Rock Engineering Department Dorstfontein Regional Offices

Exxaro Coal Central

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KALABASFONTEIN PROJECT, FORZANDO COMPLEX: GEOTECHNICAL RISK ASSESSMENT

1. Introduction.

Exxaro Coal Central (ECC) holds a prospecting right to the Kalabasfontein area. As part of the Mining Right Application an Environmental Impact Assessment (EIA) must be conducted / completed. The assessment must consider the impact mining activities will have on the integrity of the environment or surface structures.

Several features occur on the surface area within the Kalabasfontein Reserve Area that needs to be protected. The features include dwellings, provincial roads, wetlands, streams and farmhouses. These features will either be undermined, or mining will occur within 100 m of them.

ECC plans to exploit the No.4 Seam reserves in this area. The reserves will be exploited through underground mining methods with mining heights (total seam extraction) expected to range from 2.1 m - 2.7. Mining heights more than 2.7 m may be encountered in localized zones. The depth of mining in the reserve area will range between 29.0 m and 117.0 m below ground surface.

This report details the geotechnical methodology that will be followed in the Mine Design Process to ensure that mining has no impact on the stability or integrity of the surface

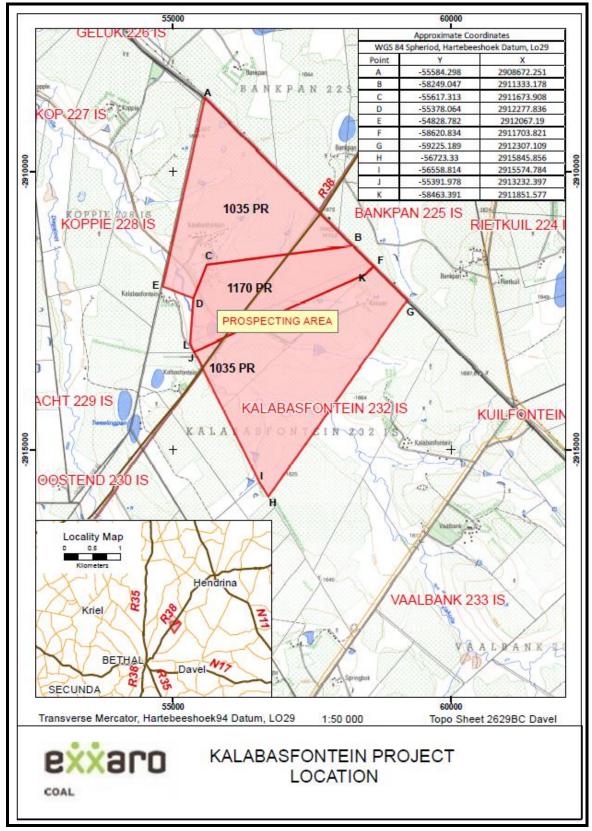


Figure 1: Plan showing Kalabasfontein Project location.

2. Information provided.

The following information was provided for use in this investigation:

- Locality plans (Figure 1).
- Geological boreholes logs (Appendix 1 & Indicated in Figure 2).

3. Methodology

The following investigation methodology was used in the risk assessment:

• Analysis of geological borehole log information for pillar designs, sinkhole and subsidence analysis.

4. Pillar Design.

Two risks can be expected when undermining surface structures:

- Pillars can collapse, usually over the entire panel,
- Roof failure can occur resulting in sinkhole formation.

a. Pillar Stability.

1) <u>Pillar Strength</u>

The pillar's strength is calculated using the van der Merwe and Mathey (2013) equation which is based on the review of 85 panel pillar cases as compared to the widely used Salamon and Munro (1967) formula which was based on 27 failed panel pillar cases. The van der Merwe and Mathey (2013) formula is given by:

$$\sigma_s = 5.47 \frac{w_s^{0.s}}{h} \text{ (MPa)} \tag{1}$$

Where:

 σ_s - is the pillar strength.

- h is the pillar height.
- *w* is the pillar width or effective pillar width for rectangular pillars.

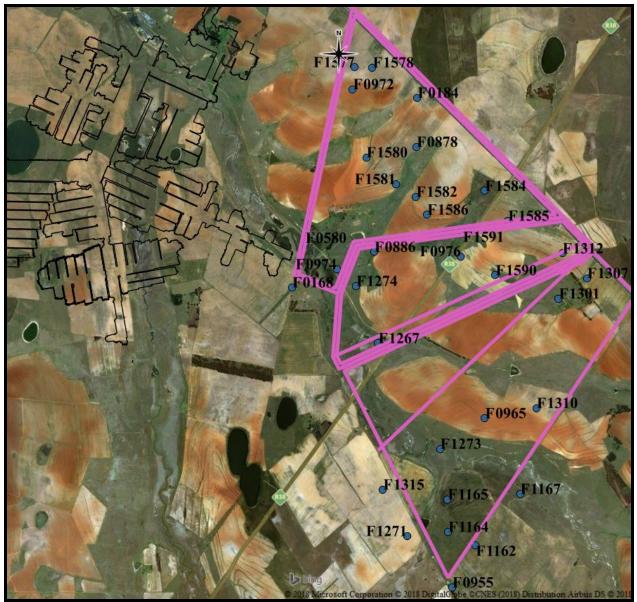


Figure 2: Satellite image showing Kalabasfontein boundaries (Purple) and the boreholes used in the assessment.

2) Pillar Load.

The pillar load is calculated using the tributary area theory which states that individual pillars carry an equal proportion of the of overburden load. This assumption applies where the pillars are of uniform size and the panel width is greater than the depth to the seam. The pillar load for square pillars is given by:

$$Load = \frac{0.025HC_1C_2}{w_1w_2} MPa$$
 (2)

Where:

- H is the depth to floor of the seam.
- *C1* is the pillar center distance in the split direction.
- C2 is the pillar center distance in the advance direction.
- w_1 pillar width in the split direction.
- w_2 is the pillar width in the advance direction.
- 3) <u>Safety Factor</u>

The pillar safety factor is the ratio between the pillar strength and the pillar load.

$$Safety Factor = \frac{Pillar Strength}{Pillar load}$$
(3)

b. Probability of Survival (POS)

A study undertaken by van der Merwe and Mathey (2013a) found that safety factor on its own is only a subjective evaluation of pillar stability. This is due to the fact that the survival of the pillar cannot be quantified through a safety factor calculation although a higher safety factor implies a higher rate of survival.

The concept of probability of survival was introduced to overcome the safety factor limitations. The following probability of survival formula was derived from the study:

$$POS_{OR} = 100 - 100 Exp[-2.5FS_{OR}^{1.8}](\%)$$
(4)

Where FS is safety factor calculated with equation 3.

van der Merwe and Mathey (2013a) further proposed acceptable POS norms which are given in the table below:

Table 1: Recommended POS

Category	Minimum POS	Remarks
	(%)	
Production panel	99.0	Short term, limited access, low traffic
Secondary development	99.5	Medium term, general access, medium traffic
Main development	99.9	Long term, general access, high traffic
Surface structure (1)	99.99	Low sensitivity to subsidence
Surface structure (2)	99.995	High sensitivity to subsidence, public access

c. Pillar Life Index

Van der Merwe (2003) undertook a study of failed pillar cases in both the Vaal and Witbank Coalfields in an effort to predict the life of pillars before failure. A recent review or update of the rate scaling was conducted by van der Merwe (2016) taking into account the concept of Probability of Survival

The amount a pillar has to scale in order to reach a Probability of Survival of 50%, is given by:

$$d_c = w - [0.002285HhC^2]^{0.3571} \,(\text{m}) \tag{5}$$

Where H = mining depth (m)

C = pillar centre distance (m)

h = mining height (m)

The predicted life of the pillar is then given by:

$$PLI = \left[\frac{d_c}{mh^x}\right]^{\frac{1}{1-x}}$$
(Years) (6)

Where m = dimensionless constant, 0.1799 for the No, 1, 2 and 4 Seams x = dimensionless constant, 0.7549 for the No, 1, 2 and 4 Seams h = mining height (m).

d_c = amount of scaling for POS of 50%

Category	Minimum PLI	Remarks
	(Years)	
Production panel	500 years	Short term, limited access, low traffic
Secondary development	800 years	Medium term, general access, medium traffic
Main development	1 000 years	Long term, general access, high traffic
Surface structure (1)	2 000 years	Low sensitivity to subsidence
Surface structure (2)	2 000 years	High sensitivity to subsidence, public access

The calculated pillar life index was found to be in excess of 2 000 years. Cognisance must be given to the fact that no pillar failure has been reported at Forzando South Coal Mine.

5. Sinkholes

Bulking factor analysis determines the height at which roof failure will progress to before being arrested by fallen material or by the effect of wedging. Bulking factor is defined as the ratio of total volume (solid plus void) to solid volume. Bulking factor is an important factor in determining the amount of material that will spill into the workings and the height of the goaf (z). A suggested bulking factor for caved sedimentary roof strata of 1, 3 was used. It should be noted that this approach assumes failure on the immediate roof of an intersection.

The caving height z is given by:

$$12\frac{\left(hD_{B}^{2}+2h^{2}D_{B}\cot\alpha\right)}{(K-1)\pi} = \left[\frac{(fD_{B})^{3}}{2\tan\phi} - (fD_{B}-2z\tan\phi)^{2}\left(\frac{fD_{B}}{2\tan\phi}-z\right)\right] (m)$$
(7)

Where $D_B = \text{bord width}$

f = ratio of bottom of collapse cavity to bord width (i.e. if the bottom of the collapse is the intersection width, f = 1.414)

K = bulking factor

 α = angle of repose of collapsed rock

 ϕ = inclination of collapse cavity sidewall, measured off the vertical. (20°)

The second termination mechanism, wedging out, occurs when the cavity height is given by:

$$z_m = \frac{f D_B}{2 \tan \phi} \quad (m) \tag{8}$$

The maximum height of the cavity is then the smallest of z or z_m . If the collapse cavity reaches the bottom of the weathered rock zone, it is assumed that a sinkhole can occur.

6. <u>Subsidence</u>

The act of mining will ultimately result in some sort of surface subsidence. Whether the subsidence is visible or not is dependent on the following factors:

- Depth of mining.
- Percentage extraction.
- The time at which the subsidence occurs.

The magnitude of subsidence in a stable pillar system is negligible. Cognisance must be given to the fact that although highly unlikely, pillar failure might occur resulting in the subsidence. The maximum subsidence in that unlikely event is given by:

$$S_{m,pf} = 2.986 \left\{ 1 - \frac{1}{2^{\lambda}} \right\}$$
(m) (9)

$$\lambda = \frac{h_{\theta/H}}{0.027}$$
(10)

Where *H* = mining depth

*h*_e = equivalent mining height, *mining height x extraction ratio*.

Van der Merwe and Madden (2010) further classifies the expected subsidence profile into the following classes based on the panel width and magnitude of subsidence:

Class	S _m /H	Description
A	<0.001	Barely noticeable, smooth, continuous profile, hairline cracks
В	0.001 - 0.005	Difficult to notice, smooth profile, cracks 1 to 2 cm wide
С	0.005 - 0.02	Noticeable in flat terrain, smooth, cracks 2 to 10 cm wide, compression ridges 1 to 5 cm high
D	0.02 – 0.05	Noticeable in most terrains, visible vertical displacements across cracks, cracks 10 to 50 cm wide, compression ridges 5 to 50 cm high
E	>0.05	Severe profile, almost vertical sides, cracks wider than 50 cm, compression ridges higher than 50 cm

Table 3: Classification of subsidence profiles (Van der Merwe et al, 2010)

7. <u>Results</u>

		Depth								Pillar Width		
Table 4: Summary of		to	Mining	Centre	Centre	Effective	Pillar		Corrected	to	Percentage	
assessmentBorehole	Base of	Floor	Height	Distance	Distance	Width	Strength	Load	Safety	Height	Areal	
number	Weathering	(H) (m)	(m)	(m)	2 (m)	(m)	(MPa)	(MPa)	Factor	Ratio	Extraction	PoS
F0168	16.00	100.56	2.45	18.00	18.00	10.80	14.98	6.98	2.45	4.41	64.00	99.99965
F0184	14.00	90.16	2.10	15.00	18.00	9.06	15.18	7.22	2.40	5.14	68.80	99.99944
F0580	3.90	71.23	2.10	15.00	15.00	7.80	13.47	6.59	2.45	3.71	72.96	99.99966
F0878	16.18	103.78	2.10	18.00	18.00	10.80	17.48	7.21	2.77	5.14	64.00	99.99998
F0886	10.72	40.63	2.10	15.00	15.00	7.80	13.47	3.76	4.30	3.71	72.96	100
F0955	15.77	42.84	2.10	15.00	15.00	7.80	13.47	3.96	4.08	3.71	72.96	100
F0965	17.50	61.45	2.10	15.00	15.00	7.80	13.47	5.68	2.85	3.71	72.96	99.99999
F0972	36.96	117.03	2.10	18.00	18.00	10.80	17.48	8.13	2.46	5.14	64.00	99.99966
F0974	6.22	42.21	2.10	15.00	15.00	7.80	13.47	3.90	4.14	3.71	72.96	100
F0976	19.50	70.12	2.10	15.00	15.00	7.80	13.47	6.48	2.49	3.71	72.96	99.99976
F1162	12.67	38.11	2.10	15.00	15.00	7.80	13.47	3.52	4.59	3.71	72.96	100
F1164	9.35	47.47	2.10	15.00	15.00	7.80	13.47	4.39	3.68	3.71	72.96	100
F1165	6.59	30.82	2.10	15.00	15.00	7.80	13.47	2.85	5.67	3.71	72.96	100
F1167	9.57	26.99	2.10	15.00	15.00	7.80	13.47	2.50	6.48	3.71	72.96	100
F1267	12.43	69.54	2.10	15.00	15.00	7.80	13.47	6.43	2.51	3.71	72.96	99.9998
F1271	12.54	49.78	2.10	15.00	15.00	7.80	13.47	4.60	3.51	3.71	72.96	100
F1273	6.37	67.28	2.10	15.00	15.00	7.80	13.47	6.22	2.60	3.71	72.96	99.99991

