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# APPENDICES

# CONTENTS

# APPENDIX A

## SELECTED WEARING COURSE MATERIAL SPECIFICATIONS FOR MINE HAUL ROADS

Haul Road Material Selection Specifications from Kaufman and Ault (1977).

| | |
|---|---|
| **SCREEN ANALYSIS (%) PASSING** | |
| 75.00mm | 100 |
| 63.00 | 100 |
| 53.00 | 100 |
| 37.50 | 100 |
| 26.50 | 98 |
| 19.00 | 92 |
| 13.20 | 82 |
| 4.75 | 65 |
| 2.00 | 53 |
| 0.425 | 33 |
| 0.075 | 16[A] |
| **CONSTANTS** | |
| Grading modulus | - |
| Dust ratio | - |
| Liquid limit | ≤25 |
| Plasticity index | ≤10 |
| Linear shrinkage (%) | - |
| Max dry density (kg/m$^3$) | - |
| OMC (%) | 12 |
| MMC (%) | - |
| Dry density (kg/m$^3$) | - |
| % Max dry density | - |
| 100% Mod CBR | 80 |
| % Swell | - |
| Wearing course thickness | 150mm |

A Kaufman and Ault suggest a minimum of 5% fines for hot, dry conditions to prevent drying and loosening and a maximum of 10% fines for wet conditions to reduce slipperiness and cutting-up of the wearing course.

A-3

Haul Road Material Selection Specifications from Fung (1981). Adapted from AASHTO M147-65 standard specification for materials for aggregate and soil-aggregate subbase, base and surface courses.

| | |
|---|---|
| **SCREEN ANALYSIS (%) PASSING** | |
| 75.00mm | - |
| 63.00 | - |
| 53.00 | - |
| 37.50 | - |
| 26.50 | 100 |
| 19.00 | - |
| 13.20 | - |
| 9.75 | 50-85 |
| 4.75 | 35-65 |
| 2.00 | 25-50 |
| 0.425 | 15-30 |
| 0.075 | 8-15 |
| **CONSTANTS** | |
| Grading modulus | - |
| Dust ratio | >0,66 |
| Liquid limit | ≤35 |
| Plasticity index | ≤4-9 |
| Linear shrinkage (%) | - |
| Max dry density (kg/m$^3$) | - |
| OMC (%) | - |
| MMC (%) | - |
| Dry density (kg/m$^3$) | - |
| % Max dry density | - |
| 100% Mod CBR | 80 |
| % Swell | - |
| Wearing course thickness | - |

Haul Road Material Selection Specifications from McInnes (1982). Adapted from the Standards Association of Australia (NAASRA, 1974) specification for pavement materials (part 2) for natural gravels, sand-clay and soft and fissile rock.

| **SCREEN ANALYSIS (%) PASSING** | A |
|---|---|
| 75.00mm | - |
| 63.00 | - |
| 53.00 | - |
| 37.50 | - |
| 26.50 | - |
| 19.00 | 55 |
| 13.20 | - |
| 9.75 | - |
| 4.75 | - |
| 2.00 | ≤30 |
| 0.425 | - |
| 0.075 | - |
| **CONSTANTS** | |
| Grading modulus | - |
| Dust ratio | - |
| Liquid limit | ≤35 |
| Plasticity index | ≤4-15[B] |
| Linear shrinkage (%) | ≤6 |
| Max dry density (kg/m$^3$) | - |
| OMC (%) | - |
| MMC (%) | - |
| Dry density (kg/m$^3$) | - |
| % Max dry density | - |
| 100% Mod CBR | 60 |
| % Swell | - |
| Aggregate pliers value (%) | 20 |
| Wearing course thickness | 150 |

[A] McInnes presents details of grading requirements in terms of a grading envelope similar to Olmstead's chart together with similar functionality defect descriptions for materials outside the suggested grading envelope. Olmstead's chart for mechanically stable mixtures is presented overleaf.

[B] Suggested values for gravel and soft rock. If enough gravel fraction present, McInnes proposes PI may be extended upto 25. Sand-clays limited to low rainfall regions (<400mm) and a PI of 5-15.

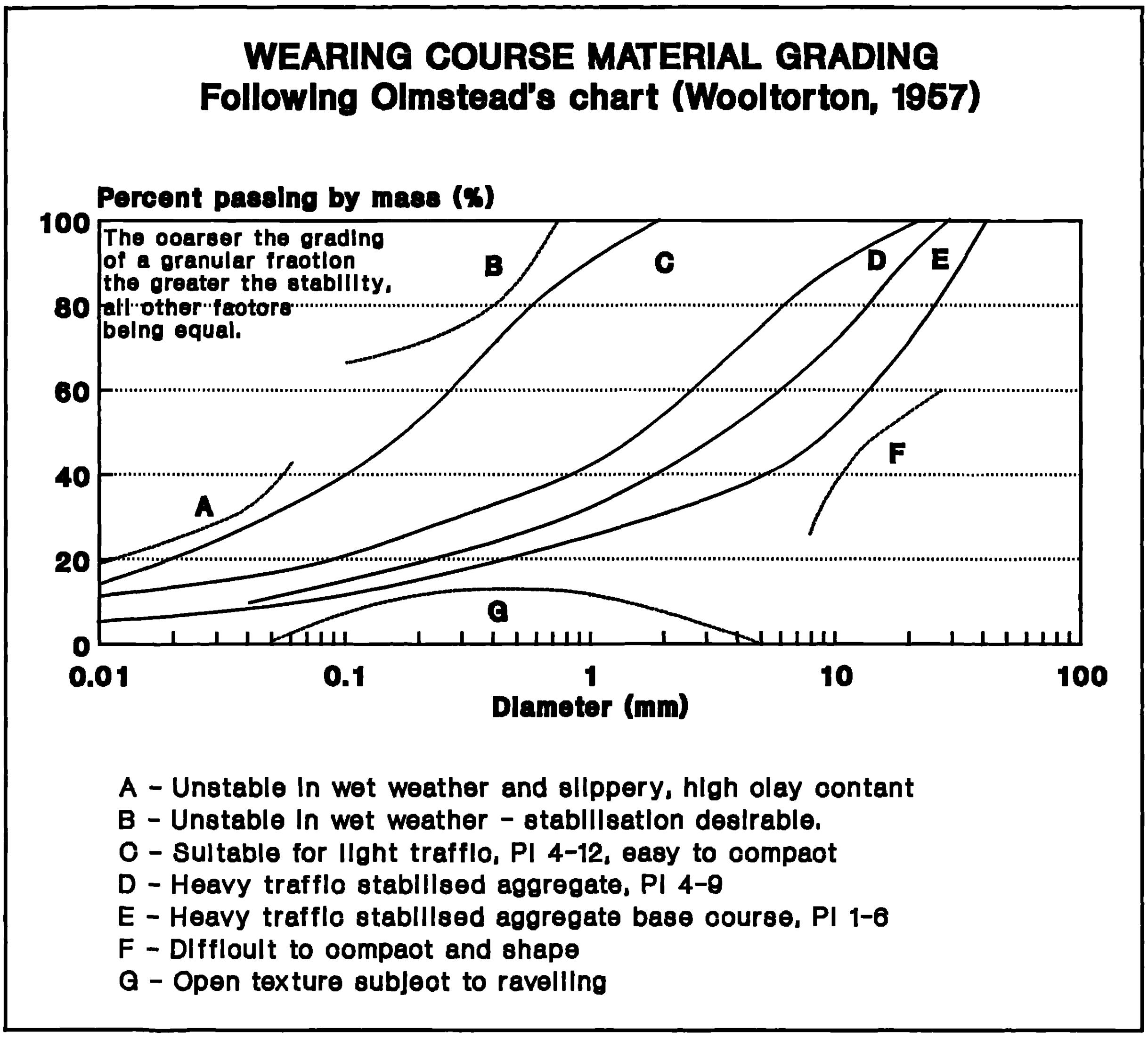



**Figure 1** Olmstead's chart for suitable wearing course material grading envelopes.

# APPENDIX B

## DYNAMIC CONE PENETROMETER ANALYSIS OF PAVEMENT STRUCTURES

B-2

**Contents**

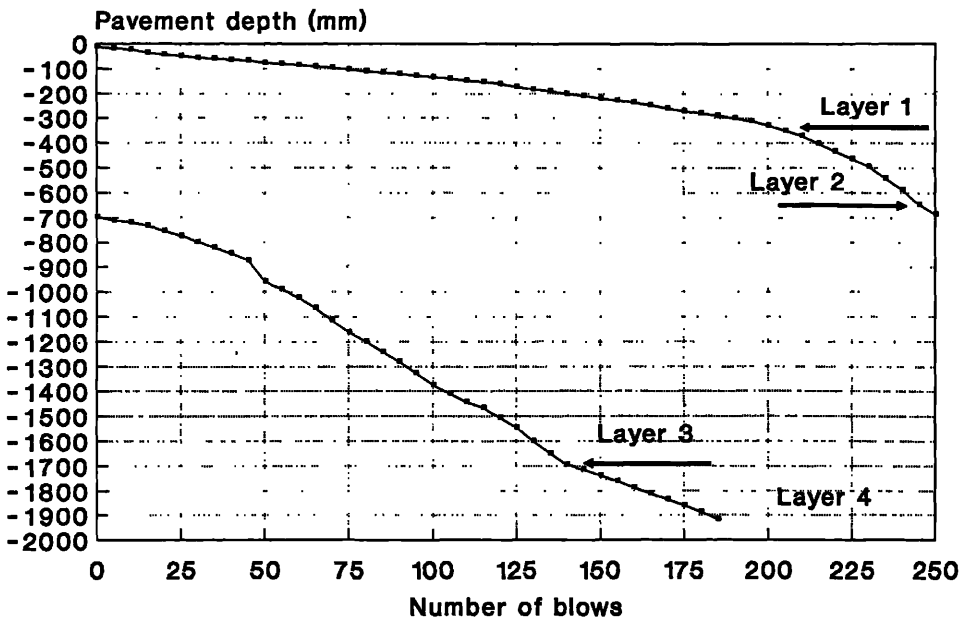
DCP Curve Diagram
Layer CBR and redefined CBR Diagram
Balance Curve Diagram

For Kriel, Kromdraai and New Vaal Colliery test sites 1, 2 and 3.

## DCP CURVE

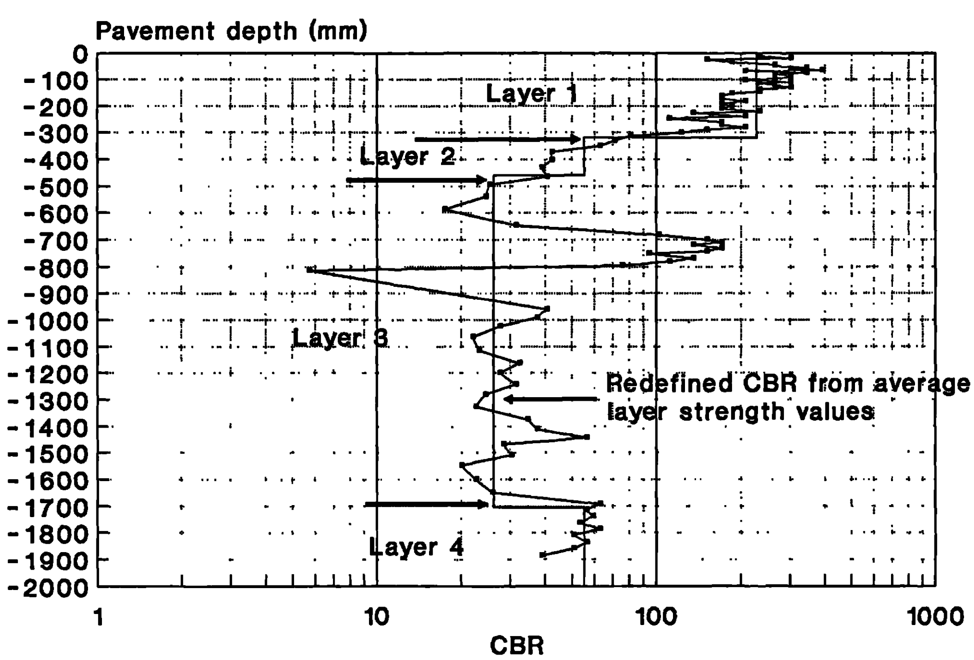
Kriel Site 1

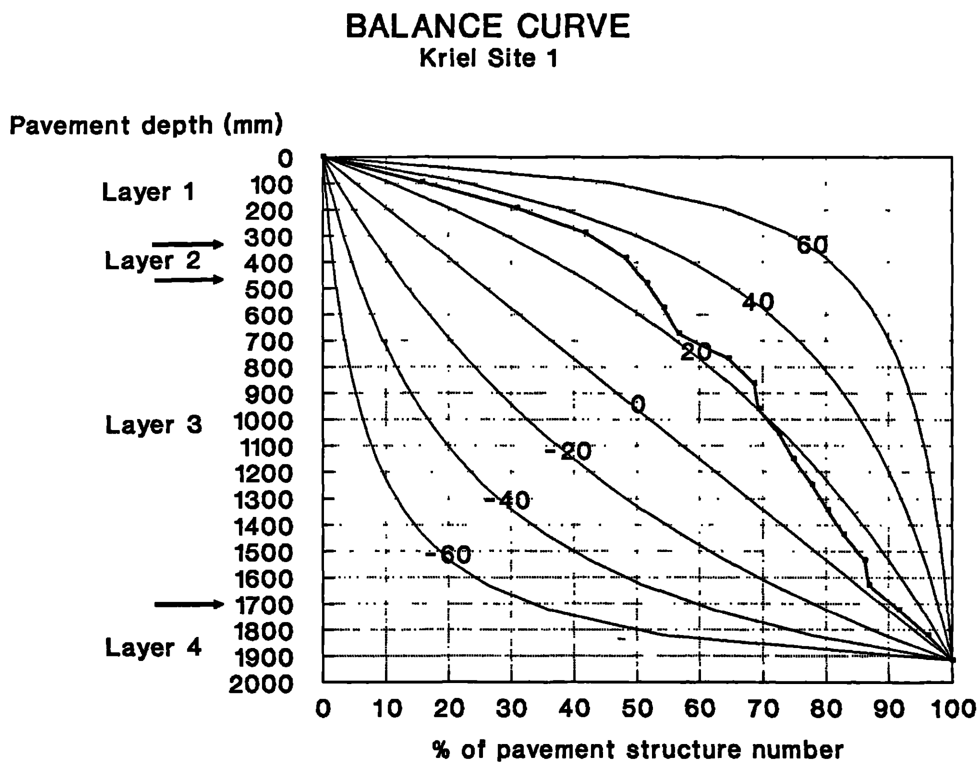
Two tests to 1.918m at CH 563.00

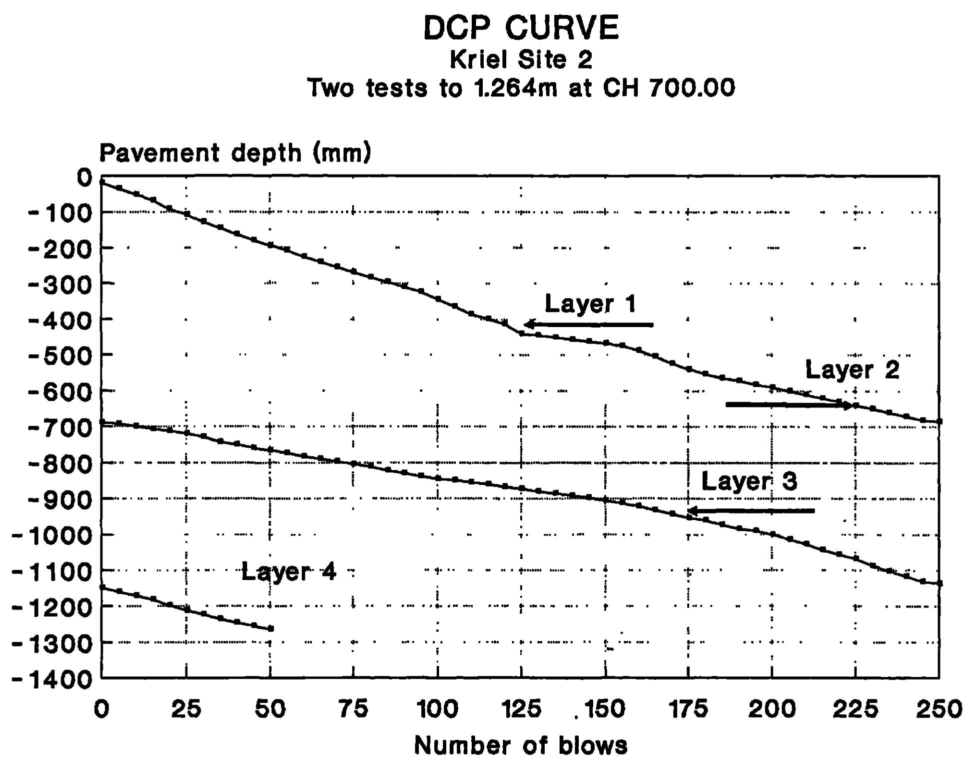


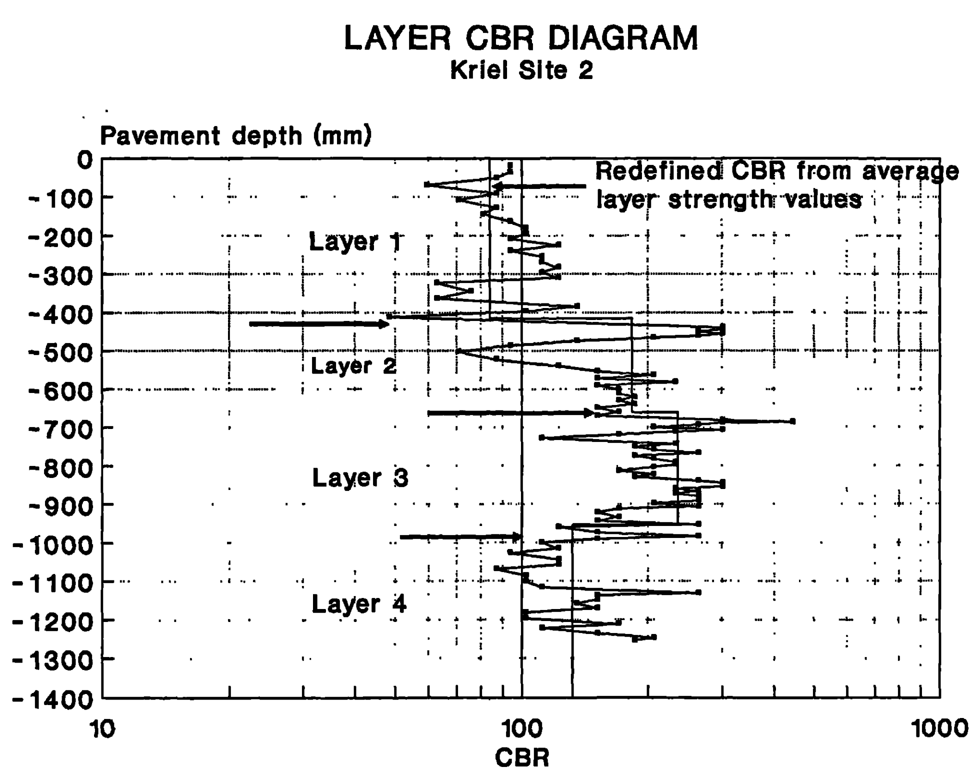

## LAYER CBR DIAGRAM

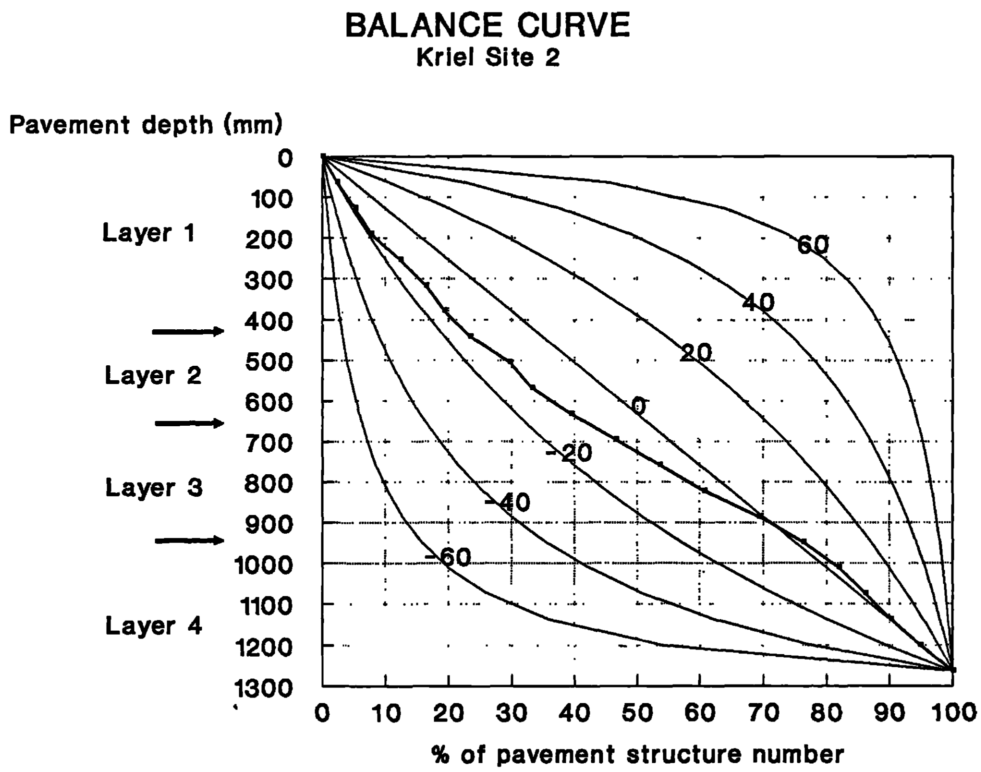
Kriel Site 1

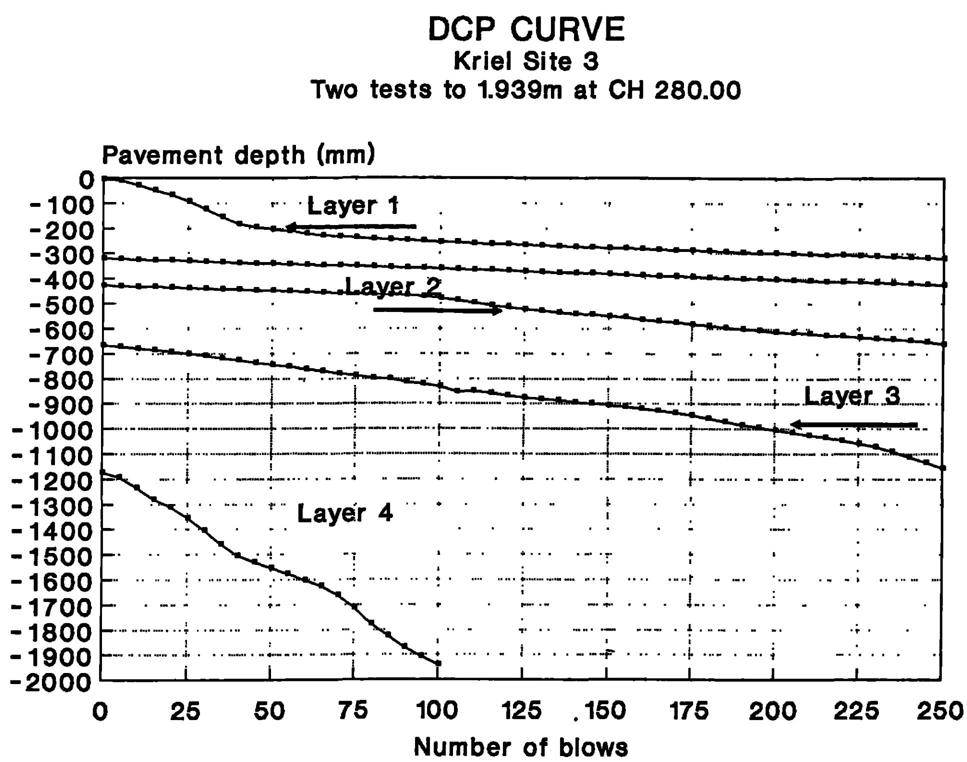


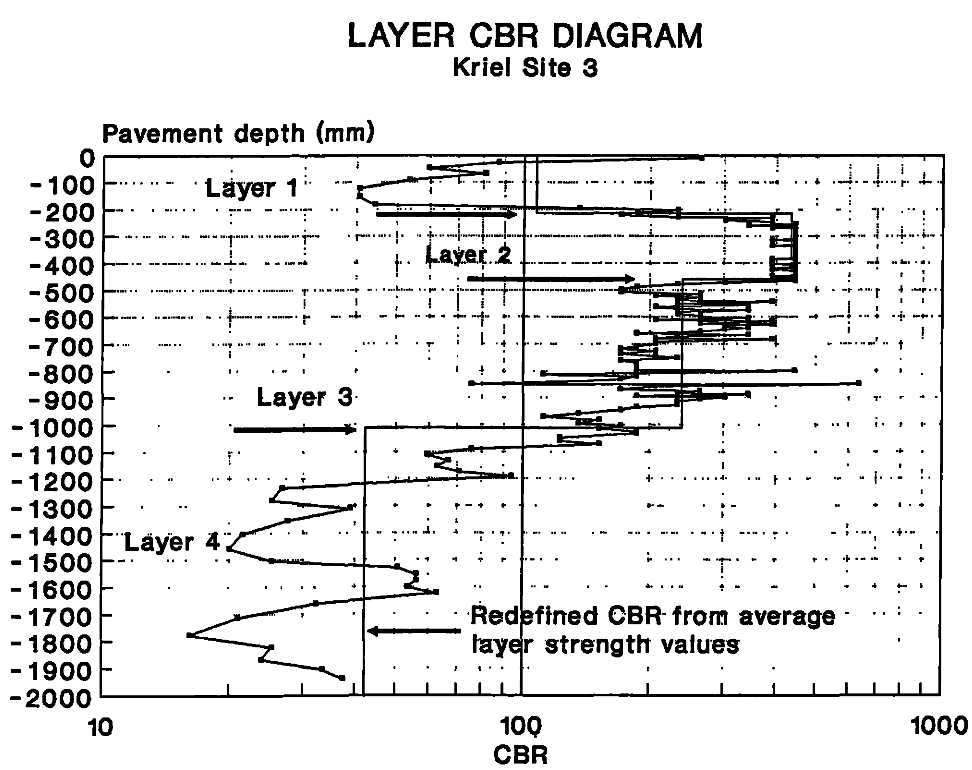

BALANCE CURVE
Kriel Site 1
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
Layer 4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
60
40
20
0
-20
-40
-60
0 10 20 30 40 50 60 70 80 90 100
% of pavement structure number

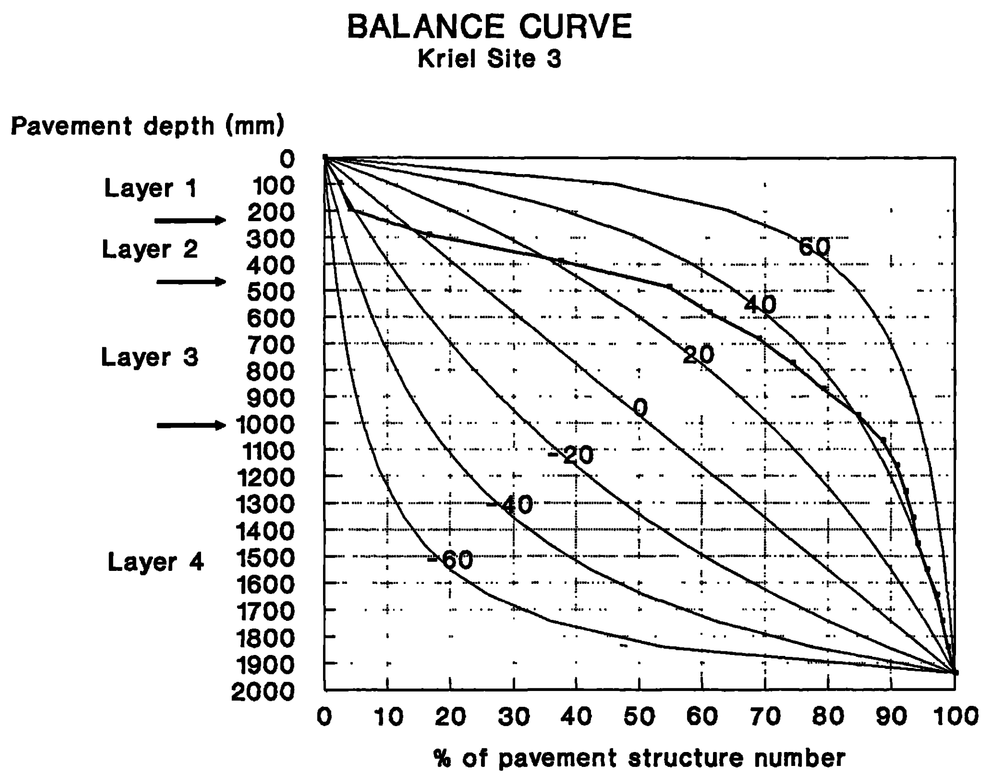

DCP CURVE
Kriel Site 2
Two tests to 1.264m at CH 700.00
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
Layer 1
Layer 2
Layer 3
Layer 4
0
25
50
75
100
125
150
175
200
225
250
Number of blows

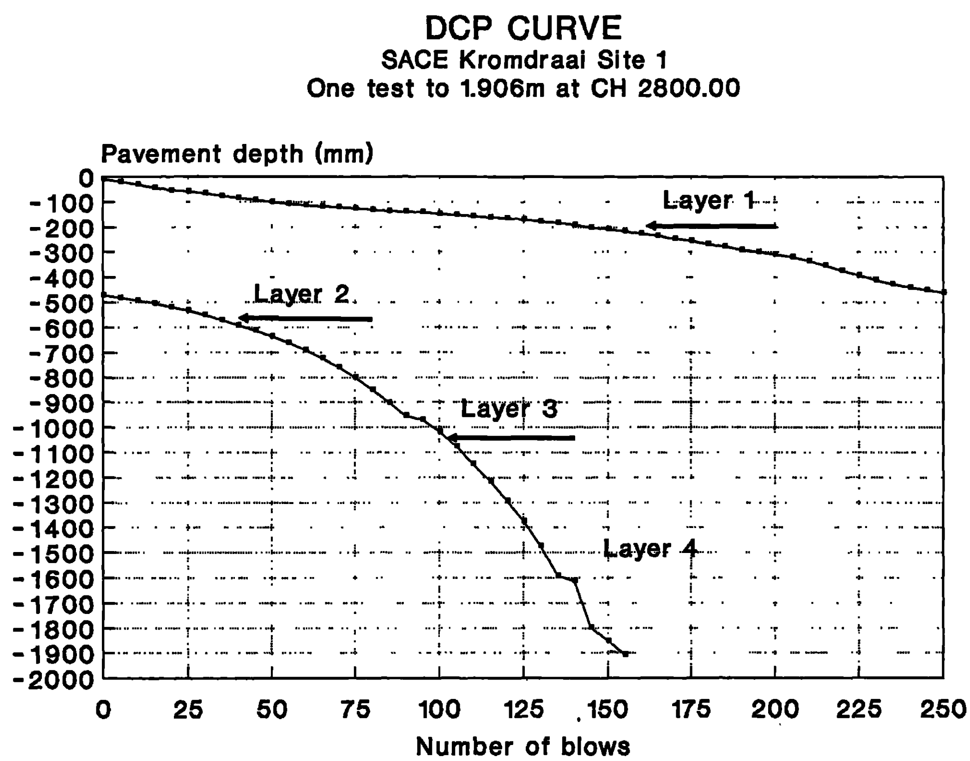

LAYER CBR DIAGRAM
Kriel Site 2
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
Redefined CBR from average layer strength values
Layer 1
Layer 2
Layer 3
Layer 4
10
100
1000
CBR

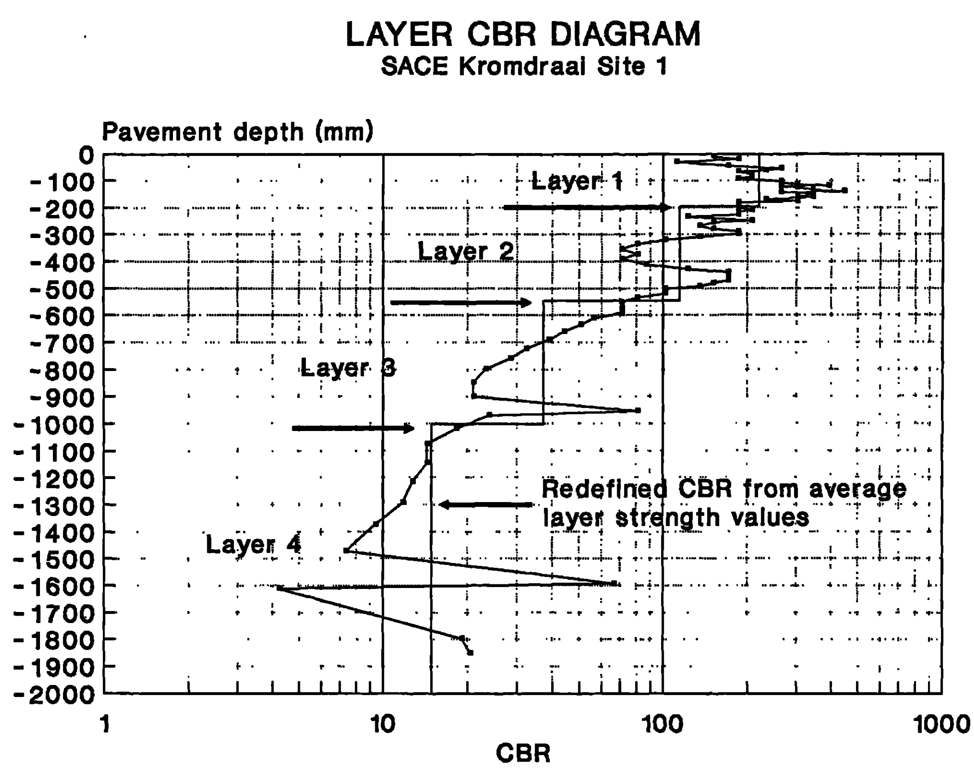

BALANCE CURVE
Kriel Site 2
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
Layer 4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
0
10
20
30
40
50
60
70
80
90
100
% of pavement structure number
60
40
20
0
-20
-40
-60

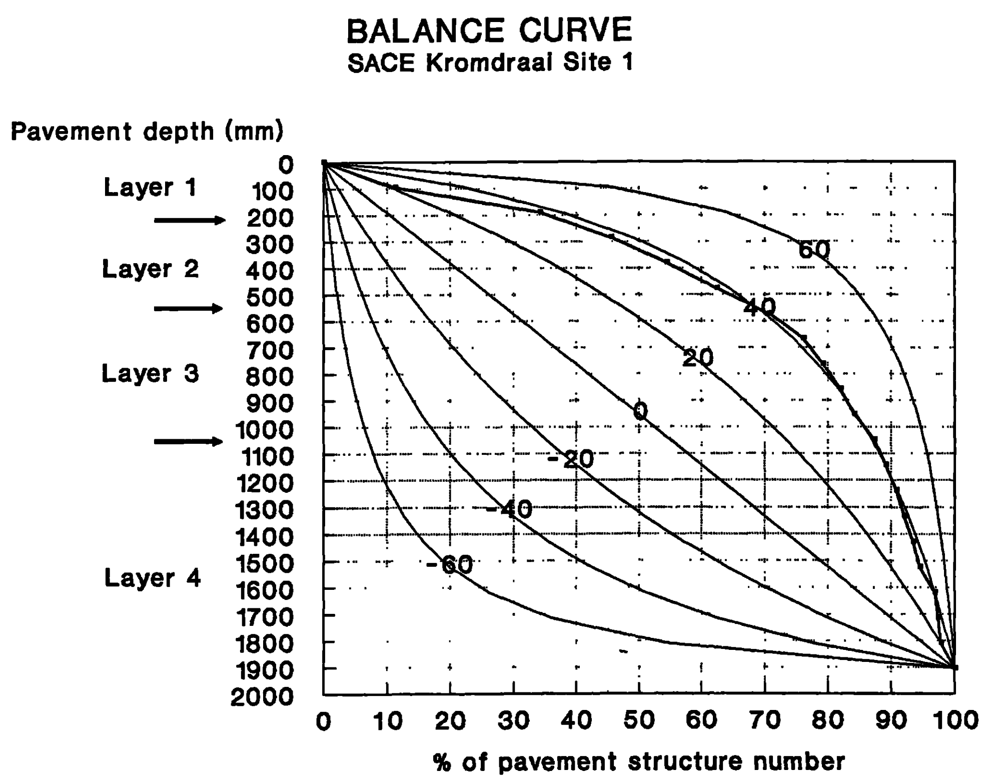

DCP CURVE
Kriel Site 3
Two tests to 1.939m at CH 280.00
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
Layer 1
Layer 2
Layer 3
Layer 4
0
25
50
75
100
125
150
175
200
225
250
Number of blows


LAYER CBR DIAGRAM
Kriel Site 3
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
Layer 1
Layer 2
Layer 3
Layer 4
Redefined CBR from average
layer strength values
10
100
1000
CBR


BALANCE CURVE
Kriel Site 3
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
Layer 4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
60
40
20
0
-20
-40
-60
0
10
20
30
40
50
60
70
80
90
100
% of pavement structure number

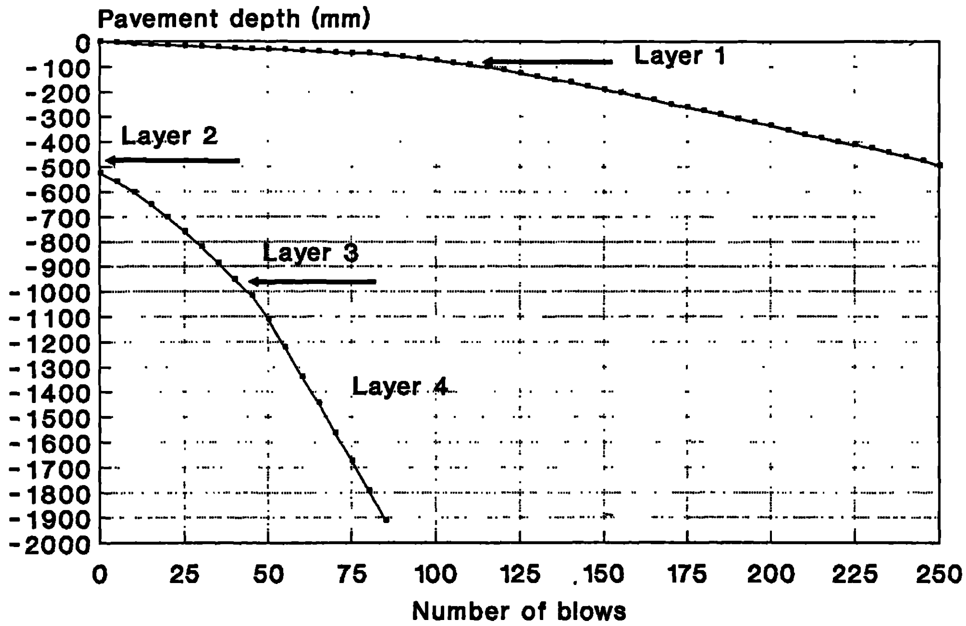

DCP CURVE
SACE Kromdraai Site 1
One test to 1.906m at CH 2800.00
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
Layer 1
Layer 2
Layer 3
Layer 4
0
25
50
75
100
125
150
175
200
225
250
Number of blows


LAYER CBR DIAGRAM
SACE Kromdraai Site 1
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
Layer 1
Layer 2
Layer 3
Layer 4
Redefined CBR from average
layer strength values
1
10
100
1000
CBR


BALANCE CURVE
SACE Kromdraai Site 1
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
Layer 4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
60
40
20
0
-20
-40
-60
0 10 20 30 40 50 60 70 80 90 100
% of pavement structure number

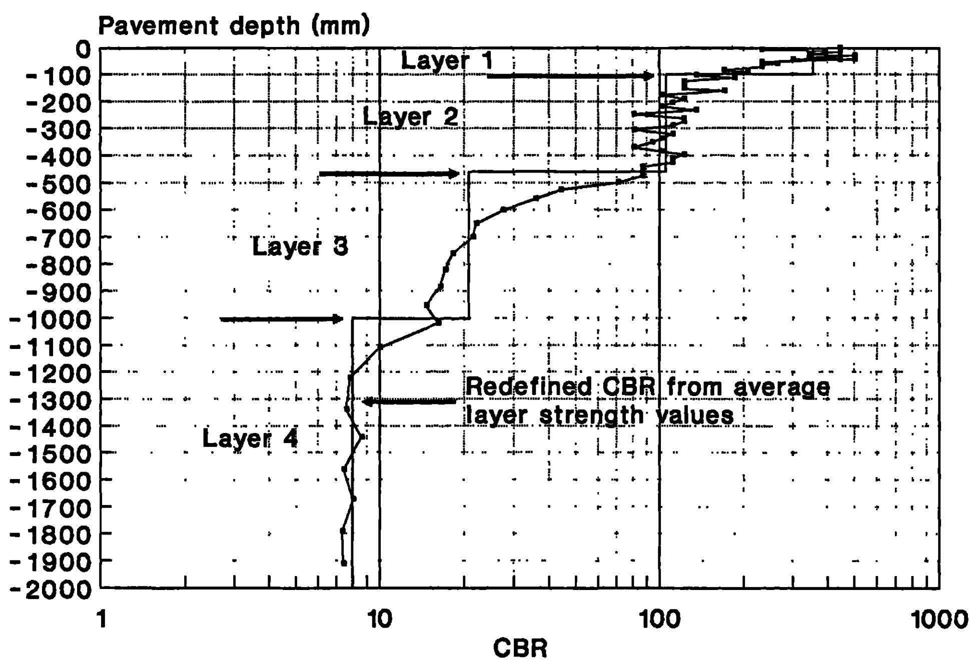
## DCP CURVE

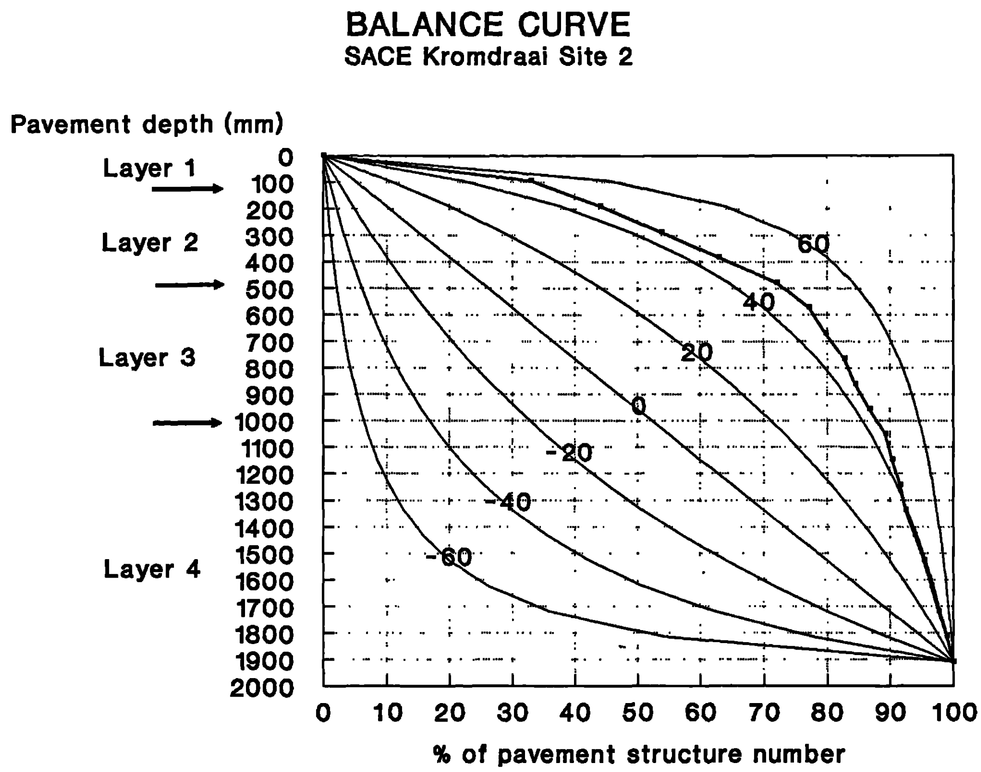
SACE Kromdraai Site 2
One test to 1.911m at CH 1900.00



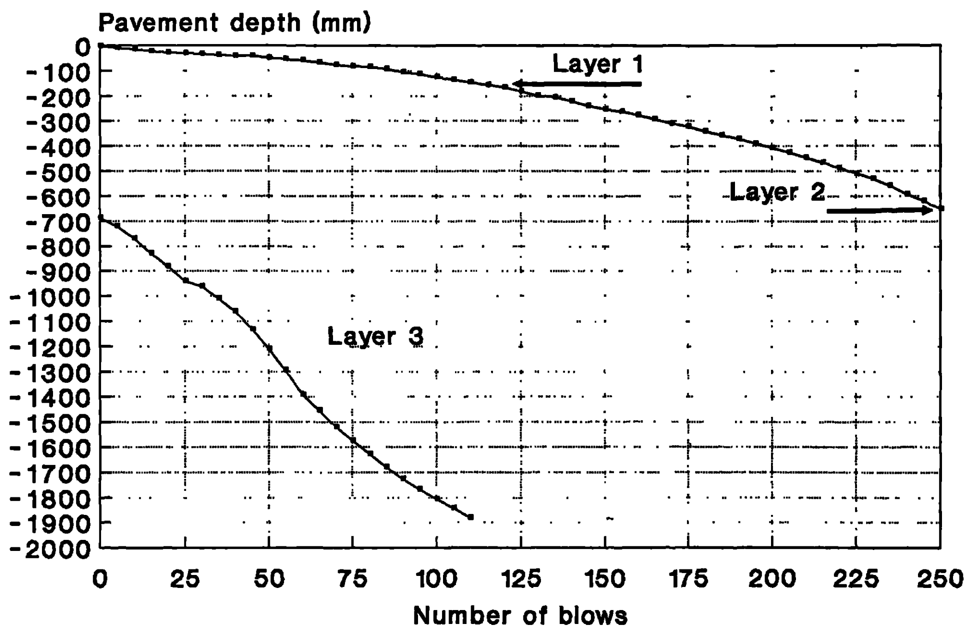

## LAYER CBR DIAGRAM

SACE Kromdraai Site 2

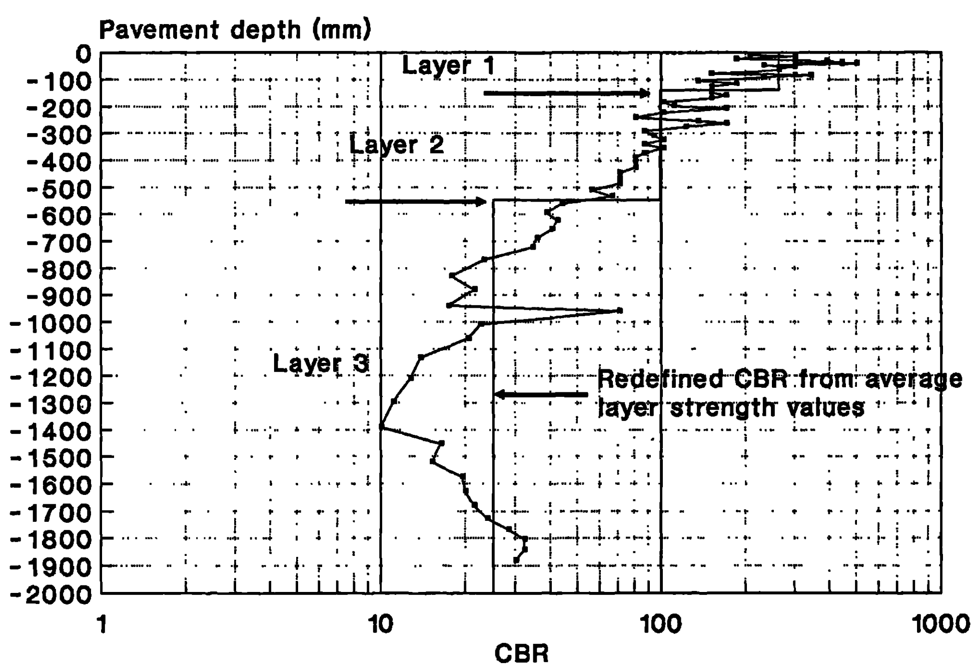


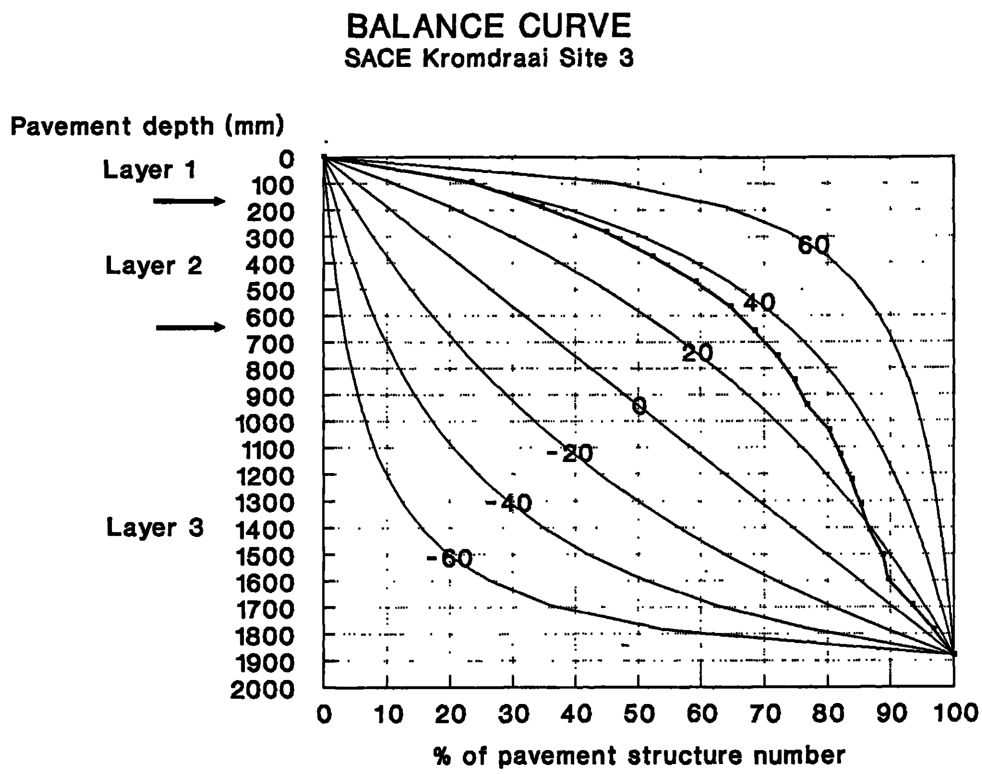

BALANCE CURVE
SACE Kromdraai Site 2
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
Layer 4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
60
40
20
0
-20
-40
-60
0 10 20 30 40 50 60 70 80 90 100
% of pavement structure number

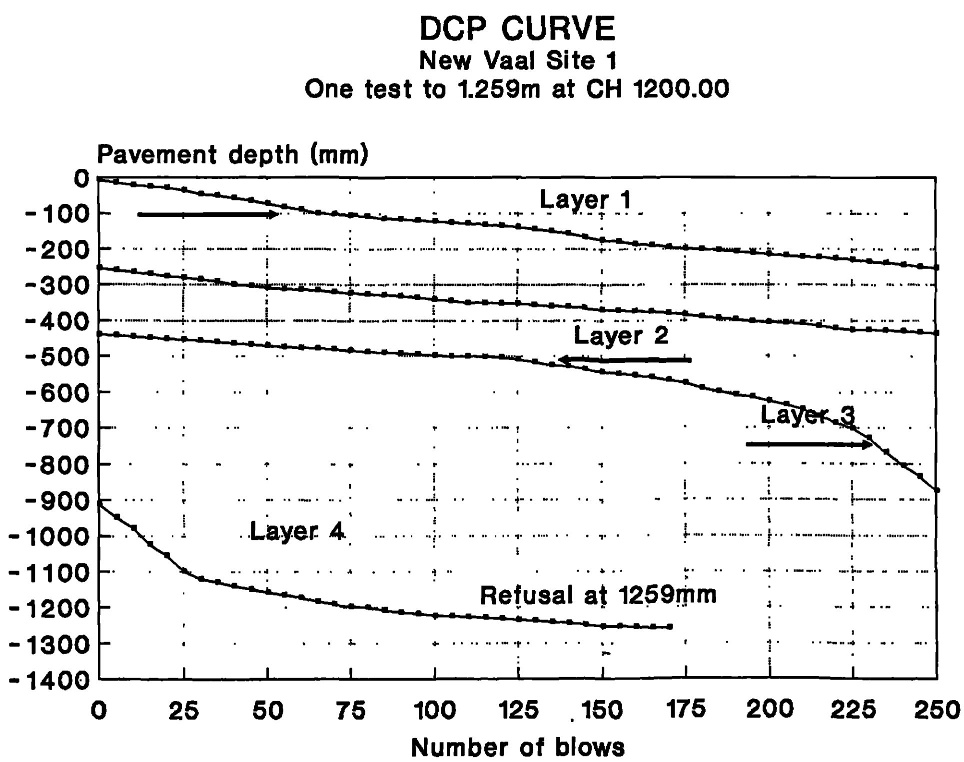
## DCP CURVE
SACE Kromdraai Site 3
One test to 1.881m at CH 1075.00

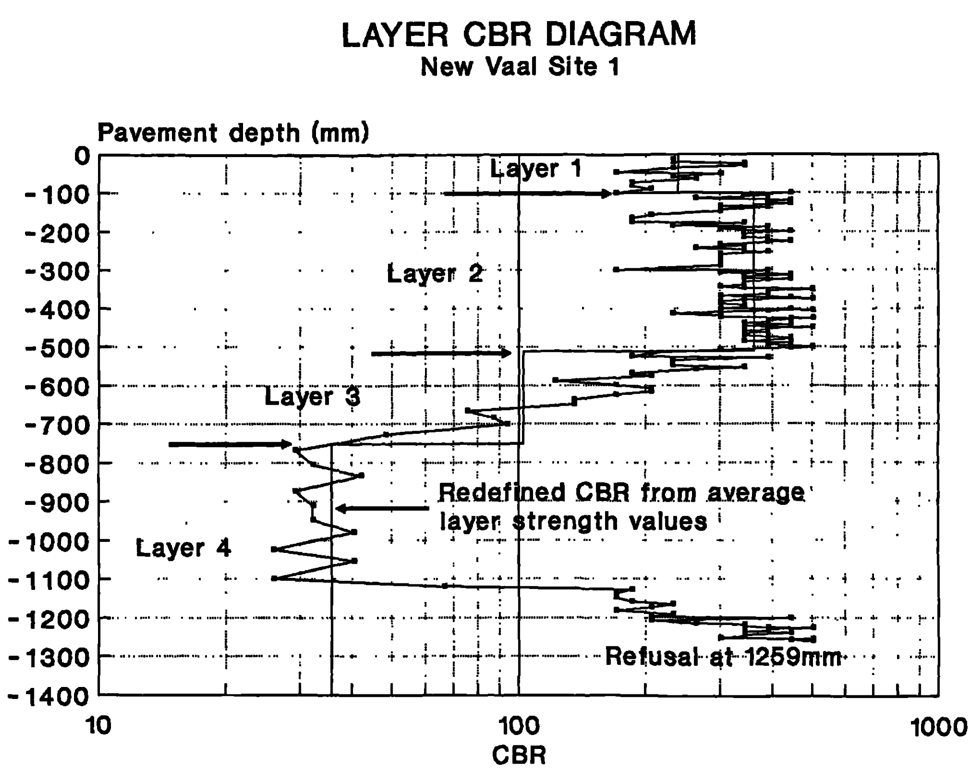


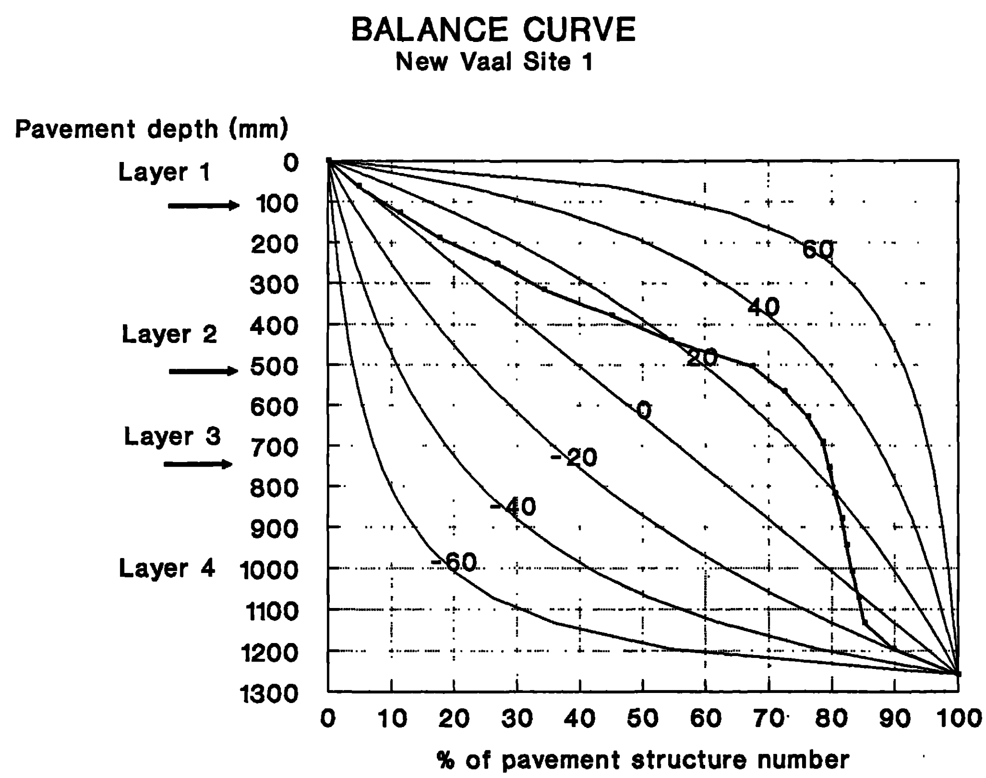

## LAYER CBR DIAGRAM
SACE Kromdraai Site 3




BALANCE CURVE
SACE Kromdraai Site 3
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
0 10 20 30 40 50 60 70 80 90 100
% of pavement structure number
60
40
20
0
-20
-40
-60


DCP CURVE
New Vaal Site 1
One test to 1.259m at CH 1200.00
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
0
25
50
75
100
125
150
175
200
225
250
Number of blows
Layer 1
Layer 2
Layer 3
Layer 4
Refusal at 1259mm

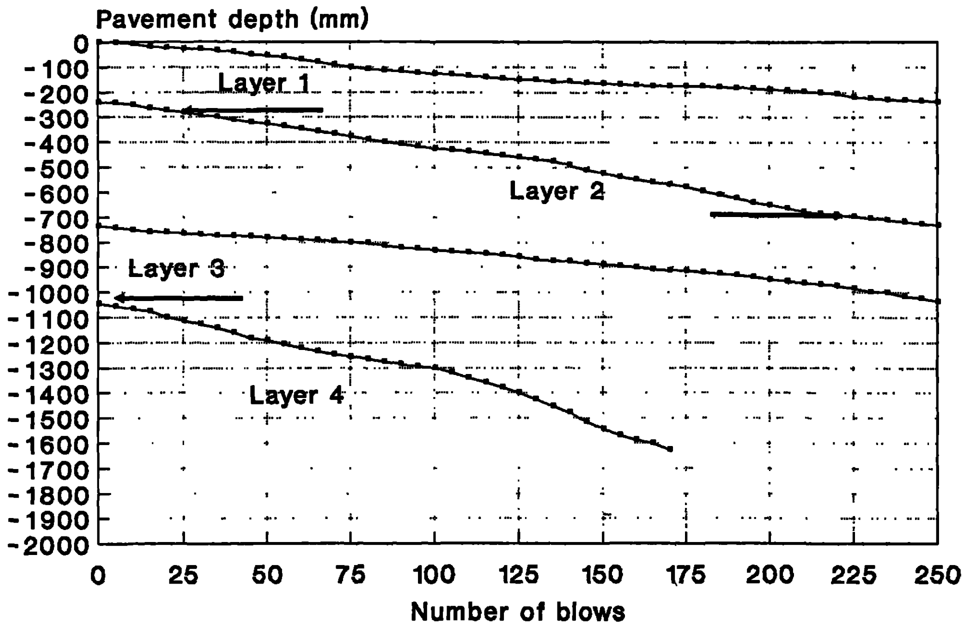

LAYER CBR DIAGRAM
New Vaal Site 1
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
10
100
1000
CBR
Layer 1
Layer 2
Layer 3
Layer 4
Redefined CBR from average layer strength values
Refusal at 1259mm


BALANCE CURVE
New Vaal Site 1
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
Layer 4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
60
40
20
0
-20
-40
-60
0 10 20 30 40 50 60 70 80 90 100
% of pavement structure number

# DCP CURVE

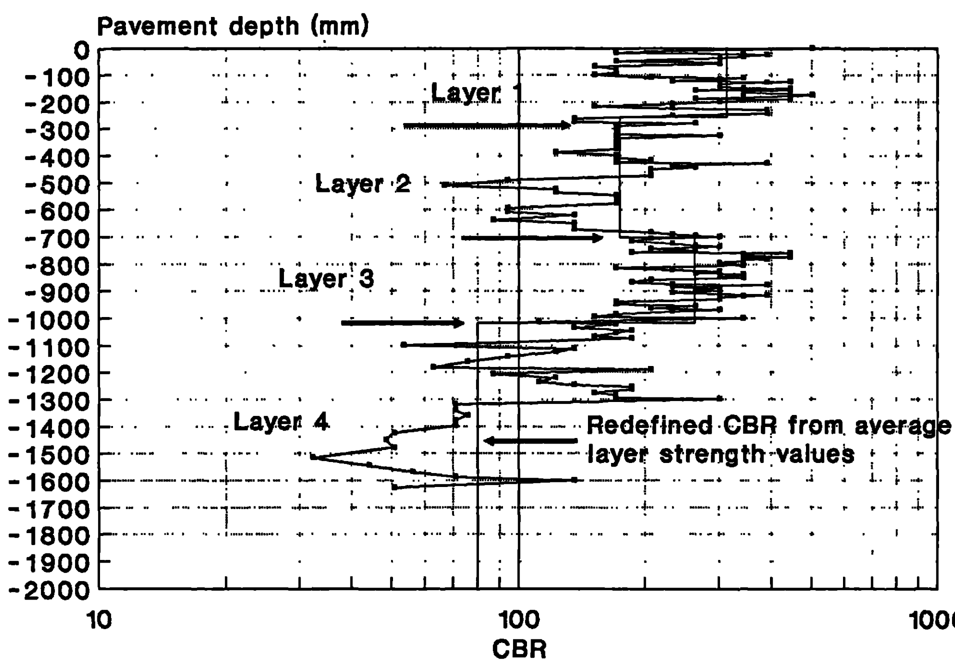
New Vaal Site 2

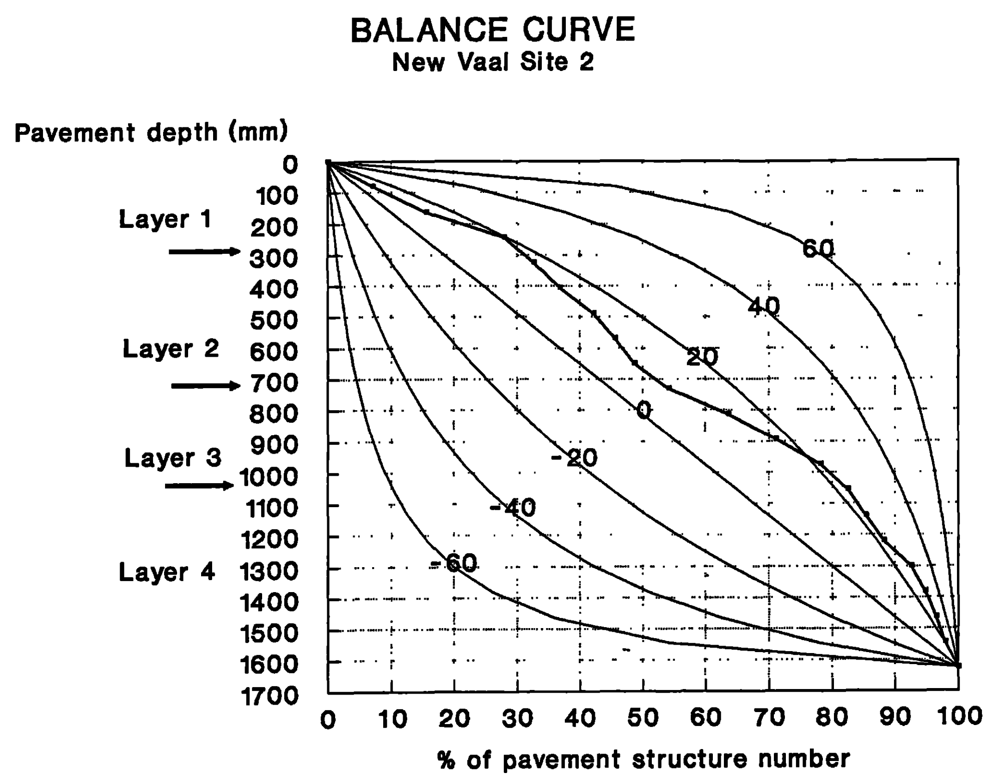
One test to 1.620m at CH 3300.00

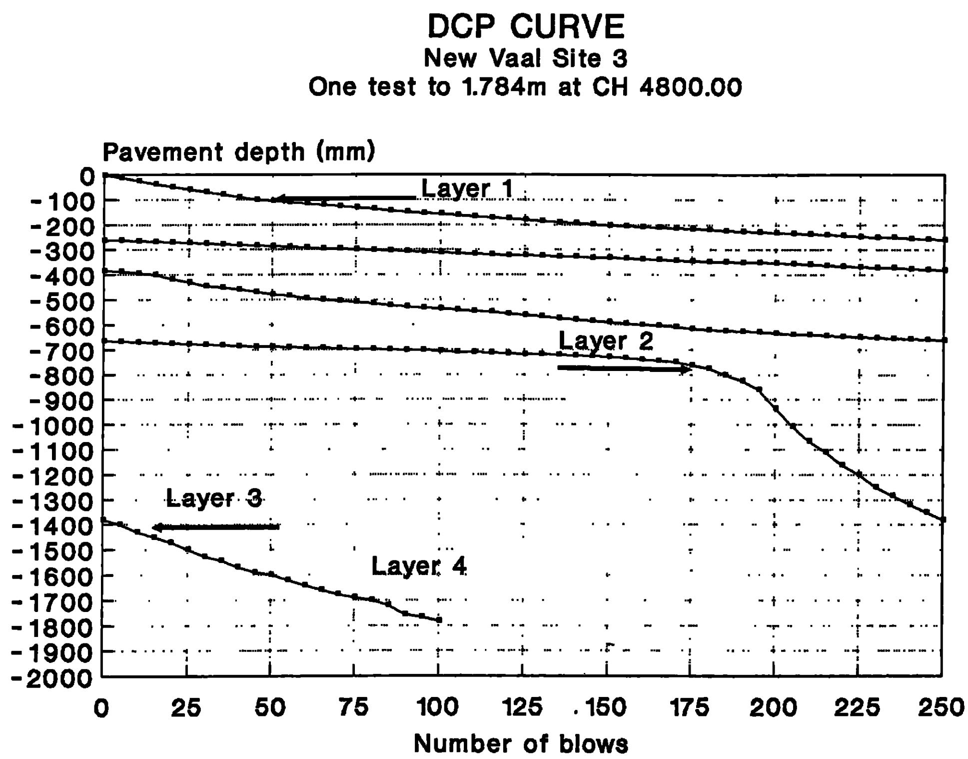


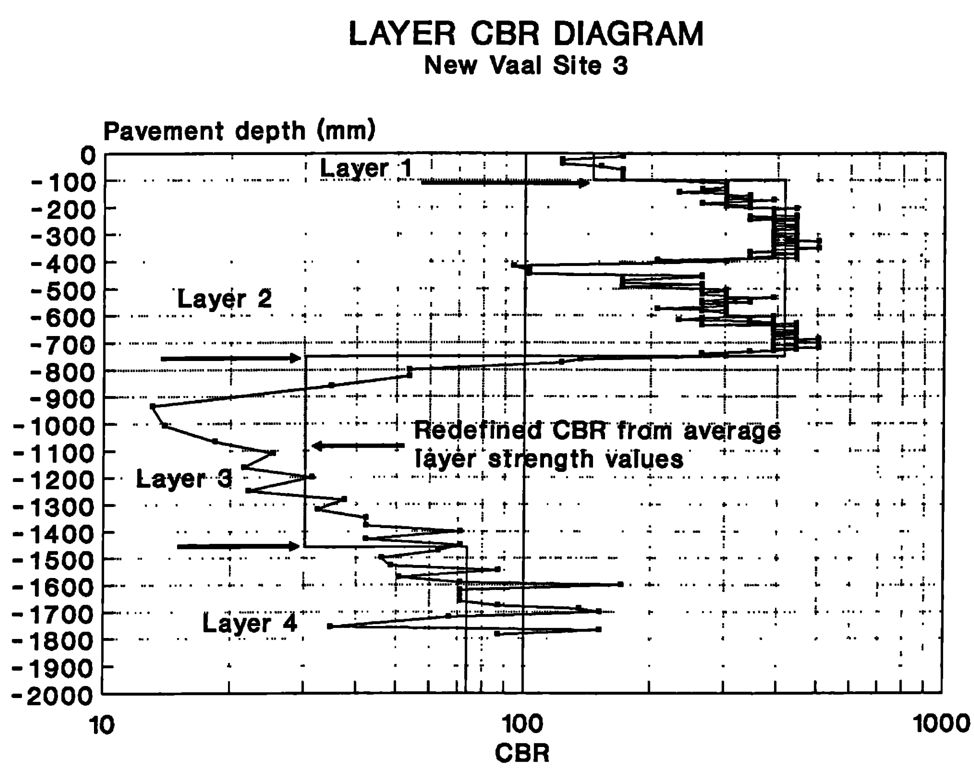

# LAYER CBR DIAGRAM

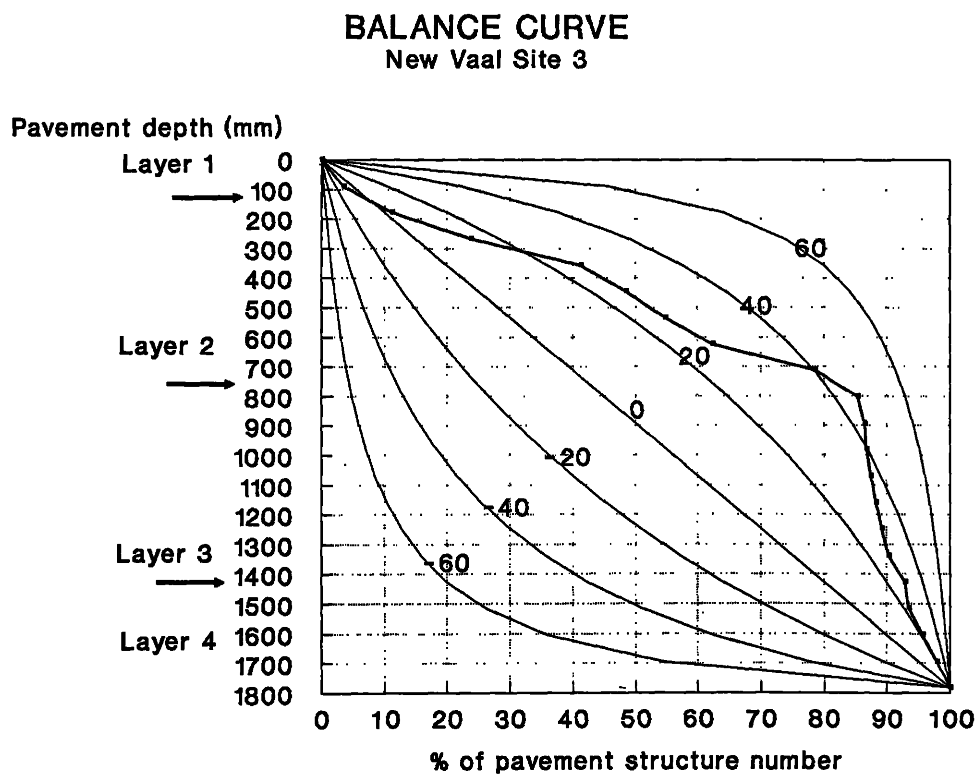
New Vaal Site 2




BALANCE CURVE
New Vaal Site 2
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
Layer 4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
60
40
20
0
-20
-40
-60
0 10 20 30 40 50 60 70 80 90 100
% of pavement structure number


DCP CURVE
New Vaal Site 3
One test to 1.784m at CH 4800.00
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
0
25
50
75
100
125
150
175
200
225
250
Number of blows
Layer 1
Layer 2
Layer 3
Layer 4


LAYER CBR DIAGRAM
New Vaal Site 3
Pavement depth (mm)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
10
100
1000
CBR
Layer 1
Layer 2
Redefined CBR from average layer strength values
Layer 3
Layer 4



BALANCE CURVE
New Vaal Site 3
Pavement depth (mm)
Layer 1
Layer 2
Layer 3
Layer 4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
0 10 20 30 40 50 60 70 80 90 100
% of pavement structure number
60
40
20
0
-20
-40
-60

# APPENDIX C

# CALIFORNIA BEARING RATIO (CBR) DESIGN PROCEDURE

## Contents

| CBR DESIGN METHOD<br>Euclid R170 Kriel Colliery | | |
|---|---|---|
| | REAR | FRONT |
| MAX LOAD PER WHEEL or DUAL SET (kN) | 858.0 | 406.0 |
| TYRE PRESSURE (kPa) | 630.0 | 630.0 |
| LOAD DISTRIBUTION (%) | 55.0 | 45.0 |
| LOAD REPETITION FACTOR (ALFA) | 0.78 | |
| CONTACT AREA SINGLE TYRE (SQ.M) (A) | 1.362 | 0.644 |
| CONTACT RADIUS SINGLE TYRE (M) (r) | 0.658 | 0.453 |
| | | r EQUIV |
| TYRE WIDTH (M) | 0.90 | |
| FRONT TO REAR AXLE DISTANCE (m) | 5.65 | 8.58 |
| REAR DUAL ASSEMBLY WIDTH (m) | 3.80 | 5.77 |
| SINGLE DUAL CENTRE TO CENTRE DISTANCE (m) | 1.37 | |

**Table C1.** Basic Data for CBR Cover Curve Evaluation.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 0.5 | 0.05 | 0.13 | 0.00 | 0.00 | **MAX DEFL** | **1.47** |
| FL | 0.5 | 0.15 | 0.13 | 0.00 | 0.00 | **EQV DEFL** | **1.34** |
| BR | 0.5 | 0.20 | 0.15 | 0.27 | 0.13 | **MAX ESWL(kN)** | **941.24** |
| BL | 0.5 | 0.11 | 0.15 | 0.27 | 1.34 | | |
| | TOTAL | 0.51 | 0.56 | 0.54 | 1.47 | | |

**Table C2.** ESWL for Points A B C and D at Depth 0.5r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 1 | 0.06 | 0.13 | 0.00 | 0.00 | **MAX DEFL** | **1.19** |
| FL | 1 | 0.15 | 0.13 | 0.00 | 0.00 | **EQV DEFL** | **1.06** |
| BR | 1 | 0.21 | 0.15 | 0.28 | 0.13 | **MAX ESWL(kN)** | **963.23** |
| BL | 1 | 0.11 | 0.15 | 0.28 | 1.06 | | |
| | TOTAL | 0.53 | 0.56 | 0.56 | 1.19 | | |

**Table C3.** ESWL for Points A B C and D at Depth 1r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 2 | 0.07 | 0.14 | 0.00 | 0.00 | **MAX DEFL** | **0.81** |
| FL | 2 | 0.16 | 0.14 | 0.00 | 0.00 | **EQV DEFL** | **0.67** |
| BR | 2 | 0.23 | 0.16 | 0.29 | 0.14 | **MAX ESWL(kN)** | **1037.28** |
| BL | 2 | 0.12 | 0.16 | 0.29 | 0.67 | | |
| | TOTAL | 0.58 | 0.60 | 0.58 | 0.81 | | |

**Table C4.** ESWL for Points A B C and D at Depth 2r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 3 | 0.08 | 0.14 | 0.00 | 0.00 | **MAX DEFL** | **0.62** |
| FL | 3 | 0.17 | 0.14 | 0.00 | 0.00 | **EQV DEFL** | **0.47** |
| BR | 3 | 0.23 | 0.17 | 0.27 | 0.14 | **MAX ESWL(kN)** | **1131.83** |
| BL | 3 | 0.12 | 0.17 | 0.27 | 0.47 | | |
| | TOTAL | 0.60 | 0.62 | 0.54 | 0.61 | | |

**Table C5.** ESWL for Points A B C and D at Depth 3r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 4 | 0.10 | 0.14 | 0.00 | 0.00 |
| FL | 4 | 0.16 | 0.14 | 0.00 | 0.00 |
| BR | 4 | 0.20 | 0.16 | 0.24 | 0.14 |
| BL | 4 | 0.11 | 0.16 | 0.24 | 0.36 |
| | TOTAL | 0.57 | 0.60 | 0.48 | 0.49 |

| | |
|---|---|
| **MAX DEFL** | **0.60** |
| **EQV DEFL** | **0.36** |
| **MAX ESWL(kN)** | **1430.00** |

**Table C6.** ESWL for Points A B C and D at Depth 4r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 5 | 0.11 | 0.14 | 0.00 | 0.00 |
| FL | 5 | 0.15 | 0.14 | 0.00 | 0.00 |
| BR | 5 | 0.19 | 0.15 | 0.23 | 0.14 |
| BL | 5 | 0.11 | 0.15 | 0.23 | 0.29 |
| | TOTAL | 0.56 | 0.58 | 0.46 | 0.43 |

| | |
|---|---|
| **MAX DEFL** | **0.58** |
| **EQV DEFL** | **0.29** |
| **MAX ESWL(kN)** | **1716.00** |

**Table C7.** ESWL for Points A B C and D at Depth 5r.

**Sample calculation for required CBR cover at specified depths**

Following the modified Equation [4.12] which relates required pavement thickness *t* (inches) to CBR (%);

$$t = \alpha\sqrt{A}\left(-0.0481-1.1562\left(\log\frac{CBR}{p_e}\right)-0.6414\left(\log\frac{CBR}{p_e}\right)^2-0.4730\left(\log\frac{CBR}{p_e}\right)^3\right) \quad [4.12]$$

where

$$p_e = \frac{ESWL}{A} \quad [4.10]$$

and

| | | |
|---|---|---|
| ESWL | = | equivalent single wheel load (kN) |
| A | = | contact area ($m^2$) |
| $\alpha$ | = | repetition factor |

using conversion factors of;

| | | |
|---|---|---|
| 1 pound per square inch (psi) | = | 6,894 kPa |
| 1 inch | = | 25,4mm |

to accomodate the original units of Equation [4.12].

The repetition factor is calculated from the average annual run-of-mine tonnage produced by each mine and an average haul truck fully laden capacity of 154t, over a 20 year life of mine. In the case of Kriel Colliery, producing some 400 000tpa equates to approximately 52 000 total repetitions. If four wheels are considered when calculating the ESWL, the repetition factor equates to 0,78.

