3.3 Characteristics of different Soil Groups

5.3.3.3.1 The Heavy Clay Rich Soils

The colluvial derived soils and those derived from the more basic parent materials (intrusive diabase and dolerite) returned structures within the soil profile that are expansive, with notable cracking within the soil profile in the dry state, and indications of slickenslides in the wet state.

Generally the C-horizons that underlie these horizons are composed of moderately hard and shallow weathering rock (saprolite). Intake rates and drainage of these soils are poor, while the erosion hazard is moderate.

These soils generally have a moderate to low nutrient status, and are subject to serious physical limitations if the soils are worked too wet or too dry.

The major soils that fit this category include the Rensburg, Arcadia and to some degree the Swartland and/or Sterkspruit soil Forms. These soils are characterised by dark brown to black vertic or melanic (crumbly) topsoil's and moderate blocky to massive and vertic structured, clay rich "B" horizons. These soils are poorly drained and will pose a problem to handling and re-working during the construction as well as the rehabilitation phases.

Erosion and compaction are the main problems that will need to be managed on these soil types. This is due to the sensitivity of the soils to mechanical disturbances during/after the removal of surface vegetation. The existing and established vegetation binds and stabilises the soils ensuring fair growing conditions and good soil retention.

These same conditions will need to be emulated as soon after storage/stockpiling and/or rehabilitation of the soils has been undertaken.

5.3.3.3.2 Light Textured -Yellow-brown and Red Apedal Soils

More extensive areas of lighter textured soils are found associated with the sedimentary geology and will be of the more significant materials affected by the proposed infrastructure and surface development.

The lighter textured soils (Hutton, Clovelly and Glencoe) are characterised by an orthic A-horizon overlying a red or orange to brown apedel "B", with possible indications of a ferricrete layer in the B/C-horizon.

The lithologies encountered are generally resistant, massive, intrusive geologies, resulting in shallow weathering within the saprolitic zone.

The working of these soils as well as the storage (stockpiling) will need to be well managed.

5.3.3.3.3 Shallow soils

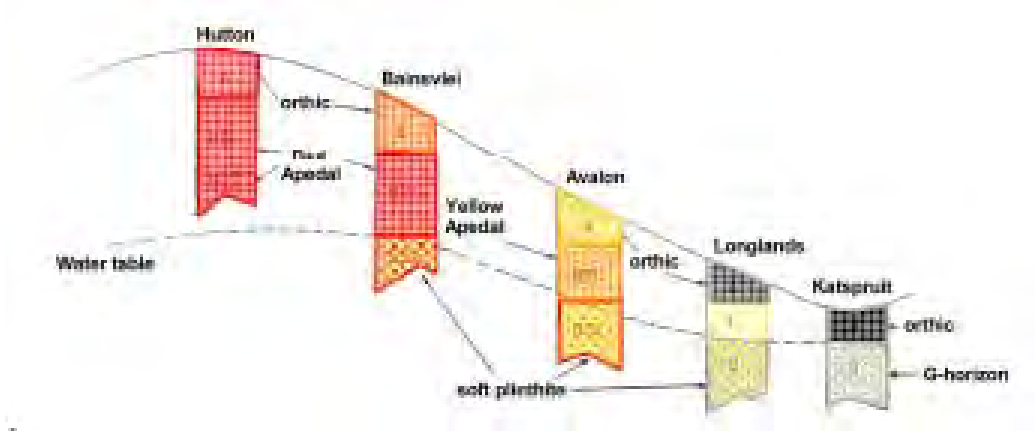
The generally shallow rooting depths of the soils that dominate the area (<500mm) are associated with the hard and resistant lithologies that underlie the site.

5.3.3.4 Soil distribution

The distribution of the soils (Figures 5.3.1a - Soil Polygon Map) is closely linked to the topography and parent materials from which they are derived and their position in the topography (Refer to Figure 5.3.3 – Typical Orthic Phase - Catena).

The distribution of the soils is a function of the topography, erosion profile and climatic conditions.

Figure 5.3.3 – Typical Catena



5.3.4 Soil Depth

The average soil depths of the areas that are to be disturbed were determined using a bucket auger (1.5m) as well as a number of soil pits, and any existing excavations (refer to Soil Characterisation - Mapping).

On average, the sandy loams and sandy clay loams returned rooting depths between 500mm and 1,200mm, while the transitions zone soils returned depths of between 500mm and 600mm.

The hydromorphic soils forms returned shallower rooting depths of between 300mm and 500mm.

The structured soils forms range from 300mm to 500mm, while the Rensburg, Arcadia and Bonheim Forms returned E.R.D's from 200mm to 400mm.

A number of the recently excavated pits and other areas of exposure were used to obtain a clear cross section through the soil profiles. These areas were used to obtain a better understanding of the soil catena in the area.

The stripping ratios of the topsoil, subsoil and overburden should be based on the soil classification mapping – Refer to Figure 2.1.1, while detailed information will need to be obtained for the actual surface areas that are to be disturbed before soil stripping begins. It is imperative that these areas are assessed in more detail as part of the design phase.

5.3.5 Soil Erosion and Compaction

The erosion potential of a soil is expressed by an erodibility factor ("K"), which is determined from soil texture, permeability, organic matter content and soil structure.

The Soil Erodibility Nomograph of (*Wischmeier et al*, 1971) was used to calculate the "K" value. An index of erosion (I.O.E.) for soils is then determined by multiplying the "K" value by the slope percentage. Erosion problems may be experienced when the Index of Erosion is greater than 2.

The "K" value is used to express the "erodibility" of a particular soil form. Erodibility is defined as the vulnerability or susceptibility of a soil to erosion. It is a function of both the physical characteristics of that soil as well as the treatment of the soil.

Erodibility ratings are expressed as:

Resistant	"K" factor = <0.15
Moderate	"K" factor = 0.15-0.35
Erodible	"K" factor = 0.35-0.45
Highly erodible	"K" factor = >0.45

The average "Erosion Indices" for the dominant soil forms on the study site are shown in Table 2.1.5. The majority of the soils mapped can be classified as having a moderate erodibility index.

This is largely ascribed to the generally low organic carbon content and the sensitivity of the soils to solution weathering. These factors are offset by the generally gentle to flat topography and the moderate clay contents. The vulnerability of the "B" horizon to erosion once/if the topsoil is removed must not be under estimated.

The wet and structured soils are susceptible to compaction due to the swelling clays that are common in the majority of the materials classified. These soils will need to be managed extremely well, both, during the stripping operation, as well as during the stockpiling/storage and rehabilitation stages.

The concerns around erosion and compaction are directly related to the fact that the protective vegetation cover and topsoil will be disturbed during any mining or construction operation. Once disturbed, the actions of wind and water are increased. Loss of soil (topsoil and subsoil) is extremely costly to any operation, and is generally only evident at closure or when rehabilitation operations are compromised.

Well planned management actions during the construction and operational phases will save time and money in the long run, and will have an impact on the ability to successfully "close" an operation once completed.

Table 5.3.5 Erodibility of Differing Soil Forms

Soil Form	Erodibility Index	Index of Erosion (I.O.E.)
Hutton, Clovelly, Griffin	Moderate	1.30 – 1.40
Glencoe, Dresden	High	1.40 – 1.60
Valsrivier/Swartland	High	1.40 – 1.60
Sepane	Moderate\to high	1.35 – 1.45
Kroonstad, Katspruit	Moderate to High	1.35 – 1.45
Rensburg, Arcadia	Moderate to High	1.30 – 1.45
Avalon, Pinedene, Bloemdal	Moderate to High	1.15 – 1.35
Mispah, Glenrosa	High	1.45
Westleigh/Longlands	Moderate to High	1.30 – 1.45

5.3.6 Dry Land Production Potential

The dryland production potential of the shallow soils and the more structured Forms, are poor.

The deeper, and apedel soil are easier to cultivate and have a better propensity to both drainage as well as the holding of moisture within the soil that is available to the plant. These soils are more productive dryland materials that are also easier to manage.

5.3.7 Irrigation Potential

The irrigation potential for the soils is "moderate to good" in terms of the soil structure and drainage capability. With good water management, and adequate drainage, the deeper (>700mm) soils could be economically cultivated to irrigated crops.

The spatial distribution and occurrence of these soils is limited and it is unlikely that sufficiently large enough areas of soil are available to make the use of

irrigation viable on anything other than highly intensive market gardening tunnel gardening.

Irrigation is practice to some extent in the area of study. Again, the spatial distribution of the soils with adequate soil rooting depths will limit the size of the areas that can be cultivated, thus limiting the potential for economic irrigation farming. In addition, for any irrigation to be undertaken in the area on a large (sustainable) scale, it would require the installation of a number of surface water impoundments as storage during the dry months.

A more detailed study would be needed if irrigated farming is to be considered as an "End Use" for the rehabilitated areas.

5.3.8 Soil Utilization Potential

In general, the soils that will be disturbed and that will require rehabilitation, are moderately deep to shallow, (ERD = 400mm to 800mm), moderately well drained, with a susceptibility to erosion and compaction and in a significant proportion of the study area show signs of wetness at depth (shallow or perched water table).

The wet based and structured soils will be difficult to work, both from a trafficability, workability, storage and rehabilitation point of view.

Compaction must be considered carefully as the working of the wet based and structured soils when wet (rainy season), will be detrimental and compaction will occur.

The structure of the soil will affect their workability, and provision will need to be made for the timing of the stripping and rehabilitation works to be undertaken if the structural integrity of these soils are to be maintained.

The potential for the use of the hydromorphic soils for economic crop production and/or market gardening is at best poor, and should not be considered for anything other than as wilderness/conservation lands (preferred option), while the potential for economic farming of the structured soils is considered at best to be "low intensity grazing land". The less structured and non hydromorphic soils are that cover a substantial portion of the site are considered arable class soils, and as such can be considered for use in low intensity livestock grazing and or arable crop production.

5.4 Pre-Mining Land Capability

5.4.1 Data Collection

The land capability of the study area was classified into four classes (wetland, arable land, grazing land and wilderness) according to the Chamber of Mines Guidelines (1991) and the Canadian Land Inventory System. The criteria for this classification are set out in Table 5.4.1 below.

Table 5.4.1: Criteria for pre-mining land capability (Chamber of Mines 1991)

Criteria for Wetland

- Land with organic soils or supporting hygrophilous vegetation where soil and vegetation processes are water determined.

Criteria for Arable land

- Land, which does not qualify as a wetland.
- The soil is readily permeable to a depth of 750 mm.
- The soil has a pH value of between 4.0 and 8.4.
- The soil has a low salinity and SAR
- The soil has less than 10% (by volume) rocks or pedocrete fragments larger than 100 mm in the upper 750 mm.
- Has a slope (in %) and erodibility factor (K) such that their product is <2.0
- Occurs under a climate of crop yields that are at least equal to the current national average for these crops.

Criteria for Grazing land

- Land, which does not qualify as wetland or arable land.
- Has soil, or soil-like material, permeable to roots of native plants, that is more than 250 mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100 mm.
- Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants utilisable by domesticated livestock or game animals on a commercial basis.

Criteria for Wilderness land

- Land, which does not qualify as wetland, arable land or grazing land.

5.4.2 Description

The "Capability" of the land is a function of not only the soils and their relative depth and structure/texture, but also the geomorphological aspects of the area. The topographic slope, aspect and altitude combined with the climate and ground roughness (rockiness and percentage outcrop) all need to be considered when classifying the ability of the land.

In this rating system, it was decided based on the present land utilization, that the ability of the land to sustain agriculture was important, and that the economic potential of the area was measured at present in terms of its ability to be farmed. However, at closure, the area will need to be rehabilitated and the baseline information presented here will be invaluable in making sound sustainable decisions that are economically viable to determine the End land Use.

Figures 5.4a and Table 5.4.2.1a illustrate the distribution of land capability classes for the area assessed in terms of the June 2010 study, while Table 5.4.2.1b is a copy of the 2002 assessment.

Table 5.4.2.1a: Land Capability Summary 2010 Assessment

Leeuwpan Land Capability Table		
Land Capability	Area (Ha)	% of Area
Wetland	231.16	32.37%
Canal	4.86	0.68%
Pan	475.37	66.58%
Stream	2.62	0.37%
Total Area (Ha)	714.02	100.00%

Northern Block Land Capability Table		
Land Capability	Area (Ha)	% of Area
Grazing	4.78	0.27%
Wilderness	811.42	46.05%
Wetland	441.47	25.06%
Town	234.79	13.33%
Road	75.69	4.30%
Railway	52.28	2.97%
Gholf course	21.56	1.22%
Refuse dump	7.44	0.42%
Stream	112.51	6.39%
Total Area (Ha)	1761.94	100.00%

Springbokdraai Land Capability Table		
Land Capability	Area (Ha)	% of Area
Grazing	28.18	1.49%
Wilderness	541.81	28.59%
Wetland	1195.91	63.11%
Stream	129.13	6.81%
Total Area (Ha)	1895.02	100.00%

Table 5.4.2.1b – Land Capability 2002 Assessment		
Land Capability Rating	**Area (Ha)**	**% of Total Area (Ha)**
Arable	779.3	3.9
Grazing	3405.4	16.88
Conservation	10042.5	49.84
Wetlands	3474.1	17.25
Streams	1101.6	5.48
Out of Survey	1040.5	5.17
Disturbed Areas	299	1.48
Total Area	**20142.4**	**100**

5.4.2.1 Arable

The land capable of sustaining arable crop production comprises the deep well drained, red (Hutton) and yellow-brown (Clovelly and Griffin) soils that occur on the midslope and upper midslope positions. In addition, there are areas associated with the more structured soil Forms, specifically the Valsrivier Form soil, that are capable of cultivation under good management conditions. The more structured and hydromorphic soils are not considered to be arable soils under the classification.

Some of the heavier structured soils, as well as large areas of the hydromorphic soil types (Avalon's and Westleigh's) have been cultivated at present, specifically in the northern part of the survey area.

5.4.2.2 Grazing

The areas that classify as grazing land are generally confined to the shallower and more structured soil Forms that are moderately well drained.

These soils are generally darker in colour, and are not always free draining to a depth of 750 mm, but are capable of sustaining palatable plant species on a sustainable basis especially since only the subsoils (at a depth of 500 mm) are periodically saturated. There are no rocks or pedocrete fragments in the upper horizons of any of the soil groups, which will limit the land capability to wilderness land.

5.4.2.3 Conservation/Wilderness

The areas that classify as either conservation, or wilderness land are found associated with the shallow rocky soils that were mapped in association with the ridge slope positions that are defined by the less resistant dolerite dykes that have intruded into the sediments. These areas are confined predominantly to the southern portion of the area mapped.

5.4.2.4 Wetland

The wetland areas are defined in terms of the wetland delineation guidelines, which use both soil topography as well as botanic criteria to define the limits to this domain. In general, this zone is dominated by hydromorphic soils, and plant life that is associated

with aquatic processes. The soils are generally dark grey to black in the topsoil horizons, and high in transported clays, and show pronounced mottling on Glayed backgrounds in the subsoils. The soils are within the zone of groundwater influence.

The area investigated is dissected by a number of prominent drainage lines that terminate in prominent river systems.

The combination of soil types and hydromorphic vegetation was used to delineate the wetland soils.

The pre-mining land capability of the site is defined by a combination of the topography, geology and the soils mapped in the area.

Approximately 26.18% of the area is classified as being of wetland type.

The distribution of the land capability classes is illustrated on Figure 2.5.

Figure 5.4a Land Capability Plan – Leeuwpan

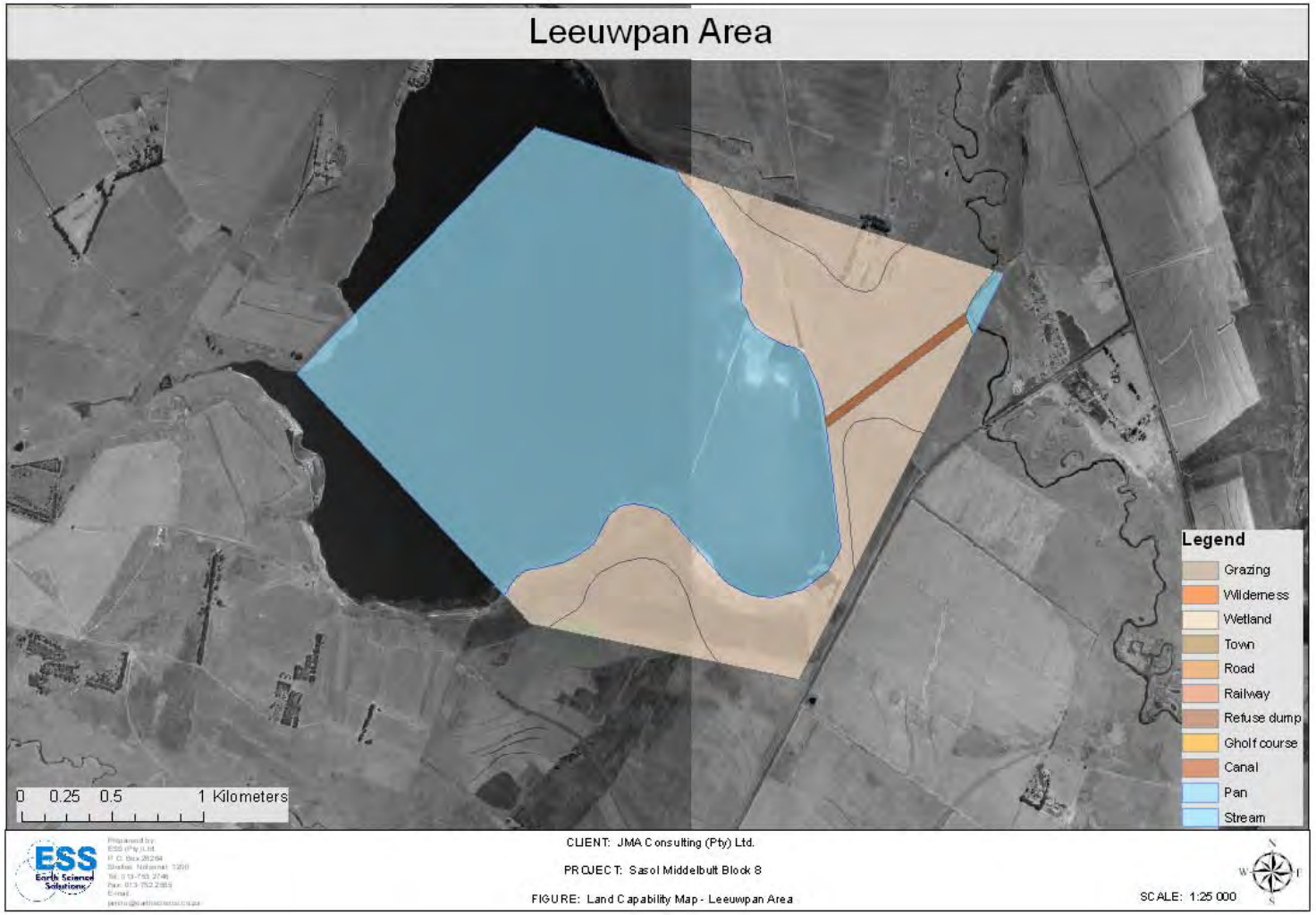


Figure 5.4b Land Capability Plan – Springbokdraai

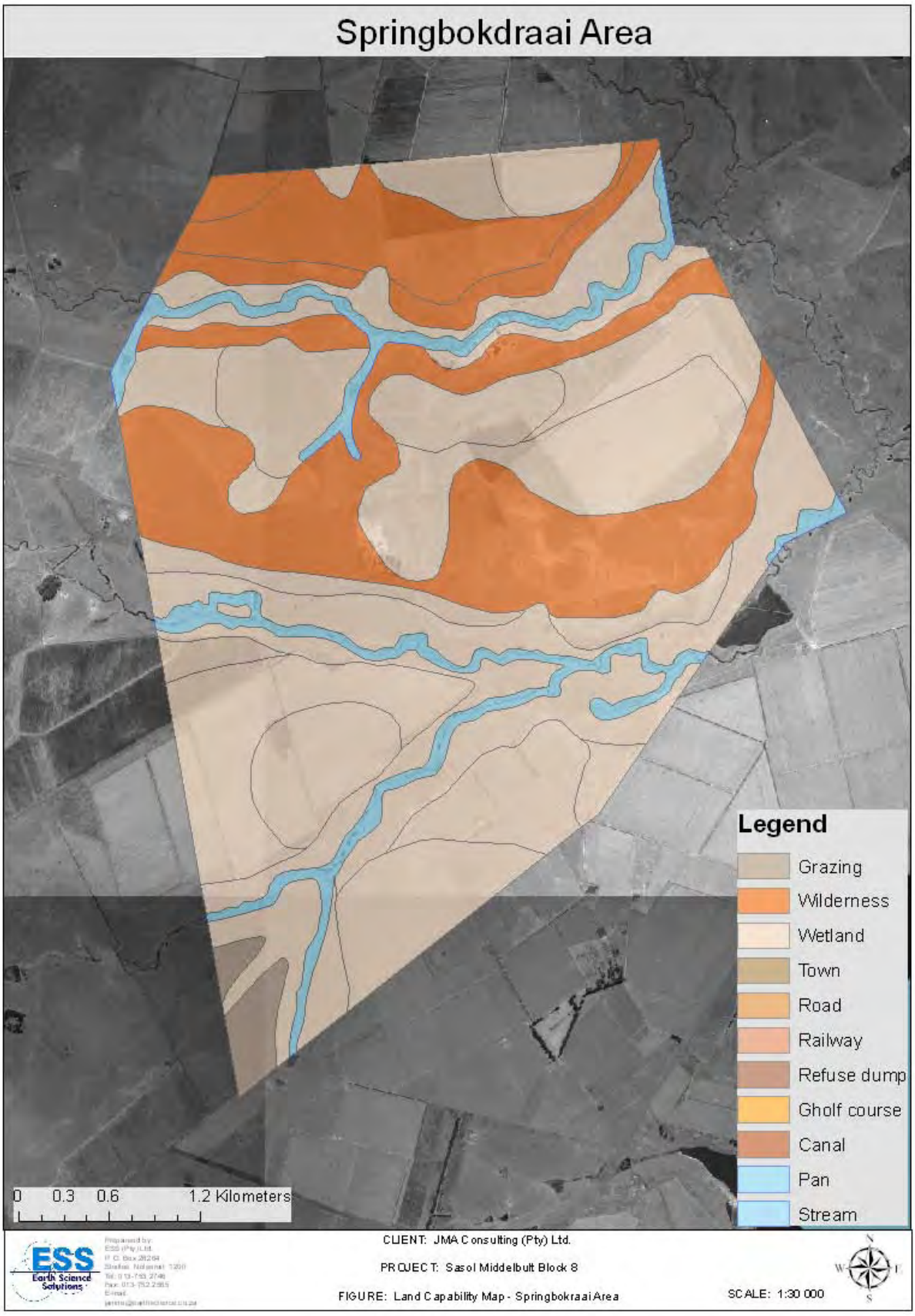


Figure 5.4c Land Capability Plan – Northern Block

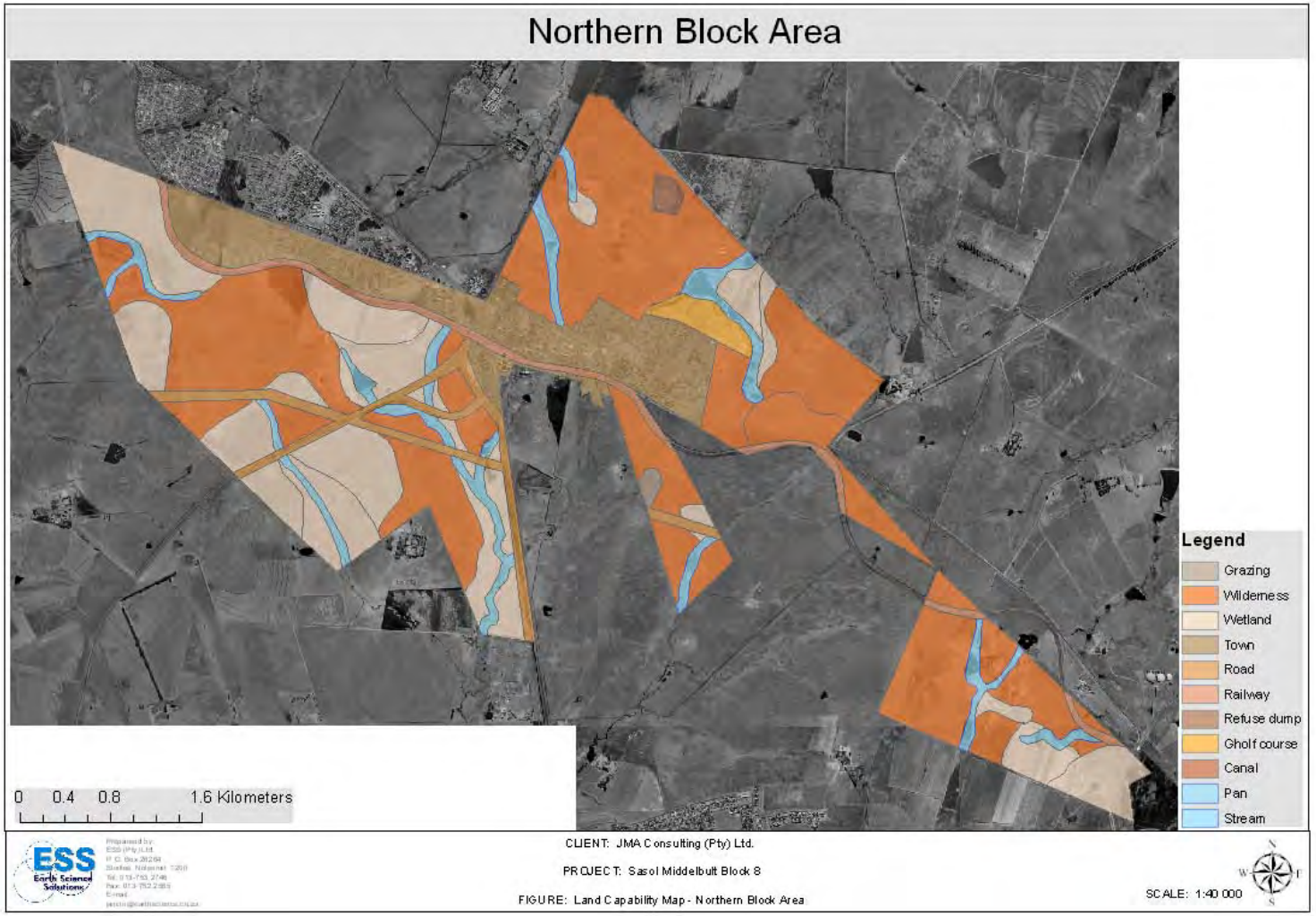
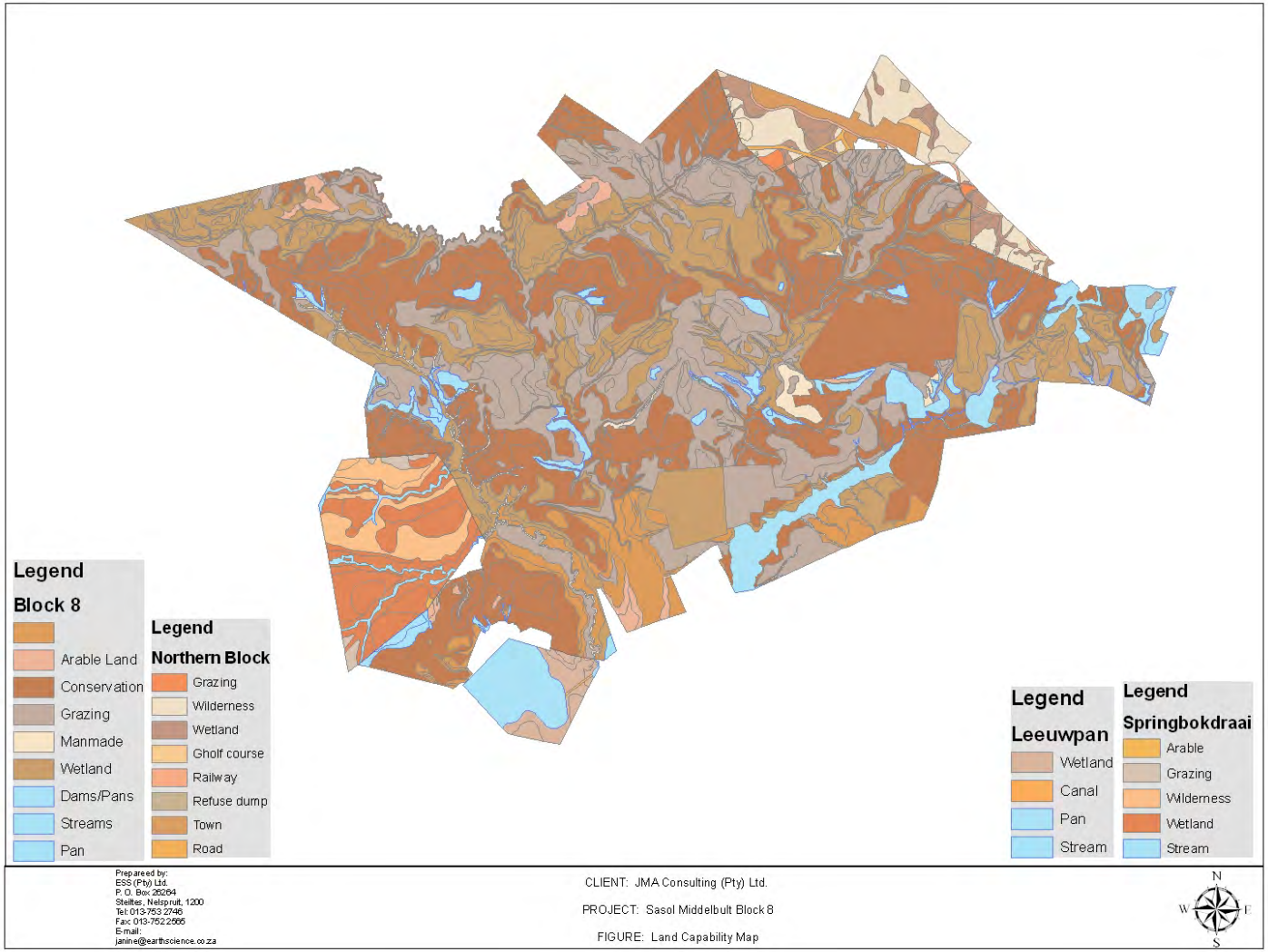


Figure 5.4d Land Capability Plan – Complete Area



6.3 Pre-Construction Land Use

6.3.1 Data Collection

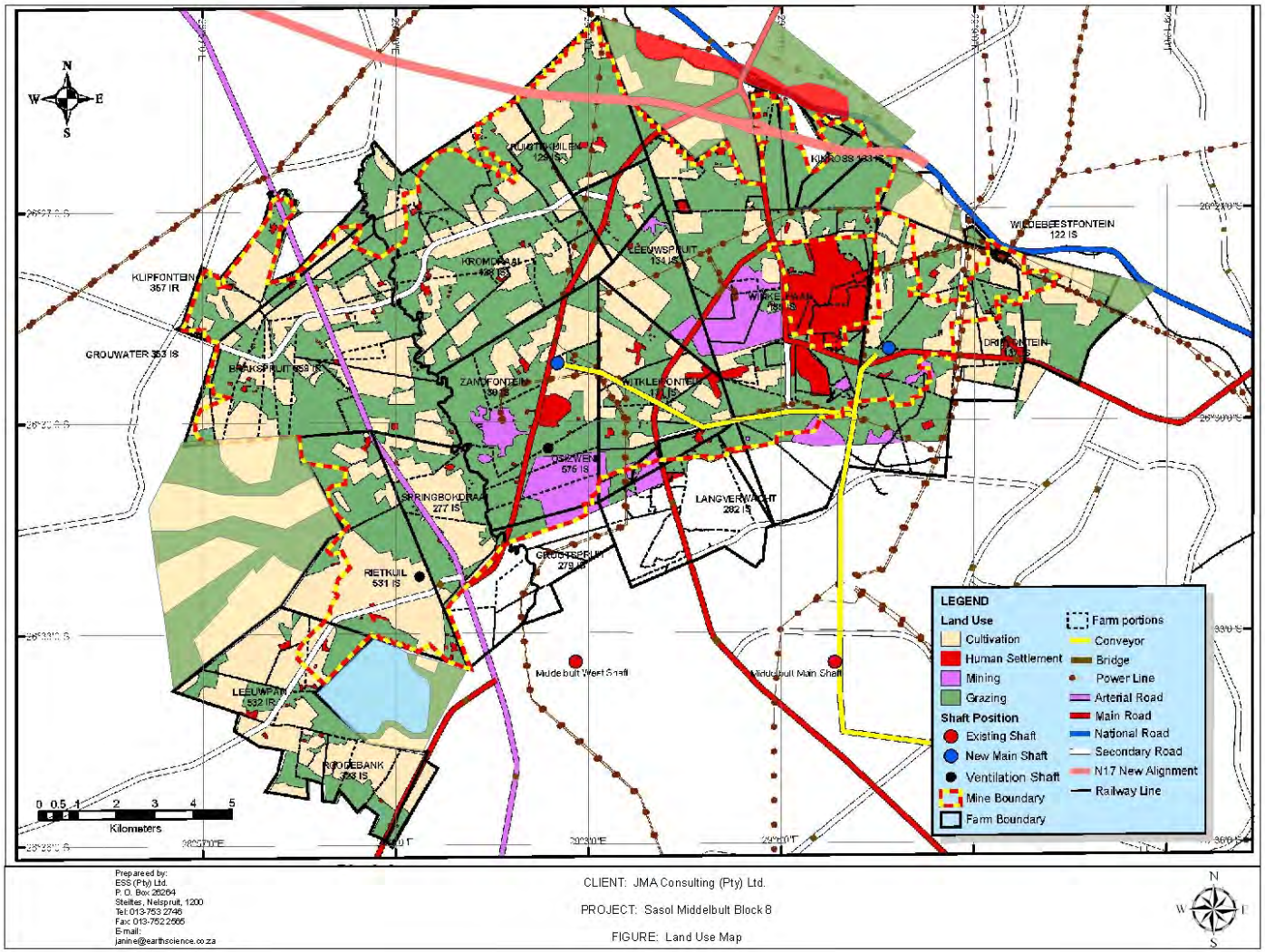
The land use was visually assessed using the orthophotographs and walk over field study as part of the ground truthing, and changes in the cropping regime and general land use for the area recorded at the time of undertaking the soil and land capability survey.

6.3.2 Description

A significant proportion of the site has been disturbed by either mining or intensive agriculture. Little to no residence are still lived in on the site with the majority of the people having left during the initiation of the original mining operation.

A moderately large area within the central and north eastern sections of the site have already been developed, with new developments taking place in the western section as well. Intensive centre pivot irrigation is also on-going on the more southerly extents of the site.

Figure 6.4 Land Use Plan – Total Area



6.4. Environmental Impact Assessment

The system for the rating and ranking of impact has been specified for this project and involves the combination of the guideline system as implemented by the department and the system developed by the client (SASOL). The detailed outcomes are detailed in the spreadsheets attached, while our specialist explanation is detailed in terms of a numeric system of evaluation. The "Ranking Scale" System is detailed below and summarised in Table 6.4:

Significance of possible impacts

In terms of the significance of a possible impact it is necessary to understand and rate the "probability of occurrence", the possible "duration" of the event, the "magnitude or severity" of the event and the "scale or extent" of the impact. In terms of the EIA, soils rank as one of the areas were the impact of both permanent loss of material utilization from the system and the long term requirements associated with the End Land Use of an area can be affected. Poor judgement and planning in the early stages of a project can result in a fatal flaw or an impact of extreme significance to a project occurring at closure.

Risk to the Environment

Occurrence

- Probability of occurrence (how likely is it that the impact may occur?), and
- Duration of occurrence (how long may it last?).

Severity

- Magnitude (severity) of impact (will the impact be of high, moderate or low severity?), and
- Scale/extent of impact (will the impact affect the national, regional or local environment, or only that of the site?)

In order to assess each of these factors for each impact, the following ranking scales were used:

Table.6.4 Ranking Scales

Probability:=P	*Duration:=D*
5 – Definite/don't know	5 – Permanent
4 – Highly probable	4 - Long-term (ceases with the operational life)
3 – Medium probability	
2 – Low probability	3 - Medium-term (5-15 years)
1 – Improbable	2 - Short-term (0-5 years)
0 – None	1 – Immediate
Scale:=S	*Magnitude:=M*
5 – International	10 - Very high/don't know
4 – National	8 – High
3 – Regional	6 – Moderate
2 – Local	4 – Low
1 – Site only	2 – Minor
0 – None	

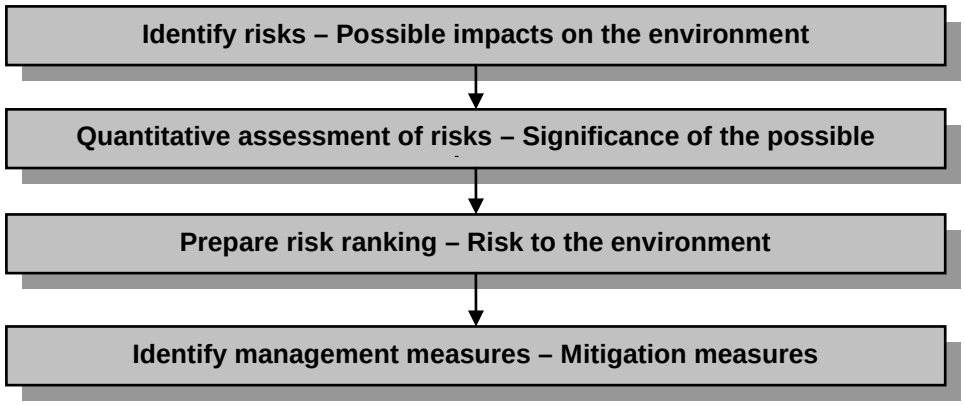
Once the above factors had been ranked for each impact, the environmental significance of each was assessed using the following formula:

SP = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). Environmental effects were rated as either of high, moderate or low significance on the following basis:

- More than 60 significance points indicated high (H) environmental significance.
- Between 30 and 60 significance points indicated moderate (M) environmental significance.
- Less than 30 significance points indicated low (L) environmental significance.

The following process will be followed:



In line with the impact assessment process, it is incumbent on the specialist to supply a professional opinion on how easily or difficult it will be to mitigate the expected impacts. The following summary tables (Table 6a – Soils and Table 6b - Land Capability) give an over view of the expected significance ratings for the impacts on the soils and land capability before mitigation and after mitigation.

6.4.3 Soils

6.4.3.1 Construction Phase

Issue: **Loss of Utilizable Soil Resource due to – Erosion, Contamination and/or Compaction during construction**

Due to the relative differences between the complex of soil forms that make up the study area, with the colluvial/alluvial derived materials and their extremes of structure and hydromorphy (confined to open pit mining mainly), and the in-situ materials that show distinctive pedogenisis, and which are better sorted and show distinctive soil formation, the impacts will be different and mitigation measures will be varied.

Construction for Project

Stripping of utilizable soil, preparation (levelling and compaction) of lay-down areas and pad footprint for stockpiling of utilizable soil and berms, opening up of foundations, mining voids (Box Cut) to underground workings and stockpiling of Utilizable Soil and soft overburden, and slope stability where required. Haulage via conveyer and construction of access road.

Control of dust and loss of materials to wind and water erosion, and protection of materials from contamination (chemical, hydrocarbons and sewage)

The construction phase will impact on all of the proposed mining and developmental activities, inclusive of:

- The construction/preparation of the footprint for the overall lay down of the materials stockpiles (Removal of vegetation and topsoil's) around the decline entrance to the Underground workings as well as the conveyer routes and the footprint to the associated mine infrastructure;
- Stockpiling of the topsoil's and any subsoil's needed to secure a viable cover for the mined out areas and related activities at closure;
- The opening up of the boxcut for the access to the decline adits and the raise boring for the ventilation shafts for the underground sections;
- Conveyer routes;
- The construction of the starter walls for any/the storm water control dams;
- Construction of access roads;
- The construction of services – electrical reticulation;
- Stockpiling of the soils and overburden (softs and cover material) from construction footprints;
- Design and construction of dirty water control dams, channels and berms (storm water control facilities) to cater for all dirty water and diversion of clean water around the facilities;
- Design and construction of site offices etc (workshops, change house etc.), and
- Clearing and removal of vegetation and the stockpiling of the topsoil prior to the lay down of soft overburden materials from the shaft development to the underground workings.

Underground mining will continue throughout the operational phase, with new areas being opened well after the completion of the conveyancing equipment and the construction of any by-product (soil) dumps and stockpiles having been started.

In addition, the soils will need to be stockpiled in different locations throughout the construction and operational phases, with the materials stripped from the areas of infrastructure development and mining being best stockpiled as close as possible to these features in the form of berms upslope of the facilities, and the soils from the adit entrance (decline adits) being stored as low level dumps and/or berms close to the voids to which they are planned to be used at closure.

Any colluvial or alluvial materials (generally wet based) that are to be mined in order to get to the resource will need to go back into the same position (alluvial streams and or channels) as close as possible to their original position in the profile once the voids have been backfilled.

Description of Impacts

The loss of the soil resource to the overall environment due to the impact on the soils stripped during the opening up of the decline to the underground workings, the construction of the footprint pads and laydown areas for the soil storage, opening up of the conveyer route and removal of soils and the disturbance of the soils associated with the construction area to be used for the support infrastructure (Workshops, Offices etc). These activities and actions will definitely be High (H) in the medium term (life of mine) (M) and restricted to the immediate mining area (L). The overall loss of the soil resource to the environment if un-mitigated will result in a High (H) Significant Rating.

Disturbance of the surface restrictive layers associated with the relatively more sensitive soils (Ferricrete and soft plinthic layers) will occur for a number of the foundations proposed, and particularly those associated with the relict land forms that occupy the upper portions of the transition zone moist grasslands that are going to be affected in some cases, while the deeper foundations required for the heavier structures and the decline adits and vent shafts will require that the underlying restrictive layers (inhibiting barrier layer) are broken through.

The majority of the workings and all of the proposed structures associated with the mining development are outside of the alluvial/riverine environment and are for the most part associated with the moderately shallow to shallow soils of the sedimentary host rock and only small areas of upper transitional zone soil forms. The variation in soil sensitivity is marked, with the dry friable sandy loams and silty loams being far easier to manage than the more hydromorphic soils that comprise the transition zone upslope of the wetlands.

The impact of removing the topsoil's and upper portion of the subsoil horizon (Utilizable soil – 500mm) will destroy any surface capping that might be in place, will remove all vegetative cover, and will expose the subsoil's to wind and water affects and induce possible erosion and compaction if not well managed and protected.

The moderate to highly sensitive soils (friable soils) will be susceptible to erosion and compaction once disturbed, and will be difficult to utilize and manage if left unprotected.

It must be emphasised, that the failure to manage the soils will result in the total loss of this resource, with a resultant high significance.

Mitigation/Management Actions

With management, the loss of this primary resource can be reduced and mitigated to a level that is more acceptable.

The impacts on the soils may be mitigated with a number of management procedures, including:

- Effective soil stripping during the dryer and less windy months when the soils are less susceptible to erosion and compaction. This will assist the stockpiling and vegetative cover to propagate before the following wet season;
- Effective cladding of any stockpiles, dumps, berms and/or by-product facilities and the minimising of the height of all stockpiles wherever possible will help to reduce wind erosion and the loss of materials;
- Soil replacement to all areas (temporary) that are not required for the operational phase, and the preparation of a seed bed to facilitate the re-vegetation program for these areas will limit potential erodibility during the operational phase and into the rehabilitation and closure phases.
- Soil amelioration (cultivation) to enhance the growing capability of the stockpiled soils so that they can be used for rehabilitation at closure and to maintain the soils viability during storage.
- Backfilling of the boxcut (decline exit from the underground workings) voids with soft overburden, discards and the creation through compaction of a **barrier layer** at the soil backfill interface using the relatively more impermeable clay rich subsoil (Non utilizable soils) and soft overburden. These actions are recommended as the ferricrete layer and any hard impermeable sedimentary layers will have been destroyed and will not be available to re-create this barrier;
- Replacement of the growing medium (Utilizable soil) in the correct order and as close as possible to its original position in the topography will help to maintain the soil pedogenisis and utilization potential relative to the ecology and biological constraints;
- Soil replacement and the preparation of a seed bed to facilitate the re-vegetation program and to limit potential erodibility during the rehabilitation process.

Care will need to be taken to keep any wet based soils separated from the dry soils, and to keep all stockpiled soils that are in storage vegetated and protected from contamination and erosion.

These soils will be stripped as “Utilizable Soil” the topsoil and upper portion of the subsoil’s (B2/1 Horizon) stored in a position that will be convenient for the final rehabilitation of the facilities during the operational and closure phases – reduce distances to be hauled and negate the need for double handling.

Only if these materials are available can rehabilitation possibly be executed successfully and cost effectively. It is suggested that an average “Utilizable Soil Depth” (USD) of 500mm be stockpiled where present/available.

Residual Impact

The above management procedures will probably reduce the significance of the impacts to Medium in the long term.

Assessment of Impacts Identified - Construction

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION					
		M	D	S	P	TOTAL	SP		M	D	S	P	TOTAL	SP
ISSUES RELATED TO SOILS														
Loss of Soil Utilization - Removed from System	Construction	8	4	1	5	65	H	Remove and Stockpile + Vegetate Utilizable soils	4	4	1	5	45	M
Loss of Soil Utilization - Erosion & Compaction	Construction	3	4	2	3	27	L	Vegetate stockpiles and keep drainage well managed	2	4	1	3	21	L
Contamination of Soil - Product & Hydrocarbon Spillage	Construction	6	4	1	3	33	M	Maintain vehicles and clear roadways regularly of spillage	2	4	1	2	14	L

6.1.2 Operational Phase

Issue: **Loss of Soil Usability**

Operation of Project – Cumulative

Loss of soil utilization - Open voids to U/G Mining – On-going soil stripping for extensions to conveyer routes and RoM Stockpile areas, the possible contamination by dirty water interaction, dust and/or hydrocarbon spillage and sewage spills, covering of the soils by infrastructure, by-product stockpiles, storage facilities and dumps, compaction by vehicle movement, and erosion and loss of materials due to wind and water interaction with unprotected soils.

