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Twenty five years of mechanisation of tabular orebodies in South African gold and platinum mines

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hydraulic two boom drill rigs. Blasting will take place twice a day at the end of each shift.

It is planned to use Nonel S.P.D. detonators. The face shape of a panel as depicted in Fig. 6 will provide for a leading face with a slashing panel approximately 5 metres behind. It is expected that by using Nonel S.P.D. detonators that most of the reef blasted on the slashing panel will be thrown into the lower leading panel.

5.3.2 Cleaning Operations

Cleaning operations will be carried out by 2,7 m^3 L.H.D. units (consideration will be given to larger units) into 16 ton trucks. Loading of the trucks will take place in the access ramps where a height of 4 metres will be available, the L.H.D. units tramming to the access ramps on strike. Loading of reef by L.H.D. unit will mainly take place on the lower panel level, any reef left on the slashing panel being transferred only to the lower panel in order to prevent any machine slipping over the edge of the slashing panel.

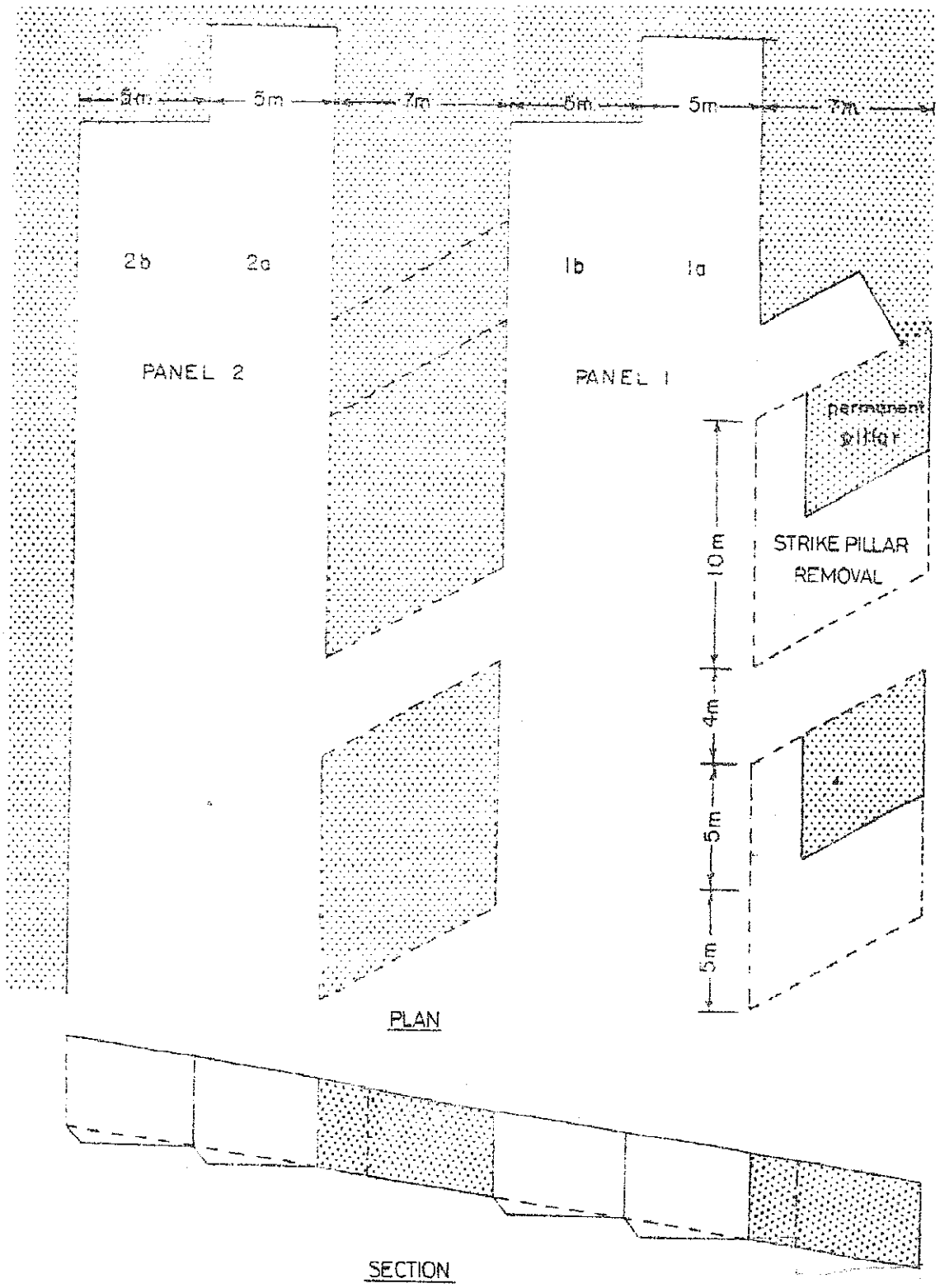
The trucks will transport the reef to a main tip up the access ramps and along strike haul roads (reef drives). These roadbeds will be prepared using crushed stone from the development operations and concreted where necessary. These haul roads developed at 8 metres wide will allow two vehicles to pass each other without the necessity for passing loops. The detailed layouts of the main tip are shown in Fig. 7 and Fig. 7a. (elevated isometric).

Final transfer of ore to the shaft system will take place by locomotive haulage on 90 level and 101 level.

5.3.3 Support

Recommended support system in the development and primary stoping operations consists of 2,7 metre x 25mm end anchored resin rebar on a 2 metres x 2 metres pattern.

