The South African National Roads Agency Ltd
P O Box 415
Pretoria
0001

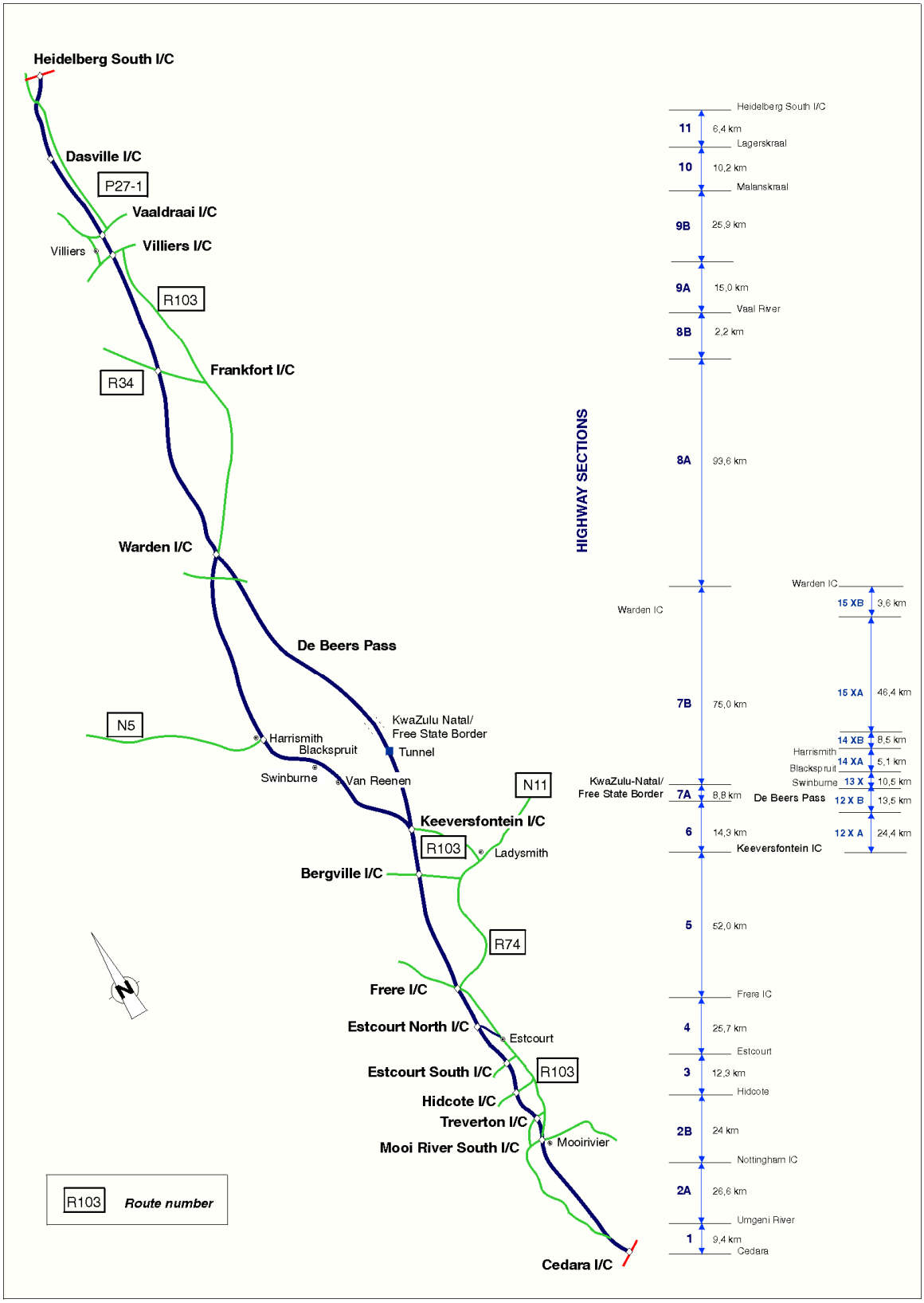
N3 Toll Road Consortium
P O Box 312
Johannesburg
2000

CONTRACT No SAPR N0304102/1

CONCESSION CONTRACT FOR THE DESIGN, CONSTRUCTION, FINANCING, OPERATING AND MAINTENANCE OF A PORTION OF NATIONAL ROUTE 3 FROM CEDARA IN KWAZULU-NATAL TO HEIDELBERG SOUTH INTERCHANGE IN GAUTENG AS A TOLL HIGHWAY WITH DEVELOPMENTS AND ASSOCIATED FACILITIES

ANNEXURE 1
ENGINEERING REQUIREMENTS

Prepared By: NRA **24 May 1999**


Heidelberg South I/C
Dasville I/C
P27-1
Vaaldraai I/C
Villiers
Villiers I/C
R103
Frankfort I/C
R34
Warden I/C
De Beers Pass
N5
Harrismith
Blackspruit
Swinburne
Van Reenen
KwaZulu Natal/
Free State Border
Tunnel
N11
Keeversfontein I/C
R103
Ladysmith
Bergville I/C
R74
Frere I/C
Estcourt North I/C
Estcourt
Estcourt South I/C
R103
Hidcote I/C
Treverton I/C
Mooi River South I/C
Mooirivier
Cedara I/C
R103 Route number
HIGHWAY SECTIONS
Heidelberg South I/C
11 6,4 km
Lagerskraal
10 10,2 km
Malanskraal
9B 25,9 km
9A 15,0 km
Vaal River
8B 2,2 km
8A 93,6 km
Warden IC
Warden IC
15 XB 3,6 km
15 XA 46,4 km
7B 75,0 km
14 XB 8,5 km
Harrismith
14 XA 5,1 km
Blackspruit
13 X 10,5 km
Swinburne
KwaZulu-Natal/
Free State Border
7A 8,8 km
De Beers Pass
12 X B 13,5 km
6 14,3 km
12 X A 24,4 km
Keeversfontein IC
5 52,0 km
Frere IC
4 25,7 km
Estcourt
3 12,3 km
Hidcote
2B 24 km
Nottingham IC
2A 26,6 km
Umgeni River
1 9,4 km
Cedara
N3 CONCESSION PROJECT
LOCALITY PLAN
RH/0005M/8

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1. GENERAL

1.1 Introduction

This Annexure outlines the engineering and Operation and Maintenance requirements of the Project to be adhered to during the Concession Period.

Words defined in the Concession Contract shall have the same meaning when used in this Annexure unless the context requires otherwise.

1.2 Highway and Highway Sections

The Highway concerned, which forms part of National Route 3 (N3), extends from Cedara in KwaZulu Natal (co-ordinates +69 748,0Y, +3 268 858,0X) to Heidelberg South interchange in Gauteng (co-ordinates +61 003,62Y, +2 938 141,47X).

The portion of existing National Route 3 and the National Route 3 via De Beers Pass which falls within the limits of the Highway have been divided into Highway Sections.

Wherever the term Highway Section is used it means the Highway Section(s) described in Table 1 below. Highway Sections are not to be confused with Route Sections which are used to identify proclaimed portions of the Highway and to which existing kilometre markers refer.

TABLE 1: HIGHWAY SECTIONS

Highway Section	Description of Highway Section	Routes Section	Start (km)	End (km)	Length of Highway Section (km)
1	Cedara to Umgeni River	N3/4	1,6	11,0	9,4
2A	Umgeni River to Nottingham Road	N3/4	11,0	37,6	26,6
2B	Nottingham Road to Hidcote	N3/4	37,6	61,6	24,0
3	Hidcote to Estcourt	N3/5	0,0	12,3	12,3
4	Estcourt to Frere	N3/5	12,3	38,0	25,7
5	Frere to Keeversfontein	N3/5	38,0	54,0	16,0
		N3/6	0,0	36,0	36,0
6	Keeversfontein to De Beers Pass	N3/6	36,0	50,3	14,3
7A	De Beers Pass to K-Natal Border	N3/6	50,3	59,1	8,8
7B	K-Natal Border to Warden Interchange	N3/7	0,0	44,8	44,8
		N3/8	0,0	30,2	30,2
8A	Warden to Villiers (S)	N3/8	30,2	48,8	18,6
		N3/9	0,0	75,0	75,0
8B	Villiers (S) to Vaal River	N3/9	75,0	77,2	2,2
9A	Vaal River to Leeuwspruit	N3/10	0,0	15,0	15,0
9B	Leeuwspruit to Malanskraal	N3/10	15,0	40,9	25,9
10	Malanskraal to Laagerspoort	N3/10	40,9	51,1	10,2
11	Laagerspoort to Heidelberg	N3/11	8,7	15,1	6,4
TOTAL LENGTH OF HIGHWAY SECTIONS 1 TO 11					**401,4**
12XA	Keeversfontein to Van Reenen	N3/6X	36,0	60,4	24,4
12XB	Van Reenen to Swinburne	N3/7X	0,0	13,5	13,5
13X	Swinburne to Blackspruit	N3/7X	13,5	24,0	10,5
14XA	Blackspruit to Harrismith	N3/7X	24,0	29,1	5,1
14XB	Harrismith Bypass	N3/7X	29,1	37,6	8,5
15XA	Harrismith to Willows	N3/7X	37,6	63,0	25,4
		N3/8X	0,0	21,0	21,0
15XB	Willows to Warden Interchange	N3/8X	21,0	24,6	3,6
TOTAL LENGTH OF HIGHWAY SECTIONS 12X TO 15X					**112,0**

2. ENGINEERING REQUIREMENTS FOR DESIGN AND CONSTRUCTION

2.1 Introduction

All Preliminary Designs, Detailed Designs and Construction Works shall be in accordance with the latest standard codes and specifications prescribed in this Annexure and any amendments or replacements of same which may occur from time to time.

2.2 Technical Design Requirements

The Concessionaire shall ensure that the Preliminary Designs and Detailed Designs which are submitted for approval are prepared as set out below.

2.2.1 Preliminary Designs

2.2.1.1 A Preliminary Design is a conceptual design of a Highway Section or a portion of it. This includes geometric alignments, the position of the road within the Road Reserve, the proposed cross-sections, toll plaza location and layout, the influence on land, environment and utilities, to such detail that a review can be undertaken for compliance with the standards and required requirements specified in this Concession Contract. The Preliminary Design must also specify design standards clearly so as to enable the Agency and the Independent Engineer to assess the design against such standards and requirements.

2.2.1.2 The content and submission of each Preliminary Design report and relevant drawings must cover:

- description of the works
- traffic analysis
- preliminary materials report and pavement design information
- details regarding drainage design
- conceptual design(s) for bridges
- details concerning utility services to be cleared and/or relocated
- details regarding land and Road Reserve requirements
- details pertaining to the negotiations with landowners, where applicable
- traffic accommodation during construction
- new toll plaza location, layout and conceptual operational systems
- environment impact details
- recommendations on specific measures with reference to standards in Tables 2.1, 2.2 and 2.3 of this Annexure.
- layout drawings, where applicable, indicating horizontal alignment details, intersections, accesses, and lane configuration
- longitudinal sections indicating proposed vertical alignments, if applicable
- typical road cross-section information
- arrangements and agreements on technical and socio-economic matters with Relevant Authorities and other roleplayers.

2.2.1.3 Ten (10) copies of the report and drawings must be submitted to the Independent Engineer as follows:

- reports on A4 size, printed on 80gsm paper, bound in book format.
- drawings reduced to A2 size and printed on 80gsm thick paper, bound in book format.

Covers and titles of documents must be as agreed upon between the Agency and the Concessionaire.

2.2.1.4 The procedure for the Preliminary Design approval must be as described in Clause 2.2.3 of this Annexure. If the Agency fails to return or comment upon any part of the Preliminary Design within twenty one (21) days of its submission (by hand) to it, the Concessionaire must give the Agency notice, delivered by hand, that the Preliminary Design shall be deemed to be approved, should no comments be received within three (3) days from the date of such notification.

2.2.1.5 Subject to Clause 2.2.1.4 the programme for submission of the Preliminary Designs must make provision for the submission of a maximum of three (3) submissions per cycle of five (5) working days. Should more than three (3) Preliminary Designs be submitted to the Agency for approval within one five working day period, then the dates of submission of submissions in excess of three (3) will be deemed to be submitted in the period following the one in which they were actually submitted.

Approval of any Preliminary Design will not relieve the Concessionaire of its obligations under the Concession Contract.

2.2.2 Detailed Designs

2.2.2.1 Detailed Design entails the preparation of working drawings and other necessary documentation to enable execution of a particular portion of the Construction Works. The Independent Engineer shall review the Detailed Design and grant its approval if the Detailed Design is in compliance with the standards and requirements specified in this Concession Contract.

2.2.2.2 The Detailed Design for any such portion of the Construction Works must include:

- all working drawings, schedules and designs required for the Construction Works in accordance with the applicable standards and codes of procedure prescribed in this Annexure;
- project specifications and other provisions pertaining to the Construction Works;
- design changes to the drawings, to comply with the Engineering Requirements as may be required and agreed to by the Independent Engineer;
- a detailed geotechnical report on the foundations for each structure and cut and embankment stability;
- expropriation details of borrowpits, spoil areas and documentation of the landowners' willingness to proceed with the land acquisition; and
- a schedule of quantities with rates, where applicable, after the completion of De Beers Pass.
- materials utilisation report

2.2.2.3 Ten (10) copies of the required documents for any section of proposed Construction Works must be provided to the Independent Engineer as follows:

- contract specifications and other documents printed in A4 size on 80gsm paper bound in book format.
- drawings reduced to A2 size and printed on 80gsm paper, bound in book format.

Within two weeks of the Independent Engineer approving the Detailed Design drawings, the Concessionaire shall submit all reports and drawings in electronic format (Microsoft Word 97 or a later version) which shall include all tables in Excel and graphics embedded within the text. The drawings must be submitted in electronic format in the latest version of either Autocad 13 or Microstation 95. The definitions of line colour and layers shall be according to the recommendation contained within Draft TMH11.

2.2.2.4 The procedure for Detailed Design approval shall be as described in Clause 2.2.3 of this Annexure.

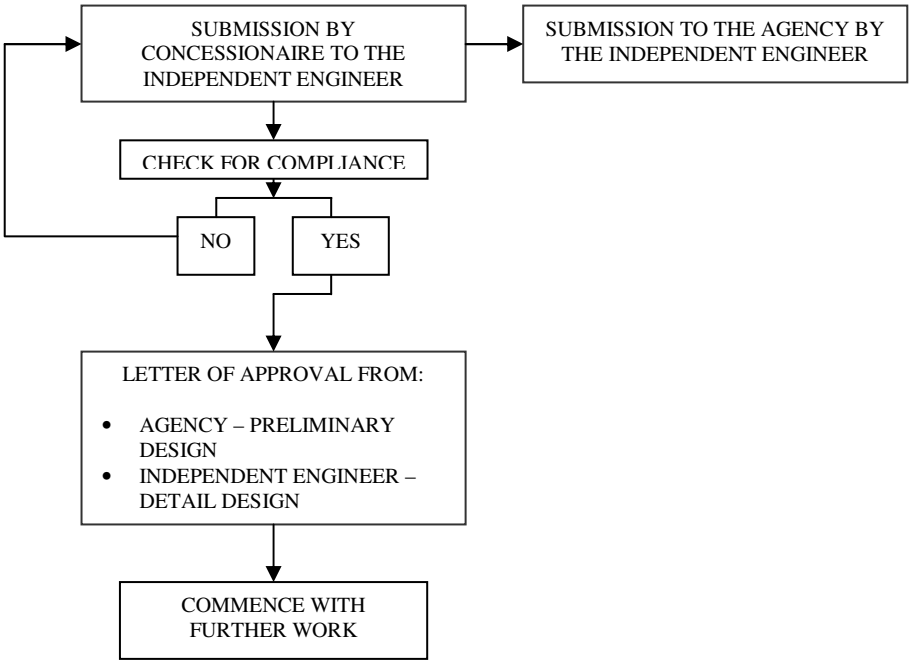
Detailed Designs shall be submitted to the Independent Engineer in accordance with the Detailed Design programme, as agreed with the Agency from time to time.

2.2.2.5 Prior to the delivery of a Detailed Design to the Independent Engineer, the Concessionaire must ensure that the O & M Contractors, (if any), have been given an opportunity to review the Detailed Design.

The comments made by the O & M Contractors shall be incorporated in the Detailed Design to be submitted to the Independent Engineer only insofar as they are compatible with the Engineering Requirements and enhance the Construction Works, but without materially affecting the Contract Price.

2.2.2.6 Approval of any Detailed Design will not relieve the Concessionaire of its obligations under this Concession Contract.

2.2.3 Approval Procedure Flow Chart



2.2.4 As-Built Drawings and Construction Report

Within 3 months after Construction Completion of any Construction Works on a Highway Section or portion of it, the Concessionaire must provide the Agency with a Construction Completion report and as-built drawings in microfilm format, as required pursuant to Clause 8.7.3 of the Concession Contract.

2.3 Geometric Design

2.3.1 Requirements

The Concessionaire must base all its geometric designs on the requirements contained in this Annexure, and the following documents and publications.

- A Policy on Geometric Design of Highways and Streets, published by the American Association of State Highway and Transportation Officials, Washington D.C., (1994), (ISBN: 1-56051-068-4).

- Highway Capacity Manual – Special Report 209, Third Edition, published by the Transportation Research Board, National Research Council, Washington D.C., (1997), (ISBN: 0-309-05516-4).

- Transportation and Land Development, issued by the Institute of Transportation Engineers, Prentice Hall, Englewood Cliffs, New Jersey 07632. (1988) report – ISBN 0-13-9304B-4025.

- South African Roads Board Drainage Manual, issued by The Department of Transport. P O Box 415, Pretoria (1986), (ISBN: 0-908381-39-5).

- Technical Recommendations for Highways: Geometric Design for Rural Roads, TRH17, published by the Committee of State Road Authorities, (1988), (ISBN: 0-7988-3312-2).

