EXXARO COAL CENTRAL

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KALABASFONTEIN PROJECT, FORZANDO COMPLEX: GEOTECHNICAL RISK ASSESSMENT

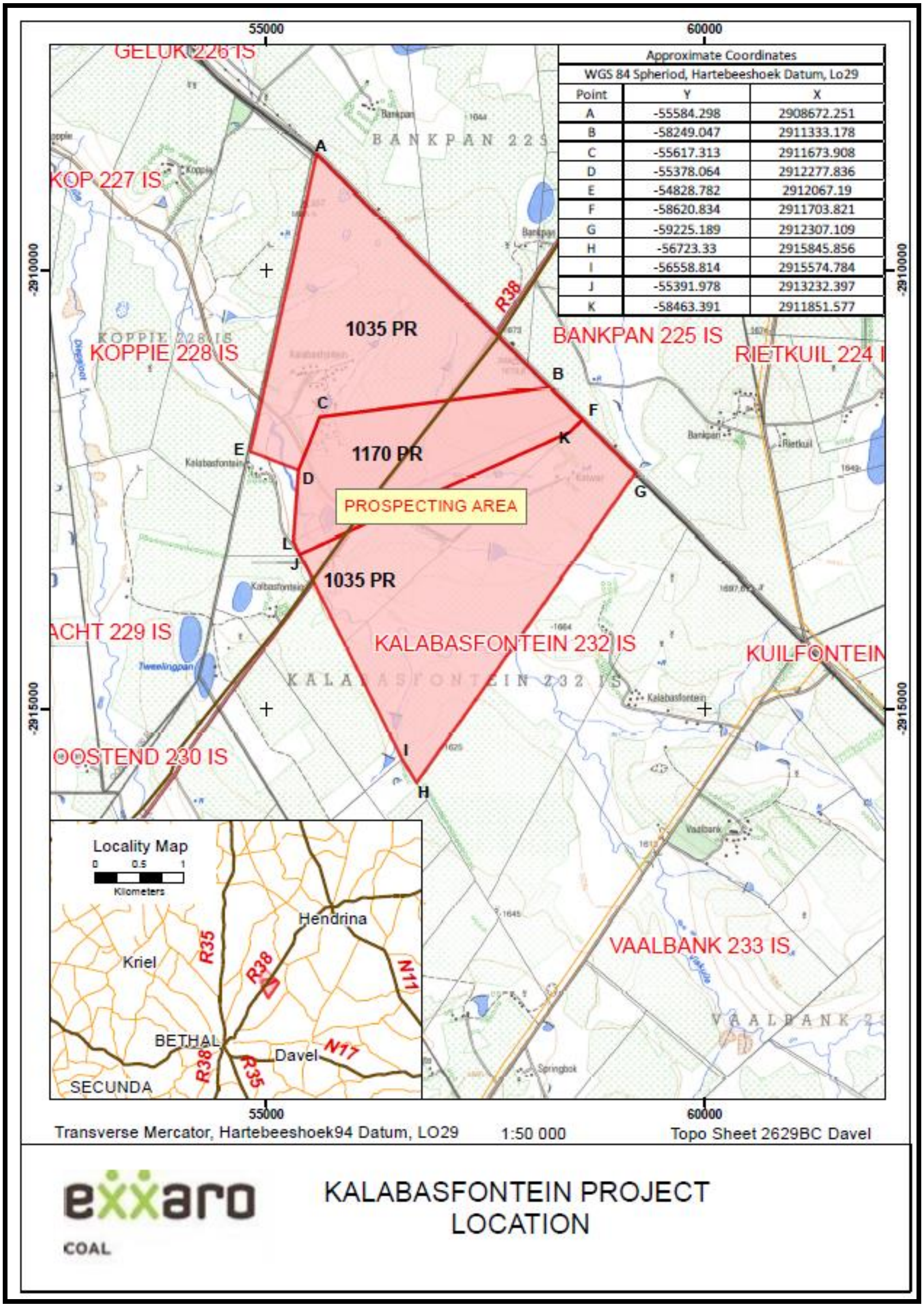
1. <u>Introduction.</u>

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



Point	Y	X
A	-55584.298	2908672.251
B	-58249.047	2911333.178
C	-55617.313	2911673.908
D	-55378.064	2912277.836
E	-54828.782	2912067.19
F	-58620.834	2911703.821
G	-59225.189	2912307.109
H	-56723.33	2915845.856
I	-56558.814	2915574.784
J	-55391.978	2913232.397
K	-58463.391	2911851.577

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) *Pillar Strength*

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:

$$\sigma_s = 5.47\frac{w_e^{0.8}}{h}\ (\mathrm{MPa}) \qquad (1)$$

Where:

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

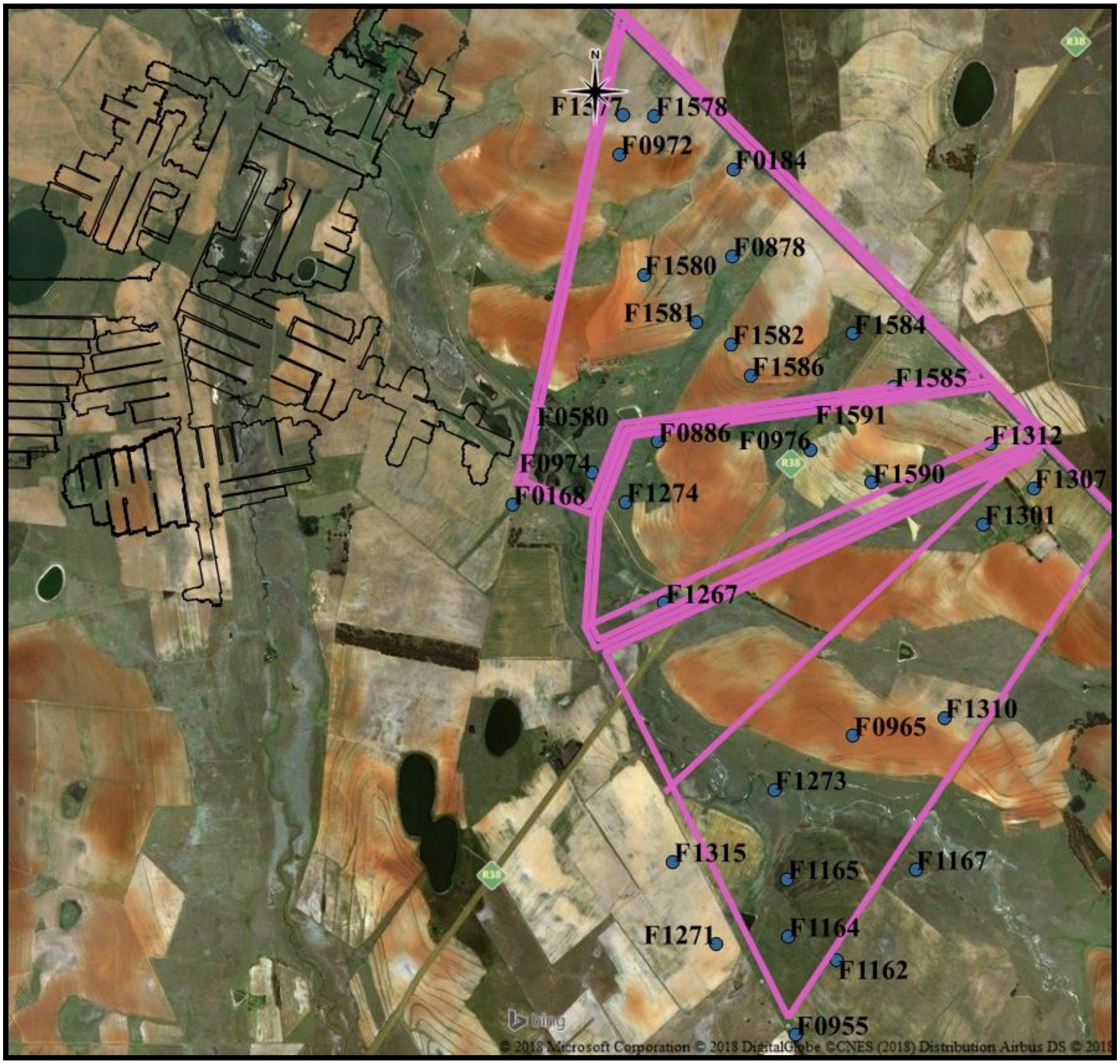


Figure 2: Satellite image showing Kalabasfontein boundaries (Purple) and the boreholes used in the assessment.

2) <u>Pillar Load.</u>

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:

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

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) Safety Factor

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

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

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:

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

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. <u>Pillar Life Index</u>

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:

$$d_c = w - [0.002285HhC^2]^{0.3571}\ (\mathrm{m}) \quad (5)$$

Where H = mining depth (m)
C = pillar centre distance (m)
h = mining height (m)

The predicted life of the pillar is then given by:

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

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%

Table 2: Recommended minimum pillar life index

Category	Minimum PLI (Years)	Remarks
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:

$$12\frac{\left(hD_B^2 + 2h^2 D_B \cot\alpha\right)}{(K-1)\pi} = \left[\frac{(fD_B)^3}{2\tan\phi} - (fD_B - 2z\tan\phi)^2\left(\frac{fD_B}{2\tan\phi} - z\right)\right]\ (\mathrm{m}) \qquad (7)$$

Where D_B = 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:

$$z_m = \frac{fD_B}{2\tan\phi} \text{ (m)} \quad (8)$$

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. Subsidence

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:

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

$$\lambda = \frac{h_e/H}{0.027} \quad (10)$$

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:

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

Class	S_m/H	Description
A	<0.001	Barely noticeable, smooth, continuous profile, hairline cracks
B	0.001 - 0.005	Difficult to notice, smooth profile, cracks 1 to 2 cm wide
C	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

7. Results

Table 4: Summary of assessmentBorehole number	Base of Weathering	Depth to Floor (H) (m)	Mining Height (m)	Centre Distance (m)	Centre Distance 2 (m)	Effective Width (m)	Pillar Strength (MPa)	Load (MPa)	Corrected Safety Factor	Pillar Width to Height Ratio	Percentage Areal 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

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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

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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	Subscicence Class
F0168	100.56	16.00	2.45	7.20	10.80	64.00	28758.33	0.98501901	0.0097953	C
F0184	90.16	14.00	2.10	7.20	9.06	68.80	20365.72	1.00709631	0.0111701	C
F0580	71.23	3.90	2.10	7.20	7.80	72.96	11046.44	1.26702794	0.0177878	C
F0878	103.78	16.18	2.10	7.20	10.80	64.00	59266.64	0.84458109	0.0081382	C
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	C
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	C
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	C
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	C

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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	Subscicence 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	C
F1307	110.09	25.07	2.34	7.20	10.80	64.00	30063.49	0.88017731	0.0079951	C
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	C
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	C
F1578	118.65	30.00	2.10	7.20	10.80	64.00	45129.23	0.75346996	0.0063504	C
F1580	95.18	8.30	2.10	7.20	9.06	68.80	17997.96	0.96368946	0.0101249	C
F1581	106.25	15.10	2.10	7.20	10.80	64.00	56621.78	0.82796624	0.0077926	C
F1582	103.76	12.70	2.46	7.20	10.80	64.00	26301.91	0.96336847	0.0092846	C
F1584	112.08	21.00	2.10	7.20	10.80	64.00	50871.15	0.79120384	0.0070593	C
F1585	112.09	21.20	2.19	7.20	10.80	64.00	40944.25	0.8199084	0.0073147	C
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	C

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Borehole number	Depth to Floor (H) (m)	Base of Weathering	Mining Heigth (m)	Bord Width (m)	Effective Width (m)	Percentage Areal Extraction	Caving Height (m)	Stable Overburden (m)	%Comp Layer	Sum Comp Layer	Max Comp Thickness (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

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Borehole number	Depth to Floor (H) (m)	Base of Weathering	Mining Heigth (m)	Bord Width (m)	Effective Width (m)	Percentage Areal Extraction	Caving Height (m)	Stable Overburden (m)	%Comp Layer	Sum Comp Layer	Max Comp Thickness (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. Sinkhole

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. Subsidence

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.

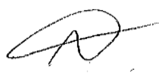
9. Recommendations

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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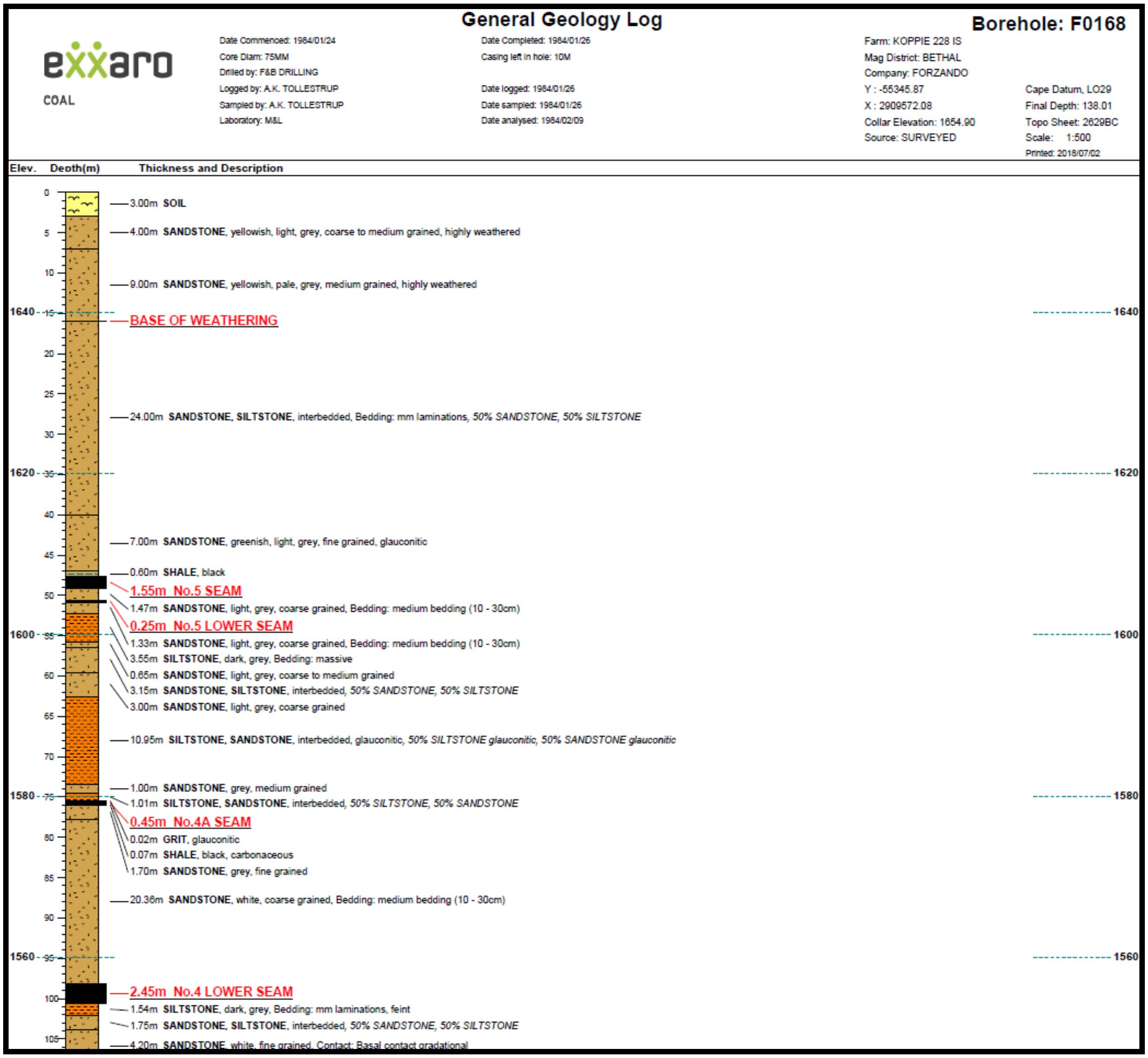
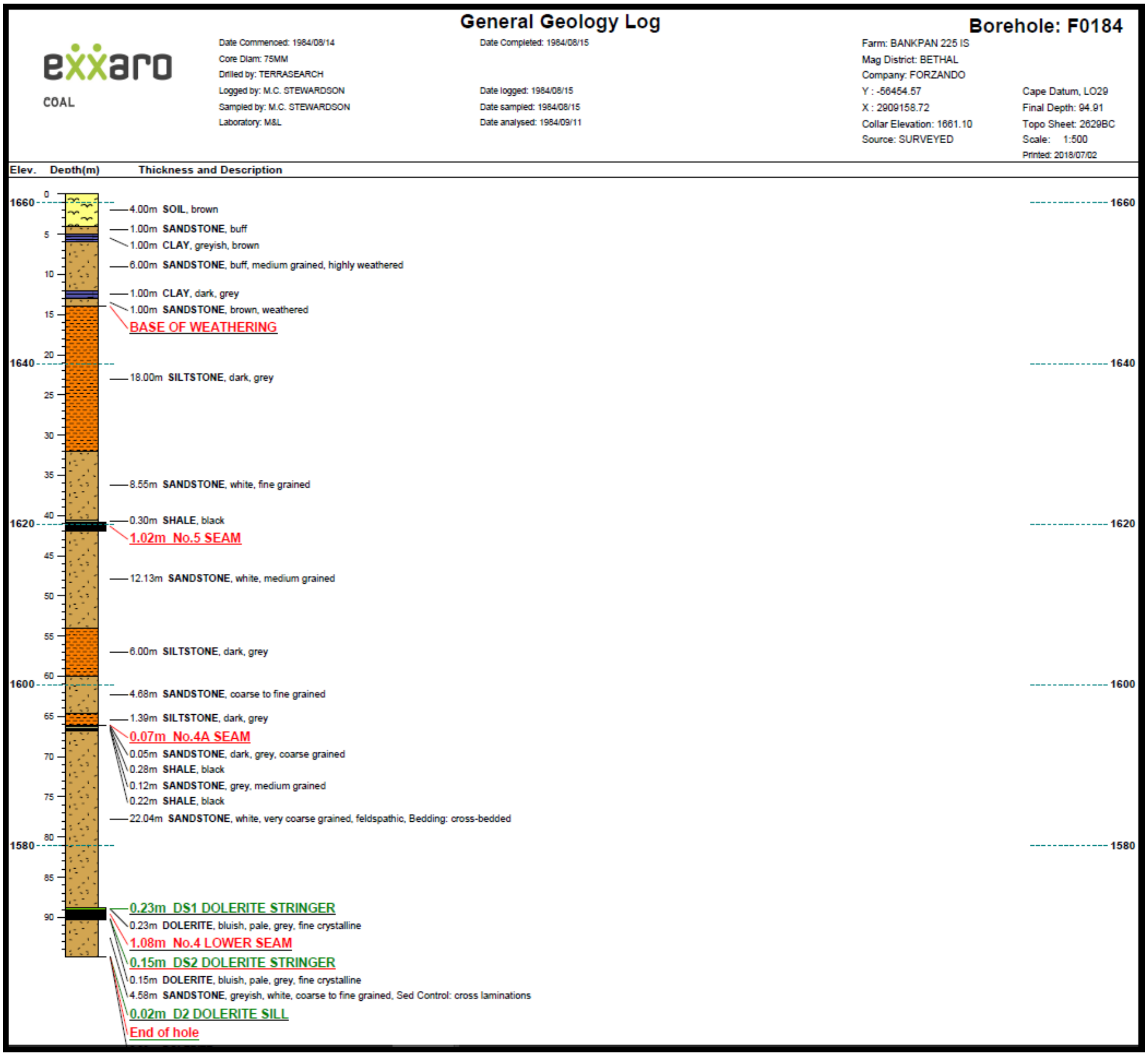
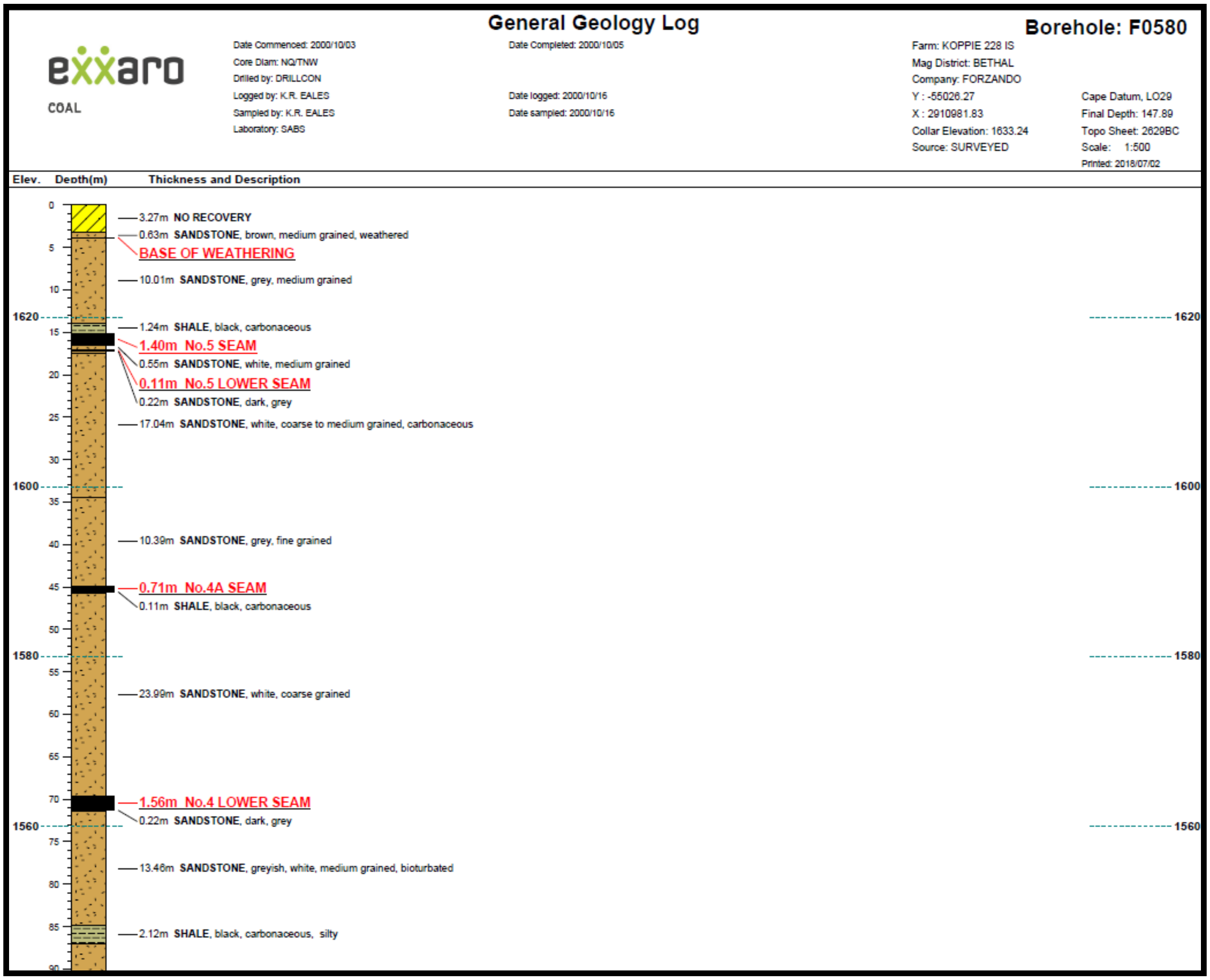
APPENDIX 1

