5.2. Water-related management during the post-mining situation (*Aide Memoire 6.3*)

5.2.1. Upslope stormwater management

We are proposing that the stormwater runoff from the undisturbed area upslope of the pit be diverted around the rehabilitated pit. From a surface recharge point of view, it is not advisable to allow clean runoff which could increase the infiltration into the pit water system to cross the rehabilitated pit, even in the post-mining scenario. We would therefore recommend that the upslope stormwater diversion constructed in the last year of the mining operation be of a permanent nature and be constructed in accordance with Regulation 287 of the Water Act.

5.2.2. Pit Surface Water drainage

The post-mining topography must allow the free draining of the rehabilitated pit. Post-mining care and maintenance will have to be conducted to infill any formation of local depressions or collapses, which could result in local high recharge to the pit. The proposed post-mining topography caters for a drainage line running in an east-west direction along the northern part of the rehabilitated pit. This drainage line should be constructed to a maximum slope of 1 in 200, depending on the rehabilitation cover soil characteristics. The slope should not fall below 1 in 500 to allow adequate drainage. The pit surface will therefore drain towards the Schoongezichtspruit. Adequate erosion control structures will be installed at the drainage points into the surface water drainage line as well as at the discharge point back to the natural surface topography.

5.2.3. Excess Mine Water

The rehabilitated pit will fill with time and the estimate to reach the sub-surface decant zone is 12 to 18 years, depending on the future rainfall pattern. It is not advisable to allow the development of an uncontrolled seepage zone. Consideration can be given to passive treatment of this seepage water if such technology is proven by the time the Mini-pit approaches closure. This will involve the construction of a barrier trench filled with organic material through which the seepage water will flow before surfacing. There are a number of such installations in the world, and this is currently being researched as part of a Water Research Commission project. The small scale of the Mini-pit operation would make it a candidate for such passive treatment technology.

The alternative approach would be to intercept the excess mine water before it seeps from the pit. This can be done by constructing a hydraulic connection below the level of the decant zone to either the existing Schoongezicht underground workings or to the Schoongezicht surface pollution control dams. The water flowing from the Mini-pit will then be integrated into the overall Landau Colliery water system. This will allow re-use and/or treatment at a central facility. The post-mining management of the excess Mini-pit water will therefore form an integral part of the overall Landau Colliery water management.

5.2.4. Summary of management recommendations for the post-mining situation

Table 5.2 (a) Recommendations for the post-mining phase of the Schoongezicht Mini-pit.

Variable	Management
Upslope Stormwater management	• Divert stormwater runoff from the undisturbed upslope area around the pit.
	• The upslope diversion should be constructed in the last year of the mining operation and should be of a permanent nature.
Pit Surface Water drainage	• Rehabilitated pit should be free draining.
	• Infill any formation of local depressions or collapses.
	• Construct a drainage line in a east-west direction, to a maximum slope of 1 in 200. Should not fall below 1 in 500 to allow for adequate drainage.
	• Erosion control to be installed at the drainage points into the surface drainage line as well as at the discharge point back to the natural topography.
Excess Mine Water	• Use some form of passive treatment of this seepage water for example a barrier trench filled with organic material through which the seepage water will flow before surfacing.
	• Alternative approach is to intercept the excess mine water before it seeps from the pit by constructing a hydraulic connection below the level of the decant zone to either the existing Schoongezicht underground workings or to the Schoongezicht pollution control dams
	• Dewatering well in spoils to control decant level

pp **A.M. VAN NIEKERK**

T.J. COLEMAN

L.A. SHAMROCK
for **Wates, Meiring & Barnard**

T. HARCK

SOUTH AFRICAN COAL ESTATES - LANDAU COLLIERY

SURFACE AND GROUNDWATER ASPECTS OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE PROPOSED SCHOONGEZICHT #2 SEAM MINI PIT

APPENDIX A

Borehole Profile Records

397 NEW ROAD WEST
HALFWAY GARDENS EXTENSION 25
1685 MIDRAND
P.O.BOX 6001, HALFWAY HOUSE
1685
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PERCUSSION DRILLING RECORD

BOREHOLE 2721

AIR LOSS	PENETRATION min/m	DEPTH (metres)	PROFILE	MATERIAL DESCRIPTION	
				0.0 - 2.7	Moist red-brown medium dense slightly clayey SAND. Colluvium and residual sandstone.
				2.7 - 7.3	Moist red-brown to yellow-beige stiff sandy CLAY.
				7.3 - 12.1	Grey to dark grey slightly weathered to unweathered fine-grained intensely-laminated hard rock SILTSTONE. Bioturbated. Becomes more shaly towards base. Pyritic.
				12.1 - 13.0	Pale grey to white unweathered fine to medium-grained thinly bedded towards base hard rock SANDSTONE becoming SILTSTONE at base.
				13.0 - 13.8	"Roof coal" #2 Upper seam.
				13.8 - 14.0	Black unweathered very fine-grained hard rock CARBONACEOUS SHALE. #2S parting.
				14.0 - 20.0	# 2 Lower seam coal.

DRILLING RIG	: Rotary Diamond	DATE	: 1996-11	X CO-ORDINATE	: 64433.601
LOGGED BY	: TR Harck	DATE	: 1996-11	Y CO-ORDINATE	: -17398.507
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1530.64
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	:
PROJECT	: Schoongezicht #2 Seam	SHEET NO	: 1 OF 2	COMPRESSOR CAPACITY	:

REF : dr359101

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PERCUSSION DRILLING RECORD

BOREHOLE 2721

AIR LOSS	PENETRATION min/m	DEPTH (metres)	PROFILE	MATERIAL DESCRIPTION	
		20		20.0 - 20.3	As above.
		21		20.3 - 21.2	Grey laminated black unweathered fine to coarse grained thinly bedded SANDSTONE with carbonaceous laminae. #1A parting.
		22		21.2 - 21.6	#1A Coal seam.
		23		21.6 - 22.6	White unweathered coarse-grained very thinly laminated at base SANDSTONE becoming SILTSTONE at base. Pyritic. #1A parting.
		24		22.6 - 23.3	# 1 Seam coal.
		25		23.3 - 24.0	White unweathered coarse-grained very thinly laminated at base SANDSTONE becoming SILTSTONE at base. Pyritic.
		26			
		27			
		28			
		29			End of hole at 24.0m. Water strike at ±8.0m ABA Samples taken at 11.3 - 11.5m; 9.0 - 9.2m; 22.1 - 22.3m.
		30			
		31			
		32			
		33			
		34			
		35			
		36			
		37			
		38			
		39			
		40			

DRILLING RIG	: Rotary Diamond	DATE	: 1996-11	X CO-ORDINATE	: 64433.601
LOGGED BY	: TR Harck	DATE	: 1996-11	Y CO-ORDINATE	: -17398.507
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1530.64
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	:
PROJECT	: Schoongezicht #2 Seam	SHEET NO	: 2 OF 2	COMPRESSOR CAPACITY	:

REF : dr359101

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PERCUSSION DRILLING RECORD

BOREHOLE 2667

DEPTH (metres)	MATERIAL DESCRIPTION
0.0 - 3.9	White highly weathered medium to coarse grained soft rock SANDSTONE.
3.9 - 6.6	Dark grey moderately weathered very fine grained soft rock siltstone.
6.6 - 9.5	Pale grey laminated black unweathered very fine grained hard rock SILTSTONE. Micaceous and pyritic.
9.5 - 10.1	Black unweathered very fine grained hard rock CARBONACEOUS SHALE.
10.1 - 11.7	Pale grey laminated black unweathered very fine grained hard rock SILTSTONE. Micaceous and pyritic.
11.7 - 13.8	Black unweathered very fine grained hard rock CARBONACEOUS SHALE.
13.8 - 14.3	White unweathered fine-grained to medium grained hard rock SANDSTONE. Poorly sorted.
14.3 - 17.0	"Roof coal" # 2 Upper seam.
17.0 - 17.3	Black unweathered very fine grained hard rock CARBONACEOUS SHALE. #2S parting.
17.3 - 20.0	# 2 Lower seam coal.

DRILLING RIG	: Rotary Diamond	DATE	: 1996-11	X CO-ORDINATE	: 64228.103
LOGGED BY	: TR Harck	DATE	: 1996-11	Y CO-ORDINATE	: -16566.765
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1525.39
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	:
PROJECT	: Schoongezicht #2 Seam	SHEET NO	: 1 OF 2	COMPRESSOR CAPACITY	:

REF : dr359102

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PERCUSSION DRILLING RECORD

BOREHOLE 2667

AIR LOSS	PENETRATION min/m	DEPTH (metres)	PROFILE	MATERIAL DESCRIPTION	
		20		20.0 - 20.7	As above.
		21		20.7 - 23.0	Grey banded black unweathered fine to coarse grained hard rock SANDSTONE with carbonaceous bands. Micaceous and pyritic. #1 and #1A partings.
		23		23.0 - 24.7	# 1 Seam coal.
		25		24.7 - 25.0	Dwyka tillite.
		27			End of hole at 25.0m. Driller reports water at ±8.0m. ABA Samples taken at 8.2 - 8.4m; 13.4 - 13.6; 17.0 - 17.2m; 22.6 - 22.8m.

DRILLING RIG	Rotary Diamond	DATE	1996-11	X CO-ORDINATE	64228.103
LOGGED BY	TR Harck	DATE	1996-11	Y CO-ORDINATE	-16566.765
DEPTH W/TABLE		AFTER		COLLAR ELEVATION	1525.39
CLIENT	SA Coal Estates	JOB NO	3591	BIT DIAMETER / TYPE	
PROJECT	Schoongezicht #2 Seam	SHEET NO	2 OF 2	COMPRESSOR CAPACITY	

REF : dr359102

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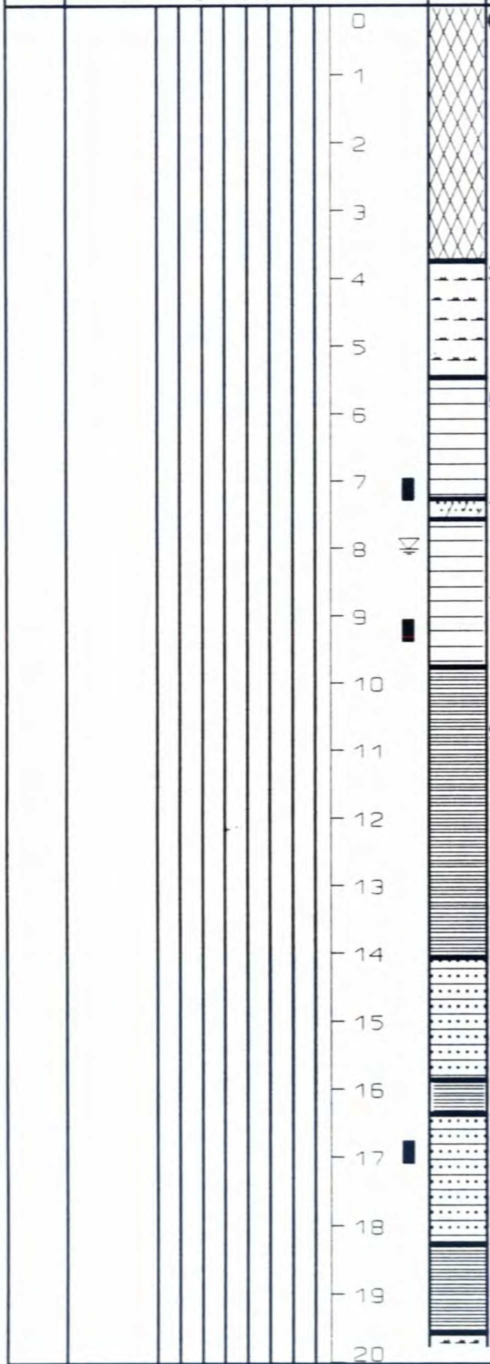
PERCUSSION DRILLING RECORD

BOREHOLE 2627

AIR LOSS	PENETRATION min/m	DEPTH (metres)	PROFILE	MATERIAL DESCRIPTION



	Material description
0.0 - 3.7	Topsoil and alluvium. No core recovery.
3.7 - 5.5	Yellow brown highly to completely weathered fine grained thinly laminated very soft rock SILTSTONE. Fe-oxides on joints/fractures.
5.5 - 7.3	Black slightly weathered very fine grained hard rock CARBONACEOUS SHALE.
7.3 - 7.6	Moist red-brown very soft SANDY CLAY to CLAYEY SAND. Completely weathered sandstone.
7.6 - 9.8	Black unweathered to slightly weathered medium hard to hard rock CARBONACEOUS SHALE with COAL bands. "Roof coal". #2 Upper seam.
9.8 - 14.1	# 2 Lower seam coal.
14.1 - 15.9	Pale grey unweathered coarse grained hard rock SANDSTONE with grey SILTSTONE bands. Micaceous and pyritic. #1A parting.
15.9 - 16.4	#1A Seam coal.
16.4 - 18.3	Pale grey unweathered coarse grained hard rock SANDSTONE with grey SILTSTONE bands. Micaceous and pyritic. #1 parting.
18.3 - 19.6	# 1 Seam coal.
19.6 - 19.8	Dark grey unweathered very fine grained hard rock SILTSTONE.

End of hole at 19.8m.
Driller reports water strike at ±8.0m.
ABA samples taken at 6.9 - 7.1; 9.0 - 9.2m; 16.7 - 16.9m.

DRILLING RIG	: Rotary Diamond	DATE	: 1996-11	X CO-ORDINATE	: 63667.581
LOGGED BY	: TR Harck	DATE	: 1996-11	Y CO-ORDINATE	: -16247.368
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1513.18
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	:
PROJECT	: Schoongezicht #2 Seam	SHEET NO	:	COMPRESSOR CAPACITY	:

REF : dr359103

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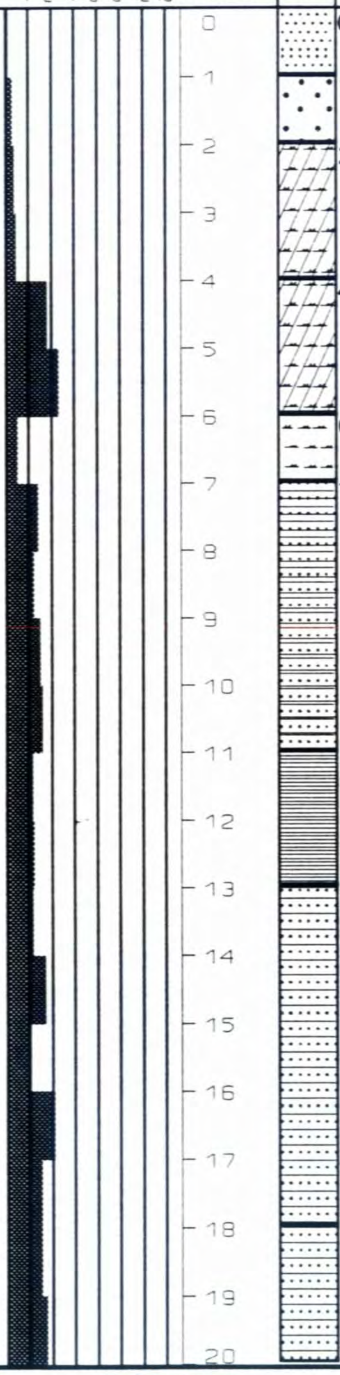
PERCUSSION DRILLING RECORD

BOREHOLE EMP 01

AIR LOSS	PENETRATION min/m	DEPTH (metres)
	0'10"	0 - 1
	0'19"	1 - 2
	0'24"	2 - 3
	0'30"	3 - 4
	1'51"	4 - 5
	2'43"	5 - 6
	0'34"	6 - 7
	1'27"	7 - 8
	1'15"	8 - 9
	1'33"	9 - 10
	1'37"	10 - 11
	1'12"	11 - 12
	1'15"	12 - 13
	1'13"	13 - 14
	1'44"	14 - 15
	1'03"	15 - 16
	2'15"	16 - 17
	1'34"	17 - 18
	1'35"	18 - 19
	1'47"	19 - 20



Depth	MATERIAL DESCRIPTION
0.0 - 1.0	Red brown topsoil.
1.0 - 2.0	Red soil with ferricrete nodules.
2.0 - 4.0	Pinkish yellow highly weathered fine grained siltstone with red/green clay.
4.0 - 6.0	Pink highly weathered very fine grained siltstone with red clay.
6.0 - 7.0	Red/brown highly weathered fine grained siltstone.
7.0 - 11.0	Medium grey slightly weathered fine grained sandstone. Interbedded with carbonaceous shale.
11.0 - 13.0	Black Coal #1 seam.
13.0 - 18.0	Light grey unweathered fine grained medium hard rock sandstone.
18.0 - 20.0	Pale grey unweathered fine grained medium hard rock poorly-sorted sandstone Dwyka.