- South African Road Traffic Signs Manual, Volumes 1 – 4, issued by The Department of Transport, P O Box 415, Pretoria (1993), (ISBN: 1-874844-88-7). Volume I ISBN 1-874844-78-X, Volume 1, Part 2: ISBN: 1-874877-79-8, Part 3: ISBN: 1-874844-80-1, Volume 4, Part 1: ISBN: 1-874844-82-8.

- "Toegang van en na Fasiliteite langs Nasionale Deurpaaie", issued by The Department of Transport, P O Box 415, Pretoria, (December 1991).

- Committee of Urban Transport Authorities : Guidelines for the Geometric Design of Urban Arterial Roads: UTG1 (1986).

- Code of Procedure for the Planning and Design of Structures, (Draft April 1996).

- Manual for the Preparation of Detailed Geometric Design Plans for National Roads, G2-Manual, (1984) obtainable from the Agency.

- Standard and Typical Plans available for Roadmarkings and Signs, obtainable from the Agency (December 1994).

- Standard and Typical Plans available for:

Fencing	SP-F series
Guard Rails	SP-G series
Information Boards	SP-I series
Rest and Service areas	SP-M series

Copies of these plans are obtainable from the Agency

2.3.2 Standards

2.3.2.1 General Principles Regarding Standards

Standards prescribed in this Annexure will form the basis for the Highway's geometric development over the Concession Period.
The engineering design of the Project must be based on the application of the standards in this Annexure, Good Industry Practice and sound engineering judgement. Any variation from the standards set out in this Annexure shall be subject to the approval of the Agency in its sole discretion and must be motivated to the Agency in detail by the Concessionaire.
The standards specified in this Annexure may be altered as agreed upon in writing between the Agency and the Concessionaire, dependent on future technological advances in the field of road engineering.

Geometric development of the Highway is to be based on the following four criteria:

- the standards specified in this Annexure;
- the existing road's standards;
- rural conditions and classification; and
- urban conditions and classification.

2.3.2.2 Geometric Design Standards

The geometry of the Highway must be upgraded for the following reasons:

- road safety;
- improvement of intersections (vertically and horizontally);
- capacity improvements;
- unacceptable operational characteristics; and
- non-conformance with minimum geometric standards.

Geometric design standards are to comply to the following:

- the new works to be constructed on Highway Sections 6, 7A, 7B, 10 and the new southbound carriageway on Highway Section 9 are to conform to the requirements of Tables 2.1 read in conjunction with Table 2.3;
- the geometry of all existing Highway Sections not conforming to Table 2.1 are to be considered against the requirements of Table 2.2 read in conjunction with Table 2.3. Highway Sections identified to conform to these requirements are listed in Appendix A1.

- all existing Highway Sections which do not comply to the requirements of Tables 2.2 and 2.3 described in the previous paragraph, must be improved to the required standards of Tables 2.1 or 2.2 read in conjunction with Table 2.3, during Upgrade Works or Repair and Replacement Works. The Agency may, after consideration of mitigatory measures in line with Good Industry Practice approve other appropriate standards in these cases. A preliminary list and possible mitigatory options are given in Appendix A2 of this Annexure.

TABLE 2.1: GEOMETRIC DESIGN STANDARDS

No.	DESCRIPTION	STANDARD
1.	GENERAL	
	- width of road reserve minimum - design speed minimum - standard cross-sections	80m 120km/h Figures 1.1 to 1.5
2.	HORIZONTAL ALIGNMENT	
2.1	Radius - minimum - desirable	 700m 1200m or greater
2.2	Crossfall - for vertical grade >1.0% - for vertical grade <1.0% over a length > 500m	 2% 3%
2.3	Maximum superelevation	7%
2.4	Minimum transition curve	100m
3.	VERTICAL ALIGNMENT	
3.1	Maximum longitudinal grade - for rolling terrain - for mountainous terrain	 4% up to 500m 5% up to 400m
3.2	Minimum longitudinal grade	0.5%
3.3	Minimum K-value - for crest curves - for sag curves	 110 52
3.4	Minimum length of vertical curve	240m

TABLE 2.2: GEOMETRIC DESIGN STANDARDS FOR EXISTING HIGHWAY SECTIONS

NO.	DESCRIPTION	STANDARD	
		FLAT TO ROLLING	ROLLING TO MOUNTAINOUS
1	GENERAL		
1.1	Design speed - dual carriageway minimum - single carriageway minimum	 90 – 120km/h 100 – 120km/h	 80 – 100km/h 90 – 100km/h
2	HORIZONTAL ALIGNMENT		
2.1	Radius (at applicable design speed) for 7% maximum superelevation - dual carriageway - single carriageway	 330 – 700m 425 – 700m	 240 – 425m 330 – 425m
2.2	Transition Curves[1] - minimum lengths	 150m	 100m
2.3	Crossfall - for vertical grade >1,0% - for vertical grade < 1,0% over lengths >500m	 2% 3%	 2% 3%
2.4	Superelevation	Refer to Tables 2.3 (a) and 2.4	
3	VERTICAL ALIGNMENT		
3.1	Maximum grades - desirable - absolute maximum - others	 4% up to 500m 6% up to 250m Less than 4%	 6% up to 500m 8,5% up to 250m Less than 4%
3.2	Minimum longitudinal grades[2] – not less than	0,3%	0,5%
3.3	Vertical alignment K-values - for crests - for sags	 46 –110 31 – 51	 33 – 60 25 – 36
3.4	Minimum vertical curve length	240m	150m
4	INTERSECTIONS		
4.1	Minimum intersection spacing	600m	600m

1 Refer to Table 2.3

2 Minimum standard for cuts, desirable for fills.

2.3.2.3 Special Consideration

The requirements listed in Tables 2.1 and 2.2 may not always be achievable on all portions of the Highway. In such cases some relaxation of standards may be allowed as provided for in Table 2.3 below, but subject to prior approval by the Agency.

TABLE 2.3

SUPERELEVATION	
(a)	A maximum superelevation of 7% must be applied. However, on existing portions of Highway where the existing horizontal curves have radii of less than 1000m, a maximum superelevation rate in excess of 7% but not exceeding 10% may be retained.
(b)	To avoid portions of road surface having zero gradient in all directions, the Concessionaire must ensure that there are no superelevation developments in areas with vertical grades less than 2%.
CROSSFALL	
(c)	The normal crossfall must be 2% as shown on the typical cross-sections. For improved drainage purposes, the crossfall must be increased to 3% where the vertical grade is less than 1% over a length of more than 500m.
HORIZONTAL CURVES	
(d)	Transition curves must generally be used on horizontal curves with radii less than 1000m. Transition curves must, however, not be used on isolated individual curves in a defined portion of Highway. Where transition curves are omitted, the lane width shall be at least 3.7m.
VERTICAL GRADES	
(e)	The maximum vertical grades given in Table 2.1 may be revised with the prior approval of the Agency. In cases where natural steep slopes in mountainous terrain may necessitate the use of steep gradients to minimise deep excavations and high fills, the provision of climbing and crawler lanes may be used after consultation with and approval by the Agency.
(f)	The road capacity on existing steep grades may be improved by adding climbing lanes.
DESIGN SPEEDS	
(g)	In all cases where the horizontal alignment of the Highway is fixed and improvements to superelevation and/or lane widths cannot achieve the desired design speeds, speed restrictions may have to be introduced for safety reasons, as agreed to and approved by the Agency. Where speed restrictions have to be introduced, they must be rigorously enforced at all times. Such sections of road must be monitored for safety and operational characteristics and reported on to the Agency every three months.
(h)	Lower design speeds may only be used with the prior approval of the Agency.
(i)	A Traffic Management Plan must be implemented for Highway Sections 1, 2A and 2B to improve Highway operation and safety on a sustainable basis. The Traffic Management Plan must include a permanent data collection procedure whereby a comprehensive traffic and incident database can be built up, maintained and reported on in terms of clause 16 of the Concession Contract. Identified unsafe locations will be remedied through Good Industry Practice. A Public Involvement Program must be introduced and an efficient enforcement program launched in conjunction with the relevant law enforcement authorities.

Table 2.4 provides the rate of superelevation for various radii and design speeds with a maximum superelevation rate of 7%.

TABLE 2.4: RATE OF SUPERELEVATION

Maximum e = 7% ; NC = Normal Crown				
Radius	**Design Speed km/h**			
M	**60**	**80**	**100**	**120**
125	R_{min}=127			
150	6.9%			
175	6.7%			
200	6.5%	R_{min}=240		
225	6.2%	7.0%		
250	5.9%	7.0%		
275	5.6%	6.9%		
300	5.3%	6.8%		
350	4.8%	6.5%		
400	4.4%	6.1%	R_{min}=426	
450	4.1%	5.7%	7.0%	
500	3.8%	5.4%	6.8%	
600	3.3%	4.8%	6.4%	R_{min}=709
700	2.9%	4.3%	5.9%	7.0%
800	2.6%	3.9%	5.4%	6.9%
900	2.3%	3.6%	5.0%	6.6%
1000	2.1%	3.3%	4.6%	6.2%
1200	2.0%	2.8%	4.0%	5.5%
1400	NC	2.5%	3.5%	4.9%
1600	NC	2.2%	3.1%	4.4%
2000	NC	2.0%	2.6%	3.6%
2500	NC	NC	2.1%	2.9%
3000	NC	NC	2.0%	2.5%
4000	NC	NC	NC	2.0%

2.3.2.4 Applicable Standards Relating to Rural and Urban Environment

Rural and urban environments must be dealt with separately in relation to road development and long term planning.

Existing urban boundaries must be used as input for road classification so as to determine applicable road design standards.

(a) Rural Areas

There shall be no divided multi-lane at-grade intersections on Highway Sections 1 to 11.

The addition of lanes to the Highway shall be subject to Clause 3.4 of this Annexure.

Highway Sections 12XA , 12XB and 13X (Van Reenens Pass) are the most critical portions of the Highway with upgrading limitations due to the existing geometry, geotechnical and geological constraints. Subject to Clause 13A.1 of the Concession Contract the Construction Works relating to De Beers Pass, Highway Sections 6 & 7 must be completed by the time the total traffic in both directions on any of Van Reenen's Pass, Highway Sections 12XA, 12XB and 13X reaches an AADT of 13 900.

The crossing of the median on a four or more lane road must be limited to identified positions on the Highway as jointly agreed between the Agency and the Concessionaire. Existing

access points may have to be closed and the access roads concerned diverted via parallel service and/or collector roads.

(b) Urban Areas

Urban boundaries as at the Effective Date are as listed in Table 2.5 below: -

TABLE 2.5: LIST OF URBAN BOUNDARIES

HIGHWAY SECTION	TOWN	ROUTE SECTION	EXTENT OF URBAN AREAS	LENGTH (km)
12XA	Van Reenen	N3/6X	km 58,5-60,4	1,9
12XB		N3/7X	km 0,0- 0,5	0,5
12XB	Swinburne	N3/7X	km 9,5-12,5	3,0
15XB	Warden	N3/8X	km 19,5-22,0	2,5

These urban boundaries may change in future as urban areas develop along the Highway.

Should property accesses not conform to safety or minimum geometric standards, the accesses must be reduced by the construction of service roads or collector roads adjacent to the Highway.

The upgrading of intersections in an urban environment on the Highway must be by lane addition in terms of the strategy set out in Clause 2.3.2.6 of this Annexure but must generally be limited to 6 through lanes (excluding left and right turn lanes).

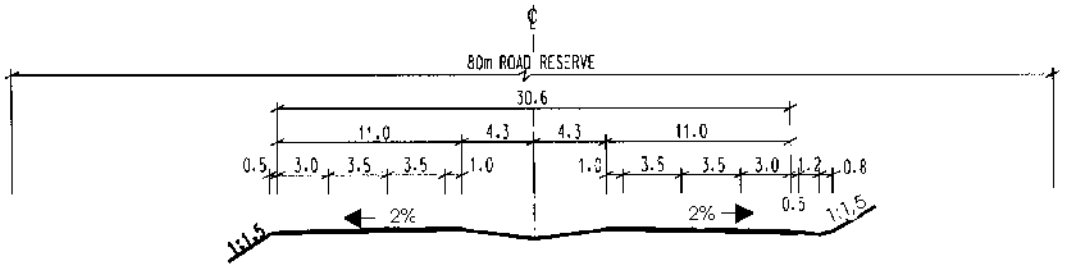
2.3.2.5 Rural Cross-sections and Cross-section Development Strategy

The rural cross-sections and development strategies are indicated in Figures 1.1 to 1.5 of this Annexure. Small variations in the cross-sections indicated may be considered for surface drainage requirements and lane channelization at at-grade intersections on Highway Sections 12X to 15X.

The cross-section of Highway Sections 12XA, 12XB and 13X (Van Reenens Pass), will not be upgraded during the Concession Period. Safety measures can, however, be implemented wherever required. Such safety improvements must be ignored in future capacity calculations for the construction and implementation of De Beers Pass Works.

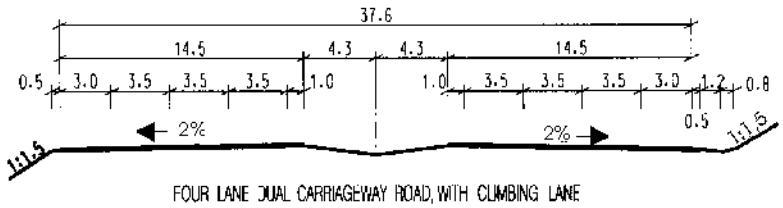
Cross-sections for crossroads, ramps and loops at interchanges must be developed in terms of traffic requirements and traffic lane widths similar to those shown in Figures 1.1 to 1.5.

FIGURES 1.1 TO 1.6: CROSS-SECTION REQUIREMENTS



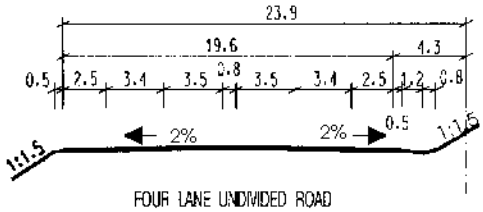
FOUR LANE DUAL CARRIAGEWAY ROAD

FIGURE 1.1



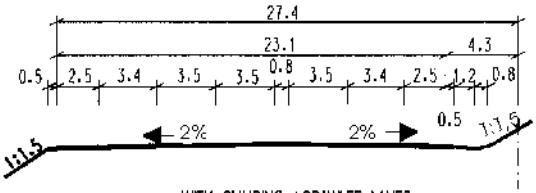
FOUR LANE DUAL CARRIAGEWAY ROAD, WITH CLIMBING LANE

FIGURE 1.2



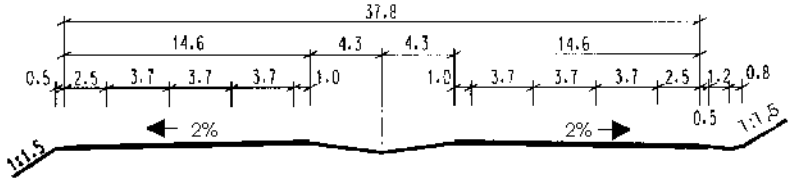
FOUR LANE UNDIVIDED ROAD

FIGURE 1.3



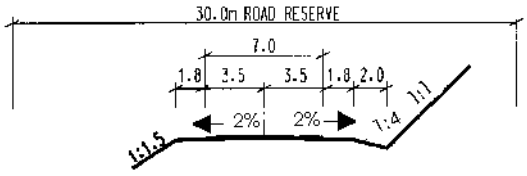
WITH CLIMBING / CRAWLER LANES

FIGURE 1.4



PROPOSED FUTURE SIX LANE, DUAL CARRIAGEWAY ROAD

FIGURE 1.5



PROPOSED TYPICAL CROSS SECTION OF ROAD P27-1

FIGURE 1.6

2.3.2.6 Geometric Standards for At-grade Intersections

The design of at-grade intersections must be in accordance with the documents listed in Clause 2.3.1 of this Annexure.

Further to the above, intersections may be identified for reasons of safety for the introduction of reduced speed limits, subject to the approval of the Agency.

Where dual carriageway or multi-lane facilities are established in urban environments without grade-separated interchanges, signalized intersections must be spaced in terms of applicable design standards and traffic capacity requirements.

For the upgrading requirements of intersections, traffic surveys and analyses for each specific intersection, or group of intersections, must be undertaken to enable evaluation in terms of level of service as per the requirements specified in Clause 3.4 of this Annexure.

When required for intersection capacity and/or safety reasons, grade-separated interchanges must be provided.

2.3.2.7 Geometric Standards for Interchanges

For ramps and loops, the applicable design standards must be in accordance with the prescribed documents in Clause 2.3.1 of this Annexure, and revisions thereof from time to time.

Where a freeway exists, interchanges must also be upgraded for capacity reasons if required.

2.3.3 Standards for Associated Facilities

The Geometric Design standards must comply with the design codes specified in this Annexure, as well as with the requirements of the Relevant Authority.

The typical cross-section of Provincial Road P27/1 must comply with Figure 1.6 of this Annexure.

2.3.4 Farm Accesses

Farm accesses must have a minimum sight distance of 300m. Where an existing access does not meet this requirement, the sight distance must be adequately improved or the access suitably relocated, all in consultation with the landowner concerned.

New accesses must not be closer than 300m from any existing access road, and subject to the following:

- Applications by means of a wayleave,
- Only one access per property unless the property is divided by a physical obstruction (river, railway line, etc.),
- Access must preferably be provided to secondary roads.

2.3.5 Arrestor Beds

Arrestor beds shall be constructed at suitable locations where crash rates caused by run away vehicles justify the necessity for such a facility.

Arrestor beds shall be located and designed according to the latest acceptable standards and Good Industry Practice.

2.4 The Design of Road Tunnels, Bridges and Drainage Structures

The Concessionaire must take into account the following requirements regarding the design of tunnels, bridges and drainage structures.

2.4.1 Road Tunnels

2.4.1.1 Introduction

The design of road tunnels must be in accordance with appropriate local and international practice with due consideration of the tunnel operation policy. The criteria set out in the document "Design of Road Tunnels Highway Agency Departmental Standards BD78 Draft 26 October 1998" and other relevant international publications and documents shall be used for the design, construction, equipment, improvement, operation and maintenance requirements for the tunnels. The following text is the most salient design considerations which have been obtained from the aforementioned draft document.