Pavement layer CBR values are calculated iteratively from Equation [4.12] such that the calculated and required depth points (*t*) agree to within 1%. Results are given in Table C8.

| DEPTH (m) | Max ESWL (kN) | $P_e$ (psi) | t (inches) | t (calculated from Eqn 4.12) | Corresponding CBR (%) |
|---|---|---|---|---|---|
| 0.33 | 941.24 | 100.25 | 12.96 | 12.96 | 38.8 |
| 0.66 | 963.23 | 102.59 | 25.92 | 25.90 | 16.4 |
| 1.32 | 1037.28 | 110.48 | 51.84 | 51.50 | 5.6 |
| 1.98 | 1131.83 | 120.55 | 77.77 | 77.50 | 3.0 |
| 2.63 | 1430.00 | 152.51 | 103.69 | 102.44 | 2.3 |
| 3.29 | 1716.00 | 182.77 | 129.61 | 129.61 | 1.8 |

**Table C8.** Sample CBR Calculation Data at Various Depths of Pavement.

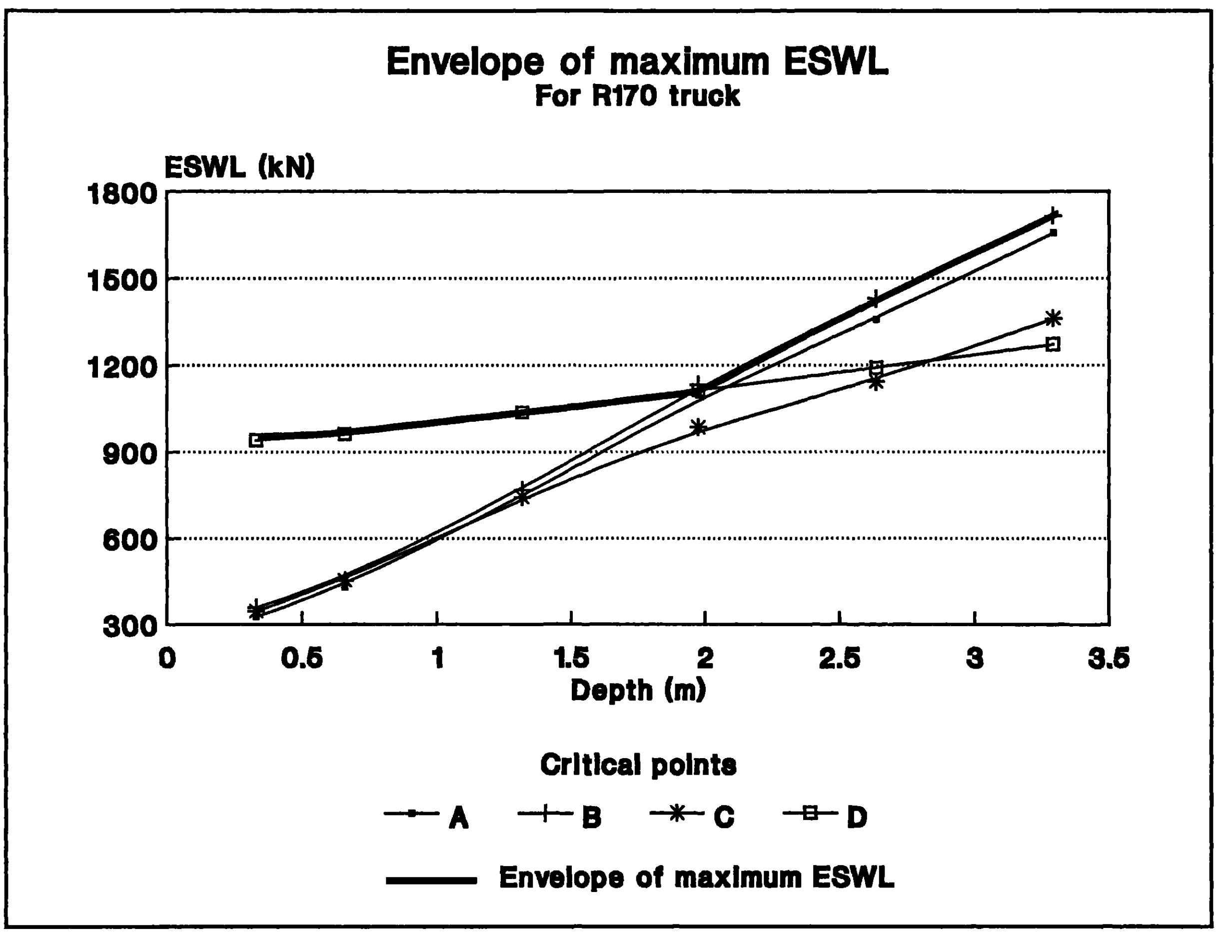



**Figure C1** Envelope of maximum ESWL - R170 truck

| **CBR DESIGN METHOD**<br>**Cat 772 (front and drive) Kriel Colliery** | | |
|---|---|---|
| | DRIVE | FRONT |
| MAX LOAD PER WHEEL or DUAL SET (kN) | 322.0 | 113.0 |
| TYRE PRESSURE (kPa) | 630.0 | 630.0 |
| LOAD DISTRIBUTION (%) | 73.0 | 27.0 |
| LOAD REPETITION FACTOR (ALFA) | 0.78 | |
| CONTACT AREA SINGLE TYRE (SQ.M) (A) | 0.511 | 0.179 |
| CONTACT RADIUS SINGLE TYRE (M) (r) | 0.403 | 0.239 |
| | | |
| | | r EQUIV |
| TYRE WIDTH (M) | 0.60 | |
| FRONT TO DRIVE AXLE DISTANCE (m) | 3.88 | 9.62 |
| DRIVE DUAL ASSEMBLY WIDTH (m) | 2.60 | 6.45 |
| SINGLE DUAL CENTRE TO CENTRE DISTANCE (m) | 0.80 | |

**Table C9.** Basic Data for CBR Cover Curve Evaluation.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 0.5 | 0.00 | 0.08 | 0.00 | 0.00 | **MAX DEFL** | **1.46** |
| FL | 0.5 | 0.11 | 0.08 | 0.00 | 0.00 | **EQV DEFL** | **1.34** |
| BR | 0.5 | 0.30 | 0.18 | 0.24 | 0.12 | **MAX ESWL(kN)** | **350.84** |
| BL | 0.5 | 0.11 | 0.18 | 0.24 | 1.34 | | |
| | TOTAL | 0.52 | 0.52 | 0.48 | 1.46 | | |

**Table C10.** ESWL for Points A B C and D at Depth 0.5r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 1 | 0.00 | 0.09 | 0.00 | 0.00 | **MAX DEFL** | **1.18** |
| FL | 1 | 0.11 | 0.09 | 0.00 | 0.00 | **EQV DEFL** | **1.06** |
| BR | 1 | 0.31 | 0.19 | 0.25 | 0.12 | **MAX ESWL(kN)** | **358.45** |
| BL | 1 | 0.12 | 0.19 | 0.25 | 1.06 | | |
| | TOTAL | 0.54 | 0.56 | 0.50 | 1.18 | | |

**Table C11.** ESWL for Points A B C and D at Depth 1r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 2 | 0.00 | 0.10 | 0.00 | 0.00 | **MAX DEFL** | **0.79** |
| FL | 2 | 0.12 | 0.10 | 0.00 | 0.00 | **EQV DEFL** | **0.67** |
| BR | 2 | 0.30 | 0.19 | 0.25 | 0.12 | **MAX ESWL(kN)** | **379.67** |
| BL | 2 | 0.12 | 0.19 | 0.25 | 0.67 | | |
| | TOTAL | 0.54 | 0.58 | 0.50 | 0.79 | | |

**Table C12.** ESWL for Points A B C and D at Depth 2r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 3 | 0.00 | 0.10 | 0.00 | 0.00 | **MAX DEFL** | **0.59** |
| FL | 3 | 0.12 | 0.10 | 0.00 | 0.00 | **EQV DEFL** | **0.47** |
| BR | 3 | 0.29 | 0.19 | 0.23 | 0.12 | **MAX ESWL(kN)** | **404.21** |
| BL | 3 | 0.12 | 0.19 | 0.23 | 0.47 | | |
| | TOTAL | 0.53 | 0.58 | 0.46 | 0.59 | | |

**Table C13.** ESWL for Points A B C and D at Depth 3r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| FR | 4 | 0.00 | 0.11 | 0.00 | 0.00 | **MAX DEFL** | **0.58** |
| FL | 4 | 0.12 | 0.11 | 0.00 | 0.00 | **EQV DEFL** | **0.36** |
| BR | 4 | 0.25 | 0.18 | 0.22 | 0.12 | **MAX ESWL(kN)** | **518.77** |
| BL | 4 | 0.12 | 0.18 | 0.22 | 0.36 | | |
| | TOTAL | 0.49 | 0.58 | 0.44 | 0.48 | | |

**Table C14.** ESWL for Points A B C and D at Depth 4r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 5 | 0.00 | 0.11 | 0.00 | 0.00 | **MAX DEFL** | **0.56** |
| FL | 5 | 0.12 | 0.11 | 0.00 | 0.00 | **EQV DEFL** | **0.29** |
| BR | 5 | 0.23 | 0.17 | 0.20 | 0.12 | **MAX ESWL(kN)** | **621.79** |
| BL | 5 | 0.12 | 0.17 | 0.20 | 0.29 | | |
| | TOTAL | 0.47 | 0.56 | 0.40 | 0.41 | | |

**Table C15.** ESWL for Points A B C and D at Depth 5r.

| **DEPTH (m)** | **CBR(%)** |
|---|---|
| 0.20 | 21.6 |
| 0.40 | 7.2 |
| 0.81 | 2.3 |
| 1.21 | 1.2 |
| 1.61 | 0.85 |
| 2.02 | 0.65 |

**Table C16.** CBR Data at Various Depths of Pavement.

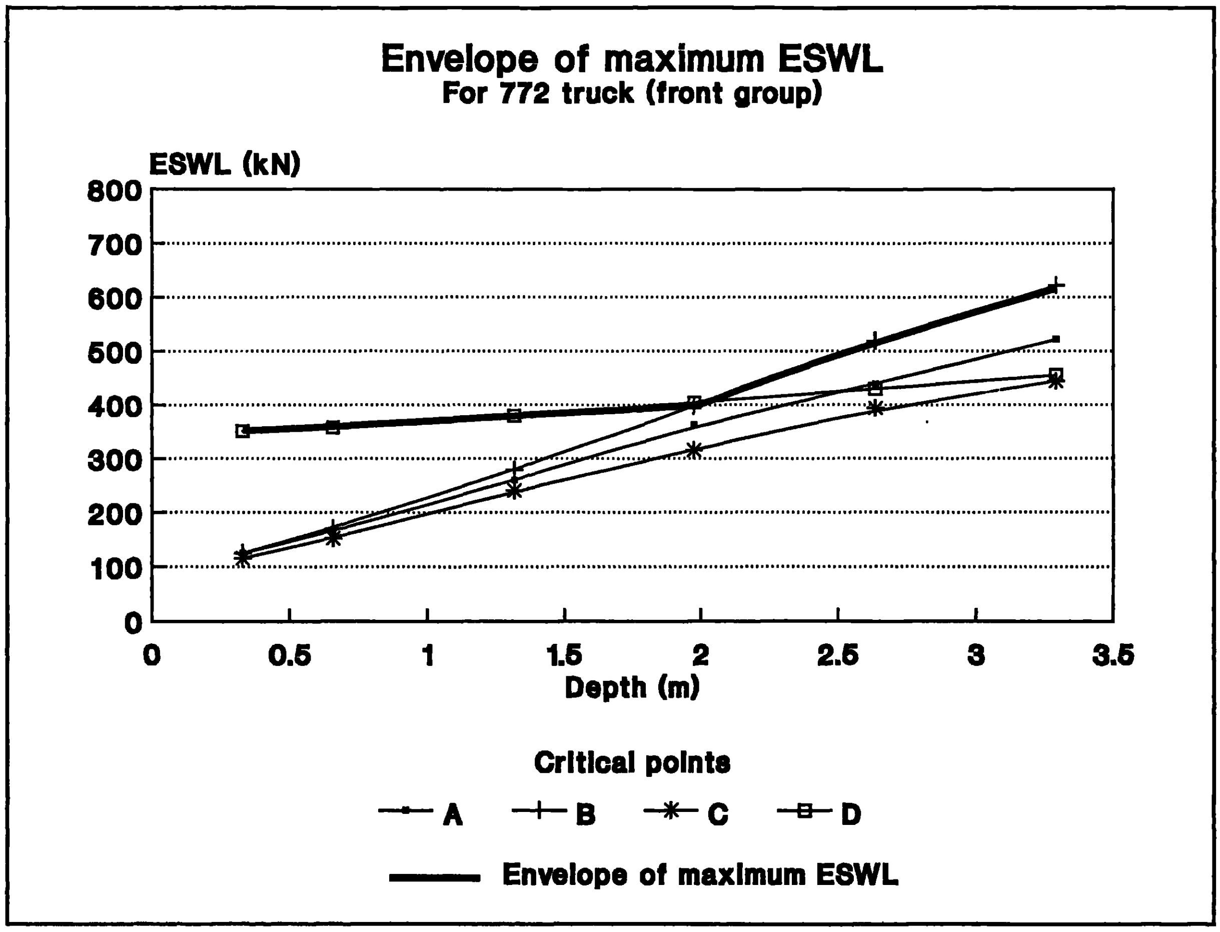



**Figure C2** Envelope of maximum ESWL - 772 front group

| CBR DESIGN METHOD<br>Cat 772 (drive and rear) Kriel Colliery | | |
|---|---|---|
| | REAR | DRIVE |
| MAX LOAD PER WHEEL or DUAL SET (kN) | 402.0 | 322.0 |
| TYRE PRESSURE (kPa) | 630.0 | 630.0 |
| LOAD DISTRIBUTION (%) | 56.0 | 44.0 |
| LOAD REPETITION FACTOR (ALFA) | 1.000 | |
| CONTACT AREA SINGLE TYRE (SQ.M) (A) | 0.638 | 0.511 |
| CONTACT RADIUS SINGLE TYRE (M) (r) | 0.451 | 0.403 |
| | | |
| | | r EQUIV |
| TYRE WIDTH (M) | 0.60 | |
| DRIVE TO REAR AXLE DISTANCE (m) | 15.60 | 34.61 |
| REAR DUAL ASSEMBLY WIDTH (m) | 2.60 | 5.77 |
| SINGLE DUAL CENTRE TO CENTRE DISTANCE (m) | 0.80 | |

**Table C17.** Basic Data for CBR Cover Curve Evaluation.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 0.5 | 0.00 | 0.00 | 0.00 | 0.00 | **MAX DEFL** | **1.47** |
| FL | 0.5 | 0.00 | 0.00 | 0.00 | 0.00 | **EQV DEFL** | **1.34** |
| BR | 0.5 | 0.00 | 0.00 | 0.25 | 0.13 | **MAX ESWL(kN)** | **441.00** |
| BL | 0.5 | 0.00 | 0.00 | 0.25 | 1.34 | | |
| | TOTAL | 0.00 | 0.00 | 0.50 | 1.47 | | |

**Table C18.** ESWL for Points A B C and D at Depth 0.5r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 1 | 0.00 | 0.00 | 0.00 | 0.00 |
| FL | 1 | 0.00 | 0.00 | 0.00 | 0.00 |
| BR | 1 | 0.00 | 0.00 | 0.26 | 0.13 |
| BL | 1 | 0.00 | 0.00 | 0.26 | 1.06 |
| | TOTAL | 0.00 | 0.00 | 0.52 | 1.19 |

| | |
|---|---|
| **MAX DEFL** | **1.19** |
| **EQV DEFL** | **1.06** |
| **MAX ESWL(kN)** | **451.30** |

**Table C19.** ESWL for Points A B C and D at Depth 1r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 2 | 0.00 | 0.00 | 0.00 | 0.00 |
| FL | 2 | 0.00 | 0.00 | 0.00 | 0.00 |
| BR | 2 | 0.00 | 0.00 | 0.27 | 0.14 |
| BL | 2 | 0.00 | 0.00 | 0.27 | 0.67 |
| | TOTAL | 0.00 | 0.00 | 0.54 | 0.81 |

| | |
|---|---|
| **MAX DEFL** | **0.81** |
| **EQV DEFL** | **0.67** |
| **ESWL(kN)** | **486.00** |

**Table C20.** ESWL for Points A B C and D at Depth 2r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 3 | 0.00 | 0.00 | 0.00 | 0.00 |
| FL | 3 | 0.00 | 0.00 | 0.00 | 0.00 |
| BR | 3 | 0.00 | 0.00 | 0.26 | 0.14 |
| BL | 3 | 0.00 | 0.00 | 0.26 | 0.47 |
| | TOTAL | 0.00 | 0.00 | 0.52 | 0.61 |

| | |
|---|---|
| **MAX DEFL** | **0.61** |
| **EQV DEFL** | **0.47** |
| **MAX ESWL(kN)** | **521.74** |

**Table C21.** ESWL for Points A B C and D at Depth 3r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 4 | 0.00 | 0.00 | 0.00 | 0.00 |
| FL | 4 | 0.00 | 0.00 | 0.00 | 0.00 |
| BR | 4 | 0.00 | 0.00 | 0.25 | 0.14 |
| BL | 4 | 0.00 | 0.00 | 0.25 | 0.36 |
| | TOTAL | 0.00 | 0.00 | 0.50 | 0.50 |

| | |
|---|---|
| **MAX DEFL** | **0.50** |
| **EQV DEFL** | **0.36** |
| **MAX ESWL(kN)** | **558.33** |

**Table C22.** ESWL for Points A B C and D at Depth 4r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 5 | 0.00 | 0.00 | 0.00 | 0.00 |
| FL | 5 | 0.00 | 0.00 | 0.00 | 0.00 |
| BR | 5 | 0.00 | 0.00 | 0.23 | 0.13 |
| BL | 5 | 0.00 | 0.00 | 0.23 | 0.29 |
| | TOTAL | 0.00 | 0.00 | 0.46 | 0.42 |

| | |
|---|---|
| **MAX DEFL** | **0.46** |
| **EQV DEFL** | **0.29** |
| **MAX ESWL(kN)** | **637.65** |

**Table C23.** ESWL for Points A B C and D at Depth 5 r.

| DEPTH (m) | CBR |
|---|---|
| 0.23 | 25.3 |
| 0.45 | 8.8 |
| 0.90 | 2.9 |
| 1.35 | 1.5 |
| 1.80 | 0.95 |
| 2.25 | 0.7 |

**Table C24.** CBR Data at Various Depths of Pavement.

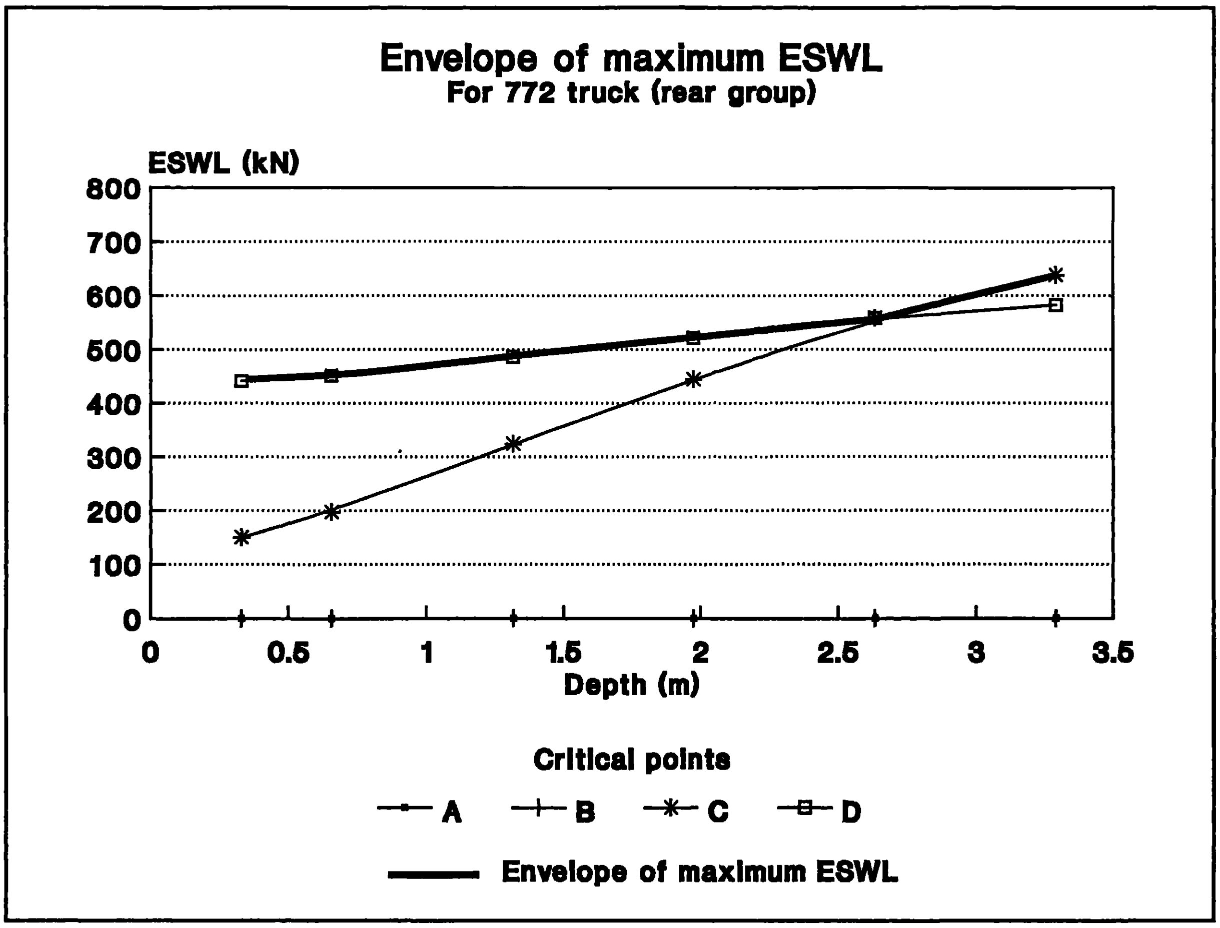



**Figure C3** Envelope of maximum ESWL - 772 rear group

| **CBR DESIGN METHOD**<br>**Haulpak 630E SACE Kromdraai Mine** | | |
|---|---|---|
| | REAR | FRONT |
| MAX LOAD PER WHEEL or DUAL SET (kN) | 862.0 | 419.0 |
| TYRE PRESSURE (kPa) | 630.0 | 630.0 |
| LOAD DISTRIBUTION (%) | 67.0 | 33.0 |
| LOAD REPETITION FACTOR (ALFA) | 0.76 | |
| CONTACT AREA SINGLE TYRE (SQ.M) (A) | 1.368 | 0.665 |
| CONTACT RADIUS SINGLE TYRE (M) (r) | 0.660 | 0.460 |
| | | |
| | | r EQUIV |
| TYRE WIDTH (M) | 0.90 | |
| FRONT TO REAR AXLE DISTANCE (m) | 5.44 | 8.24 |
| REAR DUAL ASSEMBLY WIDTH (m) | 4.42 | 6.70 |
| SINGLE DUAL CENTRE TO CENTRE DISTANCE (m) | 1.44 | |

**Table C25.** Basic Data for CBR Cover Curve Evaluation.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 0.5 | 0.00 | 0.11 | 0.00 | 0.00 |
| FL | 0.5 | 0.13 | 0.11 | 0.00 | 0.00 |
| BR | 0.5 | 0.29 | 0.17 | 0.23 | 0.11 |
| BL | 0.5 | 0.10 | 0.17 | 0.23 | 1.34 |
| | TOTAL | 0.52 | 0.56 | 0.46 | 1.45 |

| | |
|---|---|
| **MAX DEFL** | **1.45** |
| **EQV DEFL** | **1.34** |
| **MAX ESWL(kN)** | **932.76** |

**Table C26.** ESWL for Points A B C and D at Depth 0.5r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 1 | 0.00 | 0.11 | 0.00 | 0.00 |
| FL | 1 | 0.13 | 0.11 | 0.00 | 0.00 |
| BR | 1 | 0.30 | 0.18 | 0.24 | 0.11 |
| BL | 1 | 0.10 | 0.18 | 0.24 | 1.06 |
| | TOTAL | 0.53 | 0.58 | 0.48 | 1.17 |

| | |
|---|---|
| **MAX DEFL** | **1.17** |
| **EQV DEFL** | **1.06** |
| **MAX ESWL(kN)** | **951.45** |

**Table C27.** ESWL for Points A B C and D at Depth 1r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 2 | 0.00 | 0.12 | 0.00 | 0.00 |
| FL | 2 | 0.14 | 0.12 | 0.00 | 0.00 |
| BR | 2 | 0.31 | 0.19 | 0.25 | 0.11 |
| BL | 2 | 0.11 | 0.19 | 0.25 | 0.67 |
| | TOTAL | 0.56 | 0.62 | 0.50 | 0.78 |

| | |
|---|---|
| **MAX DEFL** | **0.78** |
| **EQV DEFL** | **0.67** |
| **MAX ESWL(kN)** | **1003.52** |

**Table C28.** ESWL for Points A B C and D at Depth 2r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 3 | 0.00 | 0.13 | 0.00 | 0.00 |
| FL | 3 | 0.15 | 0.13 | 0.00 | 0.00 |
| BR | 3 | 0.29 | 0.19 | 0.23 | 0.12 |
| BL | 3 | 0.12 | 0.19 | 0.23 | 0.47 |
| | TOTAL | 0.56 | 0.64 | 0.46 | 0.59 |

| | |
|---|---|
| **MAX DEFL** | **0.64** |
| **EQV DEFL** | **0.47** |
| **MAX ESWL(kN)** | **1173.97** |

**Table C29.** ESWL for Points A B C and D at Depth 3r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 4 | 0.00 | 0.13 | 0.00 | 0.00 | MAX DEFL | 0.62 |
| FL | 4 | 0.15 | 0.13 | 0.00 | 0.00 | EQV DEFL | 0.36 |
| BR | 4 | 0.25 | 0.18 | 0.20 | 0.12 | MAX ESWL(kN) | 1484.56 |
| BL | 4 | 0.12 | 0.18 | 0.20 | 0.36 | | |
| | TOTAL | 0.52 | 0.62 | 0.40 | 0.48 | | |

**Table C30.** ESWL for Points A B C and D at Depth 4r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 5 | 0.00 | 0.13 | 0.00 | 0.00 | MAX DEFL | 0.58 |
| FL | 5 | 0.14 | 0.13 | 0.00 | 0.00 | EQV DEFL | 0.29 |
| BR | 5 | 0.22 | 0.16 | 0.20 | 0.12 | MAX ESWL(kN) | 1724.00 |
| BL | 5 | 0.13 | 0.16 | 0.20 | 0.29 | | |
| | TOTAL | 0.49 | 0.58 | 0.40 | 0.41 | | |

**Table C31.** ESWL for Points A B C and D at Depth 5r.

| DEPTH (r) | CBR(%) |
|---|---|
| 0.33 | 38.5 |
| 0.66 | 16.1 |
| 1.32 | 5.4 |
| 1.98 | 3.1 |
| 2.64 | 2.35 |
| 3.30 | 1.8 |

**Table C32.** CBR Data at Various Depths of Pavement.

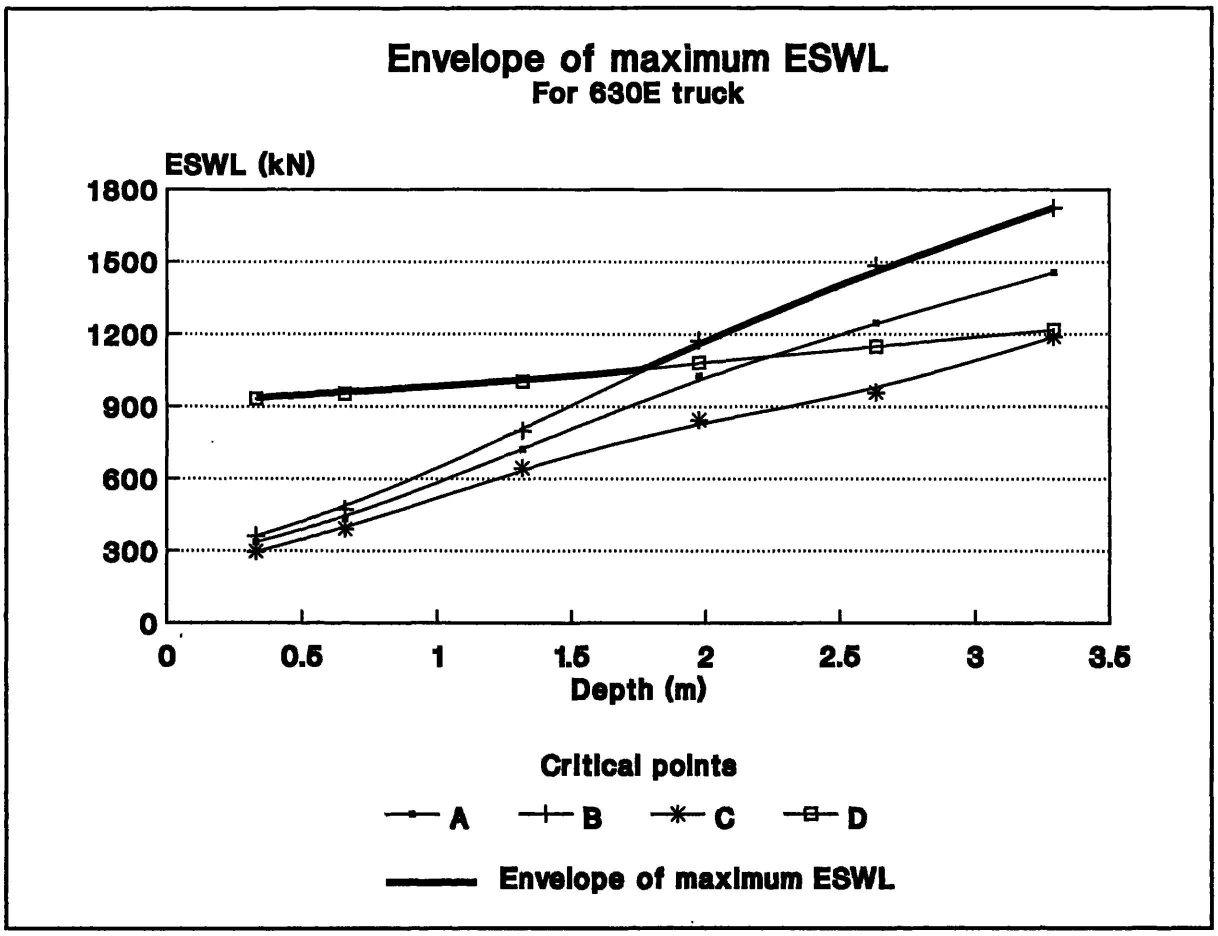



**Figure C4** Envelope of maximum ESWL - 630E truck

| **CBR DESIGN METHOD**<br>**Komatsu HD1600 M1 New Vaal Colliery** | | |
|---|---|---|
| | REAR | FRONT |
| MAX LOAD PER WHEEL or DUAL SET (kN) | 878.0 | 401.0 |
| TYRE PRESSURE (kPa) | 630.0 | 630.0 |
| LOAD DISTRIBUTION (%) | 67.0 | 33.0 |
| LOAD REPETITION FACTOR (ALFA) | 1.000 | |
| CONTACT AREA SINGLE TYRE (SQ.M) (A) | 1.394 | 0.637 |
| CONTACT RADIUS SINGLE TYRE (M) (r) | 0.666 | 0.450 |
| | | r EQUIV |
| TYRE WIDTH (M) | 0.90 | |
| FRONT TO REAR AXLE DISTANCE (m) | 6.00 | 9.01 |
| REAR DUAL ASSEMBLY WIDTH (m) | 4.38 | 6.58 |

**Table C33.** Basic Data for CBR Cover Curve Evaluation.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 0.5 | 0.00 | 0.11 | 0.00 | 0.00 | **MAX DEFL** | **1.46** |
| FL | 0.5 | 0.12 | 0.11 | 0.00 | 0.00 | **EQV DEFL** | **1.34** |
| BR | 0.5 | 0.25 | 0.16 | 0.24 | 0.12 | **MAX ESWL(kN)** | **956.63** |
| BL | 0.5 | 0.10 | 0.16 | 0.24 | 1.34 | | |
| | TOTAL | 0.47 | 0.54 | 0.48 | 1.46 | | |

**Table C34.** ESWL for Points A B C and D at Depth 0.5r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 1 | 0.00 | 0.11 | 0.00 | 0.00 | **MAX DEFL** | **1.18** |
| FL | 1 | 0.12 | 0.11 | 0.00 | 0.00 | **EQV DEFL** | **1.06** |
| BR | 1 | 0.25 | 0.16 | 0.24 | 0.12 | **MAX ESWL(kN)** | **977.40** |
| BL | 1 | 0.10 | 0.16 | 0.24 | 1.06 | | |
| | TOTAL | 0.47 | 0.54 | 0.48 | 1.18 | | |

**Table C35.** ESWL for Points A B C and D at Depth 1r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 2 | 0.00 | 0.12 | 0.00 | 0.00 | **MAX DEFL** | **0.80** |
| FL | 2 | 0.13 | 0.12 | 0.00 | 0.00 | **EQV DEFL** | **0.67** |
| BR | 2 | 0.26 | 0.17 | 0.25 | 0.13 | **MAX ESWL(kN)** | **1048.36** |
| BL | 2 | 0.11 | 0.17 | 0.25 | 0.67 | | |
| | TOTAL | 0.50 | 0.58 | 0.50 | 0.80 | | |

**Table C36.** ESWL for Points A B C and D at Depth 2r.

| | DEPTH (r) | A | B | C | D | | |
|---|---|---|---|---|---|---|---|
| FR | 3 | 0.00 | 0.12 | 0.00 | 0.00 | **MAX DEFL** | **0.60** |
| FL | 3 | 0.14 | 0.12 | 0.00 | 0.00 | **EQV DEFL** | **0.47** |
| BR | 3 | 0.26 | 0.18 | 0.24 | 0.13 | **MAX ESWL(kN)** | **1120.85** |
| BL | 3 | 0.11 | 0.18 | 0.24 | 0.47 | | |
| | TOTAL | 0.51 | 0.60 | 0.48 | 0.60 | | |

**Table C37.** ESWL for Points A B C and D at Depth 3r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 4 | 0.00 | 0.12 | 0.00 | 0.00 |
| FL | 4 | 0.14 | 0.12 | 0.00 | 0.00 |
| BR | 4 | 0.24 | 0.18 | 0.23 | 0.12 |
| BL | 4 | 0.11 | 0.18 | 0.23 | 0.36 |
| | TOTAL | 0.49 | 0.60 | 0.46 | 0.48 |

| | |
|---|---|
| **MAX DEFL** | **0.60** |
| **EQV DEFL** | **0.36** |
| **MAX ESWL(kN)** | **1463.33** |

**Table C38.** ESWL for Points A B C and D at Depth 4r.

| | DEPTH (r) | A | B | C | D |
|---|---|---|---|---|---|
| FR | 5 | 0.00 | 0.12 | 0.00 | 0.00 |
| FL | 5 | 0.14 | 0.12 | 0.00 | 0.00 |
| BR | 5 | 0.21 | 0.17 | 0.21 | 0.12 |
| BL | 5 | 0.11 | 0.17 | 0.21 | 0.29 |
| | TOTAL | 0.46 | 0.58 | 0.42 | 0.42 |

| | |
|---|---|
| **MAX DEFL** | **0.58** |
| **EQV DEFL** | **0.29** |
| **MAX ESWL(kN)** | **1756.00** |

**Table C39.** ESWL for Points A B C and D at Depth 5r.

| **DEPTH (r)** | **CBR(%)** |
|---|---|
| 0.33 | 39.0 |
| 0.67 | 16.5 |
| 1.33 | 5.6 |
| 2.00 | 2.9 |
| 2.66 | 2.3 |
| 3.33 | 1.8 |

**Table C40.** CBR Data at Various Depths of Pavement.

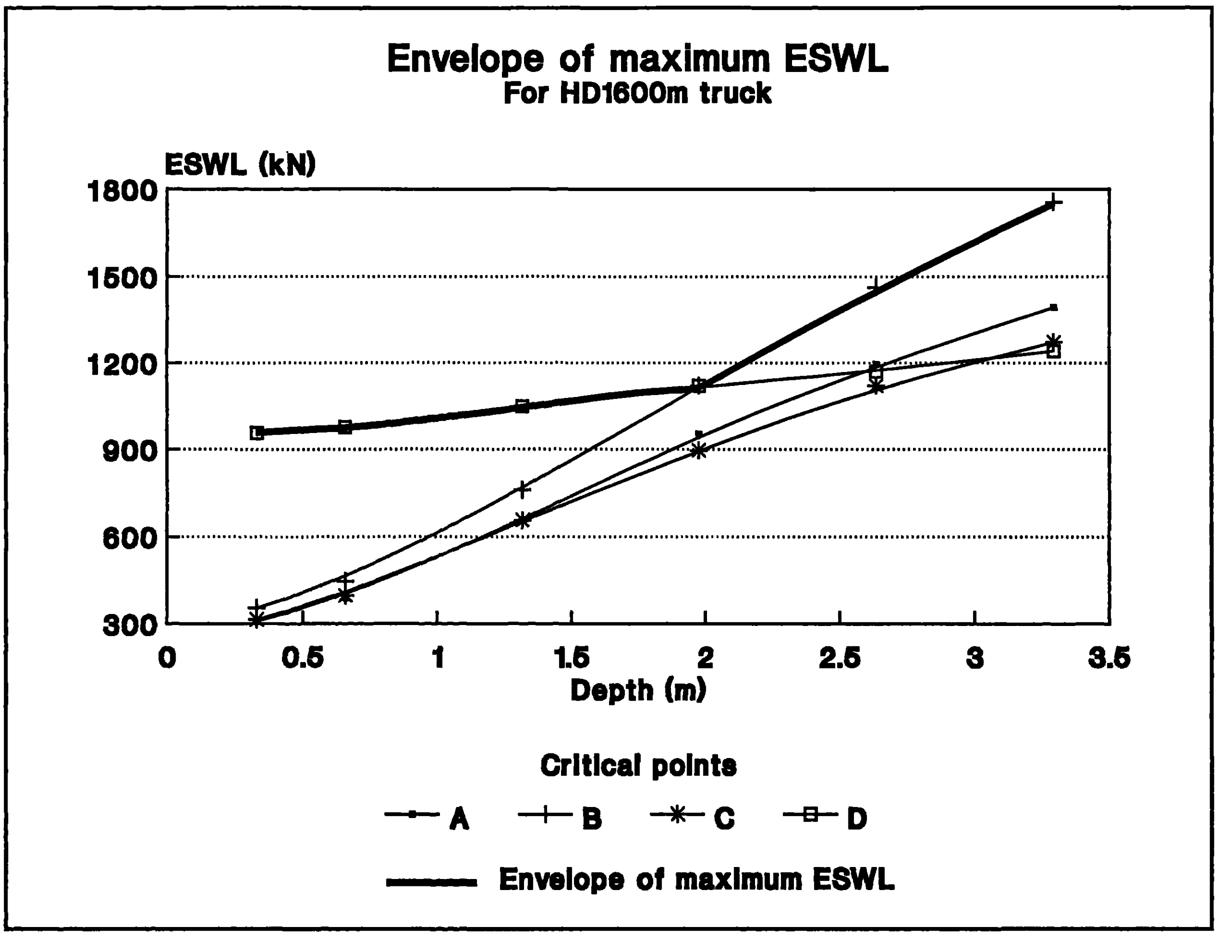
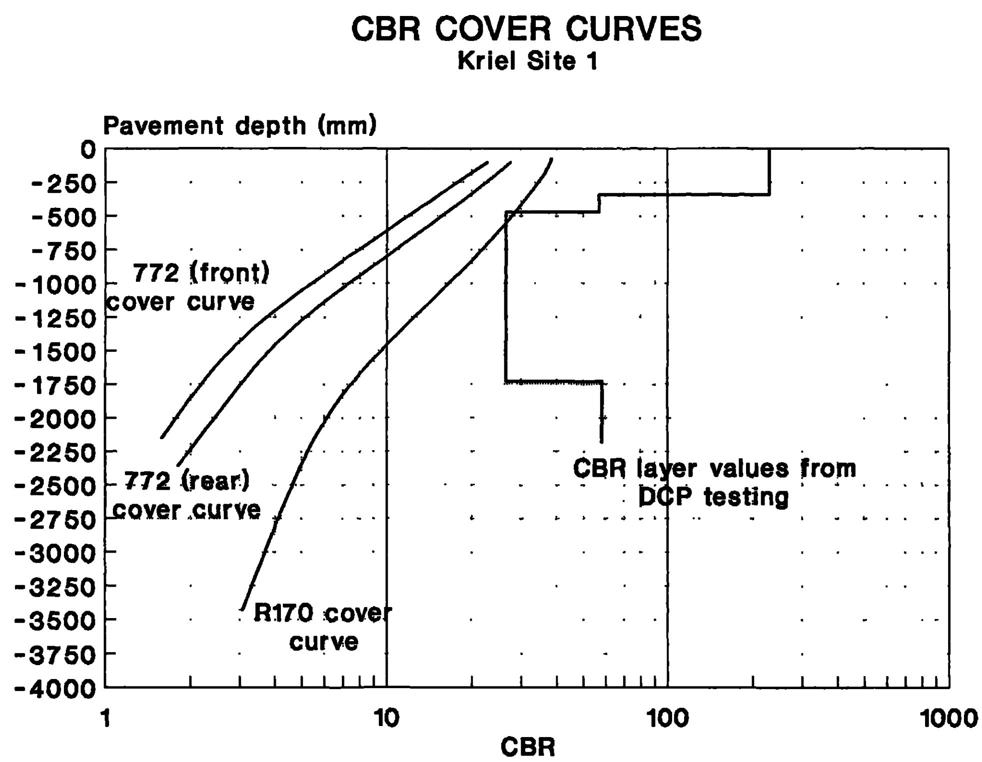
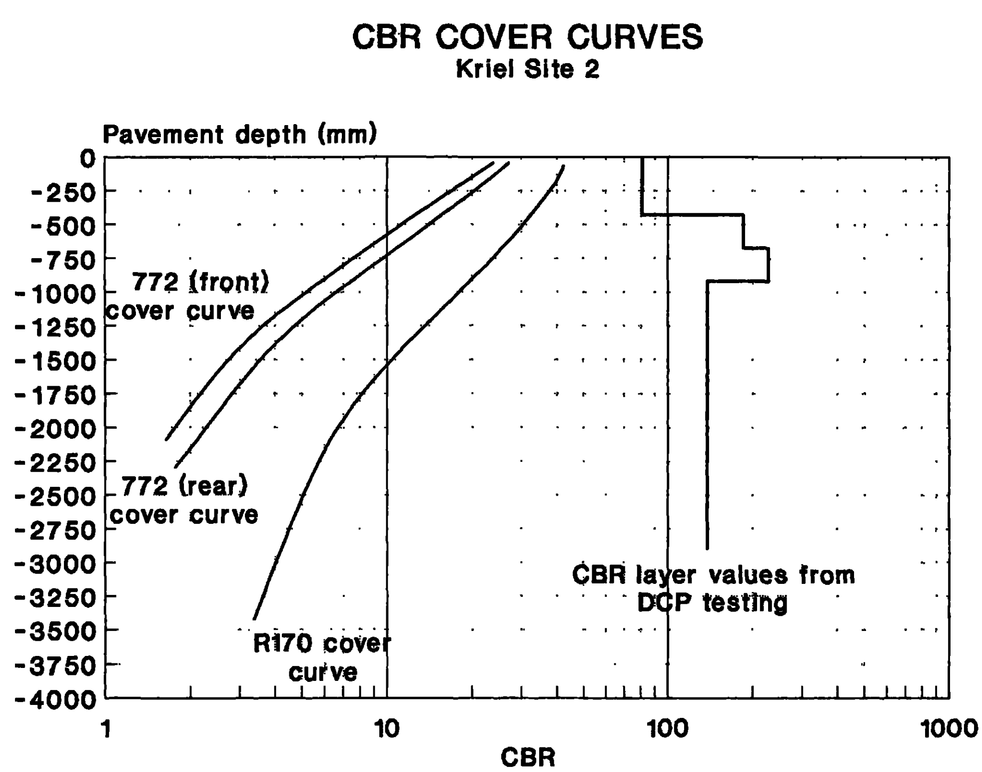
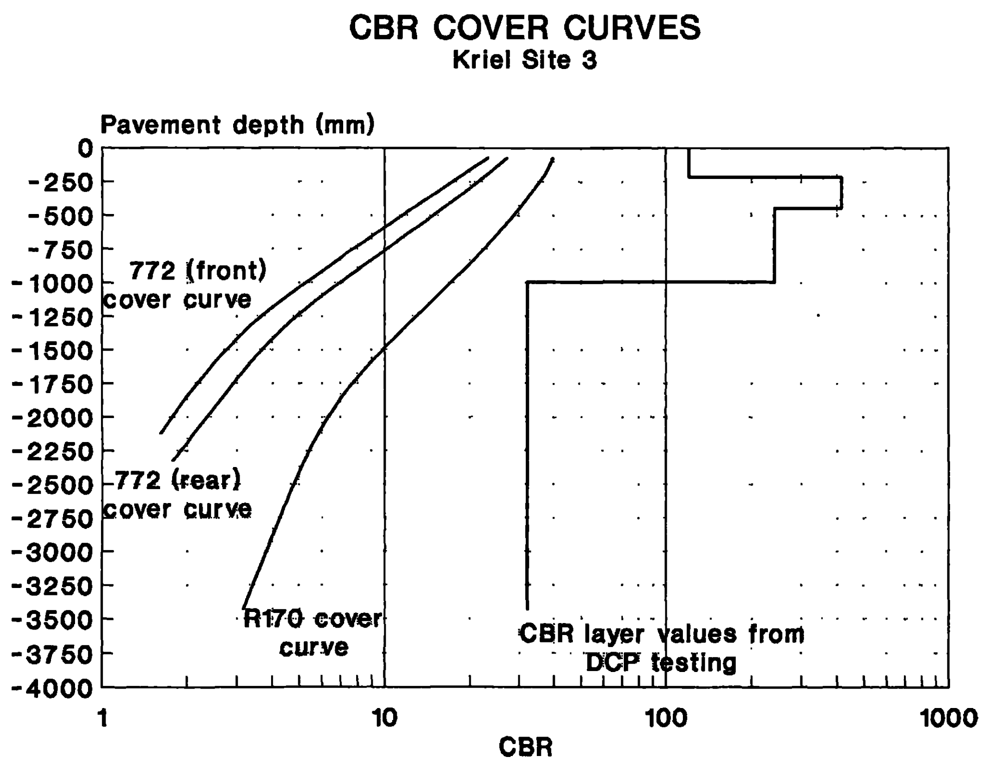
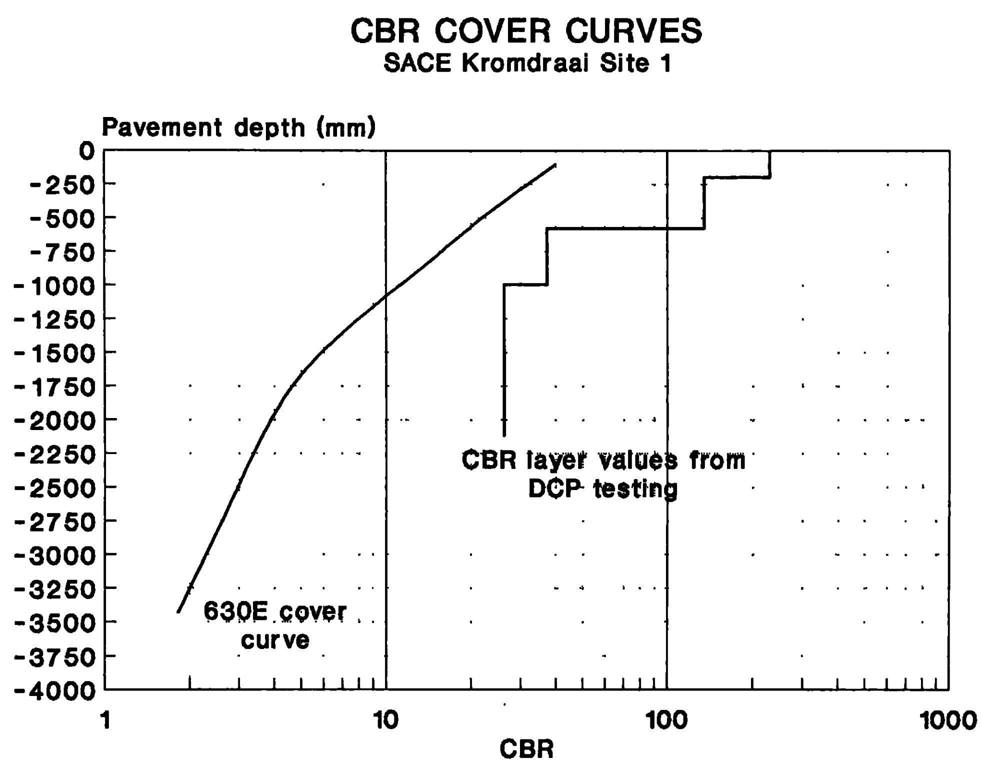


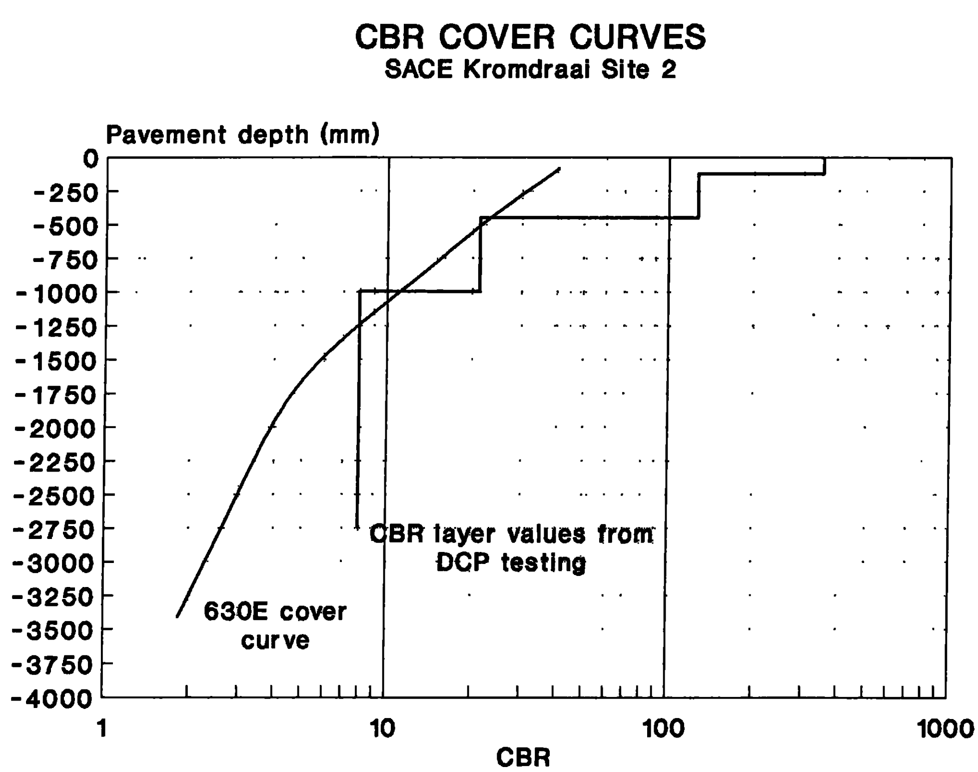

**Figure C5** Envelope of maximum ESWL - HD1600 M1 truck

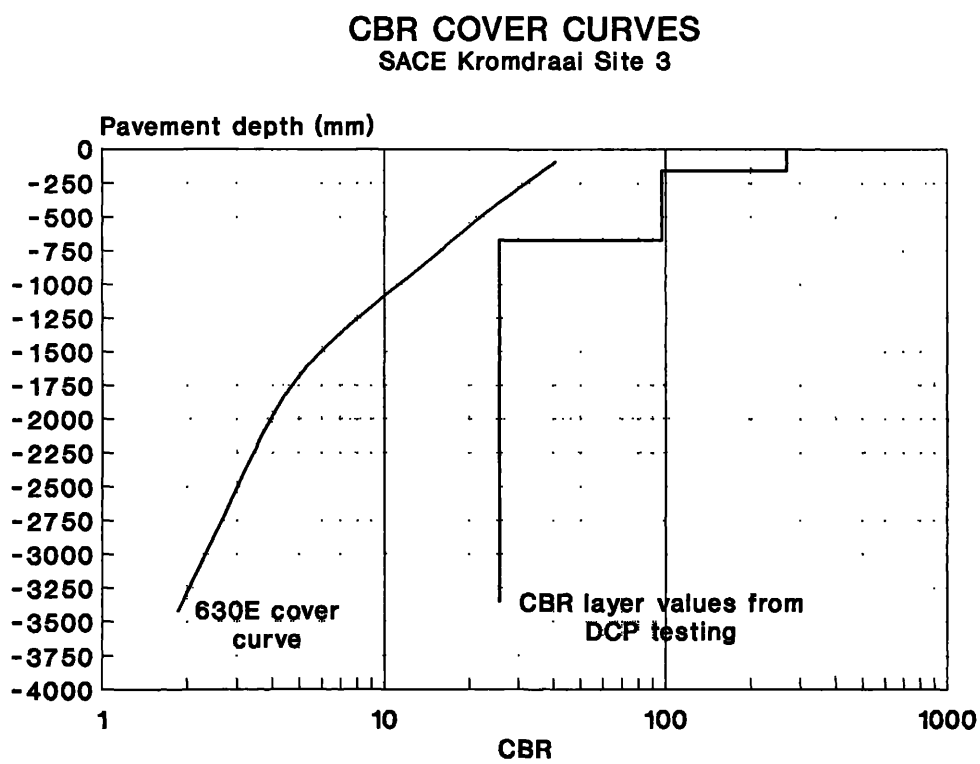

CBR COVER CURVES
Kriel Site 1
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
772 (front) cover curve
772 (rear) cover curve
R170 cover curve
CBR layer values from DCP testing
1
10
100
1000
CBR

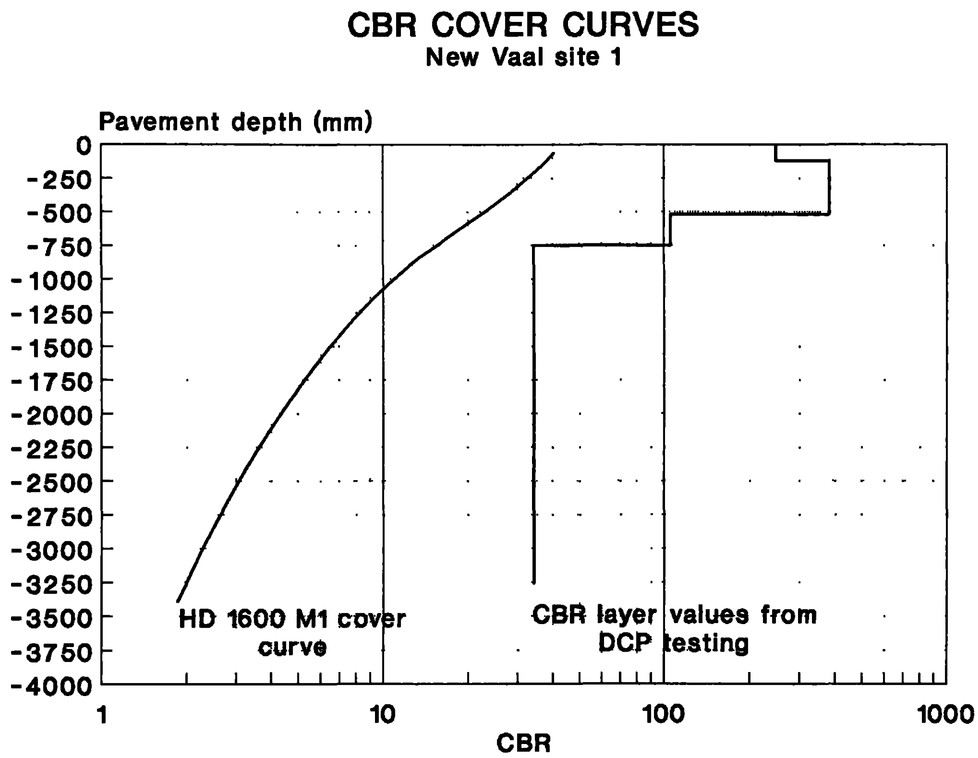

CBR COVER CURVES
Kriel Site 2
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
772 (front) cover curve
772 (rear) cover curve
R170 cover curve
CBR layer values from DCP testing
1
10
100
1000
CBR

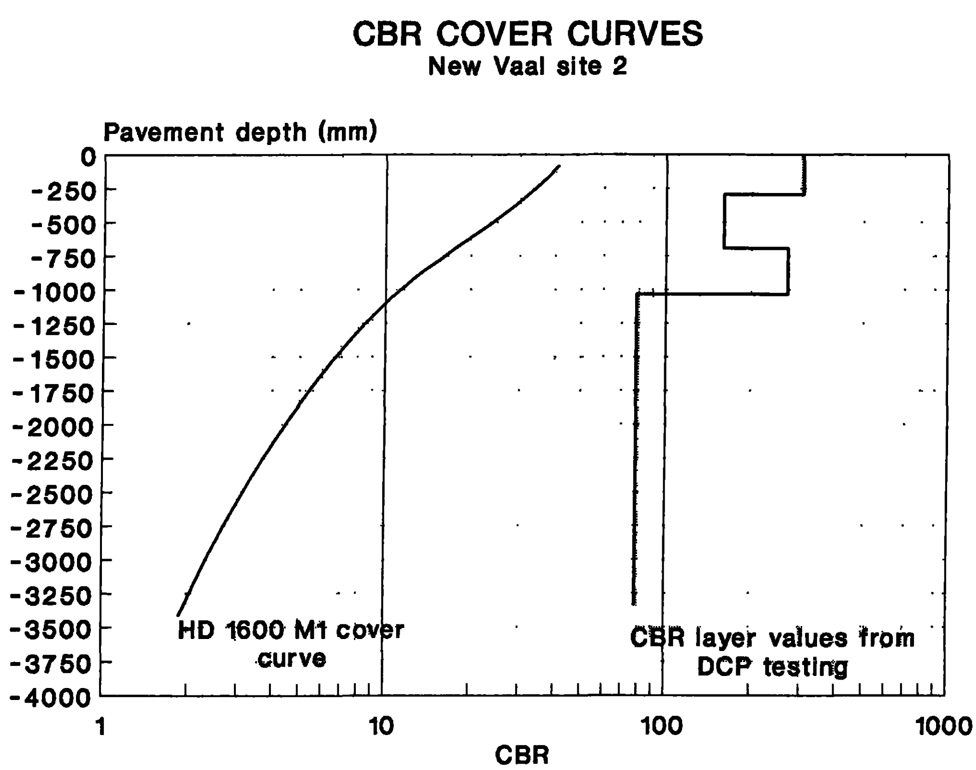

CBR COVER CURVES
Kriel Site 3
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
1
10
100
1000
CBR
772 (front)
cover curve
772 (rear)
cover curve
R170 cover
curve
CBR layer values from
DCP testing

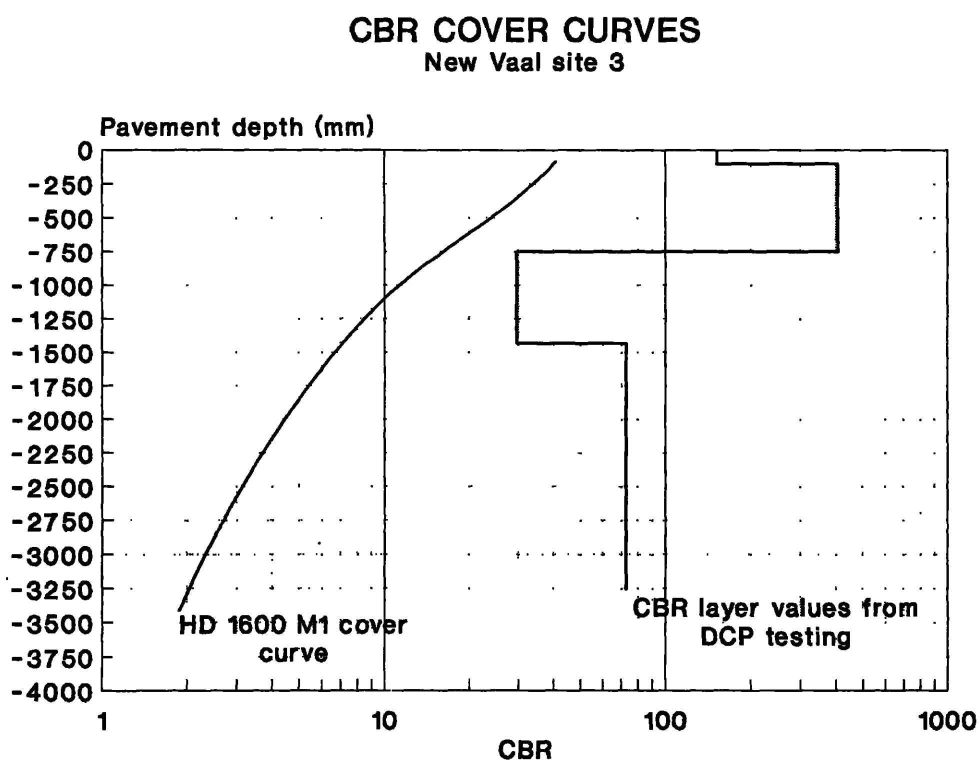

CBR COVER CURVES
SACE Kromdraai Site 1
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
1
10
100
1000
CBR
CBR layer values from DCP testing
630E cover curve


CBR COVER CURVES
SACE Kromdraai Site 2
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
1
10
100
1000
CBR
CBR layer values from DCP testing
630E cover curve


CBR COVER CURVES
SACE Kromdraai Site 3
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
1
10
100
1000
CBR
630E cover curve
CBR layer values from DCP testing


CBR COVER CURVES
New Vaal site 1
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
1
10
100
1000
CBR
HD 1600 M1 cover curve
CBR layer values from DCP testing


CBR COVER CURVES
New Vaal site 2
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
1
10
100
1000
CBR
HD 1600 M1 cover curve
CBR layer values from DCP testing


CBR COVER CURVES
New Vaal site 3
Pavement depth (mm)
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-2250
-2500
-2750
-3000
-3250
-3500
-3750
-4000
1
10
100
1000
CBR
HD 1600 M1 cover curve
CBR layer values from DCP testing

# APPENDIX D1

## RESULTS OF MDD AND MECHANISTIC ANALYSIS - KRIEL COLLIERY

D1-2

## Contents

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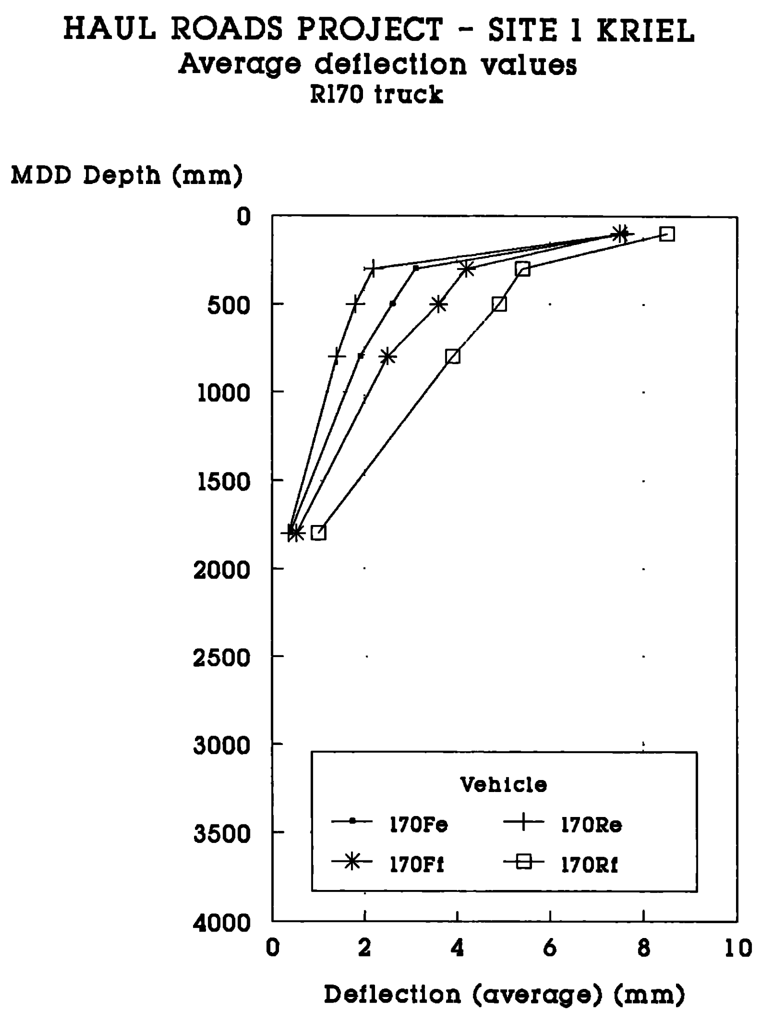
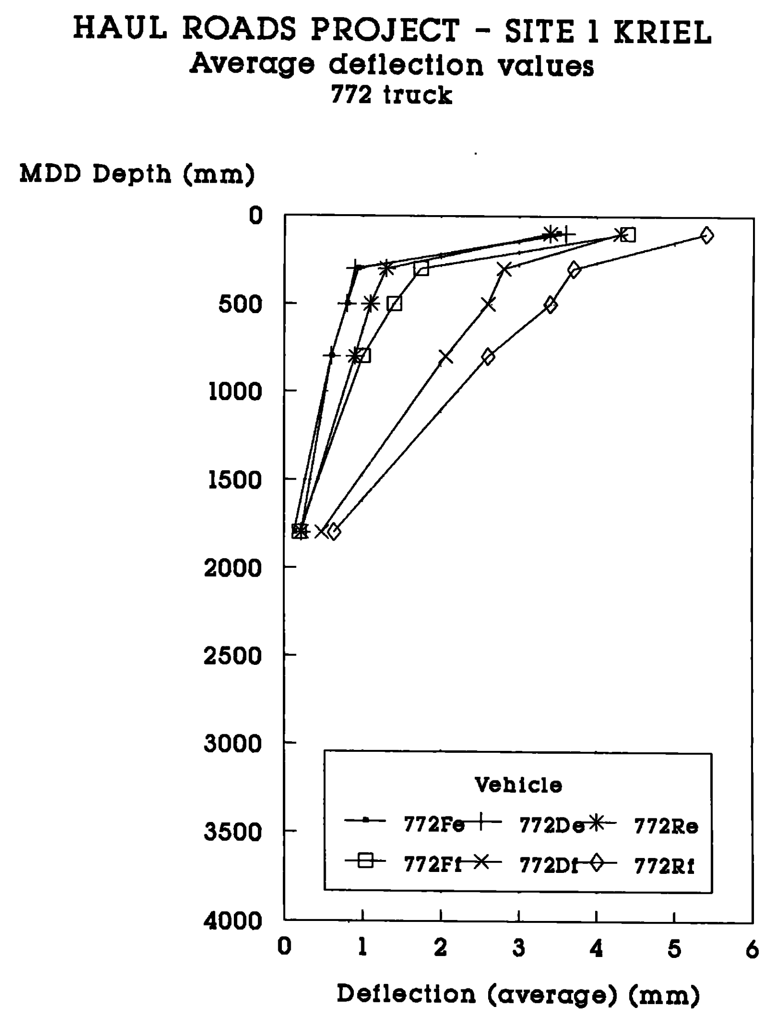
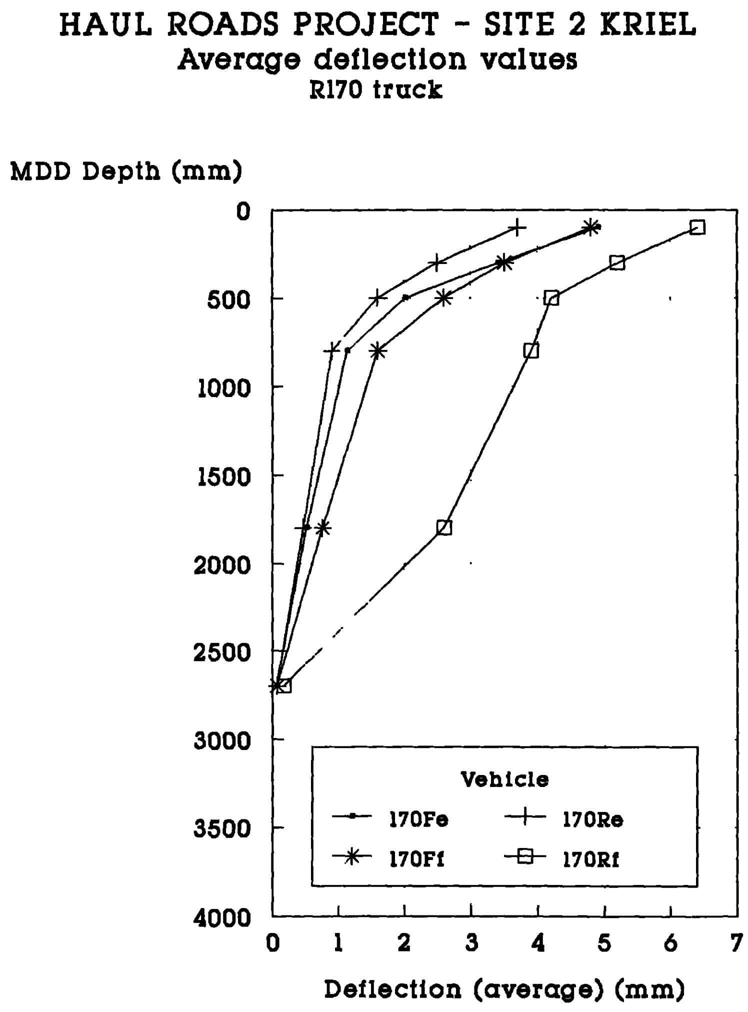
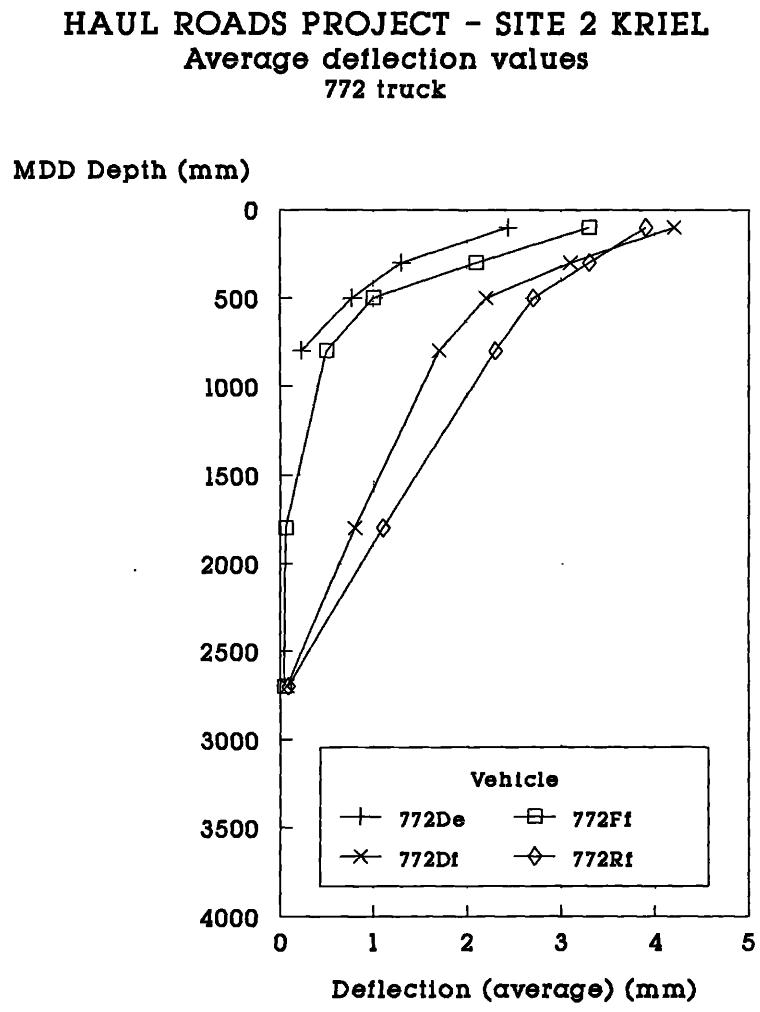
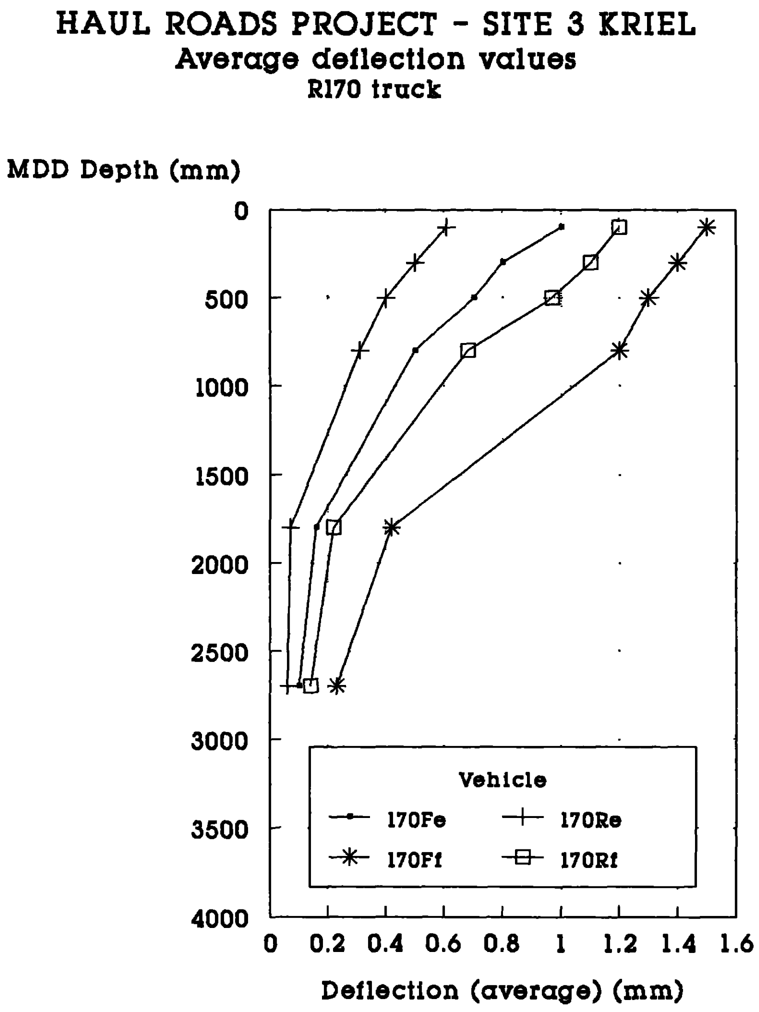
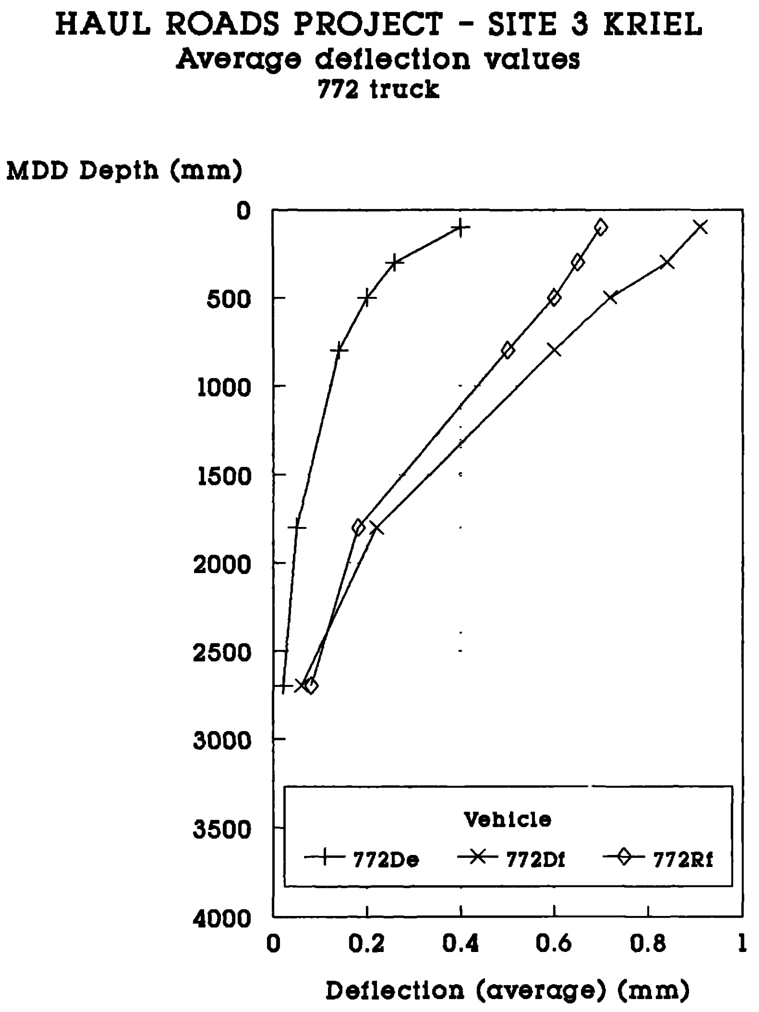



HAUL ROADS PROJECT - SITE 2 KRIEL
Average deflection values
R170 truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
1
2
3
4
5
6
7
Deflection (average) (mm)
Vehicle
170Fe
170Re
170Ff
170Rf


HAUL ROADS PROJECT - SITE 2 KRIEL
Average deflection values
772 truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
1
2
3
4
5
Deflection (average) (mm)
Vehicle
772De
772Ff
772Df
772Rf


HAUL ROADS PROJECT - SITE 3 KRIEL
Average deflection values
R170 truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Deflection (average) (mm)
Vehicle
170Fe
170Re
170Ff
170Rf


HAUL ROADS PROJECT - SITE 3 KRIEL
Average deflection values
772 truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.2
0.4
0.6
0.8
1
Deflection (average) (mm)
Vehicle
772De
772Df
772Rf

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) θ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN $(x10^{-3})$ $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 7.50 | 4.30 | 350 | 1249 | 180 | |
| 2 | ■300 | 4.20 | 4.10 | 300 | -509 | 638 | 1512 |
| 3 | ■500<br>■800 | 3.60<br>2.50 | 3.70<br>2.50 | 41 | 93 | 90 | 4917 |
| 4 | ■1800 | 0.53 | 0.53 | 21 | 89 | 41 | 2223 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 7.60 | 3.40 | 200 | 1058 | 296 | |
| 2 | ■300 | 3.10 | 3.10 | 200 | -98 | 444 | 1926 |
| 3 | ■500<br>■800 | 2.60<br>1.90 | 2.60<br>1.70 | 50 | 65 | 74 | 4165 |
| 4 | ■1800 | 0.39 | 0.38 | 20 | 61 | 23 | 1615 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 8.50 | 5.70 | 350 | 1274 | 295 | |
| 2 | ■300 | 5.40 | 5.50 | 300 | -472 | 698 | 1540 |
| 3 | ■500<br>■800 | 4.90<br>3.90 | 4.90<br>3.60 | 40 | 145 | 125 | 5343 |
| 4 | ■1800 | 1.00 | 1.00 | 17 | 55 | 24 | 4288 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTION: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN $(x10^{-3})$ $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 7.60 | 2.30 | 380 | 928 | 310 | |
| 2 | ■300 | 2.20 | 2.20 | 380 | -344 | 425 | 851 |
| 3 | ■500<br>■800 | 1.80<br>1.40 | 1.90<br>1.40 | 41 | 52 | 47 | 2539 |
| 4 | ■1800 | 0.36 | 0.36 | 19 | 59 | 21 | 1476 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 4.40 | 2.00 | 320 | 778 | 322 | |
| 2 | ■300 | 1.74 | 1.80 | 250 | -279 | 305 | 1055 |
| 3 | ■500<br>■800 | 1.40<br>1.00 | 1.50<br>1.00 | 28 | 25 | 26 | 2593 |
| 4 | ■1800 | 0.19 | 0.18 | 17 | 23 | 9 | 775 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 3.50 | 1.11 | 550 | 707 | 321 | |
| 2 | ■300 | 0.94 | 0.97 | 450 | -303 | 276 | 485 |
| 3 | ■500<br>■800 | 0.80<br>0.60 | 0.80<br>0.60 | 35 | 18 | 17 | 1385 |
| 4 | ■1800 | 0.12 | 0.11 | 19 | 16 | 6 | 467 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | DRIVE, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 4.30 | 2.90 | 450 | 989 | 283 | |
| 2 | ■300 | 2.80 | 2.90 | 400 | -458 | 505 | 866 |
| 3 | ■500<br>■800 | 2.60<br>2.06 | 2.70<br>2.00 | 36 | 63 | 58 | 2918 |
| 4 | ■1800 | 0.47 | 0.48 | 16 | 64 | 23 | 1975 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | DRIVE, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 3.60 | 1.00 | 550 | 618 | 329 | |
| 2 | ■300 | 0.90 | 0.90 | 500 | -136 | 177 | 398 |
| 3 | ■500<br>■800 | 0.80<br>0.60 | 0.85<br>0.65 | 55 | 22 | 25 | 975 |
| 4 | ■1800 | 0.21 | 0.20 | 14 | 25 | 8 | 818 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTION: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 5.40 | 3.70 | 450 | 1694 | 257 | |
| 2 | ■300 | 3.70 | 3.70 | 400 | -555 | 597 | 969 |
| 3 | ■500<br>■800 | 3.40<br>2.60 | 3.40<br>2.54 | 35 | 72 | 67 | 3529 |
| 4 | ■1800 | 0.63 | 0.63 | 15 | 75 | 27 | 2579 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 3.40 | 1.30 | 550 | 625 | 313 | |
| 2 | ■300 | 1.30 | 1.30 | 500 | -260 | 223 | 406 |
| 3 | ■500<br>■800 | 1.10<br>0.90 | 1.20<br>0.92 | 25 | 24 | 19 | 1360 |
| 4 | ■1800 | 0.21 | 0.20 | 14 | 24 | 8 | 830 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300 | 4.8<br>3.5 | 4.00<br>3.55 | 200 | 876 | 369 | |
| 2 | ■500 | 2.6 | 2.60 | 42 | 569 | 227 | 7443 |
| 3 | ■800 | 1.6 | 1.60 | 5000 | -128 | 300 | -144 |
| 4 | ■1800<br>■2700 | 0.76<br>0.066 | 1.76<br>0.056 | 33 | 50 | 29 | 1297 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300 | 4.90<br>3.40 | 4.30<br>3.40 | 100 | 781 | 400 | |
| 2 | ■500 | 2.02 | 2.20 | 35 | 444 | 215 | 8368 |
| 3 | ■800 | 1.14 | 1.30 | 3000 | -59 | 218 | -110 |
| 4 | ■1800<br>■2700 | 0.51<br>0.05 | 0.50<br>0.05 | 36 | 36 | 24 | 1077 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300 | 6.40<br>5.20 | 5.70<br>5.30 | 200 | 1051 | 309 | |
| 2 | ■500 | 4.20 | 4.60 | 60 | 604 | 237 | 5505 |
| 3 | ■800 | 3.90 | 4.30 | 3000 | -387 | 465 | -233 |
| 4 | ■1800<br>■2700 | 2.60<br>0.16 | 1.20<br>0.15 | 20 | 85 | 44 | 2754 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300 | 3.70<br>2.50 | 3.10<br>2.60 | 120 | 622 | 386 | |
| 2 | ■500 | 1.60 | 1.59 | 30 | 296 | 119 | 6606 |
| 3 | ■800 | 0.90 | 0.90 | 3700 | -26 | 156 | -74 |
| 4 | ■1800<br>■2700 | 0.46<br>0.06 | 0.43<br>0.03 | 50 | 38 | 26 | 664 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300 | 3.30<br>2.10 | 3.90<br>2.10 | 45 | 593 | 405 | |
| 2 | ■500 | 1.00 | 1.00 | 50 | 263 | 165 | 4874 |
| 3 | ■800 | 0.50 | 0.57 | 5000 | -46 | 123 | -47 |
| 4 | ■1800<br>■2700 | 0.05<br>0.04 | 0.20<br>0.02 | 25 | 12 | 7 | 456 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | DRIVE, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300 | 4.20<br>3.10 | 4.40<br>3.10 | 55 | 728 | 410 | |
| 2 | ■500 | 2.20 | 2.15 | 50 | 381 | 155 | 5466 |
| 3 | ■800 | 1.70 | 1.70 | 4500 | -117 | 232 | -134 |
| 4 | ■1800<br>■2700 | 0.80<br>0.07 | 0.80<br>0.06 | 25 | 38 | 22 | 1206 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | DRIVE, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300 | 2.44<br>1.30 | 2.60<br>1.30 | 55 | 445 | 345 | |
| 2 | ■500 | 0.77 | 0.77 | 80 | 161 | 100 | 2075 |
| 3 | ■800 | 0.23 | 0.30 | 5000 | -60 | 102 | -50 |
| 4 | ■1800<br>■2700 | | | 25 (average) | 15 | 8.5 | 463 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN (x$10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300 | 3.90<br>3.30 | 3.30<br>3.20 | 160 | 809 | 371 | |
| 2 | ■500 | 2.70 | 2.76 | 58 | 438 | 169 | 4355 |
| 3 | ■800 | 2.30 | 2.35 | 4200 | -229 | 301 | -165 |
| 4 | ■1800<br>■2700 | 1.10<br>0.08 | 1.10<br>0.80 | 18 | 39 | 22 | 1620 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN (x10$^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.50 | 1.50 | 500 | 1627 | 94 | |
| 2 | ■300 | 1.40 | 1.40 | 2500 | -13 | 520 | -370 (horizontal) |
| 3 | ■500<br>■800 | 1.30<br>1.20 | 1.30<br>1.00 | 140 | 154 | 131 | 1320 |
| 4 | ■1800<br>■2700 | 0.42<br>0.23 | 0.43<br>0.19 | 125 | 30 | 29 | 767 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.00 | 1.00 | 200 | 1294 | 296 | |
| 2 | ■300 | 0.80 | 0.78 | 2500 | 161 | 437 | -290 (horizontal) |
| 3 | ■500<br>■800 | 0.70<br>0.50 | 0.71<br>0.46 | 160 | 162 | 115 | 1058 |
| 4 | ■1800<br>■2700 | 0.16<br>0.10 | 0.16<br>0.07 | 250 | 22 | 22 | 343 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.20 | 1.20 | 600 | 1545 | 156 | |
| 2 | ■300 | 1.10 | 1.10 | 2500 | -369 | 687 | -353 (horizontal) |
| 3 | ■500<br>■800 | 0.97<br>0.68 | 0.99<br>0.69 | 160 | 305 | 163 | 1315 |
| 4 | ■1800<br>■2700 | 0.22<br>0.84 | 0.29<br>0.01 | 450 | 69 | 63 | 351 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | DRIVE, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 0.40 | 0.40 | 300 | 908 | 428 | |
| 2 | ■300 | 0.26 | 0.22 | 2400 | 124 | 242 | -113 (horizontal) |
| 3 | ■500<br>■800 | 0.20<br>0.14 | 0.20<br>0.14 | 230 | 72 | 48 | 324 |
| 4 | ■1800<br>■2700 | 0.05<br>0.02 | 0.05<br>0.02 | 400 | 11 | 11 | 96 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | DRIVE, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 0.91 | 0.92 | 250 | 1226 | 345 | |
| 2 | ■300 | 0.84 | 0.76 | 2600 | 82 | 263 | -290 (horizontal) |
| 3 | ■500<br>■800 | 0.72<br>0.60 | 0.71<br>0.46 | 130 | 171 | 97 | 952 |
| 4 | ■1800<br>■2700 | 0.22<br>0.06 | 0.17<br>0.07 | 300 | 28 | 27 | 238 |

| | |
|---|---|
| MINE | KRIEL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 772 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 0.70 | 0.70 | 600 | 1351 | 274 | |
| 2 | ■300 | 0.65 | 0.66 | 2900 | 87 | 342 | -240 (horizontal) |
| 3 | ■500<br>■800 | 0.60<br>0.50 | 0.62<br>0.45 | 263 | 182 | 124 | 694 |
| 4 | ■1800<br>■2700 | 0.18<br>0.08 | 0.18<br>0.08 | 320 | 32 | 31 | 312 |

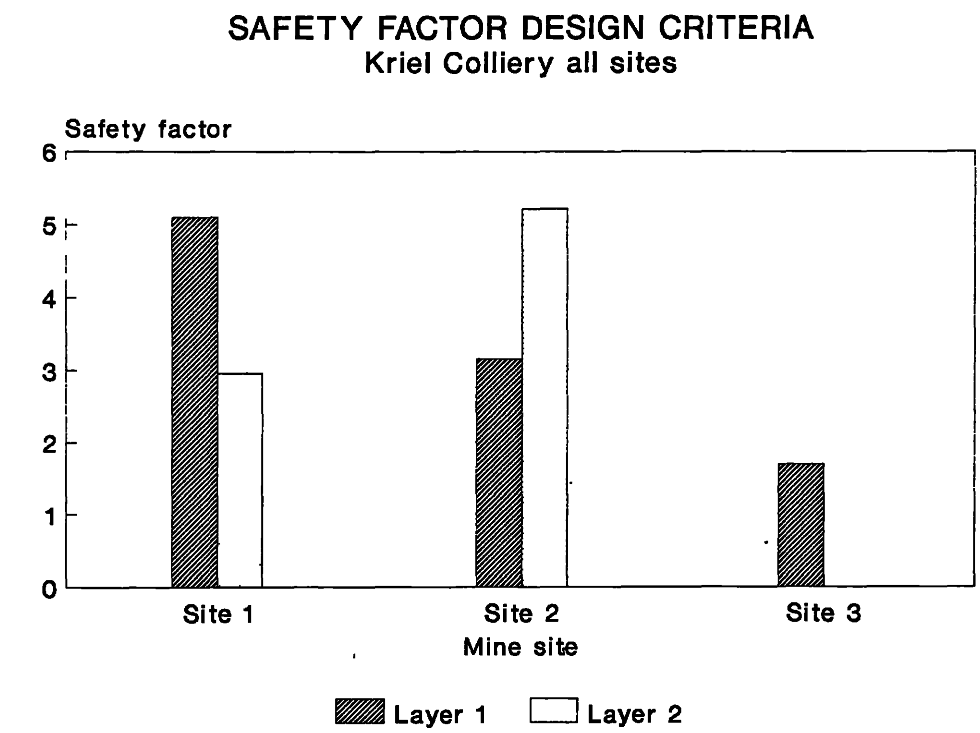
**SAFETY FACTOR ESTIMATION - KRIEL COLLIERY**

**C-TERM = 223**
**Phi-TERM= 5.5**

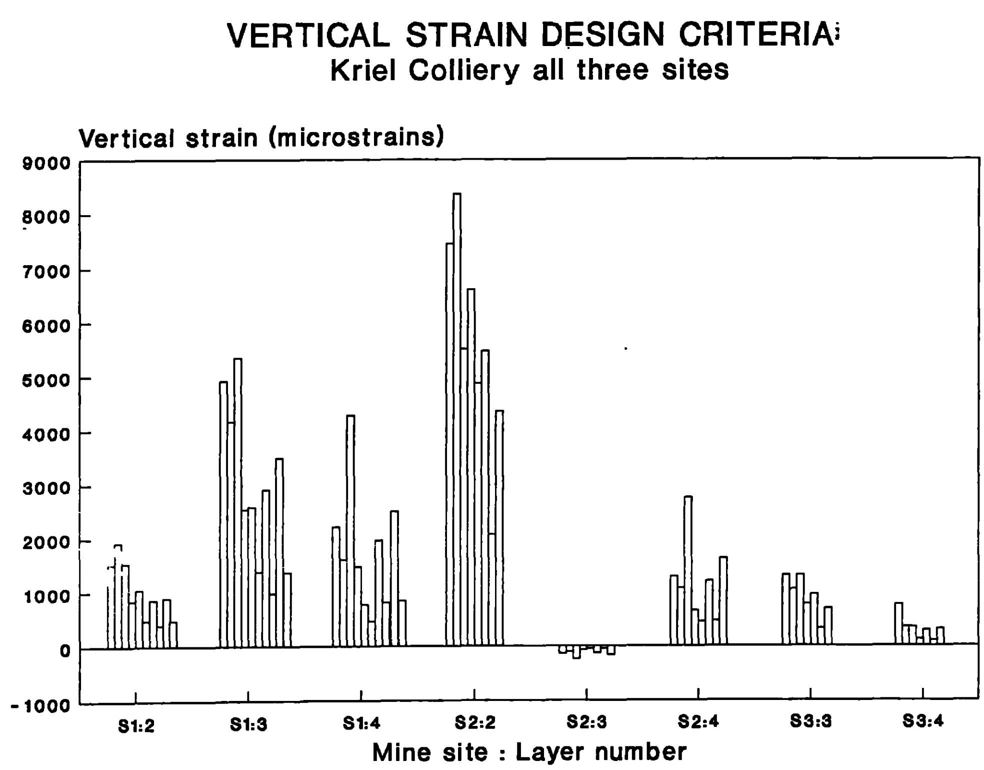
| Minor principle stress (kPa) | | Site 1 layer 1 | Site 1 layer 2 | Site 2 layer 1 | Site 2 layer 2 | Site 3 layer 1 | Site 3 layer 2 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| R170 | FF | 435 | 80 | 335 | 200 | 559 | |
| | FE | 402 | 41 | 327 | 184 | 487 | |
| | RF | 463 | 74 | 144 | 119 | 255 | |
| | RE | 364 | -37 | 218 | 55 | 53 | |
| | | | | | | | |
| Cat 772 | FF | 313 | -42 | 266 | 116 | 424 | |
| | FE | 290 | -55 | | | | |
| | DF | 252 | -95 | 314 | 162 | 178 | |
| | DE | 262 | -3 | 207 | 70 | 375 | |
| | RF | 348 | -189 | 335 | 182 | 500 | |
| | RE | 263 | -35 | | | 370 | |
| | | | | | | | |
| **Deviator stress (kPa)** | | | | | | | |
| R170 | FF | 254 | 511 | 348 | 198 | 94 | |
| | FE | 296 | 444 | 400 | 215 | 279 | |
| | RF | 195 | 689 | 323 | 84 | 80 | |
| | RE | 310 | 425 | 343 | 38 | 303 | |
| | | | | | | | |
| Cat 772 | FF | 322 | 305 | 405 | 165 | 393 | |
| | FE | 321 | 27 | | | | |
| | DF | 220 | 558 | 410 | 155 | 345 | |
| | DE | 329 | 177 | 345 | 62 | 428 | |
| | RF | 257 | 789 | 371 | 169 | 274 | |
| | RE | 313 | 223 | | | 367 | |

D1-31

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Safety factor** | | | | | | | |
| R170 | FF | 10.30 | 1.30 | 5.94 | 6.68 | 35.08 | |
| | FE | 8.22 | 1.01 | 5.05 | 5.74 | 10.40 | |
| | RF | 14.20 | 0.91 | 3.14 | 10.45 | 20.32 | |
| | RE | 7.18 | 0.05 | 4.15 | 13.83 | 1.70 | |
| | | | | | | | |
| Cat 772 | FF | 6.04 | -0.03 | 4.16 | 5.22 | 6.50 | |
| | FE | 5.66 | -2.94 | | | | |
| | DF | 7.31 | -0.54 | 4.76 | 7.19 | 3.48 | |
| | DE | 5.06 | 1.17 | 3.95 | 9.21 | 5.34 | |
| | RF | 8.32 | -1.03 | 5.57 | 7.14 | 10.85 | |
| | RE | 5.33 | 0.14 | | | 6.15 | |
| | | | | | | | |
| **Minimum safety factor** | | 5.06 | -2.94 | 3.14 | 5.22 | 1.70 | |