DRILLING RIG	: Air Percussion	DATE	:	1997-03-04	X CO-ORDINATE	:	-15940.258
LOGGED BY	: S Tibenham	DATE	:	1997-03-04	Y CO-ORDINATE	:	2863570.153
DEPTH W/TABLE	:	AFTER	:		COLLAR ELEVATION	:	1506.884
CLIENT	: SA Coal Estates	JOB NO	:	3591	BIT DIAMETER / TYPE	:	165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	:	1 OF 2	COMPRESSOR CAPACITY	:	

REF : dr359104

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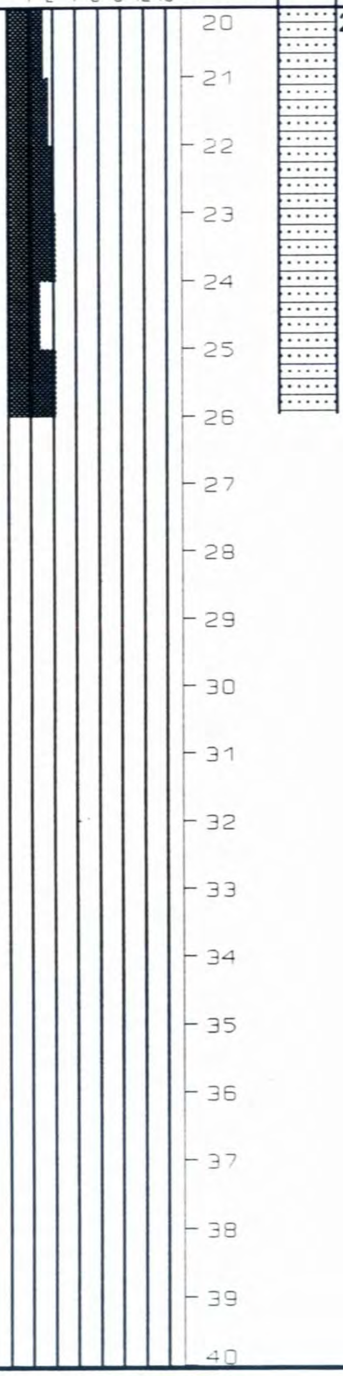
PERCUSSION DRILLING RECORD

BOREHOLE EMP 01

AIR LOSS	PENETRATION min/m	DEPTH (metres)	PRO FILE	MATERIAL DESCRIPTION
	1'38"	20		20.0 - 26.0 Pale grey unweathered fine grained medium hard rock poorly-sorted sandstone, Dwyka.
	1'51"	21		
	2'12"	22		End of hole at 26.0m.
	2'20"	23		No water seepage encountered.
	1'28"	24		No sample taken.
	2'18"	25		



DRILLING RIG	: Air Percussion	DATE	: 1997-03-04	X CO-ORDINATE	: -15940.258
LOGGED BY	: S Tibenham	DATE	: 1997-03-04	Y CO-ORDINATE	: 2863570.153
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1506.884
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	: 165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	: 2 OF 2	COMPRESSOR CAPACITY	:

REF : dr359104

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PERCUSSION DRILLING RECORD

BOREHOLE EMP 02

AIR LOSS	PENETRATION min/m	DEPTH (metres)
	0'19"	0 - 1
	0'44"	1 - 2
	0'28"	2 - 3
	1'18"	3 - 4
	1'33"	4 - 5
	1'38"	5 - 6
	1'37"	6 - 7
	1'05"	7 - 8
	0'45"	8 - 9
	0'28"	9 - 10
	0'14"	10 - 11
	0'47"	11 - 12
	1'02"	12 - 13
	2'05"	13 - 14
	1'14"	14 - 15
	1'04"	15 - 16
	0'30"	16 - 17
	1'21"	17 - 18
	1'20"	18 - 19
	1'30"	19 - 20

DEPTH	MATERIAL DESCRIPTION
0.0 - 1.0	Red brown topsoil and red sand
1.0 - 2.0	Red sand and ferricrete.
2.0 - 5.0	Yellow/brown completely weathered to medium weathered very fine grained sandstone with reddish clay.
5.0 - 7.0	Red brown slightly weathered very fine grained sandstone with reddish clay.
7.0 - 8.0	Slightly weathered red brown sandy clay.
8.0 - 9.0	Slightly moist black weathered coal and clay.
9.0 - 12.0	Black Coal #2 seam.
12.0 - 16.0	Dark grey medium weathered fine silty sandstone. Interbedded with carbonaceous shale.
16.0 - 17.0	Black Coal #1 seam.
17.0 - 20.0	Mid grey unweathered very fine grained silty sandstone with thinly-bedded carbonaceous silty shale.

DRILLING RIG : Air Percussion	DATE	: 1997-03-04	X CO-ORDINATE	:	-16319.671
LOGGED BY : S Tibenham	DATE	: 1997-03-04	Y CO-ORDINATE	:	2863440.934
DEPTH W/TABLE :	AFTER	:	COLLAR ELEVATION	:	1504.410
CLIENT : SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	:	165mm
PROJECT : Schoongezicht #2Seam	SHEET NO	: 1 OF 2	COMPRESSOR CAPACITY	:	

REF : dr359105

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BOREHOLE EMP 02

AIR LOSS	PENETRATION min/m	DEPTH (metres)	PRO FILE	MATERIAL DESCRIPTION	
	1'22"	20		20.0 - 21.0	As above.
	1'40"	21		21.0 - 24.0	Light grey unweathered fine to coarse grained medium hard rock poorly sorted sandstone. Dwyka.
	1'33"	22			
	1'23"	23			End of hole at 24.0m. No water seepage encountered. No sample taken.
		24			
		25			
		26			
		27			
		28			
		29			
		30			
		31			
		32			
		33			
		34			
		35			
		36			
		37			
		38			
		39			
		40			

DRILLING RIG	: Air Percussion	DATE	: 1997-03-04	X CO-ORDINATE	: -16319.671
LOGGED BY	: S Tibenham	DATE	: 1997-03-04	Y CO-ORDINATE	: 2863440.934
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1504.410
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	: 165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	: 2 OF 2	COMPRESSOR CAPACITY	:

REF : dr359105

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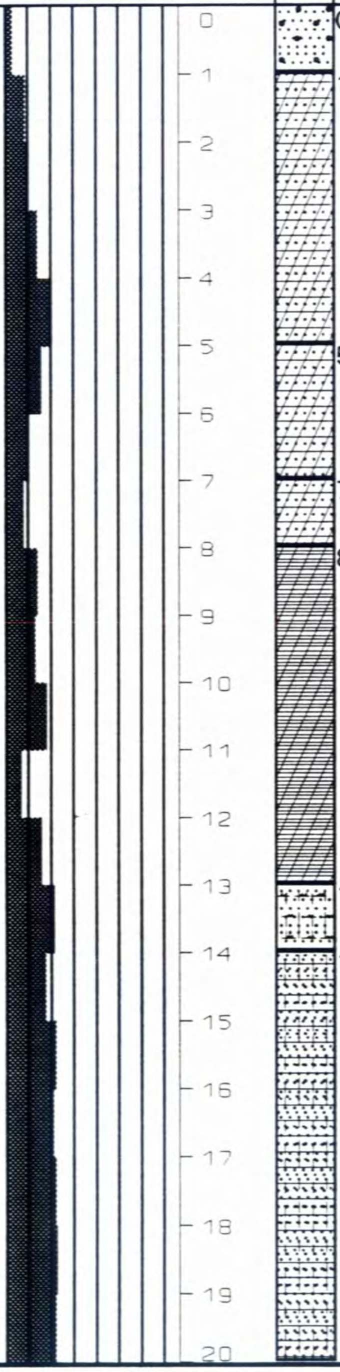
BOREHOLE EMP 03

AIR LOSS	PENETRATION min/m	DEPTH (metres)
	0'21"	0 - 1
	0'55"	1 - 2
	1'00"	2 - 3
	1'28"	3 - 4
	1'59"	4 - 5
	1'37"	5 - 6
	0'59"	6 - 7
	0'51"	7 - 8
	1'27"	8 - 9
	1'21"	9 - 10
	1'51"	10 - 11
	0'43"	11 - 12
	1'38"	12 - 13
	2'22"	13 - 14
	1'48"	14 - 15
	2'30"	15 - 16
	2'17"	16 - 17
	2'28"	17 - 18
	2'38"	18 - 19
	2'31"	19 - 20



DEPTH (metres)	MATERIAL DESCRIPTION
0.0 - 1.0	Red soil and ferricrete.
1.0 - 5.0	Yellow/red highly weathered to completely weathered very fine grained sandstone with clay.
5.0 - 7.0	Yellow highly weathered very fine grained sandstone and clay.
7.0 - 8.0	Yellow completely weathered sandstone and clay.
8.0 - 13.0	Black highly weathered coal and clay. #2 Seam and #1 seam with partings.
13.0 - 14.0	Dark grey medium weathered carbonaceous sandy siltstone.
14.0 - 20.0	Mid grey slightly weathered to unweathered very fine/medium grained hard rock silty/sandstone. Dwyka.

DRILLING RIG	: Air Percussion	DATE	:	1997-03-04	X CO-ORDINATE	:	-16730.457
LOGGED BY	: S Tibenham	DATE	:	1997-03-04	Y CO-ORDINATE	:	2863779.528
DEPTH W/TABLE	:	AFTER	:		COLLAR ELEVATION	:	1511.221
CLIENT	: SA Coal Estates	JOB NO	:	3591	BIT DIAMETER / TYPE	:	165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	:	1 OF 2	COMPRESSOR CAPACITY	:	

REF : dr359106

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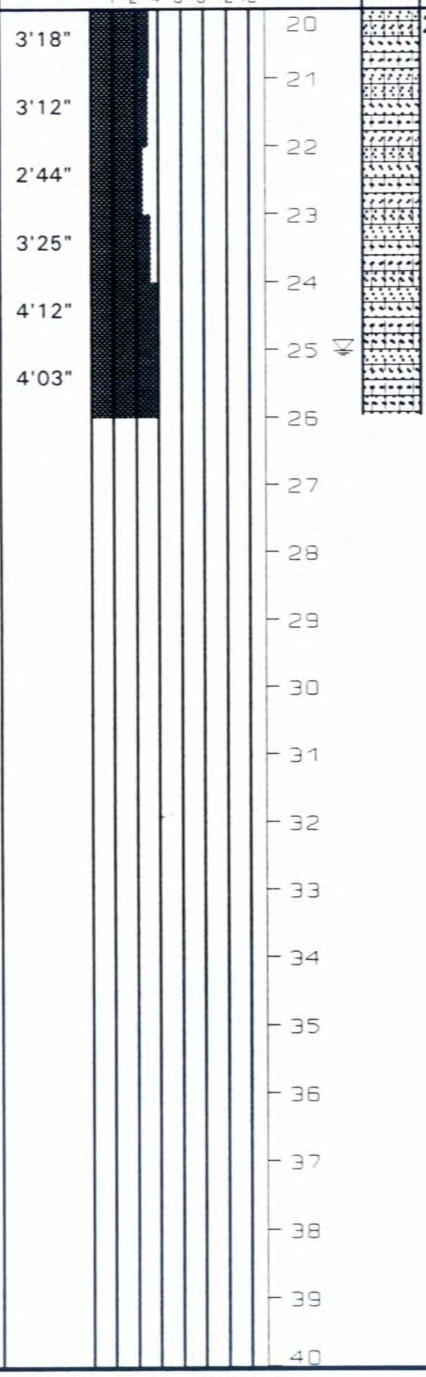
PERCUSSION DRILLING RECORD

BOREHOLE EMP 03

AIR LOSS	PENETRATION min/m	DEPTH (metres)	PROFILE	MATERIAL DESCRIPTION



20.0 - 26.0 Mid grey slightly weathered to unweathered very fine/medium grained hard rock silty/sandstone. Dwyka.

End of hole at 26.0m.
Water strike between 24.0m - 25.0m. Blow yield <0.1 l/sec.
No sample taken.

DRILLING RIG	: Air Percussion	DATE	: 1997-03-04	X CO-ORDINATE	: -16730.457
LOGGED BY	: S Tibenham	DATE	: 1997-03-04	Y CO-ORDINATE	: 2863779.528
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1511.221
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	: 165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	: 2 OF 2	COMPRESSOR CAPACITY	:

REF : dr359106

397 NEW ROAD WEST
HALFWAY GARDENS EXTENSION 25
1685 MIDRAND
P.O.BOX 6001, HALFWAY HOUSE
1685
TELEPHONE: (011) 315-0316
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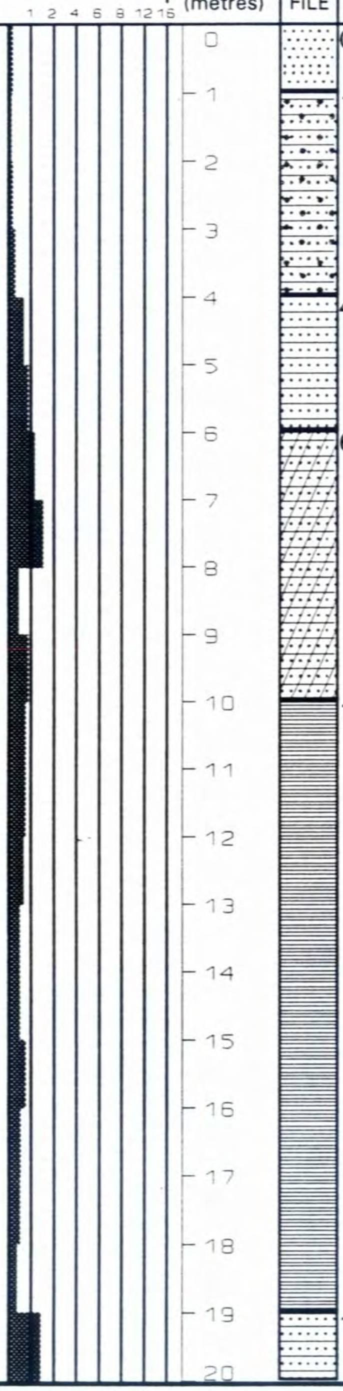
Wates Meiring & Barnard

Consulting Civil, Structural, Process and Geotechnical Engineers

PERCUSSION DRILLING RECORD

BOREHOLE EMP 04

AIR LOSS	PENETRATION min/m
	0'14"
	0'12"
	0'14"
	0'22"
	0'43"
	0'56"
	1'12"
	1'34"
	0'30"
	0'56"
	0'49"
	0'48"
	0'44"
	0'34"
	0'34"
	0'48"
	0'35"
	0'34"
	0'24"
	1'28"



DEPTH (metres)	MATERIAL DESCRIPTION
0.0 - 1.0	Red brown topsoil.
1.0 - 4.0	Reddish brown highly weathered poorly sorted medium/fine grained sandstone with ferricrete nodules.
4.0 - 6.0	Pale grey-cream medium to slightly weathered poorly sorted medium/fine grained sandstone.
6.0 - 10.0	Reddish brown medium to slightly weathered poorly sorted fine grained sandstone with clay.
10.0 - 19.0	Black Coal #2 seam and #1A seam with sandstone partings.
19.0 - 20.0	Pale grey unweathered poorly sorted medium to fine grained sandstone. No 1 parting.

DRILLING RIG	: Air Percussion	DATE	:	1997-03-04	X CO-ORDINATE	:	-17549.991
LOGGED BY	: S Tibenham	DATE	:	1997-03-04	Y CO-ORDINATE	:	2864630.008
DEPTH W/TABLE	:	AFTER	:		COLLAR ELEVATION	:	1532.700
CLIENT	: SA Coal Estates	JOB NO	:	3591	BIT DIAMETER / TYPE	:	165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	:	1 OF 2	COMPRESSOR CAPACITY	:	

REF : dr359107

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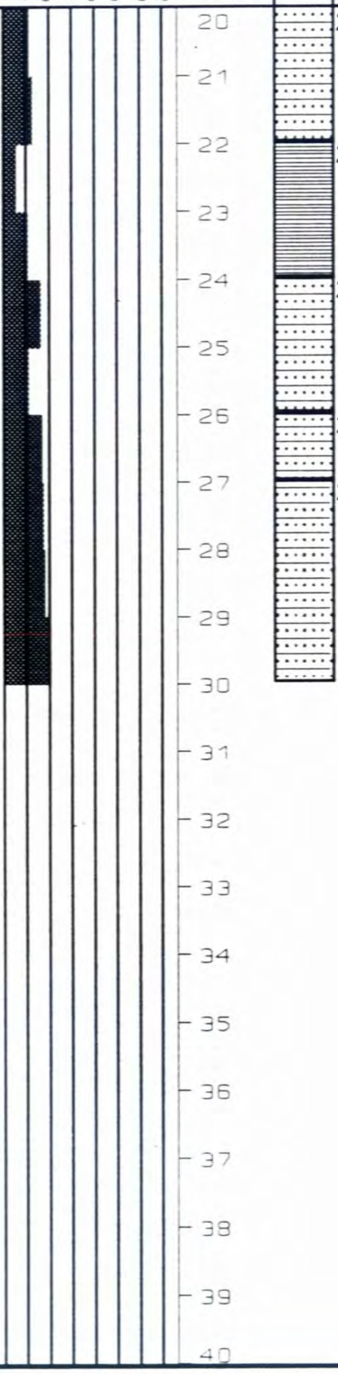
PERCUSSION DRILLING RECORD

BOREHOLE EMP 04



AIR LOSS	PENETRATION min/m	DEPTH (metres)	MATERIAL DESCRIPTION	
	1'10"	20	20.0 - 22.0	Pale grey unweathered poorly sorted medium fine grained sandstone. No 1 parting.
	1'19"	21		
	0'36"	22	22.0 - 24.0	Black coal. #1 Coal seam.
	1'07"	23		
	1'41"	24	24.0 - 26.0	Pale grey unweathered poorly sorted fine/coarse grained sandstone.
	1'09"	25		
	1'45"	26	26.0 - 27.0	Grey unweathered sandstone with carbonaceous laminae.
	1'47"	27	27.0 - 30.0	Pale grey unweathered poorly sorted fine to coarse grained sandstone. Dwyka.
	1'51"	28		
	2'02"	29		End of hole at 30.0m. No water seepage encountered. No sample taken.
		30		
		31		
		32		
		33		
		34		
		35		
		36		
		37		
		38		
		39		
		40		

DRILLING RIG	: Air Percussion	DATE	: 1997-03-04	X CO-ORDINATE	: -17549.991
LOGGED BY	: S Tibenham	DATE	: 1997-03-04	Y CO-ORDINATE	: 2864630.008
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1532.700
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	: 165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	: 2 OF 2	COMPRESSOR CAPACITY	:

REF : dr359107

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Consulting Civil, Structural, Process and Geotechnical Engineers

PERCUSSION DRILLING RECORD

BOREHOLE EMP 05

DEPTH (metres)	PENETRATION min/m
0 - 1	0'18"
1 - 2	0'17"
2 - 3	0'29"
3 - 4	0'50"
4 - 5	1'26"
5 - 6	1'31"
6 - 7	1'05"
7 - 8	0'52"
8 - 9	0'54"
9 - 10	0'46"
10 - 11	0'26"
11 - 12	0'28"
12 - 13	0'24"
13 - 14	0'52"
14 - 15	0'38"
15 - 16	0'24"
16 - 17	0'31"
17 - 18	1'34"
18 - 19	1'05"
19 - 20	0'29"

Depth	MATERIAL DESCRIPTION
0.0 - 1.0	Yellow brown topsoil.
1.0 - 3.0	Reddish brown soil and highly weathered sandstone with clay beds and ferricrete nodules.
3.0 - 7.0	Pinkish brown medium-weathered poorly sorted medium hard to hard rock fine grained sandstone.
7.0 - 17.0	Black coal. #2 seam and #1A seam with sandstone/siltstone partings.
17.0 - 20.0	Black unweathered carbonaceous shale.