2.4.1.2 General Considerations

(a) Design Consideration

The likely risk scenarios which may occur in and on the approaches to the tunnel must be identified at Preliminary Design stage. Such scenarios include, but are not limited to:

Vehicle related incidents	Non-vehicle related incidents	Vehicle loadings	Weather hazards	Planned maintenance
Fire in tunnel Crashes Breakdowns Debris on road Overheight vehicles.	Lighting failure Ventilation failure Pumping failure Telephones out of order Pedestrians in the tunnel Animals in the tunnel Vandalism	Hazardous loads Slow moving loads Wide loads Abnormal Indivisible loads.	Fog* Rapid air vapour Condensation on Windscreen, mirrors etc High winds Ice* Snow* Flooding Dazzle from the sun (particularly east to west tunnel alignments)	Lane closures Carriageway closures Total closure Contraflow operation Temporary signing

* (It might be considered that snow, fog and high winds do not relate to tunnels. However, drivers may encounter these when they exit a tunnel and may need to be warned).

Solutions for dealing with each scenario shall be developed with due consideration of the management, coordination, operation, mobilisation, access, human resources, equipment, procedural and communications requirements of the various parties involved, and the needs of the road users.

(b) Tunnel Operation and Safety

Safeguards concerning safety and the handling of emergencies are to be in place before the tunnel(s) is opened for road users. A traffic management plan in the event of failure or emergencies must also be compiled with due consideration of likely risk scenarios.

(c) Tunnel Cross Connections

Passenger escape routes through fire doors positioned in cross-connecting passages shall be considered in the design of the tunnel.

(d) Vehicle Cross Overs

Vehicle cross overs shall be considered on tunnel approaches to enable contra flow working

(e) Drainage Sumps

Drainage sumps shall be sized to accept, and be equipped to contain with safety, the largest spillage that may reasonably be expected to occur within the tunnel.

(f) Lighting and Power

Daytime counter-cast adaptation lighting shall be provided on either side of the tunnel. During night-time the tunnels must be evenly lit. In the event of failure of the normal power supply an alternative source of power will maintain power to the operational and safety systems and permit the continuous use of the tunnel.

(g) Traffic Controls

The speed restriction for tunnels is 80km/hr. Appropriate levels of equipment for measurement of traffic speed and density, shall be developed in close cooperation with the Agency.

(h) Structural Design

The structural design life of the tunnel shall be 100 years

2.4.1.4 Geometric design

(a) General

Geometric design and traffic space requirements are presented from the standpoint of providing safe passage, under free flow conditions, for the type of traffic that is permitted to use the tunnel. Basic layout and tunnel geometry, however, shall also be related to other aspects concerning the design and operation of a tunnel. These aspects are:

- ventilation (length and gradients),
- traffic movements (maintenance, emergencies),
- portals (provision for parking/turning emergency vehicles), and
- operational safety (verge widths and lay-byes)

(b) Vertical Alignment

Gradients: Gradients exceeding 5% are to be avoided.

Crossfalls: A crossfall of 2.5% (1 in 40) is recommended.

(c) Clearances for Traffic

All equipment in the road tunnel shall be placed outside of the equipment gauge.

(d) Width

Traffic lane widths in tunnels shall be in accordance with Figure 2.

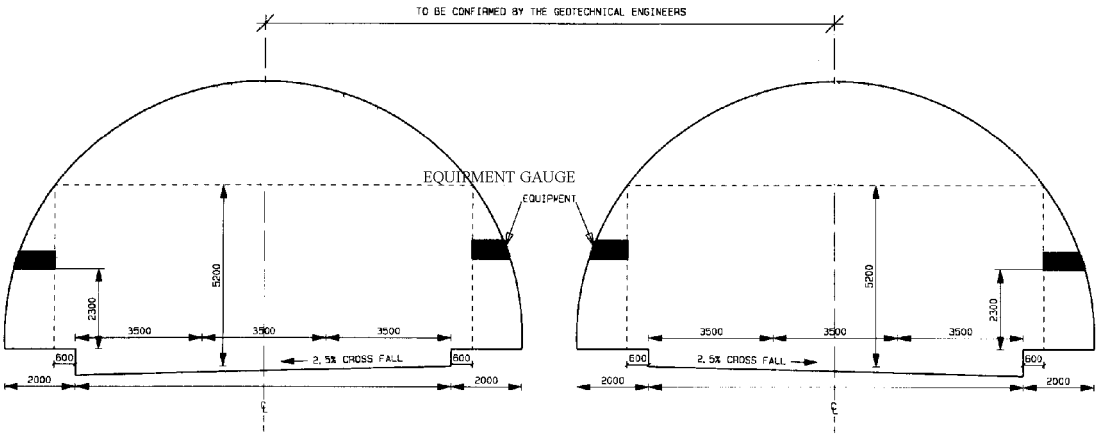


FIG. 2

(e) Height

The maintained headroom, in Figure 2 shall be based on the same requirements as for over-bridges on the Highway. The maintained headroom does not include any allowance for pavement overlays for which appropriate (and minimal) adjustments to headroom shall be made.

2.4.2 Road Related Structures

The structural design requirements must be in accordance with the applicable sections of the "Code of Procedure for the Planning and Design of Structures", Draft April 1996, obtainable from The Department of Transport, P.O. Box 415, Pretoria, 0001. It is to be noted that Chapter 13, Section 4 to Chapter 17 do not apply to this Concession Contract.

The Concessionaire is to provide the Agency with aesthetically pleasing and effective practical solutions by taking cognisance of environmental and other factors not necessarily connected with structural integrity, which may have an influence on the design of structures.

For new structures, emphasis must be placed on the durability of the concrete to be used. Details in this regard are to be submitted to the Agency for discussion.

For new bridges or bridges to be widened the width of the bridge is defined as the distance between the inner edges at deck level of the standard New Jersey balustrades to be provided on the bridge. For congruence with a defined or existing road cross-section this width shall be 400mm less than the distance between the inside faces of guardrails either on or to be placed on the approach embankments.

Existing bridges not complying with the road cross-sections of Figures 1.1 to 1.5 are listed in Appendix B of this Annexure. Mitigating factors with regard to these substandard bridge widths are given in Appendix B.

The width of any road bridge passing over the Highway must satisfy the requirements of the relevant road authority. The level of service for both vehicular and pedestrian traffic must determine whether sidewalks and shoulders, if any, must be included or excluded from the minimum road width.

The minimum vertical clearance of all structures over the Highway must be 5.2 metres for road and rail bridges and 5.6 metres for pedestrian bridges. Listed in Appendix B of this Annexure are the bridges with clearances at the Effective Date which are less than 5,2m.

2.4.3 Drainage Structures

The following design manuals and methods are to be used in the design of drainage structures.;

- South African Roads Board Drainage Manual, (Second print of 1986 version – Pretoria 1993), obtainable from Department of Transport, P O Box 415, Pretoria, 0001.

- Code of Procedure for the Planning and Design of Structures. Draft April 1996, published by Department of Transport, P O Box 415, Pretoria, 0001.

- Recommendations for Highways: Subsurface Drainage for Roads, Draft TRH15 (1994), published by Department of Transport, P O Box 415, Pretoria, 0001.

The above manuals are to be used in addition to sound engineering knowledge and Good Industry Practice. The Concessionaire must at all times use its discretion and engineering expertise to critically evaluate a requirement and, if it has sufficient merit to deviate from requirement, the Concessionaire must recommend and motivate to the Agency the reason for the required deviation for its consideration and approval.

Existing waterway structures not classified as bridges must be measured for size of opening and checked for discharge. Should the area of waterway exceed 36m², or should the 20 year return period discharge exceed 100m³/s, then such structure must be reclassified as a bridge and treated as such.

2.5 Geotechnical Requirements

The scope of the geotechnical requirements covers road pavement designs, cut and fill stabilities, and road building materials.

2.5.1 Road Pavement Designs

The Concessionaire must, in addition to any other recognized or innovative design method(s), use the following road pavement design codes and methods to design its road pavement strategy for the Concession Period:

- Dynamic Cone Penetrometer Method (flexible pavements) obtainable in electronic format from the Computer Information Centre for Transportation of the CSIR, P O Box 395, Pretoria, 0001, (ISBN: 0 7988 5075 2).

- Technical Recommendations for Highways: Structural Design of Flexible Pavement for Interurban and Rural Roads, Draft TRH4 (1996), by COLTO (ISBN 1 86844 218 7).

- American Association of State Highway and Transportation Officials (AASHTO), Guide for Design of Pavement Structures: (1986)(flexible and rigid), Washington DC.

- Concrete Pavement Design and Construction: Draft Manual M10, (1995), published by Department of Transport, P O Box 415, Pretoria, 0001, (ISBN 1 86844 267 1).

- The Classification of Pavement Rehabilitation Design Methods – Report DPVT 5 (1989), obtainable from the CSIR, P O Box 395, Pretoria, 0001, (ISBN 0 988 44854).

- Shell Pavement Design Manual – Asphalt Pavements and Overlays for Road Traffic, published by Shell International Petroleum Company Limited, London.

- Urban Transport Guideline: Structural Design of Segmental Block Pavements for Southern Africa: Draft UTG2, obtainable from Department of Transport, P O Box 415, Pretoria, 0001, (ISBN 0 7988 4083 8) (1987).

- Rehabilitation Design of Flexible Pavements in South Africa, published by the Department of Transport, ISBN 186844-307-8.

- Technical Recommendations for Highways: Surfacing Seals for Rural and Urban Roads and Compendium of Design Methods for Surfacing Seals used in the Republic of South Africa, Draft TRH3 (1998), published by the Department of Transport, P O Box 415, Pretoria, 0001.

- Technical Recommendations for Highways: Bituminous Pavement Rehabilitation Design, Draft TRH12 (1983), published by the Department of Transport, P O Box 415, Pretoria, 0001. Bituminous pavement rehabilitation design.

The Concessionaire must take cognisance of the fact that the Agency's design methods are based on a standard axle loading of 80kN which is equivalent to an axle mass of 8.2 tons. The current legal permissible single axle load is, however, 9.0 tons (88kN).

The road pavement required on Provincial Road P27/1 must conform to an ES7 type pavement (3 x 10^6 E80's) as specified in draft TRH 4 (1996).

2.5.2 Design of Cut and Fill Slopes

The stability (subsurface and other) of cuts and fills must be properly investigated and designed by the Concessionaire. In doing so the Concessionaire must use the services of a reputable, independent professional geotechnical engineer.

The minimum Factor of Safety for the stability of cuts and fills shall be 1,5, unless otherwise certified safe by an independent geotechnical engineer.

The side slope of 1:1,5 specified in Figures 1.1 to 1.5 of this Annexure is used for illustrative purposes only. The final side slope must be as specified by an independent geotechnical engineer for different qualities of materials used in the construction of the road prism and the requirements dictated by the embankment design methodology.

2.5.3 Road Building Materials

The Concessionaire must ensure that all materials used in Construction Work**s** are compatible with the environment and health regulations and practices. The quality of road building materials to be used in Construction Works is the responsibility of the Concessionaire.

The following standards/guidelines are generally used by the Agency and should be considered for adoption by the Concessionaire**:**

- South African Bureau of Standards (SABS) – various publications.

- Technical Recommendations for Highways: Guidelines for Road Construction Materials, Draft TRH14 (1987), published by Department of Transport, P O Box 415, Pretoria, 0001, (ISBN 0 7988 22724).

- Design and use of hot-mix asphalt in pavements.

- Technical Recommendations for Highways: Design and use of Hot-Mix Asphalt Surfacing in Pavements, TRH8 (1987), published by Department of Transport, P O Box 415, Pretoria, 0001, (ISBN 0 7988 41591).

- The Standard Specifications for Road and Bridge Works for State Road Authorities (1998) issued by the Committee of Land Transport Officials (COLTO) obtainable from the South African Institute of Civil Engineers.

- Technical Recommendations for Highways: Surfacing Seals for Rural and Urban Roads, and compendium of design methods for surfacing seals used in the Republic of South Africa, Draft TRH 3 (1998), published by Department of Transport, P O Box 415, Pretoria 0001.

- The testing and evaluation of the material components shall be done in accordance with section 8100 of the Committee of Land Transport Officials (COLTO) Standard Specification for Road and Bridge works for State Road Authorities (1998), published by the Committee of Land Transport Officials.

2.6 Construction Works

The Concessionaire shall construct the Construction Works in accordance with the relevant specifications, drawings, schedules and in accordance with Good Industry Practice.

2.7 Design and Construction of Toll Plazas

The Concessionaire must apply the requirements in the latest versions of amongst other things the following documents and publications in the design and construction of the toll plazas:

- South African Bureau of Standards:

    - Code 0142: Wiring of Premises (1993)
    - Code 0400: Fresh Air Ventilation
    - Code 1200: Buildings
    - Code 098: Parts 1 & 2, 1996: Lighting of public thoroughfares

- Standard Specification for Building Works, obtainable from National Road Agency (for toll plazas).

- Standard Specification for Electrical and Mechanical Works, obtainable from National Road Agency.

- Standard Specification for Toll Collection Equipment (including the revised Section 11800 on Equipment), obtainable from National Road Agency.

- Standard Specification for Operation and Maintenance of Toll Facilities in South Africa, obtainable from National Road Agency.

- Occupational Health and Safety Act (OHS) (85 of 1993).

Notwithstanding the requirements given in the documents and publications listed above, the Concessionaire must take into account the following discipline requirements and standards in the design of the toll plazas:

2.7.1 Civil and Structural Requirements

The design for each toll plaza must cover the geometrical layout, long sections, cross-sections, pavement structures, drainage, landscaping, water supply, sewage disposal, toll islands, canopies, tunnels, foundations, manholes, plaza buildings, toll booths, maintenance and operation centres, inclusive of all internal utilities.

Toll Plaza Design Standards

-	vertical canopy clearance:	5,5m minimum
-	longitudinal gradient for mainline plazas:	1,5% maximum (60m minimum either side of plaza centreline)
-	longitudinal gradient for ramp plazas:	3% maximum (60m minimum either side of plaza centreline)
-	plaza approach tapers:	1:8 minimum
-	plaza exit tapers:	1:5 minimum
-	length of plaza approaches:	60m minimum on approach and exits at full width both sides
-	type of pavement for toll plaza area:	concrete or block paving
-	normal toll lane width within the toll plaza area:	3,2m minimum
-	extra wide toll lane width for abnormal vehicles (one per direction):	6,0m minimum
-	toll island width in toll plaza area:	1,8m minimum
-	toll island length in toll plaza area:	21m minimum
-	total length of canopy along the road centreline (including overhang):	16m minimum
-	impact attenuators and toll booth protection structures must be provided	

2.7.2 Electrical and Mechanical Requirements

The design for the toll plazas must cover the electrical reticulation, distribution boards, road, area and canopy lighting, uninterrupted power supply (UPS), generators, earthing and lightning protection, fresh air supply, pressurised air supply to toll booths, air-conditioning, heating, security and lighting and power installations in the control buildings.

The power supply to the toll plaza must consist of:

- 420/242 volts 50Hz four wire (no load) as locally supplied;
- power connection from a commercial power supplier where available, a generator set, and an UPS set capable of supporting the operations of the toll plaza for at least eight hours;
  - as published in the Government Gazette of 16 November 1990 in terms of the Electricity Act, 1987;
  - current practice at toll plazas to allow adequate time for correction of power failure problems

The mechanical systems must provide an environment for the toll collector that complies with the minimum standards as specified in SABS 0400: Fresh Air Ventilation.

The carbon monoxide level within any toll booth must be not greater than 50 parts per million (ppm) at all times.

2.7.3 Lane Equipment and Management Information Systems (MIS)

The design for the toll plazas must cover the toll collection equipment, toll collection control equipment, traffic event logger (TEL), computer hardware, computer software packages and management information systems (MIS) programmes.

The design and configuration of all lane equipment must be inter-operable with existing toll plaza systems in South Africa under jurisdiction of the Agency, or as specified in the Standard Specification for Toll Collection Equipment.

The MIS to be used must be inter-operable with that described in the Standard Specification for Operation and Maintenance of Toll Facilities in South Africa and must be approved by the Agency.

All proposed changes to the lane equipment and MIS subsequent to the original approval(s) must be agreed with the Agency. Furthermore, any changes to lane equipment and MIS required by the Agency must be implemented by the Concessionaire within a reasonable time which will be determined by the extent of the change.

2.8 Operations and Maintenance

The Concessionaire must base its Operation and Maintenance procedures on the latest versions of the following publications:

- Standard Specification for Operation and Maintenance of Toll Facilities in South Africa March 1994 Volume 2 – as amended April 1996, obtainable from the Department of Transport, P O Box 415, Pretoria, 0001
- Standard Specification for Toll Collection Equipment December 1992 Volume 2A – as amended April 1996
- Standard Specification for Electrical and Mechanical Works Volume 2 – April 1997
- Government Gazette Number 16975; 14 February 1996, detailing vehicle classification at toll plazas.

2.8.1 Toll Plaza Operations and Maintenance

The operations required from Concessionaires at toll plazas will include, amongst other things, the following:

- establishing suitable resources for operating functions;
- providing training and employment of manpower to operate the toll plazas;
- provision of a toll collection function;
- administration, accounting and financial management;
- gathering of statistics, monitoring and reporting;
- liaison with relevant public and emergency authorities in relation to the Highway;
- providing specialised maintenance of toll and electronic equipment and MIS hardware and software;
- providing the day-to-day cleaning , domestic and gardening services at the toll plazas;
- carrying out structural maintenance (minor and major) at toll plazas;

- providing water reticulation, sewerage reticulation, sewage disposal and maintenance to the plaza facility at toll plazas; and
- carrying out electrical and mechanical maintenance at toll plazas.