GEOLOGICAL BOREHOLES

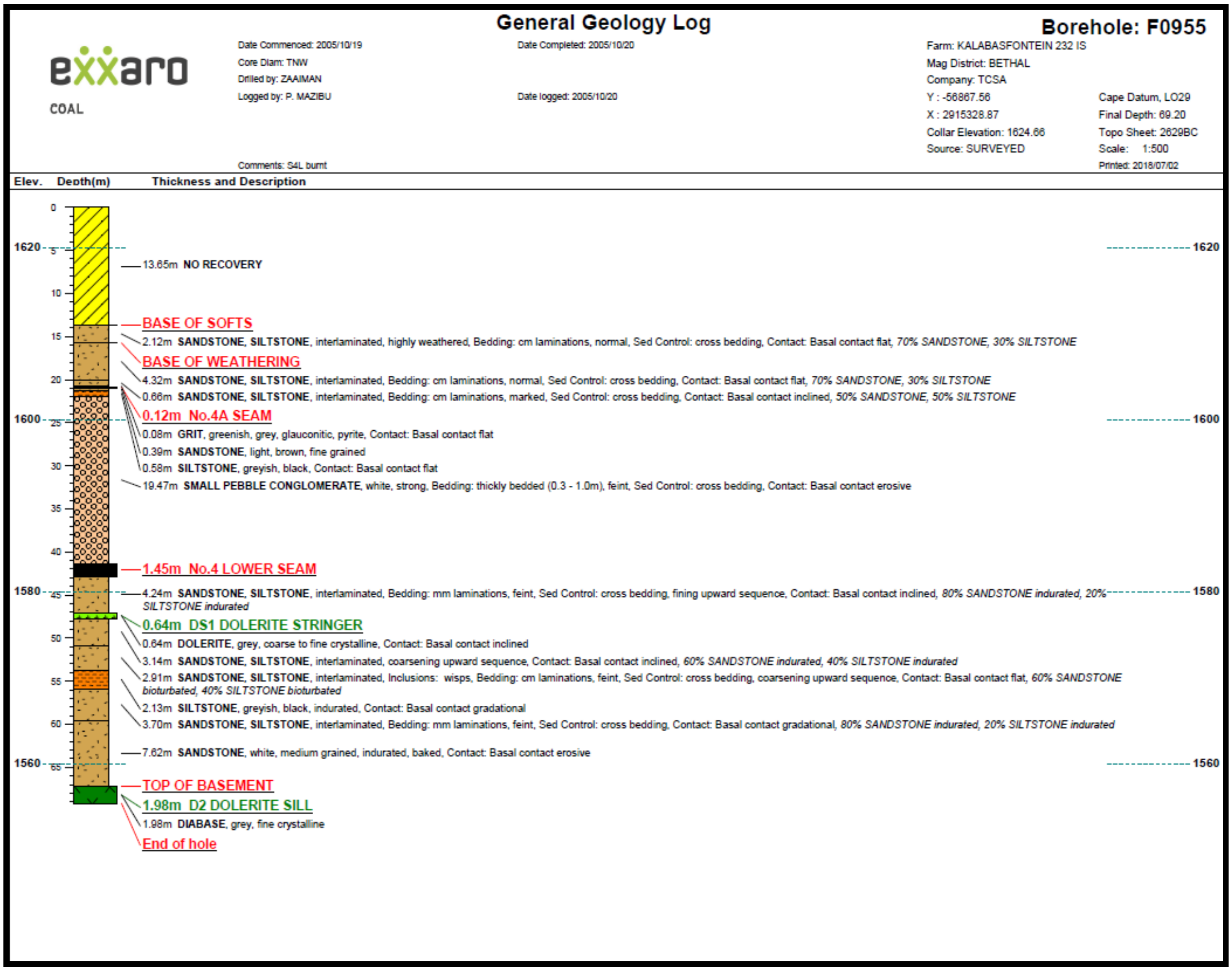

General Geology Log
Borehole: F0168
COAL
Date Commenced: 1984/01/24
Core Diam: 75MM
Drilled by: F&B DRILLING
Logged by: A.K. TOLLESTRUP
Sampled by: A.K. TOLLESTRUP
Laboratory: M&L
Date Completed: 1984/01/26
Casing left in hole: 10M
Date logged: 1984/01/26
Date sampled: 1984/01/26
Date analysed: 1984/02/09
Farm: KOPPIE 228 IS
Mag District: BETHAL
Company: FORZANDO
Y : -55345.87
X : 2909572.08
Collar Elevation: 1654.90
Source: SURVEYED
Cape Datum, LO29
Final Depth: 138.01
Topo Sheet: 2629BC
Scale: 1:500
Printed: 2018/07/02
Elev. Depth(m) Thickness and Description
3.00m SOIL
4.00m SANDSTONE, yellowish, light, grey, coarse to medium grained, highly weathered
9.00m SANDSTONE, yellowish, pale, grey, medium grained, highly weathered
BASE OF WEATHERING
24.00m SANDSTONE, SILTSTONE, interbedded, Bedding: mm laminations, 50% SANDSTONE, 50% SILTSTONE
7.00m SANDSTONE, greenish, light, grey, fine grained, glauconitic
0.60m SHALE, black
1.55m No.5 SEAM
1.47m SANDSTONE, light, grey, coarse grained, Bedding: medium bedding (10 - 30cm)
0.25m No.5 LOWER SEAM
1.33m SANDSTONE, light, grey, coarse grained, Bedding: medium bedding (10 - 30cm)
3.55m SILTSTONE, dark, grey, Bedding: massive
0.65m SANDSTONE, light, grey, coarse to medium grained
3.15m SANDSTONE, SILTSTONE, interbedded, 50% SANDSTONE, 50% SILTSTONE
3.00m SANDSTONE, light, grey, coarse grained
10.95m SILTSTONE, SANDSTONE, interbedded, glauconitic, 50% SILTSTONE glauconitic, 50% SANDSTONE glauconitic
1.00m SANDSTONE, grey, medium grained
1.01m SILTSTONE, SANDSTONE, interbedded, 50% SILTSTONE, 50% SANDSTONE
0.45m No.4A SEAM
0.02m GRIT, glauconitic
0.07m SHALE, black, carbonaceous
1.70m SANDSTONE, grey, fine grained
20.36m SANDSTONE, white, coarse grained, Bedding: medium bedding (10 - 30cm)
2.45m No.4 LOWER SEAM
1.54m SILTSTONE, dark, grey, Bedding: mm laminations, feint
1.75m SANDSTONE, SILTSTONE, interbedded, 50% SANDSTONE, 50% SILTSTONE
4.20m SANDSTONE, white, fine grained, Contact: Basal contact gradational
1640
1620
1600
1580
1560

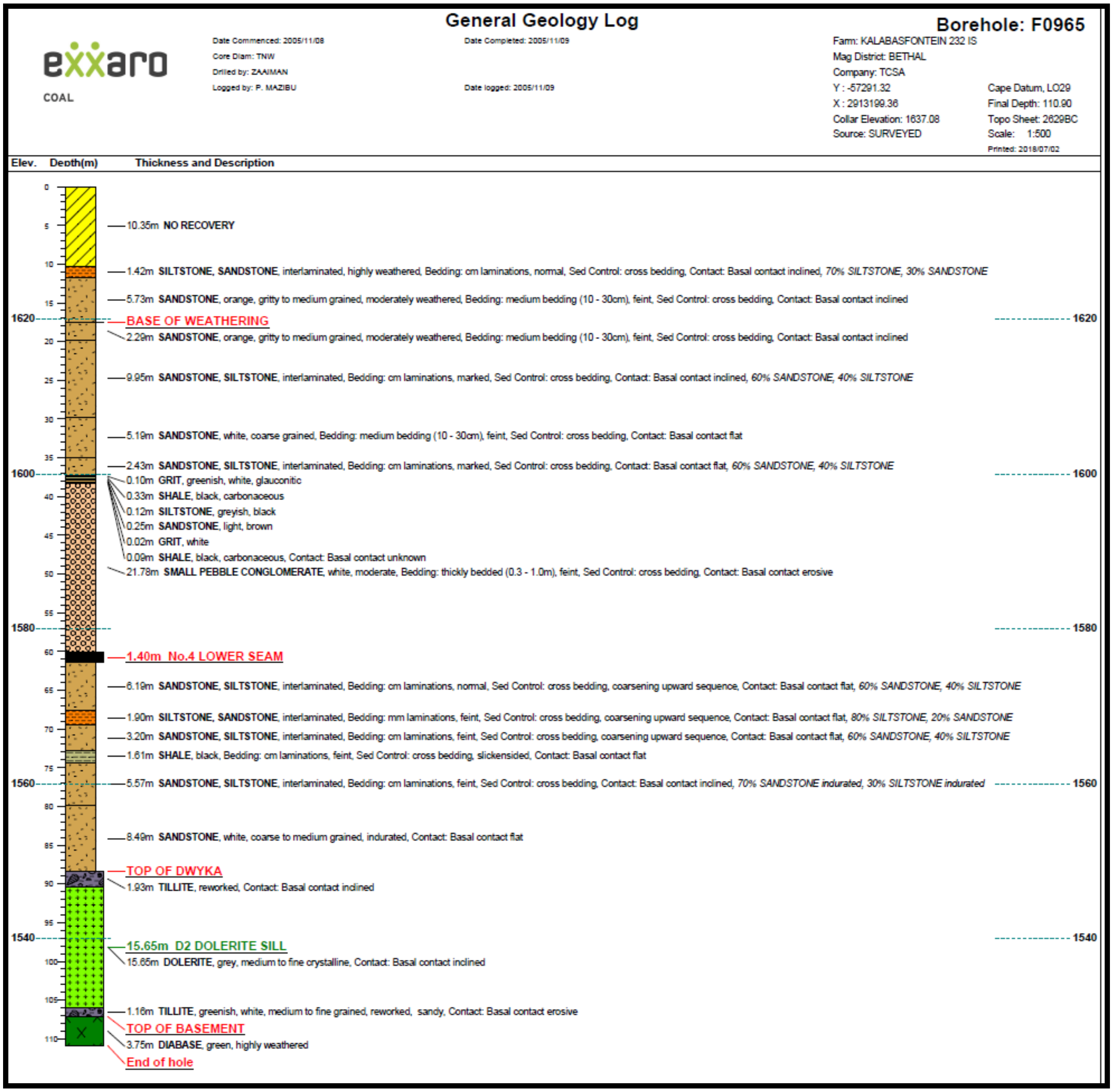

General Geology Log
Borehole: F0184
exxaro COAL
Date Commenced: 1984/08/14
Core Diam: 75MM
Drilled by: TERRASEARCH
Logged by: M.C. STEWARDSON
Sampled by: M.C. STEWARDSON
Laboratory: M&L
Date Completed: 1984/08/15
Date logged: 1984/08/15
Date sampled: 1984/08/15
Date analysed: 1984/09/11
Farm: BANKPAN 225 IS
Mag District: BETHAL
Company: FORZANDO
Y : -56454.57
X : 2909158.72
Collar Elevation: 1661.10
Source: SURVEYED
Cape Datum, LO29
Final Depth: 94.91
Topo Sheet: 2629BC
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
4.00m SOIL, brown
1.00m SANDSTONE, buff
1.00m CLAY, greyish, brown
6.00m SANDSTONE, buff, medium grained, highly weathered
1.00m CLAY, dark, grey
1.00m SANDSTONE, brown, weathered
BASE OF WEATHERING
18.00m SILTSTONE, dark, grey
8.55m SANDSTONE, white, fine grained
0.30m SHALE, black
1.02m No.5 SEAM
12.13m SANDSTONE, white, medium grained
6.00m SILTSTONE, dark, grey
4.68m SANDSTONE, coarse to fine grained
1.39m SILTSTONE, dark, grey
0.07m No.4A SEAM
0.05m SANDSTONE, dark, grey, coarse grained
0.28m SHALE, black
0.12m SANDSTONE, grey, medium grained
0.22m SHALE, black
22.04m SANDSTONE, white, very coarse grained, feldspathic, Bedding: cross-bedded
0.23m DS1 DOLERITE STRINGER
0.23m DOLERITE, bluish, pale, grey, fine crystalline
1.08m No.4 LOWER SEAM
0.15m DS2 DOLERITE STRINGER
0.15m DOLERITE, bluish, pale, grey, fine crystalline
4.58m SANDSTONE, greyish, white, coarse to fine grained, Sed Control: cross laminations
0.02m D2 DOLERITE SILL
End of hole
1660
1640
1620
1600
1580
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90