DRILLING RIG	: Air Percussion	DATE	: 1997-03-04	X CO-ORDINATE	: -17690.032
LOGGED BY	: S Tibenham	DATE	: 1997-03-04	Y CO-ORDINATE	: 286439.982
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1525.710
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	: 165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	: 1 OF 2	COMPRESSOR CAPACITY	:

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PERCUSSION DRILLING RECORD

BOREHOLE EMP 05

Depth (metres)	Penetration min/m
20 - 21	0'52"
21 - 22	1'35"
22 - 23	1'30"
23 - 24	1'34"
24 - 25	1'53"
25 - 26	1'49"

Material description

20.0 - 21.0 Black coal. #1 seam.

21.0 - 26.0 Pale grey unweathered poorly sorted medium to fine grained sandstone. Dwyka.

End of hole at 26.0m.
No seepage encountered.
No sample taken.

DRILLING RIG : Air Percussion	DATE : 1997-03-04	X CO-ORDINATE	: -17690.032
LOGGED BY : S Tibenham	DATE : 1997-03-04	Y CO-ORDINATE	: 286439.982
DEPTH W/TABLE :	AFTER :	COLLAR ELEVATION	: 1525.710
CLIENT : SA Coal Estates	JOB NO : 3591	BIT DIAMETER / TYPE	: 165mm
PROJECT : Schoongezicht #2Seam	SHEET NO : 2 OF 2	COMPRESSOR CAPACITY	:

REF : dr359108

397 NEW ROAD WEST
HALFWAY GARDENS EXTENSION 25
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Consulting Civil, Structural, Process and Geotechnical Engineers

PERCUSSION DRILLING RECORD

BOREHOLE EMP 06

AIR LOSS	PENETRATION min/m	DEPTH (metres)
	0'22"	0 - 1
	0'25"	1 - 2
	0'32"	2 - 3
	1'30"	3 - 4
	0'56"	4 - 5
	0'43"	5 - 6
	1'12"	6 - 7
	1'20"	7 - 8
	1'43"	8 - 9
	0'41"	9 - 10
	1'07"	10 - 11
	1'09"	11 - 12
	2'18"	12 - 13
	2'17"	13 - 14
	1'20"	14 - 15
	1'25"	15 - 16
	1'22"	16 - 17
	1'15"	17 - 18
	1'20"	18 - 19
	1'12"	19 - 20

Depth	MATERIAL DESCRIPTION
0.0 - 1.0	Red brown topsoil.
1.0 - 3.0	Pale pink to red highly weathered fine/medium grained sandstone with ferricrete.
3.0 - 4.0	Yellow/red highly weathered very fine grained sandstone and clay.
4.0 - 5.0	Pale yellow highly-weathered very fine grained sandstone.
5.0 - 6.0	Pink medium to slightly weathered very fine/fine grained sandstone.
6.0 - 10.0	Yellow to whitish slightly weathered fine grained sandstone with some coarse grains.
10.0 - 19.0	Dark grey unweathered very fine grained hard rock carbonaceous shale with silty laminae.
19.0 - 20.0	Black coal with carbonaceous shale. #2 Seam and #1 seam with partings.

DRILLING RIG	: Air Percussion	DATE	: 1997-03-04	X CO-ORDINATE	: -16165.302
LOGGED BY	: S Tibenham	DATE	: 1997-03-04	Y CO-ORDINATE	: 2864049.931
DEPTH W/TABLE	:	AFTER	:	COLLAR ELEVATION	: 1522.509
CLIENT	: SA Coal Estates	JOB NO	: 3591	BIT DIAMETER / TYPE	: 165mm
PROJECT	: Schoongezicht #2Seam	SHEET NO	: 1 OF 2	COMPRESSOR CAPACITY	:

REF : dr359109

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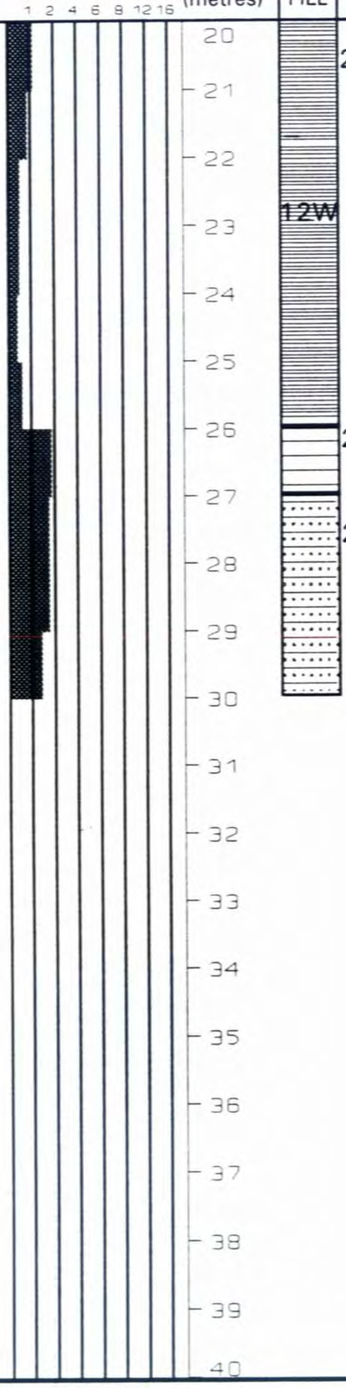
Consulting Civil, Structural, Process and Geotechnical Engineers

PERCUSSION DRILLING RECORD

BOREHOLE EMP 06

AIR LOSS	PENETRATION min/m	DEPTH (metres)	PROFILE	MATERIAL DESCRIPTION
	1'09"	20–21		20.0 - 26.0 Black coal with carbonaceous shale. #2 Seam and #1 seam with partings.
	0'54"	21–22		
	0'34"	22–23	12W	
	0'31"	23–24		
	0'27"	24–25		
	0'38"	25–26		
	1'55"	26–27		26.0 - 27.0 Mid-grey unweathered fine grained silty carbonaceous shale.
	1'48"	27–28		27.0 -0R Light grey unweathered fine to coarse grained poorly sorted sandstone. Dwyka.
	1'47"	28–29		
	1'28"	29–30		



End of hole at 30.0m.
No seepage encountered.
No sample taken.

DRILLING RIG :	Air Percussion	DATE :	1997-03-04	X CO-ORDINATE :	-16165.302
LOGGED BY :	S Tibenham	DATE :	1997-03-04	Y CO-ORDINATE :	2864049.931
DEPTH W/TABLE :		AFTER :		COLLAR ELEVATION :	1522.509
CLIENT :	SA Coal Estates	JOB NO :	3591	BIT DIAMETER / TYPE :	165mm
PROJECT :	Schoongezicht #2Seam	SHEET NO :	2 OF 2	COMPRESSOR CAPACITY :	

REF : dr359109

SOUTH AFRICAN COAL ESTATES - LANDAU COLLIERY

SURFACE AND GROUNDWATER ASPECTS OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE PROPOSED SCHOONGEZICHT #2 SEAM MINI PIT

APPENDIX B

Permeability Testing Results

PACKER TESTS CALCULATION SHEET COEFFICIENT OF PERMEABILITY		WATES MEIRING & BARNARD CONSULTING ENGINEERS			
Job No	3591-01	**Borehole No**	EMP 02	**Gauge Height(m)**	
Project	Schoongezicht #2 seam minipit	**BH Depth**	24.0	**Notes**	
Site		**Casing Depth**	13.0		
Done by	Terramonitoring	**Water table**	8.0		

Test Depth		Test length(m)	Pressure(bar)	Pressure(kPa)	Excess Head(m)	Flow Q(l/min)	Perm. K(m/s)
Top	Bottom						
16.0	19.2	3.2	1.10	110	19.2	1.25	3.77E-07
16.0	19.2	3.2	1.40	140	22.3	1.45	3.78E-07
16.0	19.2	3.2	1.85	185	26.9	2.25	4.86E-07
13.0	16.2	3.2	1.10	110	19.2	3.00	9.06E-07
14.0	17.2	3.2	1.05	105	18.7	0.15	4.65E-08
14.0	17.2	3.2	1.40	140	22.3	0.20	5.21E-08
14.0	17.2	3.2	1.90	190	27.4	0.25	5.30E-08

PACKER TESTS CALCULATION SHEET COEFFICIENT OF PERMEABILITY	WATES MEIRING & BARNARD CONSULTING ENGINEERS

Job No	3591-01	Borehole No	EMP 04	Gauge Height(m)	
Project	Schoongezicht #2 seam minipit	BH Depth	30.0	Notes	
Site		Casing Depth	4.0		
Done by	Terramonitoring	Water table	9.3		

Test Depth		Test length(m)	Pressure(bar)	Pressure(kPa)	Excess Head(m)	Flow Q(l/min)	Perm. K(m/s)
Top	Bottom						
22.0	25.2	3.2	1.25	125	22.0	1.50	3.95E-07
22.0	25.2	3.2	1.55	155	25.1	2.15	4.97E-07
22.0	25.2	3.2	2.00	200	29.7	2.75	5.37E-07
19.0	22.2	3.2	1.25	125	22.0	1.00	2.63E-07
19.0	22.2	3.2	1.50	150	24.6	1.25	2.95E-07
19.0	22.2	3.2	2.00	200	29.7	1.50	2.93E-07
14.0	17.2	3.2	1.25	125	22.0	1.00	2.63E-07
14.0	17.2	3.2	1.50	150	24.6	1.25	2.95E-07
14.0	17.2	3.2	2.00	200	29.7	1.50	2.93E-07
11.0	14.2	3.2	1.25	125	22.0	0.40	1.05E-07
11.0	14.2	3.2	1.55	155	25.1	0.50	1.16E-07
11.0	14.2	3.2	2.00	200	29.7	0.60	1.17E-07
8.0	11.2	3.2	1.25	125	21.4	No take	impervious
8.0	11.2	3.2	1.50	150	23.9	0.15	3.63E-08
8.0	11.2	3.2	2.00	200	29.0	0.20	4.00E-08

PACKER TESTS CALCULATION SHEET COEFFICIENT OF PERMEABILITY		WATES MEIRING & BARNARD CONSULTING ENGINEERS			
Job No	3591-01	**Borehole No**	EMP 05	**Gauge Height(m)**	
Project	Schoongezicht #2 seam minipit	**BH Depth**	26.0	**Notes**	
Site		**Casing Depth**	5.0		
Done by	Terramonitoring	**Water table**	15.7		

Test Depth		Test length(m)	Pressure(bar)	Pressure(kPa)	Excess Head(m)	Flow Q(l/min)	Perm. K(m/s)
Top	Bottom						
15.0	23.7	8.7	1.60	160	31.6	9.00	6.07E-07
16.6	19.8	3.2	1.90	190	35.0	2.50	4.14E-07
16.6	19.8	3.2	2.15	215	37.6	5.00	7.72E-07
16.6	19.8	3.2	2.45	245	40.7	7.50	1.07E-06
14.0	17.2	3.2	1.65	165	31.7	1.50	2.75E-07
14.0	17.2	3.2	1.95	195	34.7	2.50	4.18E-07
14.0	17.2	3.2	2.30	230	38.3	3.50	5.30E-07
10.0	13.2	3.2	1.35	135	25.4	1.25	2.86E-07
10.0	13.2	3.2	1.65	165	28.4	2.25	4.59E-07
10.0	13.2	3.2	2.05	205	32.5	4.00	7.14E-07
7.0	10.2	3.2	1.05	105	19.3	2.25	6.76E-07
7.0	10.2	3.2	1.35	135	22.4	3.50	9.08E-07
7.0	10.2	3.2	1.75	175	26.4	5.50	1.21E-06

PACKER TESTS CALCULATION SHEET COEFFICIENT OF PERMEABILITY	WATES MEIRING & BARNARD CONSULTING ENGINEERS

Job No	3591-01	Borehole No	EMP 06	Gauge Height(m)	
Project	Schoongezicht #2 seam minipit	BH Depth	30.0	Notes	
Site		Casing Depth	7.0		
Done by	Terramonitoring	Water table	6.8		

Test Depth		Test length(m)	Pressure(bar)	Pressure(kPa)	Excess Head(m)	Flow Q(l/min)	Perm. K(m/s)
Top	Bottom						
22.0	25.2	3.2	0.93	93	16.2	0.25	8.94E-08
22.0	25.2	3.2	1.23	123	19.3	0.35	1.05E-07
22.0	25.2	3.2	1.73	173	24.4	0.75	1.78E-07
19.0	22.2	3.2	0.98	98	16.7	No take	impervious
19.0	22.2	3.2	1.28	128	19.8	0.15	4.40E-08
19.0	22.2	3.2	1.73	173	24.4	0.25	5.95E-08
15.0	18.2	3.2	0.98	98	16.7	No take	impervious
15.0	18.2	3.2	1.28	128	19.8	No take	impervious
15.0	18.2	3.2	1.73	173	24.4	No take	impervious
15.0	18.2	3.2	2.23	223	29.5	No take	impervious
8.0	11.2	3.2	1.03	103	17.3	No take	impervious
8.0	11.2	3.2	1.28	128	19.8	No take	impervious
8.0	11.2	3.2	1.98	198	26.9	0.15	3.23E-08

SUPPLEMENTARY REPORT NO. 5

SCHOONGEZICHT 2 SEAM MINI-PIT: AIR QUALITY ASPECTS OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME

PREPARED FOR

A MCCLOUD
LANDAU COLLIERY, WITBANK

PREPARED BY

HJ ANNEGARN
AER (PTY) LTD
REVISION 1 : 30 JUNE 1997

EXECUTIVE SUMMARY

An survey has been made of atmospheric dust impacts likely to arise from the proposed Schoongezicht 2 Seam Mini-pit surface coal mine. The assessment has been made in line with the recommendations of the Department of Mines and Energy "Aide Memoir on Environmental Management Planning Reports". Sensitive sites that have been identified are:

- An established residential township, Schoongezicht, east (500 m at the closest mining point) of the mini-pit, which may exposed to SERIOUS and PERSISTENT dust nuisances;
- Lynnville township, which may be exposed to MODERATE dust nuisances also on a persistent basis; and
- N4 Highway, which may be exposed to visibility impairment from blasting dust.

A programme of mitigation measures and dust monitoring steps is proposed which, if implemented, will allow mining of the mini-pit to proceed with dust impacts on surrounding sensitive areas reduced to levels within the Department of Environmental Affairs Air Quality Guidelines. The measures recommended include:

- Standard engineering practice for dust suppression on haul roads, material handling and coal crushing, unless additional measures are specified;
- Continuous rehabilitation of back-filled areas, or temporary stabilisation;
- Blasting to take place only when wind direction is not towards sensitive zones;
- Chemical road dust suppressants be evaluated and used for continued implementation, if dust observations and monitoring warrant it;
- Implement visual dust monitoring, recorded weekly in a bound register;
- Fallout dust monitoring network be established, incorporating two wind directional and five single bucket samplers;
- A continuous recording suspended dust monitor be investigated to supplement fallout dust monitoring and visual recordings;
- Communications channel with surrounding communities, regarding environmental matters, be maintained and strengthened.

The structure of the report follows the relevant sections required for the EMPR format.

INTRODUCTION

This report contains as assessment of the potential atmospheric impacts of the proposed Schoongezicht 2 Seam Mini-pit opencast coal mine, and recommendations for the mitigation and management of adverse impacts.

The Schoongezicht 2 Seam Mini-pit operation will comprise a single opencast mini-pit, the South Pit, as shown in Figure 1. The location of the Schoongezicht Mini-pit is to the south of the N4 Highway. and approximately 1 km south of Lynnville, a residential suburb of Witbank. New surface structures will comprise only a primary crusher. Material will be removed from site by truck, using, in part, public roads. There will be no material or waste stockpiles on site. Coal will be processed and stockpiled at existing facilities at the Navigation Surface Complex, and fall outside the scope of this report. The current investigation is concerned exclusively with the Schoongezicht 2 Seam Mini-pit mining operation, and on-site material processing and handling, and product haulage from site to Navigation.

Further details of locality, operations etc. will be compiled for other sections of the EMPR and are not repeated in this report.

Assessment of the potential air quality impacts of the proposed Schoongezicht 2 Seam Mini-pit extension of Landau Colliery was made on the basis of an on site inspection in March 1997. Site and location maps were supplied by Landau Colliery.

The structure of this report follows the relevant sections of the Aide Memoir on Environmental Management Programme Reports (EMPR) (Department of Mines and Works, 1992). For ease of cross reference, numbering of the sections in this report follows that of the Aide Memoir. In Section 6, which is the legally binding section of the Environmental Management Programme, certain actions are listed which, if accepted, will form the basis of a dust emissions control programme for Schoongezicht. The actions are listed in general terms - specific details of how the actions are to be implemented will follow in more detailed reports and need not be included in the EMPR.

PART 2 DESCRIPTION OF THE PRE-MINING ENVIRONMENT

2.2 Climate

2.2.1 Regional climate

For the purposes of air quality assessment, the directly relevant aspects of weather and climate are wind speed and direction frequencies, and frequency of extreme events. The proximity of the Mini-pit to existing residential areas may allow even moderate dust emissions to assume nuisance proportions. Mitigation of blasting effects, from dust and noxious fumes, requires that blasting should not take place when the wind is blowing towards directions of concern.

2.2.5 Wind direction and speed frequencies

Frequencies of wind directions are summarised on a monthly and annual basis in sixteen equally spaced sectors (Table 1). Wind frequencies are summed over all wind speeds, since generation of dust by mechanical disturbances (vehicle movements, material handling) and blasting is independent of wind speed. If there were stock piles, or extensive erodable areas, then wind speed would have been relevant.

For direct use in mine planning, wind frequencies have also been summed over the sectors encompassing (a) Schoongezicht Township; and (b) Lynnville, which lie within the dust-sensitive 3 km zone around the Mini-pit (Table 1). These sensitive areas lie in wind-direction sectors between SSE and NW from the Mini-pit (Figure 1). The inclusive sectors over which the winds are summed are defined in a footnote to Table 1.

Wind data presented in Table 1 are for the year 1993, from a site in the Witbank region. The data were monitored by Eskom TRI* at 10 m above ground using a standard meteorological mast. Data were recorded as hourly averages. The overall data availability is 87% for the year. No data are available for April (0%). For November, data recovery was 64%, and for May, 85%. For all other months data availability was greater than 95%.

Implications of winds towards the sensitive sectors are discussed in later sections.

2.2.7 Incidence of extreme weather conditions - frost, hail, drought, high winds.

Extreme weather conditions are not considered relevant to the proposed Mini-pit. The extent of exposed material and spoil pile will be small in relation to other operations in the region. Extreme high winds, associated with thunder storm down drafts or with frontal weather, result in dust storms on the scale of kilometers. Wind blown dust from the Mini-pit operations will contribute, but in proportion to the exposed area this is not significant on a regional or local scale.