The Concessionaire must submit to the Independent Engineer and the Agency, two months prior to the commencement of toll collection services at any of the toll plazas, and other road related services, the Operations and Maintenance Manuals which must include, amongst other things:

- personnel structure for operations;
- arrangements for personnel transport to and from the toll plaza;
- establishment and training programmes for operations;
- security aspects for the toll plaza;
- procedures to determine toll plaza manning levels,
- procedures for auditing operations; financial and technical;
- procedures for handling complaints in respect of operations;
- procedures for financial management and reporting of operating functions; and
- quality assurance procedures for operating functions.

The Concessionaire must submit to the Independent Engineer and the Agency monthly reports for each toll plaza, covering the following:

- daily number of vehicles using the Highway and passing through the toll plaza, specifying the different vehicle classes and their direction, and providing cumulative figures;
- statistics on percentage attraction in comparison with alternative routes;
- daily amounts collected by way of toll fees, with a breakdown showing method of payment (noting discounts and/or concessions granted);
- total operating cost per plaza;
- lane manning level report;
- number of vehicles which drive through toll booths without paying appropriate toll fees;
- number of evasions, underpaid and unsettled toll fee occurrences;
- the number and amount of overpaid tolls;
- complaints by users regarding operations;
- any other information which the Agency may require;
- warrants of free passage;
- monetary value of discrepancies between vehicle classification of toll collectors and of automatic vehicle classification (AVC) devices (overall and, if required, by collector); and
- the daily traffic reported by the toll MIS and by an independent toll audit counting system (also by vehicle class, if required)

The Operation and Maintenance of toll plazas must comply with the following requirements:

- toll plazas are to be operational 24 hours per day throughout the year.

- the status of each toll lane (in terms of whether the lane is open or closed and in terms of which payment methods are accepted) must be indicated clearly and unambiguously.

- the “Average Service Time and Maximum Queue Length Specification” must be met in the context of Clause 12410 of the “Standard Specification for Operation and Maintenance of Toll Facilities in South Africa”.

- the Concessionaire must at each toll plaza display the levels of toll payable from the approved dates and times, for the information of the road users and at other convenient distances from the toll plazas.

- the methods of payment of tolls must be in accordance with the methods of payment currently processed by the MIS used at toll plazas on the Highway under the jurisdiction of the Agency. Any new payment method and/or toll authority cards and/or Concessionaire/operator cards, must be approved by the Agency and the transactions must be processed by the MIS.

- a warrant system must be implemented in accordance with Annexure 7 to grant exemption from toll fees to the South African Police Services, South African National Defence Force and other vehicles agreed to by the Agency;

- the Concessionaire must develop, maintain and improve to the satisfaction of the Agency all software and computer programs and their documentation for use in conjunction with toll collection, toll control and traffic data. The Agency must have "read only" access to all computer data for the operation and control of toll collection. If the Agency so requires, the Concessionaire shall provide the Agency with its own terminal at the Agency's Northern and Eastern Region premises at the Agency's expense.

- the Concessionaire must make available to customers at each toll plaza a register for noting any claims and complaints together with the actions taken. The Concessionaire must take account of, and deal with, all such reasonable claims and complaints and make this information available to the Agency.

2.8.2 Route Operations

Work required for route operations of the Highway will include, amongst other things, the following:

- establishment of suitable resources and manpower to carry out the operations on the Highway;
- training of personnel to carry out the route operations on the Highway;
- maintaining a traffic management function, inclusive of road user interaction;
- liaison with relevant public, police, security and emergency authorities and the drawing up of such co-operation and co-ordination arrangements as are permissible in respect of such services to be provided in connection with the Highway as part of IMS;
- route management services on the Highway;
- a patrol service which shall:-
  - assist motorists with broken-down vehicles;
  - notifying relevant service providers along the route;
  - note, remove (where possible) and report on all road obstructions; and
  - note and report on obvious Routine Maintenance requirements along the route.

- update and review, on a continual basis, the appropriate emergency procedures for the Highway in the event of multiple vehicle collisions; main pipeline leakages or bursts; or other incidents which may cause major traffic disruptions.

- ensure that the emergency procedures are carried out promptly and efficiently by its staff, and ensure that any diversion or disruption of traffic is reported without delay to a regional or local command and control centre of the police force, any relevant

municipal authorities, and/or to an officer or any other party designated by the Agency.

- the implementation of an SOS telephone system, at not more than 4km spacing in pairs, over the entire Highway, which must not later than the expiry of the Initial Construction Period, operate full time and which must form part of the Highway equipment.

- a service to monitor, maintain and respond to the SOS emergency phone system on the Highway

- the implementation of route services to assist users of the Highway in the case of a breakdown and/or a crash and the rendering of first aid support (CPR and pressure bandages) to crash victims until such time as the victims can be transported to the nearest medical facility.

- the implementation of safety procedures at a crash site, which will entail the:

    - informing of the Relevant Authorities as soon as possible, but, in no event, later than 15 minutes from notification that a crash has occurred;

    - the rendering of first aid support;

    - securing the crash site; and

    - the erecting road signage.

- provision of patrols in each direction over the entire Highway as follows:

    Shift 1 (06h00 – 14h00) and Shift 2 (14h00 – 22h00)

    - the patrol vehicle will commence from the base station on average not later that 30 minutes after the start of the shift and proceed slowly along the length of the designated patrol section of road so as to reach the furthermost point approximately halfway into the shift (after 4 hours).

    - during the second half of the shift the patrol vehicle will proceed slowly, so as to reach the base not earlier than 30 minutes prior to the change end of shift.

    - the above frequency and timing of patrols will however depend on the incidents on the road and whether or not a rapid response is required. In some cases, due to the time spent at a major incident it may not be possible to complete a full patrol sweep.

    Shift 3 (22h00 – 06h00)

    - the patrol vehicle and patrol person will be present at the base station (between these hours) or at a suitable satellite point along the road but need not carry out any routine patrolling unless specifically instructed.

- keeping the Highway open for traffic 24 hours per day throughout the year. In the event that any part of the Highway is closed, keeping all other portions that can still be safely operated open to traffic at all times.

- organising the removal of any vehicles, debris and other objects which may interrupt or be a danger to the traffic flow on the Highway.

- during periods of actual or anticipated adverse weather, using all reasonable endeavours to ensure that the Highway remains open to traffic under safe conditions. Emergency measures shall be performed in order to obtain acceptable traffic conditions under the circumstances;

- specifying and controlling the traffic signs and proper safety measures to be implemented by third parties in the event of construction works having to take place on any section of Highway being used by traffic;

- taking all reasonable measures to ensure that traffic flow on the Highway is convenient and safe.

Two months prior to the commencement of operations on any part of the Highway, the Concessionaire must submit to the Agency the Operations and Maintenance Manuals which shall include amongst other things, the following:

- personnel structure for route operations;
- arrangements for personnel transport to and from the toll plazas;
- establishment and training programmes for route operations;
- procedures relating to operating SOS telephones on the Highway;
- procedures relating to route services;
- procedures for handling complaints;
- procedures for traffic management and reporting; and
- procedures for dealing with incidents and emergencies.

The Concessionaire must submit the following monthly reports to the Independent Engineer and the Agency;

- the crashes on the Highway, stating the exact position, nature, time and date of each incident.
- a report on the operation of SOS telephones, including all calls received, a break-down of the types of call, the actions taken and availability of the SOS telephones during the month.
- a report on the route services provided, indicating all incidents responded to, the reaction time of the service, and the assistance rendered at the scene.
- other relevant information which may be required by the Agency.

2.8.3 Routine Maintenance

The Concessionaire must carry out all Routine Maintenance of the Highway in accordance with procedures to be set out in the Operation and Maintenance Manuals.

Certain road pavement distresses and Routine Maintenance defects of the Highway cannot be attended to immediately after the Effective Date. A delay period for compliance with the Agency's requirements for specific aspects are listed in Appendix C of this Annexure.

2.8.3.1 Routine Maintenance Activities

Routine Maintenance shall include, but not be limited to, the following activities;

- erection, maintenance and removal of temporary road signs for the accommodation of traffic;

- maintenance of road pavements;
- repairs to edge breaks;
- repairs to gravel shoulders and rounding;
- removal of live animals from the Road Reserve and measures to prevent similar future occurrences;
- clearing of carcasses from the Road Reserve and disposal thereof;
- clearing of refuse from the Road Reserve, laybyes and plaza areas, and disposal thereof;
- regular mowing of grass in the Road Reserve and removal of grass cuttings;
- removal of edge build-ups;
- cleaning of bridge drainage pipes and accumulated debris in expansion joints and bridge bearings;
- cleaning of all drainage structures and disposal of excess material;
- cleaning of all road signs;
- repairing of damaged guardrails, fencing and road signs;
- repair of existing drainage facilities to combat erosion and repair of erosion damage;
- replacement of road studs;
- repainting of road markings;
- cleaning of stained or soiled elements of the works; removing graffiti and placards from structures;
- maintenance of vegetation and ground cover by, inter alia, hydroseeding, application of fertiliser, supplying and spreading topsoil, planting and maintaining trees and shrubs, and eradicating weeds and undesirable plant growth;
- closing of illegal accesses;
- prevention of illegal trading;
- maintenance of tunnels;
- provision of emergency assistance;
- provision of monthly reports to the Agency based on inspections performed as specified;
- compilation and updating of a database of road furniture, based on routine inspections of the works;
- liaison with the Agency and accompanying it on inspections when required;
- preparation and implementation of a Maintenance Management System; and
- specialised maintenance of toll and electronic equipment and MIS hardware and software.

2.8.3.2 Routine Maintenance Requirements

The Concessionaire must ensure that the Routine Maintenance work required within the Road Reserve, to roads, structures and drainage, is carried out as follows regarding:-

(a) Accommodation of Traffic

Interference with traffic, particularly during maintenance work, must be minimised in order to ensure that traffic maintains free-flowing conditions and acceptable levels of safety and service. The Concessionaire must programme its work to this end, and must ensure that the rate of progress during maintenance work is such that the duration of work and hence disruption to traffic flow are minimised.

The Concessionaire must provide, erect and maintain the necessary traffic control devices, road signs, channelization devices, barricades, warning devices and road markings (hereinafter referred to as traffic control facilities), as shown in the latest edition of the South African Road Traffic Signs Manual and Road Note 13 and must remove them when no longer

required. The Concessionaire must ensure that the above-mentioned traffic control facilities are in position at all times and are functioning properly. The Concessionaire must inspect all temporary traffic control facilities at least twice daily, and rectify any shortcomings.

(b) Clearing of the Site

The Concessionaire must inspect the Highway at appropriate intervals as part of its clearing operations, at the same time recording damaged guardrails, fencing, road signs and any other matters requiring attention. Suitable records must be kept of all such inspections.

The Concessionaire must keep the Site clear of foreign articles, litter and rubbish. All material cleared from the Road Reserve must be disposed of at appropriate dumping sites. The location of dumping sites is the responsibility of the Concessionaire. Written approval from the landowners or relevant authorities, on whose property the dumping occurs, must be obtained. No dumping sites shall be permitted within the Road Reserve.

The Concessionaire must adhere to national and local environmental and health legislation and regulations regarding the dumping of carcasses, toxic waste, hazardous chemicals (including spillages) and other harmful or potentially harmful substances.

The Concessionaire must clear the full length of the Road Reserve of foreign articles, litter and rubbish at least once per month.

The cleaning of laybys and interchange areas, and the emptying of rubbish bins, must be carried out at regular intervals and on a daily basis during peak holiday periods. Such intervals are to be agreed by the Agency and the Concessionaire.

Clearing the road surface of glass, debris, oil and other substances at all times will form part of the Concessionaire's responsibilities.

Provision must be made in the operational procedures for dealing with major crashes and other cases of emergency on the Highway.

(c) Clearing around Trees and Shrubs

The Concessionaire is required to clear around trees and shrubs within the Road Reserve, to at least 0,5m beyond the extremity of the drip zone of the tree or shrub or to a 3m diameter circle, whichever is the lesser. Clearing must include, amongst other things, the loosening of soil, eradication of weeds, the forming of ponds with walls approximately 150mm above surrounding ground level around young shrubs and trees, and the removal of all debris to approved dumping sites. Clearing around plants must be done annually during the months of May and June.

(d) Removal of Motor Wrecks and Abandoned Vehicles

Any abandoned vehicle or motor wreck must be reported to the police. The Concessionaire must, in consultation with the police and where necessary, with relevant authorities and owners (where they are reasonably contactable) make arrangements regarding the removal of such motors wrecks and abandoned vehicles from the Road Reserve within 3 days of notification. Vehicles standing on the roadway which have not been removed within 8 hours of notification, must be removed by the Concessionaire to a place of reasonable safety.

(e) Cleaning of Structures

The Concessionaire must remove from all structures placards, graffiti, and any other forms of soiling or staining which have a noticeable effect on the Highway or on the aesthetical appearance of the structures. This must be done on a monthly basis.

(f) Removal of Illegal Advertising Signs

The Concessionaire must remove all illegal signs from the Site. The Agency must also be notified of illegal advertising signs outside the Road Reserve.

The procedure for removing illegal signs from the Site must be agreed with the Agency before removal commences

(g) Illegal developments

The Concessionaire must notify the Agency of perceived illegal developments within the Road Reserve, outside the Road Reserve but within the "building restriction area", and on land belonging to the Agency alongside the Highway.

(h) Clearing of Drains and Drainage Structures

The Concessionaire must carry out quarterly inspections of all open and side drains, sub-soil drainage, banks and dykes, culvert inlets and outlets, culverts and other conduits on the Site, and, on an annual basis, outside the Road Reserve. The Concessionaire must ensure that all drainage systems are clear and in good order. Any damage or obstructions must be recorded and repaired on an ongoing basis.

Any erosion below the design grades for banks, catchwater banks, dykes, open drains and side drains must be backfilled to the original line, grade and cross-section with suitable soil, gravel or rock obtained from approved borrow pits and compacted in layers not exceeding 150mm thickness to a minimum of 90% of modified AASHTO density.

Where applicable, after completion of remedial works, open and side drains, banks, dykes and eroded areas must be grassed and/or sodded.

All existing lined open drains, as well as culvert inlets and outlets, must be cleared and sediment removed from the floors and sides. This work must be done during the winter season to coincide with other operations undertaken by the Concessionaire. The original line, grade and cross-section must be maintained during all clearing and shaping operations.

Accumulated silt and debris in any stormwater culvert must not exceed 75mm in thickness.

(i) Maintenance of Cut and Fill slopes

The Concessionaire must inspect all cut slopes at least once a year, preferably during the winter months and record any signs of distress, erosion, blockage of catchwater drains at the tops of cuttings, loose rocks and boulders. Remedial work may include the re-stressing of rock anchors, removal of fallen and/or loose rocks and boulders, reconstructing and/or cleaning cut-off drains, as well as repairing, trimming and revegetating eroded areas. This work must be completed within 2 months after the date of inspection but before the rainy season starts, except where there is a hazard to road users, in which case the work must be done as soon as reasonably possible.

The Concessionaire must inspect all fill slopes at least once a year, preferably during the winter months, and record any signs of settlement, slips, erosion or other forms of distress. Remedial work to such distress must be completed within 2 months, and, if possible before

the rainy season starts, except where there is a hazard to road users, in which case the work must be effected as soon as reasonably possible.

Where erosion has damaged the surface of cut or fill slopes, the damage must be made good by backfilling with suitable material compacted to a minimum of 90% of modified AASHTO density. The surface must then be retrimmed to the original design profile. In more serious cases where the surface has eroded deeper than 500mm, measured perpendicular from the face of the slope, the slope must be cut back by benching, backfilled and compacted to the standard required above, using suitable light compaction equipment. The slope must then be retrimmed and revegetated by hydroseeding, sodding or any other method agreed to by the Agency.

The Concessionaire must protect all areas susceptible to erosion by installing all necessary temporary and permanent drainage works as soon as possible and by taking such measures as may be necessary to prevent surface water from being concentrated in streams which could scour slopes, banks or other areas.

Any runnels developing must be backfilled and compacted and the areas concerned restored to good condition. The Concessionaire must not allow erosion to develop on a large scale before effecting repairs. All erosion damage must be repaired as soon as possible and in accordance with Good Industry Practice.

(j) Guardrails

The Concessionaire must inspect the Highway on a daily basis to check for damaged guardrails. Information as to the location of such damage must be recorded.

Damaged guardrails must be repaired or replaced within 3 weeks of the damage first being recorded, or earlier if conditions are hazardous to road users. Repaired or replaced guardrails must comply with the specification for new guardrails.

(k) Fencing

The Concessionaire must keep all fencing in a state of good repair at all times. Any breach in Road Reserve fencing, noticed during inspections or brought to the attention of the Concessionaire, must be recorded and remedied as soon as reasonably practical.

(l) Road Signs

The Concessionaire must carry out daily inspections of all road signs to ensure that they are in good functional condition under day and night conditions. Damaged or missing standard, regulatory and warning signs must be recorded and the Concessionaire must as soon as reasonably practical replace or repair such signs. The Concessionaire must keep sufficient stock of the abovementioned standard signs and supports to enable replacement as soon as reasonably possible. Information signs must be repaired or replaced within two weeks of the damage being noted. Damaged or missing non-standard signs must be recorded on the Maintenance Management System and the Concessionaire must as soon as reasonably practical order the necessary materials to replace damaged parts and repair the sign as soon as possible thereafter. The Concessionaire must provide temporary signs or institute any other interim arrangements necessary to ensure the safety of road users.

Retro-reflective and non retro-reflective materials used for all road signs shall comply with the requirements of SABS 1519-1990 as amended. Retro-reflective materials for warning and regulatory signs must be Class I or better. Retro-reflective material for information and other direction signs must have Class I backgrounds and borders and must have Class III legends

and symbols. All retro-reflective and non retro-reflective materials must have a minimum warranty grade of 7 years.

All road signs and supports must be designed, constructed and erected to withstand wind loading and must conform with other criteria outlined in the South African Road Traffic Signs Manual (SARTSM).

All road signs shall be inspected at least once a year by means of a night time visual inspection. Such inspections are to be undertaken by a team of at least two people travelling in a sedan car. A sign will be deemed acceptable if it is legible from a distance of 100m and shows no indication of non-uniform retro-reflective properties (excluding the effect of dew on the signface surface). Signs on all road sections on which signs are identified as giving non-uniform retro-reflectivity, as well as signs older than five years, will be sampled for on-site testing.