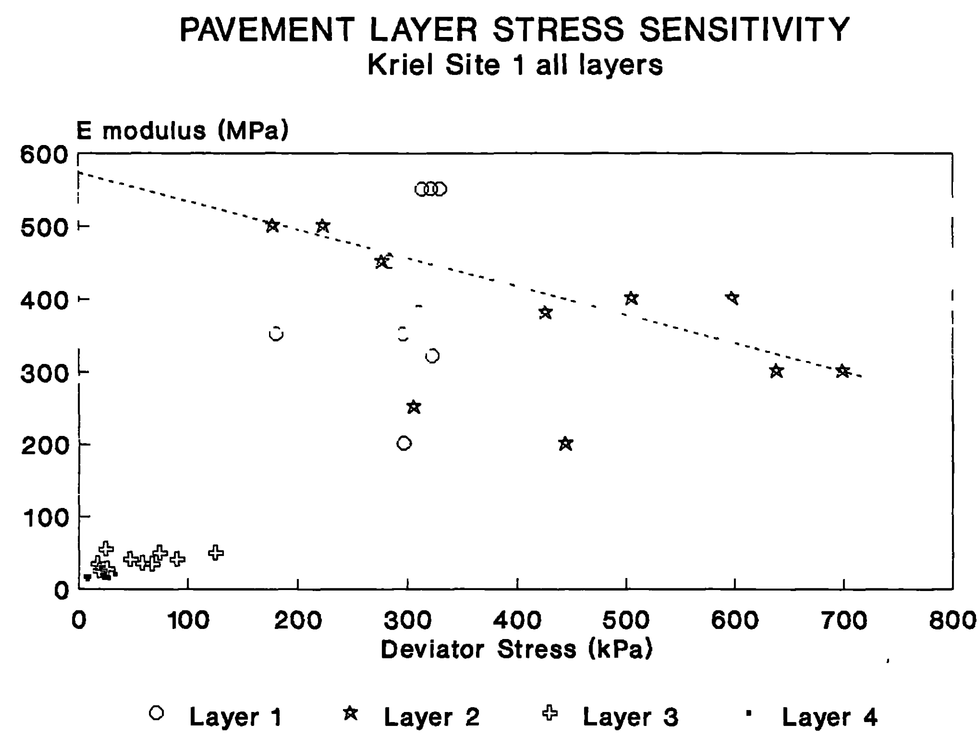

Site 3 layer 2 stabilised

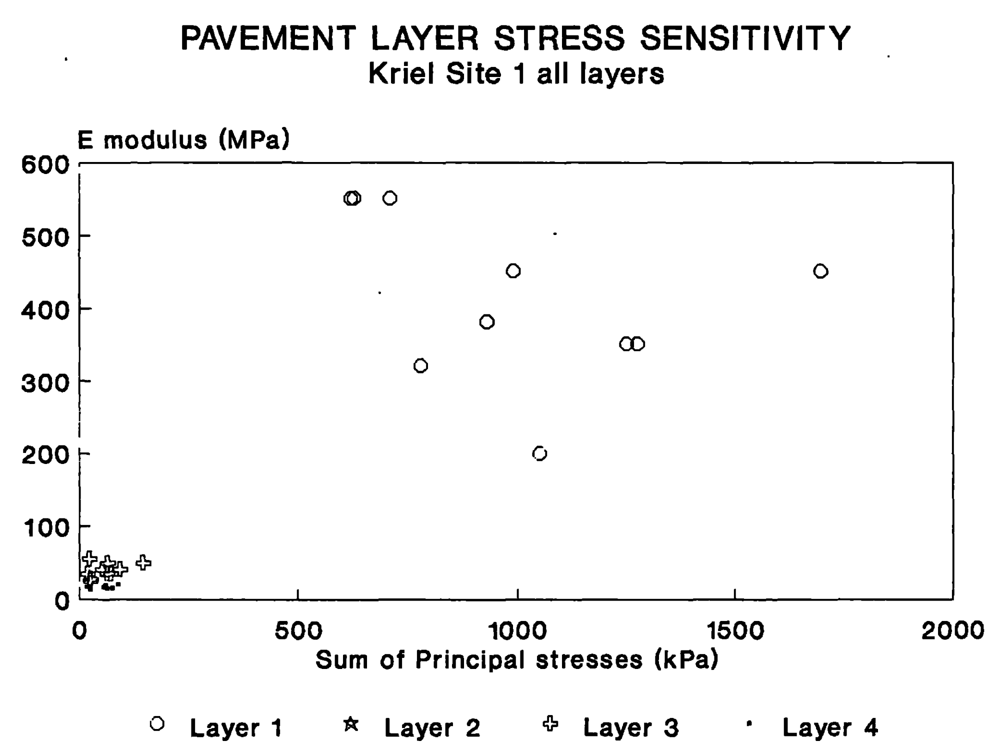



Site 3 layer 2 stabilised

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

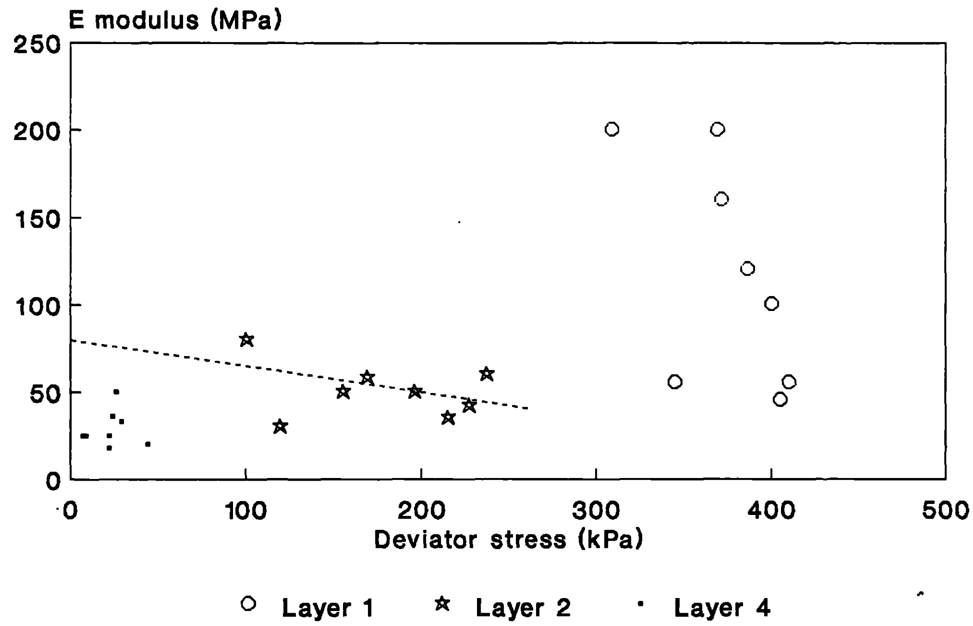




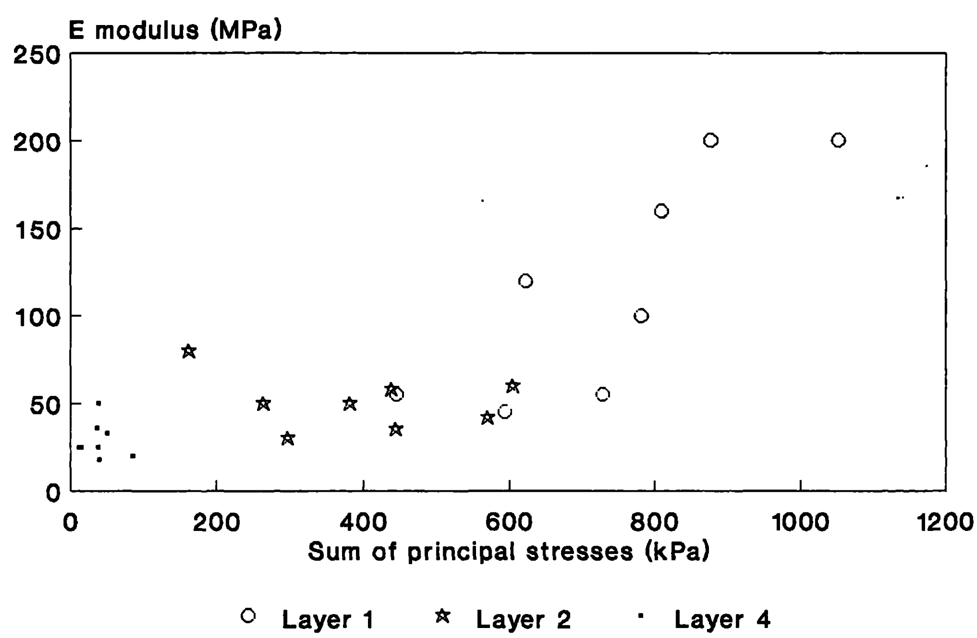

Layer 2 omitted

PAVEMENT LAYER STRESS SENSITIVITY
Kriel site 2 all layers

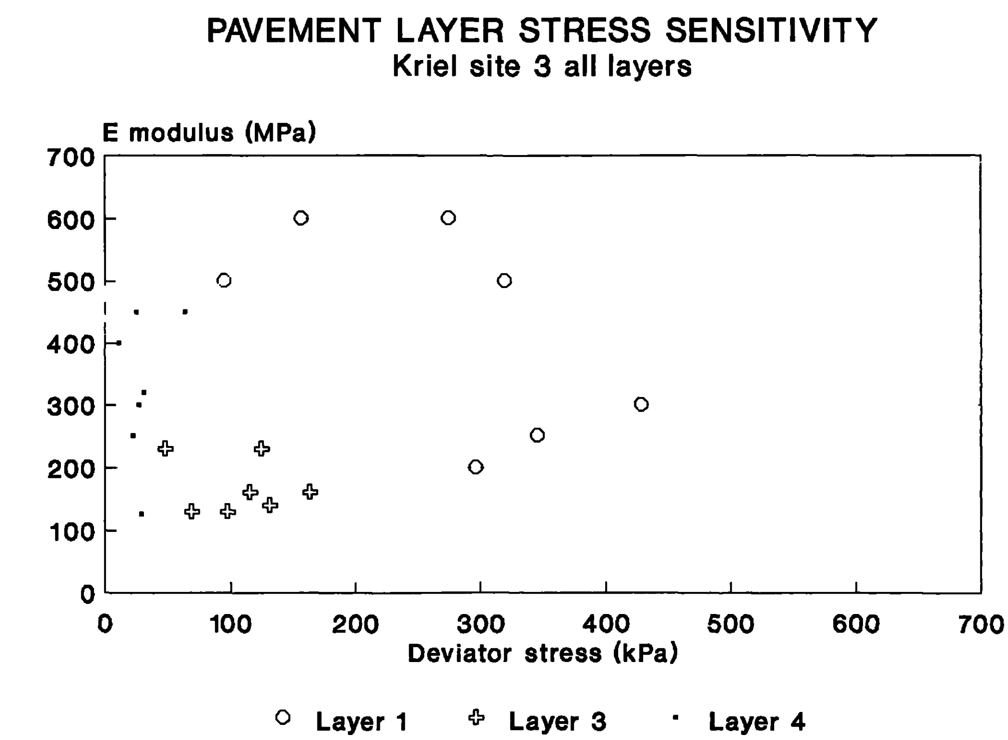



Layer 3 data omitted

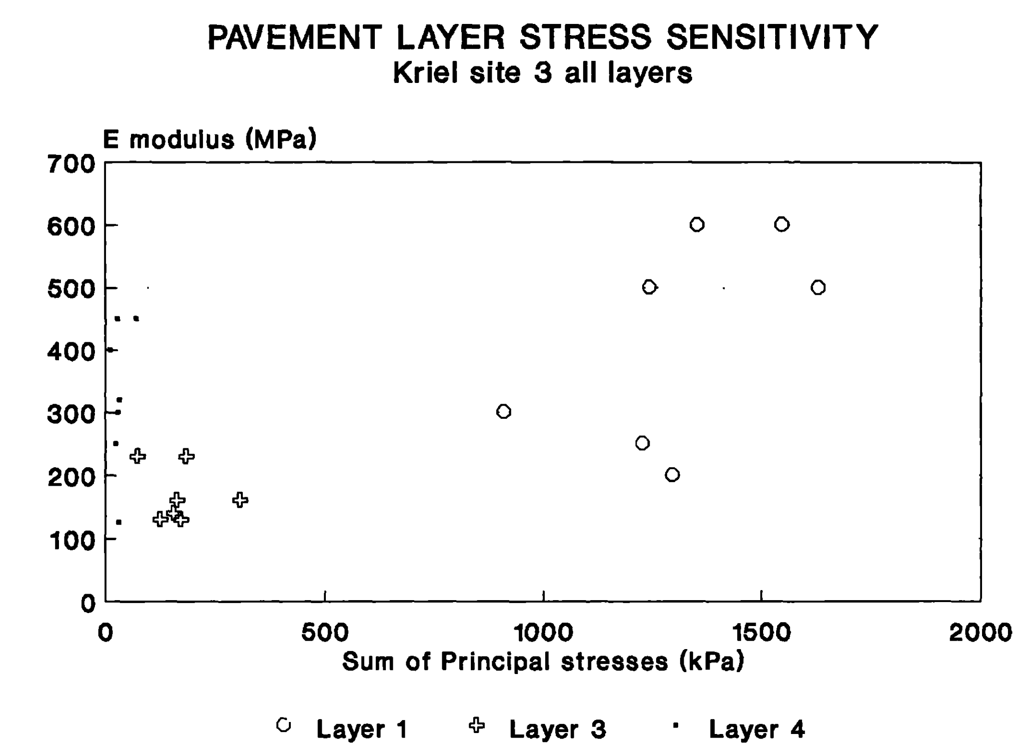
PAVEMENT LAYER STRESS SENSITIVITY
Kriel site 2 all layers




Layer 3 data omitted




Stabilised layer 2 omitted



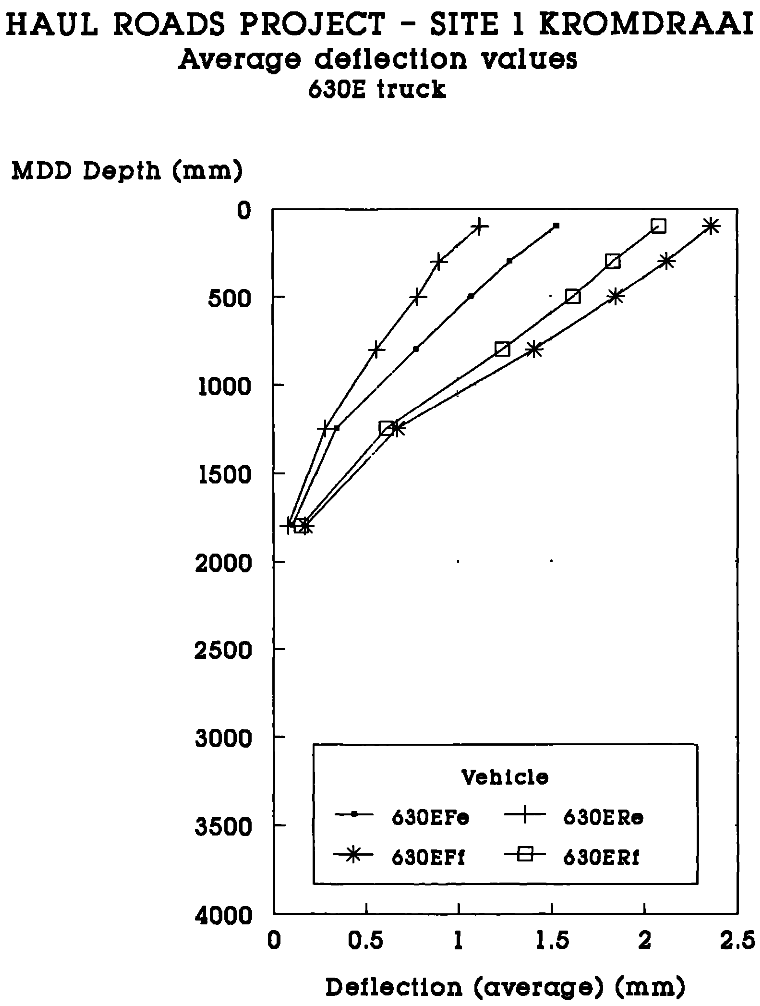

Stabilised layer 2 omitted

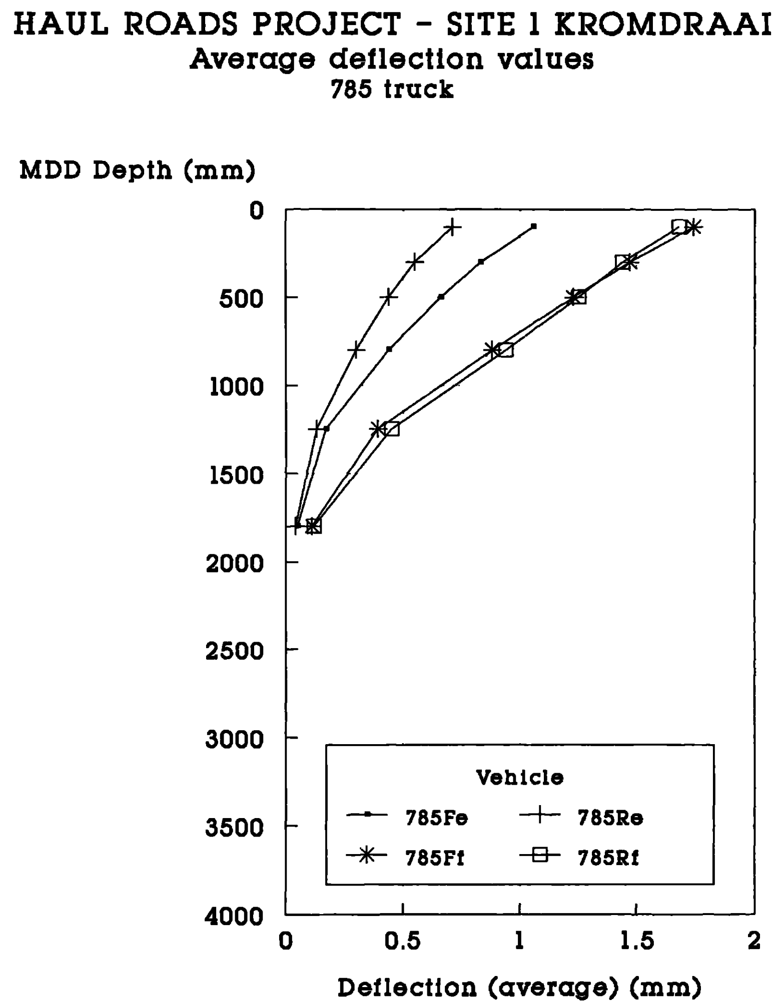
# APPENDIX D2

## RESULTS OF MDD AND MECHANISTIC ANALYSIS - KROMDRAAI COLLIERY

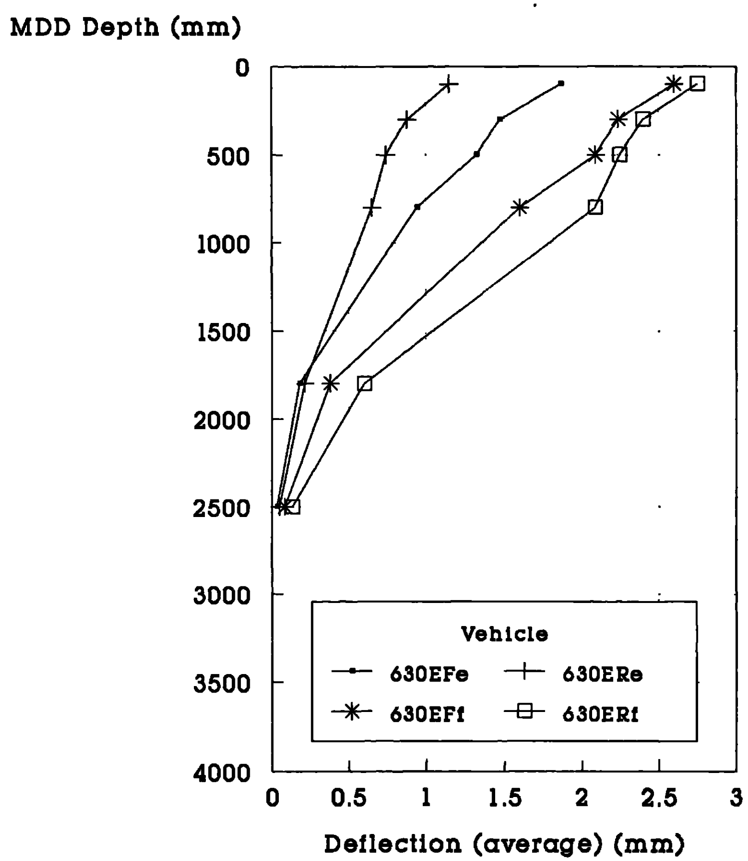
D2-2

**Contents**

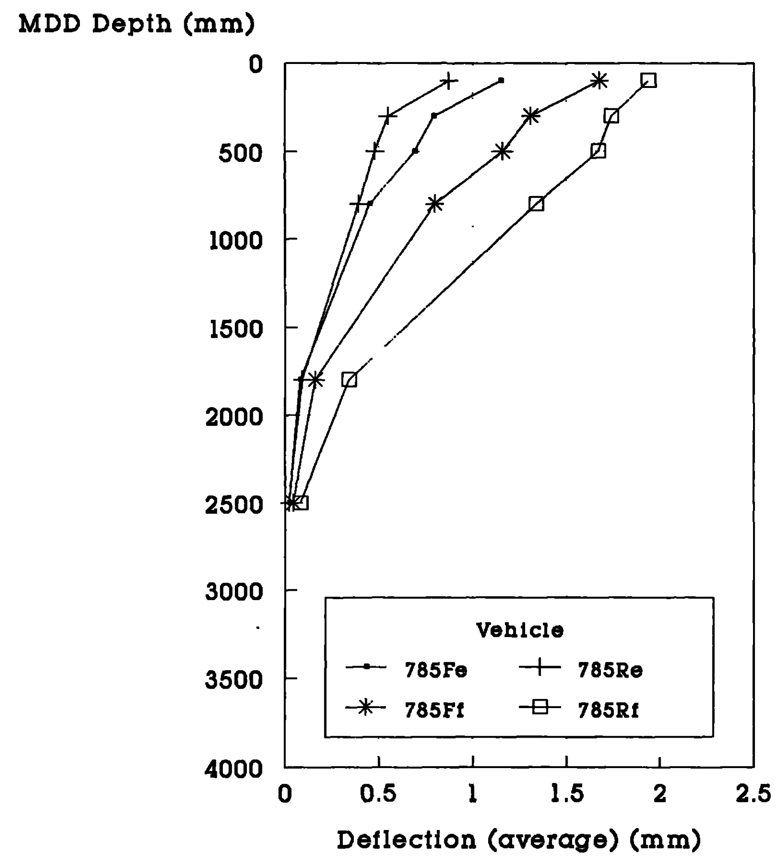

HAUL ROADS PROJECT - SITE 1 KROMDRAAI
Average deflection values
630E truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.5
1
1.5
2
2.5
Deflection (average) (mm)
Vehicle
630EFe
630ERe
630EFf
630ERf

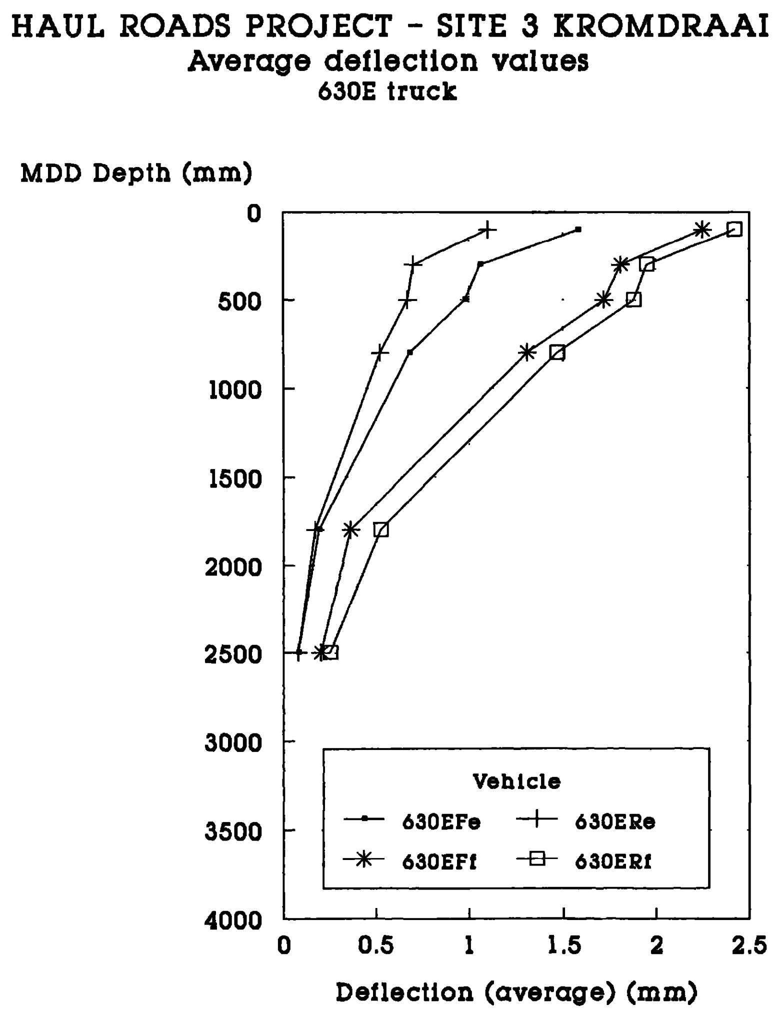

HAUL ROADS PROJECT - SITE 1 KROMDRAAI
Average deflection values
785 truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.5
1
1.5
2
Deflection (average) (mm)
Vehicle
785Fe
785Re
785Ff
785Rf

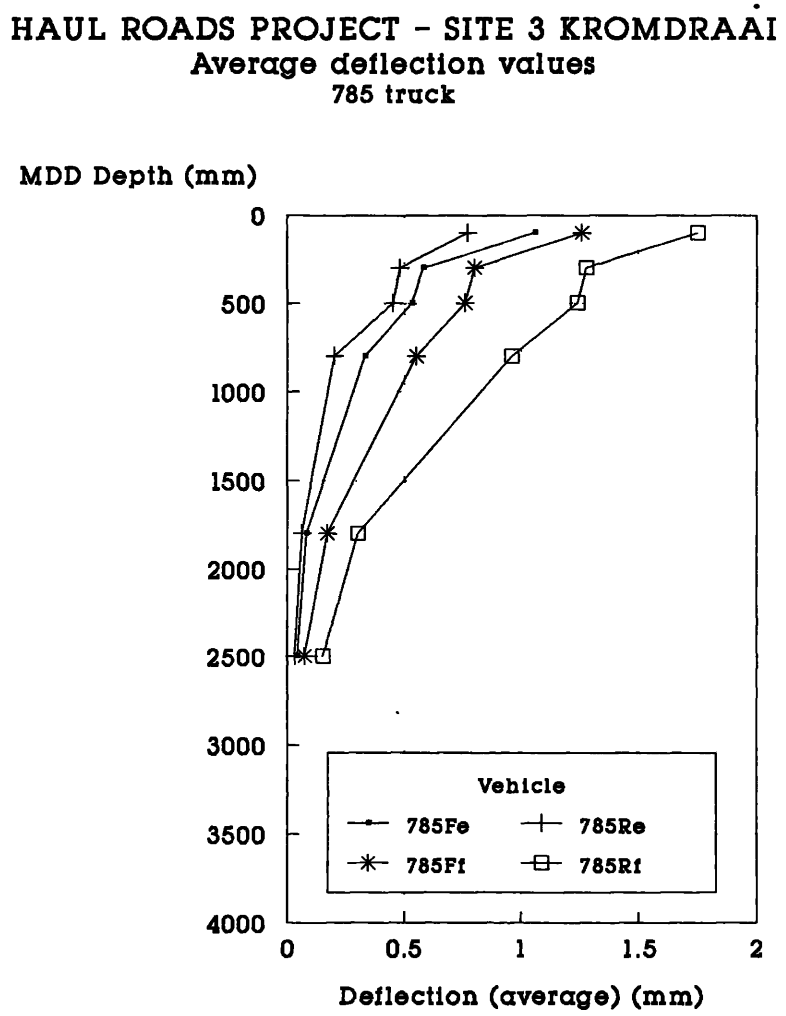
HAUL ROADS PROJECT - SITE 2 KROMDRAAI
Average deflection values
630E truck




HAUL ROADS PROJECT - SITE 2 KROMDRAAI
Average deflection values
785 truck




HAUL ROADS PROJECT - SITE 3 KROMDRAAI
Average deflection values
630E truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.5
1
1.5
2
2.5
Deflection (average) (mm)
Vehicle
630EFe
630ERe
630EFf
630ERf


HAUL ROADS PROJECT - SITE 3 KROMDRAAI
Average deflection values
785 truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.5
1
1.5
2
Deflection (average) (mm)
Vehicle
785Fe
785Re
785Ff
785Rf

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.53 | 1.52 | 165.0 | 1363.0 | 257.7 | |
| 2 | ■300<br>■500 | 1.28<br>1.07 | 1.29<br>1.24 | 1490.0 | 152.9 | 384.4 | 926.9 |
| 3 | ■800 | 0.77 | 0.77 | 40.0 | 118.7 | 59.3 | 1990 |
| 4 | ■1250<br>■1800 | 0.34<br>0.10 | 0.34<br>0.09 | 93.0 | 62.4 | 38.5 | 649.6 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 2.36 | 2.36 | 180 | 1510.0 | 171.3 | |
| 2 | ■300<br>■500 | 2.12<br>1.85 | 2.18<br>2.13 | 1540 | 107.4 | 435.2 | 170.9 |
| 3 | ■800 | 1.41 | 1.41 | 32 | 153.2 | 74.3 | 298.1 |
| 4 | ■1250<br>■1800 | 0.68<br>0.20 | 0.67<br>0.18 | 63 | 87.1 | 50.8 | 1226.0 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.02 | 1.04 | 350 | 1236.0 | 310.1 | |
| 2 | ■300<br>■500 | 0.90<br>0.82 | 0.89<br>0.80 | 620 | 119.3 | 302.2 | 601.0 |
| 3 | ■800 | 0.55 | 0.54 | 68 | 96.1 | 60.8 | 1257.0 |
| 4 | ■1250<br>■1800 | 0.28<br>0.08 | 0.27<br>0.08 | 106 | 57.8 | 36.8 | 489.9 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 2.08 | 2.05 | 240 | 1493.0 | 226.2 | |
| 2 | ■300<br>■500 | 1.83<br>1.62 | 1.84<br>1.79 | 750 | 288.3 | 467.4 | 306.6 |
| 3 | ■800 | 1.24 | 1.24 | 84 | 309.5 | 167.4 | 2494.0 |
| 4 | ■1250<br>■1800 | 0.61<br>0.18 | 0.62<br>0.17 | 146 | 179.7 | 115.3 | 1117.0 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.06 | 1.06 | 200 | 1229.0 | 327.1 | |
| 2 | ■300<br>■500 | 0.83<br>0.66 | 0.83<br>0.76 | 840 | 103.8 | 298.8 | 344.9 |
| 3 | ■800 | 0.44 | 0.43 | 38 | 73.4 | 39.1 | 1492.0 |
| 4 | ■1250<br>■1800 | 0.17<br>0.05 | 0.16<br>0.04 | 114 | 34.5 | 23.4 | 336.6 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.74 | 1.73 | 160 | 1341 | 275.5 | |
| 2 | ■300<br>■500 | 1.47<br>1.23 | 1.48<br>1.42 | 1346 | 1001 | 359.2 | 17.41 |
| 3 | ■800 | 0.88 | 0.89 | 22 | 80.4 | 37.0 | 2242.0 |
| 4 | ■1250<br>■1800 | 0.39<br>0.11 | 0.39<br>0.11 | 55 | 44.6 | 22.2 | 718.3 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 0.71 | 0.71 | 260 | 1042.0 | 391.0 | |
| 2 | ■300<br>■500 | 0.55<br>0.41 | 0.52<br>0.47 | 810 | 96.1 | 225.0 | 421.3 |
| 3 | ■800 | 0.30 | 0.30 | 63 | 69.2 | 37.2 | 803.8 |
| 4 | ■1250<br>■1800 | 0.13<br>0.04 | 0.14<br>0.04 | 138 | 36.0 | 23.9 | 264.1 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 1 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.50 | 1.52 | 420 | 1409.0 | 245.4 | |
| 2 | ■300<br>■500 | 1.45<br>1.39 | 1.44<br>1.37 | 710 | 49.8 | 372.4 | 46.8 |
| 3 | ■800 | 0.93 | 0.93 | 45 | 129.0 | 69.9 | 1928.0 |
| 4 | ■1250<br>■1800 | 0.45<br>0.12 | 0.45<br>0.12 | 83 | 73.6 | 45.7 | 827.1 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | 100 | 1461.0 | 207.7 | |
| 2 | ■100<br>■300 | 1.87<br>1.47 | 1.86<br>1.62 | 310 | 560.9 | 389.2 | 882.2 |
| 3 | ■500<br>■800 | 1.32<br>0.94 | 1.32<br>0.76 | 97 | 178.7 | 150.5 | 2563.0 |
| 4 | ■1800<br>■2500 | 0.18<br>0.03 | 0.18<br>0.03 | 158 | 45.1 | 40.9 | 684.8 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | 100 | 1532.0 | 173.6 | |
| 2 | ■100<br>■300 | 2.60<br>2.24 | 2.60<br>2.42 | 350 | 671.2 | 387.6 | 530.1 |
| 3 | ■500<br>■800 | 2.09<br>1.60 | 2.09<br>1.39 | 98 | 214.1 | 197.2 | 3023.0 |
| 4 | ■1800<br>■2500 | 0.38<br>0.08 | 0.38<br>0.07 | 104 | 64.2 | 55.5 | 1331.0 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | 100 | 1337.0 | 272.7 | |
| 2 | ■100<br>■300 | 1.15<br>0.80 | 1.15<br>0.92 | 342 | 496.3 | 341.1 | 1054.0 |
| 3 | ■500<br>■800 | 0.74<br>0.65 | 0.75<br>0.68 | 220 | 71.5 | 116.2 | 915.9 |
| 4 | ■1800<br>■2500 | 0.21<br>0.05 | 0.21<br>0.04 | 97 | 36.8 | 28.5 | 570.1 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | 100 | 1487.0 | 209.8 | |
| 2 | ■100<br>■300 | 2.75<br>2.40 | 2.76<br>2.55 | 338 | 775.2 | 384.5 | 704.9 |
| 3 | ■500<br>■800 | 2.25<br>2.09 | 2.25<br>1.80 | 137 | 257.4 | 247.2 | 2416.0 |
| 4 | ■1800<br>■2500 | 0.60<br>0.13 | 0.60<br>0.12 | 110 | 114.7 | 91.5 | 1504.0 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) θ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | 100 | 1357.0 | 258.1 | |
| 2 | ■100<br>■300 | 1.15<br>0.79 | 1.14<br>0.89 | 310 | 372.1 | 334.1 | 1121.0 |
| 3 | ■500<br>■800 | 0.69<br>0.45 | 0.69<br>0.36 | 91 | 92.8 | 79.6 | 1638.0 |
| 4 | ■1800<br>■2500 | 0.08<br>0.02 | 0.08<br>0.01 | 176 | 21.2 | 20.1 | 314.9 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN (x$10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | 100 | 1437.0 | 218.7 | |
| 2 | ■100<br>■300 | 1.68<br>1.31 | 1.69<br>1.44 | 300 | 492.1 | 374.5 | 983.4 |
| 3 | ■500<br>■800 | 1.16<br>0.80 | 1.16<br>0.67 | 90 | 138.3 | 121.6 | 2337.0 |
| 4 | ■1800<br>■2500 | 0.16<br>0.04 | 0.16<br>0.03 | 138 | 34.6 | 31.7 | 614.4 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN (x$10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | 100 | 1274.0 | 307.7 | |
| 2 | ■100<br>■300 | 0.87<br>0.55 | 0.87<br>0.62 | 294 | 306.4 | 280.3 | 1384.0 |
| 3 | ■500<br>■800 | 0.48<br>0.39 | 0.48<br>0.32 | 130 | 74.7 | 60.9 | 926.7 |
| 4 | ■1800<br>■2500 | 0.09<br>0.02 | 0.09<br>0.02 | 160 | 23.7 | 20.8 | 284.1 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | 100 | 1424.0 | 233.5 | |
| 2 | ■100<br>■300 | 1.94<br>1.74 | 1.94<br>1.79 | 450 | 431.4 | 362.2 | 490.6 |
| 3 | ■500<br>■800 | 0.67<br>1.34 | 1.65<br>1.16 | 68 | 149.6 | 108.7 | 2288.0 |
| 4 | ■1800<br>■2500 | 0.34<br>0.08 | 0.34<br>0.06 | 91 | 52.5 | 43.3 | 960.8 |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.58 | 1.58 | 52 | 1282.0 | 296.5 | |
| 2 | ■300<br>■500 | 1.06<br>0.98 | 1.05<br>0.94 | 460 | 443.7 | 345.3 | 683.9 |
| 3 | ■800<br>■1800<br>■2500 | 0.68<br>0.19<br>0.08 | 0.68<br>0.22<br>0.09 | 153 | 32.9 | 33.1 | 1147.0 |
| | | | | | | | |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 2.25 | 2.25 | 54 | 1340.0 | 266.4 | |
| 2 | ■300<br>■500 | 1.81<br>1.72 | 1.82<br>1.67 | 500 | 510.5 | 364.6 | 412.7 |
| 3 | ■800<br>■1800<br>■2500 | 1.31<br>0.36<br>0.20 | 1.31<br>0.46<br>0.19 | 108 | 49.2 | 46.7 | 1837.2 |
| | | | | | | | |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.10 | 1.10 | 61 | 1219.0 | 344.5 | |
| 2 | ■300<br>■500 | 0.70<br>0.67 | 0.71<br>0.64 | 835 | 274.4 | 270.4 | 393.3 |
| 3 | ■800<br>■1800<br>■2500 | 0.52<br>0.17<br>0.08 | 0.52<br>0.23<br>0.09 | 123 | 30.1 | 26.1 | 685.2 |
| | | | | | | | |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 630E |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 2.42 | 2.43 | 55 | 1330 | 277.0 | |
| 2 | ■300<br>■500 | 1.95<br>1.88 | 1.95<br>1.75 | 395 | 611.5 | 385.5 | 734.5 |
| 3 | ■800<br>■1800<br>■2500 | 1.47<br>0.52<br>0.25 | 1.47<br>0.59<br>0.25 | 156 | 94.8 | 86.9 | 1645.0 |
| | | | | | | | |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN $(x10^{-3})$ $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.06 | 1.06 | 58 | 1215.0 | 344.0 | |
| 2 | ■300<br>■500 | 0.58<br>0.53 | 0.59<br>0.47 | 480 | 288.0 | 271.0 | 810 |
| 3 | ■800<br>■1800<br>■2500 | 0.33<br>0.08<br>0.04 | 0.33<br>0.10<br>0.04 | 166 | 16.2 | 16.8 | 642.3 |
| | | | | | | | |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.26 | 1.26 | 52 | 1254.0 | 313.9 | |
| 2 | ■300<br>■500 | 0.80<br>0.76 | 0.81<br>0.71 | 688 | 356.1 | 313.8 | 442.7 |
| 3 | ■800<br>■1800<br>■2500 | 0.55<br>0.17<br>0.07 | 0.54<br>0.18<br>0.07 | 137 | 24.2 | 24.0 | 875.5 |
| | | | | | | | |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 0.77 | 1.043 | 54 | 1124.0 | 395.7 | |
| 2 | ■300<br>■500 | 0.48<br>0.45 | 0.48<br>0.36 | 331 | 210.3 | 201.7 | 1318.0 |
| 3 | ■800<br>■1800<br>■2500 | 0.27<br>0.06<br>0.03 | 0.27<br>0.10<br>0.04 | 195 | 18.8 | 18.6 | 423.4 |
| | | | | | | | |

| | |
|---|---|
| MINE | SACE KROMDRAAI COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100 | 1.75 | 1.76 | 52 | 1256.0 | 319.1 | |
| 2 | ■300<br>■500 | 1.28<br>1.24 | 1.27<br>1.20 | 450 | 355.9 | 308.0 | 734.2 |
| 3 | ■800<br>■1800<br>■2500 | 0.96<br>0.30<br>0.15 | 0.97<br>0.36<br>0.15 | 110 | 40.5 | 38.0 | 1158.0 |
| | | | | | | | |

**SAFETY FACTOR ESTIMATION - SACE KROMDRAAI COLLIERY**

**C-TERM = 223**

**Phi-TERM 5.5**

| Minor principle stress (kPa) | | Site 1 layer 1 | Site 1 layer 2 | Site 2 layer 1 | Site 2 layer 2 | Site 3 layer 1 | Site 3 layer 2 |
|---|---|---|---|---|---|---|---|
| 630E | FF | 617 | 326 | 626 | 482 | 624 | 413 |
| | FE | 626 | 307 | 625 | 446 | 624 | 378 |
| | RF | 617 | 392 | 628 | 510 | 625 | 454 |
| | RE | 612 | 234 | 625 | 392 | 634 | 269 |
| 785 | FF | 630 | 272 | 624 | 413 | 627 | 327 |
| | FE | 627 | 233 | 624 | 346 | 634 | 276 |
| | RF | 613 | 252 | 623 | 379 | 629 | 318 |
| | RE | 604 | 177 | 627 | 286 | 616 | 184 |
| **Deviator stress (kPa)** | | | | | | | |
| 630E | FF | 171 | 435 | 173 | 387 | 266 | 364 |
| | FE | 257 | 384 | 207 | 389 | 296 | 345 |
| | RF | 226 | 467 | 209 | 384 | 277 | 385 |
| | RE | 310 | 302 | 272 | 341 | 344 | 270 |
| 785 | FF | 275 | 359 | 218 | 374 | 313 | 313 |
| | FE | 327 | 299 | 258 | 334 | 344 | 271 |
| | RF | 245 | 372 | 233 | 362 | 319 | 308 |
| | RE | 391 | 225 | 307 | 280 | 395 | 201 |

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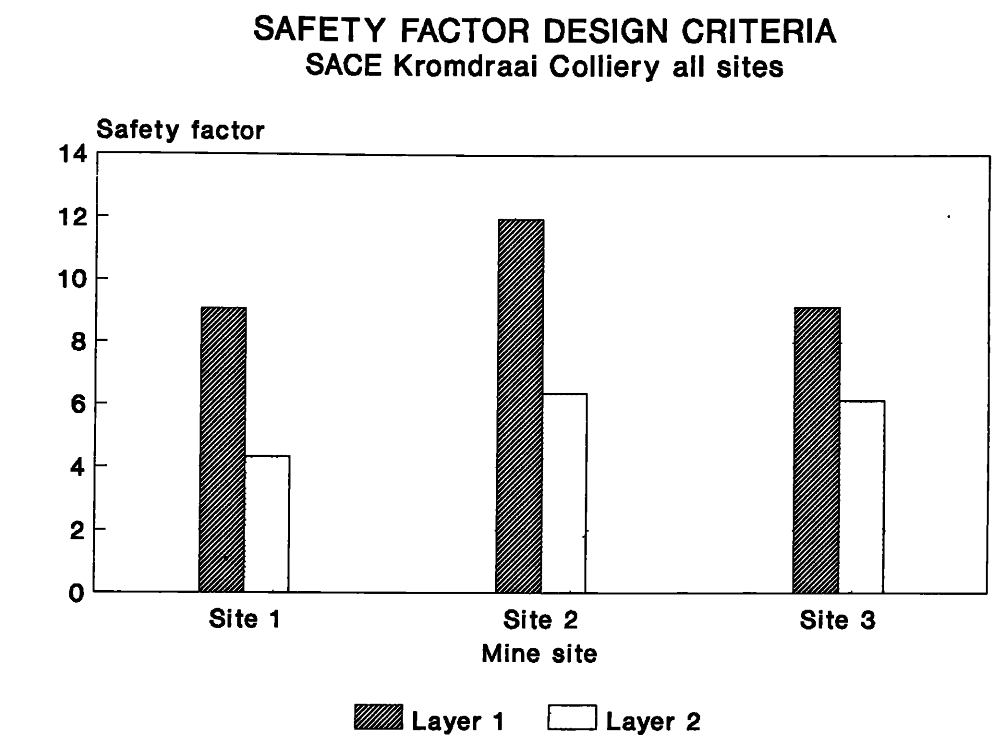
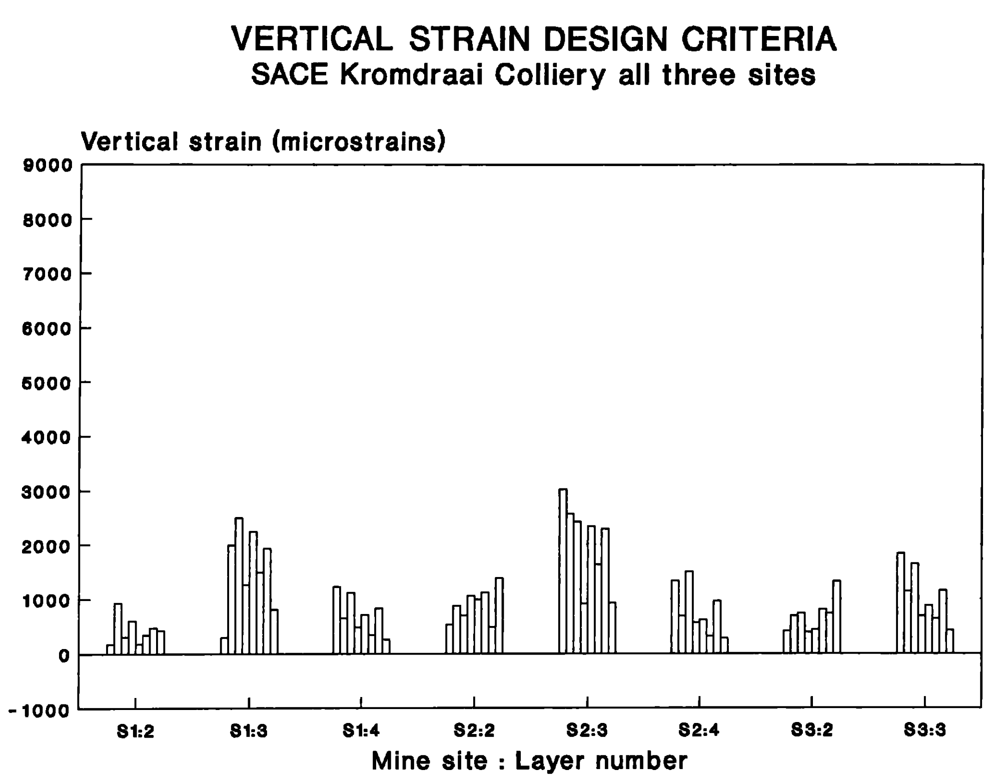
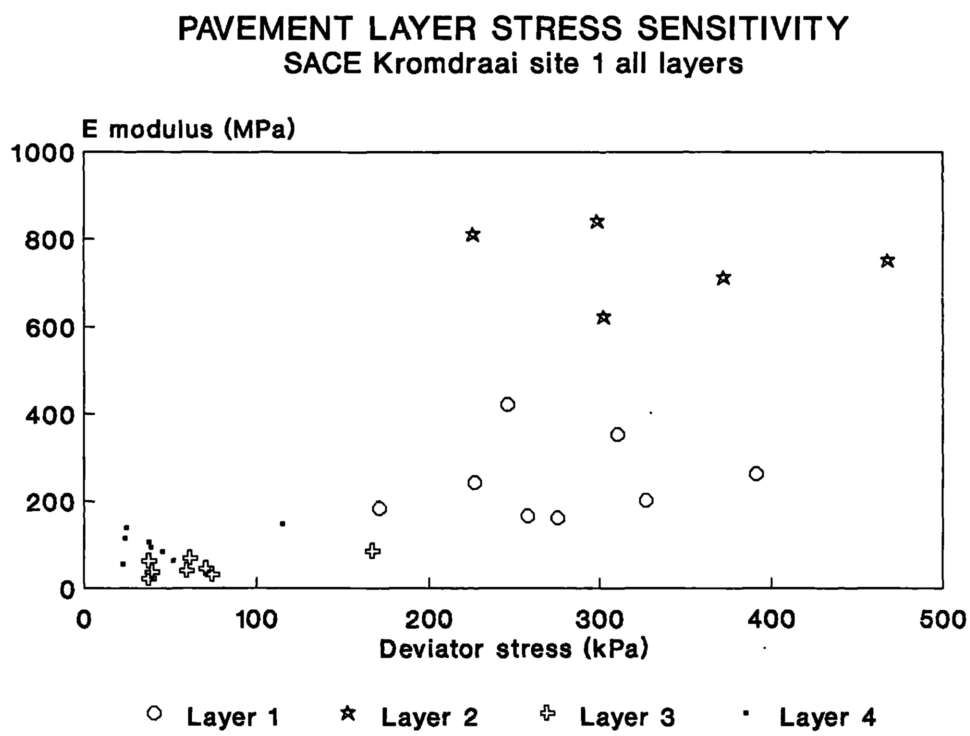
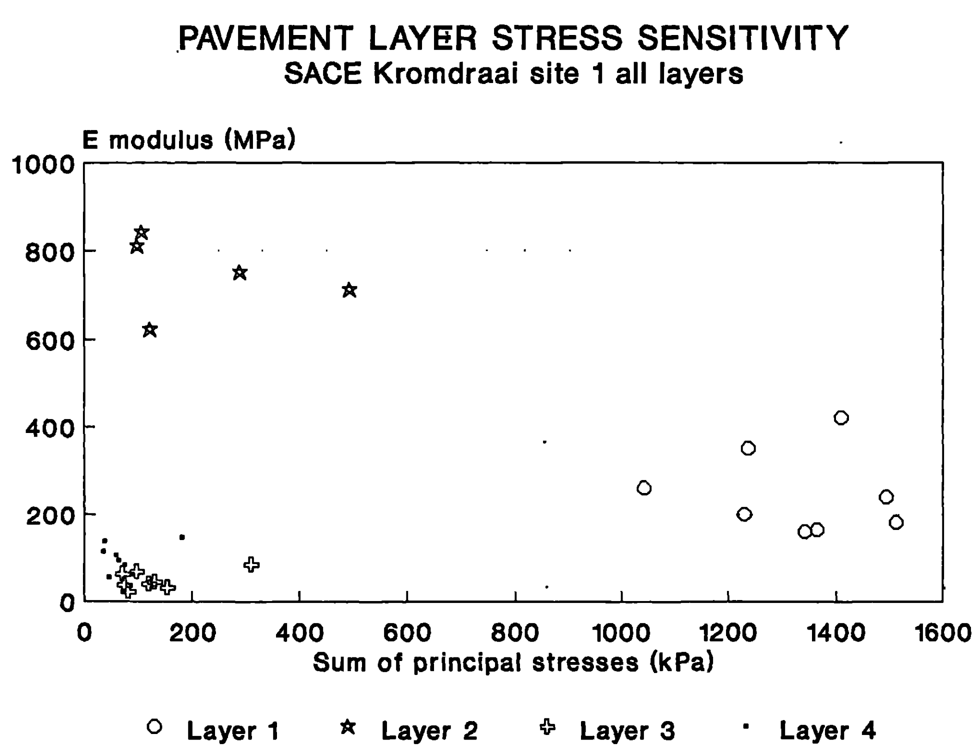
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Safety factor** | | | | | | | |
| 630E | FF | 21.15 | 4.63 | 21.19 | 7.43 | 13.74 | 6.35 |
| | FE | 14.26 | 4.98 | 17.68 | 6.88 | 12.35 | 6.67 |
| | RF | 16.00 | 5.09 | 17.59 | 7.89 | 13.21 | 7.06 |
| | RE | 11.18 | 5.00 | 13.46 | 6.98 | 10.78 | 6.31 |
| | | | | | | | |
| 785 | FF | 13.41 | 4.79 | 16.77 | 6.67 | 11.73 | 6.26 |
| | FE | 11.23 | 5.03 | 14.17 | 6.37 | 10.78 | 6.42 |
| | RF | 14.67 | 4.33 | 15.66 | 6.37 | 11.54 | 6.40 |
| | RE | 9.07 | 5.32 | 11.96 | 6.41 | 9.74 | 6.14 |
| | | | | | | | |
| **Minimum safety factor** | | 9.07 | 4.33 | 11.96 | 6.37 | 9.14 | 6.14 |

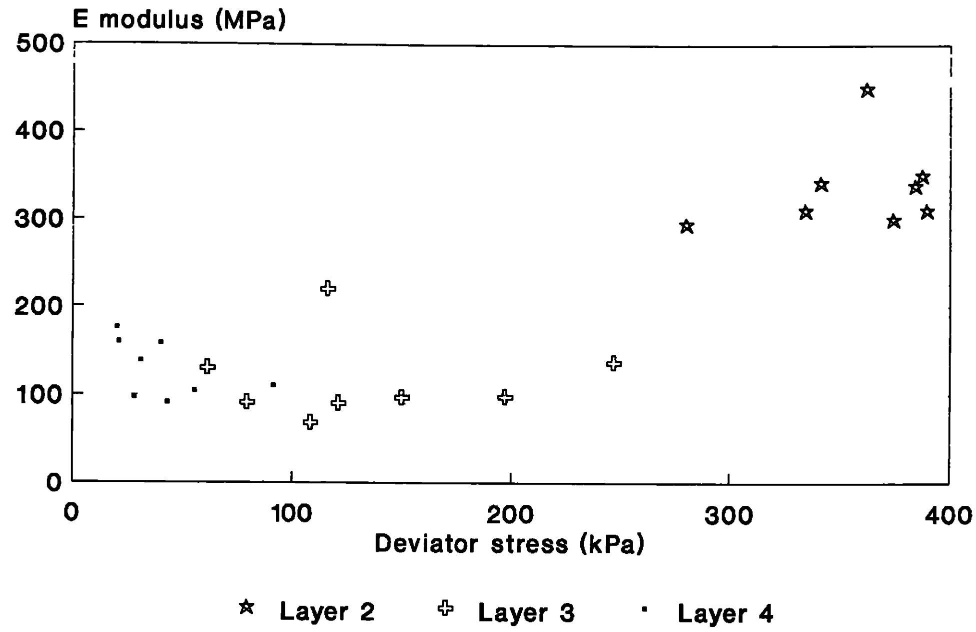

SAFETY FACTOR DESIGN CRITERIA
SACE Kromdraai Colliery all sites
Safety factor
14
12
10
8
6
4
2
0
Site 1
Site 2
Site 3
Mine site
Layer 1
Layer 2


VERTICAL STRAIN DESIGN CRITERIA
SACE Kromdraai Colliery all three sites
Vertical strain (microstrains)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
S1:2
S1:3
S1:4
S2:2
S2:3
S2:4
S3:2
S3:3
Mine site : Layer number


PAVEMENT LAYER STRESS SENSITIVITY
SACE Kromdraai site 1 all layers
E modulus (MPa)
1000
800
600
400
200
0
0
100
200
300
400
500
Deviator stress (kPa)
Layer 1
Layer 2
Layer 3
Layer 4

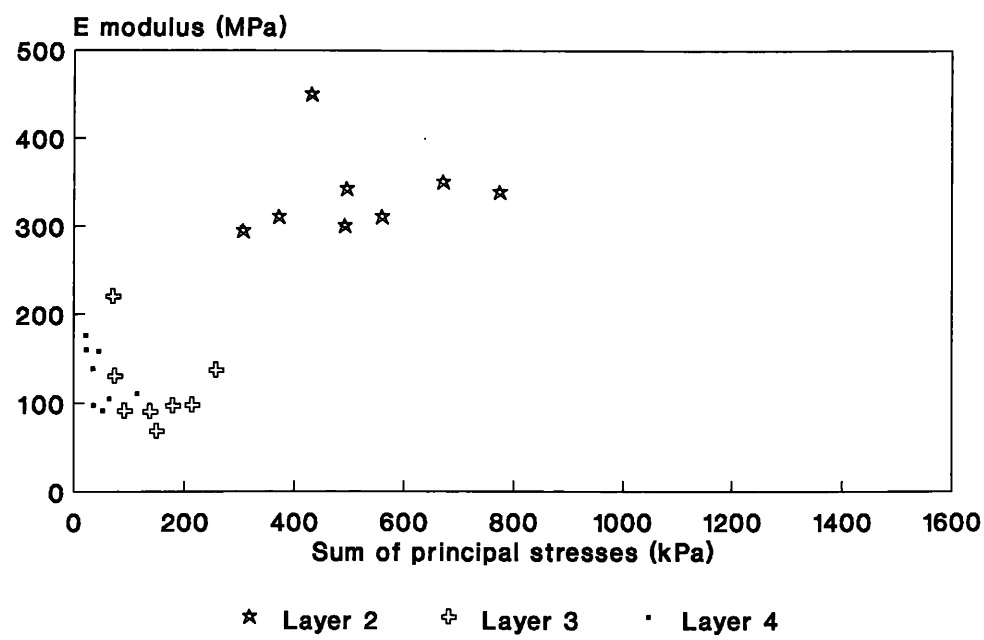

PAVEMENT LAYER STRESS SENSITIVITY
SACE Kromdraai site 1 all layers
E modulus (MPa)
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
1600
Sum of principal stresses (kPa)
Layer 1
Layer 2
Layer 3
Layer 4

PAVEMENT LAYER STRESS SENSITIVITY
SACE Kromdraai site 2 all layers

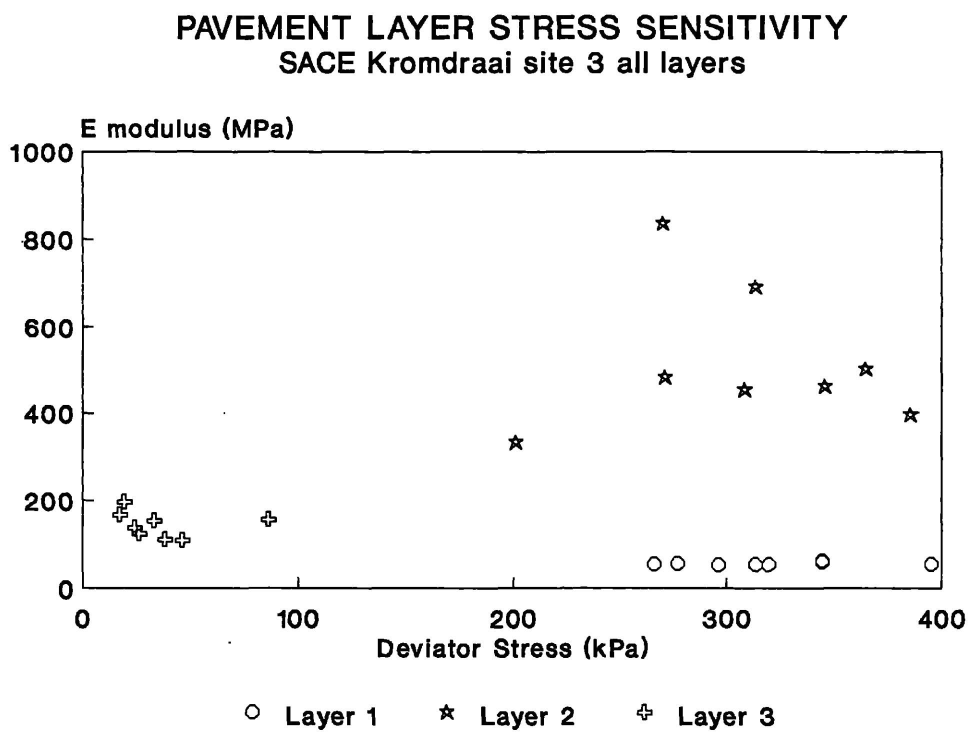


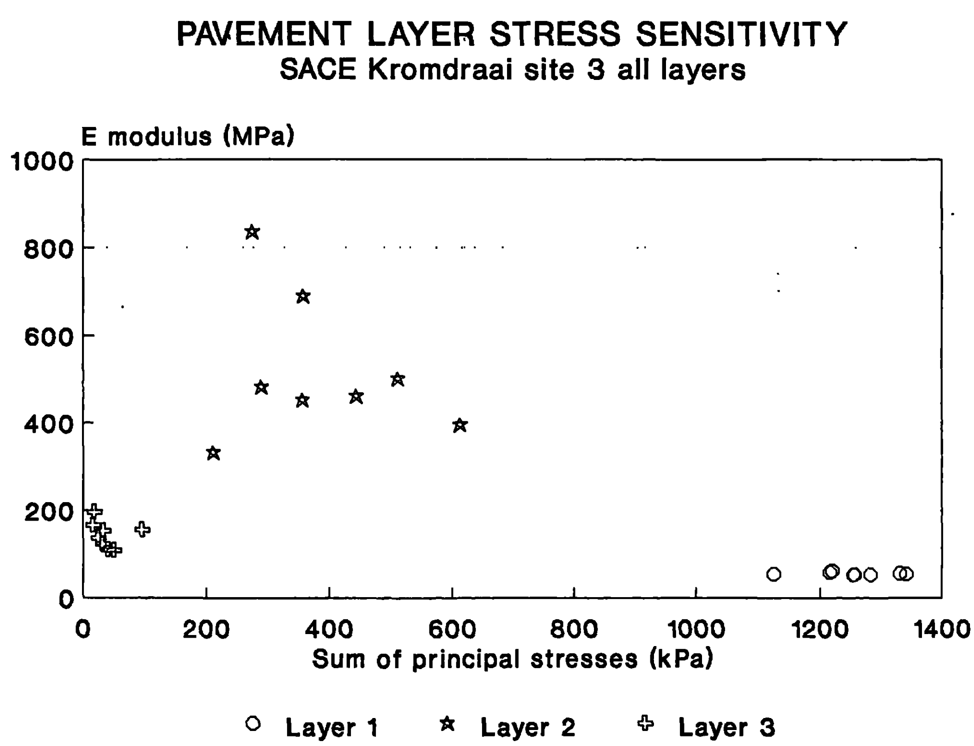

Layer 1 omitted

PAVEMENT LAYER STRESS SENSITIVITY
SACE Kromdraai site 2 all layers




Layer 1 omitted


PAVEMENT LAYER STRESS SENSITIVITY
SACE Kromdraai site 3 all layers
E modulus (MPa)
1000
800
600
400
200
0
0
100
200
300
400
Deviator Stress (kPa)
Layer 1
Layer 2
Layer 3

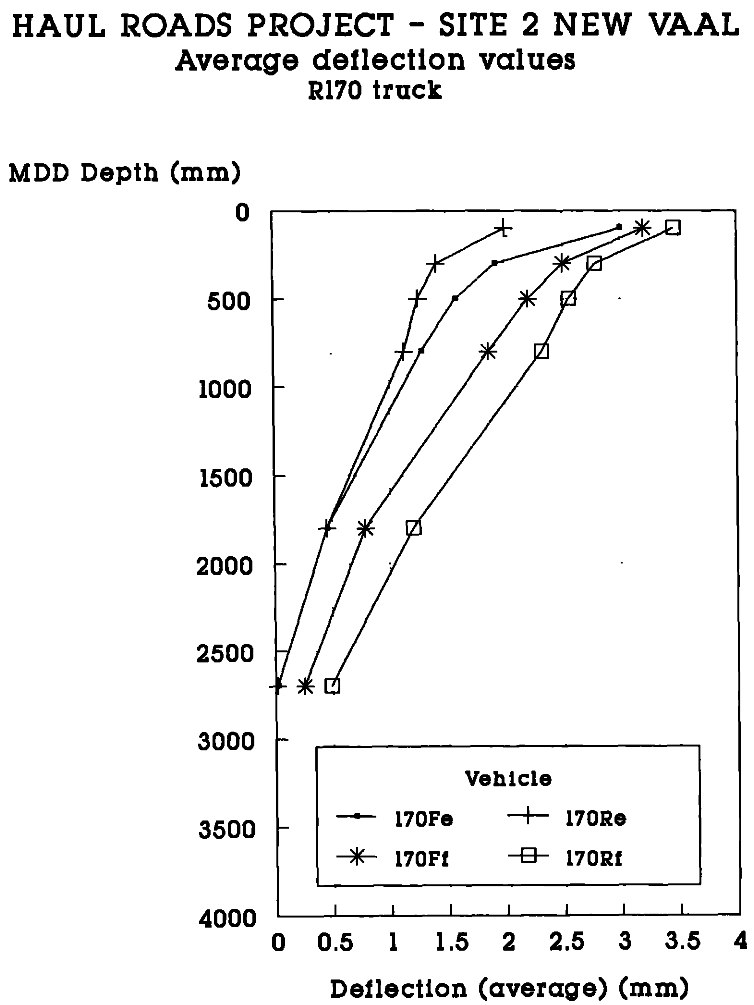

PAVEMENT LAYER STRESS SENSITIVITY
SACE Kromdraai site 3 all layers
E modulus (MPa)
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
Sum of principal stresses (kPa)
Layer 1
Layer 2
Layer 3

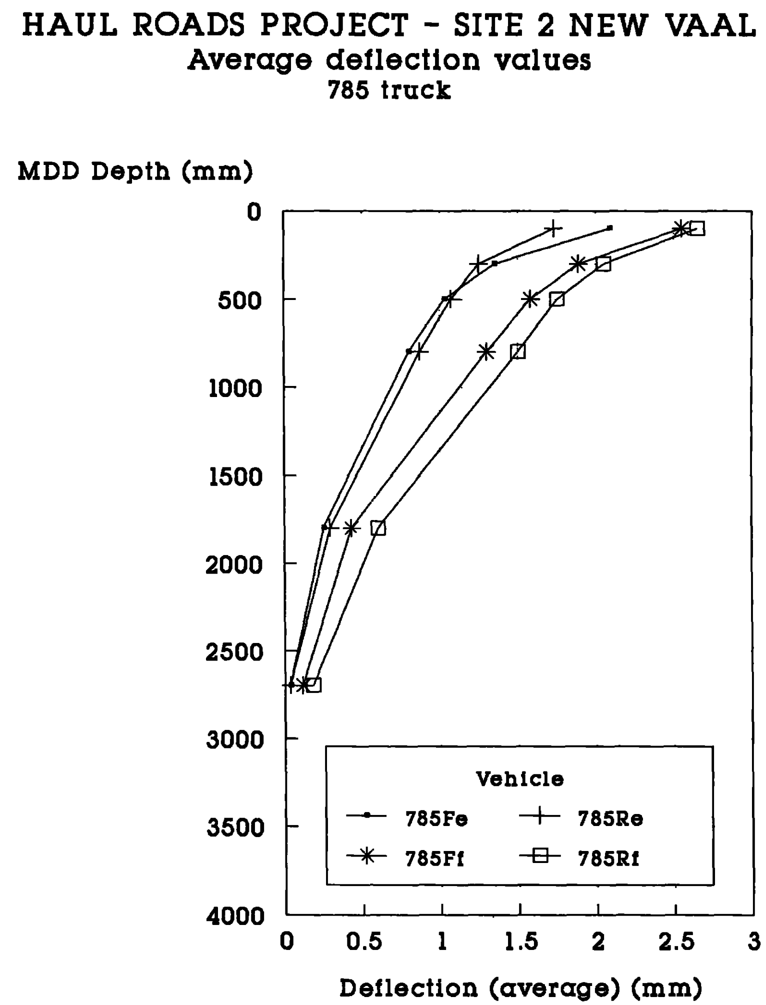
# APPENDIX D3

## RESULTS OF MDD AND MECHANISTIC ANALYSIS - NEW VAAL COLLIERY

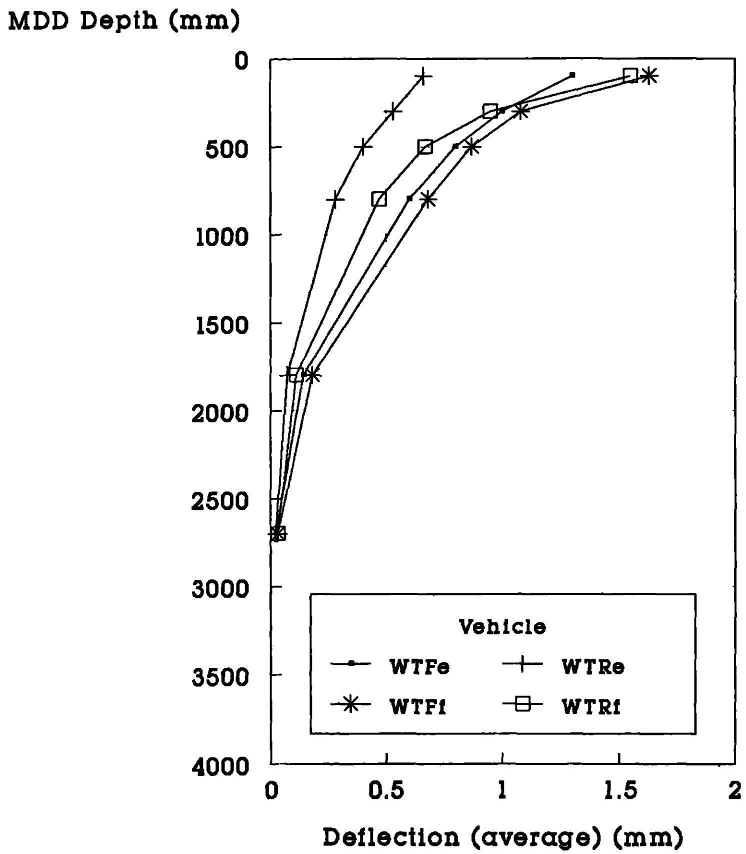
D3-2

## Contents

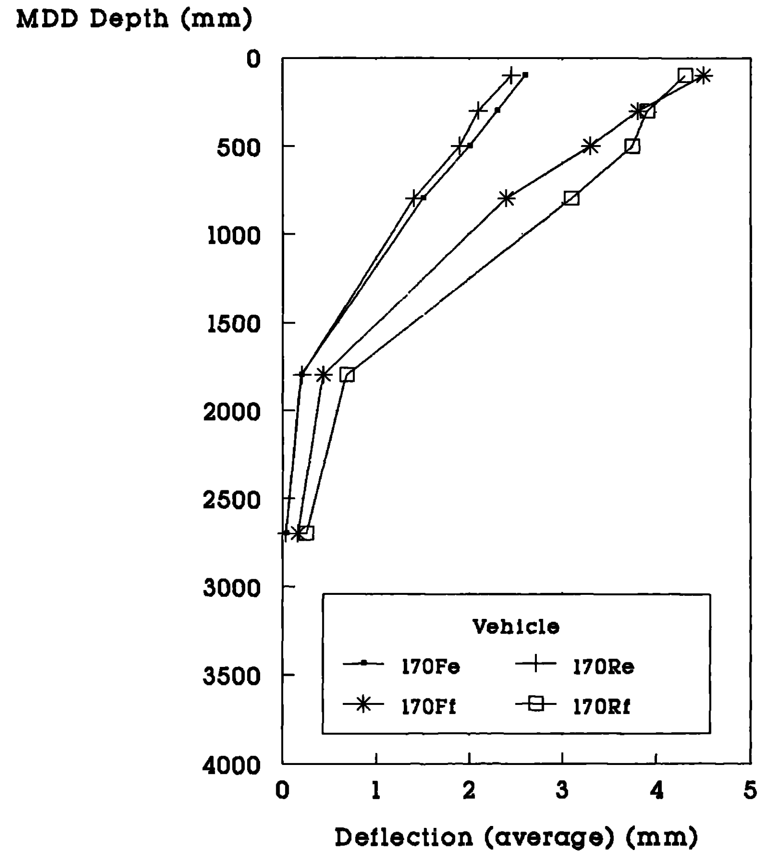

HAUL ROADS PROJECT - SITE 2 NEW VAAL
Average deflection values
R170 truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.5
1
1.5
2
2.5
3
3.5
4
Deflection (average) (mm)
Vehicle
170Fe
170Re
170Ff
170Rf


HAUL ROADS PROJECT - SITE 2 NEW VAAL
Average deflection values
785 truck
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.5
1
1.5
2
2.5
3
Deflection (average) (mm)
Vehicle
785Fe
785Re
785Ff
785Rf

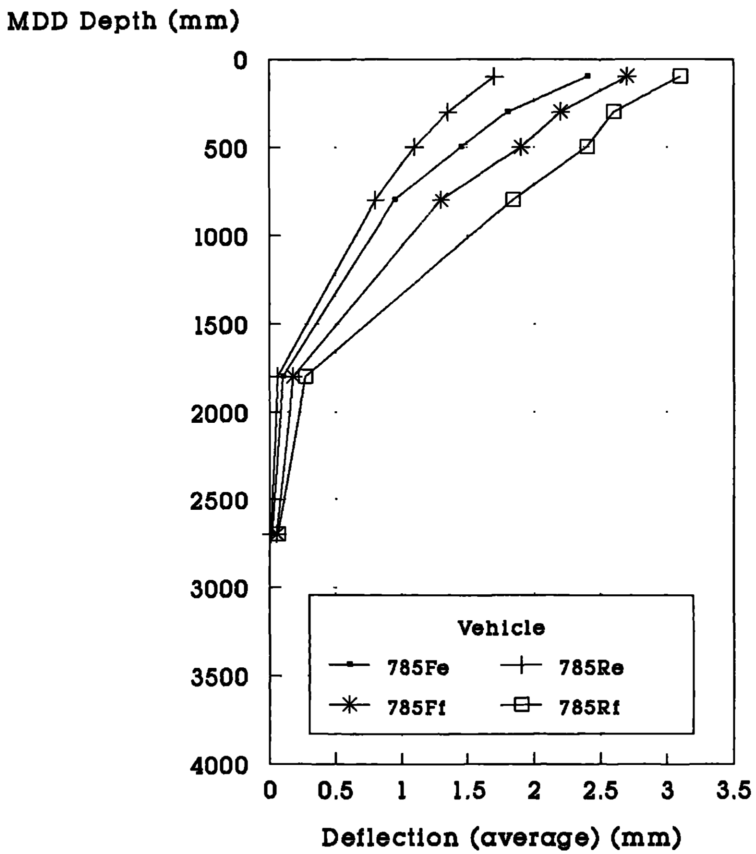
**HAUL ROADS PROJECT - SITE 2 NEW VAAL**
**Average deflection values**
**Water truck R50**



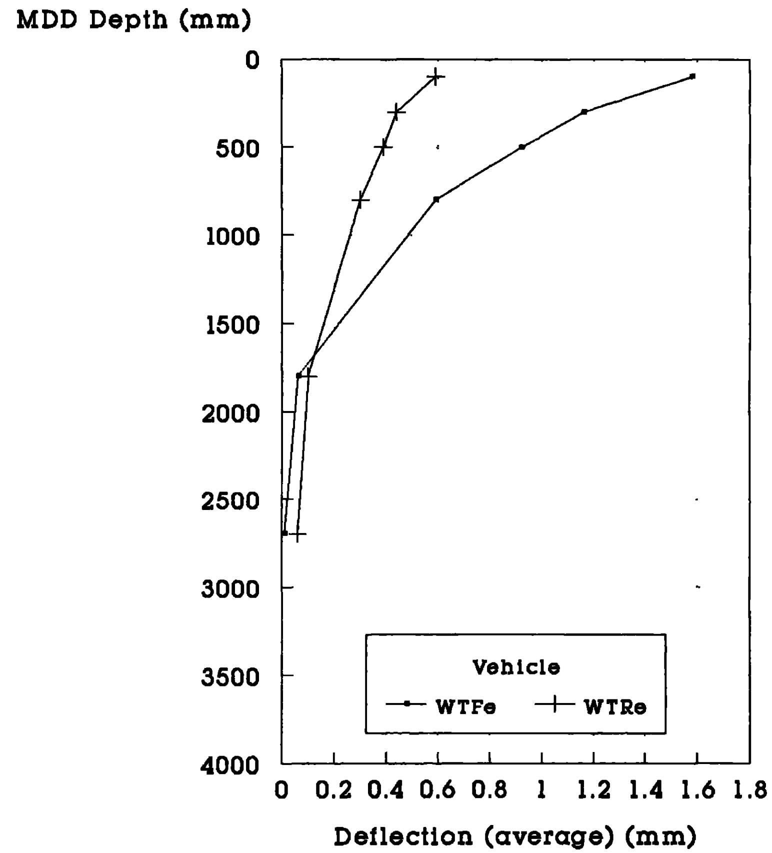

**HAUL ROADS PROJECT - SITE 3 NEW VAAL**
**Average deflection values**
**R170 truck**

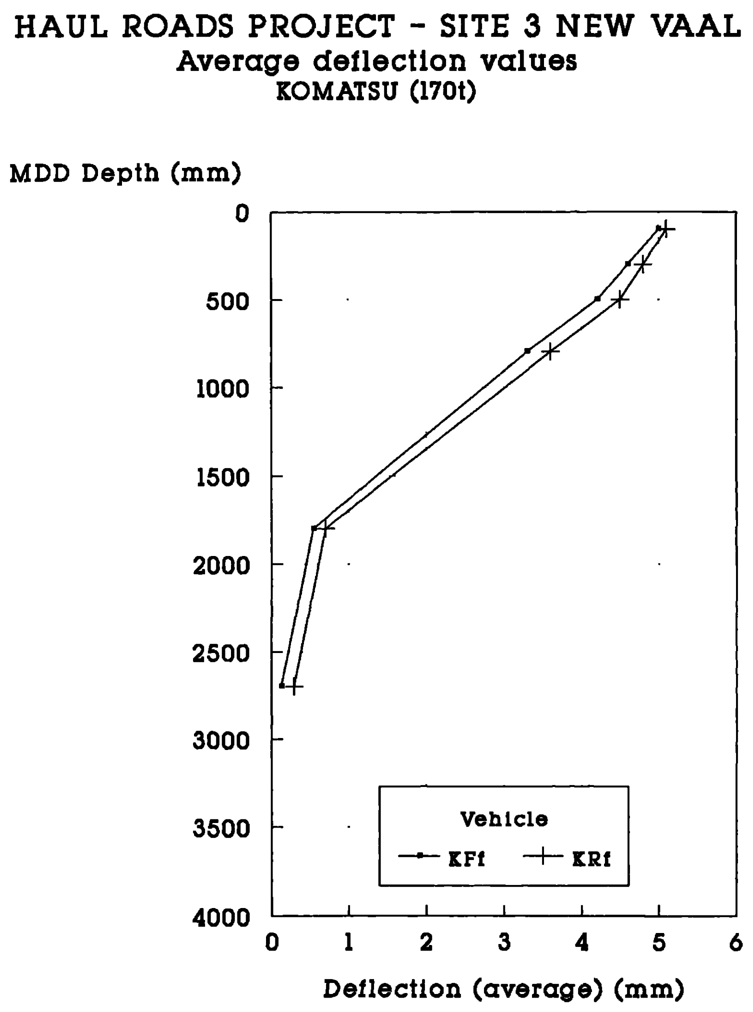


**HAUL ROADS PROJECT - SITE 3 NEW VAAL**
**Average deflection values**
**785 truck**




**HAUL ROADS PROJECT - SITE 3 NEW VAAL**
**Average deflection values**
**Water truck R50**




HAUL ROADS PROJECT - SITE 3 NEW VAAL
Average deflection values
KOMATSU (170t)
MDD Depth (mm)
0
500
1000
1500
2000
2500
3000
3500
4000
0
1
2
3
4
5
6
Deflection (average) (mm)
Vehicle
KFf
KRf

| | |
|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) θ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 3.00<br>1.92<br>1.57 | 2.35<br>1.91<br>1.57 | 190 | 201.2 | 212.9 | |
| 2 | ■800 | 1.28 | 1.27 | 31 | 36.1 | 25.8 | 1727 |
| 3 | ■1800<br>■2800 | 0.45<br>0.15 | 0.45<br>0.09 | 61 | 21.8 | 14.1 | 367.6 |
| | | | | | | | |

| | |
|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 3.20<br>2.50<br>2.20 | 2.80<br>2.50<br>2.10 | 227 | 283.2 | 273.0 | |
| 2 | ■800 | 1.85 | 1.84 | 34 | 50.3 | 38.8 | 1644 |
| 3 | ■1800<br>■2800 | 0.78<br>0.25 | 0.78<br>0.17 | 48 | 34.6 | 20.7 | 672.1 |
| | | | | | | | |

| | |
|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 2.00<br>1.41<br>1.25 | 1.70<br>1.41<br>1.20 | 274 | 157.5 | 174.1 | |
| 2 | ■800 | 1.12 | 1.12 | 30 | 45.0 | 24.8 | 1065 |
| 3 | ■1800<br>■2800 | 0.45<br>0.15 | 0.44<br>0.09 | 77 | 29.6 | 16.6 | 318.9 |
| | | | | | | | |

| | |
|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 3.46<br>2.78<br>2.55 | 3.02<br>2.76<br>2.53 | 283 | 337.0 | 301.7 | |
| 2 | ■800 | 2.32 | 2.34 | 54 | 89.7 | 73.0 | 1714 |
| 3 | ■1800<br>■2800 | 1.20<br>0.48 | 1.20<br>0.29 | 56 | 70.7 | 39.4 | 1047 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 2.09<br>1.35<br>1.03 | 1.87<br>1.35<br>1.04 | 153 | 112.4 | 132.3 | |
| 2 | ■800 | 0.80 | 0.80 | 21 | 17.7 | 11.9 | 889.3 |
| 3 | ■1800<br>■2800 | 0.25<br>0.03 | 0.25<br>0.04 | 54 | 10.5 | 6.3 | 191.7 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 2.55<br>1.89<br>1.58 | 2.35<br>1.89<br>1.55 | 186 | 168.5 | 188.1 | |
| 2 | ■800 | 1.30 | 1.29 | 19 | 27.8 | 17.3 | 1372 |
| 3 | ■1800<br>■2800 | 0.43<br>0.11 | 0.43<br>0.08 | 50 | 16.7 | 10.3 | 323.0 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 1.73<br>1.25<br>1.07 | 1.85<br>1.25<br>1.00 | 113 | 72.5 | 83.8 | |
| 2 | ■800 | 0.87 | 0.88 | 20 | 21.2 | 13.0 | 908.9 |
| 3 | ■1800<br>■2800 | 0.29<br>0.06 | 0.29<br>0.05 | 58.5 | 12.5 | 7.9 | 209.2 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 2.65<br>2.05<br>1.75 | 2.51<br>2.05<br>1.77 | 181 | 224.5 | 219.5 | |
| 2 | ■800 | 1.50 | 1.51 | 53 | 62.4 | 49.8 | 1316 |
| 3 | ■1800<br>■2800 | 0.60<br>0.18 | 0.60<br>0.13 | 78 | 40.7 | 26.0 | 521.4 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | WATER CAR |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 1.30<br>1.00<br>0.80 | 1.47<br>1.00<br>0.76 | 160 | 82.8 | 101.5 | |
| 2 | ■800 | 0.60 | 0.59 | 15 | 13.3 | 7.1 | 739.1 |
| 3 | ■1800<br>■2800 | 0.14<br>0.02 | 0.14<br>0.018 | 100 | 8.1 | 4.2 | 68.53 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | WATER CAR |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN $(x10^{-3})$ $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 1.63<br>1.08<br>0.87 | 1.35<br>1.08<br>0.82 | 240 | 109.5 | 133.1 | |
| 2 | ■800 | 0.68 | 0.68 | 15 | 15.9 | 8.2 | 819.6 |
| 3 | ■1800<br>■2800 | 0.18<br>0.03 | 0.18<br>0.027 | 81 | 9.8 | 5.2 | 101.0 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | WATER CAR |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 0.66<br>0.53<br>0.38 | 0.90<br>0.53<br>0.38 | 158 | 58.5 | 64.5 | |
| 2 | ■800 | 0.28 | 0.28 | 64 | 16.6 | 12.8 | 298.8 |
| 3 | ■1800<br>■2800 | 0.080<br>0.030 | 0.08<br>0.02 | 138 | 9.3 | 6.5 | 77.43 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 2 |
| TRUCK TYPE | WATER CAR |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 1.55<br>0.93<br>0.67 | 1.31<br>0.93<br>0.68 | 208 | 191.8 | 165.7 | |
| 2 | ■800 | 0.54 | 0.47 | 187 | 59.8 | 49.2 | 398.3 |
| 3 | ■1800<br>■2800 | 0.13<br>0.03 | 0.12<br>0.02 | 430 | 30.6 | 23.2 | 90.18 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 2.60<br>2.30<br>2.00 | 2.70<br>2.30<br>1.96 | 180 | 382.9 | 328.4 | |
| 2 | ■800 | 1.50 | 1.50 | 30 | 86.6 | 54.2 | 2993 |
| 3 | ■1800<br>■2800 | 0.19<br>0.03 | 0.19<br>0.04 | 176 | 30.6 | 24.6 | 270.4 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 4.50<br>3.80<br>3.30 | 4.96<br>3.81<br>3.12 | 125 | 259.1 | 253.9 | |
| 2 | ■800 | 2.40 | 2.41 | 39 | 71.6 | 40.2 | 4334 |
| 3 | ■1800<br>■2800 | 0.43<br>0.16 | 0.43<br>0.09 | 126 | 28.4 | 22.2 | 660.4 |
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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 2.45<br>2.10<br>1.90 | 2.63<br>2.10<br>1.76 | 142 | 251.5 | 251.6 | |
| 2 | ■800 | 1.40 | 1.41 | 21 | 69.55 | 36.3 | 2545 |
| 3 | ■1800<br>■2800 | 0.20<br>0.03 | 0.21<br>0.04 | 133 | 28.4 | 21.5 | 268.1 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | R170 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 4.30<br>3.90<br>3.75 | 4.25<br>3.89<br>3.64 | 207 | 542.3 | 383.4 | |
| 2 | ■800 | 3.10 | 3.10 | 36 | 217.7 | 122.0 | 4351 |
| 3 | ■1800<br>■2800 | 0.68<br>0.25 | 0.68<br>0.14 | 136 | 91.3 | 69.0 | 851.9 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) θ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 2.40<br>1.80<br>1.45 | 2.50<br>1.80<br>1.30 | 110 | 257.3 | 252.7 | |
| 2 | ■800 | 0.95 | 0.95 | 30.5 | 50.5 | 38.1 | 2114 |
| 3 | ■1800<br>■2800 | 0.11<br>0.02 | 0.11<br>0.02 | 166 | 15.6 | 13.5 | 173.4 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 2.70<br>2.20<br>1.90 | 2.80<br>2.20<br>1.80 | 142 | 359.1 | 315.3 | |
| 2 | ■800 | 1.30 | 1.30 | 35 | 77.8 | 54.0 | 2670 |
| 3 | ■1800<br>■2800 | 0.18<br>0.05 | 0.18<br>0.037 | 160 | 25.7 | 21.7 | 277.9 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 1.70<br>1.35<br>1.10 | 2.00<br>1.35<br>1.03 | 100 | 160.2 | 171.2 | |
| 2 | ■800 | 0.80 | 0.80 | 25 | 47.1 | 27.8 | 1600 |
| 3 | ■1800<br>■2800 | 0.06<br>0.01 | 0.06<br>0.01 | 294 | 16.4 | 13.5 | 85.63 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | 785 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 3.10<br>2.60<br>2.40 | 3.12<br>2.61<br>2.32 | 159 | 414.9 | 342.9 | |
| 2 | ■800 | 1.84 | 1.84 | 41 | 150.2 | 92.2 | 3062 |
| 3 | ■1800<br>■2800 | 0.27<br>0.06 | 0.27<br>0.09 | 220 | 54.3 | 44.2 | 374.0 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | HD460 WATER CAR |
| WHEEL LOAD | FRONT, EMPTY |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 1.58<br>1.16<br>0.92 | 1.73<br>1.16<br>0.85 | 129 | 201.1 | 209.4 | |
| 2 | ■800 | 0.59 | 0.59 | 36 | 36.9 | 26.6 | 1349 |
| 3 | ■1800<br>■2800 | 0.06<br>0.01 | 0.06<br>0.01 | 212 | 11.1 | 9.5 | 99.37 |
| | | | | | | | |

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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | HD1600 M1 |
| WHEEL LOAD | FRONT, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 5.00<br>4.60<br>4.20 | 5.15<br>4.61<br>4.17 | 147 | 481.1 | 358.9 | |
| 2 | ■800 | 3.30 | 3.30 | 20.5 | 122.1 | 75.3 | 5757 |
| 3 | ■1800<br>■2800 | 0.54<br>0.12 | 0.57<br>0.12 | 85 | 46.2 | 35.7 | 791.9 |
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|---|---|
| MINE | NEW VAAL COLLIERY |
| SITE NUMBER | 3 |
| TRUCK TYPE | HD1600 M1 |
| WHEEL LOAD | REAR, FULL |

| LAYER | MDD DEPTH (mm) | DEFLECTIONS: MDD MEASURED (mm) | DEFLECTIONS: ELSYM5A CALCULATED (mm) | EFFECTIVE ELASTIC MODULUS (MPa) $E_{Eff}$ | SUM OF PRINCIPAL STRESSES (kPa) $\theta$ | DEVIATOR STRESS (kPa) $\sigma_D$ | VERTICAL STRAIN ($x10^{-3}$) $\varepsilon_v$ |
|---|---|---|---|---|---|---|---|
| 1 | ■100<br>■300<br>■500 | 5.10<br>4.80<br>4.50 | 5.37<br>4.80<br>4.31 | 138 | 569.3 | 392.0 | |
| 2 | ■800 | 3.60 | 3.59 | 34 | 239.9 | 138.2 | 5389 |
| 3 | ■1800<br>■2800 | 0.70<br>0.29 | 0.71<br>0.15 | 141 | 95.9 | 75.1 | 914.3 |
| | | | | | | | |

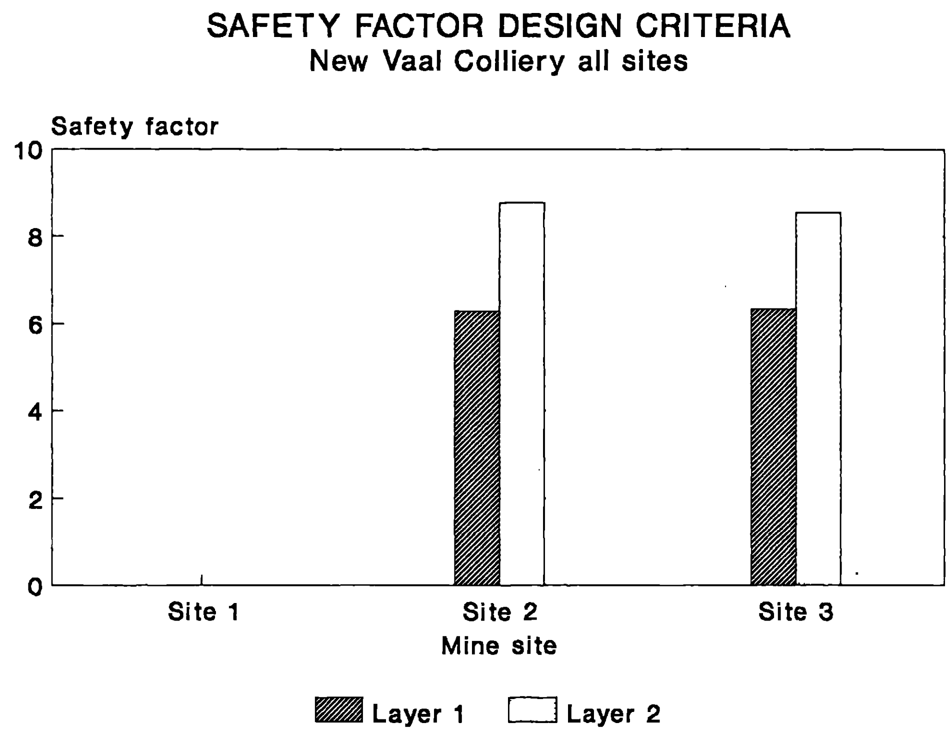
**SAFETY FACTOR ESTIMATION - NEW VAAL COLLIERY**

**C-TERM = 223**

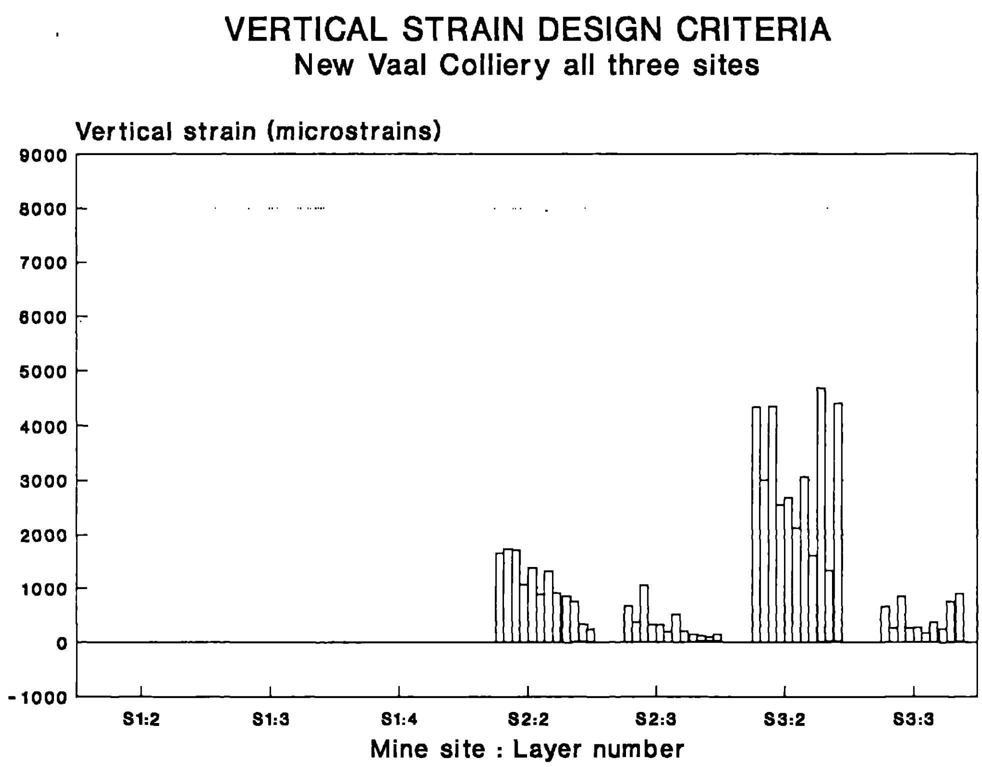
**Phi-TERM 5.5**

| Minor principle stress (kPa) | | Site 1 layer 1 | Site 1 layer 2 | Site 2 layer 1 | Site 2 layer 2 | Site 3 layer 1 | Site 3 layer 2 |
|---|---|---|---|---|---|---|---|
| R170 | FF | | | 276 | 43 | 428 | 115 |
| | FE | | | 209 | 29 | 346 | 65 |
| | RF | | | 306 | 76 | 430 | 149 |
| | RE | | | 165 | 31 | 249 | 45 |
| 785 | FF | | | 181 | 21 | 329 | 62 |
| | FE | | | 125 | 14 | 254 | 40 |
| | RF | | | 214 | 53 | 359 | 108 |
| | RE | | | 78 | 15 | 165 | 33 |
| Water car | FF | | | 125 | 11 | | |
| | FE | | | 95 | 9 | 206 | 30 |
| | RF | | | 174 | 52 | | |
| | RE | | | 61 | 15 | | |
| HD1600 | FF | | | | | 399 | 90 |
| | RF | | | | | 444 | 166 |
| **Deviator stress (kPa)** | | | | | | | |
| R170 | FF | | | 273 | 38 | 253 | 40 |
| | FE | | | 212 | 25 | 328 | 54 |
| | RF | | | 301 | 73 | 383 | 122 |
| | RE | | | 174 | 25 | 251 | 36 |