STOPE LAYOUT



TRACKLESS MINING SYSTEM: DETAILED PANEL LAYOUT

Scale 1:200

FIG 6

PROPOSED MAIN TIP SCALE 1 : 125

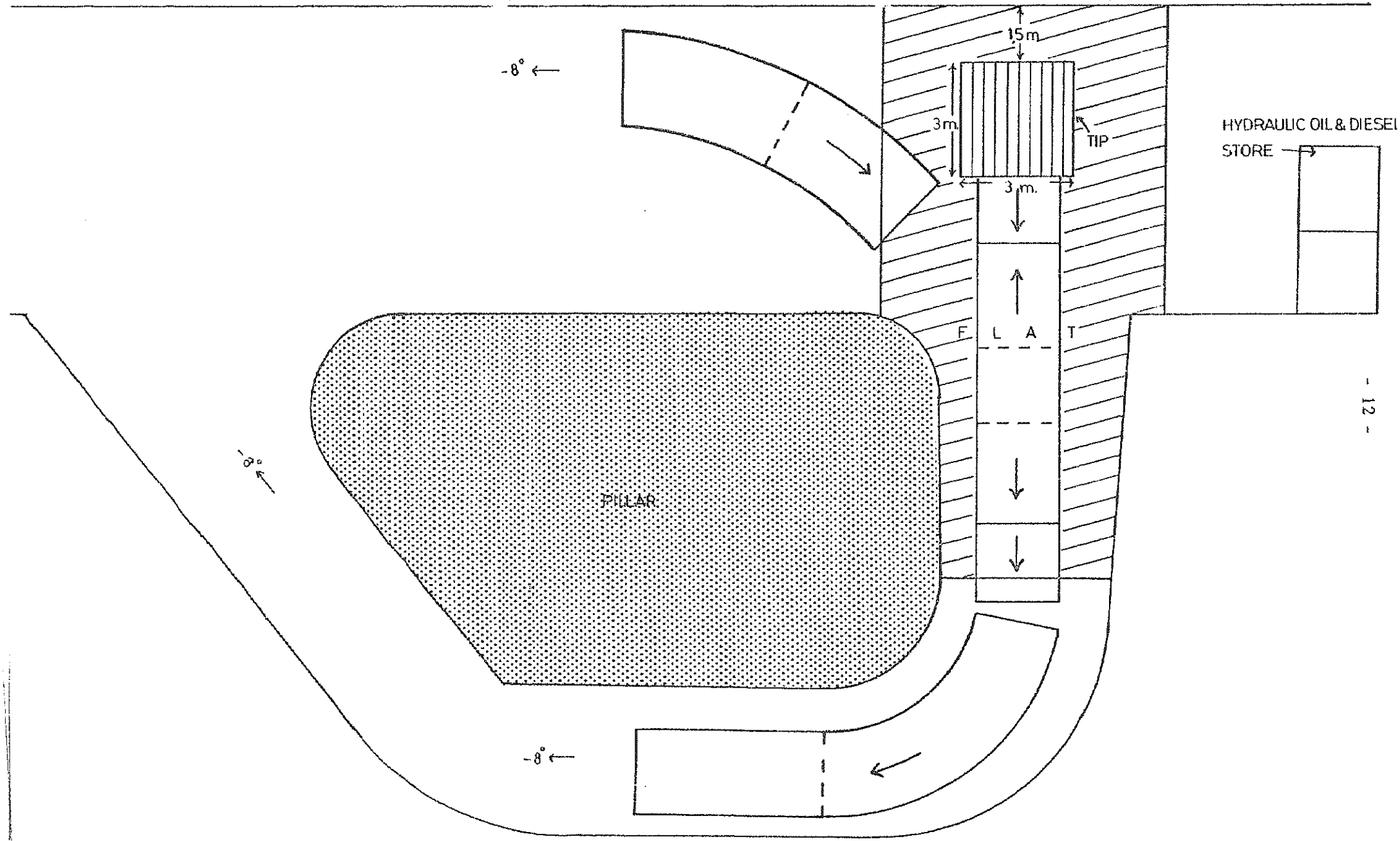


FIG.7

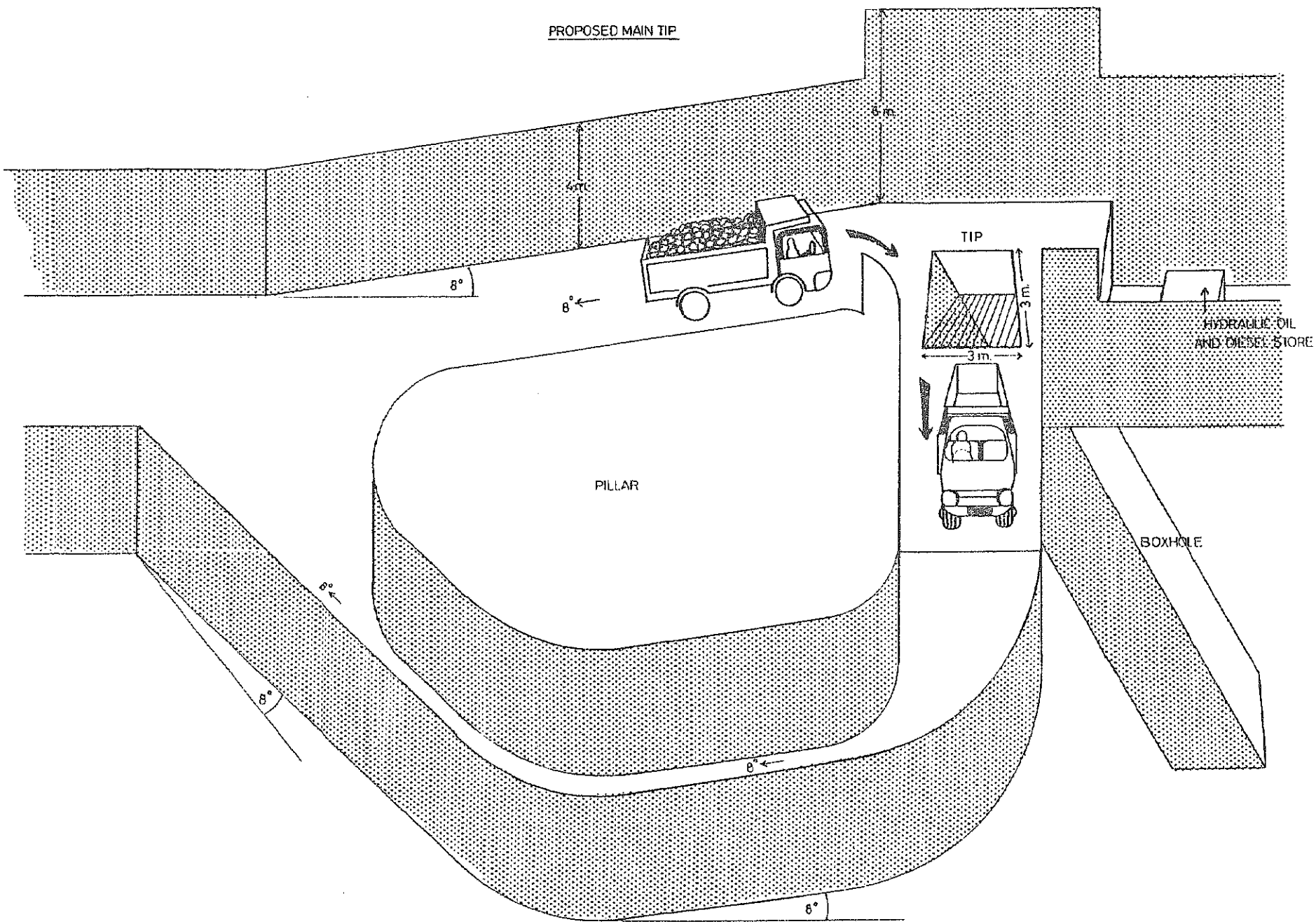

PROPOSED MAIN TIP
8 m.
4 m.
8°
8°
TIP
3 m.
3 m.
HYDRAULIC OIL
AND DIESEL STORE
PILLAR
BOXHOLE
8°
8°
8°
8°

FIG. 7a

Rock Mechanics recommendations showing detailed sketches of the support systems for development and primary stoping are given in Annexure 3.

During secondary extraction, because operations are being carried out on retreat it will not be necessary to install the above support when pillars are being reduced in size (see Annexure 2), and depending on actual experience, support recommendations will be made when secondary mining takes places.

5.4 Ventilation

5.4.1 Air Requirements

The total volume of air required, to satisfy all criteria is 125 m^3/s. This volume represents 84% of the total air volume available for the East Ventilation District in which this project is envisaged.

The criteria are:

5.4.1.1 Tons to be mined per month.

5.4.1.2 Diesel exhaust fume dilution.

5.4.1.3 Heat removal.

5.4.1.4 Treble-shift development (at a later stage possible).

5.4.1.5 Early re-entry period after blast (< 3 hours).

5.4.2 System Balance

The volume of air required represents 24% of the total air available at Cooke 2 Shaft. This means that air available for conventional stoping, in the same district is 30 m^3/s. Two stoping lines can be ventilated effectively with this volume of air.

The South district at Cooke 1 Shaft will experience a reduction of 38% in the total volume of air through it.

5.4.3 Ventilation System in the Stopes

A modified ventilation system will be used to supply air to the stope faces. This method would allow for a 3 hour re-entry after blast (pending approval by I.O.M.) and fresh air in all roadways and workshops.