On site-testing of the retro-reflective properties of road signs will be done with a portable retro-reflectometer measuring at an entrance angle of 5.0° and an observation angle of 0.33°. The co-efficient of retro-reflection so determined shall be compared to the relevant values given in SABS 1519-1.

Signs having a co-efficient of retro-reflection less than 50% of the value given in SABS 1519-1 for new materials, or such other value as may be mutually agreed, will be have to be replaced.

(m) Road Studs and Road Markings

The Concessionaire must inspect the road at least four times a year and replace damaged or missing road studs. The Concessionaire must keep sufficient stock of the specified adhesive and road studs to facilitate immediate replacement where necessary after each quarterly inspection. All road studs must be installed in accordance with the recommendations of the manufacturer. Damaged road studs are to be removed flush with the road pavement, leaving no protuberances or depressions. The road surface must be restored to its original level before fixing new studs.

All road studs shall be inspected at least once every six months by means of a night time visual inspection. The test shall be undertaken by a team of at least two people driving in a sedan car.

The road studs on a road section shall be deemed acceptable if they are visible for a distance of at least 216m on a straight and level part of the road under high beam illumination; i.e. 9 studs at 24m spacing.

Road studs not complying with these criteria shall be replaced.

The visual inspection is to be supplemented by taking on-site retro-reflectivity measurements with a portable retro-reflectometer measuring at an observation angle of 0.33°. These measurements are to be taken with a view to establishing terminal performance indicators for future guidance.

Road markings shall be assessed at least once every six months by means of a day time and a night time visual inspection.

The inspections are to be undertaken by a team of at least two people travelling in a sedan car. Markings will be deemed acceptable under daytime conditions if, on a straight and level section, not looking towards the sun, they are visible for at least 210m. Road markings will be

deemed acceptable under night time conditions they are if functional on a straight and level section for a distance of 155m under high beam illumination.

Markings not complying with the above visibility criteria shall be repainted.

The visual inspections shall be supplemented by on-site retro-reflectivity and traffic-wear index measurements taken on a sample basis from those road markings sections deemed to be suspect. Retro-reflectivity measurements will be taken in accordance with SABS 1261 and the traffic wear index determined in accordance with SABS 1248. Both these sets of measurements will be used to establish terminal performance indicators to be implemented at a later stage.

(n) Road Related Structures

Bridges and other structures must be inspected regularly. (This inspection must not be confused with the Bridge Management System Inspections as described in this Annexure). Bridge drainage channels, scupper pipes, and accumulated debris in expansion joints and at bridge abutments must be cleaned regularly. Damaged and/or leaking expansion joints must be repaired or replaced.

Any form of subsidence on paving and erosion in abutment fills must be rectified.

Maintenance activities on any bridge must be completed within two months after it has been inspected, or earlier if conditions are such as to constitute a hazard to road users.

All steel overhead sign structures must be inspected each year in April and any form of distress, as well as damage to the structure or paintwork recorded. Remedial measures must be completed within three months following the inspection, or earlier if the safety of the public may be affected. Repainting of damaged areas must be done according to the agreed specification. In cases where painting shows signs of deterioration due to climatic conditions to an extent that steelwork may become corroded, the part of the structure affected must be repainted to the specification listed in this Annexure.

The maintenance of a bridge must include, but not be limited to, the following:

- repair of existing balustrades/parapets;
- replacement/repair/painting of guardrails
- reinstatement of embankment erosion/scour protection;
- clearing of debris and unblocking of drainage provisions;
- bridge reinstatement if damage has occurred;
- repair of concrete spalling, crack injection/sealing, corrosion of reinforcement;
- clearing of debris and blockages of any drainage provision for the bridge; and
- reinstatement of bridge if damage has occurred.

(o) Repair of Concrete

Repairs to concrete shall be done in accordance with Draft CSRA Series 10 000, published by The Department of Transport.

(p) Road Pavement Repairs

The Concessionaire must inspect the Highway daily and record all forms of potholes, edge breaks and shoulder stepping. Such road failures must be repaired as soon as possible, especially where road safety may be affected, but in each case not later than specified below:

Description	Diameter	Days
Potholes	Greater in size than 100mm and deeper than 25mm	2
	Other than these listed	4
Edge breaks	greater than 100mm width	7
Shoulder stepping	greater than 75mm	7

Repairs to road failures must be carried out in accordance with the Standard Specifications for Road and Bridge Works published by COLTO, 1998 edition.

(q) Shoulder Stepping

Repairs must be effected with suitable gravel and in accordance with COLTO Standard Specifications for bridge and roadworks.

(r) Landscaping and Grassing work

The Concessionaire must make use of the services of a horticulturist for major landscaping and grassing activities.

The Concessionaire must re-establish grass growth wherever required to maintain acceptable cover.

The Concessionaire must further replace, during the growing season, all trees and shrubs which have died or have been damaged beyond recovery.

Areas with poor grass cover, as well as trees and shrubs with stems smaller than 100mm in diameter, must be fertilised at the start of every growing season, or as recommended by a horticulturist.

Undesirable plant growth must be dealt with as indicated in Bulletin 413, issued by the Department of Agriculture, Agriculture Info. The same must be done to growths:

- within 300mm of the road pavement,
- in between block paving or at any other location where direct or indirect damage could be caused to the works,
- which may affect the safety of road users, and
- growing in joints/crevices in concrete side drains.

All undesirable plant growth must be uprooted and physically removed to prevent regrowth. The physical removal must be performed on an ad hoc basis. The removed vegetation must be disposed of at approved dumping sites.

The Concessionaire must take reasonable steps to ensure that undesirable plants are eradicated before flowering takes place.

All grass inside the Road Reserve must be cut at least once a year during the month of May. In addition to this, the following areas must receive one extra grass cut between the months of November to February:

- a strip 3 metres wide, measured from the edge of the paved surface, where no concrete side drains are provided.
- a strip 2 metres wide, measured from the outside of the concrete side drain.
- all grassed side drains, culvert inlets and outlets.

- the width of the median (where applicable).
- the grassed area between all ramps and the carriageway at interchanges.
- areas where the grass obstructs sight distance or the visibility of road signs.
- additional ad hoc mowing where necessary for public safety.

In all cases, grass must be mowed to an approximate height of 100mm measured above the surrounding ground level. The bulk of the grass cuttings must be removed within 2 days, irrespective of whether the grass is baled or not.

Appropriate alternative cutting methods must be used in areas not accessible to normal cutting machines, such as around road signs, trees, large obstructions, under guardrails, at wingwalls and abutments, on steep slopes, and in drainage trenches and dongas. The finished work must provide a neat and evenly cut appearance, with no isolated tufts of grass remaining.

Firebreaks 5m wide and 200m apart, must be burnt across the median of dual carriageway sections of the Highway soon after the grass has been cut and removed. The Concessionaire must also negotiate with adjoining landowners a plan of action for the general control of veld fires within the parameters of the relevant act.
Shrubs and trees in the Road Reserve must be pruned as instructed and supervised by a horticulturist.

3. HIGHWAY PERFORMANCE REQUIREMENTS

The requirements specified below cover the functional and structural aspects of the road pavement, the stability of problematic cut and fill slopes, and the management systems for the Highway.

Certain functional aspects of the Highway cannot be attended to immediately after the Effective Date. Permissible delay periods for complying with certain of the Routine Maintenance requirements are listed in Appendix C of this Annexure.

3.1 Geotechnical

3.1.1 Introduction

Performance objectives for road pavements and for the stability of cuts and fills are aimed at ensuring that, inter alia:

- road user costs due to road roughness are minimised,
- the risk of crashes due to poor functional condition is reduced,
- the extent and frequency of patching operations is limited,
- the condition of the road pavement and the stability of cuts and fills do not endanger the safety of the public, and
- the road pavement meets the specified visual, functional and structural standards at the end of the Concession Period.

Three categories of Highway have been identified and performance requirements for each category have been specified accordingly. The three catalogues are presented in Table 3.16.

To achieve the stated objectives, the following methodology must be used:

3.1.2 Functional Parameters

Certain functional parameters are to be measured at specified positions, frequencies and accuracies. The results of these measurements must meet specified minimum requirements during the Concession Period. These functional parameters are presented in Table 3.1 below for the applicable road pavement types.

TABLE 3.1: FUNCTIONAL PARAMETERS

PARAMETER	APPLICABLE PAVEMENT TYPE		
	FLEXIBLE (e.g. Granular Base)	**RIGID (e.g. Concrete)**	**SEMI-RIGID (e.g. Block Paving)**
1. Road Roughness (Riding quality)	Yes	Yes	Yes
2. International Surface Friction (IFI)	Yes	Yes	Yes
3. Rut Depth	Yes	No	Yes
4. Faulting	No	Yes	No
5. Surface Macrotexture	Yes	Yes	Yes

3.1.3 Structural Parameters

The structural condition of the pavement must be determined by visual assessment of the pavement condition and deflection measurements.

The visual condition and deflection measurements, as listed in Tables 3.21 and 3.22 of this Annexure, must meet the specified requirements at the end of the Concession Period.

The listed criteria for deflection measurements in Table 3.22 are to act as a guide and must not be considered in isolation. If indications exist that the deflection requirements and the visual assessment requirements specified in this Annexure are not met, or are in conflict, a detailed evaluation as agreed to and approved by the Agency must be carried out by the Concessionaire. This assessment must be used to decide whether the structural condition of the pavement is acceptable at the end of the Concession Period.

3.1.4 Stability of Cut and Fill Slopes

The stability of problematic cut and fill slopes must be determined and monitored with appropriate instrumentation and other methods.

3.1.5 Management Systems

The frequency of monitoring given for data capturing and pavement management systems (PMS) must be considered as a minimum requirement only. The Concessionaire must determine appropriate higher frequencies should these be required. The data must be processed and captured in a compatible and acceptable PMS agreed to by the Agency.

3.2 Specifications for Functional Conditions

Assessments of functional conditions must be undertaken by the Concessionaire or its agent at prescribed intervals and reported in an agreed format. Before such assessments are commenced, the Concessionaire must notify the Agency and afford it or its agent the opportunity of being present during the process. In addition the Agency or its agent reserves the right to carry out its own assessments.

3.2.1 Road Roughness (Riding Quality)

3.2.1.1 Definition

Road roughness is defined as the deviations of a road pavement from a true planar surface, which deviations affect vehicle dynamics, riding quality and the dynamic loads exerted on the pavement.

3.2.1.2 Measuring Equipment

Measurements must be done with an inertial profilometer or similar equipment capable of producing Class 2 measurements, as defined in ASTM standard (E950-94).

3.2.1.3 Calibration and Operation

Calibration, validation and operation of the inertial profilometer must be carried out in accordance with the manufacturer's requirements, and must at least meet the requirements of the Agency.

3.2.1.4 Position and Frequency of Measurements

The specification for the measurement of roughness is given in Table 3.2.

TABLE 3.2: SPECIFICATION FOR MEASUREMENT OF ROAD ROUGHNESS

SPECIFIC ITEM	SPECIFICATION (Minimum)
Frequency of Measurement	One year after Effective Date thereafter annually
Position of Measurement	Slow lanes, both directions in both wheel paths
Testing Interval	Measurements accumulated and stored as m/km roughness for every 10m

3.2.1.5 Data Processing

Road roughness data must be processed so as to produce results in the format specified in Table 3.3.

TABLE 3.3: SPECIFICATION FOR OUTPUT OF ROAD ROUGHNESS RESULTS

ITEM	SPECIFICATION
Unit	International Roughness Index (IRI) calculated for each 10m
Segment Lengths	1km
Statistical Summary	Produce cumulative distribution graph for each segment

3.2.1.6 Acceptance Criteria:

Using the cumulative distribution graph, the processed road roughness results must meet the acceptance criteria presented in Table 3.4.

TABLE 3.4: ACCEPTANCE CRITERIA FOR ROAD ROUGHNESS

LIMITING ROUGHNESS VALUES (IRI)				MAXIMUM LENGTH (%) OF SEGMENT WITH ROUGHNESS WORSE THAN LIMITING VALUE
Category 1	Category 2	Category 3	Toll Plaza Area (Concrete and Block Paving)	
3.2	3.5	4.2	-	20
3.5	3.8	4.6	-	5
4.5	4.9	5.9	5.9	0

3.2.2 Surface Friction

3.2.2.1 Definition

Surface friction is measured as the ratio of the force to the normal load on the wheel of a SCRIM (Sideway-Force Coefficient Routine Investigation Machine), or equivalent approved, under wet road surface conditions. This ratio is termed the Sideway-force Coefficient of Friction (SFC) or the International Friction Index (IFI) according to the PIARC Experiment to Internationally Compare and Harmonise Texture and Surface Friction resistance Measurements.

3.2.2.2 Equipment

The equipment used for the measurement of surface friction (outside the toll plaza area), must be the SCRIM developed by the TRRL or similar approved machine. Within 200m of the toll plaza and at stop signs the surface friction shall be measured with a pendulum tester.
The equipment must be certified by the manufacturer or its agents as being in good working order and the work must similarly be certified as having been carried out in accordance with the operating instructions.

3.2.2.3 Position and Frequency of Measurement

Surface friction measurements must be recorded in accordance with the specification presented in Table 3.5.

TABLE 3.5: SPECIFICATIONS FOR MEASUREMENT OF SURFACE FRICTION

ITEM	SPECIFICATION
Frequency of Measurement	Two years after Effective Date thereafter every two years
Speed of Measurement	50km/h
Position of Measurement	Slow and fast lanes outer wheel paths, both directions
Testing Interval	Record data over 10m intervals

3.2.2.4 Data Processing and Outputs:

Surface friction data must be processed so as to produce results in the format specified in Table 3.6.

TABLE 3.6: SPECIFICATION FOR OUTPUT OF SURFACE FRICTION RESULTS

ITEM	SPECIFICATION
Unit	Sideway Force Coefficient (SFC) at 50km/h
Segment lengths	1km for the Highway and appropriate lengths on either side of junctions
Statistical summary	Produce average coefficient over each section
Classification of segments	Classify all segments into one of the terrain categories listed in Table 3.7

3.2.2.5 Investigatory Levels

The processed surface friction (SFC_{50}) data shall be evaluated against the lowest permissible limit for the applicable terrain category shown in Table 3.7. If the SFC_{50} value at any particular location is found to be at or below the limit specified in Table 3.7, further investigations must be carried out to establish the likelihood of associated unsafe situations requiring remedial action.

TABLE 3.7: INVESTIGATORY LEVELS SFC_{50}

SITE DEFINITION	INVESTIGATORY LEVELS (SFC_{50}) PER SITE							
	.30	.35	.40	.45	.50	.55	.60	.65
Dual carriageway (all purpose) – non event sections [1]		x						
Single carriageway – non event sections [1]			x					
Dual carriageway (all purpose) – minor junctions			x					
Single carriageway – minor junctions				x				
Approach to and across major junctions (all limbs)				x				
Gradient 5% to 10%, longer than 50m dual (downhill only), single (uphill and downhill)				x				
Horizontal curve (not subject to 70km/h or lower speed limit). Radius ≤ 250m				x				
Approach to traffic signals, pedestrian crossing, railway level crossing or similar						x		

[1] = Non event – not at grade intersections

The lowest permissible limit for investigatory purposes when a pendulum tester is used is a pen value of 40.

3.2.3 Rut Depth

3.2.3.1 Definition

The rut depth is defined as the maximum vertical distance (mm) in the wheel path measured between the road surface and the bottom of a two metre straight edge placed transversely across a wheel path.

3.2.3.2 Equipment and Accuracy

No specific equipment is specified. The accuracy of the equipment and method used must be such as to achieve, over a 100m section, an accuracy on the average rut depth within 3mm of the true mean, as measured below a 2 metre straight edge at 5 metre intervals. The required degree of accuracy must be achieved on five successive tests on the same section of road.

3.2.3.3 Measurement Specification

Rut depth measurements must be taken in accordance with the specification presented in Table 3.8.

TABLE 3.8: SPECIFICATION FOR MEASUREMENT OF RUT DEPTHS

ITEM	SPECIFICATION
Frequency of Measurement	Two years after Effective Date thereafter every two years
Position of Measurement	Outside wheel path in the slow lane, in both directions
Testing Intervals	10 metres

3.2.3.4 Data Processing

Rut depth data must be processed so as to produce results in the format specified in Table 3.9.

TABLE 3.9: SPECIFICATION FOR OUTPUT OF RUT DEPTHS

ITEM	SPECIFICATION
Unit	mm
Segment lengths	1km
Statistical summary	Produce cumulative distribution graph for each segment

3.2.3.5 Acceptance Criteria

Using the cumulative distribution graph for each segment, the measured rut depths must meet the acceptance criteria presented in Table 3.10.

TABLE 3.10: ACCEPTANCE CRITERIA FOR RUT DEPTH

LIMITING RUT DEPTH (mm)	MAXIMUM LENGTH (%) OF SEGMENT WITH RUT DEPTH WORSE THAN LIMITING VALUE
15	10
20	5
25	0

3.2.4 Surface Macrotexture

3.2.4.1 Definition

Macrotexture is the deviation of a pavement surface from a true planar surface with the characteristic dimensions along the surface of 0,5 – 50mm.

3.2.4.2 Equipment and Accuracy

The macrotexture shall be measured using a non-contact laser spot sensor capable of meeting the requirements contained within ISO 13473-1.

3.2.4.3 Measurement Specification

Macrotexture measurements must be taken in accordance with the specification presented in Table 3.11.

TABLE 3.11: SPECIFICATION FOR MEASUREMENT OF MACROTEXTURE

Item	Specification
Frequency of measurement	Every two years
Position of measurement	Outside wheel path in the slow lane, in both directions
Testing intervals	10 metres

3.2.4.4 Data Processing

Macrotexture data must be processed so as to produce results in the format specified in Table 3.12.