Description of Impacts

During the operational phase, all of the construction activities for the infrastructure and major by-product storage structures will have been completed and the conveyer line, RoM storage area of product the deposition of any by-product will have begun along with the on-going and continuous mining operation.

The loss of the soil utilization and the covering of materials for extended periods of time will lead to the compaction and sterilization of the materials for future use. This will definitely result in a High (H) negative impact that will last for the duration of the mining venture within the mining area. The consequence is moderate (M) with an overall significance of High.

The movement of product by conveyer, the use of access roads and the on-going additions of by-product to the stockpiles and storage facilities will all impact on the size of area to be impacted, and ultimately on the area of soil affected.

Spillage from moving vehicles and the conveyancing of coal, possibly leakage or spillage of hydrocarbons and leakage from any waste areas such as sewage works etc. will negatively impact the in-situ materials, while unmanaged dirty water will erode and contaminate the soils that it comes into contact with.

Un-managed soil stockpiles and soil that is left uncovered and not vegetated will be lost to water and wind erosion, and will be prone to compaction if left unprotected.

The preservation of any restrictive layers or capping to the soil will be lost along with its protective properties wherever the soils have been stripped, and it will be difficult or impossible to re-produce or re-create these features during the rehabilitation phase.

In contrast, but of similar concern, is the presence of the semi impermeable barrier layer that forms at the base of many of the soil forms mapped in the study area, and which is associated with the relict land forms (ferricrete and soft plinthic horizons).

All of these soils will be impacted upon to differing degrees, and will have been stockpiled for future use during the rehabilitation phase and at closure.

The significance of the impact on these soils during the operational phase will differ both in intensity and duration, with the soils associated with the infrastructure remaining in a stockpile for the full life of the mining and processing operations, with the adit declines and ventilation shafts remaining open for the life if the mining of any particular section.

It is inevitable however, that the soils utilization potential will be lost during the operational phase, and possibly for ever if they are not well managed and a mitigation plan is not implemented.

Mitigation/Management Action

The impacts on the stockpiled and stored soils may be mitigated with management procedures including:

- Minimisation of overall/total area of impacted;
- Timorous replacement of the soils so as to minimise the area of disturbance;
- Effective vegetative and soil cover and protection from wind (dust) and dirty water contamination;
- Adequate protection from erosion (wind and water);
- Servicing of all vehicles and equipment on a regular basis and in well constructed and bunded areas, well constructed and maintained oil traps and dirty water collection systems;
- Cleaning of all roadways and haulage ways, drains and storm water control facilities;
- Containment and management of spillage;
- Soil replacement and the preparation of a seed bed to facilitate and accelerate the re-vegetation program and to limit potential erosion, and
- Soil amelioration to enhance the growth capability of the soils and sustain the soils ability to retain oxygen and nutrients, thus sustaining vegetative material during the storage stage;

Of consequence during the operational phase will be the minimising of the area that is being impacted by the mining operation and its related support structures and operations, and maintenance of the integrity of the soils. This will require that the soils are kept free of contamination (dust and dirty water), and stabilized and protected from erosion and compaction. The action of wind on dust generated and the loss of materials downwind will need to be considered, while contamination of the soils used on the roads, conveyer lines and workshop areas will need to be managed.

However, if the soils are stripped to a “utilizable” depth, and replaced as close as possible to their original position in the topography, the chances of nature being able to restore the systems present prior to disturbance will be better and greater/higher.

Residual Impact

In the long term, the above mitigation measures will probably reduce the impact on the utilizable soil reserves to a **Medium** impact.

Assessment of Impacts Identified - Operational

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION					
		M	D	S	P	TOTAL	SP		M	D	S	P	TOTAL	SP
ISSUES RELATED TO SOILS														
Loss of Soil Utilization - Open Cast Mining	Operation	8	4	1	5	65	H	Managment of Roll Over Mining - Optimisation of sequence and Compaction of backfill	6	2	1	4	36	M
Contamination due to Product and Hydrocarbon Spillage or Sewage discharge	Operation	6	4	1	4	44	M	Maintenance of Vehicles, good housekeeping and managemnt Interventions	4	4	1	3	27	L
Loss of soil due to Infrastructure Construction, dumps, stockpiles etc.	Operation	10	4	1	5	75	H	Rehabilitation of areas as soon after no longer needed	6	4	1	4	44	M
Erosion & Compaction - wind, water and vehicle movement	Operation	6	4	2	4	48	M	Maintence of vegetative cover and stormwater controls	4	4	1	3	27	L

6.1.3 Decommissioning & Closure Phase

Issue: Net loss of soil potential due to change in materials (Physical and Chemical) and loss of nutrient base.

Decommissioning and Closure – Cumulative

Loss of the soils original nutrient store by leaching, erosion and de-oxygenation while stockpiled. Impact of vehicle movement, dust contamination and erosion during soil replacement and demolishing of infrastructure, slope stabilization and re-vegetation of disturbed areas. Possible contamination by dirty water interaction (use of mine water for irrigation of re-vegetation), dust and/or hydrocarbon spillage from construction vehicles. Positive impacts of reduction in areas of disturbance and return of soil utilization potential, uncovering of areas of storage and rehabilitation of compacted materials.

Description of Impact

The impact will remain the net loss of the soil resource if no intervention or mitigating strategy is implemented. The impact will be high, negative and permanent over the area of disturbance, with a relatively high consequence and resultant high significance. Un-managed closure will result in a long term depletion of soil utilization potential.

Management/Mitigation Actions

Ongoing rehabilitation during the decommissioning phase of the project will probably bring about a net long-term positive impact on the soils.

The initial impact will be high and negative due to the necessity for vehicle movement while rehabilitating the open voids, moving of softs and soils, the demolishing of storm water controls, dams etc and the demolishing of buildings and infrastructure. Dust will be generated and soil will be contaminated and eroded.

The positive impacts of rehabilitating an area are the reduction in the area previously disturbed, the amelioration of the affected soils and oxygenation of the growing medium, the stabilizing of slopes and revegetation of areas decommissioned with a reduction in areas previously subjected to wind or water erosion.

Assessment of Impacts Identified - Decommissioning & Closure

POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION					
		M	D	S	P	TOTAL	SP		M	D	S	P	TOTAL	SP
ISSUES RELATED TO SOILS														
Loss of Soil Nutrient Pool	Decomm & Closure	8	4	1	5	65	H	Fertilization and amelioration of rehabilitated areas	6	2	1	4	36	M
Impact of Vehicle Movement during replacement	Decomm & Closure	8	4	1	5	65	H	Restriction of vehicle movement and good planning of rehabilitation	4	2	1	4	28	L
Contamination by Dirty water, dust and hydrocarbon spills	Decomm & Closure	8	4	1	3	39	M	Maintenance of vehicles and site Managemnt/House Keeping	4	2	1	4	28	L
Reduction in area of impact and return of soil utilization potential	Decomm & Closure	2	2	1	5	25	L	Implementation of Rehabilitation Plan	2	2	1	5	25	L

Residual Impacts

On mine closure the long-term negative impact on the soils will probably be of medium to low significance if the management plan set out in Environmental Plan is effectively implemented to reinstate current soil conditions. The success of re-creating a **barrier layer** to the disturbed areas will require significant management inputs and corrective engineering to the environment and rehabilitation.

Chemical amelioration of the soils will possibly have a low but positive impact on the nutrient status (only) of the soils in the medium term.

7. ENVIRONMENTAL MANAGEMENT PLAN

Based on the studies undertaken, it has been possible to assess the impacts that mining could potentially have on the soils and their resultant utilization potential, and has aided in a better understanding of the possible management and mitigation measures that could help in minimising the impacts during the rehabilitation process, decommissioning and at closure.

The management and mitigation measures proposed have been tabled for the different stages of the project and, based on the soil forms that will be impacted or affected and the resultant utilization change, with an environmental management plan (EMP) suggested for each of the stages of mining.

The plan caters for the construction, operation and decommissioning stages of the project, and gives recommendations on the stripping and handling of the soils during the construction and operational phases, with recommendations given for the rehabilitation and ultimate closure of the facility as part of the "End Use" planning. It is imperative that a full and detailed EMP is implemented if the economics of mine closure are to be understood, and the relative positioning and timings of materials handling are to be aligned with the mining plan.

All alluvial and or colluvial materials and all associated soils that are not going to be mined, but which might be impacted by the process or support infrastructure, will be impacted permanently, and will require that the utilizable soil (Top 500mm) is stripped and stored for possible utilization for rehabilitation at closure

7.1 Construction Phase

Soil Stripping and Handling

In considering any management plan for soils it is imperative that the soil physical and chemical composition are known as these will be exceptionally important in obtaining a utilizable material at decommissioning and/or during rehabilitation. The method of stockpiling and general handling of the soil will vary depending on the composition.

Table 7.1 – Construction Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Construction	Delineation of areas to be stripped		Stripping will only occur where soils are to be disturbed by activities that are described in the design report, and where a clearly defined end rehabilitation use for the stripped soil has been identified.
	Reference to biodiversity action plan		It is recommened that all vegetation is stripped and stored as part of the utilizable soil. However, the requirements for moving and preserving fauna and flora according to the biodiversity action plan should be consulted.
	Stripping and Handling of soils	Handling	Soils will be handled in dry weather conditions so as to cause as little compaction as possible. Utilizable soil (Topsoil and upper portion of subsoil B2/1) must be handled and stockpiled separately from the lower "B" horizon and all softs (decomposed rock).
		Stripping	The "Utilizable" soil will be stripped to a depth of 500mm or until hard rock is encountered. These soils will be stockpiled together with any vegetation cover present (only large bushes to be removed prior to stripping). The total stripped depth should be 500mm, where possible.
	Delineation of Stockpiling areas	Location	Stockpiling areas will be identified in close proximity to the source of the soil to limit handling and to promote reuse of soils in the correct areas.
		Designation of Areas	Soils stockpiles will be demarcated, and clearly marked to identify both the soil type and the intended area of rehabilitation.

The sandy and silty loams (low clay contents) that form the topsoil's, along with the upper portion of the subsoil's (B2/1 Horizon) within which the majority of the nutrient store occurs **(Utilizable Soil)** will need to be stripped and stockpiled for use at closure.

The concept of stripping and storage of all "utilizable" soil is tabled as a minimum requirement and as part of the overall Soil Utilization Guidelines.

In terms of the "Minimum Requirements", usable soil is defined here as ALL soil above an agreed subterranean cut-off depth defined by the project soil scientist and will vary for different types of soil encountered in a project area. It does not differentiate between topsoil (orthic horizon) and other subsoil horizons.

Soil stripping requirements are set to enable the mining company to achieve post mining land capabilities stipulated by the management plan and are based on pre-mining land capability assessment for the area in question. Pre-mining grazing land capability is the norm that is aimed for in most situations post mining. However, in this sensitive environment, although a low intensity grazing land status is tabled as the minimum requirement, it is likely that moderate grazing could be achieved with the possibility of low yielding crop production if the rehabilitation plan is well managed and implemented.

The following requirements (**all be they generic**) should be adhered to wherever possible:

- Over areas of OPEN CAST PITS or openings of a boxcut to UNDERGROUND workings *strip all usable soil* as defined (500mm). Stockpile alluvial soils should be stockpiled separately from the colluvial (shallower) materials, which in turn should be stored separately from the overburden.

At *rehabilitation* replace soil to appropriate soil depths, and cover areas to achieve an appropriate topographic aspect and attitude to achieve a free draining landscape and as close as possible the pre-mining land capability rating.

- Over area of STRUCTURES (Offices, Workshops, Haul Roads) AND SOFT OVERBURDEN STOCKPILES *strip the top 300 mm* of usable soil over all affected areas including terraces and *strip remaining usable soil* where founding conditions require further soil removal. Store the soil in stockpiles of not more than 1.5 m around infrastructure area for closure rehabilitation purposes. Stockpile hydromorphic soils separately from the dry materials. *For rehabilitation* strip all gravel and other material places to form terraces and recycle as construction material or place in open pit. Remove foundations to a maximum depth of 1m. Replace soil to appropriate soil depths, and over areas and in appropriate topographic position to achieve pre-mining land capability and land form.

- Over area of CONSTRUCTION OF BY-PRODUCT/TAILINGS/SLURRY STORAGE FACILITIES AND HARD OVERBURDEN STOCKPILES *strip usable soil* to a *depth of 750 mm* in areas of *arable soils* and *between 300mm and 500mm* in areas of *soils with grazing land capability.* Stockpile hydromorphic soils separately from the dry and friable materials. *For rehabilitation* strip all gravel and other material places to form terraces and recycle as construction material or place in open pit. Remove foundations to a maximum depth of 1m. Replace soil to appropriate soil depths, and over areas and in appropriate topographic position to achieve pre-mining land capability.

- Over area of ACCESS ROADS, LAY-DOWN PADS AND CONVEYOR SERVITUDES *strip the top 150 mm* of usable soil over all affected areas and stockpile in longitudinal stockpile within the mining lease area.

In general, the depth of the topsoil's material for the site is between 300mm and 450mm. However, due to the shallow soil depths on the more rocky slopes, and the need to rehabilitate these areas with sufficient materials to induce growth at closure, it is recommended that a minimum of 500mm is stripped from the mining and associated infrastructure areas (Sites with impacts to below the B2/1 level, or foundations that extend into the saprolitic zone (weathered rock)), and 300mm from all roads (Access and Haulage Ways) and founding pads for the soil stockpiles and all dump footprints.

The positioning of any/all storage facilities will need to be assessed on the basis of the cost of double handling, distances to the point of rehabilitation need, and the potential for use of the materials as storm water management facilities (berms). Suggestions include the use of materials in positions upslope of the mining infrastructure and open cast mining facilities as clean water diversion berms, and/or as stockpiles close to, but outside of the final voids that are to be created by the mining operations.

Soils removed from area that require deep foundations, lay-down pads for by-product facilities and the processing facility, dam footprints, all access roads and conveyancing lines and their associated support infrastructure must be stockpiled as close as possible to the facilities as is possible without the topsoil's becoming contaminated or impacted by the operations.

The vegetated soils should be stripped and stockpiled without the vegetation having been cleared/stripped off wherever practical, while any grassland/natural veld that have been disturbed should be fertilized with super phosphate prior to being stripped (wherever practical).

This will ensure that the fertilizer is well mixed into the soil during the stripping operation and will aid in the quick cover to the stockpiles and reduce the amount of fertilizer required during the rehabilitation program. All utilization of the land for any other purpose will need to stop before mining begins.

The lower portions of the subsoil's (>500mm) and the soft overburden material (where removed) can be stored as separate stockpiles close to the areas where they will be required for backfilling and final rehabilitation.

The base to all of the proposed structures to be constructed should be founded on stabilized materials, the soils having been stripped to below the topsoil contact (200mm to 300mm) and or to 500mm as the depth of utilizable soil.

It is proposed that prior to soil stripping, an appropriate (to be determined by local experts) fertilizer (super phosphate) should be added to the sandy loams and silty clay loams at a rate of about 200 kg/ha if they have not previously been fertilized. This will help to enhance the seed pool and encourage growth within the stored materials.

The stripping and handling of these sensitive materials during the construction phase or while opening up of the open cast mining sections is highlighted, because the correct removal, storage and reinstatement of the materials will have a significant effect on the costs and the final success or failure of the rehabilitation plan at closure.

Of importance to the success and long term sustainability of rehabilitating these sensitive environments will be the replacement of the materials in their correct topographic position, and the ability of the rehabilitation team to re-create a layer within the final profile that will inhibit vertical infiltration of water.

This will be no mean feat, as the natural materials that are achieving this function at present (pre-mining and development) will have been disturbed or destroyed.

Long term and forward planning for the utilization of the materials to their best advantage and the understanding of the final "End Land Use" will need to be well understood if the optimum utilization of the materials is to be achieved. Please refer to the recommendations of materials replacement under the decommissioning and closure plan section.

The consequences of not achieving these goals will need to be assessed and quantified in terms of the long term ecological impacts, and will require the input of the specialist ecologists, hydrogeologists and engineers in formulating the management plan.

7.2 Operational Phase

Soil Stockpiling and Storage

Based on the findings of the baseline studies the sensitivity of the soil materials has been evaluated and site specific recommendations are made that are relevant to the unique conditions that pertain to this highveld environment.

Table 7.2– Operational Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Operation	Stockpile management	Vegetation establishment and erosion control	Rapid growth of vegetation on the Soil Stockpiles will be promoted (e.g. by means of watering or fertilisation). The purpose of this exercise will be to protect the soils and combat erosion by water and wind.
		Storm Water Control	Stockpiles will be established with storm water diversion berms to prevent run off erosion.
		Stockpile Height and Slope Stability	Soil stockpile heights will be restricted where possible to <1.5m so as to avoid compaction and damage to the soil seed pool. Where stockpiles higher than 1.5m cannot be avoided, these will be benched to a maximum height of 15m. Each bench should ideally be 1.5m high and 2m wide. For storage periods greater than 3 years, vegetative cover is essential, and should be encouraged using fertilization and induced seeding with water. The stockpile side slopes should be stabilized at a slope of 1 in 6. This will promote vegetation growth and reduce run-off related erosion.
		Waste	No waste material will be placed on the soil stockpiles.
		Vehicles	Equipment movement on to of the soil stockpiles will be limited to avoid topsoil compaction and subsequent damage to the soils and seedbank.

It is proposed that the construction of any berms needed and soil storage stockpiles are undertaken in a series of 1,5m lifts if the storage facilities are to be greater than 1,5m high. For soils that are to be stored for any length of time (greater than three years) it is recommended that all utilizable soil should be stockpiled, while the heavier subsoil's and calcrete materials should be stored as separate stockpiles. Storing the soil in this manner will maximize the beneficial properties of each material, and render them available for use at closure in the best position. Separation of these layers at the time of utilizing these soils is a matter for management, as the mixing and dilution of the soil properties is not recommended.

The utilizable soil stockpiled must be adequately vegetated as soon after emplacement on the storage pads as possible and maintained throughout the life of mining.

It is imperative, where possible, that the slopes of the stockpile berm facility are constructed to 1:6 or shallower. This will minimize the chances of erosion of the soils and will enhance the growth of vegetation. However, prior to the establishment of vegetation, it is recommended that erosion control measures, such as the planting of Vetiver Grass hedges, or the construction of benches and cut-off drains be included in the stockpile/berm design.

These actions will limit the potential for uncontrolled run-off and the subsequent erosion of the unconsolidated soils, while the vegetation is establishing itself, and throughout the life of the mining operation.

Vetiver is a recognised and certified natural grass specie in South Africa, and after many years of trials and testing has been given a positive record of decision as a non invasive material that can be used as a hedging grass in the development of erosion control. The advantages to the use of Vetiver Grass, is documented in the attached brochure (Refer Appendix 2 - The Vetiver Network International - www.vetiver.org).

Erosion and compaction of the disturbed soils and the management of the stored or stockpiled materials are the main issues that will need to be managed on these sensitive soil forms. This is due to the sensitivity of the soils to mechanical disturbances during/after the removal of surface vegetation and the difficulties in replacing the disturbed materials.

Working with or on the differing soil materials (all of which occur within the areas that are to be disturbed) will require better than average management and careful planning if rehabilitation is to be successful. Care in removal and stockpiling or storage of the "Utilizable" soils, and protection of materials which are derived from the "hardpan ferricrete" layer is imperative to the success of sustainable rehabilitation in these areas. The sensitivity of the soils is a factor to be considered during the rehabilitation process (Refer to section on Soil Handling and Removal – Construction Phase (7.1) and Mitigation and Management Measures – Decommissioning and Closure Section (7.3))

7.3 Decommissioning and Closure

Soil Replacement and Land Preparation

During the decommissioning and closure phase of any mining project there will a number of actions being undertaken or completed. The removal of all infrastructure and the demolishing of concrete slabs, the backfilling of any and all open voids and the compaction of the barrier layer, and the topdressing of the disturbed and backfilled areas with utilizable soil ready for re-vegetation are all considered part of a successful closure operation.

The order of replacement, fertilization and stabilization of the backfilled materials and final cover materials (soil and vegetation) are all important to the success of the decommissioning plan and final closure.

There will be a positive impact on the environment in general and on the soils in particular as the area of disturbance is reduced, and the soils are returned to a state that can support low to moderate intensity grazing or sustainable agriculture.

Table 7.3 – Decommissioning and Closure Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Decommissioning & Closure	Rehabilitation of Disturbed land & Restoration of Soil Utilization	Placement of Soils	Stockpiled soil will be used to rehabilitate disturbed sites either ongoing as disturbed areas become available for rehabilitation and/or at closure. The utilizable soil (500mm) removed during the construction phase or while opening up of decline adit entrance, shall be redistributed in a manner that achieves an approximate uniform stable thickness consistent with the approved postmining land use (Low intensity grazing), and will attain a free draining surface profile. A minimum layer of 300mm of soil will be replaced.
		Fertilization	A representative sampling of the stripped soils will be analysed to determine the nutrient status of the utilizable materials. As a minimum the following elements will be tested for: EC, CEC, pH, Ca, Mg, K, Na, P, Zn, Clay% and Organic Carbon. These elements provide the basis for determining the fertility of soil. based on the analysis, fertilisers will be applied if necessary.
		Erosion Control	Erosion control measures will be implemented to ensure that the soil is not washed away and that erosion gulleys do not develop prior to vegetation establishment.
	Pollution of Soils	In-situ Remediation	If soil (whether stockpiled or in its undisturbed natural state) is polluted, the first management priority is to treat the pollution by means of in situ bioremediation. The acceptability of this option must be verified by an appropriate soils expert and by DWAF, on a case by case basis, before it is implemented.
		Off site disposal of soils.	If in situ treatment is not possible or acceptable then the polluted soil must be classified according to the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF 1998) and disposed at an appropriate, permitted, off-site waste facility.

Fertilizers and Soil Amendments

For any successful soil amelioration and resultant successful vegetative cover, it is necessary to distinguish between the initial application of fertilizers or soil amendments and maintenance dressings. Basal or initial applications are required to correct disorders that might be present in the in-situ material and raise the fertility status of the soil to a suitable level prior to seeding. The initial application of fertilizer and lime to the disturbed soils is necessary to establish a healthy plant cover as soon as possible. This will prevent erosion. Maintenance dressings are applied for the purpose of keeping up nutrient levels. These applications will be undertaken only if required, and only after additional sample analysis has been undertaken.

Fertilizer requirements reported herein are based on the sampling of the soils at the time of the baseline survey and will definitely alter during the storage stage.

The quantities of additives required at any given time during the storage phase or after rehabilitation has been established will potentially change due to physical and chemical processes. The fertilizer requirements should thus be re-evaluated at the time of rehabilitation.

It is recommended that a qualified person (agronomist or plant ecologist) be employed to establish the possible need or not for lime, organic matter and fertilizer requirements that will be applied, prior to the starting of the rehabilitation process.

The soils mapped are generally deficient in zinc, phosphorus, magnesium, copper and potassium. It is recommended that a standard commercial fertilizer be added to the soil before re-vegetation. The fertilizer should be added to the soil in a slow release granular form at a rate of approximately 200 kg/ha.

It will be necessary to re-evaluate the nutrient status of the soils at regular intervals to determine the possibility of needing additional fertilizer applications. In addition, it is important that only small amounts of fertilizer are added on a more frequent basis, rather than adding large quantities in one application.

The following maintenance is recommended:

- The area must be fenced, and all animals kept off the area until the vegetation is self sustaining;
- Newly seeded/planted areas must be protected against compaction and erosion;
- Traffic should be limited were possible while the vegetation is establishing itself;
- Plants should be watered and weeded as required on a regular and managed basis;
- Check for pests and diseases at least once every two weeks and treat if necessary;
- Replace unhealthy or dead plant material;
- Fertilise, hydro seeded and grassed areas with 200 kg/ha ammonium sulphate 4-6 weeks after germination, and
- Repair any damage caused by erosion;

Soil Sampling

During the rehabilitation exercise preliminary soil sampling should be carried out to determine the fertilizer requirements more accurately. Additional soil sampling should also be carried out annually until the levels of nutrients, specifically magnesium, phosphorus and potassium, are at the required level (approximately 20 and 120 mg/kg respectively). Once the desired nutritional status has been achieved, it is recommended that the interval between sampling be increased. An annual environmental audit should be undertaken. If growth problems develop, ad hoc, sampling should be carried out to determine the problem.

Sampling should always be carried out at the same time of the year and at least six weeks after the last application of fertilizer.

All of the soil samples should be analysed for the following parameters:

- pH (H_2O);
- Electrical conductivity;
- Calcium mg/kg;
- Magnesium mg/kg;
- Potassium mg/kg;
- Sodium mg/kg;
- Cation exchange capacity;
- Phosphorus (Bray I);
- Zinc mg/kg;
- Clay% and;
- Organic matter content (C %)

Impact Significance Assessment Summary Tables

Construction Phase

STEPS FOR POPULATING THE IMPACT ASSESSMENT AND MITIGATION TABLE

LIST ALL IMPACTS FOR THE APPROPRIATE PHASE (CONSTRUCTION, OPERATIONAL, DECOMMISSIONING OR CLOSURE PHASE).
DETERMINE THE SEVERITY TOTAL BY USING TABLE 1.
FROM THE SUM-TOTAL OBTAINED IN COLUMN M, OBTAIN A **C-VALUE** FROM TABLE 2.
GET A PROBABILITY VALUE FROM TABLE 3 (**P-VALUE**).
OBTAIN THE CORRECT **LEVEL OF RISK** FROM TABLE 4 AND INSERT IN COLMN P.
REPEAT SEVERITY TOTAL **AFTER** MITIGATION AND RECALCULATE C VALUE IN COLUMN T.
DETERMINE NEW **RISK LEVEL** IN COLUMN U (POST-MITIGATION).
RANK IMPACTS FOR ALL STAGES FROM LEVEL 1 - LEVEL 6.

Impact description and significance assessment table for the construction phase

Environmental management measure table

Environmental Component	Activity Description	Impact Identification/Description	Criteria for Determining Severity: Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL	SEVERITY C-NUMBER	Degree Of Likelihood	Risk Level Before Mitigation	Mitigatory Difficulty	Mitigation/ Management Objective	Proposed Mitigation Measure	Severity Total After Mitigation - C Number	Risk Level After Mitigation	EMP COMPONENTS: Responsible Person	Time schedule	Budget Quantum	Budget Allocation	Provisioning Method	Compliance Audit	Performance Assessment
Soils & Land Capability	**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES**		**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES**																**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES**						
	Coal throw-out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	Loss of Soil utilization (removed from system), impact on structure and possibility of contamination to soil profile	4	2	1	2	1	2	2	14	C4	Likely - P6	Level 3 Risk	Medium	Store utilizable resource and manage erosion loss and structural deformation, plus compact footprint and engineer a barrier layer	Remove utilizable soils before construction, stockpile and protect from erosion and compactio and impacts of contamination by dust or dirty water	C3	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m2	Rehab Fund		
	Conveyor Pedestal for crossing of Trichardt Spruit in the 1:10 year flood line) - Activity 1 (m).	Loss of small area of utilization at point of construction of pedestal, as well as loss of use of area under conveyor belt	1	0	1	2	1	2	0	7	C2	Almost Certain P7	Level 5 Risk	Medium	Limit area of impact	Remove and store soils for use at closure	C2	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m3	Rehab Fund		
	Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 6 (d).	Loss of Soil utilization (removed from system), impact on structure and possibility of contamination to profile	4	3	1	2	1	2	2	15	C4	Almost Certain P7	Level 3 Risk	High	Remove, store and protect soils	Return soils to free draining surface after dam has been closed and topdressed	C3	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m4	Rehab Fund		
	Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic metres of material - Activity 4.	Loss of small area of utilization at point of construction of pedestal, as well as loss of use of area under conveyor belt	1	0	1	2	1	2	0	7	C2	Almost Certain P7	Level 5 Risk	Medium	Limit area of impact	Remove and store soils for use at closure	C2	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m5	Rehab Fund		
	Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 9.	Loss of Soil utilization (removed from system), impact on structure and possibility of contamination to profile	2	2	1	1	1	2	2	11	C3	Likely - P6	Level 5 Risk	Low	Reduce Impact on Soils & Land Utilization	Bund the area of possible impact	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m6	Rehab Fund		
	Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	Exposure of the soils to wind and water erosion and the loss of the soil utilization potential for the life of the mining venture	3	1	1	2	1	1	2	11	C3	Likely - P7	Level 5 Risk	Medium	Protection of Resource	Storage of soil with vegetation	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m7	Rehab Fund		
	Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Potential for contamination of soils underlying the storage facility (dam) used to contain the dewatering	3	2	1	1	1	2	2	12	C3	Likely - P6	Level 5 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m8	Rehab Fund		
	Installation of a Terra Radio System above ground at the Shaft Complex Area - Activity 14.	Loss of soil utilization potential for the life of the mining operation. Digging of foundations	1	0	1	2	1	2	0	7	C2	Almost Certain P7	Level 5 Risk	Medium	Limit area of impact	Removal and storage of Utilizable soil	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m9	Rehab Fund		
	Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	Loss of soil utilization potential, possibility of contamination to in-situ materials and stockpiled soils by dust, product spills and hydrocarbons	4	1	2	2	1	1	2	13	C3	Almost Certain P7	Level 4 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C3	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m10	Rehab Fund		
	LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES		**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES**																**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES**						
	Construction of a Double Circuit 132 kV Overhead Powerline from Eskom Supply Point (SOL B) to Shondoni Mine Transmission Feeder Bays - Activity 6 (f).	Loss of soil utilization potential for the foundations to pylons and the area underneith the powerline cable/route & construction of service road	4	0	2	2	1	1	2	12	C3	Almost Certain P7	Level 4 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C3	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m2	Rehab Fund		
	Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Steel Coal Supply area) at a rate of more than 50 cubic metres per day - Activity 1 (i).	Loss of soil utilization potential, possibility of contamination to in-situ materials and stockpiled soils by dust, product spills and hydrocarbons	4	2	2	2	1	1	2	14	C4	Almost Certain P7	Level 3 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C3	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m3	Rehab Fund		
	Development of an area including shaft surface infrastructure and conveyor route where more than 20 hectares is disturbed - Activity 2.	Loss of soil utilization potential and possible contamination of soils due to spillage of raw product and hydrocarbons (lubricants)	4	2	2	2	1	1	2	14	C4	Almost Certain P7	Level 3 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C3	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m4	Rehab Fund		
	NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40		**NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40**																**NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40**						
	Taking water from a water resource - Section 21 (a).	The reduction in water resources will potentially reduce the irrigation potential and render the land capability less productive due to lowering of soil moisture content.	4	0	2	2	1	2	2	13	C3	Almost Certain P7	Level 4 Risk	High	Retain Soil Moisture	Augment Water Supplies	C3	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m2	Rehab Fund		
	Impeding or diverting the flow of water in a watercourse - Section 21 (c).	Diversion of water from its present course could affect the land capability in terms of productivity due to reduction in soil moisture content	4	0	2	2	1	2	2	13	C3	Possible P5	Level 5 Risk	High	Retain Soil Moisture	Augment Water Supplies	C3	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m3	Rehab Fund		
	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	Discharge of waste to unprotected soils will render them less useable. The loss of this resource could potentially be permisant if not managed.	4	1	2	1	1	2	2	13	C3	Low P4	Level 5 Risk	High	Protect soil Quality	Line all channels	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m4	Rehab Fund		
	Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	N/A to soils directly. However, the contamination of the water resource would ultimately impact on soils that are irrigated or over which they flow if not protected.	4	1	2	1	1	2	2	13	C3	Low P4	Level 5 Risk	High	Protect soil Quality	Line all channels	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m5	Rehab Fund		
	Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	Diversions of water courses or rivers will impact the soils over which the water is engineered to flow. These soils will be lost from the system and potentially be contaminated or impacted by poor quality water	4	0	2	2	1	2	2	13	C3	Possible P5	Level 5 Risk	High	Retain Soil Moisture	Augment Water Supplies	C3	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m6	Rehab Fund		
	Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Taking of water from the earths system will alter the soil moisture dynamics which will in turn affect the biosphere and ecology of the area that is dependent on and adapted to the present biological balance.	4	0	2	2	1	2	2	13	C3	Almost Certain P7	Level 5 Risk	High	Retain Soil Moisture	Augment Water Supplies	C3	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m7	Rehab Fund		
	Exemptions from GNR 704		**Exemptions from GNR 704**																**Exemptions from GNR 704**						
	No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	N/A								0															
	No person in control of a mine or activity may, except in relation to a matter contemplated in Regulation 10 (winning sand and alluvial minerals), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 metres from any water course or estuary, whichever is the greatest - Regulation 4(b).	N/A								0															
	No person in control of a mine or activity may use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any water course or estuary - Regulation 4(d).	N/A								0															
	No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource - Regulation 5.	N/A								0															
	NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008		**NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008**																**NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008**						
	NEMWA Section 19(3) and GN 718.									0															
	SHONDONI SHAFT AREA		**SHONDONI SHAFT AREA**																**SHONDONI SHAFT AREA**						
	Clearing of surface area and construction of Shaft Infrastructure	Loss of vegetative cover and topsoil protection - possibility of erosion and loss of resource permisantly and the impact of compaction on unprotected soil	4	1	1	1	1	1	1	10	C3	Almost Certain P7	Level 4 Risk	Medium	Protection of essurce	Removal of Utilizable Soil and Storage	C2	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m2	Rehab Fund		
	Development of berms and surface water control infrastructure, laydown areas and RoM product stockpiles	Loss of soil resource and its utilization potential and the possible contamination of the soil resource by mine product	4	2	1	1	1	1	1	11	C3	Almost Certain P7	Level 4 Risk	Medium	Protection of Resource	Removal of Utilizable Soil and Storage	C2	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m3	Rehab Fund		
	Construction of Workshops and support infrastructure including sewage works and lubrication bays, re-fueling points and repair areas	Loss of soil resource and its utilization potential and the possible contamination of the soil resource by mine product	4	2	1	1	1	1	1	11	C3	Almost Certain P7	Level 4 Risk	Medium	Protection of Resource	Removal of Utilizable Soil and Storage	C2	Level 5 Risk	SHEQ	At Decommissioning		R 200.00/m4	Rehab Fund		
										0															
	UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM		**UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM**																**UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM**						
	Construction and commissioning of the shaft complex inclusive of decline hoscut and ventilation shaft	Loss of soil resource and utilization potential from the system for the life of the mining venture	3	1	0	2	1	1	1	9	C2	Almost Certain P7	Level 5 Risk	Moderate	Prevent Loss of and Contamination to the resource	Strip and Stockpile utilizable soils	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m2	Rehab Fund		
	Removal of all surface vegetation and top soil for storage footprint for soil stockpiling	Loss of vegetative cover and topsoil protection - possibility of erosion and loss of resource permisantly and the impact of compaction on unprotected soil	3	1	0	2	1	1	1	9	C2	Almost Certain P7	Level 5 Risk	Moderate	Prevent Loss of and Contamination to the resource	Strip and Stockpile utilizable soils	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m3	Rehab Fund		
	Collapse of near surface ground around shaft and decline entrances	Loss of soil resource and utilization potential from the system for the life of the mining venture	2	1	0	1	1	1	1	7	C2	Low P4	Level 6 Risk	Moderate	Prevent loss of resource	Geotechnical investigation	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m4	Rehab Fund		
	Contamination of soils by product and hydrocarbon spils during construction	Loss of soil resource and utilization potential from the system for the life of the mining venture	3	1	0	2	1	1	1	9	C2	Almost Certain P7	Possible P5	Moderate	Prevent Loss of and Contamination to the resource	Strip and Stockpile utilizable soils	C2	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m5	Rehab Fund		
	CONVEYOR BELT ROUTE		**CONVEYOR BELT ROUTE**																**CONVEYOR BELT ROUTE**						
	Construction of lookout and collection bin facilities, pedestals and service road	Loss of soil resource and utilization potential of the soils from the system for the life of the mining venture	4	1	1	1	1	1	2	11	C3	Almost Certain P7	Level 4 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C3	Level 6 Risk	SHEQ	At Decommissioning		R 200.00/m2	Rehab Fund		
	Spillage of hydrocarbons from construction vehicles and lubricants used on conveyor working parts (motors etc)	Potential contamination of soils and their loss from the system	4	3	1	2	1	1	2	14	C4	Almost Certain P7	Level 3 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C3	Level 4 Risk	SHEQ	At Decommissioning		R 200.00/m3	Rehab Fund		

Operational Phase

STEPS FOR POPULATING THE IMPACT ASSESSMENT AND MITIGATION TABLE

LIST ALL IMPACTS FOR THE APPROPRIATE PHASE (CONSTRUCTION, OPERATIONAL, DECOMMISSIONING OR CLOSURE PHASE).
DETERMINE THE SEVERITY TOTAL BY USING TABLE 1.
FROM THE SUM-TOTAL OBTAINED IN COLUMN M, OBTAIN A **C-VALUE** FROM TABLE 2.
GET A PROBABILITY VALUE FROM TABLE 3 **(P-VALUE).**
OBTAIN THE CORRECT **LEVEL OF RISK** FROM TABLE 4 AND INSERT IN COLMN P.
REPEAT SEVERITY TOTAL **AFTER** MITIGATION AND RECALCULATE C VALUE IN COLUMN T.
DETERMINE NEW **RISK LEVEL** IN COLUMN U (POST-MITIGATION).
RANK IMPACTS FOR ALL STAGES FROM LEVEL 1 - LEVEL 6.

Impact description and significance assessment table for the operational phase

Environmental management measure table

Environmental Component	Activity Description	Impact Identification/Description	Criteria for Determining Severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk Level Before Mitigation	Mitigatory Difficulty	Mitigation/ Management Objective	Proposed Mitigation Measure	Severity Total After Mitigation - C Number	Risk Level After Mitigation	EMP COMPONENTS						
			Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL									Responsible Person	Time schedule	Budget Quantum	Budget Allocation	Provisioning Method	Compliance Audit	Performance Assessment
Soil and Land Capability	**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES**		**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES**																**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES**						
	Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	Contamination of soil footprint by RoM Product, and loss of soil utilization	4	2	1	1	1	1	1	11	C3	Almost Certain - P7	Level 7 Risk	Medium	Prevent contamination of resource and minimise area of impact	Keep area as small as possible and maintain stormwater controls and barrier layer	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Conveyor Pedestal for crossing of Tritchardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	Contamination of soil footprint by RoM Product and Hydrocarbon spills, and loss of soil utilization	4	3	1	1	1	2	1	13	C3	Almost Certain - P7	Level 7 Risk	Medium	Prevent contamination of resource and minimise area of impact	Keep area as small as possible and maintain stormwater controls and barrier layer	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	Contamination of subsoils by dirty water seepage, and loss of utilization of the resource	4	3	1	2	1	2	1	14	C4	Almost Certain	Level 3 Risk	Medium	Prevent contamination of resource and minimise area of impact	Keep area as small as possible and maintain stormwater controls and barrier layer - Dam Seal	C3	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Excavation for Coal Conveyor Pedestal for crossing of Tritchardt Spruit, removing more than 5 cubic metres of material - Activity 4.	None - Completed during construction phase - No added impacts								0									SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	Possible contamination of soil footprint outside of bunded area. Loss of soil utilization	3	3	1	1	1	2	1	12	C3	Possible P5	Level 5 Risk	High	Keep soils from being Contaminated	Bunding of Fuel Tanks and mangement of fuel filling procedures - Housekeeping issue	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Removal of Indigenous Vegeration of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	Loss of soil and land utilization if this is ongoing into the operational phase.	3	1	1	2	1	1	2	11	C3	Likely - P6	Level 5 Risk	Medium	Protection of Resource	Storage of soil with vegeration	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Removal of santer found in the underground workings on the No. 4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Potential ongoing impact on soil moisture and loss of land utilization	3	2	1	1	1	2	2	12	C3	Likely - P6	Level 5 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Installation of a Terra Radio System above ground at the Shaft Complex Area - Activity 14.	Completed in Construction Phase - No additional impacts of consequence other than the loss of the soil resource and utilization potential .	2	0	0	1	2	1	1	7	C2	Likely - P6	Level 5 Risk	Low	Save stored resource	Minimize area of impact and save stored resource	C1	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	Loss of soil resource and utilization potential and possible contamination by product and hydrocarbon spills	4	3	2	1	1	2	2	15	C4	Likely - P6	Level 3 Risk	Medium	Keep spillage to minimum	Clean up spills immediately and maintain equipment and vehicles	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES		**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES**																**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES**						
	Construction of a Double Circuit 132 kV Overhead Powerline from Eskom Supply Point (SOL B) to Shondoni Mine Transmission Feeder Bays - Activity 1 (o).	Ongoing loss of soil resuace and utilization potential due to service road	4	0	2	2	1	1	2	12	C3	Almost Certain - P7	Level 4 Risk	Medium to High	Reduce area of impact and maintain soil storage erosion and comparison of service road and stockpiles	Routine maintenance and vegecative cover control - monthly house keeping	C2	Level 5 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area) at a rate of more than 50 cubic metres per day - Activity 1 (l).	On-going loss of soil resource and utilization potential and possible contamination by product and hydrocarbon spills	4	3	2	1	1	2	2	15	C4	Likely - P6	Level 3 Risk	Medium	Keep spillage to minimum	Clean up spills immediately and maintain equipment and vehicles	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Development of an area including shaft surface infrastructure and conveyor route where more than 20 hectares is disturbed - Activity 2.	Loss of soil resource and utilization potential and possible contamination by product and hydrocarbon spills	4	2	2	2	1	1	2	14	C4	Almost Certain P7	Level 3 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C3	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40		**NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40**																**NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40**						
	Taking water from a water resource - Section 21 (a).	The on-going reduction in water resources will potentially reduce the irrigation potential and render the land capability less productive due to lowering of soil moisture content.	4	0	2	2	1	2	2	13	C3	Almost Certain P7	Level 4 Risk	High	Retain Soil Moisture	Augment Water Supplies	C3	Level 5 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Impeding or diverting the flow of water in a watercourse Section 21 (c).	Diversion of water from its present course could affect the land capability in terms of productivity due to reduction in soil moisture content	4	0	2	2	1	2	2	13	C3	Possible P5	Level 5 Risk	High	Retain Soil Moisture	Augment Water Supplies	C3	Level 5 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	Discharge of waste to unprotected soils will render them less useable. The loss of this resource could potentially be permineant if not managed.	4	1	2	1	1	2	2	13	C3	Low P4	Level 5 Risk	High	Protect soil Quality	Line all channels	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	N/A to soils directly. However, the contamination of the water resource would ultimately impact on soils that are irrigated or over which they flow if not protected.	4	1	2	1	1	2	2	13	C3	Low P4	Level 5 Risk	High	Protect soil Quality	Line all channels	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	Diversions of water courses or rivers will impact the soils over which the water is engineered to flow. These soils will be lost from the system and potentialy be contaminated or impacted by poor quality water	4	0	2	2	1	2	2	13	C3	Possible P5	Level 5 Risk	High	Retain Soil Moisture	Augment Water Supplies	C3	Level 5 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Taking of water from the earths system will alter the soil moisture dynamics which will in turn affect the biosphere and ecology of the area that is dependent on and adapted to the present biological balance.	4	1	2	2	1	2	2	14	C3	Almost Certain P7	Level 4 Risk	High	Retain Soil Moisture	Augment Water Supplies	C3	Level 5 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Exemptions from GNR 704		**Exemptions from GNR 704**																**Exemptions from GNR 704**						
	No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	N/A								0															
	No person in control of a mine or activity may, except in relation to a matter contemplated in Regulation 10 (winning sand and alluvial minerals), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 metres from any water course or estuary, whichever is the greatest - Regulation 4(b).	N/A								0															
	No person in control of a mine or activity may use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any water course or estuary - Regulation 4(d).	N/A								0															
	No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource - Regulation 5.	N/A								0															
	NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008		**NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008**																**NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008**						
	NEMWA Section 19(3) and GN 718.									0															
	SHONDONI SHAFT AREA		**SHONDONI SHAFT AREA**																**SHONDONI SHAFT AREA**						
	On-going mining - haulage of raw product to surface and beneficiation	Continued loss of soil resource and utilization potential, plus possible contamination of footprint soils.	3	2	0	1	1	1	1	9	C2	Almost Certain - P7	level 5 Risk	Moderate	Prevent Loss of and Contamination to the resource	Maintain surface water controls, dust supression and control spillage, and maintain storage facilities	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Possible contamination of footprint soils and stored berm materials by dirty santer in area of shaft workings	Continued loss of soil resource and utilization potential, plus possible contamination of footprint soils.	3	3	0	1	1	1	1	10	C3	Likely - P6	Level 4 Risk	Moderate	Prevent Loss of and Contamination to the resource	Maintain surface water controls, dust supression and control spillage, and maintain storage facilities	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Compaction of in-situ footprint and stored material, plus erosion of unprotected areas and storage facilities.	Continued loss of soil resource and utilization potential	3	1	0	1	1	1	1	8	C2	Likely - P6	Level 6 Risk	Moderate	Prevent loss of resource	Maintain surface water controls, and movement fo vehicles	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Vehicle impacts	Loss of resource by dust emmissions	3	1	1	1	1	1	1	9	C2	Likely - P6	Level 6 Risk	Moderate	Prevent Loss of the resource	Maintain surface water controls, dust supression and control spillage	C2	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM		**UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM**																**UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM**						
	Ongoing operation of shafts, access roads and haulage ways	Continued loss of soil resource with possibility of contamination by operational activities - fleet product and vehicle impacts - Hydrocarbons, compaction and/or erosion	3	1	0	1	1	1	1	8	C2	Almost Certain - P7	Level 5 Risk	Medium	Prevent contamination and loss of resource	Restrict area of impact and manage spillage of product and hydrocarbons	C1	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	Potential for contamination of stored soils from adit declines and shafts operations - water, by product and hydrocarbons from operation vehicles	The continued loss of resource and utilization potential due to operation of mining infrastructure and storage of product (RoM) and natural materials	3	1	0	1	1	1	1	8	C2	Almost Certain - P7	Level 5 Risk	Medium	Prevent contamination and loss of resource	Restrict area of impact and manage spillage of product and hydrocarbons	C1	Level 6 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		
	CONVEYOR BELT ROUTE		**CONVEYOR BELT ROUTE**																**CONVEYOR BELT ROUTE**						
	Operation of haulage facility	Ongoing loss of resource and soil utilization potential, and the potential for contamination by spillage of product and hydrocarbons	4	3	2	1	1	1	2	14	C4	Almost Certain P7	Level 3 Risk	Medium	Protection of Resource	Removal and storage of Utilizable soil	C3	Level 5 Risk	SHEQ	Ongoing	See Decommissioning	See Decommissioning	Rehab Fund		

Decommissioning Phase

STEPS FOR POPULATING THE IMPACT ASSESSMENT AND MITIGATION TABLE

LIST ALL IMPACTS FOR THE APPROPRIATE PHASE (CONSTRUCTION, OPERATIONAL, DECOMMISSIONING OR CLOSURE PHASE).
DETERMINE THE SEVERITY TOTAL BY USING TABLE 1.
FROM THE SUM-TOTAL OBTAINED IN COLUMN M, OBTAIN A **C-VALUE** FROM TABLE 2.
GET A PROBABILITY VALUE FROM TABLE 3 (**P-VALUE**).
OBTAIN THE CORRECT **LEVEL OF RISK** FROM TABLE 4 AND INSERT IN COLMN P.
REPEAT SEVERITY TOTAL **AFTER** MITIGATION AND RECALCULATE C VALUE IN COLUMN T.
DETERMINE NEW **RISK LEVEL** IN COLUMN U (POST-MITIGATION).
RANK IMPACTS FOR ALL STAGES FROM LEVEL 1 - LEVEL 6.