A detailed report on the ventilation requirements for this operation has been compiled by the Environmental Control Department for future mine planning.

5.5 Equipment, Workshops and Other Engineering Considerations

5.5.1 Equipment

Details of the equipment required for the build-up period to full production is shown in Schedule 1. (Schedule 1 also reflects the planned production build-up.)

This schedule does not provide for any additional locomotives or hoppers for 90 level and/or for the streamlined 101 level; such requirements will be motivated at a later stage.

5.5.2 Workshop Requirements

Workshop facilities will be provided for in close proximity to the 90 level elevation reef development. Development of a permanent workshop will take place immediately the first L.H.D. unit is made available. Details of the workshop area when completed are shown on Fig. 8. The workshop will provide for two major bays (initially A and when in full production A + B). Details of the calculation of the workshop requirements are shown in Annexure 4.

The proposed workshop is extensive and will be developed in the footwall of the E8 Reef horizon and it is therefore axiomatic that rock mechanics aspects be considered. Annexure 5 provides for a diagrammatic layout of the proposed workshop and shows the actual pillars to be left on the E8 Reef horizon. The configuration of the workshop area has been designed to take cognizance of the stoping layout as previously described.

In the initial period whilst the permanent workshop is being constructed a temporary bay will be made available in the 90 N11 Reef Drive East. (Reef drive to be developed at a later stage)

5.5.3 Maintenance of Equipment

Maintenance of all equipment will be carried out in accordance with strict schedules. Stores will be equippped in the workshop area (see workshop details in Fig. 8).