TABLE 3.12: SPECIFICATION FOR OUTPUT OF SURFACE MACROTEXTURE

Item	Specification
Unit	Mean Profile Depth (ISO 13473-1) calculated for each 100 metres
Segment Lengths	1 km
Statistical Summary	Produce cumulative distribution graph for each segment

3.2.4.5 Acceptance Criteria

No minimum specification exist, the macrotexture is used along with the surface friction to report the IFI.

3.2.5 Faulting

3.2.5.1 Definition and Measurement

Faulting is measured as the difference in elevation across transverse or longitudinal joints. Measurement must be taken in accordance with the specification presented in Table 3.13.

TABLE 3.13: SPECIFICATION FOR MEASUREMENTS OF FAULTING

ITEM	SPECIFICATION
Frequency of measurement	Two years after Effective Date thereafter every two years
Position of measurement	On wheel paths in both travelling lanes in both directions
Testing intervals	Each transverse joint and every 5m length on the longitudinal joints

3.2.5.2 Data Processing

Faulting measurement data must be processed so as to produce results in the format specified in Table 3.14.

TABLE 3.14: SPECIFICATION FOR OUTPUT OF FAULTING MEASUREMENT DATA

ITEM	SPECIFICATION
Unit	mm
Segment Lengths	200m
Statistical Summary	Produce cumulative distribution graph for each segment

3.2.5.3 Acceptance Criteria

Using the cumulative distribution graph for each segment, the measured faulting depths must meet the acceptance criteria presented in Table 3.15.

TABLE 3.15: ACCEPTANCE CRITERIA FOR FAULTING

LIMITING FAULTING DEPTH (mm)	MAXIMUM NUMBER OF TRANSVERSE JOINTS OR 5m LENGTHS OF LONGITUDINAL JOINT (%)
5	10
10	0

3.3 Specifications for Structural Condition

It is the responsibility of the Concessionaire to provide and maintain a road pavement structure of sufficient structural capacity and adequately sound condition to carry the traffic safely and comfortably during the Concession Period. In addition to the assessment of functional items, the structural condition of the road pavement must also be monitored through visual assessment and deflection measurements during prescribed seasons. This information must be made available to the Agency.

Neither the visual assessment results nor the deflection measurements hereinafter specified must be used in isolation for the determination of the structural condition of the pavement. In the event of either of the criteria not being met, a detailed evaluation, subject to the approval of the Agency, shall be carried out to determine the structural capacity and remaining pavement life.

The procedure for assessing the remaining structural capacity for any Highway Section or portion thereof must be agreed between the Agency and the Concessionaire.

At the end of the Concession Period, the Highway must have the following remaining road pavement structural life for the Highway categories indicated in Table 3.16:

TABLE 3.16

CATEGORY	HIGHWAY SECTIONS	REMAINING STUCTURAL LIFE AT END OF CONCESSION PERIOD
1	1 to 11	18 MESAS
2	12XA, 12XB, 13X and 14XA	8 MESAS
3	14XB, 15XA and 15XB	3 MESAS

* MESAS = Million Equivalent 80kN Standard Axles

3.3.1 Visual Assessment

3.3.1.1 Assessment Methodology:

Visual condition assessment must be carried out by certified assessors approved and appointed by the Concessionaire in accordance with the standard visual condition assessment manuals. The data must be processed and captured by the Concessionaire in a Pavement Management System (PMS). Table 3.17 specifies requirements for the visual assessments. The detailed requirements for patching, potholes and failures are summarised in Table 3.18.

TABLE 3.17: SPECIFICATION REQUIREMENTS FOR VISUAL ASSESSMENT

ITEM	SPECIFICATION
Method: - Flexible Pavement - Rigid Pavement	As described in: TMH9 Manual (obtainable from the Agency) M3-1 Manual (obtainable from the Agency)
Frequency:	Annually: Between the months of January and March.
Segment Length: - Flexible - Rigid	 1 km 200m
Carriageways:	Each carriageway is to be assessed separately.
Distress Items:	As specified in the approved Pavement Management System
Detail Extent of Certain Individual Distress Items: (See Table 3.21)	Where required by the Agency, the extent of certain individual distress items shall be measured by tape measure (per lane), during the final three years of the Concession Contract, to determine if the extents exceed the acceptance criteria in Table 3.21. The minimum length of distress (longitudinally) must be taken as 0,5m for any single occurrence.

TABLE 3.18: SPECIFICATION FOR MEASUREMENT OF EXTENT OF PATCHES

ITEM	SPECIFICATION
Frequency of Measurement	As agreed with the Agency
Position of Measurement	Measured per lane
Method of Measurement	Measure by tape measure in longitudinal direction
Accuracy of Measurement	Measure to nearest 0,1m
- Patches	Measure actual length
- Potholes	Measure 0,5m additional on both sides
- Failure	Measure 1,0m additional on each side
Description of patches, failures and potholes	As described in latest version of TMH9: Visual Assessment Manual

3.3.2.2 Data Processing

The visual distress data must be processed by the method specified in the PMS to determine a visual condition index (VCI) for each road segment. The VCI for each road segment must be reported, together with its classification into a road category.

3.3.2 Surface Deflection Measurement

3.3.2.1 Measurement of Surface Deflection

The surface deflection of the pavement as measured by a Falling Weight Deflectometer (FWD) must be used as an indicator of the structural capacity of the pavement structure. Measurements must be carried out by the Concessionaire. Table 3.19 specifies the requirements for the monitoring of deflection measurements. All measurements must be taken at the same positions during the same month of the year.

TABLE 3.19: SPECIFICATION FOR MEASUREMENT OF SURFACE DEFLECTION

ITEM	SPECIFICATION
Equipment	Approved falling weight deflectometer
Sensor positions	0, 200, 300, 450**,** 600, 900, 1200, 1500, 1800mm
Calibration	As agreed with the Agency
Test positions	Outer wheel path, slow lane, both directions
Test interval	Every 200m at permanent premarked positions
Frequency	In the first year and then every third year, as well as in the last three years of Concession Period between the months of April and May
Test load	Two drops at 40kN target load followed by one drop at 50kN target load
Test pressure	550 kPa (40kN) /685kPa (50kN)
Surface temperature	Measured on the road surface and record in °C at each test point
Air temperature	Ambient air temperature and record in °C at each testpoint

3.3.2.2 Data processing

The surface deflection data must be processed to produce the information specified in Table 3.20.

TABLE 3.20: SPECIFICATION FOR OUTPUT OF SURFACE DEFLECTION RESULTS

ITEM	SPECIFICATION
Deflection measurements	(a) Record measurements in µm for each sensor (b) Normalize the 40kN target load measurement (Drop 2) in µm for each sensor to 40kN load (c) Adjust the normalised values to a temperature of 21°C using the Bells equation.
Deflection parameters	Based on (b) above determine the following for each test position: - Ymax, (Maximum Deflection) - BLI, (Base Layer Index, $d_0 - d_{300}$) - MLI (Middle Layer Index, $d_{300} - d_{600}$) (d_{300} and d_{600} Indicate the corresponding deflections at horizontal distances of 300mm and 600mm respectively from the centre of the applied load)

3.3.3 Acceptance Criteria:

3.3.3.1 Visual Condition Criteria

The acceptance criteria presented in Table 3.21 must be met during the final three years of the Concession Period. Any improvements in visual condition of the road pavement due to improvements undertaken during the last three years of the contract must not be taken into account, unless the measures include adequate structural repairs, crack sealing and an asphalt overlay of average thickness not less than 50mm.

TABLE 3.21: ACCEPTANCE CRITERIA FOR VISUAL CONDITION ASSESSMENTS

VISUAL CONDITION ITEM	ACCEPTANCE CRITERIA		
	Category 1	**Category 2**	**Category 3**
VCI Change in VCI units per year	≥ 60 ≤ 15	≥ 60 ≤ 15	≥ 50 ≤ 15
Individual Distress items per Lane: TMH9 1. Flexible Pavements:	Extent: % of length		
a. Crocodile Cracking (1<Degree≤3) b. Longitudinal Cracking (1<Degree≤3) c. Pumping (1<Degree≤3) d. Patching (1<Degree≤3) e. Failures (1<Degree≤3)	≤ 5 ≤10 ≤ 5 ≤ 5 ≤ 1	≤ 5 ≤15 ≤ 5 ≤ 5 ≤ 1	≤10 ≤20 ≤10 ≤10 ≤ 5
	Extent: Number		
f. Potholes (1<Degree≤3)	≤2	≤4	≤6
2. Rigid Pavements: (MANUAL 3-1)	Extent: Number of slabs		
a. Cracked Slab (Open or spalled) b. Shattered Slab (Open or spalled) c. Joint associated Cracks (Open or spalled) d. Blow-up, Failures, potholes e. Patches – Concrete with defect f. Asphalt Patches g. Joint Seal Condition (Degree≤3) h. Pumping (Degree≤5) i. Faulting (moderate≤10mm) j. Faulting (severe>10mm)	≤4 ≤2 ≤6 0 0 0 ≤8 ≤3 ≤3 0	≤6 ≤2 ≤8 0 ≤2 0 ≤10 ≤ 5 ≤ 5 0	≤ 8 ≤ 4 ≤10 ≤ 1 ≤ 4 ≤ 2 ≤10 ≤ 8 ≤ 8 ≤ 2

3.3.3.3 Deflection Criteria

At the end of the Concession Period, the Highway shall be returned to the Agency with at least the specified minimum 90th percentile residual of the structural capacity given in Table 3.16. The results of the deflection surveys in the last three years of the Concession Period

must be compared to the guidelines criteria given in Table 3.22 and must be used in arriving at the structural capacity of the road pavement at the end of the Concession Period.

Despite the existence of internationally recognised deflection based criteria for concrete pavements, no criteria are specified in this Annexure. When the technology for deflection based criteria is improved and locally validated, the deflection based guidelines for concrete pavements shall be agreed upon between the Agency and the Concessionaire.

Uniform sections consisting of accumulated segments, each of maximum total length 5km, must be identified on the following basis:

- pavement structure;
- traffic volume, and
- co-efficient of variation which shall be less than 25 percent.

The 90th percentile value per uniform section must be used in judging acceptance. Outliers must be excluded from uniform sections and evaluated individually to determine appropriate action and extent of action required. To determine whether or not a value is an outlier, the procedure given in subclause 8204(d) of the Standard Specification for Road and Bridge Works for State Road Authorities 1998, published by the Committee of Land Transport Officials (COLTO) must be followed.

TABLE 3.22: GUIDELINE CRITERIA FOR SURFACE DEFLECTION

BASE TYPE	90TH PERCENTILE VALUE (Micron)									ANNUAL CHANGE IN VALUES
	Category 1			Category 2			Category 3			
	Ymax	BLI	MLI	Ymax	BLI	MLI	Ymax	BLI	MLI	
Granular Base	≤ 270	≤ 130	≤ 60	≤ 370	≤ 180	≤ 90	≤ 500	≤ 260	≤ 130	≤ 20%
Asphalt Base (>90mm)	≤ 220	≤ 100	≤ 50	≤ 320	≤ 150	≤ 80	≤ 450	≤ 210	≤ 100	≤ 20%
Stabilized Gravel Base	≤ 195	≤ 90	≤ 40	≤ 280	≤ 130	≤ 60	≤ 400	≤ 190	≤ 90	≤ 20%

3.3.4 Stability of Cut and Fill Slopes

It is the responsibility of the Concessionaire to ensure and maintain the stability of cut and fill slopes for the duration of the Concession Period. All risks of failure must be identified, monitored and stabilised as required.

The type and frequency of assessment required will vary according to the nature of each slope, environment and other conditions and therefore no predetermined method or frequency is prescribed. The Concessionaire must institute a system that identifies the risk of failure and categorises slopes accordingly. Depending on the risk category, the Concessionaire must institute appropriate monitoring procedures. Such monitoring procedures must include amongst other things, but not be limited to, the recording of movements, crack development, seepage, slides, slips and rockfalls.

Measures used for stabilising slopes must include, but not be limited to, anchors, dowels, pins, drains and/or retaining walls and must also be monitored regularly for effectiveness.

Outputs from regular assessments of each slope must be analysed by an independent professional geotechnical engineer and compared with acceptable criteria for the type and nature of the slope and the materials concerned. During this process the need for stabilisation measures must be identified and, where necessary, implemented to safeguard motorists and the integrity of the slope.

3.4 Traffic Capacity

3.4.1 Introduction

The Concessionaire must maintain a traffic management system (TMS), which includes the monitoring of traffic movements along, across, entering and leaving the Highway. This traffic management system must provide sufficient information to enable the yearly calculation of the levels of service at representative points along the Highway as well as at interchanges and intersections.

Where Repair and Replacement Works and Upgrade Works necessitate the removal or destruction of a counting station, it must be reinstated as soon as practically possible. Whenever damage is caused to one of the Agency's comprehensive traffic observations (CTO) counting stations by the Concessionaire's activities, the Concessionaire must reimburse the Agency for reinstating such counting station.

The Concessionaire will have to take over the operation of existing or newly constructed CTO stations should the Agency decide to terminate traffic monitoring at any of these stations. The Agency will, however, remain the owner of such stations.

3.4.2 Traffic Monitoring

Traffic counts are required on an ongoing basis to monitor capacity requirements. The Concessionaire must provide a traffic counting plan on an annual basis.

This traffic counting plan must include the following:

- a counting strategy,
- a decision as to which stations are permanent or secondary, and
- time intervals for counting at secondary stations, intersections and interchanges.

The Agency's existing CTO stations listed in Annexure 18 can be incorporated into the counting strategy. Data from CTO stations can be purchased from the Agency. The Concessionaire must, however, install, operate and maintain additional counting stations in accordance with the agreed traffic counting plan. In addition, traffic counts will be available from toll plazas and must also be utilised for traffic assessments.

It is not a requirement that all stations must be operational for 365 days a year. The stations must rather be stratified into permanent (continuous) and secondary (semi-permanent) stations as agreed upon with the Agency.

Traffic information required for a specific portion of Highway on which no counter or counting station is installed, must be derived from suitable traffic study information. Should it be required, however, short term machine counting must be arranged to substantiate traffic study figures and/or counts from nearby permanent stations.

One-week automatic traffic counts must be undertaken at least every 3 years at all significant intersections. Such counts must be supplemented by manual one-day (12-hour) counts to individually record all turning movements at intersections. The specific week for conducting

specific one-week intersection counts must be determined from nearby permanent station counts and will be subject to approval of the Agency. Interchange ramp terminals must be dealt with in the same way.

3.4.3 Traffic Analysis Strategy

3.4.3.1 For the Highway

Uniform portions of the Highway must be identified in terms of cross-sections, horizontal and vertical design standards, access control, and traffic patterns. These uniform portions must be recorded on a distance-flow rate diagram. Traffic patterns can be derived from permanent and other traffic counting stations.

Each uniform portion of Highway must be analysed for specific road characteristics as indicated in the latest Highway Capacity Manual (HCM). The variables used in the analysis must be in accordance with Good Industry Practice.

The following information must be made available in advance of every meeting pertaining to the establishment of an Additional Construction Works Programme;

- a distance-flow rate diagram for "LOS "D"" of the Highway, indicating capacity demand and capacity provided;
- reporting on and re-assessment of traffic volumes;
- level of service of each uniform portion of Highway;
- the estimated remaining period for each uniform portion of Highway before upgrading will be required; and
- safety report and remedial measures necessary to ensure safe operations.

3.4.3.2 For Intersections

Data obtained from detailed intersection traffic counts and other available counts must be used for conducting detailed capacity analyses of all turning and through movements. Such an analysis must be conducted for each intersection at least every 3 years. A report of the results of each analysis must be prepared and must contain:

- the prevailing levels of service, average delays, and volume to capacity ratio experienced for each movement at the intersection concerned;
- the expected capacity lifespan of the intersection or parts thereof in terms of the traffic capacity requirements specified; and
- recommendations for the upgrading of the intersection or parts thereof to fulfil the capacity criteria.

3.4.3.3 For Interchanges

Data from detailed traffic counts at interchange ramp terminals and other available traffic counts must be used for conducting detailed analyses of all turning movements at ramp terminals, as well as merging and diverging movements at on- and off-ramps. Such an analysis must be conducted for each interchange at least every 3 years. Interchanges in urban areas, which may influence one another, must be analysed as a system. A report must be prepared of the results of each analysis and must contain;

- the prevailing levels of service, average delays and volume to capacity (V/C) ratios experienced for each movement at the interchange ramp terminals;

- levels of service for merging and diverging movements for the on- and off- ramps;

- the expected capacity lifespan of the interchange and all parts thereof in terms of the traffic capacity requirements specified; and
- recommendations for upgrading the interchange or parts thereof to fulfil the required capacity criteria.

3.4.4 Capacity Requirements

3.4.4.1 General

In terms of Clause 8.10 of the Concession Contract, the Concessionaire must ensure that level of service D ("LOS "D"") is at least maintained on any Highway Section (other than Highway Section 12XA, 12XB and 13X), as defined in the latest version of the American Highway Capacity Manual (HCM). The level of service must at least be maintained during any hour of the year, except during the 30 hours with the highest traffic volume during the year under consideration. In urban areas, "LOS "D"" must at least maintained during the peak hour, which must be taken as the normal weekday peak hour. Subject to Clause 8.10 of the Concession Contract, capacity improvements must be introduced by means of additional lanes, climbing lanes passing lanes or other acceptable means agreed with the Agency.

The Highway must be divided into uniform portions in terms of cross-section, terrain, heavy vehicle percentages and access arrangements. The service flow rate in terms of Average Annual Daily Traffic (AADT) associated with "LOS "D"" must be calculated for each uniform Highway Section using the Highway Capacity Manual. In accordance with Clause 3.4.3 in this Annexure a distance-service flow diagram must be prepared and updated yearly to graphically illustrate the traffic flow and the service flow for each Highway Section.

The need for upgrading the Highway or parts thereof must not solely be evaluated in terms of capacity requirements. The primary objective must remain the safety of the road user and should it appear that a portion of the Highway or an intersection is hazardous, although operating at an acceptable level of service, the Concessionaire must take the necessary steps to improve the condition without adversely affecting the operating speed.

