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CBH RESOURCES LIMITED RASP UNDERGROUND MINE - SUBSIDENCE STUDY

P.J. Potter & M. Goss

Notting Hill

MINENHIL00060AC

2 November 2007

Coffey Mining Pty Ltd ABN 52 065 481 209
1/21 Howleys Road Notting Hill VIC 3168 Australia

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Mr Pascal Blampain
CBH Resources Limited
PO Box 1967
North Sydney NSW 2059

Dear Pascal

RE: Rasp Underground Mine – Subsidence

Please find enclosed our geotechnical report on the subsidence study for the mining of Rasp Mine. Please contact the undersigned if you have any further queries in relation to this report.

It has been a pleasure working with you on this project and we look forward to being of further assistance in the future.

For and on behalf of Coffey Mining Pty Ltd

DRMiller

Don Miller

Principal Engineering Geologist/Regional Manager

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DOCUMENT REVIEW AND SIGN OFF

Name	Position	Role	Signature	Date Issued
P.J. Potter	Engineering Geologist	Author		01/10/2007
M. Goss	Geotechnical Engineer	Author		01/10/2007
D Miller	Principal Geotechnical Engineer	Reviewer		01/10/2007

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1 INTRODUCTION

CBH Resources (CBH) is proposing a long hole open stope at the RASP Mine in Broken Hill. CBH were contacted by the Australian Railway Track Corporation (ARTC) in regard to the potential for subsidence, resulting from mining (as shown in plan in Figure 3), affecting the railway lines and surrounding infrastructure. Coffey Mining Pty Ltd (Coffey Mining) was requested by CBH to undertake a geotechnical study to determine the likelihood of any subsidence from the proposed open stope mining operations on the railway area.

1.1 Scope

The key issues to be addressed by the study are:

- Effect, if any, on surface railway operations from the proposed operation
- Potential subsidence at surface

1.2 Methodology

The subsidence review study undertaken by Coffey Mining has included:

- Review of railway and infrastructure location in relation to proposed underground mining
- Review of available geotechnical data to establish typical ground conditions (Reference 1 and 2)
- Analysis of stable spans for open stoping in the ore, meta-sediments and potosi gneiss units
- Analysis of void propagation.

2 BACKGROUND

CBH Resources has begun development of the decline into the Rasp Mine from the existing Kintore Pit to access the Western Mineralisation.

The area around the portal and the first section of the decline have been geotechnically mapped and reported (References 1 and 2) as part of the development of the decline. The Western Mineralisation is some 1000 metres remote from the portal and existing Kintore Pit but this remains the only geotechnical data available in the area.

The proposed stope designs for the first two years of operation (and comprising six individual stopes) have been provided by CBH.

2.1 Stope Geometry

The geometry (length and width) of the six proposed open stopes as provided by CBH are listed in the table below. This analysis has used the median geometry of those proposed stopes as being typical for the open stoping proposed for the whole of the Western Mineralisation. Lengths and widths of the stopes were taken from the proposed stope shapes then area and circumference (and hence hydraulic radii) of the stopes calculated and the median taken. The height of the stopes was given as 30m with a 5m development drive at both the bottom and top of the stope giving a total height of 40m.

	Length	**Width**	**Height**
Stope	60	26	40
	80	14	40
	80	14	40
	63	15	40
	83	12	40
	62	20	40
Median	72	14	40

The current stope designs have the stope backs at depth ranges from 200m below surface to 300m below surface with four of the six stopes at 250m below surface. Stopes may be planned as high as 150 metres below surface.

2.2 Geology

2.2.1 Rock Types and Mineralisation

The Rasp Mine ore deposit is hosted within a quartz/gahnite and garnet quartzite unit. This unit is hosted within a meta-sediment sequence. The Potosi Gneiss unit is found in the hanging wall and footwall with the hangingwall unit being about 10 to 25 metres above the ore horizon. This is shown in east-west section in Figure 2. Both the ore and the Potosi Gneiss are competent rock types, angular and blocky.

2.3 Railway Line Infrastructure

It is understood that a 150m exclusion zone exists below much of the existing railway and infrastructure. This will mean that no mining will be undertaken within this zone. The extent, in plan and section, of the exclusions zones is shown in Figures 1, 2 and 3. These figures show that the stoping is currently directly below much of the railway and its infrastructure.