PROPOSED WORKSHOP SCALE 1:500

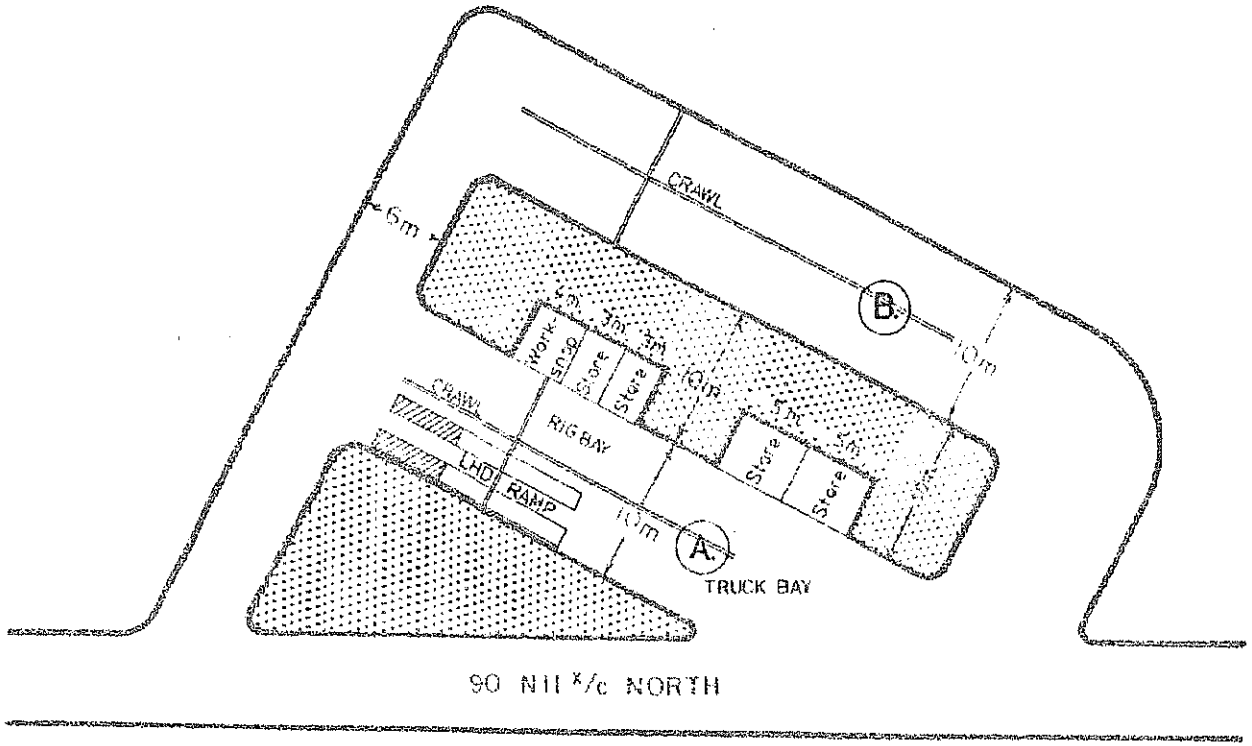


FIG 8.

5.5.4 Fuel Supply

Fuel supply facilities will be established in close proximity to the workshop and issue of fuel will take place under strict control. Fuel will probably be transported underground by fuel tanker and pumped into the storage tanks near the workshops. However, consideration will be given to pumping fuel to the underground storage tanks direct from surface.

5.5.5 Access of Equipment to the Mine

All trackless equipment will be transported through Cooke 2 Shaft and along 90 level haulage to the 90 N11 crosscut. The dimensions of the compartments of the Cooke 2 Shaft dictates that certain equipment be partially stripped on surface and re-assembled underground. Full documentation regarding transport of equipment through the Cooke 2 Shaft is given in Annexure 6; this documentation provides for details of the dimensions and masses of sub-assemblies of certain favoured equipment and further provides confirmation that such equipment can be transported to the underground workings. It will be necessary to transport all equipment along 90 level haulage by a low profile flat car.

6. LABOUR

Full details of labour complements (C.W.S. and N.C.W.S.) are given in Schedule 2; this schedule shows the monthly increase in complements to full production.

7. TRAINING

Training of operators and artisans is of vital importance and this training will commence prior to the commissioning of any equipment underground. All suppliers of trackless equipment provide training programmes for their respective equipment and comprises part of the package deal when purchasing such equipment.

Details of persons (C.W.S. and N.C.W.S.) required to be sent for training during 1984 are shown in Schedule 3.

8. EFFICIENCIES

8.1 N.C.W.S. Labour

Current labour planning in the conventional wide reef stopes is 7,5 tons per N.C.W.S. per shift and in general the actual performance does not exceed this figure. It is therefore necessary to plan for a total N.C.W.S. stoping complement of 222 in order to achieve 40 000 tons per month production. Stope preparation crews, construction crews and winch moving crews will probably necessitate a total stoping complement of at least 242 N.C.W.S.

The proposed trackless mining operation would probably require a complement of 23 per shift (N.C.W.S. stoping complement). The complement per shift can be detailed below for a production of 40 000 tons per month.

Job Category	Complement
Drill Rig Operators (3 rigs).	6
ST 3½ yd³ LHD Drivers (5 machines).	5
Truck Drivers.	4
Team Leaders.	2
Rock Bolter and Helpers.	5
Tip Attendant.	1
Total per Shift	23
Total for double shift operation is therefore:	46
Assuming a crew of 4 N.C.W.S. for pipe construction.	4
Total stoping complements	50

Such a complement will therefore provide for an efficiency of 33 tons per stoping N.C.W.S. employee per shift compared with a present planned efficiency of 7 tons per N.C.W.S. employee per shift (planned figure adjusted to account for additional crews discussed and estimated at 6,9 tons per N.C.W.S. employee per shift).

The proposed system could therefore provide for a reduction of N.C.W.S. labour of the order of 192 persons; such a reduction being a strong motivation for the introduction of a highly mechanised operation if consideration is given to the continuous escalating cost of N.C.W.S. labour and in addition the obvious advantages of employing a reduced N.C.W.S. labour force.

8.2 C.W.S. Labour

A comparison of C.W.S. labour for a trackless operation and for conventional wide reef stoping for a production of 40 000 tons is given below:

Job Category	Trackless	Conventional
Mine Overseer.	1	1
Shift Bosses.	2	4
Miners.	2	5
General Miners	1	2
Foreman Engineering	1	1
Electrician	2	4
Mechanical Fitters.	6	4
Hydraulic Fitters.	4	0
Boilermaker	1	1
Total	20	22
Total tons	40 000	40 000
Tons per C.W.S. per Shift	83	76

9. SAFETY

It is axiomatic that in wide body mining operations where conventional labour intensive methods of mining are employed it becomes more difficult to make the workings safe as the mining height increases. However, where mechanised mining is practised in wide body mining, the safety of persons at the face is improved with the use of mechanised equipment.

Further, there is evidence to show that accidents from falls of ground are reduced significantly in highly mechanised operations compared to conventional operations due to the reduced complement working in a mechanised operation.

A list of serious accidents that have occurred during 1983 from fall of ground and persons falling from ladders or platforms in wide reef stopes at Cooke 2 is given in Table 1.