Borehole number	Base of Weathering	Depth to Floor (H) (m)	Mining Heigth (m)	Center Distance (m)	Center Distance 2 (m)	Effective Width (m)	Pillar Strength (MPa)	Load (MPa)	Corrected Safety Factor	Pillar Width to Height Ratio	Percentage Areal Extraction	PoS
F1274	9.87	53.59	2.10	15.00	15.00	7.80	13.47	4.95	3.26	3.71	72.96	100
F1301	12.22	93.48	2.10	15.00	18.00	9.06	15.18	7.49	2.32	5.14	68.80	99.9988
F1305	13.98	108.76	2.67	18.00	18.00	10.80	13.75	7.55	2.08	4.04	64.00	99.99117
F1307	25.07	110.09	2.34	18.00	18.00	10.80	15.69	7.65	2.34	4.62	64.00	99.99907
F1310	12.23	49.34	2.10	15.00	15.00	7.80	13.47	4.56	3.54	3.71	72.96	100
F1312	12.90	117.48	2.10	18.00	18.00	10.80	17.48	8.16	2.45	5.14	64.00	99.99963
F1315	8.20	46.88	2.29	15.00	16.00	8.27	12.95	4.10	3.72	3.84	71.40	100
F1577	21.00	112.70	2.10	18.00	18.00	10.80	17.48	7.83	2.55	5.14	64.00	99.99986
F1578	30.00	118.65	2.10	18.00	18.00	10.80	17.48	8.24	2.42	5.14	64.00	99.99954
F1580	8.30	95.18	2.10	15.00	18.00	9.06	15.18	7.63	2.27	5.14	68.80	99.99828
F1581	15.10	106.25	2.10	18.00	18.00	10.80	17.48	7.38	2.71	5.14	64.00	99.99997
F1582	12.70	103.76	2.46	18.00	18.00	10.80	14.92	7.21	2.37	4.39	64.00	99.99923
F1584	21.00	112.08	2.10	18.00	18.00	10.80	17.48	7.78	2.57	5.14	64.00	99.99988
F1585	21.20	112.09	2.19	18.00	18.00	10.80	16.76	7.78	2.46	4.93	64.00	99.99967
F1586	17.80	108.96	2.16	18.00	18.00	10.80	16.99	7.57	2.57	5.00	64.00	99.99988
F1590	9.80	91.25	2.10	15.00	18.00	9.06	15.18	7.31	2.37	5.14	68.80	99.99928
F1591	11.40	95.70	2.10	15.00	18.00	9.06	15.18	7.67	2.26	5.14	68.80	99.99809

Borehole number	Depth to Floor (H) (m)	Base of Weathering	Mining Heigth (m)	Bord Width (m)	Effective Width (m)	Percentage Areal Extraction	Pillar Life (yr)	max Subsidence	Subsidence Ratio	Subsicence Class
F0168	100.56	16.00	2.45	7.20	10.80	64.00	28758.33	0.98501901	0.0097953	С
F0184	90.16	14.00	2.10	7.20	9.06	68.80	20365.72	1.00709631	0.0111701	С
F0580	71.23	3.90	2.10	7.20	7.80	72.96	11046.44	1.26702794	0.0177878	С
F0878	103.78	16.18	2.10	7.20	10.80	64.00	59266.64	0.84458109	0.0081382	С
F0886	40.63	10.72	2.10	7.20	7.80	72.96	30015.93	1.85190222	0.0455797	D
F0955	42.84	15.77	2.10	7.20	7.80	72.96	27792	1.79382549	0.0418727	D
F0965	61.45	17.50	2.10	7.20	7.80	72.96	15036.6	1.41165322	0.0229724	D
F0972	117.03	36.96	2.10	7.20	10.80	64.00	46478.15	0.76243877	0.0065149	С
F0974	42.21	6.22	2.10	7.20	7.80	72.96	28405.27	1.8100514	0.0428821	D
F0976	70.12	19.50	2.10	7.20	7.80	72.96	11436.78	1.28198878	0.0182828	С
F1162	38.11	12.67	2.10	7.20	7.80	72.96	32819.64	1.92222638	0.0504389	E
F1164	47.47	9.35	2.10	7.20	7.80	72.96	23734.14	1.68213681	0.0354358	D
F1165	30.82	6.59	2.10	7.20	7.80	72.96	42980.86	2.15265515	0.069846	E
F1167	26.99	9.57	2.10	7.20	7.80	72.96	49964.12	2.29070021	0.0848722	E
F1267	69.54	12.43	2.10	7.20	7.80	72.96	11646.45	1.28994257	0.0185496	С
F1271	49.78	12.54	2.10	7.20	7.80	72.96	21969.57	1.63102611	0.0327647	D
F1273	67.28	6.37	2.10	7.20	7.80	72.96	12502.85	1.32186345	0.0196472	С

Borehole number	Depth to Floor (H) (m)	Base of Weathering	Mining Heigth (m)	Bord Width (m)	Effective Width (m)	Percentage Areal Extraction	Pillar Life (yr)	max Subsidence	Subsidence Ratio	Subsicence Class
F1274	53.59	9.87	2.10	7.20	7.80	72.96	19376.09	1.55273027	0.0289743	D
F1301	93.48	12.22	2.10	7.20	9.06	68.80	18766.09	0.97797063	0.0104618	C
F1305	108.76	13.98	2.67	7.20	10.80	64.00	15116.38	0.9911215	0.0091129	С
F1307	110.09	25.07	2.34	7.20	10.80	64.00	30063.49	0.88017731	0.0079951	С
F1310	49.34	12.23	2.10	7.20	7.80	72.96	22293.73	1.64054017	0.0332497	D
F1312	117.48	12.90	2.10	7.20	10.80	64.00	46099.23	0.75992626	0.0064686	С
F1315	46.88	8.20	2.29	7.20	8.27	71.40	24013.54	1.76636226	0.0376784	D
F1577	112.70	21.00	2.10	7.20	10.80	64.00	50297.49	0.78748367	0.0069874	С
F1578	118.65	30.00	2.10	7.20	10.80	64.00	45129.23	0.75346996	0.0063504	С
F1580	95.18	8.30	2.10	7.20	9.06	68.80	17997.96	0.96368946	0.0101249	С
F1581	106.25	15.10	2.10	7.20	10.80	64.00	56621.78	0.82796624	0.0077926	С
F1582	103.76	12.70	2.46	7.20	10.80	64.00	26301.91	0.96336847	0.0092846	С
F1584	112.08	21.00	2.10	7.20	10.80	64.00	50871.15	0.79120384	0.0070593	С
F1585	112.09	21.20	2.19	7.20	10.80	64.00	40944.25	0.8199084	0.0073147	С
F1586	108.96	17.80	2.16	7.20	10.80	64.00	46649.21	0.83006011	0.007618	C
F1590	91.25	9.80	2.10	7.20	9.06	68.80	19825.47	0.99734773	0.0109298	C
F1591	95.70	11.40	2.10	7.20	9.06	68.80	17769.53	0.95940276	0.0100251	С

Borehol e number	Depth to Floor (H) (m)	Base of Weatherin g	Mining Heigth (m)	Bord Width (m)	Effectiv e Width (m)	Percentag e Areal Extraction	Caving Height (m)	Stable Overburden (m)	%Comp Layer	Sum Comp Layer	Max Comp Thicknes s (m)
F0168	100.56	16.00	2.45	7.20	10.80	64.00	14.00	68.11	39.05%	32.06	20.36
F0184	90.16	14.00	2.10	7.20	9.06	68.80	14.00	60.06	52.46%	38.85	22.04
F0580	71.23	3.90	2.10	7.20	7.80	72.96	14.00	51.23	74.23%	48.42	23.99
F0878	103.78	16.18	2.10	7.20	10.80	64.00	14.00	71.50	56.25%	48.09	19.24
F0886	40.63	10.72	2.10	7.20	7.80	72.96	14.00	13.81	97.48%	27.11	15.19
F0955	42.84	15.77	2.10	7.20	7.80	72.96	14.00	10.97	77.97%	19.47	19.47
F0965	61.45	17.50	2.10	7.20	7.80	72.96	14.00	27.85	64.44%	26.97	21.78
F0972	117.03	36.96	2.10	7.20	10.80	64.00	14.00	63.97	57.27%	44.65	22.59
F0974	42.21	6.22	2.10	7.20	7.80	72.96	14.00	19.89	83.80%	28.4	23.18
F0976	70.12	19.50	2.10	7.20	7.80	72.96	14.00	34.52	63.03%	30.58	16.61
F1162	38.11	12.67	2.10	7.20	7.80	72.96	14.00	9.34	89.37%	20.86	50.86
F1164	47.47	9.35	2.10	7.20	7.80	72.96	14.00	22.02	65.38%	23.55	23.55
F1165	30.82	6.59	2.10	7.20	7.80	72.96	14.00	8.13	93.85%	20.77	20.77
F1167	26.99	9.57	2.10	7.20	7.80	72.96	14.00	1.32	100.00%	15.32	15.32
F1267	69.54	12.43	2.10	7.20	7.80	72.96	14.00	41.01	55.34%	30.44	18.93
F1271	49.78	12.54	2.10	7.20	7.80	72.96	14.00	21.14	62.15%	21.84	21.84
F1273	67.28	6.37	2.10	7.20	7.80	72.96	14.00	44.81	65.91%	38.76	22.13

Borehol e number	Depth to Floor (H) (m)	Base of Weatherin g	Mining Heigth (m)	Bord Width (m)	Effectiv e Width (m)	Percentag e Areal Extraction	Caving Height (m)	Stable Overburden (m)	%Comp Layer	Sum Comp Layer	Max Comp Thicknes s (m)
F1274	53.59	9.87	2.10	7.20	7.80	72.96	14.00	27.62	74.41%	30.97	17.74
F1301	93.48	12.22	2.10	7.20	9.06	68.80	14.00	65.16	56.92%	45.06	20.39
F1305	108.76	13.98	2.67	7.20	10.80	64.00	14.00	78.11	71.54%	65.9	20.55
F1307	110.09	25.07	2.34	7.20	10.80	64.00	14.00	68.68	72.44%	59.89	18.78
F1310	49.34	12.23	2.10	7.20	7.80	72.96	14.00	21.01	65.21%	22.83	21.63
F1312	117.48	12.90	2.10	7.20	10.80	64.00	14.00	88.48	60.69%	62.2	15.53
F1315	46.88	8.20	2.29	7.20	8.27	71.40	14.00	22.39	74.00%	26.93	22.97
F1577	112.70	21.00	2.10	7.20	10.80	64.00	14.00	75.60	69.71%	62.46	22.73
F1578	118.65	30.00	2.10	7.20	10.80	64.00	14.00	72.55	54.47%	47.14	22.3
F1580	95.18	8.30	2.10	7.20	9.06	68.80	14.00	70.78	46.59%	39.5	24.59
F1581	106.25	15.10	2.10	7.20	10.80	64.00	14.00	75.05	57.77%	51.44	24.11
F1582	103.76	12.70	2.46	7.20	10.80	64.00	14.00	74.60	57.04%	50.54	24.69
F1584	112.08	21.00	2.10	7.20	10.80	64.00	14.00	74.98	55.32%	49.22	18.92
F1585	112.09	21.20	2.19	7.20	10.80	64.00	14.00	74.70	66.99%	59.42	16.56
F1586	108.96	17.80	2.16	7.20	10.80	64.00	14.00	75.00	42.34%	37.68	15.57
F1590	91.25	9.80	2.10	7.20	9.06	68.80	14.00	65.35	58.36%	46.31	16.95
F1591	95.70	11.40	2.10	7.20	9.06	68.80	14.00	68.20	58.98%	48.48	19.14

8. Conclusions.

a. Pillar Stability.

No potential pillar instability is anticipated if the Reserves are mined with pillars laid-out on minimum 15.0m x 15.0 m center and maximum 18.0 m x 18.0 m center layout with 7.2 m bords. Pillar size variation will be a function of bord width, mining depth and mining height. Pillar sizes generally increase with increasing mining depth, mining height and bord widths. All the pillars were found to have a probability of survival more than 99.995% which is recommended for the highly sensitive surface structures. This therefore implies a probability of failure of < 0.005%.

Pillar life index calculation shows that all pillars will have a life index of at least 11 046 years before a 50% probability of failure is reached. This is far more than the recommended 2000 years for highly sensitive structures.

b. <u>Sinkhole</u>

A maximum caving height of 14.0 m was calculated for all areas should roof failure occur. No sinkhole is therefore expected in the reserve area as the maximum caving height does not progress to / intersect the weathered zone in any of the boreholes.

Cognisance must also be given to the fact that the overburden is comprised of at least 39% competent sandstone layers. Competent means any lithological units with a thickness of at least 1.0 m and a composition of at least 80% sandstone.

A minimum sandstone thickness of 15 m in the overburden was found during the investigation. This layer has a unsupported stable span of at least 20 m when jointed and 49 m when unjointed. Thus, pillar failure must occur before the overburden can fail. This means that sinkhole hole probabilities are low in the area.

c. <u>Subsidence</u>

The magnitude of maximum subsidence in a bord and pillar layout is dependent on the unlikely event that panel's pillar system fails. Cognisance must be taken to the fact that the calculated pillar life index and probability of survival are far greater than the recommended minimums, indicating a stable pillar system.

The investigation shows that a Class C, D & E subsidence profile will occur in the area in the unlikely event that pillar fails. The subsidence profile will have the following characteristics:

- Class C: Noticeable in flat terrain, smooth, cracks 2 to 10 cm wide, compression ridges 1 to 5 cm high.
- Class D: Noticeable in most terrains, visible vertical displacements across cracks, cracks 10 to 50 cm wide, compression ridges 5 to 50 cm high.
- Class E: Severe profile, almost vertical sides, cracks wider than 50 cm, compression ridges higher than 50 cm.

Class D & E subsidence will largely be constrained to distal southern and western portion of the reserve area.

