THE SOUTH AFRICAN NATIONAL ROADS AGENCY (SOC) LIMITED

PROJECT No. R.061-080-2012/1

FOR

CONSULTING ENGINEERING SERVICES FOR

SPECIAL DEVELOPMENT PROJECTS ON NATIONAL ROUTE R61 SECTION 8 FROM MTHATHA TO LUSIKISIKI

DETAILED DESIGN REPORT (FINAL)

R.061-080-2012/1 PACKAGE 3

CONSTRUCTION OF BRIDGES, INTERSECTION WIDENINGS AND LIVESTOCK UNDERPASSES ON NATIONAL ROUTE R61 SECTION 8 FROM LIBODE EAST (KM 28.1) TO MNGAZI (KM 73.0)

BOOK 1 OF 1

January 2014

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EXECUTIVE SUMMARY

Hatch Goba (Pty) Ltd were awarded the contract to undertake the assessment, design and construction supervision for the construction of various structures and facilities relating to vehicular and pedestrian safety along National Route R61 Section 8. The aforementioned contract was awarded by SANRAL in 2010, and was initially divided into four special development packages.

These four special development packages were subsequently unpacked into eleven smaller construction projects (referred to hereafter as “packages”) as indicated on the figure overleaf. Four of these packages were earmarked for local SMME work under the direction of a construction manager (Packages 5, 7, 9 and 10) and included the construction of community access roads. The remaining seven packages included conventional works on the R61. The construction project covered by this report is referred to as Package 3.

Package 3 commences at Libode East (SV 28+100) and proceeds in an easterly direction up to Mngazi (SV 73+000). This package is has a non-included portion of 20.3 km’s, between SV 47+900 and SV 68+200, for which another consultant is responsible.

Portion 1 of Package 3 commences at Libode east (SV 28+100) and proceeds in an easterly direction to the Tutor Ndamase Pass (SV 47+900), in which the following is proposed:

- Formalisation of five existing intersections,
- One bridge and two underpass structures
- Four underpass structures are proposed through the Tutor Ndamase Pass.
- Some community access roads are proposed adjacent to the R61

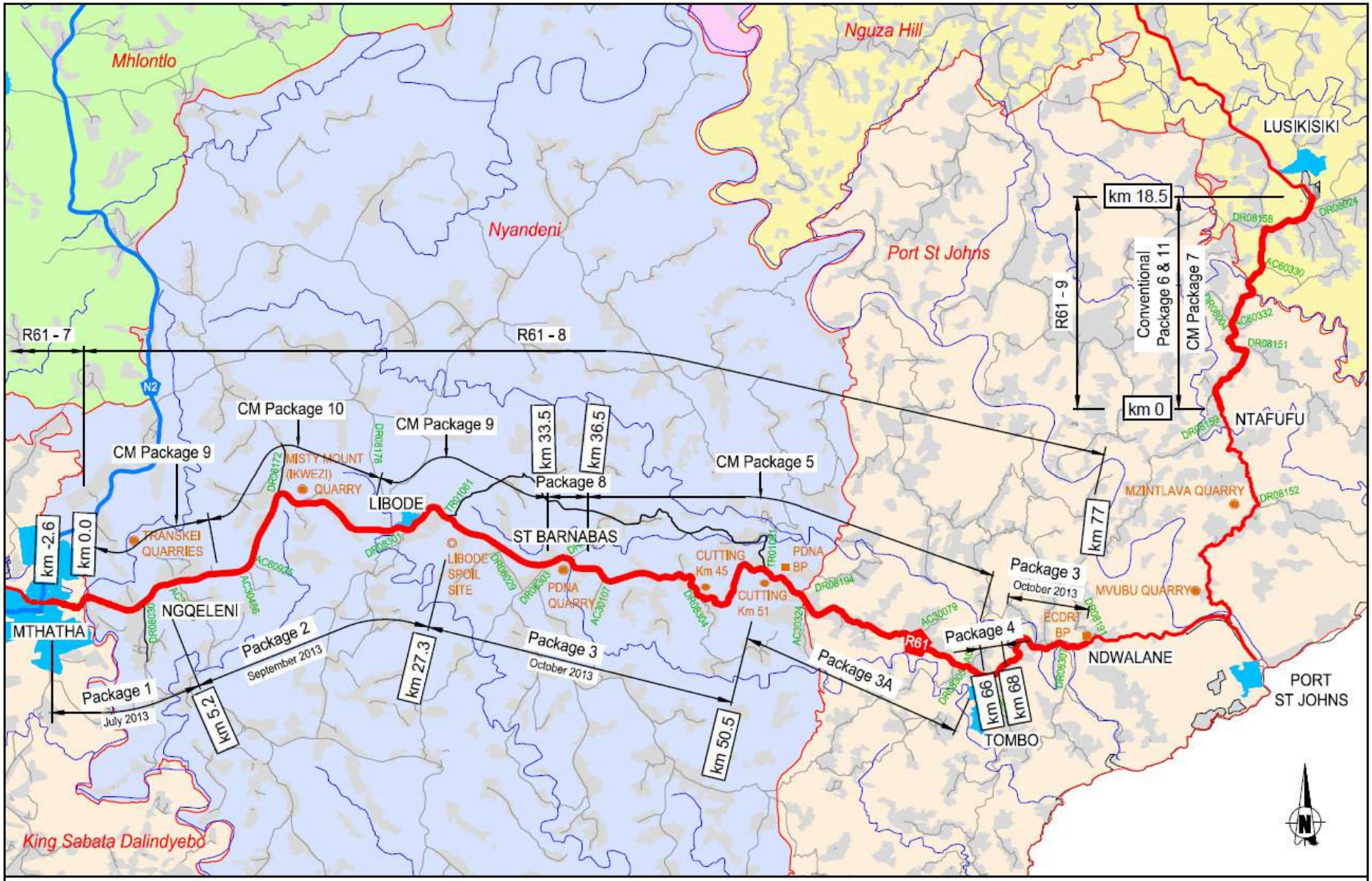
Portion 2 of package 3 continues from SV 68+200 to SV 73+000 where the following is proposed:

- Formalisation of four existing intersections in the Mngazi River Valley
- Two bridges forming part of these intersections
- Two underpass structures
- Some community access roads are proposed adjacent to the R61

A detailed assessment report covering all the packages, submitted in April 2011 under separate cover, dealt with the proposals above (albeit in their initial concept form).

The construction of Package 3 is due to commence in March 2014, with a construction period of 30 months.

Several properties are affected by the widening of the existing road reserve to accommodate the proposed intersection widenings. The acquisition of additional land is dealt with by means of landowner relocation and compensation through an on-going process. Access to severed properties has been restored by the design of access roads off the R61. Accesses that are deemed unsafe will be permanently closed as part of SANRAL’s access management objectives.


Mhlontlo
Nguza Hill
Nyandeni
Port St Johns
King Sabata Dalindyebo
LUSIKISIKI
NTAFUFU
MTHATHA
NGQELENI
LIBODE
ST BARNABAS
TOMBO
NDWALANE
PORT ST JOHNS
R61 - 7
R61 - 8
R61 - 9
Conventional Package 6 & 11
CM Package 7
CM Package 9
CM Package 10
CM Package 9
CM Package 5
Package 8
km 18.5
km 0
km -2.6
km 0.0
km 33.5
km 36.5
km 77
km 5.2
km 27.3
km 50.5
km 66
km 68
N2
R61
MISTY MOUNT (IKWEZI) QUARRY
TRANSKEI QUARRIES
LIBODE SPOIL SITE
PDNA QUARRY
CUTTING Km 45
CUTTING Km 51
PDNA BP
MZINTLAVA QUARRY
MVUBU QUARRY
ECDRT BP
Package 1
July 2013
Package 2
September 2013
Package 3
October 2013
Package 3A
Package 4
Package 3
October 2013
CM = CONSTRUCTION MANAGER CONTRACT
MATERIAL SOURCES
CONSULTING ENGINEERING SERVICES FOR SPECIAL DEVELOPMENT PROJECTS ON NATIONAL ROUTE R61 FROM MTHATHA TO LUSIKISIKI

Although the scope of the appointment was limited to safety improvements, the existing road pavement has been investigated throughout the extent of the project and has been assessed in terms of its remaining life. Although the deflections indicate a very marginal remaining life it was considered that all the testing has been undertaken prior to a very recent (2011) double seal using SE-2 binder which was constructed on the road. The rut and IRI values indicates that the road is in a fair condition even though these measurements were taken prior to the latest reseal. Therefore it is proposed that the pavement not be strengthened at this stage. This strategy allows that at the time when the N2 Wild Coast Highway is developed appropriate interventions may be designed.

Proposed pavements for widenings adjacent to the existing road formation have been designed for a similar remaining life.

Specific bituminous seal types have been proposed at the upgraded intersections to take into account the need to emit audible road noise to alert pedestrians of oncoming traffic. The community access roads are proposed with pavements which could be constructed with an increased labour content.

The above pavements proposed are as follows:

<table>
<tr><th rowspan="2">Layer Type</th><th colspan="2">R61 Intersection Widenings</th><th colspan="2">Provintial District Roads</th><th colspan="6">Community Access Roads</th></tr>
<tr><th>Thick. (mm)</th><th>Class.</th><th>Thick. (mm)</th><th>Class.</th><th>Thick. (mm)</th><th>Class.</th><th>Thick. (mm)</th><th>Class.</th><th>Thick. (mm)</th><th>Class.</th></tr>
<tr><td rowspan="2">Surfacing / Base</td><td>-</td><td>S2*</td><td>-</td><td>S9*</td><td rowspan="2">120</td><td rowspan="2">Concrete</td><td>-</td><td>AC*</td><td rowspan="2">120</td><td rowspan="2">75/1: 1 Cell Slab</td></tr>
<tr><td>150</td><td>G1</td><td>125</td><td>G1</td><td>100</td><td>SBM*</td></tr>
<tr><td>Subbase</td><td>200</td><td>C4</td><td>125</td><td>C4</td><td>125</td><td>C4</td><td>125</td><td>C4</td><td>150</td><td>C4</td></tr>
<tr><td>Selected SG</td><td>150</td><td>G7</td><td>150</td><td>G5</td><td rowspan="3">Semi infinite</td><td rowspan="3">G9</td><td rowspan="3">Semi infinite</td><td rowspan="3">G9</td><td rowspan="3">Semi infinite</td><td rowspan="3">G9/ In-situ</td></tr>
<tr><td>Selected SG</td><td>150</td><td>G9</td><td>150</td><td>G7</td></tr>
<tr><td>SG</td><td>Semi infinite</td><td>G10</td><td>Semi infinite</td><td>G10</td></tr>
<tr><td>Structural Capacity</td><td colspan="2">3 MESA</td><td colspan="2">0.3 MESA</td><td colspan="2">0.3 MESA</td><td colspan="2">0.3 MESA</td><td colspan="2">0.2 – 0.8 MESA</td></tr>
</table>

The general scope and construction cost of Package 3 can be summarised as follows:

(i) Intersection upgrading with laybys and pedestrian walkways 9 No.

(ii) Single lane vehicle underpass 2 No.

(iii) Vehicle and pedestrian bridges 3 No.

(iv)	Livestock underpasses	6 No.
(v)	Access Road and construction upgrading	4 km.

The construction cost is estimated as follows:

a.	General Requirements		R 55.0 million
b.	Roadworks		R 76.8 million
c.	R61 Structures		R 11.9 million
d.	Relocation of Water Mains		R 0.8 million
e.	BEE Requirements		R 6.1 million
f.	Relocation of Houses		R 7.1 million
g.	Bridge Structures		R 12.7 million
h.	Underpass Structures		R 6.5 million
i.	SMME Subcontracts		R 12.2 million
		TOTAL	**R 189.1 million** (excl. VAT)

Implementation is planned to take place over a period of 30 months commencing March 2014, with completion estimated in August 2016.

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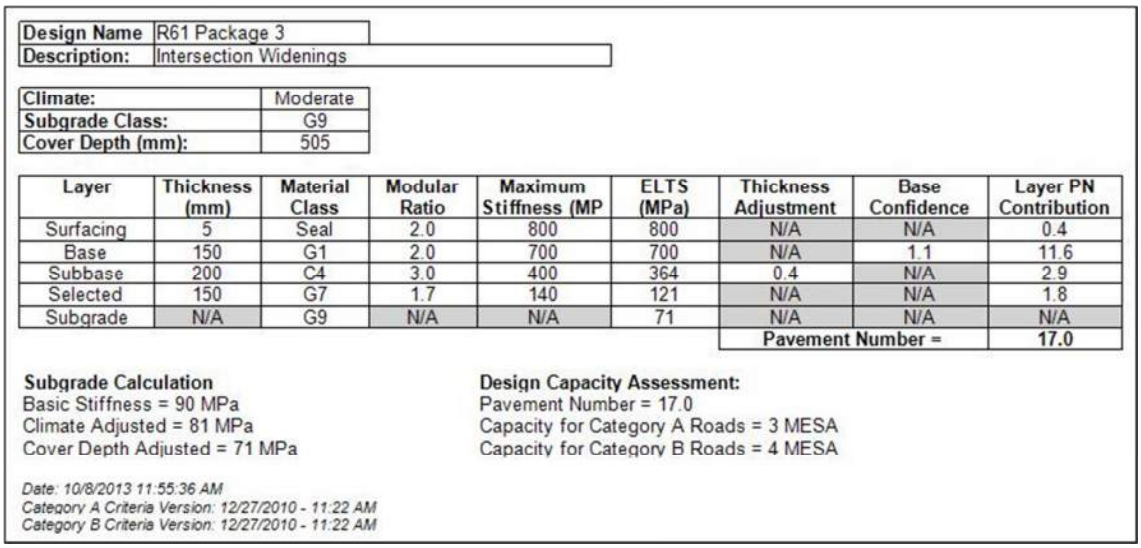

Design Name	R61 Package 3
Description:	Intersection Widenings

Climate:	Moderate
Subgrade Class:	G9
Cover Depth (mm):	505

Layer	Thickness (mm)	Material Class	Modular Ratio	Maximum Stiffness (MP	ELTS (MPa)	Thickness Adjustment	Base Confidence	Layer PN Contribution
Surfacing	5	Seal	2.0	800	800	N/A	N/A	0.4
Base	150	G1	2.0	700	700	N/A	1.1	11.6
Subbase	200	C4	3.0	400	364	0.4	N/A	2.9
Selected	150	G7	1.7	140	121	N/A	N/A	1.8
Subgrade	N/A	G9	N/A	N/A	71	N/A	N/A	N/A
						Pavement Number =		**17.0**

Subgrade Calculation
Basic Stiffness = 90 MPa
Climate Adjusted = 81 MPa
Cover Depth Adjusted = 71 MPa

Design Capacity Assessment:
Pavement Number = 17.0
Capacity for Category A Roads = 3 MESA
Capacity for Category B Roads = 4 MESA

Date: 10/8/2013 11:55:36 AM
Category A Criteria Version: 12/27/2010 - 11:22 AM
Category B Criteria Version: 12/27/2010 - 11:22 AM

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1 INTRODUCTION

1.1 Terms of Reference

In November 2010, Goba (Pty) Ltd (now Hatch Goba (Pty) Ltd), were awarded the contract to undertake the assessment, design and construction supervision for roadworks, structures and facilities relating to vehicular and pedestrian safety along National Route R61 Section 8 (R61-8). The extent of the works was defined as commencing in Sprigg Street in Mthatha CBD East and proceeding eastward towards Ndwalane, some 80km away, where this portion of the route under SANRAL terminates. SANRAL's jurisdiction resumes some 20km north of Port St. Johns at the Ntafufu River Bridge and thereafter proceeds northwards. The limit of works under this contract ends at Lusikisiki which falls within Section 9 of the R61, a further 18km away.

Eleven construction packages were subsequently developed as part of the abovementioned contract. The construction contract covered by this report (denoted Package 3) includes two portions, the first portion being between SV 28+100 and SV 47+900 and the second between SV 68+200 and SV 73+000. Furthermore Package 8 between SV 33+800 and SV 36+200 is currently under construction and is therefore not included in this portion namely Package 3.

1.2 Scope of Work under Package 3

It is important to note that some of the safety improvements have been developed within previous studies and are reported herein. The scope of engineering services provided by Hatch Goba for Package 3, as with the other packages, was to improve safety for all road users, including pedestrians. It encompassed the following:

(i) A geometric assessment of the existing alignment;
(ii) The determination, by consultation and field observation, of nodes requiring geometric upgrades;
(iii) The planning of suitable community access roads and the detailed geometric design of surfaced intersection bellmouths and/or underpasses serving these access roads off the R61; and
(iv) The determination, by continuous consultation and design forums, of the positioning of accesses, both at-grade and grade-separated off the R61.

The scope of work also included the following:

(i) Geotechnical investigations, by means of rotary core drilling at bridge sites for the determination of likely founding conditions;
(ii) Environmental studies in order to obtain water use licences from the Department of Water Affairs;
(iii) Traffic counting, traffic observations and origin-destination studies;
(iv) Land acquisition processes including numerous house relocation plans;
(v) Liaison with utility service owners and the design for the relocation thereof;
(vi) Pavement investigations and design including:

- Evaluation of the existing pavement history;
- Limited existing pavement investigations;
- Structural capacity analysis of the existing pavement;
- An analysis of current traffic, likely traffic growth and cumulative traffic over the design life;
- Essential pavement repair options required for the short term;
- Proposed new pavement options for widening and the creation of audible approach lane noise for crossing pedestrians; and
- Proposed new pavement options for community access roads;

(vii) Structural design of a vehicular and pedestrian bridge at Qiti (SV 43+410) and Qhaka (SV 72+655);
(viii) Structural design of a low level bridge over the Mngazi River at SV 71+500;
(ix) Structural design of 2 no. 4.0m x 4.5m vehicular underpass structures (SV 69+810 and SV 71+400) and 6 no. 2.4m x 2.4m livestock underpasses;
(x) A hydraulic assessment of the existing Mngazi river bridge as well as the size determination of the proposed Mnagzi river bridge;
(xi) Material sourcing; and
(xii) Execution of environmental procedures, including applications for water use licence applications (WULA) where required.

1.3 General Description of the Project

The project entails the upgrading of 9 specific nodes along National Route 61 Section 8 (R61-8) and is divided into two distinct sections, the first being 5 nodes between the turn off to Gangata (limit of construction SV 28+100) and the Tutor Ndamase Pass (SV 47+900) and the second being 4 nodes within the Mngazi River Valley (SV 68+200 and limit of construction SV 73+000). The combined total distance for the project is 23.50km. Several existing informal and 41 undesirable accesses are to be closed. Short lengths of community access roads are considered to be upgraded to offer access to existing dwellings. The nature of upgrading at nodes is summarized below:

(i)	Intersection upgrade with layby's, walkways and other pedestrian facilities	9 No.
(ii)	Construction of vehicular and pedestrian bridges	3 No
(iii)	Construction of single lane vehicular underpasses	2 No.
(iv)	Construction of livestock underpasses	6 No.

Annexure A contains a Key Plan which indicates the extent of the works for Package 3.

The effect of rationalisation of intersections along the route has reduced the number of access points onto this section of the R61 from 66 to 25 (of which 9 major intersections are to be upgraded). These are described in greater detail in Chapter 16 of this report.

This project further requires the construction of three bridge structures and two major underpass structures. Two of the three bridge structures (B0234 Qiti Overpass and B0237 Mngazi River Bridge) have been dealt with in their respective bridge reports, whereas the proposed bridge at Qhaka was the subject of a report submitted to SANRAL in August 2013 and approved of later in that month. An application for the bridge number is currently in process.

The vehicular underpasses (C0390 Mgxabakazi and C0391 Mngazi) were approved of in principle by SANRAL at various Design Progress Meetings. The culvert numbers for several livestock underpasses are currently being applied for.

1.4 Objectives and Strategies

The primary objective of the various package upgrades along the R61 is to primarily address vehicular and pedestrian safety along the road. This need was identified at the time when SANRAL became responsible for the management of this route. ITS Engineers (Pty) Ltd were appointed to identify safety issues and recommend suitable solutions. Their report (Practical Design Guidelines for Pedestrian Facilities on Higher Order Roads) culminated in a set of guidelines. The basic design principles have been defined and these emphasize the road class and function and define the hierarchy of addressing road safety as a 3-step process, namely:

1. Prevention;
2. Warning; and
3. Mitigation.

The guidelines recommend a macro level assessment and to address road design aspects. The estimation of engineering works for all the packages of the R61 from Mthatha to Lusikisiki was determined by means of an addendum to the guidelines, which set out a schedule of works required to achieve safety objectives. This schedule formed the basis for Hatch Goba's contract. SANRAL required that the abovementioned guidelines be assessed critically, thereby determining accurately the necessary works to achieve the same objectives.

A series of design meetings were held over a period of two years, where Hatch Goba's design proposals were interrogated, thereby developing the design scope into a logical set of infrastructure upgrading projects.

Although the planned N2 Wild Coast Highway (N2WCH) does not affect the works recommended under this appointment, it is unavoidable that the implications of this road need to be considered. The approach that has been adopted is that, where the N2WCH is known to have an effect on current designs, those designs must take cognisance thereof. The recommended works is anticipated to amplify the goals of the N2WCH once it is developed.
For planning purposes, we have assumed that this route will be operational by the year 2020.

1.5 Scope of Investigation

The project comprised a number of investigations, as highlighted below.

(i) The scope of the geometric investigation included the following:

- Tacheometric surveys.
- Evaluation of existing site conditions.
- Assessment of horizontal and vertical curves as well as stopping sight distances.
- 12-hour Traffic observations and traffic counting.

(ii) The scope of the pavement investigation included the following:

- Test pit investigation to determine the existing pavement structure.
- Laboratory testing of recovered materials to determine material class.
- Falling Weight Deflectometer (FWD) measurements were made available to establish the extent of deflections occurring within the existing pavement structure.
- The measurements were used to ascertain the structural capacity of the road and to analyse future improvements and possible strengthening of the pavement.
- Rut and roughness measurements as obtained from SANRAL's PMS data.

(iii) The scope of the bridge investigations included the following:

- Tacheometric surveys.
- Rotary core drilling to determine founding conditions for two bridges. Approval for the investigation of a third bridge has been recently obtained as referred to above and the investigation will commence in due course.

1.6 Design Programme

Due to the substantial scope of work across all eleven packages, the letting of contract administration services will take place alongside the tender process for construction.

Based upon recent discussions with SANRAL the revised design phase programme for package 3 was agreed to as follows:

(i)	Detail Design Report Submission	06 September 2013
(ii)	Detail Design Report Discussion	19 September 2013
(iii)	Detail Design Report Final Submission	11 October 2013
(iv)	Draft Construction Tender Document Submission	19 December 2013
(v)	Draft Tender Document Discussion	TBA
(vi)	Draft Tender Document Final Submission	TBA
(vii)	Advertise Tender	TBA
(viii)	Tender Documents Available	TBA
(ix)	Site Clarification Meeting	TBA

(x)	Tenders Close	TBA
(xi)	Tender Evaluation Report Submission	TBA
(xii)	Memorandum to Contracts Committee	TBA
(xiii)	Construction Tender Awarded	TBA
(xiv)	Construction Handover	TBA

The final submission and tender process will depend on the status of the land acquisition process and will be agreed in early January 2013.

2 PHYSIOGRAPHY

2.1 Topography

Over the western half of package 3, the R61 is located along the eastern watershed of the Corana River catchment. The road is located on generally flat terrain up to the Khuleka township (approximately SV 34+000), where it becomes increasingly undulating towards the coast. At the Qiti township (approximately SV 43+000) the terrain undulation increases and becomes hilly, almost mountainous with sharp rises and falls with the road constructed along the hill ridges meandering into the valleys below up to the end of the section in question (SV 47+900). At SV 68+200 the R61 gradually approaches the Mngazi River Valley with a bridge crossing the Mngazi River at SV 71+500 and then ascending to the end of the section in question (SV 73+000).

In conclusion the topography is generally undulating, becoming more hilly and broken towards the coast. The coastal area has a moderate to high relief with the Mngazi River flowing through a deep meandering gorge.

2.2 Climate

The R61-8 is situated in an area where the climate is sub-tropical. The climatic information was supplied by the South African Weather Service and is provided in the following sub-paragraphs.

2.2.1 Temperatures

The monthly average daily minimum and maximum temperatures are shown in Figure 2-1 and Figure 2-2 below.

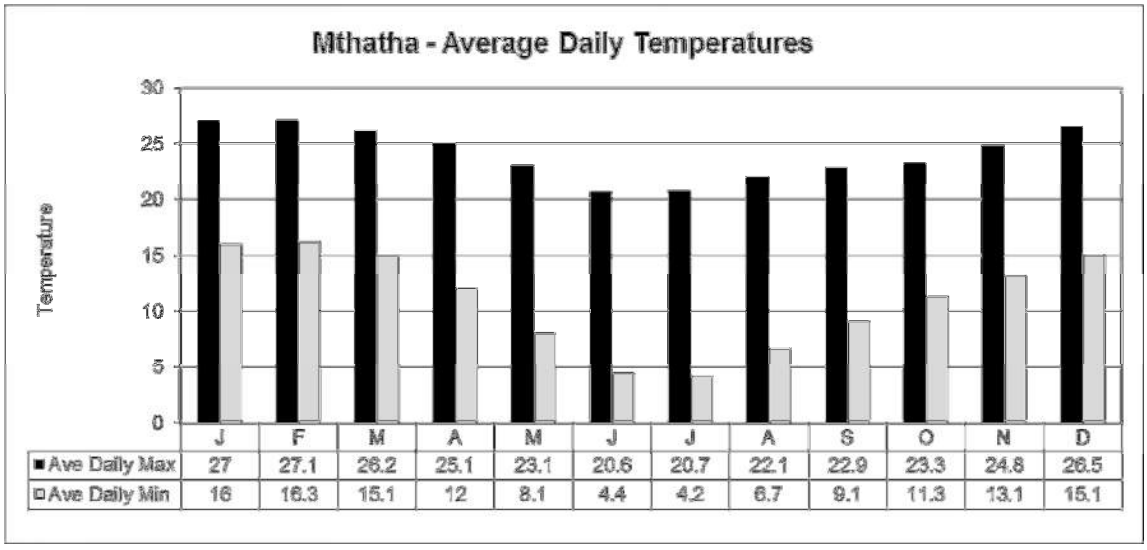


Figure 2-1: Mthatha monthly Average Daily Minimum and Maximum Temperatures.

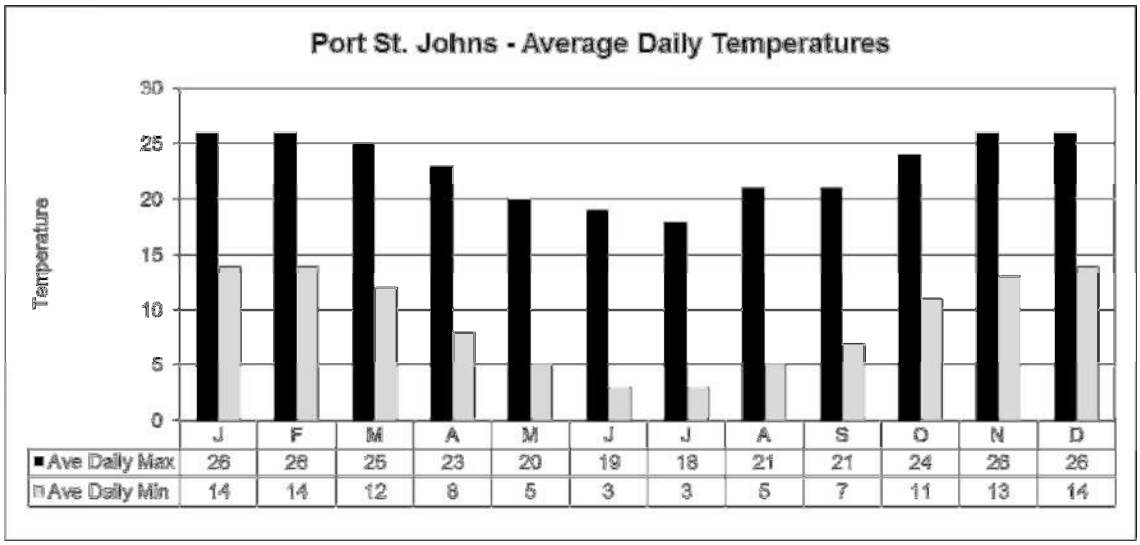


Figure 2-2: Port St. Johns monthly Average Daily Minimum and Maximum Temperatures.

The region is warmest in a range of summer months, most notably December, with average daily maximum temperatures for Mthatha and Port St. Johns ranging between 28℃ and 26℃ respectively. The region is the coldest in July with an average daily minimum temperature of 4.2℃ and 3℃ respectively. During the summer months the average daily minimum temperatures ranges between 12℃ to 17℃.

2.2.2 Precipitation

The study area receives an average annual rainfall of 650mm per year.

The average monthly rainfall varies between 35mm and 87mm in the summer months and between 11mm and 18mm in the winter months (refer Figure 2-3 and Figure 2-4).

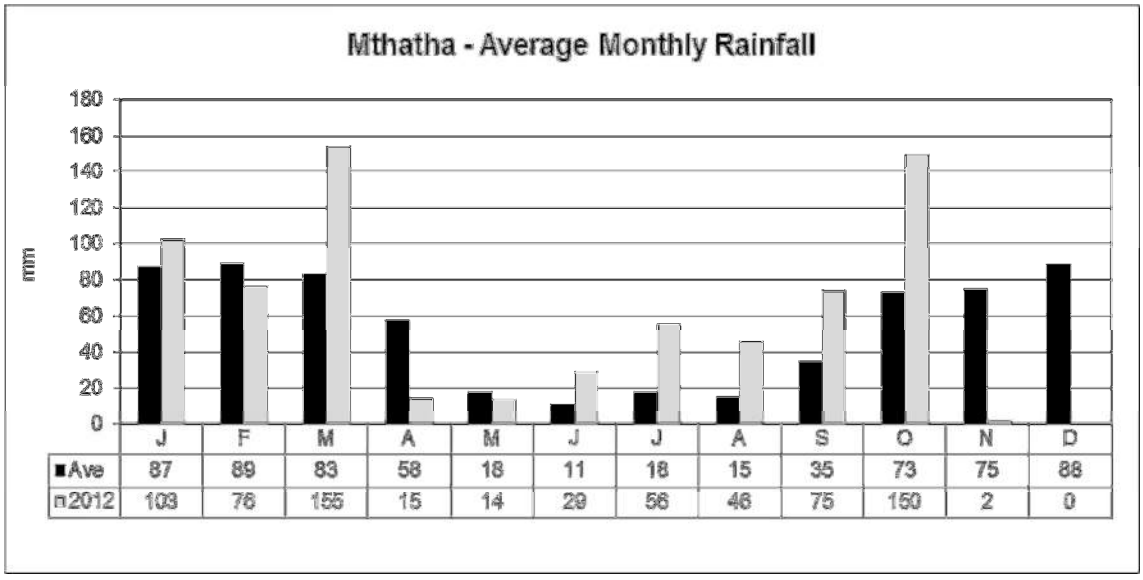


Figure 2-3: Mthatha average monthly rainfall.