3 GEOTECHNICAL STUDY

Surface subsidence can occur, as a result of mining, from stress redistribution around stoping or, should a stope fail that failure propagates upwards towards the surface.

At the depths of stoping expected, surface subsidence resulting from local redistribution of stresses around the initial stopes is not expected. That deformation would only be expected to influence an area two or three times the stope height, that is, for some 80 m to 120 m. As such surface subsidence of this type is not expected as the currently planned stopes are 200 to 250 m below surface. Future mining could extend up to the base of the 150 m exclusion zone but this is still greater that the expected stress redistribution effects from single stopes.

To assess the potential for caving type failure to occur in either the hangingwall or backs of the open stopes an empirical analysis has been employed. This analysis relies on the assessment of the rock mass quality for the ore and hangingwall rock types and a look up chart which compares stability based on the rock mass quality and the spans of the planned open stopes (as measured by hydraulic radius). This method has been developed from case studies and has been refined, for open stopes, by Stewart and Forsyth (Reference 3). This chart is itself based on Laubscher's caving stability graph (Reference 4). In these charts caving is taken to mean continuous caving, where ongoing propagation of the caving front will occur if void space is available.

3.1.1 Rockmass Quality

There is limited geotechnical data available for the Western Mineralisation. Recent geotechnical investigations have concentrated on the upper sections of decline to access the Western Mineralisation and the portal located in the Kintore Pit. Theses developments are some 1000m from the proposed stoping. The data does however have some coverage over the major rock types expected in the Western Mineralisation and this data has been taken as typical of that expected. Data has been collected from drillholes WMDD4033, WNDD4053, WMDD4054, WMDD4055, ZLDD5007, ZLD5008, ZLD5019, ZLD5021, and ZLD5023. Only five of these drillholes provided information on the western mineralisation and two on the Potosi gneiss.

Rock mass quality has been estimated using Q', a measure of core RQD, the number of joint sets, joint roughness and any alteration present on the surface of the joints. The number of major joint sets (three) has been taken from the mapping in the Kintore Pit and applied to the Western Mineralisation. The remaining measures are obtained from the core logs. In this particular case all joints recorded in the rock types of interest (ore, Potosi and metasediments) were logged as having chlorite coatings less than 1mm thick. This description downgrades the quality of the rock mass as chlorite is a soft and slick mineral which weakens the rock mass. However, the coating thickness has a direct impact on this and it is not possible to determine, from the logs available, whether the chlorite is a smear on the surface or a thicker infill. Thus there is a possibility that the rock mass quality indices calculated may be underestimates.

The following data was used for the assessment of rock mass quality. The table shows that core quality indices were logged over varying distances and that some indices are summary values over long lengths (10 metres or more). Recent geotechnical logging has recorded quality indices for every metre length of core.

Rock Type	Drill Hole	Total length	No records
Ore	4053	3	1
	4054	70	6
	4055	13	1
	5007	16	5
	4033	50	51
	Total	152	64
Metasediments	4053	194	33
	4054	42	8
	4054	93	15
	4055	101	15
	5007	53	26
	5008	73	11
	5019	52	17
	5023	53	18
	5021	49	3
	4033	249	236
	4033	44	44
	4033	13	13
Potosi	4053	17	3
	4033	34	34

From this data the rock mass quality Q’ has been calculated per logged length and then normalised to provide an estimate of the distribution of rock mass quality within the three major rock types as tabled below. The distribution is modelled by the 25% and 75% quartiles and the median value.

Rock Type	Assigned UCS	Q’ statistics
Ore	150	25% quartile: 4.2 Median: 5.6 75% quartile: 6.2
Metasediments	40	25% quartile: 4.0 Median: 8.0 75% quartile: 9.4
Potosi	200	25% quartile: 8.8 Median: 9.4 75% quartile: 9.4

The rock strength was estimated during logging by an index value with the ore rated as Extremely Hard (EH), the Potosi Gneiss rated as Very Hard (VH) and the metasediments rated as Hard (H). These qualitative estimates are usually correlated with strengths of 150 MPa, 100 MPa and 40 MPa respectively. Very limited testing of core strength has been reported (Reference 1) on the Potosi with results between 208 and 234 MPa. On the basis of these tests, the strength of the Potosi has been revised to 200 MPa.

On the basis of these results the Potosi rock mass is better quality than the ore which is better quality than the metasediments. This agrees with CBH’s experience.