9. <u>Recommendations</u>

The following are recommended based on the investigation:

- The following mine design will apply when mining in the area:
 - Pillar Centers Range : Minimum 15.0 m x 15.0 m and Maximum of 18.0 m x 18.0 m
 - Bord width : 7.2 m
 - Mining Height : Total seam thickness extraction
 - Pillar design process will be such that the Probability of survival criterion for the different surface features is met or satisfied.
- Surface elevation monitoring points should be installed at positions surrounding the sensitive structures such as building and tarred road at convenient points. During mining, surveys should be conducted monthly and continued monthly for three months after mining has ceased for a period of three months. Thereafter the periods can be relaxed to quarterly for a further year and after that annual surveys should be conducted.
- Survey beacons should consist of 20 mm rebar and be anchored in concrete with the anchor at least a metre deep. The protruding end of the beacon should not protrude more than 10 cm, to avoid accidental damage.
- Similar beacons should be installed in an area with similar ground conditions, more than 200 m away from any undermining to serve as control measurements.

Should you have any further queries please feel free to contact myself at the following locations: Tel. (011) 441 6989, Cell. (084) 372 4507, or Email. rofhiwa.phadagi@exxaro.com

Yours Sincerely

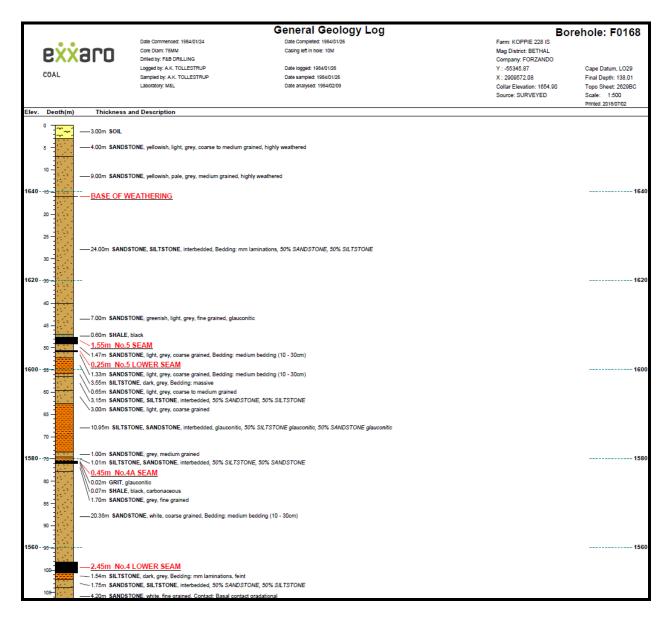
Mr. Rofhiwa Phadagi

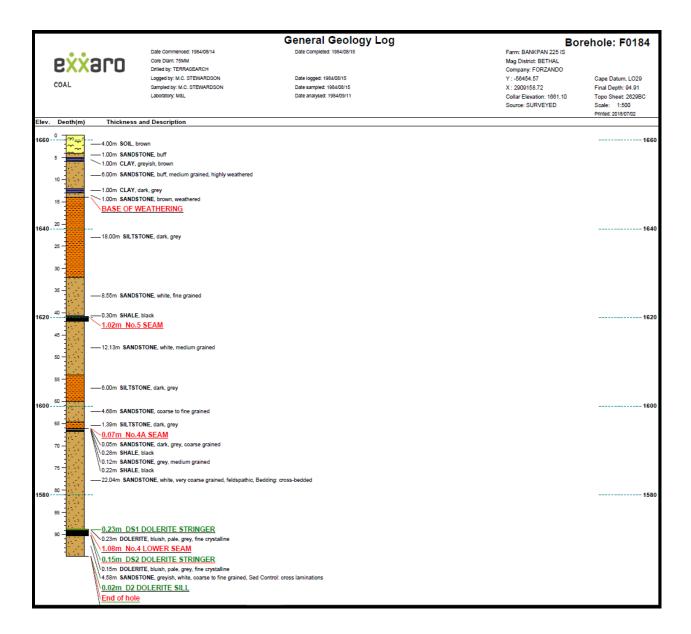
10. References.

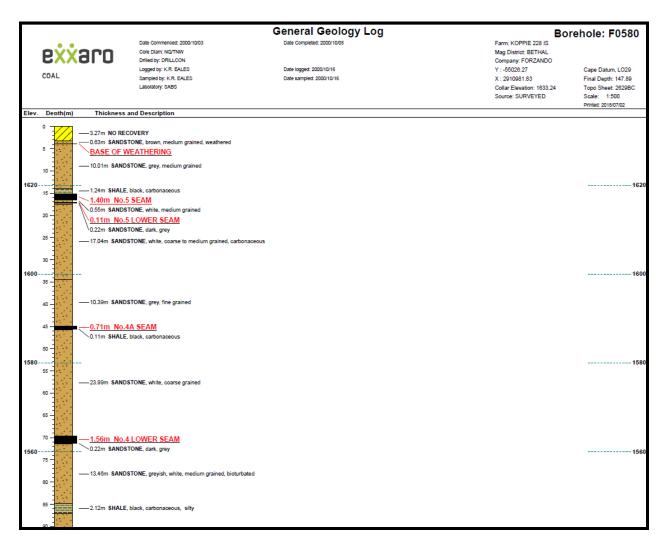
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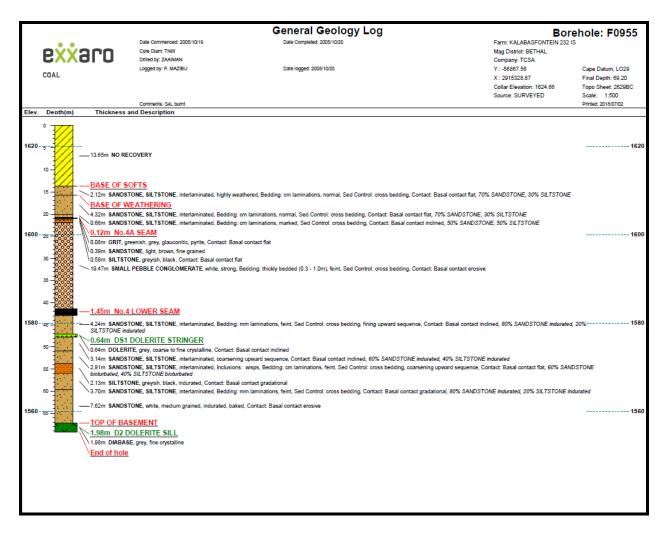
APPENDIX 1

GEOLOGICAL BOREHOLES









				General Geology Log	Para	hole: F0965
			Date Commenced: 2005/11/08	Date Completed: 2005/11/09	Farm: KALABASFONTEIN 232 IS	nole: F0965
- 1	nvv	aro	Core Diam: TNW		Mag District: BETHAL	
	577		Driled by: ZAAIMAN		Company: TCSA	
	COAL		Logged by: P. MAZIBU	Date logged: 2005/11/09	Y : -57291.32	Cape Datum, LO29
`	JOAL				X:2913199.36	Final Depth: 110.90
					Collar Elevation: 1637.08 Source: SURVEYED	Topo Sheet: 2629BC Scale: 1:500
					00102.001120	Printed: 2018/07/02
Elev.	Depth(m)	Thickness and	d Description			
-	; -<u>///</u>		WERY			
1	n - <u>/ / /</u>					-
		-1.42m SILISION	E, SANDS I ONE, Interiaminated, highly	y weathered, Bedding: cm laminations, normal, Sed Control: cross bedding, Contact: Basal cont	actingined, 70% SILTSTONE, 30% SANDSTON	E
1	15	-5.73m SANDSTO	NE, orange, gritty to medium grained, n	noderately weathered, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding,	Contact: Basal contact inclined	
1620	-	BASE OF WE	ATHERING			1620
	20 -	2.29m SANDSTO	NE, orange, gritty to medium grained, n	noderately weathered, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding,	Contact: Basal contact inclined	
	25 -	-9.95m SANDSTO	NE, SILTSTONE, interlaminated, Beddi	ing: cm laminations, marked, Sed Control: cross bedding, Contact: Basal contact inclined, 60%	SANDSTONE, 40% SILTSTONE	
	1.5					
3	80					
		-5.19m SANDSTO	NE, white, coarse grained, Bedding: me	edium bedding (10 - 30cm), feint, Sed Control: cross bedding, Contact: Basal contact flat		
3	-1.5					
1600	101.0		NE, SILTSTONE, Interlaminated, Beddi nish, white, glauconitic	ing: cm laminations, marked, Sed Control: cross bedding, Contact: Basal contact flat, 60% SAN	DSTONE, 40% SILTSTONE	1600
4	<u>6000</u>	0.33m SHALE, bla				
	6000	0.12m SILTSTON				
	5-0000	0.25m SANDSTO				
	-0000	0.02m GRIT, white	e ack, carbonaceous, Contact: Basal cont	taat unkoown		
	. <u>- 2000</u>			derate, Bedding: thickly bedded (0.3 - 1.0m), feint, Sed Control: cross bedding, Contact: Basal o	contact erosive	
	5 - 2000					
1580						1580
	1.21		OWER SEAM			
	15	-6.19m SANDSTO	NE, SILTSTONE, interlaminated, Bedd	ing: cm laminations, normal, Sed Control: cross bedding, coarsening upward sequence, Contact	t: Basal contact flat, 60% SANDSTONE, 40% SIL	TSTONE
	(<u>1</u>					
,	70			ing: mm laminations, feint, Sed Control: cross bedding, coarsening upward sequence, Contact: i		
				ing: cm laminations, feint, Sed Control: cross bedding, coarsening upward sequence, Contact: E	Sasal contact flat, 60% SANDSTONE, 40% SILTS	TONE
,	5		ack, Bedding: cm laminations, feint, Sec	d Control: cross bedding, slickensided, Contact: Basal contact flat		
1560	-	5.57m SANDSTO	NE, SILTSTONE, interlaminated, Bedd	ing: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact inclined, 70% SA/	NDSTONE indurated, 30% SILTSTONE indurated	d 1560
8	a - 1 - 1 - 1					
	100					
	15	-8.49m SANDSTO	NE, white, coarse to medium grained, ir	ndurated, Contact: Basal contact flat		
9		TOP OF DWY	KA worked. Contact: Basal contact inclined	d		
		t the second sec	the new, contact, paper contact fromes	-		
9	s - 1111	-				
1540						1540
			E, grey, medium to fine crystalline, Con	tact: Basal contact inclined		
1	105	-				
	a			reworked, sandy, Contact: Basal contact erosive		
	10 X	TOP OF BASE				
		End of hole	green, highly weathered			
		-Life of hole				

	ole: F0972
Date Commenced: 2005/11/15 Date Completed: 2005/11/18 Farm:: KALABASFONTEIN 232 IS Core Diano: TNVINQ Main District: FBTHAI	
Core Diam: TNUNQ Mag District: BETHAL Driled by: ZAMAN Company: TCSA	
Logged by: P. MAZIBU Date logged: 2005/11/18 Y :- 55637.76 C:	ape Datum, LO29
COAL X: 2909048.64 FI	nal Depth: 198.43
Collar Elevation: 1667.60 To	po Sheet: 2629BC
	cale: 1:500
Elev. Depth(m) Thickness and Description Provide Additional Provided Provid	inted: 2018/07/02
s – 1	
1660	1660
16 - 1	
22 - <mark>1</mark> 5 (*)	
-21.55m SANDSTONE, orangy, while, grit to fine grained, moderately weathered, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding. fining upward sequence, Contact: Basal contact en	osive
1640	1640
3	
BASE OF WEATHERING	
40 -	
45	
1620	1620
50	
eo - 7.59m SANDSTONE, SILTSTONE, 00% SANDSTONE glaucontic, 10% SILTSTONE glaucontic	
-0.59m SILTSTONE, SANDSTONE, Interiaminated, Bedding: mm laminations, normal, Sed Control: cross bedding, Contact: Basal contact inclined, 80% SILTSTONE, 20% SANDSTONE	
65 D.21m SHALE, black, coaly, weak, Contact: Basal contact flat 1600	1600
1600	1600
0.42m No.5 LOWER SEAM	
75 - 2.00m \$AND\$TONE, white, grit to coarse grained, strong, Bedding: medium bedding (10 - 300m), feint, Sed Control: cross bedding. Contact: Basai contact flat	
-3.07m \$AND\$TONE, SILTSTONE, Interiaminated, Bedding: mm laminations, feint, Sed Control: cross bedding. Contact: Basai contact inclined, 80% SANDSTONE, 10% SILTSTONE	
80 -	
-6.75m SANDSTONE, SILTSTONE, Interfaminated, Bedding: cm laminations, marked, Sed Control: cross bedding, Contact: Basal contact inclined, 60% SANDSTONE, 40% SILTSTONE	
1580	1580
D.0.3m COAL; mixed, Contact: Basal contact inclined, 60% COAL bright, 40% COAL lustrous D.16m GRIT, white, glaucontite, moderate, Contact: Basal contact inclined	
Vulterin Verli, write, gauconter, moerale, Contact basal contact incined Vulterin Verli, write, gauconter, moerale, Contact basal contact incined Vulterin Verlin, No.4A SEAM	
FOCOS POCOS - 22.59m SMALL PEBBLE CONGLOMERATE, while, inclusions: wisps, Bedding: thickly bedded (0.3 - 1.0m), feint, Sed Control: cross bedding, Contact: Basal contact erosive	
1560	1560
11-2000	
300 SANDSTONE, SILTSTONE, Intertaminated, Bedding: on laminations, marked, Sed Controi: cross bedding, coarsening upward sequence, Contact: Basal contact flat, 70% SANDSTONE, 30% SILTS	TONE
125 - 1.21m SILTSTONE, SANDSTONE, 80% SILTSTONE, 20% SANDSTONE	