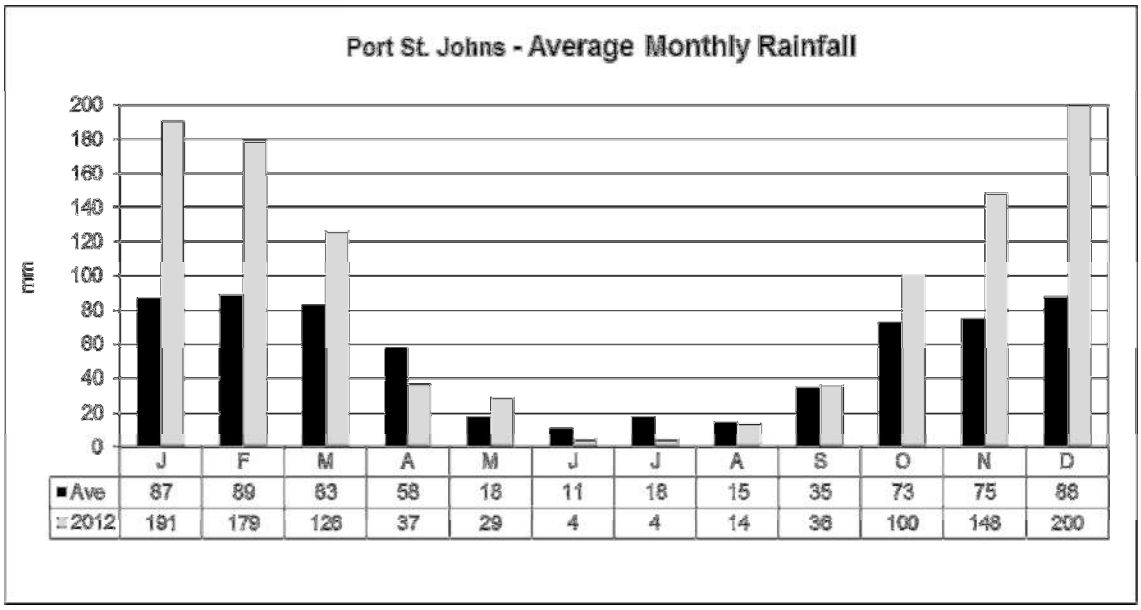


Figure 2-4: Port St. Johns average monthly rainfall.

The average monthly number of rain days exceeding the precipitation threshold of 10mm is between 1 and 3 days. (refer Figure 2-5 and Figure 2-6).

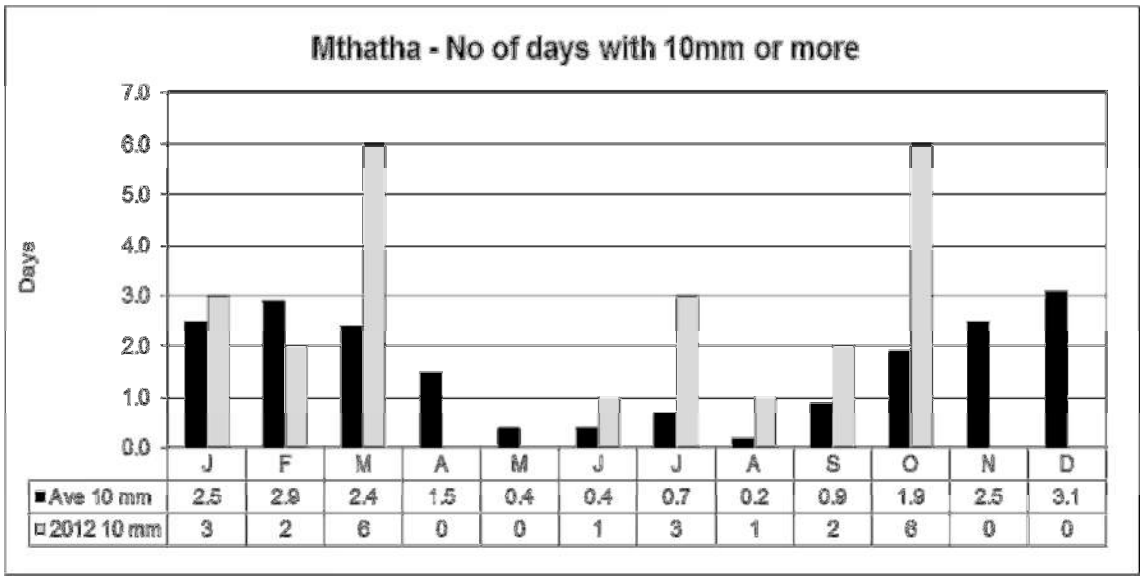


Figure 2-5: Mthatha average monthly rainfall (in days) above a specified threshold of 10mm.

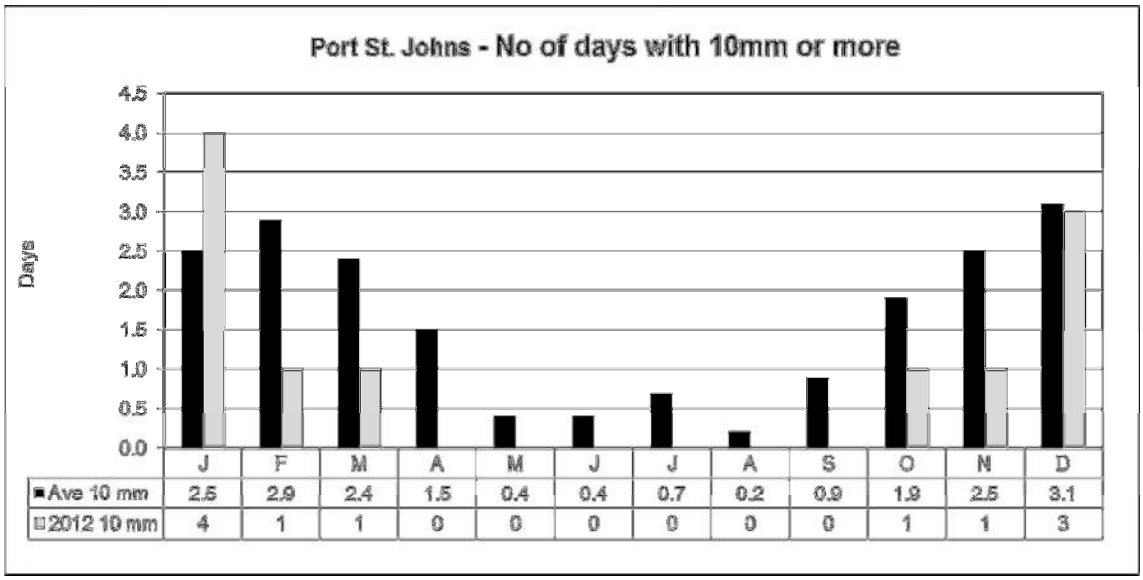


Figure 2-6: Port St. Johns average monthly rainfall (in days) above a specified threshold of 10mm.

2.2.3 Wind

Prevailing winds are predominantly westerly/south-westerly with the average daily wind speed being 13 km per hour. Wind speeds have however, been known to reach 76 km per hour.

2.2.4 Conclusions

It is evident from the temperature information that an embargo period between 1 May and 30 September for the construction of seals may be considered. In some cases, for example, temporary seals, the design may allow for construction during the winter.

The rainfall information indicates that an annual "N" value in terms of extension of time (Clause B1215) of 26 days per annum may be considered. Reducing it by 3 days to allow for reduction in working days over the builders break in December is recommended.

In terms of the wind and minimum temperatures during the winter general inclement weather conditions may be experienced for approximately 5 days per annum.

2.3 Climatic Classification of the Region

Climate determines the mode and rate of weathering. The effect of climate on the weathering process (i.e. soil formation) is determined by the climatic N-value defined by Weinert,1980[1].

Package 3 of the R61-8 falls within the southern moderate to wet macroclimatic region of South Africa, with the following climatological indices being applicable:

Climatic Region: Moderate

[1] The Natural Road Construction Materials of Southern Africa, Pretoria, South Africa, 1980

Weinert Number (Mthatha): N=2.3 (Weinhert, 1980, Figure 7, page 31)

An N-value of less than 5 indicates weathering primarily by decomposition of rock minerals whereas an N-value greater than 5 indicates the breakdown of rock minerals primarily by disintegration. The significance of the area being in a moderate area will be demonstrated later in this report.

2.4 Vegetation

According to Acocks' "Veld Types of South Africa", 1988[2], the R61-8 is located across the Highland Sourveld, Dohne Sourveld and Valley Bushveld. It is noteworthy that the area is developing and therefore large areas of the natural veld types have been disturbed by either settlements or some cultivated lands being established.

2.4.1 Highland Sourveld and Dohne Sourveld

These sour grasslands occur at altitudes of 600m to 1 400 m above sea level, most commonly in the Drakensberg foothills of Eastern Cape and KwaZulu-Natal.

This vegetation type is a dense, sour grassland with Redgrass Themeda triandra, Speargrass Heteropogon contortus, Hairy Tridentgrass Tristachya leucothrix, Eragrostis curvula and Elionurus muticus as some of the dominant species. Trees and shrubs that occur on sheltered sites, rocky hills and ridges, include Common Spikethorn Maytenus heterophylla, Small Knobwood Zanthoxylum capense, Buffalo Thorn Ziziphus mucronata, Rhus rehmanniana and Acacia sieberiana in the north. In fire-protected areas the incidence of other species increases, including forest pioneers such as Cape Beech Rapanea melanophloeos and Fynbos species.

2.4.2 Valley Bushveld

Found in the relatively low-lying valleys in the drainage basin of the White and Black Kei.

Sweet Thorn Acacia karroo bushclumps or individuals characterize this type, but the grass layer mostly remains intact, except where severely overgrazed. The most prominent grass species include Redgrass Themeda triandra, Bushveld Turpentinegrass Cymbopogon plurinodis, Weeping Lovegrass Eragrostis curvula, Sporobolus fimbriatus, Heteropogon contortus, Digitaria eriantha and Eustachys paspaloides.

[2] ACOCKS, J.P.H. 1988. Veld types of South Africa, 3rd edn. Mem. Bot. Surv. S. Afr. 57:1-146

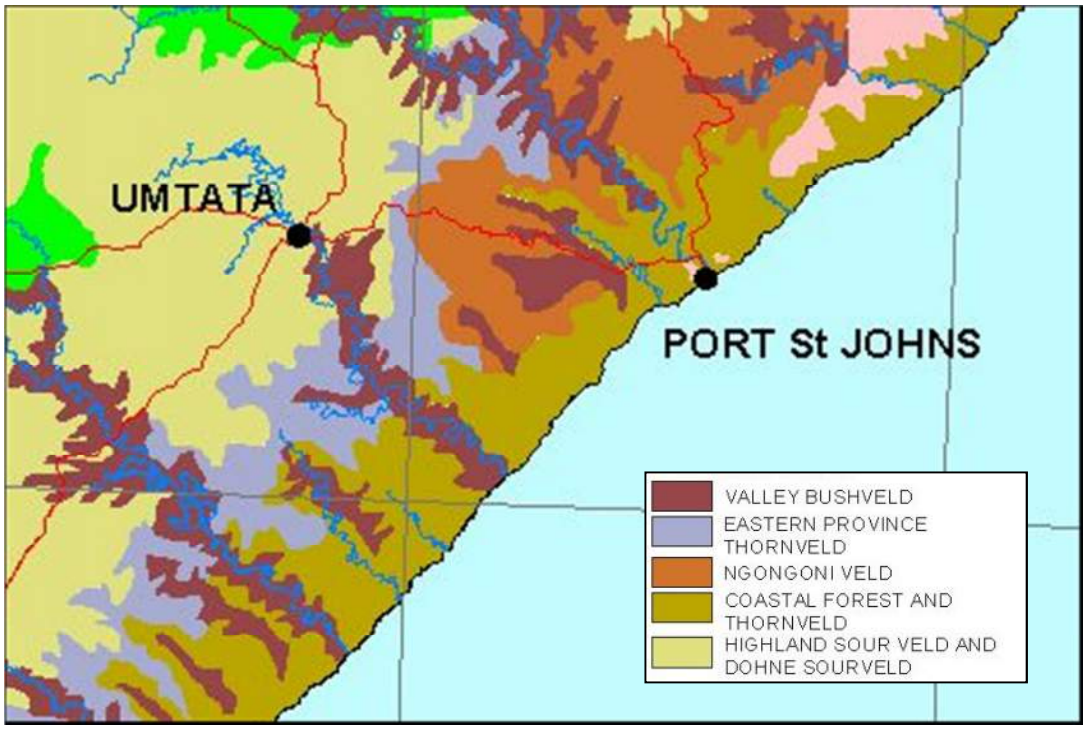


Figure 2-7: Vegetation regions around the Mthatha area.

2.4.3 Conclusions

The extent of the natural vegetation being disturbed is not considered as having a notable influence on the run-off factors during rainstorms yet and therefore the current capacities of drainage structures should still be operating as initially designed.

There are no negative impacts that are to be anticipated with the road development associated with the vegetation occurring along the route

In areas were vegetation needs to be re-established it is recommended that a mixture of the following grasses be applied - information provided by Dr. Janine Bothma (refer Table 2-1):

Table 2-1: Type and amount of various grass types required for re-establishment.

Grass Species	kg/Ha
Aristida congesta	4
Cenchrus ciliaris	5
Digitaria eriantha	6
Eragrostis lehmanniana	2
Fingerhuthia africana	4
Panicum maximum	7
Setaria sphacelata	7
Eragrostis tef (Summer)	2
Lolium perenne (winter)	3
Total seed/Ha (Summer)	**37**
Total seed/Ha (Winter)	**38**

2.5 Geology

The regional geology of the area is indicated in Figure 2-5 below.

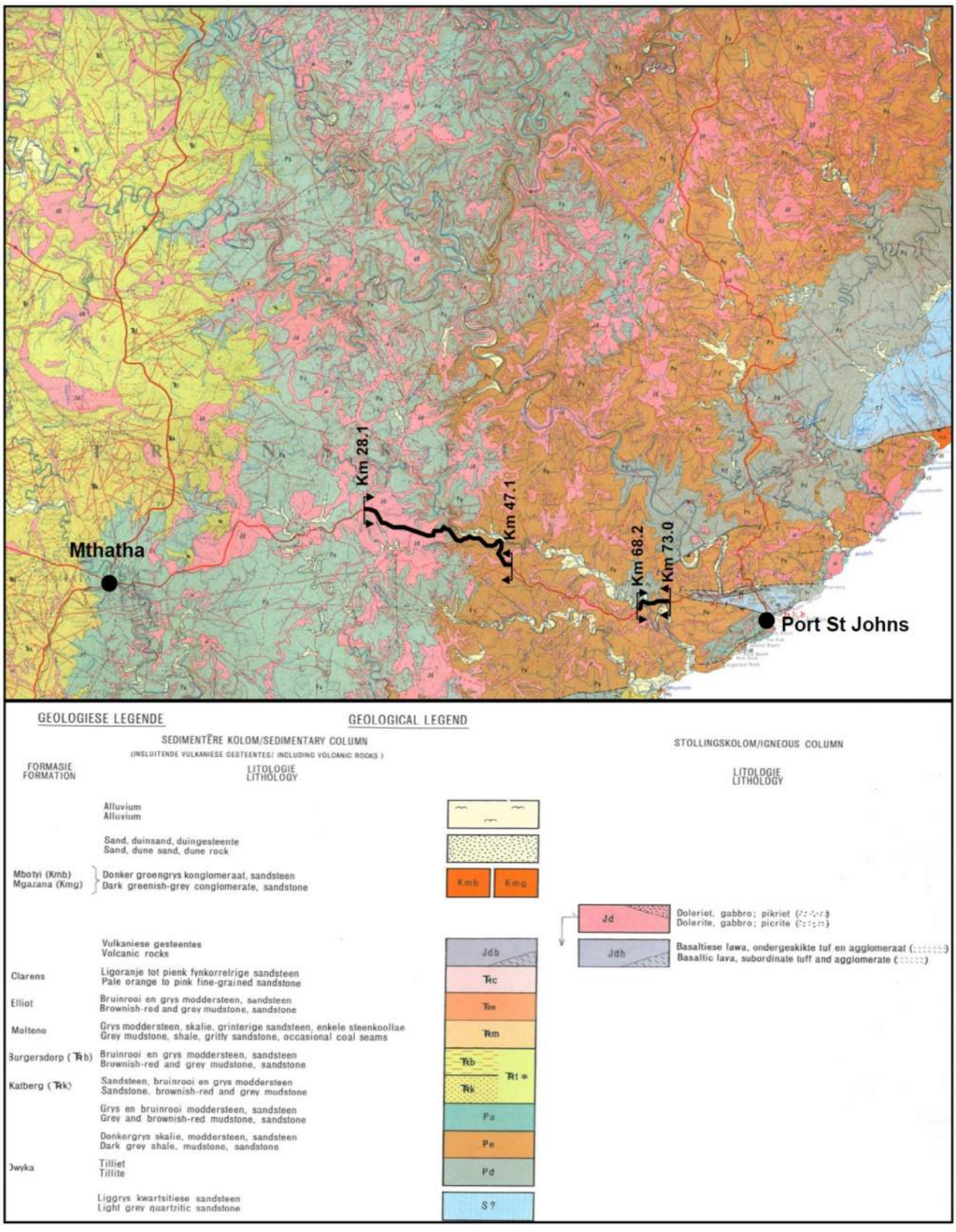


Figure 2-8: Geological information relating to the R61-8.

2.5.1 Stratigraphy

The site of investigation spans an area where bedrock occurs associated with several units of the Karoo Supergroup as follows:

Adelaide Formation: The Adelaide Formation of the Beaufort Group, Karoo Supergroup is indicated in light grey blue on the map and referred to as Pa. The lithology of the Adelaide Subgroup is described as consisting of alternating bands of bluish-grey, greenish-grey or greyish red mudrocks and grey, very fine grained to medium grained lithofeldspathic sandstones. Sandstone generally constitutes 20% to 30% of the total thickness of the succession, but it may be as little as 10%; the rest being made up by mudstone. The succession is characterised by the upwards fining cycles of material.

Ecca Group: The Ecca Group of the Karoo Supergroup is indcated in light brown on the map and referred to as Pe. The most important lithological property of this group is that it consists primarily of dark grey, carbon rich shale, associated with interbedded sandstone bands. The shale is laminated and upon weathering subject to slaking into plates and flakes. The arenaceous interbeds vary from greywacke to grit.

Dwyka Formation: The Dwyka Formation can be associated with the Karoo Supergroup. On the map it is indicated in grey and referred to as Pd. The sediments of the Dwyka Formation are regarded as glacial deposits and the composition there of varies considerably. In the area under discussion it is described as blue grey diamictite tending to varved shale. The composition of the rock matrix is thus predominantly argillaceous.

Post Karoo Dolerite: Intrusive dykes and sills of dolerite may be present in the area. On the map it is indicated in dark red and referred to as Jd. Dolerite can be described as an intrusive, hypabyssal, basic igneous rock with a mineral assemblage of plagioclase and pyroxene. In an unweathered form it is described as dark blue-grey, fine grained, very hard rock

The geology map does not indicate the presence of fault zones or shear zones in the area. However, the presence of small displacements in the sediments can often be associated with the intrusions of dolerite. Such displacements are not indicated on the map.

Considering the climatic conditions in the area (Weinert N is 2,3), the rock materials will be subject to chemical decomposition instead of mechanical weathering, which may result in the presence of expansive clay.

2.5.2 Influence of the Geology on the Presence of Construction Material

The extent of material suitable for sourcing of construction material is determined by a combination of the climatic conditions and the mineral assemblage of bedrock. The lithology in the area can be considered as follows for the procurement of construction material:

Mudrock: Materials such as mudstone contain intergranular clay due to its origin and conditions of original deposition, and decomposes to clay due to climatic conditions. Generally Mudrock is therefore not suitable as a source for road construction material. Unweathered mudrock can be used in the fill and selected layers. This unweathered rock can usually be excavated to a considerable extent with a 30 ton excavator due to the presence of discontinuities in the rock matrix.

Sandstone: Sandstone may be considered suitable as a road construction material. Residual sandstone is usually of G7 quality and poorer. Suitable outcrops of sandstone can be crushed to provide road construction gravel of up to G5 quality. It is however essential that before material for construction is sourced from the sandstone, it be subjected to a mineralogical analysis to ensure that the mineral assemblage does not contain clays or primary minerals that can decompose to clay.

Dolerite: Dolerite is usually the most frequently used road construction material in the area. Dolerite generally weathers to dark yellow, coarse sand with a substantial clay content. The addition of road lime or cement may be required to decrease the plasticity index of the residual dolerite. Stabilized residual dolerite may be used for the construction of layerworks up to subbase. Un-weathered dolerite can be sourced via quarries for crushed stone products. Care must be taken to assess the presence of possible interstitial clay or the susceptibility of the un-weathered dolerite to rapid mechanical weathering. It is thus important to subject samples of un-weathered dolerite to a mineralogical analysis and ethylene glycol durability tests. Intact, un-weathered dolerite will hardly be excavated by conventional equipment and will require drilling and blasting to remove it.

Tillite: Unweathered tillite is a source for crushed stone products for both base course construction and seals.

2.5.3 Influence of the Geology on Founding Conditions

Founding conditions for bridge structures are characterized by the presence of thick horizons of soft/loose and expansive soils. These materials are generally also subject to erosion due to its grain size distribution.

Founding conditions for bridge and culvert structures can thus be regarded as follows :

Mudrock: Intact mudrock can be regarded as hard rock. However, the suitability of mudrock as a horizon for founding is usually compromised by the presence of discontinuities in the rock matrix. The main set of discontinuities is usually horizontally orientated, but in the presence of fault zones it may be displaced. Especially if the mudrock is weathered, the discontinuities may be open and filled with clay. For founding of structures, imposed foundation stresses therefore need to be reduced. Culverts can be founded directly on bedrock of mudrock, but founding by means of piling will require socketing of the piles into the mudrock.

Sandstone: Intact sandstone can be regarded as hard rock. However, the suitability of sandstone as a horizon for founding may be compromised by the presence of fine muscovite contained in the rock matrix. The muscovite is usually the mineral most

susceptible to weathering in sandstone. Although the sandstone usually contains less discontinuities than mudrock, the presence of muscovite reduces the hardness thereof, resulting in bedrock with an effective safe bearing capacity in the region of 10MPa to 15MPa only. The principle remains that such material is suitable for founding structures safely by means of end bearing piles. Culverts can be founded directly on bedrock of sandstone. Care must also be taken when designing piled foundations as mudstone may be present as intercalated strata between the sandstone beds. As the mudrock is more susceptible to weathering than the sandstone, it may be present as bands of highly weathered, soft rock between more resilient sandstone strata.

Dolerite: In an unweathered form dolerite can be regarded as extremely hard with a uni-axial compressive strength exceeding 300MPa.

Tillite: Tillite may be a highly variable material. Should the matrix be argillaceous, the residual soils may be very highly expansive.

3 ROAD CROSS-SECTION

3.1 Standard Cross-Section

3.1.1 National Road

The R61-8 consists of a continuous, uniform cross-section with a surfaced width of 10.4m and lane widths varying from 3.5m to 3.7m. The original road width appears to be 3.7m wide lanes and 1.5m surfaced shoulders, but varies slightly due to reseal and remarking over the years. No provision was made for turning lanes under the original construction. Several road features have been added to the original construction at various positions, and include laybys, raised medians, substantial speed humps at high pedestrian volume crossings and walkways (both kerbed and positioned within the road verges at existing ground level).

Preliminary planning for the N2WCH (as indicated on the Hawkins Hawkins and Osborne drawings) did not include an upgrade to the overall basic width of the road, but proposed standard intersection upgrades at selected positions. The proposed basic road reserve width at the time was 36m, which was subsequently increased by SANRAL to 50m so as to allow for future upgrading.

As discussed under 1.3, most of the upgrading under this project consists of 9 intersections that have been identified herein and in earlier studies for upgrading to safely accommodate turning traffic and provide safe pedestrian crossing zones. These have been designed according to the typical intersection layout that was developed over the course of the project. Each intersection upgrade (consisting of 700 linear metres of road widening) entails the provision of concrete-lined side drains, laybys and protected walkways, as shown on the figures 3.1 to 3.4 hereafter. Dedicated right-turn lanes as well as deceleration and acceleration tapers have been provided in all cases. A short, raised median is provided as a pedestrian refuge for persons crossing at the intersections. Medians and laybys have also been provided for as shown.

Although pavement layers are indicated on these drawings, the final layerworks proposed in this regard is discussed in Section 8.

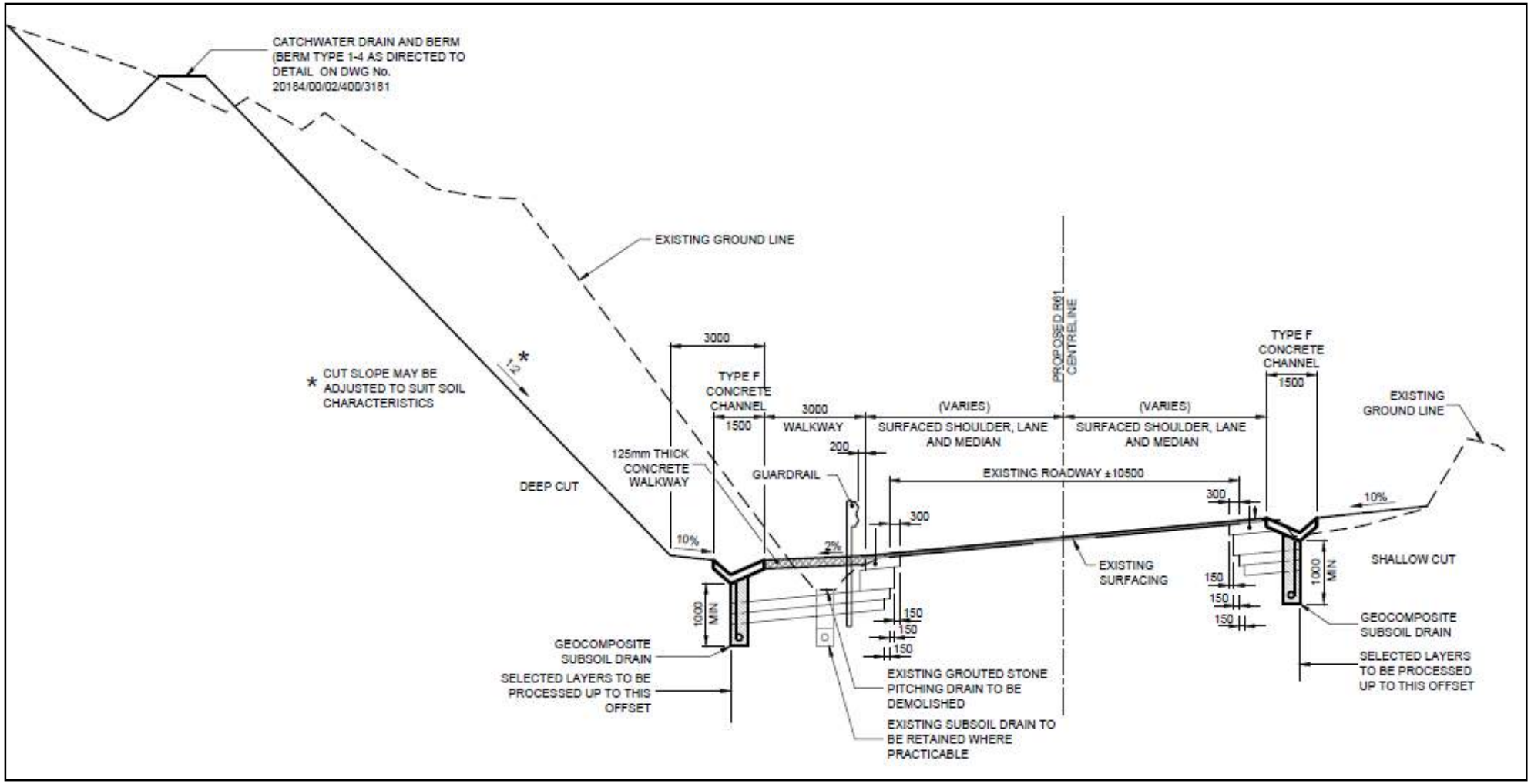


Figure 3-1: Intersection Widening – Cut Condition (Note: Final pavement layer works – refer Section 8).

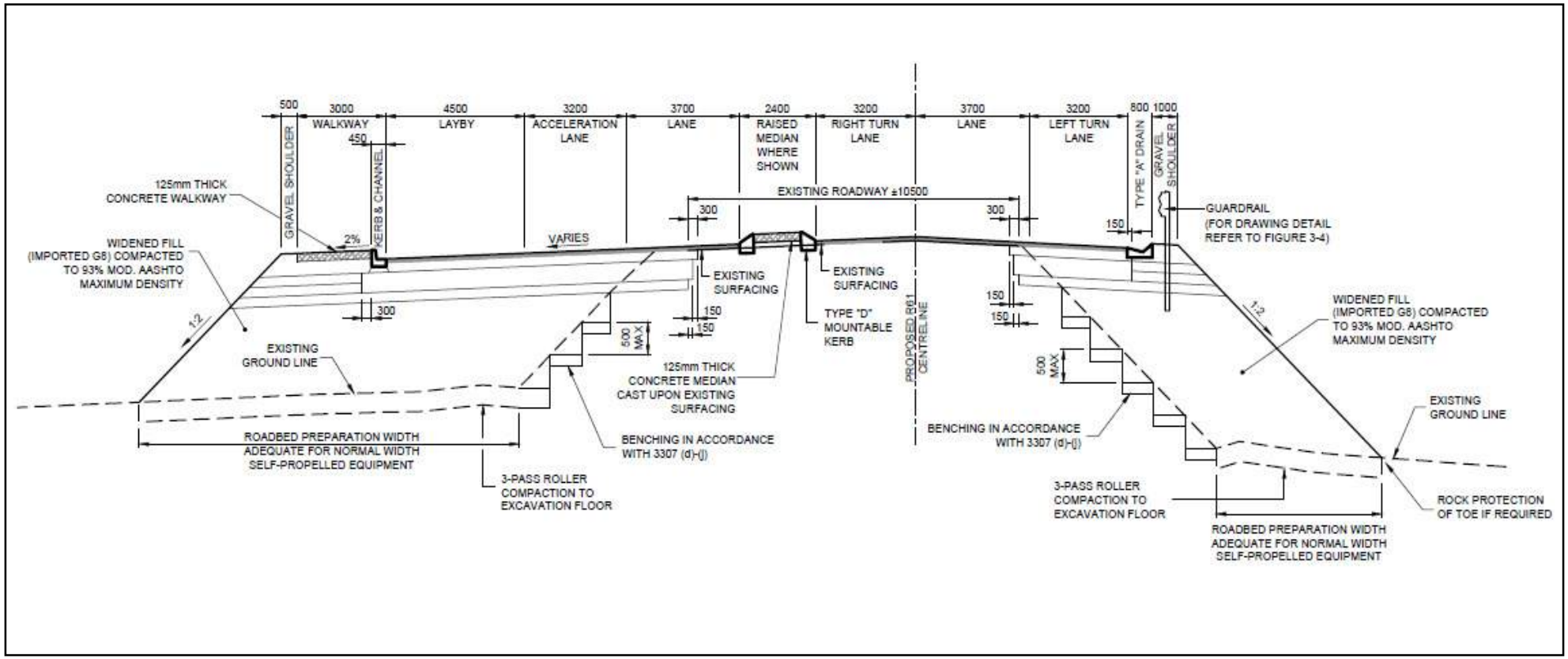


Figure 3-2: Intersection Widening – Median and Kerb Details (Note: Final pavement layer works – refer Section 8).