3.1.2 Analysis of Stope Failure Potential

To provide an estimate of the potential for stope hangingwall or back failure the rock mass quality can be compared to published estimates of stable/caving stope spans. The appropriate rock mass quality index to undertake this is the Mathews Stability Number N’ which needs to be calculated from the Q’ estimates reported above. N’ considers the additional influences of the stress field the stope is in and any stress concentrations (factor A) and the influence on stability resulting from the orientation of unfavourable joints to the stope walls or backs (factors B and C).

The median Q’ (representing 50% of the population sampled) was used to calculate the Stability Number for each rock type. Factor A was calculated using a realistic maximum induced stress of 10MPa. UCS is then divided by the induced stress.

Factor B is calculated by using the difference in orientation between the rock wall face (hangingwall or back) and the angle of the dominant joint set. Previous mapping in the Kintore open pit and the decline geotechnical drill holes has identified three major joint sets in the rock mass which are expected to also occur in the Western Mineralisation. Of these joint sets, joint set 3 (84/078) has been chosen for stope faces dipping at 60º as this strikes closest to parallel to the hangingwall and is most likely to fail.

Foliation has been neglected due to its inconsistent and welded nature which makes it less likely to pose any issues. For the backs, joint set 2 (64/026) is considered the most dominant set.

The Mathews Stability Numbers for the hangingwall and backs in each of the three rock types are tabled below. Values for stope backs in the Potosi and metasediments, and the hangingwall in Potosi have been generated, even though they are not expected as stoping does not occur in these rock types in these orientations, as they are useful in considering failure in these materials should the hangingwall or backs fail in the ore/metasediments.

Rock Type	**Mathews Stability Number N'**	
Ore	Hangingwall: 4.8	Backs: 9.3
Metasediments	Hangingwall: 2.1:	Backs: 4.0
Potosi	Hangingwall: 8.1:	Backs: 15.5

The expected stability of the hangingwalls and backs is estimated by the Mathews Stability Number and the hydraulic radius of the hangingwalls and backs of the proposed open stopes. This is shown in Figure 4. This figure shows:

- The backs in ore are expected to be stable
- The hangingwall developed in the ore may show potential major failure but continuous caving is not expected
- The hangingwall developed in the metasediments plots in the transition zone between potential major failure and potential caving.

The analysis predicts some hangingwall failures but is based on the limited data available and the assessment that all joints are chlorite coated. Removing this would increase the stability number in each case and improved stability would be expected. It is reported that, in the Perilya operations to the south east of the Western Mineralisation, 200,000 tonnes stopes are stable. This would correspond to similar size stopes as considered in this analysis.

The potential for failures in the hangingwall can be reduced by either/or cable bolting the hangingwall from the upper and lower access drives (as shown in Figure 5), thereby reducing the unsupported span to something in the order of 20 to 25 m, or by using backfill from the end of the stope to restrict the open span length (Avoca method) (as shown in Figure 6). This analysis shows that in both cases for ore and metasediments that cable bolting or backfilling to reduce the open stope unsupported span length to 20 metres will improve stability to the point where the hangingwall is assessed as potentially unstable only.

Should a continuous cave start above the hangingwall in the metasediments then that failure may propagate vertically. The resulting horizontal span of the cave would be in the order of 25 m. This cave would be restricted when it encounters the Potosi unit in the hangingwall as this span should be supported by the Potosi (see Figure 4) plotting in the transition zone from stable to potentially unstable.

4 CONCLUSION AND RECOMMENDATIONS

On the basis of the data available and the analysis presented above a stope failure is not expected to propagate through to the surface and significant surface subsidence is not predicted above the stopes. The analysis estimates some hangingwall failures with the currently estimated rock mass properties and the open stope geometry proposed. These failures are expected to be localised and to not result in continuous caving to the surface. The presence of a more competent Potoisi Gneiss unit above the stope hangingwalls will restrict any failure from propagating upward assuming the unit is always above the stopes.

The analysis should be updated once exploratory drilling in the Western Mineralisation is undertaken and the core can be geotechnically logged. In particular attention should be paid in the logging to determining the rock mass quality over more representative core lengths and to the identification of chloritic infilling and its potential affects on stope stability.