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* Eskom TRI wind data used with permission.

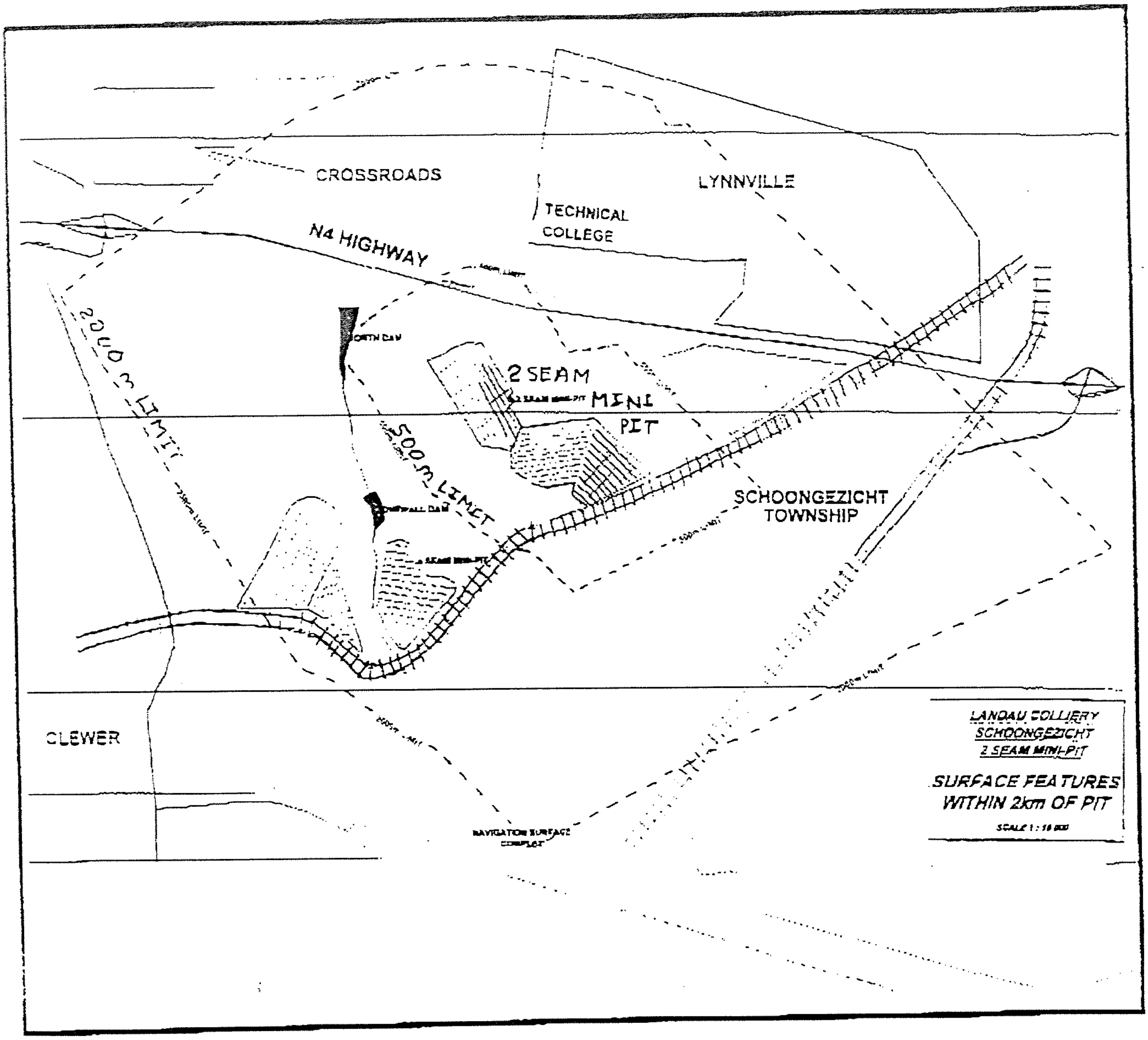

Figure 1. Surface features of the Schoongezicht 2 Seam Mini-pit, showing the 500 m and 2,000 m contours from the edge of the pit, and potentially dust sensitive zones.

TABLE 1. Mpumalanga Highveld wind frequencies by month and direction, and by sensitive sector and month. Sensitive sectors, defined in the footnote, are wind directions towards Schoongezicht and Lynnville townships.

	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AVAIL (%)	87.0%	99.9%	100.0%	95.3%	-	85.1%	100.0%	99.9%	99.9%	100.0%	100.0%	63.2%	100.0%
N	9.5%	7.5%	3.6%	5.9%	-	8.5%	9.4%	8.2%	14.7%	9.6%	9.0%	15.2%	13.8%
NNE	6.7%	6.1%	2.5%	4.8%	-	5.2%	5.8%	4.3%	8.3%	10.1%	7.7%	8.8%	10.1%
NE	5.9%	7.7%	3.1%	3.4%	-	8.2%	5.6%	4.4%	5.2%	7.1%	7.8%	5.3%	7.1%
ENE	5.4%	5.5%	4.9%	4.1%	-	4.6%	3.2%	3.8%	6.2%	7.6%	6.6%	4.4%	7.9%
E	7.4%	9.3%	9.2%	7.2%	-	3.8%	3.8%	5.8%	9.4%	7.6%	8.2%	7.7%	8.7%
ESE	16.8%	20.9%	30.8%	24.4%	-	10.9%	13.2%	16.4%	16.2%	11.3%	11.6%	21.1%	9.9%
SE	13.3%	14.1%	14.7%	14.1%	-	11.7%	13.3%	22.1%	12.4%	10.6%	9.1%	14.1%	9.8%
SSE	3.3%	4.4%	3.3%	6.1%	-	3.0%	2.1%	4.0%	3.5%	2.5%	3.5%	1.3%	2.0%
S	2.5%	3.1%	2.5%	2.8%	-	2.4%	4.9%	1.7%	1.7%	1.5%	3.2%	0.4%	2.4%
SSW	2.6%	2.2%	2.8%	2.7%	-	4.1%	4.0%	2.8%	1.3%	1.9%	3.8%	0.7%	1.9%
SW	2.7%	1.1%	2.7%	1.7%	-	6.2%	6.5%	2.0%	1.7%	1.5%	3.1%	1.3%	1.9%
WSW	3.1%	1.5%	4.3%	1.6%	-	3.8%	5.7%	3.2%	2.4%	3.8%	3.1%	1.5%	3.0%
W	3.8%	2.7%	5.1%	4.5%	-	6.5%	4.9%	3.1%	2.3%	3.2%	4.7%	3.7%	2.8%
WNW	5.0%	3.9%	3.9%	6.6%	-	6.2%	5.3%	4.8%	2.7%	7.2%	5.5%	5.9%	5.2%
NW	6.0%	4.7%	2.7%	4.7%	-	7.6%	6.1%	7.8%	4.7%	6.5%	8.1%	8.6%	7.4%
NNW	6.1%	5.4%	3.9%	5.5%	-	7.4%	6.3%	5.4%	7.1%	7.9%	5.1%	0.0%	5.9%
Sector ST	**23%**	**16%**	**21%**	**22%**		**34%**	**33%**	**24%**	**15%**	**24%**	**28%**	**22%**	**22%**
Sector LV	**18%**	**15%**	**21%**	**19%**		**26%**	**28%**	**17%**	**13%**	**14%**	**21%**	**9%**	**14%**

Schoongezicht Township = ST
Sector ST: SSW to NW inclusive

Lynnville Township and N4 Highway = LV
Sector LV: SSE to W inclusive.

2.11 Air quality

Existing air quality

The Witbank/Middleburg area of the Mpumalanga Highveld is a region of major coal mining, heavy metallurgical industries and power generation. The emissions from these activities, aggravated by unfavourable climatic dispersion, has resulted in poor air quality over the whole region. This is manifested specifically in high particle concentrations and poor visibility. Locally there may be high concentrations of SO_2 gas, from burning coal discards, although this situation has improved dramatically in recent years. Emissions from domestic coal burning may result in localised areas of very poor visibility (<20 m) during early mornings and evenings, and high particle exposures of the residents.

Contributions of wind blown, mechanically generated and detonation dust have not been quantified on a regional basis. Localised visual observations have recorded heavy emissions of dust from coal stockpiles, spoil piles, ash dams and, seasonally, from ploughed agricultural land. Continuous operations, like draglining and movement of mine haul trucks on unpaved roads, have been identified as significant generators of crustal dust. Intermittent overburden and coal blasting generate plumes which are highly visible, but of short duration. Quantitatively, the amount of dust contributed by blasting is small compared to potential dust emissions from other continuous mining activities. Collectively, these sources are classified as fugitive sources of dispersed dust.

The size distribution of particles in fugitive dispersed dust is continuous, with a mean size dependent on the generating process and the time since material became airborne. Once airborne, larger particles (sand and grit >200 μm diameter) will settle out very rapidly, except in extremely turbulent wind. During blasting, particles of this size may considered part of the flyrock, and protection is provided against impacts by regulations concerning blasting safety.

Settleable particles, in the range $30 < d < 200$ μm, separate from the air stream fairly rapidly under gravity, and can generate have measurable dust deposition rates up to ~2 km from source, depending on wind speed and height of ejection. This component of the dust size spectrum is the most likely to cause short term nuisance in the form of soiling, mechanical damage, or physical irritation of eyes and respiratory tracts.

Suspended particles, with $d < 30$ μm, are likely to be transported many kilometers, and have mean atmospheric residence times of minutes to hours. Particles at the lower end of this size fraction can be inhaled, and are of concern form a respiratory health viewpoint. The lower end of this size range can be taken for practical purposes as $d \sim 1$ μm.

Historically, the Witbank district was predominantly a maize cultivation area. Soil cultivation itself has led to large exposed areas of soil on a seasonal basis, and both ploughing and harvesting, and burning of agricultural residues, are dust and fume producing activities.

The expansion of surface mining operations in the Mpumalanga Highveld over the two past decades have added considerable additional sources of fugitive dispersed dust: new areas of exposed material; additional dragline, front-end loader and scraper material handling; and haul truck vehicle traffic on unpaved roads. These activities contribute to near-surface deterioration of air quality.

However, several years of experience in monitoring fallout dust on coal mines on the Mpumalanga have shown that measurable fallout from surface mining operations is restricted to a 1 km zone from source, provided standard engineering practices are followed for dust mitigation. The sources most likely to result in heavy dustfall rates are* :

- Haul truck operations on unpaved roads on surface (i.e. outside the pit confines)
- Untreated or unrehabilitated coal discards - wind erosion and truck operations
- Unshielded continuous conveyor transfer points.

For practical purposes then, evaluation of impacts of dust from surface mining may be focused on zones within 1 km of the mine boundaries, and corridors of 500 m to 1 km on either side of public roads used by mine haul trucks. (The broader provision of the EMPR guidelines for a 3 km zone for fallout dust, is more relevant to gold mine slime tailings which are elevated up to 50 m above the surrounding topography.)

The continuous size range of dispersed dust at the point of emission has relevance to monitoring and control. If fallout dust is monitored and controlled, then simultaneously suspended dust be mitigated. Except in the case of severe dust emissions, in urban residential environments, or for very extensive operations, it is not necessary to monitor separately the suspended dust fraction.

Potential impact sites external to mine

The plan for the Schoongezicht Mini-pit specifies a truck and shovel operation in a open cast mini-pit. Run of mine coal will be delivered to an on-site primary crusher. The location of this crusher is such that it will be almost totally shielded on the northern and north eastern aspects by an existing earth embankment. This arrangement will assist in shielding visual, noise and dust impacts of the crusher.

Coal from the crusher will be conveyed to the Navigation Surface Complex by haul trucks, traveling partly on unpaved mine-owned roads, and partly on public roads.

Information on the surroundings of the Schoongezicht colliery were determined on the basis of a visual inspection. The surroundings of the 2 Seam Mini-pit, the 500 m and the 2,000 m zones are indicated on the map in Figure 1. Land use activities in the 3 km zone around the proposed Schoongezicht Mini-pit, with identification of dust sensitive receptors, is presented in Table 2.

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* Dustfall rates, expressed as (mg/m^2/day), averaged over 30 days, are classified by the Department of Environment Affairs into four categories: SLIGHT (D < 250 mg/m^2/day); MODERATE (250 < D < 600); HEAVY (600 < D < 1,200); and VERY HEAVY (D > 1,200)

Table 2. Land use activities surrounding the proposed Schoongezicht 2 Seam Mini-pit.

DIRECTION	CLOSEST DISTANCE	ACTIVITY	ACCESS/ OWNERS	POTENTIAL IMPACTS
NW, N, NE	300 m	N4 highway	Public	Serious: Short duration visibility impairment
NNW, N, NNE, NE, ENE	800 m	Lynnville residential township; Technical college	Public	Moderate; persistent ; 18% ann. frequency
NNE, NE, ENE, E	500 m	Schoongezicht residential township	Public	Serious: Persistent 23% ann. frequency
E to S	100 m	Railway line	Industrial	Negligible
E to SSW	200 m	Derelict mine	Private	Negligible
S to NNW	200 m	Schoongezicht surface mine	Landau	Negligible
NW	2 km	Crossroads township	Public	Negligible

Potential impact sites internal to mine

Schoongezicht 2 Seam Mini-pit comprises only mine working areas. There are no areas of public access within the boundaries of the proposed operation, hence there are no applicable EMPR requirements internal to the mine boundaries with respect to air quality. Workers on site will be protected to normal industrial hygiene management provisions applicable to mines and works.

PART 5 ENVIRONMENTAL IMPACT ASSESSMENT

5.1 CONSTRUCTION PHASE

The nature of the Schoongezicht 2 Seam Mini-pit operation is such that for practical purposes construction and operation are identical. The major activity during construction will the creation of the initial boxcut. Refer to sections on the operational phase.

5.2 OPERATIONAL PHASE

Gaseous pollutants

No gaseous emissions will result from routine operations in the Mini-pit, other than diesel exhaust fumes from heavy vehicles. Standard mining practice applied in the construction and maintenance of stockpiles and waste dumps will prevent spontaneous combustion. No specific further measures are necessary in this regard.

Sources of dust and particle pollution

Sources of dust on the mini-pit will arise from the following activities:

- overburden scraping, loading, dumping and leveling
- drilling
- blasting
- muck pile scraping and loading
- haul truck travel on unpaved haulways
- haul truck unloading
- primary crushing.

Impact of fallout and suspended dust

There are residential and public access areas close to the mine boundaries which might involve public exposure to high levels of airborne particles, and to dust fallout, in terms of the DEAT guideline values.

Within the 3 km radius of the mine boundaries, receptor sites sensitive to suspended and fallout dust have been identified (see Tables 2) as

Schoongezicht residential township	500 m to north east;
Lynnville residential township	800 m to north and north east; and
N4 Highway	300 m at nearest point.

The proximity of the Schoongezicht residential township (500 m) to the Mini-Pit make the probability of adverse fallout and suspended dust HIGH, and the nature of the impact SEVERE. On an annual basis, the wind will blow towards the township for 23% of the time, with modest seasonal variation. The months with highest frequency of winds across the mine towards Schoongezicht township are May and June (34 and 33%), and the lowest January (16%) and August (15%).

The magnitude of the dust impacts is regarded as SERIOUS, as even with mitigation due to standard engineering practice, there will be a serious loss of amenity due to dustfall and suspended dust. With a continuous generation of dust from haul truck activity, and a drift of the dust cloud towards the township for 23% annual frequency, increased dustiness could become a pervasive impact. Intermittent nuisance would occur if blasting were to take place when the wind was blowing towards the township. The situation is aggravated by the specific topographical features: the township is on the opposite side of a shallow valley from the Mini-pit, hence dust clouds generated in the pit may be carried across the valley and wash across the township on the opposite hillside. In the absence of any mitigation, levels of respirable dust could approach DEAT guideline values.

The overall assessment of the dust impacts is that the Schoongezicht township is in one of the most vulnerable positions so far encountered in South Africa ,with respect to dust impacts from surface coal mining. Extraordinary measures will have to be taken to mitigate these potential impacts so that the residents can continue to enjoy their current health and amenity.

The nearest residential point of Lynnville township is 800 m from the Mini-pit, with slightly lower frequency of winds in that sector (18% annually). The greater distance already has a mitigatory effect so that dust impacts are likely to be MODERATE to MINOR. Any steps taken to mitigate dust impacts on Schoongezicht township will benefit also Lynnville, so discussion of control measures for both receptors can be considered together.

Visibility

The N4 Highway is close enough to the Mini-Pit that SERIOUS driving visibility could occur if the wind was blowing towards the road at the time of blasting under stable atmospheric conditions. The probability of winds towards the road is MODERATE (~20% annual, taken as same sectors as Lynnville). The duration is short (2-3 minutes) per event. The road has a moderate traffic density during daylight hours, so that there is a HIGH probability of visibility impairment to drivers when the wind is towards the road under stable or neutral atmospheric conditions.

Impact of contributions to regional suspended dust

Activities at the Mini-pit will add a small contribution to the regional suspended particle burden of the atmosphere. The small scale of the operation will make this INSIGNIFICANT on a regional scale.

PART 6 ENVIRONMENTAL MANAGEMENT PROGRAMME

6.1 Construction phase

For the purposes of environmental management, the nature of construction and operation of the Schoongezicht 2 Seam Mini-pit are similar with respect to atmospheric dust impacts. For the construction phase, the provisions of detailed in Section 6.2 will apply.

6.2 Operational phase

Gaseous pollutants

The separation of 500 m from the nearest haul road to the residents is regarded as more than adequate to allow for the dispersion of diesel fumes from haul trucks under all atmospheric conditions.

No specific further measures are deemed necessary for the control gaseous emissions.

Dust pollutants

Control of dust from Schoongezicht Mini-pit will be based on three aims:

- to minimize emission of settleable dust which will adversely impact on the Schoongezicht and Lynnville townships;
- to minimise emissions of suspended dust which may reach Schoongezicht during westerly winds; and
- to completely prevent visibility impairment on the N4 Highway.