Impact description and significance assessment table for the decommissioning phase

Environmental management measure table

			Criteria for Determining Severity																EMP COMPONENTS						
Environmental Component	Activity Description	Impact Identification/Description	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL	SEVERITY C-NUMBER	Degree Of Likelihood	Risk Level Before Mitigation	Mitigatory Difficulty	Mitigation/ Management Objective	Proposed Mitigation Measure	Severity Total After Mitigation C-Number	Risk Level After Mitigation	Responsible Person	Time schedule	Budget Quantum	Budget Allocation	Provisioning Method	Compliance Audit	Performance Assessment
Soil and land Capability	**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES**																								
	Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	Action will have been completed and stopped. Rehabilitation of footprint	4	1	1	0	-1	1	1	7	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	Mine Manager/Environmental Manager/Other	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund	Yes or No	Inadequate / Adequate
	Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	Removal of conveyer infrastructure	3	1	2	0	-1	1	2	8	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	Removal of sediment and all waste product and closure of dam	3	1	1	0	-1	1	1	6	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Construction	R 200.00/m2	Closure	Rehabilitation Fund		
	Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic metres of material - Activity 4.	Removal of pedestal and rehabilitation of service road	3	1	0	0	-1	1	2	6	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Construction	R 200.00/m2	Closure	Rehabilitation Fund		
	Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	Decommissioning and removal of facility. Rehabilitation of footprint	4	1	1	0	-1	1	1	7	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related infrastructure - Activity 12.	Removal of all infrastructure and rehabilitation of shaft footprint	4	1	1	0	-1	1	1	7	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Creation of pumping	2	0	2	0	-1	1	1	5	C2	Likely P4	Level 6 Risk	Low	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Installation of a Tetra Radio System above-ground at the Shaft Complex Area - Activity 14.	Removal of all infrastructure and rehabilitation of shaft footprint	3	1	1	0	-1	1	1	6	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	Closure of roadway and rehabilitation of footprint	4	1	2	0	-1	1	2	9	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES																								
	Construction of a Double Circuit 132 kV Overhead Powerline from Eskom Supply Point (SOL B) to Shondoni Mine Transmission Feeder Bays - Activity 1 (f).	Removal of all infrastructure and rehabilitation of footprint of pylons and service road	4	1	2	0	-1	1	2	9	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area) at a rate of more than 50 cubic metres per day - Activity 1 (i).	Removal of all infrastructure and concrete plinths and the rehabilitation of the footprint to the conveyer and service roadway	4	1	2	0	-1	1	2	9	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Development of an area including shaft surface infrastructure and conveyor route where more than 20 hectares is disturbed - Activity 2.	Removal of all infrastructure and concrete plinths and the rehabilitation of the footprint to the conveyer and service roadway	4	1	1	0	-1	1	2	8	C2	Likely P4	Level 6 Risk	Medium	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40																								
	Taking water from a water resource - Section 21 (a).	Cessation of all pumping	2	0	2	0	-1	1	1	5	C2	Likely P4	Level 6 Risk	Low	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Impeding or diverting the flow of water in a watercourse - Section 21 (c).	Maintenance of watercourse	4	1	2	3	0	1	2	13	C3	Likely P4	Level 5 Risk	High	Return area to as close as possible it's original condition	Maintain Status Quo	C2	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	Cessation of all/any discharge, removal of infrastructure and equipment and rehabilitation of all disturbed footprints	2	1	2	0	-1	1	2	7	C2	Likely P4	Level 6 Risk	Low	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	Cessation of all pumping and/or discharges	2	0	2	0	-1	1	2	6	C2	Likely P4	Level 6 Risk	Low	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	Maintenance of the altered watercourse	4	1	2	3	0	1	2	13	C3	Likely P4	Level 5 Risk	High	Return area to as close as possible it's original condition	Maintain Status Quo	C2	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Cessation of all pumping and/or discharges	2	0	2	0	-1	1	2	6	C2	Likely P4	Level 6 Risk	Low	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund	Rehabilitation Fund	
	Exemptions from GNR 704																								
	No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	N/A								0															
	No person in control of a mine or activity may, except in relation to a matter contemplated in Regulation 10 (winning sand and alluvial minerals), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 metres from any water course or estuary, whichever is the greatest - Regulation 4(b).	N/A								0															
	No person in control of a mine or activity may use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any water course or estuary - Regulation 4(d).	N/A								0															
	No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource - Regulation 5.	N/A								0															
	NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008																								
	NEMWA Section 19(3) and GN 718.									0															
	SHONDONI SHAFT AREA																								
	Replacement of soils	Loss of soils nutrient while in storage	4	1	0	0	-1	1	0	5	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Add fertilizer and Lime as required (Lab Analysis)	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Irrigation of vegetation	Contamination by dirty water used for watering re-vegetation	4	1	0	0	1	1	0	7	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Maintain Stormwater Controls and channel all dirty water	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Movement of rehabilitation vehicles	Hydrocarbon spills from rehab vehicles, compaction & Dust	4	1	0	0	1	1	0	7	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Maintain vehicles in good working order	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Rehabilitation of impacted footprint areas	Reduction in area	4	1	0	0	-1	1	0	5	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	UNDERGROUND MINING ACTIVITIES OF THE NO.5 2 AND 4 COAL SEAM																								
	Replacement of soils	Loss of soils nutrient while in storage	3	1	0	0	-1	1	0	4	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Add fertilizer and Lime as required (Lab Analysis)	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Irrigation of vegetation	Contamination by dirty water used for watering re-vegetation	3	1	0	0	1	1	0	6	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Maintain Stormwater Controls and channel all dirty water	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Movement of rehabilitation vehicles	Hydrocarbon spills from rehab vehicles, compaction & Dust	3	1	0	0	1	1	0	6	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Maintain vehicles in good working order	C1	Level 6 Risk	Engineering and SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Rehabilitation of impacted footprint areas	Reduction in area	3	1	0	0	-1	1	0	4	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	CONVEYOR BELT ROUTE																								
	Replacement of soils	Loss of soils nutrient while in storage	4	1	0	0	-1	1	0	5	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Add fertilizer and Lime as required (Lab Analysis)	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Irrigation of vegetation	Contamination by dirty water used for watering re-vegetation	4	1	0	0	1	1	0	7	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Maintain Stormwater Controls and channel all dirty water	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Movement of rehabilitation vehicles	Hydrocarbon spills from rehab vehicles, compaction & Dust	4	1	0	0	1	1	0	7	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	Maintain vehicles in good working order	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		
	Rehabilitation of impacted footprint areas	Reduction in area	4	1	0	0	-1	1	0	5	C2	Likely P4	Level 6	Medium	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Ongoing	R 200.00/m2	Closure	Rehabilitation Fund		

Post Closure Phase

STEPS FOR POPULATING THE IMPACT ASSESSMENT AND MITIGATION TABLE

LIST ALL IMPACTS FOR THE APPROPRIATE PHASE (CONSTRUCTION, OPERATIONAL, DECOMMISSIONING OR CLOSURE PHASE).
DETERMINE THE SEVERITY TOTAL BY USING TABLE 1.
FROM THE SUM-TOTAL OBTAINED IN COLUMN M, OBTAIN A **C-VALUE** FROM TABLE 2.
GET A PROBABILITY VALUE FROM TABLE 3 (**P-VALUE**).
OBTAIN THE CORRECT **LEVEL OF RISK** FROM TABLE 4 AND INSERT IN COLMN P.
REPEAT SEVERITY TOTAL **AFTER** MITIGATION AND RECALCULATE C VALUE IN COLUMN T.
DETERMINE NEW **RISK LEVEL** IN COLUMN U (POST-MITIGATION).
RANK IMPACTS FOR ALL STAGES FROM LEVEL 1 - LEVEL 6.

Impact description and significance assessment table for the Post-closure phase

Environmental management measure table

Environmental Component	Activity Description	Impact Identification/Description	Criteria for Determining Severity: Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL	SEVERITY C-NUMBER	Degree Of Likelihood	Risk Level Before Mitigation	Mitigatory Difficulty	Mitigation/ Management Objective	Proposed Mitigation Measure	Severity Total After Mitigation - C Number	Risk Level After Mitigation	EMP COMPONENTS: Responsible Person	Time schedule	Budget Quantum	Budget Allocation	Provisioning Method	Compliance Audit	Performance Assessment
	LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES		**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES**																						
	Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	4	1	1	0	-1	1	1	7	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund	Yes or No	Inadequate / Adequate
	Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	3	1	2	0	-1	1	2	8	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	3	1	1	0	-1	1	1	6	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	3	1	0	0	-1	1	2	6	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	4	1	1	0	-1	1	1	7	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	4	1	1	0	-1	1	1	7	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	2	0	2	0	-1	1	1	5	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	3	1	1	0	-1	1	1	6	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Construction of an Access Road (sudder than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	4	1	2	0	-1	1	2	9	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES		**LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 387 ACTIVITIES**																						
	Construction of a Double Circuit 132 kV Overhead Powerline from Eskom Supply Point (SDL B) to Shondoni Mine Transmission Feeder Bays - Activity 1 (f).	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	4	1	2	0	-1	1	2	9	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Saxil Coal Sapply area) at a rate of more than 50 cubic meters per day - Activity 1 (i).	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	4	1	2	0	-1	1	2	9	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Development of an area including shaft surface infrastructure and conveyor zone where more than 20 hectares is disturbed - Activity 2.	Maintenance of soil quality and vegetative cover - Additions of nutrients and possibly water to rehabilitated footprint area	4	1	1	0	-1	1	2	8	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Use clean water and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m12	Closure	Rehab Fund		
Soil and land Capability	**NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40**		**NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40**																						
	Taking water from a water resource - Section 21 (a).	None	2	0	2	0	-1	1	1	5	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Impeding or diverting the flow of water in a watercourse - Section 21 (c).	Maintenance of River Banks	4	1	2	3	0	1	2	13	C3	Likely P6	Level 5 Risk	High	Return area to as close as possible it's original condition	Maintain Status Quo	C2	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	None	2	1	2	0	-1	1	2	7	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	Restrict access to area and reduce vehicle movement	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	None	2	0	2	0	-1	1	2	6	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	Maintenance of River Banks	4	1	2	3	0	1	2	13	C3	Likely P6	Level 5 Risk	High	Return area to as close as possible it's original condition	Maintain Status Quo	C2	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	None	2	0	2	0	-1	1	2	6	C2	Likely P6	Level 6 Risk	Low	Return area to as close as possible it's original condition	None	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	Exemptions from GNR 704		**Exemptions from GNR 704**																						
	No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	N/A								0															
	No person in control of a mine or activity may, except in relation to a matter contemplated in Regulation 10 (winning sand and alluvial minerals), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 metres from any water course or estuary, whichever is the greatest - Regulation 4(b).	N/A								0															
	No person in control of a mine or activity may use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any water course or estuary - Regulation 4(d).	N/A								0															
	No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource - Regulation 5.	N/A								0															
	NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008		**NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008**																						
	NEMWA Section 19(3) and GN 718.									0															
	SHONDONI SHAFT AREA		**SHONDONI SHAFT AREA**																						
	Maintenance of Rehabilitated area	Addition of fertilizers (Possible pollutant), vehicle impacts (Compaction and dust)	4	1	0	0	-1	1	0	5	C2	Likely P6	Level 6	Low	Return area to as close as possible it's original condition	Add fertilizer and Lime as required (Lab Analysis)	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM		**UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM**																						
	Maintenance of Rehabilitated area	Addition of fertilizers (Possible pollutant), vehicle impacts (Compaction and dust)	4	1	0	0	-1	1	0	5	C2	Likely P6	Level 6	Low	Return area to as close as possible it's original condition	Add fertilizer and Lime as required (Lab Analysis)	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		
	CONVEYOR BELT ROUTE		**CONVEYOR BELT ROUTE**																						
	Maintenance of Rehabilitated area	Addition of fertilizers (Possible pollutant), vehicle impacts (Compaction and dust)	4	1	0	0	-1	1	0	5	C2	Likely P6	Level 6	Low	Return area to as close as possible it's original condition	Add fertilizer and Lime as required (Lab Analysis)	C1	Level 6 Risk	SHEQ	Post Closure	R 10.00/m2	Closure	Rehab Fund		

8 ENVIRONMENTAL MONITORING PLAN

8.1 Monitoring Philosophy and Requirements

8.1.1 Monitoring Philosophy

The observation and recording of environmental data are costly exercises and therefore the philosophy and reasoning behind an environmental monitoring system should always be sound. The benefits of sound environmental monitoring are not only legal compliance, but also certain business benefits such as the improvement of operational efficiency, the improvement of risk management, the reduction of liabilities, the avoidance of adverse publicity and ultimately the improvement of business performance.

Current Environmental Legislation in South Africa requires mining and industry to comply with the philosophy of Integrated Environmental Management. The applicable legislation includes inter alia the Constitution, the National Environmental Management Act, the Environment Conservation Act, the Minerals and Petroleum Resources Development Act, and the National Water Act, to name but a few of the more prominent acts.

Some of the general principles of Integrated Environmental Management include meaningful participation with Interested and Affected Parties, due consideration of alternatives that includes the "no go option", and understanding that activities will not be approved if there is scientific uncertainty.

The abovementioned legislation is furthermore applied subject to a number of emerging Environmental Law Norms, including norms such as sustainable development, a human right to a decent environment, legal standing, inter-generational equity, the public trust doctrine, the precautionary principle, the preventive principle, the polluter pays principle, local level governance and the norm of common but differentiated responsibility.

Some of these norms have a profound influence on the way in which mining and industry need to perform their environmental management. In this regard, the precautionary principle, which states that "where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation." This norm introduces and elevates scientific quantification of impacts, and the associated risks to human health and the environment, to a status of representing a fundamental requirement in Environmental Management.

This implies that from a technical perspective, all environmental systems must be understood to their full consequence, to allow for accurate, quantitative impact and risk assessment, on which to base decisions related to the management of these systems. In simple laymen terms, this means that the different biophysical components of the environment must be measured and monitored, to supply quantitative decision making information of high certainty, on which to base the management of the environment.
However, effective integrated environmental management does not only require a fundamental understanding of the environmental components and the activities and

processes which could impact on the environment, but more important, the transient development of the impacts associated with these processes, need to be understood to such a degree that their future development and response to management, remedial and/or rehabilitation measures, can be predicted.

Environmental Monitoring therefore forms the cornerstone of Integrated Environmental Management.

Environmental Management policies in South Africa advocate the Risk Based (Averse) Approach, subject to the implementation of the Best Practical Environmental Option (BPEO), using the management hierarchy of Source-Pathway-Receptor. The Source-Pathway-Receptor hierarchy requires an in-depth understanding of the origin of all pollutants, the pathway these pollutants could follow into the environment and the ultimate fate of these pollutants. The overarching Risk Profile relates to the protection of Human Health and the Environment. BPEO is a minimum requirement in terms of South African Environmental Management Policy and forms the basis of all source control measures to be implemented.

On a practical level, compliance with all the above legislation, environmental law norms, guidelines and policies, requires environmental monitoring systems which must ensure the generation, interpretation and reporting of information of high scientific integrity.

The monitoring of the soil environment has not been legislated in terms of South African Law, but as an integral part of the "pathway" that any pollutant or contaminant is likely to follow, it is often an area where the contaminant is detected in the early stages of a problem, and often, due to its variability and ability to inhibit flow rates is part of the protection mechanism that can be used in mitigating impacts. The soils can also of course be part of the source of contamination.

Monitoring of the water in the environment are legislated and, although the nature of the material being sampled and analysised is different, the principles and methodology are similar. Formal technical guidelines for Environmental Monitoring are currently being developed locally.

Internationally there are norms that have been tabled for certain metal content and hydrocarbon limits to soils, and SA have adopted a similar approach to the understanding of soil quality, with research being undertaken on a need to know basis. This is often not satisfactory, and a retrospective philosophy that is often costly.

In addition, it is not only important to understand the presence of contamination in the vadose zone and soil profile, but it is necessary to understand the quality of a soil if it is to be used as a growing medium. The nutrient content of a soil is important to the success of failure of many a rehabilitation project.

The results of soil analysis should be assessed to determine areas of success and identify any activities that require corrective or preventative action and improvement.

In this particular case (Soil and Land Capability), it is the intention of this monitoring plan to raise awareness regarding the possibility of problems within the soil profile (be it due to inputs of material from the mining activities that are a potential source of contamination, or the observation of nutrient levels), that can be mitigated.

By monitoring and observing the development (trends) of change within a soil profile, the corrective action to remedy the situation is highlighted early.

Data should be collected systematically, from appropriate sources at a frequency consistent with the environmental objectives and targets, taking cognizance of the significance of the environmental aspects.

The environmental management plan specifies the baseline conditions that are to be achieved as part of the rehabilitation planning, and gives input into the procedures for the dealing of contaminated soils.

At the outset, and as part of the baseline information gathered, soil chemistry was measured for the pre-mining environment. This must be used as the basis for any change that becomes apparent during the activity.

The demarcating of specific points for monitoring are not recommended as composite samples were originally taken at the time of baseline investigation. Sampling of specific points during the life cycle of the mining venture will need to be decided on a need to understand basis, with the rehabilitated areas being sampled for nutrient levels when required, and any areas of concern regarding contamination will need to be determined and a specific grid decided for each individual situation.

As with any monitoring and data capture, protocols need to be developed for the specifics of the area and the material being sampled In the case of soils, it is important that aspects such as sampling technique, sampling equipment, sampling frequency, sample preservation, analysing technique, and variables to be analysed for, should be formalized and documented.

The frequency of monitoring/sampling should at all times be a combined function of the sampling objectives and the expected variability in the parameter(s) to be monitored. In the case of soils the changes and variation in quality are generally a function of input or removal due to a known action or process and the measuring of change will be determined on a need to know basis. This is specifically true for the rehabilitation of an area, or when a spill has occurred. Thus, the frequency of sampling will be determined by the circumstance.

The success of any monitoring program depends inter alia on the selection of appropriate sampling techniques and equipment to satisfy all monitoring objectives. Broadly speaking these objectives should support regulatory requirements, certain operational decision making requirements and corrective action evaluation. Incorrect or poorly selected sampling techniques will render all of the preceding effort (such as evaluation of site conditions, optimization of sampling frequency and selection of variables to be analysed for) futile.

Great care should at all times be taken in the field to prevent mishaps or contamination. In the case of soil monitoring, the equipment used will depend on the depth at which the sample is to be taken and the quantity of material that is needed. If only the nutrient content of a soil is needed as part of the rehabilitation planning, then relatively small quantities of soil are needed, while the understanding of a soils physical attributes and its engineering properties or possible containment of a contaminant will often require that a much bigger sample is taken a varying depths through the profile.

Aspects such as timing, techniques, and the capture of the information will vary with the different reasons for undertaking the sampling. Please refer to Section 7 – Management Planning for details on sampling periods and determinants that are recommended.

LIST OF REFERENCES

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APPENDIX 1

VETIVER GRASS

THE VETIVER SYSTEM
A PROVEN SOLUTION

The Vetiver Network International - www.vetiver.org

VETIVER GRASS
A HEDGE AGAINST EROSION

The Vetiver Network International - www.vetiver.org

Malaysia - highway stabilization | India - beach stabilization | Fiji - 2m high vetiver created terrace | Ethiopia - soil conservation | Cambodia - river bank stabilization | Australia - wastewater treatment

The problems we face are growing at a pace that challenges our ability to solve them

- Soil loss results in physical, chemical, and biological degradation and loss of ability to produce food.
- Land slides, unstable slopes and flooding destroy agricultural land and valuable infrastructure.
- Siltation of drains, lakes, reservoirs, and rivers reduce storage capacity and can result in flooding.
- Overuse and misuse of large areas of land, and contamination by toxic runoff from mine dumps, landfills, feedlots, salinization, etc.., require extensive reclamation programs.
- Water polluted by mineral or organic sediments as well as the pollutants mentioned above detrimentally affect drinking water supplies, fresh and saltwater fisheries, and coral reefs.
- Decreased groundwater recharge in watersheds results in local water shortages.
- Inattention to site stabilization and maintenance results in infrastructure failure and losses.

Solutions are often too complex or costly given existing resources and capacity

- The complexity and high cost of engineering and structural designs; ambitious and impracticable environmental protection and remedial practices - often due to over demanding design engineers and supervisors - and unnecessary high-end quality control measures; as well as, amongst others, bureaucratic accounting and bidding procedures.
- Low potential for sustainability due to lack of funds for maintenance, unsuitability to local conditions/ capacity, or need for continuous subsidies to maintain effectiveness.

Many of these problems share a common solution in THE VETIVER SYSTEM

The Vetiver System (VS)

- Consists of a simple vegetative barrier (a hedge) comprising upright, rigid, dense, and deeply-rooted clump grass, that slows runoff, allowing sediments to stay on site, eventually forming natural terraces.
- Vetiver grass is already found in more than 120 countries throughout the tropics and sub-tropics.
- It has been used for more than a century in many Asian, African, and Caribbean countries as a traditional "soil binding" technology.
- Today, the VS is used for soil and moisture conservation, bioengineering, and for bioremediation.

It is not weedy or invasive

- Hedges are propagated and established vegetatively. **Analyses show that recommended cultivars of *Chrysopogon zizanioides* (south India type) are sterile and are not invasive.**

Deep, tough roots

- Vetiver's deep, massive fibrous root system can reach down to two to three meters in the first year.
- This massive root system is likened to *"living nails"*, binding the soil together.
- The measured maximum resistance of vetiver roots in soils is equivalent to one-sixth that of mild steel (75 Mpa); stronger than most tree roots; improves soil shear strength by as much as 39%
- The fibrous mat of roots strengthens earthen structures and removes many contaminants from soil and soil water.
- Closely planted slips grow into dense hedgerows with a deep, tough root systems. They can withstand inundation, and effectively reduce flow velocities, forming excellent filters that prevent soil loss.

THE PLANT -- VETIVER GRASS -- *Vetiveria zizanioides L (Nash) recently reclassified* ***Chrysopogon zizanioides L (Roberty)***

Chrysopogon zizanioides L (Roberty) previously named Vetiveria zizanioides L (Nash) common name: ***Vetiver Grass***

Planting slip

Tissue cultivation of vetiver grass

6 month vetiver root grown in Senegal

Cross section through a two year old hedgerow. Note sediment build up over original top soil (brown line)

Longitudinal section through hedgerow

Newly planted vetiver hedgerow

Large differences occur between the roots of vetiver grass species and cultivars. Compare *C. zizanioides* (upper) with *C. nemoralis* (lower)

Indian vetiver nursery of containerized plants

Planting containerized vetiver on steep highway fill slope in Malaysia

Vetiver inflorescence. In many cases vetiver never flowers, but when it does, it produces rather beautiful non-fertile flowers

WHY VETIVER GRASS

For a plant to be useful for agriculture and biological engineering, and be accepted as safe, it should have as many as possible of the following characteristics:

- Its seed should be sterile, and the plant should not spread by stolons or rhizomes, and therefore not escape and become a weed.
- Its crown should be below the surface so it can resist fire, over grazing, and trampling by livestock.
- It should be capable of forming a dense, ground level, permanent hedge, as an effective filter, preventing soil loss from runoff. Apparently only clones will grow 'into' each other to form such a hedge.
- It should be perennial and permanent, capable of surviving as a dense hedge for decades, but only growing where we plant it.
- It should have stiff erect stems that can, at minimum, withstand flowing water of 1 foot (30 cm) depth that is moving at 1 foot per second (0.3 meters/second).
- It should exhibit xerophytic and hydrophytic characteristics if it is to survive the extremes of nature. Vetiver grass, once established, is little affected and highly tolerant of droughts or floods.
- It should have a deep penetrating root system, capable of withstanding tunnelling and cracking characteristics of soils, and should the potential to penetrate vertically below the plant to at least three meters.
- It should be capable of growing in extreme soil types, regardless of nutrient status, pH, sodicity, acid sulphate or salinity, and toxic minerals. This includes sands, shales, gravels, mine tailings, and even more toxic soils.
- It should be capable of developing new roots from nodes when buried by trapped sediment, and continue to grow upward with the rising surface level, forming natural terraces.
- It should not compete with the crop plants it is protecting.
- **it should not be a host (or intermediate host) for undesirable pests or diseases of any other plants.**
- It should be capable of growing in a wide range of climates -- from 300 mm of rainfall to over 6,000 mm -- from air temperatures of -15° C (where the soil does not freeze) to more than 55° C. It should be able to withstand long and sustained droughts (>6 months).
- It should be cheap and easy to establish as a hedge and easily maintained by the user at little cost.
- It should be easily removed when no longer required.

Vetiver Grass cultivars used around the world for essential oil production, originating from south India, have all these characteristics.

Dense crown of a vetiver grass clump from which roots and shoots emerge

After a fire vetiver hedge remains vertical and quickly recovers with new growth

Erosion sediment trapped by a vetiver hedgerow in Madagascar.

Closely spaced (15 cm between plants at planting) hedgerow at left assures a properly dense hedge

Very dense and very effective vetiver hedgerow

VS FOR AGRICULTURE

- **On-farm** - in modern and traditional agriculture VS is used to trap sediments, control runoff, increase soil moisture recharge, and stabilize soils during intense rainfall and floods. There is only minimal competition with adjacent perennial and annual crops for moisture or nutrients. VS is used for wind erosion control, forage, and pest control.
- **On-farm** - VS protects rural structures such as roads, ponds, drains, canals and building sites. Also used for land and gully rehabilitation.
- **Off-farm** - VS plays a vital role in watershed protection at large scales - slowing down and spreading rainfall runoff, recharging groundwater reserves, reducing siltation of drainage systems, lakes and ponds, reducing agrochemical loading into groundwater and watercourses, and for rehabilitation of misused land.

Top left: Vetiver hedgerows protecting farm crops on steep slopes in the highlands of N.E. Thailand

Top center: Vetiver hedgerow on Darling Downs, Australia, used to reduce erosive power of flooding on flat land -- as a result more land can be cropped each year

Top right: Farmers from Gundalpet, India, have used vetiver for centuries to reduce soil loss, conserve moisture, provide forage, and increase groundwater recharge

Bottom left: Vetiver hedgerow used to protect crops from high winds in Pintang Island, China

Bottom center: Vetiver used to stabilize a farm road in Malaysia

Bottom right: A irrigation drain/canal stabilized by vetiver hedgerow

THE VETIVER SYSTEM
A PROVEN SOLUTION
The Vetiver Network International - www.vetiver.org

VETIVER GRASS
A HEDGE AGAINST EROSION
The Vetiver Network International - www.vetiver.org

VS FOR BIO-ENGINEERING

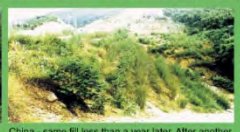
- For the stabilization and protection of infrastructure (roads, railroads, and building sites) VS is proven effective, efficient, and low cost when compared to other 'hard' engineering alternatives using cement, rock, and steel. Vetiver grass roots have an Mpa of 75 (1/6 the strength of mild steel) and will improve soil shear strength at a depth of 0.5 meters by as much as 39%. VS costs from 55% to 85% less than traditional engineering systems. **For successful applications cultivars of *Chrysopogon zizanioides* originally from south India should be used**. These cultivars are of the same genotype as Monto and Sunshine, and are **non-invasive.** They have a more massive root structure than non sterile *C.zizanioides* accessions from north India, Africa (*C.nigratana*) and Thailand (*C.nemoralis*)

The KEY to successful VS applications for infrastructure is the availability of large quantities of good quality vetiver planting material. Above, from left to right, are nurseries from Senegal (containerized), China (bare rooted) and Thailand (from in vitro plantlets)

Venezuela - rehabilitation of bauxite mine tailings. The soils are very acid and prone to slippage. High levels of fertilizer assure good growth

China - expressway stabilization. This cut was prone to massive slip. Stabilization with VS has given complete protection

China - unstable highway fill prior to VS treatment. Road stability was so bad in untreated state that major lateral cracks in the pavement occurred



China - same fill less than a year later. After another two years this fill became fully forested. Untreated cut in background

Spain - unstable and eroding highway fill treated with VS. Untreated eroded fill on right. VS grows well under low rainfall Mediterranean climate

Vietnam: the Ho Chi Minh Highway has been stabilized with vetiver grass. The batters and fills are stable and withstand cyclonic rainfall events

Vietnam - Ho Chi Minh Highway - with and without vetiver stabilization

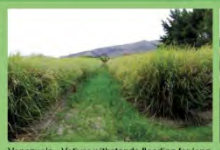
Thailand - a gas pipeline was laid through tropical forest. On steep slopes the right of way was stabilized with vetiver - native plants regenerated

Disaster mitigation - this railroad in Madagascar was closed down by frequent cyclone damage. Stabilization with vetiver was vital in its rehabilitation

Congo D.R. - huge gullies that destroy urban areas and houses can be rehabilitated and stabilized using the Vetiver System.

VS FOR WATER RELATED APPLICATIONS

- VS protects ponds, reservoirs, and rivers banks from erosion caused by wave action, it strengthens earthen dams against collapse, and it reduces maintenance costs and ensures the integrity of dam walls, canal and river banks, and drains.
- VS improves groundwater recharge through improved infiltration and reduced rainfall runoff, and the quality of water by removing sediments and chemicals.

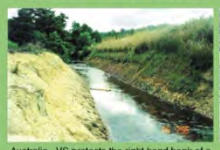


Venezuela - Vetiver withstands flooding for long periods. This grass was flooded for 8 months. Vetiver one month after flood receded

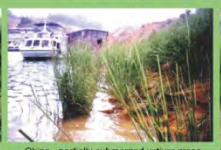
China - VS used to stabilize a small river bank located behind hedge allowing the safe production of crops

Vietnam - Vetiver is increasingly used to stabilize the banks of fishponds and to purify pond water

Zimbabwe - a fast flowing stream protected from stream bank erosion using VS application

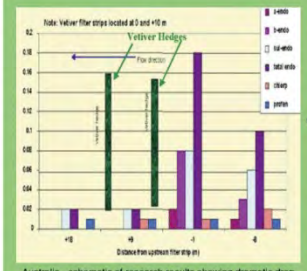


Australia - VS protects the right hand bank of a drain cut through acid sulphate soils of Queensland. Note left hand bank is devoid of any vegetation



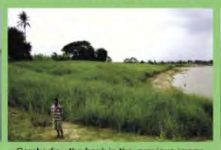
China - partially submerged vetiver grass used to stabilize the draw-down slope of a reservoir in Guangdong Province

Australia - this river bank and bridge abutment have been stabilized with vetiver. Vetiver is an excellent interface for concrete and soil



Australia - schematic of research results showing dramatic drop of pesticide levels as pesticide laden water moves through vetiver hedges from right to left. (Green columns = hedges - all other columns pesticide levels)

Cambodia - This very large bank on the Mekong River has been under continuous erosion. The land owner with assistance from TVNI is stabilizing using vetiver hedgerows.



Cambodia - the bank in the previous image has been reshaped and planted with vetiver hedgerows. Very good growth seven months after planting.

Vietnam - cyclone damage to sea dykes is a major problem. VS has been applied successfully for disaster mitigation

Vietnam - the left hand bank of the canal has been reshaped and stabilized with vetiver, the right bank has yet to be treated.

VS FOR BIO-REMEDIATION

- Onsite and offsite pollution control from wastes and contaminants is a breakthrough application of VS for environmental protection. Vetiver is being used to rehabilitate a large copper mine in China, coal mines in Indonesia, diamond mine spoils in South Africa, to control erosion and leachate from municipal landfills in China.... and more.
- Research has clearly established vetiver's tolerance to extremely high levels of Al, Mn, As, Cd, Cr, Ni, Cu, Pb, Hg, Se, and Zn.
- Vetiver has been used to reclaim soils and increase site productivity in places that were previously believed to be totally unproductive.

Vetiver grass will remove phosphate and nitrate from polluted water. The beaker on the left is before treatment; on the right 4 days later 90% P and 94% N removed

Australia - VS used as a buffer to absorb seeping sewage from this holiday camp site thus reducing runoff and smells

Australia - VS used to stabilize a gold slimes waste area. The hedges reduce the incidence of wind-blown, cyanide-polluted dust

Australia - VS used hydroponically on a pig effluent pond to reduce high levels of phosphate and nitrate

VS FOR OTHER USES

- In disaster mitigation and vulnerability reduction, VS has a crucial role to play.... *"The storms were terrible. [Afterward there were] landslides, roads destroyed, agricultural lands washed away; but, where there were vetiver barriers, everything seemed normal".* (pers. comm. Mr. E. Mas, USDA/NRCS after Hurricane George, Puerto Rico)
- For handicrafts, perfumes, and medicinal purposes.
- For paper making, mulch, thatch, reinforcing bricks, biofuel, pest control, carbon sequestering, and many other uses.

Thailand - a selection of handicrafts, including handbags, vases, lamp shades, book covers, hats and other crafts from vetiver grass leaves and stems

Zimbabwe - a nicely thatched meeting house using vetiver grass thatch. The thatch will last three times as many years due to its resistance to insects and fungus attack

ACT NOW! Contact TVNI for additional technical information.

The Vetiver Network International
709 Briar Rd., Bellingham, WA 98225 USA

Tel/Fax: (001) 360-671-5985
E-mail: coordinator@vetiver.org

Home Page: http//www.vetiver.org
Vetiver Clients Gallery: http://picasaweb.google.com/VetiverClients
Vetiver Picture Gallery:http://picasaweb.google.com/VetiverNetwork
Blog: http://vetivernetinternational.blogspot.com

The Vetiver Network (TVNI) is a nonprofit foundation under United States code 501 (c) (3). It is a volunteer organization that promotes the use of the Vetiver System through dissemination of information and networking worldwide. TVN has helped established over 25 regional and country-based affiliated networks.

Contact your local vetiver network at:

FOR SUCCESSFULL VETIVER SYSTEMS APPLICATION ONLY USE CULTIVARS OF *CHRYSOPOGON ZIZANIOIDES* WITH CHARACTERISTICS OF SOUTH INDIAN GENOTYPES - SUCH AS SUNSHINE, MONTO, KARNATAKA, FIJI, MADUPATTY. THESE NOT ONLY HAVE GOOD ROOT SYSTEMS, BUT ARE KNOWN TO BE NON-INVASIVE AND ARE EXTENSIVELY RESEARCHED

APPENDIX 5.5(A)

SPECIALIST REPORT
GEOLOGY

FINAL

GEOLOGY
SPECIALIST STUDY REPORT

Sasol Mining – Middelbult-Shondoni
EMPR Addendum, EIA and IWULA

Date: September 2010
JMA Project: JMA/10391
File Reference: Prj5431

COMPILED FOR

SASOL MINING (Pty) Ltd
Middelbult Colliery
Shondoni Shaft

COMPILED BY

JMA Consulting (Pty) Ltd
Sustainable Environmental Solutions through Integrated Science and Engineering

TABLE OF CONTENTS

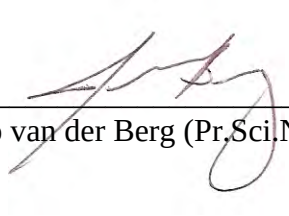
APPENDICES

1. INTRODUCTION

The Geology Baseline Report forms one of 11 baseline reports (listed below) compiled for the overall **Middelbult Block 8 Shondoni** project.

- Soils Baseline Report
- Animal Life Baseline Report
- Plant Life Baseline Report
- Wetland Baseline Report
- Aquatic Ecosystems Baseline Report
- **Geology Baseline Report**
- Ground Water Baseline Report
- Surface Water Baseline Report
- Noise Baseline Report
- Archaeology Baseline Report
- Visuals Baseline Report

The geology baseline report should be read in conjunction with the Topography, Soils and Ground Water Baseline Reports.



Jaco van der Berg (Pr.Sci.Nat.)

Prj5431

2. TERMS OF REFERENCE

The geology across the extent of the study area forms the basis for the topography, soils, vegetation, ground water and surface water components of the biophysical environment, whilst at the same time provides the setting for the extensive underground mining operations. The geology and nature thereof, therefore represents a crucially important component of the overall environment.

A fundamental understanding of the geology at Shondoni is thus a prerequisite on which to base impact assessments for soils, vegetation, ground water and surface water and from which to design and implement effective environmental management measures related to these environmental components.

The terms of reference for the geological base line study are as follows:

- Provide the regional geological setting in order to conceptualize the ground water and mining environments.

- Provide site specific quantitative geological information in support of the soils and ground water baseline studies and impact assessments, including aspects related to lithology, stratigraphy, mineralogy, geochemistry, weathering profile and structural features such as faults, dykes and sills.

- Provide an understanding of the environment within which the underground mining operations take place.

3. PROJECT TEAM

The following scientists were involved with the geological investigation and in the compilation of this Geology Baseline Report for Shondoni:

Jasper Muller (Pr.Sci.Nat.)
(M.Sc. Geohydrology)

Jaco van der Berg (Pr.Sci.Nat.)
(M.Sc. Geohydrology)

Shane Turner (Cand.Sci.Nat.)
(B.Sc. Hons. Geology)

All senior project team members are registered as professional earth and/or environmental scientists with SACNASP. Synoptic CV's for the above mentioned personnel are attached as Appendix 3(A) of this report.

4. APPROACH AND METHODOLOGY

The geological investigation comprised a quantitative site specific investigation using the geological data obtained from the Sasol Geology Department. The approach and methodology that was followed for the compilation of the geology baseline report is systematically described below.

The investigation comprised of the following:

- Obtain, review and verify existing geological and mining information. This included regional geological information as well as historical information related to mining, contained in old and current Environmental Management Programme Report's (EMPR's).

- Verify the existing geological information within the study area. The geological information supplied by the Sasol Geology Department was obtained from over 600 exploration boreholes. 30 additional monitoring boreholes were sited and were drilled. The boreholes were drilled in pairs (one shallow (SSW-) and one deep (SDF-) borehole) and were used to determine the geohydrological differences between shallow weathered zone aquifers and deeper Karoo aquifers. Each borehole was geologically profiled according to the lithology, weathered status and physical properties of the underlying host rock that it penetrated.

- Compile information sets including borehole logs and site reports, diagrams, thematic maps and contour maps. The cross sections provided by the Sasol Geology Department are included as well.

- Discuss the geological setting based on the information obtained from the geological logs recorded at the exploration and monitoring boreholes.

- Identify and analyse the different lithological units. Determine the geochemical composition as well as the acidification potential of each of the lithological units.

5. REGIONAL GEOLOGY

The aim of this regional geological discussion is not intended to elaborate on the tectonics and formation of the geological attributes of the area, but rather to delineate the geological features of interest, describe the stability of the lithologies and set the scene for the geohydrological discussion as well. The occurrence and movement of ground water, as well as the ground water quality, are functions of the geological host rock in which the ground water occurs, including the alteration thereof as a result of human activities, such as mining.

The regional geology of the across the extent of the study area will be discussed with reference to the clipped region of the 1:250 000 Geological Map Series of South Africa – Sheet 2628 EAST RAND, (1986), displayed as Figure 5(A). The extent of the study area (Total Mine Lease Area) is delineated by and includes the Middelbult Reserve, Block 8 Reserve, New Northern Block Reserve, Springbokdraai Reserve as well as the Leeuwpan Reserve. The extents of the individual reserves are delineated by the green lines, whilst the position of the Shondoni Shaft is located by the yellow star on Figure 5(A).

The Regional Geology Map (Figure 5(A)) depicts that the surface geology within and adjacent to the Study Area is dominated by the sedimentary rocks of the Vryheid Formation (Pv) as well as Jurassic Age Dolerite Intrusives (Jd).

The Vryheid Formation forms part of the Ecca Group of the Karroo Supergroup, and outcrops extensively across the study area. The Vryheid Formation generically consists of interbedded sandstones and shale layers. Carbonaceous shale and coal layers are generally associated with the Vryheid Formation as well. The dolerite present within the study area (Jd) is younger than the Vryheid Formation and intruded into and through the sedimentary rocks of the Vryheid Formation. The dolerite intrusions typically occur as dykes and sills and are often responsible for the devolatization of the coal adjacent to the dolerite intrusions. The river beds across the study are typically associated with the deposition of tertiary and quaternary sands and sediments.

Figure 5(A) indicates that gold (Au), silver (Ag) and coal (C) has been or is currently being mined within the study area as well.

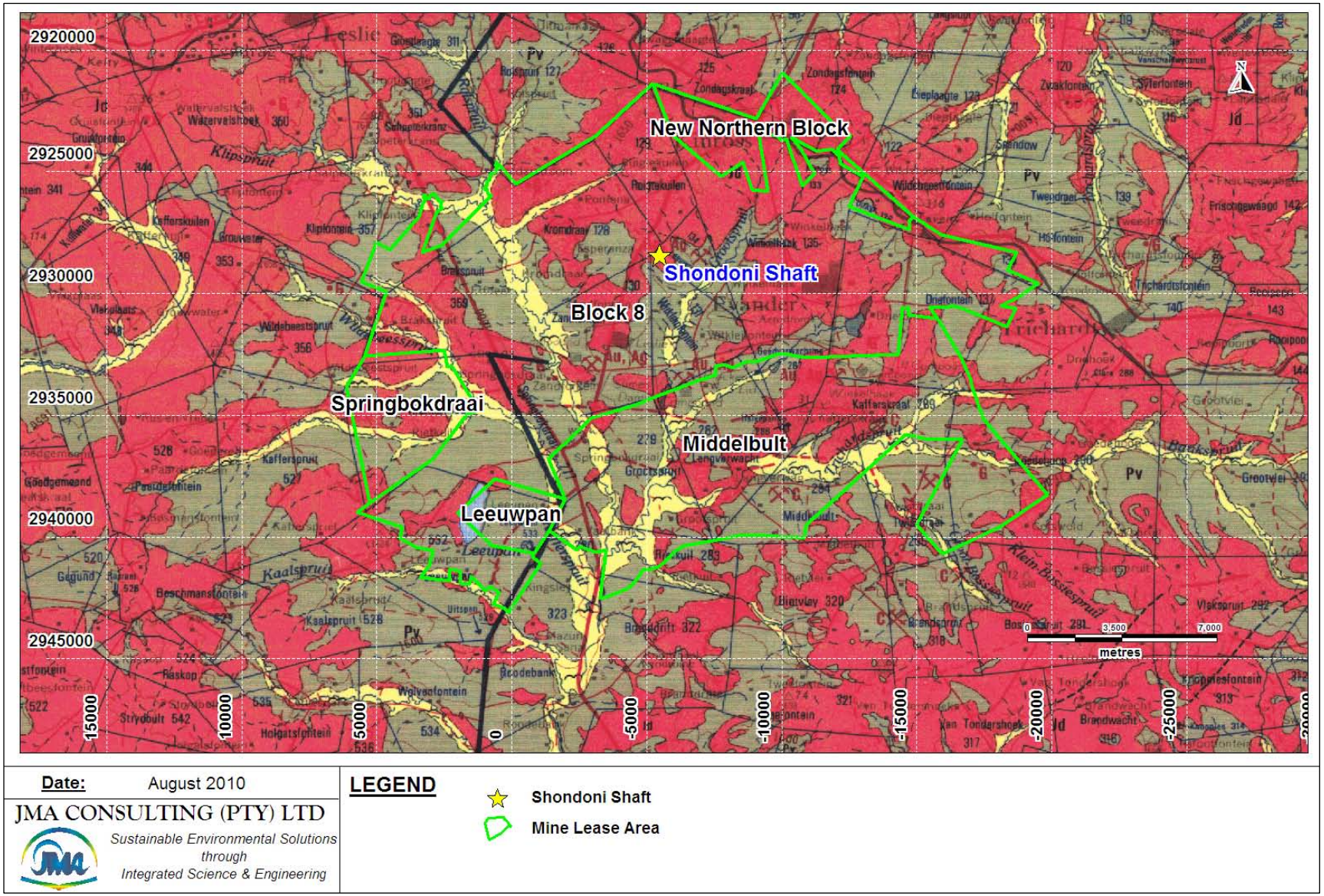


Figure 5(A): Middelbult Block 8 Regional Geology

6. SITE GEOLOGY

The site specific geology will be discussed with regards to the geological information recorded in the database which was provided by Sasol's Geology Division and is therefore limited to the amount of geological data available at the time of the compilation of the report. The geological data was obtained from the geological logs recorded from over 600 exploration boreholes across the Mine Lease Area (Study Area). The geological information was statistically assessed and evaluated with regards to the lithological thicknesses and structural compartmentalization.