REFERENCES

1. M. A. Lynch (December 2006) CBH Resources Limited - Rasp Mine Decline Geotechnical Assessment – Preliminary Report. Coffey Mining, Job No MINENHIL00060AA.
2. M. A. Goss (July 2007) CBH Resources Limited - Rasp Mine Geotechnical Assessment. Coffey Mining, Job No MINENHIL00060AA
3. Stewart and Forsayth (1995). The Mathews Method for Open Stope Design. CIM Bulletin July_Aug 1995
4. Laubscher (1990). A Geomechanics Classification System for the Rating of Rock Mass in Mine Design. J. S Afr. Inst Min. Metall 90(10): p257-273.

Figures

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Coffey Mining Pty Ltd	ABN 52 065 481 209	
Drawn PJP	CBH Resources Limited	FIGURE 1
Approved MG	Rasp Mine	
Date 19/9/2007	Cross Section - North South - 9400E	
Scale 1:2000		Job no: MINENHIL00060AC

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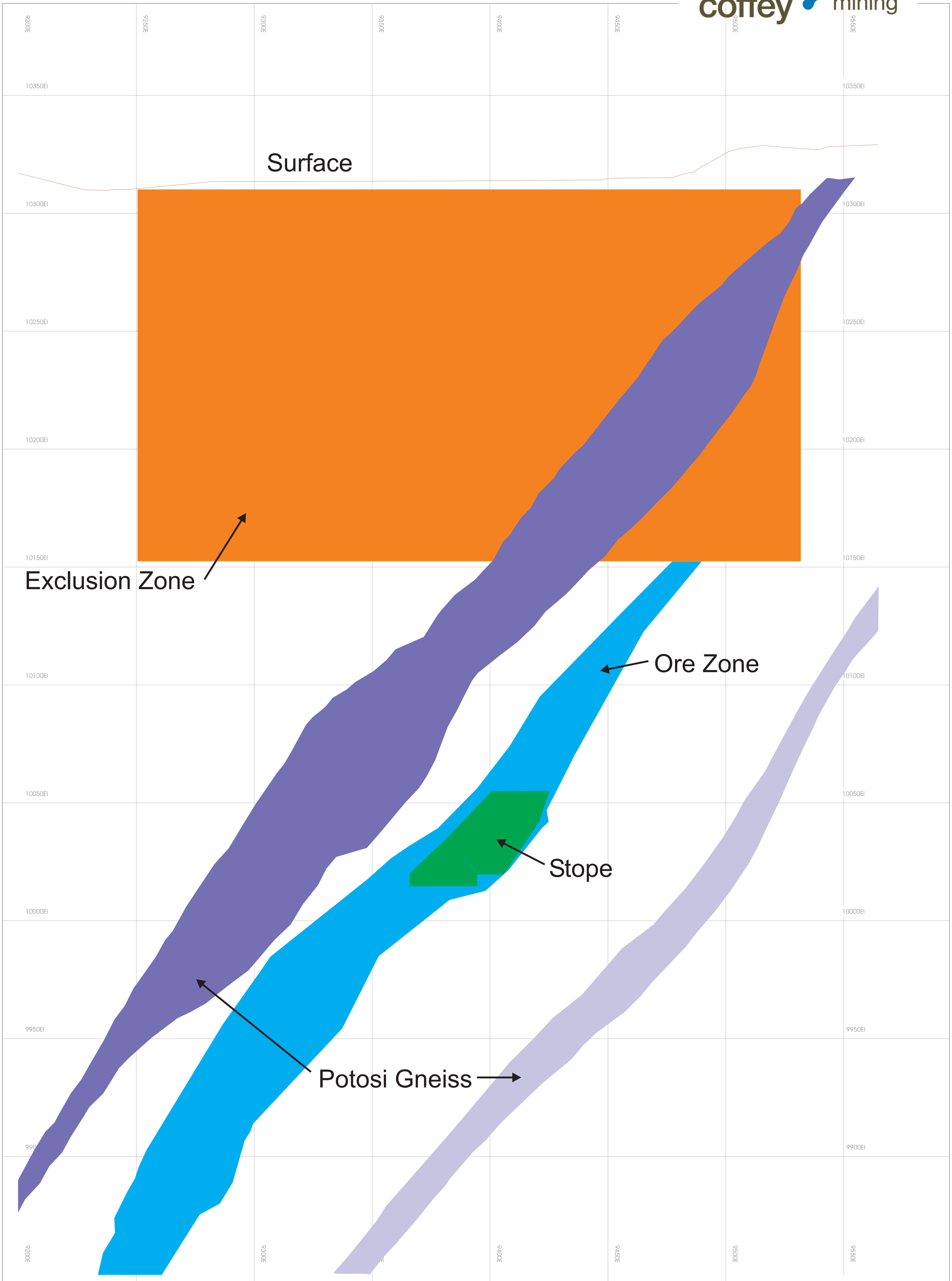
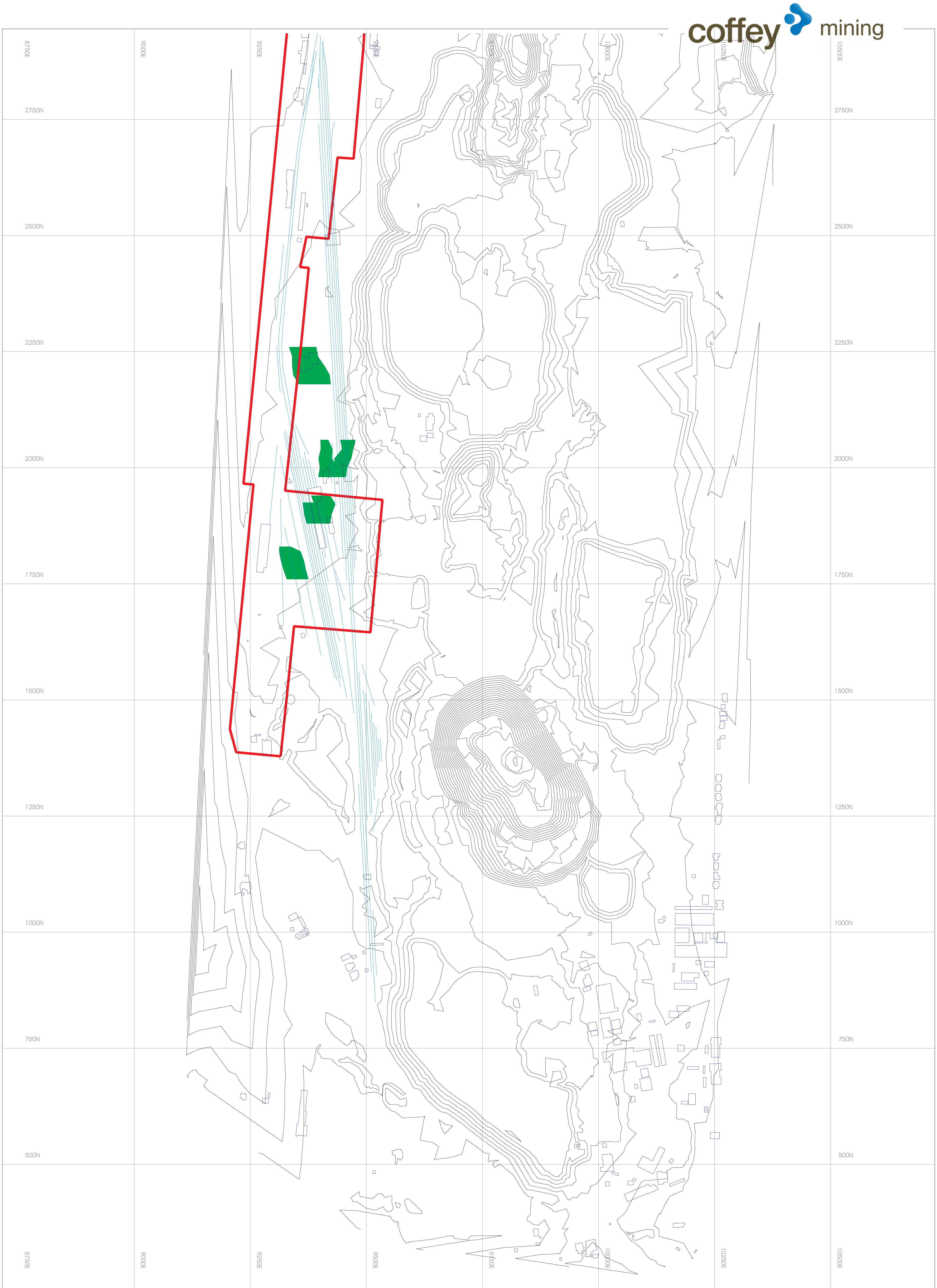


Coffey Mining Pty Ltd	ABN 52 065 481		
Drawn	PJP	CBH Resources Limited Rasp Mine Cross Section - East West - 1900N	FIGURE 2
Approved	MG		
Date	19/9/2007		
Scale	1:1500		Job no: MINENHIL00060AC