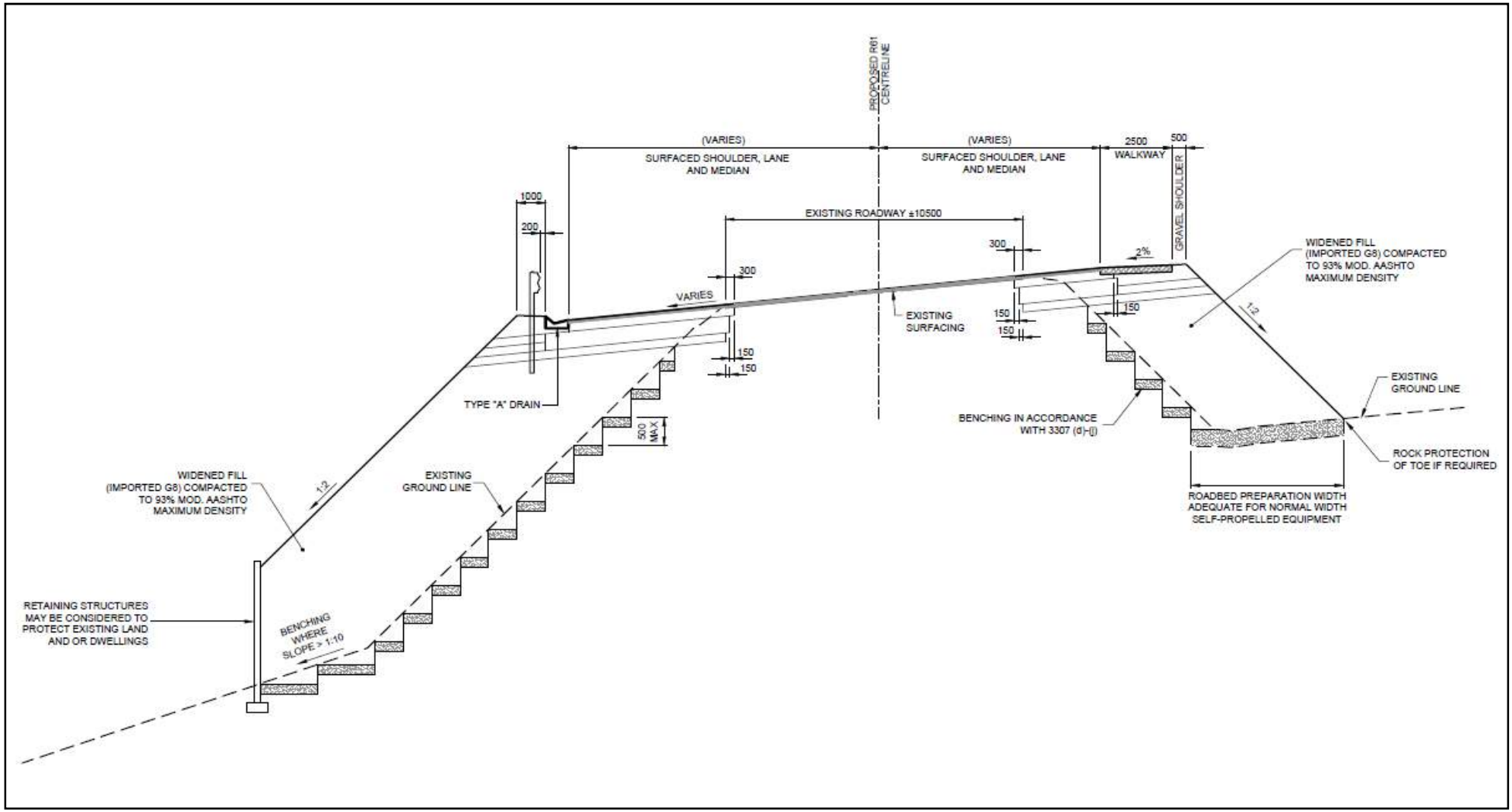


Figure 3-3: Intersection Widening – High Fill Condition (Note: Final pavement layer works – refer Section 8).

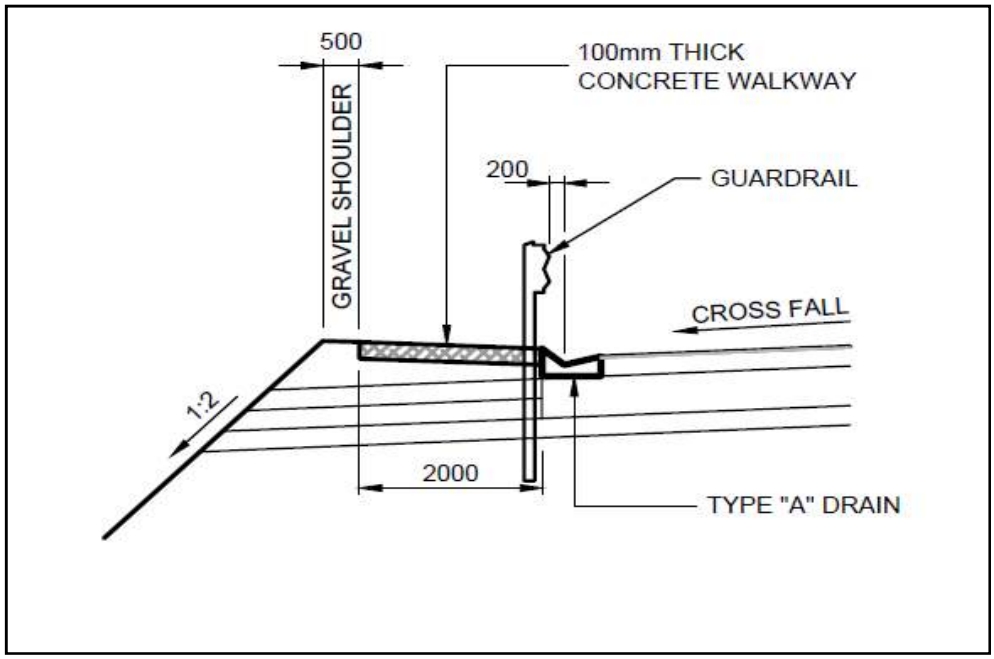
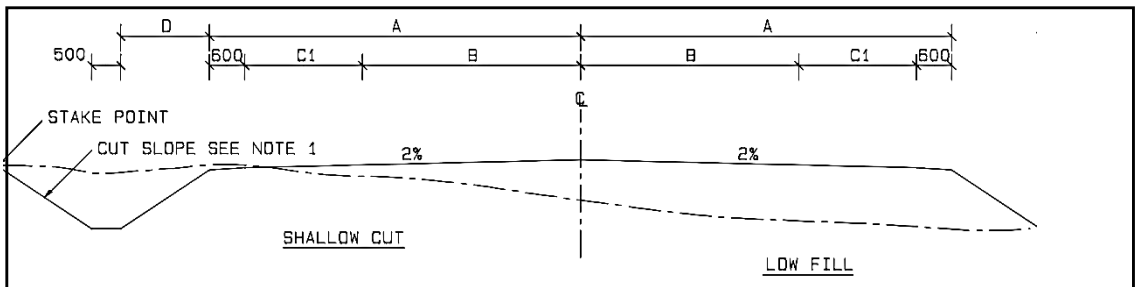


Figure 3-4: Intersection Widening – High Fill Condition with Sidewalk.

3.1.2 Provincial Roads

Provincial roads intersect with the R61 at two positions along this package, namely District Road DR08029 at SV 30+435, and District Road DR08304 at SV44+860.

District Road DR08029 will be realigned over a distance of 400m and upgraded to a cross section that is consistent with a Provincial Class 2 facility. It is proposed that this road be constructed with surfaced 3.4m wide lanes and 1.5m wide gravel shoulders, as shown below (Figure 3.5). A 20m wide road reserve (consistent with the former CPA Divisional Road standard, currently DRPN) is also recommended. The adjoining community access road A will be constructed to a Provincial Class 4 facility i.e. with surfaced 3.4m wide lanes ad 0.9m wide gravel shoulders, as shown below (figure 3.5) for 20m wide road reserve.



Class	A	B	C1	D
1	6300	3700	2000	1200
2	5500	3400	1500	1200
3	4900	3400	900	1200
4 (extrapolated)	4300	3400	300	1000

Figure 3-5: Provincial Route Typical Cross Section

District Road DR08304 will be upgraded only insofar as is required for the intersection upgrading (over a length of 40m). It is proposed that this short length of road be upgraded to a Provincial Class 4 facility and constructed with surfaced 3.4m wide lanes and 0.9m wide gravel shoulders, as shown in Figure 3.5 above. From this point it will be tied into the existing surfaced road width of 8m.

All proposed upgrading to Provincial Roads have been forwarded to the Provincial Roads Departments each of which have subsequently been approved.

3.1.3 Municipal and Local Roads

The Nyandeni Local Municipality has jurisdiction over the following numbered roads that intersect the R61:

(i) AC30554 at SV31+500 to Ezinkozweni (Mafini)

(ii) AC30107 at SV37+970 to Mkangiso (Ngidini)

(iii) AC30488 at SV38+720 to Mabaleni (Enjiveni)

(iv) AC30105 at SV42+705 to Njiveni (Qiti)

The Port St Johns Municipality has jurisdiction over the following numbered road that intersects the R61:

(i) AC30081 at SV71+685 to Qhaka (Mngazi)

The upgrading of these accesses is shown on the Key Plan in Annexure A, and in more detail on the draft tender drawings in Annexure B.

Memoranda of Agreement between SANRAL and the local municipalities have been drafted with respect to road maintenance as well as electrical installations along the national road as required. These memoranda require final ratification.

In accordance with access management planning, 41 existing accesses will need to be permanently closed within this Package 3 construction project. Nine formalised intersections will be constructed at safe locations that best serve the residential areas alongside the R61. These intersections will be constructed with 15m bell mouth radii (except in exceptional cases where space does not permit), narrowing to a surfaced width of between 4m and 7.4m depending on the road function. In most cases, turning traffic volumes are low with 12 hour turning volumes (all movements combined) of 7, 27, 121, 7 and 22 respectively at the AC intersections listed above. Non-numbered local accesses (other than those that intersect the nine formalised intersections) will be retained or realigned slightly to remove staggers, thereby improving traffic safety during turning movements. The bell mouth areas will be surfaced here. These bell mouths occur at the following locations:

(i) SV 29+560 upgrade gravel bellmouth (north)

(ii) SV 30 +140 upgrade existing bellmouth (north)

(iii) SV 32+670 retain surfaced bellmouth (north)

(iv) SV 32+670 upgrade gravel bellmouth (south)

(v)	SV 36+720	upgrade gravel bellmouth (north)
(vi)	SV 36+875	retain surfaced bellmouth (south)
(vii)	SV 37+250	realign bellmouth to improve sight distance (north)
(viii)	SV 37+970	retain surface bellmouth (south)
(ix)	SV 40+000	upgrade existing bellmouth (north)
(x)	SV 41+240	upgrade existing bellmouth (south)
(xi)	SV 42+705	upgrade existing bellmouth (north)
(xii)	SV 69+110	realign bellmouth opposite northern bellmouth
(xiii)	SV 69+125	upgrade gravel bellmouth (north)
(xiv)	SV 70+825	upgrade gravel bellmouth (north)

Apart from the aforementioned numbered accesses, all remaining informal accesses will be closed.

Local access roads serving small communities where no alternative accesses are available will be surfaced to a width of 4m where traffic volumes are very low. On steep grades, the local streets will be upgraded to a concrete wearing course (either continuously reinforced or jointed). A typical cross-section of such a road is shown in Figure 3-6 below:

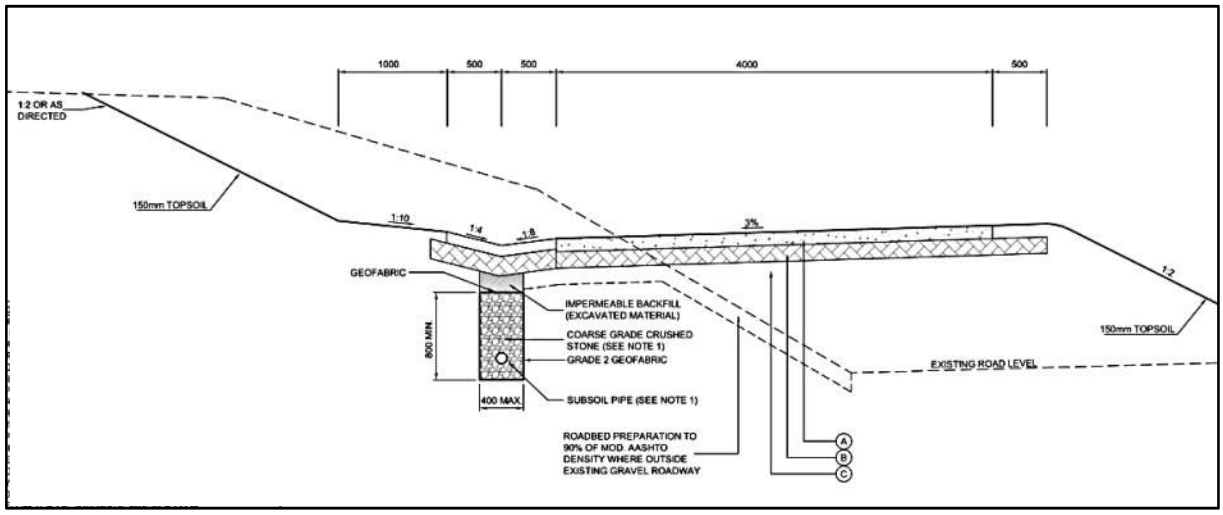


Figure 3-6: Local route typical cross section (Note: Final pavement layer works – refer Section8).

Note that a full list of the intersections described above is presented in tabular form in Chapter 16 of this report.

The pavement design layer A, B and C are discussed in Chapter 8.

3.2 Batter Slopes

3.2.1 National Road

The existing batter slopes are typically 1:2 throughout this portion of the R61 and have been designed as such where widening occurs with the exception of portions where dwellings are close to the extrapolated fill toe or top of cut face. The proposed 50m wide road reserve affects approximately 30 properties near intersection upgrades (half of which requires dwellings to be relocated and the other half required property boundaries to be amended). In another instance, a low retaining (road in cut) wall may be constructed to avoid relocation. In all cases the passage of maintenance plant between the toe and the fence will be ensured.

Certain existing hard rock cuttings will be widened to a safe batter slope which may vary from site to site depending on material properties. In some instances these batter slopes may be steeper. Surplus cut material will be re-used as fill or layer works in widenings.

Earthworks quantities will take into account appropriate benching methods. Where existing fills are to be widened substantially (closer to the intersection point), method B (where artificially wide benches are not required) will be used. Towards the limits of construction, with the proposed fill widening occurring over long, flat tapers, method A may be employed (where wide benches are cut into the existing fill so that batters are constructed in their final position initially). Traffic accommodation will, however, need to be considered, and in some instances, the fill may be constructed wider than designed in order to accommodate temporary traffic accommodation.

3.2.2 Provincial Roads and Local Streets

Provincial roads and local streets have all been designed with cut/fill batter slopes of 1:2 or flatter, except where they pass through closely spaced houses. In such instances, steeper cut faces or retaining walls will need to be constructed.

4 EXISTING PAVEMENT STRUCTURE AND MAINTENANCE HISTORY

The as-built data for the R61 Section 8 was provided by SANRAL for inclusion in the pavement investigations.

The existing pavement structure is provided in the form of a strip map and the contents of the data set are normally verified through analysis of the test pit data (refer Annexure C). The data as received from SANRAL has been included in Figure 4-1 herein after. The existing pavement structure is summarized in Table 4-1 below:

Table 4-1: Pavement Structures as derived from the As-built data records.

	SV 28+100 to SV 31+000 SV 34+000 to SV 36+000			**SV 31+000 to SV 34+000**		**SV 36+000 to SV 47+900 SV 68+200 to SV 73+000**	
Year	**1984**	**2001**	**2010**	**2001**	**2010**	**1987**	**2010**
Seals		**19.0/6.7 Double Seal**	**19.0/6.7 Double Seal**				
		13.2 Single Seal	13.2 Single Seal		**19.0/6.7 Double Seal**		**19.0/6.7 Double Seal**
	19.0 Cape Seal	19.0 Cape Seal	19.0 Cape Seal	19.0 Cape Seal	19.0 Cape Seal	19.0 Cape Seal	19.0 Cape Seal
Pavement layers	150 G4	150 G2	150 G2	150 G4	150 G4	150 G4	150 G4
	150 G5	150 G5	150 G5	150 C4	150 C4	150 G5	150 G5
	100 G7	150 G7	150 G7	150 G5	150 G5	100 G7	100 G7
	100 G9	150 G9	150 G9	100 G7	100 G7	100 G9	100 G9
				100 G9	100 G9		

SV 28+100 to SV 31+000 and SV 34+000 to SV 36+000

This section was constructed in 1984 with a base layer of approximately 150mm thick G4 natural gravel material, 150mm thick G5 subbase natural gravel material, 100mm G7 upper selected natural gravel material and 100mm G9 lower selected natural gravel material with a 19mm Cape Seal overlay. A subsequent 13.2mm single seal was added in 2001. Subsequent to the PMS as-built data being issued the road has been resealed using a 19/6.7mm double seal in 2011 using a SE-2 binder.

SV 31+000 to SV 34+000

This section was constructed in 2001 with a base layer of approximately 150mm thick G4 natural gravel material, 150mm thick C4 subbase of stabilised natural gravel material, 150mm G5 upper selected natural gravel layer, G7 lower selected natural gravel material and 100mm G9 in-situ natural gravel material with a 19mm Cape Seal overlay. Once again the subsequent 19.0/6.7 double seal using a SE-2 binder, which was added in 2010, is not indicated on the SANRAL PMS as-built data.

SV 36+000 to SV 47+900 and SV 68+200 to SV 73+000

This section was constructed in 1987 with a base layer of approximately 150mm thick G4 natural gravel material, 150mm thick G5 subbase natural gravel material, 100mm G7 upper selected natural gravel material and 100mm G9 lower selected natural gravel material with a 19mm Cape Seal overlay. Here as well, the subsequent 19.0/6.7 double seal using a SE-2 binder, which was added in 2010, is not indicated on the SANRAL PMS as-built data.

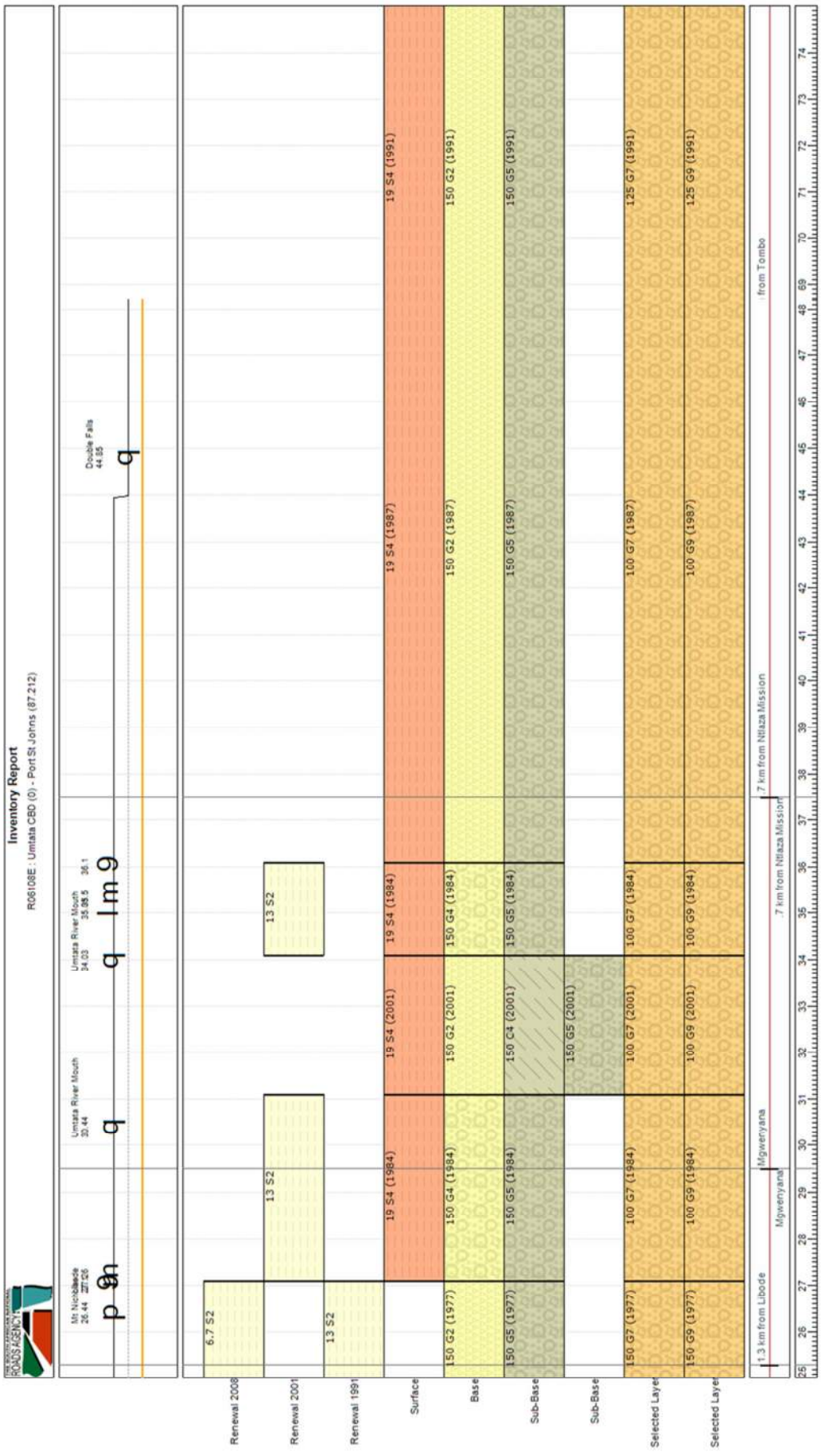


Figure 4-1: SANRAL As-built Inventory Report for R61-8 km 28.1 to km 47.9 and km 69.3 to km 73.0.

5 EXISTING PAVEMENT INVESTIGATIONS

5.1 Introduction

Information obtained from the SANRAL road condition database was utilised together with additional field data obtained for the analysis of this section of the R61-8. The purpose of the field investigations and analysis of data is to confirm the structural condition of the existing pavement. The following data sets were evaluated:

- General Visual Condition observations
- Mechanical Surveillance data
- Test Pit data

The mechanical surveillance data included roughness (riding quality), rut measurements, texture measurements, Falling Weight Deflectometer (FWD) readings and as-built data. It is important to notice that this project's main objective is the improvement of safety and that additional investigations were not concentrated around the structural analysis of the existing road but rather to determine the in-situ conditions for the design of these safety improvements.

We do however analyse the pavement with the information at hand for the records and good management of the road network.

5.2 Visual Condition Survey

A drive-over visual observation was conducted during August 2012. The visual condition observations indicated that very little defects were present at the time. Considering the newly constructed seal in 2010 less than one year earlier no defect were expected.

Due to the nature and scope of this appointment and the current condition of the road at the time no detail inventory of defects were compiled. The road is thus visually in a good condition with very few, if any, surface defects noted. This may be attributed to the good performance of the recent reseal in 2010.

5.3 Mechanical Surveillance Data

Information provided by SANRAL was used in the assessment of the existing pavement. The mechanical surveillance data provided was obtained by non-destructive means and includes falling weight deflectometer and other standard road condition measurements. Table 5-1 below indicates the data provided for analysis.

Table 5-1: Summary of Available Mechanical Surveillance Data.

	Section	Direction	From (SV)	To (SV)	Year
FWD Deflection	R61	Eastbound	28.0	73.0	2005
	R61	Westbound	N/A	N/A	2005
	R61	Eastbound	28.0	73.0	2008
	R61	Westbound	N/A	N/A	2008
Roughness (Riding Quality)	R61	Eastbound	28.0	73.0	2009
	R61	Westbound	28.0	73.0	2009

Rutting	R61	Eastbound	28.0	73.0	2009
	R61	Westbound	28.0	73.0	2009
Texture	R61	Eastbound	28.0	73.0	2009
	R61	Westbound	28.0	73.0	2009

5.3.1 Falling Weight Deflectometer (FWD) Data

An analysis was carried out using the 2009 FWD data to determine likely uniform sections along the road using the Cumulative Sum of Differences (CUSUM) method.

This statistical method is deemed current best practice in determining uniformity within a data set by evaluating the difference between individual data points and the average value for the data set and representing this difference graphically. Any dramatic change in direction on the graph indicates a large difference in the data set and a likely uniform section.

Note that the data shaded in grey between SV 33+800 to SV 36+200 and SV 49+900 to SV 68+200 was not analysed and falls outside the scope of works.

This analysis was carried out for each of the standard deflection bowl parameters as shown in Figure 5-1 below.

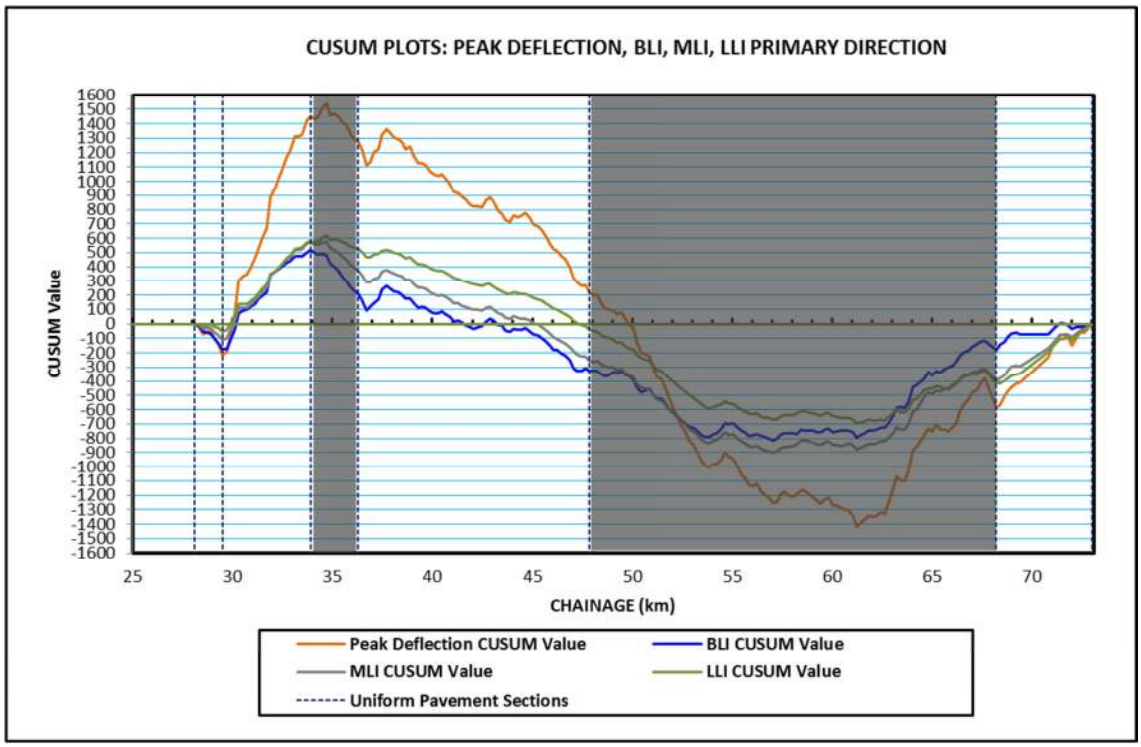


Figure 5-1: CUSUM plots for FWD parameters.

Based on the CUSUM analysis of the FWD data, this portion of road can be divided into four preliminary uniform sections. These are indicated by the dotted dark blue vertical lines on the graph in Figure 5-1 above. The uniform sections are summarised as follows:

- Section 1: SV 28+100 to SV 29+510
- Section 2: SV 29+510 to SV 33+800
- Section 3: SV 36+200 to SV 47+900
- Section 4: SV 68+200 to SV 73+000

5.3.2 FWD Benchmarking

In terms of the deflection benchmarking as defined by Horak in 2008[3] the deflection parameters of this project is classified according to the criteria indicted in Table 5-2 below.

Table 5-2: Structural condition rating criteria for deflection bowl parameters for a granular base pavement (Horak, 2008).