In addition to the exploration boreholes, 30 geohydrological monitoring boreholes were drilled. These boreholes were logged according to the geology which they penetrated as well as the geohydrological properties of the subsurface. These boreholes were drilled in pairs (one shallow (SSW-) and one deep (SDF-) borehole) and were used to determine the geohydrological differences between shallow weathered zone aquifers and deeper Karoo aquifers. The geological logs and boreholes site reports of the geohydrological monitoring boreholes are attached as Appendix 6(A) to this report.

Four cross sections were compiled by Sasol's Geology Division and are attached as Appendix 6(B). The surface extents across which the cross sections are drawn are indicated in Figure 6(A). The site specific geology will be discussed with reference to these cross sections as well as the information obtained from the geological logs generated for each of the exploration boreholes as well as the ground water monitoring boreholes. The locations of the exploration boreholes, monitoring boreholes as well as the external user boreholes are indicated in Figure 6(B). The locations as well the borehole numbers are indicated on the A3 Map attached as Appendix 6(C).

Figure 6(C) shows the intersections of the main dolerite structures associated with the No. 4L coal seam as well as the major fault zones within the study area. The extent of coal devolatilization associated with the different dolerite intrusions are indicated on Figure 6(C) as well. The interpolated elevations of the No. 4L coal seam floor are indicated in Figure 6(D), whilst the proposed underground mining extent and layout for the No. 4 coal seam is depicted in Figure 6(E). The interpolated elevations of the No. 2 coal seam floor are indicated in Figure 6(F), and the proposed underground mining extent and layout of the No. 2 coal seam is depicted in Figure 6(G).

It is evident from the Figures 6(E) and 6(G) that the current proposed underground mining extent of the No 4 Coal Seam is far larger than for the No 2 coal seam. The coal will be mined out by standard Board and Pillar as well as High Extraction underground mining methods from the No 4 seam, whilst the No 2 seam will be entirely mined by standard Board and Pillar underground mining methods. The detailed mine layout and underground mining extents will not be discussed as part of the geology baseline study.

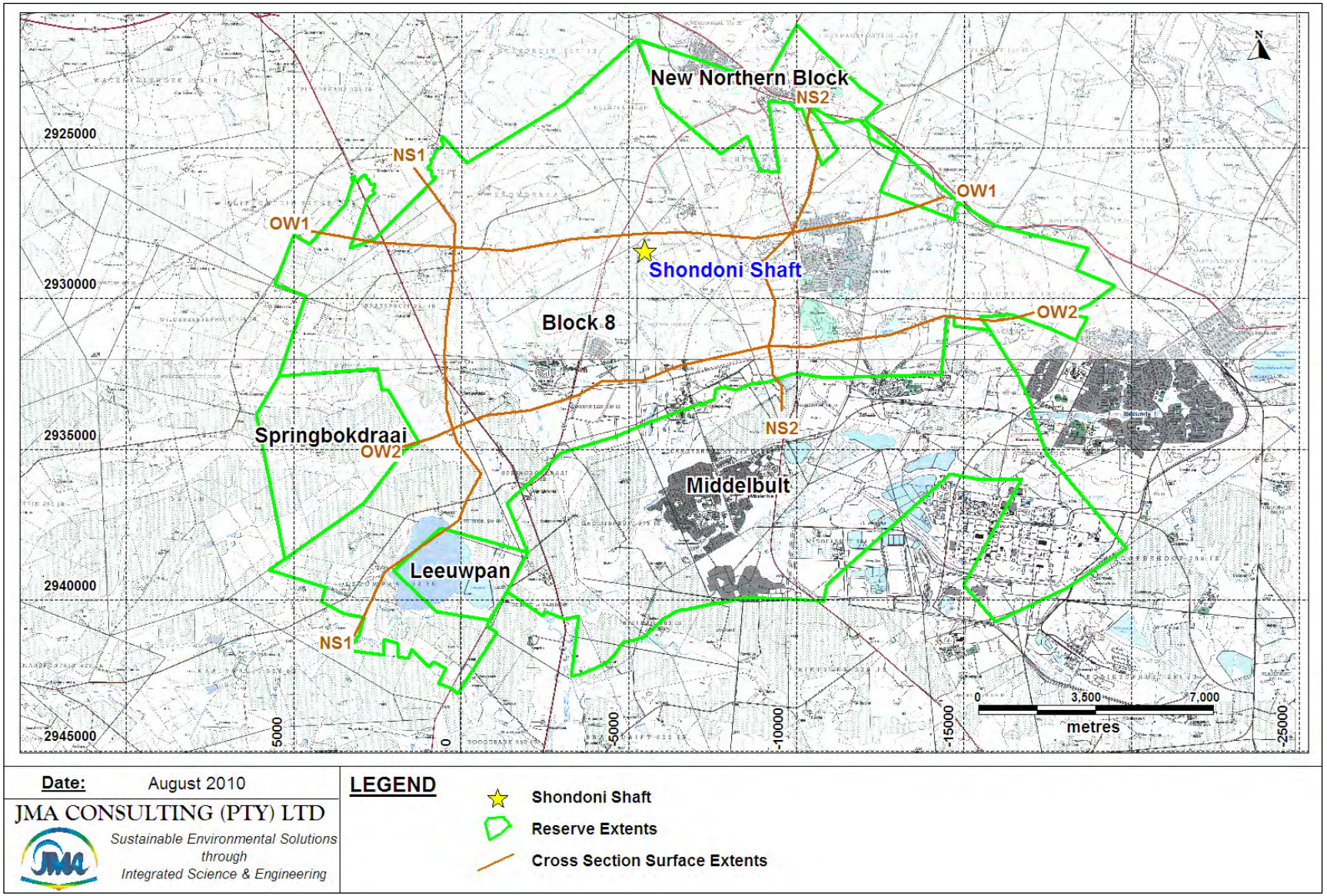


Figure 6(A): Cross Sectional Surface Extents

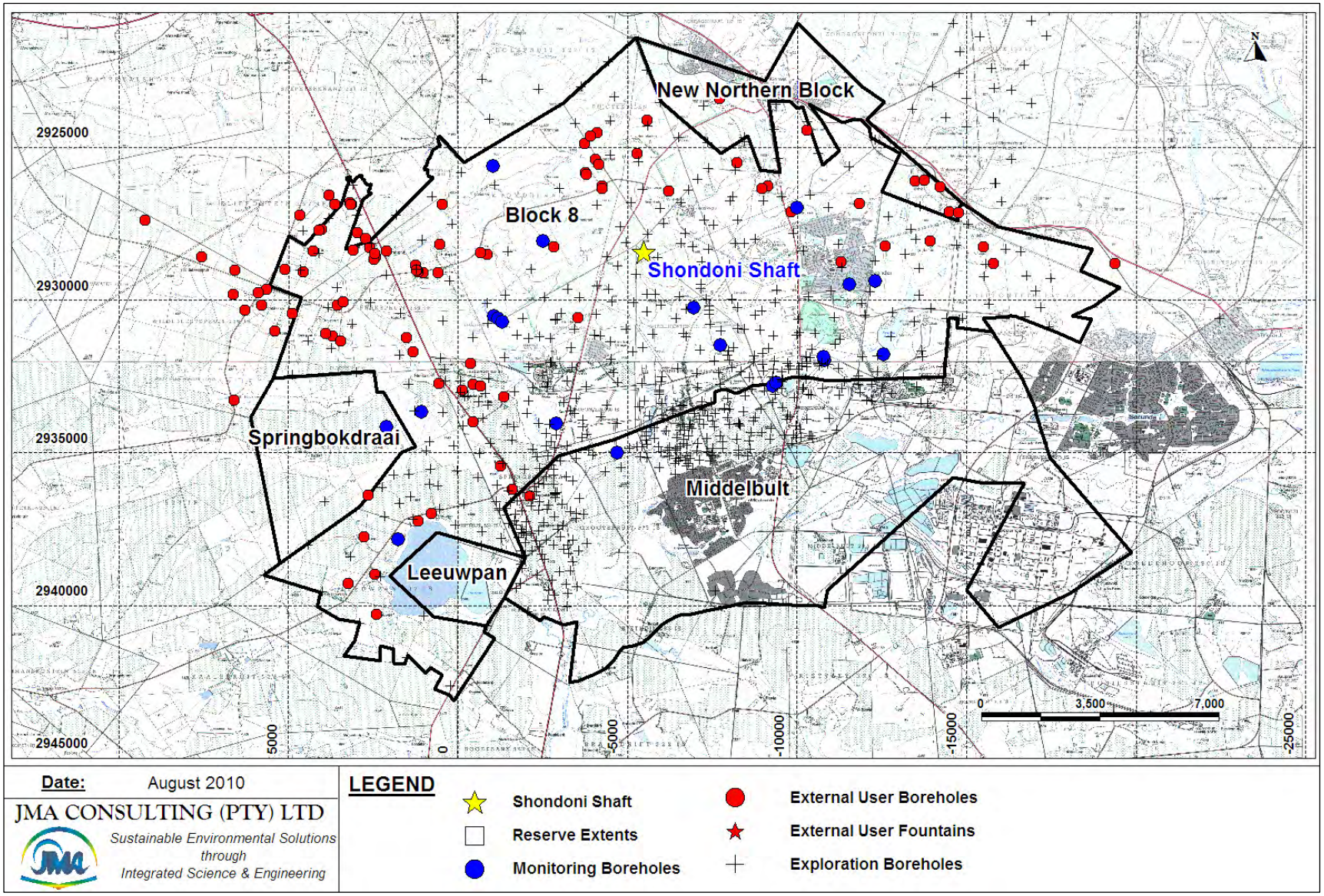


Figure 6(B): Exploration Borehole, Monitoring Borehole and External User Borehole Locations.

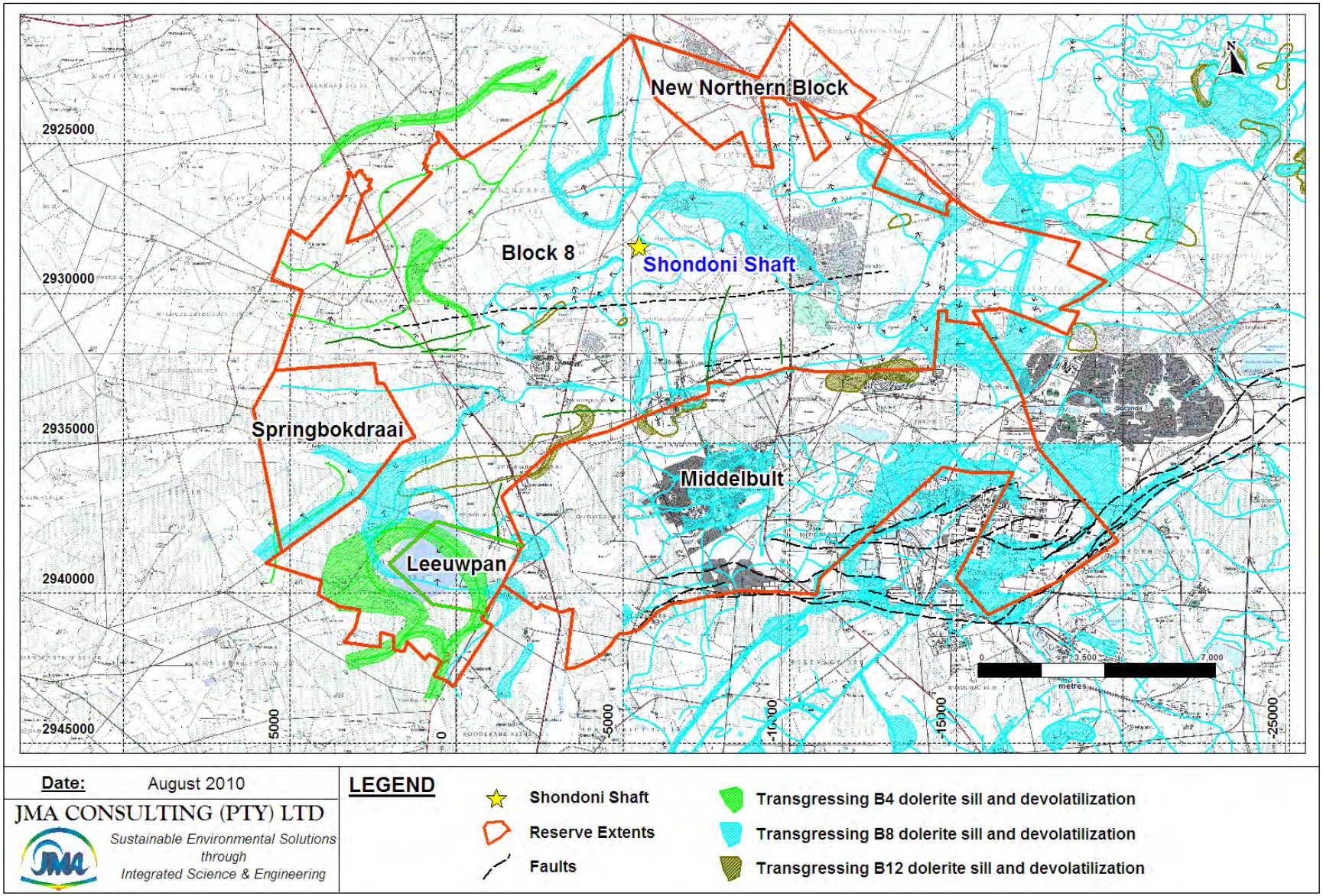


Figure 6(C): Major Secondary Geological Structures within the Study Area

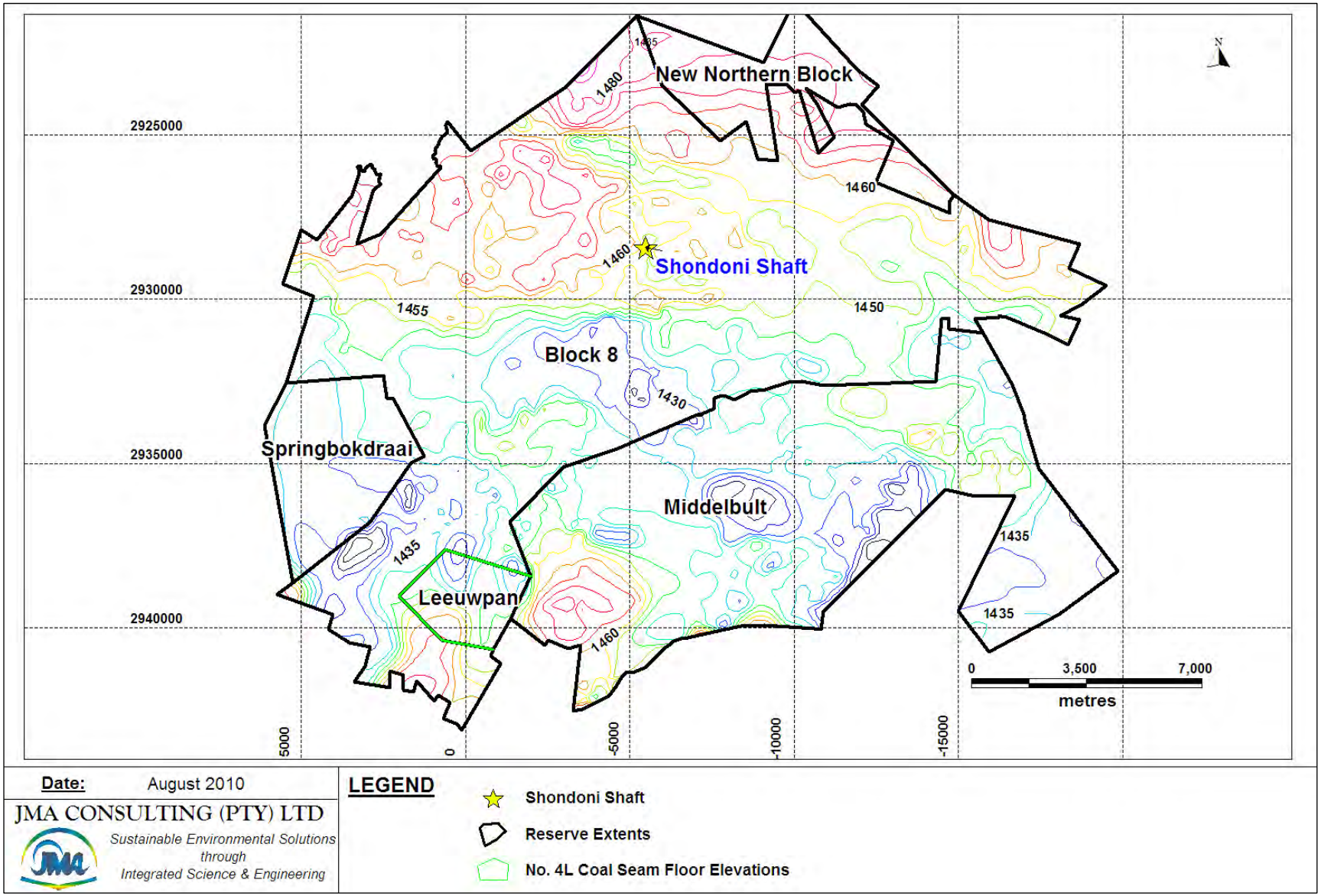


Figure 6(D): Interpolated Elevation Distribution of the No. 4L Coal Seam Floor

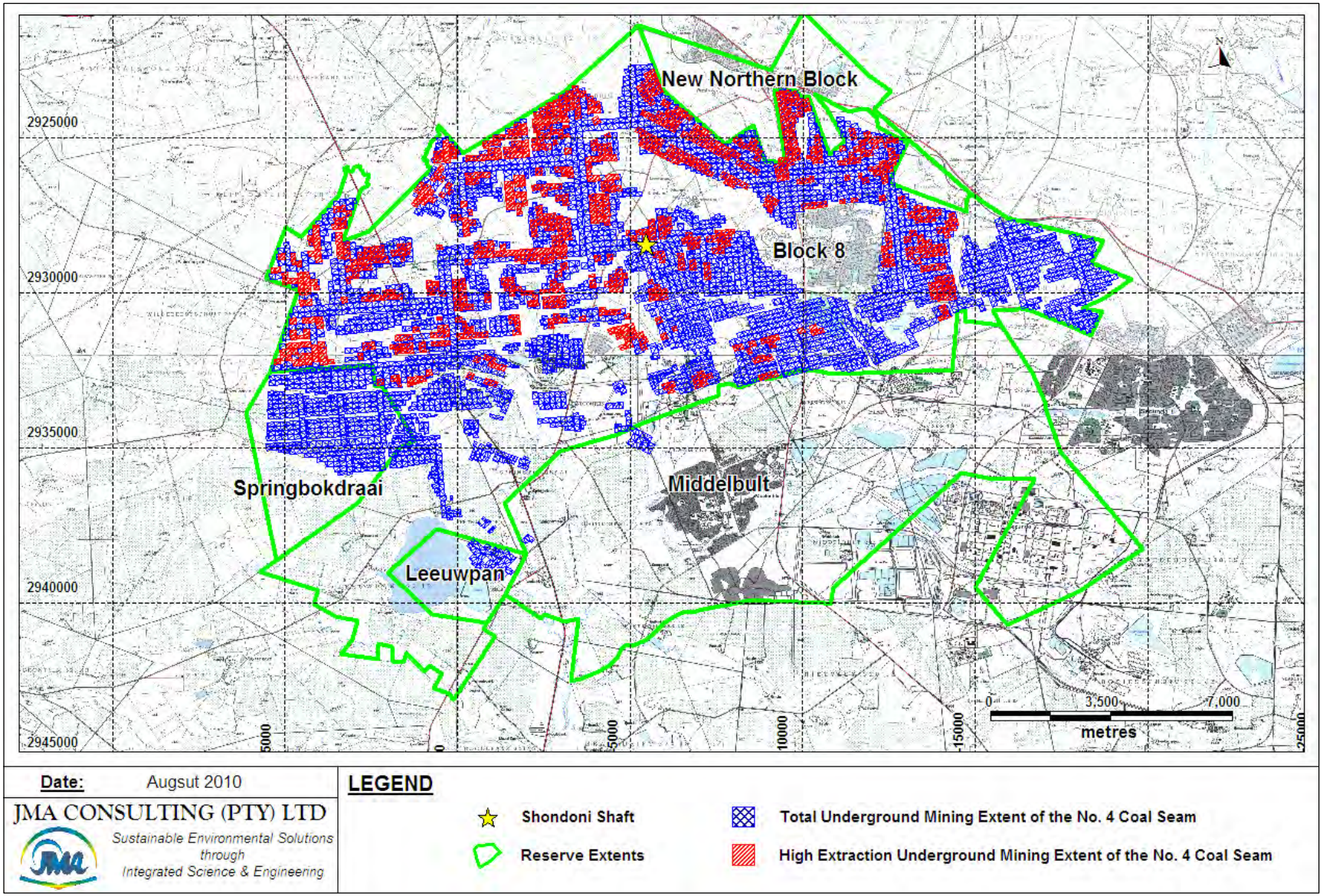


Figure 6(E): Proposed Underground Mining Extent and Layout of the No. 4 Coal Seam

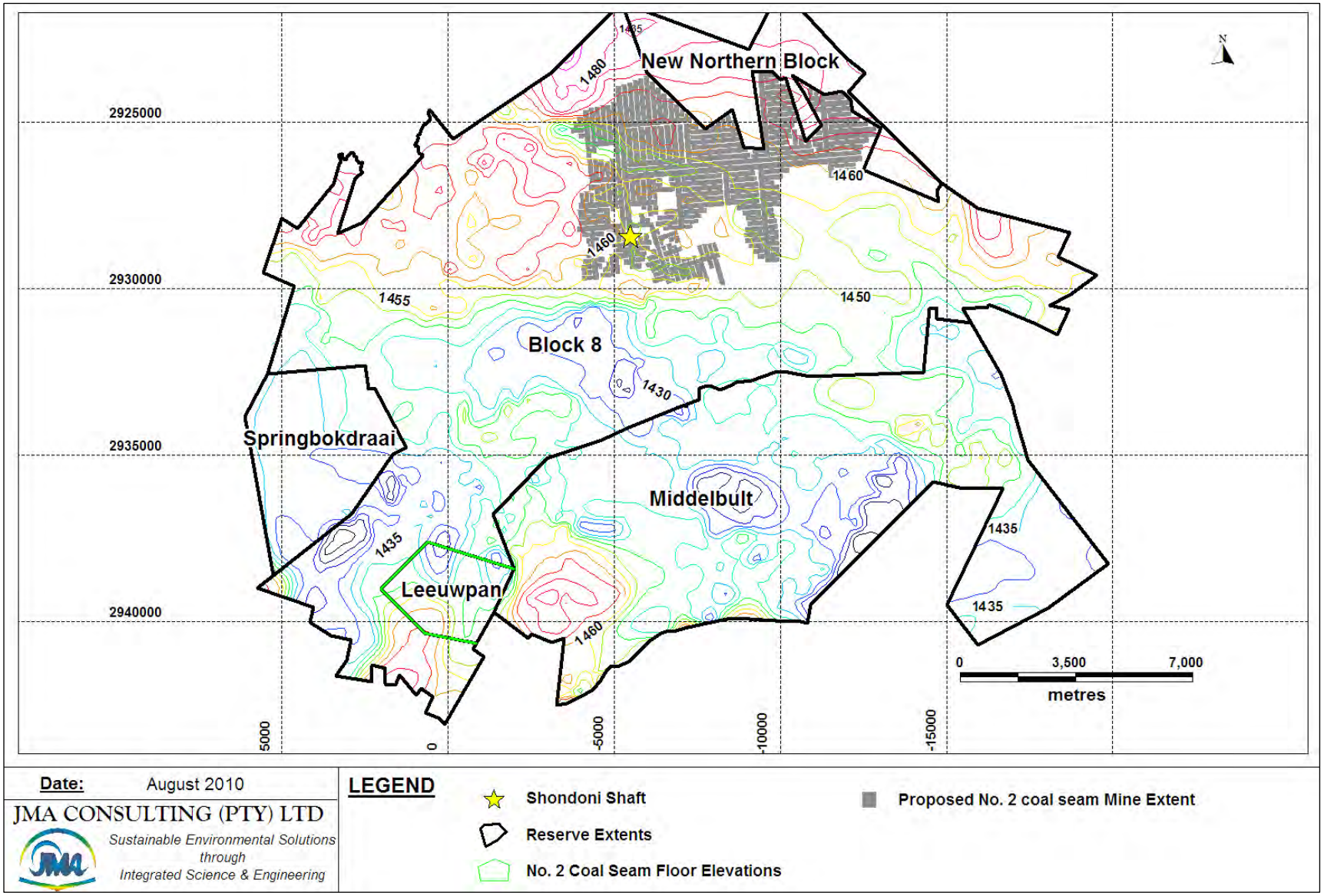


Figure 6(F): Interpolated Elevation Distribution of the No.2 Coal Seam Floor

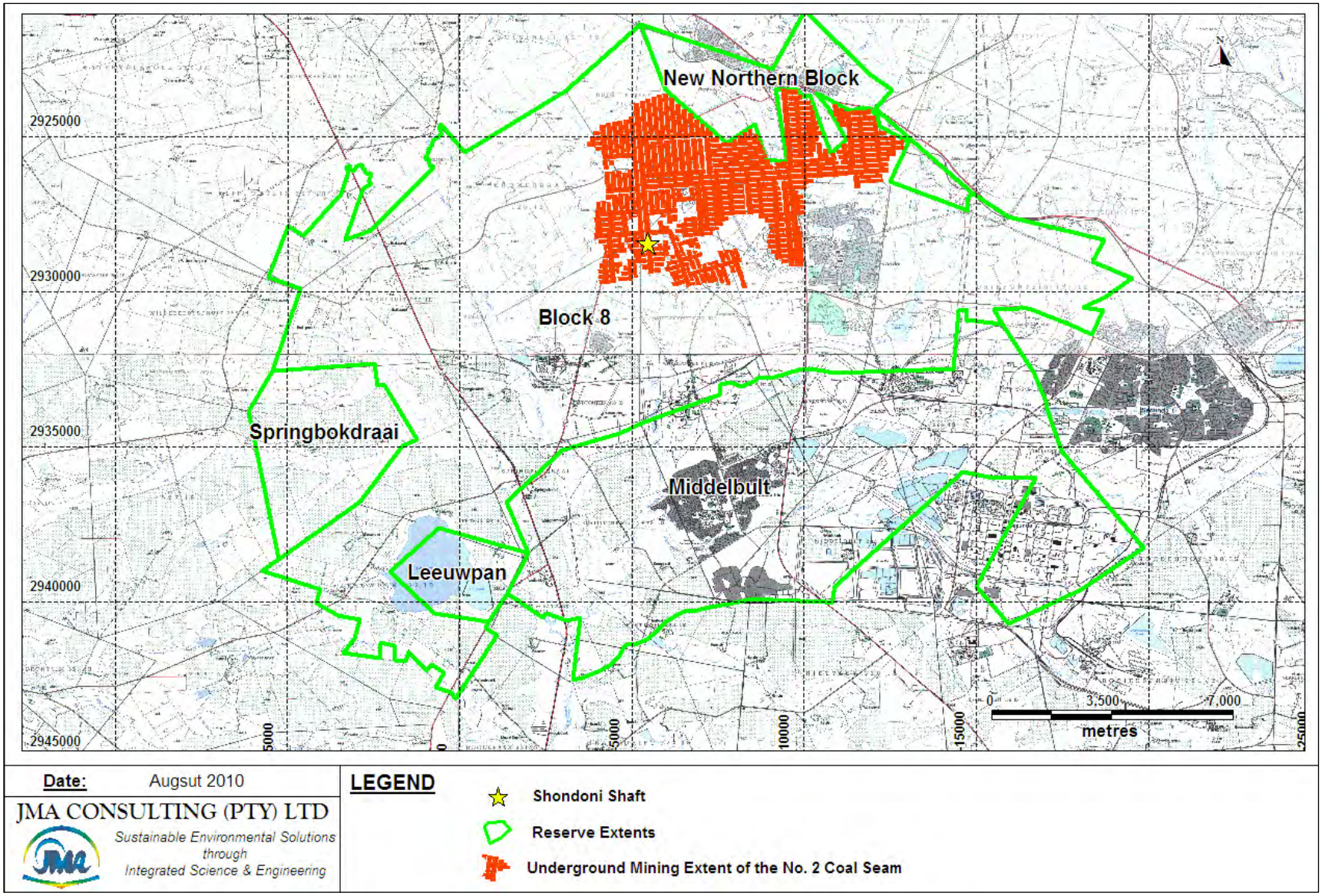


Figure 6(G): Proposed Underground Mining Extent and Layout of the No. 2 Coal Seam

6.1. LITHOLOGY AND STRATIGRAPHY

The geology of the study area comprises mainly of sedimentary lithologies, belonging to the Karoo Supergroup, particularly, sandstone and sand/siltstone intervals of the Vryheid Formation, which rests unconformably on a (pre-Karoo) gabbro basement.

The general lithological profile of the study area, up to, and including the No. 2 coal seam, comprises of:

- Soft overburden consisting of soils and weathered sandstone and some occasional highly weathered dolerite.
- Hard overburden consisting of fresh to slightly weathered dolerite, sandstone and shale units.
- No.5 coal seam (only present in some areas)
- Inter burden units of sandstone
- No.4H and/or 4L coal seam with a thin layer of sandstone in between if both are present
- Karoo Sediments
- No. 2 coal seam

Dolerite dykes and sills also appear unconformably across the study area.

The No. 4L coal seam floor elevations are depicted in Figure 6(D), whilst the No. 2 coal seam floor elevations are depicted in Figure 6(F). The No. 4L seam ranges in elevation between 1436.20 mamsl and 1527.14 mamsl with an average elevation of 1483.43 mamsl. The No. 2 seam occurs some 20 to 30 meters below the No. 4L seam and ranges in elevation between 1408.98 mamsl and 1493.50 mamsl with an average elevation of 1449.734 mamsl.

The No. 4L coal seam has the highest elevations within the New Northern Block Reserve, and becomes progressively lower towards the South across the Block 8 and Springbokdraai Reserves. The No. 4L coal seam is the deepest across the southern as well as south-western extent of the Block 8 Reserve. The No. 4L coal seam has a high lying area across the south-western corner of the Middelbult Reserve, whilst the central parts of the Middelbult Reserve has the lowest No. 4L coal seam elevations.

The No. 2 coal seam floor elevation contours across the study area depicts a similar pattern as the No 4L coal seam floor elevations contours. The No. 2 coal seam has the highest elevations across the northern extent of the Block 8 Reserve as well as the New Northern Block reserve. The No. 2 coal seam floor elevations become progressively lower towards to the south, across the extent of the Block 8 Reserve. The lowest elevations occur across the south-western extent of the Block 8 reserve, the Springbokdraai Reserve as well as the central areas of the Middelbult reserve. The No. 2 coal seam elevation becomes progressively higher across the south-western corner of Middelbult Reserve up to an elevation of 1475 mamsl.

The proposed underground mining extent of the No. 2 coal seam is depicted in gray on Figure 6(F). The No. 2 coal seam across this extent ranges in elevation between 1448 mamsl and 1477 mamsl. The lie of the No. 2 coal seam across this extent is very similar to the No. 4L coal seam as well and is the highest across the northern

extent of the Block 8 Reserve. The coal seam becomes progressively lower towards the southern and south-eastern extent of the proposed underground mine extent. The interpolated No. 2 coal seam elevation below the surface location of the Shondoni Shaft is ± 1450 mamsl, whilst the No. 4L coal seam elevation at the same point is ±1485 mamsl.

It should be remembered that the floor contour elevations have been interpolated using the Kriging method, and the floor elevations do therefore indicate the effects of faulting.

The coal seams have been displaced and devolatilized to varying degrees as a result of the tectonics and intrusives within the study area. The locations of the dolerite intrusions as well as the extents of devolatilization of the No. 4 coal seam associated with the intrusives are delineated on Figure 6(C). The displacement of the coal seams as a result of the dolerite intrusions, generally ranges from no displacement to not much more than the than the coal seam thickness itself. There is however a displacement of roughly 35 *m*, almost equal to the thickness of the transgressing and troughing B4 sill, compartmentalizing the southern-most portion of the reserve on Leeuwpan 532 IR, and is indicated on cross-section NS1 (Appendix 6(B)).

The Block 8 underground reserve is largely separated from the existing Middelbult Colliery, compartmentalized and sub-compartmentalized by a ± 15 *m* thick southwest-northeast B8 dolerite sill (Figure 6(B)). The sill underlies the Middelbult Colliery, close to the floor of the Karoo sediments before bending upwards to the vertical again, transgressing the coal seams before surfacing on Zandfontein 130 IS. Centrally from Zandfontein 130 IS, to both the east and the west this sill has numerous sub-vertical split-offs, which join up and split off again.

On the farm Springbokdraai 591 IR the ± 15 *m* thick B8 dolerite sill splits into two sills 12 *m* and 3 *m* in thickness respectively. The larger sill is placed underneath the coal seams, close to the floor of the Karoo sediments, before bending sub-vertically upwards to transgress the coal seams and compartmentalize a large portion of the reserve underlying Rietkuil 591 IR.

The No. 4L coal seam floor elevation pertaining to this compartment, slopes from an elevation ranging between 1470 *mamsl* and 1465 *mamsl* along the sub-vertical 12 *m* thick B8 dolerite sill in the north, to an elevation of 1450 *mamsl* along the sub-vertical 3 *m* off-shoot in the south. The eastern off-shoot forms the western boundary of the larger Middelbult Colliery compartment while the western off-shoot forms the eastern boundary of the compartment.

The NS1 geological cross-section and Figure 6(A) indicate that the ± 15 *m* thick B8 dolerite sill originates from an 18 *m* thick sill dipping from above the 4L coal seam to the north on Leeupan 532 IR to transgress the seams on its way down before bending to the horizontal below the coal seams to attenuate to the north. On its way down this B8 sill also intersects a 30 *m* thick transgressing B4 dolerite sill that troughs most of Leeupan. Some 1 *km* west of Leeupan the 18 *m* thick sill splits into two sills respectively 15 *m* and 3 *m* in thickness. The No. 4L coal seam floor elevation pertaining to this compartment, slopes from a high of 1525 *mamsl* in the south-east to a low of 1450 *mamsl* in the far north-west, before rising again to an elevation of 1465 *mamsl* in the north-western corner of this compartment.

The larger Middelbult Colliery compartment is of particular significance, as a sizable portion of the proposed Block 8 mine layout, including the proposed brown field accesses from Middelbult Colliery, falls within this compartment. Of significance is the fact that both the Leslie Gold Mines Ltd and Winkelhaak slimes dams are located in this area. Some existing high extraction mining panels occur as close as 20-50 *m* to the west of the south-western corner of the Leslie Gold Mines Ltd slimes dam and 80-100 *m* to the east of the Winkelhaak slimes dam. Manifested impacts relating to the de-watering of the shallow weathered zone aquifer(s) over some of Middelbult Colliery's high extraction panels have already been observed in some of the SSF monitoring boreholes.

The portion of the proposed mine layout underlying the south-western corner of Rietkuil 531 is compartmentalized by the ± 15 *m* thick B8 dolerite sill that splits off the larger 18 *m* sill some 1 *km* west of Leeupan and bends backward to the south-west. This area is further sub-compartmentalized by a 45 *m* thick B4 dolerite sill that splits into two smaller sills respectively 38 *m* and 7 *m* in thickness. The No. 4L coal seam floor elevation appears to slope towards the north-eastern corner of this compartment to a low of 1450 *mamsl*.

Both to the east of Evander on Leeuwspruit 134 IS and Winkelhaak 134 IS and to the north of Evander on Kinross 133 IS and Winkelhaak 134 IS various off-shoots varying in thickness between 1 *m* and 4 *m* further sub-compartmentalize the two larger sub-compartments to this compartment.

Apart from the portions of the Block 8 reserve separated from Middelbult Colliery, compartmentalized and sub-compartmentalized by transgressing B8 dolerite sills, the north-western portion of the reserve with specific reference to the cadastral farms Salpeterkranz 128 IS, Rolspruit 127 IS, Klipfontein 357 IR, Brakspruit 359 IR and Kromdraai 128 IS, is further compartmentalized by a 20 *m* thick transgressing B4 dolerite sill.

6.2. WEATHERING PROFILE

The limit of weathering as well as the total overburden depths of the study area was determined from the exploration boreholes as recorded by Sasol's Geology Division and is summarized in Table 6.2(A).

Table 6.2(A): Summary of the Limit of Weathering and Overburden Depths

Description	Value	
Soft soil overburden thickness (*m*)	Min.	1.42
	Max.	23.32
	Ave.	**6.44**
Weathering Thickness (*m*) *(Highly weathered zone, followed by a slightly weathered/fractured zone)*	Min.	9.14
	Max.	33.56
	Ave.	**15.27**
Total Overburden from surface to the No.5 coal seam – where present (*m*)	Min.	0.00
	Max.	135.55
	Ave.	**76.17**
Total Overburden from surface to the No.4L coal seam (*m*)	Min.	16.95
	Max.	182.40
	Ave.	**108.54**
Total Overburden from surface to the floor of the Karoo Sediments (*m*)	Min.	91.28
	Max.	256.73
	Ave.	**182.87**

Table 6.2(A) indicates that the study area has an average overburden (soil) thickness of 6.44 metres, and ranges in thickness from 1.42 meters to 23.32 meters. The soil is predominantly underlain by a highly weathered zone, followed by a slightly weathered to fractured zone. The weathered zone consists of soft overburden, weathered sandstone and some occasional weathered dolerite. The overburden becomes progressively harder and consists of more fractured to slightly weathered dolerite, sandstone and shale units. The total weathering thickness across the study area ranges between 9.14 m and 33.56 m, with an average thickness of 15.27 m across the extent of the study area.

The depth to the No. 5 coal seam ranges between 0 meters (where it outcrops at the surface) and a maximum depth of 135.55 meters below the surface. The No. 5 coal seam lies at an average depth of 76.17 meters below the surface level, across the extent of the study area. The No. 4 coal seam lies at a greater depth and is a lot more extensive than the No. 5 coal seam within the study area. The No. 4L coal seam ranges in depth from 16.95 m to 182.40 m below the surface, with an average depth of 108.54 m below the surface. The No. 4L coal seam is underlain and predominantly separated from the No. 2 by the Karroo Sediments.

The base of the Karoo consists of tillite overlain by sandstone and siltstone of the Pietermaritzburg Formation, which is in turn overlain by sediments from the Vryheid Formation.

6.3. DYKES AND FAULTS

Analyses of the geological database and cross sections provided by the Sasol Geology Division in terms of the physical properties of the B4 intersections, indicated an area along the central southern bounds of the Block 8 reserve, neighboured by the Middelbult Mine, to be overlain by a fairly jointed B4 sill. This area also co-insides with the proposed brown field access to the reserve from the Middelbult Mine. Seventy-three (73) jointed intersections were recorded at intervals ranging in depth between 2 m and 50 m. The average depth of these intersections ranged between 13 m and 30 m. The thickness of these intervals ranged between 1 m and 26 m and averaged at 16 m. Some semi-vertical jointed intersections and double-jointed contacts were also noted.

Additionally, a number of joints and faults were recorded below the overlying B4, including the No. 4L coal seam horizon, while 3 boreholes intersected brecciated contacts along a siltstone interval. Another nine regional fault contacts along sandstone intervals were recorded, while three boreholes intersected fault contacts along the No. 4L coal seam horizon at depths ranging between 65 m and 67 m.

The dolerite occurrences in the area, have specific significance with regard to the geohydrology of the study area. Not only can ground water compartments exist as a result of these features, but the possible ground water interaction between mines, will also be a function of the dolerite distribution. It is important that an over-simplification of the compartmentalization of the mining sections not be adopted for geohydrological purposes. Compartmentalization of the coal reserves, on the coal seam horizon, as it relates to mining activities, does not necessarily imply a ground water compartment for the aquifer(s).

6.3.1. Dykes

The Karoo sediments were displaced by two phases of post-Karoo dolerite intrusions. The oldest, namely the B4 dolerite intrusions, are fine to medium crystalline dolerite, typically occurs as a massive sill, is mostly restricted to the surface and has a maximum thickness of ± 49 *m.* This sill is eroded away in the lower lying areas. Locally the B4 dolerite is not only surface bound, but transgresses the coal seams in a trough-like fashion to effectively compartmentalize these portions of the reserve on the mining horizon (Figure 6(C)).

The B6 dolerite is a porphyritic dolerite, usually 3 m thick and intersects the coal seams less frequently than the B8 dolerite. Out of 615 exploration boreholes only one intersection was noted.

The B8 dolerite is a fine grained porphyritic dolerite and intruded later than the B4 dolerites. The B8 dolerite intruded along semi-planar features, with the result that it is mainly exposed as dykes, i.e. almost vertical intrusives. The B8 ranges in thickness from very thin to a maximum of 18 m. The prominent, east-west striking dyke or sub-vertical sill, separating most of the Block 8 reserve from Middelbult Colliery (Figure 6(C)), can be seen to range in thickness between 7 m and 15 m.

The B8 sill dolerite, ± 18 m in thickness, features near vertical off-shoots (dykes), where it transfers from one horizontal plane to another. These features occur

predominantly along the planes of transference. This phenomenon results in extensive geological compartmentalization observed across the study area.

The B12 dolerite is a light grey, fine-grained porphyritic dolerite with large needle-like phenocrysts, roughly ranging in thickness between 0,12 *m* and 0,75 *m*. The B12 dolerite does not intersect the No. 4L seam as abundantly as the B4 or B8 dolerite intrusions (Figure 6(C)).

Twenty-three dolerite intersections were recorded in twenty of the newly drilled monitoring boreholes. Thirteen water strikes, associated with host rock contacts as well as the contact between weathered and fresh dolerite, were recorded along these intersections.

6.3.2. Faults

In the central portion of the study area two normal faults of significance occur. The larger of the two faults has a throw of 15 m to the south, the dip also being to the south. This fault has a east-west strike and stretches between Brandspruit 359 IR in the west and the town of Evander in the east, over a distance of 15,5 km, intersecting the Kinross Mines Ltd Slimes Dams to the west of Evander. (Figure 6(C)).

This fault zone was intersected in boreholes SSW-7, SDF-7 and SDF-10. Major water strikes were encountered in boreholes SSW-7 and SDF-7, both located some 800 m west of the Kinross Mines Ltd Slimes Dams. Borehole SSW-7 intersected large calcified fracture planes with pyrite mineralisation, yielding water make of ± 22 l/s, in the overlying B4 dolerite at a depth of 17-18 m. Borehole SDF-7, situated some 10 m south of borehole SSW-7, recorded a water strike of ± 19 l/s, also at a depth of 17-18 m in a highly fractured B4 dolerite (no calcification observed), and a further ± 10 l/s at a depth of 41-43 m, along a fracture in a fresh sandstone/shale succession. The strike of this fault zone beyond the property boundary has not been confirmed.

The smaller fault situated some 2 km south of the larger fault to the south of Kinross Mines Ltd, has a throw of 9 m to the north on the No.4L seam, the dip also being to the north. As with the larger fault, the strike is also east-west in orientation. It stretches between Witkleifontein 131 IS in the west and between Evander's Sewage Works and the Winkelhaak Mines Slimes Dams in the east, over a distance of 4 km. The strike of this fault zone beyond the property boundary has also not been confirmed.

6.4. MINERALOGY AND GEOCHEMISTRY

The mineralogy and geochemistry of the geological units up to the No. 2 coal seam was determined. Due to the limited depth to which the boreholes were drilled, mineralogy and geochemical analysis of the No. 2 seam could therefore not be conducted.

6.4.1. Acid Base Accounting

The determination of the acidification potential of overlying geological units gives an indication of the long-term impact on water quality entering mine workings. The same level of oxidation as found in spoils of a strip mine will, however, not take place in disturbed stratigraphical units above underground workings. It is important to semi-quantitatively identify the geochemical nature of stratigraphical units and its influence on the long-term quality of water in mined-out horizons, in case acidification takes place, due to dewatering and subsequent oxygen ingress in overlying stratigraphical units.

Acid Base Accounting (ABA) and various leaching tests were performed on 20 samples, using the Modified Sobek (Lawrence) Method. Based on the results of the ABA and leaching tests, the following conclusions can be reached in regard to the overall acid generating potential of stratigraphical units above the No.4L coal seam:

- Paste pH levels measured indicate the presence of either excess base or acid material in stratigraphical units for the current (in-situ) situation. None of the samples had paste (initial) pH-levels of lower than 7.77. This is an indication of the excess base material present in the stratigraphical units at this stage. The ground water draining initially into the underground workings will display the effects of this excess base material, in the form of elevated Alkalinity values.

- A total S% calculation usually gives an indication of the sum-total of all sulphur species present in the rock. This figure might include an entire range of sulphate species, sulfide species, and organic sulphur species, some of which are only partly, or not oxidizable at all. The total S calculated for Middelbult Block 8 does not give an overestimation of the material available for oxidation, since only the reactive components were measured.

- The range in total S% of all of the lithologies is relatively big (0.001% - 2.271%), with an average value of 0.370%. This is an indication of the heterogeneity in terms of pyrite mineralisation and distribution in the different stratigraphic units.

- The Acid Generation Potential (AP) gives an indication of the gross potential for acidification per volume material. The range in AP is between 0.031 kg/t $CaCO_3$ and 70.969 kg/t $CaCO_3$, with an average value of 11.573 kg/t $CaCO_3$. A number of 5 samples (25%) showed elevated values above the average.