3.4.4.2 Capacity Criteria for Highway Sections 12XA, 12XB and 13X (Van Reenen's Pass)

Highway Sections 12XA , 12XB and 13X (Van Reenen's Pass) are the most critical portions of the Highway, upgrading limitations due to the existing geometrical, geotechnical and geological constraints. Subject to clause 13A.1 of the Concession Contract, Construction Works relating to De Beers Pass, Highway Sections 6 & 7 must be completed by the time the total traffic in both directions on any of Van Reenen's Pass, Highway Sections 12XA, 12XB and 13X reaches an AADT of 13 900.

3.4.4.3 Capacity Criteria at Intersections

(a) For Urban Intersections

Capacity related requirements for urban intersections must be judged in terms of the performance (measure of effectiveness) of the intersections during normal weekday morning and afternoon peak hours and the Saturday peak hour. The measure of effectiveness is the average stopped delay and/or volume to capacity ratio per lane group for a signalized intersection and average total delay for a priority controlled intersection. The level of service at which a lane group operates is based on the delay per vehicle. Intersections must be upgraded when the level of service of any particular lane group is worse than "LOS "D"" and/or the average volume to capacity ratio exceeds 0.9 for a signalized intersection. In addition, for signalized intersections, if the number of right turning vehicles is more than

twice the number of cycles per hour, the level of service is worse than "LOS "D"", and/or the volume to capacity ratio exceeds 0.9, upgrading of the intersection must be undertaken to ensure that "LOS "D"" is at least maintained and a volume to capacity ratio of less then 0.9 is achieved for that movement.

The level of service must be calculated using the accepted criteria for priority controlled and signalised intersections. Guidelines are provided in Table 3.23 which follows.

TABLE 3.23 CAPACITY CRITERIA FOR INTERSECTIONS

CRITERION	TYPE OF INTERSECTION	
	PRIORITY CONTROLLED	SIGNALISED
VOLUME/CAPACITY RATIO (V/C)	Not applicable	V/C not to exceed 0.9
"LOS "D""	Total delay not to exceed 30 seconds	Average stopped delay not to exceed 40 seconds

(b) For Rural Intersections

Levels of service for rural intersections along the Highway must be calculated using the above capacity criteria.

(c) Combination of Intersections

Where a prescribed analysis shows that an intersection or an approach to an intersection requires upgrading due to it not meeting specified effectiveness requirements, such specific upgrading need not be undertaken if it can be demonstrated to the Agency that one or more of the following improvements to the Highway will adequately improve traffic operation for the next year at the intersection under review:

- an additional interchange;
- another new intersection; or
- network improvement.

Signalized intersections spaced less than 1000 meters apart must be analyzed as a system.

(d) Capacity Criteria at Interchanges

The same capacity criteria as for intersections are applicable to ramp terminals at interchanges subject to clause 8.10 of the Concession Contract. A "LOS "D"", as defined in the Highway Capacity Manual, must at least be maintained for all merging and diverging movements at on- and off-ramps.

3.4.5 Future Developments

Each future Development which could individually result in peak hour traffic volume at any point on the Highway (including ramp terminals) increasing by more than 150 peak hour trips, must be thoroughly investigated by means of an appropriate traffic impact study (TIS). Peak hour trips refer to trip ends, which include primary and pass-by trips. The costs of such a study shall be borne by the developer promoting the Development. If the findings of a study show that the Concessionaire will derive no toll income, or a disproportionately low toll income, from the traffic generated by the Development, then appropriation of the cost of providing access to the Development and the implications of accommodating the

Development traffic on the portion of Highway affected by merging, diverging and weaving movements, must be negotiated by the developer and the Concessionaire. To verify the assumptions made in the original TIS, a further TIS must be undertaken at the cost of the developer one year after completion of the Development.

3.5 Tunnels, Bridges and Drainage Structures

3.5.1 Tunnels

The construction, Operation and Maintenance of any tunnel(s) must be in accordance with local and international Good Industry Practice.

3.5.1.1 Fresh Air Requirements

The quality of the air for visibility and other hazardous substances such as carbon monoxide, nitrogen dioxide, carbon dioxide and oxides of sulphur must be monitored and reported on a regular basis at a frequency agreed with the Agency. The levels of all these must be maintained within local and international levels agreed from time to time.

3.5.1.2 System Upgrade

At the end of the Concession Period all equipment and installations must be handed over in a good working condition.

3.5.1.3 Durability

The effect on all structures and components with regards durability shall be considered at all times by the Concessionaire and appropriate materials shall be used.

The Concessionaire shall take all reasonable measures to reduce the possibilities of water leakage through and into the road tunnel structure for the 100 year design life.

Where any joint or crack is weeping at the end of the Concession Period the tunnel shall not be accepted by the Agency until such time as, an effective remedial sealing work has been undertaken with material with a proven record of satisfactory service within road tunnels and to the satisfaction of the Agency.

3.5.2 Road Related Structures

The performance requirements for road related structures must be read in conjunction with the "Code of Procedure for the Planning and Design of Structures" Draft April 1996, obtainable from the Department of Transport, P O Box 415, Pretoria, 0001.

3.5.3 Bridge Management System

The Concessionaire will be required to adopt and implement a bridge management system (BMS). The system should preferably be compatible with that adopted by the Agency. Whether compatible or not, inspection reports shall be submitted to the Agency on a regular basis as determined by the inspection programme. Towards the end of the Concession Period if the systems is not compatible, the Concessionaire and the Agency must come to an agreement whereby compatibility can be obtained.

Bridge inspections must be carried out only by personnel who have received the requisite training. Alternatively, the training of approved candidate inspectors, at the cost of the Concessionaire, can be arranged through the Agency.

Bridge inspections must be carried out at maximum intervals of 5 years.

Structures that are to be monitored must be inspected at intervals compatible with the defect being monitoring a month.

Routine Maintenance personnel are to report on any untoward or accidental damage which may occur to bridges or other structures. On completion of any inspection(s), the relevant report(s) must be submitted to the Agency for updating of its database.

On bridges older than 20 years, even if visually intact, special inspections must be carried out to test for carbonisation so that preventive measures may be applied before visual damage occurs.

The BMS system currently in use by the Agency includes a relevancy rating which can vary between 1 and 4. A rating of 4 indicates that the defect must receive immediate attention.

Defects with a relevancy rating of 3 must be attended to within a period of 2 years. Defects with lesser ratings are not regarded as urgent.

Any concrete defect falling below an acceptable rating must be monitored and repaired before it becomes so serious as to be hazardous. The draft Specifications for the Rehabilitation and Repair of Concrete Bridges, Series 10 000, published by the Committee for State Road Authorities, are obtainable from the Department of Transport, P O Box 415, Pretoria, 0001, and must be complied with in the repair of all concrete elements.

Accidental damage to structures must as soon as reasonably practical be made safe and the necessary repairs effected to restore the integrity of the structure.

Notwithstanding the provisions of paragraph 11.13 of the Draft Code of Procedure for the Planning and Design of Structures, all watertight type expansion joints must be tested to ensure that they are watertight at the time of installation.

The inspection of all types of expansion joint must be carried out at maximum intervals of 3 years and, if applicable, must also include watertightness tests as described below. The test shall consist of ponding water to a depth of at least 50mm above the joint constructed under the particular phase of work (i.e. half width). The ponding must be maintained for one hour and if no evidence of leakage is detected, the joint shall be accepted as being of watertight construction. If the joint is found to be leaking, the Concessionaire must remedy the situation and repeat the test on the affected portion of the joint. The testing must be carried out immediately on completion of a section of the joint to take advantage of the accommodation of traffic arrangements in existence at the time.

Consideration must be given to providing non-watertight joints on new bridges. Abutments for bridges with such joints must be designed with easy to maintain drainage systems to gather and dispose of water passing through the joint(s). Precautions must be taken to ensure that such water can neither stain the faces of abutments nor lead to corrosion of any bearings that may have been provided.

The restoration of a bridge must include the following:

- refurbishment/replacement of bearings;

- replacement of neoprene seals in gland type joints;
- replacement of failed pressfit seals or removal thereof and replacement by silicon sealant if concrete nosings are still in sound condition; or, if necessary, total replacement of expansion joints;
- replacement of failed pressfit seals or removal thereof and replacement by silicon sealant if concrete nosings are still in sound condition; or, if necessary, total replacement of expansion joints;
- repair of road approaches and bridge surfacing; and

If service levels so require, bridges shall be upgraded and should include but not be limited to the following:

- replacement of existing balustrades/parapets with Agency standard NJ type balustrades;
- widening of the bridge to comply with the road cross-section;
- strengthening of the bridge to comply with the latest loading standards. Some bridges designed to TMH7 (1981) before its revision in 1988 may be undersigned and as a matter of course the load carrying capacity of such bridges should be checked to confirm their structural integrity for current levels of service.
- the provision of safety measures to protect pedestrians from road traffic. This must be done where pedestrian numbers exceed 200 per day or where a facility such as a school, shopping area, clinic etc. exists nearby, necessitating use of the structure for pedestrian access.

4. LIST OF REFERENCES

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- Manual for the Preparation of Detailed Geometric Design Plans for National Roads, G2-Manual, (1984).
- South African Roads Board Drainage Manual, The Department of Transport Ltd (1986), (ISBN: 0-908381-39-5).
- Technical Recommendations for Highways: Geometric Design for Rural Roads, TRH17, published by the Committee of State Road Authorities, (1988), (ISBN: 0-7988-3312-2).
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4.2 Design of Tunnels, Bridges and Drainage Structures

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4.3 Geotechnical Designs

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4.4 Construction

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4.5 Design and Construction of Toll Plazas

South African Bureau of Standards:

- Code 0142: Wiring of Premises (1993)
- Code 0400: Fresh Air Ventilation
- Code 1200: Buildings

Standard Specification for Building Works, obtainable from Department of Transport, P O Box 415, Pretoria, 0001 (for toll plazas).

Standard Specification for Electrical and Mechanical Works, obtainable from Department of Transport, P O Box 415, Pretoria, 0001.

Standard Specification for Toll Collection Equipment, obtainable from Department of Transport, P O Box 415, Pretoria, 0001.

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4.6 Toll Plaza Maintenance

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Standard Specifications for Toll Collection Equipment and Amendment to Section 11800 of this document, obtainable from Department of Transport, P O Box 415, Pretoria, 0001.

APPENDIX A1: CONSTRAINTS ON HIGHWAY SECTIONS AT EFFECTIVE DATE

Highway Section	Constraint not conforming to Table 2.1 of this Annexure	Location	Remedial Measures Required	Comments
1: Cedara - Umgeni	Horizontal Radius < 700m	km 1,72 (497m) R=513 km 6,94 (179m) R=571	Traffic Management & Enforcement Plan	All Highway portions comply with Table 2.2
	Grade > 4%	km 1,5 - 2,0 (500m @ 5,05%) km 4,0 - 4,4 (400m @ 4,55%) km 6,1 – 6,6 (500m @ 5,05%)	Passing lanes year 25 Passing lanes year 16 Passing lanes year 9	
2A: Umgeni - Nottingham	Horizontal Radius < 700m	km 16,64 (180m) R= 400 km 18,37 (260m) R= 380 km 19,24 (200m) R= 380 km 20,6 (400m) R= 460 km 21,,6 (200m) R= 460 km 22,7 (260m) R= 350 km 23,74 (410m) R= 460 km 24,8 (190m) R= 350 km 25,5 (130m) R= 350 km 26,7 (290m) R= 380 km 27,08 (440m) R= 380 km 28,5 (150m) R= 380 km 28,9 (190m) R= 450 km 31,47 (320m) R= 380 km 32,35 (80m) R= 380 km 32,85 (160m) R= 400 km 34,3 (160m) R= 380 km 34,7 (230m) R= 380 km 37,4 (280m) R= 550	Traffic Management & Enforcement Plan	All Highway portions comply with Table 2.2
	Grade >4%	km 14,0 – 16,3 (2300m @ 5%) km 18,6 – 19,48 (880m @ 5,3%) km 19,9 – 20,24 (340m @ 4,8%) km 23,2 – 24,2 (1000m @ 5,2%) km 26,9 – 27,2 (300m @ 4,7%) km 29,26 – 29,6 (340m @ 4,5%) km 31,44 – 31,9 (460m @ 5%) km 34,18 – 34,7 (520m @ 4,7%) km 35,28 – 35,8 (520m @ 5%) km 36,84 – 37,54 (700m @ 5%)	Passing lane year 5/6 Passing lane year 5/6 Passing lane year 5/6 Passing lane year 5/6 Passing lane year 5/6 Passing lane year 5/6 Passing lane year 5/6 Passing lane year 5/6 Passing lane year 5/6 Passing lanes year 23	
2B: Nottingham – Hidcote	Horizontal Radius < 700m	km 43,6 (80m) R= 380	Traffic Management & Enforcement Plan	
	Grade >4%	km 45,10 – 45,52 (420m @ 5%) km 47,28 – 48,5 (1220m @ 4,7%)	Passing lanes year 23 Passing lanes year 23	
3: Hidcote – Estcourt	Grade > 4%	km 2,33 – 3,33 (1000m @ 7%)	Passing lane year 7	
4: Estcourt – Frere	Grade > 4%	km 14,43 – 15,57 (1140m @ 5%)	Passing lane year 7	
8A Warden-Villiers	Grade <0.5%	km 20,2 - km 20,9 (700m @ 0,0 %) km 42,1 - km 43,0 (900m @ 0,48%) km 44,3 - km 44,6 (300m @ 0,46 %) km 47,1 - km 47,6 (500m @ 0,45%) km 53,1 - km 53,8 (700m @ 0,35 %) km 64,1 - km 65,9 (1800m @ 0,31 %) km 71,0 - km 72,4 (1400m @ 0,20 %)	2% crossfall to be rectified to 3% crossfall during first rehabilitation work in year 9	
	Crossfall < 3%(VG<1% >500m)	km 33,100 – km 34,500 (1400m) km 40,000 – km 41,100 (1100m) km 41,800 – km 44,000 (2200m) km 2,400 – km 3,400 (1000m) km 5,700 – km 6,700 (1000m) km 7,5 – km 8,3 (800m) km 9,0 – km 9,5 (500m) km15,7 – km 17,6 (1900m) km 27,6 – km 28,8 (1200m) km 49,4 – km 51,3 (1900m) km 60,8 – km 66,5 (5700m) km 69,4 – km 72,8 (3400m)	2% crossfall to be rectified to 3% crossfall during first rehabilitation work in year 9	
8B Villiers – Vaal River	Crossfall < 3%(VG<1% x500m)	km 18,9 – km 19,8 (900m) km 21,0 – km 22,4 (1400m)	2% crossfall to be rectified to 3% crossfall during first rehabilitation in year 9	
9A Vaal River – Leeufontein	Grade <0.5%	km 0,0 - km 0,5 (500m @ 0,02 %) km 4,8 – km 5,0 (200m @ 0,27%) km 6,2 - km 7,2 (1000m @ -0,1 %) km 9,3 - km 9,4 (100m @ 0,01 %) km 10,0 – km 10,6 (600m @ -0,01%) km 13,6 – km 13,9 (300m @ 0,44%)	Construct crossfall to 3% during first rehabilitation in year 1	

APPENDIX A1: CONSTRAINTS ON HIGHWAY SECTIONS AT EFFECTIVE DATE (CONT.)

Highway Section	**Constraint not conforming to Table 2.1 of this Annexure**	**Location**	**Remedial Measures Required**	**Comment**
9B Leeufontein – Malanskraal	Grade <0.5%	km 20,0 – km 20,5 (500m @ -0,02 %) km 21,0 – km 21,6 (600m @ -0,01 %) km 22,6 – km 23,3 (700m @ -0,02 %) km 24,3 – km 25,2 (900m @ 0,15 %) km 25,6 – km 26,0 (400m @ 0,0 %) km 26,2 – km 26,5 (300m @ 0,46 %) km 27,2 - km 28,3 (1100m @ 0,30 %) km 28,7 - km 28,9 (200m @ 0,01 %) km 32,9 - km 33,3 (400m @ -0,16 %) km 34,7 - km 35,0 (300m @ 0,0 %)	Construct crossfall to 3% during rehabilitation in year 1	
	Crossfall < 3%(V<1% >500m)	km 15,9 - km 16,2 (300m) km 17,3 - km 17,5 (200m) km 18,6 - km 19,6 (1000m) km 20,0 - km 20,6 (600m) km 20,9 - km 21,7 (800m) km 22,3 - km 25,3 (3000m) km 25,5 – km 28,9 (3400m)	Construct crossfall to 3% during rehabilitation in year 1	
	2% camber	km 15 – km 40,9	Camber to be rectified to 2% crossfall	
12XA Keeversfontein – Van Reenen	Horizontal Radius < 700m	km 46,0 (700m) R= 450 km 47,7 (330m) R= 360 km 48,2 (250m) R= 360 km 50,9 (220m) R= 360 km 52,8 (270m) R= 380 km 53,2 (330m) R= 500 km 54,1 (170m) R= 500 km 54,6 (180m) R= 360 km 55,1 (300m) R= 350 km 58,3 (320m) R= 400 km 59,2 (370m) R= 500 km 59,9 (203m) R= 380	Daylighting and removal of obstructions to increase sight distance and safety	All Highway portions comply with Table 2.2
	Grade >4%	km 45,1 – 46,75 (650m @ 6%) km 47,2 – 48,15 (950m @ 6%) km 51,5 – 51,85 (350m @ 6%) km 53,0 – 54,2 (1200m @ 6%) km 55,8 – 56,8 (1000m @ 6%)	} None	
12XB Van Reenen to Swinburne	Horizontal Radius <700m	km 3,2 (430m) R= 500 km 4,3 (760m) R= 500 km 7,7 (320m) R= 500	Daylighting and removal of obstructions to increase sight distance and safety	All Highway portions comply with Table 2.2
	Grade > 4%	km 2,2 – 2,5 (300m @ 6%) km 4,3 – 4,85 (550m @ 5,7%) km 5,5 – 6,5 (1000m @ 5,7%) km 7,85 – 8,1 (250m @ 5,7%)	} None	
13X Swinburne – Blackspruit	Horizontal Radius < 700m	km 16,2 (430m) R= 440 & 380 km 16,9 (790m) R= 440 km 17,9 (400m) R= 450	Daylighting and removal of obstructions to increase sight distance and safety	All Highway portions comply with Table 2.2
	Grade > 4%	km 15,7 – 16,0 (300m @ 6,8%)NB km 15,7 – 16,27 (570m @ 5,7%)SB km 16,8 – 18,1 (1300m @ 6,7%)	} None	
14XB Harrismith Bypass	Superelevation >7%	km 28,3 – 28,7 (400m @ 9,0%) km 28,7 – 29,4 (700m @ 7,5%) km 29,4 – 29,9 (500m @ 8,5%)		All Highway portions comply with Table 2.2
	Horizontal Radius <700m	km 28,2 (800m) R= 560 km 29,4 (482m) R= 463 km 34,0 (662m) R= 455 km 34,9 (359m) R= 460 km 35,5 (962m) R= 483	} None	All Highway portions comply with Table 2.2
	Grade > 4%	km 31,1 – 31,3 (200m @ 5,2%) km 34,1 – 35,6 (1500m @ 5%)	None	Complies Table 2.2
	Grade <0.5%	km 30,1 – 30,6 (500m @ 0,05%) km 33,0 – 33,3 (300m@ 0,02%) (N3-7x)	2% crossfall to be rectified to 3% during rehabilitation in year 1 and 2	

APPENDIX A1: CONSTRAINTS ON HIGHWAY SECTIONS AT EFFECTIVE DATE (CONT.)