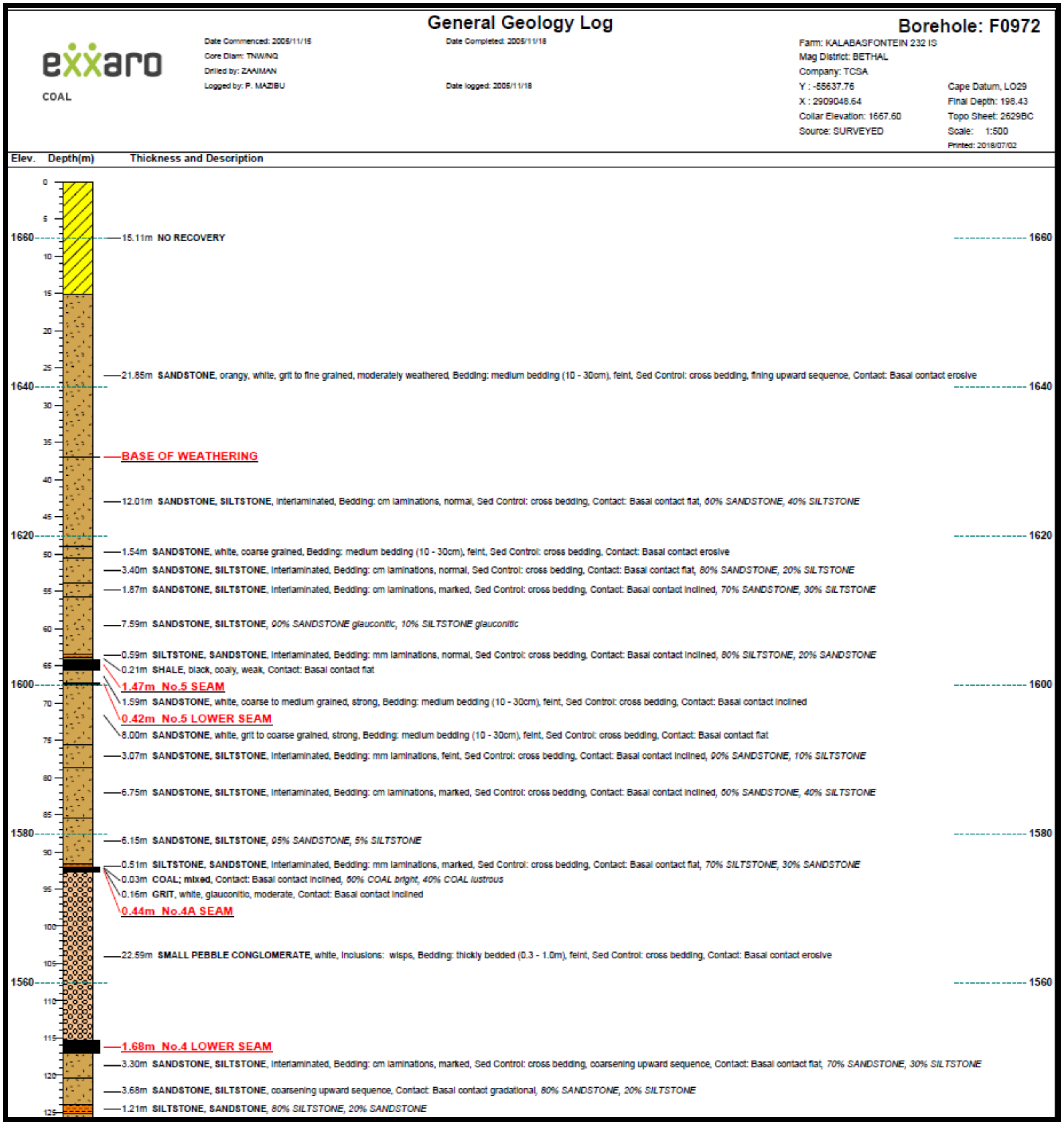
EXXARO COAL CENTRAL



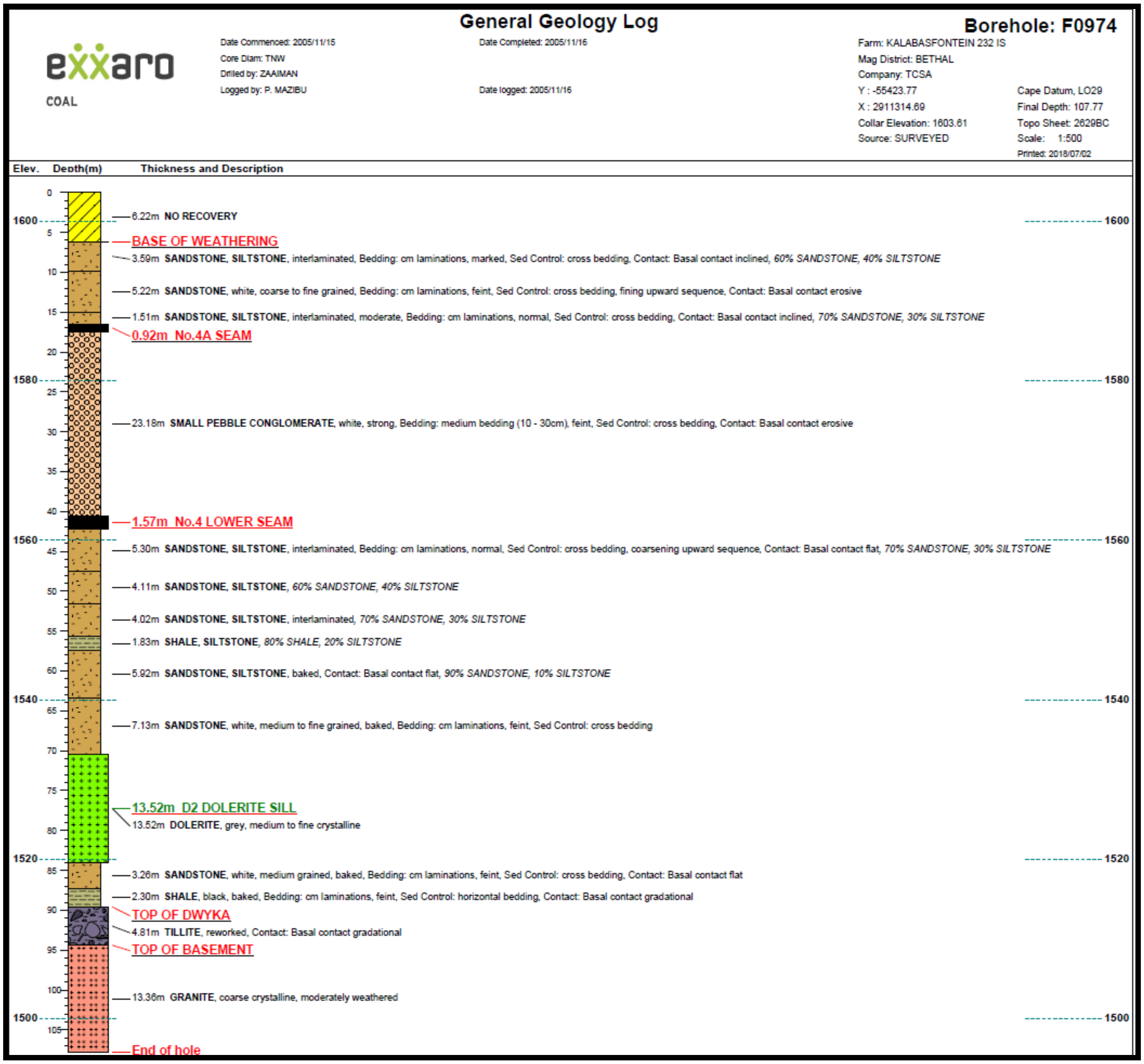
EXXARO COAL CENTRAL




General Geology Log
Borehole: F0965
exxaro
COAL
Date Commenced: 2005/11/08
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: P. MAZIBU
Date Completed: 2005/11/09
Date logged: 2005/11/09
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -57291.32
X : 2913199.36
Collar Elevation: 1637.08
Source: SURVEYED
Cape Datum, LO29
Final Depth: 110.90
Topo Sheet: 2629BC
Scale: 1:500
Printed: 2018/07/02
Elev. Depth(m) Thickness and Description
10.35m NO RECOVERY
1.42m SILTSTONE, SANDSTONE, interlaminated, highly weathered, Bedding: cm laminations, normal, Sed Control: cross bedding, Contact: Basal contact inclined, 70% SILTSTONE, 30% SANDSTONE
5.73m SANDSTONE, orange, gritty to medium grained, moderately weathered, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding, Contact: Basal contact inclined
BASE OF WEATHERING
2.29m SANDSTONE, orange, gritty to medium grained, moderately weathered, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding, Contact: Basal contact inclined
9.95m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, marked, Sed Control: cross bedding, Contact: Basal contact inclined, 60% SANDSTONE, 40% SILTSTONE
5.19m SANDSTONE, white, coarse grained, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding, Contact: Basal contact flat
2.43m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, marked, Sed Control: cross bedding, Contact: Basal contact flat, 60% SANDSTONE, 40% SILTSTONE
0.10m GRIT, greenish, white, glauconitic
0.33m SHALE, black, carbonaceous
0.12m SILTSTONE, greyish, black
0.25m SANDSTONE, light, brown
0.02m GRIT, white
0.09m SHALE, black, carbonaceous, Contact: Basal contact unknown
21.78m SMALL PEBBLE CONGLOMERATE, white, moderate, Bedding: thickly bedded (0.3 - 1.0m), feint, Sed Control: cross bedding, Contact: Basal contact erosive
1.40m No.4 LOWER SEAM
6.19m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, normal, Sed Control: cross bedding, coarsening upward sequence, Contact: Basal contact flat, 60% SANDSTONE, 40% SILTSTONE
1.90m SILTSTONE, SANDSTONE, interlaminated, Bedding: mm laminations, feint, Sed Control: cross bedding, coarsening upward sequence, Contact: Basal contact flat, 80% SILTSTONE, 20% SANDSTONE
3.20m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, feint, Sed Control: cross bedding, coarsening upward sequence, Contact: Basal contact flat, 60% SANDSTONE, 40% SILTSTONE
1.61m SHALE, black, Bedding: cm laminations, feint, Sed Control: cross bedding, slickensided, Contact: Basal contact flat
5.57m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact inclined, 70% SANDSTONE indurated, 30% SILTSTONE indurated
8.49m SANDSTONE, white, coarse to medium grained, indurated, Contact: Basal contact flat
TOP OF DWYKA
1.93m TILLITE, reworked, Contact: Basal contact inclined
15.65m D2 DOLERITE SILL
15.65m DOLERITE, grey, medium to fine crystalline, Contact: Basal contact inclined
1.16m TILLITE, greenish, white, medium to fine grained, reworked, sandy, Contact: Basal contact erosive
TOP OF BASEMENT
3.75m DIABASE, green, highly weathered
End of hole
1620
1600
1580
1560
1540

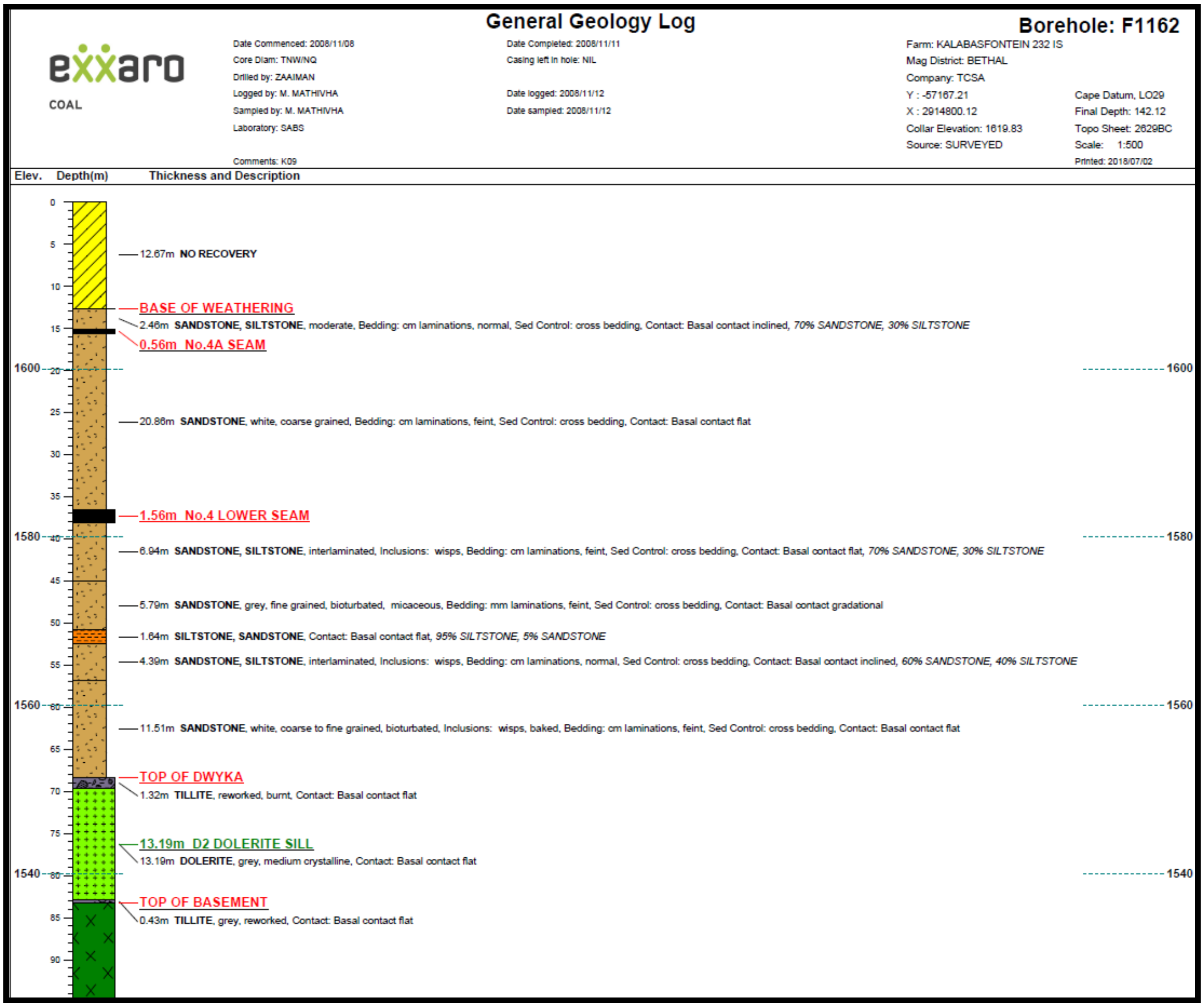

exxaro
COAL
General Geology Log
Borehole: F0972
Date Commenced: 2005/11/15
Core Diam: TNW/NQ
Drilled by: ZAAIMAN
Logged by: P. MAZIBU
Date Completed: 2005/11/18
Date logged: 2005/11/18
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -55637.76
X : 2909048.64
Collar Elevation: 1667.60
Source: SURVEYED
Cape Datum, LO29
Final Depth: 198.43
Topo Sheet: 2629BC
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
15.11m NO RECOVERY
21.85m SANDSTONE, orangy, white, grit to fine grained, moderately weathered, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding, fining upward sequence, Contact: Basal contact erosive
BASE OF WEATHERING
12.01m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, normal, Sed Control: cross bedding, Contact: Basal contact flat, 60% SANDSTONE, 40% SILTSTONE
1.54m SANDSTONE, white, coarse grained, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding, Contact: Basal contact erosive
3.40m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, normal, Sed Control: cross bedding, Contact: Basal contact flat, 80% SANDSTONE, 20% SILTSTONE
1.87m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, marked, Sed Control: cross bedding, Contact: Basal contact inclined, 70% SANDSTONE, 30% SILTSTONE
7.59m SANDSTONE, SILTSTONE, 90% SANDSTONE glauconitic, 10% SILTSTONE glauconitic
0.59m SILTSTONE, SANDSTONE, interlaminated, Bedding: mm laminations, normal, Sed Control: cross bedding, Contact: Basal contact inclined, 80% SILTSTONE, 20% SANDSTONE
0.21m SHALE, black, coaly, weak, Contact: Basal contact flat
1.47m No.5 SEAM
1.59m SANDSTONE, white, coarse to medium grained, strong, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding, Contact: Basal contact inclined
0.42m No.5 LOWER SEAM
8.00m SANDSTONE, white, grit to coarse grained, strong, Bedding: medium bedding (10 - 30cm), feint, Sed Control: cross bedding, Contact: Basal contact flat
3.07m SANDSTONE, SILTSTONE, interlaminated, Bedding: mm laminations, feint, Sed Control: cross bedding, Contact: Basal contact inclined, 90% SANDSTONE, 10% SILTSTONE
6.75m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, marked, Sed Control: cross bedding, Contact: Basal contact inclined, 60% SANDSTONE, 40% SILTSTONE
6.15m SANDSTONE, SILTSTONE, 95% SANDSTONE, 5% SILTSTONE
0.51m SILTSTONE, SANDSTONE, interlaminated, Bedding: mm laminations, marked, Sed Control: cross bedding, Contact: Basal contact flat, 70% SILTSTONE, 30% SANDSTONE
0.03m COAL; mixed, Contact: Basal contact inclined, 60% COAL bright, 40% COAL lustrous
0.16m GRIT, white, glauconitic, moderate, Contact: Basal contact inclined
0.44m No.4A SEAM
22.59m SMALL PEBBLE CONGLOMERATE, white, inclusions: wisps, Bedding: thickly bedded (0.3 - 1.0m), feint, Sed Control: cross bedding, Contact: Basal contact erosive
1.68m No.4 LOWER SEAM
3.30m SANDSTONE, SILTSTONE, interlaminated, Bedding: cm laminations, marked, Sed Control: cross bedding, coarsening upward sequence, Contact: Basal contact flat, 70% SANDSTONE, 30% SILTSTONE
3.68m SANDSTONE, SILTSTONE, coarsening upward sequence, Contact: Basal contact gradational, 80% SANDSTONE, 20% SILTSTONE
1.21m SILTSTONE, SANDSTONE, 80% SILTSTONE, 20% SANDSTONE