			General Geology Log	Bor	ehole: F0974
		Date Commenced: 2005/11/15	Date Completed: 2005/11/16	Farm: KALABASFONTEIN 232 IS	
PYY	aro	Core Diam: TNW		Mag District: BETHAL	
677		Drilled by: ZAAIMAN		Company: TCSA	
COAL		Logged by: P. MAZIBU	Date logged: 2005/11/16	Y : -55423.77 X : 2911314.69	Cape Datum, LO29 Final Depth: 107.77
				Collar Elevation: 1603.61	Topo Sheet: 2629BC
				Source: SURVEYED	Scale: 1:500
					Printed: 2018/07/02
Elev. Depth(m)	Thickness an	nd Description			
0					
	-6.22m NO RECO	VERY			
1600					1600
	BASE OF WE				
10	-3.59m SANDSTO	ONE, SILTSTONE, interlaminated, Bedd	ing: cm laminations, marked, Sed Control: cross bedding, Contact: Basal contact inclined, 60% SAN	DSTONE, 40% SILTSTONE	
10					
1.5		JNE, white, coarse to fine grained, Bedd	ing: cm laminations, feint, Sed Control: cross bedding, fining upward sequence, Contact: Basal conta	act erosive	
15	1.51m SANDSTO	ONE, SILTSTONE, interlaminated, mode	rate, Bedding: cm laminations, normal, Sed Control: cross bedding, Contact: Basal contact inclined,	70% SANDSTONE, 30% SILTSTONE	
00000	<u>0.92m No.4A</u>	SEAM			
20 - 00000					
1580					1580
25 - 00000					
0000					
30 - 00000	-23.18m SMALL F	PEBBLE CONGLOMERATE, white, stro	ng, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding, Contact: Basal contact	t erosive	
6666					
35 - 0 0 0 0					
35 - 0 0 0 0					
40 - <mark>020202</mark>		OWER SEAM			
1560					1560
45 -	5.30m SANDSTO	ONE, SILTSTONE, interlaminated, Bedd	ing: om laminations, normal, Sed Control: cross bedding, coarsening upward sequence, Contact: Ba	sal contact flat, 70% SANDSTONE, 30% S	ILTSTONE
50 -	-4.11m SANDSTO	ONE, SILTSTONE, 60% SANDSTONE,	40% SILTSTONE		
55 -	-4.02m SANDSTO	ONE, SILTSTONE, interlaminated, 70%	SANDSTONE, 30% SILTSTONE		
term man man or	1.83m SHALE, S	ILTSTONE, 80% SHALE, 20% SILTST	DNE		
60 -					
1.5		ONE, SILTSTONE, baked, Contact: Basa	al contact flat, 90% SANDSTONE, 10% SILTSTONE		
1540					1540
65 —	7.13m_SANDSTO	NE white medium to fine grained bake	ed, Bedding: cm laminations, feint, Sed Control: cross bedding		
1.53		JNE, white, medium to line grained, bake	eu, beduing, chriaminations, feint, deu control, cross beduing		
70 -	7				
	:				
75					
	<u>13.52m D2 D</u>	OLERITE SILL			
80 - + + + + +	13.52m DOLERI	TE, grey, medium to fine crystalline			
	-				
1520	-				1520
			Iding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact flat		
			int, Sed Control: horizontal bedding, Contact: Basal contact gradational		
90	TOP OF DWY				
-90		reworked, Contact: Basal contact gradati	onal		
95 -	<u>TOP OF BAS</u>	EMENT			
1 11 11					
100-		E, coarse crystalline, moderately weathe	red		
1500		_,			1500
1500	-				1500
	—End of hole				
	- End of hole				