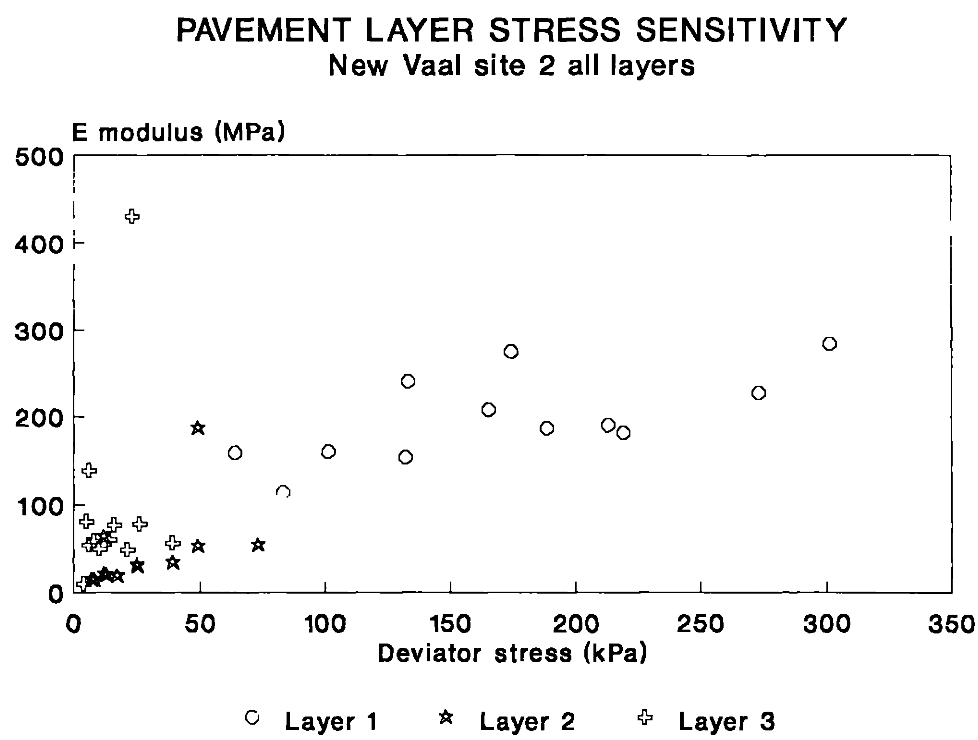
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 785 | FF | | | 188 | 17 | 315 | 54 |
| | FE | | | 132 | 11 | 252 | 38 |
| | RF | | | 219 | 50 | 342 | 92 |
| | RE | | | 83 | 13 | 171 | 27 |
| | | | | | | | |
| Water car | FF | | | 133 | 8 | | |
| | FE | | | 101 | 7 | 209 | 26 |
| | RF | | | 165 | 49 | | |
| | RE | | | 64 | 12 | | |
| | | | | | | | |
| HD1600 | FF | | | | | 359 | 75 |
| | RF | | | | | 392 | 138 |
| | | | | | | | |
| **Safety factor** | | | | | | | |
| R170 | FF | | | 6.38 | 12.09 | 10.19 | 21.39 |
| | FE | | | 6.47 | 15.30 | 6.48 | 10.75 |
| | RF | | | 6.33 | 8.78 | 6.76 | 8.55 |
| | RE | | | 6.50 | 15.74 | 6.34 | 13.07 |
| | | | | | | | |
| 785 | FF | | | 6.48 | 19.91 | 6.45 | 10.44 |
| | FE | | | 6.90 | 27.27 | 6.43 | 11.66 |
| | RF | | | 6.39 | 10.29 | 6.43 | 8.88 |
| | RE | | | 7.86 | 23.50 | 6.61 | 14.98 |
| | | | | | | | |
| Water car | FF | | | 6.85 | 35.44 | | |
| | FE | | | 7.38 | 38.93 | 6.49 | 14.92 |
| | RF | | | 7.15 | 10.39 | | |
| | RE | | | 8.73 | 25.46 | | |
| | | | | | | | |
| HD1600 | FF | | | | | 6.73 | 9.57 |
| | RF | | | | | 6.80 | 8.23 |
| | | | | | | | |
| **Minimum safety factor** | | | | 6.33 | 8.78 | 6.34 | 8.55 |

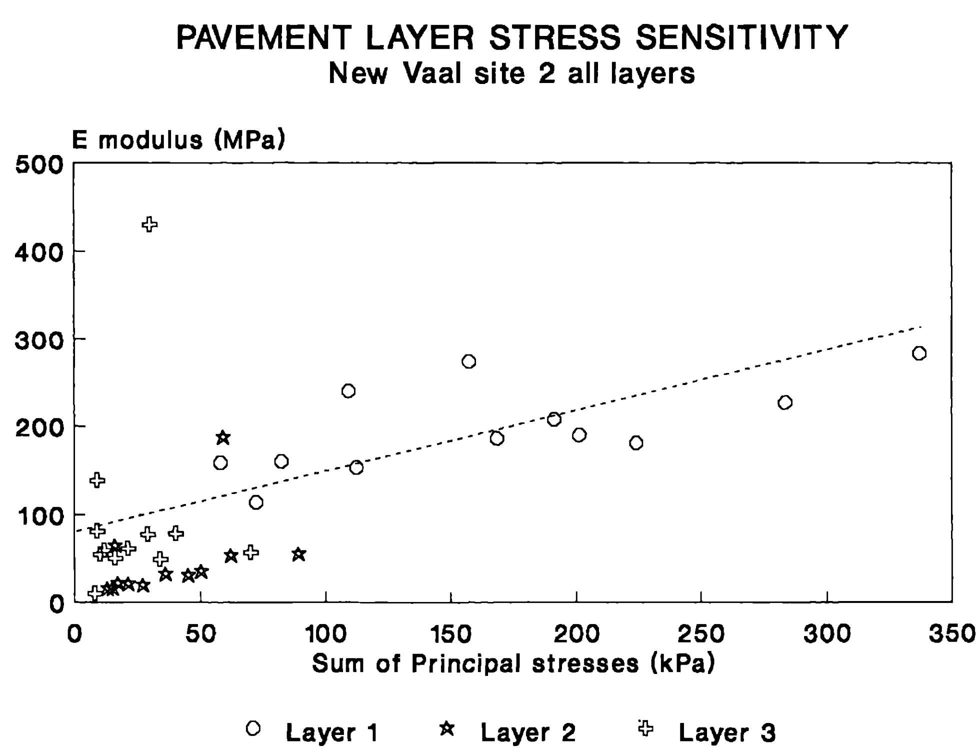


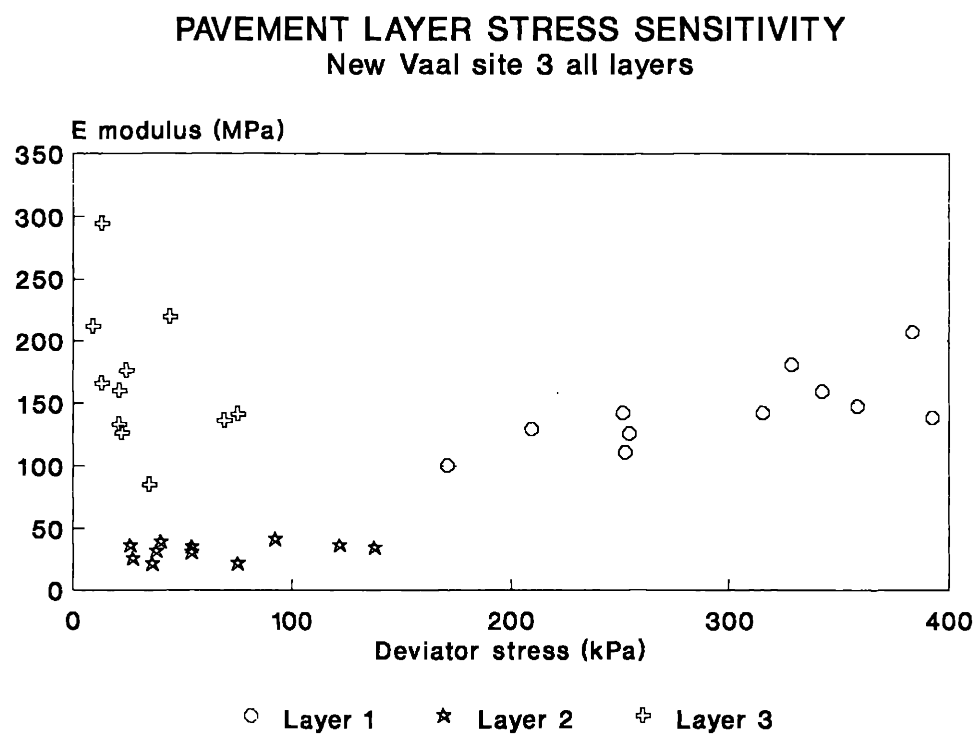

No data for site 1

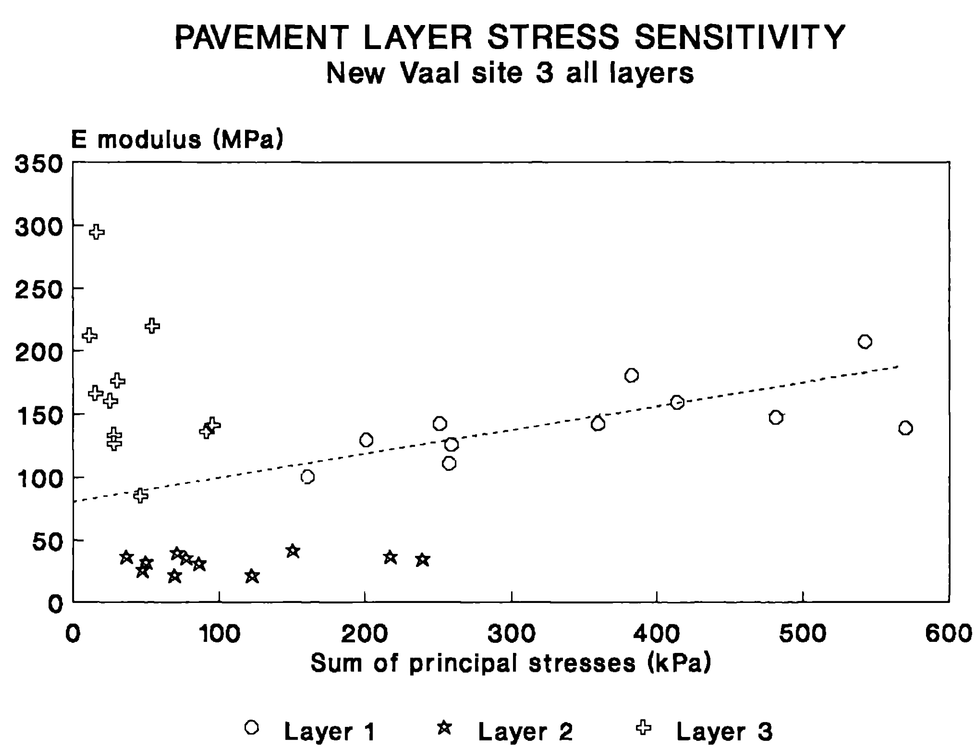



Site 1 no data


PAVEMENT LAYER STRESS SENSITIVITY
New Vaal site 2 all layers
E modulus (MPa)
500
400
300
200
100
0
0
50
100
150
200
250
300
350
Deviator stress (kPa)
Layer 1
Layer 2
Layer 3


PAVEMENT LAYER STRESS SENSITIVITY
New Vaal site 2 all layers
E modulus (MPa)
500
400
300
200
100
0
0
50
100
150
200
250
300
350
Sum of Principal stresses (kPa)
Layer 1
Layer 2
Layer 3


PAVEMENT LAYER STRESS SENSITIVITY
New Vaal site 3 all layers
E modulus (MPa)
350
300
250
200
150
100
50
0
0
100
200
300
400
Deviator stress (kPa)
Layer 1
Layer 2
Layer 3


PAVEMENT LAYER STRESS SENSITIVITY
New Vaal site 3 all layers
E modulus (MPa)
350
300
250
200
150
100
50
0
0
100
200
300
400
500
600
Sum of principal stresses (kPa)
Layer 1
Layer 2
Layer 3

# APPENDIX D4

## DATA PERTAINING TO THE PROPOSED EMPIRICAL RELATIONSHIP BETWEEN ELASTIC MODULUS AND DCP PENETRATION RATE

**EMPIRICAL RELATIONSHIP BETWEEN EFFECTIVE ELASTIC MODULUS AND DCP PENETRATION RATE (DN)**

**KRIEL COLLIERY**

| | EFFECTIVE ELASTIC MODULUS SITE 1 | | | | EFFECTIVE ELASTIC MODULUS SITE 2 | | | | EFFECTIVE ELASTIC MODULUS SITE 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | layer 1 | layer 2 | layer 3 | layer 4 | layer 1 | layer 2 | layer 3 | layer 4 | layer 1 | layer 2 | layer 3 | layer 4 |
| | 350 | 300 | 41 | 21 | 200 | 42 | 5000 | 33 | 500 | 2500 | 140 | 125 |
| | 200 | 200 | 50 | 20 | 100 | 35 | 3000 | 36 | 200 | 2500 | 160 | 250 |
| | 350 | 300 | 40 | 17 | 200 | 60 | 3000 | 20 | 600 | 2500 | 160 | 450 |
| | 380 | 380 | 41 | 19 | 120 | 30 | 3700 | 50 | 500 | 2500 | 130 | 450 |
| | 320 | 250 | 28 | 17 | 45 | 50 | 5000 | 25 | 250 | 2600 | 130 | 300 |
| | 550 | 450 | 35 | 19 | 55 | 50 | 4500 | 25 | 300 | 2400 | 230 | 400 |
| | 450 | 400 | 36 | 16 | 55 | 80 | 5000 | 25 | 600 | 2900 | 263 | 320 |
| | 550 | 500 | 55 | 14 | 160 | 58 | 4200 | 18 | | | | |
| | 450 | 400 | 35 | 15 | | | | | | | | |
| | 550 | 500 | 25 | 14 | | | | | | | | |
| Average Eeff (kPa) | 415.00 | 368.00 | 38.60 | 17.20 | 116.88 | 50.63 | 4175.00 | 29.00 | 421.43 | 2557.14 | 173.29 | 327.86 |
| Log avrg Eeff (kPa) | 2.62 | 2.57 | 1.59 | 1.24 | 2.07 | 1.70 | 3.62 | 1.46 | 2.62 | 3.41 | 2.24 | 2.52 |
| DN | 1.38 | 4.75 | 8.10 | 4.65 | 3.35 | 1.90 | 1.38 | 2.30 | 2.67 | 0.47 | 1.39 | 7.50 |
| Log DN | 0.14 | 0.68 | 0.91 | 0.67 | 0.53 | 0.28 | 0.14 | 0.36 | 0.43 | -0.33 | 0.14 | 0.88 |

**EMPIRICAL RELATIONSHIP BETWEEN EFFECTIVE ELASTIC MODULUS AND DCP PENETRATION RATE (DN)**

**SACE KROMDRAAI COLLIERY**

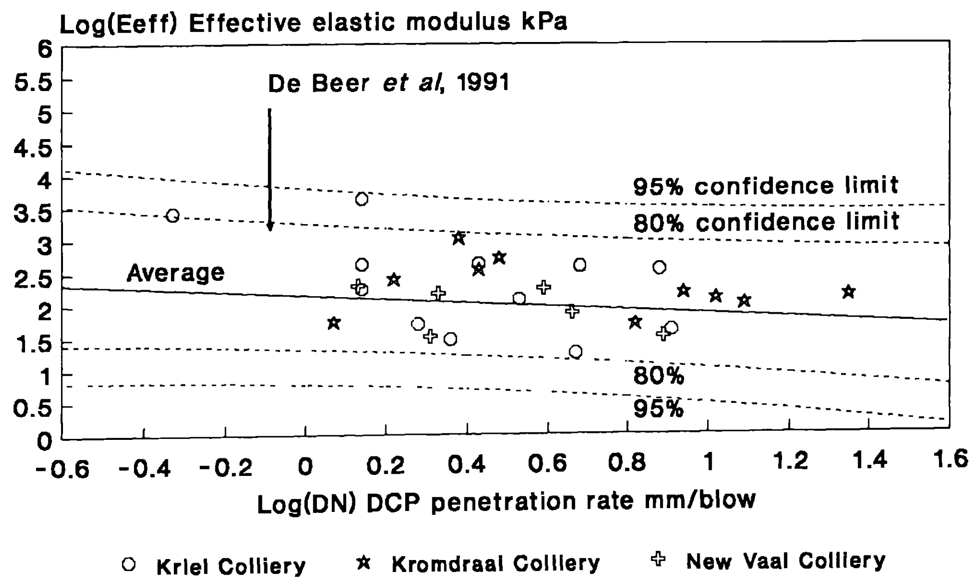
| | EFFECTIVE ELASTIC MODULUS SITE 1 | | | | EFFECTIVE ELASTIC MODULUS SITE 2 | | | | EFFECTIVE ELASTIC MODULUS SITE 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | layer 1 | layer 2 | layer 3 | layer 4 | layer 1 | layer 2 | layer 3 | layer 4 | layer 1 | layer 2 | layer 3 | |
| | 180 | 1540 | 32 | 63 | | 350 | 98 | 104 | 54 | 500 | 108 | |
| | 165 | 1490 | 40 | 93 | | 310 | 97 | 158 | 52 | 460 | 153 | |
| | 240 | 750 | 84 | 146 | | 338 | 137 | 110 | 55 | 395 | 156 | |
| | 350 | 620 | 68 | 106 | | 342 | 220 | 97 | 61 | 834 | 123 | |
| | 160 | 1346 | 22 | 55 | | 300 | 90 | 138 | 52 | 688 | 137 | |
| | 200 | 840 | 38 | 114 | | 310 | 91 | 176 | 58 | 480 | 166 | |
| | 420 | 710 | 45 | 83 | | 450 | 68 | 91 | 52 | 450 | 110 | |
| | 260 | 810 | 63 | 138 | | 294 | 130 | 160 | 54 | 331 | 195 | |
| Average Eeff (kPa) | 246.88 | 1013.25 | 49.00 | 99.75 | | 336.75 | 116.38 | 129.25 | 54.75 | 517.25 | 143.50 | |
| Log avrg Eeff (kPa) | 2.39 | 3.01 | 1.69 | 2.00 | | 2.53 | 2.07 | 2.11 | 1.74 | 2.71 | 2.16 | |
| DN | 1.65 | 2.40 | 6.65 | 12.30 | | 2.68 | 10.40 | 22.40 | 1.17 | 3.00 | 8.80 | |
| Log DN | 0.22 | 0.38 | 0.82 | 1.09 | | 0.43 | 1.02 | 1.35 | 0.07 | 0.48 | 0.94 | |

**EMPIRICAL RELATIONSHIP BETWEEN EFFECTIVE ELASTIC MODULUS AND DCP PENETRATION RATE (DN)**

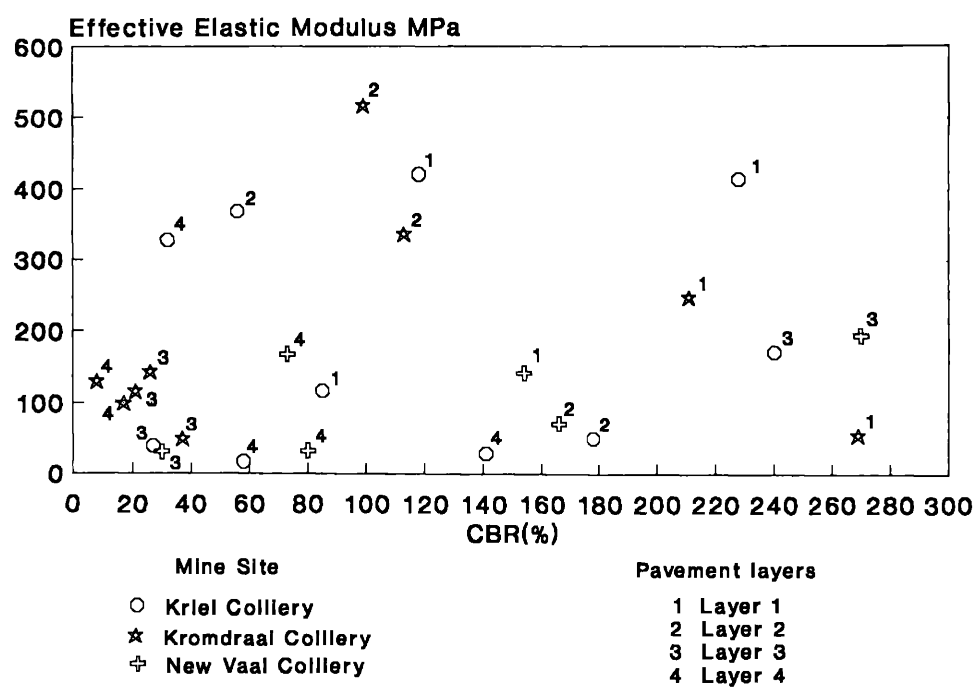
**NEW VAAL COLLIERY**

| | EFFECTIVE ELASTIC MODULUS SITE 2 | | | EFFECTIVE ELASTIC MODULUS SITE 3 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | layer 1 | layer 2 | layer 3 | layer 1 | layer 2 | layer 3 | | | | | | |
| | 240 | 15 | 81 | 125 | 39 | 126 | | | | | | |
| | 160 | 15 | 100 | 180 | 30 | 176 | | | | | | |
| | | | | 207 | 36 | 136 | | | | | | |
| | 158 | 64 | 138 | 142 | 21 | 133 | | | | | | |
| | 227 | 34 | 48 | 142 | 35 | 160 | | | | | | |
| | 190 | 31 | 61 | 110 | 30 | 166 | | | | | | |
| | 283 | 54 | 56 | 159 | 41 | 220 | | | | | | |
| | 274 | 30 | 77 | 100 | 25 | 294 | | | | | | |
| | 186 | 19 | 50 | 129 | 36 | 212 | | | | | | |
| | 153 | 21 | 54 | 147 | 20 | 85 | | | | | | |
| | 181 | 53 | 78 | 138 | 34 | 141 | | | | | | |
| | 113 | 20 | 58 | | | | | | | | | |
| Average Eeff (kPa) | 196.82 | 32.36 | 72.82 | 143.55 | 31.55 | 168.09 | | | | | | |
| Log avrg Eeff (kPa) | 2.29 | 1.51 | 1.86 | 2.16 | 1.50 | 2.23 | | | | | | |
| DN | 1.35 | 2.02 | 4.60 | 2.15 | 7.80 | 3.90 | | | | | | |
| Log DN | 0.13 | 0.31 | 0.66 | 0.33 | 0.89 | 0.59 | | | | | | |

EMPIRICAL RELATIONSHIP BETWEEN EFFECTIVE ELASTIC MODULUS AND DCP PENETRATION RATE
All mine site layers




EMPIRICAL RELATIONSHIP BETWEEN EFFECTIVE ELASTIC MODULUS AND CBR
All mine site layers



# APPENDIX E1

## KLEINKOPJE COLLIERY BLOCK 2A ROAD - CASE STUDY COMPARATIVE COST DATA

**Contents**

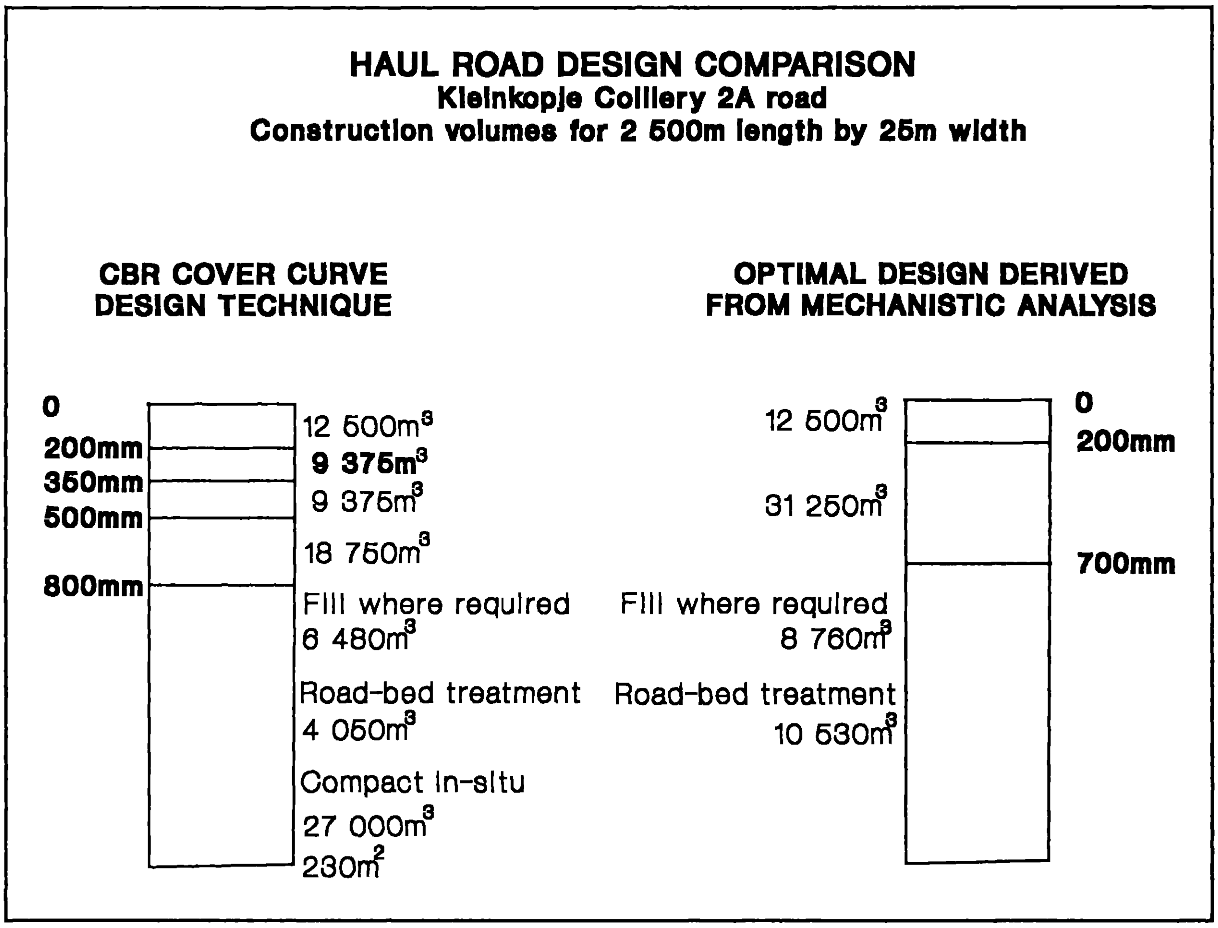



**Figure E1** Summary of designs and construction volumes

**Table E1** Unit Costs for Design Comparison

| Activity description | Unit | Unit cost (R) |
|---|---|---|
| Compaction of in-situ | $m^2$<br>$m^3$ | 0,36<br>5,46 |
| Road bed treatment to 90% Mod AASHTO<br>Road bed treatment to 98% Mod AASHTO | $m^3$<br>$m^3$ | 2,09<br>2,21 |
| Place and compact selected rock fill or layer | $m^3$ | 5,46 |
| Place and compaction of wearing course | $m^3$ | 11,57 |
| Construction of side drains | $m^3$ | 8,76 |
| Construction of berms | $m^3$ | 7,49 |
| Finishing | m | 3,06 |

**Table E2** Summary of preliminary and general costs - optimum mechanistic design

| Item no. | Payment refers | Description | Unit | Quantity | Rate | Amount (R) |
|---|---|---|---|---|---|---|
| | **SABS 1200A** | **SCHEDULE 1: PRELIMINARY AND GENERAL** | | | | |
| 1.1<br>1.2<br>1.3 | 8.3 | Fixed charge items<br>Value-related items<br>Time-related items | | | sum<br>sum<br>sum | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 410 000 |

**Table E3** Summary of costs for haulroad - optimal mechanistic design

| Item no. | Payment refers | Description | Unit | Quantity | Rate | Amount (R) |
|---|---|---|---|---|---|---|
| | **SABS 1200D** | **SCHEDULE 2: HAUL ROAD** | | | | |
| 2.1<br>1.2<br>1.3 | 8.3<br>8.3.3 | **EXCAVATION**<br>Restricted excavation | | | | |
| | 8.3.3(a) | Excavate in class A material and dispose for drains | $m^3$ | 1000 | 8,67 | 8670 |
| | 8.3.3(a) | Excavate in class A material and stockpile to form embankment<br>Excavate in class A material side drain stockpile and form berms in 300mm layers | $m^3$ | 7500 | 7,49 | 56175 |
| 2.2 | **SABS 1200DM**<br>8.3.3(a) | **EARTHWORKS, ROAD SUBGRADE** | | | | |
| | | Road bed preparation and compaction of materials to 90% Mod AASHTO density | $m^3$ | 10530 | 2,09 | 22008 |
| | 8.3.4(a) | Borrow to fill | | | | |
| | | Selected rock from spoils in 600mm layer where indicated and compacted by 10 passes of 10t vibratory roller. Blend and slush after compaction. | $m^3$ | 8760 | 5,46 | 47830 |
| 2.3 | **SABS 1200ME**<br>8.3.4(a) | **BASE** | | | | |
| | | Selected rock from spoils | | | | |
| | | 500mm layer, compacted by 10 passes of 10t vibratory roller. Blend and slush after compaction. | $m^3$ | 31250 | 5,46 | 170625 |
| 2.4 | **SABS 1200MF**<br>8.3.1 | **WEARING COURSE** | | | | |
| | | Selected ferricrete from designated borrow pit | | | | |
| | | 200mm wearing course compacted to 98% Mod AASHTO | $m^3$ | 12500 | 11,57 | 144625 |
| | 8.4.13 | **FINISHING** | | | | |
| | | Finishing of road reserve and unsurfaced road | m | 2500 | 3,06 | 7650 |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 457583 |

**Table E4** Summary of costs - optimal mechanistic design

| Item no. | Payment refers | Description | | Amount (R) |
|---|---|---|---|---|
| 1 | SABS 1200A | SCHEDULE 1: PRELIMINARY AND GENERAL | | 410 000 |
| 2 | SABS 1200D | SCHEDULE 2: HAUL ROADS | | 457 583 |
| | | VAT | @14% | 121 461 |
| TOTAL | | | | 989 044 |

**Table E5** Summary of preliminary and general costs - CBR-based design

| **Item no.** | **Payment refers** | **Description** | **Unit** | **Quantity** | **Rate** | **Amount (R)** |
|---|---|---|---|---|---|---|
| | **SABS 1200A** | **SCHEDULE 1: PRELIMINARY AND GENERAL** | | | | |
| 1.1<br>1.2<br>1.3 | 8.3 | Fixed charge items<br>Value-related items<br>Time-related items | | | sum<br>sum<br>sum | |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 410 000 |

**Table E6** Summary of haul road costs - CBR-based design

| Item no. | Payment refers | Description | Unit | Quantity | Rate | Amount (R) |
|---|---|---|---|---|---|---|
| | **SABS 1200D** | **SCHEDULE 2: HAUL ROAD** | | | | |
| 2.1 | 8.3 | **EXCAVATION** | | | | |
| | 8.3.3 | Restricted excavation | | | | |
| | 8.3.3(a) | Excavate in class A material and dispose for drains | $m^3$ | 1000 | 8,67 | 8670 |
| | 8.3.3(a) | Excavate in class A material and stockpile to form embankment | | | | |
| | | Excavate in class A material side drain stockpile and form berms in 300mm layers | $m^3$ | 7500 | 7,49 | 56175 |
| 2.2 | **SABS 1200DM** | **EARTHWORKS, ROAD SUBGRADE** | | | | |
| | | Compaction of in-situ | $m^2$ | 27000 | 0,36 | 9720 |
| | 8.3.3(a) | | $m^3$ | 230 | 5,46 | 1256 |
| | | Road bed preparation and compaction of materials to 90% Mod AASHTO density | $m^3$ | 4050 | 2,09 | 8465 |
| | | Road bed preparation and compaction of materials to 90% Mod AASHTO density | $m^3$ | 6480 | 2,61 | 16 913 |
| | 8.3.4(a) | Borrow to fill<br>Selected rock from spoils in 500mm layer where indicated and compacted by 10 passes of 10t vibratory roller. Blend and slush after compaction. | $m^3$ | 7300 | 5,46 | 39858 |
| | 8.3.4(a) | Borrow to rock layer<br>Selected rock from spoils in 500mm layer where indicated and compacted by 10 passes of 10t vibratory roller. Blend and slush after compaction. | $m^3$ | 18750 | 5,46 | 102375 |
| 2.3 | **SABS 1200ME** | **SUB-BASE** | | | | |
| | 8.3.4(a) | Selected ferricrete from designated borrow pit | | | | |
| | | 150mm layer, compacted by 4 passes of 10t vibratory roller. | $m^3$ | 9375 | 5,46 | 108468 |
| 2.4 | **SABS 1200ME** | **BASE** | | | | |
| | 8.3.4(a) | Selected ferricrete from designated borrow pit | | | | |
| | | 150mm layer, compacted by 4 passes of 10t vibratory roller. | $m^3$ | 9375 | 5,46 | 108468 |
| 2.5 | **SABS 1200MF** | **WEARING COURSE** | | | | |
| | 8.3.1 | Selected ferricrete from designated borrow pit<br>200mm wearing course compacted to 98% Mod AASHTO | $m^3$ | 12500 | 11,57 | 144625 |
| 2.6 | 8.4.13 | **FINISHING** | | | | |
| | | Finishing of road reserve and unsurfaced road | m | 2500 | 3,06 | 7650 |
| | | **TOTAL CARRIED TO SUMMARY** | | | | 612643 |

**Table E7** Summary of costs - CBR-based design

| Item no. | Payment refers | Description | | Amount (R) |
|---|---|---|---|---|
| 1 | SABS 1200A | SCHEDULE 1: PRELIMINARY AND GENERAL | | 410 000 |
| 2 | SABS 1200D | SCHEDULE 2: HAUL ROADS | | 612 643 |
| | | VAT | @14% | 143 169 |
| TOTAL | | | | 1 165 812 |

# APPENDIX F1

## RESULTS OF FUNCTIONAL PERFORMANCE MONITORING - KRIEL COLLIERY

F1-2

**Contents**

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# FUNCTIONAL PERFORMANCE ASSESSMENT
## KRIEL COLLIERY
**Summary of defect (degree x extent) score**

| **Site 1** Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd. | Cracks slip | Cracks croc. | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 9 | 6 | 8 | 4 | 6 | 9 | 4 | 6 | 12 | 8 | 72 |
| June | 4 | 4 | 9 | 12 | 8 | 9 | 12 | 1 | 4 | 3 | 66 |
| July | 9 | 6 | 9 | 6 | 9 | 8 | 9 | 2 | 4 | 6 | 68 |
| August | 6 | 6 | 9 | 12 | 16 | 6 | 6 | 1 | 4 | 6 | 72 |
| September | 9 | 4 | 6 | 12 | 9 | 6 | 4 | 1 | 4 | 9 | 64 |
| October | 16 | 4 | 12 | 12 | 6 | 6 | 6 | 1 | 6 | 25 | 94 |
| November | 9 | 4 | 9 | 12 | 12 | 6 | 9 | 1 | 4 | 9 | 75 |
| December | 4 | 2 | 4 | 16 | 16 | 6 | 9 | 1 | 2 | 2 | 62 |
| January | 9 | 4 | 9 | 8 | 16 | 6 | 9 | 1 | 4 | 12 | 78 |
| February | 6 | 4 | 9 | 12 | 16 | 6 | 6 | 2 | 4 | 1 | 66 |
| March | 2 | 1 | 3 | 20 | 25 | 6 | 6 | 1 | 2 | 1 | 67 |
| April | 4 | 4 | 9 | 16 | 20 | 6 | 6 | 1 | 4 | 1 | 71 |
| Average dry season (May-Aug) | 7.00 | 5.50 | 8.75 | 8.50 | 9.75 | 8.00 | 7.75 | 2.50 | 6.00 | 5.75 | |
| Average wet season (Sept-Apr) | 7.38 | 3.38 | 7.63 | 13.50 | 15.00 | 6.00 | 6.88 | 1.13 | 3.75 | 7.50 | |
| Annual Average | 7.25 | 4.08 | 8.00 | 11.83 | 13.25 | 6.67 | 7.17 | 1.58 | 4.50 | 6.92 | |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KRIEL COLLIERY**
**Summary of defect (degree x extent) score**

| **Site 2** Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd. | Cracks slip | Cracks croc. | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 9 | 4 | 20 | 9 | 12 | 16 | 9 | 1 | 4 | 9 | 93 |
| June | 12 | 9 | 9 | 9 | 16 | 16 | 9 | 1 | 4 | 4 | 89 |
| July | 9 | 4 | 12 | 12 | 12 | 12 | 8 | 1 | 4 | 9 | 83 |
| August | 8 | 12 | 20 | 9 | 16 | 8 | 9 | 9 | 4 | 9 | 104 |
| September | 9 | 9 | 20 | 9 | 12 | 6 | 9 | 6 | 4 | 12 | 96 |
| October | 12 | 9 | 25 | 12 | 16 | 6 | 9 | 6 | 4 | 12 | 111 |
| November | 4 | 2 | 4 | 12 | 25 | 6 | 9 | 4 | 2 | 9 | 77 |
| December | 6 | 9 | 9 | 9 | 16 | 6 | 6 | 4 | 2 | 6 | 73 |
| January | 9 | 4 | 12 | 9 | 0 | 9 | 6 | 6 | 6 | 8 | 69 |
| February | 12 | 2 | 20 | 12 | 3 | 6 | 9 | 4 | 20 | 4 | 92 |
| March | 12 | 2 | 20 | 12 | 9 | 6 | 9 | 4 | 12 | 4 | 90 |
| April | 9 | 2 | 16 | 12 | 9 | 6 | 9 | 4 | 12 | 4 | 83 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 9.50 | 7.25 | 15.25 | 9.75 | 14.00 | 13.00 | 8.75 | 3.00 | 4.00 | 7.75 | |
| Average wet season (Sept-Apr) | 9.13 | 4.88 | 15.75 | 10.88 | 11.25 | 6.38 | 8.25 | 4.75 | 7.75 | 7.38 | |
| Annual Average | 9.25 | 5.67 | 15.58 | 10.50 | 12.17 | 8.58 | 8.42 | 4.17 | 6.50 | 7.50 | |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KRIEL COLLIERY**
**Summary of defect (degree x extent) score**

| **Site 3** Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd. | Cracks slip | Cracks croc | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 6 | 6 | 6 | 8 | 8 | 9 | 6 | 1 | 1 | 6 | 57 |
| June | 6 | 4 | 4 | 12 | 16 | 4 | 6 | 1 | 1 | 1 | 55 |
| July | 9 | 9 | 9 | 8 | 9 | 9 | 4 | 1 | 1 | 6 | 65 |
| August | 5 | 6 | 9 | 9 | 9 | 9 | 4 | 2 | 1 | 4 | 58 |
| September | 9 | 9 | 9 | 9 | 6 | 9 | 4 | 1 | 1 | 6 | 63 |
| October | 12 | 9 | 12 | 9 | 10 | 9 | 4 | 1 | 1 | 9 | 76 |
| November | 9 | 6 | 9 | 12 | 12 | 9 | 6 | 1 | 1 | 4 | 69 |
| December | 9 | 6 | 9 | 9 | 12 | 6 | 6 | 1 | 1 | 4 | 63 |
| January | 2 | 2 | 1 | 20 | 20 | 4 | 6 | 1 | 1 | 2 | 59 |
| February | 2 | 2 | 6 | 12 | 20 | 8 | 12 | 1 | 1 | 1 | 65 |
| March | 2 | 2 | 1 | 15 | 20 | 4 | 6 | 1 | 1 | 2 | 54 |
| April | 1 | 2 | 6 | 20 | 20 | 8 | 6 | 1 | 1 | 1 | 66 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 6.50 | 6.25 | 7.00 | 9.25 | 10.50 | 7.75 | 5.00 | 1.25 | 1.00 | 4.25 | |
| Average wet season (Sept-Apr) | 5.75 | 4.75 | 6.63 | 13.25 | 15.00 | 7.13 | 6.25 | 1.00 | 1.00 | 3.63 | |
| Annual Average | 6.00 | 5.25 | 6.75 | 11.92 | 13.50 | 7.33 | 5.83 | 1.08 | 1.00 | 3.83 | |

F1-6

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KRIEL COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 1**

| Month (1994-1995) | Days between maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| March | 0 | 67 | 136 |
| December | 1 | 62 | 98 |
| September | 2 | 64 | 82 |
| February | 3 | 66 | 137 |
| July | 3 | 68 | 114 |
| April | 4 | 71 | 98 |
| November | 4 | 75 | 101 |
| June | 5 | 66 | 114 |
| May | 6 | 72 | 113 |
| August | 7 | 75 | 107 |
| January | 9 | 78 | 113 |
| October | 9 | 94 | 94 |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KRIEL COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 2**

| Month (1994-1995) | Days between maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| January | 0 | 75 | 50 |
| December | 1 | 73 | 34 |
| July | 2 | 83 | 49 |
| November | 3 | 77 | 37 |
| February | 4 | 92 | 64 |
| March | 6 | 90 | 54 |
| September | 6 | 96 | 29 |
| May | 9 | 93 | 31 |
| October | 11 | 111 | 48 |
| April | 12 | 83 | 61 |
| June | 15 | 89 | 58 |
| August | 15 | 112 | 50 |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KRIEL COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 3**

| Month (1994-1995) | Days between maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| January | 0 | 59 | 113 |
| April | 0 | 66 | 98 |
| February | 1 | 65 | 137 |
| March | 2 | 54 | 136 |
| May | 2 | 57 | 113 |
| December | 3 | 63 | 98 |
| June | 4 | 55 | 114 |
| November | 5 | 69 | 101 |
| August | 6 | 59 | 107 |
| October | 8 | 76 | 94 |
| July | 11 | 65 | 114 |
| September | 13 | 63 | 82 |

F1-9

| | | |
|---|---|---|
| **Kriel Mine** | **Site 1** | |
| Date of assessment | May 94 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 16138.64 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 142.47 | |
| Truck repetitions per day | 113 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS. Watered recently, fine coal slush on road. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 4 | 2 |
| Loose material | 2 | 2 |
| Dustiness | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 3 |
| Cracks - slip | 4 | 3 |
| Cracks - crocodile | 4 | 2 |
| **Sum Degree x extent** | | **72** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 15910.45 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 139.12 | |
| Truck repetitions per day | 114 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>New WC addedd +50mm but stoney, poor crossfall. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 2 | 4 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 1 | 3 |
| **Sum Degree x extent** | | **66** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 15910.45 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 139.12 | |
| Truck repetitions per day | 114 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>New WC firmer, better profile but defects increasing. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 2 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudional | 1 | 2 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **68** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 7 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 17046.36 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 159.85 | |
| Truck repetitions per day | 107 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 3 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 3 | 3 |
| Loose material | 4 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **75** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Sept 94 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 11552.55 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 141.74 | |
| Truck repetitions per day | 82 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 17 | |
| COMMENTS<br>Bladed and loose material exc. Skid res dry poor. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 4 | 3 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **64** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 5 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 9 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 12185.32 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 129.06 | |
| Truck repetitions per day | 94 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 65 | |
| COMMENTS<br>Severe croc cracks and large deformation/potholes. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 4 | 4 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 2 | 3 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 3 |
| Cracks - crocodile | 5 | 5 |
| **Sum Degree x extent** | | **94** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 5 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 13783.52 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 136.41 | |
| Truck repetitions per day | 101 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 66 | |
| COMMENTS<br>Muddy when wet, cracks as it dries. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **75** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

F1-16

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Dec 94 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 13479.13 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 138.03 | |
| Truck repetitions per day | 98 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 59 | |
| COMMENTS<br>Rain fairly recent, deforms in wheel tracks. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose material | 4 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 2 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **62** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 5 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| Kriel Mine | Site 1 | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 9 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 17393.48 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 154.84 | |
| Truck repetitions per day | 113 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 101 | |
| COMMENTS<br>Sl more dust (coal) loaded side of road. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 2 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 4 | 3 |
| **Sum Degree x extent** | | **78** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 18592.82 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 135.62 | |
| Truck repetitions per day | 137 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 45 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 2 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **66** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

F1-19

| Kriel Mine | Site 1 | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 0 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 17783.39 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 131.09 | |
| Truck repetitions per day | 136 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 141 | |
| COMMENTS | | |
| WEARING COURSE SURFACE | | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 1 | 1 |
| Rutting | 1 | 3 |
| Loose material | 4 | 5 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 1 |
| Cracks - crocodile | 1 | 1 |
| Sum Degree x extent | | 67 |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

F1-20

| **Kriel Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 16217.78 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 165.34 | |
| Truck repetitions per day | 98 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 64 | |
| COMMENTS<br>Less loose fine on faster unladen side. | | |
| WEARING COURSE SURFACE | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 4 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **71** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

F1-21

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 9 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 4399.45 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 142.5 | |
| Truck repetitions per day | 31 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>60mm WC placed, not scarified, stoney and dusty | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 4 | 5 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 4 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **93** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 15 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 8076.64 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 139.12 | |
| Truck repetitions per day | 58 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Poor skid res and erosion (l and a) and drainage. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 4 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 4 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **89** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 3 | |

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 6774.55 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 139.12 | |
| Truck repetitions per day | 49 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Dusty, loose material from blading, damage on bends exc. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **83** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

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| Kriel Mine | Site 2 | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 15 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 8007.27 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 159.85 | |
| Truck repetitions per day | 50 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 3 | |
| COMMENTS<br>Longitudinal cracks appear, poor profile. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 4 | 4 |
| Corrugations | 4 | 3 |
| Rutting | 5 | 4 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 3 | 3 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **112** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 4 | |

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Sep 94 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 4084.95 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 141.74 | |
| Truck repetitions per day | 29 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 17 | |
| COMMENTS<br>Vlei dry but profile sstill poor. Some local repairs. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 5 | 4 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 3 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 3 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 4 | 3 |
| **Sum Degree x extent** | | **96** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 4 | |

F1-26

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 11 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 6233.73 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 129.06 | |
| Truck repetitions per day | 48 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 65 | |
| COMMENTS<br>Road appears to be drying after vlei pumped. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 4 |
| Corrugations | 3 | 3 |
| Rutting | 5 | 5 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 3 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 4 | 3 |
| **Sum Degree x extent** | | **111** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 4647.2 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 127.24 | |
| Truck repetitions per day | 37 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 66 | |
| COMMENTS<br>Recent blading, stones form ridges, potholes not out. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 2 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **77** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Dec 94 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 4859.57 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 142.56 | |
| Truck repetitions per day | 34 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 59 | |
| COMMENTS<br>Some pushing thru of base seen, dusty despite water. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudional | 2 | 2 |
| Cracks - slip | 1 | 2 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **73** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 0 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 5807.52 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 116.86 | |
| Truck repetitions per day | 50 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Wet | |
| Rainfall for month (mm) | 101 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 4 |
| Loose material | 3 | 3 |
| Dustiness | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 2 | 3 |
| Cracks - slip | 2 | 3 |
| Cracks - crocodile | 2 | 4 |
| **Sum Degree x extent** | | **75** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 5 | |
| Erosion - longitudinal | 3 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

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| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 8201.00 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 136.47 | |
| Truck repetitions per day | 64 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Wet | |
| Rainfall for month (mm) | 45 | |
| COMMENTS<br>Very badly cut up - rain. Worse than score predicts. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 1 | 2 |
| Rutting | 5 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 1 | 3 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 4 | 5 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **92** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

| **Kriel Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 6909.43 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 127.95 | |
| Truck repetitions per day | 54 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 141 | |
| COMMENTS<br>Sl more damage seen on loaded side (degree +0.5-1) | | |
| WEARING COURSE SURFACE | | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 1 | 2 |
| Rutting | 5 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 4 | 3 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **90** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

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| | | |
|---|---|---|
| **Kriel Mine** | **Site 2** | |
| Date of assessment | Apr 95 | |
| Days since last maintenance | 12 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 10037.57 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 165.73 | |
| Truck repetitions per day | 61 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 64 | |
| COMMENTS | | |
| WEARING COURSE SURFACE | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 1 | 2 |
| Rutting | 4 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 3 | 4 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **83** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 4 | |
| Traffic (t/day) | 16138.64 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 142.47 | |
| Truck repetitions per day | 113 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Blading forms layers 30mm thick which lift up off road. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose material | 2 | 4 |
| Dustiness | 2 | 4 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **57** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 4 | |
| Traffic (t/day) | 15910.45 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 139.12 | |
| Truck repetitions per day | 114 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>New Wc added, dusty despite damp road. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **55** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 11 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 15910.45 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 139.12 | |
| Truck repetitions per day | 114 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Loose material at side and centre, more rutting laden. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose material | 2 | 4 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **65** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 17046.36 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 159.85 | |
| Truck repetitions per day | 107 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 3 | |
| COMMENTS<br>Small potholes appearing, 40mm diam 30mm deep at stones. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **59** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Sept 94 | |
| Days since last maintenance | 13 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 11552.55 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 141.74 | |
| Truck repetitions per day | 82 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 17 | |
| COMMENTS<br>Needs mtce, defect degree increasing both sides. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **63** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 8 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 12185.32 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 129.06 | |
| Truck repetitions per day | 94 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 65 | |
| COMMENTS<br>Watered am, Wc lifting out of road in plates ±30mm | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 4 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 4 |
| Loose material | 3 | 3 |
| Dustiness | 2 | 5 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **76** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

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| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 4 | |
| Traffic (t/day) | 13783.53 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 136.41 | |
| Truck repetitions per day | 98 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 66 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **69** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Dec 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 13479.13 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 138.03 | |
| Truck repetitions per day | 98 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 59 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **63** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 0 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 17393.48 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 154.84 | |
| Truck repetitions per day | 113 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 101 | |
| COMMENTS<br>Mtce today, bumps on stones, some loose, watering too. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 1 |
| Loose material | 4 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **59** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 18592.82 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 135.62 | |
| Truck repetitions per day | 137 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 45 | |
| COMMENTS<br>Loose material and dusty after blading. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **65** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 17783.39 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 131.09 | |
| Truck repetitions per day | 136 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 141 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 1 |
| Loose material | 3 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **54** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kriel Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 0 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 16217.78 | |
| Truck type(s) | R170, BD180 | |
| Truck factor (t) | 165.34 | |
| Truck repetitions per day | 98 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 64 | |
| COMMENTS<br>Loose material and dusty out of wheel tracks. | | |
| WEARING COURSE SURFACE | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 3 |
| Loose material | 5 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **66** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

# APPENDIX F2

## RESULTS OF FUNCTIONAL PERFORMANCE MONITORING - KROMDRAAI COLLIERY

F2-2

## Contents

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KROMDRAAI COLLIERY**
Summary of defect (degree x extent) scores

| **SITE 1** Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matr. | Dust | Stones fixed | Stones lse | Cracks longtd | Cracks slip | Cracks croc | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 4 | 4 | 9 | 6 | 12 | 4 | 12 | 9 | 1 | 9 | 70 |
| June | 6 | 6 | 3 | 9 | 12 | 4 | 9 | 1 | 1 | 6 | 57 |
| July | 2 | 4 | 2 | 9 | 16 | 4 | 9 | 2 | 1 | 4 | 53 |
| August | 4 | 4 | 4 | 9 | 12 | 4 | 9 | 1 | 1 | 2 | 50 |
| September | 6 | 6 | 8 | 9 | 10 | 6 | 6 | 2 | 1 | 4 | 58 |
| October | 4 | 2 | 2 | 15 | 8 | 4 | 9 | 1 | 1 | 1 | 47 |
| November | 6 | 4 | 4 | 12 | 15 | 6 | 6 | 4 | 2 | 4 | 63 |
| December | 2 | 1 | 2 | 12 | 12 | 4 | 9 | 1 | 1 | 1 | 45 |
| January | 4 | 2 | 6 | 9 | 1 | 4 | 4 | 4 | 2 | 6 | 42 |
| February | 4 | 4 | 9 | 8 | 12 | 6 | 6 | 1 | 1 | 1 | 52 |
| March | 4 | 4 | 4 | 16 | 12 | 4 | 1 | 1 | 6 | 2 | 54 |
| April | 4 | 4 | 4 | 16 | 9 | 4 | 1 | 1 | 6 | 2 | 51 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 4.00 | 4.50 | 4.50 | 8.25 | 13.00 | 4.00 | 9.75 | 3.25 | 1.00 | 5.25 | |
| Average wet season (Sep-Apr) | 4.25 | 3.38 | 4.88 | 12.13 | 9.88 | 4.75 | 5.25 | 1.88 | 2.50 | 2.63 | |
| Annual average | 4.17 | 3.75 | 4.75 | 10.83 | 10.92 | 4.50 | 6.75 | 2.33 | 2.00 | 3.50 | |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KROMDRAAI COLLIERY**
Summary of defect (degree x extent) scores

| **SITE 2** Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd | Cracks slip | Cracks croc | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 1 | 4 | 4 | 12 | 15 | 4 | 12 | 1 | 1 | 8 | 62 |
| June | 3 | 4 | 4 | 6 | 20 | 4 | 12 | 1 | 1 | 2 | 57 |
| July | 4 | 4 | 4 | 9 | 16 | 4 | 9 | 1 | 1 | 6 | 58 |
| August | 2 | 1 | 4 | 16 | 20 | 4 | 12 | 1 | 1 | 6 | 67 |
| September | 1 | 4 | 6 | 9 | 16 | 4 | 9 | 1 | 1 | 6 | 57 |
| October | 1 | 4 | 6 | 6 | 16 | 4 | 6 | 1 | 1 | 6 | 51 |
| November | 1 | 4 | 6 | 12 | 20 | 4 | 9 | 1 | 1 | 6 | 64 |
| December | 1 | 4 | 6 | 12 | 16 | 4 | 9 | 1 | 1 | 4 | 58 |
| January | 1 | 4 | 6 | 9 | 0 | 4 | 9 | 1 | 1 | 4 | 39 |
| February | 1 | 4 | 6 | 9 | 1 | 4 | 6 | 1 | 1 | 4 | 37 |
| March | 4 | 4 | 6 | 9 | 16 | 4 | 6 | 2 | 1 | 4 | 56 |
| April | 4 | 4 | 6 | 9 | 12 | 4 | 9 | 1 | 1 | 4 | 54 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 2.50 | 3.25 | 4.00 | 10.75 | 17.75 | 4.00 | 11.25 | 1.00 | 1.00 | 5.50 | |
| Average wet season (Sep-Apr) | 1.75 | 4.00 | 6.00 | 9.38 | 12.13 | 4.00 | 7.88 | 1.13 | 1.00 | 4.75 | |
| Annual average | 2.00 | 3.75 | 5.33 | 9.83 | 14.00 | 4.00 | 9.00 | 1.08 | 1.00 | 5.00 | |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KROMDRAAI COLLIERY**
Summary of defect (degree x extent) score

| **SITE 3** Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd | Cracks slip | Cracks croc | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 1 | 4 | 6 | 12 | 12 | 4 | 2 | 1 | 1 | 4 | 47 |
| June | 4 | 2 | 4 | 12 | 15 | 4 | 1 | 1 | 4 | 1 | 48 |
| July | 4 | 2 | 4 | 12 | 9 | 4 | 6 | 1 | 4 | 1 | 47 |
| August | 5 | 2 | 4 | 8 | 6 | 4 | 2 | 1 | 4 | 1 | 37 |
| September | 9 | 2 | 4 | 6 | 4 | 4 | 1 | 1 | 4 | 1 | 36 |
| October | 9 | 2 | 4 | 12 | 6 | 4 | 1 | 1 | 6 | 1 | 46 |
| November | 12 | 2 | 6 | 12 | 12 | 4 | 1 | 1 | 8 | 1 | 59 |
| December | 12 | 4 | 6 | 12 | 12 | 4 | 1 | 1 | 8 | 1 | 61 |
| January | 12 | 6 | 4 | 16 | 1 | 4 | 1 | 1 | 8 | 1 | 54 |
| February | 1 | 2 | 4 | 12 | 20 | 6 | 1 | 1 | 1 | 2 | 50 |
| March | 1 | 1 | 1 | 12 | 20 | 4 | 1 | 1 | 1 | 1 | 43 |
| April | 6 | 4 | 4 | 9 | 12 | 4 | 1 | 1 | 4 | 1 | 46 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 3.50 | 2.50 | 4.50 | 11.00 | 10.50 | 4.00 | 2.75 | 1.00 | 3.25 | 1.75 | |
| Average wet season (Sep-Apr) | 7.75 | 2.88 | 4.13 | 11.38 | 10.88 | 4.25 | 1.00 | 1.00 | 5.00 | 1.13 | |
| Annual average | 6.33 | 2.75 | 4.25 | 11.25 | 10.75 | 4.17 | 1.58 | 1.00 | 4.42 | 1.33 | |

| FUNCTIONAL PERFORMANCE ASSESSMENT<br>KROMDRAAI COLLIERY<br>Summary of maintenance, defect score and repetitions per month<br><br>Site 1 | | | |
|---|---|---|---|
| Month (1994-1995) | Days since last maintenance | Defect (degree x extent) | Repetitions per day |
| December | 1 | 45 | 98 |
| January | 2 | 42 | 106 |
| October | 3 | 47 | 90 |
| April | 4 | 51 | 94 |
| February | 4 | 52 | 94 |
| July | 5 | 53 | 104 |
| March | 5 | 54 | 112 |
| June | 5 | 57 | 118 |
| August | 6 | 50 | 102 |
| May | 6 | 70 | 104 |
| September | 7 | 58 | 78 |
| November | 9 | 63 | 104 |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KROMDRAAI COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 2**

| Month (1994-1995) | Days between maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| December | 1 | 58 | 56 |
| February | 2 | 37 | 47 |
| October | 4 | 51 | 49 |
| March | 5 | 56 | 47 |
| January | 6 | 51 | 45 |
| April | 6 | 54 | 53 |
| July | 8 | 58 | 52 |
| September | 11 | 57 | 39 |
| June | 12 | 57 | 59 |
| August | 12 | 66 | 51 |
| May | 14 | 62 | 54 |
| November | 14 | 64 | 52 |

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**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KROMDRAAI COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 3**

| Month (1994-1995) | Days between maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| February | 1 | 50 | 56 |
| March | 3 | 43 | 47 |
| September | 5 | 36 | 47 |
| June | 8 | 45 | 39 |
| October | 9 | 46 | 49 |
| August | 11 | 38 | 45 |
| April | 14 | 46 | 51 |
| July | 14 | 47 | 52 |
| December | 15 | 61 | 49 |
| May | 16 | 47 | 36 |
| January | 17 | 54 | 53 |
| November | 18 | 59 | 52 |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 16000.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 108 | |
| Truck speed (km/h) | 35 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Cracking locally load side, loose material. Road bladed only and watered. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 2 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 3 | 3 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **70** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 17600.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 118 | |
| Truck speed (km/h) | 35 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Slightly more small potholes unloaded side (uphill) | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **57** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 1 | |

| | | |
|---|---|---|
| **Kromdraai Mine** | **Site 1** | |
| Date of assessment | Jul 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 15400.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 104 | |
| Truck speed (km/h) | 35 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Watered am. WC at edge of road - poor profile. Thickness WC 150mm | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 2 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **53** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 15200.00 | |
| Truck type(s) | 620E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 102 | |
| Truck speed (km/h) | 35 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 1 |
| **Sum Degree x extent** | | **50** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Sept 94 | |
| Days since last maintenance | 7 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 11400.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 78 | |
| Truck speed (km/h) | 35 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 8 | |
| COMMENTS<br>Road lifting up in plates 30mm thick, 200mm diameter. Layering of WC seen | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 4 |
| Loose material | 3 | 3 |
| Dustiness | 2 | 5 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 2 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **58** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 13200.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 90 | |
| Truck speed (km/h) | 35 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 55 | |
| COMMENTS<br>Bladed recently, dusty with loose material on road. WC=150mm | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 1 |
| Loose material | 3 | 5 |
| Dustiness | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **47** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 9 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 15400 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 104 | |
| Truck speed (km/h) | 35 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 68 | |
| COMMENTS<br>Shrinkage cracking seen. Some large local depressions locally. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 5 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudional | 2 | 2 |
| Cracks - slip | 1 | 2 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **63** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| | | |
|---|---|---|
| **Kromdraai Mine** | **Site 1** | |
| Date of assessment | Dec 94 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 14400 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 98 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 90 | |
| COMMENTS<br>Road pushing up in centre along longt cracks (load side only) | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 1 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **45** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 15800 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 108 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Wet | |
| Rainfall for month (mm) | 120 | |
| COMMENTS<br>Loose material in centre of road only. Unloaded side similar. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 3 | 2 |
| Loose material | 3 | 3 |
| Dustiness | 1 | 1 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 2 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **42** |
| Skid resistance - wet | 1 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 3 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| Kromdraai Mine | Site 1 | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 13800 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 88 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Wet | |
| Rainfall for month (mm) | 49 | |
| COMMENTS<br>Slightly less dust on faster unloaded side. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 2 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **52** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 16600.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 112 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 128 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 4 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 2 | 3 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **54** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kromdraai Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 13800.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 94 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | moist | |
| Rainfall for month (mm) | 114 | |
| COMMENTS<br>Slightly less rutting on unloaded side. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 4 | 4 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 3 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **51** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 14 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 8000.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 54 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Forming layers due to 20-30mm deep blading. Lifting loaded side. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 4 |
| **Sum Degree x extent** | | **62** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 1 | |

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 12 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 8800.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 59 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Considerable loose material, compacting on loaded side. Few large stones. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 2 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **57** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 1 | |

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 8 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 7700.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 52 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Croc cracks may be shrinkage. Rutting slightly less unloaded and less dust. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **58** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 1 | |

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| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 12 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 7600.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 51 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Less dust unloaded side (faster trucks - more blown to edge). | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 2 |
| Loose material | 4 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **66** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 1 | |

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Sep 94 | |
| Days since last maintenance | 11 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 5700.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 39 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 8 | |
| COMMENTS<br>Poor cross erosion - too steep a profile (lateral). | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugatic ns | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **57** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 1 | |

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 6600.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 45 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 55 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 2 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **51** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 1 | |

F2-27

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 14 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 7700 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 52 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 68 | |
| COMMENTS<br>Road edge cutting into road due to excessive cross erosion (both sides) | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **64** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 1 | |

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Dec 94 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 7200 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 49 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 90 | |
| COMMENTS<br>Layer WC added ±50mm. Rain 2 days previous eroded cross direction. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **58** |
| Skid resistance - wet | 2 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 7900 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 54 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 120 | |
| COMMENTS<br>Poor side drainage and cross erosion. Less rutting unloaded side. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **51** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 3 | |

F2-30

| **Kromdraai Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 6900 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 44 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Wet | |
| Rainfall for month (mm) | 49 | |
| COMMENTS<br>Slip cracks in middle pushing up centre of road - noticeable loaded side. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 1 | 1 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **37** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

F2-31

**Kromdraai Mine** **Site 2**

| | |
|---|---|
| Date of assessment | Mar 95 |
| Days since last maintenance | 5 |
| Maintenance frequency/7 days | 1 |
| Traffic (t/day) | 8300 |
| Truck type(s) | 630E |
| Truck factor | 148 |
| Truck repetitions per day | 56 |
| Truck speed | 40 |
| Moisture conditions | Dry |
| Rainfall for month | 128 |

COMMENTS
Some pushing up in centre of road, lifts in plates 10mm- 15mm.

**WEARING COURSE SURFACE**

| | Degree | Extent |
|---|---|---|
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **56** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 3 | |

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**Kromdraai Mine** **Site 2**

| | |
|---|---|
| Date of assessment | Apr 95 |
| Days since last maintenance | 6 |
| Maintenance frequency/7 days | 1 |
| Traffic (t/day) | 6900 |
| Truck type(s) | 630E |
| Truck factor | 148 |
| Truck repetitions per day | 47 |
| Truck speed | 40 |
| Moisture conditions | Moist |
| Rainfall for month | 114 |

COMMENTS
Slight potholes extra extent on unloaded side.

**WEARING COURSE SURFACE**

| | Degree | Extent |
|---|---|---|
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **54** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 4 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 3 | |

F2-33

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 16 | |
| Maintenance frequency/7 days | 0.2 | |
| Traffic (t/day) | 5400.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 36 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Traffic started. Forming hard layer in wheel path. Less dust unloaded. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 2 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **47** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 2 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 8 | |
| Maintenance frequency/7 days | 0.2 | |
| Traffic (t/day) | 7200.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 49 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Traffic increasing. signs of larger local deformation - both sides. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **45** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 2 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 14 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 7700.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 52 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Considerable loose material despite blading. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **47** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 2 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 11 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 7600.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 51 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose material | 2 | 4 |
| Dustiness | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 2 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **38** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Sept 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 5700.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 39 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 8 | |
| COMMENTS<br>Deformation increasing - forming potholes - unloaded sl more. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose material | 2 | 3 |
| Dustiness | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **36** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 9 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 6600.00 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 45 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 55 | |
| COMMENTS<br>Slip cracks visible, profile poor due to defm and worsening. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 2 | 3 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **46** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 18 | |
| Maintenance frequency/7 days | 0.2 | |
| Traffic (t/day) | 7700 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 52 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 68 | |
| COMMENTS<br>Little mtce - potholes incr and loose material, dustier on loaded side. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 4 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **59** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Dec 94 | |
| Days since last maintenance | 15 | |
| Maintenance frequency/7 days | 0.2 | |
| Traffic (t/day) | 7200 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 49 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 90 | |
| COMMENTS<br>Slip cracks in middle visible and some plating. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 4 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **61** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 3 | |

| Kromdraai Mine | Site 3 | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 17 | |
| Maintenance frequency/7 days | 0.3 | |
| Traffic (t/day) | 7900 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 54 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 120 | |
| COMMENTS<br>Very cut up after rain (bends), ponding and bad erosion across profile. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 2 |
| Loose material | 4 | 4 |
| Dustiness | 1 | 1 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 4 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **54** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 6900 | |
| Truck type(s) | 630E | |
| Truck factor (t) | 148 | |
| Truck repetitions per day | 44 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 49 | |
| COMMENTS<br>More dust loaded side (spillage?), more rutting than unloaded. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **50** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 3 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 8300 | |
| Truck type(s) | 630E | |
| Truck factor | 148 | |
| Truck repetitions per day | 56 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 128 | |
| COMMENTS<br>Dusty with loose material, approx same both sides. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 1 |
| Rutting | 1 | 1 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| Sum Degree x extent | | **43** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 3 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 2 | |

| **Kromdraai Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 14 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 6900 | |
| Truck type(s) | 630E | |
| Truck factor | 148 | |
| Truck repetitions per day | 47 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 114 | |
| COMMENTS<br>Profile not ideal, some erosion across road. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 2 | 2 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **46** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 3 | |

# APPENDIX F3

## RESULTS OF FUNCTIONAL PERFORMANCE MONITORING - NEW VAAL COLLIERY

**F3-2**

## Contents

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**NEW VAAL COLLIERY**
**Summary of defect (degree x extent) score**

| **Site 1** Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd | Cracks slip | Cracks croc. | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 6 | 6 | 9 | 9 | 12 | 4 | 9 | 4 | 1 | 6 | 66 |
| June | 6 | 6 | 6 | 4 | 12 | 4 | 6 | 4 | 1 | 6 | 55 |
| July | 6 | 6 | 4 | 6 | 9 | 6 | 4 | 4 | 1 | 6 | 52 |
| August | 4 | 6 | 6 | 6 | 12 | 6 | 4 | 4 | 1 | 4 | 53 |
| September | 8 | 3 | 6 | 4 | 9 | 6 | 4 | 4 | 1 | 12 | 57 |
| October | 4 | 2 | 2 | 12 | 16 | 6 | 6 | 4 | 1 | 4 | 57 |
| November | 6 | 4 | 6 | 9 | 12 | 12 | 4 | 6 | 1 | 12 | 72 |
| December | 8 | 6 | 6 | 9 | 12 | 12 | 4 | 6 | 1 | 12 | 76 |
| January | 6 | 6 | 9 | 6 | 9 | 12 | 4 | 6 | 1 | 12 | 71 |
| February | 4 | 4 | 6 | 12 | 12 | 9 | 6 | 4 | 1 | 4 | 62 |
| March | 1 | 1 | 1 | 20 | 20 | 2 | 2 | 2 | 1 | 2 | 52 |
| April | 4 | 2 | 4 | 9 | 16 | 4 | 4 | 4 | 1 | 4 | 52 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 5.50 | 6.00 | 6.25 | 6.25 | 11.25 | 5.00 | 5.75 | 4.00 | 1.00 | 5.50 | |
| Average wet season (Sept-Apr) | 5.13 | 3.50 | 5.00 | 10.13 | 13.25 | 7.88 | 4.25 | 4.50 | 1.00 | 7.75 | |
| Annual average | 5.25 | 4.33 | 5.42 | 8.83 | 12.58 | 6.92 | 4.75 | 4.33 | 1.00 | 7.00 | |

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## FUNCTIONAL PERFORMANCE ASSESSMENT
## NEW VAAL COLLIERY
**Summary of defect (degree x extent) score**

| Site 2<br>Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd. | Cracks slip | Cracks croc. | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 8 | 4 | 4 | 1 | 6 | 12 | 4 | 1 | 1 | 6 | 47 |
| June | 8 | 6 | 6 | 9 | 12 | 12 | 4 | 1 | 1 | 6 | 65 |
| July | 4 | 4 | 6 | 9 | 12 | 8 | 9 | 1 | 1 | 6 | 60 |
| August | 3 | 2 | 2 | 6 | 16 | 8 | 12 | 1 | 1 | 4 | 55 |
| September | 4 | 4 | 6 | 9 | 16 | 10 | 12 | 1 | 1 | 6 | 69 |
| October | 4 | 4 | 9 | 9 | 20 | 10 | 9 | 1 | 1 | 9 | 76 |
| November | 2 | 4 | 9 | 9 | 9 | 6 | 9 | 1 | 1 | 6 | 56 |
| December | 2 | 4 | 9 | 6 | 9 | 6 | 9 | 2 | 1 | 6 | 54 |
| January | 4 | 4 | 9 | 9 | 0 | 6 | 6 | 2 | 1 | 6 | 47 |
| February | 4 | 4 | 4 | 4 | 9 | 15 | 6 | 2 | 1 | 3 | 52 |
| March | 1 | 2 | 1 | 16 | 25 | 4 | 1 | 1 | 1 | 1 | 53 |
| April | 1 | 2 | 1 | 20 | 25 | 4 | 1 | 1 | 1 | 1 | 57 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 5.75 | 4.00 | 4.50 | 6.25 | 11.50 | 10.00 | 7.25 | 1.00 | 1.00 | 5.50 | |
| Average wet season (Sept-Apr) | 2.75 | 3.50 | 6.00 | 10.25 | 14.13 | 7.63 | 6.63 | 1.38 | 1.00 | 4.75 | |
| Annual average | 3.75 | 3.67 | 5.50 | 8.92 | 13.25 | 8.42 | 6.83 | 1.25 | 1.00 | 5.00 | |

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**FUNCTIONAL PERFORMANCE ASSESSMENT**
**NEW VAAL COLLIERY**
**Summary of defect (degree x extent) score**

| Site 3<br>Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd. | Cracks slip | Cracks croc. | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 4 | 9 | 4 | 12 | 20 | 16 | 6 | 1 | 1 | 4 | 77 |
| June | 9 | 9 | 9 | 12 | 16 | 16 | 6 | 1 | 1 | 4 | 83 |
| July | 9 | 9 | 4 | 12 | 16 | 16 | 6 | 1 | 1 | 4 | 78 |
| August | 5 | 9 | 9 | 12 | 20 | 12 | 12 | 1 | 1 | 6 | 87 |
| September | 6 | 9 | 6 | 12 | 16 | 8 | 12 | 1 | 1 | 6 | 77 |
| October | 6 | 9 | 4 | 20 | 20 | 8 | 12 | 1 | 1 | 4 | 85 |
| November | 3 | 8 | 8 | 20 | 20 | 10 | 4 | 1 | 3 | 6 | 83 |
| December | 3 | 4 | 4 | 20 | 20 | 8 | 4 | 1 | 3 | 6 | 73 |
| January | 2 | 2 | 2 | 20 | 20 | 8 | 4 | 1 | 3 | 6 | 68 |
| February | 2 | 6 | 4 | 16 | 16 | 12 | 9 | 1 | 2 | 6 | 74 |
| March | 4 | 6 | 4 | 12 | 20 | 16 | 6 | 1 | 1 | 4 | 74 |
| April | 4 | 9 | 4 | 12 | 20 | 16 | 6 | 1 | 1 | 6 | 79 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 6.75 | 9.00 | 6.50 | 12.00 | 18.00 | 15.00 | 7.50 | 1.00 | 1.00 | 4.50 | |
| Average wet season (Sept-Apr) | 3.75 | 6.63 | 4.50 | 16.50 | 19.00 | 10.75 | 7.13 | 1.00 | 1.88 | 5.50 | |
| Annual average | 4.75 | 7.42 | 5.17 | 15.00 | 18.67 | 12.17 | 7.25 | 1.00 | 1.58 | 5.17 | |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**NEW VAAL COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 1**

| Month (1994-1995) | Days between maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| October | 1 | 57 | 360 |
| March | 2 | 52 | 348 |
| June | 2 | 55 | 356 |
| April | 3 | 52 | 372 |
| July | 3 | 52 | 334 |
| August | 4 | 53 | 345 |
| September | 5 | 57 | 361 |
| February | 5 | 62 | 364 |
| January | 7 | 71 | 388 |
| November | 7 | 72 | 353 |
| May | 8 | 66 | 393 |
| December | 12 | 76 | 356 |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**NEW VAAL COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 2**

| Month (1994-1995) | Days between maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| March | 1 | 53 | 184 |
| April | 1 | 57 | 177 |
| February | 3 | 52 | 133 |
| May | 4 | 47 | 186 |
| December | 5 | 54 | 169 |
| January | 6 | 56 | 187 |
| November | 8 | 56 | 168 |
| July | 11 | 60 | 179 |
| June | 13 | 65 | 131 |
| August | 16 | 54 | 199 |
| September | 16 | 69 | 195 |
| October | 18 | 76 | 161 |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**NEW VAAL COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 3**

| Month (1994-1995) | Days between maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| January | 2 | 68 | 66 |
| December | 3 | 73 | 45 |
| February | 7 | 74 | 104 |
| March | 8 | 74 | 68 |
| April | 11 | 79 | 72 |
| May | 14 | 77 | 77 |
| June | 17 | 78 | 82 |
| September | 18 | 77 | 91 |
| July | 18 | 78 | 117 |
| October | 19 | 85 | 25 |
| November | 21 | 83 | 100 |
| August | 21 | 88 | 106 |

| New Vaal Mine | Site 1 | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 8 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 55000.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 393 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 0 | |
| COMMENTS<br>Loose material centre of road, polishing and pock marks seen. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **66** |
| Skid resistance - wet | 2 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| | | |
|---|---|---|
| **New Vaal Mine** | **Site 1** | |
| Date of assessment | Jun 94 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 49800.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 356 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 0 | |
| COMMENTS<br>Pock marks form larger potholes. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose material | 2 | 2 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **55** |
| Skid resistance - wet | 2 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 46800.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 334 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 0 | |
| COMMENTS<br>Some croc cracks ±300mm edge side, centre of road loose material. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose material | 3 | 2 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **52** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 48300.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 345 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 1 | |
| COMMENTS<br>Dry and dusty, not compacting well after scarify and blade. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose material | 3 | 2 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **53** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

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| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Sept 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 50500.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 361 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 0 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 4 |
| Corrugations | 1 | 3 |
| Rutting | 2 | 3 |
| Loose material | 2 | 2 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudional | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 4 |
| **Sum Degree x extent** | | **57** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 4 | |
| Traffic (t/day) | 50398.26 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 360 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 37 | |
| COMMENTS<br>WC breaks out to a depth of 20-30mm in wheel tracks, poptholing worse. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **57** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 7 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 49378.91 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 353 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 81 | |
| COMMENTS<br>Sl less loose material on unladen side of road. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 3 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 3 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 4 |
| **Sum Degree x extent** | | **72** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

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| | | |
|---|---|---|
| **New Vaal Mine** | **Site 1** | |
| Date of assessment | Dec 94 | |
| Days since last maintenance | 12 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 49782.61 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 356 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 92 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 4 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 3 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 3 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 4 |
| **Sum Degree x extent** | | **76** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 7 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 54347.83 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 388 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 109 | |
| COMMENTS<br>Bends genrally more damaged than straight sections, more cut when wet. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose material | 2 | 3 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 3 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 4 |
| **Sum Degree x extent** | | **71** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 50928.55 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 364 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 43 | |
| COMMENTS<br>Dust palliative applied upto ramp 4. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 3 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **62** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 3 | |
| Traffic (t/day) | 48720.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 348 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 87 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 1 |
| Rutting | 1 | 1 |
| Loose material | 4 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 1 | 2 |
| Stoniness - loose | 2 | 1 |
| Cracks - longitudinal | 1 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **52** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 52080.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 372 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 54 | |
| COMMENTS<br>Spillage on laden side increases dust, not only from WC. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **52** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 26000.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 186 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 0 | |
| COMMENTS<br>Small pock marks, local undulations 10-15mm, some large stones in wc | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 4 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 1 | 1 |
| Dustiness | 2 | 3 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **47** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 13 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 18300.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 131 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 0 | |
| COMMENTS<br>Pock marks lead to potholes. Less dust unladen side. Crossfall excsve. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 4 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **65** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

| New Vaal Mine | Site 2 | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 11 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 25000.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 179 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 0 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 4 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **60** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 16 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 27800.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 199 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 1 | |
| COMMENTS<br>Some polishing of WC evident, dusty laden side, more loose on road. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 1 | 2 |
| Loose material | 3 | 2 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 4 | 2 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **54** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Sep 94 | |
| Days since last maintenance | 16 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 27300.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 195 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 0 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 5 | 2 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **69** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 18 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 22545.22 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 161 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 37 | |
| COMMENTS<br>Considerable loose mat and dusty, mostly small unladen, fine dust laden. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 5 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **76** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 8 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 23568.26 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 168 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 81 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **56** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| | | |
|---|---|---|
| **New Vaal Mine** | **Site 2** | |
| Date of assessment | Dec 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 23596.78 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 169 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 92 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 2 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **54** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 26197.83 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 187 | |
| Truck speed | 40 | |
| Moisture conditions | Wet | |
| Rainfall for month | 109 | |
| COMMENTS<br>Slippery when wet, cuts up on bends junctions easily. Little erosion. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 3 | 2 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **56** |
| Skid resistance - wet | 5 | |
| Skid resistance - dry | 5 | |
| Erosion - longitudinal | 3 | |
| Erosion - cross | 4 | |
| Drainage - on road | 4 | |
| Drainage - side of road | 5 | |

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| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 18665.64 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 133 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 43 | |
| COMMENTS<br>Loose material loaded side - poor skid resistance on exc crossfall. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 2 | 2 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 5 | 3 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 2 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 3 |
| **Sum Degree x extent** | | **52** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 257650.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 184 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 87 | |
| COMMENTS<br>Good after blading, loose and dust problem both sides | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 1 |
| Loose material | 4 | 4 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **53** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 2 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **New Vaal Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 24780.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 177 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 54 | |
| COMMENTS<br>Dusty and loose material after blading. Ridges from large stones in WC | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 1 |
| Loose material | 4 | 5 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 2 | 2 |
| Stoniness - loose | 1 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **57** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 14 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 10800.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 77 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 0 | |
| COMMENTS<br>Less traffic - less mtce and water - dust appears to be ash component. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 4 | 4 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **77** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 17 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 11500.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 82 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 0 | |
| COMMENTS<br>Little difference laden/unladen sides, v dusty and loose material | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 4 | 4 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **78** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| | | |
|---|---|---|
| **New Vaal Mine** | **Site 3** | |
| Date of assessment | Jul 94 | |
| Days since last maintenance | 18 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 16400.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 117 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 0 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 4 | 4 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **78** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 21 | |
| Maintenance frequency/7 days | 0.25 | |
| Traffic (t/day) | 14800.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 106 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 1 | |
| COMMENTS<br>Dry and dusty, little mtce, little traffic. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 4 | 3 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **88** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

**New Vaal Mine** **Site 3**

| | |
|---|---|
| Date of assessment | Sept 94 |
| Days since last maintenance | 18 |
| Maintenance frequency/7 days | 0.5 |
| Traffic (t/day) | 12700.00 |
| Truck type(s) | R170, 630E |
| Truck factor | 140 |
| Truck repetitions per day | 91 |
| Truck speed | 40 |
| Moisture conditions | dry |
| Rainfall for month | 0 |

COMMENTS
Potholes and cracking evident under loose material. Skid res dry poor.