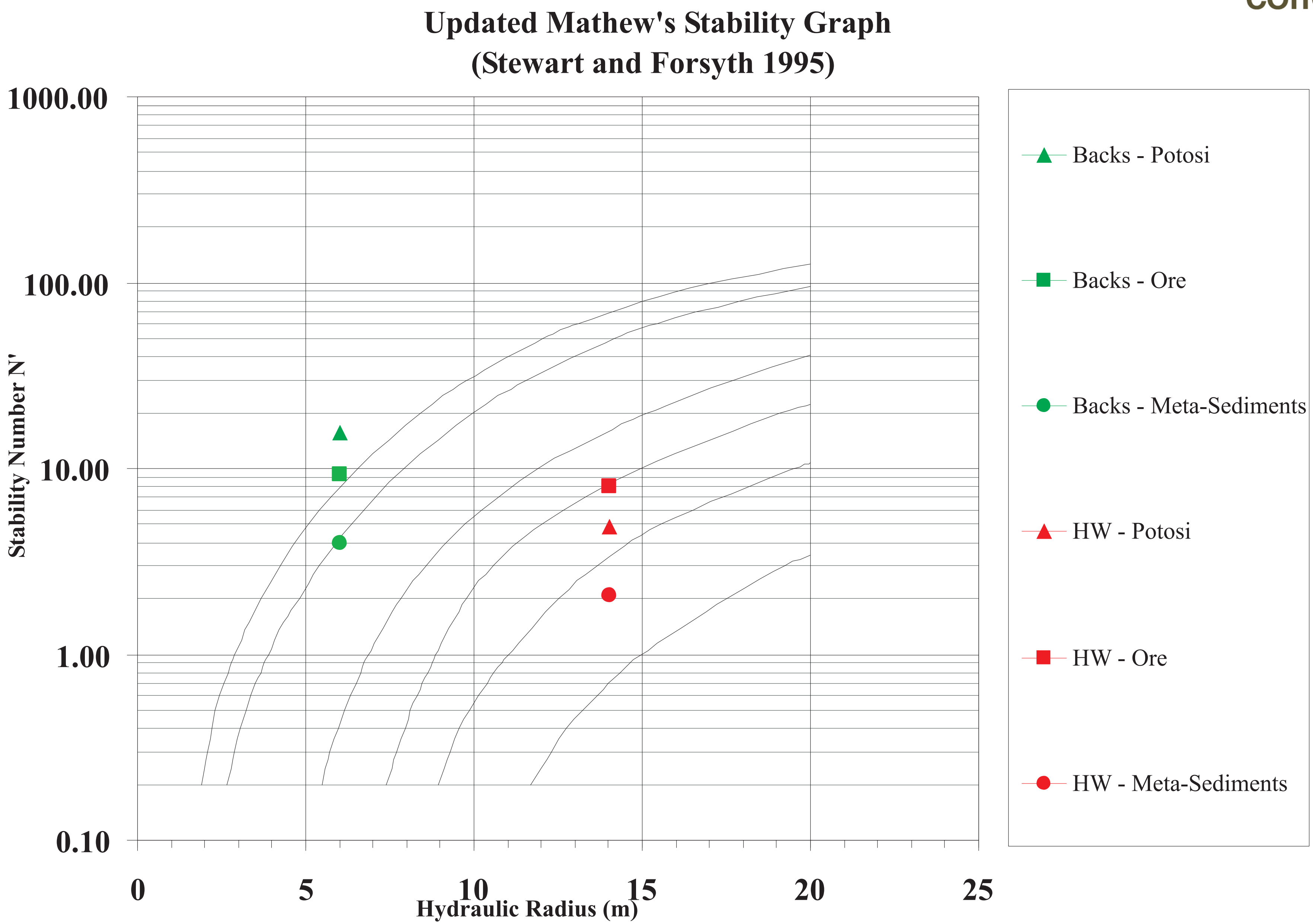
Coffey Mining Pty Ltd **ABN 52 065 481**

Drawn	PJP
Approved	MG
Date	19/9/2007
Scale	1:7500

CBH Resources Limited
Rasp Mine
Plan

FIGURE 3

Job no: MINENHIL00060AC



Coffey Mining Pty Ltd	ABN 52 065 481 209		
Drawn	PJP	CBH Resources Mathews Stability for Backs and Hangingwall	FIGURE 4
Approved	DM		
Date	1/10/07		
Scale			Job no: MINENHIL00060AC