				General Ge	ology Log	Boreh	ole: F0976
			Date Commenced: 2005/11/18	Date Completed: 2005/		Farm: KALABASFONTEIN 232 IS	
	ΰů	200	Core Diam: TNW			Mag District: BETHAL	
E	XΧ	aro	Drilled by: ZAAIMAN			Company: TCSA	
			Logged by: P. MAZIBU	Date logged: 2005/11/2	1		ape Datum, LO29
COA	L						inal Depth: 125.65
							opo Sheet: 2629BC
							cale: 1:500
			Comments: S4L burnt. Dolerite highly fracture	d			rinted: 2018/07/02
Elev. Den	oth(m)	Thickness a	nd Description				
0 -							
5 -							
1640	17						1640
10		19.50m NO REC	OVERY				
15 -							
20 -	///	-BASE OF W	EATHERING				
			ONE, SILTSTONE, 90% SANDSTONE gla				
1		0.59m SILTSTO	NE, SANDSTONE, interlaminated, Beddin	g: mm laminations, normal, Sed Control:	cross bedding, Contact: Basal contact inclined,	80% SILTSTONE, 20% SANDSTONE	
25 -		0.64m SHALE, b	olack, carbonaceous				
1620	111		ONE, white, coarse grained, Bedding: med	ium bedding (10 - 30cm), feint, Sed Cont	trol: cross bedding, Contact: Basal contact inclin	ned	1620
30 -		0.22m No.5	LOWER SEAM				
1	61. F	8.25m SANDST	ONE, white, coarse to fine grained, Beddin	g: medium bedding (10 - 30cm), feint, Se	ed Control: cross bedding, coarsening upward s	equence, Structure: faults, Contact: Basal contact erosive	
. 1	1.1						
35 -	6 F 1						
1	1211						
40 -	61 A		ONE, SILTSTONE, interlaminated, Beddin	g: om laminations, marked, Sed Control:	cross bedding, Contact: Basal contact inclined,	60% SANDSTONE, 40% SILTSTONE	
45 -	<u>et 1</u>						
	91.4					ontact: Basal contact erosive, 80% SANDSTONE, 20% S.	
1600		1.46m SANDST	ONE, SILTSTONE, interlaminated, Beddin	g: cm laminations, marked, Sed Control:	cross bedding, Contact: Basal contact inclined,	60% SANDSTONE, 40% SILTSTONE	1600
50 -	ംംം	<u>0.72m No.4/</u>	ASEAM				
-	0000						
55 - 0	0000						
~~~	8000						
	0000		PEBBLE CONGLOMERATE, white, weak	, baked, Bedding: medium bedding (10 -	30cm), feint, Sed Control: cross bedding, fining	upward sequence, Contact: Basal contact erosive	
60 - 6	888						
-	0000						
65 -	888						
1580	0.00		UPPER SEAM				1580
1580	1	1.11m SANDST	ONE, SILTSTONE, interlaminated, Beddin	g: mm laminations, normal, Sed Control:	cross bedding, Contact: Basal contact erosive,	90% SANDSTONE indurated, 10% SILTSTONE indurate	d 1980
70 -			DOLERITE STRINGER				
1	++++		E, light, green, fine crystalline, Contact: Ba	sal contact erosive			
75 -					Control: cross bedding, Contact: Basal contact e	rosive, 50% SANDSTONE, 50% SILTSTONE	
/° -		MAX .	LOWER SEAM	•			
	:::::	WN	DOLERITE STRINGER				
80 -		W/					
-			DOLERITE STRINGER				
85 -	:::::			Bedding: mm laminations, normal, Sed 0	Control: cross bedding, Contact: Basal contact f	at, 50% SANDSTONE, 50% SILTSTONE	
1560		11	DOLERITE STRINGER				1560
1			E, light, green, fine crystalline, Contact: Ba				
90 -		//		Bedding: mm laminations, normal, Sed 0	Control: cross bedding, Contact: Basal contact i	ndined, 60% SANDSTONE, 40% SILTSTONE	
1	:::::	1	DOLERITE SILL				
95 -	1111	123.52m DOLERI	ITE, grey, medium to fine crystalline, Conta	ct: Basal contact inclined			
1		-4.65m SHALF	olack, baked, slickensided, Contact: Basal	contact gradational			
100	1.1.1						





			General Geology Log		Borehole: F1165
		Date Commenced: 2008/11/14	Date Completed: 2008/11/14	Farm: KALABASFONTE	
	000	Core Diam: TNW/NQ	Casing left in hole: NIL	Mag District: BETHAL	14 232 13
EXX	aro	Drilled by: ZAAIMAN		Company: TCSA	
••••		Logged by: M. MATHIVHA	Date logged: 2008/11/17	Y : -56814.12	Cape Datum, LO29
COAL		Sampled by: M. MATHIVHA	Date sampled: 2008/11/17	X : 2914219.28	Final Depth: 81.00
		Laboratory: SABS	Date damped. 20071117	Collar Elevation: 1605.61	
		catoratory, ondo		Source: SURVEYED	Scale: 1:500
		Comments: K07		Source: Sonverteb	Printed: 2018/07/02
Elev. Depth(m)	Thickness an	d Description			Prince. 2010/01/02
1600-5 10	0.30m No.4A	ATHERING NRE, grey, fine grained, bioturbated, Inclus SEAM	ions: wisps, strong, Contact: Basal contact flat ted, strong, Bedding: cm laminations, feint, Sed Control: cross bedding, Cont	nct: Basal contact flat, 80% SANDSTONE biofurbated,	1600 20% SILTSTONE
15 20 1580 25	bioturbated — 20.77m SANDST	ONE, white, coarse grained, Inclusions: w	risps, strong, Bedding: om laminations, feint, Sed Control: cross bedding, Con	act: Basal contact flat	1580
30		% SILTSTONE micaceous carbonaceous	ous, carbonaceous, strong, Bedding: cm laminations, feint, Sed Control: cross ted, Inclusions: wisps, Bedding: mm laminations, feint, Sed Control: cross be		
40	SILTSTONE biotu	rbated, 40% SANDSTONE bioturbated			
	-2.89m SANDSTO	NE, black, fine grained, bioturbated, Bedd	ing: mm laminations, feint, Sed Control: cross bedding, Contact: Basal contact	t flat	
1560-45		NE, SILTSTONE, interlaminated, micaced	flat, 95% SILTSTONE shaly, 5% SANDSTONE shaly	ding, Contact: Basal contact gradational, 80% SANDS	1560 TONE micaceous
50		-	isions: wisps, strong, Bedding: om laminations, feint, Sed Control: cross bedd	ing. Contact: Basal contact flat	
		OWER SEAM			
1540 - 55	0.92m SILTSTON		t		1540
	2.94m DIADASE	arey ecorre contalline			
80 — 🗙		grey, coarse crystalline			
	<u>End of hole</u>				

			General Geology Log	Boreh	ole: F1167
		Date Commenced: 2008/11/18	Date Completed: 2008/11/19	Farm: KALABASFONTEIN 232 IS	OIE. F1107
		Core Diam: TNW/NQ	Casing left in hole: NIL	Mag District: BETHAL	
- E)	xaro	Drilled by: ZAAIMAN		Company: TCSA	
-		Logged by: M. MATHIVHA	Date logged: 2008/11/20		Cape Datum, LO29
COAL		Sampled by: M. MATHIVHA	Date sampled: 2008/11/20		Final Depth: 84.06
		Laboratory: SABS			Topo Sheet: 2629BC
					Scale: 1:500
		Comments: K10		1	Printed: 2018/07/02
Elev. Dept	th(m) Thickness and	d Description			
1600	9.57m NO RECOV	/ERY			1600
10	BASE OF WE		ns, feint, Sed Control: cross bedding, Contact: Basai contact inclined		
20			is, rem, sed control, cross bedding, contact. Sasar contact incined		1580
30 -	0.32m SANDSTOR	NE, SILTSTONE, Interlaminated, Inclusions: wispe NE, SILTSTONE, Interlaminated, micaceous, Bedd	, Bedding: mm laminations, normal, Sed Control: horizontal bedding. Cr Ing: mm laminations, feint, Sed Control: cross bedding, Contact: Basal o		
35 - 1		NE, greyish, black, fine grained, bioturbated, inclus	ions: wisps, Contact: Basal contact flat		
40	-1.91m SILTSTON	E, black, shaly, Contact: Basal contact flat			
156045		NE, SILTSTONE, Interlaminated, bioturbated, mica urbated micaceous, 40% SILTSTONE bioturbated in	aceous, Inclusions: wisps, Bedding: mm laminations, normal, Sed Cont micaceous	oi: horizontal bedding, Contact: Basal contact gradational, 60%	1560
50		DNE, while, fine grained, baked, Contact: Basal cor	ntact flat		
60		E, grey, fine crystalline, Contact: Basal contact flat			1540
70 - 6	3.15m TILLITE, re				
75		MENT			
88	× — 12.17m DIABASE	, greenish, white, highly weathered			

			General Geology Log	Boreh	nole: F1267
	•	Date Commenced: 2009/09/17	Date Completed: 2009/09/18	Farm: KALABASFONTEIN 232 IS	
	Xaro	Core Diam: TNW	Casing left in hole: 0.0M	Mag District: BETHAL	
		Drilled by: ZAAIMAN		Company: TCSA	
60.47		Logged by: T.P. NGOBENI	Date logged: 2009/09/19		Cape Datum, LO29
COAL		Sampled by: T.P. NGOBENI	Date sampled: 2009/09/19		Final Depth: 134.35
		Laboratory: SGS			Topo Sheet: 2629BC
					Scale: 1:500
Elev. Depth(m	Thisbase	Comments: WAS KAL07			Printed: 2018/07/02
Elev. Depth(m	n) I hickness ar	nd Description			
°					
5	BASE OF SO	FTS			
1620	 7.12m SILTSTO	NE, SANDSTONE, Interiaminated, weathe	red, Contact: Basai contact sharp, 60% SILTSTONE laminated micaceous, 40% SANE	STONE pyrtte nodules glauconitic	1620
			red, Contact: Basal contact sharp, 60% SILTSTONE laminated micaceous, 40% SANE	STOLE author advice advice alle	
15	0.98m No.5		red, Contact. Basal contact sharp, 00% SiE 75 FONE laminated micaceous, 40% SANE	STONE pyrite rodules glauconiac	
1.0			, feidspathic, Inclusions: occassional siltstone laminations, Contact: Basal contact sha	-	
20	Satism SANDSTO	onc, write, coarse grained, pyrite hodules	, receptanto, monetoris. occassional sitistorie laminations, Contact: Basal contact sna	ι μ	
	0.04m D4 D4				
25			ructure: slickensides, Contact: Basal contact sharp		
1600	**	e, nym, grey, me orystanne, qualizitic, st	www.e. envicemented, outlate, papar contact enarg		1600
30 -	- 2.94m SANDSTO	ONE, white, coarse grained, pyrite nodules	, carbonaceous, baked, Contact: Basal contact sharp		
		OLERITE STRINGER	· · · ·		
35 -			andy, Structure: breccia, Contact: Basal contact sharp		
			t Basal contact gradational, 80% SILTSTONE laminated micaceous, 20% SANDSTON	E pyrtte nodules micaceous	
40			bathic, pyrite nodules, inclusions: wisps, occassional sitistone laminations, Sed Contro		
2.63					
45			t Basal contact sharp, 70% SILTSTONE laminated micaceous, 30% SANDSTONE pyl	ne nodules micaceous	
1580	0.97m No.4A		iles, carbonaceous, Contact: Basal contact sharp		1580
50			COAL; bright bright duil, 20% COAL; duil bright duil		
	- C.T.III CORL, III	and, origin, dai, inclusione. pyine, copp	oone, angin angin aan, zote oone, aan angin aan		
55 - 1 - 5	-				
		TONE, white, gritty, feidspathic, inclusions	coal stringer, Sed Control: micaceous bedding planes, Contact: Basal contact sharp		
50					
50 <b>-</b>	-				
2.63	1				
65 -	0.44m No.4 I	UPPER SEAM			
1560	0.76m SILTSTO	NE, SANDSTONE, Interlaminated, Contac	t Basal contact sharp, 60% SILTSTONE laminated micaceous, 40% SANDSTONE py	Ite nodules toward base	1560
70 - 20000	0.52m SANDSTO	ONE, white, fine to coarse grained, feldspa	thic, pyrte nodules, baked, Sed Control: coarsening upward sequence, Contact: Basa	contact sharp	
	1.95m No.4 l	LOWER SEAM			
75					
	17.07m 88 7874	NE CANDETONE Interiminated Contra	at Bacal contact cham. 200/ OII TOTOME Maturbated microsovy. 200/ 044/00TOME	nutto podulor micacoour	
80 -		AND A NOT ONE, Internaminated, Conta	ct: Basal contact sharp, 80% SILTSTONE bloturbated micaceous, 20% SANDSTONE	ayine nounes modueous	
~ <u>-</u>					
85 -					
1540					1540
90 -		ONE, white, fine to coarse grained, feidsna	thic, pyrite nodules, baked, Sed Control: coarsening upward sequence, Contact: Basa	contact sharp	
	-				
95	1				
111	::				
100 + + +					
	** \	OLERITE SILL	, quartzitic, mixed, Contact: Basal contact sharp		
105	SIS.77m DOLERI	re, greensn, rignt, grey, coarse crystalline	r, quanzaro, mixeu, contact basar contact sharp		
1520					1520
110					

				General Geology Log	Boreh	ole: F1271
			Date Commenced: 2009/09/30	Date Completed: 2009/10/01	Farm: KALABASFONTEIN 232 IS	010.112/1
	nvv	200	Core Diam: TNW	Casing left in hole: 0.0M	Mag District: BETHAL	
	EXX	aro	Driled by: ZAAIMAN		Company: TCSA	
			Logged by: T.P. NGOBENI	Date logged: 2009/09/02	Y:-56301.43	Cape Datum, LO29
	COAL		Sampled by: T.P. NGOBENI	Date sampled: 2009/10/02	X:2914679.45	Final Depth: 105.70
			Laboratory: SGS		Collar Elevation: 1616.42	Topo Sheet: 2629BC
					Source: SURVEYED	Scale: 1:500
			Comments: WAS KAL11			Printed: 2018/07/02
Elev.	Depth(m)	Thick	ness and Description			
1600	20	- 1.45m \$ BASE 0.50m \$ 	OF SOFTS ANDSTONE, yellowish, brown, coarse grained, mice OF WEATHERING ILTSTONE, SANDSTONE, Interiaminated, Contact	aceous, inclusions: occassional sitistone laminations, moderately weathered, Bed Basai contact sharp, 70% SILTSTONE pyrite nodules micaceous, 30% SANDSTO LTSTONE pyrite nodules micaceous, 30% SANDSTONE feldspathic glaucontic		1600 1580
1560	45	8.25m \$		pyrtle nodules, inclusions: occassional sitistone laminations, Contact: Basal conta Basal contact sharp, 80% SILTSTONE bioturbated micaceous, 20% SANDSTONE		1560
1540	70	sharp	ANDSTONE, whitish, light, grey, fine to medium gra	ined, feldspathic, pyrite nodules, inclusions: occassional silistone iaminations, ba	ked, Sed Control: coarsening upward sequence, Contact: Ba	sai contact 1540
1520-	90 - 95 - 100 - 105 - X	17.70m 0.44m \$ 0.97m TOP O 0.42m \$	DOLERITE, greenish, light, grey, fine to coarse crys ILTSTONE, light, grey, laminated, micaceous, bake <u>No.1 SEAM</u> IF BASEMENT ANDSTONE, dark, grey, medium grained, feldspath IABASE, greenish, coarsely crystailine, Bedding; m:	o, micaceous, Inclusions: grit, occassional sittsione laminations, Contact: Basal o		1520

			General Geology Log	Bor	ehole: F1273
		Date Commenced: 2009/10/01	Date Completed: 2009/10/03	Farm: KALABASFONTEIN 2321	
eXX	ann	Core Diam: TNW	Casing left in hole: 0.0M	Mag District: BETHAL	
5///		Drilled by: ZAAIMAN		Company: TCSA	
COAL		Logged by: T.P. NGOBENI	Date logged: 2009/10/05	Y:-56721.56	Cape Datum, LO29
COAL		Sampled by: T.P. NGOBENI	Date sampled: 2009/10/05	X:2913582.54	Final Depth: 106.14
		Laboratory: SGS		Collar Elevation: 1645.11	Topo Sheet: 2629BC
		Comments: WAS KAL09		Source: SURVEYED	Scale: 1:500 Printed: 2018/07/02
Elev. Depth(m)	Thickness an	d Description			Printed: 2016/07/02
°					
<u> </u>	-6.25m SOIL				
16405	BASE OF SO	CT 6			164
	BASE OF WE				
10 - 201			nitic, toward base, Contact: Basal contact sharp, 80% SANDSTONE pyrite nodules i	ward base 20% SILTSTONE laminated micaceous	
			nitic, toward base, Contact: Basal contact sharp, 60% SANDSTONE pyrite nodules i nitic, toward base, Contact: Basal contact sharp, 80% SANDSTONE pyrite nodules i		
15	1.71m No.5 S		······································	,	
	1.1111 110.0 0	-Crim			
20	-16.63m SANDST	ONE, white, medium to coarse grained, for	eldspathic, pyrite nodules, inclusions: occassional siltstone laminations, siltstone, Br	edding: laminated, Sed Control: coarsening upward sequ	ence, Contact:
	Basal contact shar				
1620-35-					162
30					
35					
	-11.68m SILTSTO	NE, SANDSTONE, Interlaminated, Conta	act: Basal contact sharp, 70% SILTSTONE laminated micaceous, 30% SANDSTONE	glauconttic pyrite nodules	
40	0.32m_SANDSTO	NE whitish coarse grained feldsnathin	glauconitic, Bedding: massive, Contact: Basal contact sharp		
	0.39m No.4A		gradomito, bedding, maserve, contact, basar contact enarp		
1600-46			micaceous, Inclusions: occassional slitstone laminations, Contact: Basal contact sh	am	160
1.5	0.43m No.4A		micacede, inclusione. Occasedinal ensione laminatione, contact. Desar contact en	ai p	
50	0.4311 NO.4A	I SEAM			
1.50					
	-22.13m SANDST	ONE, white, gritty, feldspathic, inclusions	s: mica, occassional bright stringers		
55					
60 -					
1580-66-					158
	— <u>1.85m No.4 L</u>	OWER SEAM			
70 -	-5.00m SANDSTO	NE, whitish, medium grained, pyrite nodu	ules, micaceous, inclusions: occassional sitistone laminations, Contact: Basal conta	ct gradational	
1.5.5				2	
75 -					
80	-15.92m SILTSTO	NE, SANDSTONE, Interlaminated, Conta	act: Basal contact sharp, 80% SILTSTONE bloturbated micaceous, 20% SANDSTON	IE pyrite nodules micaceous	
156086					156
90 -					
1.1	-8.09m SANDSTO	INF white medium grained pyrite podule	es, carbonaceous, inclusions: occassional siltstone laminations, Contact: Basai con	tact sham	
95	0.10m COAL; du	II, calcitic, burnt			
	1.33m D2 D0	LERITE SILL			
100	1.33m DOLERITE	E, light, grey, finely crystalline, inclusions:	calcte on cleats, Contact: Basal contact sharp		
			ct. Basal contact sharp, 00% SANDSTONE pyrite nodules, 10% SILTSTONE bioturba	ated micaceous	
1540106		OWER SEAM			154
	1.08m SANDSTO	NE, light, grey, coarse grained, pyrite no	dules, banded, Inclusions: sitstone, grit, Contact: Basal contact sharp		
	WTOP OF DWY				
	4.50m DIABASE,	greenish, light, grey, coarsely crystalline	, baked, Bedding: massive		
	End of hole				
	-				

			General Geology Log	Bore	hole: F1274
		Date Commenced: 2009/10/03	Date Completed: 2009/10/06	Farm: KALABASFONTEIN 232 IS	
PYY	aro	Core Diam: TNW	Casing left in hole: 0.0M	Mag District: BETHAL	
- UAA		Driled by: ZAAIMAN Logged by: T.P. NGOBENI	Date logged: 2009/10/06	Company: TCSA Y : -55668.96	Case Datum L 000
COAL		Sampled by: T.P. NGOBENI	Date sampled: 2009/10/06	X:2911526.84	Cape Datum, LO29 Final Depth: 112.50
		Laboratory: SGS		Collar Elevation: 1614.63	Topo Sheet: 2629BC
				Source: SURVEYED	Scale: 1:500
	_	Comments: WAS KALD4			Printed: 2018/07/02
Elev. Depth(m)	Thickness ar	nd Description			
5			pyrtle nodules, inclusions: occassional siltsione laminations, weathered, Contact	Basal contact sharp	
10	-BASE OF WE		pyrtle nodules, Inclusions: occassional siltstone laminations, Contact: Basal cont	act sharp	
1600	7.78m SILTSTO	NE, SANDSTONE, Interlaminated, Contact	t Basal contact sharp, 80% SILTSTONE laminated micaceous, 20% SANDSTON	E pyrite nodules micaceous	1600
25	0.66m SILTSTO	NE, SANDSTONE, Interlaminated, glaucor	thic, pyrtle nodules, inclusions: wisps, occassional sitistone laminations, Sed Co ntito, gritty, Contact: Basal contact sharp, 80% SILTSTONE laminated micaceous;		
30 -	0.73m No.44 1.01m SANDSTO		t Basal contact sharp, 70% SANDSTONE carbonaceous wisps, 30% SiLTSTONE	E micaceous laminated	
40 -	17.74m \$AND\$1	CONE, white, gritty, feidspathic, inclusions	: occassional silistone laminations, Contact: Basal contact sharp		1580
45		UPPER SEAM			
50	-5.10m SANDSTO				
1560- ₅₅ - <b>6000</b>	— <u>1.61m No.4 I</u>	LOWER SEAM			1560
	—14.14m SILTSTO	DNE, SANDSTONE, Interlaminated, Conta	ct: Basal contact sharp, 80% SILTSTONE bloturbated micaceous, 20% SANDST	DNE pyrite nodules micaceous	
70	-2.21m SHALE, c				
1.11	0.93m SHALE, C				
1540-75-	0.12m SHALE, c				1540
	0.01m SANDSTO				
		LEADER SEAM			
80 -	0.25m SHALE, c				
	0.27m SHALE, c				
85 -			Contact: Basal contact sharp, 50% SILTSTONE laminated micaceous, 50% SILTS	I UNE WINNATED MICACEOUS	
90-		DLERITE SILL E, light, grey, finely crystalline, chilled con	tacts, inclusions: calcite on cleats, Contact: Basal contact irregular		
1520			pyrtte nodules, Contact: Basal contact gradational		1520
202			Contact: Basal contact sharp, 70% SANDSTONE pyrite nodules coaly, 30% SILTS	TONE laminated micaceous	
100	— <u>TOP OF BAS</u>				
₩	9.20m DIABASE	, greenish, light, grey, coarsely crystalline,	Bedding: massive		
K X	— <u>End of hole</u>				

			General Geology Log	Borehole: F1301
		Date Commenced: 2010/09/10	Date Completed: 2010/09/10	Farm: KALABASFONTEIN 232 IS
PY	aro	Core Diam: TNW	Casing left in hole: 0.0m	Mag District: BETHAL
6//		Driled by: ZAAIMAN Logged by: M. MATHIVHA	Date logged: 2010/09/15	Company: TCSA
COAL		Lugges dy. M. MATHIVHA	Date sampled: 2010/09/15	Y : -58231.97 Cape Datum, LO29 X : 2911697.21 Final Depth: 164.23
		Laboratory: SGS		Collar Elevation: 1660.11
				Source: SURVEYED Scale: 1:500
		Comments: KB010		Printed: 2018/07/02
Elev. Depth(m)	Thickness an	d Description		
16600				166
~~1				
5	12 22m_ SOIL_bro	DWD		
10				
	BASE OF SO	FTS		
15	BASE OF WE	ATHERING		
1640-20-				164
	21.05m SANDST	ONE SILTSTONE Interlaminated carbo	naceous, wisps, inclusions: mica, Bedding: cm cross-bedding, normal, Sed Control: h	onizonial bedding. Contact: Basal contact fat 50% SANDSTONE
25 -		ps, 50% SILTSTONE carbonaceous wisp		tonzonial bedang, contact, badar contact nat, control on tonz
30 -				
1 - 1				
35	- 54m SANDSTO	NE greenich white fine grained giauco	nitic, Bedding: mm to cm laminations, feint, Sed Control: horizontal bedding, Contact: E	Bacal contact flat
		AL, greenan, white, me granieu, grauou	nino, bedang, nin to annaninatona, rein, seu control, nonzonal bedang, contact, c	addi kuritak nat
1620-40-	0.85m SILTSTON	E, black, shaly		162
1.50	1.03m No.5 \$	SEAM		
45				
50 -	-14.36m SANDST	ONE, white, fine to medium grained, mica	aceous, glauconitic, Bedding: mm cross-bedding, feint, Contact: Basal contact flat	
55				
1.5		NE SILTSTONE Interlaminated micage	ous, carbonaceous, Bedding; cm cross-bedding, feint, Contact: Basai contact flat, 80	% SANDSTONE micaceous carbonaceous 20% SILTSTONE
1600	micaceous carbon	aceous	cas, enconnectas, acading, en erea acading, icini, central adai contast na, ce	160
	-4.10m SILTSTON	E, SANDSTONE, Interlaminated, carbon	aceous, wisps, inclusions: grit, Bedding: mm to cm laminations, normal, Sed Control:	horizontal bedding, Contact: Basal contact flat, 60% SILTSTONE
65	carbonaceous wis	ps, 40% SANDSTONE carbonaceous wi	sps	
	-7 16m SANDSTO	NE SILTSTONE Interlaminated carbon	aceous, wisps, Bedding: mm to cm laminations, feint, Sed Control: horizontal bedding	Contact: Basal contact flat 90% SANDSTONE carbonaceous wisns
70		carbonaceous wisps		
<i>"</i>		SEAM		
75				
1580		ONE, white, grit to coarse grained, micac	eous, Bedding: cm cross-bedding, feint, Contact: Basai contact flat	158
1.5				
85 -				
90				
		OWER SEAM		
95 -				
1.50	——6.08m \$AND\$TC micaceous	ONE, SILTSTONE, Interlaminated, micace	ous, Bedding: cm to dm iaminations, normal, Sed Control: horizontal bedding, Contact	E Basal contact flat, 70% SANDSTONE micaceous, 30% SILTSTONE
1560		IE, micaceous, Contact: Basal contact fla		156
	-2.20m att15100	<ul> <li>moadedus, contata, pasar contact ha</li> </ul>	<b>x</b>	
105				
		NE SANDSTONE Interiorinated minor	eous, 90% SILTSTONE micaceous, 10% SANDSTONE micaceous	
110	The service of the se	, estimo i sinc, interiorninated, milat		
110				

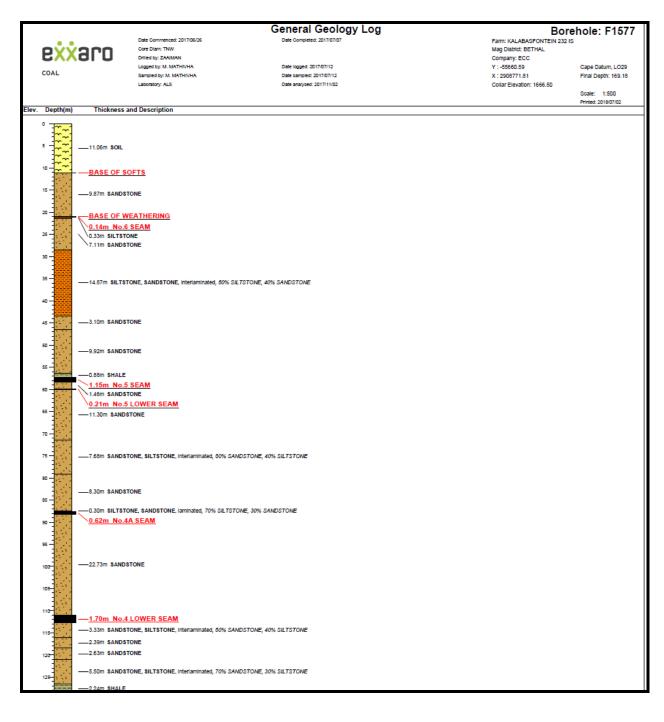
			General Geology Log	Boreh	ole: F1305
		Date Commenced: 2010/10/01	Date Completed: 2010/10/02	Farm: KALABASFONTEIN 232 IS	
	aro	Core Diam: TNW	Casing left in hole: 0.0m	Mag District: BETHAL	
5//		Driled by: ZAAIMAN		Company: TCSA	
60.41		Logged by: M. MATHIVHA	Date logged: 2010/10/05		Cape Datum, LO29
COAL			Date sampled: 2010/10/05		Final Depth: 170.39
		Laboratory: SGS		Collar Elevation: 1665.85	
					Scale: 1:500
Elev. Depth(m)	Thistory	Comments: KB006 d Description		F	Printed: 2018/07/02
Elev. Deptn(m)	I nickness an	d Description			
	1				
~~~~~	-6.81m SOIL, yello	with house			
5 - Tr		wish, brown			
1660	BASE OF SO	FTS			1660
10.0					
10	-7.17m SANDSTO	NE, orangy, brown, medium grained, i	micaceous, massive, weathered in parts, Contact: Basal contact flat		
15		ATHERING			
1.00					
20 -	-11.99m SANDST	ONE, orangy, brown, medium grained.	micaceous, massive, Contact: Basal contact flat		
1.1					
1640-25					1640
1.1.1					
30 - 5 (5)					
35		ONE, SILTSTONE, Interlaminated, mi aceous carbonaceous, 30% SILTSTO	caceous, carbonaceous, inclusions: siderite, Bedding: cm to dm iaminations, normal, Sed Controi: horizont NE micaceous carbonaceous	al bedding, Contact: Basal contact flat, 7	0%
40 -					
1.1.1					
1620-45-					1620
1020	carbonaceous	ONE, SILTSTONE, Interlaminated, mi	caceous, carbonaceous, inclusions: glauconite, Contact: Basal contact flat, 00% SANDSTONE micaceous	carbonaceous, 10% SILTSTONE micace	6005
	001001000000				
~	1 OPm BILTETON	IE black alguagette instucions: cano	irtana langar ar handr		
-	1.40m No.5 S	E, black, glauconitic, inclusions: sand	abore renses or barros		
55 - 61	~1.40m No.5 S	EAM			
1.00					
60	12 55m 84ND8T	ONE ON TRIONE Intertaminated mi	caceous, carbonaceous, Bedding: cm cross-bedding, normal, Sed Control: horizontal bedding, Contact: Bas	and an interview of the second	
2 (S)		% SILTSTONE micaceous carbonace		al contact hat, boys annebar one most	eous
1600					4000
1600					1600
70					
18 E	-7 69m SANDSTO	INE SILTSTONE Interlaminated mic	aceous, gritty, inclusions: wisps, siderite, Bedding: cm to dm laminations, normal, Sed Control: horizontal b	edding, Contact: Basal contact flat, 50%	
	SANDSTONE mic	aceous gritty, 50% SILTSTONE micad	eous gritty	,,,,,	
75					
80 -	-8.92m SANDSTO	NE, white, coarse grained, gritty, mas	ssive, inclusions: coal bands, Contact: Basal contact irregular		
- 5 (LS)		SEAM			
158085		<u>SCAII</u>			1580
1.1.1					
90 -					
1.25					
95 -		ONE white coarse grained grifty ca	rbonaceous, Bedding: massive, Contact: Basal contact flat		
1.55	20.0000 000000	one, mile, ooaloe granes, gray, oa			
100					
100 S 1 S 1					
100					
1560-105					1560
		OWER SEAM			
110	-2.46m SANDSTO	NE, SILTSTONE, Interlaminated, side	ritic, carbonaceous, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Base	al contact flat, 70% SANDSTONE siderit	c
1.11		% SILTSTONE sideritic carbonaceous		and an and the second	20015
115	 2.6/m SANDSTO carbonaceous. 10 	NE, SILTSTONE, Interfaminated, mic % SILTSTONE micaceous carbonace	aceous, carbonaceous, Bedding: mm to cm iaminations, feint, Sed Control: horizontal bedding, Contact: Bar ous	sai contaot nat, 90% SANDS FONE MICat	leous
		NE, black, fine grained, micaceous, s			
1.1	-4.64m SANDSTO		aceous, Bedding: cm to dm iaminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 8	0% SANDSTONE micaceous, 20% SILT	STONE
120 1 4 3	micaceous				
	- 0.34m 00 T0T00	to black selecters in heritages with	Overlage Care Contract Care		