**WEARING COURSE SURFACE**

| | Degree | Extent |
|---|---|---|
| Potholes | 2 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **77** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 19 | |
| Maintenance frequency/7 days | 0.25 | |
| Traffic (t/day) | 3455.04 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 25 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 37 | |
| COMMENTS<br>More damage at junctions and turns, rutting and kicking out WC | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose material | 4 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 4 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **85** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 21 | |
| Maintenance frequency/7 days | 0.25 | |
| Traffic (t/day) | 14003.04 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 100 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 81 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 3 |
| Corrugations | 2 | 4 |
| Rutting | 2 | 4 |
| Loose material | 4 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 5 |
| Stoniness - loose | 4 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 3 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **83** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Dec 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 0.2 | |
| Traffic (t/day) | 6339.96 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 45 | |
| Truck speed | 40 | |
| Moisture conditions | dry | |
| Rainfall for month | 92 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 4 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 4 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 3 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **73** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 0.20 | |
| Traffic (t/day) | 9217.39 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 66 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 109 | |
| COMMENTS<br>Dust and loose material after blading. Ridges from fixed stones. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 2 |
| Loose material | 4 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 4 | 1 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 3 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **68** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

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| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Feb 95 | |
| Days since last maintenance | 7 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 14497.50 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 104 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 43 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose material | 4 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 2 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **74** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 8 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 9520.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 68 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 87 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 4 | 4 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **74** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| **New Vaal Mine** | **Site 3** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 11 | |
| Maintenance frequency/7 days | 0.5 | |
| Traffic (t/day) | 10080.00 | |
| Truck type(s) | R170, 630E | |
| Truck factor | 140 | |
| Truck repetitions per day | 72 | |
| Truck speed | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month | 54 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 4 | 4 |
| Stoniness - loose | 3 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **79** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

# APPENDIX F4

## RESULTS OF FUNCTIONAL PERFORMANCE MONITORING - KLEINKOPJE COLLIERY

**F4-2**

## Contents

F4-3

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KLEINKOPJE COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 1**

| Month (1994-1994) | Days since last maintenance | Defect (degree x extent) | Repetitions/day |
|---|---|---|---|
| September | 1 | 70 | 43 |
| January | 2 | 49 | 53 |
| November | 2 | 60 | 44 |
| July | 3 | 72 | 59 |
| April | 3 | 88 | 89 |
| March | 4 | 77 | 79 |
| February | 5 | 60 | 23 |
| August | 6 | 86 | 69 |
| October | 8 | 75 | 74 |
| June | 8 | 76 | 11 |
| May | 9 | 78 | 24 |
| December | 11 | 79 | 143 |

F4-4

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KLEINKOPJE COLLIERY**
**Summary of maintenance, defect score and repetitions**

**Site 2**

| Month (1994-1995) | Days since last maintenace | Defect (Degree x extent) | Repetitions/day |
|---|---|---|---|
| April | 1 | 76 | 62 |
| July | 2 | 63 | 3 |
| November | 2 | 70 | 42 |
| January | 2 | 71 | 87 |
| June | 3 | 79 | 13 |
| October | 3 | 82 | 68 |
| September | 4 | 79 | 43 |
| December | 5 | 75 | 8 |
| May | 5 | 90 | 23 |
| February | 6 | 75 | 54 |
| August | 6 | 88 | 12 |
| March | 9 | 88 | 73 |

**FUNCTIONAL PERFORMANCE ASSESSMENT**
**KLEINKOPJE COLLIERY**
**Summary of defect (degree x extent) score**

| **Site 1** Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd | Cracks slip | Cracks croc | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 1 | 4 | 6 | 12 | 25 | 12 | 9 | 4 | 1 | 4 | 78 |
| June | 2 | 4 | 6 | 9 | 25 | 12 | 9 | 4 | 1 | 4 | 76 |
| July | 4 | 6 | 9 | 12 | 12 | 12 | 9 | 1 | 1 | 6 | 72 |
| August | 4 | 6 | 6 | 20 | 20 | 12 | 12 | 1 | 1 | 4 | 86 |
| September | 6 | 9 | 6 | 8 | 16 | 12 | 9 | 1 | 1 | 2 | 70 |
| October | 8 | 9 | 6 | 12 | 16 | 12 | 9 | 1 | 1 | 1 | 75 |
| November | 4 | 4 | 6 | 9 | 16 | 12 | 6 | 1 | 1 | 1 | 60 |
| December | 6 | 6 | 12 | 9 | 20 | 12 | 6 | 1 | 1 | 6 | 79 |
| January | 2 | 4 | 6 | 6 | 9 | 12 | 4 | 1 | 1 | 4 | 49 |
| February | 4 | 4 | 12 | 12 | 12 | 3 | 6 | 2 | 1 | 4 | 60 |
| March | 2 | 4 | 4 | 12 | 25 | 12 | 9 | 4 | 1 | 4 | 77 |
| April | 4 | 4 | 9 | 20 | 20 | 12 | 12 | 2 | 1 | 4 | 88 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 2.75 | 5.00 | 6.75 | 13.25 | 20.50 | 12.00 | 9.75 | 2.50 | 1.00 | 4.50 | |
| Average wet season (Sept-Apr) | 4.50 | 5.50 | 7.63 | 11.00 | 16.75 | 10.88 | 7.63 | 1.63 | 1.00 | 3.25 | |
| Annual average | 3.92 | 5.33 | 7.33 | 11.75 | 18.00 | 11.25 | 8.33 | 1.92 | 1.00 | 3.67 | |

# FUNCTIONAL PERFORMANCE ASSESSMENT
## KLEINKOPJE COLLIERY
### Summary of defect (degree x extent) score

| Site 2 Month (1994-1995) | Pothole | Corrug. | Rutting | Loose matrl. | Dust | Stones fixed | Stones loose | Cracks longtd | Cracks slip | Cracks croc | TOTAL DEFECT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 6 | 6 | 9 | 12 | 25 | 6 | 12 | 1 | 1 | 12 | 90 |
| June | 6 | 6 | 12 | 12 | 12 | 8 | 12 | 1 | 1 | 9 | 79 |
| July | 4 | 4 | 4 | 12 | 16 | 6 | 9 | 1 | 1 | 6 | 63 |
| August | 5 | 9 | 6 | 10 | 25 | 8 | 16 | 1 | 1 | 6 | 87 |
| September | 4 | 6 | 6 | 10 | 25 | 8 | 12 | 1 | 1 | 6 | 79 |
| October | 6 | 4 | 9 | 12 | 16 | 12 | 12 | 1 | 1 | 9 | 82 |
| November | 4 | 4 | 9 | 12 | 12 | 6 | 12 | 1 | 1 | 9 | 70 |
| December | 4 | 6 | 12 | 12 | 12 | 6 | 12 | 1 | 1 | 9 | 75 |
| January | 4 | 4 | 4 | 12 | 0 | 12 | 9 | 1 | 1 | 4 | 51 |
| February | 4 | 6 | 12 | 12 | 12 | 6 | 12 | 1 | 1 | 9 | 75 |
| March | 4 | 9 | 9 | 15 | 25 | 6 | 12 | 1 | 1 | 6 | 88 |
| April | 4 | 4 | 1 | 20 | 25 | 6 | 12 | 1 | 1 | 2 | 76 |
| | | | | | | | | | | | |
| Average dry season (May-Aug) | 5.25 | 6.25 | 7.75 | 11.50 | 19.50 | 7.00 | 12.25 | 1.00 | 1.00 | 8.25 | |
| Average wet season (Sept-Apr) | 4.25 | 5.38 | 7.75 | 13.13 | 15.88 | 7.75 | 11.63 | 1.00 | 1.00 | 6.75 | |
| Annual average | 4.58 | 5.67 | 7.75 | 12.58 | 17.08 | 7.50 | 11.83 | 1.00 | 1.00 | 7.25 | |

| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 9 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 2707 | |
| Truck type(s) | CH120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 24 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Unloaded less cracks degree and rutting degree - local blading as reqd. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **94** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 8 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 1265 | |
| Truck type(s) | CH120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 11 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Dust and loose material, less on unload (faster) side. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 4 |
| Loose material | 3 | 5 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **95** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

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| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 6752 | |
| Truck type(s) | Ch120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 59 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **72** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 7946 | |
| Truck type(s) | Ch120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 69 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose material | 4 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **86** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Sept 94 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 4996 | |
| Truck type(s) | Ch120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 43 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 24 | |
| COMMENTS<br>Minor croc cracks loaded side only. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 3 |
| Loose material | 2 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **70** |
| Skid resistance - wet | 2 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 8 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 8558 | |
| Truck type(s) | Ch120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 74 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 64 | |
| COMMENTS<br>More stones visible - erosion of fines to road side unloaded. Not on loadside. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 4 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **75** |
| Skid resistance - wet | 2 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 5043 | |
| Truck type(s) | Ch120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 44 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 54.5 | |
| COMMENTS<br>Dust on slower load side maybe spillage, sl less unloaded but faster. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 1 |
| **Sum Degree x extent** | | **60** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

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| | | |
|---|---|---|
| **Kleinkopje Mine** | **Site 1** | |
| Date of assessment | Dec 94 | |
| Days since last maintenance | 11 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 16434 | |
| Truck type(s) | Ch120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 143 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 93 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 4 |
| Loose material | 3 | 3 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **79** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| | | |
|---|---|---|
| **Kleinkopje Mine** | **Site 1** | |
| Date of assessment | Jan 95 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 6082 | |
| Truck type(s) | CH120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 53 | |
| Truck speed (km/h) | 30 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 84.6 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose material | 2 | 3 |
| Dustiness | 3 | 3 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 2 | 2 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **49** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| | | |
|---|---|---|
| **Kleinkopje Mine** | **Site 1** | |
| Date of assessment | Feb 95 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 2691 | |
| Truck type(s) | Ch120/130 | |
| Truck factor (t) | 115 | |
| Truck repetitions per day | 23 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 64 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 1 | 3 |
| Stoniness - loose | 2 | 3 |
| Cracks - longitudinal | 1 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **60** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 9091.39 | |
| Truck type(s) | Ch120/130 | |
| Truck factor | 115 | |
| Truck repetitions per day | 79 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 108 | |
| COMMENTS<br>Varaible tonnage effects noticeable, slight potholing more unloaded side. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 2 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **77** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

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| **Kleinkopje Mine** | **Site 1** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 10257.52 | |
| Truck type(s) | Ch120/130 | |
| Truck factor | 115 | |
| Truck repetitions per day | 89 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 112 | |
| COMMENTS<br>Recent on sight blading done, some potholes due to stoniness, obv unloaded | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 4 | 5 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 2 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **88** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 1 | |
| Drainage - side of road | 1 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | May 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 2791 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 23 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Cracks form mud bounded blocks which tend to lift on load side | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 4 |
| **Sum Degree x extent** | | **90** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jun 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 1573 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 13 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Ruts more pronounced load side, unload side less loose on road. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **82** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 2 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 3 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jul 94 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 320 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 3 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Recent on sight blading, v dusty and problem with skid resistance. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 4 | 3 |
| Dustiness | 4 | 5 |
| Stoniness - fixed | 3 | 4 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 2 |
| **Sum Degree x extent** | | **71** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 5 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 1 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 2 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Aug 94 | |
| Days since last maintenance | 6 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 1481 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 12 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | dry | |
| Rainfall for month (mm) | 0 | |
| COMMENTS<br>Loose material at centre and edge of road, unload less fine loose (faster) | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 2 |
| Loose material | 2 | 5 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 4 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **88** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Sep 94 | |
| Days since last maintenance | 4 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 5185 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 43 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month (mm) | 24 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 2 |
| Loose material | 2 | 5 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **79** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Oct 94 | |
| Days since last maintenance | 3 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 8327 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 68 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 64 | |
| COMMENTS<br>Loose at road edge. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 4 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **79** |
| Skid resistance - wet | 4 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

F4-25

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Nov 94 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 5086 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 42 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 54.5 | |
| COMMENTS<br>Side of road bladed material onto road. Still dusty, poor skid resistance. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **70** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

| | | |
|---|---|---|
| **Kleinkopje Mine** | **Site 2** | |
| Date of assessment | Dec 94 | |
| Days since last maintenance | 5 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 947 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 8 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 93 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **75** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 1 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Jan 95 | |
| Days since last maintenance | 2 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 10660 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor (t) | 122 | |
| Truck repetitions per day | 87 | |
| Truck speed (km/h) | 40 | |
| Moisture conditions | Moist | |
| Rainfall for month (mm) | 84.6 | |
| COMMENTS<br>Recent rain 36hrs. Road slightly cut up on bends. Dusty despite rain. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose material | 3 | 4 |
| Dustiness | 4 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 3 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 2 | 3 |
| **Sum Degree x extent** | | **63** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 3 | |

**Kleinkopje Mine** **Site 2**

| | |
|---|---|
| Date of assessment | Feb 95 |
| Days since last maintenance | 6 |
| Maintenance frequency/7 days | 1 |
| Traffic (t/day) | 6591 |
| Truck type(s) | Ch120/130, 630E |
| Truck factor (t) | 122 |
| Truck repetitions per day | 54 |
| Truck speed (km/h) | 40 |
| Moisture conditions | Dry |
| Rainfall for month (mm) | 64 |

**WEARING COURSE SURFACE**

| | Degree | Extent |
|---|---|---|
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 4 |
| Loose material | 3 | 4 |
| Dustiness | 3 | 4 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 3 |
| **Sum Degree x extent** | | **75** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudinal | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Mar 95 | |
| Days since last maintenance | 9 | |
| Maintenance frequency/7 days | 1 | |
| Traffic (t/day) | 8845.74 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor | 122 | |
| Truck repetitions per day | 73 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 108 | |
| COMMENTS | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose material | 3 | 5 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudinal | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 3 | 2 |
| **Sum Degree x extent** | | **88** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 3 | |
| Erosion - longitudinal | 1 | |
| Erosion - cross | 2 | |
| Drainage - on road | 2 | |
| Drainage - side of road | 4 | |

| **Kleinkopje Mine** | **Site 2** | |
|---|---|---|
| Date of assessment | Apr 95 | |
| Days since last maintenance | 1 | |
| Maintenance frequency/7 days | 2 | |
| Traffic (t/day) | 7504.39 | |
| Truck type(s) | Ch120/130, 630E | |
| Truck factor | 122 | |
| Truck repetitions per day | 62 | |
| Truck speed | 40 | |
| Moisture conditions | Dry | |
| Rainfall for month | 112 | |
| COMMENTS<br>Smaller potholing evident unloaded side, rutting more loaded. | | |
| **WEARING COURSE SURFACE** | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose material | 4 | 5 |
| Dustiness | 5 | 5 |
| Stoniness - fixed | 2 | 3 |
| Stoniness - loose | 3 | 4 |
| Cracks - longitudional | 1 | 1 |
| Cracks - slip | 1 | 1 |
| Cracks - crocodile | 1 | 2 |
| **Sum Degree x extent** | | **76** |
| Skid resistance - wet | 3 | |
| Skid resistance - dry | 4 | |
| Erosion - longitudional | 2 | |
| Erosion - cross | 3 | |
| Drainage - on road | 3 | |
| Drainage - side of road | 2 | |

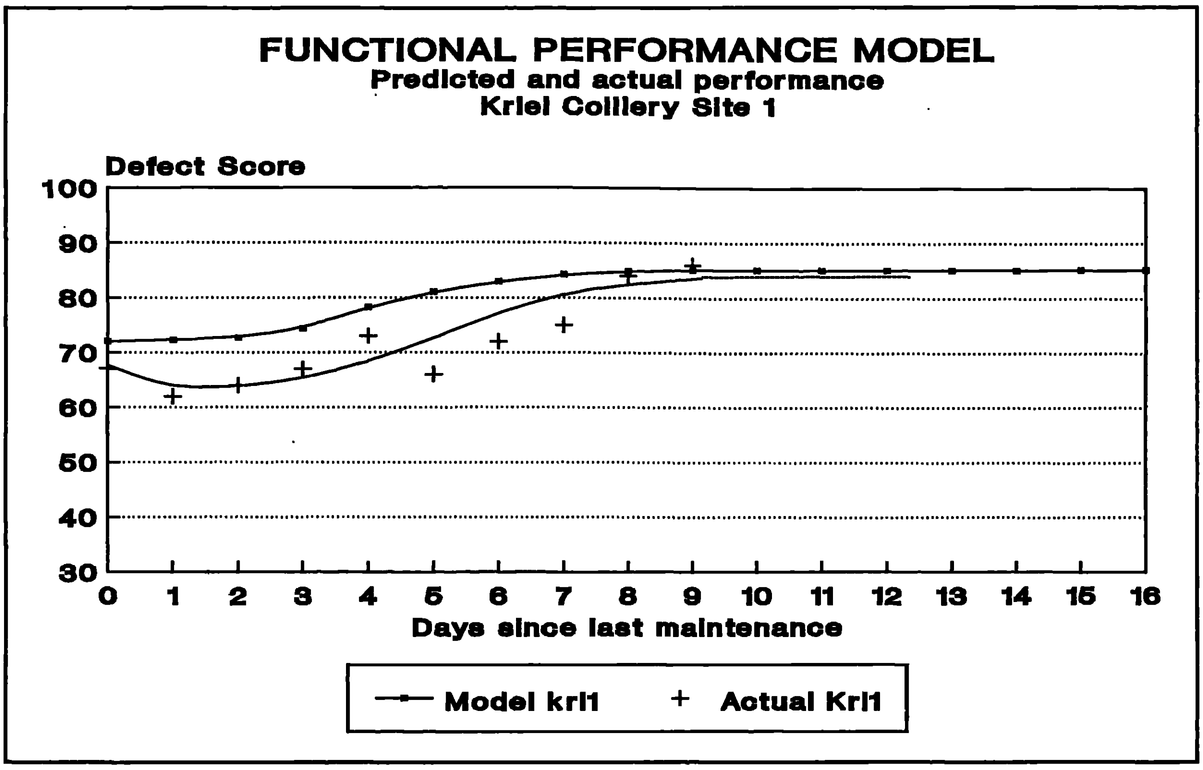
# APPENDIX G1

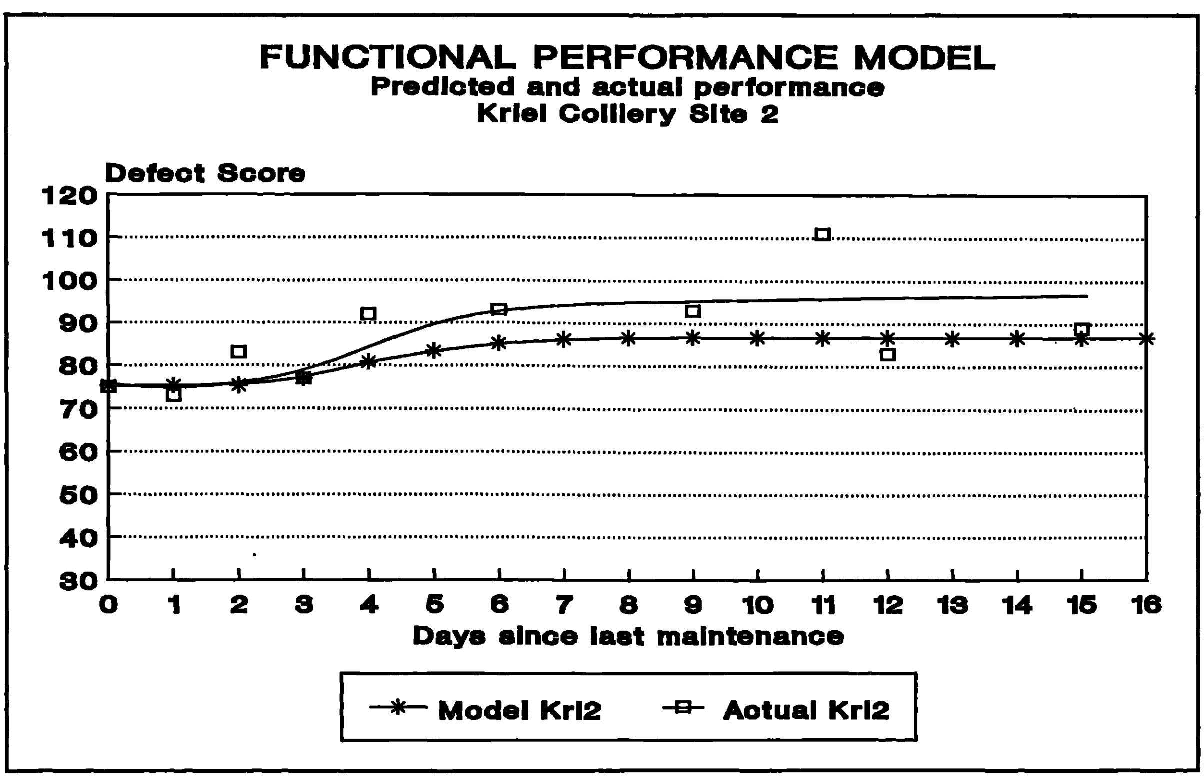
## STATISTICAL DATA AND RESULTS OF ANALYSES
## DEFECT PROGRESSION RATE MODEL

**G1-2**

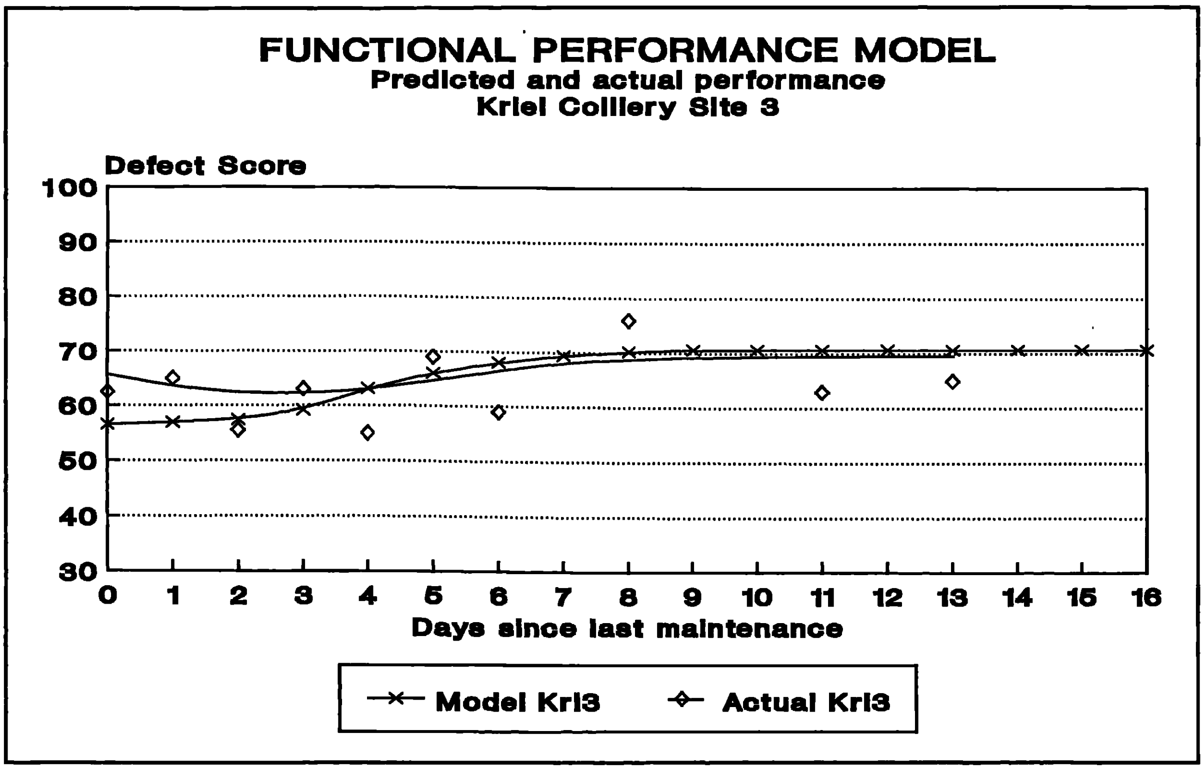
## Contents

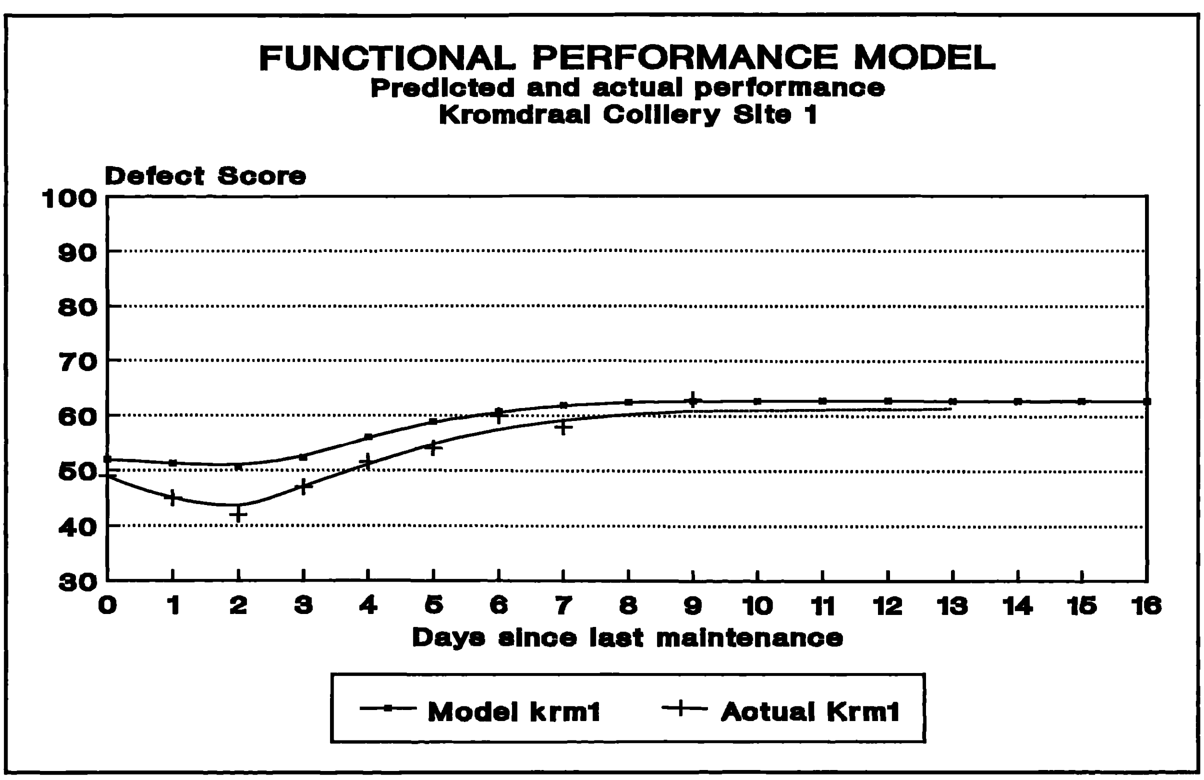
Comparison of actual against predicted defect score progression for each site.

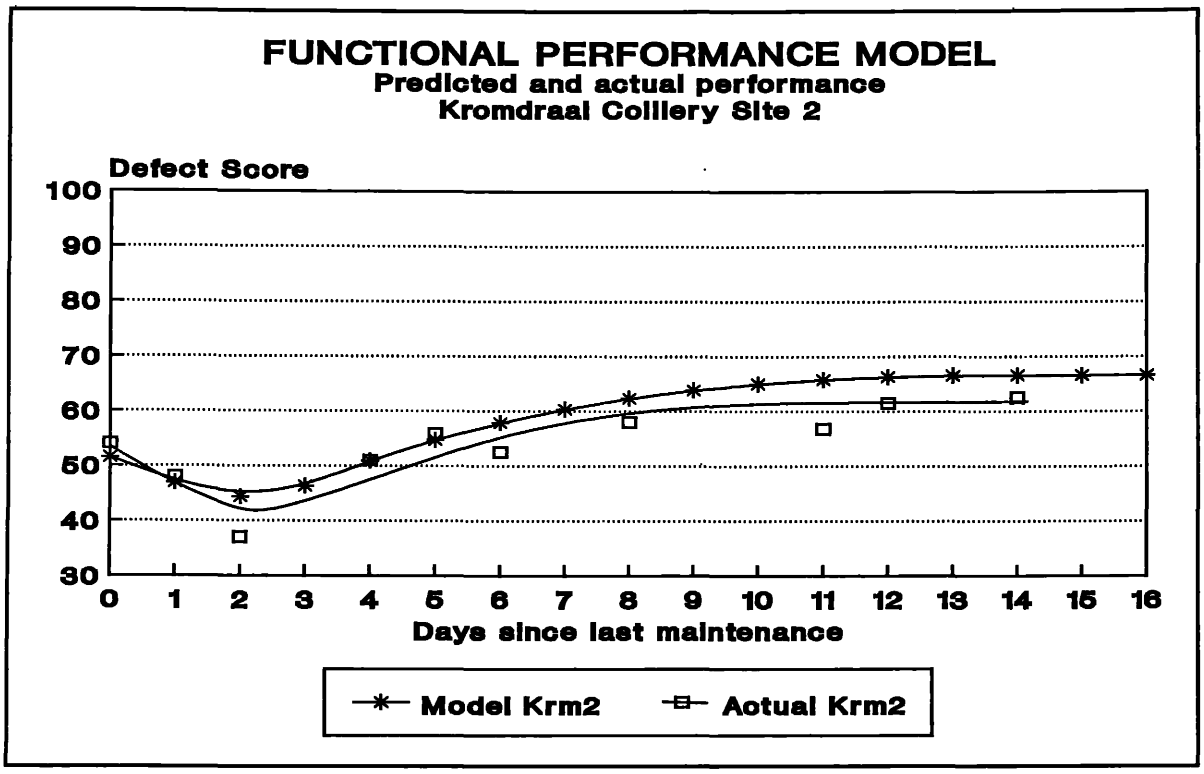

FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
Kriel Colliery Site 1
Defect Score
100
90
80
70
60
50
40
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Days since last maintenance
Model kri1
Actual Kri1

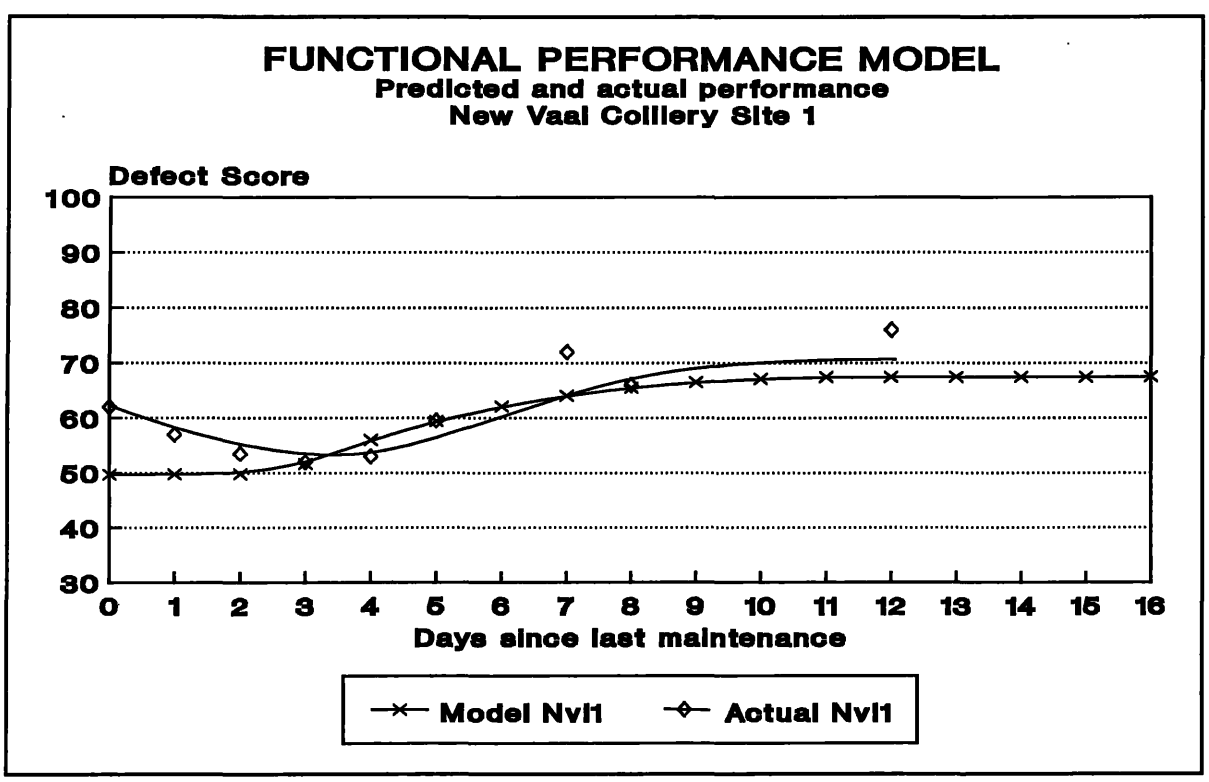

FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
Kriel Colliery Site 2
Defect Score
120
110
100
90
80
70
60
50
40
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Days since last maintenance
Model Kri2
Actual Kri2

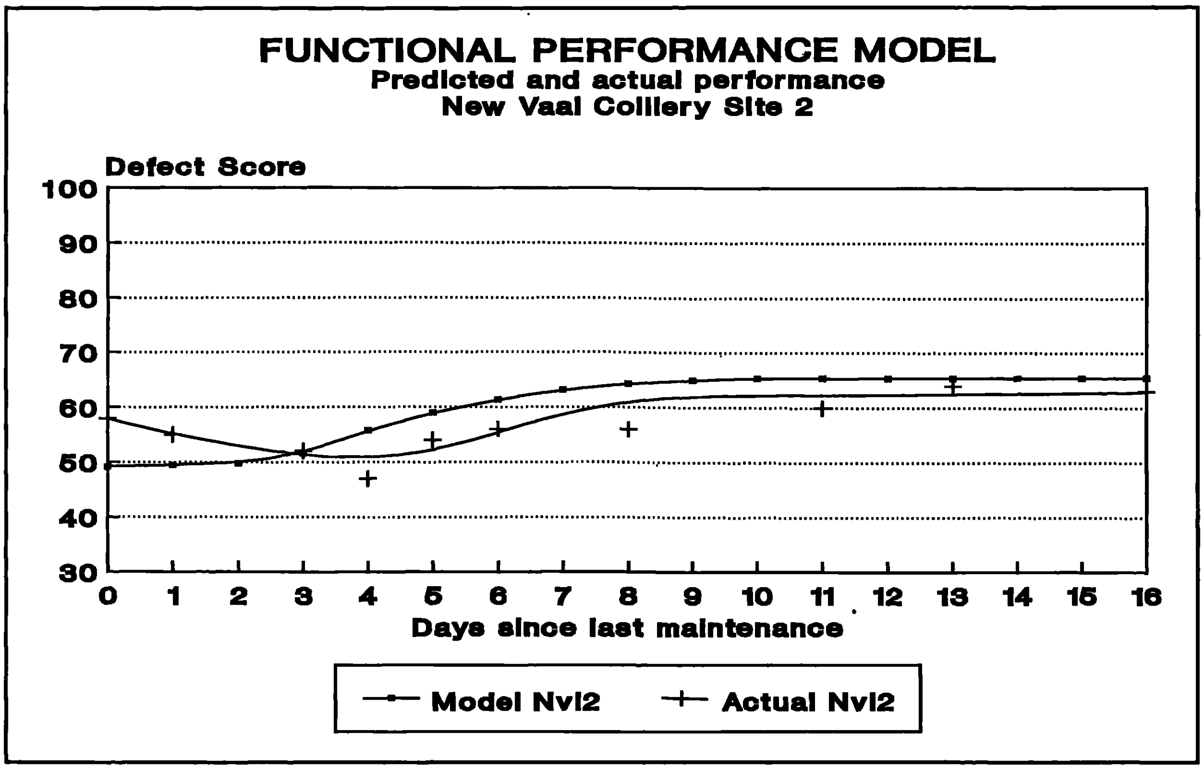
G1-4

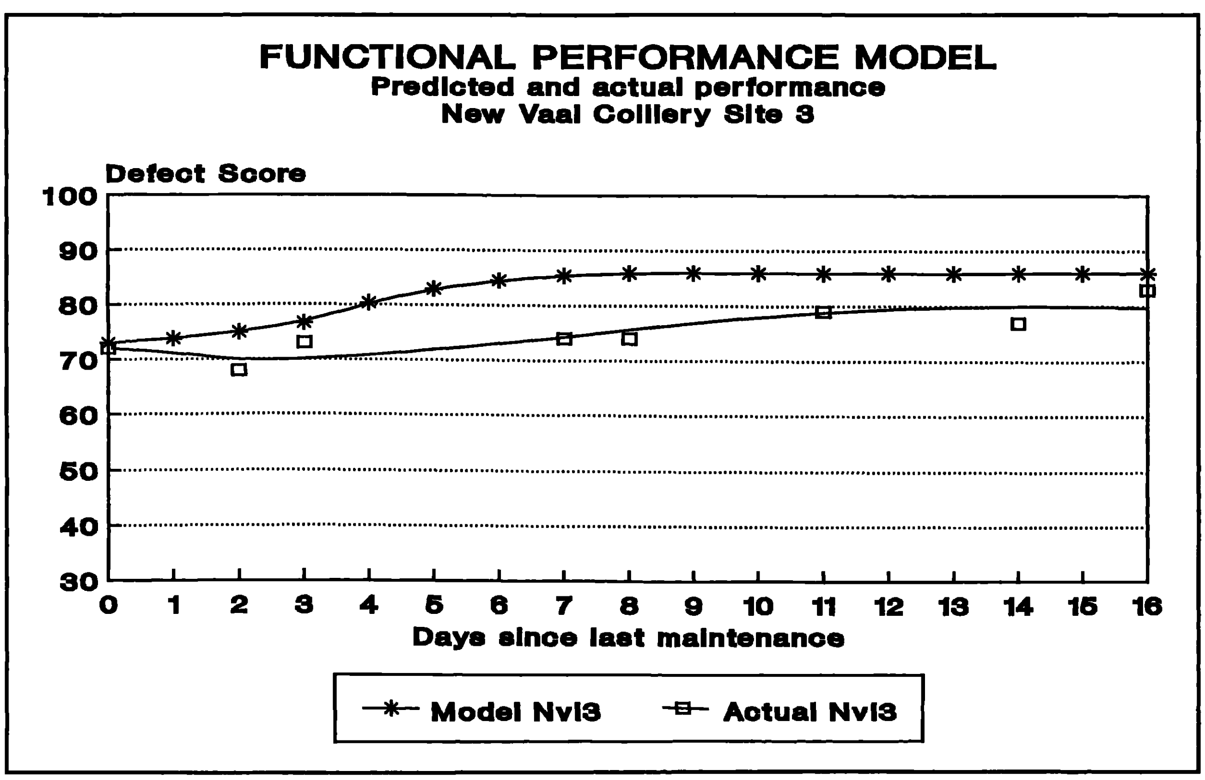

FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
Kriel Colliery Site 3
Defect Score
100
90
80
70
60
50
40
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Days since last maintenance
Model Krl3
Actual Krl3

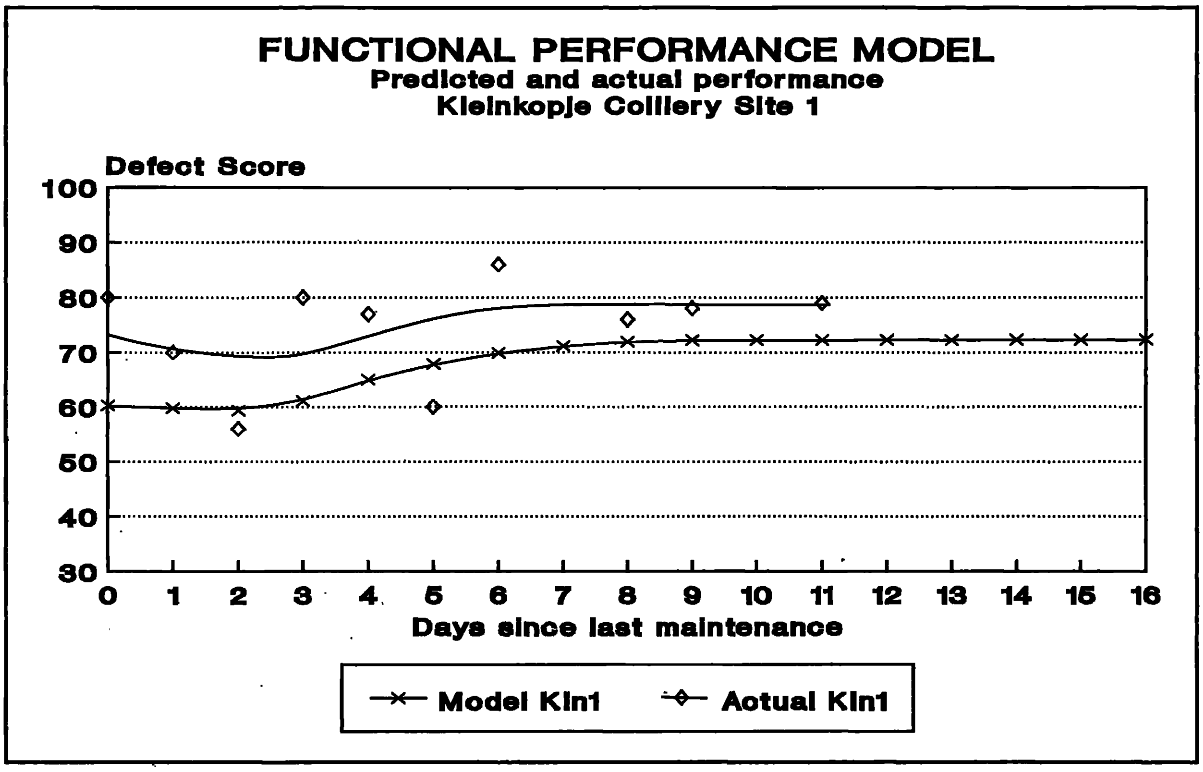

FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
Kromdraal Colliery Site 1
Defect Score
100
90
80
70
60
50
40
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Days since last maintenance
Model krm1
Actual Krm1

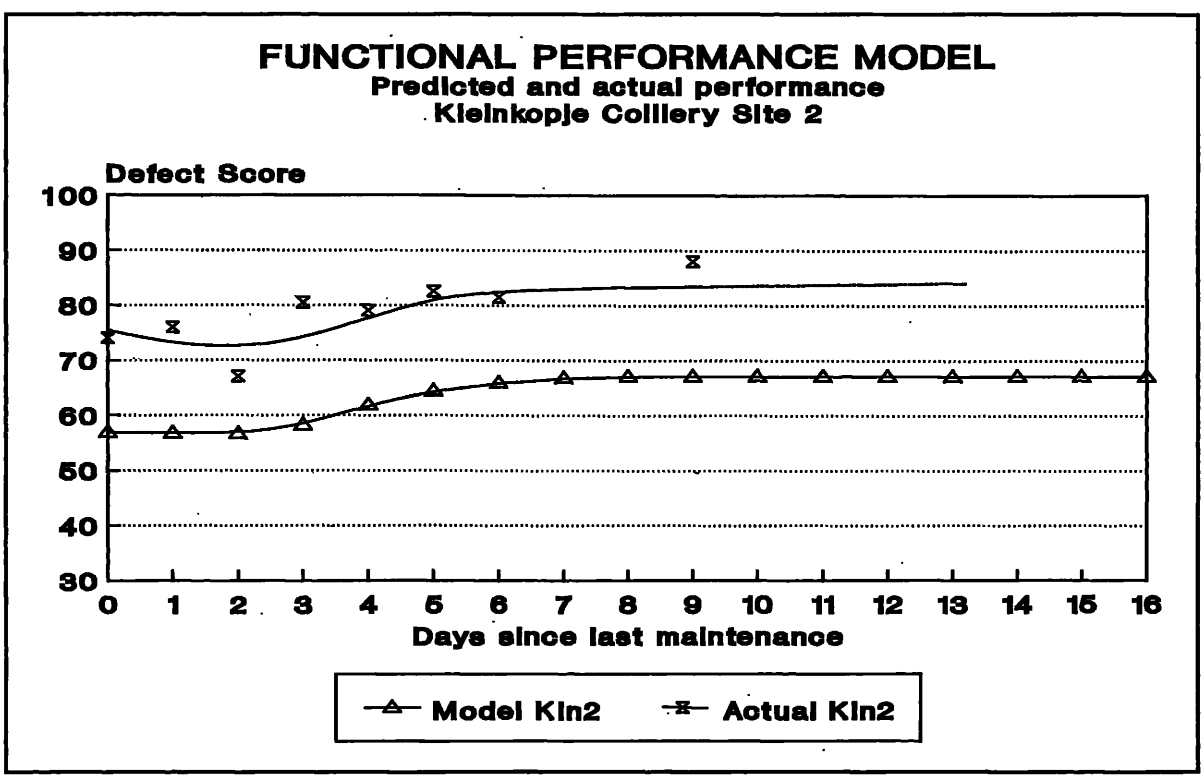

FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
Kromdraal Colliery Site 2
Defect Score
100
90
80
70
60
50
40
30
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Days since last maintenance
Model Krm2
Actual Krm2


FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
New Vaal Colliery Site 1
Defect Score
100
90
80
70
60
50
40
30
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Days since last maintenance
Model Nvl1
Actual Nvl1


FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
New Vaal Colliery Site 2
Defect Score
100
90
80
70
60
50
40
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Days since last maintenance
Model Nvl2
Actual Nvl2


FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
New Vaal Colliery Site 3
Defect Score
100
90
80
70
60
50
40
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Days since last maintenance
Model Nvl3
Actual Nvl3


FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
Kleinkopje Colliery Site 1
Defect Score
100
90
80
70
60
50
40
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Days since last maintenance
Model Kln1
Actual Kln1


FUNCTIONAL PERFORMANCE MODEL
Predicted and actual performance
Kleinkopje Colliery Site 2
Defect Score
100
90
80
70
60
50
40
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Days since last maintenance
Model Kln2
Actual Kln2

# APPENDIX G2

## STATISTICAL DATA AND RESULTS OF ANALYSES
## MATERIAL PROPERTY MODELS

**G2-2**

**Contents**

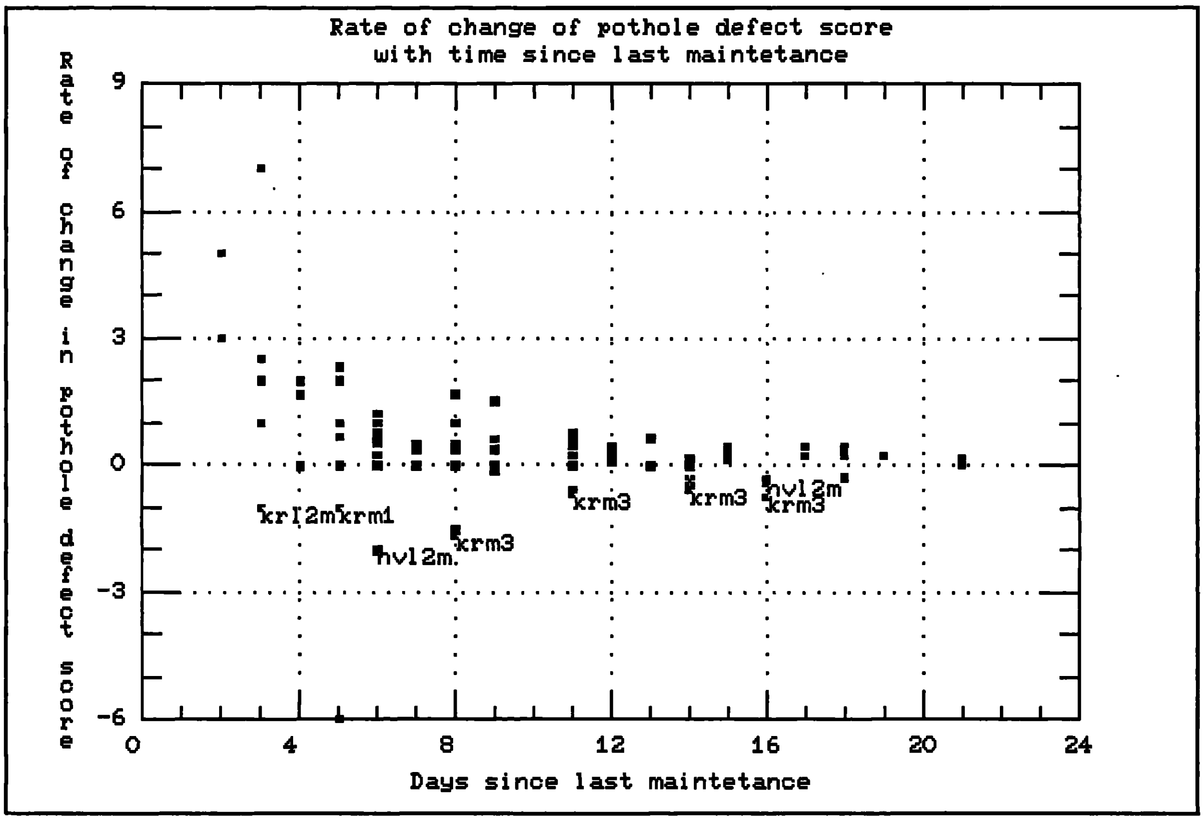



**Figure 1** Rate of change of pothole defect score with days since last maintenance.

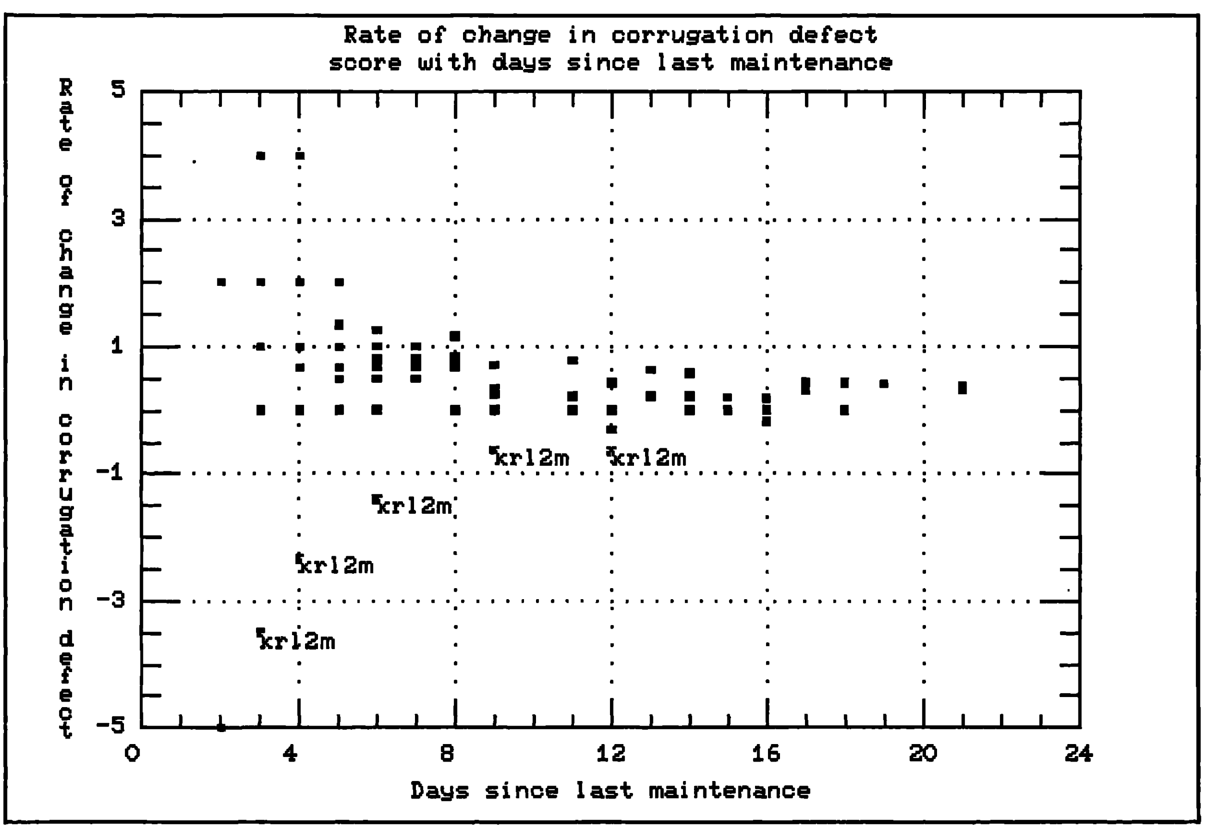



**Figure 2** Rate of change of corrugation defect score with days since last maintenance.

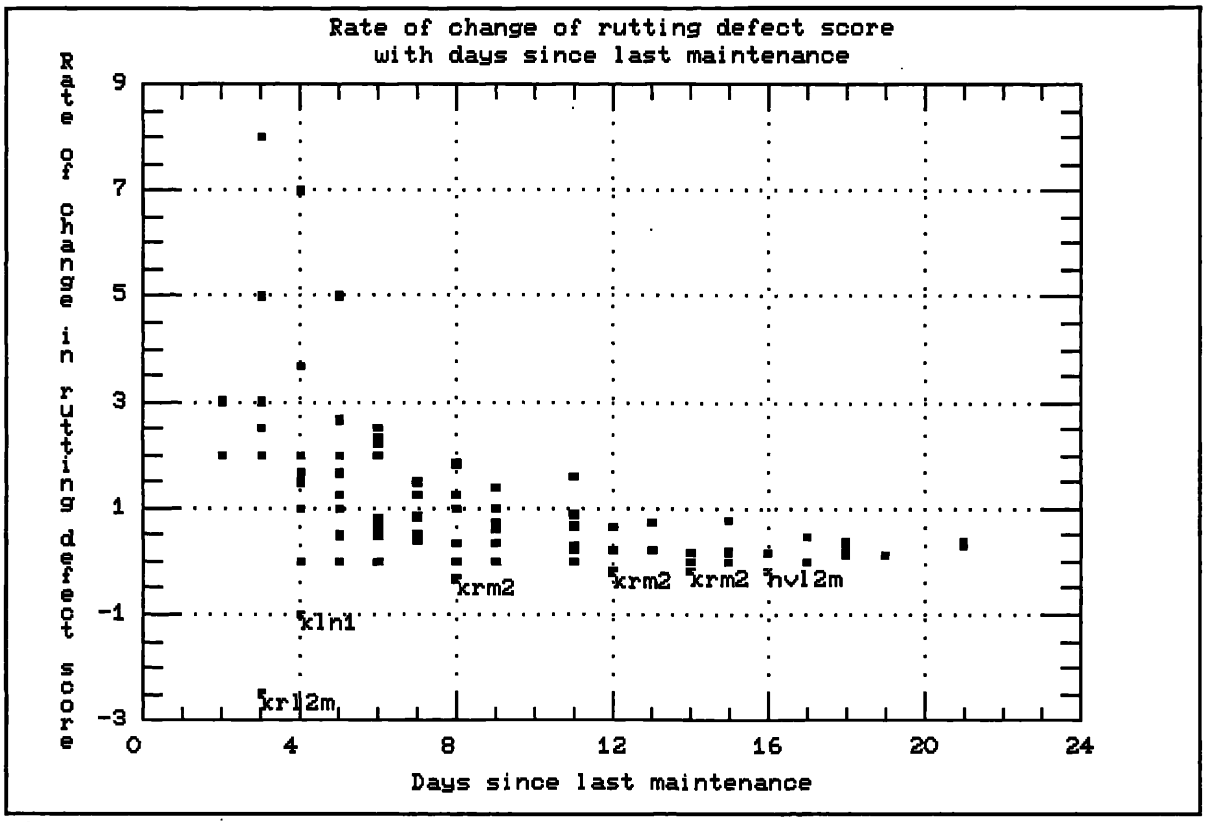



**Figure 3** Rate of change of rutting defect score with days since last maintenance.

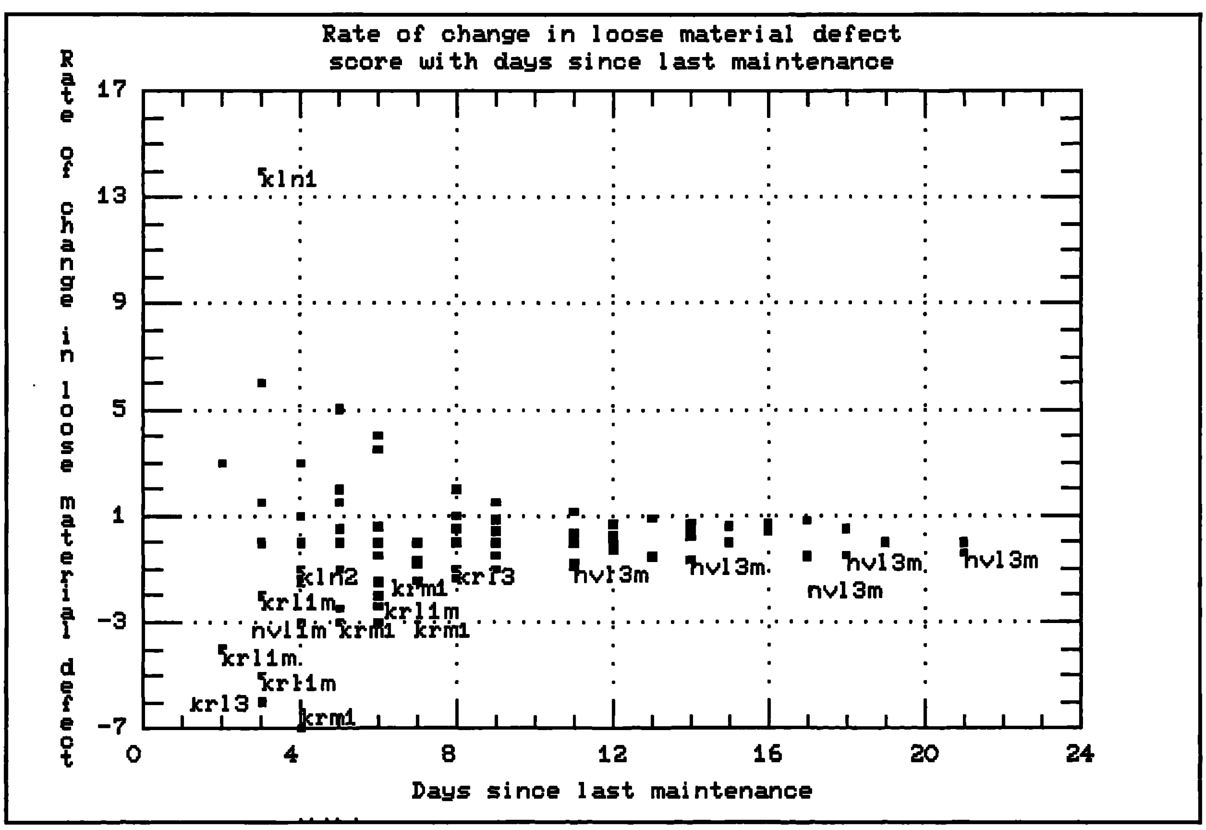



**Figure 4** Rate of change of loose material defect score with days since last maintenance.

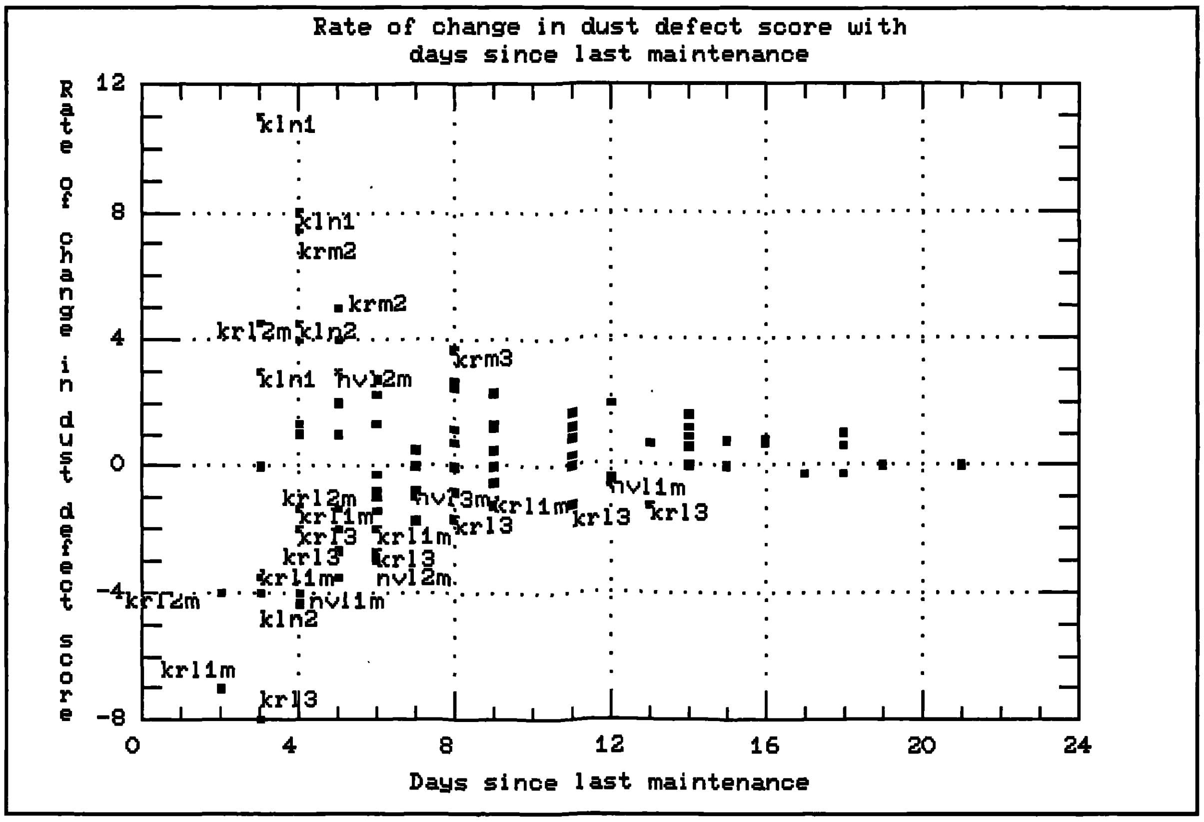



**Figure 5** Rate of change of dustiness defect score with days since last maintenance.

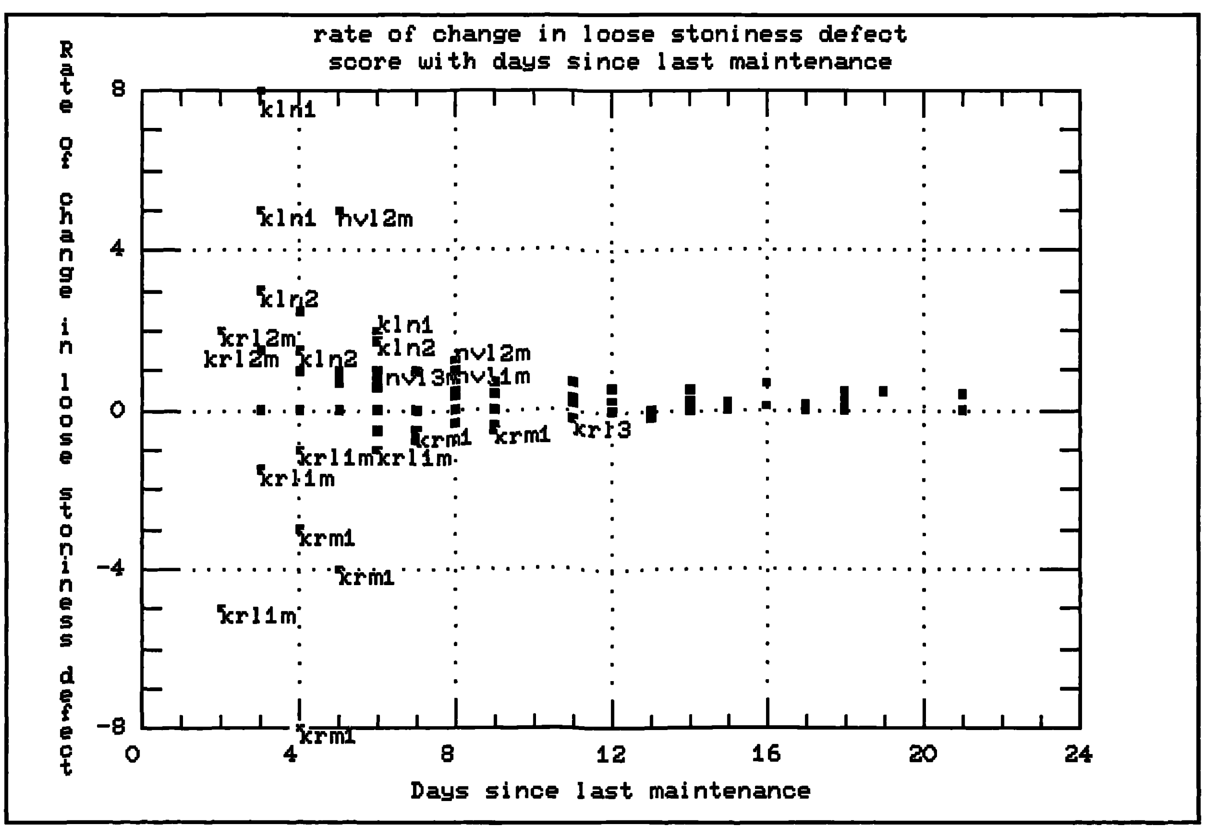



**Figure 6** Rate of change of loose stoniness defect score with days since last maintenance.

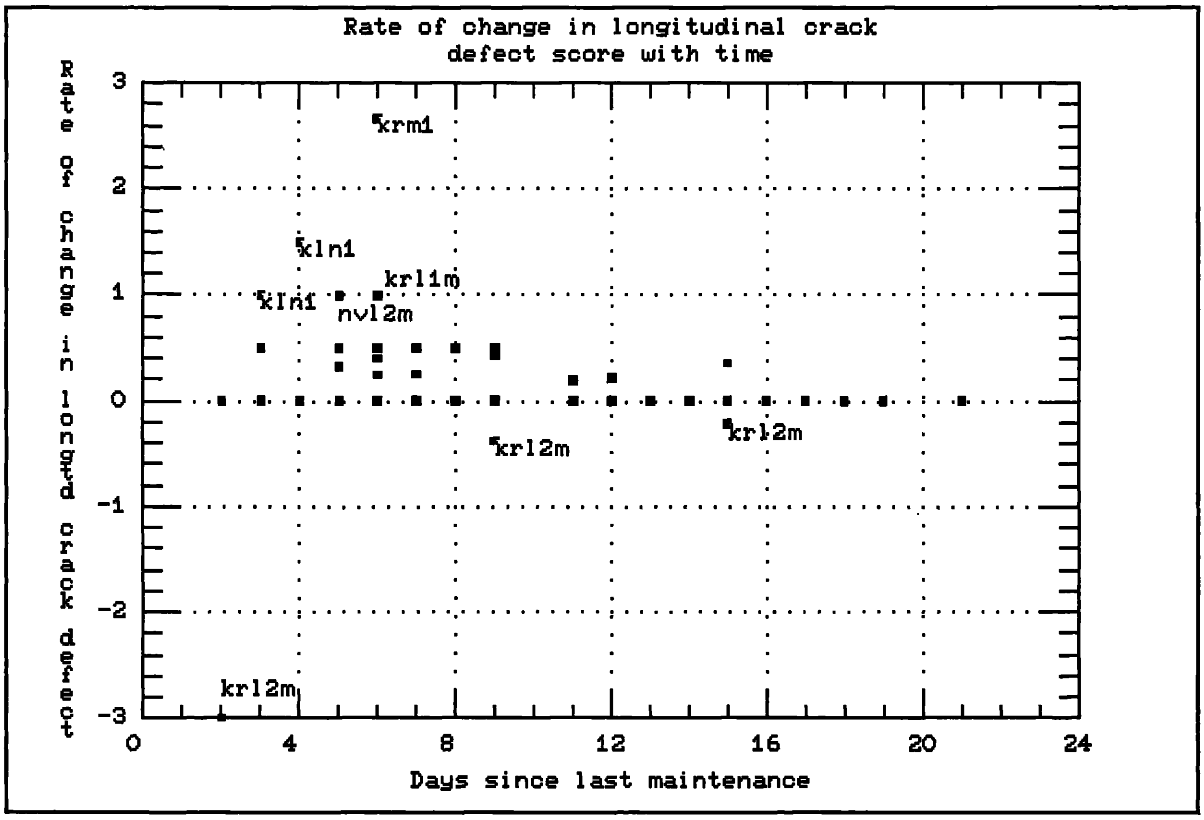



**Figure 7** Rate of change of longitudinal crack defect score with days since last maintenance.

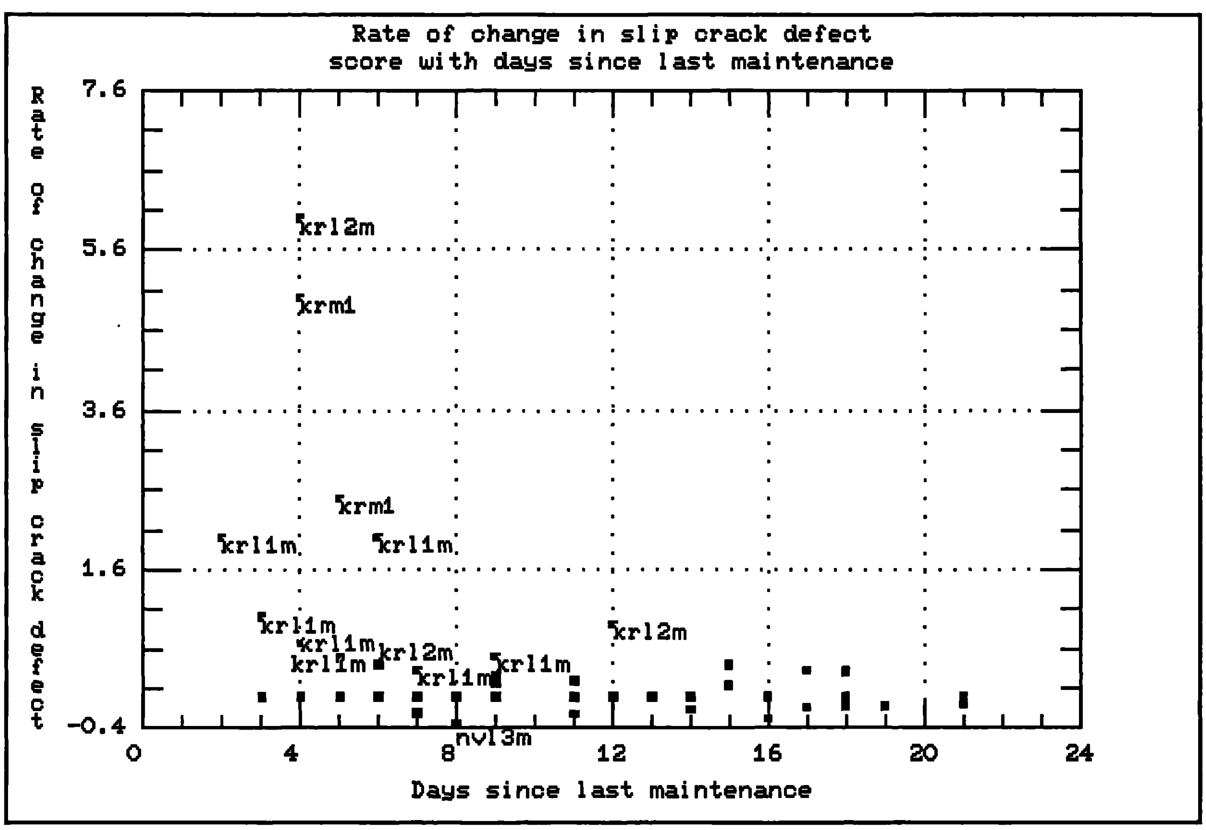



**Figure 8** Rate of change of slip crack defect score with days since last maintenance.

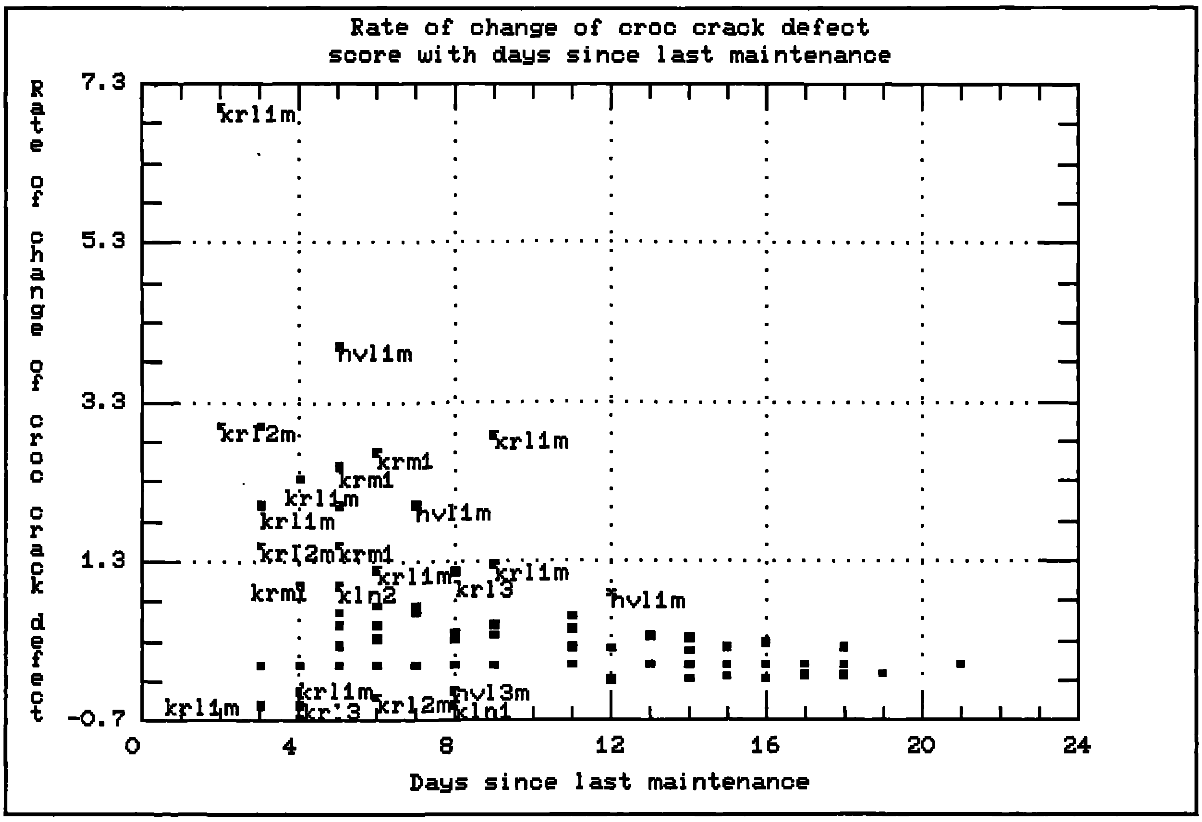



**Figure 9** Rate of change of crocodile crack defect score with days since last maintenance.

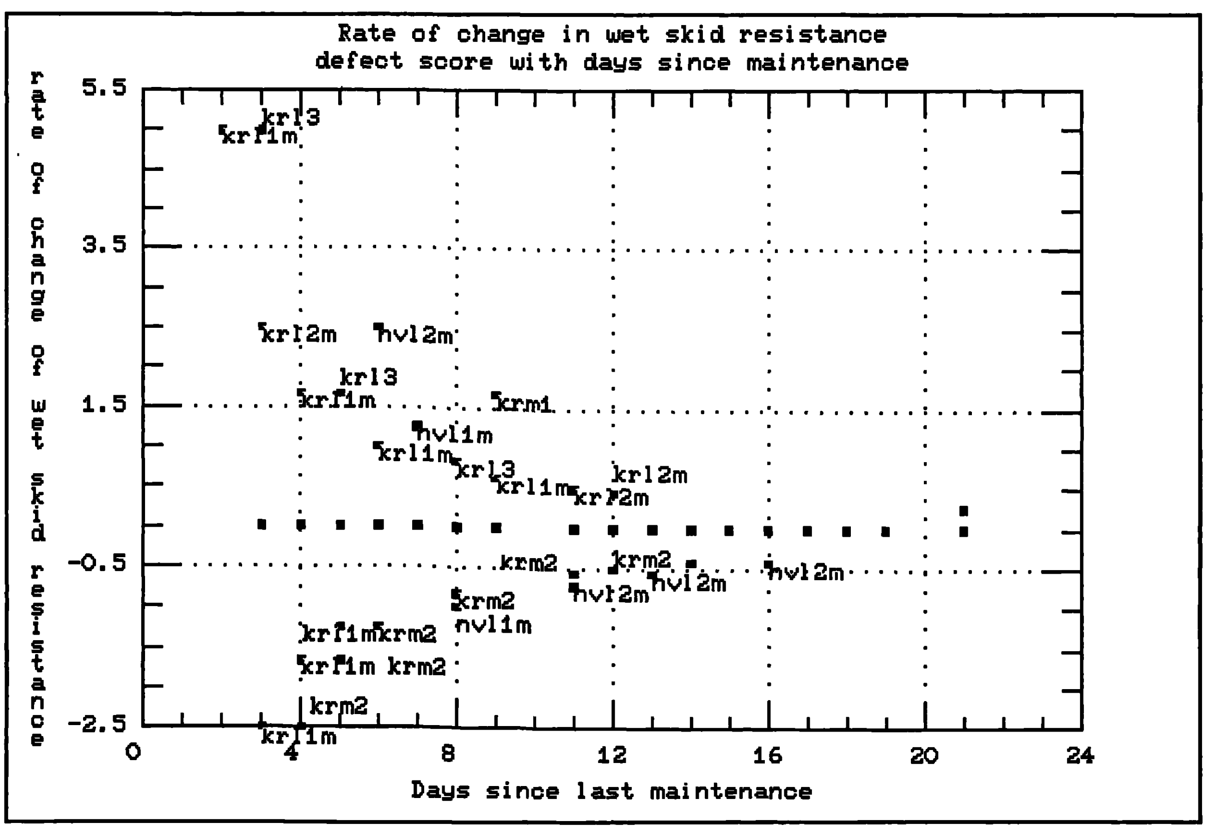



**Figure 10** Rate of change of wet skid resistance defect score with days since last maintenance.

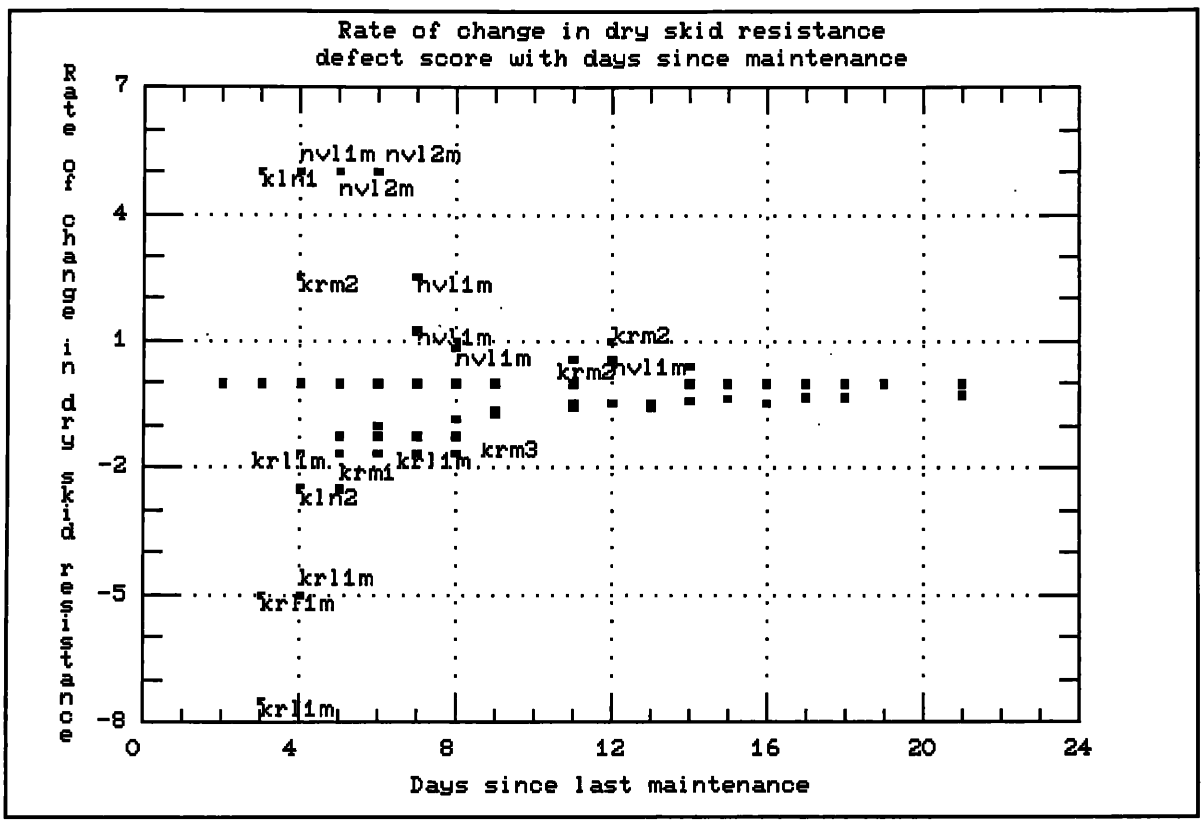



**Figure 11** Rate of change of dry skid resistance defect score with days since last maintenance.

# APPENDIX H

## RESULTS OF ACCEPTABILITY CRITERIA ASSESSMENT

# H-2

## Contents

## Haul Roads Research Project

## Functional performance assessment questionnaire

### Introduction

Functional design aspects refer to the ability of a haul road to perform its function, i.e to provide an economic, safe and vehicle friendly ride. The selection of wearing course materials primarily controls the functional performance. The effect of haul road functional performance and maintenance on mine economics and safety is not well defined at present. However, it is clear that a strong relationship exists between road structural and functional performance and safe, economically optimal mining operations. For existing operations, which may not have optimally designed and maintained systems, the problem of identifying existing deficiencies, quantifying their impact and assigning priorities within the constraints imposed by limited capital and manpower is problematic. Assessing the impact of various haul road functional deficiencies in order to identify the safety and economic benefits of taking corrective actions such as more frequent maintenance, regravelling or betterment is hampered by the lack of a problem solving methodology which can address the complex interactions of various components in a haulage system. This is reflected in the fact that most surface mine operators agree good roads are desirable, but find it difficult to translate this into a safety or cost-benefit analysis of proposed betterment activities.

The principal objectives of this questionnaire are:

- To generate data which can be used to develop functional performance related specifications for wearing course materials
- To obtain data which can be used to list priorities for maintenance and betterment activities.

The series of questions and evaluations attached on the following sheets are designed to assess the functional performance of a haul road both in terms of acceptable functional performance levels and the effect of performance deficiencies on a truck, its tyres and the productivity of the whole transport operation. Your response to these questions should be based on your overall familiarity with surface mining and perceptions about haul road functionality and the relationship between the haulage system and safe and economic mining operations.

There are two basic areas to be evaluated by the questionnaire;

1 Road user assessment of desirable and unacceptable characteristic performance limits and

2 The impact of functionality on the economics and safety of the operation.

**Instructions**

1 <u>Road User Assessment of Desirable and Unacceptable Characteristic performance Limits.</u>

Road user assessment of performance criteria is based on a classification of degree and extent for each functional characteristic of the road. Road defect upper limits are specified for desirability, together with a threshold of unacceptability. The level of functional performance of a haul road may be determined by considering those characteristics which combine to control functionality, eg. dustiness, potholes, skid resistance, etc. The extent and degree of severity of each of these characteristics may be assessed according to a five point scale as given in Table 1 and 2. Using your experience, consider each defect in a broad sense as it applies to the haul road (NOT ramp or tip areas). Using the detailed descriptions of the degree of a particular defect and extent (Table 1 and 2), complete the performance evaluation form for desirable and unacceptable levels of performance.

For example, for the characteristic of dustiness, you may decide desirable degree is $\leq 2$ and extent $\leq 3$. Unacceptable levels may be degree $\geq 4$ and extent $\geq 3$. Enter these values in the evaluation form as shown overleaf.

| CHARACTERISTIC | DESIRABLE | | UNACCEPTABLE | | COMMENTS |
|---|---|---|---|---|---|
| | DEGREE | EXTENT | DEGREE | EXTENT | |
| Dustiness | 2 | 3 | 4 | 3 | |

**TABLE 1** **Classification of the Degree of Haul Road Aspects to be Evaluated.**

| CHARACTERISTIC | DESCRIPTION | | | | |
|---|---|---|---|---|---|
| | Degree 1 | Degree 2 | Degree 3 | Degree 4 | Degree 5 |
| Potholes | Surface is pock marked , holes < 50mm diameter. | Potholes 50-100mm diameter. | Potholes 100-400mm diameter and influence riding quality. | Potholes 400-800mm diameter, influence riding quality and obviously avoided by most vehicles. | Potholes >800mm diameter, influence riding quality and require speed reduction or total avoidance. |
| Corrugations | Slight corrugations, difficult to feel in light vehicle. | Corrugations present and noticeable in light vehicle. | Corrugations very visible and reduce riding quality noticeably. | Corrugations noticeable in haul truck and causing driver to reduce speed. | Corrugations noticeable in haul truck and causing driver to reduce speed significantly. |
| Rutting | Difficult to discern unaided, <20mm. | Just discernable with eye, 20-50mm. | Discernable, 50-80mm. | Obvious from moving vehicle, >80mm. | Severe, affects direction stability of vehicle. |
| Loose material | Very little loose material on road, <5mm depth. | Small amount of loose material on road to a depth of 5-10mm. | Loose material present on road to a depth of 10-20mm. | Significant loose material on road to a depth of 20-40mm. | Considerable loose material, depth >40mm. |
| Dustiness | Dust just visible behind vehicle. | Dust visible, no oncoming vehicle driver discomfort, good visibility. | Notable amount of dust, windows closed in oncoming vehicle, visibility just acceptable, overtaking difficult. | Significant amount of dust, window closed in oncoming vehicle, visibility poor. | Very dusty, surroundings obscured to a dangerous level. |
| Stoniness - fixed in wearing course | Some protruding stones, but barely felt or heard when travelling in light vehicle. | Protruding stones felt and heard in light vehicle. | Protruding stones influence riding quality in light vehicle but still acceptable. | Protruding stones occasionally require evasive action of light vehicle. | Protruding stones require evasive action of haul truck. |
| Stoniness - loose on road | Occasional loose stone (<75mm diameter), <2/m$^2$ | Some loose stone, 2-4/m$^2$ | Loose stone 4-6/m$^2$, occasional discomfort felt. | Considerable loose stone on surface, >6/m$^2$, reducing riding quality. | Large amounts of loose stone causing significant reduction in riding quality. |
| Cracks - longitudinal | Faint cracks discernable when surface cleaned. | Distinct, mostly closed, easily discernable when walking. | Distinct, mostly open, discernable from vehicle. | Open cracks, >3mm separation <u>or</u> wide open cracks >10mm separation, in travelling lanes. | Extensive open cracks, >3mm separation together with secondary cracks <u>or</u> extensive wide |

**TABLE 1** **Classification of the Degree of Haul Road Aspects to be Evaluated (cont'd).**

| CHARACTERISTIC | DESCRIPTION | | | | |
|---|---|---|---|---|---|
| | Degree 1 | Degree 2 | Degree 3 | Degree 4 | Degree 5 |
| Cracks - slip | Faint cracks discernable when surface cleaned. | Distinct, mostly closed, easily discernable when walking. | Distinct, mostly open, discernable from vehicle. | Open cracks, >3mm separation or wide open cracks >10mm separation, in travelling lanes. | Extensive open cracks, >3mm separation together with secondary cracks or extensive wide open cracks >10mm separation, in travelling lanes. |
| Cracks - crocodile | Very faint cracks in wheel path. | Faint cracks discernable when walking, closed. | Distinct cracks upto 2mm wide, no apparent deformation. | Open cracks (>2mm) with some deformation and/or spalling of cracked areas. | Open cracks with severe deformation and/or spalling of edges. |
| Skid resistance - wet | Wearing course material of good quality, road properly cambered, little loose material present. | Wearing course strength and PI acceptable, road cambered, loose material acceptable. | Wearing course strength low, PI fairly high, unsatisfactory camber and loose material. | Wearing course strength low, PI high, water standing on surface when raining, loose material influences skid resistance significantly. | Wearing course strength very low, PI very high, road very slippery when wet, loose material reduces skid resistance unacceptably. |
| Skid resistance - dry | Wearing course material of good quality, road properly cambered, little loose material present. | Wearing course strength and PI acceptable, road cambered, loose material acceptable. | Wearing course strength low, PI fairly high, unsatisfactory camber and loose material. | Wearing course strength low, PI high, loose material influences skid resistance significantly. | Wearing course strength very low, PI very high, loose material reduces skid resistance unacceptably. |
| Drainage on road | Very little water accumulates on road, no surface erosion is evident. | Shallow depressions may retain water for a limited time, most water drains away rapidly. | water may be retained in ruts and potholes, some surface erosion evident. | Water retained over a significant portion of the road, surface erosion <50mm deep in channels. | Water ponding on road to depths >50mm and erosion channels deeper than 50mm. |
| Drainage at roadside | Side drains very effective, well shaped with no obstructions. | Slightly irregular, some loose debris or occasional erosion, road well above side drain level. | Drains irregular in shape, blocked or eroded, road above side drain level. | Drains irregular or eroded and blocked over >25% road length, road and side drain at same elevation. | Side drains deeply eroded or non existent along 75% of road length or road surface below side drain. |

NOTE.
1. Description of degrees refers to haul truck unless otherwise stated.
2. Rutting - depressions extended in length and limited in width, usually occurring in a longitudinal direction and in the wheel path.
3. Corrugations - regularly spaced transverse undulations of the pavement at regular intervals less than 1m apart.
4. Crocodile cracks - fine irregular cracks in the wheel path resembling crocodile skin.

**TABLE 2** **Classification of the Extent of Haul Road Aspects to be Evaluated.**

| EXTENT | DESCRIPTION |
|---|---|
| 1 | Isolated occurrence, less than 5% of road affected. |
| 2 | Intermittent occurrence, between 5-15% of road affected. |
| 3 | Regular occurrence, between 16-30% of road affected. |
| 4 | Frequent occurrence, between 31-60% of road affected. |
| 5 | Extensive occurrence, more than 60% of the road affected. |

## HAUL ROAD FUNCTIONAL PERFORMANCE EVALUATION FORM 1

NAME OF THE MINE? .............................
HOW LONG HAVE YOU BEEN ASSOCIATED WITH SURFACE MINING? ........................ Years

| CHARACTERISTIC | DESIRABLE | | UNACCEPTABLE | | COMMENTS |
|---|---|---|---|---|---|
| | DEGREE | EXTENT | DEGREE | EXTENT | |
| Potholes | | | | | |
| Corrugations | | | | | |
| Rutting | | | | | |
| Loose material | | | | | |
| Dustiness | | | | | |
| Stoniness - fixed in wearing course | | | | | |
| Stoniness - loose on road | | | | | |
| Cracks - longitudinal | | | | | |
| Cracks - slip | | | | | |
| Cracks - crocodile | | | | | |
| Skid resistance - wet | | * | | * | |
| Skid resistance - dry | | * | | * | |
| Drainage on road | | * | | * | |
| Drainage at roadside | | * | | * | |
| * Do not record extent for these functional aspects | | | | | |

## 2 The impact of Functionality on the Economics and Safety of the Operation.

The economic impact is quantified by first deciding if a given condition or characteristic can affect either the truck, the tyres or the operation's productivity. If any of these three items are affected, the degree to which this occurs is scored using the attached rating system. The safety impact is estimated by scoring the accident potential of each condition and characteristic. Accident potential assigns a subjective probability to every condition and characteristic. An accident in this case is defined as an unplanned event which results in operator injury or equipment damage.

Consider each item in a broad sense, ie., scoring in terms of its impact on average or typical daily operating conditions on the haul road (NOT ramp or tip areas). For example, whilst a dust problem on the road may lead to vehicle collisions, is this typical? The typical situation is a dust problem reducing visibility and vehicle speed, hence increasing cycle time. The procedure is outlined below.

STEP 1 Review each item on the scoring sheet and decide whether it affects the operation, truck or tyre. Mark appropriate box(es).

STEP 2 For each condition identified with a mark (step 1), score its expected impact during a year of production using the IMPACT RANKING SCALE, Table 3.

STEP 3 Based on your experience, evaluate the possibility that each item on the scoring sheet could cause an accident, using the ACCIDENT RANKING SCALE, Table 4.

A typical entry in the assessment form is shown below, for the pothole characteristic.

| FUNCTIONAL DESIGN CHARACTERISTIC | ITEM AFFECTED BY CHARACTERISTIC | | | IMPACT RANKING SCORE | | | ACCIDENT POTENTIAL SCORE |
|---|---|---|---|---|---|---|---|
| | Operation | Truck | Tyre | Operation | Truck | Tyre | |
| Potholes | ✓ | ✓ | ✓ | 2 | 2 | 3 | 1 |

**Table 3 Impact Ranking Scale**

| ITEM | IMPACT SCORE | DESCRIPTION |
|---|---|---|
| **TRUCK** | | |
| | 0 | No mechanical damage |
| | 1 | Minor mechanical damage, downtime < 1 shift, low potential for premature component failure. |
| | 2 | Minor mechanical damage, downtime < 1 shift, medium potential for premature component failure. |
| | 3 | Mechanical damage, downtime < 1 week, high potential for premature component failure. |
| | 4 | Mechanical damage, downtime < 1 month. |
| | 5 | Mechanical damage, downtime > 1 month. |
| **OPERATION** | | |
| | 0 | < 1% slow down. |
| | 1 | 1-5% slow down. |
| | 2 | 6-10% slow down. |
| | 3 | 11-15% slow down. |
| | 4 | >15% slow down. |
| | 5 | Production stops. |
| **TYRES** | | |
| | 0 | No impact on tyre wear. |
| | 1 | Tyre wear increased by 5%. |
| | 2 | Tyre wear increased by 10%, low potential for cuts. |
| | 3 | Tyre wear increased by 25%, medium potential for cuts. |
| | 4 | Tyre wear increased by 50%, high potential for cuts. |
| | 5 | Tyre wear increased by >50%, high potential for cuts. |

**Table 4 Accident potential scale**

| ACCIDENT POTENTIAL SCORE | DESCRIPTION |
|---|---|
| 0 | Could cause an accident resulting in operator injury or equipment damage but probability is low (P<1%). |
| 1 | P 1-5% |
| 2 | P 6-10% |
| 3 | P 11-20% |
| 4 | P 21-30% |
| 5 | P 31-42% |
| 6 | P 43-54% |
| 7 | P 55-66% |
| 8 | P 67-78% |
| 9 | P 79-90% |
| 10 | Very high probability of accident. If situation is left uncorrected, accident involving equipment damage or operator injury will almost certainly occur (P>90%) |

## SCORING SHEET - FUNCTIONAL PERFORMANCE ASSESSMENT FORM 2

| FUNCTIONAL DESIGN CHARACTERISTIC | ITEM AFFECTED BY CHARACTERISTIC | | | IMPACT RANKING SCORE | | | ACCIDENT POTENTIAL SCORE | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | Operation | Truck | Tyre | Operation | Truck | Tyre | | |
| Potholes | | | | | | | | |
| Corrugations | | | | | | | | |
| Rutting | | | | | | | | |
| Loose material | | | | | | | | |
| Dustiness | | | | | | | | |
| Stoniness - fixed in wearing course | | | | | | | | |
| Stoniness - loose on road | | | | | | | | |

Continued on next page...