The air pollution control plan for the mine will consist of the following steps:

a) Compilation of a qualitative inventory of all dust sources on the mine, including drilling, blasting, overburden handling, dust generated by vehicle movements, material handling and transport, wind blown dust from stockpiles, and coal processing. The relative importance of the various sources is available from quantitative emission estimates from a sister mine (New Vaal Colliery, 1997).
TIME SCALE: Planning phase.

b) Documentation of all measures for control of air pollution emissions, and estimates of their efficiency.
TIME SCALE: Planning phase; updated as required

c) Planning and implementation of measures to minimise dust emissions and impacts from blasting, and to minimise dust emissions from haul roads.
TIME SCALE: Planning phase; continuous during life of mine.

e) Implementation of a **fallout dust monitoring system**, for control and audit purposes, to demonstrate that applied dust mitigation measures are effective.
TIME SCALE: Continuous during life of mine. Review after first three and six months, and thereafter annually.

f) Implementation of a visual recording system, primarily as a day to day management tool, and to identify problem areas of high dust generation. This recording system should include a "Complaints Register" in the form of a bound book, to record all incoming complaints, written or verbal, from the public.
TIME SCALE: Continuous during life of mine. Review after first three and six months, and thereafter annually.

g) It is not considered necessary to perform dispersion model calculations for this site.

h) Investigation of installation of a continuously recording suspended dust monitor.

i) As a contingency plan, if visual observations or other circumstances indicate that adjacent residential areas are being exposed to high levels of suspended dust, a programme of suspended dust monitoring will be implemented, using standard environmental suspended dust monitors. Results will be assessed against the Department of Environment and Tourism guideline values.
TIME SCALE: Contingency.

Specific provisions of mitigation and monitoring

Suppression of fugitive dust

It is recommended that standard engineering practice for dust suppression be implemented on haul roads, overburden and coal handling, and confinement of dust at conveyor loading, transfer and discharge points, and confinement of dust from the primary crusher plant. Further specific additional or alternative recommendations necessary in view of the particular circumstance of the Schoongezicht 2 Seam Mini-pit are presented below.

Control of blasting dust and fumes

The proximity of the N4 Highway makes it vulnerable to visibility impairment from blasting plumes. All BATNEEC technology should be used to reduce dust emissions from blasting, and proper use these should be written into the operational guidelines for the pit manager. Measures include use of Nonel downlines through the collar stemming material; use of suitable grade of stemming material; emulsion or equivalent explosive; correct blast geometry/chrage to minimise air blast.

Specifically, the following direct measures should be made part of the dust mitigation written procedures:

- Blasts covered with excessive dust and other fines, particularly coal blasts, will require watering prior to shooting;
- Do not blast when the prevailing wind is blowing towards the direction of concern.

To assist operation personal in assessing the wind direction, we recommend the erection of a standard aeronautical type wind sock on the edge of the Mini-pit. A simple mechanical device attached to the sock, could indicate when the wind was in a sensitive sector (red-green indicator). The sensitive areas include Schoongezicht township and the N4 Highway.

As the frequency of winds towards the directions of concern sectors is relatively high (30% combined annual frequency - see Table 1), it will be necessary to observe and record the interaction of wind, atmospheric stability and blasting dust very carefully, otherwise routine blasting schedules and mine production could be severely inconvenienced. Especially during the first phase of mining, a case record should be built up to guide operational personal on when blasting is permitted, and when it should be postponed. Analysis of the continuously recording suspended dust monitor, if installed, will assist considerably in this decision making, as it would reduce the scope for subjective judgment, and replace it with quantitative assessments of the impacts of each specific event.

Fallout dust monitoring network

We recommend that a network of dust fallout samplers be installed, to collect month-long fallout samples. The network should consist of five single bucket samplers and two wind directional sampler.

The wind directional samplers should be placed at the south eastern end of Schoongezicht township, and at the Technical college, on the western end of Lynnville. The single bucket samplers should be placed at locations chosen during a site inspection, to monitor specifically dustfall rates in the residential townships.

Road dust suppressants

On a quantitative basis, the largest potential dust source in surface coal mining is from road dust generated by haul trucks. We strongly recommend that provision be made in mine operational and financial planning for the use of chemical dust suppressants on the main haul roads, areas surrounding the crusher, and all unpaved roads leaving the site that are used by the haul trucks. Recent studies have shown that such measures and not necessarily more expensive than dust suppression by road wetting with water [Decosta, 1997]*.

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* F A Decosta, Emission Inventory and Economic Evaluation of Dust Control on an Open Cast Coal Mine. MSc Dissertation, University of the Witwatersrand, 1997.

Specific attention should be paid to junctions linking unpaved roads, used by mine vehicles, to paved public roads. "Track out" dust and spillage onto the paved surface can act as a major secondary source of dust. Paving of such junctions for a distance of 30 to 50 meters back from the main road is recommended.

The written record of visual dust observations and dust monitoring results obtained during initial months of mining should be used as a guide on the extent to which use of chemical dust suppression is necessary as part of the life of mine environmental control programme.

In selecting dust suppressants, we advise strongly against the use of agents based on hygroscopic salts. The climatic conditions on the Highveld are outside the range necessary for the effective use of these agents. Instead, there are several resin or ligno-sulphonate based products from a range of vendors, which have had positive reports.

Visual observation records

We recommend that a system of visual observations of dust emission be implemented, primarily as an aid to day to day management decision making. The record can be kept informally, in the form of a bound, hard cover book, with entries recorded diary style. To establish the pattern, entries should be made at least weekly, by a senior official permanently stationed on the site (e.g. pit supervisor). The record should be tabled and initialed at all routine environmental meetings, as a way of motivating the upkeep of the record, and to ensure that dust "hot spots" identified in the record are attended to by the appropriate engineering sections.

Public communication and sampler security

We recommend that the communication programme between mine management inhabitants of the townships, already in place (March 1997) be kept operative. Specifically, for Schoongezicht township residents, the nature of the possible dust nuisance, the mitigation measures, the monitoring network operation and purpose should all be explained. The channels for expressing concerns, including the Complaints Register, should be made known. Means should be established for environmental monitoring results to be made available to the community.

Involvement of the community in this manner will at the minimum ensure the physical security of the monitoring equipment, as the community will understand that it is there for their protection.

These recommendations for a more pro-active community involvement are based on a number of considerations. Residents of the two townships are not necessarily mine employees, and so will not have the tendency of mine employees and their families to more readily accept some of the adverse aspects associated with living near mining operations. Controversies surrounding surface mining developments, specifically in the Sasolburg region, have heightened public awareness and political sensitivities. It would be prudent not to pay less attention to an lower economic township than would be paid to an upper class community. For Schoongezicht, residents will be rather closer to the pit than is the case in most other surface operations, and with no natural land form or vegetative screening. The historical approach of waiting for complaints before engaging the community may be counter productive in this case.

Rehabilitation of exposed areas

It is assumed that back filled area will be leveled, contoured and vegetated on an ongoing basis, appropriate to the mine design.

Where spoil areas are to be left fallow for extended periods (specifically for duration of August to October windy season), ridge plowing or chemical stabilisation should be applied as needed. Need will be determined on the basis of the visual observation records maintained by the mine environmental manager, or the pit supervisor.

Maintenance and rehabilitation of residue deposits

As there will be no stockpiles or residue deposits on the Schoongezicht site, this provision does not apply.

6.3 Rehabilitation and closure

Final rehabilitation will be dealt with as follows.

Product Stockpiles

There will not be any major stockpiles at the mini-pit. Any minor residue piles will be removed prior to mine shutdown. Pre-existing smouldering waste coal piles will be reclaimed in the course of the overall operation, resulting in a positive air quality benefit by removing an existing pollution source.

Pit Surface Rehabilitation

All spoil heaps will be leveled and contoured to shapes appropriate to the surrounding land forms. Saved topsoil will be used to cover the surface and vegetation will be reestablished in line with current standard practice. There will be no residual exposed soil areas which will be subject wind erosion. Surface contours and vegetation will ensure that water erosion will not lead to secondary exposure of bare soil areas.

Where appropriate, rehabilitation will commence during mine operation to minimise exposed surface areas subject to wind erosion. If such exposed areas and spoil piles are observed to be a adverse dust source for extended periods prior to final rehabilitation, then interim mitigatory measures will be taken to stabilise such surfaces.

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SUPPLEMENTARY REPORT NO. 6

THE SCHOONGEZICHT MINI-PIT

(BLASTING WITHIN 500m OF SURFACE STRUCTURES)

PREPARED FOR

ANGLO AMERICAN CORPORATION
OF SOUTH AFRICA LIMITED

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THE SCHOONGEZICHT OPENCAST MINI-PIT

(Blasting Within 500 m Of Surface Structures)

EXECUTIVE SUMMARY

1. The location of the proposed Schoongezicht Opencast Mini-Pit near Witbank is presented. The planned mining sequence is outlined. Geological data including the overburden and coal thicknesses, typical stratigraphy, and the mine cross sections, are also described. Details of the major structures and other objects within 500 m of the proposed pit are identified.

2. The question of whether blasts should consist of just a single hole, or delayed multiple holes, is addressed. It is shown that what is important is not whether one hole or many holes are shot at any one time, but rather that the resulting level of generated blast vibrations at any point of concern be limited to a level which will not cause any damage. The recommended blast design procedure successfully caters for total building damage control, regardless of the number of blastholes used in the shot.

3. It is recommended that the design blast vibration limit be a peak particle velocity value of 5 mm/s for the design of blasts, with a measured value of 8 mm/s being acceptable with respect to the nearby township and village. A comparable limit of 100 mm/s is recommended for the design of blasts with respect to the prevention of structural or other damage remote from the general public such as for the prevention of damage to the surrounding power lines. Finally a limit of 50 mm/s is recommended for the design of blasts with respect to the four steel pipelines.

4. It is estimated that single hole initiation will meet the recommended peak particle velocity restrictions to prevent damage and adverse human response to the blast vibrations. This is based on the distances involved; the recommended blasthole size of 165 mm diameter for much of the overburden (although the 102 mm hole will be necessary for use in some areas) and 102 mm for coal; the overburden and coal thicknesses; the Iso-Seismic Survey results and the resulting maximum explosives weight per delay.

5. It should be noted that the recommendations in Point 4 with regard to blasthole size are based on blast vibration. Air blast concerns may also limit the use of the 165 mm holes in some areas, depending on the choice of mining method, where collars cannot be sufficiently controlled. Again the required change will be to the 102 mm hole if it is found necessary for air blast control given the collar lengths desired for good fragmentation.

6. A final recommendation as regards choice of blasthole size relates more to political concerns. The Iso-Seismic Survey demonstrates that the use of the 165 mm hole size will present no vibration problems for the majority of the mini-pit. But the fact is that the pit will be restarting after a long dormant period and it will be under close scrutiny. The final recommendation is therefore to consider starting up operations for the first blasts with the 102 mm hole size, even though the 165 mm hole is expected to prove acceptable, until the neigbouring residents become used to blasting again. This is because blasting in an economic manner will be discernable to some degree regardless of the techniques employed.

7. Recommended blast tie-ins for both the boxpit and strip cuts are presented, these being suitable for all blasts, whether the overburden and coal are blasted together or separately. It is further recommended that surface initiation be performed using all Nonel cord. Nonel downlines are also recommended. Nonel conveniently allows in-hole delays assisting vibration control, as well as helping to control noise and dust.

8. It is recommended that all blasts be monitored for blast vibration as well as air blast. Recommended permanent monitor locations are as follows:

(i) At a secure position at one of the residences closest to the mini-pit in the Schoongezicht Township;

(ii) At a residence in Clewer, preferably on the mini-pit side of the village.

The planned mining sequence is outlined. The plan indicates that mining commences at the nearest point to Schoongezicht and Lynneville and works towards Clewer. The proposed permanent monitoring point data recorded for all blasts will continually provide further confirmation of the original blast designs which will, in turn, be based on the results from the Iso-Seismic Survey. At the same time, should unforeseen problems arise, the permanent monitoring stations will provide early warning of any changes, and will allow prompt blast design modifications to be made where necessary.

9. It is recommended that the air blast peak pressure limit resulting from blasting operations be maintained below 120 dB. All blasts should be measured for air blast at the same locations as are proposed for blast vibration monitoring points. Recommendations for the control of air blast include:

(i) Use Nonel initiation for both surface and in-hole blast initiation;

(ii) Cover Nonel detonators with at least 150 mm of drill cuttings;

(iii) Employ suitable stemming material for all blastholes of either sand or material of slightly larger sizing;

(iv) Prevent overdigging of the front row blastholes;

(v) Follow the recommendations, as outlined, relative to blast delaying practices and the firing of more than one blast at a time;

(vi) Do not blast under heavy overcast conditions, when there is the likelihood of temperature inversions, or when the wind is blowing in the direction of concern.

10. Control of flyrock is discussed. The recommendation is to use a collar of no less than 2,6 m for emulsion explosive, and a 2,5 m collar for AN/FO, when blasting using the 102 mm diameter blastholes. The corresponding collars for the 165 mm diameter blastholes are recommended to be 4,0 m for emulsion and 3,75 m for AN/FO. It is shown how shorter collars may be employed in blastholes if the explosives column is less than eight times the charge diameter in length. Finally, special precautions which should be taken when shooting blasts are stressed.

11. The report concludes with recommendations with respect to the control of blast dust and noxious fumes along with safety precautions to be followed when blasting near high voltage power lines.

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THE SCHOONGEZICHT OPENCAST MINI-PIT

1.0 INTRODUCTION

At the request of Mr. Mike Brett, Consulting Mining Engineer, this study presents recommended drilling and blasting procedures for blasting at the Schoongezicht Mini-Pit. The proposed pit is designed to mine the balance of the economic coal in the Schoongezicht area which has not already been mined. It is located south of the Witbank-Pretoria N4 Highway near the Schoongezicht Township, across the highway from Lynneville Village and adjacent to a railway line just to the southwest of Witbank. Portions of the road and railway line fall within 500 m of the proposed mini-pit location.

Figure 1 is a plan of the Schoongezicht Mini-Pit showing the effected area and the relevant surface structures close to the proposed pit boundary. Drilling and blasting recommendations will be presented for the mini-pit such that the operation can be carried out in a safe manner.

This study has been conducted to meet the requirements of Mines and Works Regulation 9.33.5: Permission to Blast More than One Shot Hole Within 500 m of Surface Objects: and the Explosives Act and Regulations, (Act 26 of 1956) Chapter 10, Paragraph 17.1.

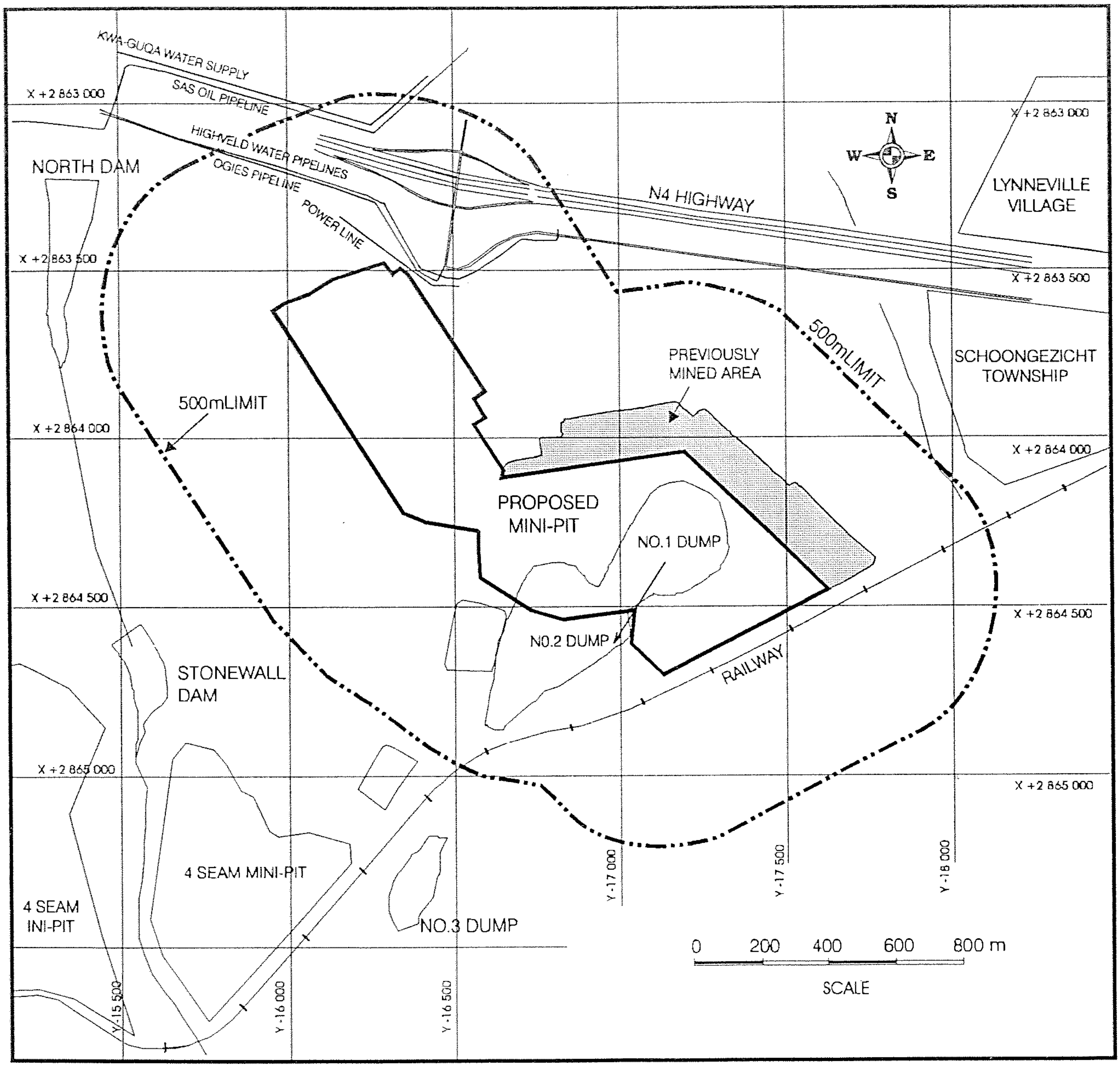

FIGURE 1: PLAN VIEW OF THE PROPOSED SCHOONGEZICHT MINI-PIT SHOWING THE SURROUNDING AREA ENCLOSED BY THE 500 m LIMIT AND THE EFFECTED SURFACE STRUCTURES.

2.0 MINE LAYOUT AND GEOLOGICAL DATA

Figure 2 shows the planned mining sequence for the pit. The mine abuts a previously mined area on the east side of the property while a boxpit is required to extend the cuts towards the west. The mine will be worked from the north towards the south.