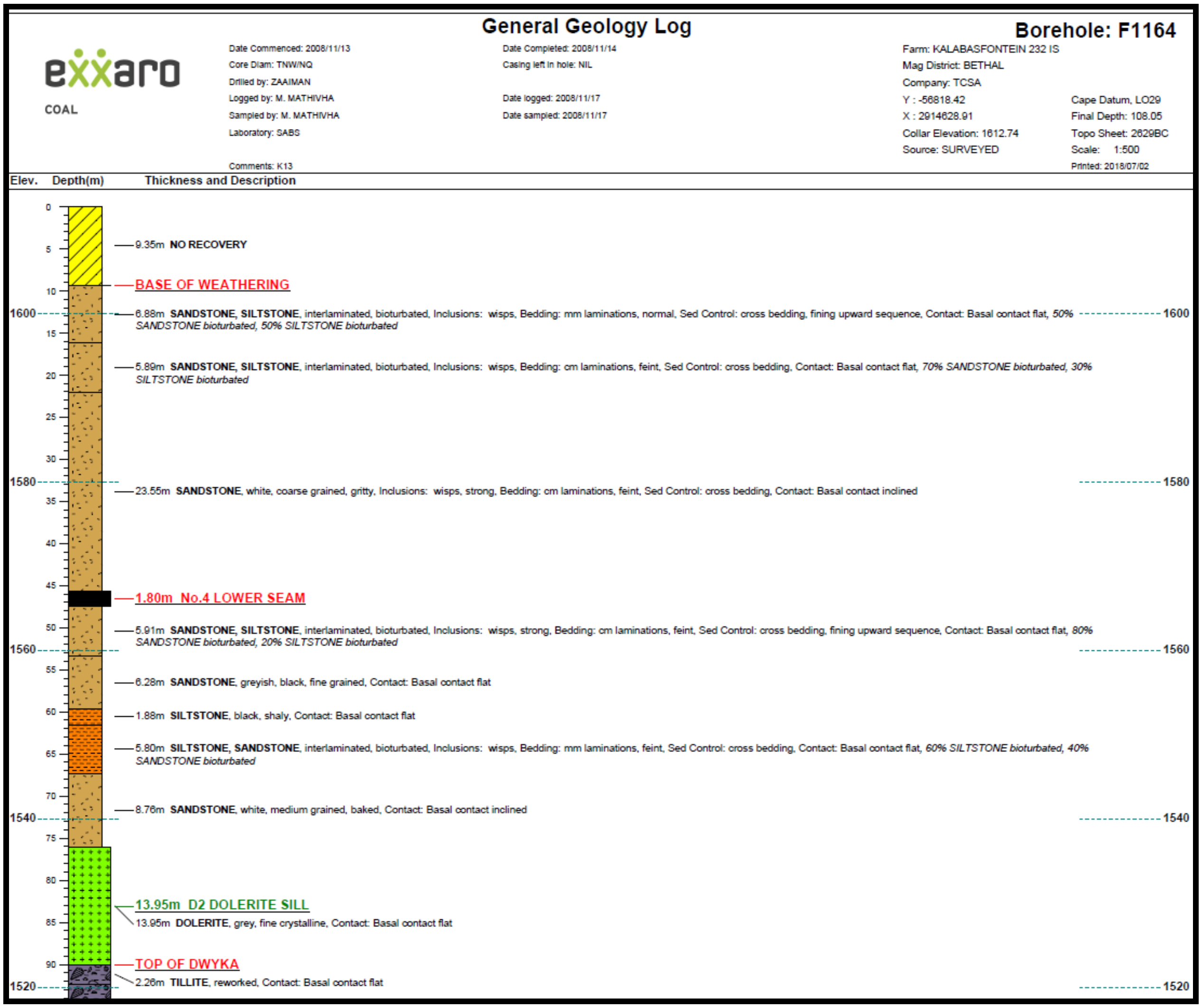
EXXARO COAL CENTRAL

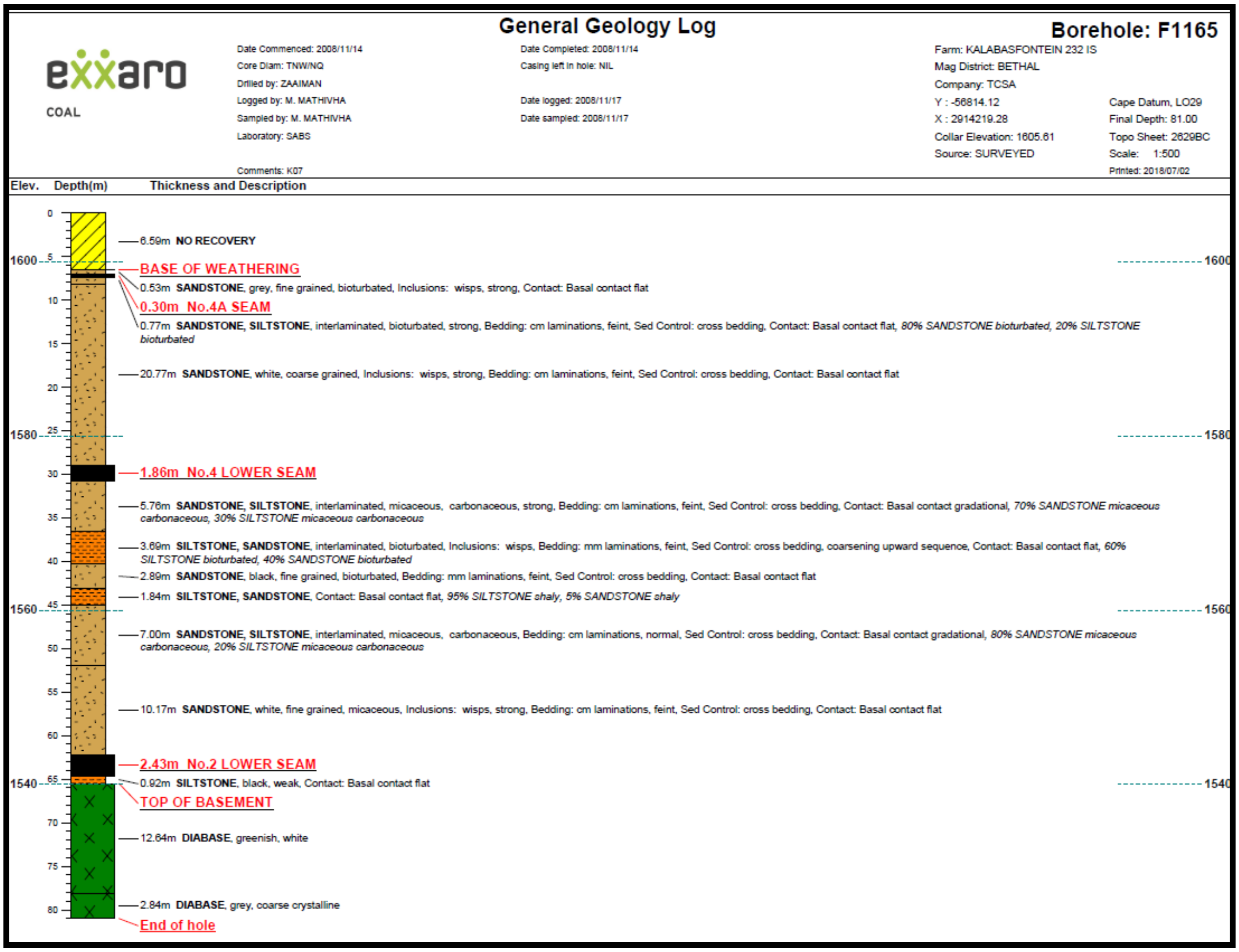


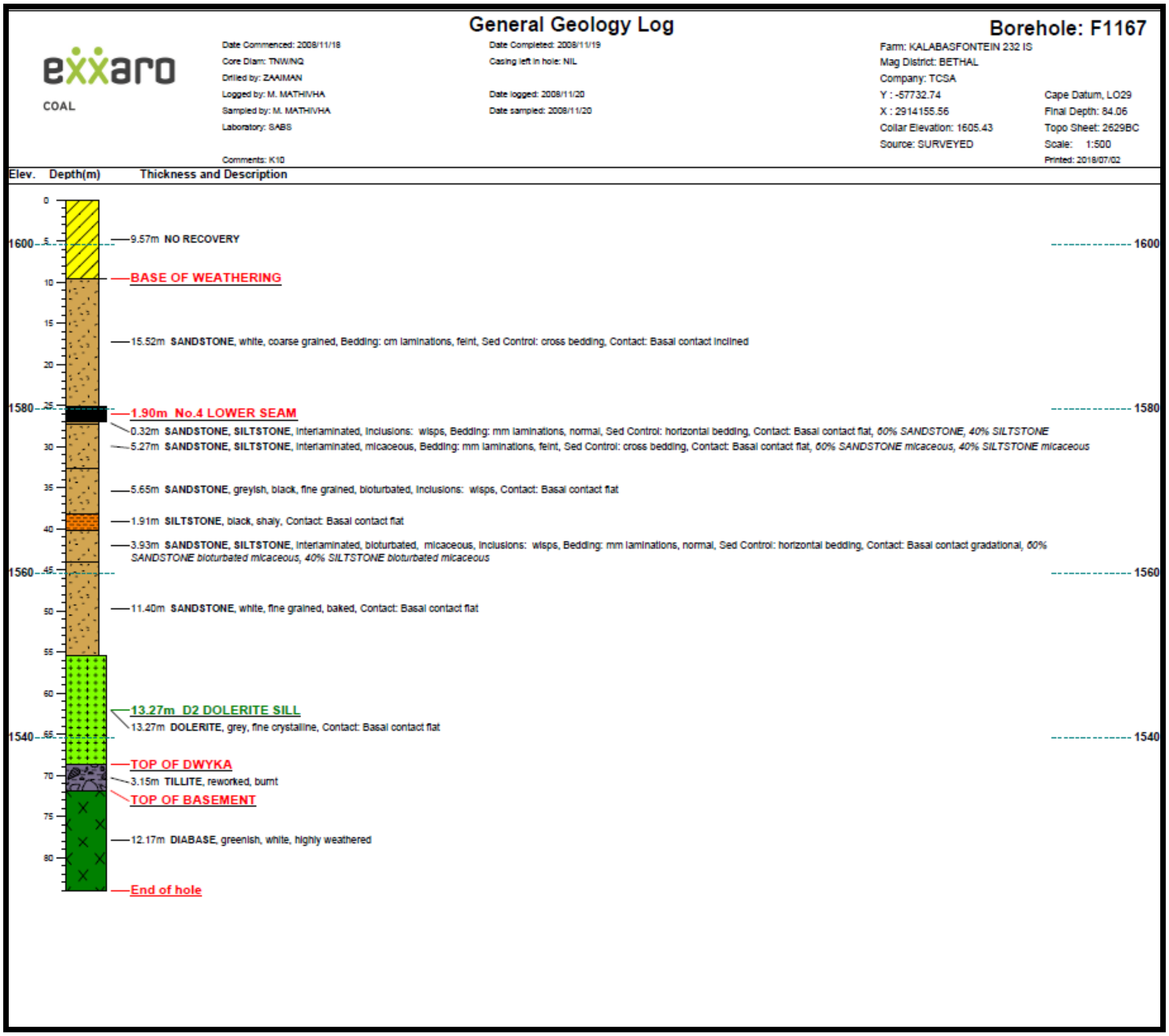
EXXARO COAL CENTRAL

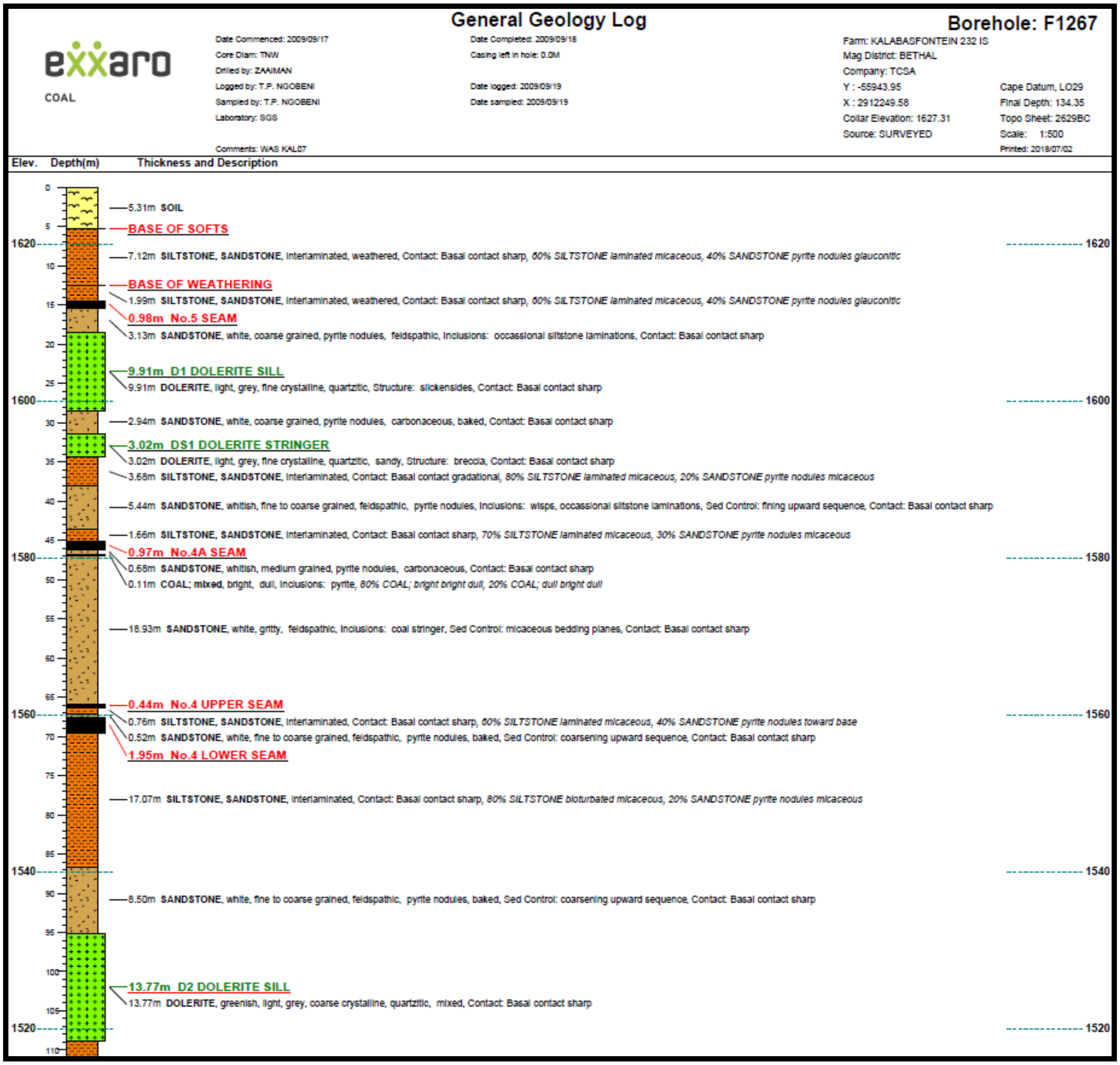
EXXARO COAL CENTRAL



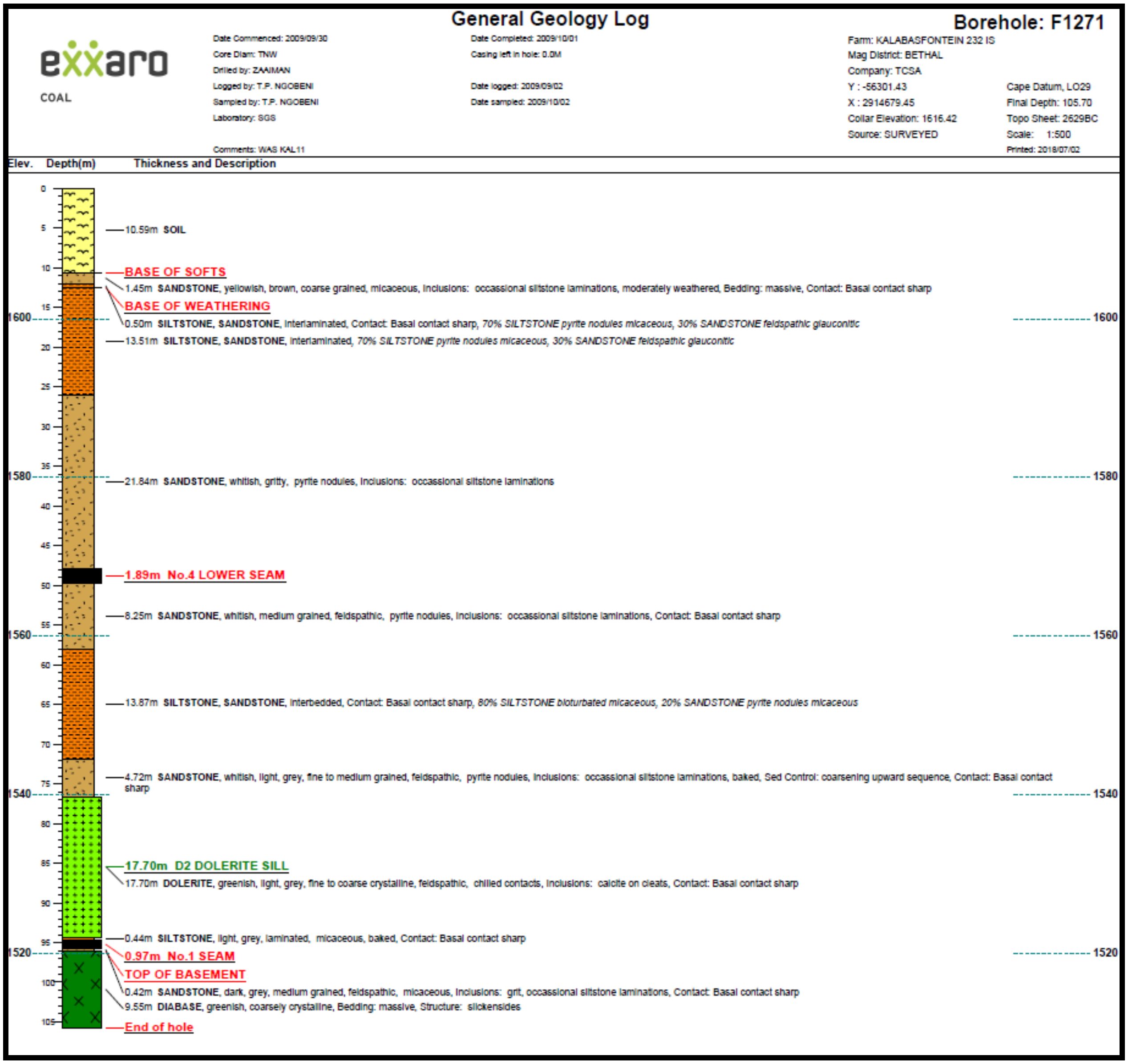

General Geology Log
Borehole: F1164
COAL
Date Commenced: 2008/11/13
Core Diam: TNW/NQ
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Sampled by: M. MATHIVHA
Laboratory: SABS
Comments: K13
Date Completed: 2008/11/14
Casing left in hole: NIL
Date logged: 2008/11/17
Date sampled: 2008/11/17
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -56818.42
X : 2914628.91
Collar Elevation: 1612.74
Source: SURVEYED
Cape Datum, LO29
Final Depth: 108.05
Topo Sheet: 2629BC
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
9.35m NO RECOVERY
BASE OF WEATHERING
6.88m SANDSTONE, SILTSTONE, interlaminated, bioturbated, Inclusions: wisps, Bedding: mm laminations, normal, Sed Control: cross bedding, fining upward sequence, Contact: Basal contact flat, 50% SANDSTONE bioturbated, 50% SILTSTONE bioturbated
5.89m SANDSTONE, SILTSTONE, interlaminated, bioturbated, Inclusions: wisps, Bedding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact flat, 70% SANDSTONE bioturbated, 30% SILTSTONE bioturbated
23.55m SANDSTONE, white, coarse grained, gritty, Inclusions: wisps, strong, Bedding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact inclined
1.80m No.4 LOWER SEAM
5.91m SANDSTONE, SILTSTONE, interlaminated, bioturbated, Inclusions: wisps, strong, Bedding: cm laminations, feint, Sed Control: cross bedding, fining upward sequence, Contact: Basal contact flat, 80% SANDSTONE bioturbated, 20% SILTSTONE bioturbated
6.28m SANDSTONE, greyish, black, fine grained, Contact: Basal contact flat
1.88m SILTSTONE, black, shaly, Contact: Basal contact flat
5.80m SILTSTONE, SANDSTONE, interlaminated, bioturbated, Inclusions: wisps, Bedding: mm laminations, feint, Sed Control: cross bedding, Contact: Basal contact flat, 60% SILTSTONE bioturbated, 40% SANDSTONE bioturbated
8.76m SANDSTONE, white, medium grained, baked, Contact: Basal contact inclined
13.95m D2 DOLERITE SILL
13.95m DOLERITE, grey, fine crystalline, Contact: Basal contact flat
TOP OF DWYKA
2.26m TILLITE, reworked, Contact: Basal contact flat
1600
1580
1560
1540
1520
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90


General Geology Log
Borehole: F1165
exxaro COAL
Date Commenced: 2008/11/14
Core Diam: TNW/NQ
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Sampled by: M. MATHIVHA
Laboratory: SABS
Comments: K07
Date Completed: 2008/11/14
Casing left in hole: NIL
Date logged: 2008/11/17
Date sampled: 2008/11/17
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -56814.12
X : 2914219.28
Collar Elevation: 1605.61
Source: SURVEYED
Cape Datum, LO29
Final Depth: 81.00
Topo Sheet: 2629BC
Scale: 1:500
Printed: 2018/07/02
Elev. Depth(m) Thickness and Description
6.59m NO RECOVERY
BASE OF WEATHERING
0.53m SANDSTONE, grey, fine grained, bioturbated, Inclusions: wisps, strong, Contact: Basal contact flat
0.30m No.4A SEAM
0.77m SANDSTONE, SILTSTONE, interlaminated, bioturbated, strong, Bedding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact flat, 80% SANDSTONE bioturbated, 20% SILTSTONE bioturbated
20.77m SANDSTONE, white, coarse grained, Inclusions: wisps, strong, Bedding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact flat
1.86m No.4 LOWER SEAM
5.76m SANDSTONE, SILTSTONE, interlaminated, micaceous, carbonaceous, strong, Bedding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact gradational, 70% SANDSTONE micaceous carbonaceous, 30% SILTSTONE micaceous carbonaceous
3.69m SILTSTONE, SANDSTONE, interlaminated, bioturbated, Inclusions: wisps, Bedding: mm laminations, feint, Sed Control: cross bedding, coarsening upward sequence, Contact: Basal contact flat, 60% SILTSTONE bioturbated, 40% SANDSTONE bioturbated
2.89m SANDSTONE, black, fine grained, bioturbated, Bedding: mm laminations, feint, Sed Control: cross bedding, Contact: Basal contact flat
1.84m SILTSTONE, SANDSTONE, Contact: Basal contact flat, 95% SILTSTONE shaly, 5% SANDSTONE shaly
7.00m SANDSTONE, SILTSTONE, interlaminated, micaceous, carbonaceous, Bedding: cm laminations, normal, Sed Control: cross bedding, Contact: Basal contact gradational, 80% SANDSTONE micaceous carbonaceous, 20% SILTSTONE micaceous carbonaceous
10.17m SANDSTONE, white, fine grained, micaceous, Inclusions: wisps, strong, Bedding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact flat
2.43m No.2 LOWER SEAM
0.92m SILTSTONE, black, weak, Contact: Basal contact flat
TOP OF BASEMENT
12.64m DIABASE, greenish, white
2.84m DIABASE, grey, coarse crystalline
End of hole