Structural Condition Rating	Deflection Bowl Parameter			
	D0 [µm]	BLI [µm]	MLI [µm]	LLI [µm]
Sound	< 500	< 200	< 100	< 50
Warning	500 – 750	200 – 400	100 – 200	50 – 100
Severe	> 750	> 400	> 200	> 100

The structural condition rating as defined in Table 5-2 above for each of the deflection parameters are shown in Figures 5-2 to 5-4 below:

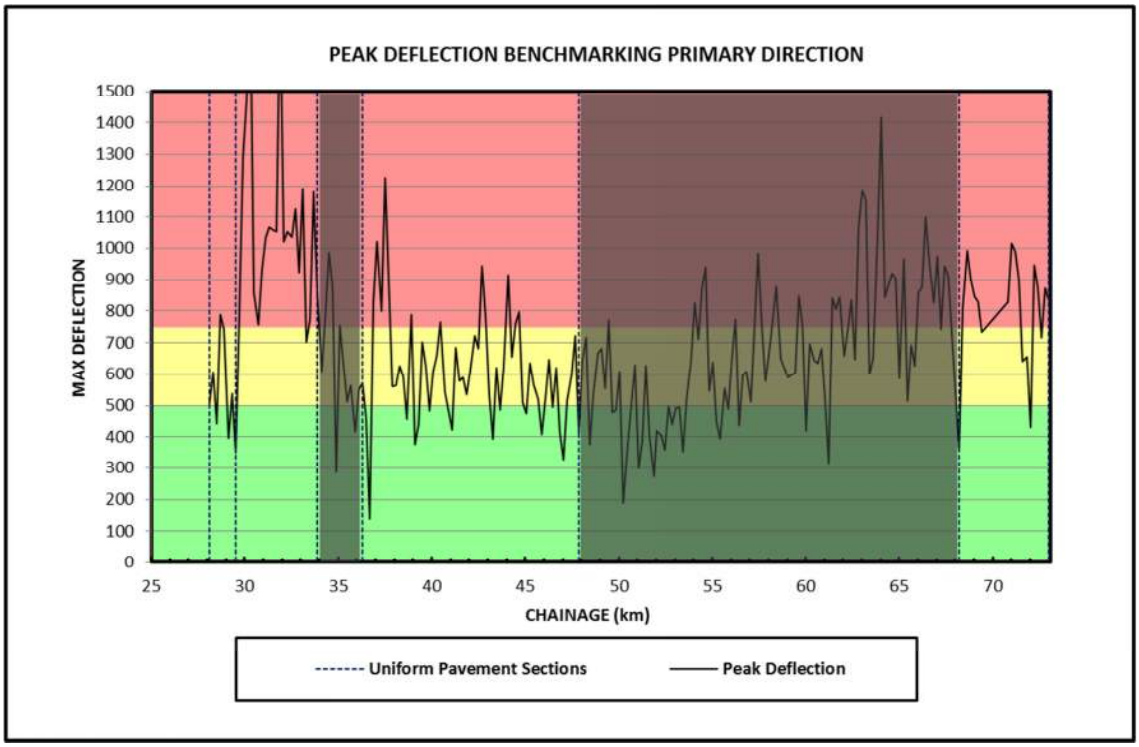


Figure 5-2: Benchmarking of Peak Deflections.

[3] Benchmarking the structural condition of flexible pavements with deflection bowl parameters, Pretoria, South Africa, 2008

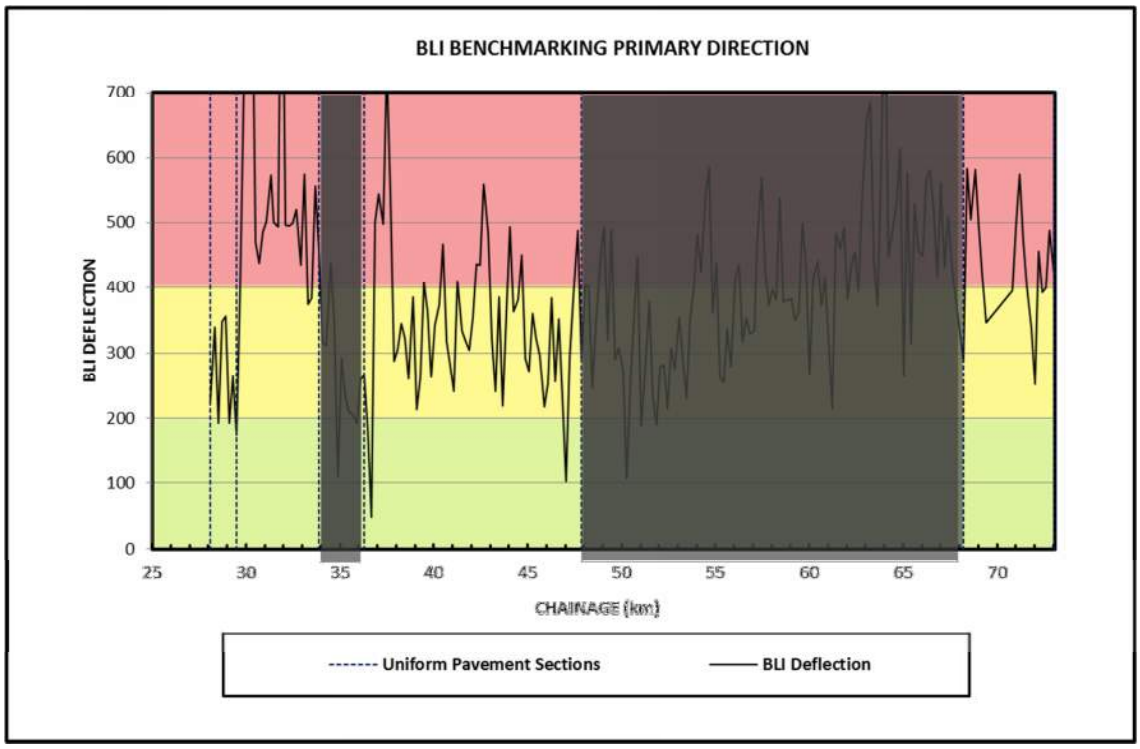


Figure 5-3: Benchmarking of Base Layer Index (BLI).

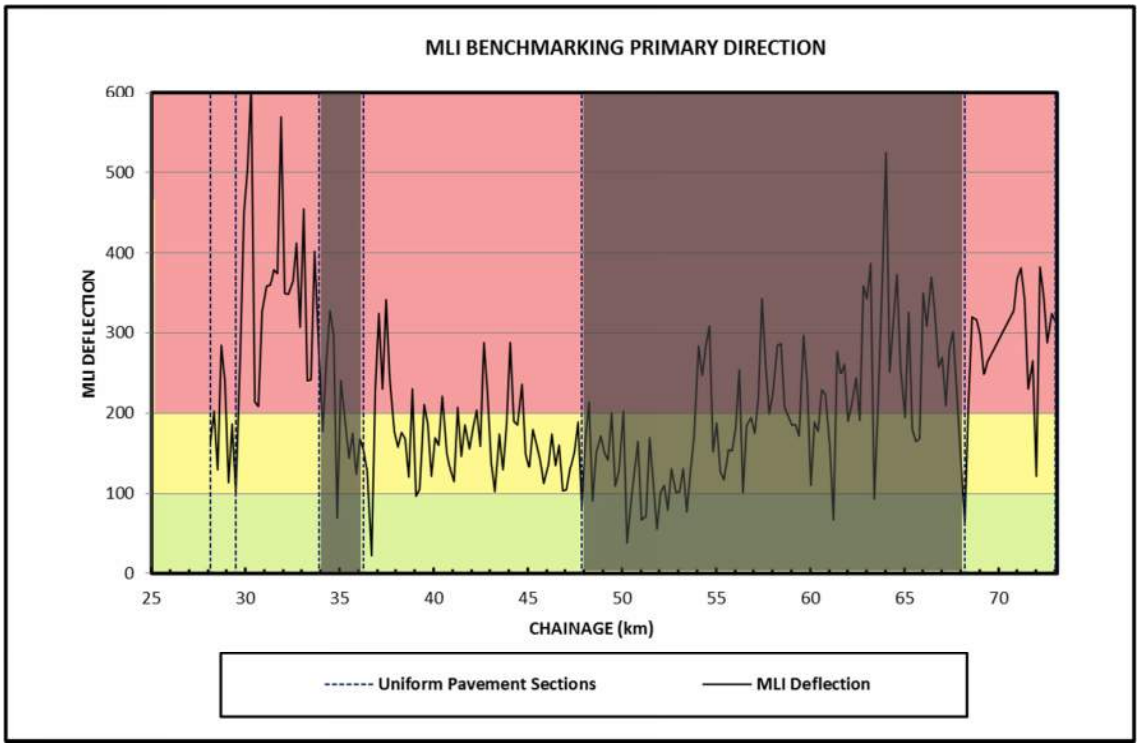


Figure 5-4: Benchmarking of Middle Layer Index (MLI).

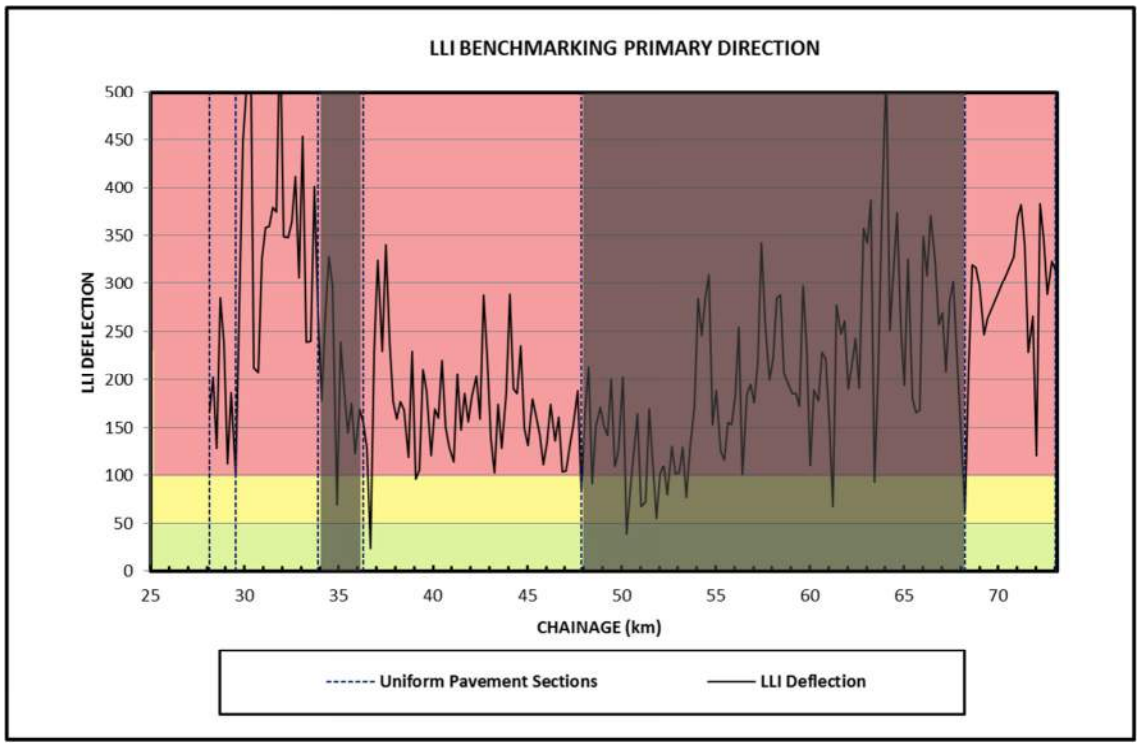


Figure 5-5: Benchmarking of Lower Layer Index (LLI).

5.3.3 Summary of Benchmarking

The benchmarking of the pavement horizons has indicated that the upper layers of the pavement structure are generally in a "Warning to Severe" condition with km 30 to 34 severe and the remainder generally warning. The lower layers are in a "Severe" condition throughout the pavement.

In some locations the benchmarking has indicated a severe condition within the upper pavement, which is generally the case between km 30 to 34 it would be expected that severe distress should be noted on the surface in the form of failures and cracking. This is however not the case as the visual condition observations indicates little, if any, physical distress on the road surface.

Moreover the entire road was resealed in 2010 to 2011 in the form of a 19.0/6.7mm double seal and the deflection measurements is dated 2009. Cognisance needs to be taken of the deterioration of the road being delayed by the construction of this seal.

In light of the above the relevance of these deflection measurements may be questioned to a certain extent and it could be reasoned that the pavement may be in a better condition than measured due to improved moisture conditions. It should also be considered that at the time when deflections were measured the road may have been a different moisture condition which influence the results of the FWD.

The analysis however indicates that the pavement structure is showing signs of weakening in the middle and lower layers which could be as a result of the ingress of

moisture into the pavement structure over time and the subsequent weakening of the base and subbase granular layers. The fact that there is no visible distress on the surface indicates that the reseal is performing as expected and is preserving the integrity of the pavement.

5.4 Riding Quality Data

The functional condition of this portion of the R61 pavement was evaluated in terms of the riding quality. The 2009 International Road Index (IRI) roughness measurements were evaluated for the Eastbound and Westbound lanes and are illustrated in Figure 5-6 below. Condition categories (VG to VP), as defined in TRH 12, were superimposed on this figure. These boundaries assist with the identification of areas where poor roughness has developed over time.

It needs to be stressed again that these measurements has been undertaken prior to the resurfacing of the road during 2010 to 2011.

Note that the data shaded in grey between SV 33+800 to SV 36+200 and SV 49+900 to SV 68+200 was not analysed and falls outside the scope of works.

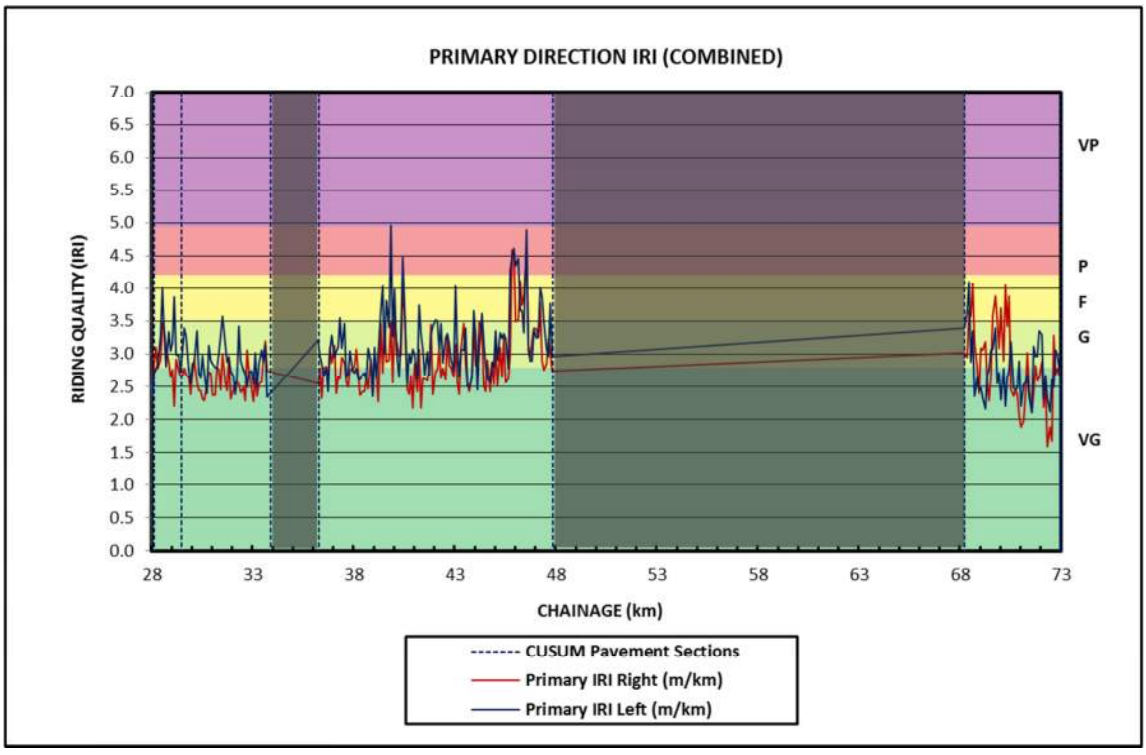


Figure 5-6: Eastbound Left and Right Wheel track Riding Quality plots.

Note: Very Poor (VP), Poor (P), Fair (F), Good (G), Very Good (VG)

A further analysis was done on the values to endeavour to put these measurements in perspective which is shown in Table 5-3.

Table 5-3: Riding Quality Evaluation.

IRI/HRI Distress Limits (%) - Primary Lane				
Uniform Section				1
From				28+100
To				29+510
IRI	Extent of Distress	Criteria	Left IRI (%)	Right IRI (%)
	Sound	<3.5	85.71	100.00
	Warning	3.5<IRI<4.2	14.29	0.00
	Severe	>4.2	0.00	0.00
HRI	Extent of Distress	Criteria	HRI (%)	
	Sound	<2.7	100.00	
	Warning	2.7<HRI<3.5	0.00	
	Severe	>3.5	0.00	
Uniform Section				2
From				29+510
To				33+800
IRI	Extent of Distress	Criteria	Left IRI (%)	Right IRI (%)
	Sound	<3.5	97.73	100.00
	Warning	3.5<IRI<4.2	2.27	0.00
	Severe	>4.2	0.00	0.00
HRI	Extent of Distress	Criteria	HRI (%)	
	Sound	<2.7	100.00	
	Warning	2.7<HRI<3.5	0.00	
	Severe	>3.5	0.00	
Uniform Section				3
From				36+200
To				47+900
IRI	Extent of Distress	Criteria	Left IRI (%)	Right IRI (%)
	Sound	<3.5	78.45	90.52
	Warning	3.5<IRI<4.2	14.66	6.90
	Severe	>4.2	6.90	2.59
HRI	Extent of Distress	Criteria	HRI (%)	
	Sound	<2.7	90.52	
	Warning	2.7<HRI<3.5	9.48	
	Severe	>3.5	0.00	
Uniform Section				4
From				68+200
To				73+100
IRI	Extent of Distress	Criteria	Left IRI (%)	Right IRI (%)
	Sound	<3.5	95.74	80.85
	Warning	3.5<IRI<4.2	4.26	19.15
	Severe	>4.2	0.00	0.00
HRI	Extent of Distress	Criteria	HRI (%)	
	Sound	<2.7	100.00	
	Warning	2.7<HRI<3.5	0.00	
	Severe	>3.5	0.00	

The following is evident from Figure 5-6 and Table 5-4:

- The riding quality functional state can generally be classified bordering on Good (G) to Very Good (VG).
- The primary IRI on the left is more pronounced except on a small section from SV 69+700 to SV 70+500 where it is more pronounced on the right.
- Isolated areas along the route can be classified as having a Fair (F) to Poor (P) functional state, particularly between:
  - SV 39+500 and SV 40+500
  - SV 45+700 and SV 46+500
  - SV 69+700 and SV 70+500

5.5 Rutting Data

Similarly, the results of the most recent 2009 rut depth measurements were analysed for the route. The rut depth measurements are illustrated below in Figure 5-7 for the Eastbound and Westbound lanes. The condition categories, as defined in TRH12, were superimposed to identify areas where excessive rutting has occurred over time.

It needs to be stressed again that these measurements has been undertaken prior to the resurfacing of the road during 2010 and 2011.

Note that the data shaded in grey between SV 33+800 to SV 36+200 and SV 49+900 to SV 68+200 was not analysed and falls outside the scope of works.

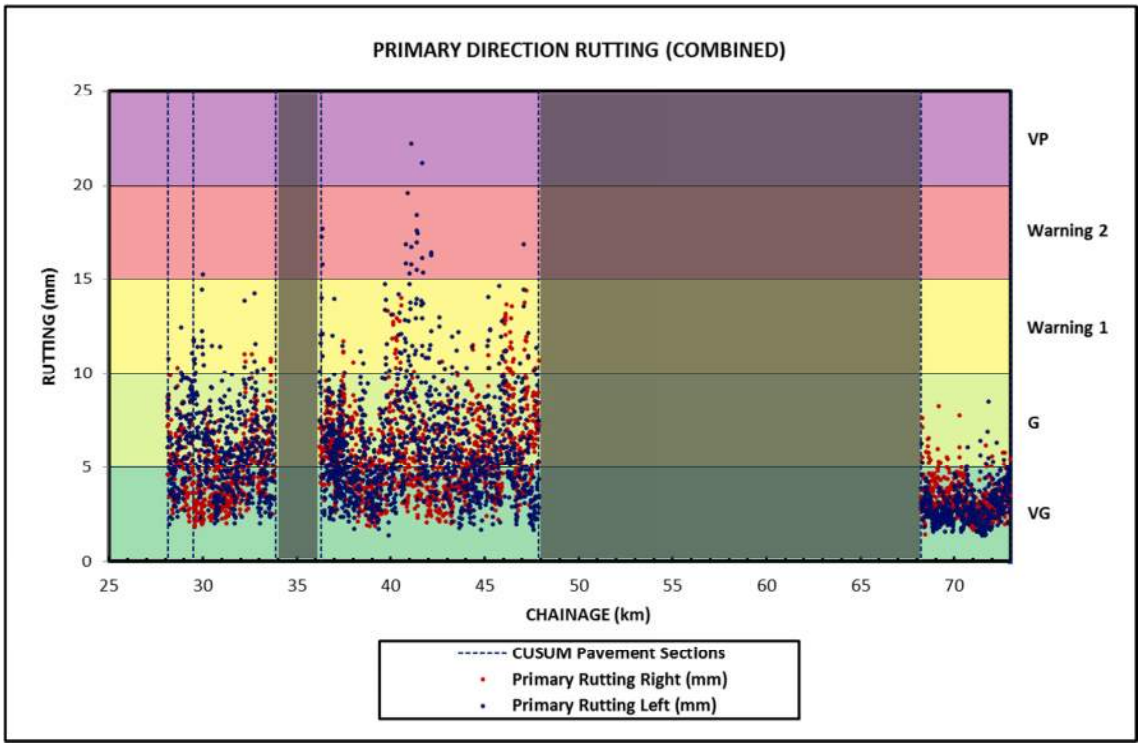


Figure 5-7: Lane Rutting data plots.

Note: Very Poor (VP), Warning 2 (More severe warning condition), Warning 1 (less severe warning condition), Good (G), Very Good (VG)

A further analysis was done on the values to endeavour to put these measurements in perspective which is shown in Table 5-4.

Table 5-4: Rutting Evaluation.

Uniform Section		1
From		28+100
To		29+510
Rutting (%)	Rutting Data Primary	
	Outer Wheel Track (%)	Inner Wheel Track (%)
> 5	63.57	52.86
> 10	3.57	0.71
> 15	0.00	0.00
> 20	0.00	0.00
Uniform Section		2
From		29+510
To		33+600
Rutting (%)	Rutting Data Primary	
	Outer Wheel Track (%)	Inner Wheel Track (%)
> 5	60.83	38.71
> 10	5.99	1.38
> 15	0.23	0.00
> 20	0.00	0.00
Uniform Section		3
From		36+200
To		47+700
Rutting (%)	Rutting Data Primary	
	Outer Wheel Track (%)	Inner Wheel Track (%)
> 5	56.70	56.22
> 10	8.61	4.94
> 15	1.67	0.00
> 20	0.16	0.00
Uniform Section		4
From		68+200
To		73+000
Rutting (%)	Rutting Data Primary	
	Outer Wheel Track (%)	Inner Wheel Track (%)
> 5	2.69	7.02
> 10	0.00	0.00
> 15	0.00	0.00
> 20	0.00	0.00

The following is evident from Figure 5-7 and Table 5-4:

- The general rutting condition state can generally be classified bordering on Good (G) to Very Good (VG).
- The primary rutting in the outer wheeltrack is more pronounced.
- Isolated areas along the route can be classified as having a Fair (F) to Poor (P) functional state, particularly between:
    - SV 39+500 and SV 40+500
    - SV 45+700 and SV 46+500

In general the road is in a Very Good (VG) to Good (G) condition with few instances exceeding a rutting depth of 10mm and problem areas correlating well with the IRI data.

5.6 Test Pit Investigation

Hatch Goba appointed Roadlab to undertake a material investigation of the proposed intersection upgrades. Part of this investigation required the excavation of test holes, at pre-determined positions, and the classification of the various pavement materials and layers.

A total of 46 test pits were excavated within the project limits in order to assess the condition and quality of the existing pavement and subgrade materials for the design of safety improvements. The test holes were excavated in the right and left lanes as well as in the centre of the road. The locations of the holes were distributed between the surfaced road, shoulders and road reserve. It should be noted that the test hole excavation formed part of a larger pavement materials investigation for the entire route between Mthatha and Lusikisiki.

The pavement structure in the test pits was profiled and representative samples taken from selected test holes for laboratory testing. Laboratory tests included moisture content, particle size distribution, Atterberg Limits and California Bearing Ratio (CBR). The laboratory test results are included in Annexure C. The positions of the test holes and a brief description of the pavement layers is summarised in Table 5-5.

Table 5-5: Summary of Test Hole depths and Classifications.

	km	28.5	33.5	36.45	36.95	37.35	37.46	39.96	40.01	41.3	42.7	43.26	44.8	44.93	69.86	69.86	71.5	71.5	72.72	72.72
	Hole nr	29	4	23	6	17	18	7	30	32	34	35	36	37	73	74	75	76	71	72
Base	Depth	130	105	170	140	155	155	180	165	140	145	215	155	135	100	140	140	170	120	160
	Classification	G4	G5	G4	G5	G4	G4	G4	G1	G4	G1	G4	G5	G1	G1	G5	G4	G5	G4	G4
Subbase	Depth	640	265	330	290	305	305	305	335	290	295	345	305	295	250	310	290	295	260	320
	Classification	G6	G6	C3	G6	G5	G5	G5	G6	G6	G5	G6	G6	G6	G5	G5	G6	G5	G6	G5
Upper Selected Layer	Depth		455	790	490	545	545	520	545	540	505	515	695	845	480	520	480	515	530	520
	Classification		G6	G8	G7	G6	G6	G7	G8	G8	G7	G7	G9	G5	G7	G8	G7	G6	G7	G8
Lower Selected Layer	Depth		805	960		975	975	1020	965		965	965			930	970	930	965	830	970
	Classification		G9	G9		G9	G9	G9	G9		G9	G9			G10	G10	G7	G7	G7	G7

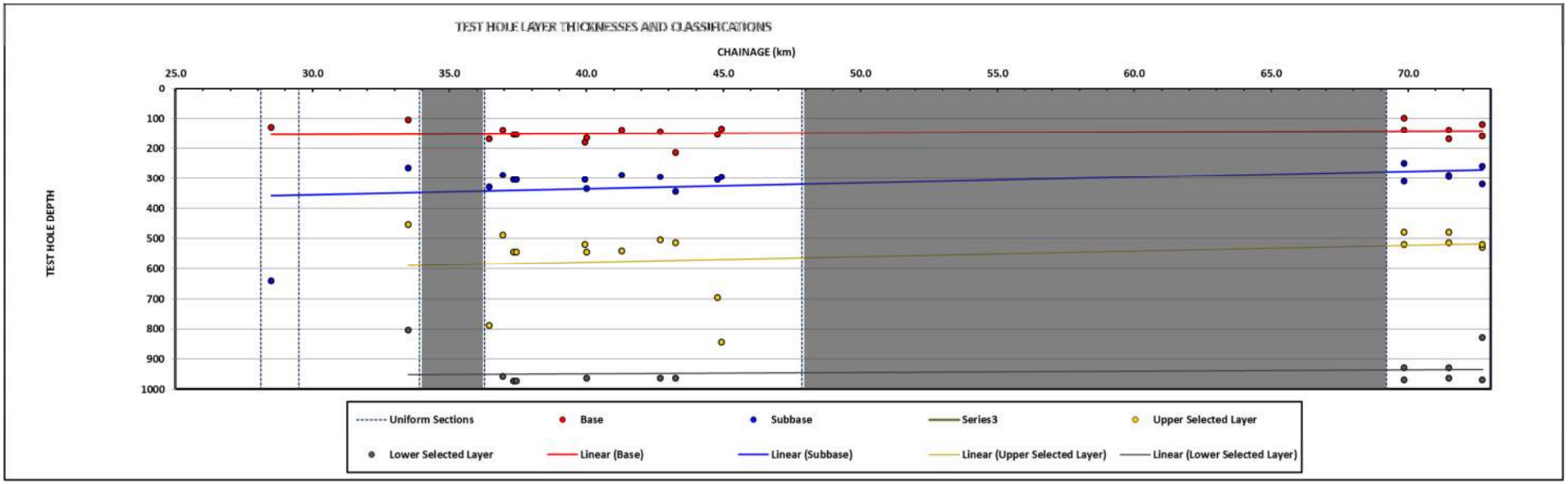


Figure 5-8: Test hole depths and trend lines for preliminary uniform sections.

5.6.1 Surfacing

Since construction in 1984 the PMS data as recorded in 2009 indicates that:

- The sections from SV 31+000 to SV 34+000, SV 36+000 to SV 47+900 and SV 68+200 to SV 73+000 constructed in 2001, 1987 and 1991 respectively still retains their original 19mm Cape Seals.
- The sections from SV 28+100 to SV 31+000 and SV 34+000 to SV 36+000 of the road has been resealed with a 13.2mm single seal in 2001.

It is important to note that the entire section received a 19.0/6.7 double seal in 2010-2011 using a SE-2 binder which is not indicated on the PMS as-built data received from SANRAL.

The existing surfacing thickness varies between 25mm – 80mm which is consistent with the various maintenance actions carried out over the pavement to date.

5.6.2 Base Layer

From the evaluation of the test pit layer thicknesses and the as-built data, it is evident that the base layer thickness is relatively uniform throughout at 150mm and representative of the as-built data. According to the laboratory materials results, the material in this horizon ranges from a G4 to G5 quality material based on the TRH classification system with isolated classifications of a G1 quality material.

The base material in this section has a Grading Moduli generally above 2.4 which indicates that the material is well graded. The PI's are generally in the order of NP to 5. All other parameters indicate that the material originally constructed as a G2 material is still representative.

The field moisture contents (FMC's) are generally annotated as slightly moist and are therefore assumed to be below optimum moisture content. This indicates that the existing surfacing is fairly impermeable and that there is little moisture ingress into the base layer. This may be attributed to the recent, yet not documented, reseal placed over the road.

5.6.3 Subbase Layer

The subbase layer thickness is relatively uniform throughout at an average of 150mm and representative of the as-built data. The subbase layer consists of coarse silty sands with dolerite pebbles or cobbles.

According to the as-built data the section between SV 31+000 and SV 34+000 was stabilised to a C4 quality material layer in 2001. This material may have devolved into an equivalent granular material in the course of a decade. The rounded nature of the alluvial aggregate is not an ideal material for this high order layer, as the smooth round surfaces do not contribute to the interlocking of the aggregate particles. The CBR values of this material are in the order of 37 and 48 at 95% compaction making it marginal for use in a subbase layer. This particular section is also the section with higher deflections than the remainder of the road.

5.6.4 Selected Layers

The layer thicknesses measured for the selected layers also vary between 200mm and 300mm with an average thickness of 250mm. Generally the material classifies as a G6/G7 quality granular material throughout and is largely representative of the as-built data in terms if thickness and quality.

5.6.5 Subgrade and Fill Layers

The fill and subgrade is generally a silty sand with CBR values, in some cases, similar to those in the selected layers. There are areas where the CBR's are low but still within the G8/G9/G10 material class.