TABLE 1

Working place	Date	Nature of Injury	Short Description of Accidents
95 N1E8	21.1.1983	Suspected fracture right hand dorsal	Struck by rock whilst barring hanging
	25.6.1983	Laceration wound right index finger	Struck by rock from hanging whilst drilling
	14.7.1983	Loss of one upper tooth (handling of equipment)	Struck by jack whilst fastening same
	29.10.1983	Laceration left cheek and loose teeth	Struck by rock from hanging whilst cleaning holes after drilling
	25.11.1983	Contused right wrist	Struck by rock from hanging whilst drilling
85 N2 E8	10.3.1983	Laceration wound right dorsum foot	Struck by rock from hanging whilst drilling
	23.7.1983	Fatal	Major fall of ground
	23.7.1983	Fatal	Major fall of ground
	23.7.1983	Fatal	Major fall of ground
	23.7.1983	Fatal	Major fall of ground
	23.7.1983	Compound fracture right tibia Closed upper right tibia. Laceration lateral and medial side right foot.	Caught by hanging whilst fastening eye bolt
	28.7.1983	Corneal left eye	Struck by rock from face whilst drilling
	4.11.1983	Fractured pelvis	Struck by hanging whilst fastening prop
	4.11.1983	Contused right shoulder	Struck by rock from hanging
106 N1 UE1A	6.8.1983	Laceration wound left middle finger	Struck by rock whilst lashing
	22.8.1983	Contused back	Fell from ladder whilst installing roof bolt
	30.9.1983	Severe laceration upper arm	Struck by rock from hanging whilst drilling
	1.10.1983	Contused right foot	Struck by rock from face whilst drilling
	11.11.1983	Medial malleolus - severe laceration heel and severed achilles	Struck by rock from hanging whilst barring
106 N1 E8	15.10.1983	Contused lumber region	Slipped and fell from platform whilst drilling
	20.9.1983	Laceration forehead and upper lip	Injured by rock from hanging whilst drilling

10. COSTS

An estimation has been made of the working costs (stoping and developing) for the trackless mining operations and also a comparison with the present working costs of the current convential method of mining. This comparison of costs at this stage is not considered definitive but should be taken as a comparative guide. It should be noted further that capital replacement costs and major overhaul costs of the trackless equipment have not been been separated from the overall estimated working costs but are included in the estimated working costs.

Nevertheless the comparison clearly indicates that the working costs for the proposed trackless operation can be expected to be considerably less than present working costs in the conventional stopes, and the difference can only be expected to increase as the cost of N.C.W.S. labour escalates with time. These costs are detailed in Schedules 4, 5 and 6.

K.A. RHODES

RANDFONTEIN ESTATES GOLD MINING COMPANY, WITWATERSRAND, LIMITED

TRACKLESS PRODUCTION SCHEDULE 2 YEARS

FROM JANUARY 1984 TO DECEMBER 1984 SHAFT COOKE 2 PAGE 1

MONTH / YEAR	1984 JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCTOBER	NOV.	DECEMBER	TOTAL YEAR		1ST QRT. 1985	2ND QRT. 1985	3RD QRT. 1985	4TH QRT 1985	YEAR TOTAL
Waste metres	10	20	5	-	-	45	45	30	-	-	-	-	155		-	-	-	-	-
Waste tons	250	660	125	-	-	3960	4950	745	-	-	-	-	10690		-	-	-	-	-
Reef metres	10	30	60	30	70	95	128	140	90	60	40	40	793		155	110	60	120	445
Reef tons	330	990	3325	990	5060	6380	11264	12320	6402	5280	3520	3520	59381		13666	9680	5280	10560	39186
Reef metre slipe	70	20	30	-	20	-	-	-	-	-	-	-	140		-	-	-	-	-
Reef tons slipe	3410	660	990	-	660	-	-	-	-	-	-	-	5720		-	-	-	-	-
Waste tons slipe	-	-	-	1100	1155	550													
Stoping m^2	-	-	-	-	-	-			784	910	1045	1100	3839		4800	8000	9650	9950	32400
Stoping tons	-	-	-	-	-	-			8624	10010	11480	14490	44604		52800	88000	103950	120000	364750
Total reef	3740	1650	4315	4510	5720	6380	11264	12320	15026	15290	15000	18010	109705		66466	97680	109250	130560	403936
Total Waste	250	660	125	1100	1155	4510	4950	745	-	-	-	-	13495						
TOTAL TONS	**3990**	**2310**	**4440**	**5610**	**6875**	**10890**	**16214**	**13065**	**15026**	**15290**	**15000**	**18010**	**123200**		**66466**	**97680**	**109250**	**130560**	**403936**

EQUIPMENT (ALL FIGURES ARE PROGRESSIVE)

TRACKLESS CAPITAL EQUIPMENT SCHEDULE - 2 YEARS

2 Boom Hydraulic	-	-	1	1	1	2	3	3	3	3	4	4	4		4	4	4	5	5
1 Boom Hydraulic Rig	-	-	-	-	-	-	-	-	-	-	-	-	-		1	1	1	1	1
Roofbolter Rig	-	-	-	-	-	1	1	1	1	1	1	1	1		1	1	1	1	1
2,7 m^3 LHD	-	-	2	2	2	3	4	4	4	4	5	6	6		6	8	8	8	8
18 ton Truck	-	-	-	-	1	2	2	2	3	4	4	4	4		4	4	4	5	5
Mobile Cement Mixer	-	-	-	-	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Scissor Utility Vehicle	-	-	-	-	1	1	1	1	1	1	1	2	2		2	2	2	2	2
Explosive Transporter	-	-	-	-	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Transport Vehicle	-	-	-	-	1	1	2	2	2	2	3	3	3		3	3	3	3	3
Impact Breaker	-	-	-	-	-	-	1	1	1	1	1	1	1		1	1	1	1	1
75 kW Fans	-	3	-	2	-	-	1	-	-	-	-	-	6		1	1	1	1	10
30 kW Fans	-	2	-	2	-	-	1	-	-	-	-	-	5		2	1	1	1	10
22 kW Fans	-	-	-	3	-	-	3	-	-	-	-	-	6		1	1	1	1	10

Note: (Major Engineering Workshop Equipment not included)