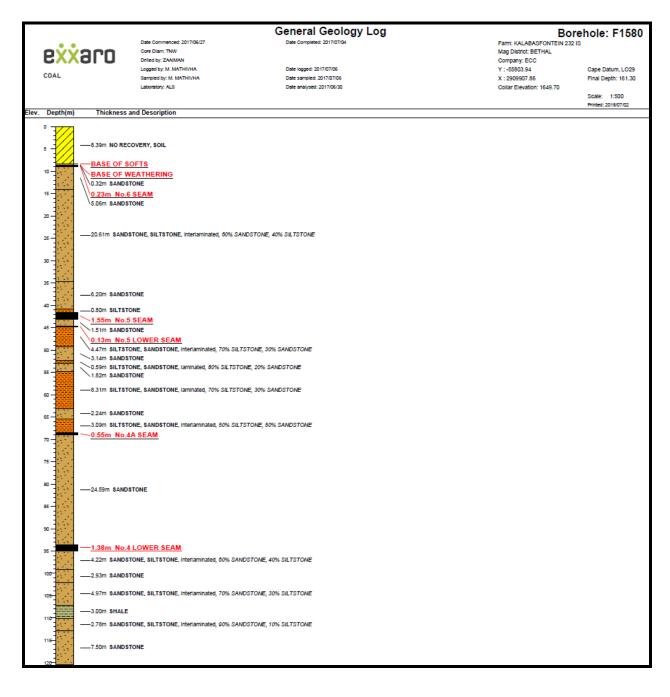
			General Geology Log		Bore	hole: F1307
		Date Commenced: 2018/10/07	Date Completed: 2010/10/11		Farm: KALABASFONTEIN 232 IS	
ov.	<u>xaro</u>	Core Diam: TNW	Casing left in hole: 0.0m		Mag District: BETHAL	
54		Drilled by: ZAAIMAN			Company: TCSA	
COAL		Logged by: M. MATHIVHA & P. DIKGWATLHE	Date logged: 2010/10/12		Y:-58591.72	Cape Datum, LO29
COAL			Date sampled: 2010/10/12		X:2911440.87	Final Depth: 179.38
		Laboratory: SGS			Collar Elevation: 1667.27 Source: SURVEYED	Scale: 1:500
		Comments: Moved to a new position KB009A			Source, SURVETED	Printed: 2018/07/02
Elev. Depth(r	n) Thickness a	nd Description				
	_					
°~	-1					
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~						
1660		eddish, brown				166
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	-1					166
¹⁰ - ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	-					
	BASE OF SC	OFTS				
15		ONE, brownish, white, coarse grained, highly weathe				
	5.00m SILTSTO	NE, grey, fine grained, slightly weathered, Contact: 8	Basal contact flat			
20						
		ONE, white, coarse grained, Bedding: cm to dm lami	inations, normal, Sed Control: horizontal laminae, Contact: Ba	sal contact flat		
25	BASE OF W	EATHERING				
1640			inations, normal, Sed Control: horizontal laminae, Contact: Ba	sal contact flat		1640
30						
30	11.63m SANDS	TONE, SILTSTONE, Interlaminated, Bedding: cm to	dm laminations, normal, Sed Control: horizontal laminae, Con	tact: Basal contact flat, 00% SAN	IDSTONE, 10% SILTSTONE	
2.50						
35 -	1					
2000	2.55m SILTSTO	NE, SANDSTONE, Interlaminated, sideritic, Inclusio	ns: pyrite, Bedding: mm to cm laminations, normal, Sed Contr	ol: horizontal laminae, Contact: E	Basal contact flat, 80% SILTSTONE si	deritic, 20%
40	SANDSTONE SK					
	~2.55M SANDSI	ONE, SILISTONE, Intenaminated, Inclusions: pyrite	e, Bedding: cm to dm laminations, normal, Sed Control: horizo	ntai laminae, Contact: Basal cont	act hat, 70% SANDS TONE, 30% SIL	ISTONE
45						
1620	9.89m SANDST	ONE, white, medium grained, bioturbated, inclusions	pyrite, Bedding: cm to dm laminations, feint, Sed Control: he	orizontal bedding, Contact: Basal	contact flat	1620
50 - 5 - 5 - 5	-					
1.1.1	-1.34m SILTSTO	NE. grevish. black, fine grained. Bedding: mm to cm	laminations, normal, Sed Control: horizontal bedding, Contact	: Basal contact flat		
	1.26m No.5		3.			
			im laminations, normal, Sed Control: horizontal bedding, Conta	act: Basal contact flat, 90% SANE	STONE, 10% SILTSTONE	
60	0.05m COAL					
60 -	-					
1.5	*	TONE, SILTSTONE, Interlaminated, Bedding: cm to	dm laminations, feint, Sed Control: horizontal bedding, Contac	t: Basal contact flat, 90% SANDS	STONE, 10% SILTSTONE	
65	-					1600
1.53						1600
70	1					
75 - 200	-7.62m SILTSTO	NE, SANDSTONE, Interlaminated, Bedding: mm to	cm laminations, normal, Sed Control: horizontal bedding, Cont	act: Basal contact flat, 80% SILT	STONE, 20% SANDSTONE	
80 -	1 20-0 044000	ONE ON TOTONS interferenced Reddies: on in d	im laminations, feint, Sed Control: horizontal bedding, Contact	Development and ARX CANDO		
1.5	-4.30m SANDST	ONE, SILISTONE, Interiaminated, Bedding, on to d	im laminasons, leini, sed Consoli. Honzontal bedding, Contact	. Dasal contact liat, 93% SANDS	TONE, 5% SILTSTONE	
85		ONE, SILTSTONE, Interlaminated, glauconitic, Bedd	ling: cm to dm laminations, normal, Sed Control: horizontal be	dding, Contact: Basal contact flat	, 60% SANDSTONE glauconitic, 40%	SILTSTONE
1580	glauconitic					1580
	• 0.32m No.4/					
1.10	10.30m SANDST	ONE, white, medium grained, Bedding: cm to dm iar	ninations, feint, Sed Control: horizontal bedding, Contact: Base	al contact flat		
95	1					
20 T		TONE, white, coarse grained, micaceous, gritty, incl	iusions: pyrite, Bedding: cm to dm laminations, feint, Sed Con	trol: horizontal bedding, Contact:	Basal contact flat	
1.1	-			-		
100	-					
1.5	-					
105	- 0.24m No.4	UPPER SEAM				
1560			e, Bedding: cm to dm laminations, feint, Sed Control: horizonta	i bedding, Contact: Basal contact	t flat, 70% SANDSTONE, 30% SILTS	TONE 1560
110		LOWER SEAM				
			e, Bedding: mm to cm laminations, normal, Sed Control: horizo	ontal bedding, Contact: Basal con	tact flat, 80% SILTSTONE, 20% SAN	DSTONE
115			cm laminations, normal, Sed Control: horizontal bedding, Cont			
		NE, greyish, black, fine grained, shaly				
120		ONE, whitish, grey, fine to medium grained, bioturba	ted, Bedding: cm to dm laminations, feint, Sed Control: horizo	ntal bedding, worm burrows, Con	tact: Basal contact flat	
120	3.18m SILTSTO	NE, SANDSTONE, Interlaminated, Bedding: mm to	cm laminations, normal, Sed Control: horizontal bedding, Cont	act: Basal contact flat, 90% SILT	STONE, 10% SANDSTONE	
	0.16m DS1	DOLERITE STRINGER	2			
125		E. grev. finely crystalline. Contact: Basal contact flat				