5.7 Summary of all Investigations

In conclusion, the following may be deduced from the various investigations and analyses:

- The visual assessment indicates that the pavement is in a good condition with little or no distress evident. This may however be attributed to undocumented reseal undertaken in 2010/2011.
- The FWD analysis indicates a relatively shallow pavement structure with an inherent weakness throughout the pavement structure.
- From Table 5-4 and Table 5-5 it is evident that the Rutting and IRI values are generally in the Good (G) to Very Good (VG) condition states with isolated occurrences in the Warning (W) and Severe (S) condition states. Considering that these measurements were taken prior to the 2010/2011 reseal of the road, it can be concluded that the road is in fair condition which is not consistent with the FWD measurements and analyses of 2009.
- It should however be considered that the base materials is generally classified as a G4 with 4 exceptions of G1 indication that some deterioration has taken place over time.
- The laboratory test results indicate that the existing base material is marginal in terms of strength however, the road seems to perform well under the current traffic. The existing subbase material is also substandard for this high order layer.

The pavements have been in place between 10 and 30 years and seem to be performing well.

6 TRAFFIC ANALYSIS

6.1 Available Historic Traffic Data

From the available historical traffic data in terms of the SANRAL Comprehensive Traffic observations (CTO) year book (2011/2012 editions) three permanent counting stations could be found within the vicinity of Mthatha. The most appropriate permanent counting station in terms of the R61 Section 8 is no. 1091 Hluleka, which is situated 5.8km east of Libode along the R61 between Mthatha and Port St. Johns. The subsequent located counting station confirms only a slight reduction in traffic volume and should therefore provide similar results.

In addition to the above mentioned data, 12-hour classified traffic counts were undertaken at the existing intersections along the route. This data is presented in Table 6-1 below.

6.2 Traffic Count Data

The traffic data obtained from the Mikros Traffic Counts are shown in Table 6-1 below:

Table 6-1 : Available traffic count data for station no. 1091 – Hluleka.

CTO	Year	Duration (Months)	ADT	ADTT	% Heavies	E80 Factors		
						0.6	2.5	2.1
						Heavies Split (%)		
						Short	Medium	Long
AVAILABLE HISTORIC TRAFFIC DATA IN THE PRIMARY DIRECTION								
1091	2003	11	1001	53	5.29	75	20	5
	2004	11	1181	62	5.25	73	18	9
	2005	11	1207	58	4.81	73	17	10
	2006	11	1152	48	4.17	73	17	10
	2007	11	1272	48	3.77	76	15	9
	2008	11	1288	65	5.05	75	16	9
	2009	11	1406	69	4.91	75	15	1
	2010	11	1342	79	5.89	78	13	9
	2012	11	1560	84	5.38	76	12	12
AVAILABLE HISTORIC TRAFFIC DATA IN THE OPPOSITE DIRECTION								
1091	2003	11	1001	53	5.29	75	20	5
	2004	11	1203	64	5.32	76	17	7
	2005	11	1233	62	5.03	75	17	8
	2006	11	1200	48	4.00	76	17	17
	2007	11	1294	48	3.71	80	15	6
	2008	11	1305	66	5.06	79	15	6
	2009	11	1414	76	5.37	79	15	6
	2010	11	1360	82	6.03	81	13	6
	2012	11	1570	84	5.35	79	12	9

The information in Table 6-1 will be used as input data for the cumulative design traffic analysis and will be discussed later in this report.

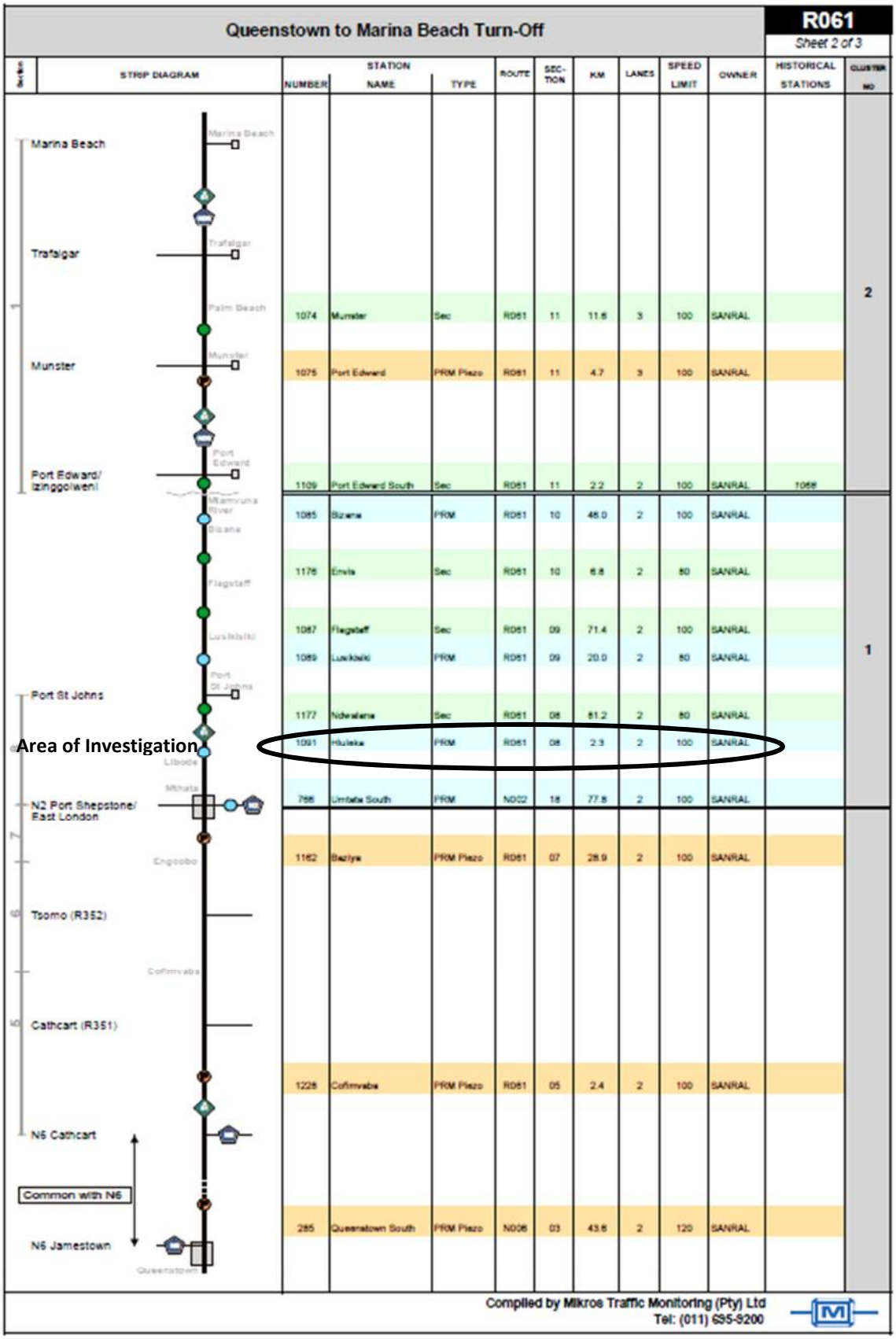


Figure 6-1: Locations of the CTO counting stations on the R61/8.

During the early stages of the design phase of this project (during development of the scope of work), several day-long traffic counts and pedestrian movement observations were carried out at the numerous higher order intersections along the route. This data was then used to determine the safety improvements and upgrades required at each intersection. Where deemed necessary, further 12-hour turning volumes were recorded by Mikros to assist in determining if the warrants justified additional turning lanes, prior to embarking on the geometric design of these additional lanes. The results of the 12-hour counts are shown in Table 6-2 below.

Table 6-2 : 12-Hour Intersection Vehicle Counts

Intersection	SV	ADT			
		EB LT	EB RT	WB LT	WB RT
Gangata	28+500		39	16	
Hluleka	31+000		113	12	
AC30488	39+300		70	4	
Qiti	43+100		14	2	
DR08304	44+900		21	4	
Mgxabakazi	69+900	5			5
Farm Access	71+200	10			22
Qhaka	72+000		20	20	
Qhaka	72+600	5	5	10	9

Where:
EB LT: East Bound Left Turning
EB RT: East Bound Right Turning
WB LT: West Bound Left Turning
WB RT: West Bound Right Turning

6.3 Analysis of Traffic Count Data

6.3.1 Existing Traffic on the R61 East of the CBD

As can be seen from Table 6-1, the ADT is almost an equal split between the primary (eastwards) and opposite (westwards) directions.

As the traffic from Mthatha decreases in an easterly direction the ADT values determined from the Mikros traffic study (2012) are therefore relevant and can be used with a high level of confidence for the project. The design ADT is therefore taken as a maximum of 3 130 vehicles per day with a heavy vehicle component of 5.89%, which is considered representative of the general traffic profile on the R61.

6.3.2 Future Attracted Traffic from the N2

As previously reported on adjacent sections, the proposed future N2 Wild Coast Highway between East London and Port Shepstone will lead to additional traffic being attracted onto the R61. Indications are that the construction of the N2 Wild Coast Highway is likely to be completed by the year 2020.

A road side interview (RSI) was undertaken on 22 November 2011 approximately 5km North of Mthatha on the N2. The purpose of the RSI was to estimate the possible traffic that may divert from the N2 to the R61. It is estimated that the traffic which could potentially divert from the N2 (between Mthatha and Kokstad) onto the R61 after development of the N2 Wild Coast Highway, is approximately 1 247 vehicles per day. This traffic volume was subsequently used in the determination of the cumulative design traffic (determined in million standard axles) over a 10 year horizon commencing in 2020.

The results of the relevant road side interview is shown in Table 6-3 below.

Table 6-3: RSI 1: N2 Trip Origin/Destination Trends.

Trip Origin / Destination	Vehs / Day
Mthatha and West / Ngolo	595
Mthatha and West / Eastern Cape Province North East	8 920
Mthatha and West / KwaZulu– Natal South West (Kokstad/Harding) area	672
Mthatha and West/Kwazulu-Natal and North (extrapolated vehs/day) relevant to this package	1 247
TOTAL	**11 434**

6.4 Future Traffic Growth

6.4.1 Existing Traffic on the R61 Section 8

The availability of a decade's worth of traffic count data from counting station number 1091 at Hluleka provides a good indication of the ADT and ADTT growth that can be expected. Table 6-4 indicates the expected increase in traffic based on the historical analyses data.

Table 6-4: Traffic growth data from counting station no. 1091 at Hluleka.

AVAILABLE HISTORIC TRAFFIC DATA							
Year	Duration (Months)	ADT	ADTT	% Heavies	E80 Factors		
					0.4	1.8	3.2
					Heavies Split (%)		
					Short	Medium	Long
2003	11	2002	106	5.29	75	20	5
2004	11	2384	126	5.28	75	18	8
2005	11	2440	48	4.92	74	17	9
2006	11	2352	96	4.08	75	17	14
2007	11	2566	96	3.74	78	15	8

AVAILABLE HISTORIC TRAFFIC DATA							
Year	Duration (Months)	ADT	ADTT	% Heavies	E80 Factors		
					0.4	1.8	3.2
					Heavies Split (%)		
					Short	Medium	Long
2008	11	2593	131	5.05	77	16	8
2009	11	2820	145	5.14	77	15	4
2010	11	2702	161	5.96	80	13	8
2012	11	3130	168	5.37	78	12	11
Approx. Growth(%)		*3.75%*	*5.36%*				

The intended scope of the work, namely safety improvements to the road itself, is not considered as the type of development which will initiate an immediate increment in traffic growth. The historic traffic growth between 2004 and 2012 is estimated to be approximately 3.75% for ADT and 5.36% for ADTT (refer Figure 6-2 and Figure 6-3).

The ADTT growth rate is high and maintaining this rate is not expected to continue in the long term. Considering an average national economic growth rate of around 2% (GDP) which is mostly generated in Gauteng, an average growth rate of 4% is considered more realistic and its use is recommended in determining heavy vehicle growth for this section of the R61.

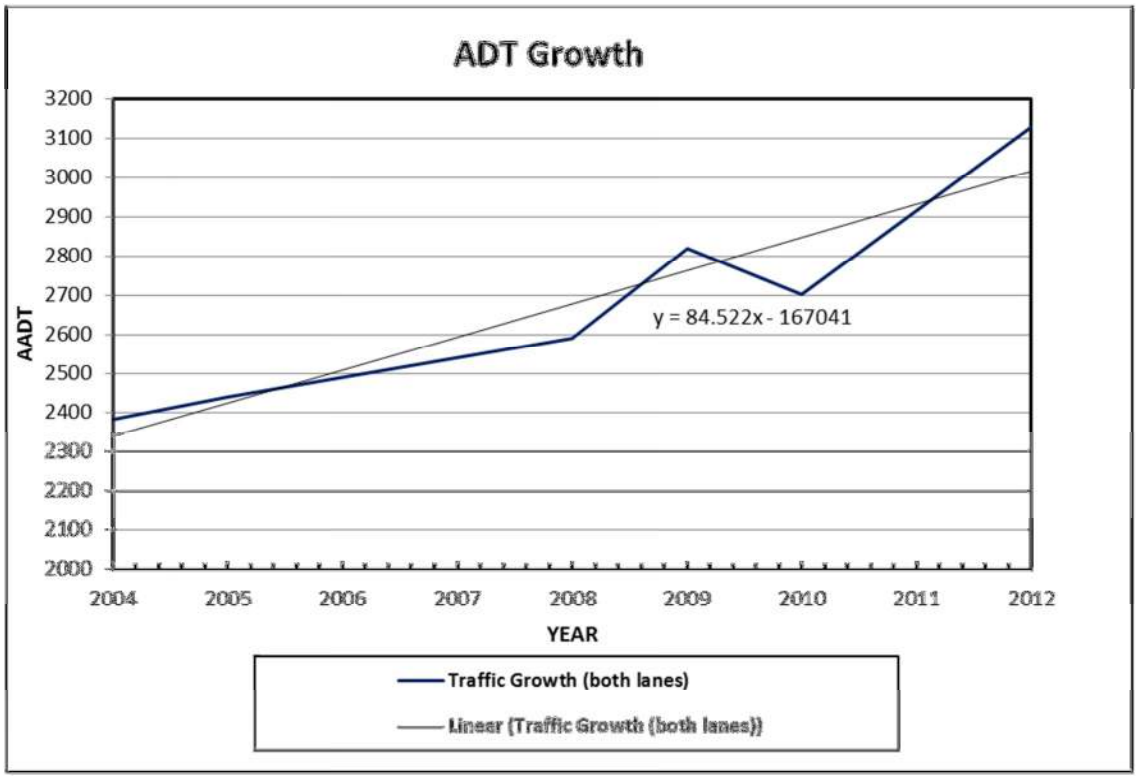


Figure 6-2: ADT growth trend line for traffic count data from 2003 to 2012.

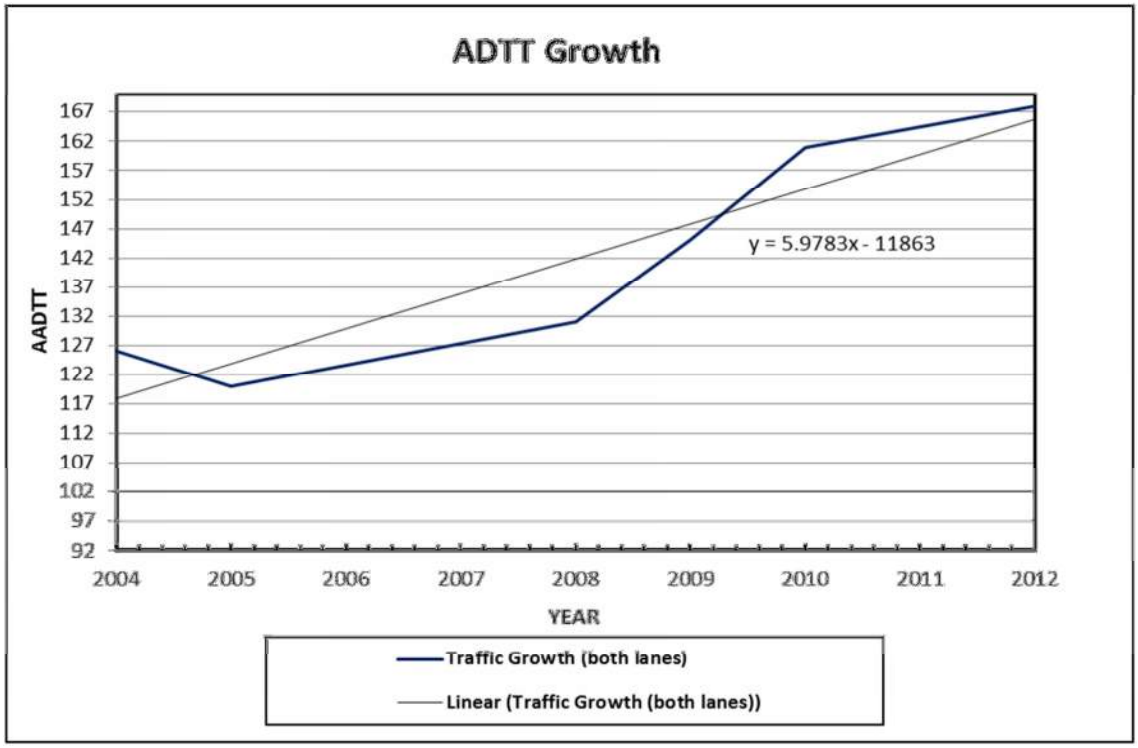


Figure 6-3: ADTT growth trend line for traffic count data from 2003 to 2012.

Considering current development in the area, a sustained ADTT growth rate of 5.36% is unlikely and a national average of 4% is recommended.

6.4.2 Future Attracted Traffic from the N2

In terms of the increment increase which needs to be allowed for as attracted traffic to the R61 from the N2 once the N2 Wild Coast Highway has been developed, very little or no historic data could be located to determine an accurate growth trend on the N2. It is again considered realistic to relate the traffic growth to the general growth of the area. Considering the South African GDP rate of approximately 2% it is assumed that the use of a 3% growth rate is realistic as a basis for determining cumulative traffic over the 20 year design period. In order to simplify the calculation, the anticipated attracted traffic of 1 247 vehicles per day in 2012 is grown by 3% per annum until 2020 and then added to the traffic projected for the R61 from 2020 until 2034.

6.5 Traffic Axle Loading

Based upon the traffic count data and RSI data, it is concluded that the 2012 traffic volumes and anticipated future traffic volumes on the R61 Section 8 are as follows:

Table 6-5 : Design Traffic in 2012 for the R61.

Description	Value in 2012
Existing Traffic	
ADT	3130
ADTT	168

Description	Value in 2012
ADTT (%)	4.0%
Heavy Vehicle Split (short:med:long)	78 : 12 : 11
E80's Per Heavy Vehicle	0.4 : 1.8 : 3.2
Average E80's per heavy vehicle	0.88
Future Attracted Traffic	
Attracted ADT (N2WCH)	1247 (in year 2020)
Attracted ADTT (N2WCH)	111 (in year 2020)
ADTT (%)	4.0% (after year 2020)
Heavy Vehicle Split (short:med:long)	46 : 17 : 37
E80's Per Heavy Vehicle	0.4 : 1.8 : 3.2
Average E80's per heavy vehicle	1.67

The heavy vehicle split of 46:17:37 is based on data obtained from station number 1286 situated North of Mthatha on the N2. This represents a substantial potential increase in the medium and long heavy vehicle classes.

As per Section 6.5 of SANRAL's Traffic Count Information Mega Year Book 2011 (CTO Year Book) and in the absence of data from weigh-in-motion surveys, the average axle loading is assumed based on the national average as being 0.4, 1.8 and 3.2 E80's per short, medium and long heavy vehicles respectively. These results in an average E80's loading per heavy vehicle of 0.88 and 1.67 for the traffic on the R61 and the potential attracted traffic respectively.

6.6 Future Traffic Load

6.6.1 Future Traffic Loading on the R61 East of the CBD

For the evaluation of the future traffic loading a sensitivity analysis was carried out in order to quantify the expected future traffic load on this section of the R61. For the purpose of the sensitivity analysis, the following assumptions were made using traffic loading data in Table 6-5:

- Road open to Traffic after Construction is 2014
- Design Period is 20 years
- ADTT growth rates of 3%, 4% and 5% were used.
- Directional Split = 50%
- Heavy Vehicle Lane Distribution Factor = 1.0
- E80's per heavy vehicle of 1.6 in 2012
- E80 growth per heavy vehicle varied between 0.5%, 1.0% and 1.5%

The detail calculation sheet for the determination of the cumulative traffic referred to in Table 6-8 below is included in Annexure D to this report.

Table 6-6 : Existing and Future anticipated Traffic Loading Sensitivity Analysis – Cumulative Traffic over a 20 year Design Life.

ADTT Growth Rate	E80's growth rate		
	0.5%	1.0%	1.5%
4%	1.90	1.99	2.09
5%	2.09	2.19	2.29
6%	2.29	2.41	2.53

From the above it is clear that the pavement of the R61 Package 3 falls within the limits of an ES 3 category pavement with the cumulative traffic which will range between 1.90 and 2.53 million E80's over the design period of 20 years. Cumulative traffic loading of 2.19 million E80's is considered realistic and is therefore considered that the traffic loading is not sensitive above the ES3 traffic class.

6.6.2 Future Traffic Loading at intersections

For the evaluation of the future traffic loading at the proposed intersections, an analysis was carried out in order to quantify the expected future traffic load on this section of the R61, particularly in the turning lanes. For the purpose of the analysis, the following assumptions were made:

- ADT = 1.25 x 12-hour traffic count
- Design Period is 20 years
- ADTT growth rates of 2%, 3% and 4% were used.
- % Heavies = 7%
- Directional Split = As per turning lane counts
- Heavy Vehicle Lane Distribution Factor = 1.0
- E80's per heavy vehicle of 1.6
- E80 growth varied between 0.5%, 1.0% and 1.5%

The detail calculation sheet for the determination of the cumulative traffic shown below is included in Annexure D to this report.

Table 6-7 : Intersection Traffic Loading Analysis – Cumulative Traffic Over a 20 year Design Life

Intersection	SV	20yr Cumulative Traffic Loading (MESA)			
		EB LT	EB RT	WB LT	WB RT
Gangata	28+500	0	0.09	0.04	0
Hluleka	31+000	0	0.26	0.03	0
AC30488	39+300	0	0.16	0.01	0
Qiti	43+100	0	0.03	0.01	0
DR08304	44+900	0	0.05	0.01	0
Mgxabakazi	69+900	0.01	0	0	0.01
Farm Access	71+200	0.02	0	0	0.05
Qhaka	72+000	0	0.05	0.05	0
Qhaka	72+600	0.01	0.01	0.02	0.02

Where:
EB LT: East Bound Left Turning
EB RT: East Bound Right Turning
WB LT: West Bound Left Turning
WB RT: West Bound Right Turning

From the above analyses the following pavement classes for the various upgrades proposed are:

- A traffic loading on the proposed access roads of maximum 0.3 million E80's is considered realistic as limited traffic information is available.
- The future traffic loading on the R61 falls within an ES3 pavement class.

These values were increased by 3% to allow for the attracted traffic in terms of consideration for these access roads being developed from a gravel access road to a formal surfaced road. The closure of 41 informal access roads due to safety considerations, will contribute to the increased in traffic at the newly developed intersections.

The above pavement classes are based on predicted traffic over a design horizon of 20 years and include attracted traffic due to the N2WCH upgrade.

7 STRUCTURAL CAPACITY ANALYSIS OF EXISTING PAVEMENT

This section of the report includes the determination of the remaining life of the existing pavement structure and the ability of the pavement to carry the predicted traffic loading until further rehabilitation measures or upgrades are planned on this route.

The remaining life of the existing pavement will be estimated through the back calculation of the FWD data and modelling the pavement layers resilient E-moduli using the Rubicon Toolbox Software package with the analysis based on the South African Mechanistic-Empirical Pavement Design Method (SAMDM).

7.1 Uniform sections

The FWD data, together with the existing pavement layers, was used to determine the uniform sections along the road.

Four uniform sections were determined in Section 5.2.1 and are shown in Table 7-1 below.

Table 7-1 : Uniform Sections Summary

Uniform Section	SV From	SV To	Area
1	28+100	29+510	Start of section to just before the Hluleka intersection.
2	29+510	33+800	Hluleka intersection to the Khuleka Township.
3	36+200	47+900	Khuleka Township to the end of section.
4	68+200	73+000	Mgxabakazi Township to the end of section.

7.2 Pavement Remaining Life

The deflection results were analysed for the sections of the R61 between SV 28+100 and SV 33+800, SV 36+200 and SV 47+900 and finally SV 68+200 and SV 73+000 together with the trial pit information. This information was used as input data into the Rubicon Toolbox Software package for back calculating the existing pavement layer stiffness. A summary of the back calculated stiffness values and the anticipated remaining life of the pavement, determined by means of utilising the South African Mechanistic Design Method (SAMDM) for the 90th percentile (Category B road) back calculated values, is shown in Table 7-2. The approximate remaining structural capacity has been determined for the following cases:

- In Million Standard Axles (MESA)
- In years excluding the attracted traffic for the N2 Wild Coast Highway

Table 7-2 : Back Calculated Stiffness and Remaining Life

Uniform Section	Layer	Stiffness Values (MPa)			Approximate Remaining Structural Capacity	
No. (km)	Approx. (Thickness)	90th %	Ave.	10th %	MESA (Excl. attracted N2WCH traffic)	Years to fail (Excl. attracted N2WCH traffic)
1 SV 28+100 to SV 29+510	Surfacing / Base (40/150mm)	600	596	592	0.10	3.06
	Subbase (150mm)	200	194	180		
	Selected SG (200mm)	120	107	86		
	Subgrade (Semi-infinite)	100	93	79		
2 SV 29+510 to SV 33+800	Surfacing / Base (40/150mm)	600	590	543	0.04	1.18
	Subbase (150mm)	240	200	150		
	Selected SG (220mm)	121	94	80		
	Subgrade (Semi-infinite)	120	99	75		
3 SV 36+200 to SV 47+900	Surfacing / Base (40/150mm)	600	550	484	0.14	4.24
	Subbase (150mm)	200	181	150		
	Selected SG (250mm)	150	135	89		
	Subgrade (Semi-infinite)	120	111	73		
4 SV 68+200 to SV 73+000	Surfacing / Base (40/150mm)	600	598	600	0.45	9.02
	Subbase (150mm)	193	130	100		
	Selected SG (250mm)	150	114	80		
	Subgrade (Semi-infinite)	120	113	93		

For the uniform sections analysed above, the back calculated stiffness values for the upper layer (surfacing and base) indicate a stiffness of the in-situ material typically conforming to a natural gravel base (G4/G5).

The back calculated stiffness values for the second layer (sub-base) indicate insitu material conforming to a natural gravel varying from a G5 to a G6 quality material, for the 90th percentile stiffness values.

The back calculated stiffness values for the upper selected layer (upper subgrade) indicate a stiffness of the in-situ material conforming to a G6/G7 quality material.

The back calculated stiffness values for the lower selected layer (upper subgrade) indicate a stiffness of the in-situ material conforming to a G8/G9/G10 quality material.

The analysis of the back calculated stiffness values indicate a very uniform layer stiffness trend when comparing the identified sections. When looking at the older

pavement structures indicated in the as-built data, this corresponds well with the expected strength deterioration.

The approximate remaining structural capacity in MESA and remaining years for all the sections indicates failure before the addition of the attracted traffic for the N2 Wild Coast Highway in 2020.

The remaining life analyses were carried out using the following criteria:

- Moderate moisture state (as described in Section 4.5.2 of this report).
- Load setup for an 80 kN dual wheel axle.
- 350mm wheel spacing.
- 750 kPa contact pressure.
- Where low stiffness values were back calculated, a stiffness value of 120 MPa was used based on the material properties.

The results of the analyses using the SAMDM are summarised in Table 7-2 and the detail analysis is included in Annexure E of this report.

7.3 Pavement Strategy Based on Remaining Life

The remaining life calculations for Uniform Sections 1, 2, 3 and 4 are much less than the required 2.41 million E80's (MESA), as determined in Section 5.6. This would imply that, in theory (based purely on computer modelling of the pavement using known parameters), all the pavement structures may reach a terminal condition within the next 1 to 9 years.

It should also be made clear that these calculations are based on outdated PMS information prior to the 2010/2011 reseal of the road. This means that the actual performance of the road could be vastly different from the derived results of these calculations.

It is also apparent when considering the stiffness values of Sections 1 and 2 in Table 7-2 that these values differ only slightly compared to the layer averages. A differential of -1%, -3%, -13% and +6% for the base-, subbase-, selected- and subgrade layers respectively is evident. However, despite this small average difference, the calculated remaining life differs by 100% indicating the sensitivity of the calculation. This infers that any remedial measures may have a considerable impact on the remaining life of the road.

It is therefore advisable that further attention be given to the possibility of periodic maintenance and reseals over the next 7 years particularly between SV 28+100 and SV 33+800. Should this strategy be adopted, together with the proposed safety improvements and intersection widening's, we believe the existing road will function satisfactorily until the upgrades required to be undertaken as part of the N2 Wild Coast Highway upgrade, are implemented within the time frames, as they are currently understood.

Should the commencement of construction of the N2WCH be delayed beyond a 5 to 8 year horizon we recommend that, at that stage, a detailed pavement investigation be carried out with the aim of identifying suitable pavement rehabilitation options that are required, specifically between SV 28+100 and SV 34+490 where the remaining life of the existing pavement is the lowest along the route, to meet the future traffic loading demands of the R61.

8 STRUCTURAL CAPACITY ANALYSIS

8.1 Background and Approach

For the purposes of this project, it is understood as part of Hatch Goba's appointment that no rehabilitation of the existing pavement on the R61 will be carried out as it is beyond the scope of this project and moreover the pavement has been evaluated and found to be acceptable within the short to medium term. The road was very recently resurfaced and it will therefore also be uneconomical to prematurely undertake interventions over this seal.

For areas where widening and/or new pavement layers are required, a pavement structure based on the TRH4 Catalogue method as well as the PN Design Method will be evaluated for a 20 year design horizon.

It is important to note that there are three types of pavement that have been investigated, namely:

(i) R61 Intersection Widenings (located at 9 different positions along the route);

(ii) Provincial District roads.

(iii) Community Access Roads (upgrading approximately 13 Community Access Roads along the route).

The above 3 pavement entities are respectively described diagrammatically in Figure 8-1 below.