RANDFONTEIN ESTATES GOLD MINING COMPANY, WITWATERSRAND, LIMITED

TRACKLESS PRODUCTION SCHEDULE 2 YEARS

FROM JANUARY 1984 TO DECEMBER 1984

LABOUR

SHAFT COOKE 2

CWS	1984 JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCTOBER	NOV.	DECEMBER	TOTAL YEAR		1ST QRT. 1985	2ND QRT. 1985	3RD QRT. 1985	4TH QRT. 1985	YEAR TOTAL
Mine Overseer	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Prod. Shift Boss D/S	-	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Prod. Shift Boss N/S	-	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Miner D/S	-	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Miner N/S	-	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Gen.Miner Construction	-	-	-	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Gen, Eng. Foreman	-	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Electrician	-	-	-	-	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Mechanical Fitter	-	1	1	1	2	2	2	2	2	2	3	3	3		4	4	5	6	6
Hydraulic Fitter	-	1	1	1	2	2	2	2	2	2	3	3	3		3	3	4	4	4
Boilermaker	-	-	-	-	-	-	1	1	1	1	1	1	1		1	1	1	1	1
Total Mining	1	5	5	5	6	6	6	6	6	6	6	6	6		6	6	6	6	6
Total Engineering	-	3	3	3	6	6	7	7	7	7	9	9	9		10	10	12	13	13
TOTAL CWS	1	8	8	8	12	12	13	13	13	13	15	15	15		16	16	18	19	19
NCWS / day (2 shifts)																			
Conv. Stoping	38	8	11	11	11	7	-	-	-	-	-	-	-		-	-	-	-	-
Conv. Devopment	6	14	18	18	20	10	-	-	-	-	-	-	-		-	-	-	-	-
Construction	-	5	5	5	5	5	5	5	5	5	5	5	5		5	5	5	5	5
Supervisors	-	2	2	2	3	3	4	4	4	4	4	4	4		4	4	4	4	4
LHD Drivers	-	-	2	2	3	4	6	8	8	8	10	10	10		10	10	10	10	10
Rig Drivers	-	-	2	2	3	5	7	8	8	8	10	10	10		12	12	12	14	14
Truck Drivers	-	-	-	-	2	4	4	4	6	8	8	8	8		8	8	8	8	8
Utility Drivers	-	-	-	-	3	3	5	7	8	8	10	12	12		12	12	12	12	12
Tip Attendent	-	-	-	-	1	1	1	1	1	1	1	1	1		1	1	1	1	1
Support	-	-	1	1	2	2	2	2	2	2	2	2	2		2	2	2	2	2
Rig Spotters	-	-	1	1	1	3	4	4	4	4	5	5	5		6	6	6	6	6
Cement Layers	-	-	-	2	2	2	4	4	4	4	4	4	4		4	4	4	4	4
Eng. Aid	-	2	2	2	4	4	4	4	4	4	6	6	6		7	7	9	10	10
Eng. NCWS	-	8	8	8	8	8	8	8	8	8	12	12	12		14	14	18	20	20
Eng. Total	-	10	10	10	12	12	12	12	12	12	18	18	18		21	21	27	30	30
Mining Total	44	29	42	44	56	49	42	47	50	52	59	61	61		64	64	64	66	66
In training	-	18	8	13	10	6	3	2	12	3	-	4	-		-	6	3	-	-
Total Production	44	24	37	37	46	39	28	31	33	35	40	40	40		43	43	43	45	45
Total Services	-	15	15	17	22	22	26	28	29	29	37	39	39		42	42	48	51	51
TOTAL COMPLEMENT	44	57	60	67	78	67	57	61	74	67	77	83	79		85	91	94	96	96

Note: Rig Drivers are to replace drill operators and such constitutes 40% of convential gangs)

RANDFONTEIN ESTATES GOLD MINING COMPANY, WITWATERSRAND, LIMITED

FROM JANUARY 1984 TO DECEMBER 1984 — TRACKLESS TRAINING SCHEDULE 2 YEARS — SHAFT COOKE 2 — PAGE 3

MONTH / YEAR	1984 JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCTOBER	NOV.	DECEMBER	TOTAL YEAR		1ST QRT. 1985	2ND QRT. 1985	3RD QRT. 1985	4TH QRT. 1985	YEAR TOTAL
N.C.W.S.																			
JOB TYPE																			
L.H.D. Drivers		2	1	1	2	2	-	-	2	-	-	-	10		-	-	-	-	-
Drill Rig Driver		2	1	2	2	1	-	-	2	-	-	-	10		2	-	2	-	4
Truck Driver		-	2	2	-	-	2	2	-	-	-	-	8		-	-	-	-	-
Utility Driver		-	-	3	2	2	1	-	2	2	-	-	12		-	-	-	-	-
Tip Attendant		-	-	1	-	-	-	-	-	-	-	-	1		-	-	-	-	-
Support		1	1	1	1	-	-	-	-	-	-	-	4		-	-	-	-	-
Rig Spotter		1	-	-	2	1	-	-	-	1	-	1	6		-	-	-	-	1
Eng. Aid		2	2	2	-	-	-	-	2	-	-	1	9		1	-	-	-	1
Eng. NCWS		8	-	-	-	-	-	-	4	-	-	2	14		-	-	-	-	-
Supervisor		2	1	1	-	-	-	-	-	-	-	-	4		-	-	-	-	-
TOTAL		**18**	**8**	**13**	**9**	**6**	**3**	**2**	**12**	**3**	**0**	**4**	**78**		**4**	**-**	**2**	**-**	**6**
C.W.S.																			
JOB TYPE																			
Mining Official		3	-	-	-	-	-	-	-	-	-	-	3		-	-	-	-	-
Mining Union men		2	-	1	-	-	-	-	-	-	-	-	3		-	-	-	-	-
Gen. Eng. Foreman		1	-	-	-	-	-	-	-	-	-	-	1		-	-	-	-	-
Eng. Artisans		2	-	3	1	-	-	-	2	-	-	-	8		1	-	2	1	4
TOTAL		**8**	**-**	**4**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**15**		**1**	**-**	**2**	**1**	**4**