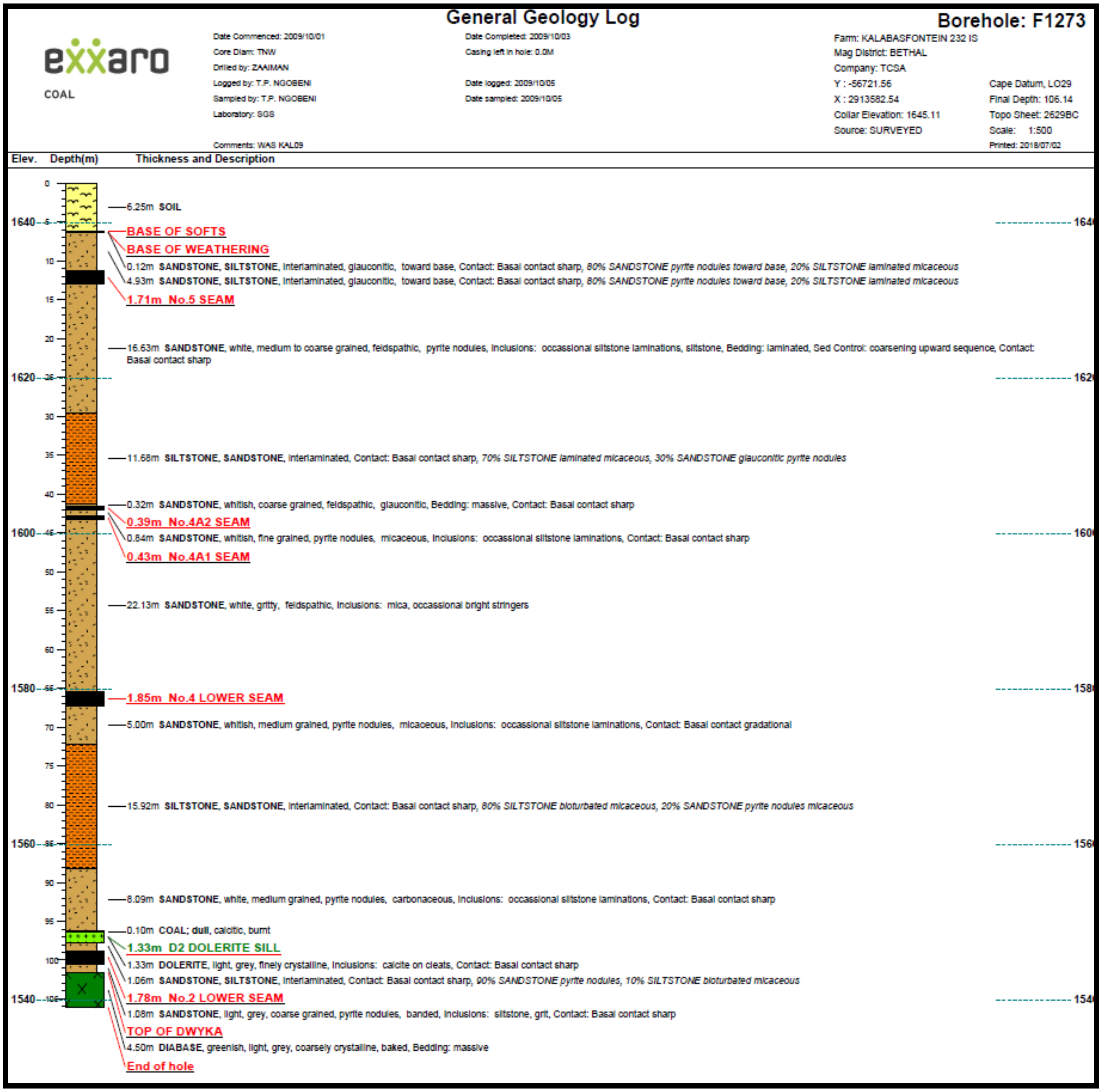

General Geology Log
Borehole: F1167
exxaro
COAL
Date Commenced: 2008/11/18
Core Diam: TNW/NQ
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Sampled by: M. MATHIVHA
Laboratory: SABS
Comments: K10
Date Completed: 2008/11/19
Casing left in hole: NIL
Date logged: 2008/11/20
Date sampled: 2008/11/20
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -57732.74
X : 2914155.56
Collar Elevation: 1605.43
Source: SURVEYED
Cape Datum, LO29
Final Depth: 84.06
Topo Sheet: 2629BC
Scale: 1:500
Printed: 2018/07/02
Elev. Depth(m) Thickness and Description
9.57m NO RECOVERY
BASE OF WEATHERING
15.52m SANDSTONE, white, coarse grained, Bedding: cm laminations, feint, Sed Control: cross bedding, Contact: Basal contact inclined
1.90m No.4 LOWER SEAM
0.32m SANDSTONE, SILTSTONE, interlaminated, Inclusions: wisps, Bedding: mm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 60% SANDSTONE, 40% SILTSTONE
5.27m SANDSTONE, SILTSTONE, interlaminated, micaceous, Bedding: mm laminations, feint, Sed Control: cross bedding, Contact: Basal contact flat, 60% SANDSTONE micaceous, 40% SILTSTONE micaceous
5.65m SANDSTONE, greyish, black, fine grained, bioturbated, Inclusions: wisps, Contact: Basal contact flat
1.91m SILTSTONE, black, shaly, Contact: Basal contact flat
3.93m SANDSTONE, SILTSTONE, interlaminated, bioturbated, micaceous, Inclusions: wisps, Bedding: mm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact gradational, 60% SANDSTONE bioturbated micaceous, 40% SILTSTONE bioturbated micaceous
11.40m SANDSTONE, white, fine grained, baked, Contact: Basal contact flat
13.27m D2 DOLERITE SILL
13.27m DOLERITE, grey, fine crystalline, Contact: Basal contact flat
TOP OF DWYKA
3.15m TILLITE, reworked, burnt
TOP OF BASEMENT
12.17m DIABASE, greenish, white, highly weathered
End of hole
1600
1580
1560
1540


General Geology Log
Borehole: F1267
exxaro
COAL
Date Commenced: 2009/09/17
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: T.P. NGOBENI
Sampled by: T.P. NGOBENI
Laboratory: SGS
Comments: WAS KAL07
Date Completed: 2009/09/18
Casing left in hole: 0.0M
Date logged: 2009/09/19
Date sampled: 2009/09/19
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -55943.95
X : 2912249.58
Collar Elevation: 1627.31
Source: SURVEYED
Cape Datum, LO29
Final Depth: 134.35
Topo Sheet: 2629BC
Scale: 1:500
Printed: 2018/07/02
Elev. Depth(m) Thickness and Description
5.31m SOIL
BASE OF SOFTS
7.12m SILTSTONE, SANDSTONE, interlaminated, weathered, Contact: Basal contact sharp, 60% SILTSTONE laminated micaceous, 40% SANDSTONE pyrite nodules glauconitic
BASE OF WEATHERING
1.99m SILTSTONE, SANDSTONE, interlaminated, weathered, Contact: Basal contact sharp, 60% SILTSTONE laminated micaceous, 40% SANDSTONE pyrite nodules glauconitic
0.98m No.5 SEAM
3.13m SANDSTONE, white, coarse grained, pyrite nodules, feldspathic, Inclusions: occassional siltstone laminations, Contact: Basal contact sharp
9.91m D1 DOLERITE SILL
9.91m DOLERITE, light, grey, fine crystalline, quartzitic, Structure: slickensides, Contact: Basal contact sharp
2.94m SANDSTONE, white, coarse grained, pyrite nodules, carbonaceous, baked, Contact: Basal contact sharp
3.02m DS1 DOLERITE STRINGER
3.02m DOLERITE, light, grey, fine crystalline, quartzitic, sandy, Structure: breccia, Contact: Basal contact sharp
3.68m SILTSTONE, SANDSTONE, interlaminated, Contact: Basal contact gradational, 80% SILTSTONE laminated micaceous, 20% SANDSTONE pyrite nodules micaceous
5.44m SANDSTONE, whitish, fine to coarse grained, feldspathic, pyrite nodules, Inclusions: wisps, occassional siltstone laminations, Sed Control: fining upward sequence, Contact: Basal contact sharp
1.66m SILTSTONE, SANDSTONE, interlaminated, Contact: Basal contact sharp, 70% SILTSTONE laminated micaceous, 30% SANDSTONE pyrite nodules micaceous
0.97m No.4A SEAM
0.68m SANDSTONE, whitish, medium grained, pyrite nodules, carbonaceous, Contact: Basal contact sharp
0.11m COAL; mixed, bright, dull, Inclusions: pyrite, 80% COAL; bright bright dull, 20% COAL; dull bright dull
18.93m SANDSTONE, white, gritty, feldspathic, Inclusions: coal stringer, Sed Control: micaceous bedding planes, Contact: Basal contact sharp
0.44m No.4 UPPER SEAM
0.76m SILTSTONE, SANDSTONE, interlaminated, Contact: Basal contact sharp, 60% SILTSTONE laminated micaceous, 40% SANDSTONE pyrite nodules toward base
0.52m SANDSTONE, white, fine to coarse grained, feldspathic, pyrite nodules, baked, Sed Control: coarsening upward sequence, Contact: Basal contact sharp
1.95m No.4 LOWER SEAM
17.07m SILTSTONE, SANDSTONE, interlaminated, Contact: Basal contact sharp, 80% SILTSTONE bioturbated micaceous, 20% SANDSTONE pyrite nodules micaceous
8.50m SANDSTONE, white, fine to coarse grained, feldspathic, pyrite nodules, baked, Sed Control: coarsening upward sequence, Contact: Basal contact sharp
13.77m D2 DOLERITE SILL
13.77m DOLERITE, greenish, light, grey, coarse crystalline, quartzitic, mixed, Contact: Basal contact sharp
1620
1600
1580
1560
1540
1520
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110

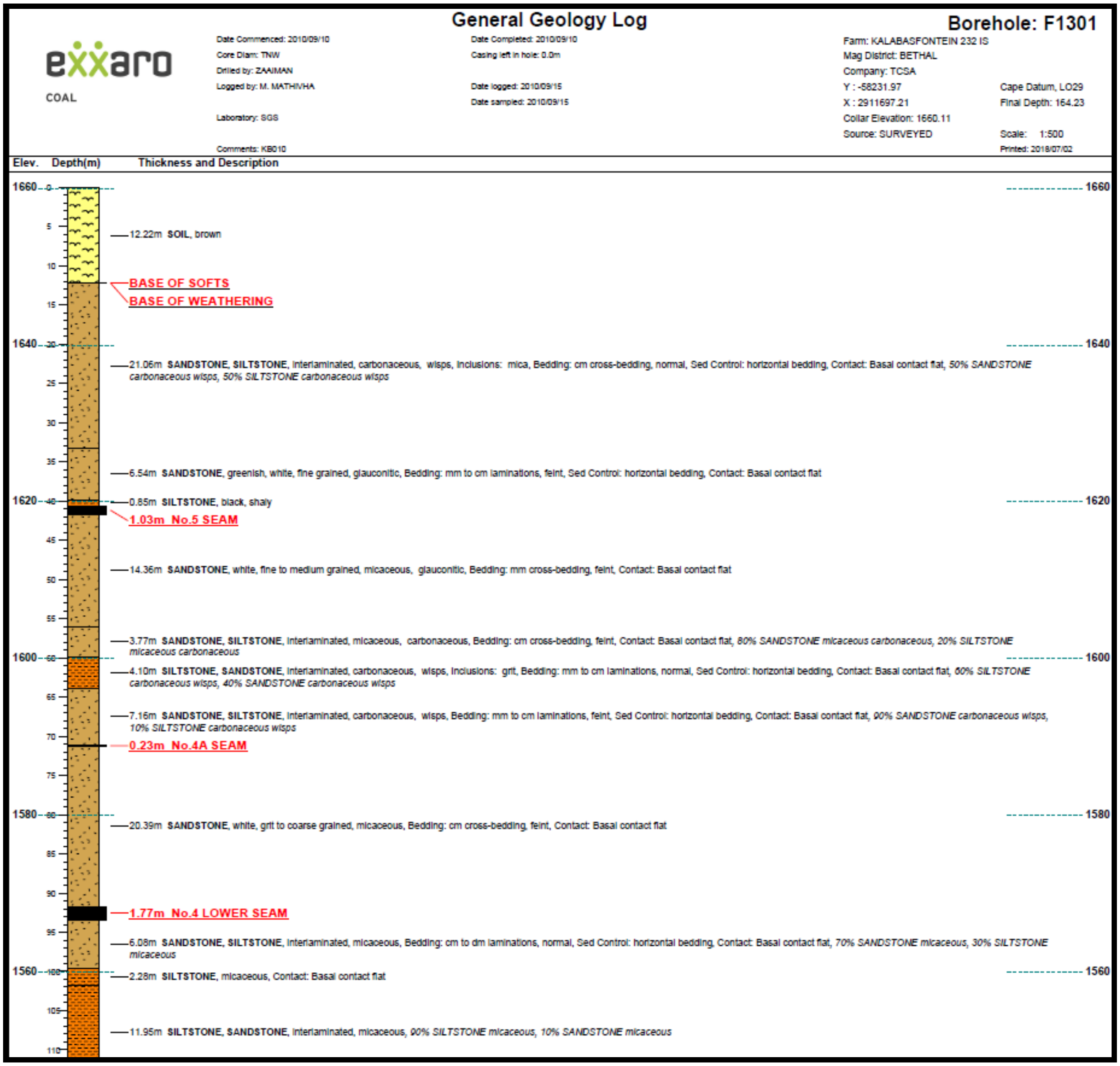
EXXARO COAL CENTRAL

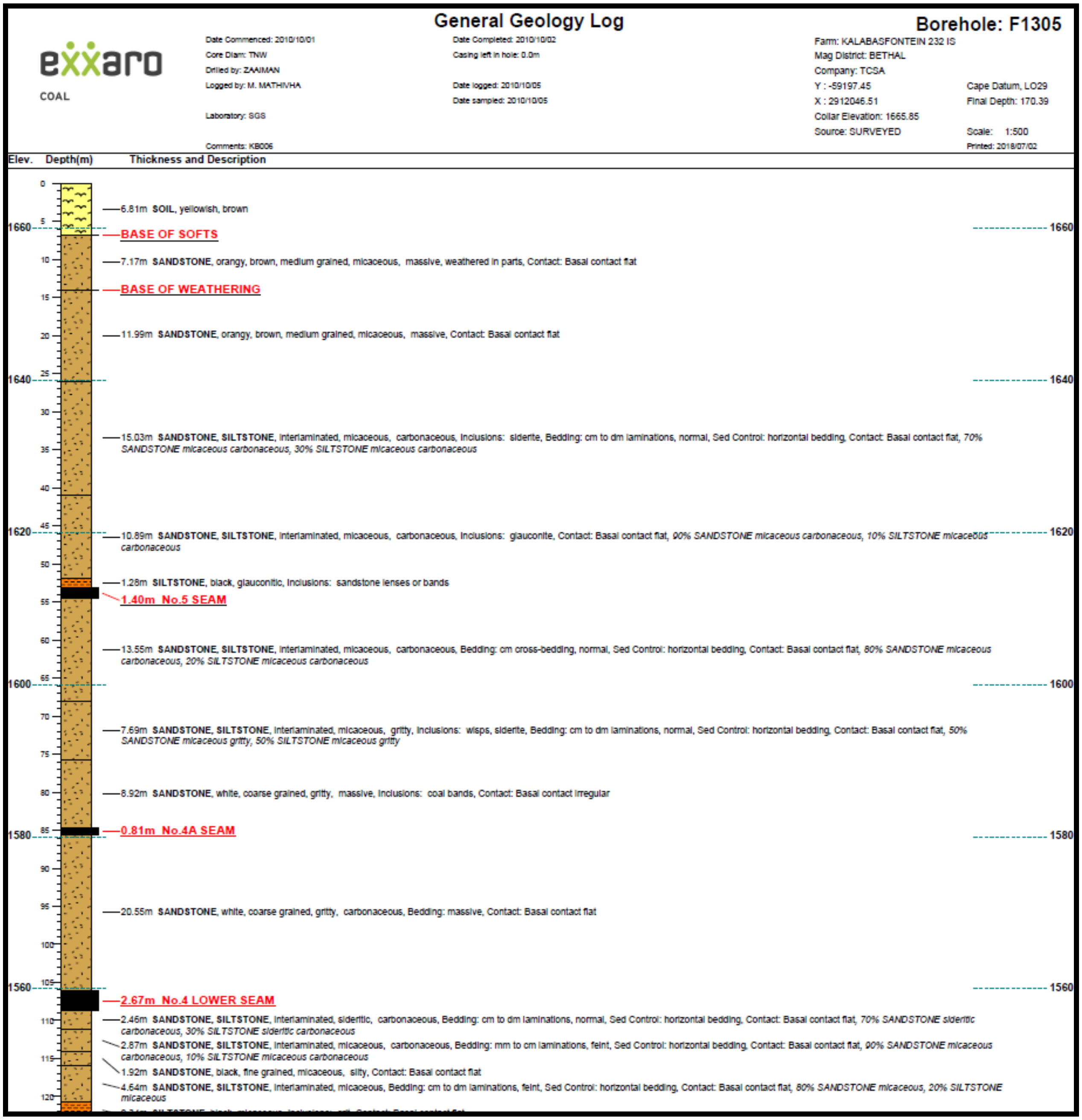


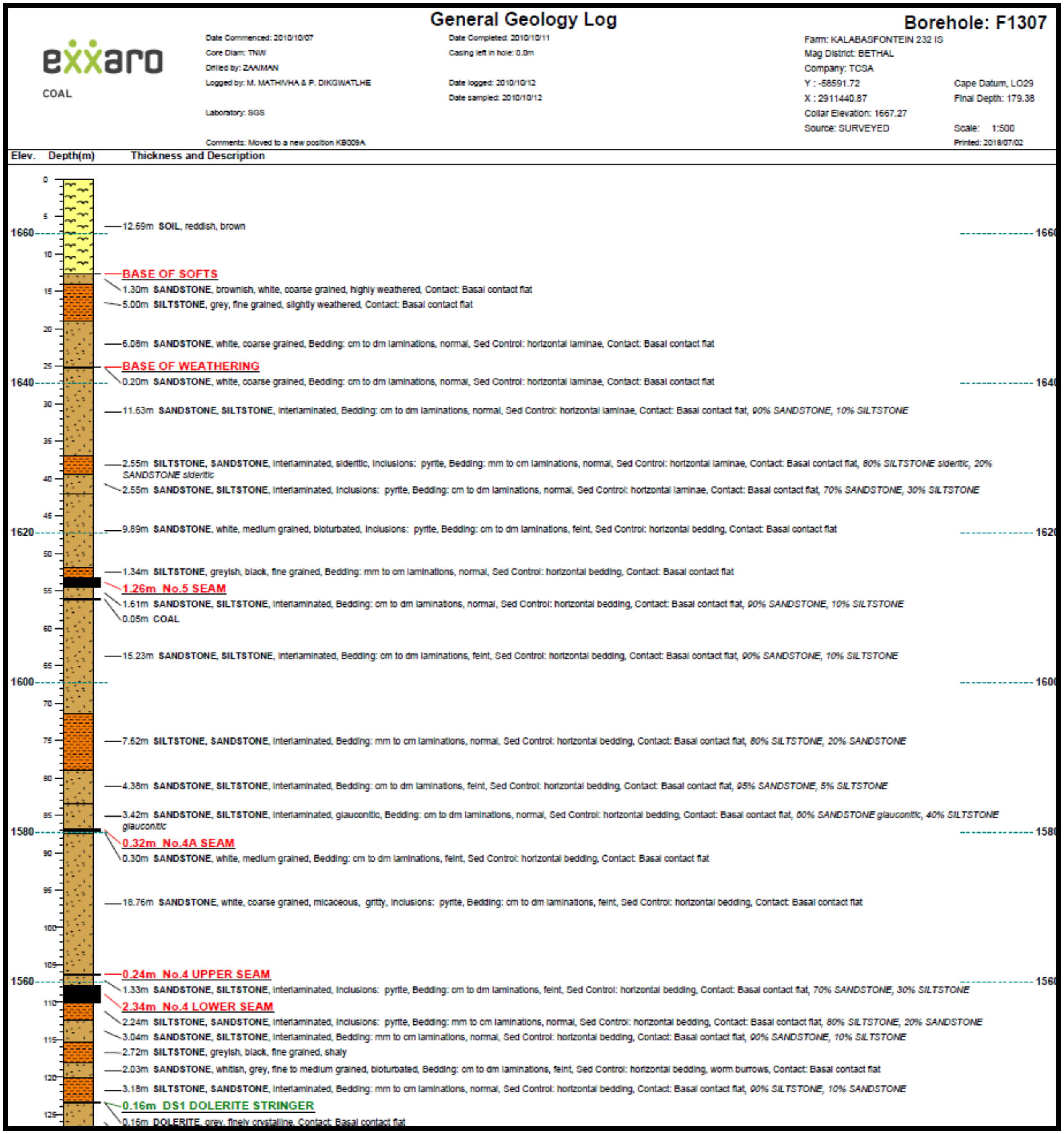
EXXARO COAL CENTRAL



EXXARO COAL CENTRAL


General Geology Log
Borehole: F1301
exxaro
COAL
Date Commenced: 2010/09/10
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Laboratory: SGS
Comments: KB010
Date Completed: 2010/09/10
Casing left in hole: 0.0m
Date logged: 2010/09/15
Date sampled: 2010/09/15
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -58231.97
X : 2911697.21
Collar Elevation: 1660.11
Source: SURVEYED
Cape Datum, LO29
Final Depth: 164.23
Scale: 1:500
Printed: 2018/07/02
Elev. Depth(m) Thickness and Description
1660
12.22m SOIL, brown
BASE OF SOFTS
BASE OF WEATHERING
1640
21.06m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Inclusions: mica, Bedding: cm cross-bedding, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 50% SANDSTONE carbonaceous wisps, 50% SILTSTONE carbonaceous wisps
6.54m SANDSTONE, greenish, white, fine grained, glauconitic, Bedding: mm to cm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat
1620
0.85m SILTSTONE, black, shaly
1.03m No.5 SEAM
14.36m SANDSTONE, white, fine to medium grained, micaceous, glauconitic, Bedding: mm cross-bedding, feint, Contact: Basal contact flat
3.77m SANDSTONE, SILTSTONE, interlaminated, micaceous, carbonaceous, Bedding: cm cross-bedding, feint, Contact: Basal contact flat, 80% SANDSTONE micaceous carbonaceous, 20% SILTSTONE micaceous carbonaceous
1600
4.10m SILTSTONE, SANDSTONE, interlaminated, carbonaceous, wisps, Inclusions: grit, Bedding: mm to cm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 60% SILTSTONE carbonaceous wisps, 40% SANDSTONE carbonaceous wisps
7.16m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Bedding: mm to cm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 90% SANDSTONE carbonaceous wisps, 10% SILTSTONE carbonaceous wisps
0.23m No.4A SEAM
1580
20.39m SANDSTONE, white, grit to coarse grained, micaceous, Bedding: cm cross-bedding, feint, Contact: Basal contact flat
1.77m No.4 LOWER SEAM
6.08m SANDSTONE, SILTSTONE, interlaminated, micaceous, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 70% SANDSTONE micaceous, 30% SILTSTONE micaceous
1560
2.28m SILTSTONE, micaceous, Contact: Basal contact flat
11.95m SILTSTONE, SANDSTONE, interlaminated, micaceous, 90% SILTSTONE micaceous, 10% SANDSTONE micaceous