SCORING SHEET - FUNCTIONAL PERFORMANCE ASSESSMENT FORM 2 (cont'd)

| FUNCTIONAL DESIGN CHARACTERISTIC | ITEM AFFECTED BY CHARACTERISTIC | | | IMPACT RANKING SCORE | | | ACCIDENT POTENTIAL SCORE | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | Operation | Truck | Tyre | Operation | Truck | Tyre | | |
| Cracks - longitudinal | | | | | | | | |
| Cracks - slip | | | | | | | | |
| Cracks - Crocodile | | | | | | | | |
| Skid resistance - wet | | | | | | | | |
| Skid resistance - dry | | | | | | | | |
| Drainage on road | | | | | | | | |
| Drainage at roadside | | | | | | | | |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Mine |
| YEARS EXPERIENCE | 2.5 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 1 | 1 | 2 | 3 | 3 | 2 | 1 | 3 |
| Corrugations | 1 | 2 | 3 | 3 | 3 | 2 | 2 | 4 |
| Rutting | 2 | 3 | 4 | 4 | 0 | 2 | 1 | 2 |
| Loose material | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 5 |
| Dustiness | 1 | 2 | 4 | 3 | 3 | 0 | | 4 |
| Stoniness - fixed | 2 | 3 | 4 | 3 | 2 | 1 | 4 | 2 |
| Stoniness - loose | 1 | 2 | 3 | 2 | 3 | 1 | 3 | 5 |
| Cracks - longitudinal | 1 | 2 | 4 | 2 | | | 1 | 0 |
| Cracks - slip | 1 | 2 | 3 | 3 | | | | |
| Cracks - crocodile | 2 | 3 | 4 | 4 | | | | |
| Skid resistance wet | 2 | | 3 | | 4 | | | 5 |
| Skid resistance dry | 2 | | 3 | | 3 | | 1 | 4 |
| Drainage on road | 1 | | 3 | | 4 | | | 3 |
| Drainage side of road | 2 | | 4 | | 2 | | | 3 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Manuf |
| YEARS EXPERIENCE | 17 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 1 | 3 | 3 | 4 | 2 | 2 | 2 | 1 |
| Corrugations | 1 | 5 | 4 | 4 | 2 | 3 | 3 | 1 |
| Rutting | 2 | 4 | 3 | 3 | 1 | 2 | 2 | 1 |
| Loose material | 1 | 5 | 4 | 4 | | 0 | 1 | 2 |
| Dustiness | 2 | 4 | 3 | 4 | 3 | | | 4 |
| Stoniness - fixed | 2 | 3 | 4 | 4 | 1 | 1 | 2 | 1 |
| Stoniness - loose | 2 | 1 | 4 | 4 | | 0 | 2 | 1 |
| Cracks - longitudinal | 2 | 2 | 3 | 3 | | 1 | 1 | 1 |
| Cracks - slip | 2 | 2 | 3 | 3 | | 1 | 1 | 1 |
| Cracks - crocodile | 2 | 2 | 3 | 3 | | 1 | 1 | 1 |
| Skid resistance wet | 2 | | 3 | | 3 | | 2 | 3 |
| Skid resistance dry | 2 | | 3 | | 2 | | 2 | 3 |
| Drainage on road | 2 | | 4 | | 1 | | 3 | 2 |
| Drainage side of road | 2 | | 3 | | 1 | | 1 | 1 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Manuf |
| YEARS EXPERIENCE | 15 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 2 |
| Corrugations | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 |
| Rutting | 3 | 3 | 4 | 4 | 1 | 1 | 1 | 1 |
| Loose material | 3 | 4 | 4 | 3 | 1 | 0 | 1 | 1 |
| Dustiness | 2 | 2 | 3 | 4 | 2 | 0 | | 2 |
| Stoniness - fixed | 3 | 4 | 3 | 5 | | 0 | 0 | 0 |
| Stoniness - loose | 2 | 3 | 3 | 4 | 0 | 1 | 1 | 2 |
| Cracks - longitudinal | 2 | 3 | 3 | 3 | | | | |
| Cracks - slip | 2 | 3 | 3 | 3 | | | | |
| Cracks - crocodile | 2 | 3 | 3 | 3 | | | | |
| Skid resistance wet | 2 | | 3 | | 4 | 4 | | 6 |
| Skid resistance dry | 3 | | 3 | | 2 | 2 | 2 | 6 |
| Drainage on road | 2 | | 3 | | 1 | 0 | | 0 |
| Drainage side of road | 2 | | 3 | | 1 | | | 3 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Manuf |
| YEARS EXPERIENCE | 30 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 1 |
| Corrugations | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 |
| Rutting | 3 | 3 | 3 | 3 | | | 1 | 3 |
| Loose material | 3 | 4 | 4 | 4 | 2 | | | 2 |
| Dustiness | 2 | 3 | 3 | 3 | 1 | 1 | | 4 |
| Stoniness - fixed | 4 | 3 | 4 | 3 | | | 3 | 2 |
| Stoniness - loose | 1 | 3 | 3 | 3 | | | 3 | 2 |
| Cracks - longitudinal | 3 | 3 | 4 | 4 | | | | 1 |
| Cracks - slip | 4 | 4 | 5 | 4 | | | | 1 |
| Cracks - crocodile | 4 | 4 | 4 | 4 | | | | 1 |
| Skid resistance wet | 3 | | 3 | | 3 | 2 | 3 | 7 |
| Skid resistance dry | 3 | | 3 | | 3 | 2 | 3 | 7 |
| Drainage on road | 3 | | 4 | | 2 | | 4 | 5 |
| Drainage side of road | 1 | | 3 | | 2 | | 2 | 4 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Mine |
| YEARS EXPERIENCE | 6 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 2 | 2 | 3 | 3 | 3 | 1 | 1 | 2 |
| Corrugations | 1 | 2 | 3 | 3 | 2 | 2 | | 2 |
| Rutting | 2 | 2 | 3 | 3 | 2 | 2 | | 2 |
| Loose material | 2 | 2 | 3 | 3 | | | 0 | 2 |
| Dustiness | 2 | 2 | 3 | 3 | 3 | | | 10 |
| Stoniness - fixed | 1 | 2 | 4 | 3 | | 1 | 0 | 2 |
| Stoniness - loose | 2 | 2 | 3 | 3 | 3 | 1 | 2 | 1 |
| Cracks - longitudinal | 2 | 2 | 3 | 3 | | 2 | 2 | 2 |
| Cracks - slip | 2 | 2 | 3 | 3 | | 2 | 2 | 2 |
| Cracks - crocodile | 2 | 2 | 4 | 3 | | 2 | 2 | 2 |
| Skid resistance wet | 1 | | 3 | | 2 | | 2 | 8 |
| Skid resistance dry | 1 | | 3 | | 2 | | 2 | 4 |
| Drainage on road | 1 | | 3 | | 2 | | 2 | 3 |
| Drainage side of road | 2 | | 3 | | 3 | | 2 | 3 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Mine |
| YEARS EXPERIENCE | 15 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 1 | 2 | 3 | 5 | 1 | | 1 | 0 |
| Corrugations | 1 | 2 | 3 | 5 | 1 | | 1 | 0 |
| Rutting | 2 | 3 | 4 | 5 | 1 | | 1 | 0 |
| Loose material | 1 | 2 | 3 | 5 | 4 | | 4 | 4 |
| Dustiness | 1 | 3 | 4 | 5 | 4 | | 2 | 4 |
| Stoniness - fixed | 1 | 3 | 4 | 5 | 4 | | 1 | 1 |
| Stoniness - loose | 1 | 3 | 4 | 5 | 4 | | 1 | 2 |
| Cracks - longitudinal | 1 | 3 | 4 | 5 | 2 | 2 | 2 | 2 |
| Cracks - slip | 1 | 3 | 4 | 5 | 2 | 3 | 2 | 2 |
| Cracks - crocodile | 1 | 3 | 4 | 5 | 2 | | 1 | 1 |
| Skid resistance wet | 2 | | 3 | | 1 | | 2 | 2 |
| Skid resistance dry | 2 | | 3 | | 3 | | | 3 |
| Drainage on road | 2 | | 3 | | 1 | 1 | 2 | 2 |
| Drainage side of road | 2 | | 3 | | 2 | 1 | 2 | 3 |

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## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Mine |
| YEARS EXPERIENCE | 6 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 2 | 2 | 4 | 4 | 1 | 2 | 1 | 0 |
| Corrugations | 2 | 2 | 3 | 4 | 2 | 1 | 1 | 1 |
| Rutting | 3 | 2 | 4 | 3 | 0 | 0 | 1 | 0 |
| Loose material | 1 | 2 | 3 | 3 | 3 | | | 4 |
| Dustiness | 2 | 2 | 3 | 3 | 1 | | | 4 |
| Stoniness - fixed | 3 | 2 | 4 | 4 | | | 2 | 0 |
| Stoniness - loose | 3 | 2 | 4 | 4 | 1 | | 1 | 0 |
| Cracks - longitudinal | 3 | 2 | 4 | 4 | | | 1 | 0 |
| Cracks - slip | 3 | 2 | 4 | 4 | | | 1 | 0 |
| Cracks - crocodile | 3 | 3 | 5 | 4 | 0 | | 0 | 0 |
| Skid resistance wet | 2 | | 3 | | 4 | | | 4 |
| Skid resistance dry | 2 | | 3 | | 1 | | | 1 |
| Drainage on road | 2 | | 4 | | 2 | | 1 | 1 |
| Drainage side of road | 2 | | 3 | | 1 | | | 1 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| RESPONDENT | Mine |
|---|---|
| YEARS EXPERIENCE | 5 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 1 |
| Corrugations | 2 | 3 | 3 | 5 | 2 | 2 | 1 | 1 |
| Rutting | 3 | 2 | 4 | 3 | 2 | | | 1 |
| Loose material | 1 | 1 | 1 | 1 | 2 | | 3 | 5 |
| Dustiness | 2 | 1 | 2 | 1 | 4 | | | 5 |
| Stoniness - fixed | 1 | 1 | 2 | 2 | 2 | | 3 | 2 |
| Stoniness - loose | 1 | 1 | 1 | 1 | 2 | | | 2 |
| Cracks - longitudinal | 2 | 3 | 2 | 4 | 2 | | | 1 |
| Cracks - slip | 3 | 4 | 4 | 5 | 2 | 3 | 3 | 3 |
| Cracks - crocodile | 3 | 3 | 4 | 4 | 2 | | 2 | 2 |
| Skid resistance wet | 2 | | 4 | | 5 | 5 | | 5 |
| Skid resistance dry | 1 | | 3 | | 1 | 5 | 5 | 3 |
| Drainage on road | 1 | | 2 | | 5 | | | 5 |
| Drainage side of road | 1 | | 2 | | 3 | 2 | 3 | 1 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Mine |
| YEARS EXPERIENCE | 9 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 1 | 2 | 3 | 2 | 3 | 1 | 2 | 2 |
| Corrugations | 1 | 2 | 3 | 2 | 2 | 1 | 2 | 2 |
| Rutting | 1 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| Loose material | 1 | 2 | 3 | 2 | 5 | 2 | 2 | 4 |
| Dustiness | 1 | 2 | 3 | 2 | 6 | 1 | 1 | 6 |
| Stoniness - fixed | 1 | 2 | 3 | 2 | | | | |
| Stoniness - loose | 1 | 2 | 3 | 2 | 3 | 1 | 1 | 2 |
| Cracks - longitudinal | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 1 |
| Cracks - slip | 1 | 2 | 3 | 2 | 1 | 3 | 2 | 3 |
| Cracks - crocodile | 1 | 2 | 3 | 2 | 2 | 2 | 3 | 3 |
| Skid resistance wet | 1 | | 3 | | 5 | 4 | 2 | 6 |
| Skid resistance dry | 1 | | 3 | | 6 | 6 | 2 | 6 |
| Drainage on road | 2 | | 3 | | 6 | 1 | 2 | 4 |
| Drainage side of road | 1 | | 3 | | 1 | 1 | 1 | 3 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Mine |
| YEARS EXPERIENCE | 3 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 1 | 2 | 3 | 4 | 4 | 3 | 3 | 3 |
| Corrugations | 1 | 2 | 3 | 4 | 2 | 2 | 2 | 0 |
| Rutting | 2 | 3 | 3 | 4 | 2 | | 2 | 0 |
| Loose material | 1 | 2 | 3 | 4 | 3 | | 4 | 2 |
| Dustiness | 1 | 3 | 3 | 4 | 4 | 0 | | 10 |
| Stoniness - fixed | 2 | 3 | 3 | 4 | 2 | | 2 | 0 |
| Stoniness - loose | 1 | 2 | 3 | 3 | 3 | | 2 | 2 |
| Cracks - longitudinal | 2 | 3 | 3 | 4 | | | 0 | 0 |
| Cracks - slip | 2 | 3 | 4 | 4 | | | 0 | 0 |
| Cracks - crocodile | 3 | 3 | 3 | 4 | | | 0 | 0 |
| Skid resistance wet | 1 | | 2 | | 4 | | 1 | 5 |
| Skid resistance dry | 1 | | 3 | | 2 | | | 0 |
| Drainage on road | 1 | | 3 | | 2 | | 1 | 4 |
| Drainage side of road | 1 | | 3 | | 4 | | | 6 |

| CRITICAL FUNCTIONAL PERFORMANCE EVALUATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| RESPONDENT | Mine | | | | | | | |
| YEARS EXPERIENCE | 20 | | | | | | | |
| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 2 | 3 | 4 | 4 | 3 | 2 | 3 | 1 |
| Corrugations | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 1 |
| Rutting | 2 | 2 | 3 | 3 | 2 | | | |
| Loose material | 2 | 3 | 4 | 3 | 1 | | | |
| Dustiness | 2 | 3 | 4 | 3 | 5 | | | 10 |
| Stoniness - fixed | 2 | 3 | 4 | 3 | 2 | | 2 | |
| Stoniness - loose | 2 | 2 | 3 | 3 | 3 | | 2 | 2 |
| Cracks - longitudinal | 1 | 2 | 3 | 2 | | | | |
| Cracks - slip | 1 | 2 | 4 | 3 | | | | |
| Cracks - crocodile | 1 | 2 | 4 | 3 | | | | |
| Skid resistance wet | 1 | | 2 | | 4 | | 1 | 3 |
| Skid resistance dry | 1 | | 2 | | | | | |
| Drainage on road | 2 | | 3 | | 2 | | 1 | 4 |
| Drainage side of road | 2 | | 3 | | 3 | | | 7 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Mine |
| YEARS EXPERIENCE | 11 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 1 | 2 | 3 | 3 | 1 | 1 | 2 | 1 |
| Corrugations | 1 | 1 | 2 | 3 | 3 | 3 | 1 | 2 |
| Rutting | 1 | 1 | 2 | 2 | 4 | 3 | 4 | 2 |
| Loose material | 1 | 1 | 2 | 3 | 1 | 0 | 4 | 3 |
| Dustiness | 1 | 3 | 4 | 4 | 3 | 3 | | 4 |
| Stoniness - fixed | 1 | 1 | 2 | 1 | 3 | 3 | 4 | 2 |
| Stoniness - loose | 1 | 1 | 2 | 2 | 1 | 1 | 4 | 3 |
| Cracks - longitudinal | 5 | 1 | 5 | 3 | | | | |
| Cracks - slip | 5 | 1 | 5 | 3 | | | | |
| Cracks - crocodile | 5 | 1 | 5 | 3 | | | | |
| Skid resistance wet | 2 | | 3 | | 2 | 2 | 3 | 3 |
| Skid resistance dry | 2 | | 3 | | 2 | 2 | 3 | 3 |
| Drainage on road | 1 | | 3 | | 2 | | 1 | 1 |
| Drainage side of road | 1 | | 3 | | 1 | 1 | 1 | 1 |

## CRITICAL FUNCTIONAL PERFORMANCE EVALUATION

| | |
|---|---|
| RESPONDENT | Mine |
| YEARS EXPERIENCE | 29 |

| | Desirable | | Unacceptable | | Impact ranking score | | | Accident |
|---|---|---|---|---|---|---|---|---|
| | Degree | Extent | Degree | Extent | Operation | Truck | Tyre | Pot score |
| Potholes | 1 | 2 | 3 | 3 | 1 | 1 | 2 | 1 |
| Corrugations | 1 | 1 | 2 | 3 | 3 | 3 | 1 | 2 |
| Rutting | 1 | 1 | 2 | 2 | 4 | 3 | 4 | 2 |
| Loose material | 1 | 1 | 2 | 3 | 1 | 0 | 4 | 3 |
| Dustiness | 1 | 3 | 4 | 4 | 3 | 3 | | 4 |
| Stoniness - fixed | 1 | 1 | 3 | 3 | 3 | 3 | 4 | 2 |
| Stoniness - loose | 1 | 1 | 2 | 2 | 1 | 1 | 4 | 3 |
| Cracks - longitudinal | 3 | 2 | 3 | 4 | | | | |
| Cracks - slip | 3 | 2 | 3 | 4 | | | | |
| Cracks - crocodile | 3 | 2 | 3 | 4 | | | | |
| Skid resistance wet | 2 | | 3 | | 2 | 2 | 3 | 3 |
| Skid resistance dry | 2 | | 3 | | 2 | 2 | 3 | 3 |
| Drainage on road | 1 | | 3 | | 2 | | 2 | 1 |
| Drainage side of road | 1 | | 3 | | 1 | 1 | 1 | 1 |

## SUMMARY OF FUNCTIONAL QUESTIONNAIRE RESPONSES

**Limits of acceptability for functional performance**

| | Acceptable | | Unacceptable | | | |
|---|---|---|---|---|---|---|
| | Average Degree | Average Extent | Average Degree | Average Extent | Average Desirable | Average Undesirable |
| Potholes | 1.5 | 2.1 | 3.1 | 3.3 | 3.2 | 10.2 |
| Corrugations | 1.5 | 2.3 | 2.8 | 3.5 | 3.4 | 9.9 |
| Rutting | 2.1 | 2.4 | 3.2 | 3.2 | 5.0 | 10.2 |
| Loose material | 1.5 | 2.4 | 2.9 | 3.1 | 3.5 | 9.0 |
| Dustiness | 1.5 | 2.5 | 3.3 | 3.3 | 3.9 | 10.9 |
| Stoniness - fixed | 1.8 | 2.4 | 3.4 | 3.2 | 4.4 | 10.9 |
| Stoniness - loose | 1.5 | 1.9 | 2.9 | 2.9 | 2.8 | 8.5 |
| Cracks - longitudinal | 2.2 | 2.3 | 3.4 | 3.3 | 5.0 | 11.2 |
| Cracks - slip | 2.3 | 2.5 | 3.7 | 3.5 | 5.7 | 13.1 |
| Cracks - crocodile | 2.5 | 2.5 | 3.8 | 3.5 | 6.2 | 13.3 |
| Skid resistance wet | 1.8 | | 2.9 | | 8.8 | 14.6 |
| Skid resistance dry | 1.8 | | 2.9 | | 8.8 | 14.6 |
| Drainage on road | 1.6 | | 3.2 | | 8.1 | 15.8 |
| Drainage side of road | 1.5 | | 3.0 | | 7.7 | 15.0 |

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## SUMMARY OF FUNCTIONAL QUESTIONNAIRE RESPONSES

### Impact of functionality on safety

| | Percent responses identifying impact | | | Average impact score | | | Weighted ID x impact | | | Percent responses identifying AP | Average AP | Weighted average AP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Operation | Truck | Tyres | Operation | Truck | Tyres | Operation | Truck | Tyres | | | |
| Potholes | 100.0 | 92.3 | 100.0 | 2.1 | 1.7 | 1.3 | 2.1 | 1.5 | 1.3 | 100.0 | 1.4 | 1.4 |
| Corrugations | 100.0 | 92.3 | 92.3 | 2.2 | 2.1 | 1.9 | 2.2 | 1.9 | 1.7 | 100.0 | 1.5 | 1.5 |
| Rutting | 92.3 | 61.5 | 76.9 | 1.8 | 1.9 | 1.3 | 1.7 | 1.2 | 1.0 | 84.6 | 1.5 | 1.2 |
| Loose material | 84.6 | 46.2 | 76.9 | 2.3 | 0.5 | 2.0 | 1.9 | 0.2 | 1.5 | 92.3 | 2.9 | 2.7 |
| Dustiness | 100.0 | 53.8 | 15.4 | 3.2 | 1.1 | 1.5 | 3.2 | 0.6 | 0.2 | 92.3 | 5.5 | 5.1 |
| Stoniness - fixed | 61.5 | 46.2 | 92.3 | 2.4 | 1.5 | 1.9 | 1.5 | 0.7 | 1.7 | 84.6 | 1.4 | 1.2 |
| Stoniness - loose | 84.6 | 53.8 | 92.3 | 2.2 | 0.9 | 1.8 | 1.8 | 0.5 | 1.6 | 92.3 | 2.1 | 1.9 |
| Cracks - longitudinal | 23.1 | 30.8 | 53.8 | 1.7 | 1.5 | 1.5 | 0.4 | 0.5 | 0.8 | 61.5 | 0.9 | 0.5 |
| Cracks - slip | 23.1 | 38.5 | 53.8 | 1.7 | 2.4 | 1.8 | 0.4 | 0.9 | 1.0 | 61.5 | 1.5 | 0.9 |
| Cracks - crocodile | 30.8 | 23.1 | 53.8 | 1.5 | 1.7 | 1.5 | 0.5 | 0.4 | 0.8 | 61.5 | 1.3 | 0.8 |
| Skid resistance wet | 100.0 | 46.2 | 69.2 | 3.3 | 3.2 | 2.2 | 3.3 | 1.5 | 1.5 | 92.3 | 4.6 | 4.2 |
| Skid resistance dry | 92.3 | 46.2 | 69.2 | 2.4 | 3.2 | 2.4 | 2.2 | 1.5 | 1.7 | 92.3 | 3.8 | 3.5 |
| Drainage on road | 100.0 | 23.1 | 76.9 | 2.5 | 0.7 | 2.3 | 2.5 | 0.2 | 1.8 | 92.3 | 2.5 | 2.3 |
| Drainage side of road | 100.0 | 38.5 | 61.5 | 1.9 | 1.2 | 1.8 | 1.9 | 0.5 | 1.1 | 100.0 | 3.0 | 3.0 |

# APPENDIX I

## PERFORMANCE RANKING OF SITES AND CRITICAL DEFECTS

**I-2**

## Contents

| MATERIAL PARAMETER VARIATION WITH FUNCTIONAL PERFORMANCE RANKING OVERALL UNWEIGHTED FUNCTIONAL PERFORMANCE | | | | | | |
|---|---|---|---|---|---|---|
| **PERFORMANCE RANKING** | **DR** | **LL** | **PI** | **PL** | **GC** | **SP** |
| B2 | 0.4 | 21.0 | 4.0 | 17.0 | 30.1 | 82.0 |
| B2 | 0.4 | 17.0 | 5.0 | 12.0 | 31.1 | 90.0 |
| B2 | 0.6 | 23.0 | 8.0 | 15.0 | 21.3 | 196.0 |
| B2 | 0.5 | 24.0 | 8.0 | 16.0 | 28.7 | 128.0 |
| B2 | 0.4 | 18.0 | 4.0 | 14.0 | 24.8 | 102.0 |
| B2 | 0.5 | 21.0 | 6.0 | 15.0 | 30.7 | 111.0 |
| Average | *(0.5)* | *(20.7)* | *(5.8)* | *(14.8)* | *(27.8)* | *(118.2)* |
| C1 | 0.6 | 24.0 | 8.0 | 16.0 | 30.9 | 160.0 |
| C1 | 0.6 | 24.0 | 10.0 | 14.0 | 36.3 | 198.0 |
| C1 | 0.4 | 22.0 | 5.0 | 17.0 | 26.2 | 72.0 |
| C1 | 0.6 | 23.0 | 7.0 | 16.0 | 28.8 | 164.5 |
| C1 | 0.5 | 22.0 | 7.0 | 15.0 | 27.7 | 178.5 |
| Average | *(0.5)* | *(23.0)* | *(7.4)* | *(15.6)* | *(30.0)* | *(154.6)* |

| MATERIAL PARAMETER VARIATION WITH FUNCTIONAL PERFORMANCE RANKING OVERALL WEIGHTED FUNCTIONAL PERFORMANCE | | | | | | |
|---|---|---|---|---|---|---|
| **PERFORMANCE RANKING** | **DR** | **LL** | **PI** | **PL** | **GC** | **SP** |
| B2 | 0.4 | 21.0 | 4.0 | 17.0 | 30.1 | 82.0 |
| B2 | 0.4 | 17.0 | 5.0 | 12.0 | 31.1 | 90.0 |
| B2 | 0.4 | 18.0 | 4.0 | 14.0 | 24.8 | 102.0 |
| B2 | 0.5 | 24.0 | 8.0 | 16.0 | 28.7 | 128.0 |
| Average | *(0.4)* | *(20.0)* | *(5.3)* | *(14.8)* | *(28.7)* | *(100.5)* |
| C1 | 0.6 | 24.0 | 8.0 | 16.0 | 30.9 | 160.0 |
| C1 | 0.4 | 22.0 | 5.0 | 17.0 | 26.2 | 72.0 |
| C1 | 0.5 | 21.0 | 6.0 | 15.0 | 30.7 | 111.0 |
| C1 | 0.6 | 24.0 | 10.0 | 14.0 | 36.3 | 198.0 |
| C1 | 0.6 | 23.0 | 8.0 | 15.0 | 21.3 | 196.0 |
| C1 | 0.6 | 23.0 | 7.0 | 16.0 | 28.8 | 164.5 |
| C1 | 0.5 | 22.0 | 7.0 | 15.0 | 27.7 | 178.5 |
| Average | *(0.5)* | *(22.7)* | *(7.3)* | *(15.4)* | *(28.8)* | *(154.3)* |

| MATERIAL PROPERTY VARIATION WITH FUNCTIONAL PERFORMANCE RANKING FOR CORRUGATION DEFECT | | | | | | |
|---|---|---|---|---|---|---|
| **PERFORMANCE RANKING** | **DR** | **LL** | **PI** | **PL** | **GC** | **SP** |
| A | 0.4 | 21.0 | 4.0 | 17.0 | 30.1 | 82.0 |
| A | 0.5 | 21.0 | 6.0 | 15.0 | 30.7 | 111.0 |
| A | 0.6 | 24.0 | 8.0 | 16.0 | 30.9 | 160.0 |
| A | 0.4 | 18.0 | 4.0 | 14.0 | 24.8 | 102.0 |
| A | 0.5 | 24.0 | 8.0 | 16.0 | 28.7 | 128.0 |
| A | 0.6 | 23.0 | 8.0 | 15.0 | 21.3 | 196.0 |
| A | 0.6 | 24.0 | 10.0 | 14.0 | 36.3 | 198.0 |
| A | 0.6 | 23.0 | 7.0 | 16.0 | 28.8 | 164.5 |
| A | 0.5 | 22.0 | 7.0 | 15.0 | 27.7 | 178.5 |
| Average | *(0.5)* | *(22.2)* | *(6.9)* | *(15.3)* | *(28.8)* | *(146.7)* |
| B1 | 0.4 | 17.0 | 5.0 | 12.0 | 31.1 | 90.0 |
| Average | *(0.4)* | *(17.0)* | *(5.0)* | *(12.0)* | *(31.1)* | *(90.0)* |
| B2 | 0.4 | 22.0 | 5.0 | 17.0 | 26.2 | 72.0 |
| Average | *(0.4)* | *(22.0)* | *(5.0)* | *(17.0)* | *(26.2)* | *(72.0)* |

| MATERIAL PROPERTY VARIATION WITH FUNCTIONAL PERFORMANCE RANKING FOR LOOSE MATERIAL DEFECT | | | | | | |
|---|---|---|---|---|---|---|
| **PERFORMANCE RANKING** | **DR** | **LL** | **PI** | **PL** | **GC** | **SP** |
| B1 | 0.5 | 24.0 | 8.0 | 16.0 | 28.7 | 128.0 |
| Average | *(0.5)* | *(24.0)* | *(8.0)* | *(16.0)* | *(28.7)* | *(128.0)* |
| B2 | 0.6 | 23.0 | 8.0 | 15.0 | 21.3 | 196.0 |
| B2 | 0.5 | 21.0 | 6.0 | 15.0 | 30.7 | 111.0 |
| B2 | 0.4 | 18.0 | 4.0 | 14.0 | 24.8 | 102.0 |
| B2 | 0.6 | 24.0 | 8.0 | 16.0 | 30.9 | 160.0 |
| B2 | 0.6 | 23.0 | 7.0 | 16.0 | 28.8 | 164.5 |
| B2 | 0.4 | 17.0 | 5.0 | 12.0 | 31.1 | 90.0 |
| Average | *(0.5)* | *(21.0)* | *(6.3)* | *(14.7)* | *(27.9)* | *(137.3)* |
| C1 | 0.4 | 21.0 | 4.0 | 17.0 | 30.1 | 82.0 |
| C1 | 0.4 | 22.0 | 5.0 | 17.0 | 26.2 | 72.0 |
| C1 | 0.6 | 24.0 | 10.0 | 14.0 | 36.3 | 198.0 |
| C1 | 0.5 | 22.0 | 7.0 | 15.0 | 27.7 | 178.5 |
| Average | *(0.5)* | *(22.3)* | *(6.5)* | *(15.8)* | *(30.1)* | *(132.6)* |

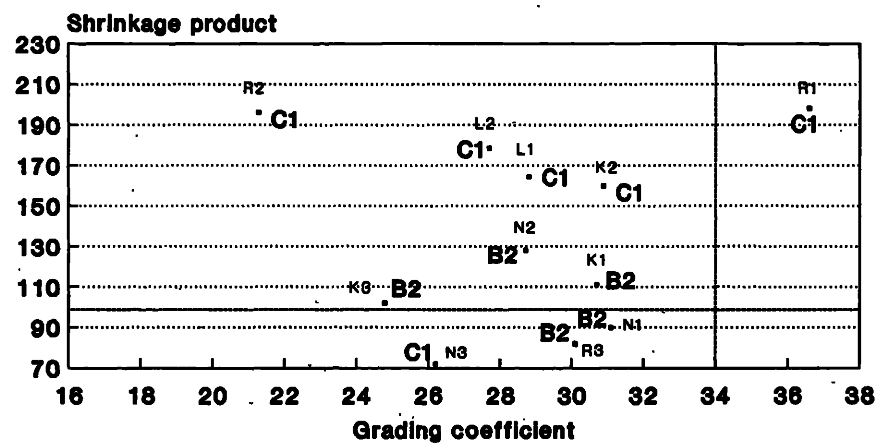
| MATERIAL PROPERTY VARIATION WITH FUNCTIONAL PERFORMANCE RANKING FOR DUSTINESS DEFECT | | | | | | |
|---|---|---|---|---|---|---|
| **PERFORMANCE RANKING** | **DR** | **LL** | **PI** | **PL** | **GC** | **SP** |
| B2 | 0.4 | 21.0 | 4.0 | 17.0 | 30.1 | 82.0 |
| B2 | 0.4 | 17.0 | 5.0 | 12.0 | 31.1 | 90.0 |
| B2 | 0.4 | 18.0 | 4.0 | 14.0 | 24.8 | 102.0 |
| B2 | 0.5 | 24.0 | 8.0 | 16.0 | 28.7 | 128.0 |
| Average | *(0.4)* | *(20.0)* | *(5.3)* | *(14.8)* | *(28.7)* | *(100.5)* |
| C1 | 0.6 | 24.0 | 8.0 | 16.0 | 30.9 | 160.0 |
| C1 | 0.5 | 21.0 | 6.0 | 15.0 | 30.7 | 111.0 |
| C1 | 0.6 | 23.0 | 8.0 | 15.0 | 21.3 | 196.0 |
| C1 | 0.6 | 24.0 | 10.0 | 14.0 | 36.3 | 198.0 |
| Average | *(0.6)* | *(23.0)* | *(8.0)* | *(15.0)* | *(29.8)* | *(166.3)* |
| C2 | 0.4 | 22.0 | 5.0 | 17.0 | 26.2 | 72.0 |
| C2 | 0.6 | 23.0 | 7.0 | 16.0 | 28.8 | 164.5 |
| C2 | 0.5 | 22.0 | 7.0 | 15.0 | 27.7 | 178.5 |
| Average | *(0.5)* | *(22.3)* | *(6.3)* | *(16.0)* | *(27.6)* | *(138.3)* |

| MATERIAL PROPERTY VARIATION WITH FUNCTIONAL PERFORMANCE RANKING FOR LOOSE STONINESS DEFECT | | | | | | |
|---|---|---|---|---|---|---|
| **PERFORMANCE RANKING** | **DR** | **LL** | **PI** | **PL** | **GC** | **SP** |
| A | 0.4 | 21.0 | 4.0 | 17.0 | 30.1 | 82.0 |
| A | 0.4 | 17.0 | 5.0 | 12.0 | 31.1 | 90.0 |
| Average | *(0.4)* | *(19.0)* | *(4.5)* | *(14.5)* | *(30.6)* | *(86.0)* |
| B1 | 0.5 | 21.0 | 6.0 | 15.0 | 30.7 | 111.0 |
| B1 | 0.5 | 24.0 | 8.0 | 16.0 | 28.7 | 128.0 |
| B1 | 0.6 | 23.0 | 7.0 | 16.0 | 28.8 | 164.5 |
| B1 | 0.6 | 24.0 | 10.0 | 14.0 | 36.3 | 198.0 |
| B1 | 0.4 | 18.0 | 4.0 | 14.0 | 24.8 | 102.0 |
| Average | *(0.5)* | *(22.0)* | *(7.0)* | *(15.0)* | *(29.9)* | *(140.7)* |
| B2 | 0.6 | 24.0 | 8.0 | 16.0 | 30.9 | 160.0 |
| B2 | 0.4 | 22.0 | 5.0 | 17.0 | 26.2 | 72.0 |
| B2 | 0.6 | 23.0 | 8.0 | 15.0 | 21.3 | 196.0 |
| Average | *(0.5)* | *(23.0)* | *(7.0)* | *(16.0)* | *(26.2)* | *(142.7)* |
| C1 | 0.5 | 22.0 | 7.0 | 15.0 | 27.7 | 178.5 |
| Average | *(0.5)* | *(22.0)* | *(7.0)* | *(15.0)* | *(27.7)* | *(178.5)* |

| MATERIAL PROPERTY VARIATION WITH FUNCTIONAL PERFORMANCE RANKING FOR WET SKID RESISTANCE DEFECT | | | | | | |
|---|---|---|---|---|---|---|
| **PERFORMANCE RANKING** | **DR** | **LL** | **PI** | **PL** | **GC** | **SP** |
| B2 | 0.4 | 21.0 | 4.0 | 17.0 | 30.1 | 82.0 |
| B2 | 0.4 | 17.0 | 5.0 | 12.0 | 31.1 | 90.0 |
| B2 | 0.4 | 18.0 | 4.0 | 14.0 | 24.8 | 102.0 |
| B2 | 0.5 | 22.0 | 7.0 | 15.0 | 27.7 | 178.5 |
| B2 | 0.4 | 22.0 | 5.0 | 17.0 | 26.2 | 72.0 |
| B2 | 0.6 | 23.0 | 7.0 | 16.0 | 28.8 | 164.5 |
| B2 | 0.6 | 23.0 | 8.0 | 15.0 | 21.3 | 196.0 |
| B2 | 0.6 | 24.0 | 10.0 | 14.0 | 36.3 | 198.0 |
| Average | *(0.5)* | *(21.3)* | *(6.3)* | *(15.0)* | *(28.3)* | *(135.4)* |
| C1 | 0.5 | 24.0 | 8.0 | 16.0 | 28.7 | 128.0 |
| C1 | 0.5 | 21.0 | 6.0 | 15.0 | 30.7 | 111.0 |
| Average | *(0.5)* | *(22.5)* | *(7.0)* | *(15.5)* | *(29.7)* | *(119.5)* |
| C2 | 0.6 | 24.0 | 8.0 | 16.0 | 30.9 | 160.0 |
| Average | *(0.6)* | *(24.0)* | *(8.0)* | *(16.0)* | *(30.9)* | *(160.0)* |

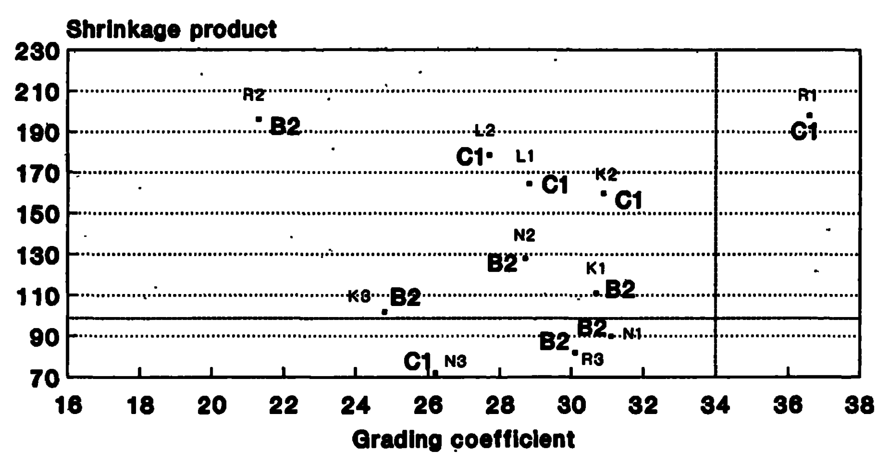
| MATERIAL PROPERTY VARIATION WITH FUNCTIONAL PERFORMANCE RANKING FOR DRY SKID RESISTANCE DEFECT | | | | | | |
|---|---|---|---|---|---|---|
| **PERFORMANCE RANKING** | **DR** | **LL** | **PI** | **PL** | **GC** | **SP** |
| B2 | 0.4 | 21.0 | 4.0 | 17.0 | 30.1 | 82.0 |
| B2 | 0.4 | 17.0 | 5.0 | 12.0 | 31.1 | 90.0 |
| B2 | 0.5 | 21.0 | 6.0 | 15.0 | 30.7 | 111.0 |
| B2 | 0.4 | 18.0 | 4.0 | 14.0 | 24.8 | 102.0 |
| B2 | 0.5 | 22.0 | 7.0 | 15.0 | 27.7 | 178.5 |
| B2 | 0.6 | 23.0 | 7.0 | 16.0 | 28.8 | 164.5 |
| B2 | 0.6 | 23.0 | 8.0 | 15.0 | 21.3 | 196.0 |
| B2 | 0.5 | 24.0 | 8.0 | 16.0 | 28.7 | 128.0 |
| Average | *(0.5)* | *(21.1)* | *(6.1)* | *(15.0)* | *(27.9)* | *(131.5)* |
| C1 | 0.6 | 24.0 | 8.0 | 16.0 | 30.9 | 160.0 |
| C1 | 0.4 | 22.0 | 5.0 | 17.0 | 26.2 | 72.0 |
| C1 | 0.6 | 24.0 | 10.0 | 14.0 | 36.3 | 198.0 |
| Average | *(0.5)* | *(23.3)* | *(7.7)* | *(15.7)* | *(31.1)* | *(143.3)* |

**Overall Functional Performance Classification**
**in terms of TRH20 selection guidelines**
For all mine sites (including defect weights)

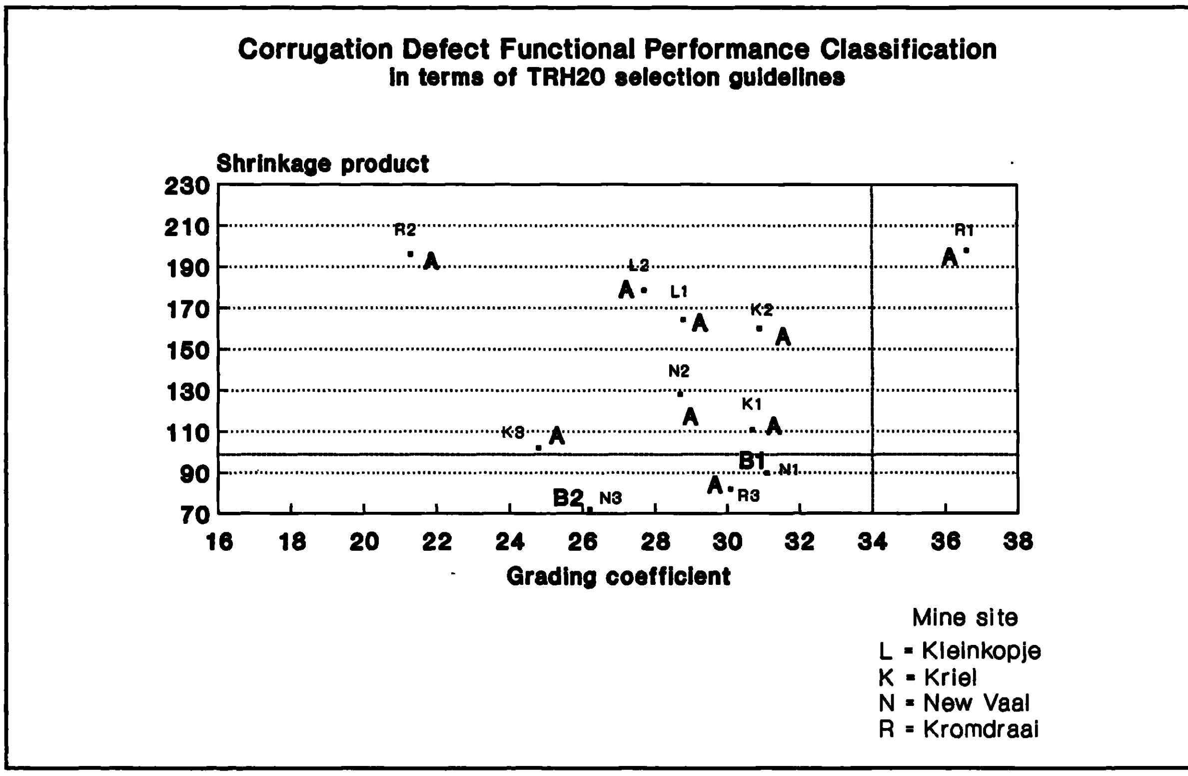


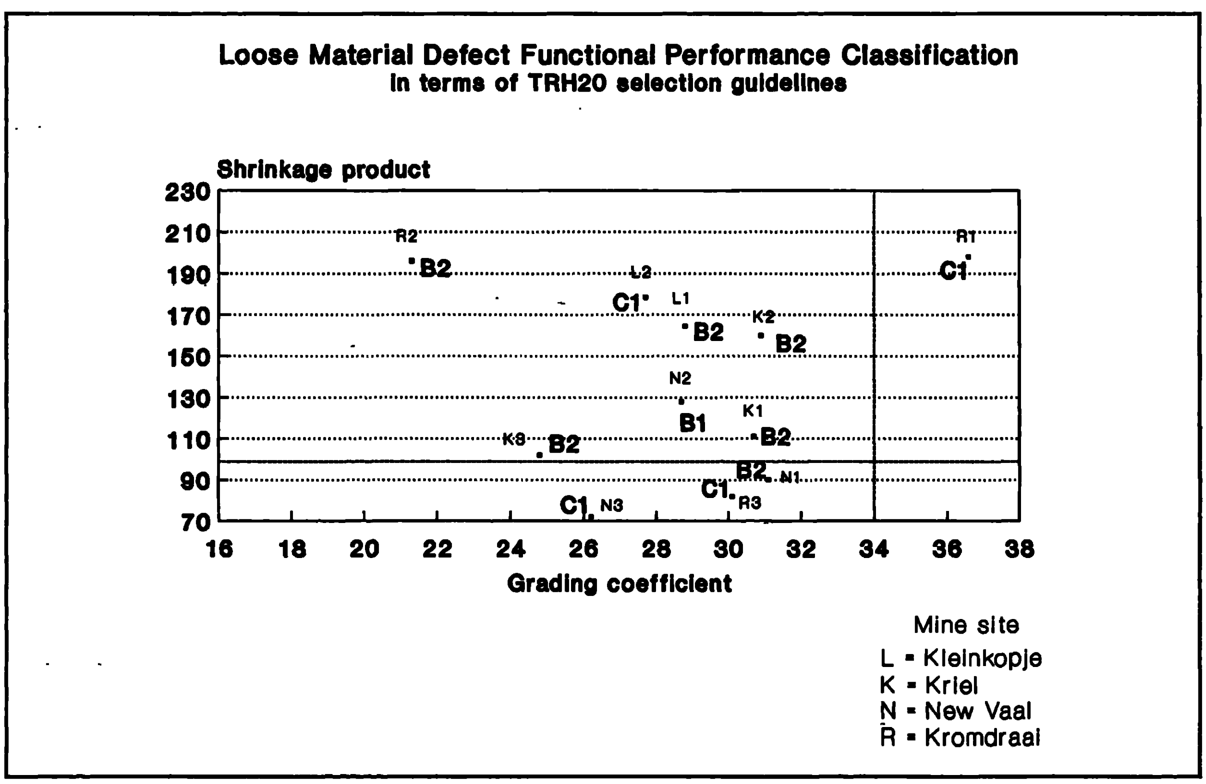

Mine site
L - Kleinkopje
K - Kriel
N - New Vaal
R - Kromdraai

**Overall Functional Performance Classification**
**in terms of TRH20 selection guidelines**
For all mine sites (excluding defect weights)

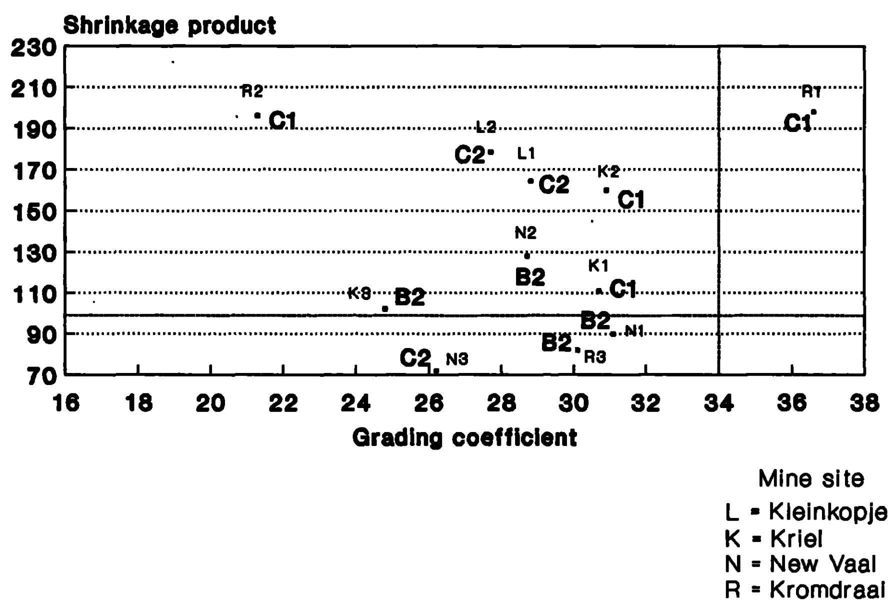



Mine site
L - Kleinkopje
K - Kriel
N - New Vaal
R - Kromdraai

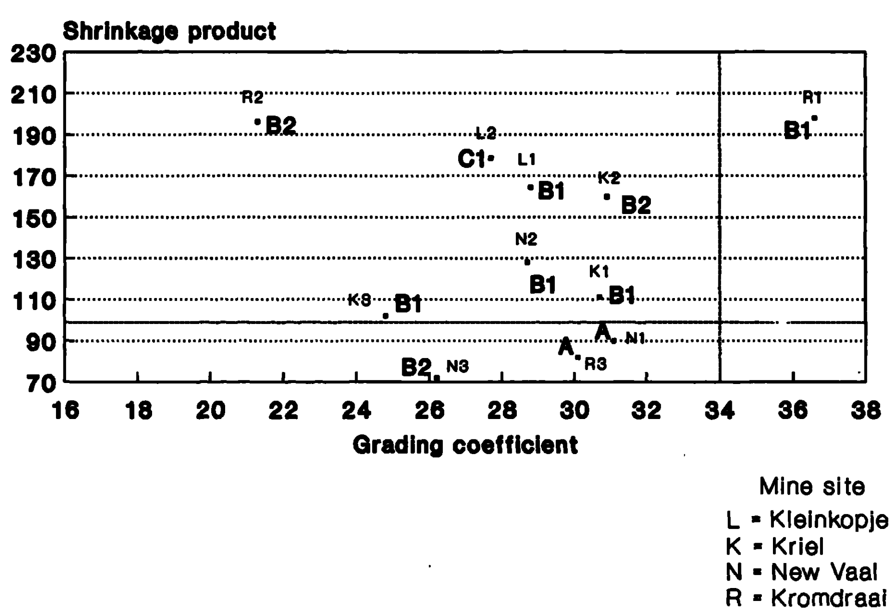

Corrugation Defect Functional Performance Classification
In terms of TRH20 selection guidelines
Shrinkage product
230
210
190
170
150
130
110
90
70
16
18
20
22
24
26
28
30
32
34
36
38
Grading coefficient
R2
R1
L2
L1
K2
N2
K1
K3
N1
B1
B2
N3
R3
A
Mine site
L = Kleinkopje
K = Kriel
N = New Vaal
R = Kromdraai


Loose Material Defect Functional Performance Classification
In terms of TRH20 selection guidelines
Shrinkage product
230
210
190
170
150
130
110
90
70
16
18
20
22
24
26
28
30
32
34
36
38
Grading coefficient
R2
R1
L2
L1
K2
N2
K1
K3
N1
N3
R3
B1
B2
C1
Mine site
L = Kleinkopje
K = Kriel
N = New Vaal
R = Kromdraai

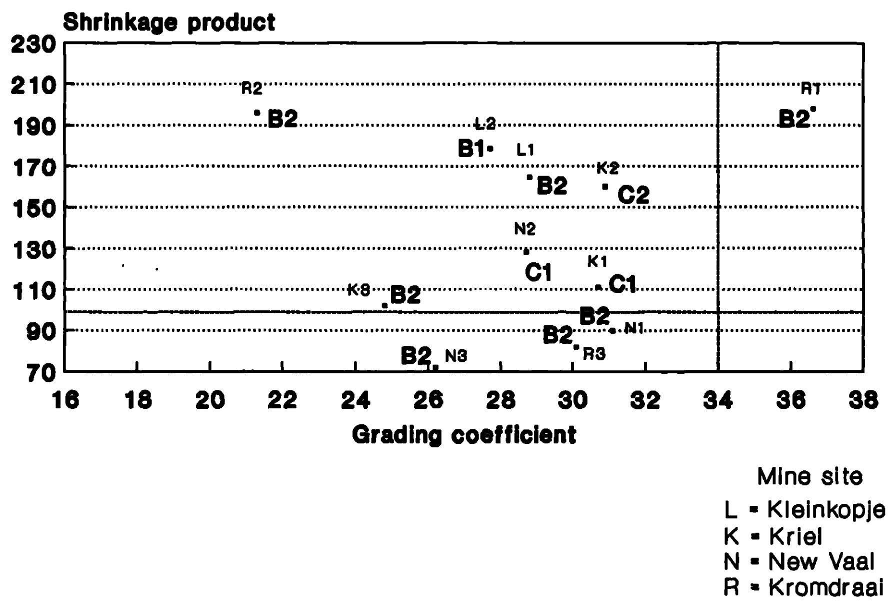
**Dustiness Defect Functional Performance Classification**
**in terms of TRH20 selection guidelines**



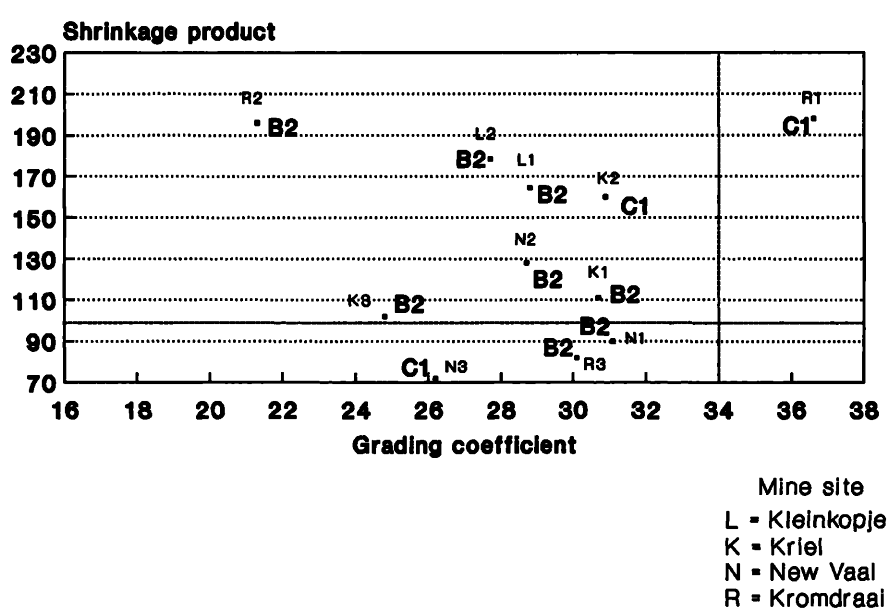

**Loose Stoniness Defect Functional Performance Classification**
**in terms of TRH20 selection guidelines**



**Wet Skid Resistance Defect Functional Performance**
**Classification in terms of TRH20 selection guidelines**




**Dry Skid Resistance Defect Functional Performance**
**Classification in terms of TRH20 selection guidelines**



# APPENDIX J1

## RESULTS OF HAUL ROAD IRI ROUGHNESS EVALUATION
## KRIEL COLLIERY

**——ProRough-31(R)——**

**IRI (RARS_80) from profile elevations.**

**Input File : KL-11-LI.L_R**

**Route description : KRIEL Road 11 (Loaded inner)**

**File creation date : 1995/12/11**

**Profile interval (mm) : 246.55**

**Wheeltrack : INNER**

**Start at km : 1.698**

**Measuring direction : NEGATIVE (-)**

**Correlation equation : IRI(final)=1.018*IRI(calc)+0.234**

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | Max l | Max ul |
| 0.1 | 2.83 | 3.92 | 6.86 | 10 | 10.00 | 3.92 | 10.00 |
| 0.2 | 2.57 | 3.44 | 3.41 | 4.35 | 4.35 | 3.44 | 4.35 |
| 0.3 | 2.05 | 3 | 2.48 | 8.77 | 8.77 | 3.00 | 8.77 |
| 0.4 | 6.02 | 5.84 | 2.31 | 9.08 | 9.08 | 6.02 | 9.08 |
| 0.5 | 8.8 | 7.98 | 4 | 3.97 | 8.80 | 8.80 | 4.00 |
| 0.6 | 4.22 | 10.38 | | | 10.38 | 10.38 | ERR |
| 0.7 | 4.82 | 8.47 | 4.4 | 7.55 | 8.47 | 8.47 | 7.55 |
| 0.8 | | | 4.9 | 7.78 | 7.78 | ERR | 7.78 |
| 0.9 | 4.49 | 6.39 | | | 6.39 | 6.39 | ERR |
| 1 | 7.63 | 8.35 | 7.77 | 8.44 | 8.44 | 8.35 | 8.44 |
| 1.1 | | | 4.92 | 9.18 | 9.18 | ERR | 9.18 |
| 1.2 | | 6.84 | | | 6.84 | 6.84 | ERR |
| 1.3 | 3.76 | 3.7 | | 6.53 | 6.53 | 3.76 | 6.53 |
| 1.4 | 8.87 | 8.18 | 11.12 | 6.67 | 11.12 | 8.87 | 11.12 |
| 1.5 | | 9.57 | 4.25 | 6.3 | 9.57 | 9.57 | 6.30 |
| 1.6 | | 11.73 | 7.31 | 8.3 | 11.73 | 11.73 | 8.30 |

J1-3

——————ProRough-31(R)——————

IRI (RARS_80) from profile elevations

Input File : KL-6-LI.L_R

Route description : KRIEL Road 6 (Loaded inner)

File creation date : 1995/12/11

Profile interval (mm) : 246.55

Wheeltrack : INNER

Start at km : 1.849

Measuring direction : NEGATIVE (-)

Correlation equation : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | Max l | Max ul |
| 0.1 | 5.91 | 3.95 | 8.99 | | 8.99 | 5.91 | 8.99 |
| 0.2 | 5.28 | 8.57 | 7.65 | 5.6 | 8.57 | 8.57 | 7.65 |
| 0.3 | 7.24 | 6.45 | 11.21 | 4.97 | 11.21 | 7.24 | 11.21 |
| 0.4 | 4.81 | 9.75 | 9.98 | 8.07 | 9.98 | 9.75 | 9.98 |
| 0.5 | 3.89 | 3.77 | 4.02 | 4.48 | 4.48 | 3.89 | 4.48 |
| 0.6 | 4.64 | 5.62 | 3.93 | 4.9 | 5.62 | 5.62 | 4.90 |
| 0.7 | 6.79 | 9.47 | 5.43 | 7.38 | 9.47 | 9.47 | 7.38 |
| 0.8 | 9 | | 6.48 | | 9.00 | 9.00 | 6.48 |
| 0.9 | 5.38 | 6.64 | | | 6.64 | 6.64 | ERR |
| 1 | 2.98 | 5.72 | | 6.85 | 6.85 | 5.72 | 6.85 |
| 1.1 | 3.08 | 6.33 | 6.07 | 4.33 | 6.33 | 6.33 | 6.07 |
| 1.2 | 3.44 | 10.1 | 3.28 | 7.61 | 10.10 | 10.10 | 7.61 |
| 1.3 | 4.69 | 9.43 | 3.61 | 5.78 | 9.43 | 9.43 | 5.78 |
| 1.4 | 7.4 | | 4.77 | 4.61 | 7.40 | 7.40 | 4.77 |
| 1.5 | 7.75 | | | 7.05 | 7.75 | 7.75 | 7.05 |
| 1.6 | 6.64 | 8.62 | 6.52 | | 8.62 | 8.62 | 6.52 |
| 1.7 | 3.62 | 9.2 | 5.04 | 9.05 | 9.20 | 9.20 | 9.05 |
| 1.8 | | 10.62 | 3.92 | 6.41 | 10.62 | 10.62 | 6.41 |

J1-4

**ProRough-31(R)**

**IRI (RARS_80) from profile elevations**

**Input File** : **KL-MH-UO.L_R**

**Route description** : **KRIEL Road 7 (Loaded inner)**

**File creation date** : **1995/12/11**

**Profile interval (mm)** : **246.55**

**Wheeltrack** : **INNER**

**Start at km** : **1.600**

**Measuring direction** : **NEGATIVE (-)**

**Correlation equation** : **IRI(final)=1.018*IRI(calc)+0.234**

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | Max I | Max ul |
| 0.1 | 2.9 | 2.88 | | | 2.90 | 2.90 | ERR |
| 0.2 | 4.72 | 3.31 | 2.79 | 2.78 | 4.72 | 4.72 | 2.79 |
| 0.3 | 4.16 | 3.7 | 3.49 | 4.27 | 4.27 | 4.16 | 4.27 |
| 0.4 | 3.33 | | 5.76 | | 5.76 | 3.33 | 5.76 |
| 0.5 | 2.68 | 3.88 | 5.11 | 4.49 | 5.11 | 3.88 | 5.11 |
| 0.6 | 3.5 | 4.2 | 2.79 | 3.72 | 4.20 | 4.20 | 3.72 |
| 0.7 | 2.67 | 9.75 | 3.3 | 4.88 | 9.75 | 9.75 | 4.88 |
| 0.8 | 3.34 | 4.9 | 6.5 | 11.05 | 11.05 | 4.90 | 11.05 |
| 0.9 | 3.26 | | 3.86 | | 3.86 | 3.26 | 3.86 |
| 1 | 4.68 | 12.55 | | 8.03 | 12.55 | 12.55 | 8.03 |
| 1.1 | 2.83 | | | | 2.83 | 2.83 | ERR |
| 1.2 | 5.18 | | | | 5.18 | 5.18 | ERR |
| 1.3 | 5.8 | | | | 5.80 | 5.80 | ERR |
| 1.4 | 6.5 | 5.2 | 5.83 | 7.6 | 7.60 | 6.50 | 7.60 |
| 1.5 | 7.63 | 5.4 | 6.35 | 11.21 | 11.21 | 7.63 | 11.21 |

**————ProRough-31(R)————**

**IRI (RARS_80) from profile elevations**

**Input File** : KL-MH-LI.L_R

**Route description** : KRIEL - Main Haul (Loaded Inner)

**File creation date** : 1995/12/11

**Profile interval (mm)** : 246.55

**Wheeltrack** : INNER

**Start at km** : 4.592

**Measuring direction** : NEGATIVE (-)

**Correlation equation** : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | Max l | Max ul |
| 0.1 | 6.24 | 5.41 | 5.25 | 7.78 | 7.78 | 6.24 | 7.78 |
| 0.2 | 5.07 | 4 | 5.42 | 5.02 | 5.42 | 5.07 | 5.42 |
| 0.3 | 3.26 | 4.93 | 4.39 | 4.07 | 4.93 | 4.93 | 4.39 |
| 0.4 | | 6.62 | 6.08 | 4.56 | 6.62 | 6.62 | 6.08 |
| 0.5 | 4.38 | 4.36 | 5.08 | 2.59 | 5.08 | 4.38 | 5.08 |
| 0.6 | 5.94 | 3.54 | | 4.89 | 5.94 | 5.94 | 4.89 |
| 0.7 | 4.77 | 3.69 | 5.57 | 3.23 | 5.57 | 4.77 | 5.57 |
| 0.8 | 6.34 | 6.73 | 4.78 | 3.67 | 6.73 | 6.73 | 4.78 |
| 0.9 | 4.17 | 3.63 | 4.1 | 3.19 | 4.17 | 4.17 | 4.10 |
| 1 | 3.59 | 3.18 | 4.73 | 3.6 | 4.73 | 3.59 | 4.73 |
| 1.1 | 4.58 | 4.19 | 4.23 | 3.69 | 4.58 | 4.58 | 4.23 |
| 1.2 | 3.87 | 5.07 | 2.67 | 2.2 | 5.07 | 5.07 | 2.67 |
| 1.3 | 4.93 | 4.53 | 2.34 | 2.58 | 4.93 | 4.93 | 2.58 |
| 1.4 | 5 | 3.44 | 6.58 | 2.6 | 6.58 | 5.00 | 6.58 |
| 1.5 | 5.29 | 4.47 | 4.07 | 2.05 | 5.29 | 5.29 | 4.07 |
| 1.6 | 4.45 | 4.32 | 2.91 | 2.36 | 4.45 | 4.45 | 2.91 |
| 1.7 | 4.95 | 4.46 | 2.3 | 2.65 | 4.95 | 4.95 | 2.65 |
| 1.8 | 10.92 | 5.63 | 2.65 | 2.59 | 10.92 | 10.92 | 2.65 |
| 1.9 | | 6.65 | 3.03 | 2.3 | 6.65 | 6.65 | 3.03 |
| 2 | 6.86 | 5.97 | 5.5 | 2.11 | 6.86 | 6.86 | 5.50 |
| 2.1 | 6.18 | 6.41 | 5.12 | 2.63 | 6.41 | 6.41 | 5.12 |
| 2.2 | 5.15 | 4.62 | 2.96 | 3.1 | 5.15 | 5.15 | 3.10 |
| 2.3 | 4.32 | 5.3 | 3.27 | 2.9 | 5.30 | 5.30 | 3.27 |

# J1-6

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.4 | 3.32 | 4.22 | 4.51 | 2.84 | 4.51 | 4.22 | 4.51 |
| 2.5 | 3.86 | 3.85 | 3.4 | 3.2 | 3.86 | 3.86 | 3.40 |
| 2.6 | 4.01 | 4.75 | 4.32 | 3.12 | 4.75 | 4.75 | 4.32 |
| 2.7 | | 6.12 | 6.26 | 3.65 | 6.26 | 6.12 | 6.26 |
| 2.8 | 7.07 | 4.74 | 6.62 | 3.96 | 7.07 | 7.07 | 6.62 |
| 2.9 | 4.26 | 3.73 | 3.83 | 2.62 | 4.26 | 4.26 | 3.83 |
| 3 | 4.19 | 5.62 | 3.65 | 3.4 | 5.62 | 5.62 | 3.65 |
| 3.1 | 3.45 | 3.35 | 3.71 | 4.16 | 4.16 | 3.45 | 4.16 |
| 3.2 | 3.62 | 5.91 | 3 | 3.16 | 5.91 | 5.91 | 3.16 |
| 3.3 | 9.11 | 9.97 | 3.37 | 3.75 | 9.97 | 9.97 | 3.75 |
| 3.4 | 5.4 | 10.36 | 5.23 | 3.43 | 10.36 | 10.36 | 5.23 |
| 3.5 | 4.49 | 10.01 | 4.73 | 2.86 | 10.01 | 10.01 | 4.73 |
| 3.6 | 4.03 | 7.31 | 4.53 | 5.98 | 7.31 | 7.31 | 5.98 |
| 3.7 | 6.12 | 10.14 | 4.78 | 4.06 | 10.14 | 10.14 | 4.78 |
| 3.8 | 5.32 | 6.15 | 5.53 | 3.53 | 6.15 | 6.15 | 5.53 |
| 3.9 | 5.09 | 5.17 | 3.26 | 3.66 | 5.17 | 5.17 | 3.66 |
| 4 | 4.8 | 6.56 | 4.34 | 2.87 | 6.56 | 6.56 | 4.34 |
| 4.1 | 6.65 | | 5.72 | 3.02 | 6.65 | 6.65 | 5.72 |
| 4.2 | 8.17 | 4.69 | 2.83 | 2.9 | 8.17 | 8.17 | 2.90 |
| 4.3 | 6.43 | 6.12 | 2.7 | 2.42 | 6.43 | 6.43 | 2.70 |
| 4.4 | | | 4.33 | 3.88 | 4.33 | ERR | 4.33 |
| 4.5 | 5.3 | 7.66 | | | 7.66 | 7.66 | ERR |

J2-1

# APPENDIX J2

## RESULTS OF HAUL ROAD IRI ROUGHNESS EVALUATION
## KROMDRAAI COLLIERY

J2-2

**————ProRough-31(R)————**

**IRI (RARS_80) from profile elevations**

**Input File : KD-H2-LI.L_R**

**Route description : KROMDRAAI Haul 2 (Loaded inner)**

**File creation date : 1995/12/08**

**Profile interval (mm) : 246.55**

**Wheeltrack : INNER**

**Start at km : 0.000**

**Measuring direction : POSITIVE (+)**

**Correlation equation : IRI(final)=1.018*IRI(calc)+0.234**

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max iri | maxl | max ul |
| 0.1 | 3.65 | 4.66 | 6.27 | 5.25 | 6.27 | 4.66 | 6.27 |
| 0.2 | 3.13 | 5.41 | 7.81 | 7.8 | 7.81 | 5.41 | 7.81 |
| 0.3 | 4.31 | 7.58 | 5.99 | 3.18 | 7.58 | 7.58 | 5.99 |
| 0.4 | 3.61 | 5.65 | 7.34 | 4.09 | 7.34 | 5.65 | 7.34 |
| 0.5 | 4.15 | 4.44 | 6.78 | 6.74 | 6.78 | 4.44 | 6.78 |
| 0.6 | 5.09 | 5.05 | 4.28 | 4.74 | 5.09 | 5.09 | 4.74 |
| 0.7 | 8.7 | 3.67 | 2.98 | 4.31 | 8.70 | 8.70 | 4.31 |
| 0.8 | 4.11 | 3.84 | 4.66 | 5.26 | 5.26 | 4.11 | 5.26 |
| 0.9 | 7.76 | 3.75 | 2.95 | 3.77 | 7.76 | 7.76 | 3.77 |
| 1 | 3.91 | 3.92 | 4.56 | 8.29 | 8.29 | 3.92 | 8.29 |
| 1.1 | 3.49 | 3.37 | 6.85 | 5.58 | 6.85 | 3.49 | 6.85 |
| 1.2 | 5.41 | 3.12 | 5.25 | 7.07 | 7.07 | 5.41 | 7.07 |
| 1.3 | 3.44 | 2.9 | 5.24 | 7.07 | 7.07 | 3.44 | 7.07 |
| 1.4 | 5.19 | 3.35 | 4.12 | 3.57 | 5.19 | 5.19 | 4.12 |
| 1.5 | 7.17 | 2.79 | 3.19 | 3.84 | 7.17 | 7.17 | 3.84 |
| 1.6 | 3.21 | 2.77 | 3.7 | 2.22 | 3.70 | 3.21 | 3.70 |
| 1.7 | 5.21 | 3.74 | 3.08 | 2.8 | 5.21 | 5.21 | 3.08 |
| 1.8 | 4.71 | 4.63 | 3.29 | 2.46 | 4.71 | 4.71 | 3.29 |
| 1.9 | 3.75 | 2.96 | 3.25 | 3.16 | 3.75 | 3.75 | 3.25 |
| 2 | 3.96 | 2.98 | 3.04 | 3.59 | 3.96 | 3.96 | 3.59 |
| 2.1 | 4.5 | 4.12 | 3.77 | 2.23 | 4.50 | 4.50 | 3.77 |
| 2.2 | 4.63 | 4.01 | 3.94 | 3.05 | 4.63 | 4.63 | 3.94 |
| 2.3 | 4.29 | 3.88 | 7.95 | 5.01 | 7.95 | 4.29 | 7.95 |
| 2.4 | 3.67 | 4.8 | 5.04 | 4.23 | 5.04 | 4.80 | 5.04 |

**———ProRough-31(R)———**

**IRI (RARS_80) from profile elevations**

**Input File** : KD-H1-LI.L_R

**Route description** : KROMDRAAI - Haul 1 (Loaded inner)

**File creation date** : 1995/12/08

**Profile interval (mm)** : 246.55

**Wheeltrack** : INNER

**Start at km** : 1.534

**Measuring direction** : NEGATIVE (-)

**Correlation equation** : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | max iri | maxl | max ul |
| 0.1 | 3.18 | 3.57 | 4.07 | 3.57 | 4.07 | 3.57 | 4.07 |
| 0.2 | 2.43 | 2.43 | 3.64 | 3.93 | 3.93 | 2.43 | 3.93 |
| 0.3 | 3.21 | 2.94 | 4.03 | 3.93 | 4.03 | 3.21 | 4.03 |
| 0.4 | 2.89 | 2.6 | 4.15 | 4.75 | 4.75 | 2.89 | 4.75 |
| 0.5 | 2.95 | 3.38 | 3.07 | 4.81 | 4.81 | 3.38 | 4.81 |
| 0.6 | 3.31 | 2.99 | 3.03 | 5.18 | 5.18 | 3.31 | 5.18 |
| 0.7 | 2.76 | 2.77 | 2.96 | 3.22 | 3.22 | 2.77 | 3.22 |
| 0.8 | 3.34 | 3.04 | 2.69 | 2.42 | 3.34 | 3.34 | 2.69 |
| 0.9 | 4.5 | 4.29 | 3.62 | 3.47 | 4.50 | 4.50 | 3.62 |
| 1 | 4.06 | 4.67 | 3.97 | 4.26 | 4.67 | 4.67 | 4.26 |
| 1.1 | 5.21 | 4.23 | 4.06 | 3.62 | 5.21 | 5.21 | 4.06 |
| 1.2 | 5.23 | 4.19 | 4.83 | 3.68 | 5.23 | 5.23 | 4.83 |
| 1.3 | 4.58 | 3.39 | 3.14 | 4.15 | 4.58 | 4.58 | 4.15 |
| 1.4 | 5.69 | 6.61 | 4.58 | 4.32 | 6.61 | 6.61 | 4.58 |
| 1.5 | 6.82 | 5.97 | 4.08 | 4.65 | 6.82 | 6.82 | 4.65 |

J2-4

**———ProRough-31(R)———**

**IRI (RARS_80) from profile elevations**

**Input File : KD-MH-LI.L_R**

**Route description : KROMDRAAI - Main haul (Loaded inner)**

**File creation date : 1995/12/08**

**Profile interval (mm) : 246.55**

**Wheeltrack : INNER**

**Start at km : 0.900**

**Measuring direction : NEGATIVE (-)**

**Correlation equation : IRI(final)=1.018*IRI(calc)+0.234**

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max iri | maxl | max ul |
| 0.1 | 5.64 | 5.09 | 7.04 | 8.06 | 8.06 | 5.64 | 8.06 |
| 0.2 | 4.47 | 6.62 | 3.86 | 5.76 | 6.62 | 6.62 | 5.76 |
| 0.3 | 4.26 | 7.24 | 4.61 | 8.27 | 8.27 | 7.24 | 8.27 |
| 0.4 | 3.56 | 7.09 | 3.77 | 3.86 | 7.09 | 7.09 | 3.86 |
| 0.5 | 4.63 | 3.94 | 2.95 | 3.29 | 4.63 | 4.63 | 3.29 |
| 0.6 | 5.16 | 4.8 | 4.1 | 3.77 | 5.16 | 5.16 | 4.10 |
| 0.7 | 4.12 | 6.07 | 3.97 | 3.83 | 6.07 | 6.07 | 3.97 |
| 0.8 | 4.6 | 4.67 | 2.42 | 2.75 | 4.67 | 4.67 | 2.75 |

**APPENDIX J3**

**<u>RESULTS OF HAUL ROAD IRI ROUGHNESS EVALUATION</u>**

**<u>NEW VAAL COLLIERY</u>**

J3-2

**———ProRough-31(R)———**

**IRI (RARS_80) from profile elevations**

**Input File** : NV-MH-LI.L_R

**Route description** : NEW VAAL - Main Haul (Loaded inner)

**File creation date** : 1995/12/08

**Profile interval (mm)** : 246.55

**Wheeltrack** : INNER

**Start at km** : 5.238

**Measuring direction** : NEGATIVE (-)

**Correlation equation** : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | max l | max r |
| 0.1 | 4.04 | 3.8 | 3.66 | 6.67 | 6.67 | 4.04 | 6.67 |
| 0.2 | 5.91 | 7.12 | 2.78 | 6.09 | 7.12 | 7.12 | 6.09 |
| 0.3 | 3.24 | 4.76 | 2.63 | 4.21 | 4.76 | 4.76 | 4.21 |
| 0.4 | 2.77 | 3.53 | 1.89 | 5.07 | 5.07 | 3.53 | 5.07 |
| 0.5 | 4.33 | 4.27 | 3.5 | 3.58 | 4.33 | 4.33 | 3.58 |
| 0.6 | 4.67 | 4.49 | 2.75 | 4.37 | 4.67 | 4.67 | 4.37 |
| 0.7 | 3.63 | 4.23 | 3.23 | 4.35 | 4.35 | 4.23 | 4.35 |
| 0.8 | 4.01 | 4.18 | 3.06 | 4.28 | 4.28 | 4.18 | 4.28 |
| 0.9 | 3.1 | 3.45 | 2.67 | 4.37 | 4.37 | 3.45 | 4.37 |
| 1 | 3.08 | 3.54 | 3.53 | 4.84 | 4.84 | 3.54 | 4.84 |
| 1.1 | 3.79 | 4.12 | 3.15 | 4.34 | 4.34 | 4.12 | 4.34 |
| 1.2 | 3.23 | 3.71 | 3.43 | 4.06 | 4.06 | 3.71 | 4.06 |
| 1.3 | 3.5 | 3.92 | 4.02 | 4.39 | 4.39 | 3.92 | 4.39 |
| 1.4 | 3.81 | 4.12 | 3.55 | 3 | 4.12 | 4.12 | 3.55 |
| 1.5 | 3.11 | 4.82 | 5.04 | 3 | 5.04 | 4.82 | 5.04 |
| 1.6 | 3.86 | 3.38 | 4.58 | 3.27 | 4.58 | 3.86 | 4.58 |
| 1.7 | 6.68 | 7 | 4.04 | 4.08 | 7.00 | 7.00 | 4.08 |
| 1.8 | 3.86 | 4.18 | 4.84 | 5.08 | 5.08 | 4.18 | 5.08 |
| 1.9 | 2.11 | 3.25 | 3.96 | 4.17 | 4.17 | 3.25 | 4.17 |
| 2 | 5.09 | 2.97 | 3.03 | 4.2 | 5.09 | 5.09 | 4.20 |
| 2.1 | 5.17 | 5.9 | 2.66 | 4.47 | 5.90 | 5.90 | 4.47 |
| 2.2 | 3.49 | 3.51 | 4.64 | 4.02 | 4.64 | 3.51 | 4.64 |
| 2.3 | 2.77 | 2.9 | 4.39 | 8.27 | 8.27 | 2.90 | 8.27 |
| 2.4 | 2.29 | 3.09 | 2.91 | 3.34 | 3.34 | 3.09 | 3.34 |

J3-3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.5 | 2.74 | 3.21 | 2.79 | 2.83 | 3.21 | 3.21 | 2.83 |
| 2.6 | 2.91 | 3.27 | 3.01 | 2.79 | 3.27 | 3.27 | 3.01 |
| 2.7 | 3.09 | 4.97 | 4.15 | 3.42 | 4.97 | 4.97 | 4.15 |
| 2.8 | 3.31 | 3.64 | 2.73 | 3.49 | 3.64 | 3.64 | 3.49 |
| 2.9 | 3.82 | 5.4 | 3.49 | 3.23 | 5.40 | 5.40 | 3.49 |
| 3 | 3.58 | 6.05 | 3.4 | 3.84 | 6.05 | 6.05 | 3.84 |
| 3.1 | 4.47 | 5.32 | 3.74 | 3.84 | 5.32 | 5.32 | 3.84 |
| 3.2 | 4.04 | 4.04 | 5.07 | 3.28 | 5.07 | 4.04 | 5.07 |
| 3.3 | 3 | 3.41 | 4.2 | 2.93 | 4.20 | 3.41 | 4.20 |
| 3.4 | 3.35 | 3.33 | 4.14 | 2.69 | 4.14 | 3.35 | 4.14 |
| 3.5 | 3.5 | 3.21 | 3.67 | 3.77 | 3.77 | 3.50 | 3.77 |
| 3.6 | 4.35 | 3.03 | 3.3 | 3.61 | 4.35 | 4.35 | 3.61 |
| 3.7 | 4.47 | 3.42 | 3.89 | 3.76 | 4.47 | 4.47 | 3.89 |
| 3.8 | 3.54 | 3.95 | 3.5 | 3.56 | 3.95 | 3.95 | 3.56 |
| 3.9 | 3.1 | 3.15 | 4.25 | 7.04 | 7.04 | 3.15 | 7.04 |
| 4 | 3.43 | 2.85 | 3.56 | 4.72 | 4.72 | 3.43 | 4.72 |
| 4.1 | 2.53 | 3.81 | 2.07 | 3.01 | 3.81 | 3.81 | 3.01 |
| 4.2 | 2.76 | 3 | 2.92 | 5.35 | 5.35 | 3.00 | 5.35 |
| 4.3 | 3.63 | 3.47 | 4.62 | 6.53 | 6.53 | 3.63 | 6.53 |
| 4.4 | 3 | 3.92 | 4.22 | 7.97 | 7.97 | 3.92 | 7.97 |
| 4.5 | 2.73 | 3.57 | 2.35 | 5.36 | 5.36 | 3.57 | 5.36 |
| 4.6 | 3.19 | 3.82 | 1.96 | 5.43 | 5.43 | 3.82 | 5.43 |

J3-4

**——ProRough-31(R)——**

**IRI (RARS_80) from profile elevations**

**Input File : NV-R3-LI.L_R**

**Route description : NEW VAAL - Road 3 (Loaded inner)**

**File creation date : 1995/12/08**

**Profile interval (mm) : 246.55**

**Wheeltrack : INNER**

**Start at km : 0.697**

**Measuring direction : NEGATIVE (-)**

**Correlation equation : IRI(final)=1.018*IRI(calc)+0.234**

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max iri | Max l | Max ul |
| 0.1 | 4.89 | 5.65 | 5.91 | 5.91 | 4.89 | 5.91 | 5.91 |
| 0.2 | 5.36 | 5.42 | 2.3 | 5.42 | 5.36 | 5.42 | 3.86 |
| 0.3 | 4.83 | 7.09 | 3.93 | 7.09 | 4.83 | 7.09 | 5.51 |
| 0.4 | 5.33 | 4.67 | 6.05 | 6.05 | 5.33 | 6.05 | 6.05 |
| 0.5 | 10.53 | 13.07 | 5.96 | 13.07 | 10.53 | 13.07 | 9.52 |
| 0.6 | 10.01 | 11.84 | 7.76 | 11.84 | 10.01 | 11.84 | 9.80 |

J3-5

**——ProRough-31(R)——**

**IRI (RARS_80) from profile elevations**

**Input File** : NV-R5-LI.L_R

**Route description** : NEW VAAL - Road 5 (Loaded inner)

**File creation date** : 1995/12/08

**Profile interval (mm)** : 246.55

**Wheeltrack** : INNER

**Start at km** : 0.746

**Measuring direction** : NEGATIVE (-)

**Correlation equation** : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | max l | max r |
| 0.1 | 3.11 | 4.07 | 3.95 | 4.68 | 4.68 | 4.07 | 4.68 |
| 0.2 | 3.67 | 4.46 | 3.23 | 2.84 | 4.46 | 4.46 | 3.23 |
| 0.3 | 3.45 | 3.16 | 3.25 | 2.86 | 3.45 | 3.45 | 3.25 |
| 0.4 | 3.58 | 3.09 | 3.25 | 3.75 | 3.75 | 3.58 | 3.75 |
| 0.5 | 3.99 | 3.92 | 3.72 | 3.32 | 3.99 | 3.99 | 3.72 |
| 0.6 | 4.24 | 6.37 | 3.25 | 5.18 | 6.37 | 6.37 | 5.18 |
| 0.7 | 2.7 | 3.38 | 4.47 | 3.77 | 4.47 | 3.38 | 4.47 |

# APPENDIX J4

## RESULTS OF HAUL ROAD IRI ROUGHNESS EVALUATION
## KLEINKOPJE COLLIERY

# J4-2

———ProRough-31(R)———

**IRI (RARS_80) from profile elevations**

**Input File** : KK-2A-LI.L_R

**Route description** : KLEINKOPPIE Road 2A (Loaded inner)

**File creation date** : 1995/12/11

**Profile interval (mm)** : 246.55

**Wheeltrack** : INNER

**Start at km** : 2.900

**Measuring direction** : NEGATIVE (-)

**Correlation equation** : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | max l | max ul |
| 0.1 | | 6.76 | | | 6.76 | 6.76 | ERR |
| 0.2 | 5.99 | 5.24 | | 11.02 | 11.02 | 5.99 | 11.02 |
| 0.3 | 4.93 | 4.08 | 3.76 | 5.54 | 5.54 | 4.93 | 5.54 |
| 0.4 | 4.33 | 4.77 | 5.4 | 4.84 | 5.40 | 4.77 | 5.40 |
| 0.5 | 5.64 | 3.3 | 5.04 | 4.18 | 5.64 | 5.64 | 5.04 |
| 0.6 | 3.24 | 4.03 | 5.41 | 4.26 | 5.41 | 4.03 | 5.41 |
| 0.7 | 3.78 | 3.93 | 4.93 | 5.16 | 5.16 | 3.93 | 5.16 |
| 0.8 | 5.11 | 4.69 | 3.91 | 5.57 | 5.57 | 5.11 | 5.57 |
| 0.9 | 3.11 | 3.28 | | 8.06 | 8.06 | 3.28 | 8.06 |
| 1 | 3.56 | 2.7 | 4.92 | 4.3 | 4.92 | 3.56 | 4.92 |
| 1.1 | 3.85 | 3.24 | 4.98 | 2.82 | 4.98 | 3.85 | 4.98 |
| 1.2 | 3.77 | 4.62 | 6.8 | 3.94 | 6.80 | 4.62 | 6.80 |
| 1.3 | 3.61 | 3.59 | 5.36 | 3.01 | 5.36 | 3.61 | 5.36 |
| 1.4 | 2.63 | 2.62 | 3.48 | 4.12 | 4.12 | 2.63 | 4.12 |
| 1.5 | 3.45 | 3.61 | 2.7 | 3.11 | 3.61 | 3.61 | 3.11 |
| 1.6 | 4.66 | 4.6 | 2.18 | 2.95 | 4.66 | 4.66 | 2.95 |
| 1.7 | 4.18 | 3.65 | 3.88 | 4.08 | 4.18 | 4.18 | 4.08 |
| 1.8 | 3.52 | 2.94 | 5.09 | 5.68 | 5.68 | 3.52 | 5.68 |
| 1.9 | 2.91 | 5.35 | 3.02 | 3.28 | 5.35 | 5.35 | 3.28 |
| 2 | 2.25 | 4.51 | 3.25 | 3.11 | 4.51 | 4.51 | 3.25 |
| 2.1 | 3.26 | 3.82 | 3.39 | 2.7 | 3.82 | 3.82 | 3.39 |
| 2.2 | 2.46 | 3.07 | 2.81 | 2.52 | 3.07 | 3.07 | 2.81 |
| 2.3 | 3.7 | 4.13 | 2.55 | 2.59 | 4.13 | 4.13 | 2.59 |

**J4-3**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.4 | 3.45 | 3.46 | 3.77 | 2.96 | 3.77 | 3.46 | 3.77 |
| 2.5 | 5.35 | 5.18 | 3.18 | 2.23 | 5.35 | 5.35 | 3.18 |
| 2.6 | 4.5 | 4.58 | | 5.79 | 5.79 | 4.58 | 5.79 |
| 2.7 | 3.41 | 4.2 | 4.76 | 4.69 | 4.76 | 4.20 | 4.76 |
| 2.8 | 6.27 | 5.19 | 4.11 | 4.03 | 6.27 | 6.27 | 4.11 |

J4-4

———ProRough-31(R)———

**Input File** : KK-3A-LI.L_R

**Route description** : KLEINKOPPIE Road 3A (Loaded inner)

**File creation date** : 1995/12/11

**Profile interval (mm)** : 246.55

**Wheeltrack** : INNER

**Start at km** : 2.600

**Measuring direction** : NEGATIVE (-)

**Correlation equation** : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | max l | max ul |
| 0.1 | 4.28 | 5.04 | 4.51 | 4.15 | 5.04 | 5.04 | 4.51 |
| 0.2 | 4.27 | 3.78 | 3.29 | 3.44 | 4.27 | 4.27 | 3.44 |
| 0.3 | 3.44 | 4.59 | 3.92 | 4.89 | 4.89 | 4.59 | 4.89 |
| 0.4 | 4.03 | 4.77 | 3.31 | 4.59 | 4.77 | 4.77 | 4.59 |
| 0.5 | 3.69 | 4.77 | 4.1 | 3.85 | 4.77 | 4.77 | 4.10 |
| 0.6 | 7.2 | 3.46 | | 6.74 | 7.20 | 7.20 | 6.74 |
| 0.7 | 6.33 | 5.41 | 5.75 | 4.03 | 6.33 | 6.33 | 5.75 |
| 0.8 | 6.09 | 3.77 | 4.72 | 3.94 | 6.09 | 6.09 | 4.72 |
| 0.9 | 3.04 | 3.92 | 6.05 | 3.87 | 6.05 | 3.92 | 6.05 |
| 1 | 4.93 | 3.5 | 4.16 | 2.87 | 4.93 | 4.93 | 4.16 |
| 1.1 | 5.73 | 5.37 | 4.18 | 3.02 | 5.73 | 5.73 | 4.18 |
| 1.2 | 6.5 | 5.09 | 5.63 | 6.45 | 6.50 | 6.50 | 6.45 |
| 1.3 | | 8.82 | 5.52 | 4.81 | 8.82 | 8.82 | 5.52 |
| 1.4 | 6.02 | 5.59 | | | 6.02 | 6.02 | ERR |
| 1.5 | 5.95 | 5.34 | 4.38 | 5.52 | 5.95 | 5.95 | 5.52 |
| 1.6 | 6.8 | 10.3 | 3.96 | 5.44 | 10.30 | 10.30 | 5.44 |
| 1.7 | | 4.62 | 5.95 | 4.58 | 5.95 | 4.62 | 5.95 |
| 1.8 | 4.39 | 6.58 | 4.62 | 6.02 | 6.58 | 6.58 | 6.02 |
| 1.9 | 5.22 | 7.84 | 7.27 | 6.36 | 7.84 | 7.84 | 7.27 |
| 2 | 6.26 | 8.48 | 6.23 | 7.37 | 8.48 | 8.48 | 7.37 |
| 2.1 | 4.8 | 5.97 | 6.69 | 7.29 | 7.29 | 5.97 | 7.29 |
| 2.2 | | 6.64 | 5.25 | 7.24 | 7.24 | 6.64 | 7.24 |
| 2.3 | 4.19 | 4.25 | 5.39 | 6.92 | 6.92 | 4.25 | 6.92 |
| 2.4 | 5.44 | 9 | 5.72 | | 9.00 | 9.00 | 5.72 |
| 2.5 | 3.84 | 4.81 | 6.22 | 8.37 | 8.37 | 4.81 | 8.37 |

J4-5

———ProRough-31(R)———

**IRI (RARS_80) from profile elevations**

**Input File** : KK-5W-LI.L_R

**Route description** : KLEINKOPPIE Road 5W (Loaded inner)

**File creation date** : 1995/12/11

**Profile interval (mm)** : 246.55

**Wheeltrack** : INNER

**Start at km** : 2.842

**Measuring direction** : NEGATIVE (-)

**Correlation equation** : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | max l | max ul |
| 0.1 | 5.01 | 5.92 | 4.74 | 3.6 | 5.92 | 5.92 | 4.74 |
| 0.2 | 5.07 | 6.66 | 4.99 | 6.34 | 6.66 | 6.66 | 6.34 |
| 0.3 | 3.98 | 4.72 | 5.45 | 4.94 | 5.45 | 4.72 | 5.45 |
| 0.4 | 2.73 | 2.92 | 4.48 | 4.38 | 4.48 | 2.92 | 4.48 |
| 0.5 | 2.99 | 4.31 | 3.24 | 3.16 | 4.31 | 4.31 | 3.24 |
| 0.6 | 2.42 | 2.28 | 2.68 | 4.29 | 4.29 | 2.42 | 4.29 |
| 0.7 | 3.12 | 2.22 | 2.42 | 3.75 | 3.75 | 3.12 | 3.75 |
| 0.8 | 3.03 | 3.12 | 3.5 | 3.92 | 3.92 | 3.12 | 3.92 |
| 0.9 | 3.24 | 2.78 | 3.07 | 4.02 | 4.02 | 3.24 | 4.02 |
| 1 | 2.79 | 3.08 | 2.83 | 3.54 | 3.54 | 3.08 | 3.54 |
| 1.1 | 5.24 | 3.77 | 2.33 | 3.06 | 5.24 | 5.24 | 3.06 |
| 1.2 | 3.54 | 4.09 | 3.72 | 3.82 | 4.09 | 4.09 | 3.82 |
| 1.3 | 4.11 | 4.63 | 3.06 | 4.24 | 4.63 | 4.63 | 4.24 |
| 1.4 | 3.45 | 3.1 | 3.38 | 2.69 | 3.45 | 3.45 | 3.38 |
| 1.5 | 3.74 | 4.18 | 3.51 | 2.82 | 4.18 | 4.18 | 3.51 |
| 1.6 | 5.59 | 5.63 | 3.08 | 3.18 | 5.63 | 5.63 | 3.18 |
| 1.7 | 5.72 | 7.76 | 3.1 | 2.57 | 7.76 | 7.76 | 3.10 |
| 1.8 | 3.92 | 5.36 | 3.47 | 2.64 | 5.36 | 5.36 | 3.47 |
| 1.9 | 4.31 | 6.2 | 3.67 | 4.37 | 6.20 | 6.20 | 4.37 |
| 2 | 4.47 | 5.92 | 3.42 | 6.94 | 6.94 | 5.92 | 6.94 |
| 2.1 | 2.78 | 5.59 | 5 | 6.22 | 6.22 | 5.59 | 6.22 |
| 2.2 | 3.01 | 4.67 | 3.09 | 4.11 | 4.67 | 4.67 | 4.11 |
| 2.3 | 4.78 | 4.35 | 2.35 | 4.25 | 4.78 | 4.78 | 4.25 |