Schedule 3

Schedule 4

WORKING COSTS (STOPING) FOR CONVENTIONAL WIDE REEF STOPES : 40 000 TONS PER MONTH PRODUCTION

Operation	Rands	Rand per Ton
Development		
Development on 101 level for reserve of 3 million tons mineable		
Haulage 600m x R600/m		
Crosscuts 1800m x R600/m		
Travellingways 450m x R450/m		
Ore passes 3280m x R380/m	2 900 000	0,97
Labour		
Mining : C.W.S.		
4 Stopers x R3200		
2 S/Bosses x R2500	17 800	0,44
N.C.W.S		
242 x R380	91 900	2,30
Engineering : C.W.S.		
4 Artisans x R2100	8 400	0,21
N.C.W.S.		
4 Aides x R450		
8 Unskilled x R380	4 800	0,12
Blasting		
Assumed to be the present average cost of R1,12/ton in wide reef stopes		1,12
Drilling		
Jackhammer, airlegs estimated at R0,13 per ton		
Drill steel costs calculated at R0,61 per ton		0,74

Schedule 4 (Cont.)

Operation		Rands	Rands per Ton
Cleaning			
Winch spares R200 per unit per month	R0,28 per ton		
Ropes estimated at	R0,21 per ton		
Scoops assumed to be	R0,18 per ton		
Grizzlies	R0,04 per ton		
Box fronts/cylinders	R0,13 per ton		
Electricity Costs calculated at R0,29 per kW hr and assuming 18 x 75 kW and 18 x 50 kW winches for 40 000 ton production R0,56			
Total cost per ton R1.40			R1,40
Support			
Assumed cost of R0,56 for present pattern 2m x 2m with resin and rebar and including allowance for extra support and cable anchors			R0,60
Ventilation			
Repairs to air jet fans R0,06 per ton			R0,06
Other Stores			
Other store cost estimated at R0,80 per ton (budget) less cost of scraper ropes, grizzlies etc. included in cleaning costs			R0,37
Total Cost			**R8,33**

Schedule 5

WORKING COSTS (STOPING) FOR TRACKLESS MINING IN WIDE REEF STOPES : 40 000 TONS PER MONTH PRODUCTION

Operation	Rands	Rand per Ton
Development		
Haulage and Travellingway ex 101 level for bottom access and development on 90 level for ventilation airways for 3 million tons reserves (mineable)	100 000	0,03
Labour		
Mining : C.W.S.		
2 Stopers x R4000 2 S/Bosses x R2500	13 000	0,32
N.C.W.S.		
50 x R450	22 500	0,56
Engineering : C.W.S.		
6 Artisans x R2400	14 400	0,36
N.C.W.S.		
6 x R500 12 x R450	8 400	0,21
Blasting		
Assumed cost of R1,12 per ton		1,12
Drilling Rigs		
R40 per hour x 4 hours per shift on double shift basis (3 drill rigs)	23 000	0,58
Drill Steel estimated at R0,61 per ton	24 000	0,61
LHD		
R24 per hour x 6 hours per shift on double shift (5 machines, $3\frac{1}{2}$ yd^3)	34 500	0,86

Schedule 5 (Cont.)

Operation	Rands	Rand per Ton
Roof Bolters		
R40 per hour x 2 hours per shift on double shift	3 800	0,10
Trucks		
R16 per hour x 7 hours per shift on double shift (4 trucks)	21 500	0,53
Land Cruisers		
R5 per hour x 5 hours per shift on one shift (5 machines) and one machine on one shift	3 600	0,09
Support		
Assumed to be at R0,60 per ton as at present in wide reef stopes		0,60
Ventilation		
Assumed at R0,06 per ton		0,06
Other Stores		
Assumed to be at 50% of other stores for conventional stopes		0,18
Total Cost		**6,21**

Schedule 6

COMPARISON OF ESTIMATED WORKING COSTS :
CONVENTIONAL WIDE REEF STOPING AND
TRACKLESS MINING IN WIDE REEF STOPES

	Rand per Ton	
Operation	Conventional	Trackless
Development	0,97	0,03
Labour	3,07	1,45
Blasting	1,12	1,12
Support	0,60	0,60
Drilling	0,74	1,29
Cleaning	1,40	1,39
Ventilation	0,06	0,06
Other	0,37	0,27
TOTAL	8,33	6,21

ANNEXURE 1

PILLAR SIZES DURING
PRIMARY AND SECONDARY
EXTRACTION

THE RANDFONTEIN ESTATES GOLD MINING COMPANY, (W) LIMITED

M E M O R A N D U M

TO : MINE MANAGER - COOKE 1 & 2

FROM : ROCK MECHANICS ENGINEER

SUBJECT : SECONDARY PILLAR EXTRACTION IN THE AREA OF MECHANISED STOPING OPERATIONS - (E8) - COOKE 2

DATE : 11th January, 1984

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INTRODUCTION:

When mining operations reach the limits defined for the area of mechanised stoping at Cooke 2, it is intended to carry out secondary pillar extraction on those pillars cut during the primary stoping cycle.

All discontinuous pillars intended for regional stability on the upper (UE1A) reef have already been superimposed for the E8 reef and, as such, secondary extraction of stope pillars will be made in partially overstoped ground.

PRIMARY MINING:

This will take place using 7m x 10m pillars separated by 4m holings along strike and 10m spans down-dip. The initial percentage extraction will be 71%. In this case the pillar strength is well in excess of the average pillar stresses.

THE STRESS REGIME:

The initial virgin vertical stress in the area before extraction of any reef is 20MPa.

On extraction of the upper (UE1a) reef a stress relief is generally experienced on the underlying E8 reef. The DREEF computer analysis of the partial extraction of the UE1a reef indicates an average stress of 10MPa on the E8 reef i.e. 50% of the virgin overburden stress. There will be areas however where the vertical stress will be higher than this average especially around the superimposed stability pillars.