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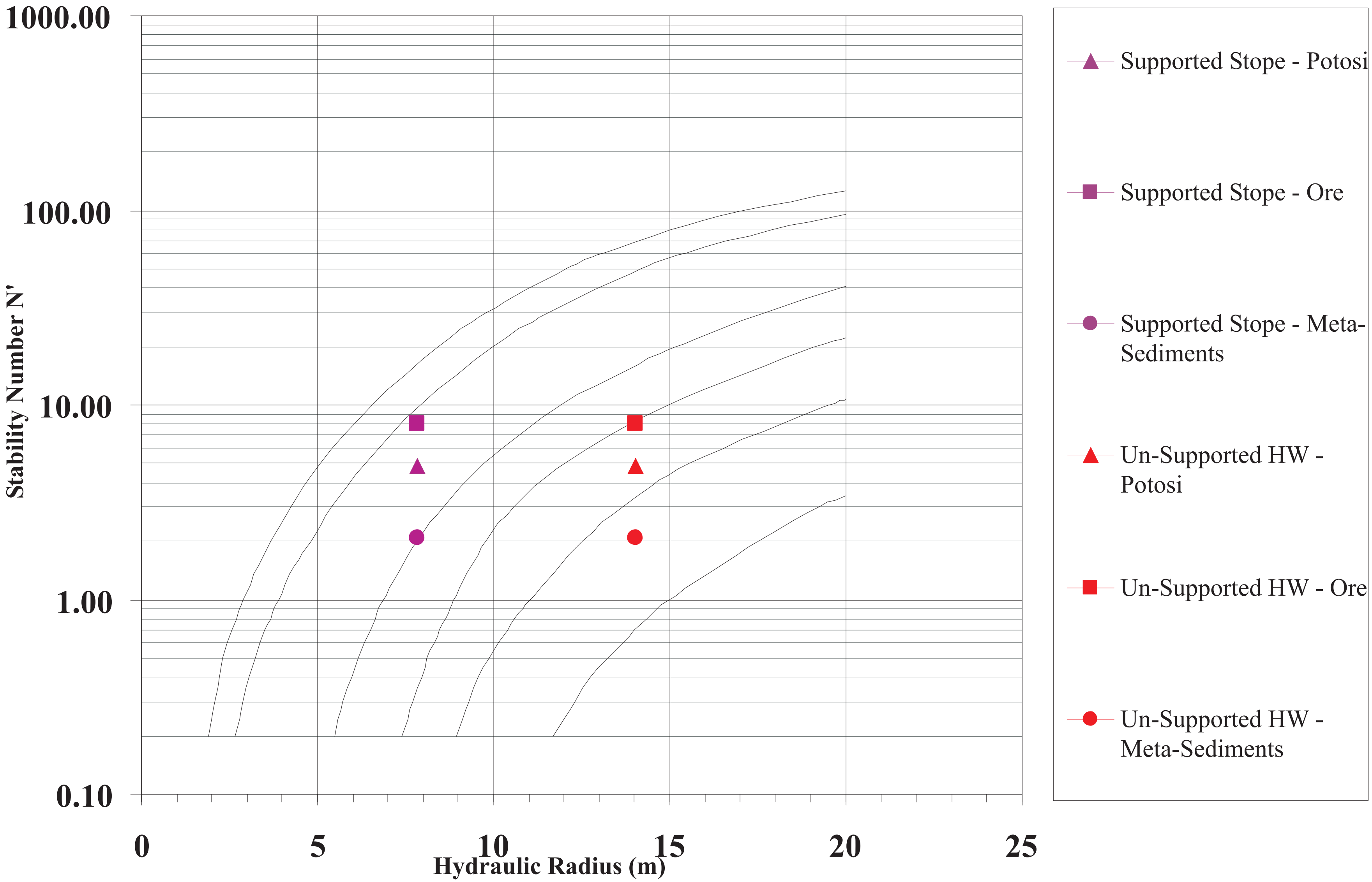
Updated Mathew's Stability Graph
(Stewart and Forsyth 1995)



Coffey Mining Pty Ltd	ABN 52 065 481 209		
Drawn	PJP	CBH Resources Mathews Stability for Hangingwall and Supported Stopes	FIGURE 5
Approved	DM		
Date	1/10/07		
Scale	(scale)		Job no: MINENHIL00060AC