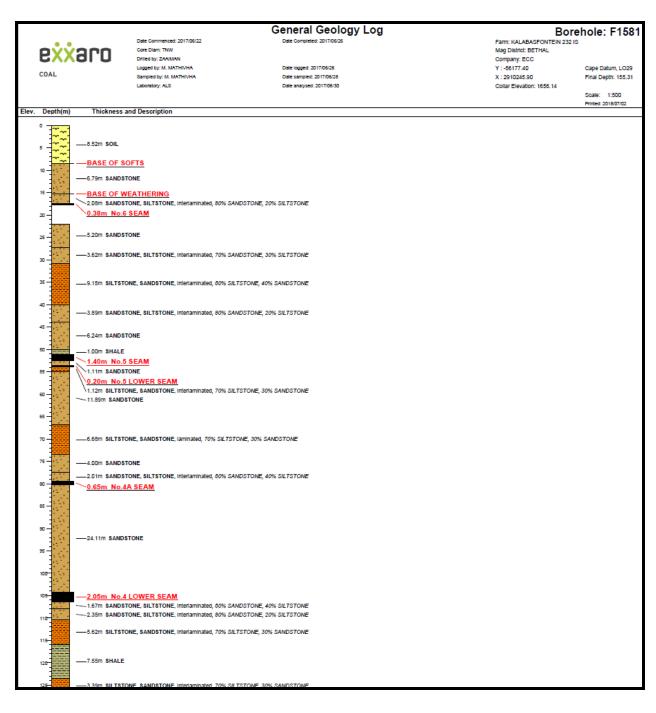
				General Geology Log	Davaha	le: F1310
			Date Commenced: 2010/10/15	Date Completed: 2010/10/16	BOFENO Farm: KALABASFONTEIN 232 IS	ne: F1310
		000	Core Diam: TNW	Casing left in hole: 0.0m	Mag District: BETHAL	
L RX	X	aro	Driled by: ZAAIMAN		Company: TCSA	
			Logged by: M. MATHIVHA	Date logged: 2010/10/19		pe Datum, LO29
COAL				Date sampled: 2010/10/19		al Depth: 94.75
			Laboratory: SGS		Collar Elevation: 1634.96	a soperior server
						ale: 1:500
			Comments: KB003			nted: 2018/07/02
Elev. Depth	h(m)	Thickness an	d Description			
°	`~`					
1	~	6.37m SOIL				
s – 💭	. m.	-BASE OF SO	те			
	212	-				
10 - 2	d'r	-5.86m SANDSTO	NE, orangy, brown, fine grained, micaced	ous, weathered, Contact: Basal contact flat		
		-BASE OF WE	ATHERING			
162015-	1.1					162
1.	12		NE, SILTSTONE, Interlaminated, micace aceous, 40% SILTSTONE micaceous ca	eous, carbonaceous, Inclusions: siderite, Bedding: cm cross-bedding, feint, Sed Cont rhonaceous	roi: horizontal bedding, Contact: Basal contact flat, 60% SAND	STONE
	11					
20		-1.20m \$AND\$TO	NE, white, medium grained, massive			
			E, SANDSTONE, Interlaminated, micace	ous, glauconitic, Bedding: cm cross-bedding, normal, Contact: Basai contact flat, 70	% SILTSTONE micaceous glauconitic, 30% SANDSTONE mic	aceous
25		glauconitic				
	1.1	0.13m No.4A				
30 -	55	NU.27m SILTSTON	E, black, shaly, micaceous, Contact: Ba	sai contact hat		
	1.1					
1600-35-	1.1	-			=	160
	11	21.63m SANDST	ONE, white, coarse grained, gritty, micad	eous, Contact: Basal contact flat		
1.1						
40	1.					
45	5					
	1		OWER SEAM			
50 - 22				ous, carbonaceous, Bedding: mm to cm laminations, feint, Sed Control: horizontal be	edding. Contact: Basal contact flat. 80% SILTSTONE micaceo	us
	1	carbonaceous, 20	% SANDSTONE micaceous carbonaceou	us		
1580	et.	3.41m SANDSTO	NE, SILTSTONE, Interlaminated, micace	ous, silty, Sed Control: coarsening upward sequence, Contact: Basal contact flat, 50	% SANDSTONE micaceous silty, 50% SILTSTONE micaceous	s silty 158
	1.1		NE, grey, fine grained, micaceous, biotu	rbated, Contact: Basal contact flat		
60 -		-1.20m SILTSTON				
60		-1.75m SANDSTO	NE, SILTSTONE, Interlaminated, Contac	t Basal contact Irregular, 80% SANDSTONE, 20% SILTSTONE		
65 -		<u>9.05m D2 D0</u>				
		▶9.05m DOLERITE	, greenish, grey, medium crystalline, cai	cite on cleats		
70						
	1.5					
1560	<u>.</u>	-			-	156
	1	12.24m \$AND\$T(ONE, Contact: Basal contact flat			
80 -	2.1					
~	1.					
: 🖷			E, SANDSTONE, gritty, 50% SILTSTON	IE griffy, 50% SANDSTONE griffy ponaceous, gritty, Contact: Basal contact flat		
85	хÛ	\		senaecore, gristy, contact, babar contact nat		
	×	TOP OF BASE	<u>emenish</u> , grey, medium crystalline, Cont	act: Basal contact flat		
90 -	\sim		pink, coarsely crystalline, Contact: Basal			
	$^{\sim}$		green, coarsely crystalline, Contact: Bas			
-	\sim	-End of hole				
		2				

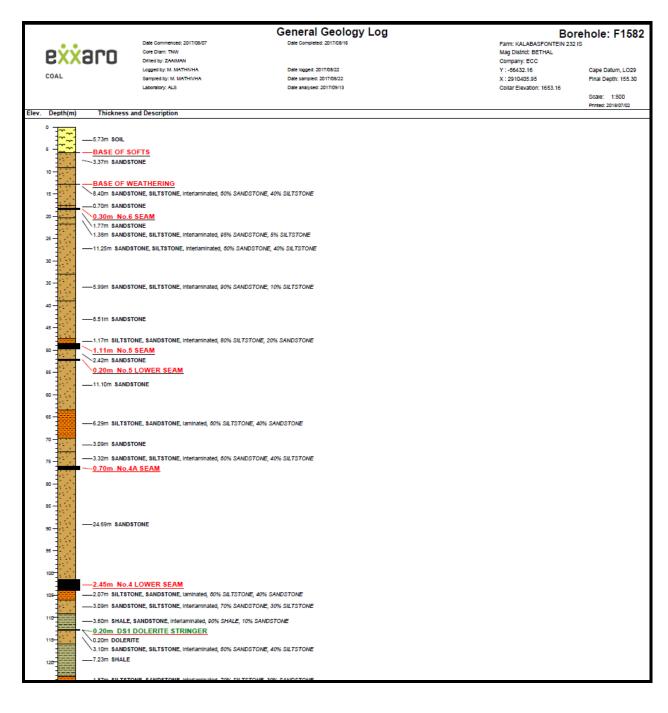
			General Geology Log		Borehole: F1312
		Date Commenced: 2010/10/19	Date Completed: 2010/10/23		BASFONTEIN 232 IS
EXX	חחב	Core Diam: TNW	Casing left in hole: 0.0m	Mag District: I	
5440		Driled by: ZAAIMAN		Company: TC	
co		Logged by: M. MATHIVHA	Date logged: 2010/10/26	Y : -58280.64	
COAL			Date sampled: 2010/10/26	X : 2911128.1	
		Laboratory: SGS		Collar Elevation	
				Source: SUR	
Elev. Depth(m)	Thickness and	Comments: KB011			Printed: 2018/07/02
Liev. Depti(iii)	Thickness and	Description			
□ 	—12.75m SOIL, brov	wnish, red			
¹⁰					
1660	-BASE OF SOF	TS			1660
	—10.64m SANDSTC	NNE, orangy, brown, fine grained, micac	eous, massive, Contact: Basal contact flat		
25 — 30 —	—9.08m SANDSTO	NE, greyish, white, fine grained, micace	ous, massive, inclusions: grit, Contact Basal contact flat		
1640	—7.14m SANDSTOP	NE, SILTSTONE, interlaminated, Beddir	ng. thickly bedded (0.3 - 1.0m), feint, Contact: Basal contact flat, 00% SANDSTONE, 1	0% SILTSTONE	1640
45	— 10.02m SANDSTC Wisps	ONE, SILTSTONE, interiaminated, carbo	onaceous, wisps, Bedding: cm cross-bedding, normal, Contact: Basal contact flat, 70%	SANDSTONE carbonaceous wisp:	s, 30% SILTSTONE carbonaceous
50 -	1.62m SANDSTON	NE, greyish, white, medium grained, ma	issive, Contact: Basal contact flat		
1620	-4.82m SANDSTOP wisps	NE, SILTSTONE, Interlaminated, carbor	naceous, wisps, Bedding: cm cross-bedding, normal, Contact: Basal contact flat, 70%	SANDSTONE carbonaceous wisps,	; 30% SILTSTONE carbonaceous 1620
60 -			ined, carbonaceous, wisps, Bedding: cm cross-bedding, feint, Structure: slickensides,	Contact: Basal contact flat	
-	-1.41m SILTSTON	E, greenish, black, fine grained, micace	ous, glauconttic, Contact: Basal contact flat		
65 -	carbonaceous, 209	6 SILTSTONE micaceous carbonaceou	eous, carbonaceous, Bedding: cm cross-bedding, normai, Sed Control: horizontal bed IS	ding, Contact: Basai contact flat, 80	% SANDSTONE micaceous
70-		OWER SEAM	manakan kacharinan untera Cardinah Barat anatari Sat		
1600	N7.53m SANDSTOP	NE, white, medium grained, micaceous,	massive, inclusions: wisps, Contact: Basal contact flat		1600
75	—7.30m SANDSTOP	NE, SILTSTONE, Interlaminated, Beddir	ng: mm to cm laminations, feint, Sed Control: horizontal bedding, Contact: Basal conta	tt flat, 70% SANDSTONE, 30% SIL	
85	—6.95m SILTSTON carbonaceous wisp	E, SANDSTONE, Interiaminated, carbon 15, 40% SANDSTONE carbonaceous wi	naceous, wisps, inclusions: siderite, Bedding: cm cross-bedding, normal, Sed Control Isps	horizontal bedding, Contact: Basal	contact flat, 60% SILTSTONE
-	-1.79m SANDSTON	NE, white, fine grained, micaceous, ma	ssive, Sed Control: coarsening upward sequence		
90	-3.41m SANDSTON	NE, white, coarse grained, massive, Cor	ntact: Basal contact flat		
1580	-2.11m SANDSTON 10% SILTSTONE I		eous, sideritic, Bedding: mm to cm laminations, normal, Sed Control: horizontal beddir	ig, Contact: Basal contact flat, 90%	SANDSTONE micaceous-sidentiis, 1580
100	0.39m No.4A 2.24m SANDSTOM SILTSTONE micac	SEAM NE, SILTSTONE, Interlaminated, micaci eous gritty	eous, grithy, Bedding: cm cross-bedding, feint, Sed Control: horizontal bedding, Contac	t: Basal contact flat, 80% SANDST	ONE micaceous gritty, 20%
105	—15.33m SANDSTO	ONE, white, coarse to medium grained, g	gritty, pebbles, Contact: Basal contact flat		
1560	-0.27m No.4 U		eous, Bedding: om to dm laminations, normal, Sed Control: horizontal bedding. Contac	t Basal contact flat, 80% SANDSTC	ONE micaceous, 20% SILTSTONE
	1.95m No.4 L	OWER SEAM			
120			eous, Bedding: cm cross-bedding, feint, Contact: Basai contact flat, 70% SANDSTONE		
125	SANDSTONE mica	NE, SILTSTONE, micaceous, bioturbat aceous bioturbated, 40% SILTSTONE m E, black, shalv, carbonaceous, inclusio		feint, Sed Control: horizontal beddir	ng, Contact: Basal contact flat, 60%