  The Neutralization Potential (NP) gives an indication of the total base potential available to neutralize acidification. The range in NP is between 5.5 kg/t $CaCO_3$ and 62.5 kg/t $CaCO_3$, with an average value of 18.3 kg/t $CaCO_3$. A number of 8 samples (40%) showed elevated values above the average. The average value

for all the samples is higher than the values recorded for the Acid Generation Potential (AP).

- The Nett Neutralization Potential (NNP) is the total of NP - AP. A positive value means excess base potential, a negative value excess acid potential. The range in NNP is between –58.5 kg/t $CaCO_3$ and 62.5 kg/t $CaCO_3$, with an average value of 6.8 kg/t $CaCO_3$. Overall a positive NNP is present. The very large range in NNP indicates the heterogeneity in the different stratigraphical (geochemical) units.

- The AP:NP Ratio and Rock Type columns are semi-quantitative methods of characterizing different potential acid-generating materials. The modified classification is shown in Table 6.4.1(A).

Table 6.4.1(A): Modified Classification of Stratigraphical Units in Terms of Acid Base Accounting (ABA)

Rock Type	Acid Forming Potential	Comments
Type I	Potentially Acid Forming	Total S (%) > 0.25% and AP:NP ratio 1:1 or less
Type II	Intermediate	Total S (%) > 0.25% and AP:NP ratio 1:4 or less
Type III	Non-Acid Forming	Total S (%) < 0.25% and AP:NP ratio 1:4 or greater

The results of the ABA and leaching tests conducted on the 20 samples, indicates that mixture of rock types are present, namely;

- 3 x Type I samples,
- 6 x Type II samples and
- 11 x Type III samples.

This again indicates the heterogeneity of the samples.

6.4.2. Geochemical Sampling

Care was taken during the sampling procedure to ensure that representative geochemical samples were taken at each borehole. The following geochemical units were identified (up to a limited depth) within the study area:

- Grey, weathered mudstone (directly beneath the soil profile),
- Light-gray, fine-grained, massive sandstone,
- Gray to dark-gray sandstone and shale (carbonaceous and micaceous),
- No. 4L coal seam,
- No. 4H coal seam, and
- No.5 coal seam.

The in-situ geochemical characteristics of the 6 units identified are summarized in Table 6.4.2(A):

Table 6.4.2(A): In-Situ Geochemical Characteristic Summary of the 6 Identified Units.

Geochemical Unit		Total % S	NP (kg/t)	AP (kg/t)	NNP (kg/t)	Ratio NP:AP
Gray, weathered mudstone	Min.	0.001	5.75	0.03	5.72	184
	Max.	0.001	5.75	0.03	5.72	184
	Ave.	0.001	5.75	0.03	5.72	184
Light-gray, fine-grained massive sandstone	Min.	0.001	5.50	0.031	5.156	3.3
	Max.	0.189	62.50	5.906	62.469	2000
	Ave.	0.058	20.47	1.80	18.67	236
Gray to dark-gray sandstone and shale	Min.	0.021	9.75	0.656	7.938	2.1
	Max.	0.226	15.00	7.063	9.094	14.8
	Ave.	0.124	12.38	3.86	8.52	8.5
No.5 coal seam	Min.	0.273	10.25	8.53	1.72	1.2
	Max.	0.273	10.25	8.53	1.72	1.2
	Ave.	0.396	16.88	12.36	4.52	1.3
No. 4H coal seam	Min.	1.527	10.25	47.72	-58.47	0.2
	Max.	2.271	12.50	70.97	-37.47	0.2
	Ave.	1.899	11.38	59.34	-47.97	0.2
No. 4L coal seam	Min.	0.547	27.50	17.09	-2.84	0.9
	Max.	1.043	29.75	32.59	10.41	1.6
	Ave.	0.795	28.63	24.84	3.78	1.3

Based on the ABA results and those indicated in Table 6.4.2(A), the following conclusions are made with regards to the different lithological units:

Gray, Weathered Mudstone

- The average %S is very low and thus also the AP. This can be attributed to the leaching of all S in the geological past.
- The NP is also low in the mudstone, though still very higher than the AP, giving rise to a big neutralizing ratio.
- The thickness of soil (soft overburden) at borehole SDF-14 is very thin over the mudstone, 1m. The overburden is also very clayey, indicating that it originates from the mudstone. The mudstone itself is weathered and situated above the water table.
- The low NP and even lower AP are probably naturally lower in the mudstone (due to the geochemical environment and type of sediments during deposition) but weathering has definitely contributed to a low AP and NP.

Light-Gray, Fine-Grained, Massive Sandstone

- This light coloured unit is present throughout the lithological profile. In the boreholes it also occurs at different depths with shallower and deeper sandstones that show the same physical characteristics (colour, texture, grain size).

- The average %S and AP varies and AP ranges from 0.031 to 5.961 kg/t but it is still substantially lower than the NP. This unit has the highest NP and NNP values of all the geochemical units sampled.

- There is a complex variation of AP and NP between the different sandstones both laterally and vertically. The AP:NP ratio ranges from 1:3.3 to 1:2000, but always keep higher than 1:3, potentially indicating a non-acid forming rock in all the samples.

- A substantial part of the overall neutralisation potential at Middelbult Block 8 is present in these units.

Grey to Dark-Gray Sandstone and Shale

- This darker coloured unit is present throughout the lithological profile. The darker colour indicates some organic material showing that deposition of these sedimentary rocks took place in a more anoxic environment than the environment of deposition of the mudstone and sandstone units discussed above.

- The average %S is slightly higher than in the above sandstone units as can be expected and likewise the AP. The NP is lower than that of the sandstone units but still much higher than the AP.

- The NP:AP ratio is more than 1:1 indicating an intermediate rock with a positive NNP.

Coal Seams No's. 4L, 4H & 5

- Coal seams forms due to the accumulation of organic matter in an anoxic geochemistry environment. If sulphur and iron is present in an anoxic environment pyrite will form. The coal seams will thus show a higher AP than the units discussed above.

- The average %S is higher, as are expected. The NP is lower than the AP.

- Interesting are the differences between the coal seams that indicates some small differences in environmental conditions during deposition. More %S are present in the No.4 coal seams than in No.5 and more in No.4H than in No.4L which led to differences in AP.

- The NP:AP ratio is less than 1:3 for the different coal seams indicating an intermediate to acid forming rock. Coal seam No.4H show in all the samples much more potential for acid forming followed by No.4L and then No.5.

7. REFERENCES

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APPENDIX 3(A)

C.V’S OF PROJECT TEAM PERSONELL

Jasper L Müller (Pr.Sci.Nat.)

Date of Birth: 16 November 1957

Nationality: S A Citizen

Position in firm: Managing Director

Qualification:

B. Sc.: Geology and Geohydrology, UOFS, 1979
B. Sc. (Hons): Geohydrology, UOFS, 1980
M. Sc. (Cum Laude): Geohydrology, UOFS, 1984

Memberships:

Geological Society of SA : Ground Water Division
South African Council for Natural Scientific Professions
National Groundwater Association.

Period employed:

1981 Hydrologist with Dept. of Water Affairs.
1983 Researcher with Institute for Ground Water Studies, UOFS.
1987 Divisional Head, Geohydrology, Environmental Science Services
1988 Founded Jasper Müller Associates.

Jasper Müller received his training as geohydrologist at the Institute for Ground Water Studies (University of the Freestate). He worked at IGS as Researcher / Lecturer, specialising in numerical aquifer analyses.

He left IGS in 1986 and joined the consulting firm Terradata, where he was involved in projects related to ground water pollution and water supply.

In 1987 he was appointed at the consulting firm Environmental Science Services. His responsibility was to structure and build a division for water sciences (ground water and surface water). During his tenure at ESS he also floated a division on ground water monitoring.

During 1988, Jasper founded JMA, which has since evolved into a consulting firm employing 17 people. JMA is a multi-disciplinary team specialising in geohydrology.

Since 1988 Jasper Müller was involved on a consulting level on more than 200 JMA projects related to water supply, aquifer management, ground water quality investigations, ground water monitoring, ground water impact and risk modelling, ground water pollution remediation and litigative consultative work.

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Jaco van der Berg (Pr.Sci.Nat.)

Date of Birth: 19 May 1972

Nationality: S A Citizen

Position in firm: Director : Mining Division

(Shareholder)

Qualification:

B. Sc.: Geology/Geochemistry, UOFS, 1993
B. Sc. (Hons): Geochemistry, UOFS, 1994
M. Sc.: Geohydrology, UOFS, 1998

Memberships:

South African Council for Natural Scientific Professions

Period employed:

1995 Geologist with Anglo American Corporation of SA
1999 Project Geohydrologist with Jasper Müller Associates

Jaco van der Berg received his training as geologist at the Geology Department of the University of the Freestate. He was an Anglo American Corporation of South Africa Bursary holder from 1991 - 1994.

He worked as a geologist-in-training at Freddies No.5 shaft during 1995. From there, he was transferred to Western Holdings No.9 shaft until the end of 1996. His main responsibilities during these two years, were:

- Underground geological mapping of development ends, raises and stopes
- Updating geological data sheets
- Structural geology planning
- Core drilling and logging
- Attending scrutiny and planning meetings
- Reserve planning

He left Anglo American in 1997 to do his M Sc at the Institute of Ground Water Studies (University of the Freestate). His thesis was on the application of power station fly ash in rehabilitation of mining environments.

He was appointed as project geohydrologist at JMA in 1998. His main line of responsibilities was the compilation of ground water inputs for mine EMPR's and geochemical modeling and risk assessment of mine residue deposits.

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Shane Turner (Cand.Sci.Nat.)

Date of Birth: 7 October 1986

Nationality: S A Citizen

Position in firm: Junior Scientist (Geohydrology)

Qualification:

B. Sc. Geology: Earth Science, US, 2007
B. Sc. (Hons) Geology, US, 2008

Memberships:

South African Council for Natural Scientific Professions
Golden Key International Honour Society

Period employed:

2009 Junior Scientist at JMA

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APPENDIX 6(A)

BOREHOLE LOGS AND SITE REPORTS
(Monitoring Boreholes)

SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00001 ***Number:*** SSW-1 ***Site type:*** Borehole

Distr./Farm No.: 137 IS ***Site Name/Des.:*** BOREHOLE SSW-1 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-12126.259	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2931161.003	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.39
Altitude [m]:	1595.40			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	10.00	215	20011106	CASED TO 165
JMA	10.00	30.00	165	20011106	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011106	0.00	8.00	165	Steel	2					
20011106	8.00	10.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	SAND AND CLAY	Brown			Sandy	Damp
1.00	6.00	SAND	Brown	Yellowish	Fine	Gritty	Damp
6.00	23.00	SANDSTONE AND SHALE	Grey	Light		Weathered	
23.00	30.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1430	0.00	1.83	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1800	0							0.02		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00001 ***Number:*** SSW-1 ***Site type:*** Borehole

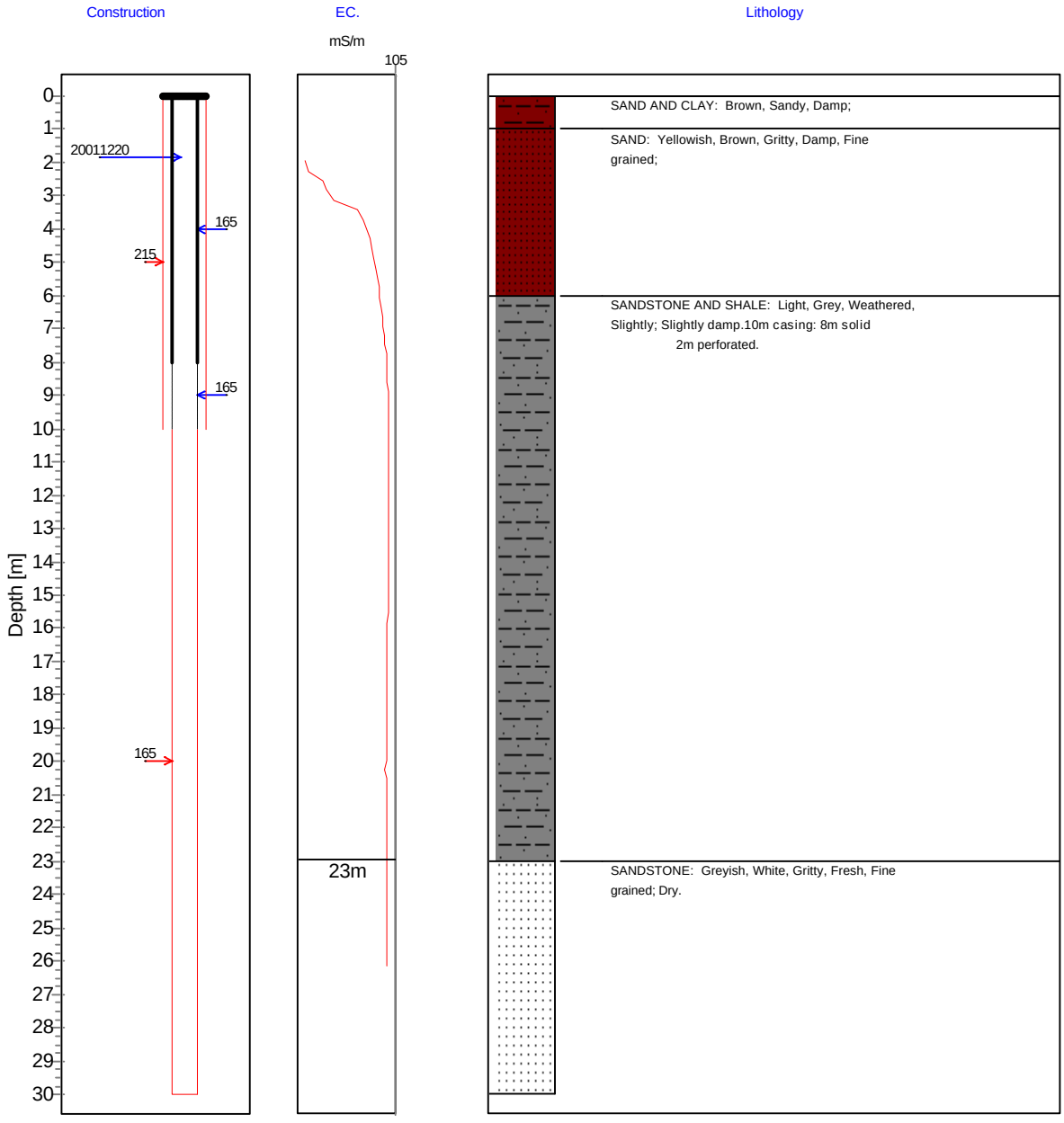
Distr./Farm No.: 137 IS ***Site Name/Descr.:*** BOREHOLE SSW-1 : BLOCK 8C

Y Coord. [m]:	-12126.259	***Alt. No. 1:***	***Topo-set.:***	Hillside (slope)	***Depth [m]:*** 30.00
X Coord. [m]:	2931161.00	***Alt. No. 2:***	***Site status:***	In use	***Collar h. [m]:*** 0.39
Altitude [m]:	1595.40		***Site purp.:***	Observation	***Drain. reg.:*** C12D
Coord. acc.:	Accurate to within 1 unit		***Use applic.:***	Industrial - mining	***Diam. [mm]:*** 165
Coord. meth.:	Global Positioning System		***Equipment:***	No equipment	***Rep. inst.:*** JMA

Construction and Geohydrological Legend

Perforated Casing
Plain Casing
Screen
Hole

19980720 Water level and date
165 Hole diam. [mm]
152 Casing diam. [mm]
Welded cap



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00002 ***Number:*** SSW-2 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SSW-2 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-10264.052	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2932049.268	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.46
Altitude [m]:	1584.90			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	6.00	215	20011114	CASED TO 165
JMA	6.00	30.00	165	20011114	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011114	0.00	3.00	165	Steel	2					
20011114	3.00	6.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	SAND AND CLAY	Black			Damp	
1.00	3.00	DOLERITE	Brown	Dark		Clayey	Weathered
3.00	5.00	DOLERITE	Brown	Yellowish	Fine to medium	Weathered	Clayey
5.00	7.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
7.00	16.00	SANDSTONE	White	Greyish	Fine	Gritty	Weathered
16.00	24.00	SHALE	Grey	Dark		Weathered	Carbonaceous
24.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1215	0.00	5.76	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1800	0							0.033		

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Borehole Construction and Geological Log

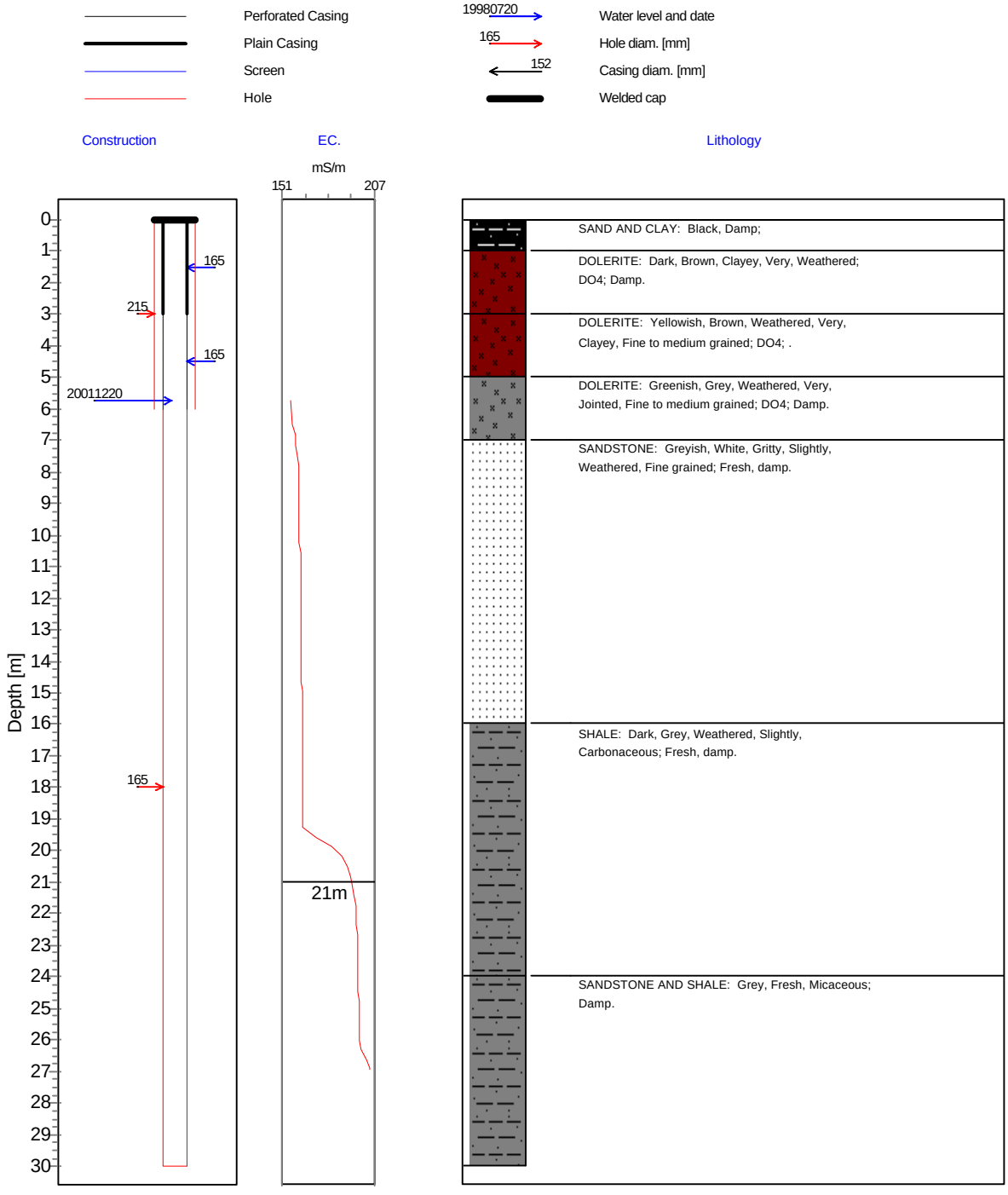
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00002 ***Number:*** SSW-2 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SSW-2 : BLOCK 8C

Y Coord. [m]:	-10264.052	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2932049.27	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.46
Altitude [m]:	1584.90			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA00003 ***Number:*** SSW-3 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SSW-3 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-9376.629	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2932735.112	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.33
Altitude [m]:	1580.49			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	8.00	215	20011106	CASED TO 165
JMA	8.00	30.00	165	20011106	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011106	0.00	8.00	165	Steel	2					

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	15.00	16.00	0.10	Estimated			SEEPAGE WATER

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown	Dark		Clayey	Damp
1.00	5.00	DOLERITE	Brown	Light		Weathered	Clayey
5.00	7.00	DOLERITE	Grey	Brownish	Medium to coarse	Jointed	Weathered
7.00	8.00	SHALE	Grey	Dark		Carbonaceous	Baked
8.00	17.00	DOLERITE	Grey	Greenish	Medium	Weathered	Fresh
17.00	25.00	SANDSTONE AND SHALE	Grey			Fresh	
25.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1820	0.00	1.99	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1200	0							0.225		

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Borehole Construction and Geological Log

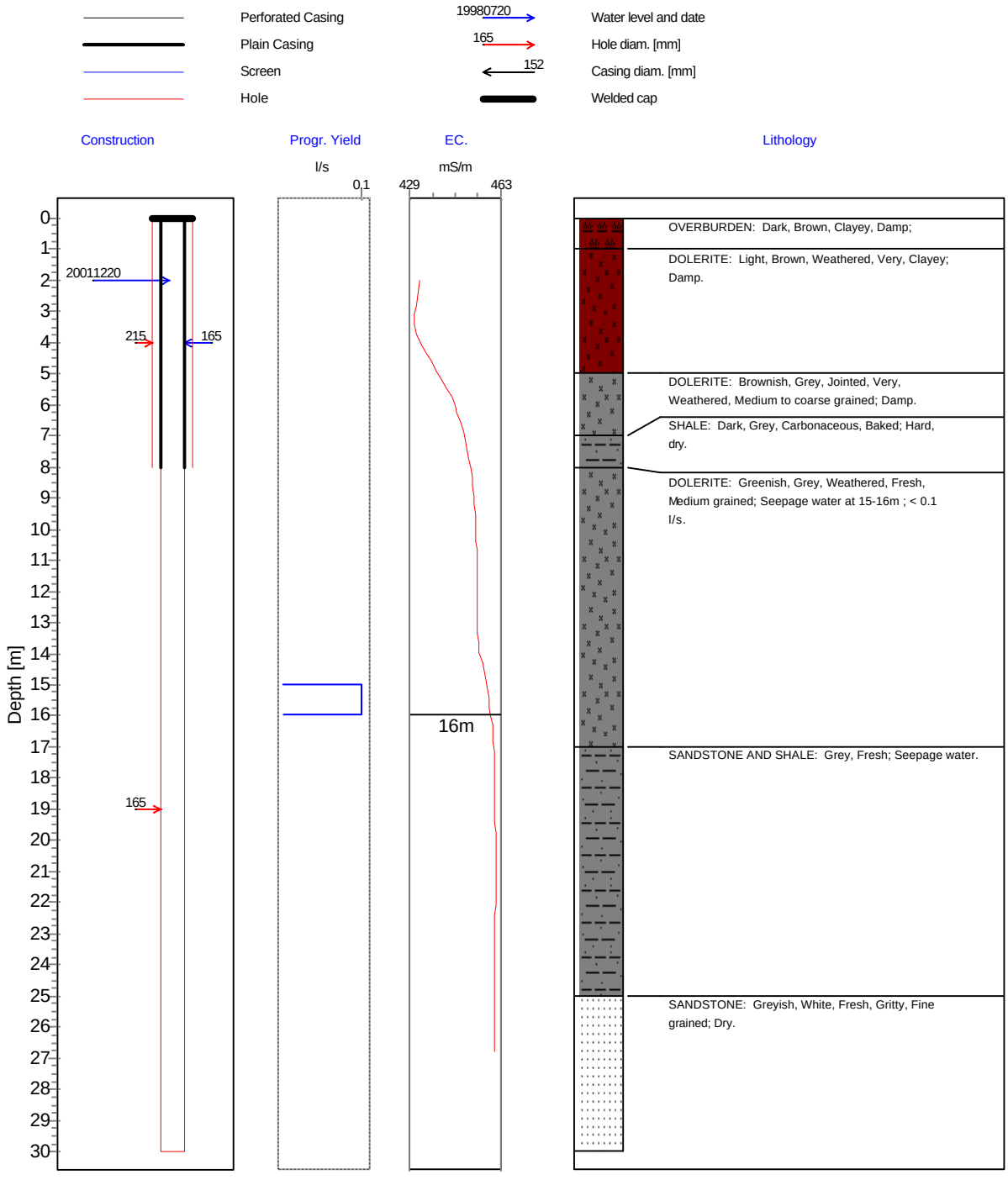
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629CA00003 ***Number:*** SSW-3 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SSW-3 : BLOCK 8C

Y Coord. [m]:	-9376.62900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2932735.11	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.33
Altitude [m]:	1580.49			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00004 ***Number:*** SSW-4 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SSW-4 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-12273.566	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2929450.186	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.40
Altitude [m]:	1643.42			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	6.00	215	20011121	CASED TO 165
JMA	6.00	30.00	165	20011121	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011121	0.00	3.00	165	Steel	2					
20011121	3.00	6.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown	Dark		Clayey	Sandy
1.00	2.00	SANDSTONE	White	Brownish	Fine	Weathered	Gritty
2.00	3.00	DOLERITE	Brown			Weathered	Clayey
3.00	4.00	DOLERITE	Grey	Brownish	Fine to medium	Weathered	Jointed
4.00	6.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
6.00	30.00	DOLERITE	Grey	Greenish		Fresh	Dry

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Borehole Construction and Geological Log

Date compiled: 2/22/02

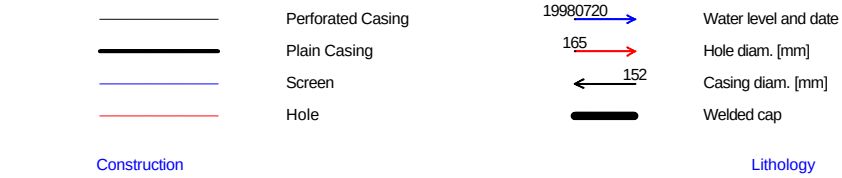
BASIC SITE INFORMATION:

Site Identifier: 2629AC00004 ***Number:*** SSW-4 ***Site type:*** Borehole

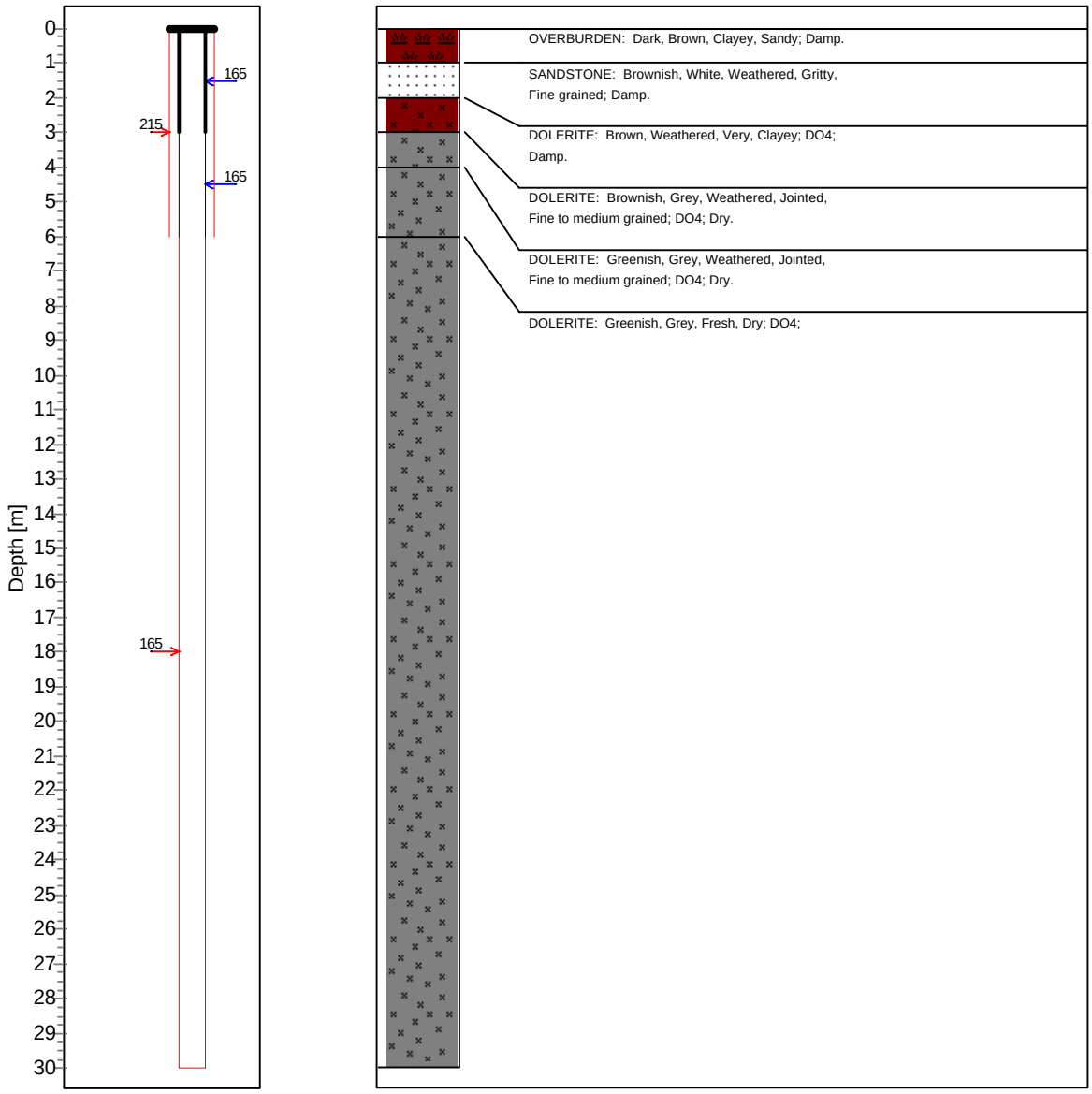
Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SSW-4 : BLOCK 8C

Y Coord. [m]:	-12273.566	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2929450.19	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.40
Altitude [m]:	1643.42			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



Construction Lithology



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00005 ***Number:*** SSW-5 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SSW-5 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-9954.009	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2926950.148	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.30
Altitude [m]:	1602.66			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	18.00	215	20011127	CASED TO 165
JMA	18.00	30.00	165	20011127	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011127	0.00	12.00	165	Steel	2					
20011127	12.00	18.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	2.00	OVERBURDEN	Brown			Clayey	Damp
2.00	5.00	CLAY	Brown	Dark		Damp	
5.00	8.00	MUDSTONE	Brown	Yellowish		Weathered	Clayey
8.00	14.00	MUDSTONE	Brown	Greyish		Weathered	Damp
14.00	18.00	SANDSTONE AND SHALE	Grey			Weathered	Micaceous
18.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020107	1055	0.00	6.05	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020107	1800	0							0.028		

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Borehole Construction and Geological Log

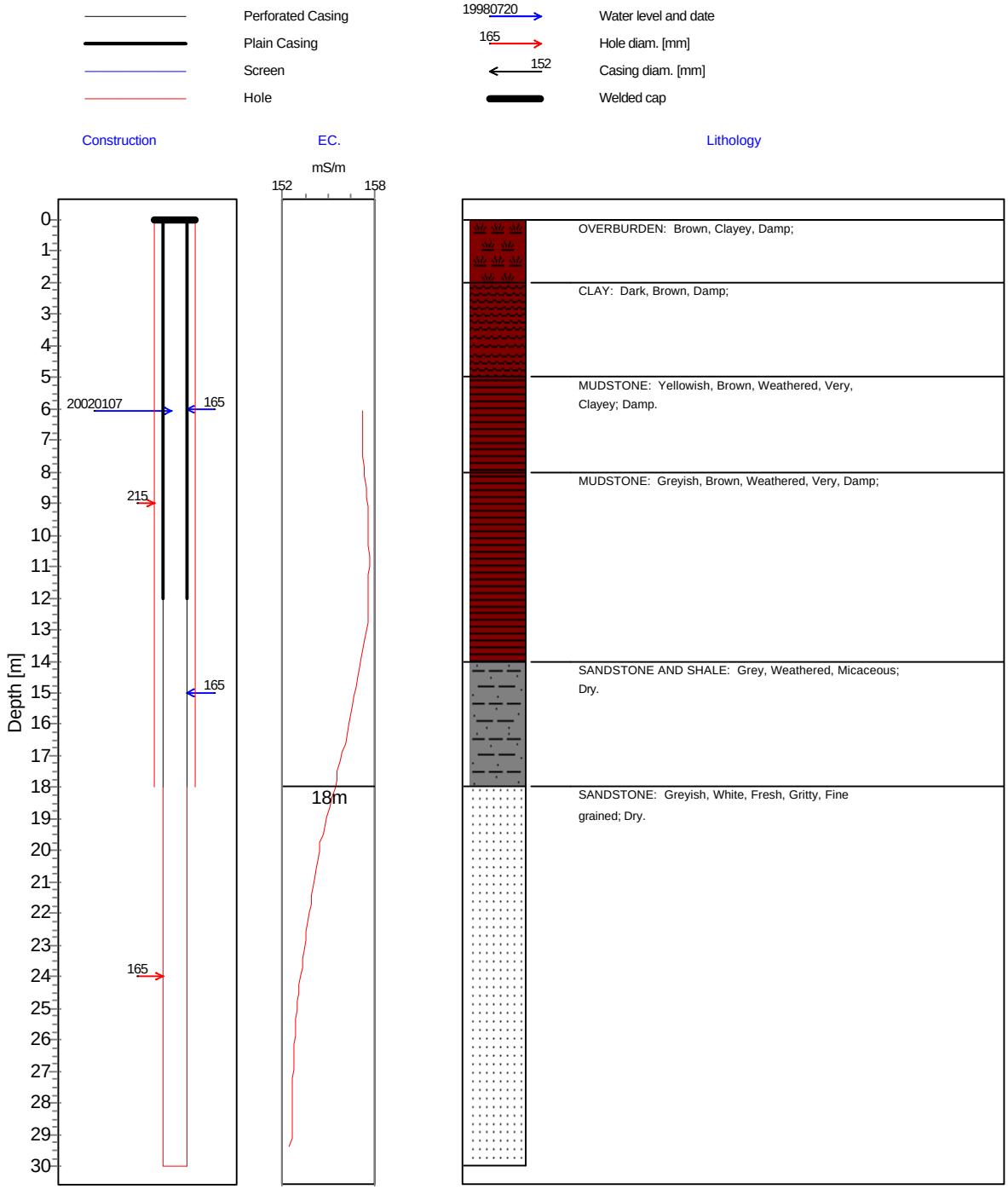
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00005 ***Number:*** SSW-5 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SSW-5 : BLOCK 8C

Y Coord. [m]:	-9954.00900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2926950.15	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.30
Altitude [m]:	1602.66			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00006 ***Number:*** SSW-6 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Des.:*** BOREHOLE SSW-6 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-7740.139	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2931471.237	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.43
Altitude [m]:	1598.56			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	12.00	215	20011106	CASED TO 165
JMA	12.00	30.00	165	20011106	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011106	0.00	8.00	165	Steel	2					
20011106	8.00	12.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Clayey	Damp
1.00	8.00	SANDSTONE AND SHALE	Grey			Weathered	Micaceous
8.00	12.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
12.00	14.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
14.00	28.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
28.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1655	0.00	5.72	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1800	0							0.007		

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Borehole Construction and Geological Log

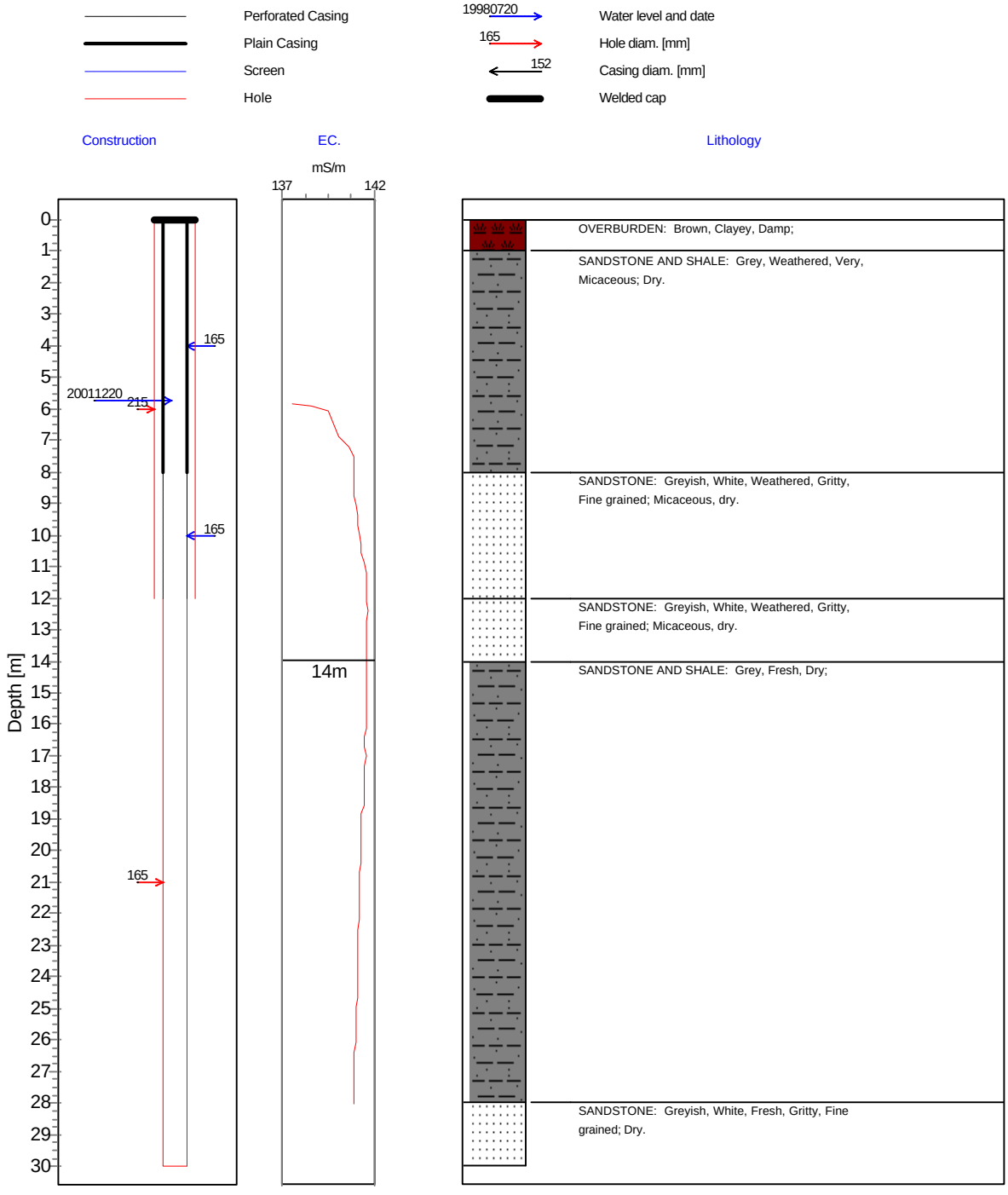
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00006 ***Number:*** SSW-6 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Descr.:*** BOREHOLE SSW-6 : BLOCK 8C

Y Coord. [m]:	-7740.13900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2931471.24	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.43
Altitude [m]:	1598.56			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00007 ***Number:*** SSW-7 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Des.:*** BOREHOLE SSW-7 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-6944.293	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2930151.57	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.45
Altitude [m]:	1580.61			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	20.00	215	20011107	CASED TO 165
JMA	20.00	30.00	165	20011107	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011107	0.00	2.00	165	Steel	2					
20011107	2.00	20.00	165	Steel	2	Perforated or slotted	250	2	43	250

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	11.00	12.00	3.00	Estimated			
JMA	17.00	18.00	22.00	Estimated			

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Black	Brownish		Clayey	Damp
1.00	4.00	CLAY	Brown			Sandy	Damp
4.00	8.00	SANDSTONE	Brown	Light	Fine	Weathered	Gritty
8.00	10.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
10.00	12.00	SHALE	Grey	Greenish		Baked	Hard
12.00	15.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
15.00	17.00	DOLERITE	Grey	Dark	Fine to medium	Weathered	Jointed
17.00	18.00	DOLERITE				Mineralised	
18.00	20.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
20.00	25.00	DOLERITE	Grey	Greenish	Fine to medium	Fresh	Jointed
25.00	26.00	SANDSTONE AND SHALE	Grey			Fresh	Baked
26.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011221	1300	0.00	1.71	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011221	30	0							6.25		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

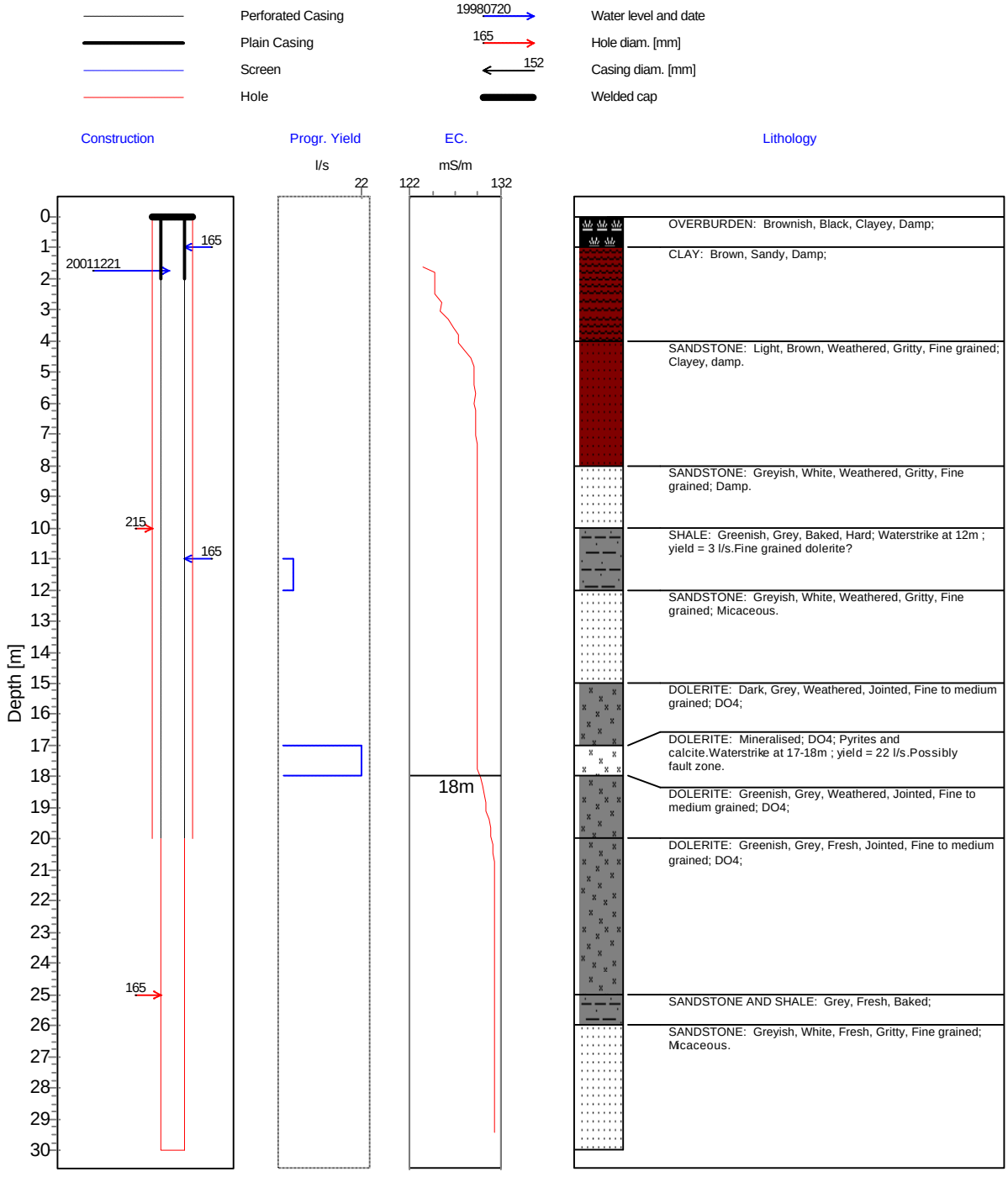
BASIC SITE INFORMATION:

Site Identifier: 2629AC00007 ***Number:*** SSW-7 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Descr.:*** BOREHOLE SSW-7 : BLOCK 8C

Y Coord. [m]:	-6944.29300	***Alt. No. 1:***		***Depth [m]:***	30.00
X Coord. [m]:	2930151.57	***Alt. No. 2:***		***Collar h. [m]:***	0.45
Altitude [m]:	1580.61	***Topo-set.:***	Hillside (slope)	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit	***Site status:***	In use	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System	***Site purp.:***	Observation	***Rep. inst.:***	JMA
		Use applic.:	Industrial - mining		
		Equipment:	No equipment		

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA00008 **Number:** SSW-8 **Site type:** Borehole

Distr./Farm No.: 130 IS **Site Name/Des.:** BOREHOLE SSW-8 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-4378.945	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2935041.205	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.37
Altitude [m]:	1580.88			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	9.00	215	20011109	CASED TO 165
JMA	9.00	30.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011109	0.00	5.00	165	Steel	2					
20011109	5.00	9.00	165	Steel	2	Perforated or slotted	250	2	43	250

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	16.00	18.00	0.10	Estimated			
JMA	27.00	28.00	0.40	Estimated			ARTESIAN