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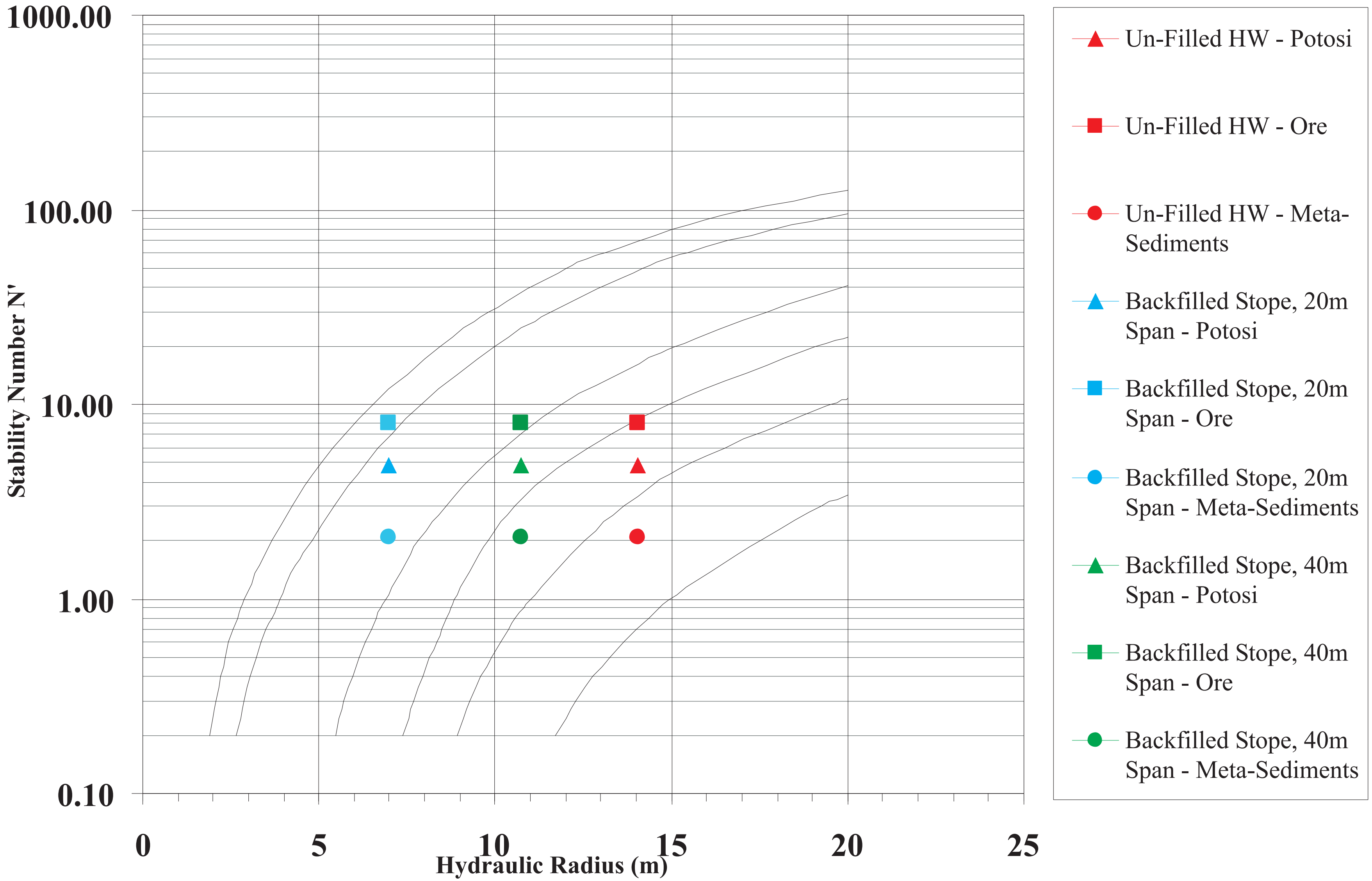
Updated Mathew's Stability Graph
(Stewart and Forsyth 1995)



Coffey Mining Pty Ltd ABN 52 065 481 209

Drawn	PJP	CBH Resources Mathews Stability for Hangingwall and Backfilled Stopes	FIGURE 6
Approved	DM		
Date	1/10/07		
Scale			Job no: MINENHIL00060AC