Highway Section	**Constraint not conforming to Table 2.1 of this Annexure**	**Location**	**Remedial Measures Required**	**Comments**
15XA Harrismith – Willows	Grade > 4%	km 14,0 – 14,35 (350m @ 5,1%) km 24,6 – 25,1 (500m @ >4%) km 26,2 – 27,0 (800m @ >4%) km 31,8 – 32,2 (400m @ >4%) km 36,0 – 37,1 (1100m @ >4%) km 39,1 – 40,1 (1000m @ >4%) km 40,9 – 41,5 (600m @ >4%) km 45,0 – 45,5 (500m @ >4%) km 46,7 – 47,8 (1100m @ >4%) km 0,4 – 0,8 (400m @ >4%) km 1,2 – 2,8 (1600m @ >4%)	No geometric improvements required on this Highway Section due to the anticipated reduction in traffic volume after the opening of De Beers Pass	All Highway portions comply with Table 2.2
	Vertical sag curve < 52	km 13,87 – 14,11		
15XB Harrismith – Warden	Vertical sag curve < 52	km 24,9 – 25,21 km 29,84 – 30,02 km 33,73 – 33,97 km 34,46 – 34,77 km 39,02 – 39,27 km 41,36 – 41,61 km 47,13 – 47,36	No geometric improvements required on this Highway Section due to the anticipated reduction in traffic volume after the opening of De Beers Pass	All Highway portions comply with Table 2.2
	Vertical crest curve <110	km 14,2 – 14,5 km 14,9 – 15,1 km 21,34 – 21,58 km 24,38 – 24,73 km 25,79 – 26,53 km 31,61 – 32,06 km 34,00 – 34,44 km 39,80 – 40,30 km 41,98 – 42,26 km 43,64 – 43,88 km 44,75 – 45,10 km 46,56 – 46,81 km 47,59 – 48,07 km 50,09 – 50,42	No geometric improvements required on this Highway Section due to the anticipated reduction in traffic volume after the opening of De Beers Pass	
	Vertical curve length < 240m	km 29,84 – 30,02 (L=180m) km 47,13 – 47,36 (L=230m) km 50,42 – 50,61 (L=190m	No geometric improvements required on this Highway Section due to the anticipated reduction in traffic volume after the opening of De Beers Pass	

APPENDIX A2: HIGHWAY PORTIONS NOT COMPLYING WITH GEOMETRIC STANDARDS IN TABLES 2.1 AND 2.2

Highway Section	**Constraint**	**Location**	**Remedial Measures Required**
1 Cedara – Umgeni	Superelevation>7%	km 1,7 – 2,2 (R=500, e=10%NB, 8,2%SB) km 6,9 – 7,1 (R=570, e=6,9%NB, 6,9%SB) km 8,8 9,1 (R=836, e=8,8%NB, 8,8SB)	To be permanently rectified during 6 lanes upgrade. As an interim measure a Traffic Management & Enforcement Program must be introduced.
	Sight distance	km 1,7 (R=500, SD = 110mNB) km 3,7 (R=790, SD=155mNB, 180mSB) km 5,2 (R=1760; SD=155mNB, 180mmSB) km 6,2 (R=870, SD=180mNB, 140mSB) km 6,9 (R=740, SD=120mNB, 120mSB) km 7,6 (R=570, SD=105mNB, 150mSB)	
2A Umgeni – Nottingham Road	Superelevation>7%	km 11,6 (R=320, e=8,8%NB, 8,8%SB) km 14,1 (R=320, e=8,8%NB, 8,8%SB) km 14,5 (R=320, e=8,8%NB, 8,8%SB) km 14,8 (R=320, e=8,8%NB, 8,8%SB) km 15,3 (R=320, e=8,8%NB, 8,8%SB) km 15,7 (R=320, e=8,8%NB, 8,8%SB) km 16,1 (R=320, e=8,8%NB, 8,8%SB) km 16,6 (R=320, e=8,8%NB, 8,8%SB) km 17,2 (R=320, e=8,8%NB, 8,8%SB) km 17,5 (R=320, e=8,8%NB, 8,8%SB) km 17,8 (R=320, e=8,8%NB, 8,8%SB) km 18,4 (R=380, e=8,0%NB, 8,0%SB) km 19,2 (R=380, e=8,0%NB, 8,0%SB) km 20,6 (R=460, e=7,1%NB, 7,1%SB) km 21,6 (R=460, e=7,1%NB, 7,1%SB) km 22,7 (R=350, e=8,4%NB, 8,4%SB) km 23,3 (R=320, e=8,8%NB, 8,8%SB) km 23,7 (R=460, e=7,1%NB, 7,1%SB) km 24,3 (R=320, e=8,8%NB, 8,8%SB) km 24,8 (R=350, e=8,4%NB, 8,4%SB) km 25,5 (R=350, e=8,4%NB, 8,4%SB) km 26,7 (R=380, e=8,0%NB, 8,0%SB) km 27,1 (R=380, e=8,0%NB, 8,0%SB) km 28,5 (R=380, e=8,0%NB, 8,0%SB) km 28,9 (R=400, e=7,2%NB, 7,2%SB) km 31,5 (R=380, e=8,0%NB, 8,0%SB) km 32,3 (R=380, e=8,0%NB, 8,0%SB) km 32,8 (R=400, e=7,2%NB, 7,2%SB) km 33,8 (R=380, e=8,0%NB, 8,0%SB) km 34,3 (R=380, e=8,0%NB, 8,0%SB) km 34,7 (R=380, e=8,0%NB, 8,0%SB)	Constraints to be addressed in detail during Preliminary Design and permanently rectified during 6 lanes upgrade widening to be effected on outside of carriageway. As an interim measure a Traffic Management & Enforcement Program will be introduced. Daylighting and removal of obstructions to increase sight distance speed restrictions and roadsigns will further be implemented.
	Sight distance	km 11,6 (R=320, SD=110mNB, 80mSB) km 14,1 (R=320, SD=80mNB, 110mSB) km 14,5 (R=320, SD=110mNB, 80mSB) km 14,8 (R=320, SD=80mNB, 110mSB) km 15,3 (R=320, SD=110mNB, 80mSB) km 15,7 (R=320, SD=110mNB, 80mSB) km 16,1 (R=320, SD=110mNB, 80mSB) km 16,6 (R=400, SD=88mNB, 125mSB) km 17,2 (R=320, SD=110mNB, 80mSB) km 17,5 (R=320, SD=80mNB, 110mSB) km 17,8 (R=320, SD=110mNB, 80mSB) km 18,4 (R=380, SD=85mNB, 120mSB) km 19,2 (R=380, SD=120mNB, 85mSB) km 20,6 (R=460, SD=132mNB, 93mSB) km 21,6 (R=460, SD=94mNB. 134mSB) km 22,7 (R=350, SD=82mNB, 117mSB) km 23,3 (R=460, SD=110mNB,. 80mSB) km 23,7 (R=460, SD=94mNB, 134mSB) km 24,3 (R=320, SD=110mNB, 80mSB) km 24,8 (R=350, SD=82mNB, 117mSB) km 25,5 (R=350, SD=117mNB, 82mSB) km 26,7 (R=380, SD=86mNB, 122mSB) km 27,1 (R=380, SD=122mNB, 86mSB) km 28,5 (R=380, SD=122mNB, 86mSB) km 28,9 (R=450, SD=94mNB, 132mSB) km 31,5 (R=380, SD=86mNB, 122mSB) km 32,3 (R=380, SD=122mNB, 86mSB) km 32,8 (R=400, SD=125mNB, 88mSB) km 33,8 (R=380, e=8,0%NB, 8,0%SB) km 34,3 (R=380, e=8,0%NB, 8,0%SB) km 34,7 (R=380, e=8,0%NB, 8,0%SB)	

APPENDIX A2: HIGHWAY PORTIONS NOT COMPLYING WITH GEOMETRIC STANDARDS IN TABLES 2.1 AND 2.2 (CONT.)

Highway Section	**Constraint**	**Location**	**Remedial Measures Required**
2A: Umgeni – Nottingham	Horizontal Radius < 600m	km 11,6 (200m) R= 320 km 14,1 (200m) R= 320 km 14,47 (160m) R= 320 km 14,79 (350m) R= 320 km 15,27 (120m) R= 320 km 15,72 (240m) R= 320 km 16,13 (360m) R= 320 km 17,18 (160m) R= 320 km 17,47 (160m) R= 320 km 17,81 (160m) R= 320 km 23,3 (240m) R=320 km 24,3 (190m) R= 320 km 36,6 (260m) R= 320 km 37,1 (250m) R= 320	To be permanently rectified during 6 lane upgrade. As an interim measure a Traffic Management & Enforcement Program must be introduced.
2B Nottingham Road to Hidcote	Superelevation >7%	km 36,6 (R=320, e=8,0%NB, 8,0SB) km 37,1 (R=320, e=8,0%NB, 8,0SB) km 37,4 ((R=550, e=6,2%NB, 6,2%SB) km 43,6 (R=380, e=8,0%NB, 8,0%SB) km 44,7 (R=400, e=7,8%NB, 7,8%SB) km 46,5 (R=650, e=5,4%NB, 5,4%SB) km 48,1 (R=600, e=5,8%NB, 5,8%SB) km 51,5 (R=600, e=5,8%NB, 5,8%SB) km 53,6 (R=600, e=5,8%NB, 5,8%SB) km 56,8 (R=600, e=5,8%NB, 5,8%SB) km 57,2 (R=600, e=5,8%NB, 5,8%SB)	Constraints to be addressed in detail during Preliminary Design and permanently rectified during 6 lanes upgrade widening to be effected on outside of carriageway. As an interim measure a Traffic Management & Enforcement Program will be introduced. Daylighting and removal of obstructions to increase sight distance speed restrictions and roadsigns will further be implemented.
	Sight Distance	km 43,6 (R=380, SD=86mNB, 122mSB) km 44,7 (R=400, SD=88mNB, 125mSB) km 46,5 (R=650, SD=160mNB, 112mSB) km 48,1 (R=600, SD=108mNB, 153mSB) km 51,5 (R=600, SD=153mNB, 108mSB) km 53,6 (R=600, SD=108mNB, 153mSB) km 56,8 (R=600, SD=153mNB, 108mSB) km 57,2 (R=600, SD=108mNB. 153mSB)	
3: Hidcote-Estcourt	Sight Distance	km 0,2 (R=600, SD=110mNB, 150mSB) km 1,1 (R=600, SD=150mNB, 110mSB) km 2,5 (R=600, SD=110mNB, 150mSB)	To be permanently rectified during 6 lane upgrade. As an interim measure a Traffic Management and Enforcement Program must be introduced.
8A Warden Villiers	Existing surfaced shoulders only 0,5m	km 30,585 – 74,991	Surfaced shoulders to be provided in year 13
8B Villiers – Vaal	Existing surfaced shoulders only 0,5m wide	km 74,991 – 77,191	Surfaced shoulders to be provided in year 13
9B Leeufontein – Malanskraal	Vertical curve length < 240m	km 15,85 – km 16,05 km 16,98 – km 17,1 km 17,95 – km 18,15 km 18,25 – km 18,75 km 19,9 - km 20,1 km 20,45 – km 20,7 km 20,55 - km 23,8 km 26,1 - km 26,2 km 26,45 - km 26,63 km 29,5 - km 29,6	To be rectified during Construction Work in year 1
12XA: Keeversfontein – Van Reenen	Horizontal Radius <600m	km 53,5 (250m) R= 260 km 53,8 (300m) R= 240 km 54,8 (230m) R= 230 km 57,5 (530m) R= 240 km 59,0 (220m) R= 240	Daylighting and removal of obstructions to increase sight distance and safety.
14XA Blackspruit – Harrismith	Grade <0,5%	km 24,4 – 24,5 (100m @ 0,1%) km 25,5 – 26,0 (500m @ 0,06%) km 27,0 – 27,1 (100m @ 0,15%) km 27,9 – 28,0 (100m @ 0,2%)	No geometric improvements required on this Highway Section due to the anticipated reduction in traffic volume after the opening of De Beers Pass.

APPENDIX A2: HIGHWAY PORTIONS NOT COMPLYING WITH GEOMETRIC STANDARDS IN TABLES 2.1 AND 2.2 (CONT.)

15XA Harrismith Warden	Superelevation >7%	km 50,5 – 50,8 (300m @ 8,2%)	No geometric improvements required on this Highway Section due to the anticipated reduction in traffic volume after the opening of De Beers Pass.
	Crossfall <3%(V<1%>500m)	km 4,7 – 7,4 (1700m @ 2%) km 7,4 – 8,6 (1200m @ 2%) km 9,9 – 10,5 (600m @ 2%) km 11,3 – 13,0 (1700m @ 2%) km 14,4 – 15,0 (600m @ 2%) km 17,1 – 19,3 (2200m @ 2%) km 19,7 – 20,5 (800m @ 2%) km 21,5 – 22,8 (1300m @ 2%) km 32,2 – 32,9 (700m @ 2%) km 43,8 – 44,9 (1100m @ 2%) km 1,9 – 2,7 (800m @ 2%) km 3,6 – 4,6 (1000m @ 2%)	
15XA Harrismith Warden (cont.)	Grade <0,5%	km 0,1 – 0,4 (300m @ <0,5%) km 4,7 – 5,4 (700m @ <0,5%) km 10,0 – 10,5 (600m @ <0,5%) km 11,3 – 13,0 (1700m @ <0,5%) km 13,5 – 14,0 (500m @ <0,5%) km 14,4 – 15,0 (600m @ <0,5%) km 17,1 – 19,3 (2200m @ <0,5%) km 19,7 – 20,5 (800m @ <0,5%)	No geometric improvements required on this Highway Section due to the anticipated reduction in traffic volume after the opening of De Beers Pass

APPENDIX B: EXISTING NON-COMPLIANT BRIDGE WIDTHS AND CLEARANCES

BRIDGE WIDTHS

Highway Section	Bridge No	Position (km)	Description	Existing Width	Required Width	Remedial Measures Required
8A Warden-Villiers	B730	0,990	River	16,10	19,6	Bridges are to be widened in Year 13
	B1114	15,9	River	16,10	19,6	
	B1115	18,008	River	16,10	19,6	
	B1116	18,095	Underpass	16,10	19,6	
	B1638	26,923	Underpass	16,10	19,6	
	B1720	57,84	Underpass	16,10	19,6	
	B1399	61,976	Underpass	16,10	19,6	
	B1400	64,086	River	16,10	19,6	
8B Villiers – Vaal River	B1405	76,00	Underpass	15,45	19,6	Bridge to be widened in Year 13

BRIDGE CLEARANCES

Route	km Distance	Description	Actual Clearance (m)
N3/4	12,91	B803 Howick North I/C	5,17
N3/4	24,29	B1305 Pinnell O/P	5,03
N3/4	31,65	B1306 Barlow O/P	5,08
N3/4	49,29	B807 Mooi River South I/C	4,97
N3/6	36,09	B1206 Ladysmith West I/C	5,08
N3/8	42,56	B729 Vissering O/P	5,15
N3/9	33,82	B1043 Dwarskloof O/P	5,15
N3/11	15,13	B243 Heidelberg South I/C	5,11

The above bridge clearances are to be improved to 5,2m when the bridge clearance is reduced to the legal limit of 4,9m.

APPENDIX C DELAY PERIOD FOR COMPLIANCE WITH AGENCY PERFORMANCE REQUIREMENTS

The following maximum permissible delay periods will be granted to the Concessionaire for the implementation of remedial action(s) required on substandard functional parameters, road pavement distresses, and on Routine Maintenance defects which could exist on portions of the Highway at the Effective Date.

Functional Conditions (as per Clause 3.2)	Maximum Permissible Delay Period
Rut depth	6 months after Effective Date except for Construction Work carried out in the Initial Construction period
Riding quality	Not later than the Initial Construction Period
Surface friction	Section 15X: year 1; Sections 12X: Year 2.
Road Pavement Distress (as per Clause 2.8.3.2 (o))	
Potholes	1 month after the Effective Date, provided ongoing repairs are carried out from the Effective Date
Edge breaks Shoulder stepping	3 months after the Effective Date, provided ongoing repairs are carried out from the Effective Date
Routine Maintenance Defects (as per Clause 28.3 where applicable)	
Cleaning of bridge drainage pipes and accumulated debris in expansion joints and bridge bearings. Cleaning of all drainage structures and disposal of excess material. Repairing damaged guardrails, fencing and road signs. Replacement of road studs. Repainting of road markings. Closing illegal accesses. Preventing illegal trading. Eradication of undesirable plant growth.	3 months after the Effective Date, provided ongoing repairs are carried out from the Effective Date