J4-6

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.4 | 8.1 | 8.16 | 4.99 | 5.7 | 8.16 | 8.16 | 5.70 |
| 2.5 | | 9.47 | 4.89 | 5.63 | 9.47 | 9.47 | 5.63 |
| 2.6 | 8.11 | 4.75 | | 4.23 | 8.11 | 8.11 | 4.23 |
| 2.7 | | 9.91 | 8.04 | 3.68 | 9.91 | 9.91 | 8.04 |
| 2.8 | 5.29 | 7.08 | 7.92 | 8.5 | 8.50 | 7.08 | 8.50 |

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---------ProRough-31(R)---------

IRI (RARS_80) from profile elevations

**Input File** : KK-14-LI.L_R

**Route description** : KLEINKOPPIE Road 14 (Loaded inner)

**File creation date** : 1995/12/11

**Profile interval (mm)** : 246.55

**Wheeltrack** : INNER

**Start at km** : 2.420

**Measuring direction** : NEGATIVE (-)

**Correlation equation** : IRI(final)=1.018*IRI(calc)+0.234

| km | IRI (100m intervals) | | | | | | |
|---|---|---|---|---|---|---|---|
| | LADEN I | LADEN O | UNLADEN I | UNLADEN O | Max IRI | max l | max ul |
| 0.1 | 4.21 | 7.08 | 5.54 | 4.98 | 7.08 | 7.08 | 5.54 |
| 0.2 | | 6.67 | 5.12 | 5.8 | 6.67 | 6.67 | 5.80 |
| 0.3 | 4.03 | 8.21 | 4.41 | 6.28 | 8.21 | 8.21 | 6.28 |
| 0.4 | 4.45 | 10.83 | 4.61 | 8.06 | 10.83 | 10.83 | 8.06 |
| 0.5 | 3.74 | 10.08 | 4.9 | 5.5 | 10.08 | 10.08 | 5.50 |
| 0.6 | 4.72 | 8.33 | 4.01 | 6.55 | 8.33 | 8.33 | 6.55 |
| 0.7 | 5.25 | 8.41 | 5.28 | 9.55 | 9.55 | 8.41 | 9.55 |
| 0.8 | 4.47 | 9.04 | 5.01 | 5.06 | 9.04 | 9.04 | 5.06 |
| 0.9 | 4.23 | 6.01 | | | 6.01 | 6.01 | ERR |
| 1 | | 6.36 | 5.81 | 4.69 | 6.36 | 6.36 | 5.81 |
| 1.1 | 3.77 | 5.42 | 5.62 | 4.49 | 5.62 | 5.42 | 5.62 |
| 1.2 | 3.46 | 6.45 | 3.7 | 3.91 | 6.45 | 6.45 | 3.91 |
| 1.3 | 4.21 | 5.24 | 3.43 | 5.78 | 5.78 | 5.24 | 5.78 |
| 1.4 | 3.13 | 5.32 | 7.08 | 5.68 | 7.08 | 5.32 | 7.08 |
| 1.5 | 5.6 | 4.88 | 4.2 | 4.82 | 5.60 | 5.60 | 4.82 |
| 1.6 | 4.58 | 6.8 | 3.31 | 4.72 | 6.80 | 6.80 | 4.72 |
| 1.7 | 5.91 | 6.61 | | | 6.61 | 6.61 | ERR |
| 1.8 | 7.33 | 7.16 | 3.72 | 4.64 | 7.33 | 7.33 | 4.64 |
| 1.9 | 7.27 | | | 9.18 | 9.18 | 7.27 | 9.18 |
| 2 | 5.58 | 8.91 | 8.75 | 7.26 | 8.91 | 8.91 | 8.75 |
| 2.1 | 4.41 | 7.57 | | 7.63 | 7.63 | 7.57 | 7.63 |
| 2.2 | 6.19 | 7.85 | 5.24 | 4.72 | 7.85 | 7.85 | 5.24 |
| 2.3 | 6.62 | 8.34 | 3.46 | 4.54 | 8.34 | 8.34 | 4.54 |
| 2.4 | 13.64 | 15.41 | 4.03 | 5.03 | 15.41 | 15.41 | 5.03 |

# APPENDIX K1

## RESULTS OF HAUL ROAD SUBJECTIVE ROUGHNESS EVALUATIONS
## KRIEL COLLIERY

K1-2

**SUMMARY OF RESULTS, MAXIMUM SECTION AVERAGE IRI (m/km) ROUGHNESS SCORE WITH SUBJECTIVE EVALUATION OF ROUGHNESS**

**Kriel Colliery**

| km | Main HR | IRI(x4) | Ramp 6 | IRI(x4) | Ramp 7 | IRI(x4) | Ramp 8/11 | IRI(x4) |
|---|---|---|---|---|---|---|---|---|
| 0.1 | 26 | 31.12 | 27 | 35.96 | 31 | 11.60 | 33 | 40.00 |
| 0.2 | 26 | 21.68 | 22 | 34.28 | 18 | 18.88 | 20 | 17.40 |
| 0.3 | 24 | 19.72 | 41 | 44.84 | 22 | 17.08 | 20 | 35.08 |
| 0.4 | 32 | 26.48 | 44 | 39.92 | 29 | 23.04 | 24 | 36.32 |
| 0.5 | 30 | 20.32 | 28 | 17.92 | 21 | 20.44 | 43 | 35.20 |
| 0.6 | 24 | 23.76 | 32 | 22.48 | 35 | 16.80 | 43 | 41.52 |
| 0.7 | 28 | 22.28 | 37 | 37.88 | 46 | 39.00 | 40 | 33.88 |
| 0.8 | 38 | 26.92 | 40 | 36.00 | 49 | 44.20 | 37 | 31.12 |
| 0.9 | 24 | 16.68 | 33 | 26.56 | 46 | 15.44 | 44 | 25.56 |
| 1.0 | 20 | 18.92 | 24 | 27.40 | 60 | 50.20 | 43 | 33.76 |
| 1.1 | 20 | 18.32 | 33 | 25.32 | 41 | 11.32 | 47 | 36.72 |
| 1.2 | 20 | 20.28 | 30 | 40.40 | 63 | 20.72 | 54 | 27.36 |
| 1.3 | 28 | 19.72 | 43 | 37.72 | 67 | 23.20 | 43 | 26.12 |
| 1.4 | 31 | 26.32 | 34 | 29.60 | 75 | 30.40 | 49 | 44.48 |
| 1.5 | 24 | 21.16 | 22 | 31.00 | | | 43 | 38.28 |
| 1.6 | 18 | 17.80 | 42 | 34.48 | | | | |
| 1.7 | 24 | 19.80 | | 36.80 | | | | |
| 1.8 | 25 | 43.68 | | | | | | |
| 1.9 | 50 | 26.60 | | | | | | |
| 2.0 | 34 | 27.44 | | | | | | |
| 2.1 | 26 | 25.64 | | | | | | |
| 2.2 | 28 | 20.60 | | | | | | |
| 2.3 | 24 | 21.20 | | | | | | |
| 2.4 | 30 | 18.04 | | | | | | |
| 2.5 | 24 | 15.44 | | | | | | |
| 2.6 | 26 | 19.00 | | | | | | |
| 2.7 | 24 | 25.04 | | | | | | |
| 2.8 | 29 | 28.28 | | | | | | |
| 2.9 | 34 | 17.04 | | | | | | |
| 3.0 | 22 | 22.48 | | | | | | |
| 3.1 | 28 | 16.64 | | | | | | |
| 3.2 | 25 | 23.64 | | | | | | |

K1-3

**SUMMARY OF RESULTS, MAXIMUM SECTION AVERAGE IRI (m/km) ROUGHNESS SCORE WITH SUBJECTIVE EVALUATION OF ROUGHNESS**
**Kriel Colliery**

| km | Main HR | IRI(x4) | Ramp 6 | IRI(x4) | Ramp 7 | IRI(x4) | Ramp 8/11 | IRI(x4) |
|---|---|---|---|---|---|---|---|---|
| 3.3 | 39 | 39.88 | | | | | | |
| 3.4 | 41 | 41.44 | | | | | | |
| 3.5 | 52 | 40.04 | | | | | | |
| 3.6 | 45 | 29.24 | | | | | | |
| 3.7 | 50 | 40.56 | | | | | | |
| 3.8 | 35 | 24.60 | | | | | | |
| 3.9 | 29 | 20.68 | | | | | | |
| 4.0 | 30 | 26.24 | | | | | | |
| 4.1 | 24 | 26.60 | | | | | | |
| 4.2 | 29 | 32.68 | | | | | | |
| 4.3 | 29 | 25.72 | | | | | | |
| 4.4 | 34 | 17.32 | | | | | | |
| 4.5 | 32 | 30.64 | | | | | | |

K1-4

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 4 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **26** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 4 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **26** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 4 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **24** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **400** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 4 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **32** |

# K1-5

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 500 | |
| | Degree | Extent |
| Potholes | 3 | 4 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 30 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 600 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 24 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 700 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 28 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 800 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 38 |

# K1-6

| **Kriel Mine** | | |
|---|---|---|
| **Main HR Segment** | **900** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 2 |
| **Sum Degree x Extent** | | **24** |

| **Kriel Mine** | | |
|---|---|---|
| **Main HR Segment** | **1000** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **20** |

| **Kriel Mine** | | |
|---|---|---|
| **Main HR Segment** | **1100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

| **Kriel Mine** | | |
|---|---|---|
| **Main HR Segment** | **1200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

K1-7

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **1300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **28** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **1400** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **31** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **1500** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **24** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **1600** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **18** |

K1-8

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 1700 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 24 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 1800 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 2 |
| Sum Degree x Extent | | 25 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 1900 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 4 | 4 |
| Sum Degree x Extent | | 50 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 2000 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 34 |

K1-9

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 2100 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 26 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 2200 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 4 |
| Sum Degree x Extent | | 28 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 2300 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 24 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 2400 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 4 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 30 |

K1-10

| Kriel Mine | | |
| --- | --- | --- |
| Main HR Segment | 2500 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 24 |

| Kriel Mine | | |
| --- | --- | --- |
| Main HR Segment | 2600 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 26 |

| Kriel Mine | | |
| --- | --- | --- |
| Main HR Segment | 2700 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 24 |

| Kriel Mine | | |
| --- | --- | --- |
| Main HR Segment | 2800 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 29 |

K1-11

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 2900 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 34 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 3000 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 22 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 3100 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 4 |
| Sum Degree x Extent | | 28 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 3200 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 25 |

K1-12

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 3300 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 4 | 4 |
| Sum Degree x Extent | | 39 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 3400 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 4 | 4 |
| Sum Degree x Extent | | 41 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 3500 | |
| | Degree | Extent |
| Potholes | 3 | 4 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 4 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 4 | 5 |
| Sum Degree x Extent | | 52 |

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 3600 | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 4 | 4 |
| Sum Degree x Extent | | 45 |

# K1-13

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **3700** | |
| | **Degree** | **Extent** |
| Potholes | 4 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 4 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 4 | 4 |
| **Sum Degree x Extent** | | **50** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **3800** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 4 | 3 |
| **Sum Degree x Extent** | | **35** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **3900** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **29** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **4000** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 4 |
| **Sum Degree x Extent** | | **30** |

K1-14

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **4100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **24** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **4200** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **29** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **4300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **29** |

| Kriel Mine | | |
|---|---|---|
| **Main HR Segment** | **4400** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **34** |

K1-15

| Kriel Mine | | |
|---|---|---|
| Main HR Segment | 4500 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 32 |

| Kriel Mine | Main HR |
|---|---|
| Segment | Comment |
| 400 | Junction workshop |
| 500 | Junction workshop |
| 3500 | Pothole at edge of road |
| 4300 | Approach to underpass |
| 4366 | Underpass |
| 4500 | End main HR |

# K1-16

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 100 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 27 |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 200 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 22 |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 300 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 4 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 3 | 4 |
| Sum Degree x Extent | | 41 |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 400 | |
| | Degree | Extent |
| Potholes | 4 | 4 |
| Corrugations | 2 | 4 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 4 |
| Sum Degree x Extent | | 44 |

# K1-17

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 500 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 4 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **28** |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 600 | |
| | Degree | Extent |
| Potholes | 4 | 2 |
| Corrugations | 2 | 4 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **32** |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 700 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 4 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **37** |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 800 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 3 | 2 |
| **Sum Degree x Extent** | | **40** |

# K1-18

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 900 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 33 |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 1000 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 24 |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 1100 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 4 | 3 |
| Sum Degree x Extent | | 33 |

| Kriel Mine | | |
|---|---|---|
| Ramp 6 Segment | 1200 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 4 |
| Sum Degree x Extent | | 30 |

# K1-19

| | | |
|---|---|---|
| **Kriel Mine** | | |
| **Ramp 6 Segment** | **1300** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 4 |
| **Sum Degree x Extent** | | **43** |

| | | |
|---|---|---|
| **Kriel Mine** | | |
| **Ramp 6 Segment** | **1400** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 4 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **34** |

| | | |
|---|---|---|
| **Kriel Mine** | | |
| **Ramp 6 Segment** | **1500** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **22** |

| | | |
|---|---|---|
| **Kriel Mine** | | |
| **Ramp 6 Segment** | **1600** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **42** |

K1-20

| **Kriel Mine** | **Ramp 6** |
|---|---|
| **Segment** | **Comment** |
| 100 | Junction |
| 300 | Junction |
| 700 | Wet and cut up |
| 1600 | End ramp 6 |

K1-21

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 100 | |
| | Degree | Extent |
| Potholes | 4 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 31 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 200 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 18 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 300 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 22 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 400 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 29 |

# K1-22

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 500 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 21 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 600 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 4 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 35 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 700 | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 3 | 4 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 46 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 800 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 4 | 4 |
| Rutting | 3 | 4 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 49 |

K1-23

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 900 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 4 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 4 |
| Sum Degree x Extent | | 46 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 1000 | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 4 |
| Loose Material | 3 | 5 |
| Stoniness - fixed | 3 | 5 |
| Sum Degree x Extent | | 60 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 1100 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 3 | 4 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 41 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 1200 | |
| | Degree | Extent |
| Potholes | 4 | 4 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 4 | 5 |
| Sum Degree x Extent | | 63 |

K1-24

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 1300 | |
| | Degree | Extent |
| Potholes | 5 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 4 | 5 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 4 | 5 |
| Sum Degree x Extent | | 67 |

| Kriel Mine | | |
|---|---|---|
| Ramp 7 Segment | 1400 | |
| | Degree | Extent |
| Potholes | 4 | 4 |
| Corrugations | 2 | 3 |
| Rutting | 4 | 5 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 5 | 5 |
| Sum Degree x Extent | | 75 |

| Kriel Mine | Ramp 7 |
|---|---|
| Segment | Comment |
| 100 | Junction |
| 1000 | Parting added |
| 1100 | Wet, parting added |

# K1-25

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **100** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 4 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **33** |

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 1 |
| **Sum Degree x Extent** | | **20** |

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **400** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 2 |
| **Sum Degree x Extent** | | **24** |

K1-26

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **500** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **43** |

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **600** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 3 | 4 |
| **Sum Degree x Extent** | | **43** |

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **700** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **40** |

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **800** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **37** |

# K1-27

| **Kriel Mine** | | |
|---|---|---|
| **Ramp 8/11 Segment** | **900** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 4 | 4 |
| **Sum Degree x Extent** | | **44** |

| **Kriel Mine** | | |
|---|---|---|
| **Ramp 8/11 Segment** | **1000** | |
| | **Degree** | **Extent** |
| Potholes | 4 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **43** |

| **Kriel Mine** | | |
|---|---|---|
| **Ramp 8/11 Segment** | **1100** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 4 |
| Rutting | 3 | 4 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 3 | 4 |
| **Sum Degree x Extent** | | **47** |

| **Kriel Mine** | | |
|---|---|---|
| **Ramp 8/11 Segment** | **1200** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 4 | 4 |
| Stoniness - fixed | 4 | 4 |
| **Sum Degree x Extent** | | **54** |

K1-28

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **1300** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 3 | 4 |
| **Sum Degree x Extent** | | **43** |

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **1400** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 4 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 4 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 3 | 5 |
| **Sum Degree x Extent** | | **49** |

| Kriel Mine | | |
|---|---|---|
| **Ramp 8/11 Segment** | **1500** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 4 | 4 |
| **Sum Degree x Extent** | | **43** |

| **Kriel Mine** | **Ramp 8/11** |
|---|---|
| **Segment** | **Comment** |
| 100 | Junction |
| 500 | Junction (ramp 8) |
| 700 | Uphill on spoils road |
| 1100 | Gulley erosion |

# APPENDIX K2

## RESULTS OF HAUL ROAD SUBJECTIVE ROUGHNESS EVALUATIONS KROMDRAAI COLLIERY

K2-2

**SUMMARY OF RESULTS, MAXIMUM AVERAGE IRI (m/km) ROUGHNESS SCORE WITH SUBJECTIVE EVALUATION OF ROUGHNESS**

**Kromdraai Colliery**

| km | Main HR | IRI(x4) | HR1 | IRI(x4) | HR2 | IRI(x4) |
|---|---|---|---|---|---|---|
| 0.1 | 29 | 32.24 | 14 | 16.28 | 11 | 25.08 |
| 0.2 | 24 | 26.48 | 16 | 15.72 | 26 | 31.24 |
| 0.3 | 25 | 33.08 | 18 | 16.12 | 20 | 30.32 |
| 0.4 | 22 | 28.36 | 17 | 19 | 22 | 29.36 |
| 0.5 | 24 | 18.52 | 22 | 19.24 | 16 | 27.12 |
| 0.6 | 23 | 20.64 | 20 | 20.72 | 26 | 20.36 |
| 0.7 | 21 | 24.28 | 14 | 12.88 | 26 | 34.8 |
| 0.8 | 23 | 18.68 | 18 | 13.36 | 15 | 21.04 |
| 0.9 | 22 | | 16 | 18 | 21 | 31.04 |
| 1.0 | | | 19 | 18.68 | 29 | 33.16 |
| 1.1 | | | 18 | 20.84 | 31 | 27.4 |
| 1.2 | | | 18 | 20.92 | 30 | 28.28 |
| 1.3 | | | 18 | 18.32 | 23 | 28.28 |
| 1.4 | | | 25 | 26.44 | 27 | 20.76 |
| 1.5 | | | 26 | 27.28 | 31 | 28.68 |
| 1.6 | | | | | 24 | 14.8 |
| 1.7 | | | | | 21 | 20.84 |
| 1.8 | | | | | 26 | 18.84 |
| 1.9 | | | | | 23 | 15 |
| 2.0 | | | | | 21 | 15.84 |
| 2.1 | | | | | 29 | 18 |
| 2.2 | | | | | 23 | 18.52 |
| 2.3 | | | | | 30 | 31.8 |
| 2.4 | | | | | 26 | 20.16 |

# K2-3

| Kromdraai Mine | | |
|---|---|---|
| Main HR Segment | 100 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 3 | 2 |
| Sum Degree x Extent | | 29 |

| Kromdraai Colliery | | |
|---|---|---|
| Main HR Segment | 200 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 2 |
| Sum Degree x Extent | | 24 |

| Kromdraai Colliery | | |
|---|---|---|
| Main HR Segment | 300 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 2 |
| Sum Degree x Extent | | 25 |

| Kromdraai Mine | | |
|---|---|---|
| Main HR Segment | 400 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 22 |

# K2-4

| Kromdraai Colliery | | |
|---|---|---|
| Main HR Segment | 500 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 24 |

| Kromdraai Colliery | | |
|---|---|---|
| Main HR Segment | 600 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 23 |

| Kromdraai Mine | | |
|---|---|---|
| Main HR Segment | 700 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 21 |

| Kromdraai Colliery | | |
|---|---|---|
| Main HR Segment | 800 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 23 |

# K2-5

| Kromdraai Colliery | | |
|---|---|---|
| Main HR Segment | 900 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 1 |
| Sum Degree x Extent | | 22 |

| Kromdraai Colliery | Main HR |
|---|---|
| Segment | Comment |
| 100 | Junction tip |
| 900 | Junction HR1 and 2 |

# K2-6

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 100 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 14 |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 200 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 16 |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 300 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 2 |
| Sum Degree x Extent | | 18 |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 400 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 17 |

# K2-7

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 500 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 5 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **22** |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 600 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 5 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **20** |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 700 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **14** |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 800 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **18** |

K2-8

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment 900 | | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **16** |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment 1000 | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 5 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **19** |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment 1100 | | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **18** |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment 1200 | | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 1 |
| **Sum Degree x Extent** | | **18** |

K2-9

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 1300 | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 1 |
| Sum Degree x Extent | | 18 |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 1400 | |
| | Degree | Extent |
| Potholes | 1 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 25 |

| Kromdraai Colliery | | |
|---|---|---|
| HR1 Segment | 1500 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 26 |

| Kromdraai Colliery | HR1 |
|---|---|
| Segment | Comment |
| 100 | Junction HR2 |
| 1400 | Junction |
| 1500 | Junction |

K2-10

| **Kromdraai Colliery** | | |
|---|---|---|
| **HR2 Segment** | **100** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **11** |

| **Kromdraai Colliery** | | |
|---|---|---|
| **HR2 Segment** | **200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **26** |

| **Kromdraai Colliery** | | |
|---|---|---|
| **HR2 Segment** | **300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 2 |
| **Sum Degree x Extent** | | **20** |

| **Kromdraai Colliery** | | |
|---|---|---|
| **HR2 Segment** | **400** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **22** |

K2-11

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 500 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 1 | 3 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 16 |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 600 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 3 |
| Sum Degree x Extent | | 26 |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 700 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 26 |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 800 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 3 | 2 |
| Loose Material | 1 | 4 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 15 |

K2-12

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 900 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **21** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1000 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **29** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1100 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **31** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1200 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **30** |

K2-13

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1300 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **23** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1400 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 5 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **27** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1500 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **31** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1600 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **24** |

K2-14

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1700 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **21** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1800 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **26** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 1900 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **23** |

| Kromdraai Colliery | | |
|---|---|---|
| HR2 Segment | 2000 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **21** |

K2-15

| **Kromdraai Colliery** | | |
|---|---|---|
| **HR2 Segment** | **2100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 5 |
| Stoniness - fixed | 1 | 2 |
| **Sum Degree x Extent** | | **29** |

| **Kromdraai Colliery** | | |
|---|---|---|
| **HR2 Segment** | **2200** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **23** |

| **Kromdraai Colliery** | | |
|---|---|---|
| **HR2 Segment** | **2300** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 5 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **30** |

| **Kromdraai Colliery** | | |
|---|---|---|
| **HR2 Segment** | **2400** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **26** |

K2-16

| **Kromdraai Colliery** | **HR2** |
|---|---|
| **SEGMENT** | |
| **0** | **Pit end start** |
| **500** | **Bend** |
| **600** | **Bend** |
| **2500** | **Bend Join HR1** |

# APPENDIX K3

## RESULTS OF HAUL ROAD SUBJECTIVE ROUGHNESS EVALUATIONS NEW VAAL COLLIERY

K3-2

**SUMMARY OF RESULTS, MAXIMUM AVERAGE SECTION IRI (m/km) ROUGHNESS SCORE WITH SUBJECTIVE EVALUATION OF ROUGHNESS**

**New Vaal Mine**

| km | Main HR | IRI(x4) | Ramp 5 | IRI(x4) | Ramp 3 | IRI(x4) |
|---|---|---|---|---|---|---|
| 0.1 | 23 | 26.68 | 24 | 26.68 | 25 | 23.64 |
| 0.2 | 14 | 28.48 | 26 | 28.48 | 22 | 21.68 |
| 0.3 | 18 | 19.04 | 20 | 19.04 | 38 | 28.36 |
| 0.4 | 20 | 20.28 | 22 | 20.28 | 52 | 24.20 |
| 0.5 | 21 | 17.32 | 20 | 17.32 | 56 | 52.28 |
| 0.6 | 21 | 18.68 | 19 | 18.68 | 52 | 47.36 |
| 0.7 | 18 | 17.40 | 18 | | 51 | 37.40 |
| 0.8 | 18 | 17.12 | | | | |
| 0.9 | 18 | 17.48 | | | | |
| 1.0 | 18 | 19.36 | | | | |
| 1.1 | 17 | 17.36 | | | | |
| 1.2 | 17 | 16.24 | | | | |
| 1.3 | 16 | 17.56 | | | | |
| 1.4 | 20 | 16.48 | | | | |
| 1.5 | 20 | 20.16 | | | | |
| 1.6 | 22 | 18.32 | | | | |
| 1.7 | 26 | 28.00 | | | | |
| 1.8 | 19 | 20.32 | | | | |
| 1.9 | 12 | 16.68 | | | | |
| 2.0 | 21 | 20.36 | | | | |
| 2.1 | 18 | 23.60 | | | | |
| 2.2 | 16 | 18.56 | | | | |
| 2.3 | 26 | 33.08 | | | | |
| 2.4 | 22 | 13.36 | | | | |
| 2.5 | 20 | 12.84 | | | | |
| 2.6 | 20 | 13.08 | | | | |
| 2.7 | 20 | 19.88 | | | | |
| 2.8 | 22 | 14.56 | | | | |
| 2.9 | 24 | 21.60 | | | | |
| 3.0 | 22 | 24.20 | | | | |
| 3.1 | 17 | 21.28 | | | | |
| 3.2 | 19 | 20.28 | | | | |
| 3.3 | 16 | 16.80 | | | | |

K3-3

**SUMMARY OF RESULTS, MAXIMUM AVERAGE SECTION IRI (m/km) ROUGHNESS SCORE WITH SUBJECTIVE EVALUATION OF ROUGHNESS**
**New Vaal Mine**

| km | Main HR | IRI(x4) | Ramp 5 | IRI(x4) | Ramp 3 | IRI(x4) |
|---|---|---|---|---|---|---|
| 3.4 | 16 | 16.56 | | | | |
| 3.5 | 18 | 15.08 | | | | |
| 3.6 | 20 | 17.40 | | | | |
| 3.7 | 16 | 17.88 | | | | |
| 3.8 | 22 | 15.80 | | | | |
| 3.9 | 23 | 28.16 | | | | |
| 4.0 | 25 | 18.88 | | | | |
| 4.1 | 20 | 15.24 | | | | |
| 4.2 | 18 | 21.40 | | | | |
| 4.3 | 18 | 26.12 | | | | |
| 4.4 | 26 | 31.88 | | | | |
| 4.5 | 21 | 21.44 | | | | |
| 4.6 | 21 | 21.72 | | | | |
| 4.7 | 21 | 21.04 | | | | |
| 4.8 | 22 | 19.12 | | | | |
| 4.9 | 22 | 20.76 | | | | |
| 5.0 | 24 | 19.64 | | | | |

# K3-4

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 100 | |
| | Degree | Extent |
| Potholes | 2 | 4 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 2 |
| Sum Degree x Extent | | 23 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 200 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 1 | 1 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 14 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 300 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 1 |
| Sum Degree x Extent | | 18 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 400 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 1 |
| Stoniness - fixed | 2 | 1 |
| Sum Degree x Extent | | 20 |

# K3-5

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 500 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 1 |
| Sum Degree x Extent | | 21 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 600 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 21 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 700 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 18 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 800 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 18 |

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# K3-6

| **New Vaal Mine** | | |
|---|---|---|
| **Main HR Segment** | **900** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **18** |

| **New Vaal Mine** | | |
|---|---|---|
| **Main HR Segment** | **1000** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **18** |

| **New Vaal Mine** | | |
|---|---|---|
| **Main HR Segment** | **1100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 1 | 1 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **17** |

| **New Vaal Mine** | | |
|---|---|---|
| **Main HR Segment** | **1200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **17** |

K3-7

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 1300 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 1 | 3 |
| Sum Degree x Extent | | 16 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 1400 | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 20 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 1500 | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 20 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 1600 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 22 |

K3-8

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 1700 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 3 | 2 |
| Sum Degree x Extent | | 26 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 1800 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| Sum Degree x Extent | | 19 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 1900 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 1 | 2 |
| Loose Material | 1 | 1 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 12 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 2000 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 21 |

# K3-9

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 2100 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 18 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 2200 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 16 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 2300 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 26 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 2400 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 22 |

K3-10

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **2500** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 1 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **2600** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 1 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **2700** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 1 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **2800** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **22** |

# K3-11

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **2900** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **24** |

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **3000** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **22** |

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **3100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **17** |

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **3200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 1 |
| **Sum Degree x Extent** | | **19** |

K3-12

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 3300 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **16** |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 3400 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **16** |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 3500 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **18** |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 3600 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 1 |
| **Sum Degree x Extent** | | **20** |

K3-13

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 3700 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 1 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 16 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 3800 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 22 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 3900 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 23 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4000 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 25 |

K3-14

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4100 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 1 |
| Sum Degree x Extent | | 20 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4200 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 18 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4300 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 18 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4400 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 1 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 26 |

K3-15

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4500 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 21 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4600 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 21 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4700 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 3 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 21 |

| New Vaal Mine | | |
|---|---|---|
| Main HR Segment | 4800 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 4 |
| Sum Degree x Extent | | 22 |

K3-16

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **4900** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 4 |
| **Sum Degree x Extent** | | **22** |

| New Vaal Mine | | |
|---|---|---|
| **Main HR Segment** | **5000** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 4 |
| **Sum Degree x Extent** | | **24** |

| New Vaal Mine | Main haul road |
|---|---|
| **Segment** | **Comment** |
| 0m | Tip junction |
| 400m | Ramp 1 junction |
| 1500m | Bend |
| 1700m | Ramp 2 junction |
| 2100m | Hard park junction |
| 3000m | Ramp 3 junction |
| 3600m | Bend |
| 3700m | Ramp 4/5 junction |
| 4400m | Ramp 6 junction |
| 5000m | Single lane |
| 5037m | End |

K3-17

| New Vaal Mine | | |
|---|---|---|
| Ramp 6 Segment | 100 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 24 |

| New Vaal Mine | | |
|---|---|---|
| Ramp 6 Segment | 200 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 26 |

| New Vaal Mine | | |
|---|---|---|
| Ramp 6 Segment | 300 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 20 |

| New Vaal Mine | | |
|---|---|---|
| Ramp 6 Segment | 400 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 22 |

K3-18

| New Vaal Mine | | |
|---|---|---|
| **Ramp 6 Segment** | **500** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

| New Vaal Mine | | |
|---|---|---|
| **Ramp 3 Segment** | **600** | |
| | **Degree** | **Extent** |
| Potholes | 4 | 3 |
| Corrugations | 2 | 4 |
| Rutting | 4 | 3 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 4 | 3 |
| **Sum Degree x Extent** | | **52** |

| New Vaal Mine | | |
|---|---|---|
| **Ramp 3 Segment** | **700** | |
| | **Degree** | **Extent** |
| Potholes | 4 | 2 |
| Corrugations | 3 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 4 | 4 |
| **Sum Degree x Extent** | | **51** |

| New Vaal Mine | Ramp 3 |
|---|---|
| **Segment** | **Comment** |
| 300m | Ramp 7 junction |
| 600m | Bend |
| 700m | Bend |
| 751m | End |

# K3-19

| New Vaal Mine | | |
|---|---|---|
| Ramp 3 Segment | 100 | |
| | Degree | Extent |
| Potholes | 3 | 1 |
| Corrugations | 1 | 1 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 2 |
| **Sum Degree x Extent** | | **25** |

| New Vaal Mine | | |
|---|---|---|
| Ramp 3 Segment | 200 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **22** |

| New Vaal Mine | | |
|---|---|---|
| Ramp 3 Segment | 300 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 4 | 3 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **38** |

| New Vaal Mine | | |
|---|---|---|
| Ramp 3 Segment | 400 | |
| | Degree | Extent |
| Potholes | 3 | 4 |
| Corrugations | 4 | 2 |
| Rutting | 4 | 4 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **52** |

K3-20

| **New Vaal Mine** | | |
|---|---|---|
| **Ramp 3 Segment** | **500** | |
| | **Degree** | **Extent** |
| Potholes | 4 | 2 |
| Corrugations | 3 | 4 |
| Rutting | 4 | 3 |
| Loose Material | 4 | 4 |
| Stoniness - fixed | 4 | 2 |
| **Sum Degree x Extent** | | **56** |

| **New Vaal Mine** | | |
|---|---|---|
| **Ramp 3 Segment** | **600** | |
| | **Degree** | **Extent** |
| Potholes | 4 | 3 |
| Corrugations | 2 | 4 |
| Rutting | 4 | 3 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 4 | 3 |
| **Sum Degree x Extent** | | **52** |

| **New Vaal Mine** | | |
|---|---|---|
| **Ramp 3 Segment** | **700** | |
| | **Degree** | **Extent** |
| Potholes | 4 | 2 |
| Corrugations | 3 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 4 | 4 |
| **Sum Degree x Extent** | | **51** |

| **New Vaal Mine** | **Ramp 3** |
|---|---|
| **Segment** | **Comment** |
| 600m | Downhill steep |
| 700m | End |

# APPENDIX K4

## RESULTS OF HAUL ROAD SUBJECTIVE ROUGHNESS EVALUATIONS
## KLEINKOPJE COLLIERY

K4-2

**SUMMARY OF RESULTS, MAXIMUM AVERAGE IRI (m/km) ROUGHNESS SCORE WITH SUBJECTIVE EVALUATION OF ROUGHNESS**

**Kleinkopje Colliery**

| km | 3A | IRI(x4) | 2A | IRI(x4) | Ramp 13/14 | IRI(x4) | 5W | IRI(x4) |
|---|---|---|---|---|---|---|---|---|
| 0.1 | 22 | 20.16 | 44 | 27.04 | 32 | 28.32 | 24 | 23.68 |
| 0.2 | 16 | 17.08 | 31 | 44.08 | 34 | 26.68 | 24 | 26.64 |
| 0.3 | 15 | 19.56 | 31 | 22.16 | 36 | 32.84 | 28 | 21.80 |
| 0.4 | 15 | 19.08 | 31 | 21.6 | 38 | 43.32 | 19 | 17.92 |
| 0.5 | 20 | 19.08 | 29 | 22.56 | 33 | 40.32 | 17 | 17.24 |
| 0.6 | 26 | 28.8 | 17 | 21.64 | 34 | 33.32 | 20 | 17.16 |
| 0.7 | 26 | 25.32 | 18 | 20.64 | 33 | 38.2 | 17 | 15.00 |
| 0.8 | 24 | 24.36 | 13 | 22.28 | 31 | 36.16 | 13 | 15.68 |
| 0.9 | 27 | 24.2 | 24 | 32.24 | 31 | 24.04 | 23 | 16.08 |
| 1.0 | 23 | 19.72 | 14 | 19.68 | 32 | 25.44 | 27 | 14.16 |
| 1.1 | 30 | 22.92 | 15 | 19.92 | 22 | 22.48 | 23 | 20.96 |
| 1.2 | 32 | 26 | 18 | 27.2 | 22 | 25.8 | 24 | 16.36 |
| 1.3 | 32 | 35.28 | 15 | 21.44 | 21 | 23.12 | 22 | 18.52 |
| 1.4 | 25 | 24.08 | 12 | 16.48 | 24 | 28.32 | 17 | 13.80 |
| 1.5 | 18 | 23.8 | 10 | 14.44 | 33 | 22.4 | 15 | 16.72 |
| 1.6 | 31 | 41.2 | 12 | 18.64 | 31 | 27.2 | 24 | 22.52 |
| 1.7 | 24 | 23.8 | 12 | 16.72 | 32 | 26.44 | 22 | 31.04 |
| 1.8 | 24 | 26.32 | 20 | 22.72 | 35 | 29.32 | 20 | 21.44 |
| 1.9 | 34 | 31.36 | 12 | 21.4 | 28 | 36.72 | 20 | 24.80 |
| 2.0 | 31 | 33.92 | 17 | 18.04 | 26 | 35.64 | 34 | 27.76 |
| 2.1 | 22 | 29.16 | 16 | 15.28 | 27 | 30.52 | 15 | 24.88 |
| 2.2 | 22 | 28.96 | 16 | 12.28 | 22 | 31.4 | 20 | 18.68 |
| 2.3 | 22 | 27.68 | 19 | 16.52 | 27 | 33.36 | 19 | 19.12 |
| 2.4 | 23 | 36 | 19 | 15.08 | 24 | 61.64 | 29 | 32.64 |
| 2.5 | 26 | 33.48 | 19 | 21.4 | | | 34 | 37.88 |
| 2.6 | 27 | | 19 | 23.16 | | | 37 | 32.44 |
| 2.7 | | | 16 | 19.04 | | | 47 | 39.64 |
| 2.8 | | | 19 | 25.08 | | | 39 | 34.00 |

K4-3

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 100 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 22 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 200 | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 1 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 16 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 300 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 1 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 15 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 400 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 1 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 15 |

# K4-4

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 500 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 1 | 4 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **20** |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 600 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 1 | 4 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **26** |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 700 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **26** |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 800 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **24** |

# K4-5

| Kleinkopje Colliery | | |
|---|---|---|
| **3A Segment** | **900** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **27** |

| Kleinkopje Colliery | | |
|---|---|---|
| **3A Segment** | **1000** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **23** |

| Kleinkopje Colliery | | |
|---|---|---|
| **3A Segment** | **1100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 1 | 3 |
| Rutting | 1 | 2 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **30** |

| Kleinkopje Colliery | | |
|---|---|---|
| **3A Segment** | **1200** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **32** |

# K4-6

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 1300 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 32 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 1400 | |
| | Degree | Extent |
| Potholes | 3 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 2 |
| Sum Degree x Extent | | 25 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 1500 | |
| | Degree | Extent |
| Potholes | 1 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 18 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 1600 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 31 |

K4-7

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 1700 | |
| | Degree | Extent |
| Potholes | 3 | 1 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 3 | 2 |
| Sum Degree x Extent | | 24 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 1800 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 24 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 1900 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 3 | 2 |
| Sum Degree x Extent | | 34 |

| Kleinkopje Colliery | | |
|---|---|---|
| 3A Segment | 2000 | |
| | Degree | Extent |
| Potholes | 2 | 4 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 31 |

K4-8

| **Kleinkopje Colliery** | | |
|---|---|---|
| **3A Segment** | **2100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **22** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **3A Segment** | **2200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **22** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **3A Segment** | **2300** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **22** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **3A Segment** | **2400** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 1 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **23** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **3A Segment** | **2500** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **26** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **3A Segment** | **2600** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 3 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **27** |

| **Kleinkopje Colliery** | **3A** |
|---|---|
| **Segment** | **Comment** |
| 0 | At tip |
| 500 | Junction |
| 700 | Junction |
| 1400 | Wet patch potholes |
| 1700 | Wet patch at junction |
| 2300 | Wet |

# K4-10

| Kleinkopje Colliery | | |
|---|---|---|
| 2A Segment | 100 | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 3 | 4 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 4 |
| Sum Degree x Extent | | 44 |

| Kleinkopje Colliery | | |
|---|---|---|
| 2A Segment | 200 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 31 |

| Kleinkopje Colliery | | |
|---|---|---|
| 2A Segment | 300 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 31 |

| Kleinkopje Colliery | | |
|---|---|---|
| 2A Segment | 400 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 31 |

K4-11

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **500** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **29** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **600** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **17** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **700** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **18** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **800** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 1 | 1 |
| Rutting | 2 | 1 |
| Loose Material | 1 | 2 |
| Stoniness - fixed | 1 | 2 |
| **Sum Degree x Extent** | | **13** |

# K4-12

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **900** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **24** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **1000** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **14** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **1100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **15** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **1200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **18** |

K4-13

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **1300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 1 |
| **Sum Degree x Extent** | | **15** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **1400** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **12** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **1500** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **10** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **1600** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **12** |

K4-14

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **1700** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **12** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **1800** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **1900** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **12** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **2A Segment** | **2000** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **17** |

K4-15

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2100** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **16** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2200** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **16** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **19** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2400** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **19** |

K4-16

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2500** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **19** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2600** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **19** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2700** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **16** |

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2800** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **19** |

K4-17

| Kleinkopje Colliery | | |
|---|---|---|
| **2A Segment** | **2900** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 1 |
| **Sum Degree x Extent** | | **22** |

| **Kleinkopje Colliery** | **2A** |
|---|---|
| **Segment** | **Comment** |
| 0 | Tip |
| 100 | Tip approach |
| 200 | 5W junction |
| 500 | Junction |
| 800 | Junction |
| 1200 | Bend |
| 2600 | Junction |
| 2900 | Junction Ramp |

# K4-18

| Kleinkopje Colliery | | |
|---|---|---|
| Ramp 13/14 Segment | 100 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 4 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 32 |

| Kleinkopje Colliery | | |
|---|---|---|
| Ramp 13/14 Segment | 200 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 4 |
| Sum Degree x Extent | | 34 |

| Kleinkopje Colliery | | |
|---|---|---|
| Ramp 13/14 Segment | 300 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 4 |
| Sum Degree x Extent | | 36 |

| Kleinkopje Colliery | | |
|---|---|---|
| Ramp 13/14 Segment | 400 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 2 |
| Stoniness - fixed | 2 | 4 |
| Sum Degree x Extent | | 38 |

K4-19

| Kleinkopje Colliery | | |
|---|---|---|
| **Ramp 13/14 Segment** | **500** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 4 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **33** |

| Kleinkopje Colliery | | |
|---|---|---|
| **Ramp 13/14 Segment** | **600** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **34** |

| Kleinkopje Colliery | | |
|---|---|---|
| **Ramp 13/14 Segment** | **700** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **33** |

| Kleinkopje Colliery | | |
|---|---|---|
| **Ramp 13/14 Segment** | **800** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 3 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **31** |

K4-20

| **Kleinkopje Colliery** | | |
|---|---|---|
| **Ramp 13/14 Segment** | **900** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **31** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **Ramp 13/14 Segment** | **1000** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 4 |
| Corrugations | 2 | 3 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **32** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **Ramp 13/14 Segment** | **1100** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 2 | 1 |
| **Sum Degree x Extent** | | **22** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **Ramp 13/14 Segment** | **1200** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 2 | 1 |
| **Sum Degree x Extent** | | **22** |

K4-21

| Kleinkopje Colliery | | |
|---|---|---|
| **Ramp 13/14 Segment** | **1300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **21** |

| Kleinkopje Colliery | | |
|---|---|---|
| **Ramp 13/14 Segment** | **1400** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **24** |

| Kleinkopje Colliery | | |
|---|---|---|
| **Ramp 13/14 Segment** | **1500** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 4 |
| **Sum Degree x Extent** | | **33** |

| Kleinkopje Colliery | | |
|---|---|---|
| **Ramp 13/14 Segment** | **1600** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 4 |
| **Sum Degree x Extent** | | **31** |

K4-22

| Kleinkopje Colliery | | |
|---|---|---|
| Ramp 13/14 Segment | 1700 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **32** |

| Kleinkopje Colliery | | |
|---|---|---|
| Ramp 13/14 Segment | 1800 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 3 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 3 | 4 |
| **Sum Degree x Extent** | | **35** |

| Kleinkopje Colliery | | |
|---|---|---|
| Ramp 13/14 Segment | 1900 | |
| | Degree | Extent |
| Potholes | 3 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 4 |
| **Sum Degree x Extent** | | **28** |

| Kleinkopje Colliery | | |
|---|---|---|
| Ramp 13/14 Segment | 2000 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **26** |

K4-23

| **Kleinkopje Colliery** | | |
|---|---|---|
| **Ramp 13/14 Segment** | **2100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 3 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **27** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **Ramp 13/14 Segment** | **2200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **22** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **Ramp 13/14 Segment** | **2300** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **27** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **Ramp 13/14 Segment** | **2400** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **24** |

K4-24

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 100 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 24 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 200 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 24 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 300 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 28 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 400 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 19 |

K4-25

| Kleinkopje Colliery | | |
|---|---|---|
| **5W Segment** | **500** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 1 | 2 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **17** |

| Kleinkopje Colliery | | |
|---|---|---|
| **5W Segment** | **600** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **20** |

| Kleinkopje Colliery | | |
|---|---|---|
| **5W Segment** | **700** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **17** |

| Kleinkopje Colliery | | |
|---|---|---|
| **5W Segment** | **800** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 1 | 2 |
| **Sum Degree x Extent** | | **13** |

K4-26

| **Kleinkopje Colliery** | | |
|---|---|---|
| **5W Segment** | **900** | |
| | **Degree** | **Extent** |
| Potholes | 3 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 3 |
| **Sum Degree x Extent** | | **23** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **5W Segment** | **1000** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **27** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **5W Segment** | **1100** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| **Sum Degree x Extent** | | **23** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **5W Segment** | **1200** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 4 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **24** |

K4-27

| **Kleinkopje Colliery** | | |
|---|---|---|
| **5W Segment** | **1300** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| **Sum Degree x Extent** | | **22** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **5W Segment** | **1400** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **17** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **5W Segment** | **1500** | |
| | **Degree** | **Extent** |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 2 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **15** |

| **Kleinkopje Colliery** | | |
|---|---|---|
| **5W Segment** | **1600** | |
| | **Degree** | **Extent** |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| **Sum Degree x Extent** | | **24** |

K4-28

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 1700 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 1 |
| Rutting | 3 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 22 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 1800 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 2 | 2 |
| Rutting | 1 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 20 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 1900 | |
| | Degree | Extent |
| Potholes | 2 | 2 |
| Corrugations | 1 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 1 | 2 |
| Sum Degree x Extent | | 20 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2000 | |
| | Degree | Extent |
| Potholes | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 34 |

K4-29

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2100 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 1 | 1 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 15 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2200 | |
| | Degree | Extent |
| Potholes | 2 | 1 |
| Corrugations | 2 | 1 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 20 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2300 | |
| | Degree | Extent |
| Potholes | 1 | 1 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 2 |
| Sum Degree x Extent | | 19 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2400 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 2 | 2 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 3 |
| Sum Degree x Extent | | 29 |

K4-30

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2500 | |
| | Degree | Extent |
| | 3 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 34 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2600 | |
| | Degree | Extent |
| Potholes | 4 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 2 | 3 |
| Sum Degree x Extent | | 37 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2700 | |
| | Degree | Extent |
| Potholes | 2 | 3 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 3 | 4 |
| Stoniness - fixed | 4 | 4 |
| Sum Degree x Extent | | 47 |

| Kleinkopje Colliery | | |
|---|---|---|
| 5W Segment | 2800 | |
| | Degree | Extent |
| Potholes | 2 | 4 |
| Corrugations | 2 | 2 |
| Rutting | 3 | 3 |
| Loose Material | 2 | 3 |
| Stoniness - fixed | 3 | 4 |
| Sum Degree x Extent | | 39 |

# APPENDIX L

## RESULTS AND ANALYSIS OF ROLLING RESISTANCE TESTS

**Contents**

Summary of rolling resistance tests, test vehicle specifications and individual test site rolling resistance data for the mine sites;

**ROLLING RESISTANCE CORRELATION WITH SUBJECTIVE EVALUATION OF ROAD ROUGHNESS - SUMMARY OF RESULTS**

| | | Average | Rolling resistance (N/kg) from linear regression (RR/speed) of individual site data | | |
|---|---|---|---|---|---|
| **Site** | **Segment** | **Evaluation score** | **20km/h** | **30km/h** | **40km/h** |
| Kleinkopje Colliery 2A road | 1600 - 1850m | 10 | 0.213 | 0.217 | 0.221 |
| New Vaal Colliery main haul road (R3) | 3200 - 3400m | 20 | 0.214 | 0.233 | 0.253 |
| Kromdraai Colliery haul road 2 | 785 - 1167m | 31 | 0.235 | 0.256 | 0.273 |
| New Vaal Colliery main haul road (end) | 4600 - 4900m | 23 | 0.184 | 0.221 | 0.258 |
| Kromdraai Colliery main haul road | 257 - 557m | 23 | 0.187 | 0.210 | 0.233 |
| Kriel Colliery main haul road | 3400 - 3700m | 47 | 0.262 | 0.295 | 0.328 |
| New Vaal Colliery ramp 3 | 300 - 600m | 60 | 0.296 | 0.319 | 0.342 |
| Kriel Colliery ramp 7 | 900 - 1200m | 83 | 0.266 | 0.282 | 0.298 |
| Kleinkopje Colliery discards road | 700 - 750m | 74 | 0.272 | 0.287 | 0.314 |

**ROLLING RESISTANCE ASSESSMENT**
**Kriel Colliery**

| | |
|---|---|
| **ROAD** | **Main haul road** |
| **SEGMENT** | **3400 - 3700m** |
| **GRADE** | **0.005** |
| **GRADE RESISTANCE** | **0.048** |
| **VEHICLE** | **Toyota Hilux LWB** |
| **VEHICLE MASS** | **1266 kg** |
| **TYRE & PRESSURE FRONT** | **190 R14C, 190 kPa** |
| **TYRE & PRESSURE REAR** | **190 R14C, 190 kPa** |
| **CONSTANT SPEED DISTANCE (m)** | **100** |

| **Constant speed t (s)** | **Deceleration** | | **Direction** | **Constant speed (km/h)** | **Total resistance (N/kg) including grade** | | **Rolling resistance (N/kg)** |
|---|---|---|---|---|---|---|---|
| | **t1 (s)** | **d1 (m)** | | | **Using t1** | **Using d1** | |
| 27 | 14 | 26.5 | up grade | 13.333 | 0.265 | 0.259 | 0.211 |
| 18 | 21 | 59.2 | up grade | 20.000 | 0.265 | 0.261 | 0.213 |
| 13 | 19 | 86.2 | up grade | 27.692 | 0.405 | 0.343 | 0.296 |
| 10 | 28 | 147.7 | up grade | 36.000 | 0.357 | 0.339 | 0.291 |
| 8 | 33 | 214.3 | up grade | 45.000 | 0.379 | 0.365 | 0.317 |
| 25 | 16 | 35.5 | down grade | 14.400 | 0.250 | 0.225 | 0.273 |
| 20 | 22 | 61.1 | down grade | 18.000 | 0.227 | 0.205 | 0.252 |
| 13 | 28 | 100.3 | down grade | 27.692 | 0.275 | 0.295 | 0.343 |
| 11 | 30 | 137.4 | down grade | 32.727 | 0.303 | 0.301 | 0.348 |
| 7 | 44 | 320.2 | down grade | 51.429 | 0.325 | 0.319 | 0.366 |

**ROLLING RESISTANCE ASSESSMENT**
**Kriel Colliery**

| | |
|---|---|
| ROAD | Ramp 7 |
| SEGMENT | 900 - 1200m |
| GRADE | 0.016 |
| GRADE RESISTANCE | 0.161 |
| VEHICLE | Toyota Hilux LWB |
| VEHICLE MASS | 1266 kg |
| TYRE & PRESSURE FRONT | 190 R14C, 190 kPa |
| TYRE & PRESSURE REAR | 190 R14C, 190 kPa |
| CONSTANT SPEED DISTANCE (m) | 100 |

| Constant speed t (s) | Deceleration | | Direction | Constant speed (km/h) | Total resistance (N/kg) including grade | | Rolling resistance (N/kg) |
|---|---|---|---|---|---|---|---|
| | t1 (s) | d1 (m) | | | Using t1 | Using d1 | |
| 25 | 10 | 20.4 | up grade | 14.400 | 0.400 | 0.392 | 0.232 |
| 18 | 14 | 40.0 | up grade | 20.000 | 0.397 | 0.386 | 0.225 |
| 14 | 17 | 59.0 | up grade | 25.714 | 0.420 | 0.432 | 0.272 |
| 10 | 23 | 117.0 | up grade | 36.000 | 0.435 | 0.427 | 0.267 |
| 8 | 29 | 185.6 | up grade | 45.000 | 0.431 | 0.421 | 0.260 |
| 27 | 28 | 63.2 | down grade | 13.333 | 0.132 | 0.109 | 0.269 |
| 20 | 37 | 92.4 | down grade | 18.000 | 0.135 | 0.135 | 0.296 |
| 13 | 44 | 196.6 | down grade | 27.692 | 0.175 | 0.150 | 0.311 |
| 11 | 59 | 278.3 | down grade | 32.727 | 0.154 | 0.148 | 0.309 |
| 8 | 64 | 423 | down grade | 45.000 | 0.195 | 0.185 | 0.345 |

**ROLLING RESISTANCE ASSESSMENT**
**Kromdraai Colliery**

| | |
|---|---|
| ROAD | Main haul road |
| SEGMENT | 257 - 557m |
| GRADE | 0.010 |
| GRADE RESISTANCE | 0.100 |
| VEHICLE | Toyota Hilux LWB |
| VEHICLE MASS | 1266 kg |
| TYRE & PRESSURE FRONT | 190 R14C, 190 kPa |
| TYRE & PRESSURE REAR | 190 R14C, 190 kPa |
| CONSTANT SPEED DISTANCE (m) | 100 |

| Constant speed t (s) | Deceleration | | Direction | Constant speed (km/h) | Total resistance (N/kg) including grade | | Rolling resistance (N/kg) |
|---|---|---|---|---|---|---|---|
| | t1 (s) | d1 (m) | | | Using t1 | Using d1 | |
| 25 | 15 | 29.5 | up grade | 14.400 | 0.267 | 0.271 | 0.171 |
| 16 | 21 | 69.8 | up grade | 22.500 | 0.298 | 0.280 | 0.180 |
| 13 | 23 | 90.5 | up grade | 27.692 | 0.334 | 0.327 | 0.227 |
| 10 | 30 | 147.1 | up grade | 36.000 | 0.333 | 0.340 | 0.240 |
| 9 | 34 | 203.5 | up grade | 40.000 | 0.327 | 0.303 | 0.203 |
| 7 | 45 | 295.4 | up grade | 51.429 | 0.317 | 0.345 | 0.245 |
| 23 | 17 | 34.4 | up grade | 15.652 | 0.256 | 0.275 | 0.175 |
| 19 | 19 | 54.7 | up grade | 18.947 | 0.277 | 0.253 | 0.153 |
| 14 | 22 | 85.6 | up grade | 25.714 | 0.325 | 0.298 | 0.198 |
| 11 | 27 | 131.3 | up grade | 32.727 | 0.337 | 0.315 | 0.215 |
| 8 | 36 | 207.4 | up grade | 45.000 | 0.347 | 0.377 | 0.277 |

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| Constant speed t (s) | Deceleration t1 (s) | Deceleration d1 (m) | Direction | Constant speed (km/h) | Using t1 (N/kg) including grade | Using d1 (N/kg) including grade | Rolling resistance (N/kg) |
|---|---|---|---|---|---|---|---|
| 7 | 43 | 282.6 | up grade | 51.429 | 0.332 | 0.361 | 0.261 |
| 27 | 92 | 104.6 | down grade | 13.333 | 0.040 | 0.066 | 0.166 |
| 28 | 76 | 109.1 | down grade | 12.857 | 0.047 | 0.058 | 0.159 |
| 29 | 47 | 78.3 | down grade | 12.414 | 0.073 | 0.076 | 0.176 |
| 30 | 36 | 58.1 | down grade | 12.000 | 0.093 | 0.096 | 0.196 |
| 30 | 45 | 71.4 | down grade | 12.000 | 0.074 | 0.078 | 0.178 |

**ROLLING RESISTANCE ASSESSMENT**
**Kromdraai Colliery**

| | |
|---|---|
| ROAD | HR2 |
| SEGMENT | 785 - 1167m |
| GRADE | 0.002 |
| GRADE RESISTANCE | 0.015 |
| VEHICLE | Toyota Hilux LWB |
| VEHICLE MASS | 1266 kg |
| TYRE & PRESSURE FRONT | 190 R14C, 190 kPa |
| TYRE & PRESSURE REAR | 190 R14C, 190 kPa |
| CONSTANT SPEED DISTANCE(m) | 100 |

| Constant speed t (s) | Deceleration | | Direction | Constant speed (km/h) | Total resistance (N/kg) including grade | | Rolling resistance (N/kg) |
|---|---|---|---|---|---|---|---|
| | t1 (s) | d1 (m) | | | Using t1 | Using d1 | |
| 26 | 16 | 28.3 | up grade | 13.846 | 0.240 | 0.261 | 0.247 |
| 19 | 26 | 59.5 | up grade | 18.947 | 0.202 | 0.233 | 0.218 |
| 13 | 37 | 126.1 | up grade | 27.692 | 0.208 | 0.235 | 0.220 |
| 10 | 45 | 201.7 | up grade | 36.000 | 0.222 | 0.248 | 0.233 |
| 8 | 49 | 276.0 | up grade | 45.000 | 0.255 | 0.283 | 0.268 |
| 6 | 62 | 382.0 | up grade | 60.000 | 0.269 | 0.364 | 0.349 |
| 26 | 16 | 30.1 | down grade | 13.846 | 0.240 | 0.246 | 0.260 |
| 18 | 26 | 61.2 | down grade | 20.000 | 0.214 | 0.252 | 0.267 |
| 13 | 39 | 129.0 | down grade | 27.692 | 0.197 | 0.229 | 0.244 |
| 11 | 46 | 181.1 | down grade | 32.727 | 0.198 | 0.228 | 0.243 |
| 8 | 56 | 283.1 | down grade | 45.000 | 0.223 | 0.276 | 0.291 |
| 7 | 67 | 375.6 | down grade | 51.429 | 0.213 | 0.272 | 0.286 |

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**ROLLING RESISTANCE ASSESSMENT - New Vaal Colliery**

| | |
|---|---|
| **ROAD** | **Main haul road** |
| **SEGMENT** | **4600 - 4900m** |
| **GRADE** | **0.001** |
| **GRADE RESISTANCE** | **0.014** |
| **VEHICLE** | **Toyota Hilux LWB** |
| **VEHICLE MASS** | **1266 kg** |
| **TYRE & PRESSURE FRONT** | **190 R14C, 190 kPa** |
| **TYRE & PRESSURE REAR** | **190 R14C, 190 kPa** |
| **CONSTANT SPEED DISTANCE(m)** | **100** |

| **Constant speed t (s)** | **Deceleration** | | **Direction** | **Constant speed (km/h)** | **Total resistance (N/kg) (including grade)** | | **Rolling resistance (N/kg)** |
|---|---|---|---|---|---|---|---|
| | **t1 (s)** | **d1 (m)** | | | **Using t1** | **Using d1** | |
| 25 | 33 | 56.6 | up grade | 14.400 | 0.121 | 0.141 | 0.128 |
| 21 | 27 | 77.7 | up grade | 17.143 | 0.176 | 0.146 | 0.132 |
| 15 | 36 | 94.2 | up grade | 24.000 | 0.185 | 0.236 | 0.222 |
| 11 | 49 | 148.0 | up grade | 32.727 | 0.186 | 0.279 | 0.266 |
| 9 | 52 | 235.2 | up grade | 40.000 | 0.214 | 0.262 | 0.249 |
| 6 | 77 | 427.4 | up grade | 60.000 | 0.216 | 0.325 | 0.311 |
| 30 | 29 | 48.4 | down grade | 12.000 | 0.115 | 0.115 | 0.128 |
| 20 | 30 | 70.8 | down grade | 18.000 | 0.167 | 0.177 | 0.190 |
| 15 | 33 | 117.7 | down grade | 24.000 | 0.202 | 0.189 | 0.202 |
| 10 | 54 | 184.6 | down grade | 36.000 | 0.185 | 0.271 | 0.285 |
| 8 | | 237.6 | down grade | 45.000 | | 0.329 | 0.342 |
| 5 | 95 | 623.6 | down grade | 72.000 | 0.211 | 0.321 | 0.334 |

**ROLLING RESISTANCE ASSESSMENT**
**New Vaal Colliery**

| | |
|---|---|
| **ROAD** | **Ramp 3** |
| **SEGMENT** | **300 - 600m** |
| **GRADE** | **0.011** |
| **GRADE RESISTANCE** | **0.105** |
| **VEHICLE** | **Toyota Hilux LWB** |
| **VEHICLE MASS** | **1266 kg** |
| **TYRE & PRESSURE FRONT** | **190 R14C, 190 kPa** |
| **TYRE & PRESSURE REAR** | **190 R14C, 190 kPa** |
| **CONSTANT SPEED DISTANCE (m)** | **100** |

| Constant speed t (s) | Deceleration | | Direction | Constant speed (km/h) | Total resistance (N/kg) including grade | | Rolling resistance (N/kg) |
|---|---|---|---|---|---|---|---|
| | t1 (s) | d1 (m) | | | Using t1 | Using d1 | |
| 27 | 17 | 36.7 | up grade | 13.333 | 0.218 | 0.187 | 0.292 |
| 23 | 20 | 54.3 | up grade | 15.652 | 0.217 | 0.174 | 0.279 |
| 14 | 28 | 126.0 | up grade | 25.714 | 0.255 | 0.202 | 0.307 |
| 10 | 37 | 222 | up grade | 36.000 | 0.270 | 0.225 | 0.330 |
| 9 | 40 | 255 | up grade | 40.000 | 0.278 | 0.242 | 0.347 |

**ROLLING RESISTANCE ASSESSMENT**
**New Vaal Colliery**

| | |
|---|---|
| **ROAD** | **Main haul road** |
| **SEGMENT** | **3200 - 3400m Ramp3 turn** |
| **GRADE** | **0.005** |
| **GRADE RESISTANCE** | **0.053** |
| **VEHICLE** | **Toyota Hilux LWB** |
| **VEHICLE MASS** | **1266 kg** |
| **TYRE & PRESSURE FRONT** | **190 R14C, 190 kPa** |
| **TYRE & PRESSURE REAR** | **190 R14C, 190 kPa** |
| **CONSTANT SPEED DISTANCE (m)** | **100** |

| **Constant speed t (s)** | **Deceleration** | | **Direction** | **Constant speed (km/h)** | **Total resistance (N/kg) including grade** | | **Rolling resistance (N/kg)** |
|---|---|---|---|---|---|---|---|
| | **t1 (s)** | **d1 (m)** | | | **Using t1** | **Using d1** | |
| 27 | 13 | 24.7 | up grade | 13.333 | 0.285 | 0.278 | 0.225 |
| 20 | 17 | 44.7 | up grade | 18.000 | 0.294 | 0.280 | 0.227 |
| 14 | 33 | 94.2 | up grade | 25.714 | 0.216 | 0.271 | 0.218 |
| 11 | 38 | 138.0 | up grade | 32.727 | 0.239 | 0.299 | 0.246 |
| 7 | 48 | 325.8 | up grade | 51.429 | 0.298 | 0.313 | 0.260 |
| 27 | 21 | 46.7 | down grade | 13.333 | 0.176 | 0.147 | 0.200 |
| 22 | 40 | 67.2 | down grade | 16.364 | 0.114 | 0.154 | 0.207 |
| 14 | 54 | 183.3 | down grade | 25.714 | 0.132 | 0.139 | 0.192 |
| 10 | 70 | 307.2 | down grade | 36.000 | 0.143 | 0.163 | 0.216 |
| 7 | 58 | 386.3 | down grade | 51.429 | 0.246 | 0.264 | 0.317 |

**ROLLING RESISTANCE ASSESSMENT**
**Kleinkopje Colliery**

| | |
|---|---|
| **ROAD** | **2A** |
| **SEGMENT** | **1600 - 1850m** |
| **GRADE** | **0.000** |
| **GRADE RESISTANCE** | **0.004** |
| **VEHICLE** | **Toyota Hilux LWB** |
| **VEHICLE MASS** | **1266 kg** |
| **TYRE & PRESSURE FRONT** | **190 R14C, 190 kPa** |
| **TYRE & PRESSURE REAR** | **190 R14C, 190 kPa** |
| **CONSTANT SPEED DISTANCE (m)** | **100** |

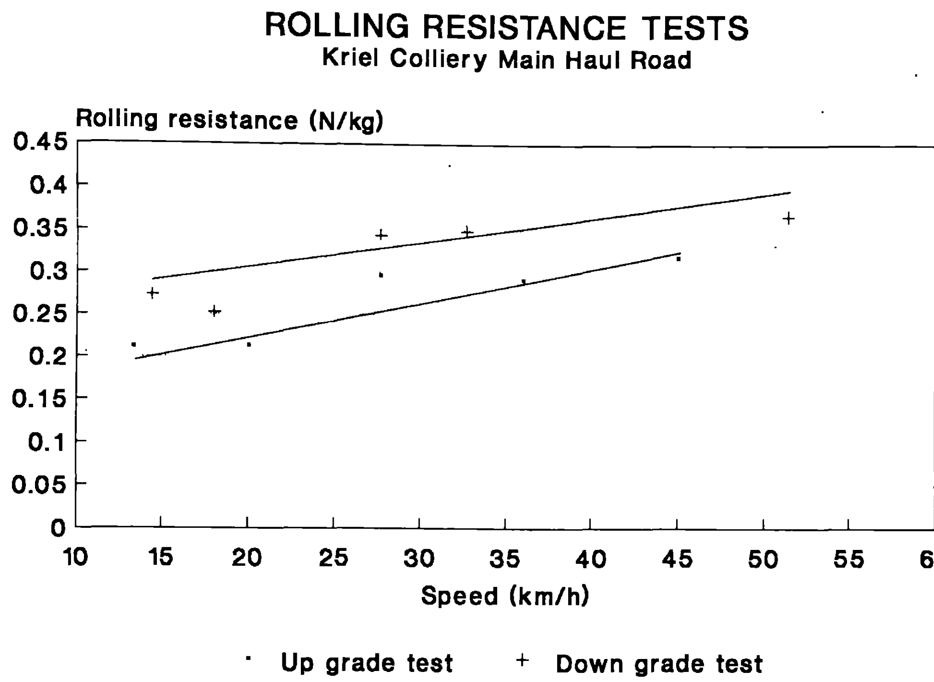
| **Constant speed t (s)** | **Deceleration** | | **Direction** | **Constant speed (km/h)** | **Total resistance (N/kg) including grade** | | **Rolling resistance (N/kg)** |
|---|---|---|---|---|---|---|---|
| | **t1 (s)** | **d1 (m)** | | | **Using t1** | **Using d1** | |
| 26 | 19 | 34.2 | up grade | 13.846 | 0.202 | 0.216 | 0.212 |
| 24 | 19 | 39.1 | up grade | 15.000 | 0.219 | 0.222 | 0.218 |
| 19 | 24 | 59.1 | up grade | 18.947 | 0.219 | 0.234 | 0.230 |
| 19 | 20 | 52.3 | up grade | 18.947 | 0.263 | 0.265 | 0.260 |
| 13 | 36 | 131.6 | up grade | 27.692 | 0.214 | 0.225 | 0.220 |
| 13 | 38 | 135.5 | up grade | 27.692 | 0.202 | 0.218 | 0.214 |
| 11 | 42 | 180.3 | up grade | 32.727 | 0.216 | 0.229 | 0.225 |
| 11 | 46 | 189.4 | up grade | 32.727 | 0.198 | 0.218 | 0.214 |
| 26 | 33 | 42.7 | down grade | 13.846 | 0.117 | 0.173 | 0.178 |
| 29 | 23 | 31.8 | down grade | 12.414 | 0.150 | 0.187 | 0.191 |
| 20 | 29 | 58.8 | down grade | 18.000 | 0.172 | 0.213 | 0.217 |

| Constant speed t (s) | Deceleration t1 (s) | Deceleration d1 (m) | Direction | Constant speed (km/h) | Using t1 (N/kg) including grade | Using d1 (N/kg) including grade | Rolling resistance (N/kg) |
|---|---|---|---|---|---|---|---|
| 20 | 30 | 60 | down grade | 18.000 | 0.167 | 0.208 | 0.213 |
| 12 | 43 | 161.5 | down grade | 30.000 | 0.194 | 0.215 | 0.219 |
| 14 | 32 | 120 | down grade | 25.714 | 0.223 | 0.213 | 0.217 |
| 14 | 38 | 131.4 | down grade | 25.714 | 0.188 | 0.194 | 0.199 |
| 11 | 45 | 190 | down grade | 32.727 | 0.202 | 0.217 | 0.222 |
| 10 | 50 | 248.5 | down grade | 36.000 | 0.200 | 0.201 | 0.206 |

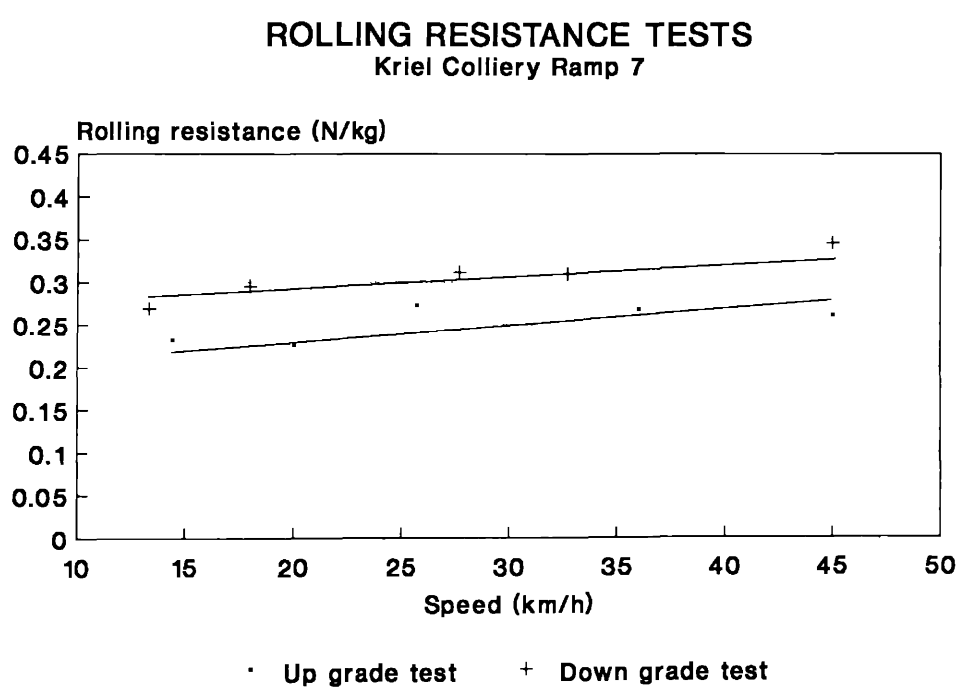
**ROLLING RESISTANCE ASSESSMENT**
**Kleinkopje Colliery**

| | |
|---|---|
| **ROAD** | **Discard road** |
| **SEGMENT** | **700 - 750m** |
| **GRADE** | **0.002** |
| **GRADE RESISTANCE** | **0.016** |
| **VEHICLE** | **Toyota Hilux LWB** |
| **VEHICLE MASS** | **1266 kg** |
| **TYRE & PRESSURE FRONT** | **190 R14C, 190 kPa** |
| **TYRE & PRESSURE REAR** | **190 R14C, 190 kPa** |
| **CONSTANT SPEED DISTANCE (m)** | **100** |

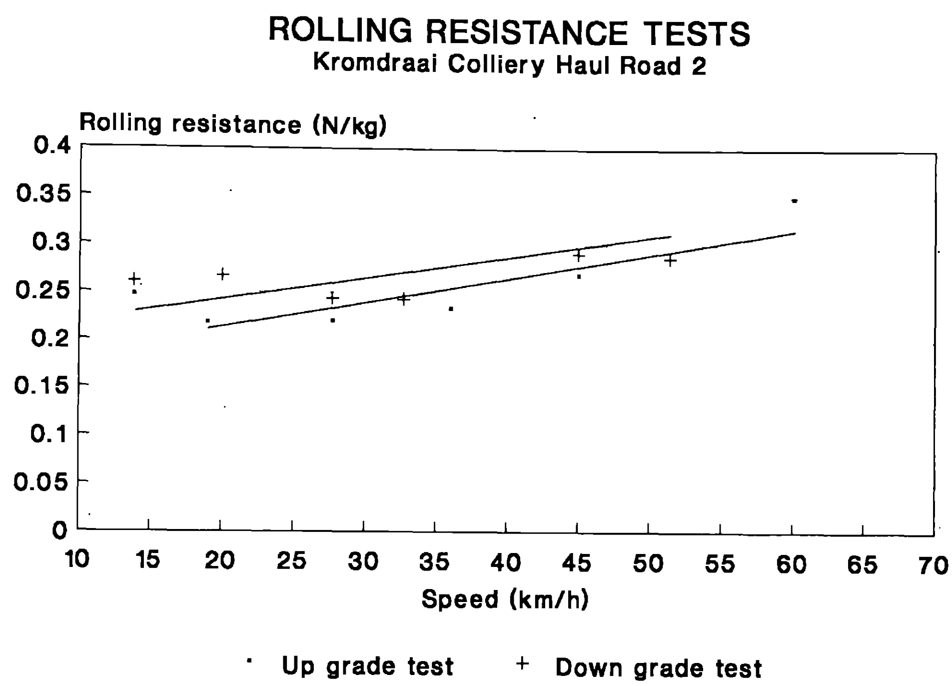
| **Constant speed t (s)** | **Deceleration t1 (s)** | **Deceleration d1 (m)** | **Direction** | **Constant speed (km/h)** | **Total resistance (N/kg) including grade: Using t1** | **Total resistance (N/kg) including grade: Using d1** | **Rolling resistance (N/kg)** |
|---|---|---|---|---|---|---|---|
| 24 | 16 | 31.8 | up grade | 15.000 | 0.260 | 0.273 | 0.257 |
| 19 | 19 | 48.3 | up grade | 18.947 | 0.277 | 0.287 | 0.270 |
| 14 | 24 | 87.4 | up grade | 25.714 | 0.298 | 0.292 | 0.276 |
| 10 | 31 | 167.0 | up grade | 36.000 | 0.323 | 0.299 | 0.283 |
| 8 | 38 | 249.0 | up grade | 45.000 | 0.329 | 0.314 | 0.297 |
| 25 | 17 | 32 | down grade | 14.400 | 0.235 | 0.250 | 0.266 |
| 19 | 20 | 53.2 | down grade | 18.947 | 0.263 | 0.260 | 0.277 |
| 13 | 28 | 110.6 | down grade | 27.692 | 0.275 | 0.268 | 0.284 |
| 10 | 33 | 171.1 | down grade | 36.000 | 0.303 | 0.292 | 0.309 |
| 8 | 36 | 240.6 | down grade | 45.000 | 0.347 | 0.325 | 0.341 |



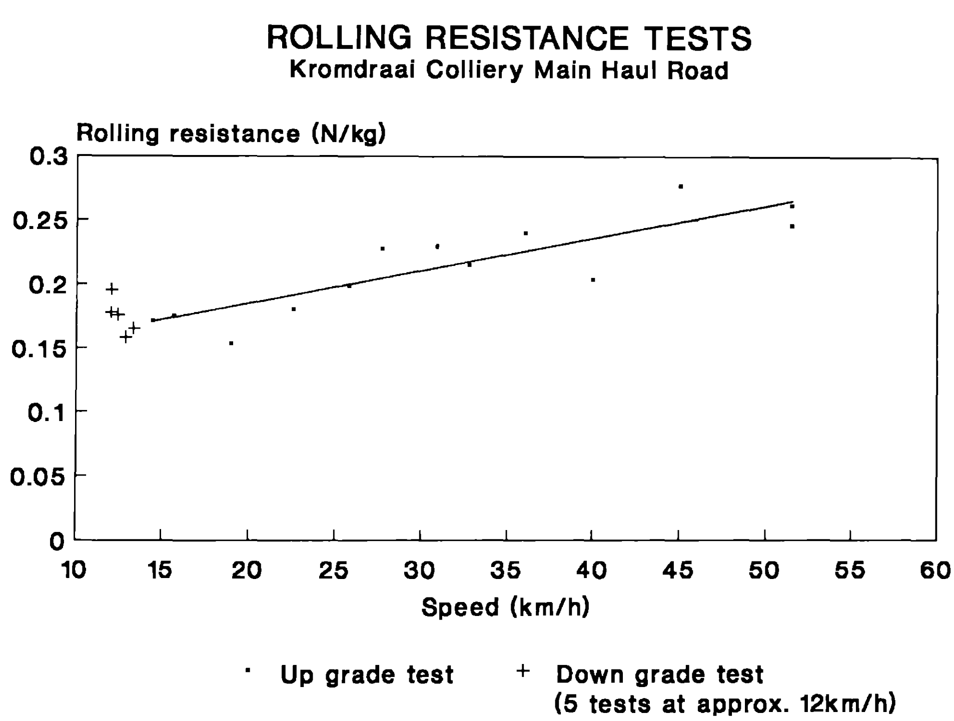

Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa inflation



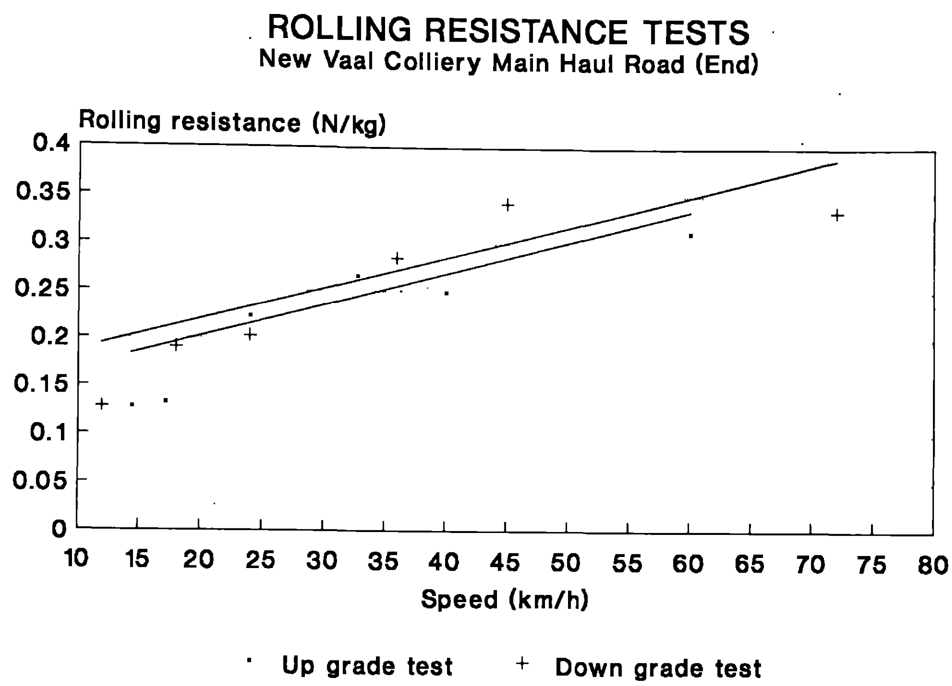

Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa Inflation



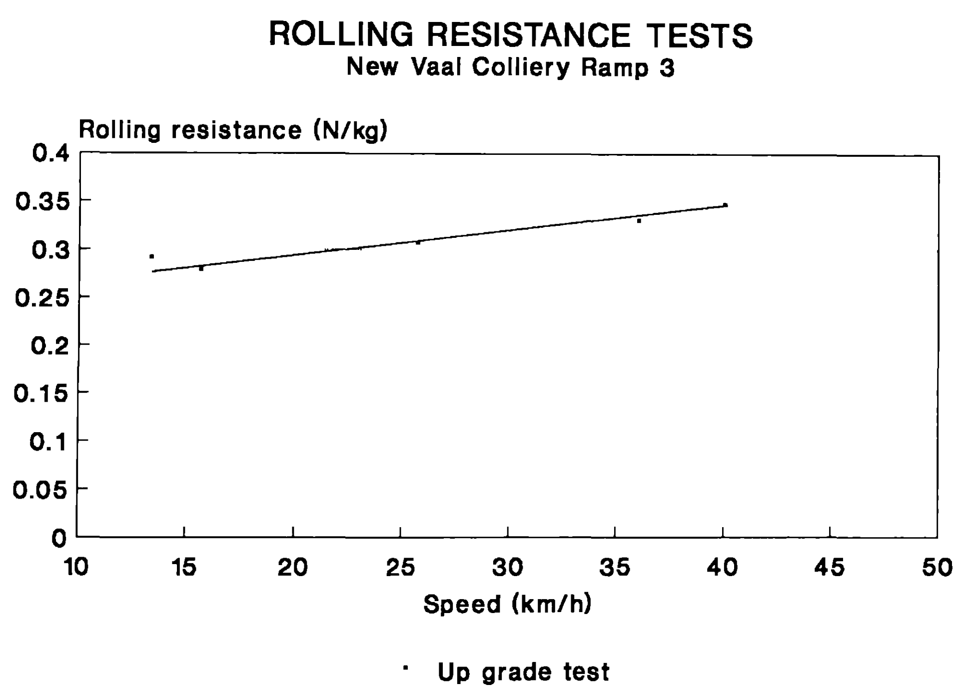

Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa Inflation




Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa inflation



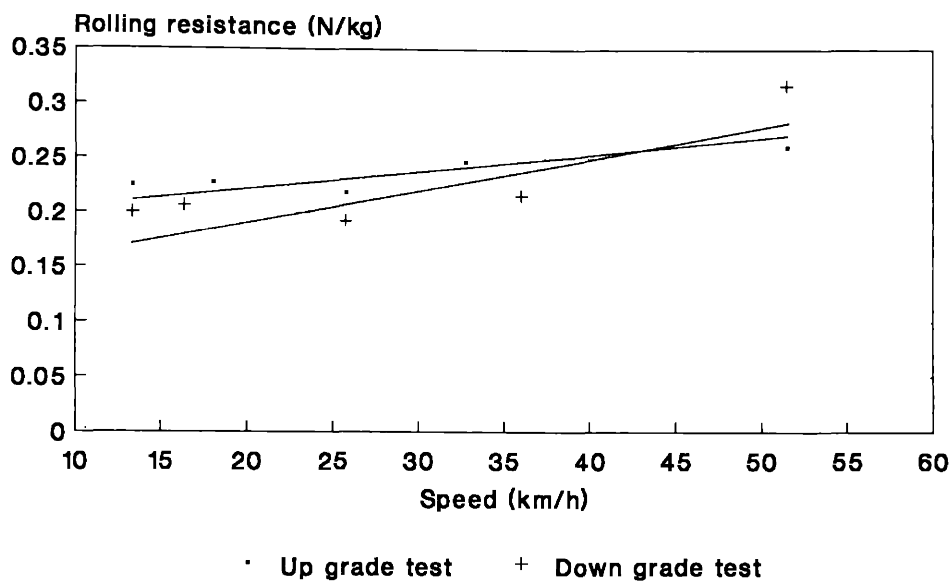

Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa inflation




Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa inflation

ROLLING RESISTANCE TESTS

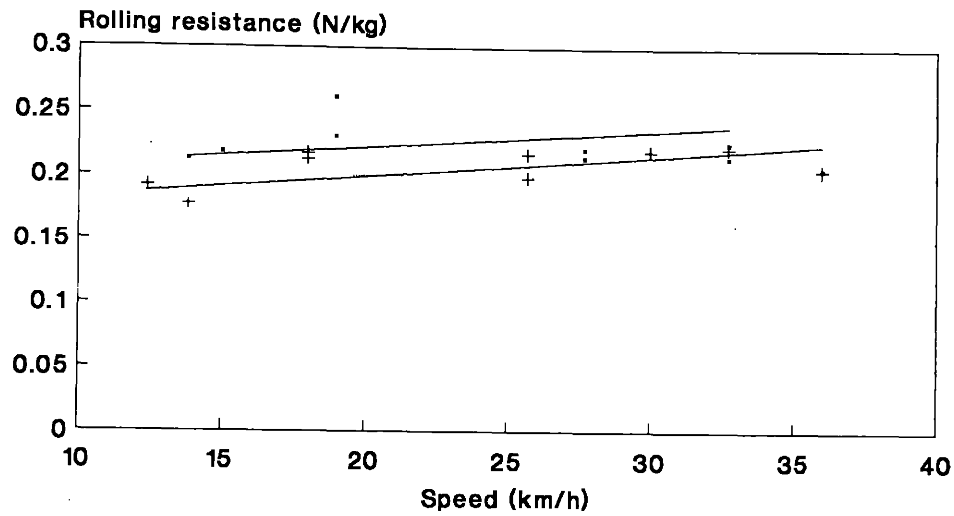
New Vaal Colliery Main Haul Road (R3)




Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa inflation

## ROLLING RESISTANCE TESTS

Kleinkopje Colliery 2A Haul Road

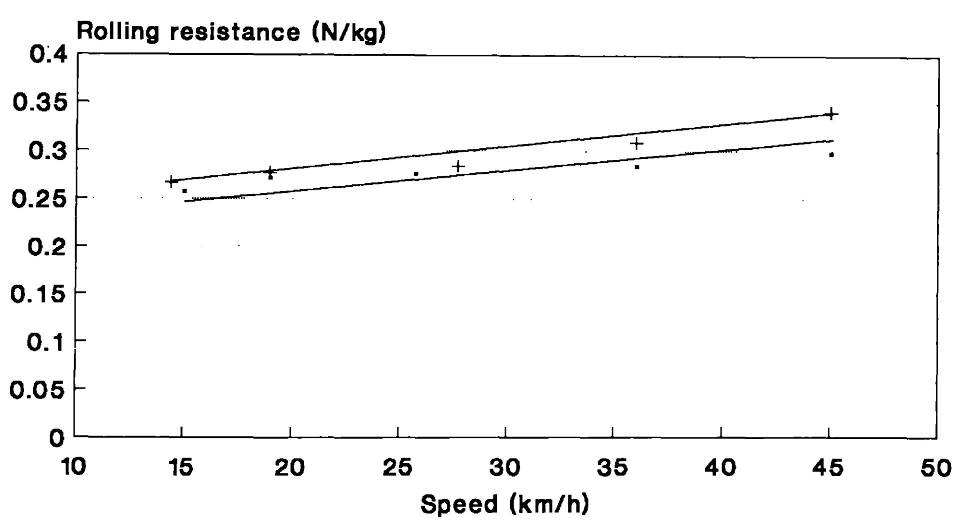



· Up grade test + Down grade test

Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa inflation

## ROLLING RESISTANCE TESTS

Kleinkopje Colliery Discards Road




· Up grade test + Down grade test

Using Toyota Hilux 2WD LWB
GVM 1266kg
190R14c tyres @ 190kPa inflation

# APPENDIX M

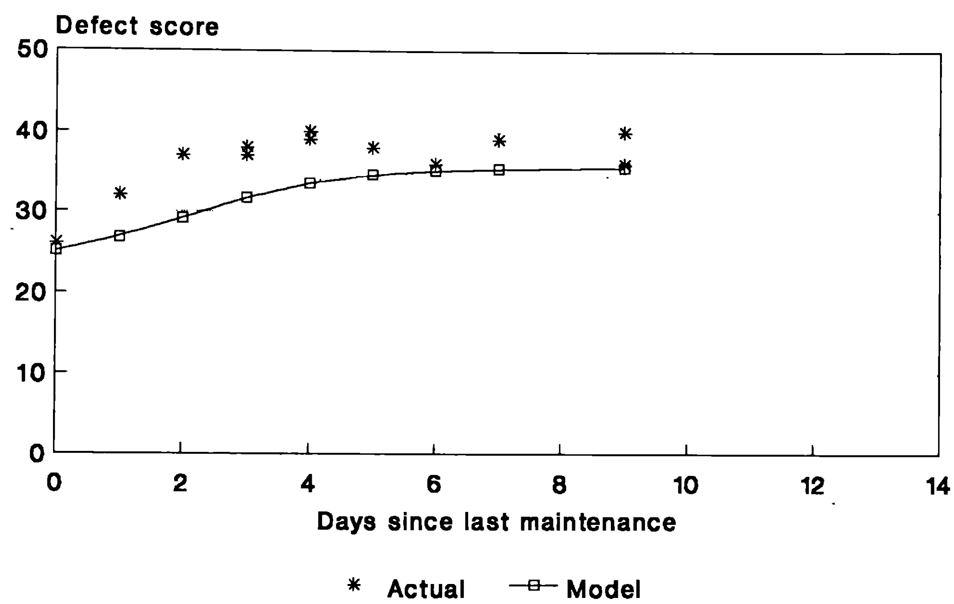
## APPLIED ROAD ROUGHNESS DEFECT SCORE PROGRESSION MODELS

M-2

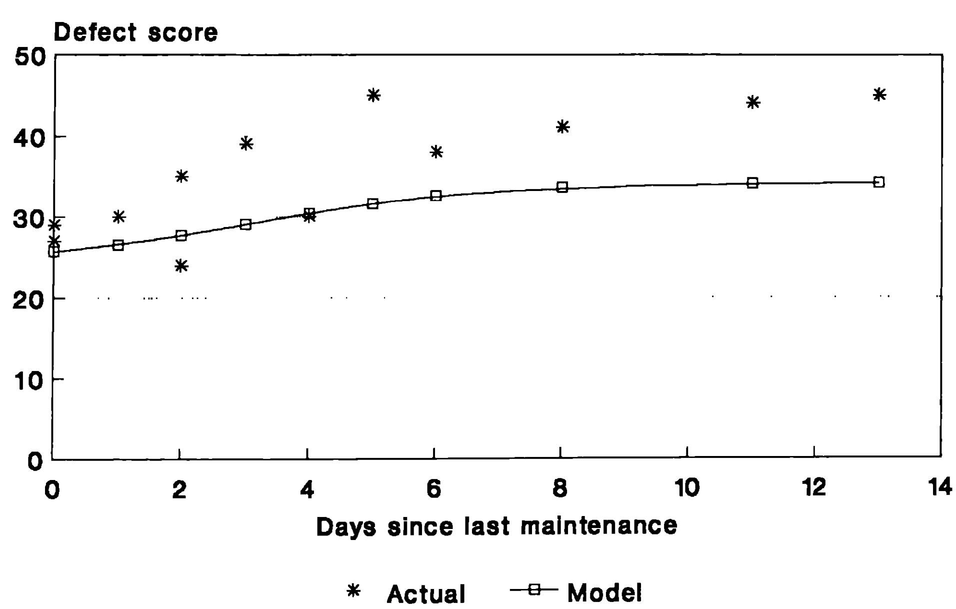
**Contents**

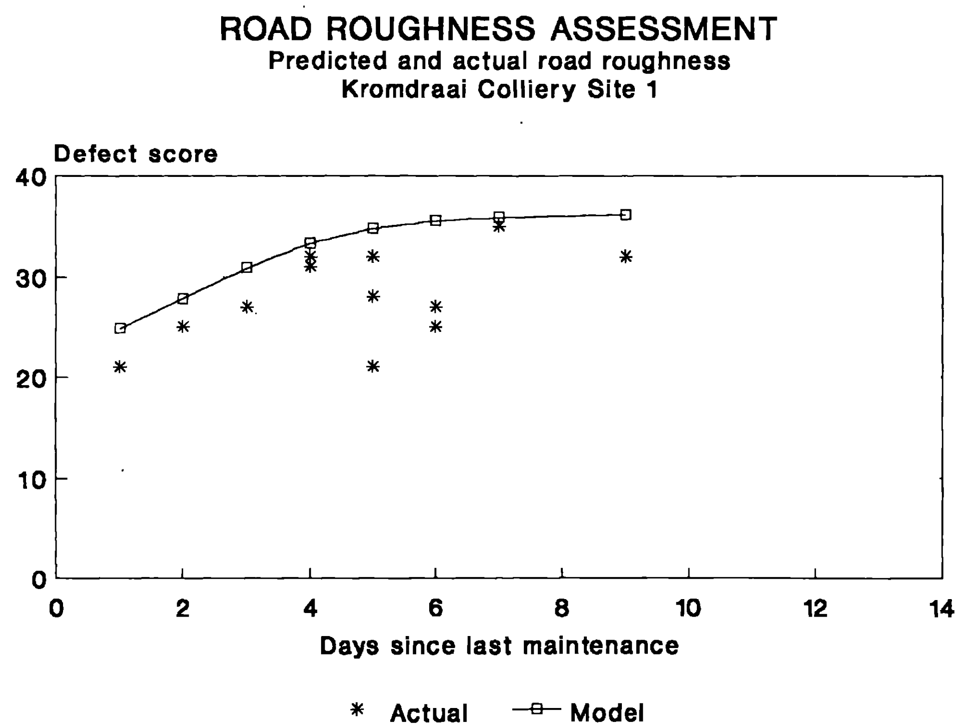
Comparison of individual mine site roughness progression (as measured during functional assessment) with roughness progression derived from model for mine sites comprising statistical data set;