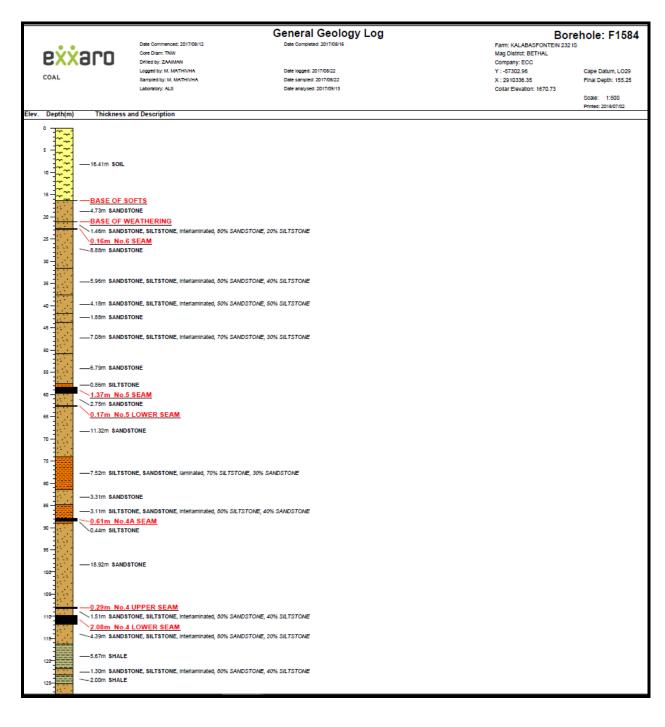
Date Commenced: 2019/11/02 Ore Date: TNW Loget by: M.MATHIVHA Date Completed: 2010/11/03 Camplet in hole: 0.0m Parm: KALABAS/FONTEIN 232.13 Mag District: BETHAL Compary: TGSA COAL Date Completed: 2010/11/03 Camplet in hole: 0.0m Date completed: 2010/11/05 Camplet in hole: 0.0m Y::e5997.66 Camplet in hole: 0.0m Camplet in hole: 0.0m Laboratory: 608 Date completed: 2010/11/15 Camplet in hole: 0.0m Date completed: 2010/11/15 Camplet in hole: 0.0m Y::e5997.66 Camplet in 10.05 Camplet in hole: 0.0m Camplet in hole: 0.0m Elev Depth(m) Thickness and Description Y::e5997.66 Camplet in hole: 0.0m Camplet in hole: 0.0m 1000-000000000000000000000000000000000				General Geology Log	Bor	ehole: F1315
COL Description Company: TC2.4			Date Commenced: 2010/11/02			
COAL Logentity: M.M.THRIVA Date ragged 20101115 Y : -5597.56 Cope ballint, CO29 Loomery: RDS Loomery: RDS Date sameler 20101115 Coller Elevation: 1811.55 Doaler: 1500 Elev DeetMin Tolkness and Description Source: SURVEYED Doaler: 1500 Image: RDS and RDS a		000	Core Diam: TNW	Casing left in hole: 0.0m	Mag District: BETHAL	
COAL Des sames 2001/15 X: 391402:16 Products: 53.5 Convert: 50.00 Convert: 50.00 Protect 2001/15 Convert: 50.00 Protect 2001	5//				Company: TCSA	
Latomary: 03 Collect Parallels and Park Basis Collect Parallels and Park Basis Collect Parallels and Description Collect Parallels and Description Collect Parallels and Description Collect Parallels Collect Col	6041		Logged by: M. MATHIVHA			
Downer: 180 is Downer: 180 is Elev. Depth(m) Thickness and Description ************************************	COAL			Date sampled: 2010/11/15		Final Depth: 89.39
Elev Depth(m) Thickness and Description 0			Laboratory: SGS			People: 1:500
Example Contact: Basal contact fat, 60% SANDSTONE, Intertainmated, direction, slightly weathered, Bedding: mm to cm laminations, fent, Sed Control: horizontal bedding. Contact: Basal contact fat, 60% SANDSTONE carbonaceous wipp, 11600- Soft SaNDSTONE, SILTSTONE, Intertainmated, carbonaceous, wipp, Bedding: cm cross-bedding, normal, Sed Control: horizontal bedding. Contact: Basal contact fat, 60% SANDSTONE carbonaceous wipp, 11600- Soft SaNDSTONE, SILTSTONE, Intertainmated, carbonaceous, wipp, Bedding: cm cross-bedding, fent. Contact: Basal contact fat, 60% SANDSTONE carbonaceous wipp, 117570K ca			Comments: KB016		Source, SORVETED	
 2.2m SANDSTONE, SILTSTONE, Interfaminated, micaceous, slightly weathered, Bedding: mm to cm laminations, fent, Sed Control: horizontal bedding. Contact: Basal contact fail, 80% SANDSTONE micaceous, 20% SILTSTONE micaceous, 20% SILTSTONE micaceous wips, 40% SILTSTONE, interfaminated, carbonaceous, wisps, Bedding: cm cross-bedding, heint, Contact: Basal contact fail, 60% SANDSTONE, SILTSTONE carbonaceous wips, 40% SILTSTONE interfaminated, carbonaceous, wisps, Bedding: cm cross-bedding, feint, Contact: Basal contact fail, 60% SANDSTONE carbonaceous wips, 40% SILTSTONE carbonaceous wips, 40% SILTSTONE carbonaceous wips, 40% SILTSTONE, Einterfaminated, carbonaceous, wisps, Inclusions: siderite, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding. Contact: Basal contact fail, 60% SANDSTONE 20m SANDSTONE, SILTSTONE, Interfaminated, carbonaceous, wisps, Inclusions: grit, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding. Contact: Basal contact fail, 60% SANDSTONE 20m SANDSTONE, SILTSTONE, Interfaminated, carbonaceous, wisps, Inclusions: grit, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding. Contact: Basal contact fail, 60% SANDSTONE 20m SANDSTONE, SILTSTONE, Interfaminated, carbonaceous, wisps, Inclusions: grit, Contact: Basal contact fail, 60% SANDSTONE silentitic micaceous, 90% SILTSTONE earbonaceous, wisps, Inclusions: grit, Contact: Basal contact fail, 60% SANDSTONE silentitic micaceous, 20% SILTSTONE silentitic micaceous, 90% SILTSTONE, Interfaminated, identific, micaceous, Bedding: thicky bedded (0.3 - 1.0m), normal, Contact: Basal contact fail, 60% SANDSTONE silentitic micaceous, 20% SILTSTONE silentitic micaceous, 30% SILTSTONE, Interfaminated, micaceous, Bedding: on to dm laminations, normal, Contact: Basal contact fail, 60% SANDSTONE micaceous, 20% SILTSTONE silentic micaceous, 20% SILTSTONE silentic micaceous, 20% SILTSTONE silentic micaceous, 20% SILTSTONE micaceous, 20% SILTSTONE micaceous, 2	Elev. Depth(m)) Thickness ar	nd Description			
 2.29m. No.4 LOWER SEAM. 3.05m SANDSTONE, SILTSTONE, Interiaminated, sidertito, micaceous, Bedding: thickly bedded (0.3 - 1.0m), normal, Contact: Basal contact flat, 80% SANDSTONE sidertitic micaceous, 20% SiLTSTONE sidertitic micaceous, 30% SiLTSTONE sidertitic micaceous, 20% SiLTSTONE micaceous, 20% SiLTSTONE sidertitic micac		 8.33m SOIL, yeii 2.29m SANDST 20% SILTSTONE 2.36m SANDST 3.66m SANDST wisps 2.90m SANDST 2.90m SANDST carbonaceous with carbonaceous with 0.41m No.4A 	owish, brown DNE, SILTSTONE, Intertaminated, micaceous, sligh micaceous DNE, SILTSTONE, Intertaminated, carbonaceous, carbonaceous wisps DNE, SILTSTONE, Intertaminated, carbonaceous, pp. 40% SILTSTONE carbonaceous wisps DNE, SILTSTONE, Intertaminated, carbonaceous, sp. 10% SILTSTONE, Intertaminated, carbonaceous, Mago	wisps, Bedding: om cross-bedding, normal, Sed Control: hortzontal bedding wisps, Bedding: om cross-bedding, feint, Contact. Basal contact flat, 90% S wisps, Inclusions: sidente, Bedding: om to dm laminations, normal, Sed Co wisps, Inclusions: grit, Bedding: om to dm laminations, normal, Sed Control	, Contact Basai contact flat, 60% SANDSTOWE carbon ANDSTONE carbonaceous wisps, 10% SILTSTONE ca ntroi: horizontal bedding, Contact: Basai contact flat, 60	rbonaceous % SANDSTONE
7.5 Im SANDSTONE, while, fine grained, micaceous, massive, Contact: Basal contact flat 75 -7.5 Im SANDSTONE, while, fine grained, micaceous, contact: Basal contact flat 75 -2.9 m. No.2 UPPER SEAM 1.10m SANDSTONE, while, fine grained, micaceous, Contact: Basal contact flat 2.46m SILTSTONE, black, inclusions: grit, sandstone lenses or bands, Contact: Basal contact flat 2.46m SANDSTONE, black, inclusions: grit, Bedding: om to dm laminations, feint, Sed Control: hortzontal bedding, Contact: Basal contact flat 75	45 50 55 55 55 55 55 55 55 55 5	3.06m SANDSTC micaceous 1.12m SANDSTC 2.09m SANDSTC 3.54m SILTSTOI SANDSTOVE mik 1.60m SANDSTC 2.23m SILTSTOI 6.58m SANDSTC 2.0% SILTSTOI 6.58m SANDSTC 0.29m No.2 1.10m SANDSTC 0.29m No.2 1.10m SANDSTC 1.38m SANDSTC 1.38m SANDSTC 1.38m SANDSTC 1.38m SANDSTC 1.38m SANDSTC 1.38m COAL 7.82m DIABASE	NE, SILTSTONE, Interlaminated, sidertilo, micaoo DNE, SILTSTONE, Interlaminated, micaoeous, Bed DNE, grey, fine grained, micaoeous, grity, Bedding WE, SANDSTONE, Interlaminated, micaoeous, grity Careous grity ONE, grey, fine grained, micaoeous, bioturbated, C NE, black, chaiy, at base, inclusions: sandstone le DNE, silt_TSTONE, Interlaminated, carbonaeous, carbonaeous wisps DNE, white, fine grained, micaoeous, massive, Cor <u>UPPER SEAM</u> NE, white, fine grained, micaoeous, Contact: Basa Lowers SEAM NE, black, inclusions: grit, sandstone lenses or bar DNE, grey, fine grained, inclusions:: grit, Bedding: c <u>EMENT</u>	ding: cm to dm laminations, normal, Sed Control: horizontal bedding. Conta ; cm to dm laminations, feint, Sed Control: horizontal bedding. Contact: Bas by, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding. Co ontact: Basai contact flat mses or bands, Contact: Basai contact flat wisps, Bedding: cm to dm laminations, feint, Sed Control: horizontal beddiny ttact: Basai contact flat al contact flat nds, Contact: Basai contact flat	ct: Basal contact flat, 70% SANDSTONE micaceous, 30 sal contact flat ontact: Basal contact flat, 80% SILTSTONE micaceous; g. Contact: Basal contact flat, 80% SANDSTONE carbo	96 SIL T3TONE 1560 gritty, 20%











	General Geology Log				Bor	Borehole: F1585		
			Date Commenced: 2017/08/17	Date Completed: 2017/08/24	Farm: KALABASFONTEIN 232			
	PXX	aro	Core Diam: TNW Drilled by: ZAAIMAN		Mag District: BETHAL			
	UNA	010	Logged by: M. MATHIVHA	Date logged: 2017/08/28	Company: ECC Y : -57592.74	Cape Datum, LO29		
	COAL		Sampled by: M. MATHIVHA	Date sampled: 2017/08/28	X : 2910713.92	Final Depth: 167.31		
			Laboratory: ALS	Date analysed: 2017/09/13	Collar Elevation: 1672.50			
						Scale: 1:500		
Flow	Depth(m)	Thickness	nd Description			Printed: 2018/07/02		
ciev.		Thickness a	na bescription					
	5 - 1 //		OVERY, SOIL					
	10	-BASE OF SC	DFTS					
	15		TONE					
	1.50							
	20							
		ASE OF W						
	25	0.20m No.6						
	30							
	1.1							
	35							
	1.50							
	40		TONE, SILTSTONE, Interlaminated, 60% S	ANDSTONE, 40% SILTSTONE				
	45							
		-4.80m SANDST	ONE					
	50							
		-2.00m SANDSI	ONE, SILTSTONE, Interlaminated, 80% SA	NDSTONE, 20% SILTSTONE				
	55		ONE					
	60 -							
			ONE, SILTSTONE, Interlaminated, 90% SA	INDSTONE 10% SILTSTONE				
	65		LOWER SEAM					
		-6.62m SANDST						
	70							
	10.0	-5.62m SANDST	ONE, SILTSTONE, Interlaminated, 90% SA	INDSTONE. 10% SILTSTONE				
	75							
	80 -		NE, SANDSTONE, laminated, 70% SILTS	TONE, 30% SANDSTONE				
	85	-6.54m SANDST	ONE, SILTSTONE, Interlaminated, 80% SA	NDSTONE. 20% SILTSTONE				
	90 -		A SEAM ONE, SILTSTONE, Interbedded, 70% SAN	DOTONE SON ON TOTONE				
		>1.22m SANDST	One, all 151 One, interbedded, 70% SAN	DOTONE, 30% SILISTONE				
	95							
	100		TONE					
	15.							
	105							
	1 23		UPPER SEAM					
	110	0.26m SILTSTO						
	1.20	0.94m SANDST	ONE ONE, SILTSTONE, Interlaminated, 70% SA	NDSTONE 30% SILTSTONE				
	115		LOWER SEAM	and a range of the formula				
			ONE, SILTSTONE, Interiaminated, 60% SA	NDSTONE, 40% SILTSTONE				
	120	12.80m SANDST	ONE					
			NE, SANDSTONE, Interlaminated, 60% S/	LTSTONE, 40% SANDSTONE				
	125	1.82m SILTSTO	NE ONE, SILTSTONE, laminated, 70% SAND	STONE. 30% SILTSTONE				
-		L Street SMIDSI	and, are removed, with lated, ruge annual	and the second second				