General Geology Log
Borehole: F1305
exxaro COAL
Date Commenced: 2010/10/01
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Laboratory: SGS
Comments: KB006
Date Completed: 2010/10/02
Casing left in hole: 0.0m
Date logged: 2010/10/05
Date sampled: 2010/10/05
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -59197.45
X : 2912046.51
Collar Elevation: 1665.85
Source: SURVEYED
Cape Datum, LO29
Final Depth: 170.39
Scale: 1:500
Printed: 2018/07/02
Elev. Depth(m) Thickness and Description
6.81m SOIL, yellowish, brown
BASE OF SOFTS
7.17m SANDSTONE, orangy, brown, medium grained, micaceous, massive, weathered in parts, Contact: Basal contact flat
BASE OF WEATHERING
11.99m SANDSTONE, orangy, brown, medium grained, micaceous, massive, Contact: Basal contact flat
15.03m SANDSTONE, SILTSTONE, interlaminated, micaceous, carbonaceous, Inclusions: siderite, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 70% SANDSTONE micaceous carbonaceous, 30% SILTSTONE micaceous carbonaceous
10.89m SANDSTONE, SILTSTONE, interlaminated, micaceous, carbonaceous, Inclusions: glauconite, Contact: Basal contact flat, 90% SANDSTONE micaceous carbonaceous, 10% SILTSTONE micaceous carbonaceous
1.28m SILTSTONE, black, glauconitic, Inclusions: sandstone lenses or bands
1.40m No.5 SEAM
13.55m SANDSTONE, SILTSTONE, interlaminated, micaceous, carbonaceous, Bedding: cm cross-bedding, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 80% SANDSTONE micaceous carbonaceous, 20% SILTSTONE micaceous carbonaceous
7.69m SANDSTONE, SILTSTONE, interlaminated, micaceous, gritty, Inclusions: wisps, siderite, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 50% SANDSTONE micaceous gritty, 50% SILTSTONE micaceous gritty
8.92m SANDSTONE, white, coarse grained, gritty, massive, Inclusions: coal bands, Contact: Basal contact irregular
0.81m No.4A SEAM
20.55m SANDSTONE, white, coarse grained, gritty, carbonaceous, Bedding: massive, Contact: Basal contact flat
2.67m No.4 LOWER SEAM
2.46m SANDSTONE, SILTSTONE, interlaminated, sideritic, carbonaceous, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 70% SANDSTONE sideritic carbonaceous, 30% SILTSTONE sideritic carbonaceous
2.87m SANDSTONE, SILTSTONE, interlaminated, micaceous, carbonaceous, Bedding: mm to cm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 90% SANDSTONE micaceous carbonaceous, 10% SILTSTONE micaceous carbonaceous
1.92m SANDSTONE, black, fine grained, micaceous, silty, Contact: Basal contact flat
4.64m SANDSTONE, SILTSTONE, interlaminated, micaceous, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 80% SANDSTONE micaceous, 20% SILTSTONE micaceous



General Geology Log

Borehole: F1307

exxaro COAL

Date Commenced: 2010/10/07
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA & P. DIKGWATLHE
Laboratory: SGS
Comments: Moved to a new position KB009A

Date Completed: 2010/10/11
Casing left in hole: 0.0m
Date logged: 2010/10/12
Date sampled: 2010/10/12

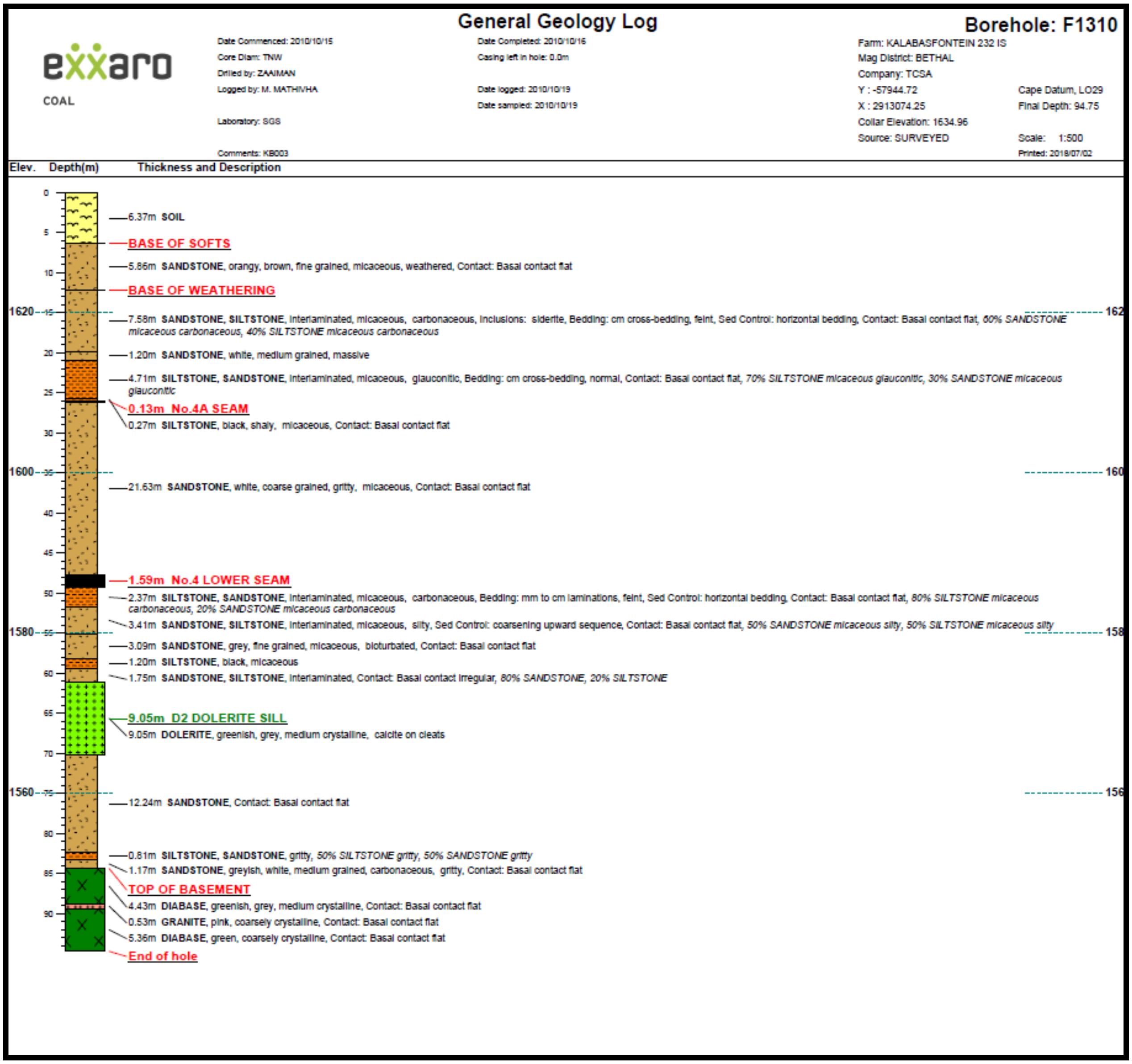
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -58591.72
X : 2911440.87
Collar Elevation: 1667.27
Source: SURVEYED

Cape Datum, LO29
Final Depth: 179.38
Scale: 1:500
Printed: 2018/07/02

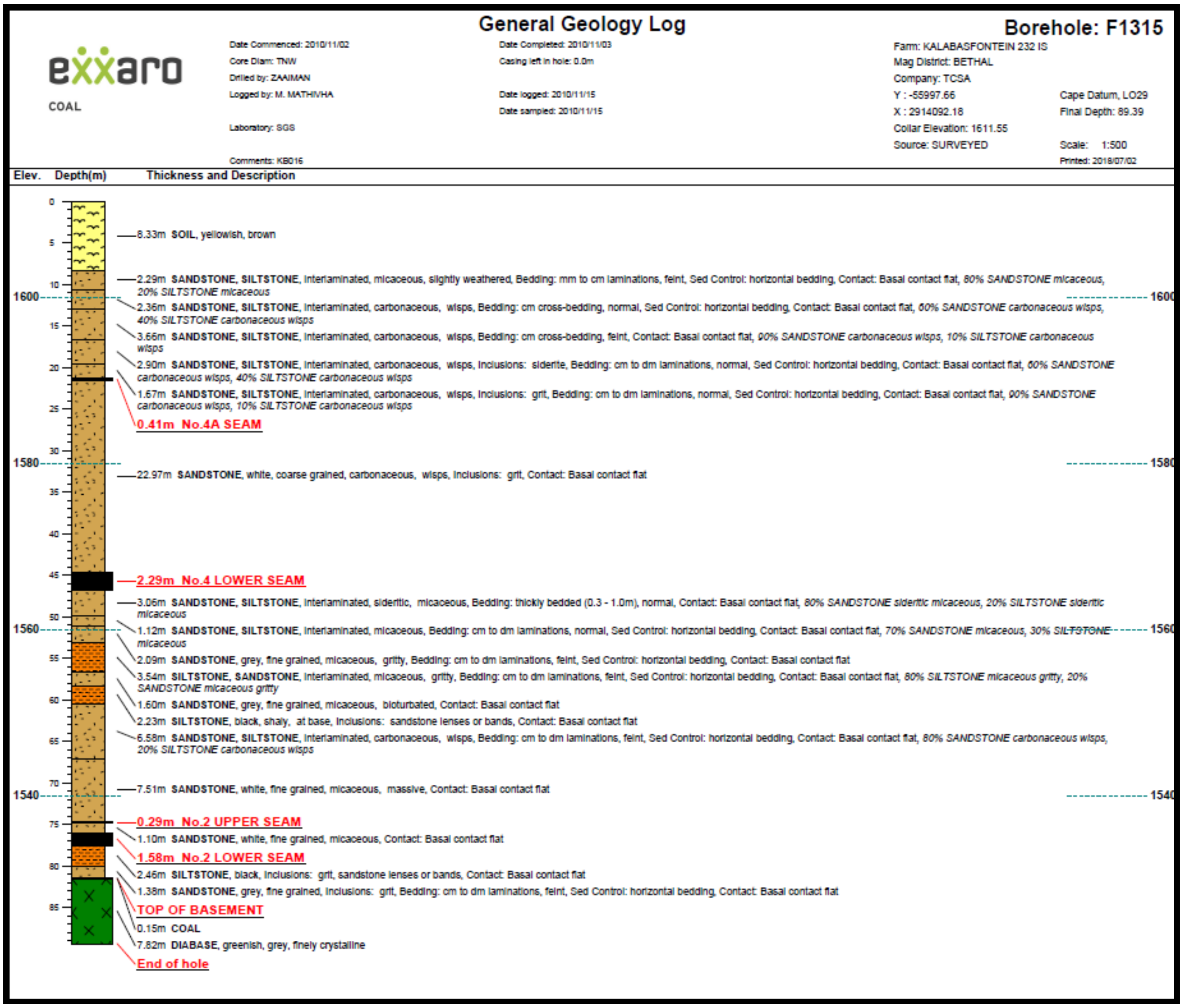
Elev. Depth(m) Thickness and Description

12.69m **SOIL**, reddish, brown
BASE OF SOFTS
1.30m **SANDSTONE**, brownish, white, coarse grained, highly weathered, Contact: Basal contact flat
5.00m **SILTSTONE**, grey, fine grained, slightly weathered, Contact: Basal contact flat
6.08m **SANDSTONE**, white, coarse grained, Bedding: cm to dm laminations, normal, Sed Control: horizontal laminae, Contact: Basal contact flat
BASE OF WEATHERING
0.20m **SANDSTONE**, white, coarse grained, Bedding: cm to dm laminations, normal, Sed Control: horizontal laminae, Contact: Basal contact flat
11.63m **SANDSTONE, SILTSTONE**, interlaminated, Bedding: cm to dm laminations, normal, Sed Control: horizontal laminae, Contact: Basal contact flat, *90% SANDSTONE, 10% SILTSTONE*
2.55m **SILTSTONE, SANDSTONE**, interlaminated, sideritic, Inclusions: pyrite, Bedding: mm to cm laminations, normal, Sed Control: horizontal laminae, Contact: Basal contact flat, *80% SILTSTONE sideritic, 20% SANDSTONE sideritic*
2.55m **SANDSTONE, SILTSTONE**, interlaminated, Inclusions: pyrite, Bedding: cm to dm laminations, normal, Sed Control: horizontal laminae, Contact: Basal contact flat, *70% SANDSTONE, 30% SILTSTONE*
9.89m **SANDSTONE**, white, medium grained, bioturbated, Inclusions: pyrite, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat
1.34m **SILTSTONE**, greyish, black, fine grained, Bedding: mm to cm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat
1.26m No.5 SEAM
1.61m **SANDSTONE, SILTSTONE**, interlaminated, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, *90% SANDSTONE, 10% SILTSTONE*
0.05m **COAL**
15.23m **SANDSTONE, SILTSTONE**, interlaminated, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, *90% SANDSTONE, 10% SILTSTONE*
7.62m **SILTSTONE, SANDSTONE**, interlaminated, Bedding: mm to cm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, *80% SILTSTONE, 20% SANDSTONE*
4.38m **SANDSTONE, SILTSTONE**, interlaminated, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, *95% SANDSTONE, 5% SILTSTONE*
3.42m **SANDSTONE, SILTSTONE**, interlaminated, glauconitic, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, *60% SANDSTONE glauconitic, 40% SILTSTONE glauconitic*
0.32m No.4A SEAM
0.30m **SANDSTONE**, white, medium grained, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat
18.76m **SANDSTONE**, white, coarse grained, micaceous, gritty, Inclusions: pyrite, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat
0.24m No.4 UPPER SEAM
1.33m **SANDSTONE, SILTSTONE**, interlaminated, Inclusions: pyrite, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, *70% SANDSTONE, 30% SILTSTONE*
2.34m No.4 LOWER SEAM
2.24m **SILTSTONE, SANDSTONE**, interlaminated, Inclusions: pyrite, Bedding: mm to cm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, *80% SILTSTONE, 20% SANDSTONE*
3.04m **SANDSTONE, SILTSTONE**, interlaminated, Bedding: mm to cm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, *90% SANDSTONE, 10% SILTSTONE*
2.72m **SILTSTONE**, greyish, black, fine grained, shaly
2.03m **SANDSTONE**, whitish, grey, fine to medium grained, bioturbated, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, worm burrows, Contact: Basal contact flat
3.18m **SILTSTONE, SANDSTONE**, interlaminated, Bedding: mm to cm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, *90% SILTSTONE, 10% SANDSTONE*
0.16m DS1 DOLERITE STRINGER
0.16m **DOLERITE**, grey, finely crystalline, Contact: Basal contact flat

EXXARO COAL CENTRAL




General Geology Log
Borehole: F1312
exxaro
COAL
Date Commenced: 2010/10/19
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Laboratory: SGS
Comments: KB011
Date Completed: 2010/10/23
Casing left in hole: 0.0m
Date logged: 2010/10/26
Date sampled: 2010/10/26
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -58280.64
X : 2911128.18
Collar Elevation: 1673.87
Source: SURVEYED
Cape Datum, LO29
Final Depth: 184.64
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
12.75m SOIL, brownish, red
BASE OF SOFTS
1660
10.64m SANDSTONE, orangy, brown, fine grained, micaceous, massive, Contact: Basal contact flat
9.08m SANDSTONE, greyish, white, fine grained, micaceous, massive, Inclusions: grit, Contact: Basal contact flat
1640
7.14m SANDSTONE, SILTSTONE, interlaminated, Bedding: thickly bedded (0.3 - 1.0m), feint, Contact: Basal contact flat, 90% SANDSTONE, 10% SILTSTONE
10.02m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Bedding: cm cross-bedding, normal, Contact: Basal contact flat, 70% SANDSTONE carbonaceous wisps, 30% SILTSTONE carbonaceous wisps
1.62m SANDSTONE, greyish, white, medium grained, massive, Contact: Basal contact flat
1620
4.82m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Bedding: cm cross-bedding, normal, Contact: Basal contact flat, 70% SANDSTONE carbonaceous wisps, 30% SILTSTONE carbonaceous wisps
4.97m SANDSTONE, greenish, white, medium to fine grained, carbonaceous, wisps, Bedding: cm cross-bedding, feint, Structure: slickensides, Contact: Basal contact flat
1.41m SILTSTONE, greenish, black, fine grained, micaceous, glauconitic, Contact: Basal contact flat
1.31m No.5 SEAM
2.02m SANDSTONE, SILTSTONE, interlaminated, micaceous, carbonaceous, Bedding: cm cross-bedding, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 80% SANDSTONE micaceous carbonaceous, 20% SILTSTONE micaceous carbonaceous
0.17m No.5 LOWER SEAM
7.53m SANDSTONE, white, medium grained, micaceous, massive, Inclusions: wisps, Contact: Basal contact flat
1600
7.30m SANDSTONE, SILTSTONE, interlaminated, Bedding: mm to cm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 70% SANDSTONE, 30% SILTSTONE
6.95m SILTSTONE, SANDSTONE, interlaminated, carbonaceous, wisps, Inclusions: siderite, Bedding: cm cross-bedding, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 60% SILTSTONE carbonaceous wisps, 40% SANDSTONE carbonaceous wisps
1.79m SANDSTONE, white, fine grained, micaceous, massive, Sed Control: coarsening upward sequence
3.41m SANDSTONE, white, coarse grained, massive, Contact: Basal contact flat
1580
2.11m SANDSTONE, SILTSTONE, interlaminated, micaceous, sideritic, Bedding: mm to cm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 90% SANDSTONE micaceous sideritic, 10% SILTSTONE micaceous sideritic
0.39m No.4A SEAM
2.24m SANDSTONE, SILTSTONE, interlaminated, micaceous, gritty, Bedding: cm cross-bedding, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 80% SANDSTONE micaceous gritty, 20% SILTSTONE micaceous gritty
15.33m SANDSTONE, white, coarse to medium grained, gritty, pebbles, Contact: Basal contact flat
0.27m No.4 UPPER SEAM
1560
2.26m SANDSTONE, SILTSTONE, interlaminated, micaceous, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 80% SANDSTONE micaceous, 20% SILTSTONE micaceous
1.95m No.4 LOWER SEAM
4.61m SANDSTONE, SILTSTONE, interlaminated, micaceous, Bedding: cm cross-bedding, feint, Contact: Basal contact flat, 70% SANDSTONE micaceous, 30% SILTSTONE micaceous
2.21m SANDSTONE, SILTSTONE, micaceous, bioturbated, Inclusions: siderite, occassional siltstone laminations, Bedding: cm cross-bedding, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 60% SANDSTONE micaceous bioturbated, 40% SILTSTONE micaceous bioturbated
1.74m SILTSTONE, black, shaly, carbonaceous, Inclusions: grit, Contact: Basal contact flat


