Drilling = 3.41  
Blasting = 2.20  
Cleaning = 3.10  
Support = 1.64  
Ventilation = 0.10  
Pumping = 0.05  
Utility Vehicles = 0.15  
Land Cruisers = 0.05  
Waste packing = 0.20  
General Mine Stores = 0.30

TOTAL = 11.20

For a conventional narrow reef operation, assume costs as at Cooke 1, R.E.G.M.  
Basic stoping costs at Cooke 1, R.E.G.M. = 12.25  
Difference in favour of trackless operations is therefore = 1.05

Footwall Waste Development

Development planned in a conventional layout for H.H. Joel provides for 91 tons/metre.

Conventional development costs are therefore:
91 tons/metre ore reserve replacement rate at R550/metre = 6.55

Footwall development for a reserve of 12.65 million tons in the area of influence of No 3/4 Shaft system is 22 000 metres. (Reef development included in basic stoping costs for mechanised option).
Mechanised option footwall development costs are therefore:
12 650 000 tons / 22 000 metres at R550/metre = 0.95
Difference in favour of the mechanised option is therefore = 5.60

Cover Drilling

In addition to the above, cover drilling and diamond drilling costs will be markedly less for a mechanised operation due to the reduction in development. This difference has been estimated at R3.10/ton. (R4.93 – R1.83)
Difference in cover/diamond drilling costs in favour of the mechanised option is therefore = 3.10

Operation of Footwall Service Levels

It has been calculated from information at Cooke 2, R.E.G.M, that the costs of operating footwall service levels for a conventional scattered mining operation is of the order of R3.85/ton. Assume cost of operating a gathering haulage to be R0.65/ton.
Difference in favour of mechanised operation is therefore = 3.20

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The total working cost savings from a mechanised operation can therefore be summarised as follows:

<table>
<thead>
<tr>
<th></th>
<th>R/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoping Costs</td>
<td>1.05</td>
</tr>
<tr>
<td>Development Costs</td>
<td>5.60</td>
</tr>
<tr>
<td>Cover/Diamond Drilling</td>
<td>3.10</td>
</tr>
<tr>
<td>Operation of Footwall Levels</td>
<td>3.20</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>12.95</strong></td>
</tr>
</tbody>
</table>

It is, therefore, believed that a cost saving of R11/ton on the conventional working costs can be realised.

**CONCLUSIONS**

The conventional scattered mining method initially proposed for the H.J. Joel Gold Mine was considered to be labour intensive and could be expected to provide for excessive waste development.

The alternative method of mining introduced to H.J. Joel Gold Mine based on the trackless access/gathering haulage concept has certain major advantages over the conventional method; these advantages can be detailed as follows:

(a) The working costs will be less mainly because of a marked reduction in labour complements and significantly less footwall development.
(b) There will be a reduction in capital expenditure; estimated at 11%.
(c) A vast improvement in productivity due to the reduced labour complements.
(d) It will be a safer operation.

It is realised that dilution could be a main area of concern for a trackless mining operation in narrow reef conditions. However, considerable attention has been given to this matter and, in terms of the proposed cycles for development and stoping operations, it is confidently predicted that the problem will be overcome; the calculations indicate that dilution can be controlled and will not be excessive.

**ACKNOWLEDGEMENT**

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**REFERENCE**

K.A. Rhodes, AMM Circular 1/86.

K.A. RHODES
OCTOBER 1987
FIG. 2: Results and status of boreholes.
FIG. 4: Scattered mining development layout.
FIG. 5: Trackless access and main reef development.
FIG. 6: Section through No. 3 and 4 shafts.
FIG. 8: 60 Level station and future development.
Fig. 9: 70 Level station and future development.

Legend:
- Future waste development.
- Existing development as at October 1987.