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown			Gravel-bearing	Damp
1.00	4.00	SANDSTONE AND SHALE	Brown	Yellowish		Weathered	Clayey
4.00	5.00	SANDSTONE	Brown	Yellowish	Fine	Weathered	Gritty
5.00	15.00	SANDSTONE AND SHALE	Brown	Light		Weathered	Dry
15.00	16.00	SANDSTONE AND SHALE	Grey			Fresh	
16.00	18.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
18.00	30.00	DOLERITE				Fresh	Jointed

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011221	1105	0.00	0.27	ARTESIAN

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Borehole Construction and Geological Log

Date compiled: 2/22/02

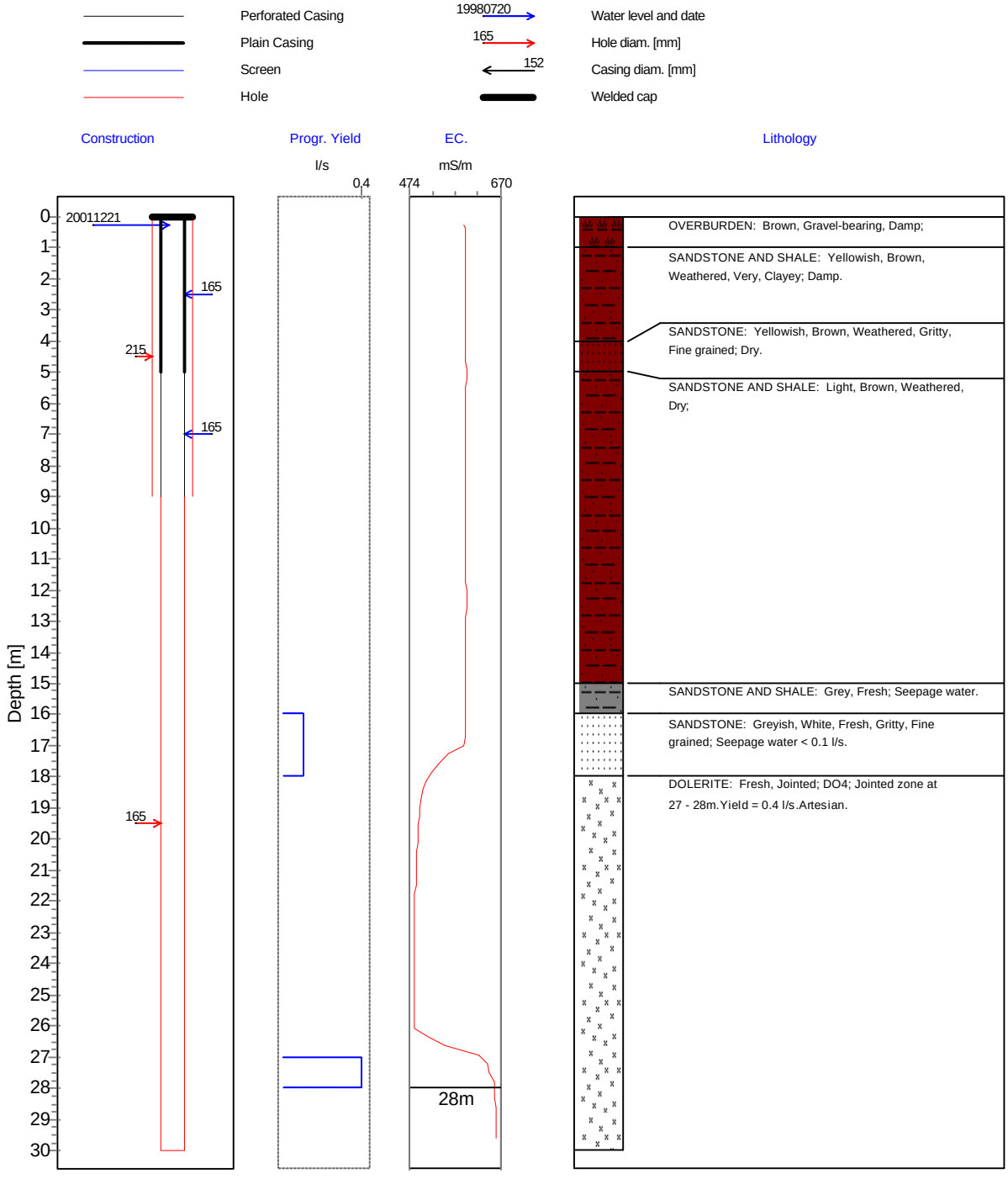
BASIC SITE INFORMATION:

Site Identifier: 2629CA00008 ***Number:*** SSW-8 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Descr.:*** BOREHOLE SSW-8 : BLOCK 8C

Y Coord. [m]:	-4378.94500	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2935041.21	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.37
Altitude [m]:	1580.88			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA00009 **Number:** SSW-9 **Site type:** Borehole

Distr./Farm No.: 130 IS **Site Name/Des.:** BOREHOLE SSW-9 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-2886.305	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2934014.816	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.38
Altitude [m]:	1569.18			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	10.00	215	20011108	CASED TO 165
JMA	10.00	30.00	165	20011108	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011108	0.00	6.00	165	Steel	2					
20011108	6.00	10.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown			Clayey	Damp
1.00	7.00	CLAY	Brown			Sandy	Damp
7.00	9.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
9.00	18.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
18.00	21.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
21.00	24.00	SHALE	Grey	Dark		Fresh	Carbonaceous
24.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011221	1405	0.00	4.62	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011221	1800	0							0.012		

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Borehole Construction and Geological Log

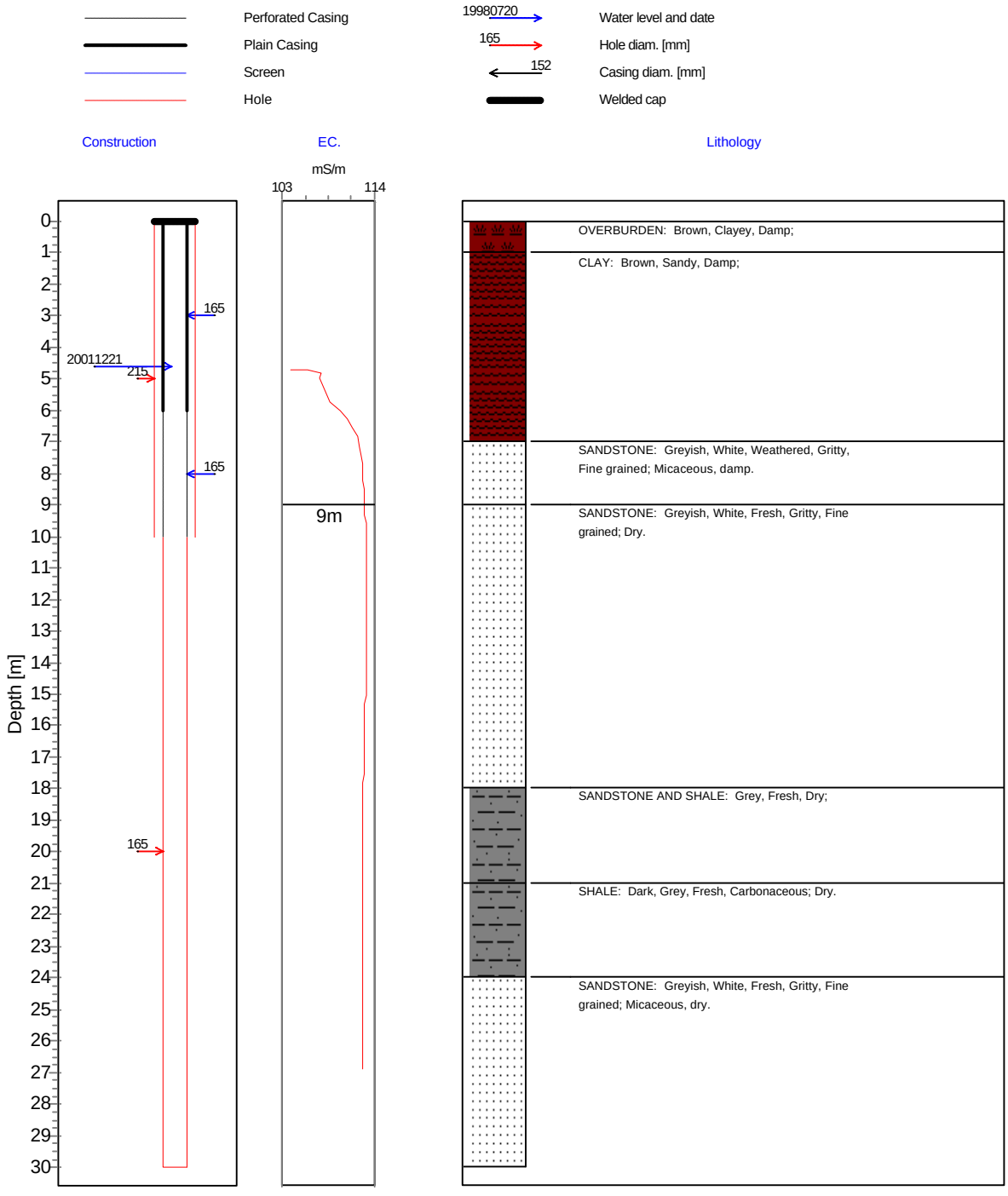
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629CA00009 ***Number:*** SSW-9 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Descr.:*** BOREHOLE SSW-9 : BLOCK 8C

Y Coord. [m]:	-2886.30500	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2934014.82	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.38
Altitude [m]:	1569.18			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00010 **Number:** SSW-10 **Site type:** Borehole

Distr./Farm No.: 128 IS **Site Name/Des.:** BOREHOLE SSW-10 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-1221.131	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2930635.716	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.39
Altitude [m]:	1571.97			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	9.00	215	20011113	CASED TO 165
JMA	9.00	30.00	165	20011113	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011113	0.00	6.00	165	Steel	2					
20011113	6.00	9.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown	Yellowish		Damp	
1.00	4.00	DOLERITE	Grey	Brownish	Fine to medium	Weathered	Jointed
4.00	6.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
6.00	8.00	MUDSTONE	Grey			Weathered	Dry
8.00	13.00	MUDSTONE	Grey			Weathered	Dry
13.00	19.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
19.00	24.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
24.00	28.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
28.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1325	0.00	3.94	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	1800	0							0.052		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

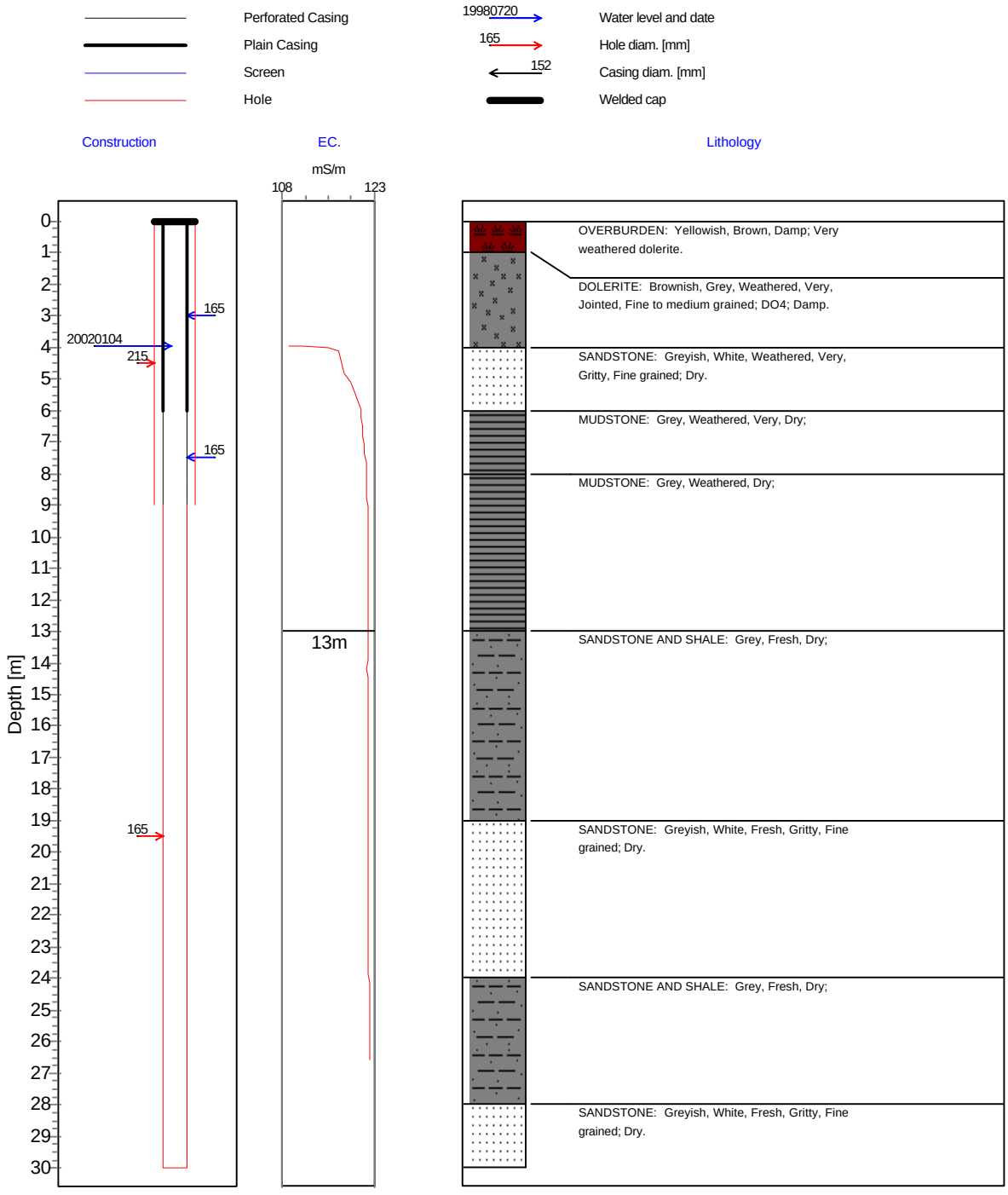
BASIC SITE INFORMATION:

Site Identifier: 2629AC00010 ***Number:*** SSW-10 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SSW-10 : BLOCK 8C

Y Coord. [m]:	-1221.13100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2930635.72	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.39
Altitude [m]:	1571.97			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00011 ***Number:*** SSW-11 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Des.:*** BOREHOLE SSW-11 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-2481.011	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2928041.734	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.38
Altitude [m]:	1634.82			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	6.00	215	20011110	CASED TO 165
JMA	6.00	30.00	165	20011110	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011110	0.00	6.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Damp	
1.00	4.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
4.00	8.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
8.00	30.00	DOLERITE	Grey	Greenish	Fine to medium	Fresh	Dry

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	0950	0.00	11.04	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.0003		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

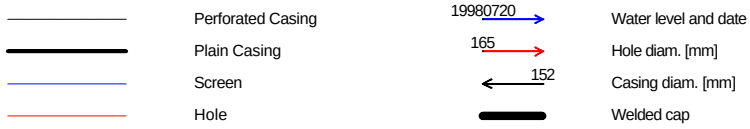
BASIC SITE INFORMATION:

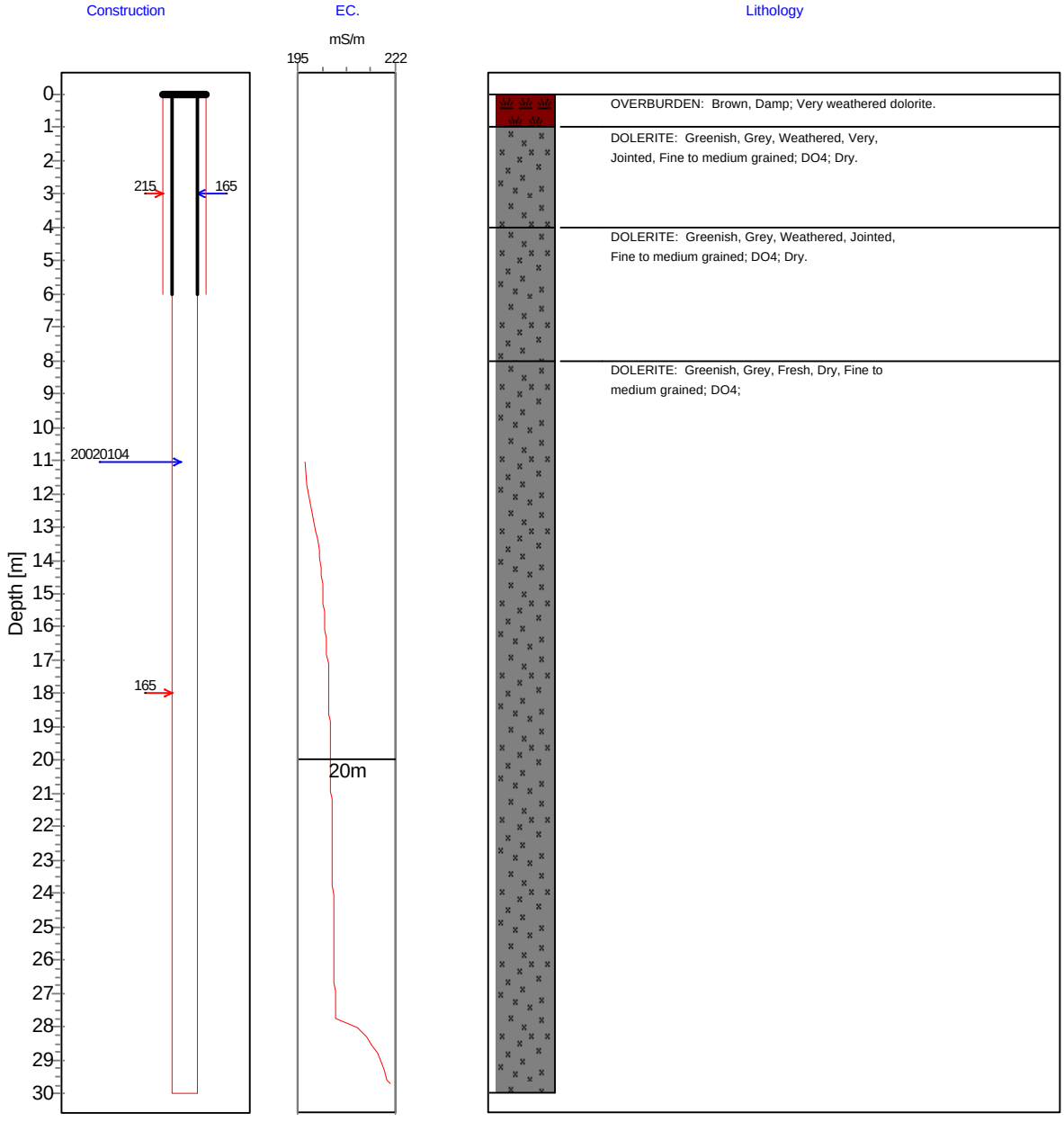
Site Identifier: 2629AC00011 ***Number:*** SSW-11 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SSW-11 : BLOCK 8C

Y Coord. [m]:	-2481.01100	***Alt. No. 1:***		***Depth [m]:***	30.00
X Coord. [m]:	2928041.73	***Alt. No. 2:***		***Collar h. [m]:***	0.38
Altitude [m]:	1634.82	***Topo-set.:***	Hillside (slope)	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit	***Site status:***	In use	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System	***Site purp.:***	Observation	***Rep. inst.:***	JMA
		Use applic.:	Industrial - mining		
		Equipment:	No equipment		

Construction and Geohydrological Legend





COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00012 **Number:** SSW-12 **Site type:** Borehole

Distr./Farm No.: 128 IS **Site Name/Des.:** BOREHOLE SSW-12 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-49.03	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2926016.517	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.44
Altitude [m]:	1607.43			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	8.00	215	20011109	CASED TO 165
JMA	8.00	30.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011109	0.00	4.00	165	Steel	2					
20011109	4.00	8.00	165	Steel	2	Perforated or slotted	250	2	43	250

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	7.00	12.00	0.10	Estimated			SEEPAGE WATER

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Grey	Dark		Damp	
1.00	5.00	DOLERITE	Brown	Yellowish		Weathered	Damp
5.00	7.00	DOLERITE	Grey	Greenish		Weathered	Jointed
7.00	12.00	DOLERITE	Grey	Greenish		Fresh	
12.00	15.00	SANDSTONE AND SHALE	Grey			Fresh	
15.00	26.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
26.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1148	0.00	8.90	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	900	0							0.21		

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Borehole Construction and Geological Log

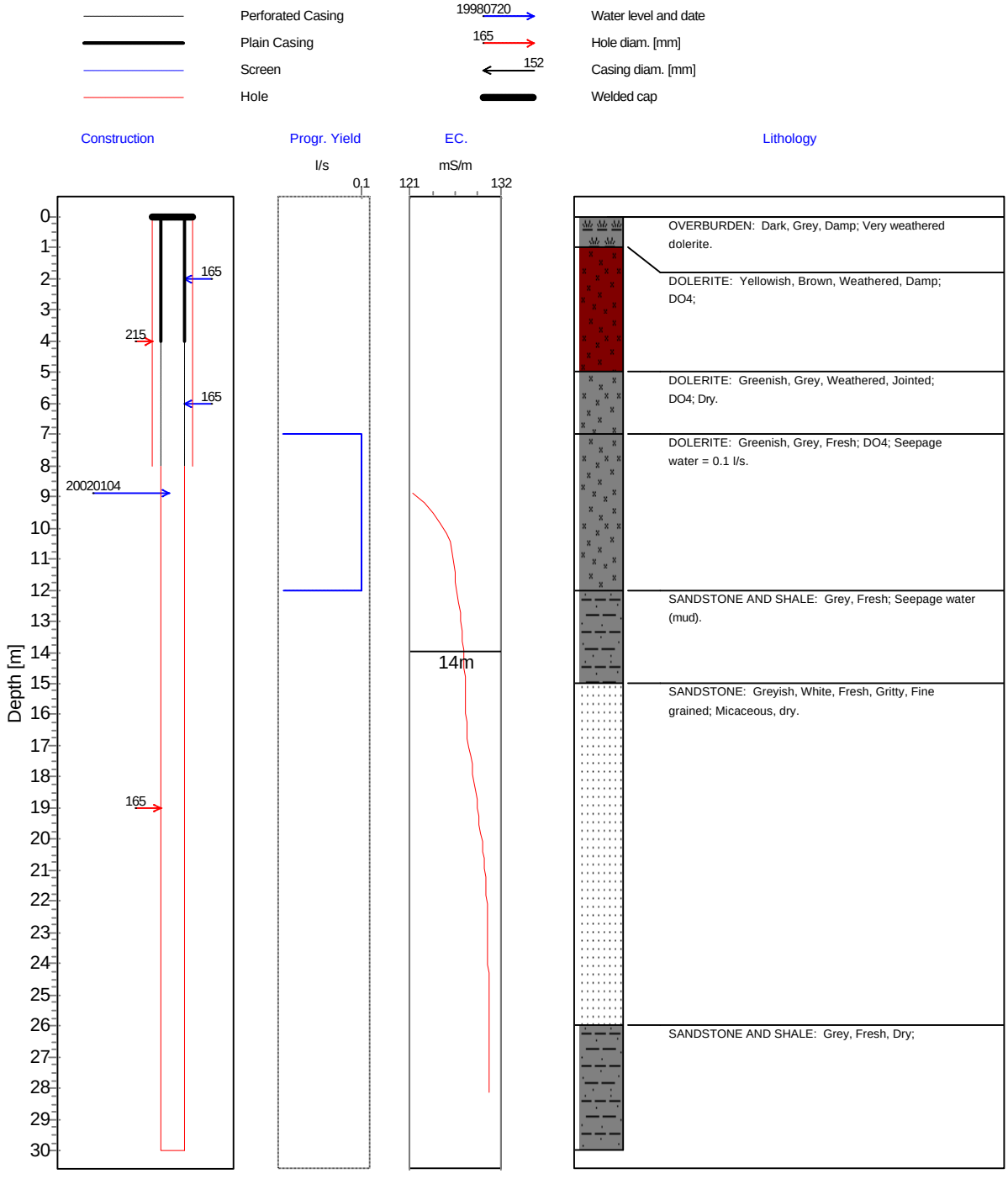
Date compiled: 2/25/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00012 ***Number:*** SSW-12 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SSW-12 : BLOCK 8C

Y Coord. [m]:	-49.03000	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2926016.52	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.44
Altitude [m]:	1607.43			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628BD00013 ***Number:*** SSW-13 ***Site type:*** Borehole

Distr./Farm No.: 359 IR ***Site Name/Des.:*** BOREHOLE SSW-13 : BLOCK 8

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	1150.64	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2930905.615	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.46
Altitude [m]:	1606.77			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	7.00	215	20011123	CASED TO 165
JMA	7.00	30.00	165	20011123	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011123	0.00	4.00	165	Steel	2					
20011123	4.00	7.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Grey	Dark		Clayey	Damp
1.00	6.00	DOLERITE	Brown	Yellowish		Weathered	Damp
6.00	7.00	DOLERITE	Grey	Greenish		Weathered	Jointed
7.00	8.00	DOLERITE	Grey	Greenish		Weathered	Jointed
8.00	29.00	DOLERITE	Grey	Greenish		Fresh	
29.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	1435	0.00	4.14	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.002		

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Borehole Construction and Geological Log

Date compiled: 2/25/02

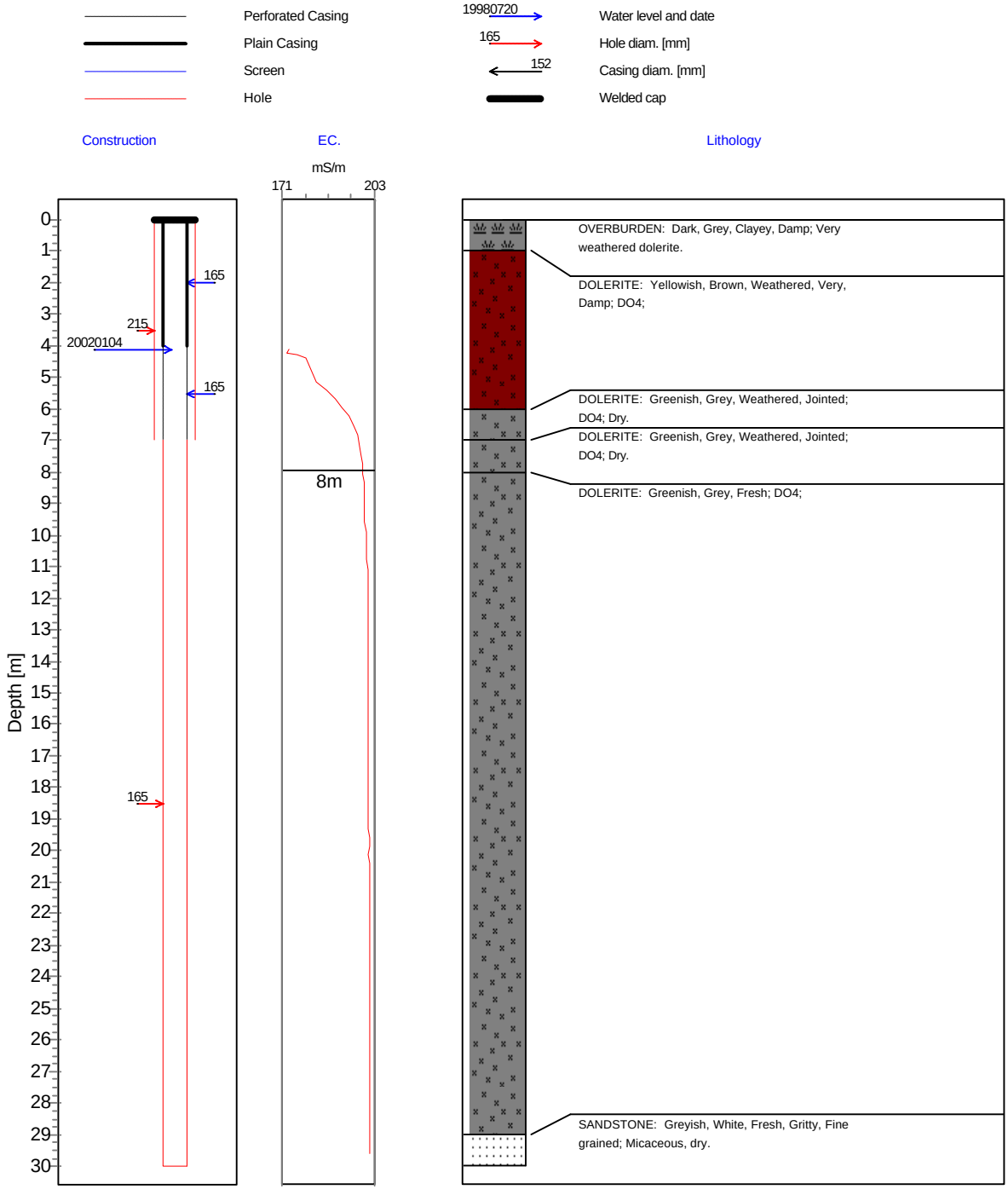
BASIC SITE INFORMATION:

Site Identifier: 2628BD00013 ***Number:*** SSW-13 ***Site type:*** Borehole

Distr./Farm No.: 359 IR ***Site Name/Descr.:*** BOREHOLE SSW-13 : BLOCK 8

Y Coord. [m]:	1150.64000	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2930905.62	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.46
Altitude [m]:	1606.77			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628DB00014 ***Number:*** SSW-14 ***Site type:*** Borehole

Distr./Farm No.: 531 IR ***Site Name/Des.:*** BOREHOLE SSW-14 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	1213.472	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2933576.742	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.40
Altitude [m]:	1571.15			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	12.00	215	20011124	CASED TO 165
JMA	12.00	30.00	165	20011124	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011124	0.00	6.00	165	Steel	2					
20011124	6.00	12.00	165	Steel	2	Perforated or slotted	250	2	43	250

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	12.00	14.00	0.10	Estimated			

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Clayey	
1.00	11.00	MUDSTONE	Brown	Yellowish		Weathered	Dry
11.00	12.00	SHALE	Grey			Baked	Jointed
12.00	14.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
14.00	24.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
24.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	1655	0.00	3.71	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.137		

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Borehole Construction and Geological Log

Date compiled: 2/25/02

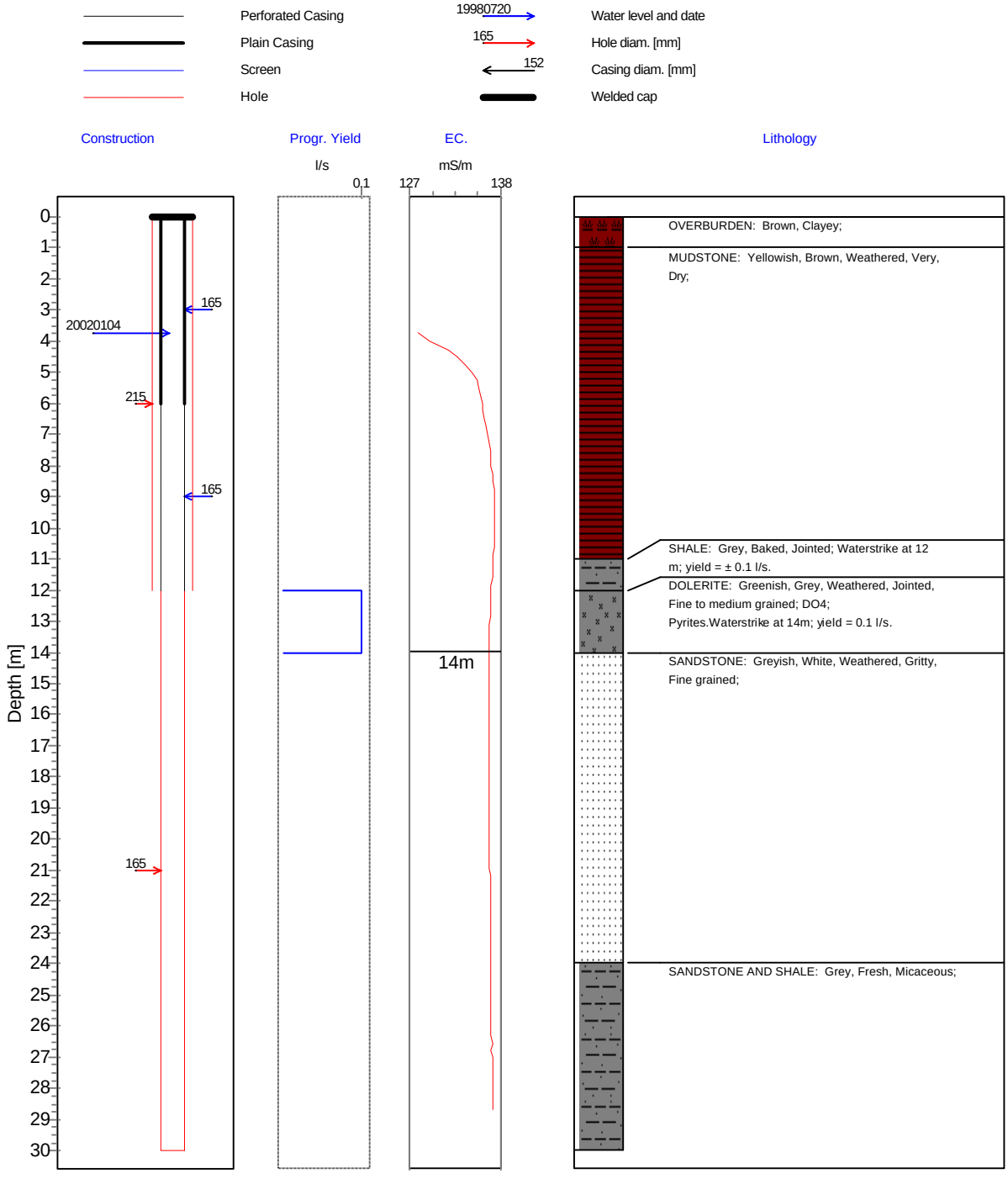
BASIC SITE INFORMATION:

Site Identifier: 2628DB00014 ***Number:*** SSW-14 ***Site type:*** Borehole

Distr./Farm No.: 531 IR ***Site Name/Descr.:*** BOREHOLE SSW-14 : BLOCK 8C

Y Coord. [m]:	1213.47200	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2933576.74	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.40
Altitude [m]:	1571.15			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628DB00015 ***Number:*** SSW-15 ***Site type:*** Borehole

Distr./Farm No.: 532 IR ***Site Name/Des.:*** BOREHOLE SSW-15 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	1797.385	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2937769.592	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.42
Altitude [m]:	1594.28			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	12.00	215	20011109	CASED TO 165
JMA	12.00	30.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011109	0.00	8.00	165	Steel	2					
20011109	8.00	12.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown	Reddish		Clayey	Damp
1.00	5.00	SANDSTONE AND SHALE	Brown	Greyish		Weathered	Sandy
5.00	11.00	SANDSTONE AND SHALE	Grey			Weathered	Dry
11.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020107	1755	0.00	7.05	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020107	1800	0							0.003		

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Borehole Construction and Geological Log

Date compiled: 2/25/02

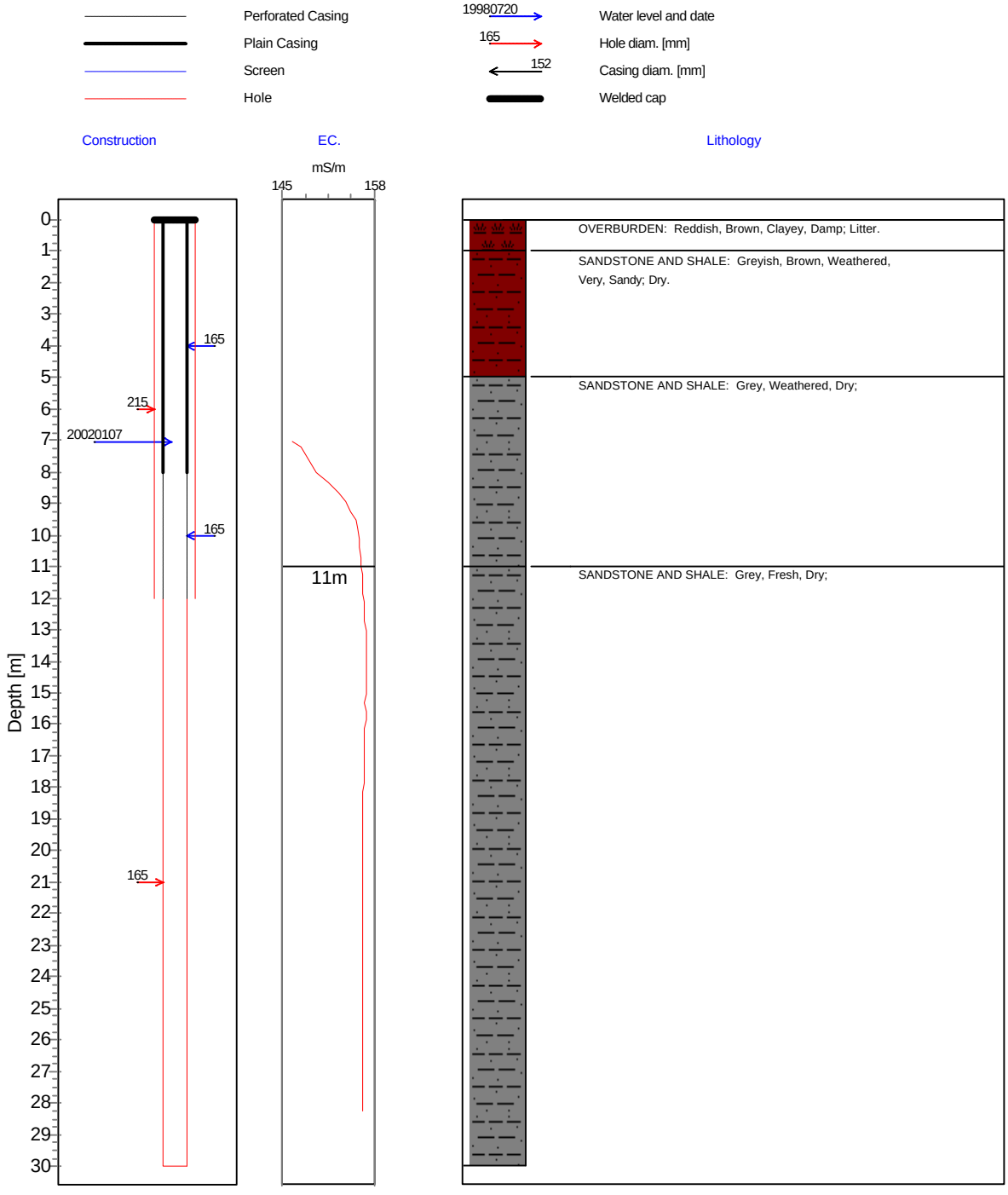
BASIC SITE INFORMATION:

Site Identifier: 2628DB00015 ***Number:*** SSW-15 ***Site type:*** Borehole

Distr./Farm No.: 532 IR ***Site Name/Descr.:*** BOREHOLE SSW-15 : BLOCK 8C

Y Coord. [m]:	1797.38500	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2937769.59	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.42
Altitude [m]:	1594.28			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10001 **Number:** SDF-1 **Site type:** Borehole

Distr./Farm No.: 137 IS **Site Name/Des.:** BOREHOLE SDF-1 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-12128.87	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2931166.389	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.37
Altitude [m]:	1595.55			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011106	CASED TO 165
JMA	30.00	80.00	165	20011106	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011106	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	31.00	48.00	0.20	Estimated		Geologist, technician,	WATER STRIKE

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	3.00	SAND AND CLAY	Brown	Dark		Sandy	
3.00	6.00	SOIL	Brown	Yellowish	Fine	Gritty	
6.00	23.00	SANDSTONE AND SHALE	Grey	Light		Weathered	
23.00	28.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
28.00	31.00	SANDSTONE AND SHALE	Grey			Fresh	
31.00	48.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
48.00	59.00	SANDSTONE AND SHALE	Grey			Fresh	
59.00	65.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
65.00	67.00	SANDSTONE AND SHALE	Grey			Fresh	
67.00	72.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
72.00	74.00	SHALE	Black	Greyish		Carbonaceous	Fresh
74.00	77.00	SANDSTONE AND SHALE	Grey			Fresh	
77.00	80.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011220	1505	0.00	1.93	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011220	1800	0							0.046		

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Borehole Construction and Geological Log

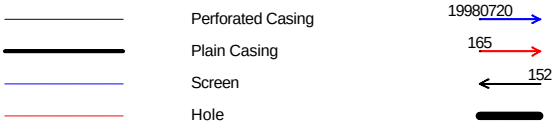
Date compiled: 2/22/02

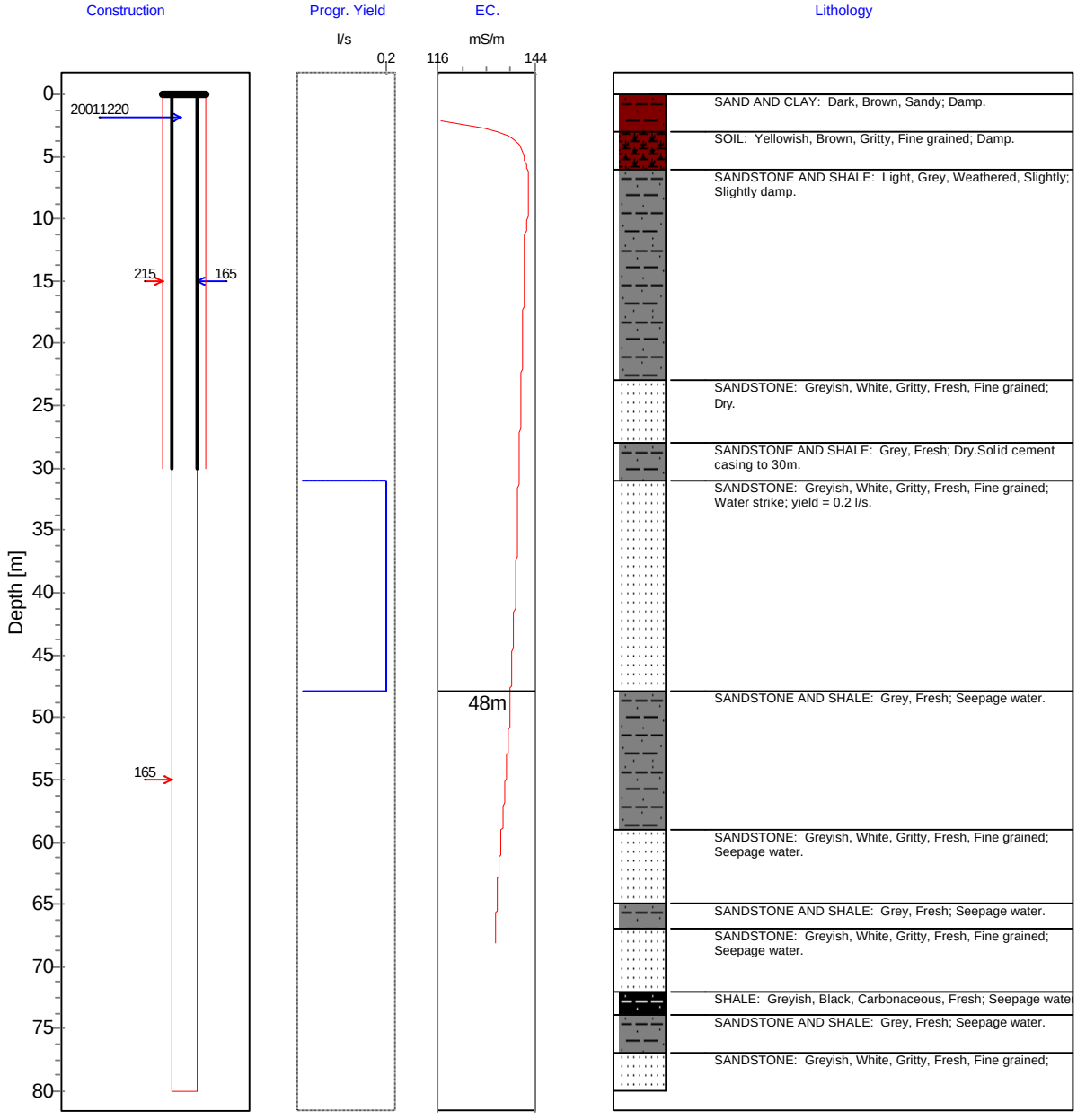
BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10001 ***Number:*** SDF-1 ***Site type:*** Borehole

Distr./Farm No.: 137 IS ***Site Name/Descr.:*** BOREHOLE SDF-1 : BLOCK 8

Y Coord. [m]:	-12128.870	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2931166.39	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.37
Altitude [m]:	1595.55			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend





COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10002 **Number:** SDF-2 **Site type:** Borehole

Distr./Farm No.: 135 IS **Site Name/Des.:** BOREHOLE SDF-2 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-10262.341	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2931990.899	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.47
Altitude [m]:	1585.91			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011114	CASED TO 165
JMA	30.00	80.00	165	20011114	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011114	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	6.00	6.00	0.10	Estimated			SEEPAGE WATER

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	SAND AND CLAY	Brown			Damp	
1.00	2.00	DOLERITE	Brown	Yellowish		Weathered	Sandy
2.00	6.00	DOLERITE	Brown	Yellowish	Medium	Weathered	
6.00	11.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
11.00	17.00	SANDSTONE	White	Greyish	Fine	Gritty	Weathered
17.00	36.00	SANDSTONE AND SHALE	Grey			Fresh	Damp
36.00	42.00	SANDSTONE	White	Greyish	Fine	Gritty	Micaceous
42.00	48.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
48.00	56.00	SANDSTONE	White	Greyish	Fine	Gritty	Micaceous
56.00	58.00	SANDSTONE	White	Greyish	Medium to coarse	Gritty	Fresh
58.00	61.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
61.00	66.00	SANDSTONE AND SHALE	White	Greyish		Fresh	Micaceous
66.00	80.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011220	1325	0.00	3.00	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011220	1800	0							0.003		