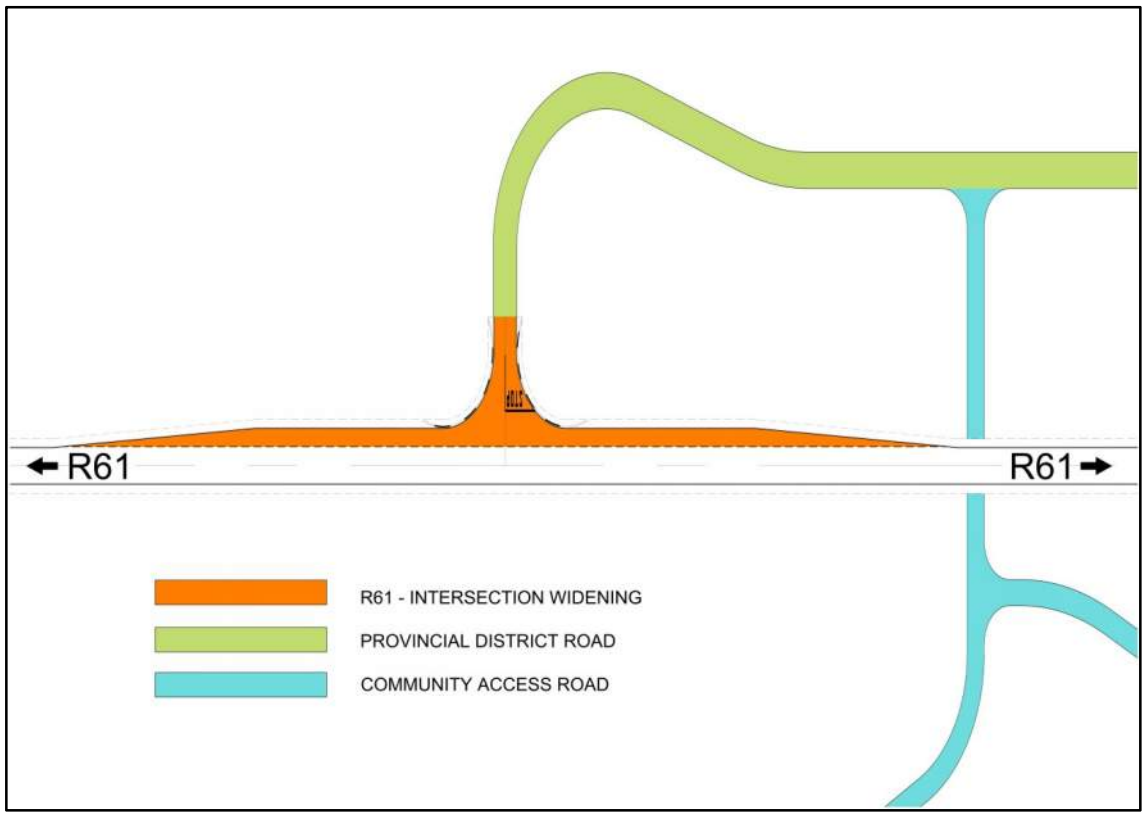


Figure 8-1: R61 Intersection Widening's, Provincial District Roads and Community Access Roads.

8.2 Strategies and Structural Design of Pavement

8.2.1 Pavement for the R61 Intersection Widenings

As discussed in Section 6 of this report the required pavement capacity ranges from 1.90 and 2.53 million E80's for a 20 year design horizon. The required pavement structure for the localised widenings are categorised as being an ES 3 class pavement.

As these portions of the road prism will require an entirely new pavement, the TRH4 catalogue design method will be used to recommend a suitable pavement structure. For the purpose of this design the following pavement design options will be assessed:

- ES3 class pavement for a Category "B" road in a moderate region with a granular base,
- ES3 class pavement for a Category "B" road with an asphalt base.

Furthermore, for practicality this pavement structure needs to be constructed adjacent to the existing pavement. The following pavement structures have been assessed for the new pavement construction for the widening's based on the TRH 4 Catalogue Method.

Table 8-1: Base Pavement Structure Options from the TRH4 Catalogue Design Method.

	Option 1 Granular Base		Option 2 Asphalt Base	
	Thickness (mm)	TRH Class	Thickness (mm)	TRH Class
Surfacing	40	AC	40	AC
Base	150	G3	80	BTB
Subbase	150	C4	200	C3
Selected SG	150	G7	150	G7
Selected SG	150	G9	150	G9
SG	Semi infinite	G10	Semi infinite	G10
Structural Capacity	**3 MESA**		**3 MESA**	
Estimated Construction Cost	**R390/m^2**		**R768/m^2**	

Note:
AC* = Continuously graded asphalt.
BTB* = Bitumen treated base.

The new pavement will essentially be constructed adjacent to an existing granular base pavement and the use of an asphalt base is not desirable as it creates a barrier for the migration of capillary moisture within the base layer due to the concentration of moisture build up here over time. This could lead to premature failures along the interface between the different base types. It is thus recommended that the G1 graded crushed stone base option be considered as the material is readily available from commercial sources located within the Mthatha area.

Based on the aforementioned, the **granular base pavement option** is recommended for the new pavement widenings.

The following changes to the ES 3 granular base pavement option based on the TRH4 catalogue design are as follows:

- 40mm asphalt surfacing is replaced with a 19/6.7 double seal surfacing,
- A 150mm G1 graded crushed stone base layer is selected to provide additional layer stiffness and is more readily available in the area,
- The C4 stabilised subbase thickness is increased to 200mm to provide additional layer stiffness due to the omission of the asphalt proposed above.
- A 150mm G7 granular upper selected layer.
- A 150mm G9 granular lower selected layer.
- A semi-infinate G10 subgrade layer.

Table 8-2: Recommended Pavement Structure for Intersection Widening's.

	Option 1 Granular Base	
	Thickness (mm)	**TRH Class**
Surfacing / Base	-	S2
	150	G1
Subbase	200	C4
Selected SG	150	G7
Selected SG	150	G9
SG	Semi infinite	G10
Structural Capacity	**3 MESA**	

Note: S2* = 19/6.7 mm Double Seal

The PN Design Method as per the Asphalt Academy of South Africa's website[4] is used to affirm the selected TRH4 Catalogue design (refer Figure 8-2).

Design Name	R61 Package 3
Description:	Intersection Widenings

Climate:	Moderate
Subgrade Class:	G9
Cover Depth (mm):	505

Layer	Thickness (mm)	Material Class	Modular Ratio	Maximum Stiffness (MP	ELTS (MPa)	Thickness Adjustment	Base Confidence	Layer PN Contribution
Surfacing	5	Seal	2.0	800	800	N/A	N/A	0.4
Base	150	G1	2.0	700	700	N/A	1.1	11.6
Subbase	200	C4	3.0	400	364	0.4	N/A	2.9
Selected	150	G7	1.7	140	121	N/A	N/A	1.8
Subgrade	N/A	G9	N/A	N/A	71	N/A	N/A	N/A
						Pavement Number =		**17.0**

Subgrade Calculation
Basic Stiffness = 90 MPa
Climate Adjusted = 81 MPa
Cover Depth Adjusted = 71 MPa

Design Capacity Assessment:
Pavement Number = 17.0
Capacity for Category A Roads = 3 MESA
Capacity for Category B Roads = 4 MESA

Date: 10/8/2013 11:55:36 AM
Category A Criteria Version: 12/27/2010 - 11:22 AM
Category B Criteria Version: 12/27/2010 - 11:22 AM

Figure 8-2: R61 Intersection Widenings pavement analysis as per the PN Design Method.

[4] http://www.asphaltacademy.co.za/bitstab.asp

8.2.2 Provincial District Road Pavement (DR08304)

As discussed in Section 6 of this report the required pavement capacity for the access roads is a maximum of 0.3 million E80s for a 20 year design horizon. A nominal pavement structure of 0.3 million E80s is proposed as the construction of access roads, in this case provincial roads, will most likely attract additional traffic and amongst other developments the construction of a new school in the vicinity will contribute towards the increase of traffic. The school is located on the left hand side at SV 71+980 This provincial district road is partially located on the existing route and the remainder of it is horisontally realigned to intersect with the R61 in a new position.

The following pavement structures have been assessed for new pavement construction for the existing Provincial District Roads, based on the TRH 4 Catalogue Method.

Table 8-3: Pavement Structure Option based on the TRH4 Catalogue Design Method.

	Option 1 Granular Base	
	Thickness (mm)	**TRH 4 Class**
Surfacing	-	Seal
Base	125	G1
Subbase	125	C4
Selected SG	150	G5
Selected SG	150	G7
SG	Semi infinite	G10
Structural Capacity	**0.3 MESA**	

Note that according to the TRH4 Catalogue Design for granular bases in a moderate climate region, a G5 granular base is recommended. However, the availability of G5 granular material in close proximity to the construction area is limited. The use of a G1 base is therefore recommended as a readily available substitute.

Based on the aforementioned the following changes to the ES 0.3 granular base option based on the TRH4 catalogue design method are recommended:

- Seal surfacing is to be replaced with a 19mm Cape Seal surfacing.

The PN Design Method as per the Asphalt Academy of South Africa's website[5] was used to affirm the selected TRH4 Catalogue design (refer Figure 8-3).

[5] http://www.asphaltacademy.co.za/bitstab.asp

Design Name	R61 Package 3
Description:	Provincial District Roads

Climate:	Moderate
Subgrade Class:	G10
Cover Depth (mm):	555

Layer	Thickness (mm)	Material Class	Modular Ratio	Maximum Stiffness (MP	ELTS (MPa)	Thickness Adjustment	Base Confidence	Layer PN Contribution
Surfacing	5	Seal	2.0	800	800	N/A	N/A	0.4
Base	125	G1	2.0	700	578	N/A	1.1	7.9
Subbase	125	C4	3.0	400	289	0.2	N/A	0.7
Selected	300	G7	1.7	140	96	N/A	N/A	2.9
Subgrade	N/A	G10	N/A	N/A	57	N/A	N/A	N/A
						Pavement Number =		12.0

Subgrade Calculation
Basic Stiffness = 70 MPa
Climate Adjusted = 63 MPa
Cover Depth Adjusted = 57 MPa

Design Capacity Assessment:
Pavement Number = 12.0
Capacity for Category A Roads = Not Suitable for Catagory A Roads
Capacity for Category B Roads = 3 MESA

Date: 11/14/2013 3:46:37 PM
Category A Criteria Version: 12/27/2010 - 11:22 AM
Category B Criteria Version: 12/27/2010 - 11:22 AM

Figure 8-3: Provincial District Roads pavement analysis as per the PN Design Method.

8.2.3 Community Access Road Pavement

Similarly to the above the required pavement capacity for the Community Access Roads is expected to be a maximum of 0.3 million E80s for a 20 year design horizon. A nominal pavement structure of 0.3 million E80s is proposed for the pavement.

The following pavement structures have been identified for the construction consideration of the Community Access Roads. Three pavement types are indicated for use on roads located on steep, gradual or universal slopes respectively.

Table 8-4: Pavement Structure Options based on the TRH4 and M10 Catalogue Design Method.

	Pavement Type 1 Concrete Base (steep slopes)		Pavement Type 2 Macadam Base (gradual slopes)		Pavement Type 3 Geocell Concrete Pavement[6] (all slopes)	
	Thickness (mm)	TRH Class	Thickness (mm)	TRH Class	Thickness (mm)	TRH Class
Surfacing	120	Concrete	-	AC*	120	75/1: 1 Cell Slab
Base			100	SBM*		
Subbase	125	C4	125	C4	150	C4
SG	Semi infinite	G9	Semi infinite	G9	Semi infinite	G9/In-situ
Structural Capacity	**0.3 MESA**		**0.3 MESA**		**0.2 – 0.8 MESA**	
Estimated Construction Cost	**R432/m²**		**R242/m²**		**R432/m²**	

Note: SBM* = Slurry Bound Macadam.
AC* = 25mm emulsion based asphalt using labour intensive methods.

[6] Labour-based methods and technologies for employment intensive construction works, A cidb guide to best practice, Best Practice Guideline – Part 4-5, Cast in situ block pavement, March 2005

It is recommended that Pavement Type 1 (Concrete Base Pavement) or Pavement Type 3 (Geocell Concrete Pavement) are instated as its labour intensive construction process will contribute to community development projects.

The PN Design Method as per the Asphalt Academy of South Africa's website was used to affirm the selected TRH4 Catalogue design for a bituminous base (refer Figure 8-4). For the concrete and geocell concrete pavement bases

Design Name	R61 Package 3
Description:	Community Access Roads

Climate:	Moderate
Subgrade Class:	G9
Cover Depth (mm):	400

Layer	Thickness (mm)	Material Class	Modular Ratio	Maximum Stiffness (MP	ELTS (MPa)	Thickness Adjustment	Base Confidence	Layer PN Contribution
Surfacing	25	Asphalt	5.0	2500	2500	N/A	N/A	6.3
Base	100	BSM1	3.0	600	600	N/A	1.0	6.0
Subbase	125	C4	3.0	400	270	0.2	N/A	0.7
Selected	150	G9	1.4	90	90	N/A	N/A	1.4
Subgrade	N/A	G9	N/A	N/A	71	N/A	N/A	N/A
						Pavement Number =		**14.0**

Subgrade Calculation
Basic Stiffness = 90 MPa
Climate Adjusted = 81 MPa
Cover Depth Adjusted = 71 MPa

Design Capacity Assessment:
Pavement Number = 14.0
Capacity for Category A Roads = Not Suitable for Catagory A Roads
Capacity for Category B Roads = 3 MESA

Date: 10/8/2013 12:05:38 PM
Category A Criteria Version: 12/27/2010 - 11:22 AM
Category B Criteria Version: 12/27/2010 - 11:22 AM

Figure 8-4: Community Access Roads pavement analysis as per the PN Design Method.

8.3 Recommendations

8.3.1 New/Existing Pavement Construction

The proposed pavement structures for the various types of infrastructure based on the typical cross sections along the route to carry the cumulative design traffic are tabulated in Table 8-7.

8.3.2 Surfacing Seal Recommendations

R61 Intersection widenings

A critical safety aspect of the project was to create pedestrian awareness of approaching traffic at intersections. One of the ways this can be achieved is to create a surface that would generate road noise to alert pedestrians of oncoming vehicles. Various options were considered including the use of rumble strips which, based on past experience, tend to lose effectiveness as the rumble materials compact and punch into the underlying surfacing over time.

A second option is to create a surfacing seal that is inherently noisy. Certain seal types generate more road noise than others. This subject is currently being assessed by SANRAL with the aim of producing guidelines on the effect of road noise on users.

From current research[7] it is evident that a 19.0/6.7mm Double Seal surfacing produces a peak sound pressure level in the region of 70 dBA at approximately 1 000 Hz which increases proportionately on approach and is audible from a distance of approximately 300m. This is as a result of the interaction between the exposed 19,0mm aggregate peaks (which are widely spaced) and the vehicle tyres. This is however largely dependent on vehicle speed.

As this interaction between the large aggregate particles in a surfacing seal and the vehicle tyres is critical in producing road noise, it is recommended that a 19.0/6.7mm Double Seal be applied at each of the intersections that are to be upgraded. This new surfacing seal is to be applied over the full width of the existing as well as the new widening to effectively increase pedestrian awareness of approaching vehicles.

Provincial District Roads

In the case of the Provincial District Roads, a 19mm Cape Seal is recommended due to its labour intensive nature and the reduction of seasonal constraints during the construction process.

Community Access Roads

Three pavement types are proposed considering the Community Access Roads.

Pavement Type 1 indicates a concrete overlay option for access roads that are located on steep slopes. Pavement Type 2 indicates a Macadam base layer option with a 25mm emulsion based asphalt using labour intensive methods for access roads that are located on more gradual slopes. Finally Pavement Type 3 indicates a Geocell Concrete Pavement base layer option.

[7] Jongens, A.W.D.: Quiet road Surfaces, Annual Transportation Convention Research Forum, Volume 5, 54-65, 1995.

Table 8-7: Recommended Pavement Design for all pavement entities.

Layer Type	R61 Intersection Widenings		Provintial District Roads		Community Access Roads					
	Thickness (mm)	Class.	Thickness (mm)	Class.	Thickness (mm)	Class.	Thickness (mm)	Class.	Thickness (mm)	Class.
Surfacing / Base	-	S2*	-	S9*	120	Concrete	-	AC*	120	75/1: 1 Cell Slab
	150	G1	125	G1			100	SBM*		
Subbase	200	C4	125	C4	125	C4	125	C4	150	C4
Selected SG	150	G7	150	G5	Semi infinite	G9	Semi infinite	G9	Semi infinite	G9/ In-situ
Selected SG	150	G9	150	G7						
SG	Semi infinite	G10	Semi infinite	G10						
Structural Capacity	**3 MESA**		**0.3 MESA**		**0.3 MESA**		**0.3 MESA**		**0.2 – 0.8 MESA**	

Note: SBM* = Slurry Bound Macadam.
AC* = 25mm emulsion based asphalt using labour intensive methods.
S2* = 19/6.7 mm Double seal.
S9* = 19 mm Cape Seal

9 GEOMETRIC DESIGN

9.1 National Road

9.1.1 Intersections

Nine nodes have been identified earlier in this report for intersection upgrades, and are repeated below:

- Gangata at SV 28+510
- Mafini at SV 31+035
- Enjiveni at SV 39+290
- Qiti at SV 43+150
- Tutor Ndamase Pass at SV 44+860
- Mgxabakazi at SV 69+860
- Mngazi at SV 71+235
- Qhaka J.P.S at SV 71+980
- Qhaka at SV 72+560

A typical intersection layout was developed in collaboration with SANRAL, which was based initially on the following typical detail available from SANRAL, which consists of rational geometric parameters such as taper rates, lane widths and public transport laybys, is indicated in Figure 9-1.

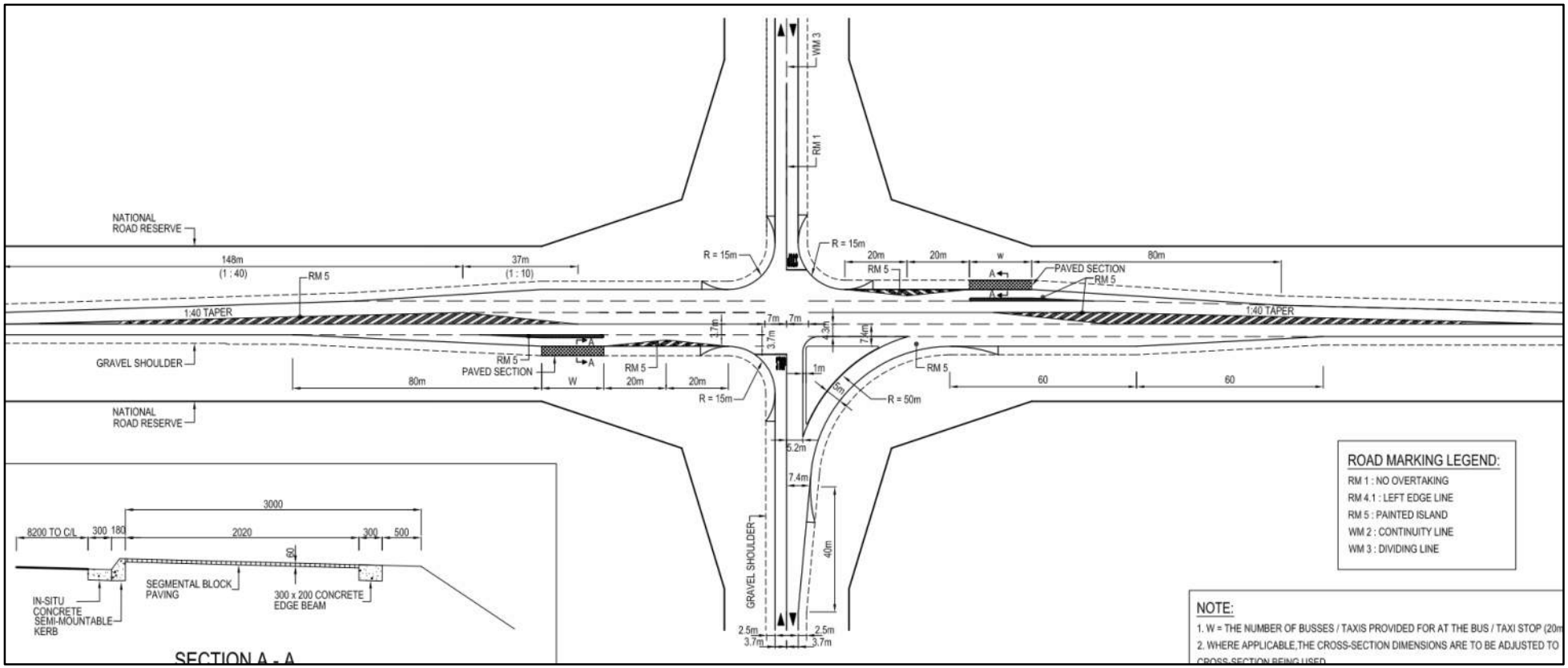


Figure 9-1 Typical SANRAL Intersection with laybys.

From this a protracted discussion ensued during which the following topics were the most important considerations in deciding on a sensible typical geometric layout:

(i) A median of sufficient width to provide refuge to crossing pedestrians.

(ii) Acceleration lanes that would allow safe merging of left-turning traffic into the mainstream.

(iii) Pedestrian walkways that would adequately protect pedestrians from errant vehicles leaving the road.

(iv) Roadmarkings and furniture that would allow for a demarcated crossing area.

(v) A seal of suitable texture that would render approaching traffic wheel noise audible to crossing pedestrians.

Having considered and debated the abovementioned matters, the typical intersection layouts on the following pages have been derived (Figure 9-2 and 9-3):

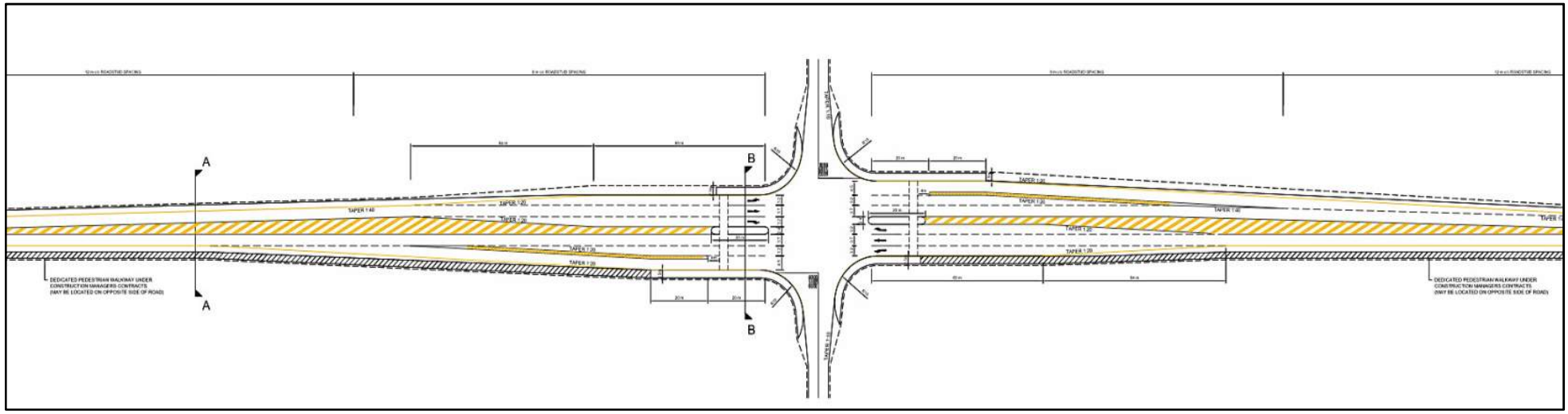


Figure 9-2: Typical Intersection Design – Crossroads.

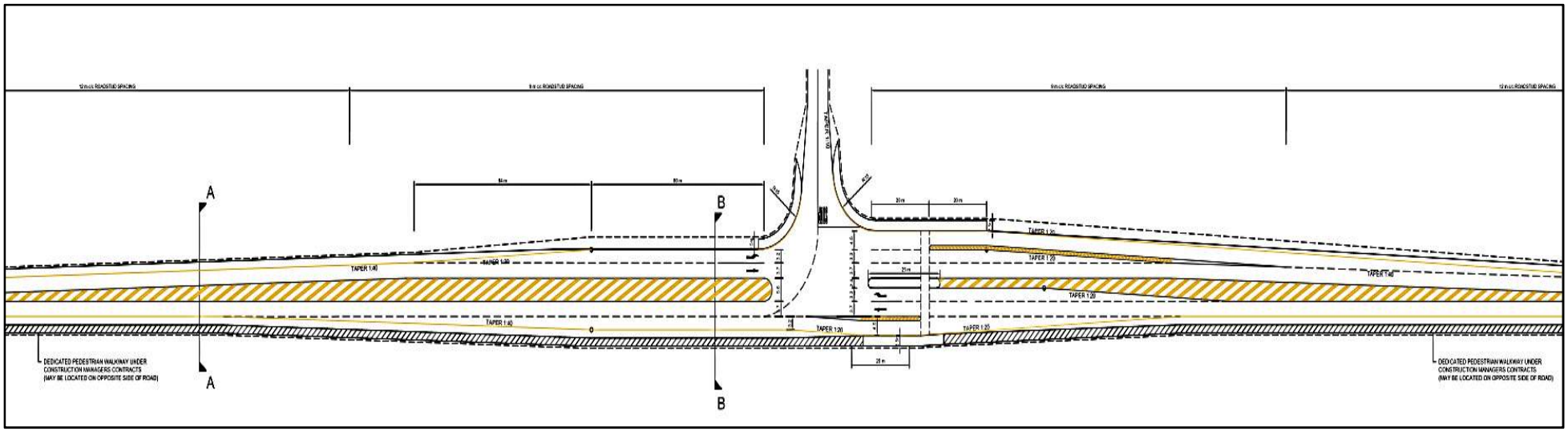


Figure 9-3: Typical Intersection Design – T-junction.

9.1.2 Horizontal Alignment and superelevation

Across Package 3, 50 horizontal curves occur between Libode and Majola Tea (including the upgrading known as St. Barnabas that is currently underway). A further 23 curves define the alignment between Tombo and Ndwalane. These have been analysed in order to interpret the current design speed as per the design manuals. Designers of the original surfaced route used superelevation tables that preceded the SANRAL Geometric Design Guidelines (GDG).

The minimum curve radius used was 110m, which characterises most of the curves down the Tutor Ndamase pass (SV 43+000 to SV 51+000). A maximum superelevation of 10% was adopted by the past designers. Curves with radii less than 300m were fitted with transition curves ranging in length from 50m to 80m (on both sides of the circular curve).

In terms of horizontal alignment, the existing road has a design speed of 90km/h between Libode East (SV 28+000) and Enjiveni (SV 40+000). From Enjiveni to Qiti the design speed rapidly decreases to 60km/h and the road starts descending rapidly at the start of the pass. Through the pass, the design speed seldom reaches more than 60km/h (mainly due to several curves of radius 110m and superelevation 10%. This curve geometry satisfies 60km/h on rural roads according to SANRAL's GDG. From Tombo (SV 68+000) to Qhaka (SV 72+500), curve radii reflect design speeds of 60-80km/h, which is also the case over the last portion towards Ndwalane, at which point the descent towards Port St. Johns commences. Table 9-1 below shows the existing geometric data and interpreted design speeds.

Table 9-1: Existing geometric data and interpreted design speeds.

Curve No.	Curve Direction	BCC SV	ECC SV	Transition Curve Length In (m)	Circular Curve Length (m)	Transition Curve Length Out (m)	Circular Curve Radius (m)	Existing rate of super elevation	Design Speed	General Description
28	Right	27 562	27 634	80	72.5	80	220	8.0	60	Open road, rolling Libode-Ntlaza
29	Left	27 919	27 947	80	28.3	80	220	9.7	80	
30	Left	28 522	29 119		596.8		1500	2.9	90	
31	Right	29 570	29 975		405.7		1000	5.5	100	
32	Left	32 187	34 533		2 345.8		2100	2.8	100	
33	Right	34 784	34 948	80	164.2	80	360	9.4	90	Ntlaza/St. Barnabas upgrade to dual
34	Right	35 231	35 613	80	381.8	80	400	9.5	100	
35	Left	35 819	36 062	80	242.3	80	250	9.3	80	
36	Right	37 184	37 463	80	278.9	80	360	9.6	95	
37	Left	37 950	38 527	80	577.7	80	500	8.3	95	Start of overall descent
38	Right	39 859	41 020		1 161.7		1550	4.5	120	
39	Left	41 332	41 441	80	109.2	80	250	9.8	80	
40	Right	41 729	41 776	80	46.3	80	250	9.6	80	
41	Left	42 178	42 330	80	152.5	80	250	9.6	80	Top of mountain pass
42	Right	42 571	42 787	80	216.1	80	170	9.8	70	

Curve No.	Curve Direction	BCC SV	ECC SV	Transition Curve Length In (m)	Circular Curve Length (m)	Transition Curve Length Out (m)	Circular Curve Radius (m)	Existing rate of super elevation	Design Speed	General Description
43	Left	42 953	43 136	80	182.3	80	170	9.3	60	
44	Right	43 331	43 662	80	331.9	80	165	9.6	65	
45	Left	43 966	44 112	60	145.9	60	110	8.9	50	Tutor Ndamase Mountain Pass
46	Right	44 232	44 255	60	23.2	60	110	9.8	55	
47	Right	44 450	44 500	80	50.1	80	200	8.7	65	
48	Left	44 739	44 779	80	39.8	80	110	9.7	55	
49	Left	44 990	44 992	60	2.0	60	450	4	55	
50	Right	45 124	45 148	60	24.3	60	110	8.1	50	
51	Left	45 271	45 380	60	109.1	60	110	9.3	50	
52	Right	45 553	45 608	80	55.1	80	250	8.1	70	
53	Right	45 853	45 986	60	133.0	60	110	9.2	50	
54	Left	46 113	46 248	60	135.6	60	110	9.7	50	
55	Right	46 398	46 416	60	17.8	60	140	8.8	55	
56	Left	46 545	46 594	60	48.7	60	110	9.7	55	
57	Right	46 721	46 721	60	0.7	60	135	8.3	50	
58	Left	46 845	46 872	60	26.6	60	110	9.7	55	
59	Left	47 040	47 060	80	19.3	80	110	9.8	55	
60	Right	47 243	47 293	60	49.9	60	110	9.6	55	
61	Left	47 415	47 443	60	28.1	60	110	10	55	
62	Right	47 575	47 619	60	43.9	60	110	9.7	55	
63	Left	47 746	47 800	60	53.6	60	110	10.7	60	
64	Right	48 186	48 190	60	3.9	60	110	9.5	55	
65	Left	48 324	48 325	60	0.8	60	130	7.6	50	
66	Right	48 455	48 460	60	5.5	60	170	8.4	60	
67	Left	48 588	48 590	60	1.7	60	135	8.1	50	
68	Right	48 716	48 718	60	1.6	60	180	9.4	70	
69	Left	49 163	49 170	60	7.5	60	330	5.4	60	
70	Right	49 297	49 334	60	36.4	60	110	9.4	50	
71	Left	49 456	49 462	50	5.7	50	320	5.8	60	
72	Right	49 582	49 700	60	118.3	60	110	9.6	55	
73	Left	49 824	49 836	60	12.1	60	110	9.7	55	
74	Right	49 960	50 000	60	40.1	60	110	9.2	50	
75	Left	50 125	50 172	60	47.5	60	110	8.5	50	
76	Left	50 344	50 357	60	13.3	60	120	8	50	
77	Right	50 666	50 965	60	298.3	60	330	6.6	60	
Package 3A due for upgrade to 80km/h throughout (2014-2016)										
120	Right	68 087	68 605		517.7		800	3.6	70	descent Tombo to Umpa
121	Left	68 658	68 781		123.3		320	8	75	

Curve No.	Curve Direction	BCC SV	ECC SV	Transition Curve Length In (m)	Circular Curve Length (m)	Transition Curve Length Out (m)	Circular Curve Radius (m)	Existing rate of super elevation	Design Speed	General Description
122	Right	68 896	68 936	86	40.1	86	160	9.8	70	
123	Left	69 126	69 202	60	75.5	60	160	9.9	70	
124	Right	69 349	69 351	60	2.6	60	190	10	70	
125	Left	69 514	69 761	60	247.7	60	160	9.5	65	Umngazi River Valley
126	Right	70 002	70 162	60	159.5	60	160	9.4	60	
127	Right	70 613	71 286		673.4		320	8.2	75	
128	Right	71 681	71 852	60	170.6	60	210	9.5	70	
129	Right	72 156	72 303		146.6		300	8.5	75	
130	Left	72 497	72 629	60	132.4	60	160	9.8	70	
131	Right	72 689	72 763	60	73.3	60	160	9	60	Gradual descent to Port St. Johns
132	Left	72 957	73 053		96.2		300	8.4	75	
133	Right	73 085	73 162		76.8		300	7.1	65	
134	Left	73 195	73 295		100.1		300	8.5	75	
135	Right	73 371	73 519	60	148.1	60	160	9.8	70	
136	Left	73 916	73 995	60	78.8	60	160	10	70	
137	Right	74 225	74 408		182.9		400	7.4	80	
138	Left	74 469	74 765		295.3		400	6.8	75	
139	Right	74 897	74 898	60	1.4	60	220	8.4	65	
140	Left	75 019	75 021	60	1.9	60	160	7.7	50	
141	Right	75 175	75 243	60	68.6	60	200	10	80	
142	Left	75 366	75 522	60	156.2	60	180	9.4	65	

Hatch Goba's brief does not include major geometric upgrading to the existing road alignment, so none of the curve radii will be increased, nor will existing superelevation rates be altered. Proposed intersection upgrading positions have been selected in safe locations and/or converted to grade separations.