Figure 3 shows that the overburden varies in thickness from approximately 8 m deep to a little more than 20 m in some places although 24 m appears to be reached at one point. The overburden is generally shallowest to the north, down to only 4 m in the extreme, and increases in depth towards the south. The most southerly point of the mine has the deepest cover.

The areas of most concern relative to blast vibration are along the north and northeast sides of the property where the overburden is shallowest, and to a lesser extent, along the southeast side adjacent to the railway where the overburden depth does reach 24 m.

The depth of weathering varies from a few metres down to as deep as 15 m in one location, see *Figure 4*. But while the weathering is relatively deep, not all of the near ground surface material is thought to be softs. Much of the material will require blasting to some extent, and some of the rocks near the surface appear to show considerable strength. Typically the entire mining area is covered with weathered sandstone near the top of the overburden sequence, followed by siltstone and shale above 2 Upper Seam.

The coal consists of a 2 Upper Seam and a 2 Select Seam split by a shale parting which overlays a sandstone (sometimes grit/siltstone) parting above 1 Seam. *Figure 5* presents the overall mining depth contours from the original topographic level to the floor of 1 Seam.

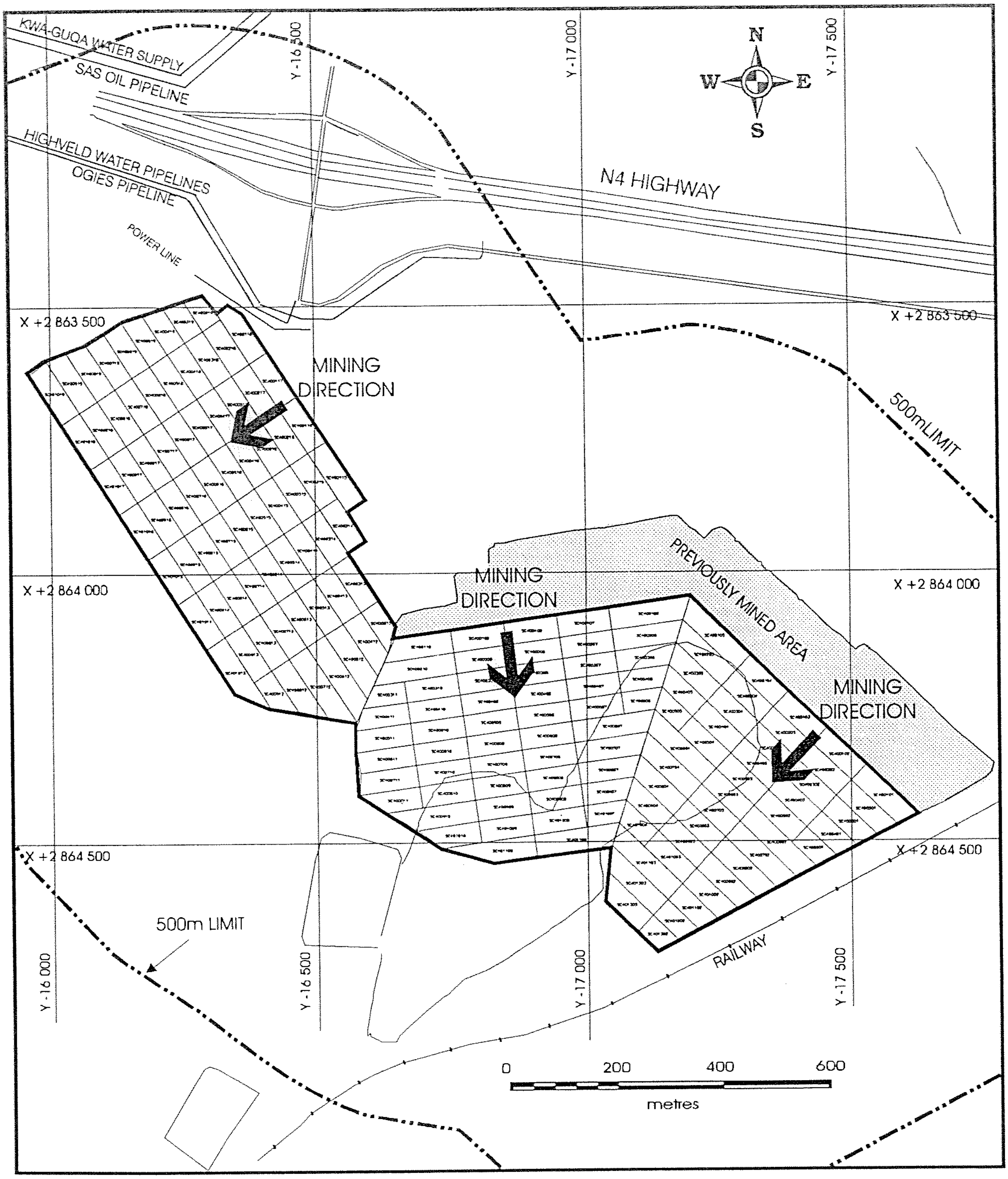

FIGURE 2: PLAN VIEW OF THE SCHOONGEZICHT MINI-PIT SHOWING THE PLANNED MINING CUTS.

FIGURE 3: OVERBURDEN DEPTH CONTOURS FOR THE SCHOONGEZICHT MINI-PIT PRESENTED IN INTERVALS OF 2m.

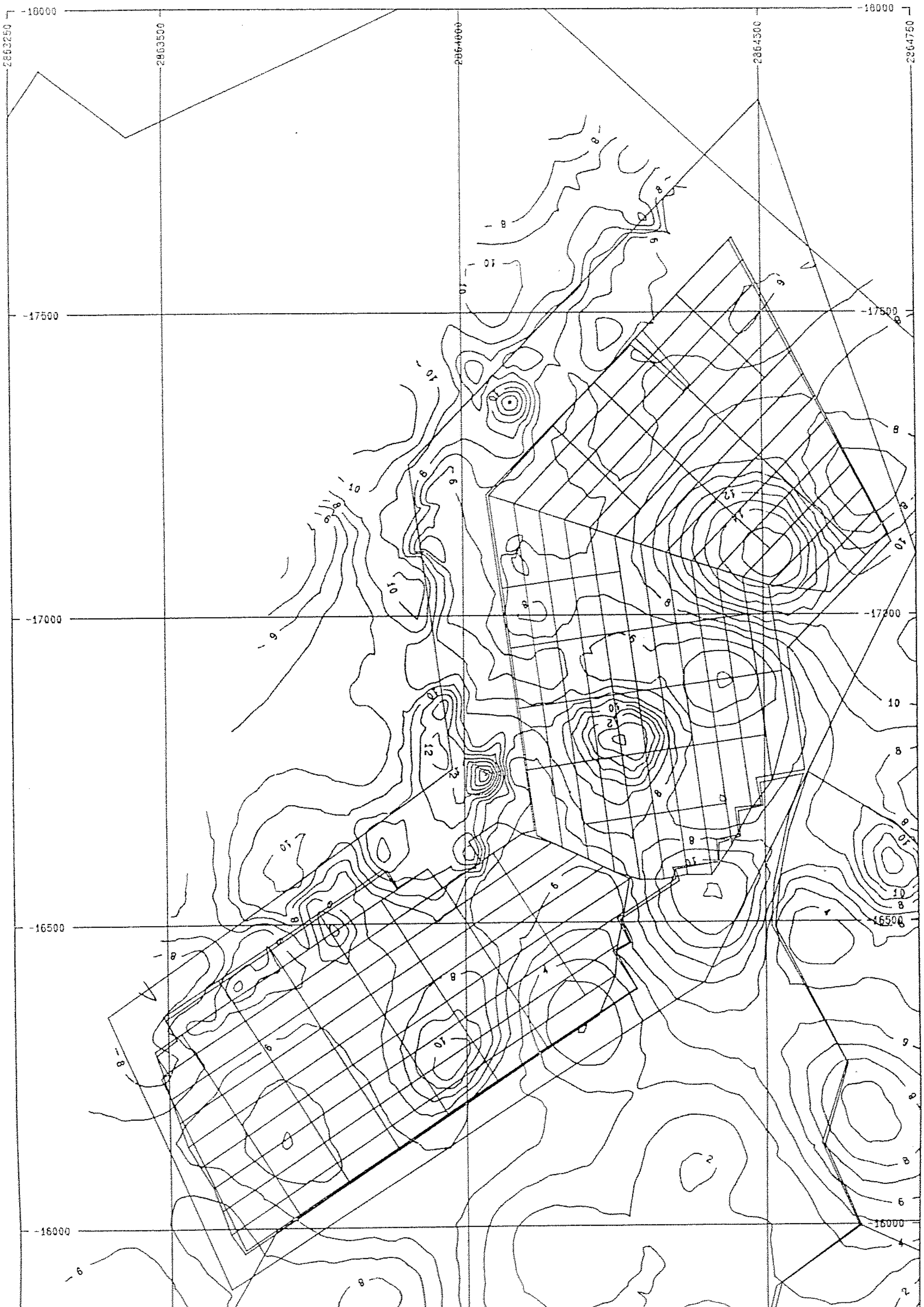

FIGURE 4: DEPTH OF WEATHERING CONTOURS FOR THE SCHOONGEZICHT MINI-PIT PRESENTED IN INTERVALS OF 1 m.

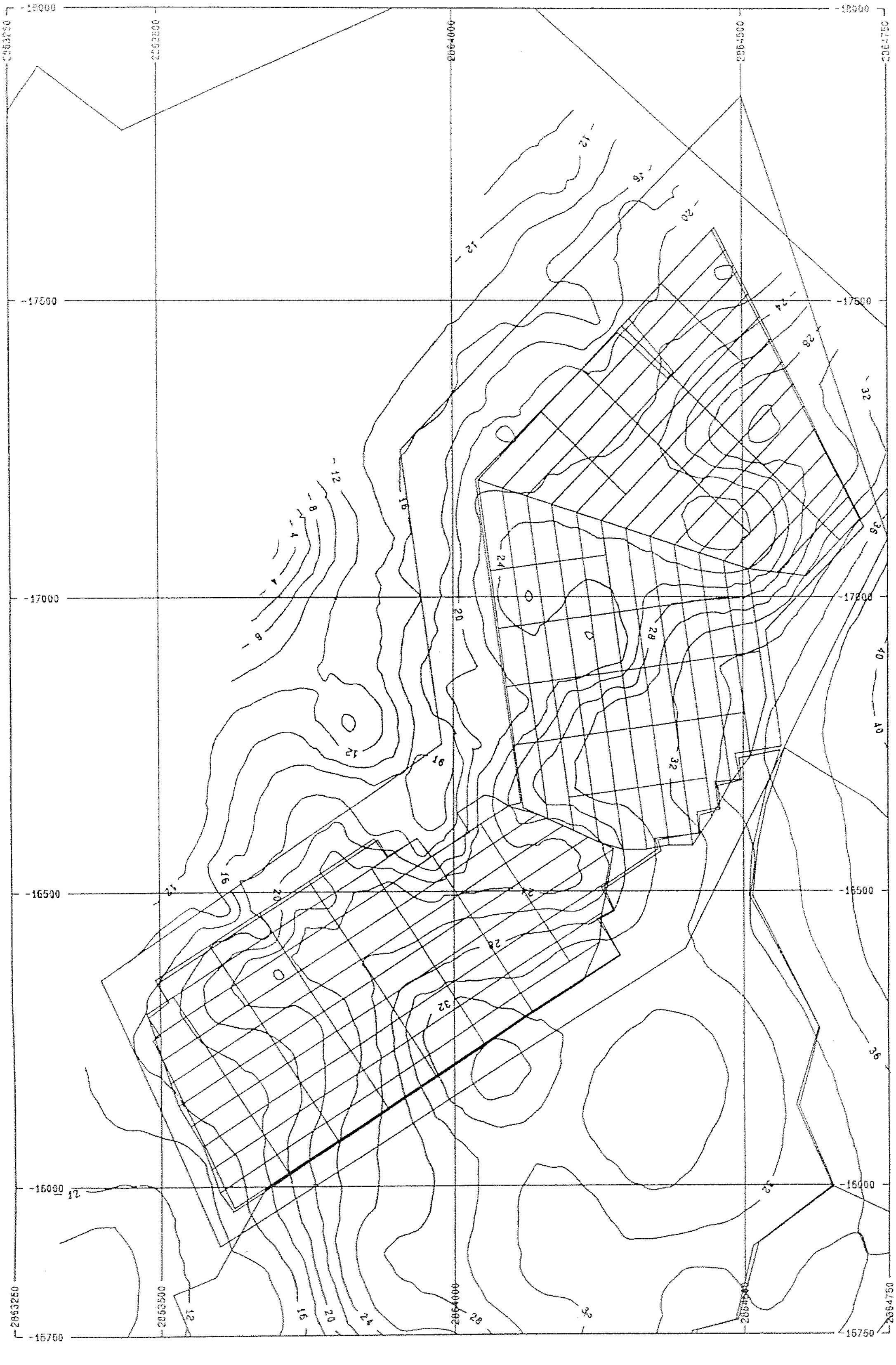

FIGURE 5: OVERALL DEPTH OF MINING CONTOURS TO THE FLOOR OF 1 SEAM FOR THE SCHOONGEZICHT MINI-PIT PRESENTED IN INTERVALS OF 2 m.

Figure 6 again presents the mine layout, this time indicating the locations of four selected boreholes used to indicate representative stratigraphic data. From west to east the borehole numbers are 2634; 2657; 2680; and 2720, the geological data being obtained from these holes being summarised in *Figures 7* through *10*.

Other significant geological features in the area are not as well known as perhaps at other localities, this partly being the reason for the Iso-Seismic Survey that has been conducted. Mine cross sections are readily available, however, and three of these appear as *Figures 11* through *13*, these being Sections A-B; C-D; and E-F as shown on *Figure 6*.

Finally *Figure 14* presents an overall mine plan indicating the minimum distances between the proposed pit and the surrounding structures and other objects of interest within the 500 m limit. As regards the north section of the mine, the main structures of interest are a power line, water and fuel oil pipelines and the Witbank-Pretoria N4 Freeway. A freeway interchange occurs near the mini-pit and so there are also some secondary roads in the area. The closest structure is the power line which is just 15 m from the edge of the pit. The Ogies and Highveld water pipelines are some 45 m from the pit, both the power line and pipelines being close to the pit at the same location. A secondary road approaches to within 50 m of the pit at the same point, and indeed there are roads, including the freeway, throughout the balance of the 500 m limit in the northern area. The closest freeway offramp is at a distance of 195 m. The SAS oil pipeline approaches to within 390 m of the pit.

There are no built up areas per se within the 500 m limit but Schoongezicht Township is located to the northeast at a closest distance of 585 m. Lynneville Village, located to the north of the N4 Freeway, is at least 1 000 m away at the closest point.

The main structure of concern to the south of the property is a railway line which borders the pit at an approximate distance of 50 m. No other structures of concern are located in the south or southwest direction.

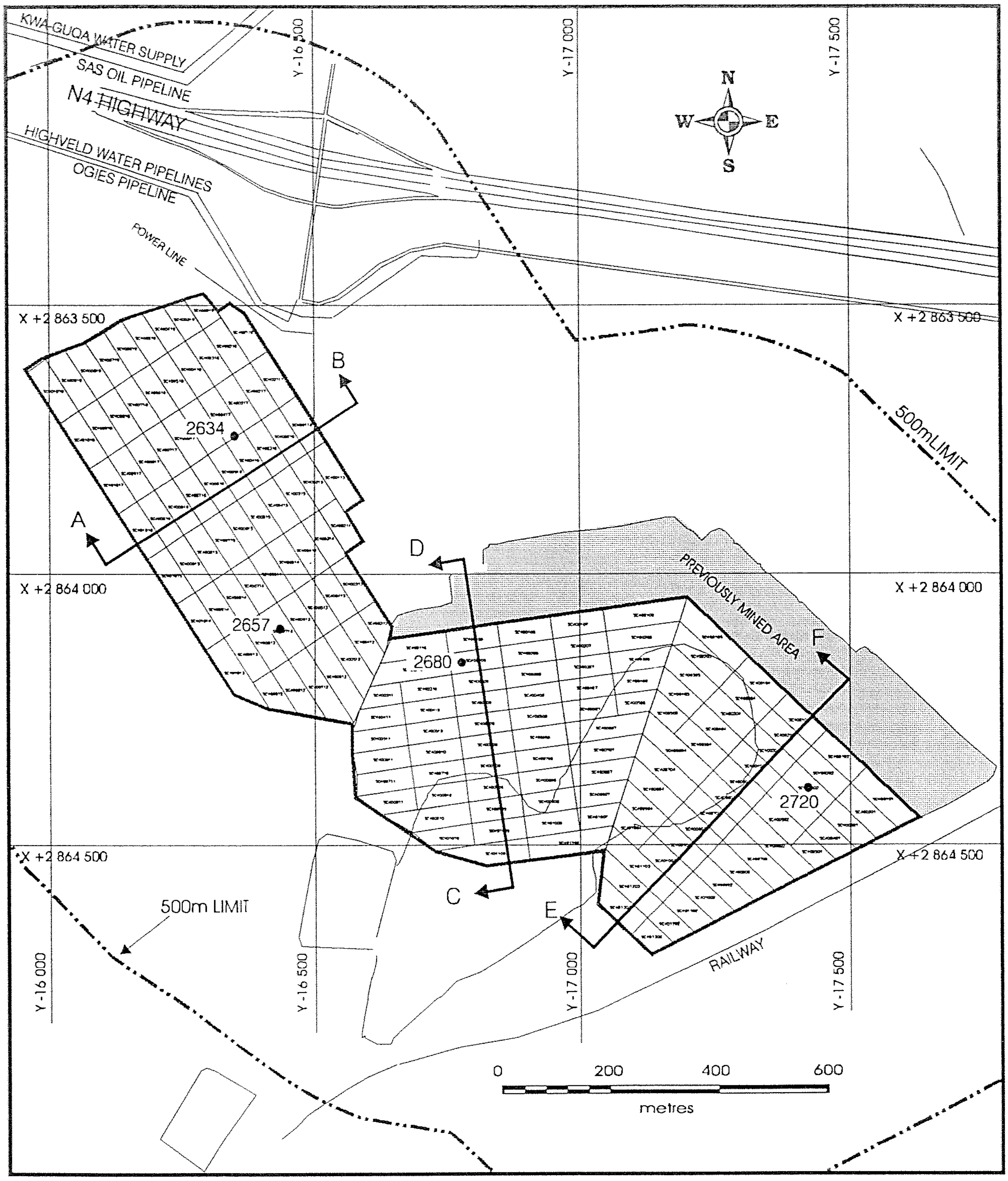

FIGURE 6: SCHOONGEZICHT MINI-PIT LAYOUT SHOWING SELECTED BOREHOLE AND MINE CROSS SECTION LOCATIONS.