In a similar manner it can be shown that areas remote from regional stability pillars will have a vertical stress of 30% of the virgin vertical overburden stress. Therefore a stress gradient will exist across the E8 reef elevation.

SECONDARY EXTRACTION:

Secondary extraction is intended to take place on retreat. The pillars will be reduced to dimensions of 5m x 5m which will result in 6,3m holings on strike and 12,5m spans down dip. Not all areas will be amenable to complete secondary extraction. For example -in areas where the vertical stress is equal to the virgin vertical overburden stress, pillars will be cut to 7m x 7m.

This emphasises the fact that no unnecessary pillars should be left on the UE1a horizon as they can be detrimental to the overall percentage extraction.

Mining activities are currently taking place above the proposed area for the mechanized stoping operations. Once the final UE1a geometry is known computer analyses will be conducted to determine the location and extent of any high stress areas on the E8 horizon.

Jonathan Sykes

pp. M.K.C. ROBERTS

C.R.M.E.

ANNEXURE 2

STAGES IN THE PARTIAL EXTRACTION OF PILLARS

STAGES IN THE PARTIAL EXTRACTION OF PILLARS

During secondary extraction operations, several pillars are systematically reduced in size simultaneously. Mining takes place on retreat on strike as shown on attached plan.

Referring to the attached plan the various stages are as follows:

Stage 1

Round 1 is taken down dip of reef from the room. The area is supported by roofbolts and reef loaded out.

Stage 2

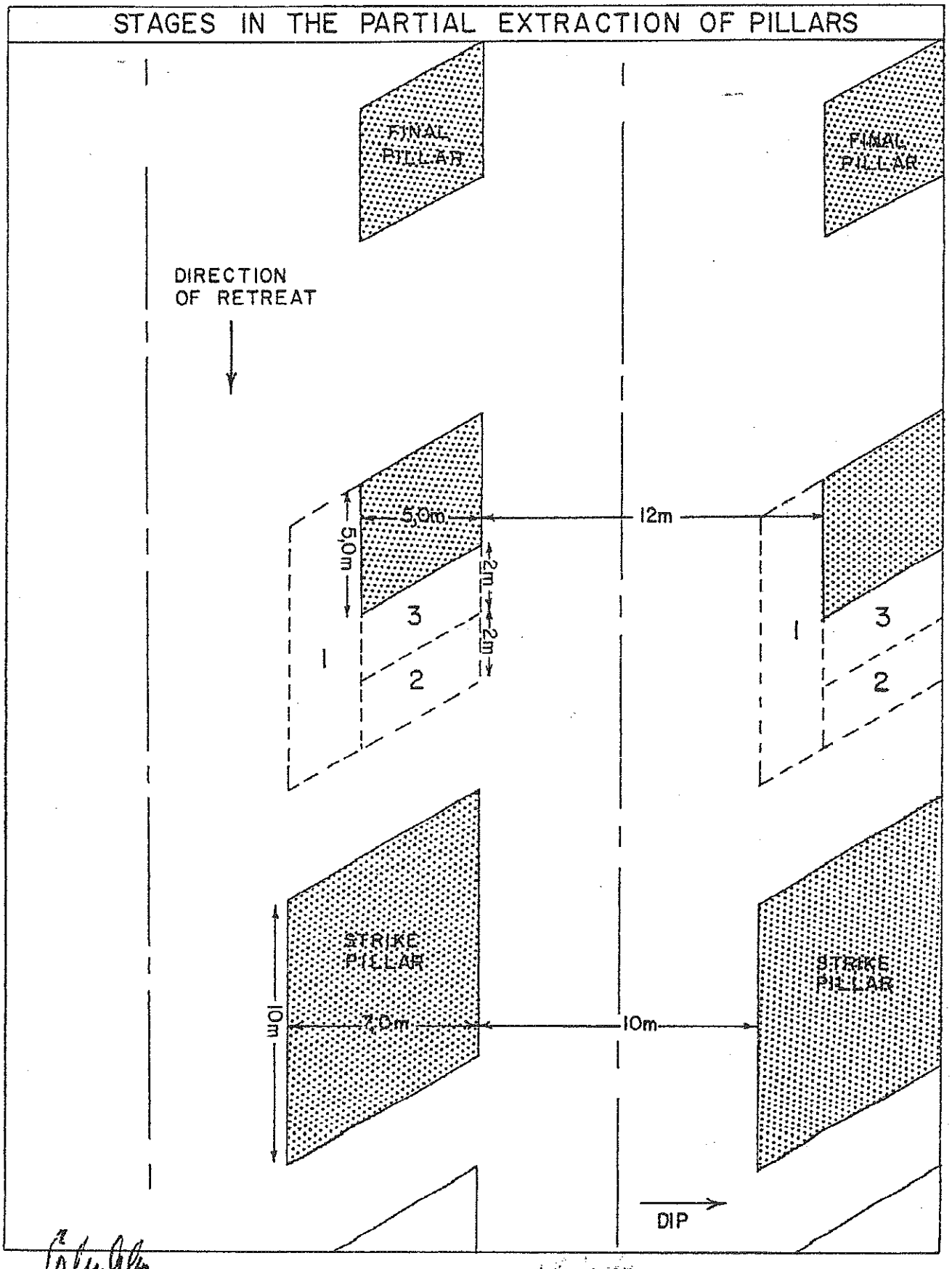
Round 2 is taken from the access holing. The area is supported by roofbolts and reef loaded out.

Stage 3

Round 3 is taken and loaded out; no support being installed.

The above stages take place in a cyclic manner, each individual stage being carried out on several pillars (the planned rate of production will dictate the actual number) simultaneously.

The final pillar size is 5 metres x 5 metres.


STAGES IN THE PARTIAL EXTRACTION OF PILLARS
FINAL PILLAR
FINAL PILLAR
DIRECTION OF RETREAT
5,0m
5,0m
12m
2m
2m
1
2
3
1
2
3
STRIKE PILLAR
STRIKE PILLAR
10m
10m
DIP

C.R.H.E.