It was agreed with SANRAL that, in general, design speeds outside the KSD Municipal Area (ie. all rural packages apart from mountain pass sections) would be 100km/h, notwithstanding extraordinary conditions at busy intersections.

9.1.3 Vertical Alignment

Several parabolic vertical curves describe the vertical alignment of the R61 across Package 3. Over the western portion (Libode to Majola Tea), the maximum positive gradient is 8%, while the minimum (negative grade) is -12%. From Tombo to Ndwalaze, the corresponding grades are 9% and -10%.

We compared the design speed of TRH17 with the SANRAL GDG and found that the SANRAL Geometric Design Guidelines for vertical curves are conservative when compared with TRH17 (when using an object height of 150mm). Under TRH17, crest curve k-values between Libode East (SV 28+000) and Enjiveni (SV 40+000) vary

between 70km/h and 100km/h. Under SANRAL GDG, the corresponding design speeds are 10km/h lower. From Enjiveni through Qiti and down the pass, vertical curve design speeds vary from 40km/h to 90km/h, but would appear to have had design speeds of 50km/h and 60km/h under SANRAL GDG and TRH17 respectively.

Over the eastern portion between Tombo and Ndwalane, minimum k-values comply with a design speed of 60km/h and 70km/h against the corresponding standards.

The typical intersection detail to be applied to all nodes listed has been designed to decrease operating speeds to less than 80km/h. For this reason, it was determined that the upgrading of the vertical alignment of the R61 was not required. In fact, from a pedestrian safety viewpoint, a lower operating speed is beneficial, provided adequate visual and audible warning measures are in place.

9.2 Provincial and Municipal Roads

9.2.1 Geometric Considerations

The formalisation of access to provincial and municipal roads has been described generally under 3.1.2 and 3.1.3. Specific mention is made of unconventional geometric design hereunder.

9.2.2 DR08304 at SV 44+860

DR08304 intersects the R61 near the start of the Tutor Ndamase Pass at SV 44+860. A 15m deep cutting to the north results in inadequate intersection sight distance and as such is dangerous in its current form. This is further exacerbated by its location on a steep vertical grade which means vehicles approach this intersection from the west at high speed. No laybys currently exist which significantly compromises pedestrian safety at this intersection.

Several corrective options were considered that would accommodate the typical intersection design and required acceleration and deceleration lanes. After numerous site visits and consultations, the solution considered appropriate was to maintain the existing southern road edge with widening taking place into the existing cut face to the north. In order to avoid unnecessary widening of the south western fill, the westbound layby will be located on the approach side of the intersection.

9.2.3 Mgxabakazi at SV 69+860

The existing cross roads at SV 69+900 serving communities north and south of the R61 is dangerous in that inadequate intersection sight distance is available. The solution considered appropriate is a quaterlink beneath the high fill. This is required in order to maintain access to the north of the R61 due to the removal of the existing unsafe access on the inside of the curve.

9.2.4 AC30081 Mngazi at SV 71+235

There are substantial rural communities located to the southwest and northeast of the R61 between SV 70+000 and SV 72+000. Pedestrian and vehicular movements between these two communities are largely served by AC30081 to the north and

unreferenced roads to the south with access in between along the R61 over the existing Mngazi River Bridge. The existing T-junction between AC30081 and the R61 is located in a dangerous position on the inside of a curve and it is proposed to relocate this intersection 400m further west to a safer location. Community access road (CAR) B will extend from the new R61 intersection across the Mngazi River and link in to AC30081. A 4.5m high by 4m wide culvert underpass will link CAR B on the north of the R61 to CAR C on the south of the R61. This improvement will accommodate 32 vehicles per day turning into this area.

9.2.5 Qhaka J.P.S at SV 71+980

The recently upgraded Qhaka J.P.S is currently accessed via an informal bellmouth on the R61 located at SV 71+980. Although laybys are provided for in both the eastbound and westbound directions, a lack of pedestrian crossing markings and turning lanes makes this intersection dangerous.

In order to limit the amount of earthworks required to upgrade this intersection, the existing eastbound layby will be retained with widening for acceleration and deceleration lanes taking place to the south only. The westbound layby will be reinstated and pedestrian guidance markings and refuge will be provided.

9.2.6 Qhaka at SV 72+560

The existing at grade intersection at SV 72+560 provides vehicular and pedestrian access to the Qhaka community located to the north of the R61 as well as access to a smaller community to the south. The intersection provides a convenient crossing point to many pedestrians, particularly those attending the recently upgraded Qhaka J.P.S to the south of the R61.

The existing intersection is located near the crest of a vertical curve with the northern access located on the inside of a horizontal curve. The effect of this is poor intersection sight distance and as such is dangerous in its current form. The southern access is located approximately 35m west of the northern access which further exacerbates the dangerous nature of the intersection.

A grade separated intersection with a half quarterlink has been designed to replace the existing intersection. This would allow the community to the north of the R61 safe, uninterrupted vehicle and pedestrian movement over the R61. A single access point onto the R61 from the south, located on the outside of a curve, allows for greatly improved intersection sight distance.

9.3 Conclusion

As discussed in detail in Section 1.4, the primary objective is to address vehicular and pedestrian safety along the R61.The basis of Hatch Goba (Pty.) Ltd.'s appointment was to critically asses the set of guidelines which ITS Engineers (Pty.) Ltd. Initially defined when SANRAL became responsible for the management of this route. These guidelines were a culmination of ITS Engineers (Pty.) Ltd.'s appointment to identify safety issues and recommend suitable solutions.

An iterative design process between SANRAL and Hatch Goba (Pty.) Ltd. has taken place resulting in a typical intersection layout being developed that will be applied at suitably safe locations along the length of the project. This typical layout with dedicated right-turn lanes as well as deceleration and acceleration tapers will allow for improved vehicular safety. A short raised median, layby's and an audible seal will facilitate pedestrian safety at each intersection.

Although traffic volumes along the R61 are anticipated to increase with the introduction of the N2WCH project, total turning volumes, i.e. left and right turning vehicles (currently varying between 7 and 147) are not expected to increase significantly. Consequently the need for such a typical intersection design as well as the proposed location of each intersection has been justified based on vehicle and pedestrian safety rather than capacity requirements.

10 STRUCTURES

10.1 Bridge Structures

Three new bridges are required on this section of the route.

(i) B0240 Qiti Overpass Bridge, km43.5

This site was identified during basic planning in 2004 as a suitable location for an agricultural overpass. During the review phase undertaken by Hatch Goba it was confirmed that the site was suitable and the bridge would serve a junior school to the north of the R61 and a shop to the south. A bridge report (rev 2) was submitted to SANRAL and was approved by Mr E Kruger on the 28th October 2012.

The bridge has been designed to accommodate future widening of the R61 from the current two lane undivided situation to a four lane undivided carriageway. The bridge has three spans of 13.85m, 30.7m and 13.85m with a total length of 59.3m. The deck has a width of 6m between parapets allowing for a single traffic lane together with a pedestrian walkway. The deck is prestressed twin spine beam deck and is supported on inclined circular column piers and cantilever wall type abutments. Approximately 10m long, 0.75m diameter end bearing piles are required for the piers and abutments.

(ii) B0234 Mngazi River Bridge, km71.6

With the proposed closure of an unsafe intersection on the R61 immediately to the east of the Mngazi River it became necessary to provide a community access road from a new intersection location to the west of the Mngazi River linking in to the existing local roads to the east. A preliminary assessment report was submitted to SANRAL in July 2013 investigating suitable locations upstream and downstream of the existing R61 Bridge. The upstream option was subsequently approved and a bridge report (rev 2) was submitted to SANRAL and was approved by Mr E Kruger on the 23th August 2013.

The bridge has been designed to accommodate a 1:10 year flood with a freeboard of 0.8m. The bridge is 60m long and comprises of three 20m spans. The deck thickness varies from 0.6m at mid-span to 1.2m at the piers and abutments yielding a pleasing arched profile. The deck is 6.7m wide allowing for a single 4m traffic lane and a 1.5m pedestrian walkway. Bollards will be provided at the deck edges and as separation between the vehicles and pedestrians. Wall type piers and abutments will be supported on spread footings on hard rock.

(iii) Qhaka Overpass Bridge, km72.6

The existing at grade intersection at SV 72+560 is located at the crest of a vertical curve with the northern access located on the inside of a horizontal curve. This effect of this is poor intersection sight distance and as such is dangerous in its current form. A preliminary assessment report was submitted to SANRAL in August 2013 where an at grade intersection solution and a grade separated

solution were investigated. The grade separated solution was subsequently approved by SANRAL on the 30th August 2013.

After further discussions with SANRAL, a left-in-left-out proposal allowing for both a three and four span bridge option was deemed the most appropriate. This proposal is currently being reviewed by SANRAL's southern region and a meeting between Hatch Goba and SANRAL has been scheduled for early February 2014 to discuss this proposal in more detail.

A tender for the foundation investigation of the Qhaka Overpass bridge is expected to be put out to tender early in February 2014.

The foundation investigation will commence in early 2014, whereby subsequently the geotechnical report will be submitted.

The above investigations will be allowed for in the construction programme.

10.2 Major Cell Structures

Two major cell structures are required on this section of the route.

The Mgxabakazi Agicultural Underpass (C0390) has been designed to eliminate a dangerous southbound movement off the R61 at SV 69+860 (Mgxabakazi). It has been agreed with SANRAL that a 4.5m high by 4m wide structure will suffice, as it will accommodate light vehicles and will also serve as a pedestrian and livestock underpass. The geometry and positioning of this major structure is described in 9.2.3 and is shown as a general arrangement drawing in Annexure G.

The Mngazi Agicultural Underpass (C0391) has been designed to eliminate a dangerous T-junction on the inside of a curve at SV 71+685 and maintain continuity between communities located to the southwest and north east of the R61 between SV 70+000 and SV 72+000. It has been agreed with SANRAL that a 4.5m high by 4m wide structure will suffice, as it will accommodate light vehicles and will also serve as a pedestrian and livestock underpass. The geometry and positioning of this major cell structures is described in 9.2.3 and is shown as a general arrangement drawing in Annexure G.

11 DRAINAGE

11.1 Topography and Runoff (Refer to Locality Plan in Annexure A)

The topography between Gangata and Ntlaza is rolling, with the road generally aligned close to the watershed. Passing through Ntlaza, the road follows an alignment that requires more curves in sympathy with the rolling terrain but remains close to the ridgeline. Around the town of Enjiveni (SV40+000), the topography on either side of the ridge becomes markedly more mountainous until Qiti (SV43+400), which marks the start of the descent known as the Tutor Ndamase pass. The pass results in a drop in altitude of 350m over 7km (average grade of 5%, and ends at the Majola Tea intersection (which is where TR01061 meets the R61).

The portion between Majola Tea and Tombo (excluded from the planned construction project) takes on a watershed alignment until Tombo, after which a short length of pass (km68-km69.5) leads onto the flat western bank of the Mngazi River. The river meanders significantly in this vicinity with the existing river bridge passing over a relatively straight portion of river just downstream of a sweeping bend. A steep ascent takes one out of the Mngazi River Valley and up to a crest vertical curve at Qhaka (km72.6).

Apart from the Mngazi River crossing at SV71+500, no significant natural watercourses cross the road. However, the following are noteworthy from a stormwater point of view:

(i) Runoff from the hard rock cutting from SV 44+700 to SV 44+950 will need to be accommodated in a cut-off drain/berm and directed into lined side drains.

(ii) Runoff from the lands south of the Qhaka intersection is to be channelled into a cut-off drain at the top of the cut face and directed into cross-drainage structures beneath the carriageway. Inlet structures as shown on typical drawings may need to be adjusted to accommodate the transition into cross drainage.

(iii) The reconfiguration of the road network in the Mngazi River Valley has necessitated river training to a steep non-perennial tributary of the Mngazi River. This tributary will be cut down to a level that will allow runoff to pass beneath the proposed community access road network and discharge into an open drain that converges with the Mngazi river just downstream of the existing R61 bridge. A separate environmental authorisation in this regard is expected to be granted early in 2014.

11.2 Cross Drainage

Existing pipe culverts were surveyed by tacheometry around the year 2000 under the N2WCH preliminary design brief of Messrs HHO. They generally consist of nominal (ie. 600mm dia.) pipe culverts spaced at positions where stormwater concentrations occur. These will all be lengthened using concrete pipe culverts of the same diameter. Due to the watershed alignment, upgrading of pipe culverts is not expected, especially west of the Tutor Ndamase pass. Capacity checks have been carried out on all existing culverts located within proposed intersection upgrades as shown in table 11-1 below. The existing stormwater capacities for all these existing culverts were found to be sufficient.

Subsurface drains will be installed along the base of all widened cuttings and will be specified as geocomposite (fin drains). These will underlie all concrete-lined drains, including those behind the walkways. Existing subsoil drains will be tested and refurbished where required. Where differential settlement has (or may) may occur along the length of the road (normally at the interface between cut and fill), transverse drains will be installed as directed, albeit only across the widened portion of the road prism.

Where subsoil drains are installed at the base of cuttings on the high side of the superelevation, it will be piped to the nearest suitable outlet site.

Subsurface soil conditions will be tested as soon as excavations commence in order to test the suitability of geocomposite (fin) drains. In unsuitable conditions where the danger of geofabric clogging is significant, conventional perforated/slotted pipes embedded in crushed-stone will be installed with suitable geofabric encapsulation.

Very deep cuttings (SV 44+900 and SV 72+500, both 20m deep) may need to be stabilised by benching, in which case cut-off drains and berms will need to be constructed to prevent runoff washing out the exposed cut materials. A geotechnical investigation is currently underway in order to determine suitable cut face geometry.

11.3 Drainage to Upgraded Intersections

The surface stormwater drainage systems to be constructed at the various intersections will be designed optimally to fit the new designs. These systems are largely limited to road prism drainage with stormwater mainly generated from the road surface.

The very steep access road to Qhaka (SV 72+560) has been designed with a concrete surface and concrete-lined side drains. Other steep access roads that intersect with main roads have been designed with a concrete surface and concrete-lined side drains.

11.4 Drainage to the Mngazi River Valley

The reconfiguration of the road network in the Mngazi River Valley has necessitated river training to a steep non-perennial tributary of the Mngazi River. The proposed vehicular underpass immediately west of the existing bridge has been positioned so that it will not be inundated under a minor flood. As such, the bed of the aforementioned tributary will need to be cut down to a level that will allow runoff to pass beneath the proposed community access road network. This will be achieved by means of a large wingwalled inlet structure and several large diameter pipes that will pass beneath the intersection and discharge into an open drain that converges with the Mngazi river just downstream of the existing R61 bridge. Environmental authorisation is expected early in 2014.

11.5 Drainage of Underpasses

The underpasses designed in this report are intended to accommodate traffic only, but their inlet, outlet and floor slopes have been detailed in such a way as to cater for

inevitable minor runoff from the surrounds. Additional cross-drainage as applicable will be installed as required.

Table 11-1: Hydraulic data for culverts at various intersections.

Hydraulic Data	1.*	2.* **D**	3.* **A**	4.* Q_{20}	5.* Q_T	6.* Q_{full}	7.* Q_T/Q_{full}	8.*
Units	SV	(m)	(km^2)	(m^3/s)	(m^3/s)	(m^3/s)	(%)	
Intersection 1	28+580	0.600	0.02565	0.26	0.36	0.44	83%	OK
	28+845	0.600	0.03465	0.39	0.53	0.45	117%	OK
Intersection 2	30+800	0.600	0.03995	0.43	0.59	0.47	125%	OK
	31+135	0.900	0.10035	0.46	0.63	1.29	49%	OK
Intersection 3	39+380	0.600	0.0341	0.40	0.54	0.45	119%	OK
Intersection 4	43+060	0.600	0.0113	0.08	0.10	0.47	22%	OK
	43+260	0.700	0.01965	0.27	0.37	0.84	44%	OK
	43+525	0.750	0.0142	0.22	0.30	0.84	35%	OK
	43+670	0.700	0.00245	0.05	0.07	0.50	79%	OK
Intersection 5	44+670	0.600	0.01925	0.29	0.40	0.50	79%	OK
	44+860	0.800	0.0145	0.30	0.41	0.99	42%	OK
	45+000	0.600	0.01525	0.30	0.41	0.48	84%	OK
Intersection 6	69+570	0.800	0.017	0.21	0.29	1.01	29%	OK
	70+100	0.600	0.0099	0.09	0.12	0.49	25%	OK
Intersection 7	71+150	0.800	0.0096	0.13	0.18	0.93	19%	OK
	71+205	0.800	0.0283	0.25	0.34	0.99	35%	OK
	71+305	0.800	0.0244	0.21	0.29	-	-	-
	71+440	1.500	0.2900	3.75	5.14	4.36	118%	OK
Intersection 8	71+690	0.600	0.0043	0.06	0.08	0.45	19%	OK
	72+000	0.600	0.0103	0.11	0.15	0.46	32%	OK
	72+115	0.750	0.0260	0.29	0.40	0.87	46%	OK
Intersection 9	72+325	0.800	0.0124	0.17	0.23	1.00	23%	OK
	72+460	0.600	0.0201	0.28	0.38	0.43	88%	OK
	72+605	0.600	0.0028	0.02	0.03	0.49	6%	OK
	72+765	0.600	0.0061	0.09	0.13	0.50	26%	OK

1.* Culvert Position

2.* Inside Diameter of Pipe (D)

3.* Effective Catchment Area (A)

4.* 1:20 Year Peak Discharge (Q_{20})

5.* Design Peak Discharge (Q_T)

6.* Capacity of Pipe with H1/D=1.2 (Q_{full})

7.* Q_T/Q_{full}

8.* Capacity

12 TRAFFIC ACCOMMODATION

12.1 Intersection upgrading

In order for public access to be maintained to existing dwellings during construction, nearby gravel T-junctions will be used. The community access roads (shown in broken blue lines on the key plan), are under construction and can serve as temporary one-way bypasses during the necessary road widenings at the major junctions.

At the nine major intersections for upgrading (refer to section 9-1), traffic can be accommodated on the existing carriageway while widening takes place. The traffic will be transferred to the widened portion to complete work on the median.

It is recommended that a temporary 9.5mm single seal with a slurry seal (Cape Seal) be constructed on the widenings to reduce the disruption to traffic. The final seal is expected to be constructed in larger sections covering a number of intersections simultaneously. It is essential that the specification address the requirement to undertake the temporary seal immediately after the layer works of a particular intersection have been completed.

The temporary seal will be designed for construction during summer and winter months, allowing the contractor to continue with the construction of the final seal outside the embargo period.

12.2 Proposed underpasses

The proposed vehicular underpass at SV 69+810 will be designed to have a construction joint midway along the length of the barrel so concrete casting can take place over two phases. During the first phase, the southern half of the underpass will be constructed across the proposed widened portion of the intersection with minimal disruption to traffic along the R61. Once complete the widening may be constructed which will be wide enough to accommodate two lanes of traffic as this widening includes a median and deceleration lane. Traffic can be accommodated on this widening while the underpass is extended to its full length under the existing R61.

The proposed vehicular underpass at SV 71+400 will be designed to have a construction joint approximately one third along the length of the barrel so casting can take place over two phases. During the first phase, the southern two thirds of the underpass will be constructed while two-way-traffic is maintained, albeit via a local deviation to the north around the construction works. Once complete, traffic can be transferred onto the new structure while the underpass is extended to its full length. When sufficient curing has taken place, restricted backfill and layerworks can commence.

13 CONSTRUCTION ASPECTS

13.1 Proposed construction sequence

An indicative programme indicates that a reasonable construction period for the completion of the project is 30 months. This construction period is based on the use of 1 structural team for the cast in-situ structures, and a second team for the placing of the precast underpass sections.

Once the mass earthworks have been completed, pavement layerworks will be imported from commercial sources and widenings to all intersections completed. All materials used for this project are to meet the minimum requirements as set out in the COLTO Standard Specifications for Road and Bridge Works for State Road Authorities 1998, as amended in the Project Specifications.

A few property relocations are unavoidable, but will be planned well in advance so that physical construction of new dwellings can proceed as soon as sites are allocated.

Due to the close proximity of the two cast in-situ underpasses and SV 69+860 and SV 71+235 to each other, it is proposed that these two underpasses are constructed simultaneously under one set of traffic control signals. As there is no viable possibility for a bypass, the construction will need to be carried out under half width construction.

13.2 Local SMME involvement

SANRAL has requested that provision be made in this project for community development aspect where the start-up SMME's, trained under NRA R.061-080-2012/1 and C.003-028-2013/1. The works under the community development aspect of the project would be completed under a separate contract number where the SMME's would be required to complete the works under the guidance and administration of the main contractor.

To achieve this request, two possible scenarios are available, namely:

- To allow for the works as provisional sums in the main contract document,
- To require the main contractor to tender the rates for the work and then to use the SMME's as sub-contractors.

Both the scenarios are viable, but each carries with it inherent risk and benefits. These are tabulated below.

With the first scenario, the major benefit is the contractual arrangement relating to the main contractor. In this option the main contractor can appoint the SMME's after award and the rates can be agreed with SANRAL. It would then be possible to employ most of the SMME's as the work could be divided between them. The main contractor would tender a percentage for the supervision and administration of the SMME's. While the main contractor would be responsible for the overall quality, they would not necessarily be penalised if the SMME's fail to perform adequately. The significant risk is that the SMME's are appointed in a non-competitive environment. This option also creates additional administration for SANRAL in terms of Variation Orders.

The second scenario's benefit is that main contractor tenders the rates for the SMME work, and as such no provisional sums will be required. For this, the main contractors would need to contact and agree rates with the SMME's prior to the submission of the tenders. While this scenario is contractually "neater" for SANRAL it will require an extended tender period, while it may also result in the tenderers using some and not all the SMME's. This may cause unhappiness within the SMMEs and the community and political structures. This unhappiness could pose a risk on the contract in terms of work stoppages. This possibility would need to be mitigated by informing the SMMEs and the community and political structures of the possible occurrence of not all SMMEs being employed.

While both scenarios have risks and benefits, it is recommended that scenario two be implemented and that the necessary SMME, community and political discussions be undertaken by SANRAL and that the tender be let with an extended tender period 6 weeks.

13.3 Embargo periods

The proposed widenings and new pavements will include double seals. The mandatory SANRAL temperature embargo period will thus apply between the months of May and August. The Easter weekend and year end shut down embargo periods will be applied.

The construction period of 30 months may include 2-3 embargo periods but it is very likely that surfacing seals will not be constructed during the first embargo period. Temporary seals referred to elsewhere will be designed with inter alia emulsion which could be constructed during the winter time.

13.4 Weather constraints

This project falls within the temperate summer rainfall region. It is expected that with the commencement of construction in April or May 2014, the rainy season will have an effect on progress only after about 5-6 months. The Contract period will have 2-3 rainy seasons. Final seal work will most likely commence after the first embargo period.

13.5 Construction Programme

A preliminary programme for inclusion in the tender documents has been included as Annexure H and a construction period of 30 months is recommended.

13.6 Design Risk Assessment

Most of the risks associated with this construction project are those inherent to road and bridge works, namely safe traffic accommodation, the risk of falling from height, flooding and drowning risks in major watercourses and the use of explosives.

The requirements of the OHS Act and regulations have been specified under Section E of Part C3: Scope of Works, part of which is a Design Health Impact and Risk Assessment (DHIRA). A tabulated example of such an assessment has been included so as to provide tenderers with a schedule of the design aspects that are included in the Works. The obvious protective measures that would usually be provided are listed with an associated baseline risk. An associated risk rating and risk category has then been mitigated down to a residual risk in order to prioritise aspects that warrant more attention than others. An extract from the DHIRA is shown in Table 13-1 below. The full DHIRA is included as Annexure J.

Table 13-1: Design Hazard Identification and Risk Assessment (DHIRA) Extract.

DESIGN RISK ASSESSMENT:												
Risk Rating multiplier: Low = 1; Medium = 2; High = 3												
				Baseline design risk					Residual risk			
COLTO REF	Design aspect present	Yes / No	Describe the obvious protective measures usually provided	Likely consequences of an accident	Frequency of Exposure	Probability of harm	Risk rating and risk category	Extra control measures necessary to reduce risk / Redesign	Likely consequences of an accident	Frequency of Exposure	Probability of harm	Risk rating and risk category
	SERIES 1000: GENERAL REQUIREMENTS AND PROVISIONS											
1218	Are there any existing services?	Yes	Electrical overhead and underground lines which run parallel with the road. Water and Telkom service cross the road.	2	1	2	4	Competent supervision and adequate pre-task training will be required.	2	1	1	2
1219	Is water available for construction use, and for site camps?	Yes	Municipal water is available	1	1	1	1	No extra measures required	1	1	1	1

low	med	high
1	4	12
2	6	18
3	8	27

14 ANCILLARY WORKS

14.1 Road and Bridge Works

As with former packages within Hatch Goba's appointment, the main focus of this project was to apply and enhance the "Practical Design Guidelines for Pedestrian Facilities on Rural Higher Order Roads" as appropriate to the R61. In combination with the preliminary designs for the N2 Wild Coast Highway, a schematic set of proposed measures was included in these guidelines, which formed the basis for quantifying the works under this appointment (at tender stage). In gaining knowledge of the site and surrounds, the proposed measures have been largely refined through ongoing information flow among the design team. SANRAL's input and consensus at various forums has been crucial in order to proceed.

Since car ownership is low, pedestrian movements are just as important a consideration as vehicular traffic. Therefore parallel walkways of sufficient width and suitably separated from vehicles (by means of barriers) have been incorporated into all junction upgrades, and are currently being implemented under a Construction Manager-based contract. It should be noted that such contract does not include the Tutor Ndamase pass, which could be considered for further walkway provision.

After nearly three years of data collection, observations and investigations, the aforementioned Guidelines have become less and less applicable to the substantially revised scope of work developed by Hatch Goba and SANRAL since 2010. and has resulted in a proposed set of infrastructure that bears very little resemblance to the Project Overview that was the basis of the original appointment

By the nature of the upgrading of intersections by adding turning lanes, grouted stone pitching side drains will be replaced with concrete lined V-drains (Type F), and new subsoil drains installed. This deviation from the former Provincial grouted stone pitching drain was agreed with SANRAL. Barrier kerbing will be provided to pedestrian platforms and median edging will be lined with mountable kerbs.

Protective guardrails will be placed between walkways and the travelled way in all instances, with openings left for crossing passengers.

Bulk water mains will need to be relocated or protected at various upgrading sites. Various tache surveys have revealed that these occur as described under 14.2.1, but the full extent thereof will need to be confirmed upon exposure.

Formal laybys will be replaced where they fall within the proposed upgrading zones, and retained elsewhere.

Signage on approaches to all upgraded intersections will be upgraded to include high visibility warning signs as well as meaningful directional signage to the preferred SANRAL specifications. In addition to signage at the upgraded intersections, further warning and regulatory signs will be furnished along portions of the route where operation speeds and pedestrian activity are high. These signs will aim to ensure that longitudinal pedestrian movement occurs within a safe motoring environment and are

anticipated to occur between SV 36+500 and SV 37+500, between SV 39+800 and SV 41+000 and finally between SV 68+200 and SV 69+500.

Seal work across upgraded junctions will be specially designed to be audible to pedestrians as they prepare to cross the road.

The road reserve to be acquired by SANRAL is nominally 50m wide, and has been designed to be wide enough for the planned N2 Wild Coast Highway. Under this Package 3 construction contract, the reserve will be set out and fenced accordingly (but only within upgrading areas). Where practicable, fence corners at intersections will be splayed according to SANRAL's standard details

It is commonly known that livestock crossing the main road in rural areas is the cause of many serious crashes. As part of this construction project and others on the R61 section 8, Hatch Goba have developed a specialised motor grid that can be maintained via a stormwater culvert-type opening beneath. A typical detail is contained in Annexure I, and will be installed at surfaced adjoining roads. Existing Services

14.2 Utility Services

14.2.1 Water Services

Water mains all fall under the jurisdiction of the OR Tambo District Municipality.

The following describes the anticipated work required in terms of service relocation where upgrading of intersections are proposed.

Gangata (SV25+510):

Bulk water main is to be protected (RHS).

School (SV39+290):

Bulk water main is to be relocated over short lengths and protected in places (LHS). Reticulation Main to be protected beneath proposed community access roads (RHS).