General Geology Log
Borehole: F1315
exxaro
COAL
Date Commenced: 2010/11/02
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Laboratory: SGS
Comments: KB016
Date Completed: 2010/11/03
Casing left in hole: 0.0m
Date logged: 2010/11/15
Date sampled: 2010/11/15
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: TCSA
Y : -55997.66
X : 2914092.18
Collar Elevation: 1611.55
Source: SURVEYED
Cape Datum, LO29
Final Depth: 89.39
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
8.33m SOIL, yellowish, brown
2.29m SANDSTONE, SILTSTONE, interlaminated, micaceous, slightly weathered, Bedding: mm to cm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 80% SANDSTONE micaceous, 20% SILTSTONE micaceous
2.36m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Bedding: cm cross-bedding, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 60% SANDSTONE carbonaceous wisps, 40% SILTSTONE carbonaceous wisps
3.66m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Bedding: cm cross-bedding, feint, Contact: Basal contact flat, 90% SANDSTONE carbonaceous wisps, 10% SILTSTONE carbonaceous wisps
2.90m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Inclusions: siderite, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 60% SANDSTONE carbonaceous wisps, 40% SILTSTONE carbonaceous wisps
1.67m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Inclusions: grit, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 90% SANDSTONE carbonaceous wisps, 10% SILTSTONE carbonaceous wisps
0.41m No.4A SEAM
22.97m SANDSTONE, white, coarse grained, carbonaceous, wisps, Inclusions: grit, Contact: Basal contact flat
2.29m No.4 LOWER SEAM
3.06m SANDSTONE, SILTSTONE, interlaminated, sideritic, micaceous, Bedding: thickly bedded (0.3 - 1.0m), normal, Contact: Basal contact flat, 80% SANDSTONE sideritic micaceous, 20% SILTSTONE sideritic micaceous
1.12m SANDSTONE, SILTSTONE, interlaminated, micaceous, Bedding: cm to dm laminations, normal, Sed Control: horizontal bedding, Contact: Basal contact flat, 70% SANDSTONE micaceous, 30% SILTSTONE micaceous
2.09m SANDSTONE, grey, fine grained, micaceous, gritty, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat
3.54m SILTSTONE, SANDSTONE, interlaminated, micaceous, gritty, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 80% SILTSTONE micaceous gritty, 20% SANDSTONE micaceous gritty
1.60m SANDSTONE, grey, fine grained, micaceous, bioturbated, Contact: Basal contact flat
2.23m SILTSTONE, black, shaly, at base, Inclusions: sandstone lenses or bands, Contact: Basal contact flat
6.58m SANDSTONE, SILTSTONE, interlaminated, carbonaceous, wisps, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat, 80% SANDSTONE carbonaceous wisps, 20% SILTSTONE carbonaceous wisps
7.51m SANDSTONE, white, fine grained, micaceous, massive, Contact: Basal contact flat
0.29m No.2 UPPER SEAM
1.10m SANDSTONE, white, fine grained, micaceous, Contact: Basal contact flat
1.58m No.2 LOWER SEAM
2.46m SILTSTONE, black, Inclusions: grit, sandstone lenses or bands, Contact: Basal contact flat
1.38m SANDSTONE, grey, fine grained, Inclusions: grit, Bedding: cm to dm laminations, feint, Sed Control: horizontal bedding, Contact: Basal contact flat
TOP OF BASEMENT
0.15m COAL
7.82m DIABASE, greenish, grey, finely crystalline
End of hole
1600
1580
1560
1540
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85

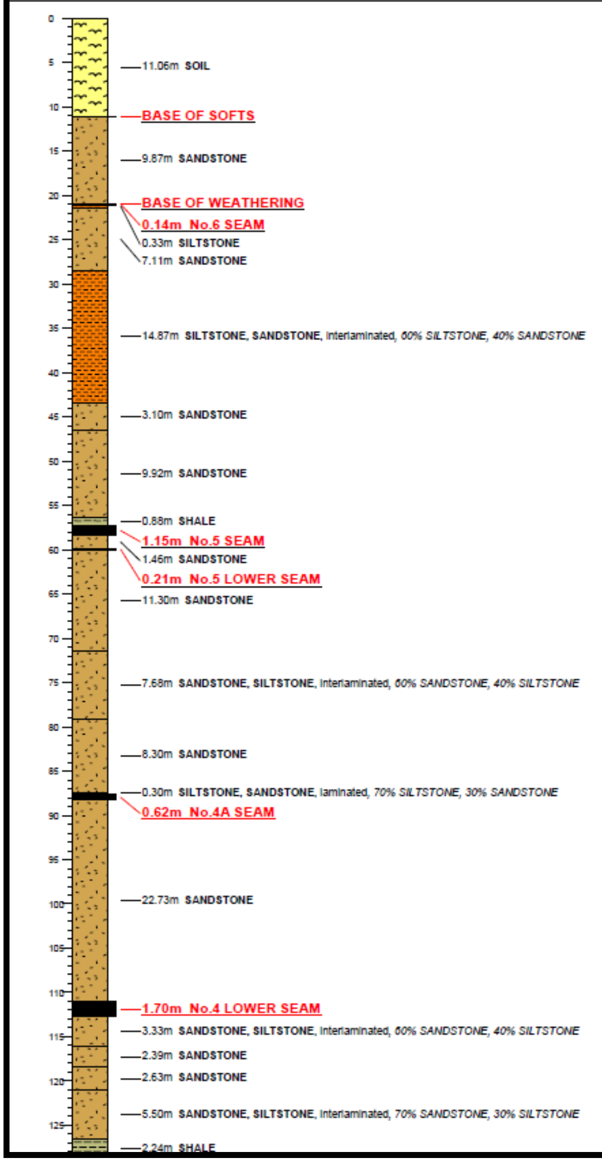
General Geology Log

Borehole: F1577

exxaro COAL

Date Commenced: 2017/06/26	Date Completed: 2017/07/07	Farm: KALABASFONTEIN 232 IS
Core Diam: TNW		Mag District: BETHAL
Drilled by: ZAAIMAN		Company: ECC
Logged by: M. MATHIVHA	Date logged: 2017/07/12	Y : -55660.59 — Cape Datum, LO29
Sampled by: M. MATHIVHA	Date sampled: 2017/07/12	X : 2908771.81 — Final Depth: 169.18
Laboratory: ALS	Date analysed: 2017/11/02	Collar Elevation: 1666.50
		Scale: 1:500
		Printed: 2018/07/02

Elev. Depth(m) Thickness and Description



General Geology Log

Borehole: F1580

exxaro COAL

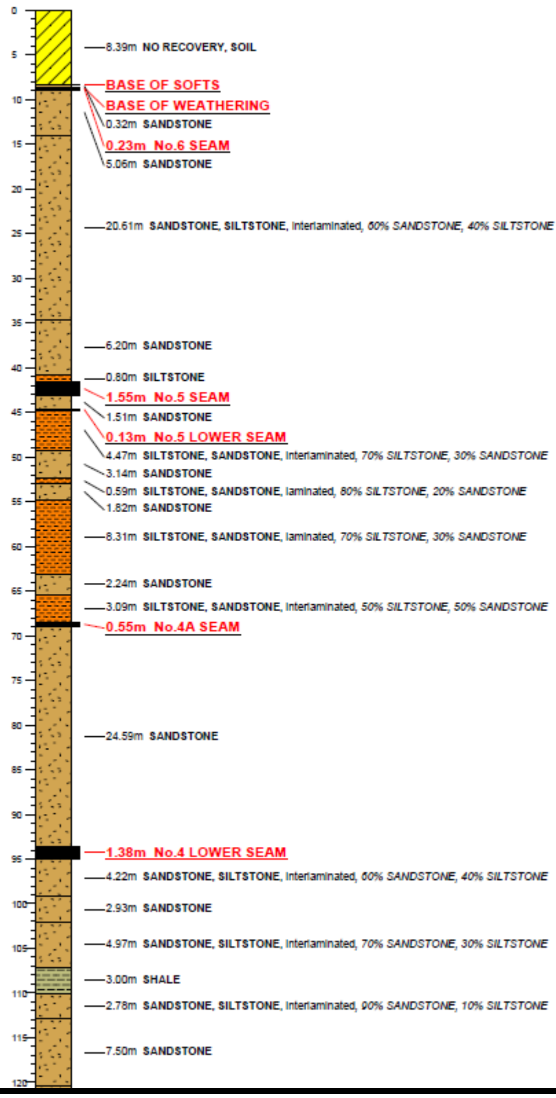
Date Commenced: 2017/06/27
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Sampled by: M. MATHIVHA
Laboratory: ALS

Date Completed: 2017/07/04
Date logged: 2017/07/06
Date sampled: 2017/07/06
Date analysed: 2017/06/30

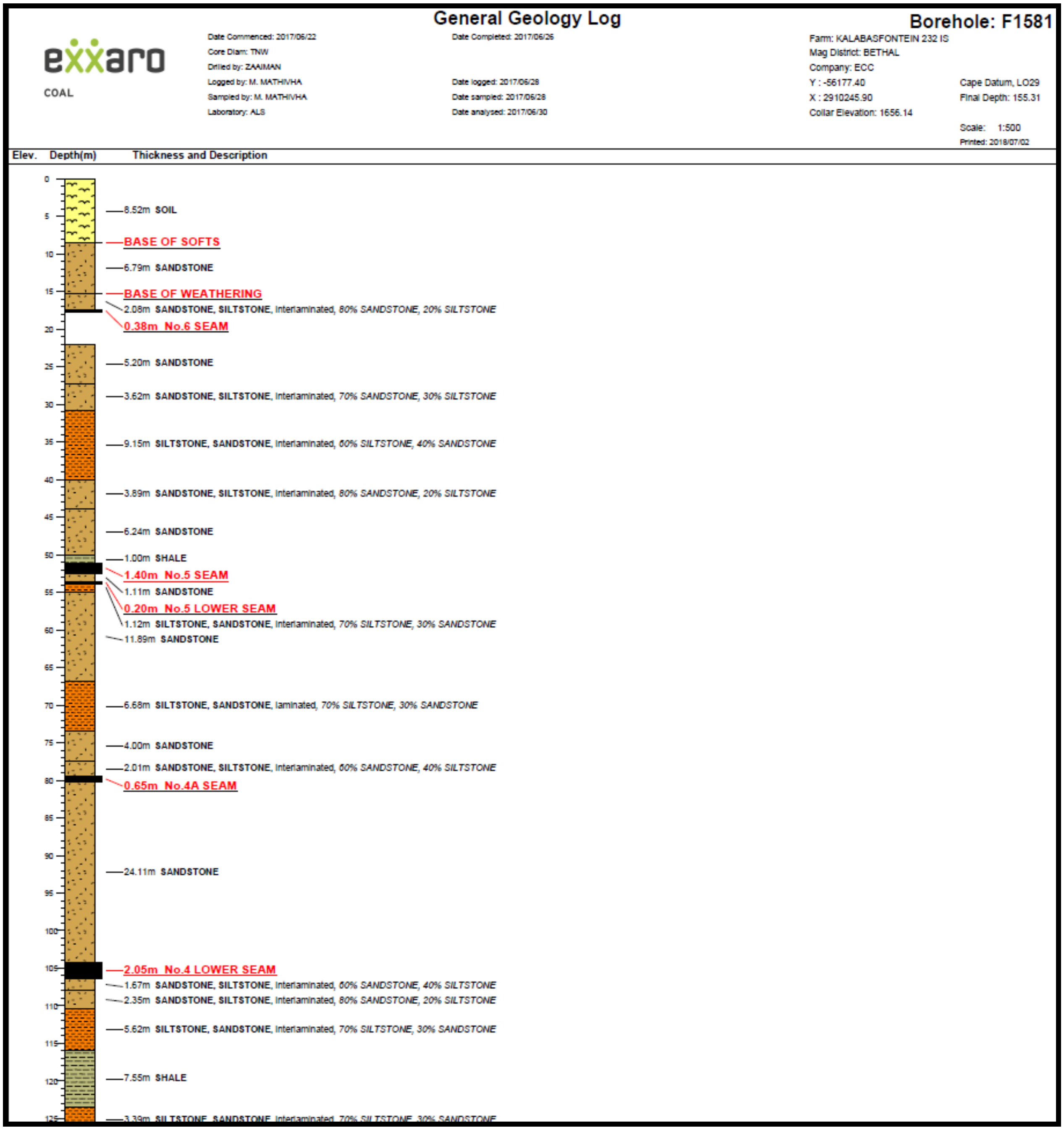
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: ECC
Y : -55803.94
X : 2909907.86
Collar Elevation: 1649.70

Cape Datum, LO29
Final Depth: 161.30
Scale: 1:500
Printed: 2018/07/02

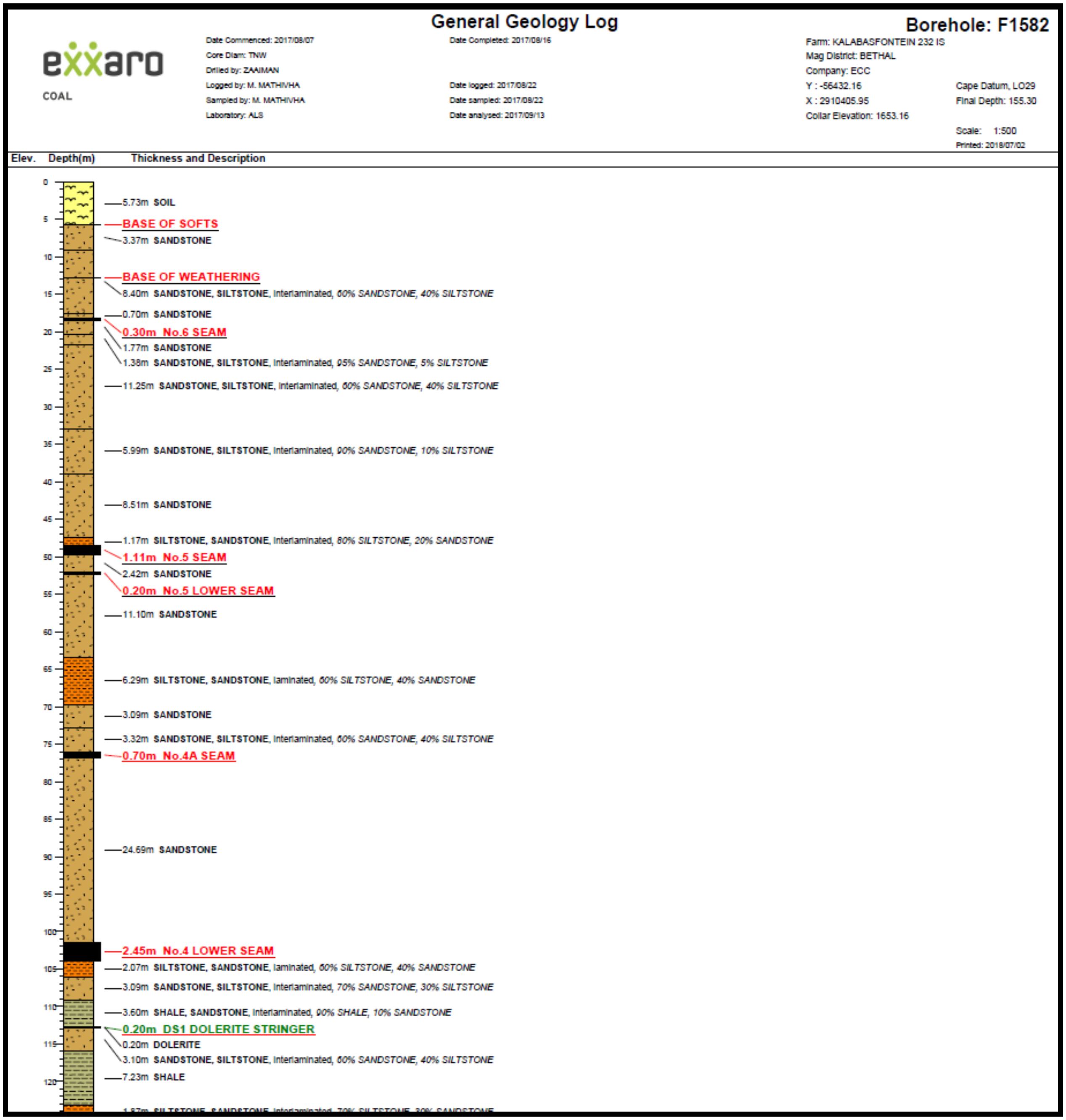
Elev. Depth(m) Thickness and Description