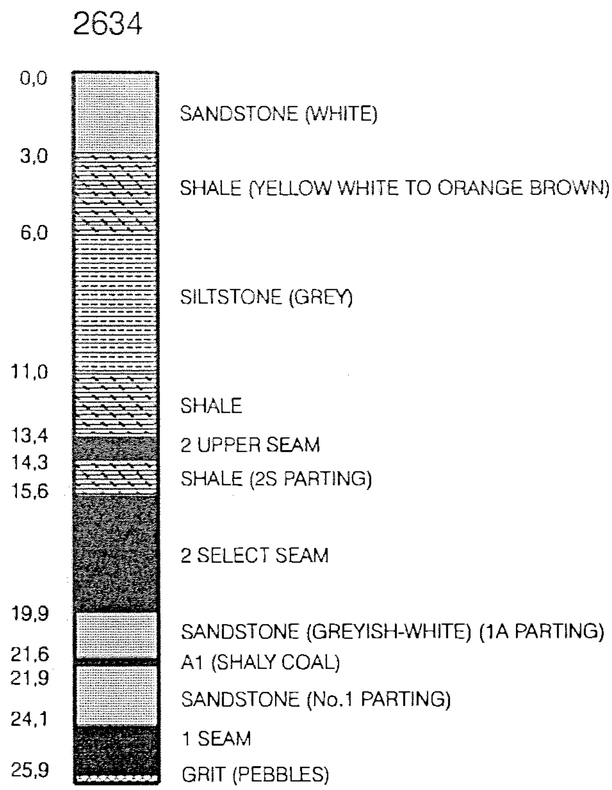

FIGURE 7: EXPLORATION BOREHOLE STRATIGRAPHIC SECTION AS RECORDED IN HOLE NO. 2634.

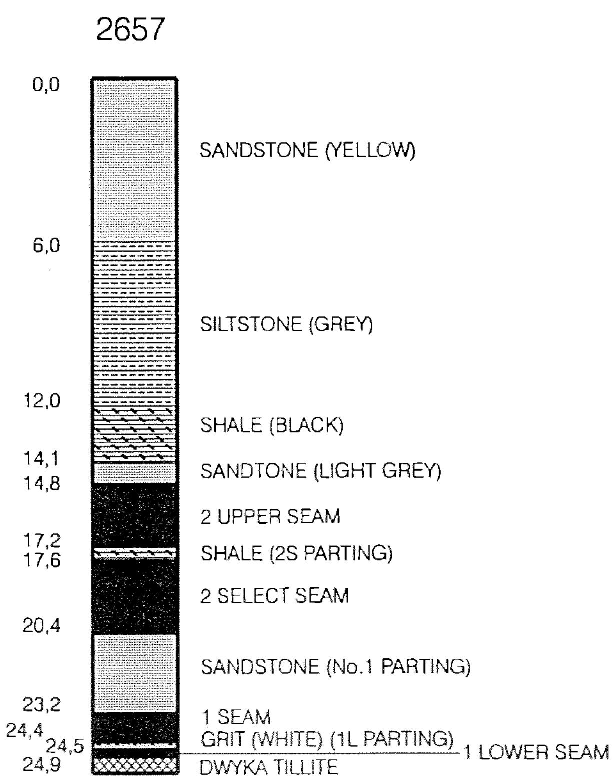

FIGURE 8: EXPLORATION BOREHOLE STRATIGRAPHIC SECTION AS RECORDED IN HOLE NO. 2657.

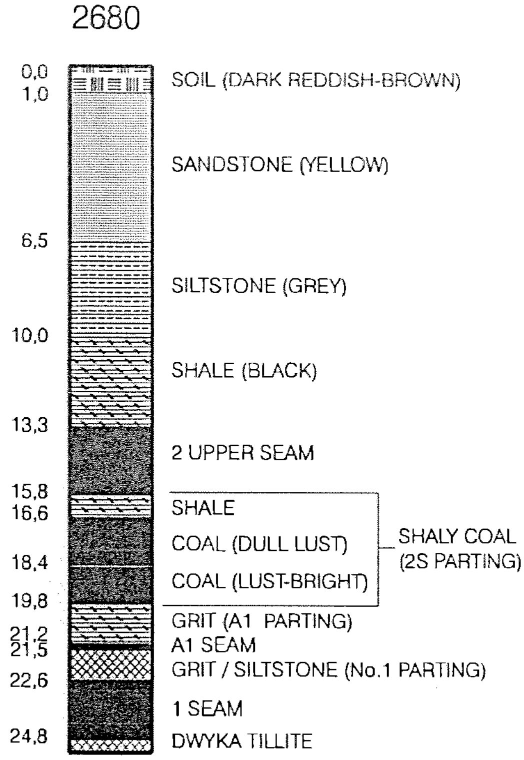

FIGURE 9: EXPLORATION BOREHOLE STRATIGRAPHIC SECTION AS RECORDED IN HOLE NO. 2680.

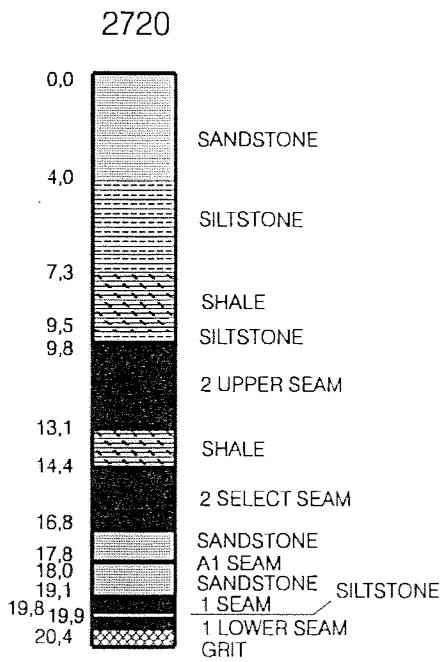

FIGURE 10: EXPLORATION BOREHOLE STRATIGRAPHIC SECTION AS RECORDED IN HOLE NO. 2720.

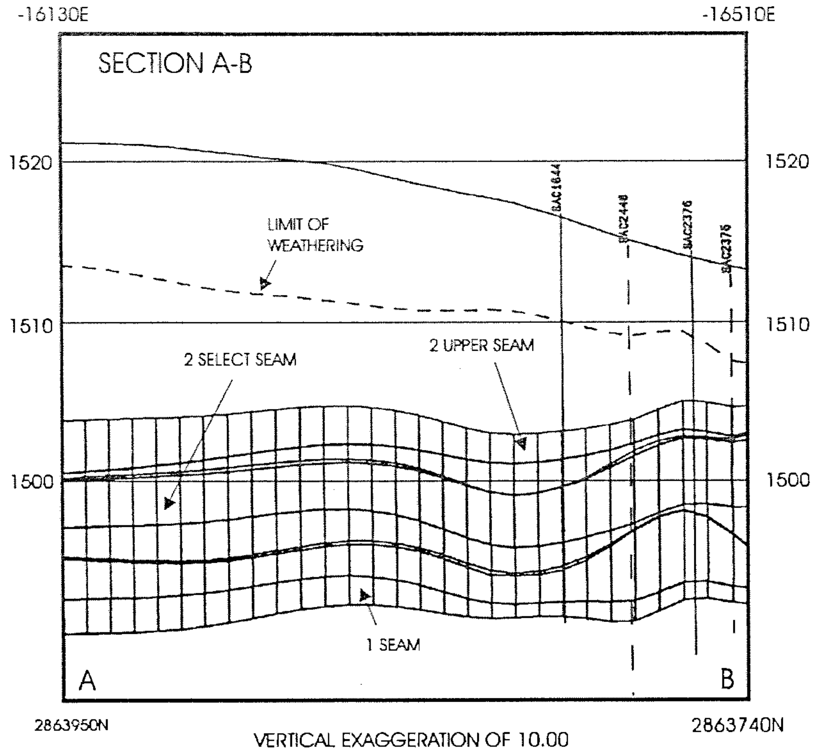

FIGURE 11: REPRESENTATIVE CROSS SECTION A-B THROUGH THE MINI-PIT AREA AS INDICATED ON FIGURE 6.

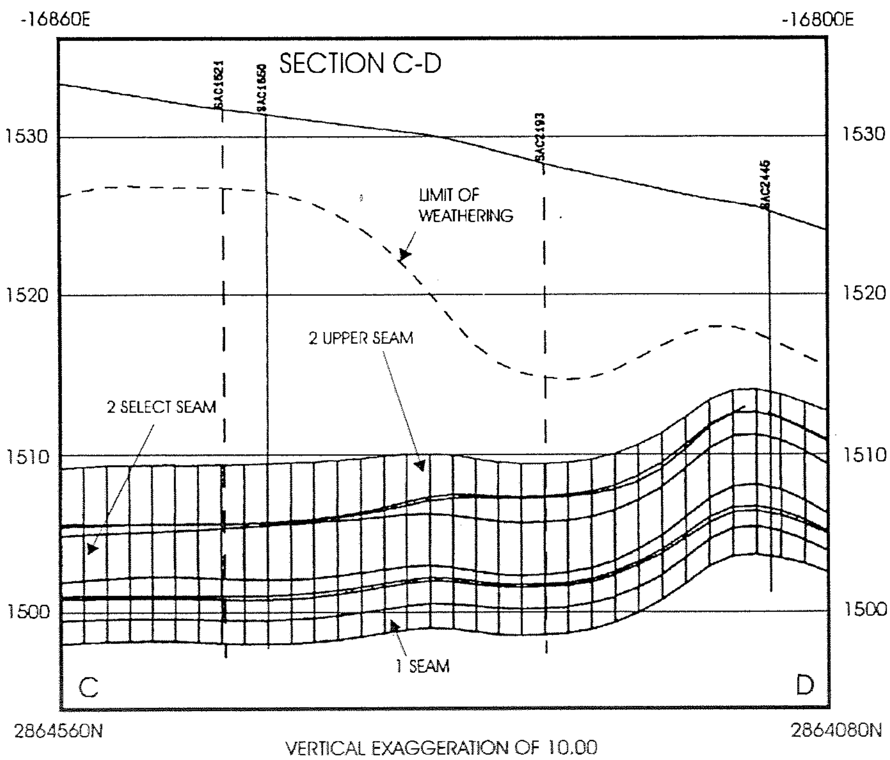

FIGURE 12: REPRESENTATIVE CROSS SECTION C-D THROUGH THE MINI-PIT AREA AS INDICATED ON FIGURE 6.

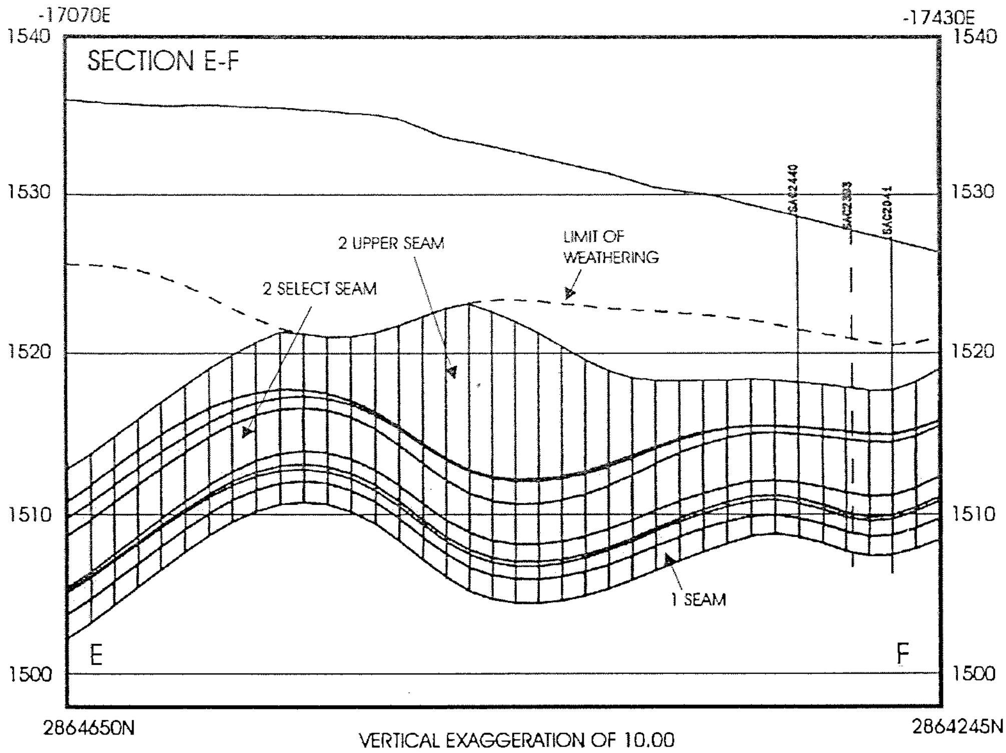

FIGURE 13: REPRESENTATIVE CROSS SECTION E-F THROUGH THE MINI-PIT AREA AS INDICATED ON FIGURE 6.

No structures of concern are located to the west of the property within the 500 m limit although two small dams are located a few hundred metres further.

This report now presents the various recommendations to appropriately control blast vibration, air blast, flyrock, fumes and dust along with outlining some other recommended precautions suggested to ensure a completely safe operation.

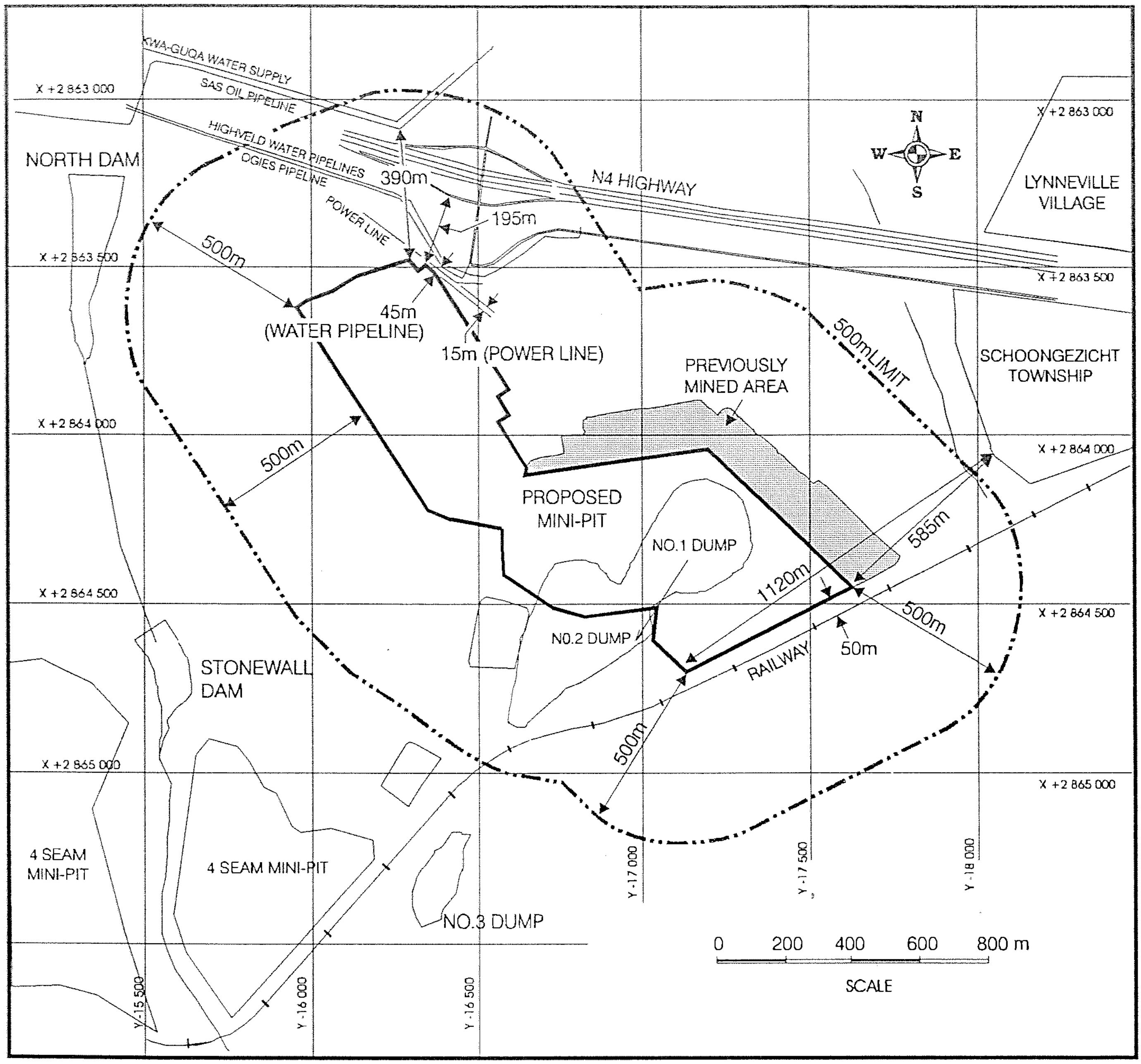

FIGURE 14: SCHOONGEZICHT MINE PLAN SHOWING THE DISTANCE TO THE CLOSEST STRUCTURES AND OTHER SIGNIFICANT OBJECTS.

3.0 BLAST DESIGN PARAMETERS - VIBRATION CONTROL

The recommended blasthole sizes for the overburden are 165 mm and 102 mm diameter and for the coal is 102 mm diameter for all areas of the mine. The 165 mm hole could be used for the coal in some areas as well if simulblasting is employed. It is not envisaged that the 165 mm hole will be used for all overburden and it is possible that decked charges may be required in some areas as will the 102 mm hole.

It should prove possible to employ the larger hole at greater distances from the structures and other objects of concern, should that be desired. The size of the hole should be consistent with the blasthole depth and resulting explosives column length to give the recommended explosives weight per delay as is outlined later in this section.

Knowledge at the time of writing suggests that much of the overburden may be dry allowing the use of AN/FO explosive. Similarly the coal seam may also be dry. Where possible, AN/FO explosive would certainly be preferred, but it is realistic to believe that many blastholes will contain water, particularly during the rainy season. As it will prove impractical to dewater and sleeve such small blastholes in order to employ AN/FO, it must be assumed that in worst case conditions the use of a water resistant emulsion explosive will be required. The anticipated AN/FO column rise will be 17,5 kg/m in the 165 mm hole and 6,7 kg/m in the 102 mm hole. The corresponding emulsion column rises are anticipated to be 9,4 kg/m in the small hole and 24,6 kg/m in the larger hole.