Qiti (SV43+100 to SV43+350):

The distribution main is to be relocated or protected alongside proposed fill/MSE Wall toe. Qiti overpass northern abutment and approach fill will necessitate relocation of water mains and specials. It would be advisable to carry out this work during the possible water supply upgrade to the school being upgraded at present.

DR08304 intersection (SV44+700 to SV44+850):

Relocate existing water main into ducting beneath sidewalk at top of MSE Wall.

A few small diameter local supply mains are located along the pass and are positioned inside existing pipe culverts. These will need to be formalised (ie. wayleave approval obtained) during construction.

A formalised overhead water tanker supply exists at the Mngazi River (just upstream of the western bridge abutment). The supply mains leading to this position will be exposed and accommodated accordingly.

14.2.2 Electrical Services

Most electrical services are administered by Eskom, who are in the process of upgrading their local distribution network substantially. Where possible, we have avoided overhead transformer relocation, but will require local supplies to be reconfigured in many instances. A working relationship has been established with Eskom over recent years, which should facilitate efficient relocation of their plant before construction.

Individual poles and overhead cables will be relocated to suit the proposed road design.

14.2.3 Municipal Water and Sewer Services

Waterborne sewerage does not occur along the route, but the relocation of conservancy tanks, septic tanks and soakaways is anticipated.

14.2.4 Telkom

Telkom services are located above ground generally on the northern side of the road reserve and will need to be relocated due to the road widening. Telkom indicated that fibre-optic cables may be installed along the route.

Discussions have been held with Telkom about the moving of this line and the approximate cost thereof. Application to Telkom for relocation of their lines will be done during the tender period so that when the contract is awarded, the relocation can be undertaken. A provisional sum has been allowed for this.

14.2.5 Current Correspondence

Correspondence was undertaken with certain utility authorities which are indicated below:

Service	Authority	Contract Address & Tel. No.	Contact Person
Electrical	ESKOM	Eskom call centre	-
Telephone lines	Telkom	Telkom East London, 043 705 6211	D Bezuidenthout
Watermains	OR Tambo DM	40 Sutherland Str, Mthatha, 047 501 6400	Phumbile

15 ROAD FURNITURE AND FIELD INVENTORY

All roadside furniture will be demolished within the upgraded zones and suitable infrastructure installed. A new suite of road signs including appropriate high-visibility warning signs (using fluorescent yellow green (FYG) edging) and general direction signs will be designed and specified.

15.1 Overhead street lighting

No street lighting will be implemented under this project however this was considered and some lighting will be installed on previous packages closer to Mthatha.

15.2 Public Transport Laybys

As stated under 16.1, all existing formal bus/taxi laybys will either be retained or replaced. Where intersection upgrading occurs at such a position, the typical design to be implemented includes laybys on both main road departure legs.

The Qhaka J.P.S node has a slight variation from the typical T-junction design where laybys are positioned approximately opposite one another. In order to limit the amount of earthworks required to upgrade the intersection, the existing eastbound layby will be retained in its current position on the departure leg and all widening taking place to the south. The westbound layby will be reinstated on the departure leg, as per the typical T-junction design. Consequently, eastbound and westbound laybys will be located diagonally opposite one another.

16 INTERSECTIONS AND ACCESSES

Table 16-1 is a summary of the accesses that will be in place after implementation of the designs under this package. The minor road in each instance has been classified according to TRH26: "South African Road Classification and Access Management Manual". Existing accesses that do not appear in this table will be closed permanently. Major intersection widenings are shown in italics.

Table 16-1: Summary of Planned Intersecting Roads and Accesses.

Major Road	SV Distance	Left/Right	Class*	Description
R61 (R1)	***28+510***	*R*	*R4*	*Local Access to Gangata at Ntlaza*
	29+560	L	R5	Local Access (surfaced bellmouth)
	30+140	L	R5	Local Access (surfaced bellmouth)
	31+035	*L&R*	*R3 & R3*	*AC30554 L to Ezinkozweni and DR08029 R to Esixotyeni*
	32+670	L&R	R5 & R5	Local Access to sportsfield L & Local Road R
	36+720	L	R5	Access to parallel services road
	36+875	R	R5	Local Access (surfaced bellmouth)
	37+250	L	R5	Gravel Access to plots at Bhakaneni
	37+970	R	R4	AC30107 to Mkangiso at Ngidini
	39+290	*L&R*	*R5 & R3*	*Local Access to school L & AC30488 R*
	40+000	L	R4	Local Access to Enjiveni
	41+240	R	R4	Local Access (surfaced bellmouth)
	42+705	L	R4	AC30105 to Njiveni at Qiti
	43+150	*R*	*R4*	*Main access to Qiti and school*
	44+860	*R*	*R3*	*DR08304*
	69+110	R	R5	Local Access (surfaced bellmouth)
	69+125	L	R5	Local Access to Mgxabakazi west
	69+860	*L*	*R4*	*Access to Mgxabakazi east*
	70+825	L	R5	Local Access to cultivated land
	71+235	*L*	*R3*	*AC30081 access to Qhaka via proposed Mngazi river bridge*
	71+980	*R*	*R5*	*Local Access to Qhaka J.P.S*
	72+560	*R*	*R4*	*Local Access to Qhaka*

* Class 1 (R1 Rural principal arterial, U1 Urban principal arterial)
Class 2 (R2 Rural major arterial, U2 Urban major arterial)
Class 3 (R3 Rural minor arterial, U3 Urban minor arterial)
Class 4 (R4 Rural collector road, U4 Urban collector street)
Class 5 (R5 Rural local road, U5 Urban local street)
Class 6 (R6 Rural walkway, U6 Urban walkway)

Having observed traffic and pedestrian behaviour for some time along this portion of the R61-8, the positioning of intersections as proposed above, allows for efficient town planning (albeit on a ribbon development axis) on a network of roads, each of which occupies a sensible position in the overall hierarchy.

17 LAND ACQUISITION REQUIREMENTS

The acquisition of land for roadworks has been programmed in close co-operation with the Manco Aurecon JV (MAJV), who have refined the acquisition procedure across notional sites over the past year or so. During the latest discussions with SANRAL in October 2013, it was it was decided to programme this work to commence in early 2014. This will allow sufficient time for the land acquisition process to take place.

The 50m wide corridor that was calculated by the MAJV some 10 years ago (in anticipation of the N2WCH) is generally adequate for the proposed upgrading, with the exception in some cases where high fills and deep cuttings (especially in the Mngazi area) result in toe positions that do not provide a working corridor for the passage of routine road maintenance equipment. Proposed motor grids need to be positioned suitably to be effective, and this requires fit for purpose splays to be fenced and gated.

Hatch Goba conducted community liaison in two phases, firstly with regard to overall road network planning in late 2012 and then for land acquisition in 2013.

We are almost complete with the fieldwork exercise as required in order to establish the details of notional site occupants so that acquisition diagrams can be determined. These will then be forwarded to MAJV in order to draw up Compensation Contracts.

Acquisition Diagrams will need to be produced for notional sites that are reduced in size or severed by virtue of designed road reserves. Approximately 30 notional sites are affected by the works of which half will be compensated for loss of a portion of land only. Of the ±15 where relocation of dwellings is required, half will be relocated on site and half will require a designated relocation area which will be secured through the MAJV community liaison structures.

Some dwellings have been erected within 60m of the road reserve and as such, are deemed illegal. The Southern Region Statutory Compliance officer is regularly informed of these as and when they become apparent. It is important that recently erected structures that transgress legal requirements do not receive compensation when demolished. Such information will be forwarded to MAJV during individual parcel data transmission.

In some minor instances, parallel service roads that are being constructed under the Construction Manager programme fall within the 50m N2WCH reserve. We have allowed construction to proceed on the same premise as the pedestrian walkways that have been located alongside the existing (narrower) fenced reserve. Fencing of the ultimate 50m reserve will be carried out as part of the future Highway project. During this phase, infrastructure within the demarcated corridor will be dealt with.

Due to there being sufficient lead time to finalise geometric designs prior to construction, we do not foresee any risks attached to the land acquisition aspect of this construction project. There are significantly fewer notional sites than previous packages 1 and 2 and most of the owners have been contacted. Linework for the

Acquisition Diagrams can be sent out before year end. Typically the conclusion of Compensation Agreements occurs within a month of linework submission.

18 LIAISON WITH INTERESTED AND AFFECTED PARTIES

18.1 Community liaison and Land Owners

This project lies within the boundaries of both the Nyandeni Local Municipality (NLM) and the Port St Johns Municipality. However, the roadworks pass through non-registered (or notional) sites. As stated under chapter 17 above, individual land owners have been contacted over the course of the past few months by means of the land acquisition process. The NLM and PSJLM are in fact not involved with land acquisition as the process falls under the authority of the Department of Rural Development and Land Reform (DRDLR).

The local communities, tribal authorities and ward councillors for the NLM portion of the project, have been contacted and informed of the projects, but may call for further representative forums which will be facilitated by ourselves.

Contact with the taxi associations has been made through the stakeholder engagement process. However no specific meetings have been held with the taxi associations, which will be held closer to the time of construction.

18.2 Routine road maintenance

The current routine road maintenance (RRM) route manager will be contacted to be made aware of the physical and time parameters associated with this project. Discussions have also been had with SANRAL's project manager responsible for this section of RRM. Pedestrian and vehicular safety issues highlighted by the routine maintenance section have been addressed and incorporated into Hatch Goba's proposed designs.

The RRM contractor will be relieved of his duties over the entire length of road (ie. from Gangata to Mngazi) during construction only between shoulder break points. The RRM Contractor will still be responsible for all other maintenance such as grass cutting, Incident Management, clearing, etc. Routine patching repairs and minor seal work in between upgrading zones will take place by the main contractor.

18.3 Other statutory authorities

Contact will be made with the Provincial traffic authority and the local SAPS station commander to inform them of the project and its anticipated timeframes and traffic accommodation requirements.

18.4 Skills audit

No skills audit has been undertaken to date, although a database of skills is being developed by virtue of ongoing road contracts under the same development project appointment.

19 ECONOMIC EVALUATION

The proposal on this project is for the construction of safety improvements. It is a special development project, where alternatives have been considered strongly throughout the consultative design process. These have been eliminated systematically on practical grounds and have therefore not been put forward in this report as subjects of an economic evaluation.

Certain economic alternatives were however considered in terms of, inter alia, the type of pavement for widening.

As stated in paragraph 8.3.1 a granular option and an asphalt option were calculated for the widening on the R61 intersections. Not only is the asphalt option less economical but it is also somewhat less practical in terms of drainage of pavement layers and therefore the granular option is proposed.

In terms of the community access roads the MacAdam base is more economical during the initial construction period.

The concrete option requires very little maintenance during extended periods of time which will ensure serviceability (under prevailing low traffic volumes) well into the future.

Furthermore the concrete option lends itself to labour intensive methods which would be incorporated into a community development project which will have a significant contribution towards the local economy.

It should be considered that substantial efforts were made during previous contracts to develop and train the local residents in this regard and further contracts can contribute significantly toward the sustainability of this development.

19.1 HDM4 economic analysis

19.1.1 R61 upgrade

An HDM4 analysis was conducted on the project for the upgrading of the intersections, the provision of overpasses and the construction of the agricultural underpasses. Refer Annexure K. The analysis was done for the project as a whole and included all the intersection upgrades.

The analysis compared the costs of doing minimal maintenance (ie. retaining the road in its current geometry) against the proposed upgrading alternative. The results of the analysis show that the project is feasible as the net present value (NPV) and internal rate of return (IRR) are both positive (R291.9 million and 21.8% respectively). The SANRAL stipulated discount rate of 8% was used.

A high NPV amount is anticipated in light of the proposed upgrading being located at specific nodes and over relatively short portions of road and is calculated over a 30

year time frame. Operational benefits are derived from improved access management at these intersections, with a resulting increase in safety and reduction in accidents.

19.1.2 Community access road upgrade

An HDM4 analysis was done for a 1km length of community access road (CAR) upgrade. This 1km portion was treated as a representative section and was analysed using the following parameters:

- Geometry : “bendy and severely undulating” (HDM4 geometry category);
- 10 light vehicles (SANRAL toll Class 1) per day;
- Eastern wet climatic zone;
- In-situ soils with high plasticity;
- A current traffic speed of 5 km/h and upgraded traffic speed of 30km/h;
- The existing road has no gravel on it and is an earth track with a terminal IRI value of 20;
- Costs were based on the current construction rates.

The analysis was undertaken for the 4 different CAR pavements, including the pavement proposed under this project. All the proposed pavement upgrades show a positive NPV and IRR. A SANRAL stipulated discount rate of 8% was used.

20 MATERIAL UTILISATION AND MATERIAL SOURCES

20.1 Material utilisation

The vertical alignment of the proposed works is governed by the levels of the existing carriageway which has meant that maintaining a cut-to-fill balance on the project has proved to be difficult.

The project is divided into two portions due to the upgrade of the R61 Section 8 between SV 50+000 and SV 68+000. As such the utilisation of materials has been split so as to avoid the 20 km gap between the two projects.

The intersections located at Gangata (SV 28+510), Mafini (SV 31+035), Enjiveni (SV 39+290) and Qiti (SV 43+150) are located in rolling terrain. However, high fills and deep cuttings at the Tutor Ndamase Pass intersection (SV 44+860), has resulted in these intersections combined earthworks generating a surplus cut of approximately 40 500 m^3.

A total cut surplus of 30 500 m^3 is available from intersections located within the Mngazi river valley at Mgxabakazi (SV 69+860), Mngazi (SV 71+235), Qhaka J.P.S (SV 71+980) and Qhaka (SV 72+560) where fill heights are significant and cuttings are deep. This surplus cut is mainly from the intersection at Qhaka (SV 72+560).

Initial test pit information indicates that the surplus cut material will be suitable for fill and selected layers. During construction, the material will be tested and designated for use in the fill or selected layers. Appropriately located stockpile sites will be determined during the construction stage.

Topsoil will be stockpiled for later use on finished slopes.

20.2 Material volumes

The pavement and mass earthworks material requirements are detailed below in Table 20-1:

Table 20-1: Material volumes.

MEASURABLE ENTITY	QUANTITY
Intersections Widenings and Access Roads	
Surfacing to widened portions (19/6.7 Double Seal)	46 500 m^2
Surfacing to existing roadway (19/6.7 Double Seal)	72 000 m^2
Base (150mm)	7 500 m^3
Subbase (200mm)	17 000 m^3
USSG (150mm)	10 500 m^3
LSSG (150mm)	8 500 m^3
Cut available for fill	72 000 m^3
Cut to spoil	71 000 m^3

MEASURABLE ENTITY	QUANTITY
Intersections Widenings and Access Roads	
Fill from necessary cut	72 000 m^3
Fill from other sources	0 m^3

Gravel layerwork volumes total 36 500 m^3, whereas the demand for crushed stone base is 7 500 m^3.

20.3 Material sources

The volumes from Table 20-1 have been calculated on the premise that a portion of the cut material will be placed in selected layers. Therefore no additional material sources are envisaged. The sub-base and base layers will be constructed of crushed stone material, and as such will be procured from commercial sources.

Two commercial quarries are available to supply crushed stone. One of these quarries is located at Misty Mount (SV 18+000) while the other is located outside Port St Johns (Mvubu Quarry). The crushed aggregates available from these quarries are of sufficient quality to meet SANRAL's required material specifications and the aggregates have been used on previous SANRAL projects. It must be noted that both these quarries are owned and operated by different established contracting firms.

One Eastern Cape Department of Roads and Public Works borrow pit is available for which mining and environmental approvals are in place. This borrow pit is located on DR08191 (1.1km from the R61 at SV 73+100) and will be used to supplement any shortfall in fill material should the available cut prove to be below specification. This borrow pit contains weathered dolerite material.

There is no additional material available from the Majola Tea to Tombo contract as PDNA (Pty.) Ltd. have confirmed that have only sufficient fill and selected materials for their project requirements. The projects hard rock source is located at approximately SV 37+000, so there may be the possibility of obtaining crushed aggregate from this source, but compensation for the crushing and screening as well as the timing of the material availability make the procurement of material from this source potentially problematic and as such is not recommended.

21 CONSTRUCTION COSTS AND PERIOD

21.1 Construction cost

A preliminary cost estimate for the works has been calculated, and is shown below in Table 21-1.

Table 21-1 : Preliminary Cost Estimate.

SECTION	DESCRIPTION	AMOUNT
1200-1400	GENERAL REQUIREMENTS	R 54 995 293
1500	ACCOMMODATION OF TRAFFIC	R 8 635 980
1700	CLEARING AND GRUBBING	R 942 330
1800	DAYWORKS	R 1 094 550
2100	DRAINS	R 2 741 309
2200	PREFABRICATED CULVERTS	R 3 638 482
2300	CONCRETE KERBING, CONCRETE CHANNELLING, CHUTES AND DOWNPIPES, AND CONCRETE LININGS FOR OPEN DRAINS	R 8 988 960
3200	SELECTION, STOCKPILING AND BREAKING DOWN THE MATERIAL FROM BORROW PITS, CUTTINGS AND EXISTING PAVEMENT LAYERS, AND PLACING AND COMPACTING THE GRAVEL LAYERS	R 4 530 000
3300	MASS EARTHWORKS	R 14 050 885
3400	PAVEMENT LAYERS OF GRAVEL MATERIAL	R 5 694 383
3500	STABILIZATION	R 1 875 419
3600	CRUSHED STONE BASE	R 3 864 370
3900	PATCHING AND REPAIRING EDGE BREAKS	R 190 200
4100	PRIME COAT	R 522 045
4400	SINGLE SEALS	R 188 983
4500	DOUBLE SEALS	R 6 225 752
5100	PITCHING, STONEWORK AND PROTECTION AGAINST EROSION	R 2 361 530
5200	GABIONS	R 2 298 172
5400	GUARDRAILS	R 2 519 009
5500	FENCING	R 868 784
5600	ROAD SIGNS	R 320 484
5700	ROAD MARKINGS	R 2 580 814
5800	LANDSCAPING AND PLANTING PLANTS	R 1 517 481
5900	FINISHING THE ROAD AND ROAD RESERVE AND TREATING OLD ROADS	R 230 950
8100	TESTING MATERIALS AND WORKMANSHIP	R 140 000
7200	MECHANICALLY STABILIZED EARTH WALLS	R 9 000 000

SECTION	DESCRIPTION	AMOUNT
6100-6600	STRUCTURES (R61-8 ONLY)	R 2 870 761
SABS	PIPE EARTHWORKS AND TRENCHES	R 804 750
BBEEE	B-BEEE REQUIREMENTS	R 6 150 000
RELOCATIONS	RELOCATION OF HOUSES	R 7 100 000
BRIDGES	QITI, MNGAZI & QHAKA BRIDGES	R 12 727 890
UNDERPASSES	ALL UNDERPASSES	R 6 468 573
SMME	COMMUNITY ACCESS ROADS	R 12 219 996
DISTRICT ROADS	DISTRICT ROADS	R 731 120
TOTAL (excl. VAT)		**R189 089 256**

21.2 Construction period

A construction period of 30 months has been recommended. The draft construction programme, as shown in Annexure H, shows how we envisage the project execution in order to complete the works within this construction period.

No special allowance is made in the programme for the land acquisition process.

The two cast in-situ underpasses (SV 69+860 and SV 71+235) are programmed to commence in month 11 after the construction of the three bridge structures. This is based on the use of one structural team for the cast in-situ structures and a second team for the precast underpass sections. It is possible to programme the construction of the two cast in-situ underpasses, but this would require an additional structural team from the contractor. It would also result in a 6 month reduction in the contract period and would require that specific land acquisition allowances be included in the document.

22 LABOUR ENHANCEMENT AND EMPOWERMENT ISSUES

22.1 Conventional Work

The scope of work entails a number of structures and widening of the existing road which is proposed to be included in a conventional project. Certain sections of provincial roads and access road may also be included into this contract. It is further proposed that the contract Participation goals of 6% labour on 12% SMME's be specified for such a contract.

22.2 Community Development Project

This project also entails some community access roads which could be constructed through a community development project as was the case with some previous packages. The roads can be divided into three operational sections as indicated in Table 22-1.

Table 22-1 : Community Access Roads suitable for community development.

SV Distance	Portion	Left/Right	Class*	Description
28+510	1	R	R 4	Local Access to Gangata at Ntlaza
31+035		L&R	R3 & R3	AC30554 L to Ezinkozweni and DR08029 R to Esixotyeni
39+290	2	L&R	R5 & 3	Local Access to school L & AC30488 R
43+150	3	R	R 4	Main access to Qiti and school
69+860	4	L	R 4	Access to Mgxabakazi east
	5			
	6			
71+235	7	L	R 3	AC30081 access to Qhaka via proposed Mngazi river bridge
	8			
	9			
72+560	10	R	R 4	Local Access to Qhaka

22.3 Conclusion

It is proposed that the details in this regards be finalised during the detail design process after proper consideration by SANRAL regarding administrative processes that will need to be implemented in this regard.

23 ENVIRONMENTAL ASPECTS

The work on the R61 falls within the approved Record of Decision (RoD) for the N2 Wild Coast Highway. The RoD requirement that should construction work be required on the route, then an Environmental Management Plan (EMP) must be submitted to the Department of Environmental Affairs (DEA) for approval prior to the commencement of construction work.

A generic EMP has been submitted to the DEA and has been approved. A copy of the Generic Construction EMP has been included as Annexure K and can be summarized as follows:

Chapter 1: Introduction: This section includes the brief overview of the various projects, aims of the Generic Construction EMP and describes the content of this Generic Construction EMP.

Chapter 2: Administration, monitoring and auditing of environmental obligations: This section identifies the management structure and responsibilities of the various stakeholders. The procedures for environmental management of the construction phase are also presented.

Chapter 3: Environmental specifications: This section presents the environmental specifications applicable to the construction phase of the various projects, including associated infrastructure.

Chapter 4: Way forward: This section briefly describes the way forward in terms of effecting further changes to the document.

The purpose of the Generic Construction EMP is to ensure that potential negative environmental impacts associated with the construction phase of the various projects are prevented and, where they cannot be prevented, are kept to a minimum and rehabilitated. In this regard, the Generic Construction EMP sets out environmental specifications for implementation by the Contractor (defined as the lead Contractor and any nominated or selected Sub-contractors) and procedures for the administration, management, monitoring and auditing of the environmental requirements associated with the construction phase.

Relevant recommendations resulting from the EIA and conditions stipulated in the ROD for the N2 Wild Coast Toll Highway have been incorporated into the Generic Construction EMP, as appropriate. This document will form the basis for the environmental specifications that the Contractor, in terms of the construction contract, will be obliged to adhere to during construction. This document will be included in the contract documentation for the construction phase and will thus form a binding agreement between the Contractor and SANRAL.

Furthermore we confirm that the water use licence application (WULA) for the Mngazi River has been submitted to EIMS and the DEA have visited the site in question. We envisage that the WULA will be approved before the end of 2013.

24 CONCLUSION

This is a Detailed Assessment and Design Report, covering the rural portion of the R61 28km east of Mthatha, which is part of a Special Development Project along the R61 Section 8, for which Hatch Goba were appointed in November 2010. It has been prepared based upon the format prescribed under this appointment, but amendments have been brought to the chapter headings and section names in order to cover the substantially altered scope of work since inception. The designs presented in this report are to be advertised for tender on 18 October 2013

The R61-8 from is a busy single carriageway serving rural settlements that are spread along the route and have proliferated in a random fashion. This has resulted in several uncontrolled gravel accesses being formed onto the national road. Activity at these positions increase substantially, which result in uncontrolled and dangerous movement of vehicles and people, as well as convenient livestock crossing access onto the main road. From a pure capacity point of view (vehicles per hour), the existing single carriageway is adequate, and would operate at a high level of service were it not for non-vehicular factors. This package 3 portion of the special development along the route needs to be upgraded in such a manner as to serve the needs of the inter-regional traffic and the local traffic (5-10km trips), including non-motorised transport. This is best achieved by means of various interventions, which are summarised below:

- The reduction, relocation and formalisation of accesses to preferred, safer locations.
- Two grade separations over the national road at SV 43+500 (Qiti) and SV 72+655 (Qhaka).
- The realignment of AC30081 over a new bridge crossing the Mngazi River.
- Two 4.5 x 4.0m underpasses at Mgxabakazi (SV 69+810) and Mngazi (SV 71+400), as part of intersection upgrades, allowing communities safe access beneath the national road.
- Six livestock underpasses constructed to facilitate the safe passage of cattle across the national road.
- The introduction of motor grids and controlled livestock gates in conjunction with the formalisation of the national road reserve.
- The retention, where applicable, of public transport laybys.

The above interventions on this national route have been developed through a protracted design process consisting of many technical meetings, site investigations and engineering analyses. The conceptual bases for these measures were twofold, namely:

- Practical Design Guidelines for Pedestrian Facilities on Higher Order Rural Roads; and

- Preliminary Planning for a major route from East London to Port Shepstone.

In terms of the pavement condition it is concluded that the road will perform adequately with the necessary periodic maintenance until the development of the N2 Wild Coast Highway commences. The envisaged start date of this development is set to be before 2020.

25 FINAL RECOMMENDATIONS

By way of a summary, we have gathered the proposals contained in this report (as well as those not explicit herein), and hereby recommend as follows:

25.1 Road Planning Improvements

(i) That of the 66 existing accesses off the R61, 41 are closed and 25 are retained and formalised (of which 11 are incorporated into major intersection upgrades).
(ii) That surfaced intersections be constructed at the specific positions listed in Table 16-1 and be detailed in accordance with their road class;
(iii) That, over the upgraded portions, the proposed 50m wide road reserve be established under this construction project,
(iv) that the road to Gangata at SV 28+510 be realigned and surfaced over a distance of approximately 90m;
(v) that municipal road AC30554 at SV be realigned and surfaced over a distance of 200m;
(vi) that district road DR08029 at SV 31+035 be realigned and surfaced over a distance of 400m;
(vii) that municipal road AC30488 at SV 39+290 be realigned and surfaced over a distance of 640m;
(viii) that the municipal road AC30081 at SV 71+680 be realigned over the proposed Mngazi river bridge to intersect with the R61 at SV 71+235;
(ix) that the existing cross roads at SV 72+560 be upgraded to a grade separated intersection

25.2 Geometric Improvements

(i) That the nine intersections identified as key nodes be upgraded to the typical details developed under this appointment;
(ii) That the local road adjoining the R61 at SV 43+340 be realigned via the Qiti overpass bridge;
(iii) That the existing cross roads at SV 69+900 be converted to T-intersection with a quarterlink;
(iv) That the intersection of municipal road AC30081 and the R61 at SV 71+680 be relocated 400m further west;
(v) That the existing cross roads at SV 72+560 be converted to a single access onto the R61 via the proposed Qhaka overpass bridge.

25.3 Capacity Improvements

(i) That the nine formalised and upgraded intersections off the R61 be provided with dedicated right turn lanes with adequate stacking length;
(ii) That the above be provided with left-turn deceleration and acceleration lanes with suitable taper rates;

25.4 Pavement Structure

Albeit that some of the deflection results indicate a marginal remaining life of the pavement in some areas, proper cognisance should be taken of the visual condition, rut measurements, test pit data, expected traffic growth before and after the N2 Wild Coast Road developments when determining whether any structural upgrade to the pavement is required. The 2010/2011 reseal of the road must also be taken into consideration. It is our opinion that, based on our holistic evaluation of the current data pertaining to the pavement, no structural upgrade to the pavement structure is currently required, within the medium term.

The works proposed include the following:

(i) That the R61-8 at the 8 intersection widenings identified be widened the following layer works:
   a) 19/6.7mm S2 Double Seal
   b) 150mm G1 base
   c) 200mm C4 subbase
   d) 150mm G7 upper selected layer
   e) 150mm G9 lower selected layer

(ii) That all district roads be constructed with the following layer works:
   a) 19mm Cape Seal
   b) 125mm G1 base
   c) 125mm C4 subbase
   d) 150mm G5 upper selected layer
   e) 150mm G7 lower selected layer

(iii) That the proposed community access roads occurring beyond bellmouth intersections on the R61 be constructed with the following two options for layer works:
   a) 125mm Jointed unreinforced Concrete wearing course or 120mm Continuously Reinforced justify Concrete wearing course
   b) 125mm C4 subbase
   c) G9 roadbed preparation

   Or,

   a) 120mm Geocell Concrete Pavement wearing course (Hyson cells)
   b) 150mm C4 subbase
   c) G9/In-situ roadbed preparation

   The above pavement lends itself to labour enhanced methods and also eventually required little maintenance over extended periods of time.

25.5 Structural Options (refer to the various Bridge Reports)

(i) That the two underpasses at SV 69+810 and SV 71+400 be constructed as 4.5m high x 4.0m wide cast in situ reinforced concrete box structures;

(ii) That the Qiti overpass be constructed as a 6.85m wide pre-stressed twin spine beam deck, supported on inclined circular column piers and cantilever wall type abutments;

(iii) That the Mngazi river bridge be constructed as a 6.7m wide three span cast in situ structure with deck thickness varying from 0.6m at midspan to 1.2m at the piers and abutments.

(iv) That the Qhaka overpass be constructed as either a three or four span bridge.

25.6 Safety Improvements

At each of the nine main intersections, the following safety features are proposed to be incorporated into the typical arrangement:

- Hardened walkways alongside the main road separated by guardrails
- A specially formulated surfacing seal that is audible to crossing pedestrians
- Raised median islands to provide refuge to crossing pedestrians

It is proposed that informal accesses onto the national road be deemed unsafe and permanently closed using appropriate measures and proper community consultations.

The intersections which are upgraded are taking into account not only vehicular safety but also pedestrian safety.

Elimination of unsafe right turn movements is also considered especially where sight distance is sub-standard. Under overpasses is recommended in this and other cases.

It is emphasized that the bulk of the work under this contract is proposed to improve the safety of the road users and communities along the road.

ANNEXURE A
KEY PLAN

ANNEXURE B
DRAFT TENDER DRAWINGS

ANNEXURE C
TEST HOLE DATA

ANNEXURE D
TRAFFIC LOADING ANALYSIS

ANNEXURE E
BACK CALCULATIONS AND STRUCTURAL ANALYSIS

ANNEXURE F
BRIDGE GENERAL ARRANGEMENT DRAWINGS

ANNEXURE G
UNDERPASS GENERAL ARRANGEMENT DRAWING

ANNEXURE H
PRELIMINARY CONSTRUCTION PROGRAMME

ANNEXURE I
PROPOSED MOTOR GRID AND GATE

ANNEXURE J
DESIGN HAZARD IDENTIFICATION AND RISK ASSESSMENT (DHIRA)

ANNEXURE K
HDM4 ANALYSIS AND SUMMARY

ANNEXURE L
ENVIRONMENTAL MANAGEMENT PLAN