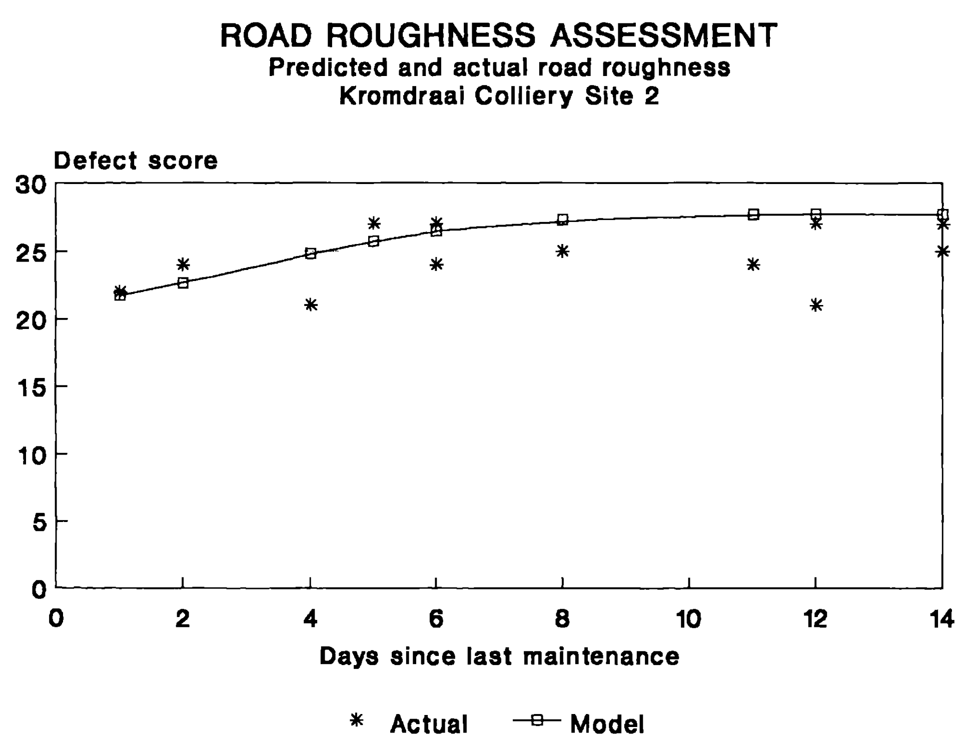
ROAD ROUGHNESS ASSESSMENT
Predicted and actual road roughness
Kriel Colliery Site 1

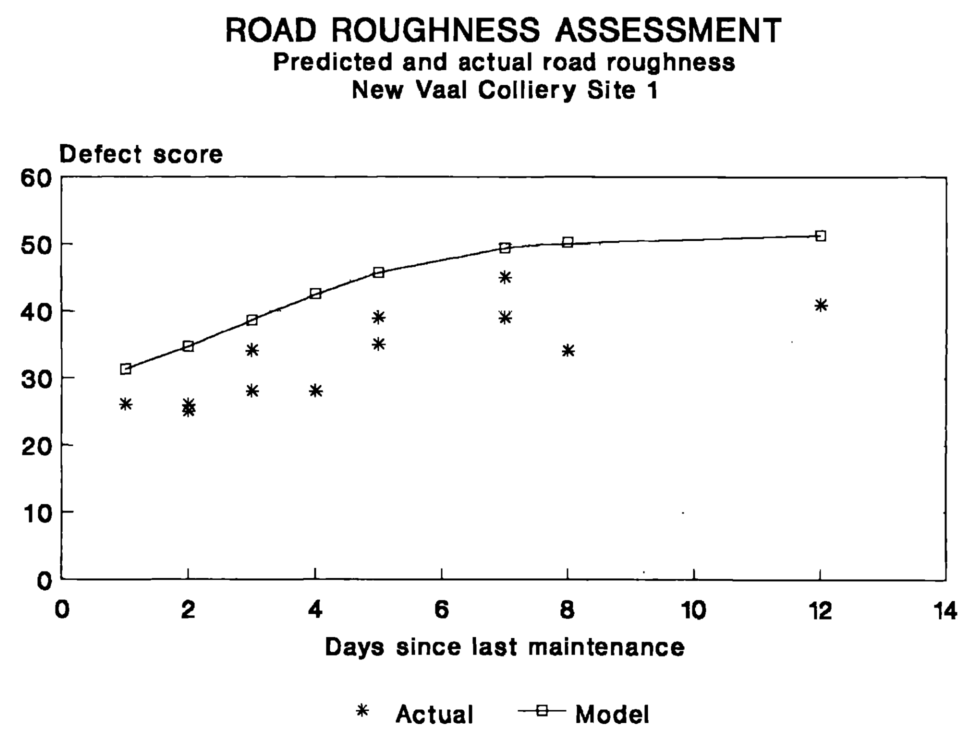


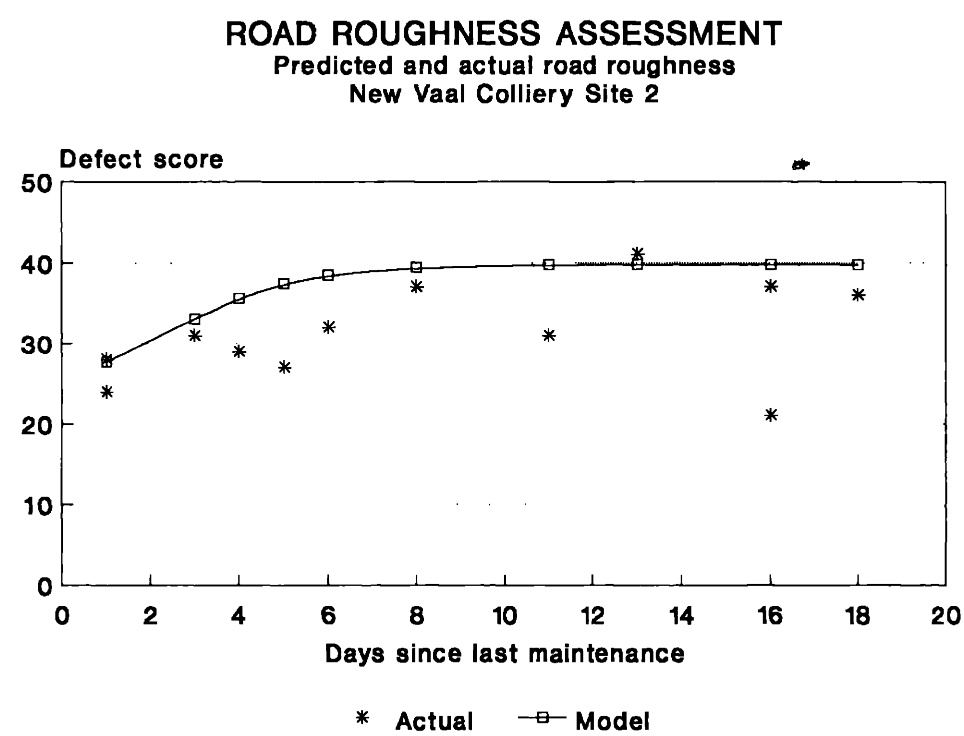

ROAD ROUGHNESS ASSESSMENT
Predicted and actual road roughness
Kriel Colliery Site 2



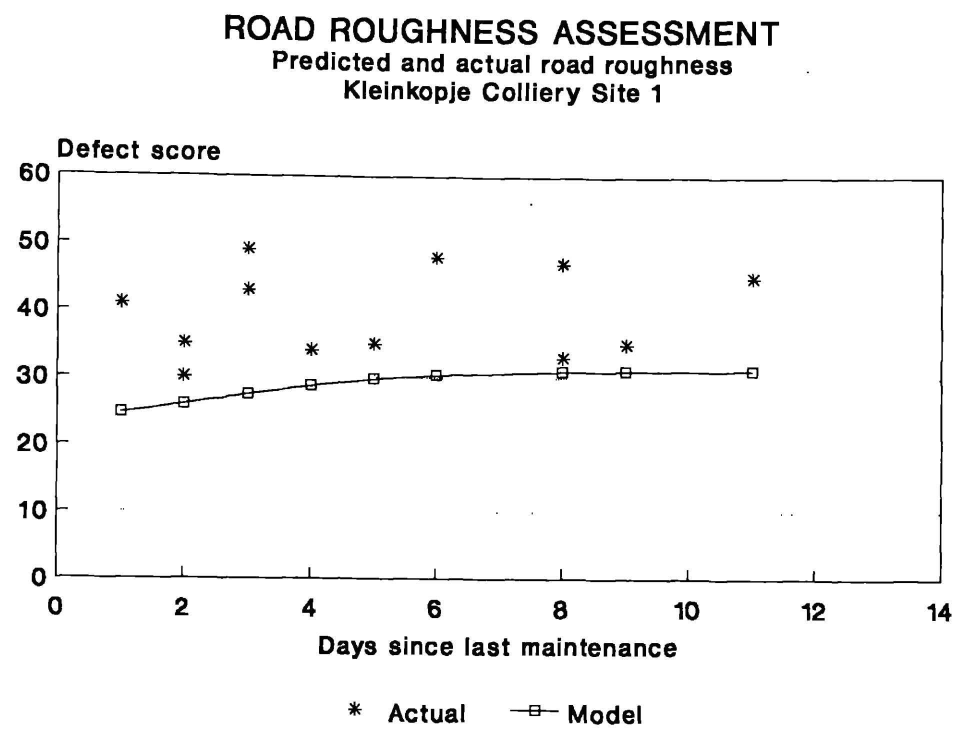

ROAD ROUGHNESS ASSESSMENT
Predicted and actual road roughness
Kromdraai Colliery Site 1
Defect score
40
30
20
10
0
0
2
4
6
8
10
12
14
Days since last maintenance
Actual
Model

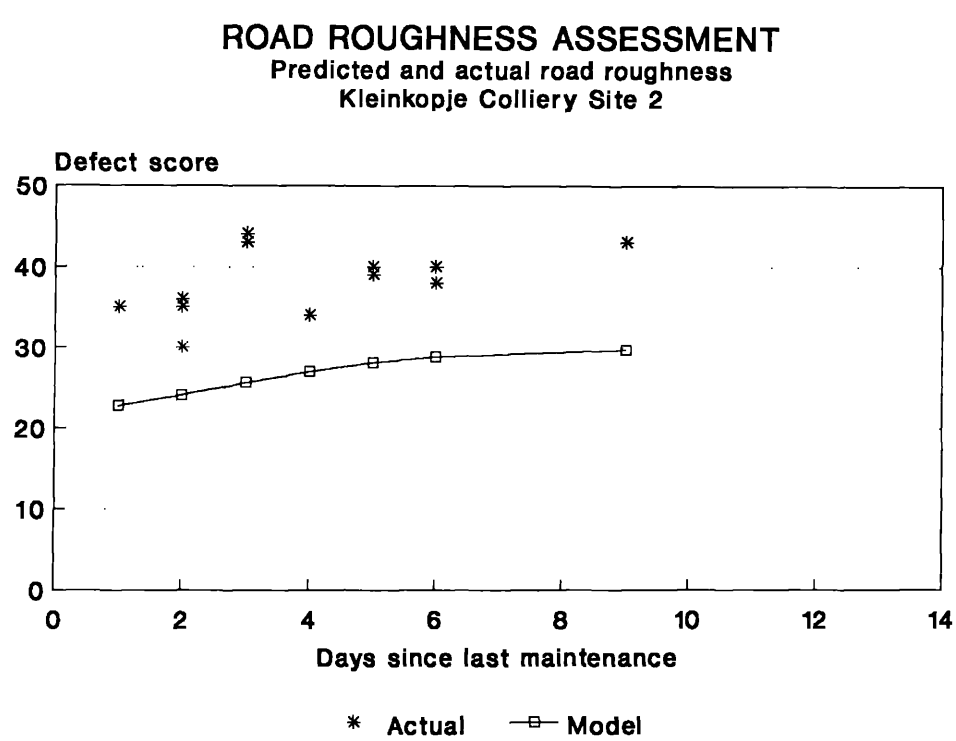

ROAD ROUGHNESS ASSESSMENT
Predicted and actual road roughness
Kromdraai Colliery Site 2
Defect score
30
25
20
15
10
5
0
0
2
4
6
8
10
12
14
Days since last maintenance
Actual
Model


ROAD ROUGHNESS ASSESSMENT
Predicted and actual road roughness
New Vaal Colliery Site 1
Defect score
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
Days since last maintenance
Actual
Model


ROAD ROUGHNESS ASSESSMENT
Predicted and actual road roughness
New Vaal Colliery Site 2
Defect score
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Days since last maintenance
Actual
Model

M-6


ROAD ROUGHNESS ASSESSMENT
Predicted and actual road roughness
Kleinkopje Colliery Site 1
Defect score
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
Days since last maintenance
Actual
Model


ROAD ROUGHNESS ASSESSMENT
Predicted and actual road roughness
Kleinkopje Colliery Site 2
Defect score
0
10
20
30
40
50
0
2
4
6
8
10
12
14
Days since last maintenance
Actual
Model

# APPENDIX N

## SPECIFICATIONS OF VEHICLE SIMULATION FLEET FOR FUEL CONSUMPTION MODELLING

**Caterpillar CAT 789**

| LOAD WEIGHT | VESSEL CAPACITY |
|---|---|
| 154.2 | 105.00 |
| (METRIC.T) | (CU.M 2:1) |

| TYPE | ENGINE | POWER (ex. 100HP) | COMMENT (Max. 18) |
|---|---|---|---|
| CAT789 | CAT3516 | 1800HP | 37.00-59 |

Mechanical drive, torque conv & DD lock-up

| WEIGHT | WHEELBASE (mm) | GRAVITY HEIGHT (mm) LOADED | EMPTY | GRAVITY RATIO *1 LOADED | EMPTY | |
|---|---|---|---|---|---|---|
| 119.800 | 5700 | 3780 | 2290 | 0.670 | 0.530 | ] |

*1 A=a/L

| TR. WIDTH (m) *2 | DEF.&FINAL RATIO | TIRE RADIUS(m) LOADED | EMPTY | |
|---|---|---|---|---|
| 14.0 | 25.4600 | 1.460 | 1.550 | ] |

** Oil Capacity of Components **

| (Engine) | (T/M) | (Final) | (Hydra.) | (Others) | |
|---|---|---|---|---|---|
| 199.0 | 300.0 | 583.0 | 318.0 | 1439.0 | ] V(Liter) |
| 250 | 1000 | 2000 | 2000 | 2000 | ] R(Hours) |

** Acceleration Factor **

| RATIO | FORWARD | REVERSE | |
|---|---|---|---|
| 5.048 | 0.433 | 0.100 | ] |
| 3.476 | 0.602 | 0.367 | ] |
| 2.222 | 0.752 | 0.536 | ] |
| 1.529 | 0.833 | 0.658 | ] |
| 1.000 | 0.885 | 0.746 | ] |
| 0.689 | 0.909 | 0.787 | ] |

** Travel Charactaristic Data **

| SPEED (Km/H) | (TONS) | GEAR | |
|---|---|---|---|
| 0.000 | 80.380 | 1 | ] |
| 1.600 | 80.000 | 1 | ] |
| 4.510 | 68.040 | 1 | ] |
| 8.000 | 45.360 | 1 | ] |
| 10.900 | 37.600 | 1 | ] |
| 11.600 | 32.700 | 1 | ] |
| 14.200 | 32.000 | 2 | ] |
| 15.100 | 27.200 | 2 | ] |
| 15.600 | 24.500 | 2 | ] |
| 18.300 | 22.700 | 3 | ] |
| 20.800 | 19.500 | 3 | ] |
| 21.200 | 18.100 | 3 | ] |
| 24.100 | 16.500 | 4 | ] |
| 27.700 | 14.700 | 4 | ] |
| 28.200 | 13.400 | 4 | ] |
| 29.900 | 13.300 | 5 | ] |
| 36.900 | 11.400 | 5 | ] |
| 38.500 | 10.000 | 5 | ] |
| 40.200 | 9.900 | 6 | ] |
| 50.400 | 8.200 | 6 | ] |
| 55.000 | 5.100 | 6 | ] |
| 55.100 | 0.000 | 6 | ] |

** Retarder Data **

| Rtw *5 (TONNES) | SPEED LIMIT (Km/H) DISTANCE | DISTANCE | DISTANCE | DISTANCE | |
|---|---|---|---|---|---|
| 0.0 | 55.0 | 55.0 | 55.0 | 55.0 | ] |
| 11.1 | 55.0 | 55.0 | 55.0 | 55.0 | ] |
| 12.0 | 55.0 | 55.0 | 55.0 | 41.7 | ] |
| 14.2 | 55.0 | 55.0 | 55.0 | 41.7 | ] |
| 15.0 | 55.0 | 55.0 | 55.0 | 30.0 | ] |
| 17.3 | 55.0 | 55.0 | 55.0 | 30.0 | ] |
| 19.2 | 55.0 | 55.0 | 41.7 | 30.0 | ] |
| 21.0 | 55.0 | 55.0 | 30.0 | 22.5 | ] |
| 23.1 | 41.7 | 41.7 | 30.0 | 22.5 | ] |
| 24.0 | 41.7 | 41.7 | 30.0 | 16.7 | ] |
| 24.3 | 30.0 | 30.0 | 30.0 | 16.7 | ] |
| 29.3 | 30.0 | 30.0 | 22.5 | 16.7 | ] |
| 30.0 | 22.5 | 22.5 | 22.5 | 16.7 | ] |
| 35.2 | 22.5 | 22.5 | 16.7 | 16.7 | ] |
| 38.1 | 16.7 | 16.7 | 16.7 | 12.8 | ] |
| 40.1 | 16.7 | 16.7 | 16.7 | 12.8 | ] |
| 45.2 | 16.7 | 16.7 | 12.8 | 12.8 | ] |
| 46.2 | 12.8 | 12.8 | 12.8 | 12.8 | ] |
| 51.0 | 12.8 | 12.8 | 12.8 | 9.0 | ] |

*5 Rtw=WEIGHT

** Fuel Consumption **

| ROTATION (RPM) | FUEL CM. (GR/PSh) | POWER (PS) | |
|---|---|---|---|
| 800 | 300.0 | 398.0 | ] |
| 1000 | 200.0 | 684.0 | ] |
| 1200 | 200.0 | 1039.0 | ] |
| 1400 | 164.0 | 1349.0 | ] |
| 1600 | 161.0 | 1537.0 | ] |
| 1800 | 162.0 | 1663.0 | ] |
| 2000 | 165.0 | 1636.0 | ] |
| 2200 | 175.0 | 800.0 | ] |
| 2300 | 200.0 | 192.0 | ] |
| 2360 | 700.0 | 0.0 | ] |

**Caterpillar CAT 785**

| LOAD WEIGHT | VESSEL CAPACITY |
|---|---|
| 117.9 | 78.00 |
| (METRIC.T) | (CU.M 2:1) |

| TYPE | ENGINE | POWER (ex. 100HP) | COMMENT (Max. 18) Mechanical drive, torque conv & DD lock-up |
|---|---|---|---|
| CAT785 | CAT3512 | 1380HP | 33.00-51 |

| WEIGHT | WHEELBASE (mm) | GRAVITY HEIGHT (mm) LOADED | EMPTY | GRAVITY RATIO *1 LOADED | EMPTY | *1 A=a/L |
|---|---|---|---|---|---|---|
| 94.900 | 5180 | 3375 | 2120 | 0.670 | 0.520 | ] |

| TR. WIDTH (m) *2 | DEF.&FINAL RATIO | TIRE RADIUS(m) LOADED | EMPTY | |
|---|---|---|---|---|
| 12.0 | 22.1000 | 1.395 | 1.475 | ] |

** Oil Capacity of Components **

| (Engine) | (T/M) | (Final) | (Hydra.) | (Others) | |
|---|---|---|---|---|---|
| 132.0 | 339.0 | 628.0 | 977.0 | 339.0 | ] V(Liter) |
| 250 | 1000 | 2000 | 2000 | 2000 | ] R(Hours) |

** Acceleration Factor **

| RATIO | LOADED | EMPTY | |
|---|---|---|---|
| 5.048 | 0.433 | 0.100 | ] |
| 3.475 | 0.602 | 0.367 | ] |
| 2.222 | 0.752 | 0.536 | ] |
| 1.529 | 0.833 | 0.658 | ] |
| 1.000 | 0.885 | 0.746 | ] |
| 0.689 | 0.909 | 0.787 | ] |

** Travel Charactaristic Data **

| SPEED (Km/H) | (TONS) | GEAR | |
|---|---|---|---|
| 0.000 | 78.300 | 1 | ] |
| 2.000 | 68.000 | 1 | ] |
| 5.000 | 50.000 | 1 | ] |
| 7.700 | 35.400 | 1 | ] |
| 7.800 | 35.000 | 1 | ] |
| 10.000 | 30.800 | 1 | ] |
| 11.200 | 25.000 | 1 | ] |
| 11.300 | 24.800 | 2 | ] |
| 14.600 | 21.000 | 2 | ] |
| 15.400 | 18.600 | 2 | ] |
| 15.500 | 18.500 | 3 | ] |
| 20.000 | 15.000 | 3 | ] |
| 20.400 | 13.800 | 3 | ] |
| 20.500 | 13.600 | 4 | ] |
| 26.900 | 11.340 | 4 | ] |
| 27.700 | 10.100 | 4 | ] |
| 27.800 | 10.000 | 5 | ] |
| 36.900 | 8.100 | 5 | ] |
| 37.700 | 7.500 | 5 | ] |
| 37.800 | 7.400 | 6 | ] |
| 40.800 | 7.300 | 6 | ] |
| 50.000 | 6.200 | 6 | ] |
| 53.800 | 3.630 | 6 | ] |
| 54.000 | 0.000 | 6 | ] |

** Retarder Data **

| Rtw *5 (TONNES) | SPEED LIMIT (Km/H) DISTANCE | DISTANCE | DISTANCE | DISTANCE | *5 Rtw=WEIGHT |
|---|---|---|---|---|---|
| 0.0 | 58.0 | 58.0 | 58.0 | 58.0 | ] |
| 5.0 | 58.0 | 58.0 | 58.0 | 58.0 | ] |
| 7.0 | 58.0 | 58.0 | 58.0 | 58.0 | ] |
| 12.7 | 58.0 | 58.0 | 58.0 | 43.0 | ] |
| 16.6 | 58.0 | 58.0 | 43.0 | 31.6 | ] |
| 16.9 | 43.0 | 43.0 | 31.6 | 31.6 | ] |
| 18.9 | 43.0 | 43.0 | 31.6 | 23.3 | ] |
| 22.4 | 31.6 | 31.6 | 23.3 | 23.3 | ] |
| 27.8 | 23.3 | 23.3 | 17.2 | 17.2 | ] |
| 29.6 | 17.2 | 17.2 | 17.2 | 17.2 | ] |
| 33.6 | 17.2 | 17.2 | 12.7 | 12.7 | ] |
| 40.0 | 12.7 | 12.7 | 12.7 | 12.7 | ] |
| 40.5 | 12.7 | 12.7 | 12.7 | 11.0 | ] |
| 41.8 | 12.7 | 12.7 | 11.0 | 5.0 | ] |

** Fuel Consumption **

| ROTATION (RPM) | FUEL CM. (GR/PSh) | POWER (PS) | |
|---|---|---|---|
| 800 | 193.0 | 472.0 | ] |
| 100 | 177.5 | 705.0 | ] |
| 1200 | 167.0 | 925.0 | ] |
| 1400 | 158.0 | 1175.0 | ] |
| 1600 | 155.0 | 1334.0 | ] |
| 1800 | 154.3 | 1350.0 | ] |
| 2000 | 157.5 | 1312.0 | ] |
| 2050 | 159.0 | 1200.0 | ] |

**Euclid R170**

| LOAD WEIGHT (METRIC.T) | VESSEL CAPACITY (CU.M 2:1) |
|---|---|
| 154.2 | 105.00 |

| TYPE | ENGINE | POWER | COMMENT (Max. 18) Torque conv & DD lock-up to electric WM |
|---|---|---|---|
| R170 | Cummins KTA50C | 1800HP | 37.00-59 |

WHEELBASE GRAVITY HEIGHT (mm) GRAVITY RATIO *1 *1 A=a/L

| WEIGHT | WHEELBASE (mm) | GRAVITY HEIGHT LOADED | GRAVITY HEIGHT EMPTY | GRAVITY RATIO LOADED | GRAVITY RATIO EMPTY | |
|---|---|---|---|---|---|---|
| 119.800 | 5700 | 3780 | 2290 | 0.670 | 0.530 | ] |

| TR. WIDTH (m) *2 | DEF.&FINAL RATIO | TIRE RADIUS(m) LOADED | TIRE RADIUS(m) EMPTY | |
|---|---|---|---|---|
| 14.0 | 25.4600 | 1.460 | 1.550 | ] |

** Oil Capacity of Components **

| (Engine) | (T/M) | (Final) | (Hydra.) | (Others) | |
|---|---|---|---|---|---|
| 199.0 | 300.0 | 583.0 | 318.0 | 1439.0 | ] V(Liter) |
| 250 | 1000 | 2000 | 2000 | 2000 | ] R(Hours) |

** Acceleration Factor **

| RATIO | FORWARD | REVERSE | |
|---|---|---|---|
| 5.048 | 0.433 | 0.100 | ] |
| 3.476 | 0.602 | 0.367 | ] |
| 2.222 | 0.752 | 0.536 | ] |
| 1.529 | 0.833 | 0.658 | ] |
| 1.000 | 0.885 | 0.746 | ] |
| 0.689 | 0.909 | 0.787 | ] |

** Travel Charactaristic Data **

| SPEED (Km/H) | (TONS) | GEAR | |
|---|---|---|---|
| 0.000 | 80.380 | 1 | ] |
| 1.600 | 80.000 | 1 | ] |
| 4.510 | 68.040 | 1 | ] |
| 8.000 | 45.360 | 1 | ] |
| 10.900 | 37.600 | 1 | ] |
| 11.600 | 32.700 | 1 | ] |
| 14.200 | 32.000 | 2 | ] |
| 15.100 | 27.200 | 2 | ] |
| 15.600 | 24.500 | 2 | ] |
| 18.300 | 22.700 | 3 | ] |
| 20.800 | 19.500 | 3 | ] |
| 21.200 | 18.100 | 3 | ] |
| 24.100 | 16.500 | 4 | ] |
| 27.700 | 14.700 | 4 | ] |
| 28.200 | 13.400 | 4 | ] |
| 29.900 | 13.300 | 5 | ] |
| 36.900 | 11.400 | 5 | ] |
| 38.500 | 10.000 | 5 | ] |
| 40.200 | 9.900 | 6 | ] |
| 50.400 | 8.200 | 6 | ] |
| 55.000 | 5.100 | 6 | ] |
| 55.100 | 0.000 | 6 | ] |

** Retarder Data **

| Rtw *5 (TONNES) | SPEED LIMIT (Km/H) DISTANCE | DISTANCE | DISTANCE | DISTANCE | *5 Rtw=WEIGHT |
|---|---|---|---|---|---|
| 0.0 | 55.0 | 55.0 | 55.0 | 55.0 | ] |
| 11.1 | 55.0 | 55.0 | 55.0 | 55.0 | ] |
| 12.0 | 55.0 | 55.0 | 55.0 | 41.7 | ] |
| 14.2 | 55.0 | 55.0 | 55.0 | 41.7 | ] |
| 15.0 | 55.0 | 55.0 | 55.0 | 30.0 | ] |
| 17.3 | 55.0 | 55.0 | 55.0 | 30.0 | ] |
| 19.2 | 55.0 | 55.0 | 41.7 | 30.0 | ] |
| 21.0 | 55.0 | 55.0 | 30.0 | 22.5 | ] |
| 23.1 | 41.7 | 41.7 | 30.0 | 22.5 | ] |
| 24.0 | 41.7 | 41.7 | 30.0 | 16.7 | ] |
| 24.3 | 30.0 | 30.0 | 30.0 | 16.7 | ] |
| 29.3 | 30.0 | 30.0 | 22.5 | 16.7 | ] |
| 30.0 | 22.5 | 22.5 | 22.5 | 16.7 | ] |
| 35.2 | 22.5 | 22.5 | 16.7 | 16.7 | ] |
| 38.1 | 16.7 | 16.7 | 16.7 | 12.8 | ] |
| 40.1 | 16.7 | 16.7 | 16.7 | 12.8 | ] |
| 45.2 | 16.7 | 16.7 | 12.8 | 12.8 | ] |
| 46.2 | 12.8 | 12.8 | 12.8 | 12.8 | ] |
| 51.0 | 12.8 | 12.8 | 12.8 | 9.0 | ] |

** Fuel Consumption **

| ROTATION (RPM) | FUEL CM. (GR/PSh) | POWER (PS) | |
|---|---|---|---|
| 800 | 300.0 | 398.0 | ] |
| 1000 | 200.0 | 684.0 | ] |
| 1200 | 200.0 | 1039.0 | ] |
| 1400 | 164.0 | 1349.0 | ] |
| 1600 | 161.0 | 1537.0 | ] |
| 1800 | 162.0 | 1663.0 | ] |
| 2000 | 165.0 | 1636.0 | ] |
| 2200 | 175.0 | 800.0 | ] |
| 2300 | 200.0 | 192.0 | ] |
| 2360 | 700.0 | 0.0 | ] |

**Dresser-Haulpak 630EH**

| LOAD WEIGHT | VESSEL CAPACITY |
|---|---|
| 163.0 | 103.00 |
| (METRIC.T) | (CU.M 2:1) |

| TYPE | ENGINE | POWER | COMMENT (Max. 18) Torque conv & DD lock-up to electric WM |
|---|---|---|---|
| HPK630E | Detroit 16v 14977B | 1800HP | 36.00-51 |

| WEIGHT | WHEELBASE (mm) | GRAVITY HEIGHT (mm) LOADED | EMPTY | GRAVITY RATIO *1 LOADED | EMPTY | |
|---|---|---|---|---|---|---|
| | | | | | | *1 A=a/L |
| 114.100 | 5440 | 3780 | 2290 | 0.667 | 0.508 | ] |

| TR. WIDTH (m) *2 | DEF.&FINAL RATIO | TIRE RADIUS(m) LOADED | EMPTY | |
|---|---|---|---|---|
| 14.0 | 24.8100 | 1.460 | 1.550 | ] |

** Oil Capacity of Components **

| | | | | | |
|---|---|---|---|---|---|
| 214.0 | 1.0 | 34.0 | 496.0 | 314.0 | ] V(Liter) |
| 250 | 1000 | 2000 | 2000 | 2000 | ] R(Hours) |
| (Engine) | (T/M) | (Final) | (Hydra.) | (Others) | |

** Acceleration Factor **

| RATIO | LOADED | EMPTY | |
|---|---|---|---|
| 5.650 | 0.682 | 0.467 | ] |
| 4.290 | 0.786 | 0.599 | ] |
| 3.180 | 0.862 | 0.718 | ] |
| 2.500 | 0.910 | 0.805 | ] |
| 1.850 | 0.939 | 0.862 | ] |
| 1.350 | 0.960 | 0.907 | ] |
| 1.000 | 0.959 | 0.905 | ] |

** Travel Charactaristic Data **

| SPEED (Km/H) | (TONS) | GEAR | |
|---|---|---|---|
| 0.100 | 68.000 | 1 | ] |
| 4.000 | 68.000 | 1 | ] |
| 7.300 | 45.400 | 1 | ] |
| 8.050 | 40.800 | 1 | ] |
| 9.660 | 36.300 | 1 | ] |
| 11.270 | 31.800 | 2 | ] |
| 13.690 | 27.200 | 3 | ] |
| 16.910 | 22.680 | 4 | ] |
| 21.410 | 18.140 | 5 | ] |
| 28.820 | 13.610 | 6 | ] |
| 35.100 | 11.340 | 7 | ] |
| 39.450 | 9.070 | 7 | ] |
| 45.890 | 6.800 | 7 | ] |
| 52.300 | 5.260 | 7 | ] |
| 52.300 | 4.000 | 7 | ] |
| 52.300 | 3.000 | 7 | ] |
| 52.300 | 2.000 | 7 | ] |
| 52.300 | 1.000 | 7 | ] |
| 52.300 | 0.000 | 7 | ] |
| 52.300 | 0.000 | 7 | ] |

** Retarder Data **

| Rtw *5 | SPEED LIMIT (Km/H) | | | | | *5 Rtw=WEIGHT |
|---|---|---|---|---|---|---|
| (TONNES) | 300M - | 300-450M | 450-700M | 700M - | | |
| 0.0 | 52.3 | 52.3 | 52.3 | 52.3 | ] | |
| 5.0 | 52.3 | 52.3 | 52.3 | 52.3 | ] | |
| 9.0 | 52.3 | 52.3 | 52.3 | 52.3 | ] | |
| 11.3 | 47.5 | 47.5 | 47.5 | 47.5 | ] | |
| 13.6 | 43.5 | 43.5 | 43.5 | 43.5 | ] | |
| 15.9 | 41.1 | 41.1 | 41.1 | 41.1 | ] | |
| 18.1 | 38.2 | 38.2 | 38.2 | 38.2 | ] | |
| 22.7 | 33.5 | 33.5 | 33.5 | 33.5 | ] | |
| 27.2 | 28.2 | 28.2 | 28.2 | 28.2 | ] | |
| 31.8 | 24.0 | 24.0 | 24.0 | 24.0 | ] | |
| 35.8 | 20.9 | 20.9 | 20.9 | 20.9 | ] | |
| 35.8 | 15.0 | 15.0 | 15.0 | 15.0 | ] | |
| 36.0 | 8.5 | 8.5 | 8.5 | 8.5 | ] | |
| 36.0 | 0.1 | 0.1 | 0.1 | 0.1 | ] | |

** Fuel Consumption **

| ROTATION | FUEL CM. | POWER | |
|---|---|---|---|
| (RPM) | (GR/PSh) | (PS) | |
| 800 | 305.0 | 398.0 | ] |
| 1000 | 205.0 | 684.0 | ] |
| 1200 | 205.0 | 1039.0 | ] |
| 1400 | 170.0 | 1349.0 | ] |
| 1600 | 163.0 | 1535.0 | ] |
| 1800 | 165.0 | 1660.0 | ] |
| 2000 | 167.0 | 1636.0 | ] |
| 2200 | 178.0 | 882.0 | ] |
| 2300 | 200.0 | 193.0 | ] |
| 2360 | 700.0 | 0.0 | ] |

## Caterpillar CAT 793

| LOAD WEIGHT | VESSEL CAPACITY |
|---|---|
| 218.0 | 129.40 |
| (METRIC.T) | (CU.M 2:1) |

| TYPE | ENGINE | POWER | COMMENT (Max. 18) Mechanical drive, torque conv & DD lock-up |
|---|---|---|---|
| CAT793 | CAT3516 | 2160HP | 40.00-57 |

| | WHEELBASE | GRAVITY HEIGHT (mm) | | GRAVITY RATIO *1 | *1 A=a/L |
|---|---|---|---|---|---|
| WEIGHT | (mm) | LOADED | EMPTY | LOADED | EMPTY |
| 143.900 | 5900 | 4330 | 2630 | 0.664 | 0.531 ] |

| TR. WIDTH (m) *2 | DEF.&FINAL RATIO | TIRE RADIUS(m) LOADED | EMPTY |
|---|---|---|---|
| 20.0 | 26.8000 | 1.490 | 1.570 ] |

** Oil Capacity of Components **

| (Engine) | (T/M) | (Final) | (Hydra.) | (Others) | |
|---|---|---|---|---|---|
| 199.0 | 300.0 | 662.0 | 189.0 | 1136.0 | ] V(Liter) |
| 250 | 1000 | 2000 | 2000 | 200 | ] R(Hours) |

** Acceleration Factor **

| RATIO | LOADED | EMPTY |
|---|---|---|
| 5.048 | 0.433 | 0.100 ] |
| 3.476 | 0.602 | 0.367 ] |
| 2.222 | 0.752 | 0.536 ] |
| 1.529 | 0.833 | 0.658 ] |
| 1.000 | 0.885 | 0.746 ] |
| 0.689 | 0.909 | 0.787 ] |

** Travel Charactaristic Data **

| SPEED (Km/H) | (TONS) | GEAR | |
|---|---|---|---|
| 0.000 | 98.700 | 1 | ] |
| 2.500 | 90.700 | 1 | ] |
| 8.200 | 55.000 | 1 | ] |
| 11.500 | 40.000 | 1 | ] |
| 12.000 | 39.000 | 2 | ] |
| 14.000 | 35.000 | 2 | ] |
| 15.500 | 30.000 | 2 | ] |
| 16.000 | 29.500 | 3 | ] |
| 20.500 | 25.000 | 3 | ] |
| 21.000 | 22.200 | 4 | ] |
| 27.000 | 18.100 | 4 | ] |
| 28.500 | 15.600 | 4 | ] |
| 36.000 | 13.700 | 5 | ] |
| 37.500 | 12.000 | 5 | ] |
| 43.500 | 11.340 | 6 | ] |
| 50.000 | 9.500 | 6 | ] |
| 53.600 | 6.200 | 6 | ] |
| 53.600 | 0.000 | 6 | ] |

** Retarder Data **

| Rtw *5 (TONNES) | SPEED LIMIT (Km/H) DISTANCE | DISTANCE | DISTANCE | DISTANCE | *5 Rtw=WEIGHT |
|---|---|---|---|---|---|
| 0.0 | 54.0 | 54.0 | 54.0 | 54.0 | ] |
| 12.9 | 54.0 | 54.0 | 54.0 | 54.0 | ] |
| 14.0 | 54.0 | 54.0 | 54.0 | 40.5 | ] |
| 20.7 | 54.0 | 54.0 | 54.0 | 40.5 | ] |
| 25.0 | 54.0 | 54.0 | 40.5 | 29.5 | ] |
| 27.6 | 40.5 | 40.5 | 40.5 | 29.5 | ] |
| 31.0 | 40.5 | 40.5 | 29.5 | 22.0 | ] |
| 32.0 | 29.5 | 29.5 | 29.5 | 22.0 | ] |
| 33.6 | 29.5 | 29.5 | 29.5 | 22.0 | ] |
| 36.2 | 29.5 | 29.5 | 22.0 | 22.0 | ] |
| 38.8 | 29.5 | 29.5 | 22.0 | 16.4 | ] |
| 40.0 | 22.0 | 22.0 | 22.0 | 16.4 | ] |
| 41.4 | 22.0 | 22.0 | 22.0 | 16.4 | ] |
| 42.0 | 22.0 | 22.0 | 16.4 | 16.4 | ] |
| 47.4 | 22.0 | 22.0 | 16.4 | 16.4 | ] |
| 48.0 | 16.4 | 16.4 | 16.4 | 16.4 | ] |
| 50.0 | 16.4 | 16.4 | 16.4 | 16.4 | ] |
| 60.3 | 16.4 | 16.4 | 12.0 | 12.0 | ] |
| 61.0 | 12.0 | 12.0 | 12.0 | 12.0 | ] |
| 64.7 | 12.0 | 12.0 | 9.0 | 9.0 | ] |

** Fuel Consumption **

| ROTATION (RPM) | FUEL CM. (GR/PSh) | POWER (PS) | |
|---|---|---|---|
| 800 | 360.0 | 478.0 | ] |
| 1000 | 240.0 | 821.0 | ] |
| 1200 | 240.0 | 1247.0 | ] |
| 1400 | 197.0 | 1620.0 | ] |
| 1600 | 193.0 | 1844.0 | ] |
| 1800 | 195.0 | 1996.0 | ] |
| 2000 | 198.0 | 1963.0 | ] |
| 2200 | 210.0 | 960.0 | ] |
| 2300 | 240.0 | 230.0 | ] |
| 2360 | 840.0 | 0.0 | ] |

# APPENDIX O

## MINE HAUL ROAD GEOEMETRY AND PRODUCTION STATISTICS

| KRIEL COLLIERY<br>ROAD GEOMETRY AND COAL PRODUCTION STATISTICS SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Haul road section** | **ROM tons (pa)** | **Length of section (m)** | **Rise (+) or fall (-) of section (m)** | **Grade (%)** | **Curvature of section (°)** | **Curvature (°/km)** |
| MAIN | 4703000 | 4660 | 70.2 | 1.51 | 134 | 28.76 |
| R6 | 1061000 | 1920 | 17.4 | 0.91 | 82 | 42.71 |
| R7 | 2482000 | 2190 | 31.3 | 1.43 | 56 | 25.57 |
| R8/11 | 1160000 | 3785 | 36.3 | 0.96 | 141 | 37.25 |

**KROMDRAAI COLLIERY**

**ROAD GEOMETRY AND COAL PRODUCTION STATISTICS SUMMARY**

| Haul road section | ROM tons (pa) 4200265 | Length of section (m) | Rise (+) or fall (-) of section (m) | Grade (%) | Curvature of section (°) | Curvature (°/km) |
|---|---|---|---|---|---|---|
| RAMP-TIP | | 195 | 11 | 5.64 | 0 | 0.00 |
| MAIN | 4200265 | 943 | -16 | -1.70 | 0 | 0.00 |
| HR1 | 3520159 | 3240 | 32 | 0.99 | 296 | 91.36 |
| HR2 | 680106 | 4530 | 25 | 0.55 | 97 | 21.41 |

| NEW VAAL COLLIERY<br>ROAD GEOMETRY AND COAL PRODUCTION STATISTICS SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Haul road section** | **ROM tons (pa)** | **Length of section (m)** | **Rise (+) or fall (-) of section (m)** | **Grade (%)** | **Curvature of section (°)** | **Curvature (°/km)** |
| RAMP-TIP | 14451000 | 36 | 6 | 16.67 | 16 | 444.44 |
| MAIN | 14451000 | 540 | 0.6 | 0.11 | 35 | 64.81 |
| R0-R2 | 9200000 | 1580 | 2.8 | 0.18 | 32 | 20.25 |
| R2-R3 | 6685000 | 1010 | 5.1 | 0.50 | 0 | 0.00 |
| R3-R4 | 4497000 | 698 | 2.7 | 0.39 | 0 | 0.00 |
| R4-R6/7 | 3950000 | 800 | -7.4 | -0.93 | 16 | 20.00 |
| R6/7-R9 | 1420000 | 581 | 0.6 | 0.10 | 0 | 0.00 |
| R0 | 5299000 | 650 | 19 | 2.92 | 56 | 86.15 |
| R2 | 2515000 | 490 | 17 | 3.47 | 0 | 0.00 |
| R3 | 2187000 | 830 | 21 | 2.53 | 0 | 0.00 |
| R4 | 547000 | 640 | 28 | 4.38 | 76 | 118.75 |
| R6/7 | 2530000 | 820 | 24 | 2.93 | 24 | 29.27 |
| R9 | 1420000 | 510 | 27 | 5.29 | 184 | 360.78 |

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YUNIBESITHI YA PRETORIA

**KLEINKOPJE COLLIERY**

**ROAD GEOMETRY AND COAL PRODUCTION STATISTICS SUMMARY**

| Haul road section | ROM tons (pa) | Length of section (m) | Rise (+) or fall (-) of section (m) | Grade (%) | Curvature of section (°) | Curvature (°/km) |
|---|---|---|---|---|---|---|
| MAIN-TIP | 5241000 | 498 | 1 | 0.20 | 0 | 0.00 |
| 5W-MAIN | 1882000 | 2217 | 40 | 1.80 | 80 | 36.08 |
| R13/14-MAIN | 2173000 | 2457 | 41 | 1.67 | 34 | 13.84 |
| 2A9-MAIN | 1186000 | 1503 | 41 | 2.73 | 74 | 49.23 |
| 2A8-MAIN | 395000 | 896 | 11 | 1.23 | 0 | 0.00 |
| 2A7-MAIN | 395000 | 440 | 0 | 0.00 | 0 | 0.00 |
| 3A-TIP | 2743000 | 2276 | 4 | 0.18 | 21 | 9.23 |
| R15 | 627000 | 753 | 17 | 2.26 | 12 | 15.94 |
| R16 | 627000 | 918 | 19 | 2.07 | 28 | 30.50 |
| R17 | 628000 | 1435 | 23 | 1.60 | 64 | 44.60 |
| R7 | 395000 | 355 | 6.1 | 1.72 | 0 | 0.00 |
| R8 | 395000 | 386 | 8.8 | 2.28 | 0 | 0.00 |
| R9 | 396000 | 522 | 10.2 | 1.95 | 0 | 0.00 |

# APPENDIX P

## LISTING OF HAUL ROAD MMS MODEL COMPUTER PROGRAM AND ASSESSMENT DATA

```
REM     Program HAULOPT
REM     To investigate optimum maintenance frequency for lowest overall
REM     vehicle operating and road maintenance total cost.
REM     By R J Thompson March 1996
REM     Version 1 of March 1996

COMMON SHARED segdata(), segname$(), segm!, mfleet(), voccostmod(), minename$
DECLARE SUB optimalsol ()
DECLARE SUB tot ()
DECLARE SUB maintcost ()
DECLARE SUB totalvoccost ()
DECLARE SUB othercost ()
DECLARE SUB speed ()
DECLARE SUB costmodeledit ()
DECLARE SUB datain ()
DECLARE SUB titles ()
DECLARE SUB costmodels ()

'***********************ERROR HANDLER*************************************
xox:
SCREEN 9: COLOR 15
ON ERROR GOTO ERRORHANDLER
KEY 1, " Quit"
ON KEY(1) GOSUB ENDPROG
KEY(1) ON
KEY 3, ""
KEY(3) OFF
KEY 7, ""
KEY(7) OFF
KEY ON

'************************Read initial data and titles***********************
CALL titles
CALL datain

'*****************Edit cost model equations and read var data****************

CALL costmodels

'**********************Calculate speeds, fuel and fuel cost*****************

' Based on total cost per segment according to length, tonnage
' and vehicle passes per day

CALL speed

'**********************Calculate tyre, parts and labour costs***************

' Based on total cost per segment according to length, tonnage
' and vehicle passes per day

CALL othercost
```

```
'**************************Calculate total VOC per section*******************

'Add individual segment costs to get total segment VOC variation with
'days since last maintenance

CALL totalvoccost

'************************Calc total maintenance cost per section***************

'Calculate total road maintenance costs and productivity
'for each section over maintenance interval.

CALL maintcost

'*******************************Calc total costs*******************************

'Calculate total cost for each segment and the complete haul

CALL tot

'************************Calc optimal maintenance policy**********************

CALL optimalsol

LOCATE 23, 54: COLOR 14, 1: PRINT ; "Press any key to exit"
a$ = INPUT$(1)

END

'****************************** ERROR HANDLER ********************************
ERRORHANDLER:
CLS : SCREEN 9
LINE (40, 100)-(600, 200), 13, B
LOCATE 9, 25: COLOR 14: PRINT "Error"; ERR; "has occurred.": COLOR 15
SELECT CASE ERR
CASE 11
  LOCATE 10, 25: PRINT "You have divided by zero - rerun program with new values"
  LOCATE 12, 25: COLOR 13: PRINT "Hit any key to continue"
  a$ = INPUT$(1)
  END
CASE 4
  LOCATE 10, 25: PRINT "Out of data - rerun program with new data"
  LOCATE 12, 25: COLOR 13: PRINT "Hit any key to continue"
  a$ = INPUT$(1)
  END
CASE 6, 7
  LOCATE 10, 25: PRINT "Overflow or out of memory - reduce segments"
  LOCATE 12, 25: COLOR 13: PRINT "Hit any key to continue"
  a$ = INPUT$(1)
  END
CASE 9
  LOCATE 10, 25: PRINT "Subscript out of range - rerun program with new values"
  LOCATE 12, 25: COLOR 13: PRINT "Hit any key to continue"
  a$ = INPUT$(1)
  END
```

```
CASE 13
  LOCATE 10, 25: PRINT "Type mismatch - rerun program with new values"
  LOCATE 12, 25: COLOR 13: PRINT "Hit any key to continue"
  a$ = INPUT$(1)
  END
CASE 40
  LOCATE 10, 25: PRINT "Variable required - rerun program with new values"
  LOCATE 12, 25: COLOR 13: PRINT "Hit any key to continue"
  a$ = INPUT$(1)
  END
CASE 51
  LOCATE 10, 25: PRINT "Internal error"
  LOCATE 12, 25: COLOR 13: PRINT "Press any key to rerun"
  WHILE INKEY$ = "": WEND
  RESUME
CASE 69
  LOCATE 10, 25: PRINT "Buffer overflow - please rerun program"
  LOCATE 11, 25: PRINT "Redo from start"
  LOCATE 13, 25: COLOR 13: PRINT "Hit any key to continue"
  a$ = INPUT$(1)
  RESUME XOX
CASE ELSE
RESUME
END SELECT

ENDPROG:
CLS
END


SUB titles

BEGIN:
SCREEN 0, 0, 0, 0: COLOR 2, 9: CLS                    'set screen
PRINT : PRINT : PRINT , "Program HAULOPT by R J Thompson, 1996": COLOR 7, 1
PRINT : PRINT : PRINT , "To investigate optimum maintenance frequency for a"
PRINT , "mine haul road in which road user costs are minimised."
PRINT : PRINT , "Road user costs include vehicle operating cost components"
PRINT , "of fuel, tyres, parts and labour and the cost of maintaining the"
PRINT , "road using water car and grader."
PRINT : PRINT , "A mine haul-road network is required which is split into"
PRINT , "individual segments depending on tonnage and wearing course"
PRINT , "material properties of each segment."
PRINT :  PRINT , "The program accomodates 2-axle rear-dump haul trucks of "
PRINT , "120-220t capacity, electric or mechanical drive."
COLOR 14, 1: LOCATE 22, 54: PRINT "Press any key to continue": a$ = INPUT$(1)
CLS : COLOR 15, 1

END SUB
```

```
SUB datain

intro1:
CLS : COLOR 2, 9
PRINT , "HAUL ROAD GEOMETRY AND MATERIAL PROPERTY DATA"
COLOR 7, 1: PRINT : INPUT "            Enter name of mine"; minename$
INPUT "            Enter number of road segments "; segm!

tryagain1:
COLOR 14, 1: LOCATE 23, 14: PRINT , "If data is correct press C else E to edit."
a$ = INPUT$(1)
IF a$ <> "E" AND a$ <> "e" AND a$ <> "c" AND a$ <> "C" THEN GOTO tryagain1
IF a$ = "E" OR a$ = "e" THEN GOTO intro1
IF a$ = "c" OR a$ = "C" THEN LOCATE 23, 1: COLOR 1, 1: PRINT "
            "
CLS : COLOR 7, 1

'************************Dimension data arrays*******************************

DIM segname$(segm!)          'name of segment array
DIM segdata(28, segm!, 21)   '1=section length
                             '2=width of road
                             '3=grade percent
                             '4=vehicle gvm
                             '5=vehicle uvm
                             '6=drive type 1-elec, 0-mech
                             '7=repalcement price VP
                             '8=daily tonnage kt
                             '9= material, 1-mix, 0-ferricrete
                             '10=CBR
                             '11=SP
                             '12=GC
                             '13=DR
                             '14=PI
                             '15=rds
                             '16=RR%
                             '17=average vehicle estimated speed
                             '18=TR% laden dir
                             '19=TR% unladen dir
                             '20=laden speed
                             '21=unladen speed
                             '22=total fuel cost
                             '23=total tyre cost
                             '24=total parts cost
                             '25=total labour
                             '26=vehicle age '000hrs
                             '27=total VOC
                             '28=total road maintenance


DIM mfleet(6)                '1=number of graders
                             '2=grader hours per day
                             '3=number of water-cars
                             '4=water-car hours per day
                             '5=grader operating cost
                             '6=water-car operating cost
```

```
DIM voccostmod(11)
                        '1=const tyre
                        '2=coeff IRI
                        '3=coeff GR
                        '4=const parts
                        '5=coeff p/vp
                        '6=coeff H^
                        '7=coeff labour v/vp
                        '8=coeff v/vp^
                        '9=price escalation
                        '10=diesel fuel price
                        '11=tyre price

segcount! = 1
introa:
CLS : COLOR 2, 1: PRINT , "HAUL TRUCK DATA"
COLOR 7, 1: PRINT : PRINT , "This data is common to all"; segm!; " segments specified"
PRINT :
    INPUT "Vehicle GVM (t)                    ", segdata(4, segcount!, 1)
    INPUT "Vehicle UVM (t)                    ", segdata(5, segcount!, 1)
    INPUT "Vehicle drive type, 1-elec, 0-mech ", segdata(6, segcount!, 1)
    INPUT "Vehicle replacement price (Rm)     ", segdata(7, segcount!, 1)
    INPUT "Average vehicle age ('1000 op hrs) ", segdata(26, segcount!, 1)

tryagaina:
    COLOR 14, 1: LOCATE 23, 14: PRINT , "If data is correct press C else E to edit."
    a$ = INPUT$(1)
    IF a$ <> "E" AND a$ <> "e" AND a$ <> "c" AND a$ <> "C" THEN GOTO tryagaina
    IF a$ = "E" OR a$ = "e" THEN GOTO introa
    IF a$ = "c" OR a$ = "C" THEN LOCATE 23, 1: COLOR 1, 1: PRINT "
    "
    CLS : COLOR 7, 1: segcount! = 0

FOR i = 2 TO segm!
  segdata(4, i, 1) = segdata(4, 1, 1): segdata(5, i, 1) = segdata(5, 1, 1): segdata(6, i, 1) = segdata(6, 1, 1)
  segdata(7, i, 1) = segdata(7, 1, 1): segdata(26, i, 1) = segdata(26, 1, 1)
NEXT i

moresegin:
segcount! = segcount! + 1

intro2:
CLS : COLOR 2, 1: PRINT "Please input values at prompt for each segment specified previously"
PRINT : PRINT "SEGMENT "; segcount!: COLOR 7, 1:
IF segcount! > segm! GOTO datainfin
    INPUT "Segment name                       ", segname$(segcount!)
    INPUT "Length of segment (km)             ", segdata(1, segcount!, 1)
    INPUT "Width of road (m)                  ", segdata(2, segcount!, 1)
    INPUT "Grade of road (%) (uphill positive) ", segdata(3, segcount!, 1)
    INPUT "Average segment speed (20-50kph)   ", segdata(17, segcount!, 1)
    INPUT "Daily tonnage hauled (kt)          ", segdata(8, segcount!, 1)
    PRINT : COLOR 2, 1: PRINT "Material properties of section": COLOR 7, 1
    INPUT "Material type, 1-mixes, 0-fericrete ", segdata(9, segcount!, 1)
    INPUT "California Bearing Ratio (%) CBR   ", segdata(10, segcount!, 1)
    INPUT "Shrinkage product (SP)             ", segdata(11, segcount!, 1)
    INPUT "Grading coefficient (GC)           ", segdata(12, segcount!, 1)
    INPUT "Dust ratio (DR)                    ", segdata(13, segcount!, 1)
    INPUT "Plasticity index (PI)              ", segdata(14, segcount!, 1)
```

```
tryagain2:
    COLOR 14, 1: LOCATE 23, 14: PRINT , "If data is correct press C else E to edit."
    a$ = INPUT$(1)
    IF a$ < > "E" AND a$ < > "e" AND a$ < > "c" AND a$ < > "C" THEN GOTO tryagain2
    IF a$ = "E" OR a$ = "e" THEN GOTO intro2
    IF a$ = "c" OR a$ = "C" THEN LOCATE 23, 1: COLOR 1, 1: PRINT " ": COLOR 7, 1
FOR inrow = 44 TO 89 STEP 9:segcount! = segcount! + 1:IF segcount! > segm! GOTO intro3

introb:
    COLOR 2, 1
    LOCATE 3, inrow: PRINT ; segcount: COLOR 7, 1
    LOCATE 4, inrow: INPUT ; "", segname$(segcount!)
    LOCATE 5, inrow: INPUT ; "", segdata(1, segcount!, 1)
    LOCATE 6, inrow: INPUT ; "", segdata(2, segcount!, 1)
    LOCATE 7, inrow: INPUT ; "", segdata(3, segcount!, 1)
    LOCATE 8, inrow: INPUT ; "", segdata(17, segcount!, 1)
    LOCATE 9, inrow: INPUT ; "", segdata(8, segcount!, 1)
    LOCATE 12, inrow: INPUT ; "", segdata(9, segcount!, 1)
    LOCATE 13, inrow: INPUT ; "", segdata(10, segcount!, 1)
    LOCATE 14, inrow: INPUT ; "", segdata(11, segcount!, 1)
    LOCATE 15, inrow: INPUT ; "", segdata(12, segcount!, 1)
    LOCATE 16, inrow: INPUT ; "", segdata(13, segcount!, 1)
    LOCATE 17, inrow: INPUT ; "", segdata(14, segcount!, 1)

tryagainb:
    COLOR 14, 1: LOCATE 23, 14: PRINT , "If data is correct press C else E to edit."
    a$ = INPUT$(1)
    IF a$ < > "E" AND a$ < > "e" AND a$ < > "c" AND a$ < > "C" THEN GOTO tryagainb
    IF a$ = "E" OR a$ = "e" THEN GOTO introb
    IF a$ = "c" OR a$ = "C" THEN LOCATE 23, 1: COLOR 1, 1: PRINT "
"
IF segcount! > segm! THEN GOTO intro3
IF segcount! = 5 OR segcount! = 10 OR segcount! = 15 THEN GOTO moresegin
NEXT inrow

'*****************************grader water car specs & fleet******************

intro3:
CLS : COLOR 2, 9
PRINT , "HAUL ROAD MAINTENANCE FLEET DATA SECTION"
COLOR 7, 1: PRINT : INPUT "Enter number of road graders available                  "; mfleet(1)
INPUT "Enter grader operating hours per days                  "; mfleet(2)
INPUT "Enter grader total operating cost Rand per hour        "; mfleet(5)
INPUT "Enter number of water-cars available                   "; mfleet(3)
INPUT "Enter water-car operating hours per day                "; mfleet(4)
INPUT "Enter water-car total operating cost Rand per hour     "; mfleet(6)

tryagain3:
COLOR 14, 1: LOCATE 23, 14: PRINT , "If data is correct press C else E to edit."
a$ = INPUT$(1)
IF a$ < > "E" AND a$ < > "e" AND a$ < > "c" AND a$ < > "C" THEN GOTO tryagain3
IF a$ = "E" OR a$ = "e" THEN GOTO intro3
IF a$ = "c" OR a$ = "C" THEN LOCATE 23, 1: COLOR 1, 1: PRINT "
datainfin:
skipabit:

END SUB
```

```
SUB costmodeledit

COLOR 2, 1: PRINT : PRINT , "VEHICLE AND MAINTENANCE FLEET COSTS"
COLOR 7, 1: PRINT : PRINT , "Haul truck operating cost data"
PRINT : PRINT , "1.  Tyre cost (R/km)      TW = "; voccostmod(1); "+"; voccostmod(2); "IRI+";
        voccostmod(3); "GR%"
PRINT , "2.  Parts cost (R/km)  P/VP = ("; voccostmod(4); "+"; voccostmod(5); "IRI)."; "H^";
        voccostmod(6)
PRINT , "3.  Labour cost (R/km)    L = "; voccostmod(7); "(P/VP)^"; voccostmod(8)

redefinecoeff1:
LOCATE 23, 1: COLOR 14, 1
INPUT ; "             Enter model number to modify (1, 2 or 3) or C to continue"; modmod$
IF modmod$ <> "1" AND modmod$ <> "2" AND modmod$ <> "3" AND modmod$ <> "C" AND
        modmod$ <> "c" THEN GOTO redefinecoeff1
IF modmod$ = "1" THEN GOTO do1
IF modmod$ = "2" THEN GOTO do2
IF modmod$ = "3" THEN GOTO do3
IF modmod$ = "c" OR modmod$ = "C" THEN GOTO skip1

do1:
COLOR 7, 1: LOCATE 9, 1: PRINT , "                                                  "
LOCATE 9, 1: INPUT ; "              1.  Tyre cost (R/km)    TW = "; voccostmod(1)
INPUT ; "+"; voccostmod(2)
INPUT ; " IRI+"; voccostmod(3)
PRINT ; "GR%"
GOTO redefinecoeff1

do2:
COLOR 7, 1: LOCATE 10, 1: PRINT , "                                                  "
LOCATE 10, 1: INPUT ; "              2.  Parts cost (R/km) P/VP = ("; voccostmod(4)
INPUT ; "+"; voccostmod(5)
INPUT ; "IRI).H^"; voccostmod(6)
GOTO redefinecoeff1

do3:
COLOR 7, 1: LOCATE 11, 1: PRINT , "                                                  "
LOCATE 11, 1: INPUT ; "              3.  Labour cost (R/km)    L = "; voccostmod(7)
INPUT ; "(P/VP)^"; voccostmod(8)
GOTO redefinecoeff1

skip1:

END SUB
```

```
SUB costmodels

'read default model coefficients into aray
voccostmod(1) = .06        'tyre model
voccostmod(2) = .012
voccostmod(3) = .002
voccostmod(4) = 4          'parts model
voccostmod(5) = 20
voccostmod(6) = .375
voccostmod(7) = 220        'labour model
voccostmod(8) = .45

CLS : COLOR 2, 1: PRINT , "VEHICLE AND MAINTENANCE FLEET COSTS"

tryagain4:
LOCATE 3, 1: COLOR 7, 1:  PRINT , "Do you want to change any cost estimate equations (Y/N)?"
a$ = INPUT$(1)
IF a$ <> "Y" AND a$ <> "y" AND a$ <> "n" AND a$ <> "N" THEN GOTO tryagain4
IF a$ = "Y" OR a$ = "y" THEN CALL costmodeledit

intro5:
CLS : COLOR 2, 1:  PRINT , "UNIT COST FACTORS"
COLOR 7, 1: PRINT
PRINT , "Parts and labour costs are based on 1995 prices"
INPUT ; "              Please specify escalation factor"; voccostmod(9)

tryagain7:
COLOR 14, 1: LOCATE 23, 14: PRINT , "If data is correct press C else E to edit."
a$ = INPUT$(1)
IF a$ <> "E" AND a$ <> "e" AND a$ <> "c" AND a$ <> "C" THEN GOTO tryagain7
IF a$ = "E" OR a$ = "e" THEN GOTO intro5
IF a$ = "c" OR a$ = "C" THEN LOCATE 23, 1: COLOR 1, 1: PRINT "

intro6:
COLOR 7, 1: LOCATE 6, 1: PRINT , "Fuel cost is based on a current diesel price "
INPUT ; "              Please specify diesel price Rand per litre"; voccostmod(10)

tryagain8:
COLOR 14, 1: LOCATE 23, 14: PRINT , "If data is correct press C else E to edit."
a$ = INPUT$(1)
IF a$ <> "E" AND a$ <> "e" AND a$ <> "c" AND a$ <> "C" THEN GOTO tryagain8
IF a$ = "E" OR a$ = "e" THEN GOTO intro6
IF a$ = "c" OR a$ = "C" THEN LOCATE 23, 1: COLOR 1, 1: PRINT "  ":COLOR 7, 1

intro7:
COLOR 7, 1: LOCATE 9, 1: PRINT , "Tyre cost is based on current tyre price "
INPUT ; "              Please specify tyre price (R)"; voccostmod(11)

tryagain9:
COLOR 14, 1: LOCATE 23, 14: PRINT , "If data is correct press C else E to edit."
a$ = INPUT$(1)
IF a$ <> "E" AND a$ <> "e" AND a$ <> "c" AND a$ <> "C" THEN GOTO tryagain9
IF a$ = "E" OR a$ = "e" THEN GOTO intro7
IF a$ = "c" OR a$ = "C" THEN LOCATE 23, 1: COLOR 1, 1: PRINT "              ":COLOR 7, 1

END SUB
```

```
SUB speed

'For calculation of vehicle speed prior to fuel consumption assessment
CLS

FOR segment = 1 TO segm!
    rdsmin = 31.1919 - (.05354 * segdata(11, segment, 1)) - (.0152 * segdata(10, segment, 1))
    rdsmax = 7.6415 + (.4215 * segdata(8, segment, 1)) + (.3133 * segdata(12, segment, 1)) + (.4952
        * rdsmin)
    rrmin = EXP(-1.7166 + .0028 * segdata(17, segment, 1))
     'PRINT ; "days  "; "rds    "; "trladen  "; "  trunladen "; "  rr%; "; "  vladen  "; "  vunladen  "
     PRINT ; "days  "; "     trl "; "    tru "; "   vl  "; "    vu  "; "     fa   "; "  fb     "; " fc     "; "fd
      "; "ftot"

    FOR days = 0 TO 20

        rdi = 1.768 + .001 * days * (2.69 * segdata(8, segment, 1) - 72.75 * segdata(14, segment, 1)
            - 2.59 * segdata(10, segment, 1) - 9.35 * segdata(12, segment, 1) + 1.67 * segdata(11,
            segment, 1))
        segdata(15, segment, (days + 1)) = rdsmin + ((rdsmax - rdsmin) / (1 + EXP(rdi)))

        ldrri = -6.368 - .00685 * segdata(15, segment, (days + 1)) + .0061 * segdata(17, segment, 1)
        segdata(16, segment, (days + 1)) = 100 * (rrmin + segdata(15, segment, (days + 1)) *
            EXP(ldrri)) / 9.81
        segdata(18, segment, (days + 1)) = segdata(16, segment, (days + 1)) + segdata(3, segment, 1)
        segdata(19, segment, (days + 1)) = segdata(16, segment, (days + 1)) - segdata(3, segment, 1)

     'speed
        IF SGN(segdata(18, segment, (days + 1))) = -1 THEN segdata(20, segment, (days + 1)) = 5
            + (49 / (1 + EXP((9.5 + ABS(segdata(18, segment, (days + 1)))) / -2.4))) ELSE segdata(20,
            segment, (days + 1)) = 9 + (55 / (1 + EXP((-2.25 + _
            segdata(18, segment, (days + 1))) / 1.75)))
        IF SGN(segdata(19, segment, (days + 1))) = 1 THEN segdata(21, segment, (days + 1)) = 20
            + (35 / (1 + EXP((-6.31 + segdata(19, segment, (days + 1))) / 1.9))) ELSE segdata(21,
            segment, (days + 1)) = 13 + (42 / (1 + EXP((10.03 + ABS( _
            segdata(19, segment, (days + 1)))) / -.803)))

    'fuel
        fa = 0: fb = 0: fc = 0: fd = 0
        IF SGN(segdata(18, segment, (days + 1))) = -1 THEN fa = -3.575 + segdata(5, segment, 1)
            * (.092 - .016 * segdata(6, segment, 1) + .0017 * segdata(4, segment, 1))
        IF SGN(segdata(18, segment, (days + 1))) = 1 THEN fb = segdata(5, segment, 1) * segdata(20,
            segment, (days + 1)) * (296 * segdata(18, segment, (days + 1)) + 4.5 * segdata(20, segment,
            (days + 1)))
        IF SGN(segdata(18, segment, (days + 1))) = 1 THEN fb = fb + segdata(4, segment, 1) *
            segdata(20, segment, (days + 1)) * (246 * segdata(18, segment, (days + 1)) + .027 *
            (segdata(20, segment, (days + 1))) ^ 2)
        IF SGN(segdata(18, segment, (days + 1))) = 1 THEN fb = 1.02 + .00001 * fb

        IF SGN(segdata(19, segment, (days + 1))) = -1 THEN fc = -3.575 + segdata(5, segment, 1)
            * (.092 - .016 * segdata(6, segment, 1))
        IF SGN(segdata(19, segment, (days + 1))) = 1 THEN fd = segdata(5, segment, 1) * segdata(21,
            segment, (days + 1)) * (296 * segdata(19, segment, (days + 1)) + 4.5 * segdata(21, segment,
            (days + 1)))
        IF SGN(segdata(19, segment, (days + 1))) = 1 THEN fd = 1.02 + .00001 * fd
```

```
'convert to l/km consumption

        fa = 1 / (segdata(20, segment, (days + 1)) / 3600) * fa / 1000
        fb = 1 / (segdata(20, segment, (days + 1)) / 3600) * fb / 1000
        fc = 1 / (segdata(21, segment, (days + 1)) / 3600) * fc / 1000
        fd = 1 / (segdata(21, segment, (days + 1)) / 3600) * fd / 1000

'total fuel cost for fleet to move segment tonnage

        segdata(22, segment, (days + 1)) = voccostmod(10) * (segdata(1, segment, 1) * (segdata(8,
           segment, 1) * 1000 / (segdata(4, segment, 1) - segdata(5, segment, 1))) * (fa + fb + fc +
           fd))

PRINT USING " ####.##"; days; segdata(18, segment, (days + 1)); segdata(19, segment, (days + 1));
           segdata(20, segment, (days + 1)); segdata(21, segment, (days + 1)); fa; fb; fc; fd;
           segdata(22, segment, (days + 1))

    NEXT days
    a$ = INPUT$(1)
    CLS
NEXT segment

END SUB
```

```
SUB othercost

' For tyre, parts and labour cost estimation

CLS

FOR segment = 1 TO segm!

PRINT ; "    days"; "    tw "; "  TWtot"; "    P/kkm"; "    Ptot  "; " L/kkm    "; " Ltot"
      FOR days = 0 TO 20

            'tyre wear costs

            tw = (voccostmod(1) + voccostmod(2) * (3.0556 + .0641 * segdata(15, segment, (days + 1)))
                + voccostmod(3) * ABS(segdata(3, segment, 1)))
            segdata(23, segment, (days + 1)) = (tw * voccostmod(11) / 1000) * 2 * (segdata(1, segment, 1)
                * (segdata(8, segment, 1) * 1000 / (segdata(4, segment, 1) - segdata(5, segment, 1))))

            'parts costs

            p1 = (voccostmod(4) + (voccostmod(5) * (3.0556 + .0641 * segdata(15, segment, (days + 1)))))
                * (segdata(26, segment, 1)) ^ voccostmod(6)
            p = voccostmod(9) * 10 * segdata(7, segment, 1) * p1
            segdata(24, segment, (days + 1)) = (p / 1000) * 2 * (segdata(1, segment, 1) * (segdata(8,
                segment, 1) * 1000 / (segdata(4, segment, 1) - segdata(5, segment, 1))))

            'labour cost

            l = voccostmod(9) * voccostmod(7) * p1 ^ voccostmod(8)
            segdata(25, segment, (days + 1)) = (l / 1000) * 2 * (segdata(1, segment, 1) * (segdata(8,
                segment, 1) * 1000 / (segdata(4, segment, 1) - segdata(5, segment, 1))))


  PRINT USING " ####.##"; days; tw; segdata(23, segment, (days + 1)); p1; segdata(24, segment, (days +
                1)); l; segdata(25, segment, (days + 1))

      NEXT days
       a$ = INPUT$(1)
       CLS
NEXT segment

END SUB
```

```
SUB totalvoccost

'To calculate total vehicle operating costs

segment = 0: segplace = 0

moretotals:
IF segment = 6 OR segment = 12 OR segment = 18 THEN segplace = segplace - 6
CLS : COLOR 2, 1: PRINT , "TOTAL DAILY VOC PER SEGMENT FOR "; minename$:  PRINT ; "Days"
FOR days = 0 TO 20: PRINT ; days: NEXT days

moresegments:
IF segment = segm! THEN GOTO out2
segment = segment + 1: segplace = segplace + 1

FOR days = 0 TO 20
    segdata(27, segment, (days + 1)) = segdata(22, segment, (days + 1)) + segdata(23, segment, (days +
        1)) + segdata(24, segment, (days + 1)) + segdata(25, segment, (days + 1))
    COLOR 2, 1: LOCATE 2, (segplace * 10): PRINT ; segname$(segment)
    COLOR 7, 1: LOCATE (3 + days), (segplace * 10): PRINT USING "#####.##"; segdata(27, segment,
        (days + 1))

NEXT days
    COLOR 14, 1: LOCATE 23, 54: PRINT "Hit any key to continue": a$ = INPUT$(1): LOCATE 23, 54:
COLOR 1, 1: PRINT , "                        "
    IF segment = 6 OR segment = 12 OR segment = 18 GOTO moretotals
    IF segment < segm! THEN GOTO moresegments

out2:

END SUB
```

```
SUB maintcost

FOR segment = 1 TO segm!
   totkm = totkm + segdata(1, segment, 1)
      FOR days = 0 TO 20
            IF segdata(15, segment, (days + 1)) > 45 THEN gradprod = .75 - .004625 * (segdata(15,
                segment, (days + 1)) - 45) ELSE gradprod = .75
            'total segment daily cost for x days interval between
            segdata(28, segment, (days + 1)) = ((mfleet(5) / gradprod) + (mfleet(6) / 6.3)) * segdata(1,
                segment, 1) / (days + 1)
      NEXT days
NEXT segment

segment = 0: segplace = 0

moremtotals:
IF segment = 6 OR segment = 12 OR segment = 18 THEN segplace = segplace - 6
CLS : COLOR 2, 1: PRINT , "TOTAL DAILY MAINTENANCE COST PER SEGMENT FOR ";
minename$:   PRINT ; "Days"
FOR days = 0 TO 20: PRINT ; days: NEXT days

moremsegments:
IF segment = segm! THEN GOTO out1
segment = segment + 1: segplace = segplace + 1

FOR days = 0 TO 20
     COLOR 2, 1: LOCATE 2, (segplace * 10): PRINT ; segname$(segment)
     COLOR 7, 1: LOCATE (3 + days), (segplace * 10): PRINT USING "#####.##"; segdata(28, segment,
        (days + 1))
NEXT days

     COLOR 14, 1: LOCATE 23, 54: PRINT "Hit any key to continue": a$ = INPUT$(1): LOCATE 23, 54:
COLOR 1, 1: PRINT , "                        "
     IF segment = 6 OR segment = 12 OR segment = 18 GOTO moremtotals
     IF segment < segm! THEN GOTO moremsegments

out1:

CLS : COLOR 2, 1: PRINT "MAINTENANCE FLEET PRODUCTIVITY."
PRINT
FOR days = 0 TO 20: PRINT ; days: NEXT days
FOR days = 0 TO 20

   COLOR 2, 1: LOCATE 2, 10: PRINT ; "Reqd km/day": LOCATE 2, 25: PRINT ; "Graded km/day":
   LOCATE 2, 40: PRINT ; "Watered km/day"

      FOR segment = 1 TO segm!
         IF segdata(15, segment, (days + 1)) > 45 THEN gradprod = .75 - .004625 * (segdata(15, segment,
               (days + 1)) - 45) ELSE gradprod = .75
         graderhrs = graderhrs + (segdata(1, segment, 1) / gradprod)
         waterhrs = waterkhrs + (segdata(1, segment, 1) / 6.3)
      NEXT segment
         graderkm = totkm * mfleet(1) * mfleet(2) / graderhrs
         waterkm = totkm * mfleet(3) * mfleet(4) / waterhrs
         COLOR 7, 1: LOCATE (3 + days), 10: PRINT USING "##.###"; totkm / (days + 1)
         COLOR 7, 1: LOCATE (3 + days), 25: PRINT USING "####.##"; graderkm
         LOCATE (3 + days), 40: PRINT USING "####.##"; waterkm
         graderhrs = 0: waterhrs = 0
```

```
NEXT days

    COLOR 14, 1: LOCATE 23, 54: PRINT "Hit any key to continue": a$ = INPUT$(1): LOCATE 23, 54:
COLOR 1, 1: PRINT , "                    "

END SUB


SUB tot

' To calculate unoptimised total daily cost per segment

segment = 0: segplace = 0

moretots:
IF segment = 6 OR segment = 12 OR segment = 18 THEN segplace = segplace - 6
CLS : COLOR 2, 1: PRINT , "UNOPTIMISED TOTAL DAILY COST PER SEGMENT FOR "; minename$:
PRINT ; "Days"
FOR days = 0 TO 20: PRINT ; days: NEXT days

moretotsegments:
IF segment = segm! THEN GOTO out3
segment = segment + 1: segplace = segplace + 1

FOR days = 0 TO 20
    COLOR 2, 1: LOCATE 2, (segplace * 10): PRINT ; segname$(segment)
    COLOR 7, 1: LOCATE (3 + days), (segplace * 10): PRINT USING "#####.##"; segdata(27, segment,
          (days + 1)) + segdata(28, segment, (days + 1))
NEXT days

    COLOR 14, 1: LOCATE 23, 54: PRINT "Hit any key to continue": a$ = INPUT$(1): LOCATE 23, 54:
    COLOR 1, 1: PRINT , "                    "
    IF segment = 6 OR segment = 12 OR segment = 18 GOTO moretots
    IF segment < segm! THEN GOTO moretotsegments


out3:

'total cost for all segments

CLS : COLOR 2, 1: PRINT , "UNOPTIMISED TOTAL DAILY COST FOR "; minename$:   PRINT ;
          "Days"
FOR days = 0 TO 20: PRINT ; days: NEXT days
LOCATE 2, (15): PRINT ; "Total cost R/day"

FOR days = 0 TO 20
    FOR segment = 1 TO segm!
      totcost = totcost + segdata(27, segment, (days + 1)) + segdata(28, segment, (days + 1))
    NEXT segment

    COLOR 7, 1: LOCATE (3 + days), 15: PRINT USING "######.##"; totcost
    totcost = 0
NEXT days

    COLOR 14, 1: LOCATE 23, 54: PRINT "Hit any key to continue": a$ = INPUT$(1): LOCATE 23, 54:
COLOR 1, 1: PRINT , "

END SUB
```

```
SUB optimalsol

'optimal policy selection

'******************************Dimension array****************************

DIM opt(6, segm!)          '1=optimal total cost
                           '2=optimal dats interval
                           '3=grader productivity for optimal
                           '4=rate of change

mm = 0:CLS
COLOR 2, 1: PRINT , "OPTIMAL MAINTENANCE FREQUENCY SOLUTION FOR "; minename$
PRINT : PRINT , "Segment", "Optimum total", , "Optimum maintenance"
PRINT , , "daily cost (R)", "interval (days)": PRINT

FOR segment = 1 TO segm!
      opt(1, segment) = 1000000!

      FOR days = 0 TO 20
      totcost = segdata(27, segment, (days + 1)) + segdata(28, segment, (days + 1))
      IF opt(1, segment) > totcost THEN GOTO swop ELSE GOTO jumpnext
swop:
      opt(1, segment) = totcost: opt(2, segment) = days + 1

jumpnext:
      NEXT days
      COLOR 7, 1: PRINT , segname$(segment), opt(1, segment), , opt(2, segment) - 1
      NEXT segment

'calculate reqd and available grader hrs

totkm = 0: totgrhrs = 0: totopcost = 0

FOR segment = 1 TO segm!
      totkm = totkm + segdata(1, segment, 1)
      IF segdata(15, segment, opt(2, segment)) > 45 THEN gradprod = .75 - .004625 * (segdata(15, segment,
        opt(2, segment)) - 45) ELSE gradprod = .75
      opt(3, segment) = (segdata(1, segment, 1) / gradprod) / opt(2, segment)
      totgrhrs = totgrhrs + opt(3, segment)
      totopcost = totopcost + opt(1, segment)
NEXT segment

availgrhrs = mfleet(1) * mfleet(2)

decidefeas:

IF availgrhrs > totgrhrs GOTO feas

COLOR 4, 1: PRINT : PRINT , "     Infeasible optimal solution since required grading hours per day"
PRINT USING "     exceeds available grader hours by ##.## hrs."; totgrhrs - availgrhrs
IF opt(2, chrateseg) = 20 THEN GOTO jumpout
a$ = INPUT$(1)
GOTO newoptsolution

feas:
COLOR 4, 1: PRINT : PRINT "     Feasible optimal solution. "
COLOR 7, 1: PRINT : PRINT USING "     ##.## grader hrs required per day.  ##.## grader hrs available.";
```

```
        totgrhrs; availgrhrs
PRINT "      Minimum total cost solution equates to a VOC and road maintenance"
PRINT USING "      combined cost of R#####.## per day."; totopcost

FOR segment = 1 TO segm!
      IF opt(2, segment) - 1 = 20 THEN GOTO print2:NEXT segment:GOTO found

print20:
PRINT : PRINT ; "      A maintenance interval of 20 days is the maximum range analysed."
PRINT ; "      Maintenance at shorter interval for these sections will increase"
PRINT ; "      costs only marginally"

GOTO found

newoptsolution:
' find segment with lowest rate of change in total cost and  extend interval by 1 day

chrate = 1000000!
FOR segment = 1 TO segm!
      opt(4, segment) = segdata(27, segment, (opt(2, segment) + 1)) + segdata(28, segment, (opt(2, segment)
        + 1)) - opt(1, segment)
          PRINT segdata(27, segment, (opt(2, segment) + 1)), segdata(28, segment, (opt(2, segment) + 1)),
              opt(1,segment), opt(4, segment)
      IF opt(4, segment) < chrate THEN GOTO swop1 ELSE GOTO jumpnext1

swop1:
      chrate = opt(4, segment): chrateseg = segment

jumpnext1:
      NEXT segment

opt(2, chrateseg) = opt(2, chrateseg) + 1
opt(1, chrateseg) = segdata(27, chrateseg, opt(2, chrateseg)) + segdata(28, chrateseg, opt(2, chrateseg))


'recalculate totgrhrs with new additional maintenance interval

totkm = 0: totgrhrs = 0: totopcost = 0:CLS

COLOR 2, 1: PRINT , "OPTIMAL MAINTENANCE FREQUENCY SOLUTION FOR "; minename$
PRINT : PRINT , "Segment", "Optimum total", , "Optimum maintenance"
PRINT , , "daily cost (R)", "interval (days)": PRINT

FOR segment = 1 TO segm!
      totkm = totkm + segdata(1, segment, 1)
      IF segdata(15, segment, opt(2, segment)) > 45 THEN gradprod = .75 - .004625 * (segdata(15, segment,
        opt(2, segment)) - 45) ELSE gradprod = .75
      opt(3, segment) = (segdata(1, segment, 1) / gradprod) / opt(2, segment)
      totgrhrs = totgrhrs + opt(3, segment)
      totopcost = totopcost + opt(1, segment)
      COLOR 7, 1: PRINT , segname$(segment), opt(1, segment), , opt(2, segment) - 1
NEXT segment

GOTO decidefeas

jumpout:
found:
END SUB
```

**MMS MODEL PROGRAM DATA - KROMDRAAI COLLIERY**

| DATA | KROMDRAAI COLLIERY | | |
|---|---|---|---|
| | Main-tip | HR2 | HR3 |
| Length (km) | 1,13 | 3,24 | 4,53 |
| Grade (%) | -0,4 | 0,99 | 0,55 |
| GVM (t) | 217 | 217 | 271 |
| UVM(t) | 111 | 111 | 111 |
| Drive system | 1 | 1 | 1 |
| Vehicle price (Rm) | 1,83 | 1,83 | 1,83 |
| Vehicle age ('000hrs) | 1,24 | 1,24 | 1,24 |
| Daily tonnage (kt) | 15 | 7,7 | 7,3 |
| Material type | 0 | 0 | 0 |
| CBR | 46 | 50 | 162 |
| SP | 198 | 196 | 82 |
| GC | 36,3 | 21,3 | 30,1 |
| DR | 0,6 | 0,6 | 0,4 |
| PI | 10 | 8 | 4 |
| Grader fleet | 3 | | |
| Grader op hrs/day | 8,2 | | |
| Cost R/op hrs | 62 | | |
| Water-car fleet | 2 | | |
| Water-car op hrs/day | 6,5 | | |
| Cost R/op hrs | 119 | | |

**MMS MODEL PROGRAM DATA - KRIEL COLLIERY**

| DATA | KRIEL COLLIERY | | | |
|---|---|---|---|---|
| | Main-HR | R6/10 | R7 | R8/11 |
| Length (km) | 4,6 | 1,92 | 2,19 | 3,78 |
| Grade (%) | 1,51 | 0,91 | 1,43 | 0,96 |
| GVM (t) | 274 | 274 | 274 | 274 |
| UVM(t) | 120 | 120 | 120 | 120 |
| Drive system | 1 | 1 | 1 | 1 |
| Vehicle price (Rm) | 1,7 | 1,7 | 1,7 | 1,7 |
| Vehicle age ('000hrs) | 11,86 | 11,86 | 11,86 | 11,86 |
| Daily tonnage (kt) | 16,74 | 3,77 | 8,84 | 4,13 |
| Material type | 0 | 1 | 1 | 1 |
| CBR | 98 | 48 | 132 | 132 |
| SP | 102 | 160 | 111 | 111 |
| GC | 24,8 | 30,9 | 30,7 | 30,7 |
| DR | 0,4 | 0,6 | 0,5 | 0,5 |
| PI | 4 | 8 | 6 | 6 |
| Grader fleet | 2 | | | |
| Grader op hrs/day | 9,4 | | | |
| Cost R/op hrs | 66,4 | | | |
| Water-car fleet | 1 | | | |
| Water-car op hrs/day | 10,1 | | | |
| Cost R/op hrs | 78,1 | | | |

**MMS MODEL PROGRAM DATA - KLEINKOPJE COLLIERY**

| DATA | KLEINKOPJE COLLIERY | | | | | | |
|---|---|---|---|---|---|---|---|
| | Main-tip | 5W& ramp | R13 /14 | 2A9 | 2A8 | 2A7 | 3A |
| Length (km) | 0,5 | 3,21 | 2,85 | 2,2 | 1,39 | 0,94 | 2,27 |
| Grade (%) | 0,2 | 2,81 | 2,17 | 2,73 | 1,23 | 1,43 | 0,18 |
| GVM (t) | 274 | 274 | 274 | 274 | 274 | 274 | 274 |
| UVM(t) | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Drive system | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Vehicle price (Rm) | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 |
| Vehicle age ('000hrs) | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Daily tonnage (kt) | 18,6 | 6,7 | 7,7 | 4,2 | 1,4 | 1,4 | 9,7 |
| Material type | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CBR | 79 | 79 | 79 | 79 | 79 | 79 | 79 |
| SP | 164,5 | 164,5 | 164,5 | 178,5 | 178,5 | 178,5 | 178,5 |
| GC | 28,8 | 28,8 | 28,8 | 27,7 | 27,7 | 27,7 | 27,7 |
| DR | 0,6 | 0,6 | 0,6 | 0,5 | 0,5 | 0,5 | 0,5 |
| PI | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Grader fleet | 3 | | | | | | |
| Grader op hrs/day | 3,9 | | | | | | |
| Cost R/op hrs | 68,4 | | | | | | |
| Water-car fleet | 2 | | | | | | |
| Water-car op hrs/day | 6,4 | | | | | | |
| Cost R/op hrs | 74,5 | | | | | | |

**MMS MODEL PROGRAM DATA - NEW VAAL COLLIERY**

| DATA | NEW VAAL COLLIERY | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Main-tip | MR0-R2 | MR2-R3 | MR3-R4 | R4-R6/7 | R6/7-R9 | R0 | R2 | R3 | R4 |
| Length (km) | 0,57 | 1,58 | 1,01 | 0,7 | 0,8 | 1,09 | 0,65 | 0,49 | 0,83 | 0,64 |
| Grade (%) | 1,14 | 0,18 | 0,5 | 0,39 | -0,93 | 2,53 | 2,92 | 3,47 | 2,53 | 4,38 |
| GVM (t) | 274 | 274 | 274 | 274 | 274 | 274 | 274 | 274 | 274 | 274 |
| UVM(t) | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Drive system | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Vehicle price (Rm) | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 | 1,7 |
| Vehicle age ('000hrs) | 14,4 | 14,4 | 14,4 | 14,4 | 14,4 | 14,4 | 14,4 | 14,4 | 14,4 | 14,4 |
| Daily tonnage (kt) | 51 | 32,7 | 23,8 | 16 | 14 | 5,05 | 18,8 | 8,9 | 7,78 | 1,9 |
| Material type | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CBR | 94 | 94 | 55 | 55 | 49 | 49 | 49 | 49 | 49 | 49 |
| SP | 90 | 90 | 128 | 128 | 72 | 72 | 72 | 72 | 72 | 72 |
| GC | 31,1 | 31,3 | 28,7 | 28,7 | 26,7 | 26,7 | 26,7 | 26,7 | 26,7 | 26,7 |
| DR | 0,4 | 0,4 | 0,5 | 0,5 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 |
| PI | 5 | 5 | 8 | 8 | 5 | 5 | 5 | 5 | 5 | 5 |
| Grader fleet | 3 | | | | | | | | | |
| Grader op hrs/day | 7,7 | | | | | | | | | |
| Cost R/op hrs | 64,7 | | | | | | | | | |
| Water-car fleet | 2 | | | | | | | | | |
| Water-car op hrs/day | 9,2 | | | | | | | | | |
| Cost R/op hrs | 82,2 | | | | | | | | | |