However the higher explosive weight per metre for the emulsion is nearly compensated for by its lower energy output per kilogram. The result is that blast ratios are calculated on the basis of kilograms of AN/FO per bank cubic metre of waste material or per tonne of coal, but the equivalent energy produced by emulsion can be directly substituted, giving a comparable column height and directly comparable blasting effects, including vibration. As such then, any blast ratios presented in this report are understood to be AN/FO ratios, or AN/FO equivalent.

The blasthole patterns to be used will not directly affect the blast vibration produced, although they will affect the number of holes required for a given cut, and thus the blast tie-in procedure.

3.1 Factors Affecting Blast Vibration

The principal factors that affect vibration levels at a given point are the weight of explosive fired, the distance from the blast, the delay period used, if any, and the blast geometry. The type of explosive, although weight strengths can differ by 40% or more, has not been shown to significantly affect vibration levels other than for very close measurements (6 m or less). Nevertheless, normalisation of explosive weights to reflect their actual energy outputs gives the theoretically best results. Geology does materially affect levels of vibration but due to each measuring site being unique, it must be evaluated on a site by site basis.

In general a scaling factor based on distance is used, being derived from the effects of geometrical dispersion of the outbound ground motion from the explosion. The total energy introduced into the ground by the charge detonation varies directly with the charge weight. The vibration propagates outward from the blast such that the volume of rock subjected to the compressional wave increases. Since the energy in the ground is distributed throughout successively larger volumes of rock, the peak ground motion levels must decrease.

Considering bench or overburden blasts having relatively deep blastholes, the explosive column approximates the shape of a cylinder for blasts close to the point of concern. The expanding wave front from charges such as these adopt an expanding cylindrical shape. The volume of this compression cylinder varies as the square of its radius. Thus the peak particle motion at any point from this type of shot will be inversely proportional to the square of the distance from the blast.

For short squat explosive charges, as may sometimes be used in coal blasts, the expanding wave front adopts an expanding spherical shape, particularly for close distances from the charge. The volume of this compression sphere varies as the cube of its radius. Thus the peak particle motion at any point from this type of shot will be inversely proportional to the cube of the distance from the blast. The result is an even more rapid reduction in energy level, and thus blast vibration, at a given distance from the blast as compared with those produced by cylindrical charges used in bench blasting. Even though some of the blast vibration levels may be automatically lower at the Schoongezicht Mini-Pit as a result of this effect, the proceeding analysis assumes the more conservative cylindrical charge shape configuration.

The scaled distance, therefore, combines the effects of charge weight (W) on the geometrical dispersion of the vibration at distance (d) in the form $d/W^{1/2}$. An empirical equation of the form

$$V_{max} = K\,(\,d/W^{1/2}\,)^{m}$$

relating the peak particle velocity with scaled distance must therefore be developed. Local site factors for each vibration component, K and m, allow for the influence of geological characteristics on the peak particle velocity and can be determined from a logarithmic plot of peak particle velocity versus scaled distance.

This scaling relationship must be further modified when delayed blasts are to be considered. The explosive weight becomes the explosive weight per delay. This is the total explosive weight fired instantaneously. Delays of 10 to 15 milliseconds, (depending on delay type), or greater have been found sufficient length to isolate individual detonations.

As illustration of this approach *Figure 15* presents peak particle velocity plotted versus scaled distance for open pit and rock strip mine multiperiod blasts which contains more than 10,000 data points recorded worldwide, (representative data only being shown on the graph itself). As such *Figure 15* represents a conservative design criteria when the upper limit line is used for design purposes.

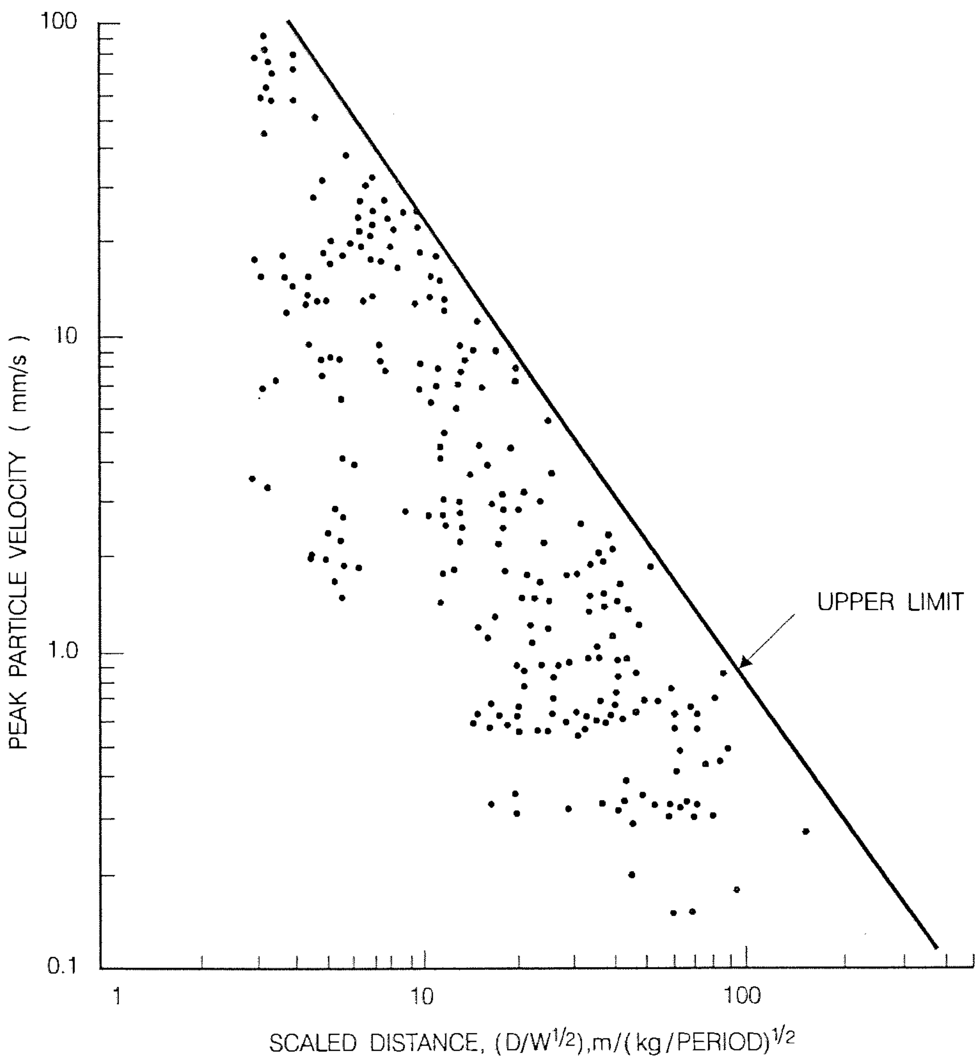

FIGURE 15: TYPICAL VIBRATION DATA FROM MULTIPERIOD DELAY BLASTS IN OPEN PITS AND ROCK STRIP MINES.

Table 1 presents the types of damage that can be expected in relation to the threshold values of peak particle velocity experienced in the ground waves from blasts. As can be

Type of Structure	Type of Damage	Peak Particle Velocity Threshold at Which Damage Starts (mm/s)	
Rigidly mounted mercury switches	Trip out	12.25	
Houses	Plaster cracking	50	Set initial limit of 125 mm/s maximum at the crusher.
Concrete block as in a new house	Cracks in blocks	200	
Cased drill holes retaining walls, loose ground	Horizontal offset	375	Beyond 250 mm/s major damage starts, such as possible cracking of cement block.
Mechanical Equipment-pumps, compressors	Shafts misaligned	1000	
Prefabricated metal building on concrete pads	Cracked pads, building twisted and distorted	1500	

TABLE 1: TYPE OF DAMAGE RELATED TO THE PEAK PARTICLE VELOCITY IN THE GROUND WAVES FROM BLASTS.

seen, the onset of plaster cracking in houses occurs at a threshold peak particle velocity value of 50 mm/s. This is an almost universally accepted damage control criterion in South Africa and elsewhere in the world, as has been definitively established by Langefors, et. al. (1958), Edwards and Northwood (1960), Duvall and Fogelson (1962), Nicholls, et.al. (1971) and others. Selecting 50 mm/s as the design value gives a design scaled distance (from the upper limit line in *Figure 12*) of 6,3 $m/kg^{1/2}$. This scaled distance, then, is the actual distance between the point of concern and the blast measured in metres divided by the maximum explosive weight per delay measured in kilograms raised to the half power. As such, designs using this scaled distance are conservative as regards control of vibration for structures and would be used if no knowledge of typical blast vibrations versus geological conditions for a given site are known.

Another factor which can influence the damage to structures is the vibration frequency. The vibration frequency tends to reduce with distance from the blast, in a similar manner to peak particle velocity, and for the same reason, ie. the reduced energy being transmitted by the vibration wave. For this reason vibration frequency does not play a major role in most surface mine blast vibration control. The United States Bureau of Mines (USBM) recommends a safe blasting upper limit line, this appearing in *Figure 16*.

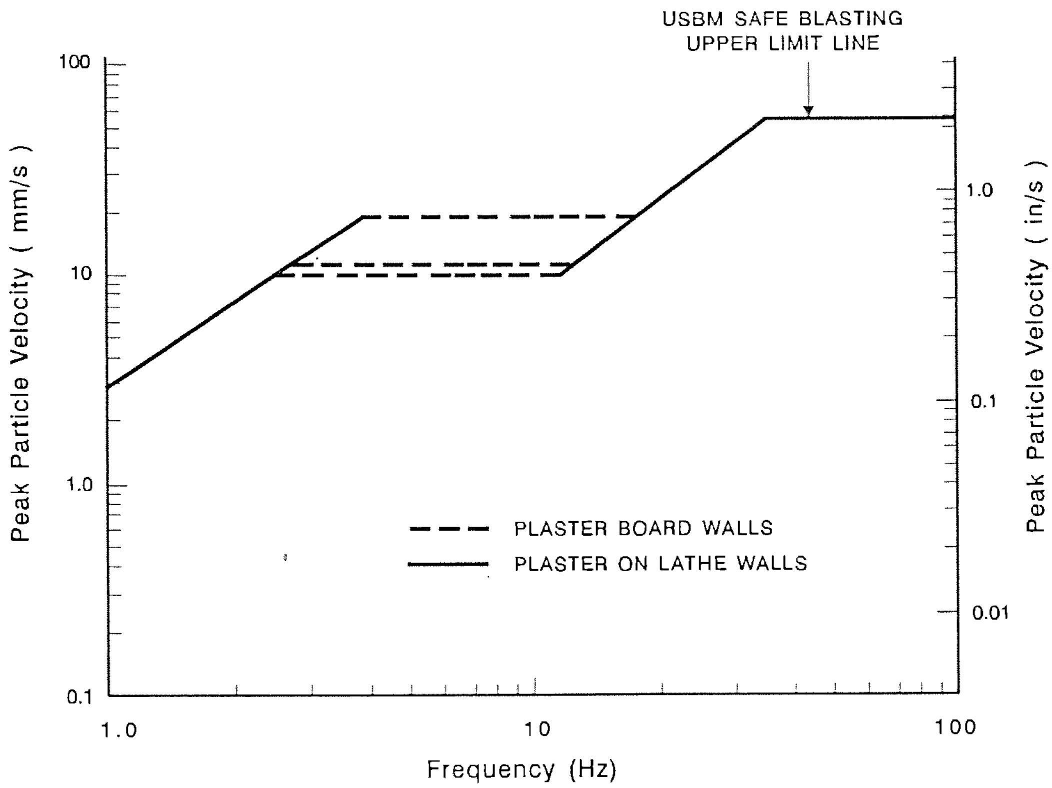

FIGURE 16: UNITED STATES BUREAU OF MINES SAFE BLASTING LIMITS.

3.2 Number of Blastholes Allowable Per Blast

One of the basic questions when designing blasts for close proximity work involves the requirement to shoot one blast at a time. This is good practice as it prevents vibrations from one blast arriving at a point of concern at the same time as vibrations from a second blast, with the possibility of a resulting enhancement of the overall vibration level being experienced. The question becomes, though: Does the requirement to shoot one blast at a time preclude the possibility of shooting more than one blasthole in a single blast?

Firstly to limit a blast to a single shot hole to control blast vibration is not sufficient to adequately control blast damage. The blast design for close proximity blasting must actually limit the blast vibrations at a point of concern below the level which will cause any damage. But limiting a blast to a single shot hole does not necessarily meet this requirement. Indeed it is possible to design a single hole blast that will be virtually guaranteed to cause damage to an adjacent building; while a correctly delayed multi-hole blast, at exactly the same location, can be designed to cause no damage. The main criterion as to whether or not damage is caused is the actual weight of explosive that is shot at one time.

In fact the use of short period delays in a multi-hole blast can transform a large blast, similar to a large single hole, into a succession of small blasts of one or more holes each. It is true that some additive effects can be experienced which tend to increase the peak vibration levels above the small single hole, or group of small holes level, for all but excessively long delays. This is because vibrations from even a single hole will have a duration of hundreds of milliseconds for most materials. However for a multi-period blast containing many blastholes, the individual blasts made up of individual blastholes are shot at a controlled relative time making the resulting peak blast vibration predictable, and thus controllable.

Numerous investigators have studied this phenomena and have shown that the peak particle velocities of ground vibrations are closely related to the maximum charge weight per delay, or the amount of explosive detonating at any one time. Such investigators include: Morris and Westwater (1953); Devine (1966); Nicholls, et. al. (1971); Gustafsson (1973); Crosby (1978); Oriard and Emmert, (1980); and Dowding (1985). The recommended minimum delay period required to ensure individually isolated blasts does differ between investigators, although currently a minimum of 10-15 milliseconds is widely accepted. It is interesting to note that Gustafsson not only recommends delayed blasts be used to control blast vibrations, he also suggests that, in certain cases, blast vibrations can be lower from a multi-period delayed blast as compared to a single shot hole containing an explosive weight equivalent to that of the maximum charge weight per delay.

In this present study, therefore, all recommendations are made based on results from multi-period blasts. This automatically means that any additive effects are catered for and that the resulting recommendations are valid for any number of individually delayed holes or groups of holes.

3.3 Human Response to Blast Vibration

Figure 17 shows the results of the experimental work of Goldman (1948) in which tests were conducted using sinusoidal mechanical vibrations of different frequencies and particle velocity on human test subjects. Since the frequency of small pit blasts are often in the range of 8-12 cycles/second then these data can be used to determine the range of scaled distance from the pit blast peak particle velocity upper limitations at which certain human reactions take place. This has been done in *Figure 18* from which it can be seen that blast vibration effects became intolerable to humans at levels appreciably lower than levels at which structural damage takes place. The result is that often complaints can be received due to human response and not due to a situation producing damage and in these instances a reduction in the peak particle velocity limit to take care of this situation is a good philosophy, particularly if such a change does not produce operational difficulties. Limits of peak particle velocity of 12 mm/s or less reduce the

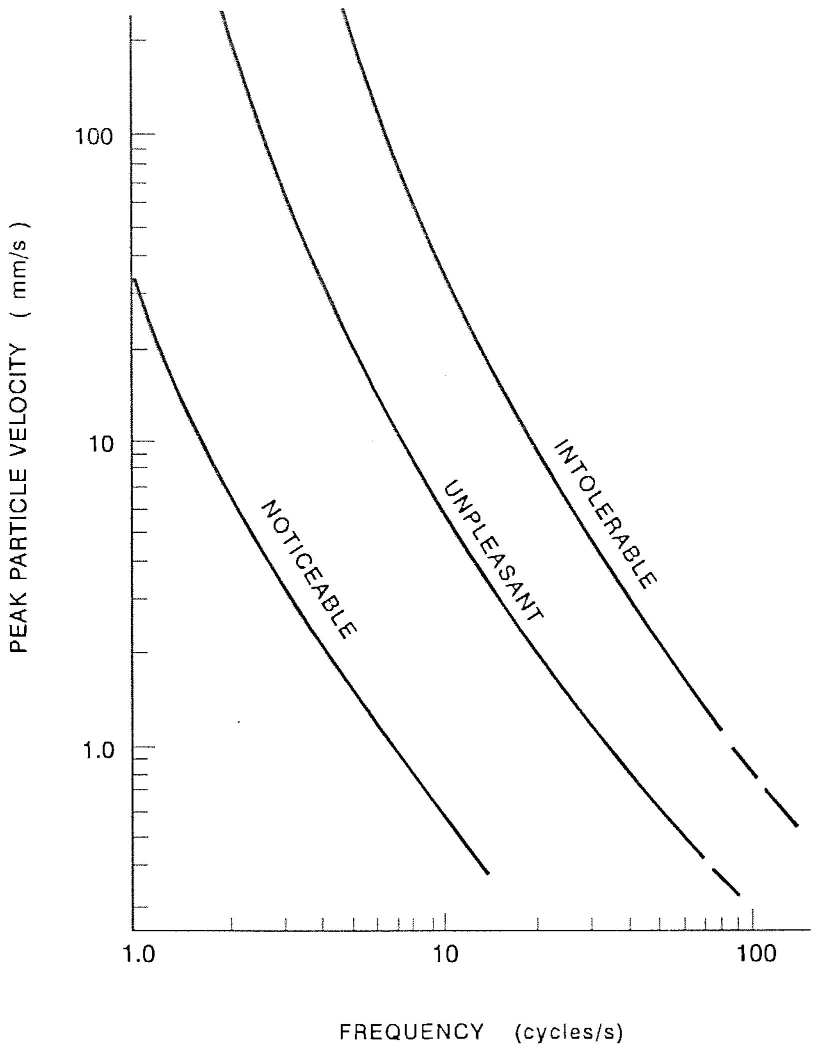

FIGURE 17: RESPONSE OF THE HUMAN BODY TO MECHANICAL VIBRATIONS. (AFTER GOLDMAN, 1948)

number of complaints by a factor of three compared to 50 mm/s. It has been noted by the United States Bureau of Mines that the percentage of people complaining about blast vibration on one construction site was as high as 30% at 50 mm/s, 10% at 12 mm/s and 1% at 2 mm/s, which is just in the perceptible range. In some instances therefore, the human response becomes the major element in the blast design.