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Borehole Construction and Geological Log

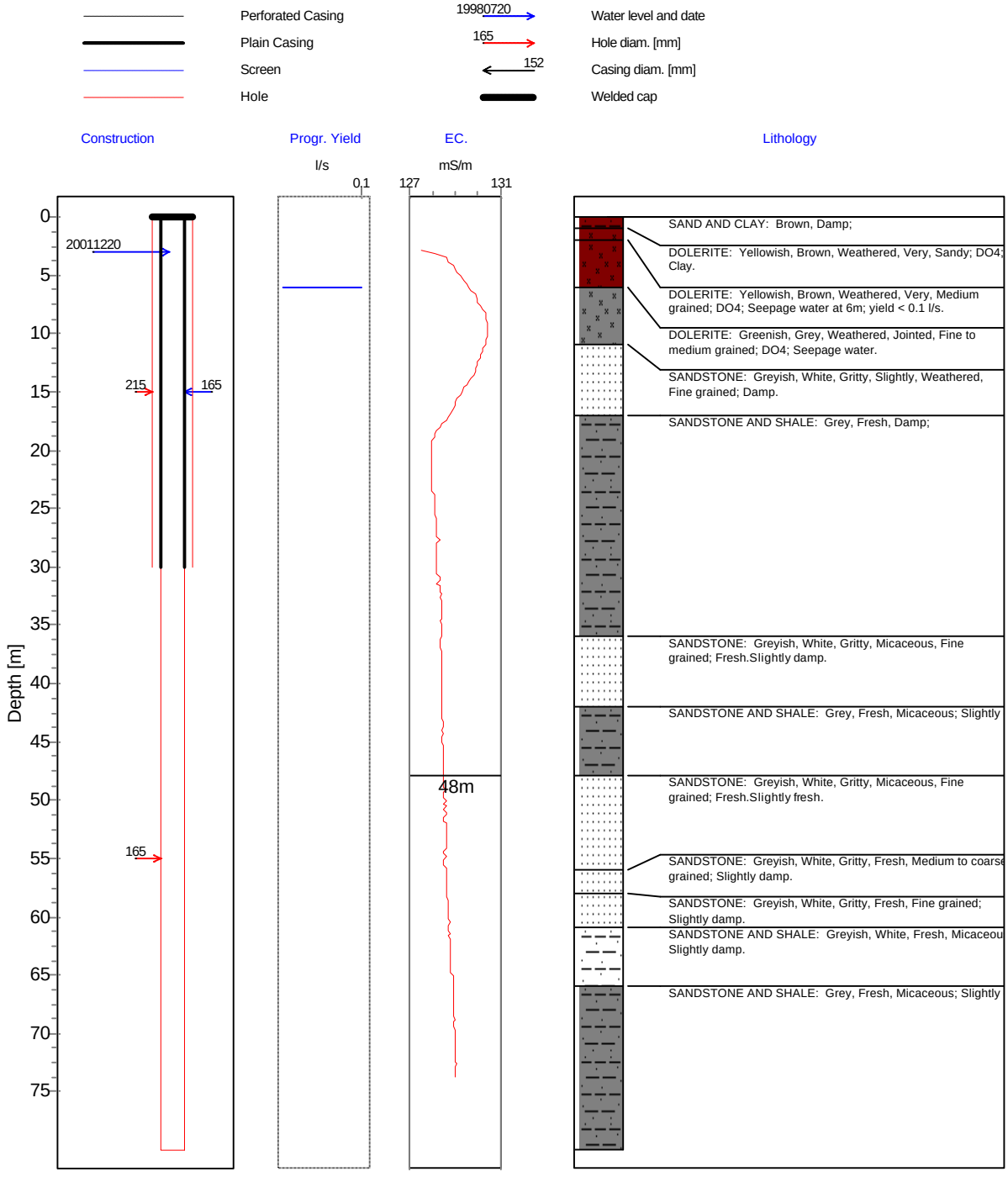
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10002 ***Number:*** SDF-2 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SDF-2 : BLOCK 8

Y Coord. [m]:	-10262.341	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2931990.90	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.47
Altitude [m]:	1585.91			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA10003 **Number:** SDF-3 **Site type:** Borehole

Distr./Farm No.: 135 IS **Site Name/Des.:** BOREHOLE SDF-3 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-9378.1	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2932721.884	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.33
Altitude [m]:	1581.11			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011105	CASED TO 165
JMA	30.00	80.00	165	20011105	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011105	0.00	30.00	165	Other material	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	8.00	9.00	0.30	Estimated			SEEPAGE WATER
JMA	17.00	18.00	1.70	Estimated			
JMA	19.00	20.00	0.70	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown	Dark		Clayey	Damp
1.00	2.00	DOLERITE	Grey	Dark		Weathered	Gravel-bearing
2.00	5.00	DOLERITE			Medium to coarse	Weathered	Feldspathic
5.00	8.00	DOLERITE	Grey	Greenish	Medium to coarse	Weathered	Jointed
8.00	13.00	DOLERITE	Grey		Medium to coarse	Weathered	Jointed
13.00	14.00	SHALE	Grey	Dark		Carbonaceous	Baked
14.00	25.00	SHALE	Grey			Weathered	Jointed
25.00	27.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
27.00	46.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
46.00	54.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
54.00	72.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	
72.00	73.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
75.00	80.00	SANDSTONE AND SHALE	White	Greyish		Fresh	Micaceous

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011220	1740	0.00	2.92	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011220	1800	0							0.001		

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Borehole Construction and Geological Log

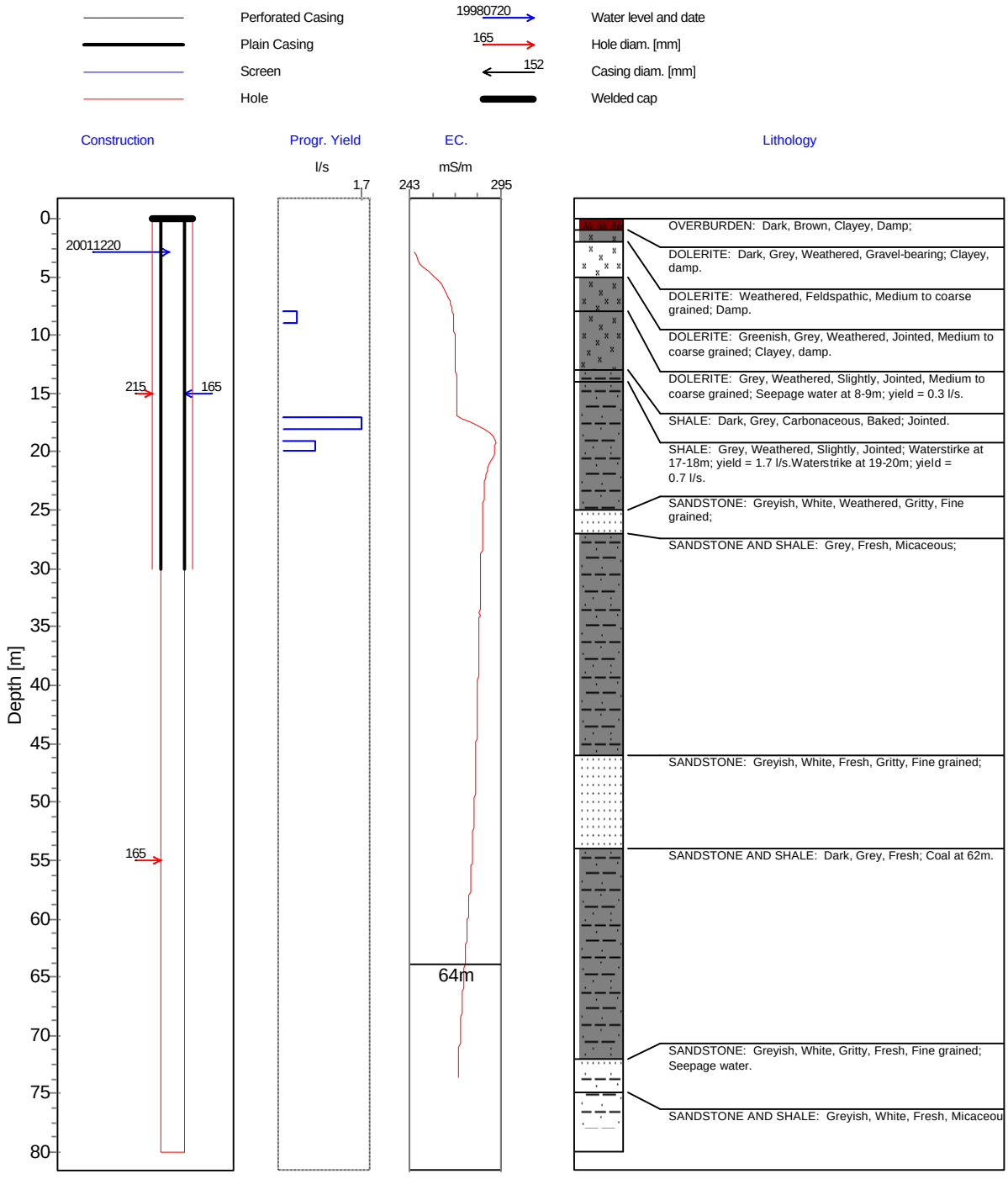
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629CA10003 ***Number:*** SDF-3 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SDF-3 : BLOCK 8

Y Coord. [m]:	-9378.10000	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2932721.88	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.33
Altitude [m]:	1581.11			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10004 ***Number:*** SDF-4 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SDF-4 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-12273.32	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2929461.409	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.30
Altitude [m]:	1643.25			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011121	CASED TO 165
JMA	30.00	80.00	165	20011121	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011121	0.00	25.00	165	Steel	2					
20011121	25.00	30.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Sandy	Damp
1.00	5.00	SANDSTONE	White	Brownish	Fine	Weathered	Gritty
5.00	6.00	DOLERITE	Grey	Brownish		Weathered	Jointed
6.00	49.00	DOLERITE	Grey	Greenish		Fresh	
49.00	50.00	SANDSTONE	Grey		Fine	Gritty	Micaceous
50.00	53.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
53.00	58.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
58.00	60.00	SHALE	Grey	Dark		Fresh	Carbonaceous
60.00	70.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
70.00	80.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020107	0840	0.00	50.37	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020107	1800	0							0.002		

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Borehole Construction and Geological Log

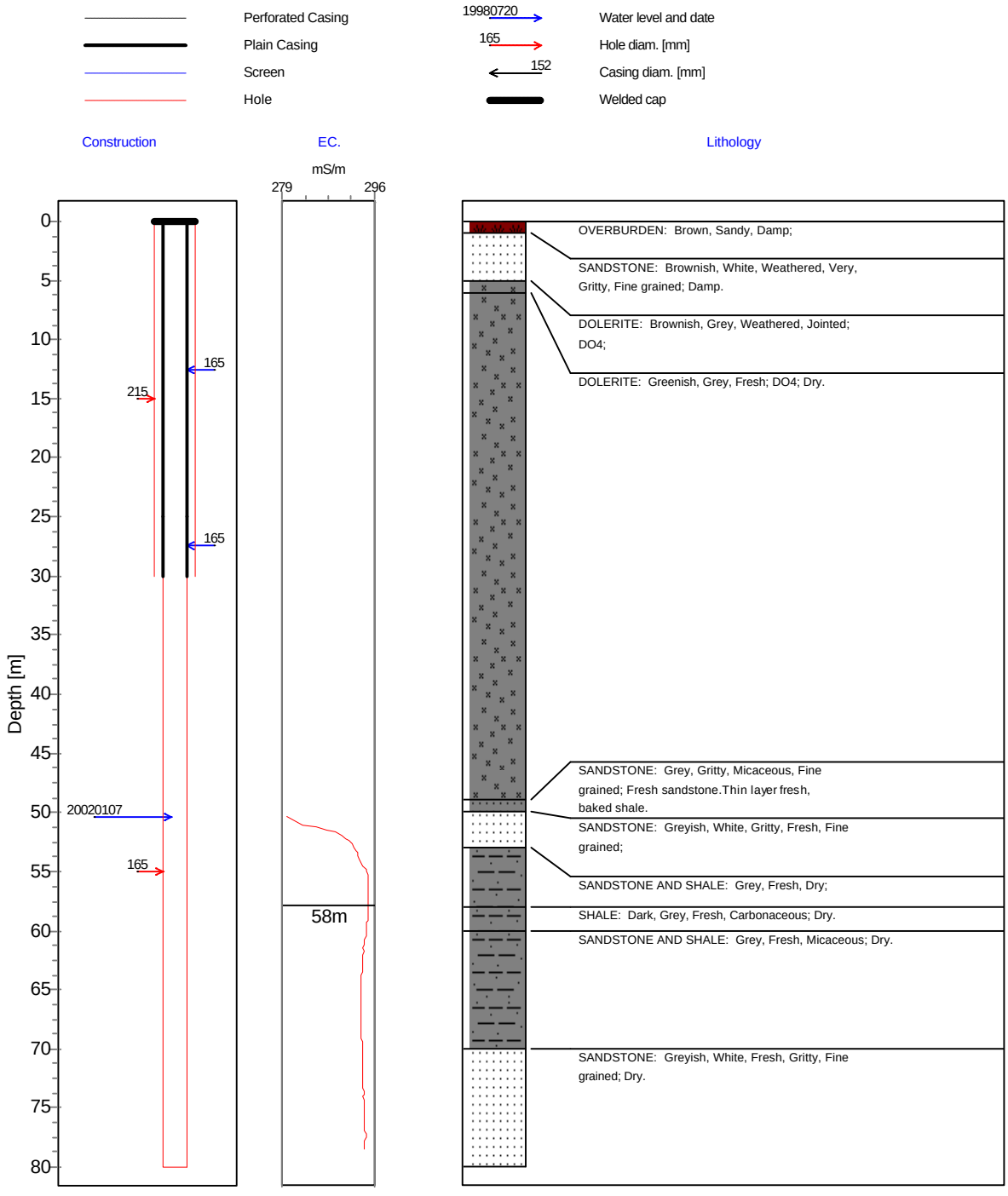
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10004 ***Number:*** SDF-4 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SDF-4 : BLOCK 8

Y Coord. [m]:	-12273.320	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2929461.41	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.30
Altitude [m]:	1643.25			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10005 **Number:** SDF-5 **Site type:** Borehole

Distr./Farm No.: 135 IS **Site Name/Des.:** BOREHOLE SDF-5 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-9957.746	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	150.00
X Coord. [m]:	2926945.507	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.27
Altitude [m]:	1602.75			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011127	CASED TO 165
JMA	30.00	150.00	165	20011127	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011127	0.00	30.00	165	PVC	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	30.00	67.00	0.10	Estimated			SEEPAGE WATER
JMA	76.00	80.00	0.10	Estimated			SEEPAGE WATER

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown			Clayey	Damp
1.00	4.00	CLAY	Brown	Dark		Damp	
4.00	9.00	MUDSTONE	Brown	Yellowish		Weathered	Clayey
9.00	12.00	MUDSTONE	Brown	Greyish		Weathered	Damp
12.00	17.00	SANDSTONE AND SHALE	Grey			Weathered	Micaceous
17.00	48.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
48.00	57.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
57.00	67.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
67.00	86.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
86.00	98.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
98.00	100.00	SANDSTONE AND SHALE	Grey			Fresh	
100.00	110.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
110.00	111.00	COAL					
111.00	144.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
144.00	145.00	COAL					
145.00	149.00	SANDSTONE			Fine	Fresh	Gritty
149.00	150.00	COAL					

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020107	1005	0.00	9.12	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020107	1800	0							0.001		

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Borehole Construction and Geological Log

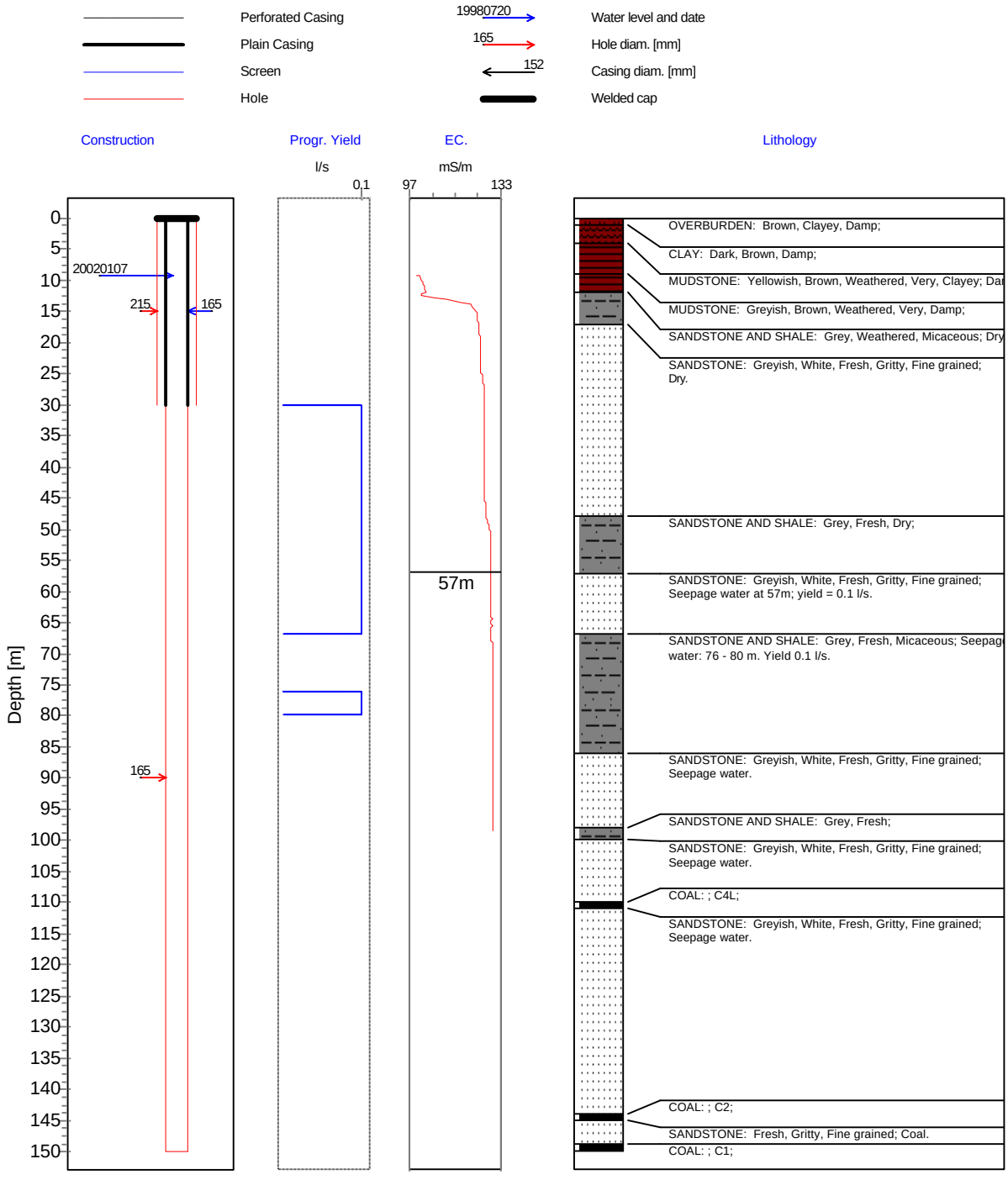
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10005 ***Number:*** SDF-5 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SDF-5 : BLOCK 8

Y Coord. [m]:	-9957.74600	***Alt. No. 1:***		***Depth [m]:***	150.00
X Coord. [m]:	2926945.51	***Alt. No. 2:***		***Collar h. [m]:***	0.27
Altitude [m]:	1602.75	***Topo-set.:***	Hillside (slope)	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit	***Site status:***	In use	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System	***Site purp.:***	Observation	***Rep. inst.:***	JMA
		Use applic.:	Industrial - mining		
		Equipment:	No equipment		

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10006 ***Number:*** SDF-6 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Des.:*** BOREHOLE SDF-6 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-7745.621	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2931473.15	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.43
Altitude [m]:	1598.84			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011107	CASED TO 165
JMA	30.00	80.00	165	20011107	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011107	0.00	30.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Damp	
1.00	5.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
5.00	8.00	DOLERITE	Brown			Weathered	Damp
8.00	12.00	DOLERITE	Grey	Brownish	Fine to medium	Weathered	Jointed
12.00	15.00	DOLERITE	Grey	Greenish	Fine to medium	Fresh	Dry
15.00	16.00	SHALE	Grey			Fresh	Baked
16.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
30.00	44.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
44.00	53.00	DOLERITE	Grey	Greenish	Medium	Fresh	Dry
53.00	60.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
60.00	80.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1620	0.00	4.04	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1800	0							0.017		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

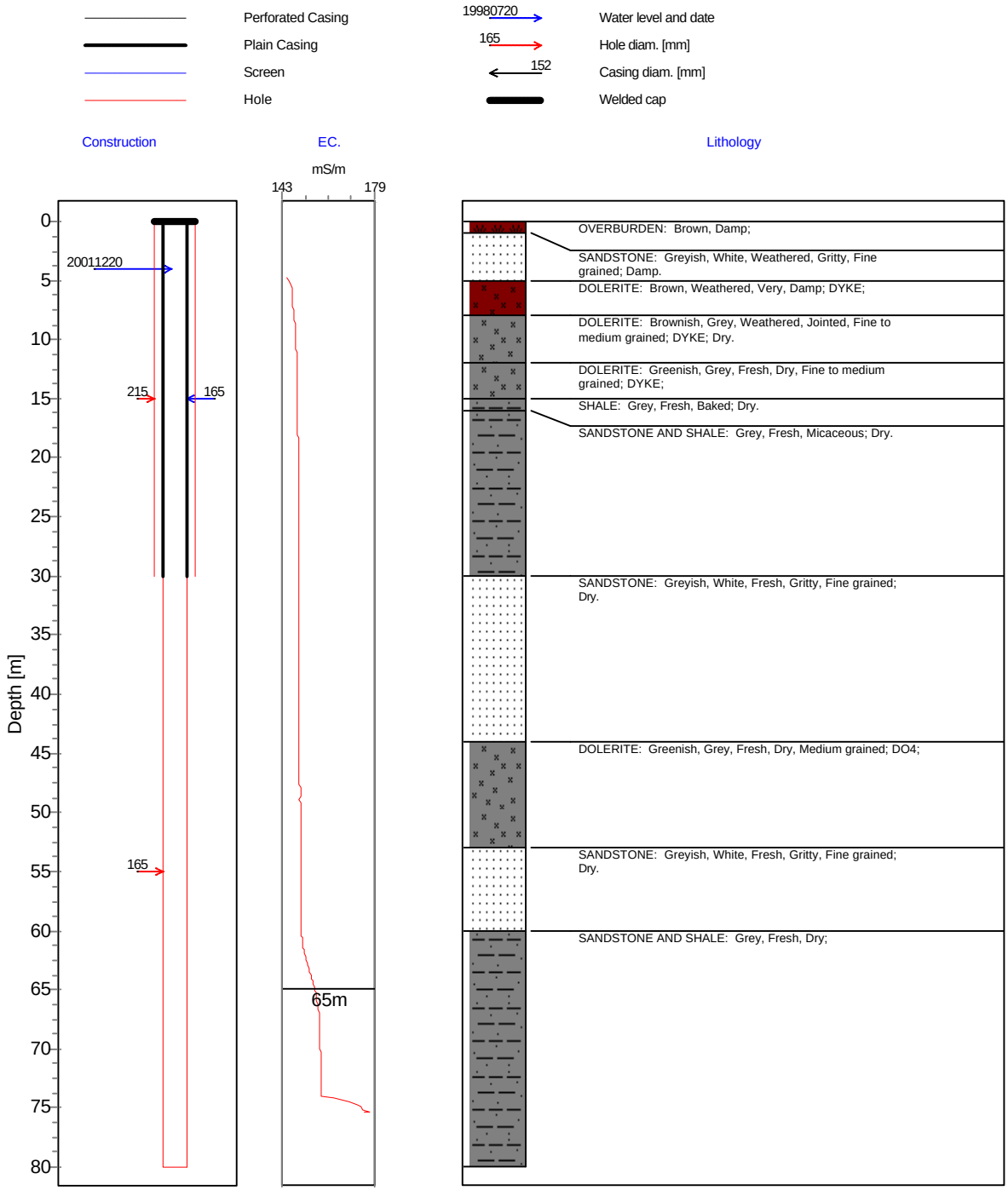
BASIC SITE INFORMATION:

Site Identifier: 2629AC10006 ***Number:*** SDF-6 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Descr.:*** BOREHOLE SDF-6 : BLOCK 8

Y Coord. [m]:	-7745.62100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2931473.15	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.43
Altitude [m]:	1598.84			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10007 **Number:** SDF-7 **Site type:** Borehole

Distr./Farm No.: 131 IS **Site Name/Des.:** BOREHOLE SDF-7 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-6945.279	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2930161.941	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.37
Altitude [m]:	1580.56			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011114	CASED TO 165
JMA	30.00	80.00	165	20011114	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011114	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	8.00	10.00	1.00	Estimated			
JMA	17.00	18.00	19.00	Estimated			
JMA	41.00	43.00	10.00	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Black			Clayey	Damp
1.00	4.00	CLAY	Brown	Yellowish		Sandy	Damp
4.00	5.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
5.00	8.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
8.00	18.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Fresh
18.00	24.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
24.00	28.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
28.00	29.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous
29.00	35.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
35.00	36.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
36.00	37.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
37.00	38.00	SHALE	Grey	Dark		Fresh	Carbonaceous
38.00	41.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
41.00	43.00	SANDSTONE AND SHALE				Weathered	Jointed
43.00	44.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
44.00	67.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
67.00	69.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
69.00	77.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
77.00	79.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
79.00	80.00	COAL					

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011221	1310	0.00	1.59	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011221	25	0							5.82		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

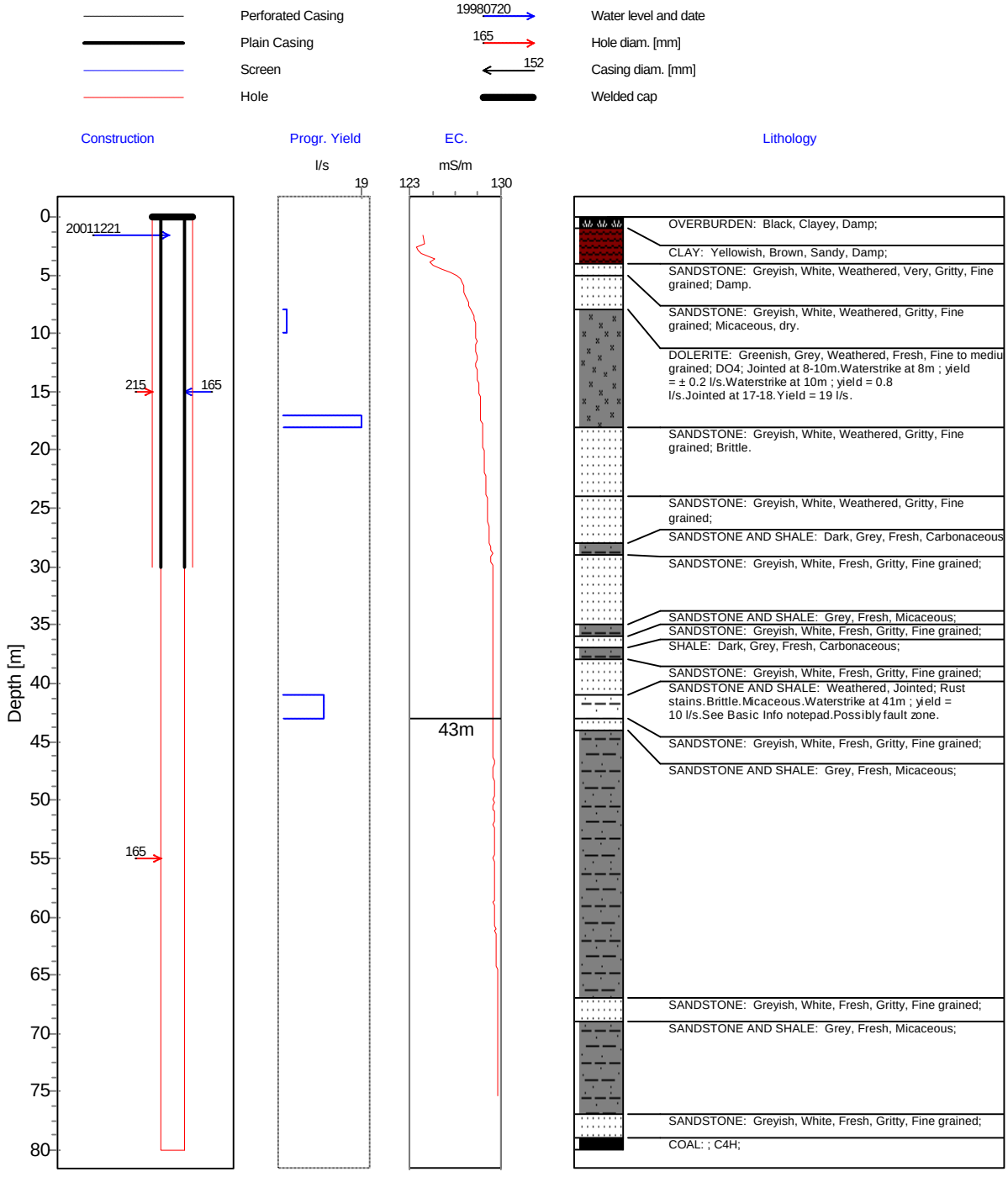
BASIC SITE INFORMATION:

Site Identifier: 2629AC10007 ***Number:*** SDF-7 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Descr.:*** BOREHOLE SDF-7 : BLOCK 8

Y Coord. [m]:	-6945.27900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2930161.94	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.37
Altitude [m]:	1580.56			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

Page 1

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA10008 **Number:** SDF-8 **Site type:** Borehole

Distr./Farm No.: 130 IS **Site Name/Des.:** BOREHOLE SDF-8 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-4384.176	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	84.00
X Coord. [m]:	2935039.747	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.51
Altitude [m]:	1580.77			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011108	CASED TO 165
JMA	30.00	84.00	165	20011108	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011108	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	12.00	13.00	0.10	Estimated			SEEPAGE WATER
JMA	27.00	28.00	0.50	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown			Gravel-bearing	Damp
1.00	5.00	SANDSTONE AND SHALE	Brown	Yellowish		Weathered	Clayey
5.00	15.00	SANDSTONE AND SHALE	Brown	Greyish		Weathered	
15.00	16.00	SANDSTONE AND SHALE	Grey			Fresh	
16.00	18.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
18.00	27.00	DOLERITE	White	Greyish		Fresh	
27.00	28.00	DOLERITE	White	Greyish		Jointed	
28.00	45.00	DOLERITE	White	Greyish		Fresh	
45.00	51.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
51.00	70.00	SANDSTONE AND SHALE	Grey			Fresh	
70.00	72.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
72.00	74.00	SHALE	Grey	Dark		Fresh	Carbonaceous
74.00	84.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011221	1115	0.00	0.26	SLUGTEST

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Borehole Construction and Geological Log

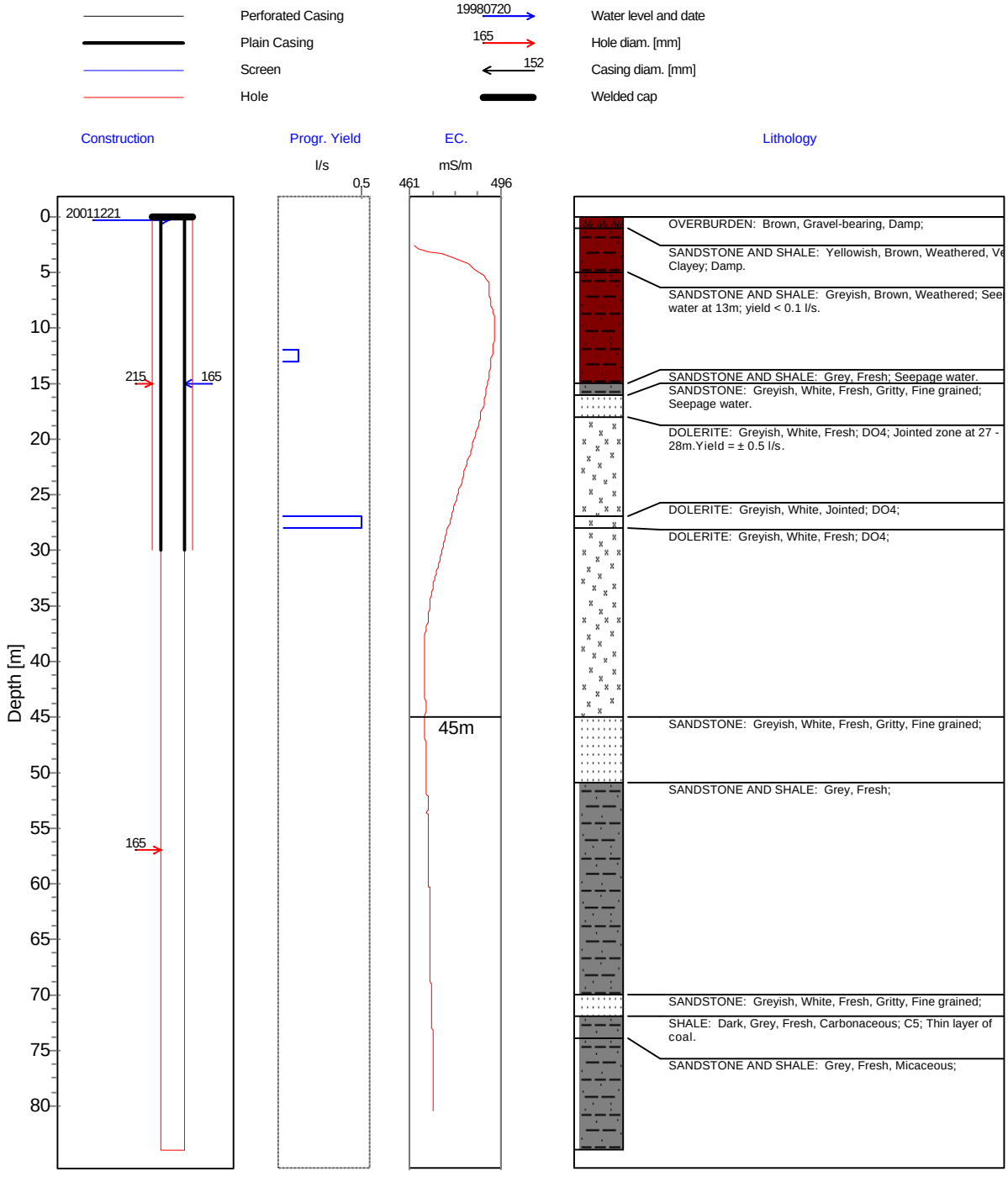
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629CA10008 ***Number:*** SDF-8 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Descr.:*** BOREHOLE SDF-8 : BLOCK 8

Y Coord. [m]:	-4384.17600	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	84.00
X Coord. [m]:	2935039.75	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.51
Altitude [m]:	1580.77			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA10009 ***Number:*** SDF-9 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Des.:*** BOREHOLE SDF-9 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-2885.659	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2934021.126	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.47
Altitude [m]:	1568.90			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011108	CASED TO 165
JMA	30.00	80.00	165	20011108	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011108	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	72.00	72.00	0.20	Estimated			

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Clayey	Damp
1.00	7.00	CLAY	Brown			Sandy	Damp
7.00	9.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
9.00	18.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
18.00	22.00	SHALE	Grey	Dark		Fresh	Carbonaceous
22.00	41.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
41.00	42.00	DOLERITE	Green	Greyish	Medium to coarse	Fresh	Dry
42.00	45.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
45.00	48.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
48.00	54.00	SANDSTONE	Grey	Greenish	Fine	Fresh	Gritty
54.00	55.00	SHALE	Grey	Dark		Fresh	Carbonaceous
55.00	57.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
57.00	70.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
70.00	73.00	SANDSTONE AND SHALE	Grey			Fresh	
73.00	80.00	SANDSTONE	White	Greenish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011221	1440	0.00	4.79	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011221	1800	0							0.006		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

BASIC SITE INFORMATION:

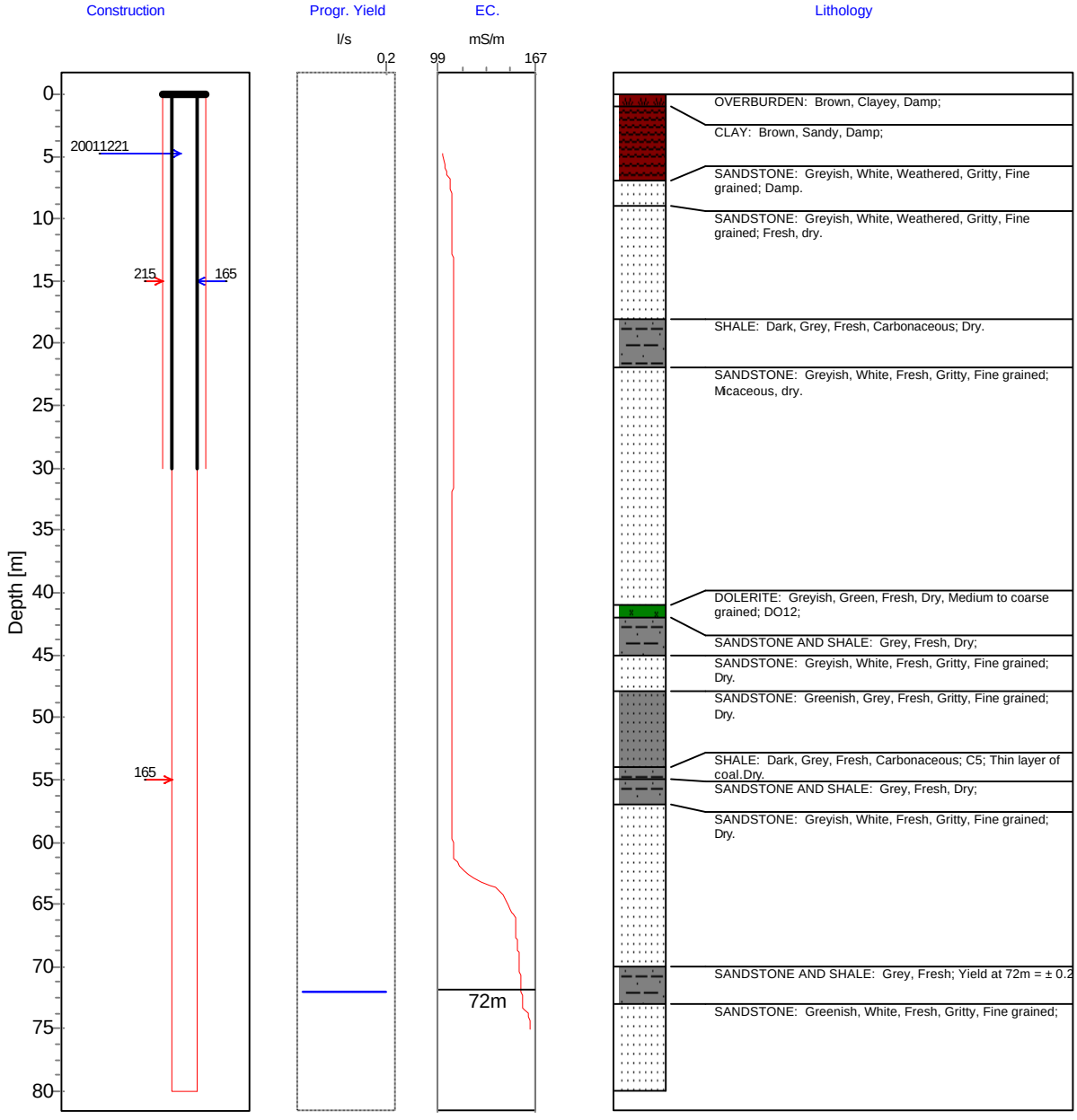
Site Identifier: 2629CA10009 ***Number:*** SDF-9 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Descr.:*** BOREHOLE SDF-9 : BLOCK 8

Y Coord. [m]:	-2885.65900	***Alt. No. 1:***	***Topo-set.:***	Hillside (slope)	***Depth [m]:*** 80.00
X Coord. [m]:	2934021.13	***Alt. No. 2:***	***Site status:***	In use	***Collar h. [m]:*** 0.47
Altitude [m]:	1568.90		***Site purp.:***	Observation	***Drain. reg.:*** C12D
Coord. acc.:	Accurate to within 1 unit		***Use applic.:***	Industrial - mining	***Diam. [mm]:*** 165
Coord. meth.:	Global Positioning System		***Equipment:***	No equipment	***Rep. inst.:*** JMA

Construction and Geohydrological Legend

Perforated Casing
Plain Casing
Screen
Hole
19980720 — Water level and date
165 — Hole diam. [mm]
152 — Casing diam. [mm]
Welded cap



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10010 **Number:** SDF-10 **Site type:** Borehole

Distr./Farm No.: 128 IS **Site Name/Des.:** BOREHOLE SDF-10 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-1235.451	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2930650.269	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.36
Altitude [m]:	1572.22			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011112	CASED TO 165
JMA	30.00	80.00	165	20011112	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011112	0.00	30.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown			Damp	
1.00	7.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
7.00	8.00	MUDSTONE	Grey			Weathered	Dry
8.00	12.00	MUDSTONE	Grey			Weathered	Dry
12.00	13.00	SHALE	Grey			Baked	Jointed
13.00	15.00	SANDSTONE AND SHALE				Fresh	
15.00	16.00	DOLERITE			Fine	Fresh	Jointed
16.00	19.00	MUDSTONE	Grey			Fresh	Dry
19.00	24.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
24.00	28.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous
28.00	50.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
50.00	63.00	SANDSTONE	White	Greenish	Fine	Fresh	Gritty
63.00	65.00	SHALE	Grey	Dark		Fresh	Carbonaceous
65.00	69.00	SANDSTONE AND SHALE				Fresh	Micaceous
69.00	78.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
78.00	80.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1250	0.00	4.43	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	1800	0							0.004		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

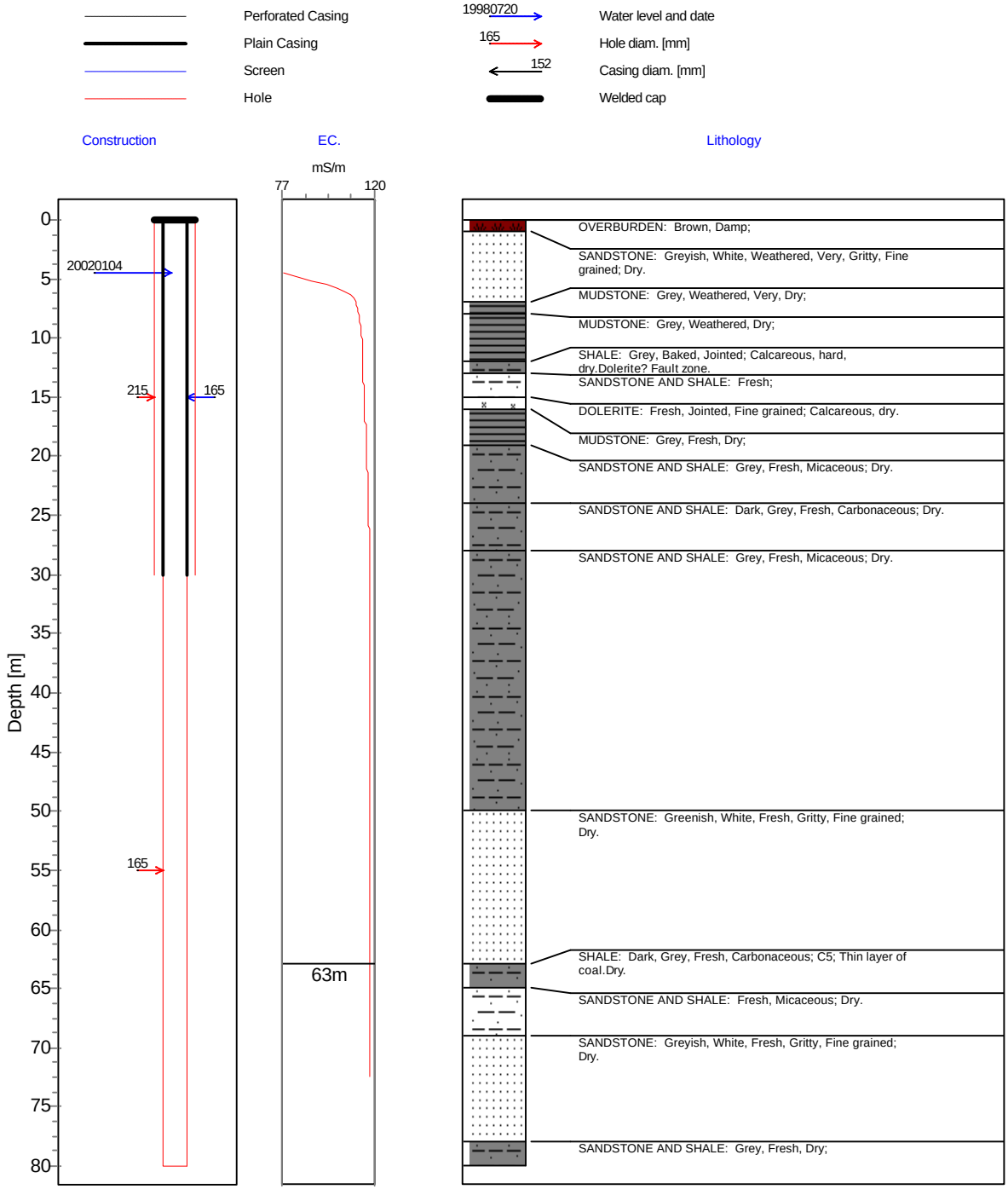
BASIC SITE INFORMATION:

Site Identifier: 2629AC10010 ***Number:*** SDF-10 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SDF-10 : BLOCK 8

Y Coord. [m]:	-1235.45100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2930650.27	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.36
Altitude [m]:	1572.22			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10011 **Number:** SDF-11 **Site type:** Borehole

Distr./Farm No.: 128 IS **Site Name/Des.:** BOREHOLE SDF-11 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-2479.305	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	144.00
X Coord. [m]:	2928046.206	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.25
Altitude [m]:	1634.64			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	6.00	215	20011126	CASED TO 165
JMA	6.00	144.00	165	20011126	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011126	0.00	6.00	165	PVC	2					

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	2.00	OVERBURDEN	Brown			Dry	
2.00	4.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
4.00	8.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
8.00	40.00	DOLERITE	Grey	Greenish	Fine to medium	Fresh	Dry
40.00	46.00	DOLERITE	Grey	Greenish		Fresh	Jointed
46.00	48.00	MUDSTONE	Grey	Greenish		Fresh	Dry
48.00	57.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
57.00	66.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
66.00	73.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous
73.00	93.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
93.00	105.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
105.00	107.00	SHALE	Grey	Dark		Fresh	Carbonaceous
107.00	108.00	COAL	Black			Dry	
108.00	109.00	SHALE	Grey	Dark		Fresh	Carbonaceous
109.00	126.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
126.00	134.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
134.00	135.00	COAL					
135.00	138.00	SANDSTONE	White	Greyish	Fine to medium	Fresh	Gritty
138.00	141.00	COAL					
141.00	144.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	0910	0.00	73.86	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	1800	0							0.053		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

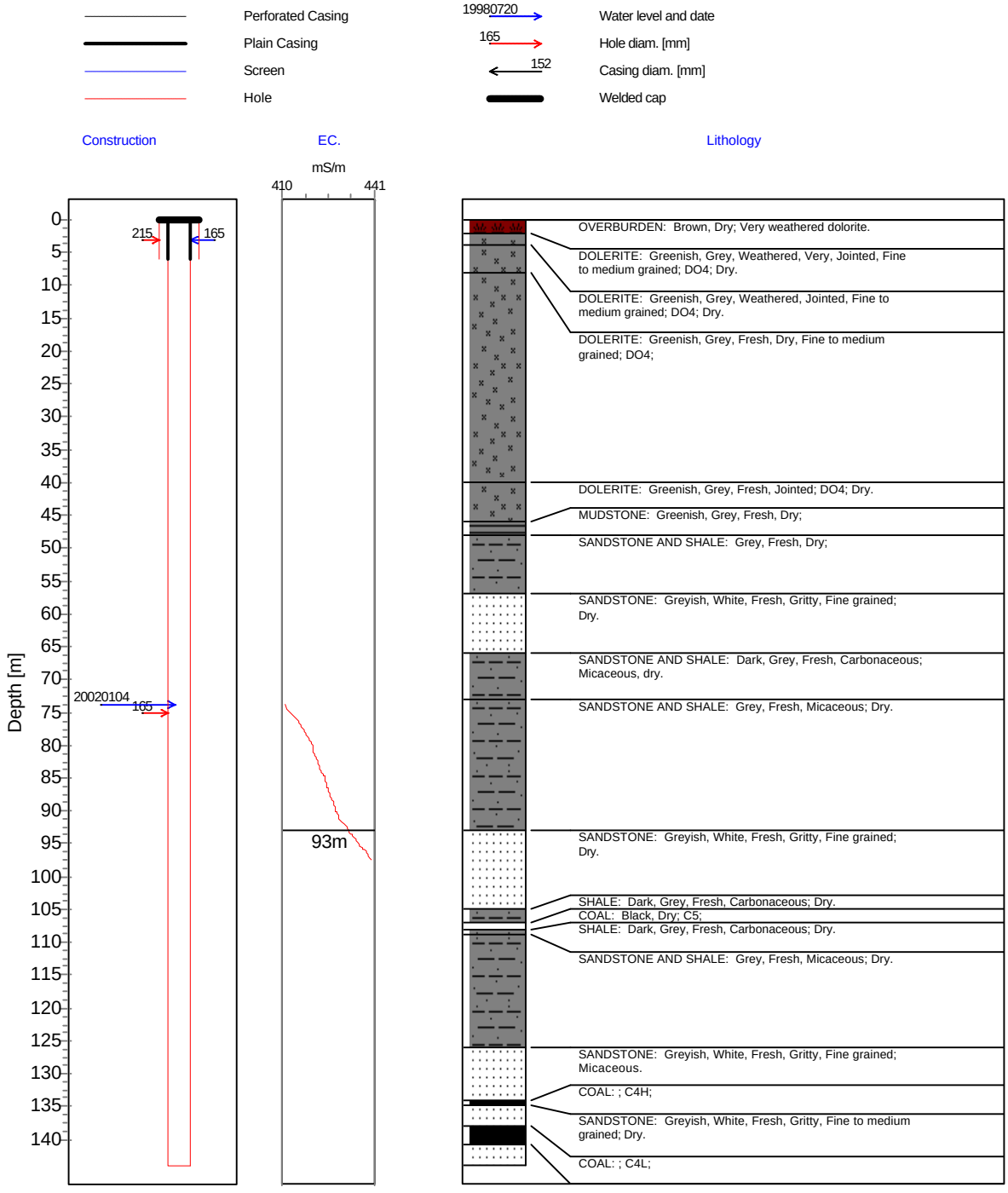
BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10011 ***Number:*** SDF-11 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SDF-11 : BLOCK 8

Y Coord. [m]:	-2479.30500	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)
X Coord. [m]:	2928046.21	***Alt. No. 2:***		***Site status:***	In use
Altitude [m]:	1634.64			***Site purp.:***	Observation
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment

Depth [m]:	144.00
Collar h. [m]:	0.25
Drain. reg.:	C12D
Diam. [mm]:	165
Rep. inst.:	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10012 **Number:** SDF-12 **Site type:** Borehole

Distr./Farm No.: 128 IS **Site Name/Des.:** BOREHOLE SDF-12 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-48.109	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2926022.541	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.43
Altitude [m]:	1607.45			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011109	CASED TO 165
JMA	30.00	80.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011109	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	11.00	12.00	0.10	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Grey	Dark		Damp	
1.00	4.00	DOLERITE	Brown	Yellowish		Weathered	Damp
4.00	7.00	DOLERITE	Grey	Greenish		Weathered	Jointed
7.00	12.00	DOLERITE	Grey	Greenish		Fresh	
12.00	14.00	SANDSTONE AND SHALE	Grey			Fresh	
14.00	27.00	SANDSTONE			Fine	Fresh	Gritty
27.00	44.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous
44.00	53.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
53.00	80.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1135	0.00	8.88	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	600	0							0.126		

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Borehole Construction and Geological Log

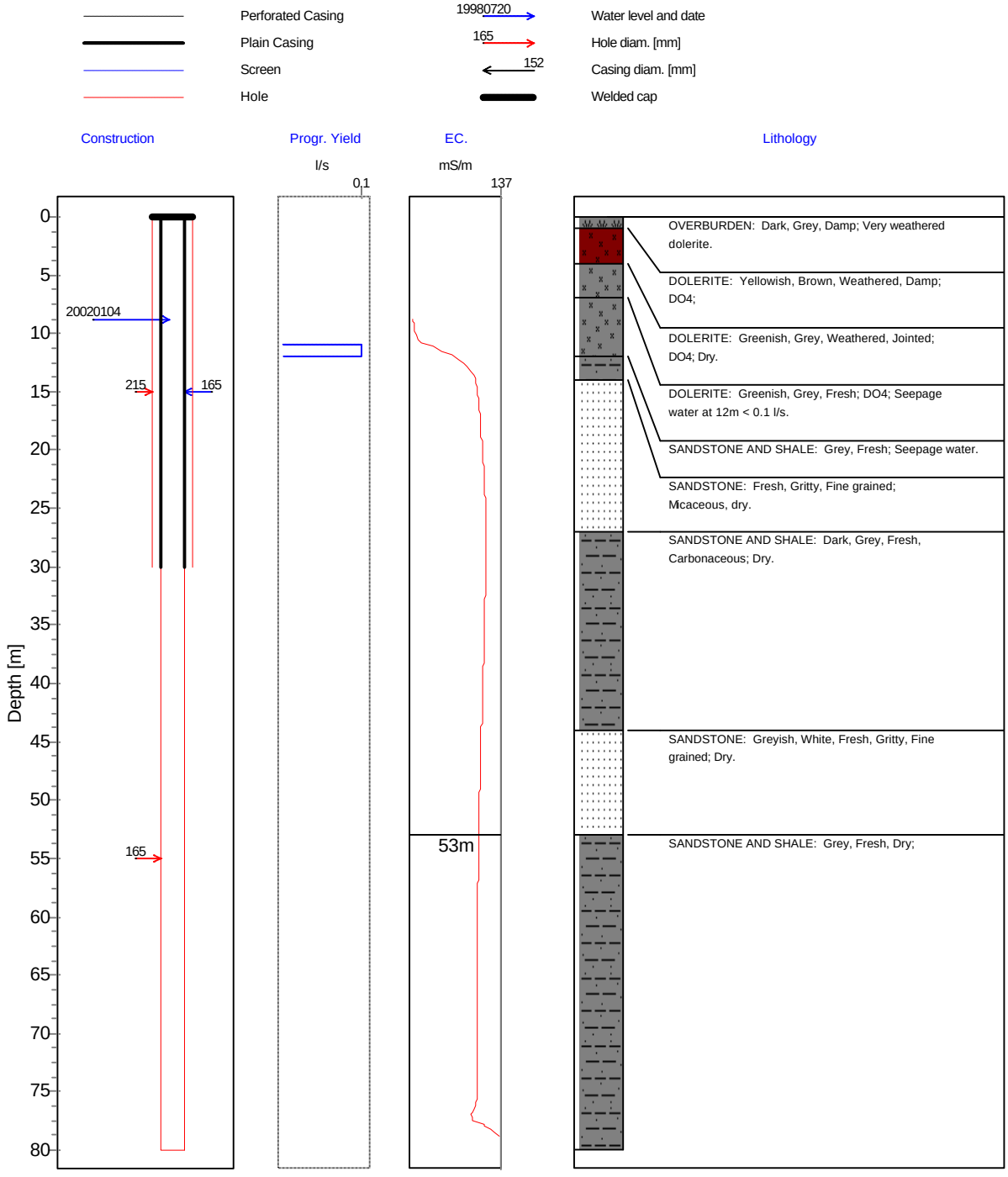
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10012 ***Number:*** SDF-12 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SDF-12 : BLOCK 8

Y Coord. [m]:	-48.10900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2926022.54	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.43
Altitude [m]:	1607.45			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628BD10013 ***Number:*** SDF-13 ***Site type:*** Borehole

Distr./Farm No.: 359 IR ***Site Name/Des.:*** BOREHOLE SDF-13 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	1145.281	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2930918.419	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.28
Altitude [m]:	1606.65			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011124	CASED TO 165
JMA	30.00	80.00	165	20011124	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011124	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	28.00	29.00	0.10	Estimated			

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Grey	Dark		Clayey	Damp
1.00	4.00	DOLERITE	Brown	Yellowish		Weathered	Damp
4.00	6.00	DOLERITE	Grey	Brownish		Weathered	Jointed
6.00	27.00	DOLERITE	Grey	Greenish		Fresh	Jointed
27.00	29.00	DOLERITE	Grey	Greenish		Weathered	Jointed
29.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
30.00	36.00	SANDSTONE AND SHALE	Grey			Fresh	Wet
36.00	38.00	SHALE	Grey	Dark		Fresh	Carbonaceous
38.00	39.00	SANDSTONE AND SHALE	Grey			Fresh	Wet
39.00	54.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
54.00	57.00	SANDSTONE AND SHALE	Grey			Fresh	Wet
57.00	66.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
66.00	69.00	SANDSTONE AND SHALE	Grey			Fresh	Wet
69.00	80.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	1550	0.00	19.41	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.024		

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Borehole Construction and Geological Log

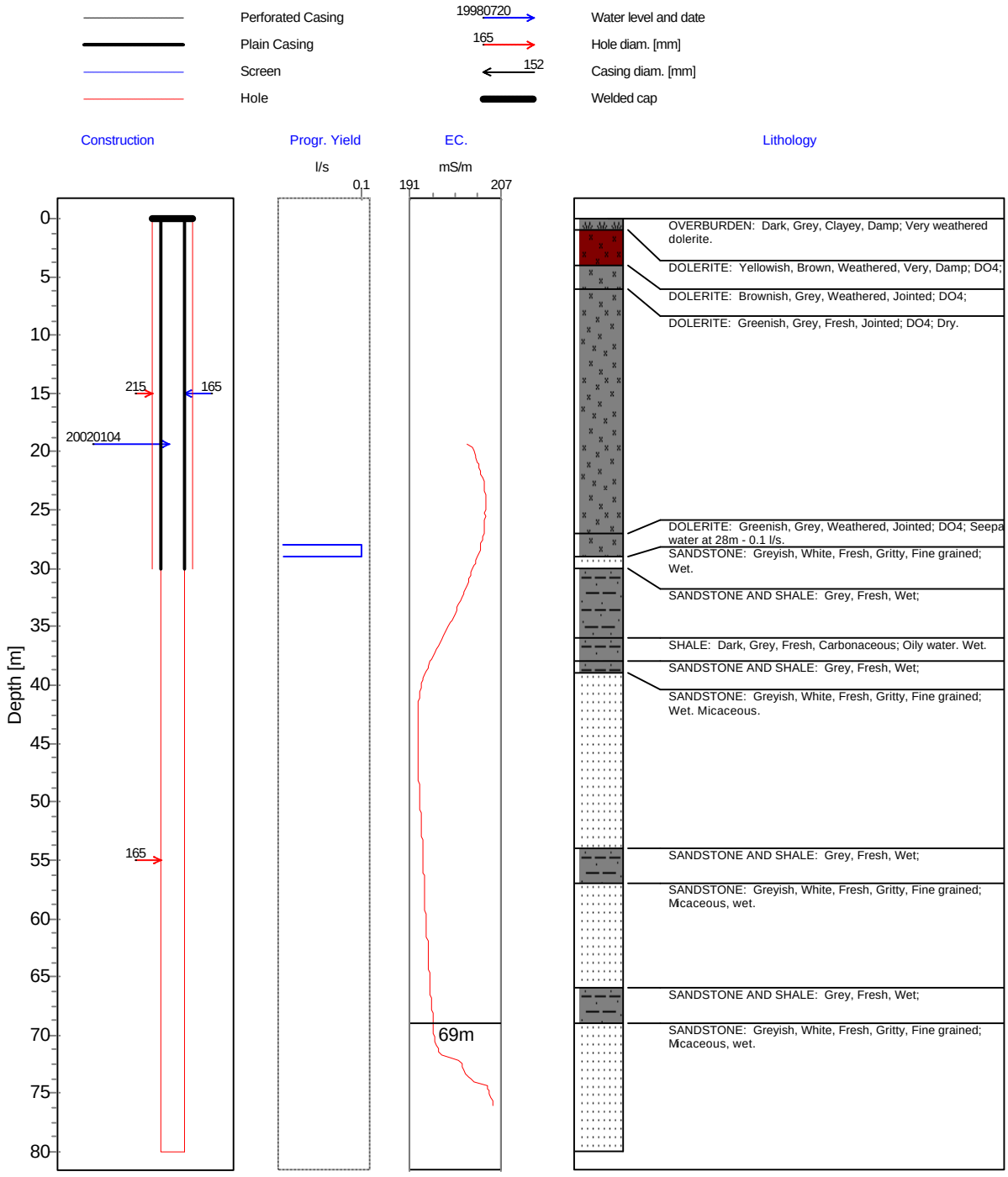
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2628BD10013 ***Number:*** SDF-13 ***Site type:*** Borehole

Distr./Farm No.: 359 IR ***Site Name/Descr.:*** BOREHOLE SDF-13 : BLOCK 8

Y Coord. [m]:	1145.28100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2930918.42	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.28
Altitude [m]:	1606.65			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628DB10014 ***Number:*** SDF-14 ***Site type:*** Borehole

Distr./Farm No.: 531 IR ***Site Name/Des.:*** BOREHOLE SDF-14 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	1207.168	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	102.00
X Coord. [m]:	2933576.875	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.49
Altitude [m]:	1571.32			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	36.00	215	20011124	CASED TO 165
JMA	36.00	102.00	165	20011124	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011124	0.00	36.00	165	PVC	2					

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	26.00	28.00	2.00	Estimated			
JMA	32.00	33.00	8.00	Estimated			
JMA	60.00	64.00	0.90	Estimated			

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Grey	Dark		Clayey	Damp
1.00	11.00	MUDSTONE	Grey			Weathered	Dry
11.00	12.00	DOLERITE	Grey	Brownish	Fine to medium	Weathered	Dry
12.00	13.00	SHALE	Grey			Weathered	Baked
13.00	26.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
26.00	44.00	SANDSTONE AND SHALE	Grey			Fresh	Jointed
44.00	47.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
47.00	52.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
52.00	54.00	SANDSTONE	White	Greyish		Fresh	Gritty
54.00	62.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
62.00	65.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
65.00	87.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
87.00	89.00	COAL					
89.00	90.00	SANDSTONE	White	Greyish	Fine to medium	Fresh	Gritty
90.00	92.00	COAL					
92.00	96.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
96.00	97.00	SANDSTONE	Grey		Fine	Fresh	Gritty
97.00	102.00	SANDSTONE AND SHALE	Grey			Fresh	

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	1735	0.00	7.57	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	300	0							0.253		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

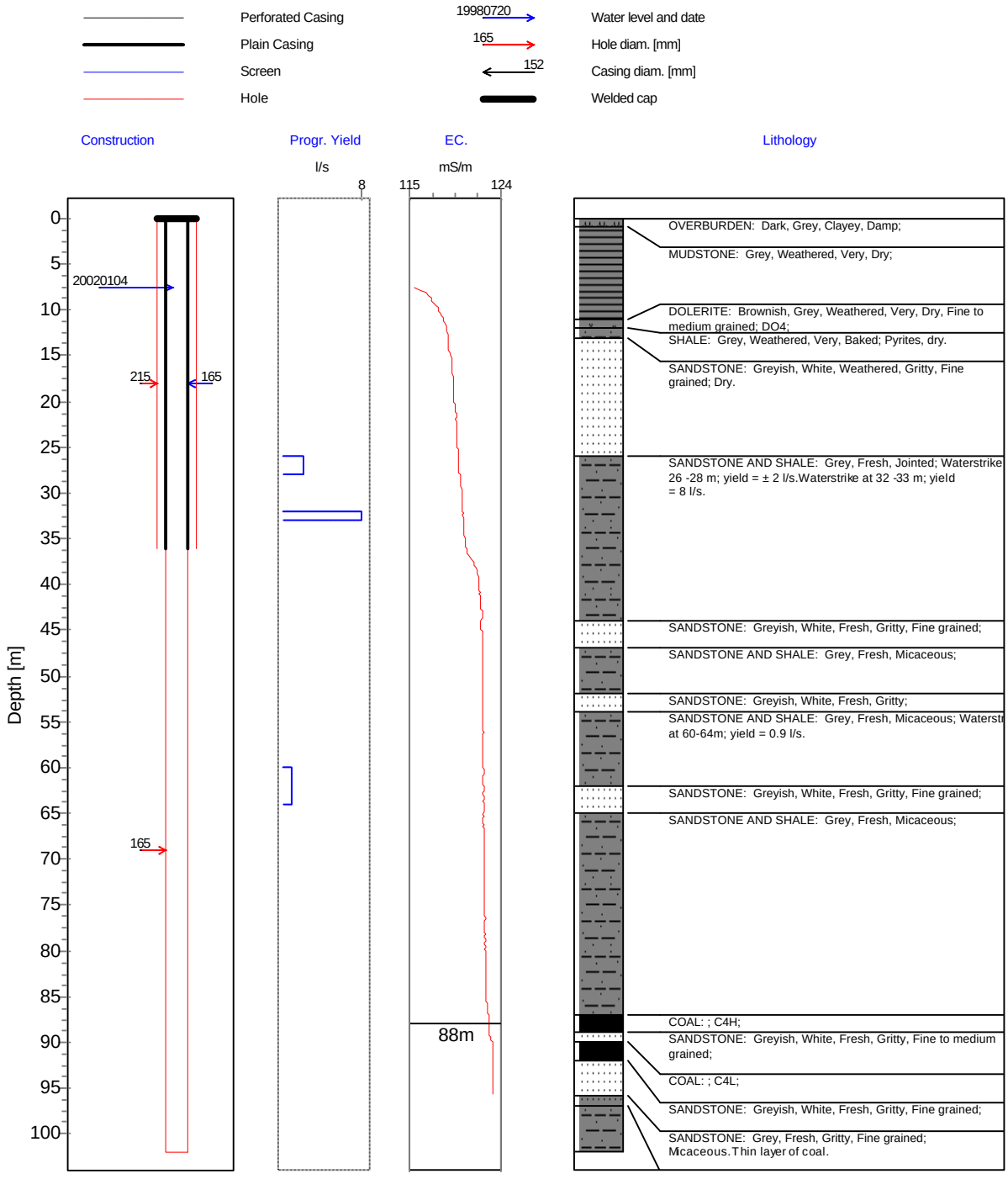
BASIC SITE INFORMATION: ***Site Identifier:*** 2628DB10014 ***Number:*** SDF-14 ***Site type:*** Borehole

Distr./Farm No.: 531 IR ***Site Name/Descr.:*** BOREHOLE SDF-14 : BLOCK 8

Y Coord. [m]:	1207.16800	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)
X Coord. [m]:	2933576.88	***Alt. No. 2:***		***Site status:***	In use
Altitude [m]:	1571.32			***Site purp.:***	Observation
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment

Depth [m]:	102.00
Collar h. [m]:	0.49
Drain. reg.:	C12D
Diam. [mm]:	165
Rep. inst.:	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628DB10015 ***Number:*** SDF-15 ***Site type:*** Borehole

Distr./Farm No.: 532 IR ***Site Name/Des.:*** BOREHOLE SDF-15 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	1802.728	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2937769.248	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.45
Altitude [m]:	1594.46			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011109	CASED TO 165
JMA	30.00	80.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011109	0.00	30.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown	Reddish		Clayey	Damp
1.00	5.00	SANDSTONE AND SHALE	Brown	Greyish		Weathered	Dry
5.00	11.00	SANDSTONE AND SHALE	Grey			Weathered	Dry
11.00	33.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
33.00	39.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
39.00	54.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
54.00	62.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
62.00	80.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020107	1715	0.00	24.06	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020107	1800	0							0.001		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

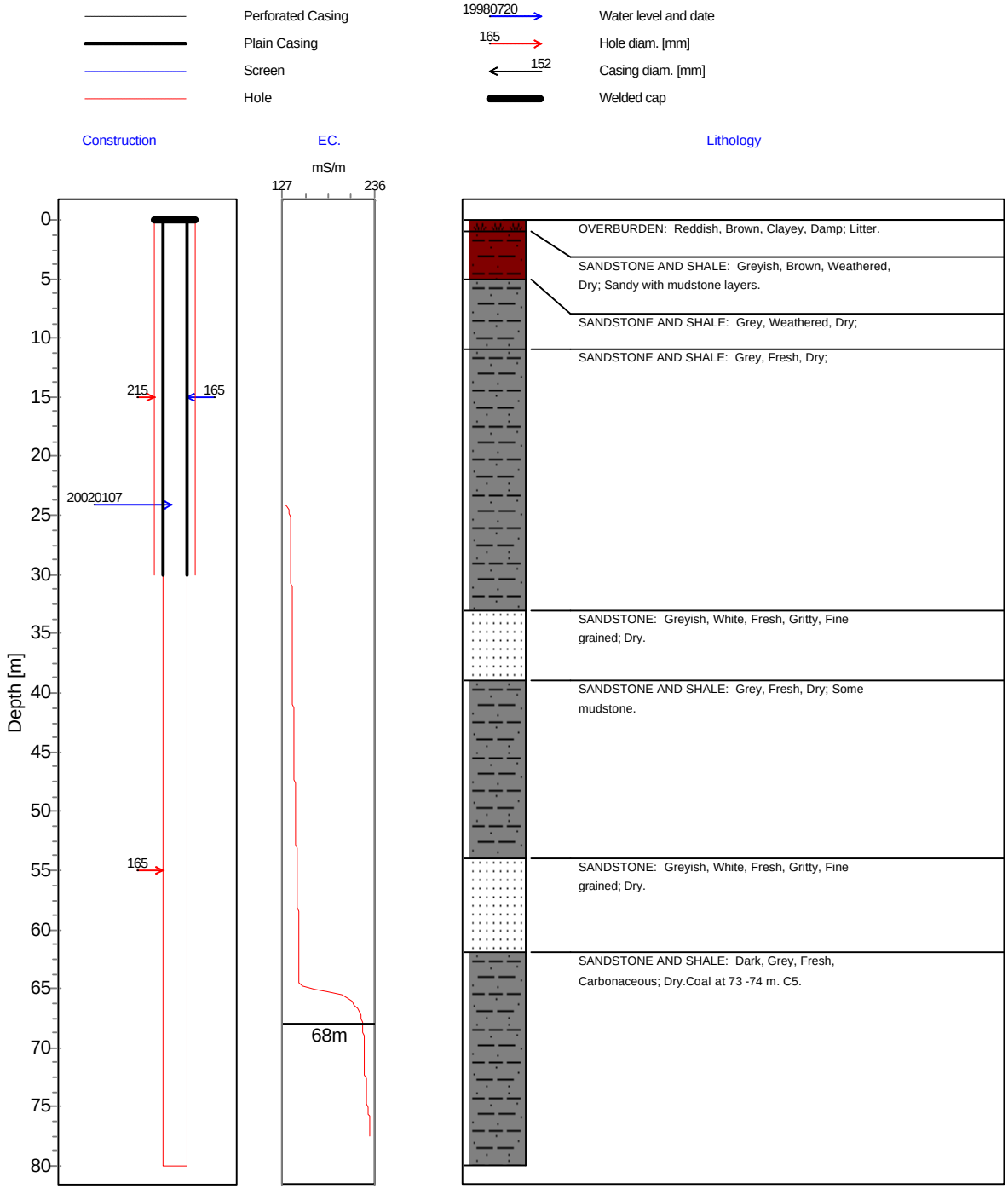
BASIC SITE INFORMATION:

Site Identifier: 2628DB10015 ***Number:*** SDF-15 ***Site type:*** Borehole

Distr./Farm No.: 532 IR ***Site Name/Descr.:*** BOREHOLE SDF-15 : BLOCK 8

Y Coord. [m]:	1802.72800	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2937769.25	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.45
Altitude [m]:	1594.46			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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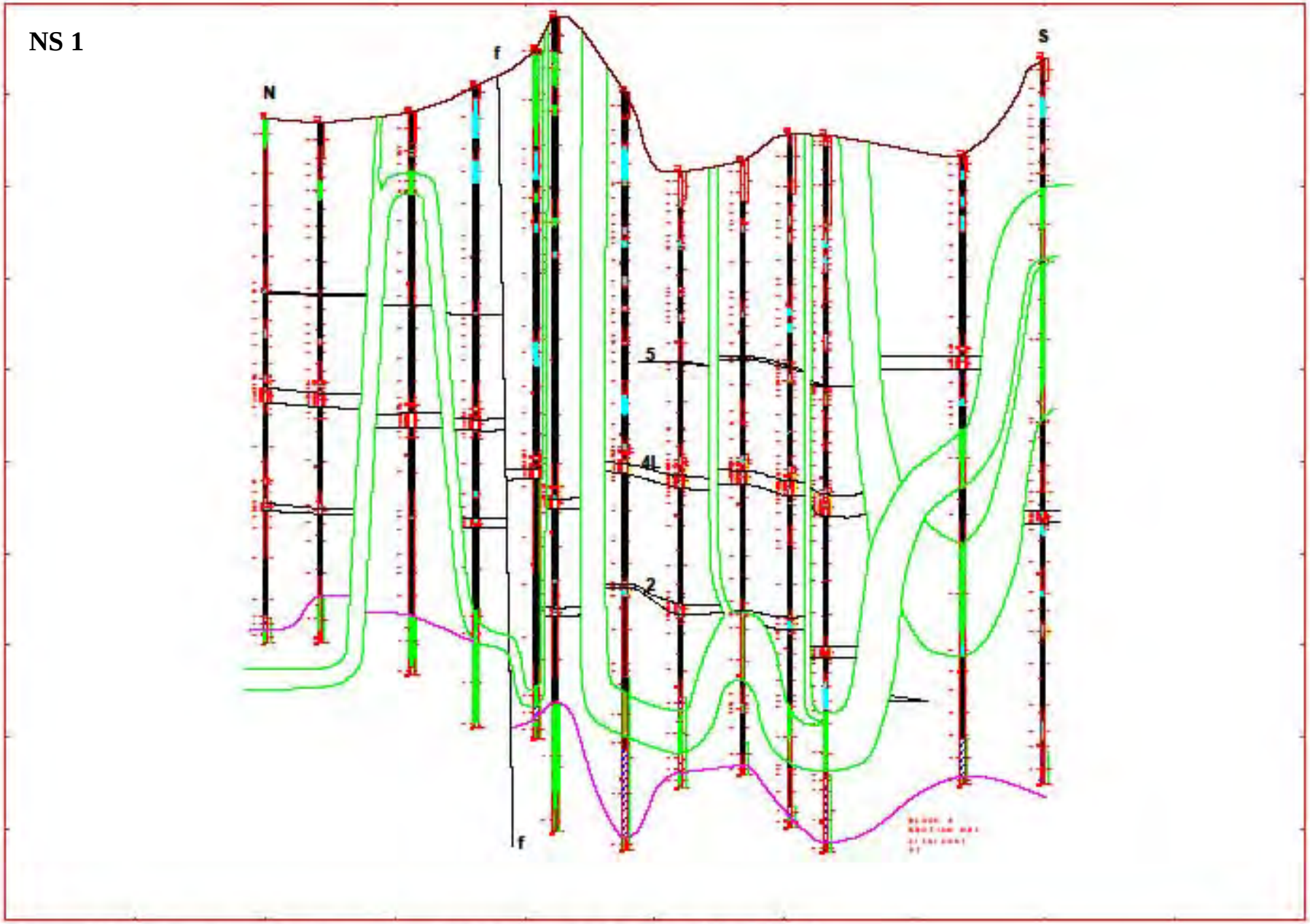
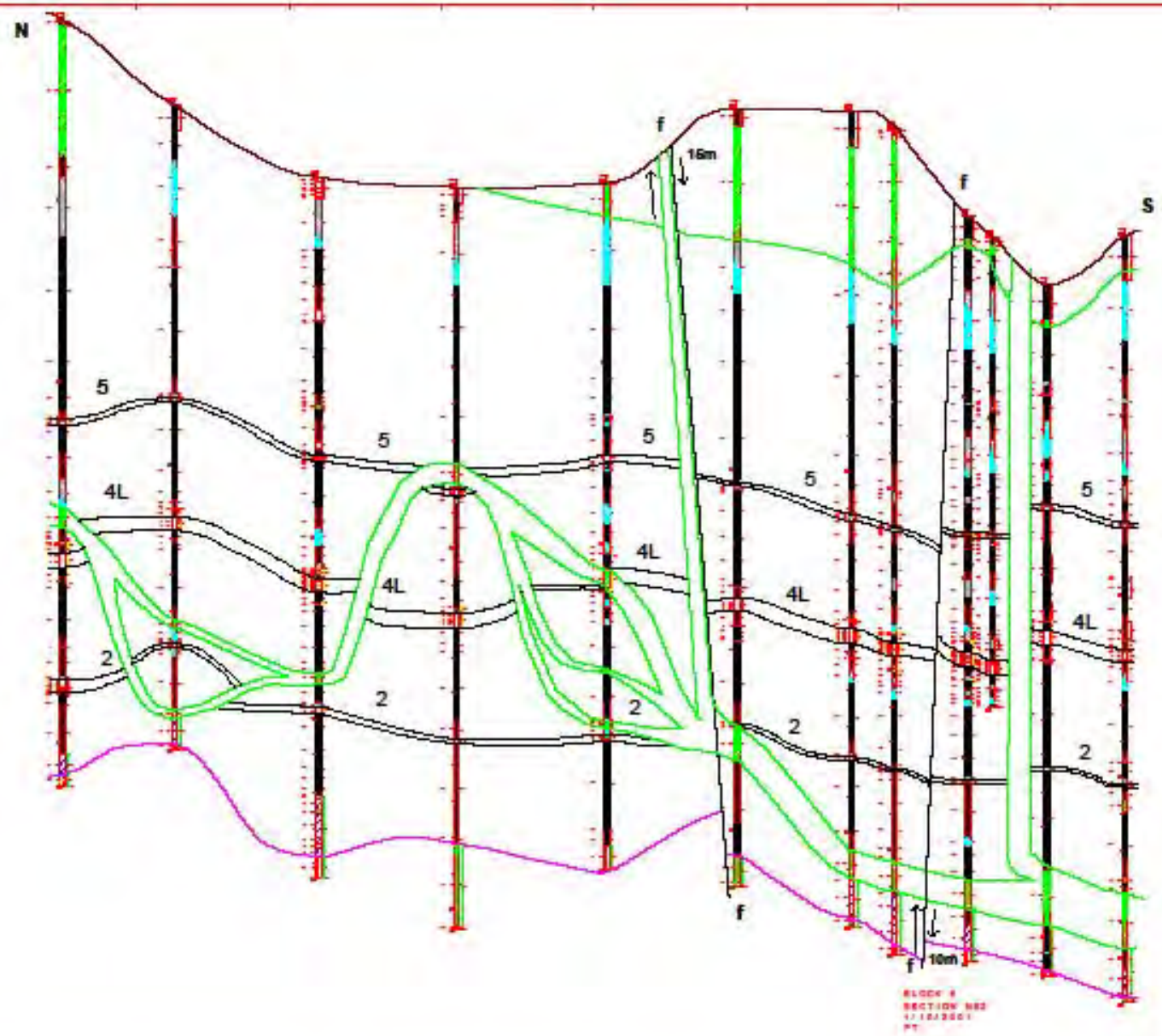
APPENDIX 6(B)

GEOLOGICAL CROSS SECTIONS

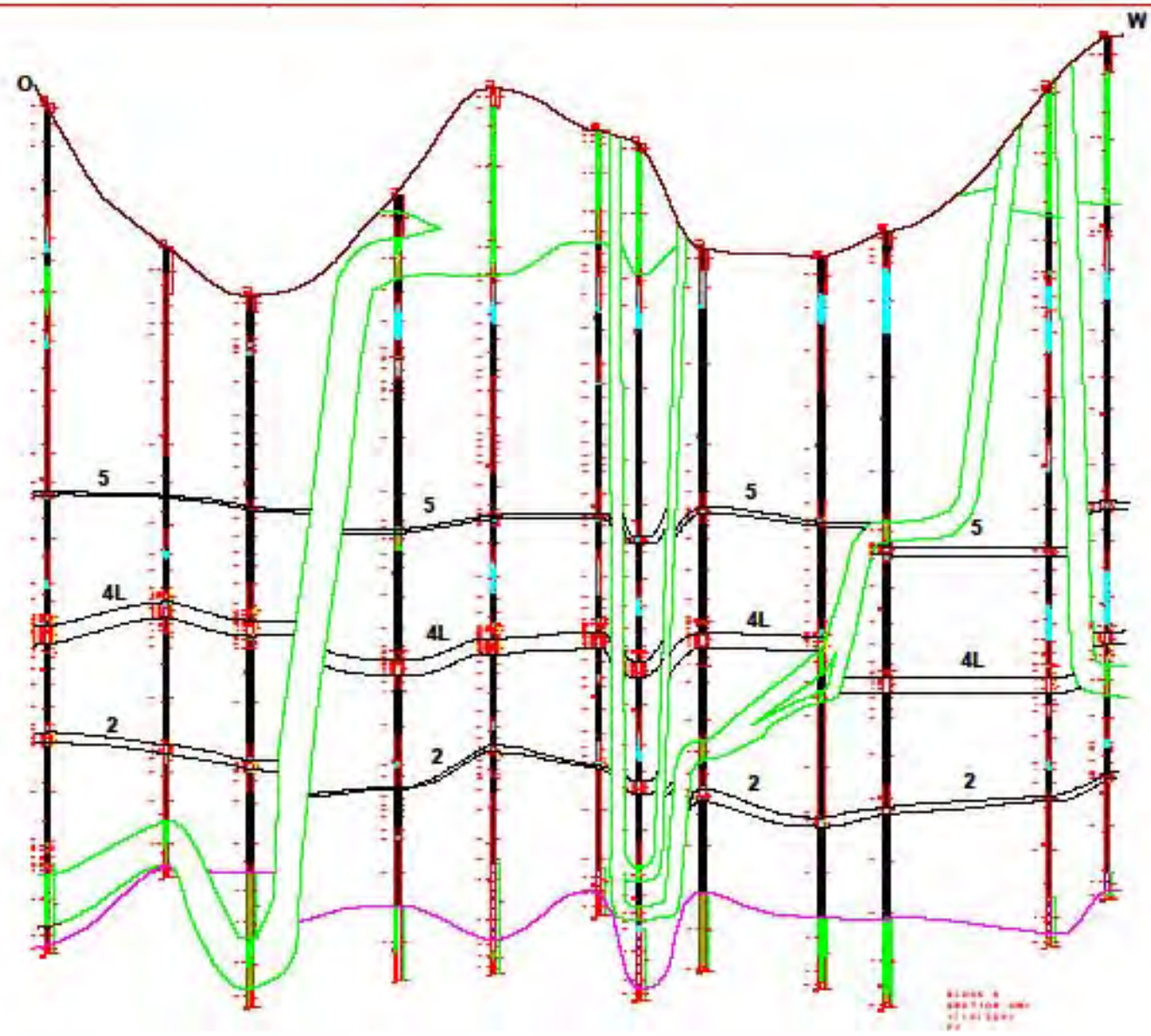
NS 1



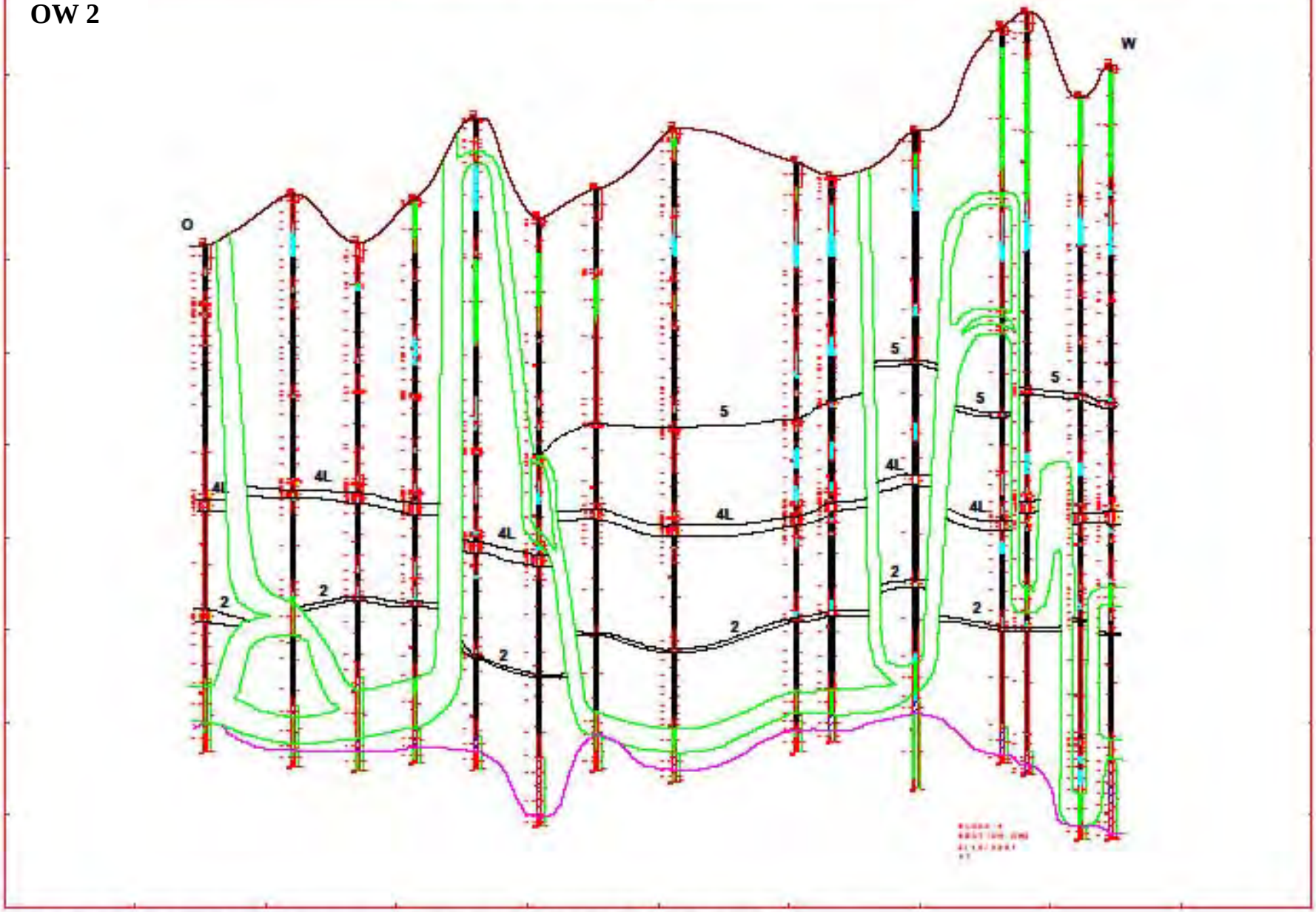
NS 2



OW 1

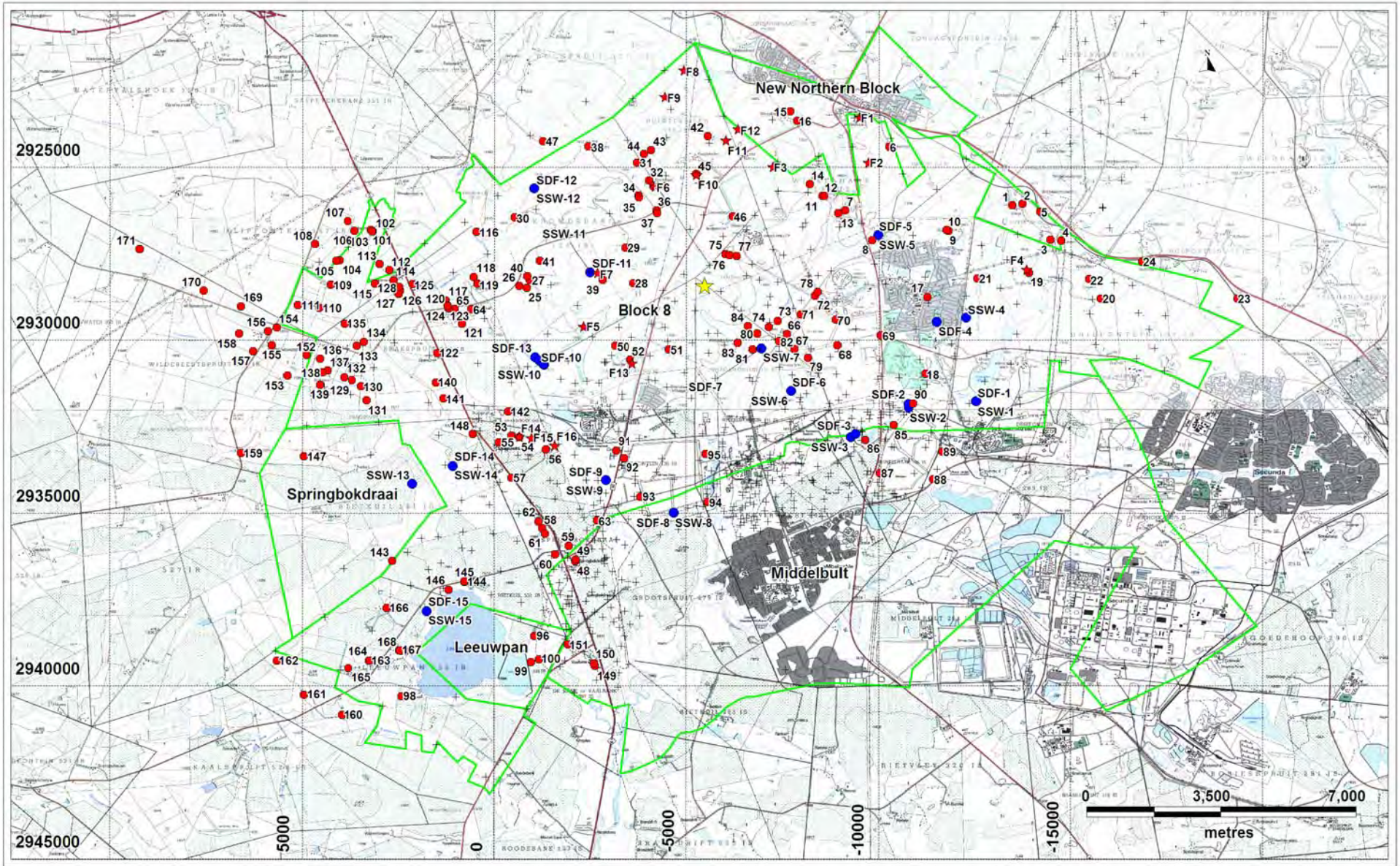


OW 2



APPENDIX 6(C)

BOREHOLE NUMBERS AND LOCALITY MAP



Date: August 2010

JMA CONSULTING (PTY) LTD

Sustainable Environmental Solutions through Integrated Science & Engineering

LEGEND

- Shondoni Shaft
- Reserve Extents
- Monitoring Boreholes
- External User Boreholes
- External User Fountains
- Exploration Boreholes