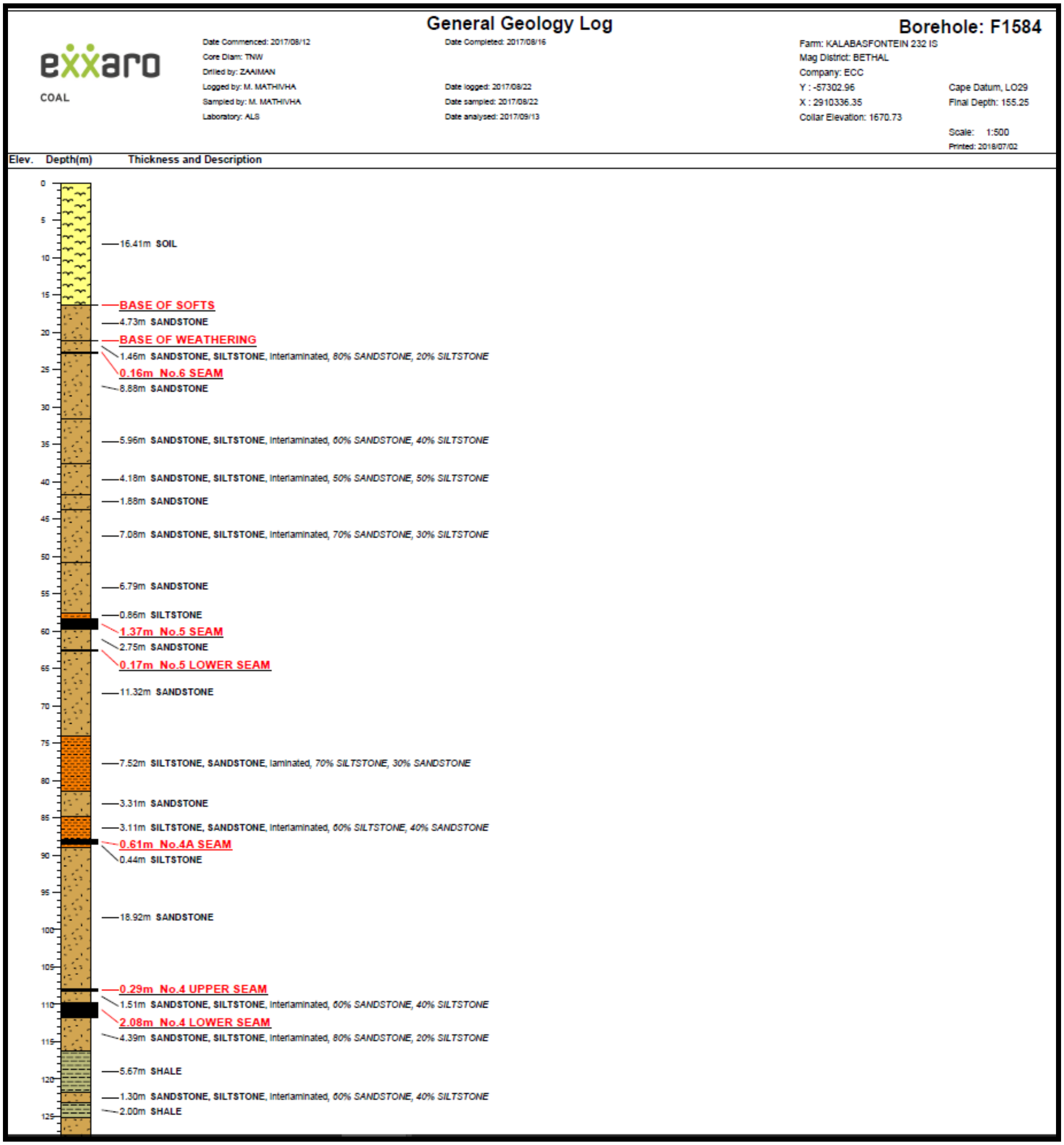


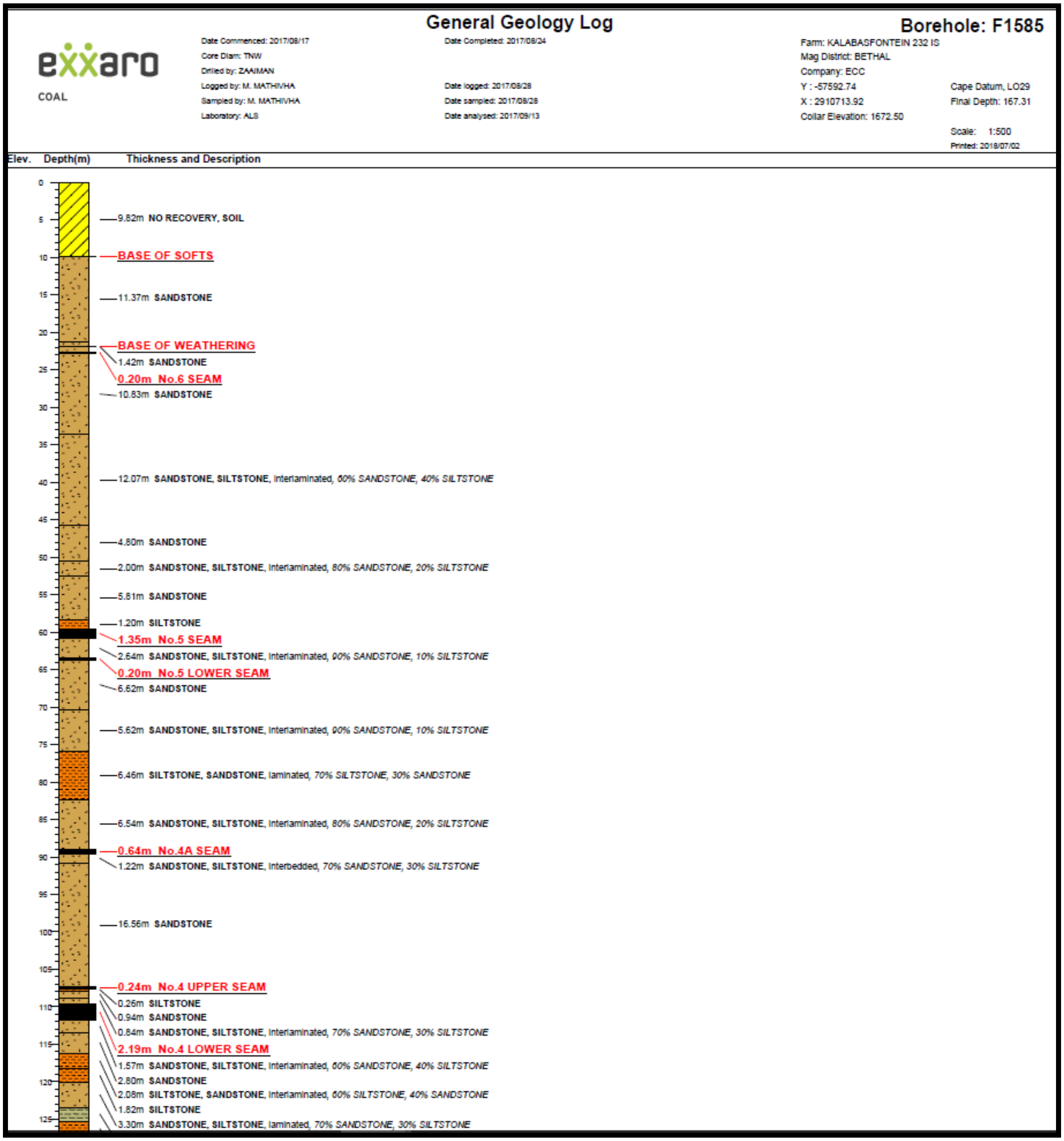
EXXARO COAL CENTRAL

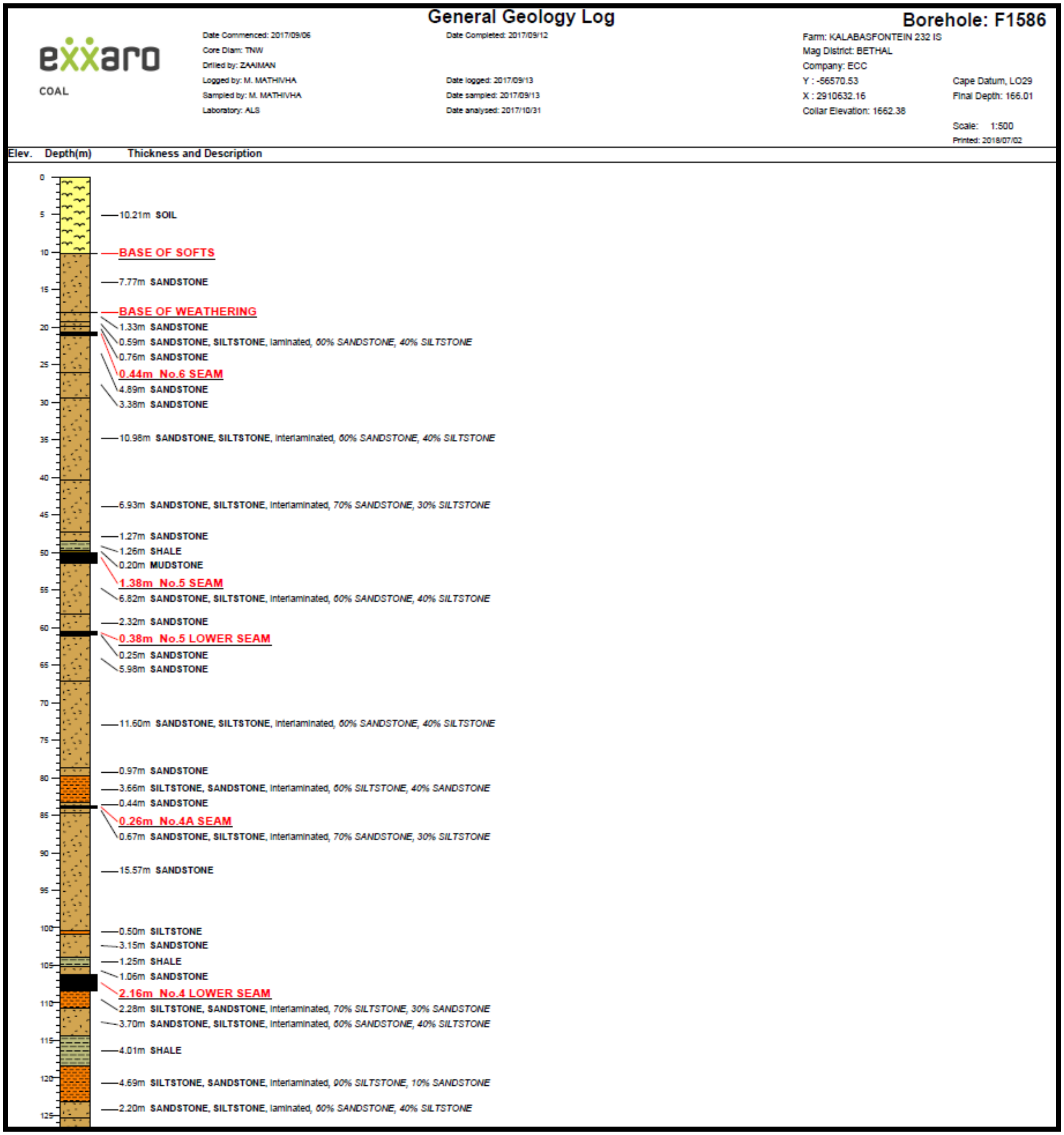


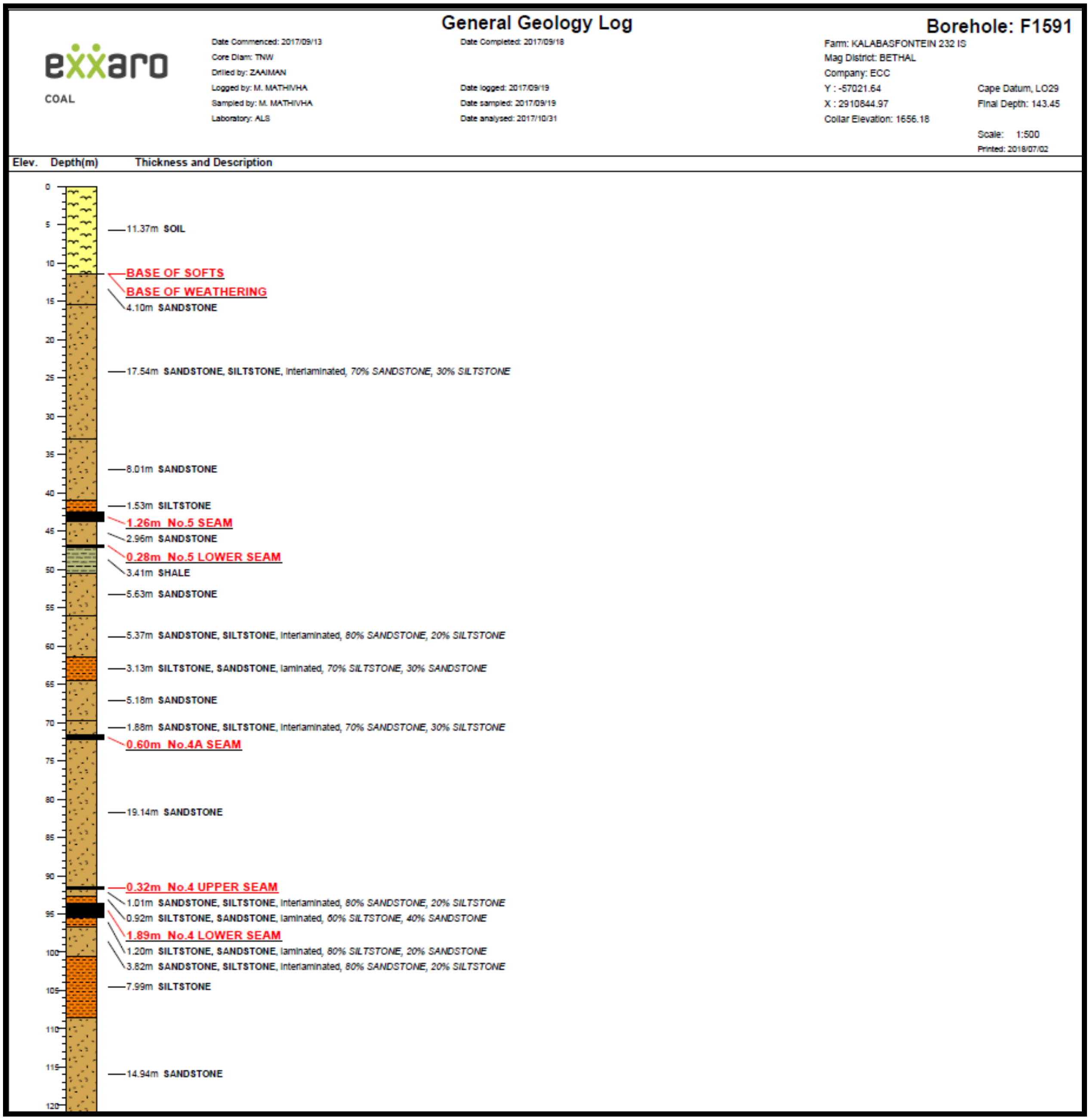
EXXARO COAL CENTRAL




General Geology Log
Borehole: F1584
exxaro COAL
Date Commenced: 2017/08/12
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Sampled by: M. MATHIVHA
Laboratory: ALS
Date Completed: 2017/08/16
Date logged: 2017/08/22
Date sampled: 2017/08/22
Date analysed: 2017/09/13
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: ECC
Y : -57302.96
X : 2910336.35
Collar Elevation: 1670.73
Cape Datum, LO29
Final Depth: 155.25
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
16.41m SOIL
BASE OF SOFTS
4.73m SANDSTONE
BASE OF WEATHERING
1.46m SANDSTONE, SILTSTONE, interlaminated, 80% SANDSTONE, 20% SILTSTONE
0.16m No.6 SEAM
8.88m SANDSTONE
5.96m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
4.18m SANDSTONE, SILTSTONE, interlaminated, 50% SANDSTONE, 50% SILTSTONE
1.88m SANDSTONE
7.08m SANDSTONE, SILTSTONE, interlaminated, 70% SANDSTONE, 30% SILTSTONE
6.79m SANDSTONE
0.86m SILTSTONE
1.37m No.5 SEAM
2.75m SANDSTONE
0.17m No.5 LOWER SEAM
11.32m SANDSTONE
7.52m SILTSTONE, SANDSTONE, laminated, 70% SILTSTONE, 30% SANDSTONE
3.31m SANDSTONE
3.11m SILTSTONE, SANDSTONE, interlaminated, 60% SILTSTONE, 40% SANDSTONE
0.61m No.4A SEAM
0.44m SILTSTONE
18.92m SANDSTONE
0.29m No.4 UPPER SEAM
1.51m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
2.08m No.4 LOWER SEAM
4.39m SANDSTONE, SILTSTONE, interlaminated, 80% SANDSTONE, 20% SILTSTONE
5.67m SHALE
1.30m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
2.00m SHALE


General Geology Log
Borehole: F1585
COAL
Date Commenced: 2017/08/17
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Sampled by: M. MATHIVHA
Laboratory: ALS
Date Completed: 2017/08/24
Date logged: 2017/08/28
Date sampled: 2017/08/28
Date analysed: 2017/09/13
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: ECC
Y : -57592.74
X : 2910713.92
Collar Elevation: 1672.50
Cape Datum, LO29
Final Depth: 167.31
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
9.82m NO RECOVERY, SOIL
BASE OF SOFTS
11.37m SANDSTONE
BASE OF WEATHERING
1.42m SANDSTONE
0.20m No.6 SEAM
10.83m SANDSTONE
12.07m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
4.80m SANDSTONE
2.00m SANDSTONE, SILTSTONE, interlaminated, 80% SANDSTONE, 20% SILTSTONE
5.81m SANDSTONE
1.20m SILTSTONE
1.35m No.5 SEAM
2.64m SANDSTONE, SILTSTONE, interlaminated, 90% SANDSTONE, 10% SILTSTONE
0.20m No.5 LOWER SEAM
6.62m SANDSTONE
5.62m SANDSTONE, SILTSTONE, interlaminated, 90% SANDSTONE, 10% SILTSTONE
6.46m SILTSTONE, SANDSTONE, laminated, 70% SILTSTONE, 30% SANDSTONE
6.54m SANDSTONE, SILTSTONE, interlaminated, 80% SANDSTONE, 20% SILTSTONE
0.64m No.4A SEAM
1.22m SANDSTONE, SILTSTONE, interbedded, 70% SANDSTONE, 30% SILTSTONE
16.56m SANDSTONE
0.24m No.4 UPPER SEAM
0.26m SILTSTONE
0.94m SANDSTONE
0.84m SANDSTONE, SILTSTONE, interlaminated, 70% SANDSTONE, 30% SILTSTONE
2.19m No.4 LOWER SEAM
1.57m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
2.80m SANDSTONE
2.08m SILTSTONE, SANDSTONE, interlaminated, 60% SILTSTONE, 40% SANDSTONE
1.82m SILTSTONE
3.30m SANDSTONE, SILTSTONE, laminated, 70% SANDSTONE, 30% SILTSTONE


General Geology Log
Borehole: F1586
COAL
Date Commenced: 2017/09/06
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Sampled by: M. MATHIVHA
Laboratory: ALS
Date Completed: 2017/09/12
Date logged: 2017/09/13
Date sampled: 2017/09/13
Date analysed: 2017/10/31
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: ECC
Y : -56570.53
X : 2910632.16
Collar Elevation: 1662.38
Cape Datum, LO29
Final Depth: 166.01
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
10.21m SOIL
BASE OF SOFTS
7.77m SANDSTONE
BASE OF WEATHERING
1.33m SANDSTONE
0.59m SANDSTONE, SILTSTONE, laminated, 60% SANDSTONE, 40% SILTSTONE
0.76m SANDSTONE
0.44m No.6 SEAM
4.89m SANDSTONE
3.38m SANDSTONE
10.98m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
6.93m SANDSTONE, SILTSTONE, interlaminated, 70% SANDSTONE, 30% SILTSTONE
1.27m SANDSTONE
1.26m SHALE
0.20m MUDSTONE
1.38m No.5 SEAM
6.82m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
2.32m SANDSTONE
0.38m No.5 LOWER SEAM
0.25m SANDSTONE
5.98m SANDSTONE
11.60m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
0.97m SANDSTONE
3.66m SILTSTONE, SANDSTONE, interlaminated, 60% SILTSTONE, 40% SANDSTONE
0.44m SANDSTONE
0.26m No.4A SEAM
0.67m SANDSTONE, SILTSTONE, interlaminated, 70% SANDSTONE, 30% SILTSTONE
15.57m SANDSTONE
0.50m SILTSTONE
3.15m SANDSTONE
1.25m SHALE
1.06m SANDSTONE
2.16m No.4 LOWER SEAM
2.28m SILTSTONE, SANDSTONE, interlaminated, 70% SILTSTONE, 30% SANDSTONE
3.70m SANDSTONE, SILTSTONE, interlaminated, 60% SANDSTONE, 40% SILTSTONE
4.01m SHALE
4.69m SILTSTONE, SANDSTONE, interlaminated, 90% SILTSTONE, 10% SANDSTONE
2.20m SANDSTONE, SILTSTONE, laminated, 60% SANDSTONE, 40% SILTSTONE


General Geology Log
Borehole: F1591
exxaro
COAL
Date Commenced: 2017/09/13
Core Diam: TNW
Drilled by: ZAAIMAN
Logged by: M. MATHIVHA
Sampled by: M. MATHIVHA
Laboratory: ALS
Date Completed: 2017/09/18
Date logged: 2017/09/19
Date sampled: 2017/09/19
Date analysed: 2017/10/31
Farm: KALABASFONTEIN 232 IS
Mag District: BETHAL
Company: ECC
Y : -57021.64
X : 2910844.97
Collar Elevation: 1656.18
Cape Datum, LO29
Final Depth: 143.45
Scale: 1:500
Printed: 2018/07/02
Elev.
Depth(m)
Thickness and Description
11.37m SOIL
BASE OF SOFTS
BASE OF WEATHERING
4.10m SANDSTONE
17.54m SANDSTONE, SILTSTONE, interlaminated, 70% SANDSTONE, 30% SILTSTONE
8.01m SANDSTONE
1.53m SILTSTONE
1.26m No.5 SEAM
2.96m SANDSTONE
0.28m No.5 LOWER SEAM
3.41m SHALE
5.63m SANDSTONE
5.37m SANDSTONE, SILTSTONE, interlaminated, 80% SANDSTONE, 20% SILTSTONE
3.13m SILTSTONE, SANDSTONE, laminated, 70% SILTSTONE, 30% SANDSTONE
5.18m SANDSTONE
1.88m SANDSTONE, SILTSTONE, interlaminated, 70% SANDSTONE, 30% SILTSTONE
0.60m No.4A SEAM
19.14m SANDSTONE
0.32m No.4 UPPER SEAM
1.01m SANDSTONE, SILTSTONE, interlaminated, 80% SANDSTONE, 20% SILTSTONE
0.92m SILTSTONE, SANDSTONE, laminated, 60% SILTSTONE, 40% SANDSTONE
1.89m No.4 LOWER SEAM
1.20m SILTSTONE, SANDSTONE, laminated, 80% SILTSTONE, 20% SANDSTONE
3.82m SANDSTONE, SILTSTONE, interlaminated, 80% SANDSTONE, 20% SILTSTONE
7.99m SILTSTONE
14.94m SANDSTONE