Not to scale.
FIG. 10: 90 Level station and future development.
FIG. 11: Shaft system: No. 3 and 4 shafts.
FIG. 12: Trackless access and main reef development Ex. 3 and 4 shafts.
FIG. 13: Total footwall waste development Ex. 3 and 4 shafts.
<table>
<thead>
<tr>
<th>DEVELOPMENT</th>
<th>W (M) x H (M)</th>
<th>REEP</th>
<th>DETAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Access Roadway North</td>
<td>5.0 x 4.5</td>
<td>Waste</td>
<td>From shaft at 60 Level. Flat development to intersection of reef plane. No tracks installed.</td>
</tr>
<tr>
<td>Main Access Ramp</td>
<td>5.6 x 4.5</td>
<td>Waste</td>
<td>From shaft at 60 Level. Development at 140° to intersect reef at sub-outcrop positions.</td>
</tr>
<tr>
<td>70 Level Main Access Roadway North</td>
<td>5.6 x 4.5</td>
<td>Waste</td>
<td>Main footwall haulage from shaft on 70 Level.</td>
</tr>
<tr>
<td>70 Level Gathering Haulages A,B etc</td>
<td>5.6 x 4.5</td>
<td>Waste</td>
<td>From 70 level main haulage to each reef block A,B etc, with ore passes up to reef elevation.</td>
</tr>
<tr>
<td>90 Level Main and Gathering Haulages</td>
<td>4.5 x 4.5</td>
<td>Waste</td>
<td>As for 70 level but with track installed.</td>
</tr>
<tr>
<td>Main Access Reef Decline (M.A.R.D)</td>
<td>4.6 x 3.8</td>
<td>Reef</td>
<td>Developed on reef horizon minus 80°.</td>
</tr>
<tr>
<td>Footwall Service Decline (F.S.D)</td>
<td>4.5 x 4.5</td>
<td>Waste</td>
<td>Development in footwall 15 metres below and parallel to main access reef decline at minus 80°.</td>
</tr>
<tr>
<td>Access Reef Decline (A.R.D)</td>
<td>4.6 x 3.8</td>
<td>Reef</td>
<td>Developed on reef horizon at minus 80° parallel to M.A.R.D and at 150 metre intervals.</td>
</tr>
<tr>
<td>Contour Drives</td>
<td>4.6 x 3.8</td>
<td>Reef</td>
<td>Developed at top of reef block to follow line of sub-outcrop.</td>
</tr>
<tr>
<td>Service Raise</td>
<td>4.6 x 3.8</td>
<td>Reef</td>
<td>Airway on reef horizon linking 2 adjacent A.R.D’s at the limits of a reef block.</td>
</tr>
<tr>
<td>Access Stope Drive</td>
<td>3.5 x 3.0</td>
<td>Reef</td>
<td>Developed on minor dip from A.R.D’s at 40 m intervals to establish stope panels.</td>
</tr>
</tbody>
</table>

FIG. 14: Development and definitions.
FIG. 15: General layout of stope panels.
FIG. 16: Dilution control in access stope drives.
FIG. 17: Sketch showing advantages of E.O.D. bucket.
**Figure 18: Reef development: Reef and waste tons trammed (per metre advanced).**

<table>
<thead>
<tr>
<th>TOTAL TONS PER METRE ADVANCED</th>
<th>ACCESS REEF DECLINE (SECTION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00</td>
<td>REEF HEIGHT</td>
</tr>
<tr>
<td>1.30</td>
<td>WASTE HEIGHT</td>
</tr>
<tr>
<td>20%</td>
<td>PERCENTAGE CLEANED</td>
</tr>
<tr>
<td>25</td>
<td>TONS IN SITU WASTE REEF</td>
</tr>
<tr>
<td>16</td>
<td>TONS TRAMMED WASTE REEF</td>
</tr>
<tr>
<td>38</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
FIG. 20: Turning points in access reef roadways.
CALCULATION OF DILUTION AT TURNING/TIPPING POINTS IN ACCESS REEF DECLINES

A) Sidewall Blasting

Area of additional waste blasted = 2 x 9,1 = 18,2 m²
Tons of waste blasted = 18,2 x 1,60 x 2,75 = 80 tons
Where: Average waste height = 160 cms

B) Hangingwall Stripping

Area of hangingwall to be blasted (see diagram) = 20 m²
Tons of waste blasted = 20 x 1,5 x 2,75 = 83 tons
Where: Thickness of h/wall stripped = 1,5m

Total waste tons blasted = 80 + 83 = 163 tons

Total reef produced in a panel = 40 x 150 x 1,43 x 2,75 = 23600 tons
Where: Face length
        Advance = 40 m
        Av. stope width = 150 m

As 163 tons of waste is produced at turning points for every 23 600 reef tons

\[
\text{Dilution} = \frac{163 \times 100}{23600} = 0,69 \% 
\]

N.B: This dilution will only occur if the waste blasted is trammed as reef.

Accompanying notes to figure 20: