Monitoring and Evaluation of Low Volume Road Trial Sections in Kenya

Monitoring Report No. 3

Across Africa Consultants Limited

KEN2043C

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Cover photo: *Across Africa Consultants Limited team conducting Visual Conditioning Survey on D379*

Quality assurance and review table

Version	Author(s)	Reviewer(s)	Date
Draft 1	George Onguko	R Geddes (CDS)	12 June 2019
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Draft 2	George Onguko	R Geddes (CDS)	24 July 2019

ReCAP Database Details: Monitoring and Evaluation of Low Volume Road Trial Sections in Kenya

Reference No:	*KEN2043C*	Location	Kenya
Source of Proposal	*Across Africa Consultants Limited*	Procurement Method	Competitive tender
Theme	LVR Design Standards	Sub-Theme	Long Term Performance Monitoring
Lead Implementation Organisation	Across Africa Consultants Limited	Partner Organisation	Material Testing & Research Division
Total Approved Budget	100,000.00 GBP	Total Used Budget	58,000.00 GBP
Start Date	20th April, 2016	End Date	31st October, 2019
Report Due Date	25th March, 2018	Date Received	31st May 2019

Contents

Tables and Figures

Abstract

The second monitoring round was conducted in October 2018 on four roads namely: D379, D382, D435 and E511.The activities carried out during this round were, traffic count survey, DCP, rut depth measurements, roughness measurements and Present Serviceability Rating. All the roads are performing well except D382 which has developed potholes big enough to prevent vehicles from using the right lane. This is evident in the roughness measurement result as well as high rut average of 18.8mm. The AADT for all the sections increased except for D435. The increase in AADT indicates that the trial sections are increasingly opening up rural areas to nearby urban centres for economic activities.

Key words

Performance Monitoring, Low Volume Roads, Design Standards

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Acronyms, Units and Currencies

$	United States Dollar (US$ 1.00 ≈ 92KShs)
AADT	Annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
AfCAP	Africa Community Access Partnership
ASTM	American Society for Testing and Material
DCP	Dynamic Cone Penetrometer
DfID	Department for International Development
DN	DCP Number (mm/blow)
DSN800	DCP Structural Number at 800 mm
FMC	Field Moisture Content (In-situ Moisture Content)
GPS	Global positioning system
IWL	Inner Wheel Path Left Hand Side
IWR	Inner Wheel Path Right Hand Side
LHS	Left Hand Side
LVSR	Low Volume Sealed Road
MoTI	Ministry of Transport and Infrastructure
MTRD	Materials Testing and Research Division
OMC	Optimum Moisture Content
OWL	Outer Wheel Path Left Hand Side
OWR	Outer Wheel Path Right Hand Side
PSR	Present Serviceability Rating
ReCAP	Research for Community Access Partnership
RHS	Right Hand Side

1 Background

1.1 Objectives of the project

The Africa Community Access Partnership (AfCAP) is a research programme funded by the UK Government's Department for International Development (DFID). The programme is aimed at promoting safe and sustainable rural access in Africa by use of low cost, proven solutions that maximize the use of local resources.

Kenya is one amongst the several AfCAP participating countries. The Government of Kenya (GoK) is on a mission to upgrade most of the low volume rural roads to paved standard. This may prove an expensive venture due to the increasing scarcity of good construction materials in many areas, which translates to long haulage distances. Therefore, AfCAP has been asked by the Ministry of Transport and Infrastructure (MoTI) through the Materials Testing and Research Department (MTRD) and the Kenya Rural Roads Authority (KeRRA) to support research on utilization of non-standard materials for Low Volume Sealed Road (LVSR) pavements. As part of this process trial sections have been constructed on roads in various locations in Kenya for research purposes.

The objective of the Monitoring & Evaluation Programme is to provide performance-based evidence which will contribute to the establishment of appropriate standards for Low Volume Sealed Roads in Kenya.

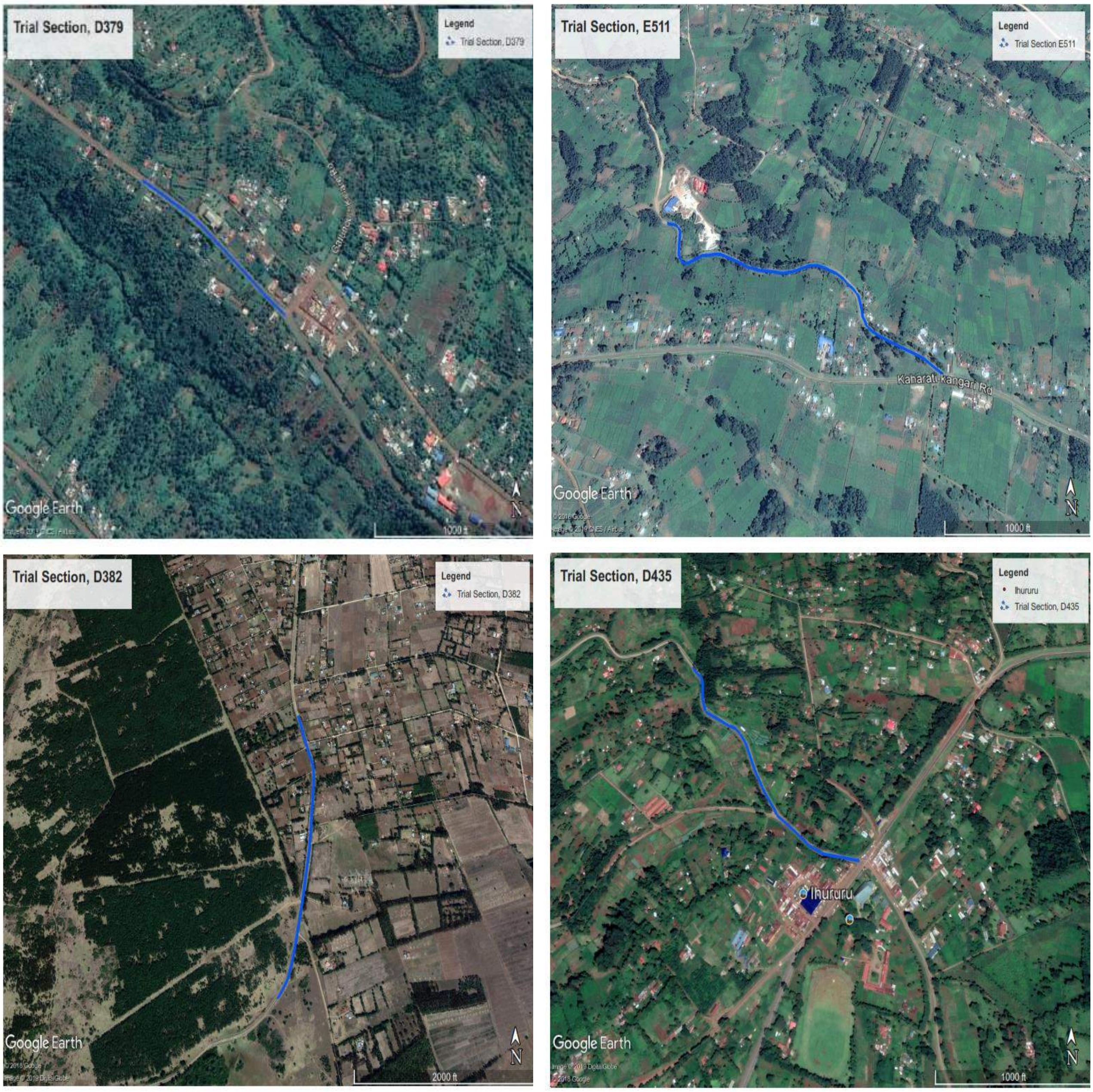
1.2 Monitoring Sections

The road sections that are being monitored under the project are listed in Table 1.1. Their location is shown in Figure 1.1.

Table 1.1: Monitoring sections

Road name	County	Section ID.		Length of section (m)	Terrain	Type of construction	Comments
		Old	New				
Wamwangi - Karatu	Kiambu	D379	_	450	Rolling	Cold mix asphalt for surfacing, Neat laterite for base and natural granular subbase	The trial section is performing well. Very few defects have been noted.
Kangari - Kinyona	Murang'a	E511	C502	900	Hilly	Cold mix asphalt for surfacing, Neat laterite for base and natural granular subbase	The pavement is performing adequately.. A few road defects such as crocodile cracks are visible along the section.
Total – Kona Mbaya	Laikipia	D382	G23324	950	Rolling	Cold mix asphalt surfacing, composite ETB base, granular material subbase	The pavement performance is fair. Defects have been noted on the entire length.
Muthuaini- Munungaini	Nyeri	D435	_	640	Hilly	Cold mix asphalt surfacing, neat weathered basalt base, natural gravel subbase	The pavement is performing extremely well.

Figure 1.1: Location of the monitoring sections



1.3 Construction costs

The construction costs for each of the trial sections is summarised in Table 1.2.

Table 1.2: Construction costs

Road name	Section ID	Length of section km	Construction cost (*Kenya Shillings)*	Construction cost USD	Cost per km (*Kenya shillings)*	Cost per km USD
Wamwangi - Karatu	D379	400 m	5,205,155	52,052	13,012,888	154,920
Kangari - Kinyona	E511	920 m	20,398,761	203,988	22,172,566	263,959
Total – Kona Mbaya	D382	950 m	13,255,432	132,555	20,711,613	246,567

Road name	Section ID	Length of section km	Construction cost (*Kenya Shillings)*	Construction cost USD	Cost per km (*Kenya shillings)*	Cost per km USD
Muthuaini-Munungaini	D435	640 m	13,282,432	132,825	20,753,541	247,066

1.4 Monitoring Surveys

The monitoring surveys that have been carried out are listed in Table 1.3.

Table 1.3: Date of monitoring survey

Road name	Section ID	Baseline survey	1st monitoring survey	2nd monitoring survey	3rd monitoring survey	4th monitoring survey
Wamwangi - Karatu	D379	May 2016 Wet	July 2017 Wet	October 2018 Dry		
Total – Kona Mbaya	D381	May 2016 Wet	July 2017 Wet	October 2018 Dry		
Lord – Kona Bahati	D382	May 2016 Wet	-	-		
Mairo Inya - Kaheho	D388	May 2016 Wet	-	-		
Muruka - Kandara	D415	May 2016 Wet	-	-		
Maragua – Gakoigo Jn	D419	May 2016 Wet	-	-		
Karega – Gathara - Ithumbi	D420	May 2016 Wet	-	-		
Gakoigo Jn – Maragua River	D421	May 2016 Wet	-	-		
Muthuaini - Munungaini	D435	May 2016 Wet	June 2017 Wet	October 2018 Dry		
Kangari - Kinyona	E511	May 2016 Wet	June 2017 Wet	October 2018 Dry		
Ruring'u - Kinunga	E579	May 2016 Wet	-	-		

The data collected from the monitoring sites during each monitoring survey are summarised in Table 1.4.

Table 1.4: Data collected and report submission

Measurement	Baseline survey	1st monitoring survey	2nd monitoring survey	3rd monitoring survey	4th monitoring survey
Construction costs	✓	✓	✓		
Maintenance activities	-	-	-		
Maintenance costs	✓	✓	✓		

Measurement	Baseline survey	1st monitoring survey	2nd monitoring survey	3rd monitoring survey	4th monitoring survey
Climate data	✔	✔	✔		
Classified traffic counts	Aug 2016 to Sept 2016	July 2017 to Aug 2017	Oct 2018		
Axle load surveys	Aug 2016 to Sept 2016	Feb 2018	-		
Drainage Assessment	✔	✔	✔		
DCP tests	Sept 2016	June 2017 to July 2017	Oct 2018		
Deflection	Aug 2016	June 2017 to July 2017	-		
Test pit	Oct 2016 to Nov 2016	June 2017 to July 2017	-		
Laboratory testing of pavement materials	✔	✔	✔		
Base moisture content	Oct 2016 to Nov 2016	June 2017 to July 2017	-		
Roughness	Jun 2016	-	Oct 2018		
Rut depth	Aug 2016	June 2017 to July 2017	Oct 2018		
Present Serviceability Rating	Nov 2016	June 2017 to July 2017	Oct 2018		
	-	-	-		
Report submitted (date)	Aug 2017	Feb 2018	May 2019		
Report approved (date)	Nov 2017	Mar 2018			

1.5 Purpose of this report

The purpose of this report is to record data collected during the baseline, first and second rounds of monitoring and to provide initial analysis of the trends in the data collected since the baseline survey and comparison in the performance of the different monitoring sections.

1.6 Weather conditions

The weather conditions during the monitoring surveys on each site are summarised in Table 1.5.

Table 1.5: Weather conditions during the monitoring surveys

Road name	Section ID	Weather conditions				
		Baseline survey	1st monitoring survey	2nd monitoring survey	3rd monitoring survey	4th monitoring survey
Wamwangi - Karatu	D379	Wet	Wet	Dry		
Total – Kona Mbaya	D381	Wet	Wet	Dry		
Lord – Kona Bahati	D382	Wet	-	-		
Mairo Inya - Kaheho	D388	Wet	-	-		
Muruka - Kandara	D415	Wet	-	-		
Maragua – Gakoigo Jn	D419	Wet	-	-		
Karega – Gathara - Ithumbi	D420	Wet	-	-		
Gakoigo Jn – Maragua River	D421	Wet	-	-		
Muthuaini - Mumungaini	D435	Wet	Wet	Dry		
Kangari - Kinyona	E511	Wet	Wet	Dry		
Ruring'u - Kinunga	E579	Wet	-	-		

2 Monitoring Section 1: Wamwangi - Karatu Road D379

2.1 Location

The start of the monitoring section is at chainage 0+000 from the start of the road, which is at Wamwangi – Karatu junction.

The GPS coordinates at the start of the monitoring section are:

South: 1° 0'14.02"

East: 36°55'8.54"

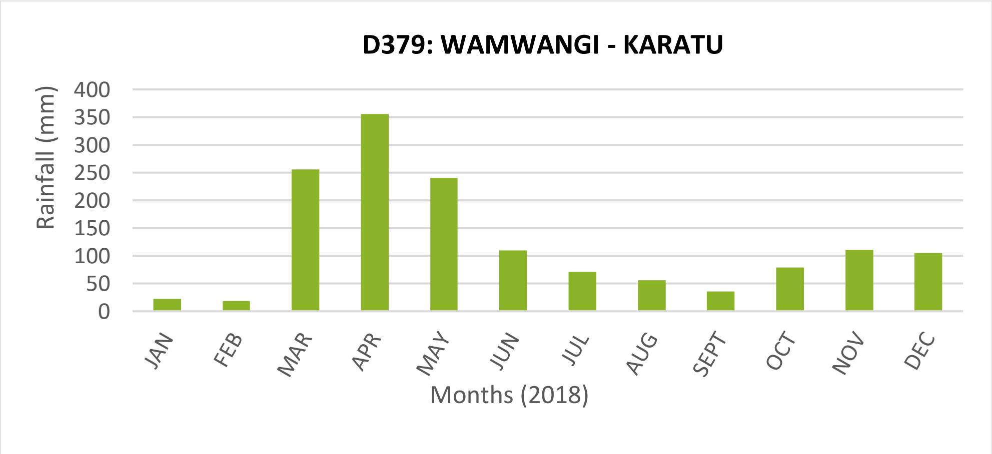
The length of the monitoring section is 400m.

Presently, the remaining section of the Wamwangi – Karatu road is under construction using the same standards as the trial section, except that bitumen emulsion is being used to stabilise the base. Initially, the road was upgraded to bitumen standard on the trial section only.

2.2 Climate

Rainfall data from the nearest weather station to the site are shown in Figure 2.1. The data was collected from a rain gauge that was installed at Wamwangi Secondary School. The months of March, April and May 2018 experienced heavy rainfall which is consistent with the trends within the region.

Figure 2.1: Rainfall Data from Wamwangi Secondary School Station



2.3 Design Details

2.3.1 Geometry

The carriageway width is 6 meters and there is no shoulder. The monitoring section is indicated by the blue line shown in Figure 2.2.

Figure 2.2: Monitoring section D379 on Wamwangi – Karatu road

2.3.2 Pavement design and surfacing

The pavement design and surfacing are shown in Figure 2.3.

Figure 2.3: Pavement design and surfacing (D379)

20 mm Cold Mix Asphalt	
160 mm neat quarry waste base	
220 mm granular sub-base (natural gravel)	
Subgrade	

The base was primed before surfacing.

The pavement was designed by Jon Hongve under AfCAP in 2012.

The traffic loading used for the design was 85,943 ESA over a design life of 15 years.

The pavement was designed according to Malawi DCP Pavement Design Manual Draft, 2011.

2.3.3 Construction

The trial section was built in 2012 by F.K Construction Company Limited.

The construction works were supervised by KeRRA Kiambu region.

The cost of construction was $ 52,052 (refer to **Error! Reference source not found.**).

2.3.4 Maintenance

The maintenance activities that have been carried out on the monitoring section since construction are summarised in Table 2.1.

Table 2.1: Maintenance activities

Period		Activities carried out	Maintenance cost (Kenya Shillings)	Maintenance cost USD
From	to			
Construction	Baseline survey	Crack sealing, Pothole patching and drainage clearing.	-	-
Baseline survey	1st monitoring survey	Bush Clearing and Drainage Cleaning.	240,800*	2,408*
1st monitoring survey	2nd monitoring survey	Bush Clearing and Drainage Cleaning.	240,800*	2,408*
2nd monitoring survey	3rd monitoring survey			
3rd monitoring survey	4th monitoring survey			

*Estimated amount[2]

2.4 Traffic

The traffic surveys carried out on the road are summarised in Table 2.2. The traffic survey was conducted during the month of October, 2018. The results and calculations of the survey are found in Annex 1.

Table 2.2: Traffic data

Mode	AADT (design)	AADT *[Baseline Survey]*	AADT *[First Monitoring]*	AADT *[Second Monitoring]*	Estimated total since construction
Motorcycle	258	320	391	427	591,300
Car	302	164	167	149	383,250
Minibus	366	10	22	24	19,163
Bus	3	0	0	0	-
Light Goods Vehicle	3	17	41	29	43,800
Medium Goods Vehicle	14	5	3	11	10,950
Heavy Goods Vehicle	2	1	0	0	365

[2] Source: KeRRA Maintenance Department.

Mode	AADT (design)	AADT *[Baseline Survey]*	AADT *[First Monitoring]*	AADT *[Second Monitoring]*	Estimated total since construction
Total motorised traffic	**948**	**517**	**624**	**640**	**1,048,828**
Total motorised traffic excluding motorcycles	**690**	**197**	**233**	**213**	**457,528**

There has been a gradual increase in the number of total motorised traffic excluding motorcycles, due to devolution, and proximity of the area to Gatundu Town.

2.5 Axle loads

The results of the axle load survey carried out on the road are summarised in Table 2.3 and Table 2.4. The calculations for the VEF and ESA per day are included in Annex 2. The ESA so obtained is for the central region of Kenya. The daily ESA increased from the baseline to the first monitoring round. The increase can be attributed to economic activity throughout the region and the fact that the roads have opened up rural areas to markets and other urban centres.

Table 2.3: Traffic loading [D379, First Monitoring]

Road	Mode	V.E.F.	Number of vehicles	Vehicle ESA [Estimated total since construction/mode]	Vehicle ESA [Estimated total since constructon]
D379	Bus	0.50	-	-	1029
	Medium Goods Vehicle	0.05	10,950	561.2	
	Heavy Goods Vehicle	1.28	365	467.6	

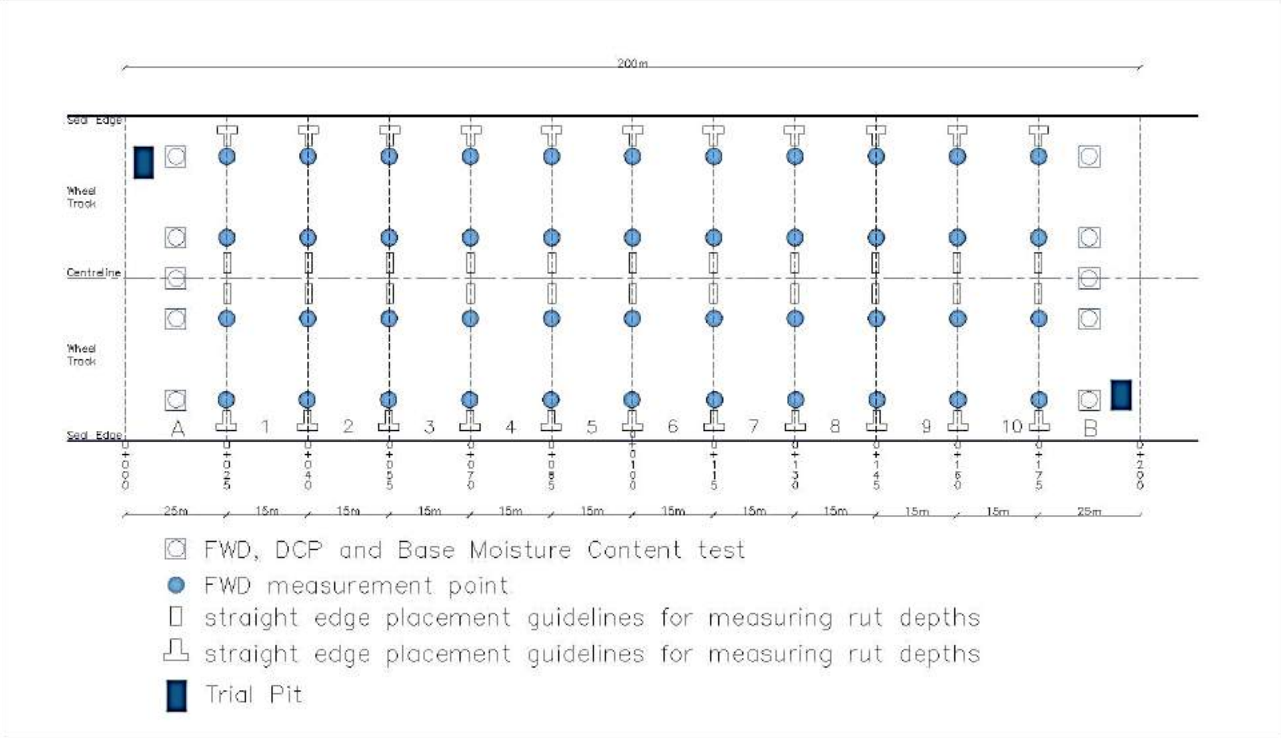
Table 2.4: Traffic loading [D379, Baseline Survey]

Road	Mode	V.E.F.	Number of vehicles	Vehicle ESA [Estimated total since construction/mode]	Vehicle ESA [Estimated total since construction]
D379	Bus	0.16	-	-	835
	Medium Goods Vehicle	0.06	10,950	696.2	
	Heavy Goods Vehicle	0.38	365	139.3	

2.6 Layout of monitoring section

The layout of the monitoring section is shown in Figure 2.4.

Figure 2.4: Layout of monitoring section



2.7 Drainage Assessment

The Drainage Assessment (h) measured in each panel is given in Table 2.5.

Table 2.5: Drainage Assessment [10th October 2018]

Chainage Km	LHS			RHS		
	Side ditch	Drainage structure	Shoulders	Shoulders	Drainage structure	Side ditch
0+000	Grassed	clogged	Grassed	Grassed	Clogged	Grassed
0+015	Grassed	No structure	Grassed	Edge breaking	No structure	Grassed
0+015 - 0+025	Light vegetation	No structure	Okay	Grassed	No structure	Grassed
0+025 - 0+040	Light vegetation	No structure	Okay	Grassed	No structure	Grassed
0+040 - 0+055	Light vegetation	No structure	Okay	Grassed	No structure	Grassed
0+055 - 0+070	Light vegetation	No structure	Okay	Grassed	No structure	Grassed
0+070 - 0+085	Light vegetation	No structure	Okay	Grassed	No structure	Grassed
0+085 - 0+100	Light vegetation	No structure	Okay	Grassed	No structure	Light Vegetation
0+100 - 0+115	Light vegetation	No structure	Okay	Grassed	Light Vegetation	Light Vegetation
0+115 - 0+130	Light vegetation	No structure	Okay	Grassed	Light Vegetation	Light Vegetation
0+130 - 0+145	Light vegetation	No structure	Okay	Grassed	Light Vegetation	Light Vegetation
0+145 - 0+160	Light vegetation	No structure	Okay	Grassed	No structure	Deposits

0+160 - 0+175	Light vegetation	No structure	Okay	Grassed	Okay	Deposits
0+190	Light vegetation	Okay	Okay	Grassed	Okay	Light Vegetation
0+175 - 0+200	Light vegetation	No structure	Okay	Grassed	No structure	Light Vegetation
0+200 - 0+250	Light vegetation	No structure	Okay	Grassed	No structure	Light Vegetation
0+250 - 0+300	Light vegetation	No structure	Okay	Grassed	No structure	Light Vegetation
0+300 - 0+350	Light vegetation	Okay	Okay	Grassed	Okay	Light Vegetation

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2.8 DCP tests (D379)

DCP Apparatus were used to carry out the tests. Across Africa Consultants team together with the MTRD team conducted the tests in this trial section. On the LTPP section, the DCP tests were carried out at five points in Panel A and B respectively. However, on the remaining sections of the road, the DCP tests were done at a 50m interval alternating between inner and outer wheel paths

The results of the DCP tests carried out on D379 are summarised in Table 2.8 , , . The field data and layer strength diagrams are given in Annex 3.

Except for the baseline survey that showed the average DN value for the base layer outside the design specification, all the other layers are within the specification envelope.

Table 2.6: DCP tests on the D379 [*Baseline / Wet Season]*

Chainage	Location of test	DN_{base} (mm)		$DN_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN 450 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+010	OWR	4.0	6.2	9.0	10.6	19.0	19.6	50.0	27.9
0+010	IWR	4.0	2.7	9.0	3.9	19.0	8.9	50.0	7.9
0+010	IWL	4.0	3.5	9.0	2.7	19.0	8.8	50.0	16.0
0+010	OWL	4.0	3.5	9.0	3.5	19.0	5.2	50.0	12.6
0+010	CL	4.0	5.7	9.0	7.2	19.0	12.2	50.0	13.0
0+012	RHS	4.0	7.6	9.0	9.8	19.0	17.7	50.0	33.9
0+186	CL	4.0	3.3	9.0	3.2	19.0	5.7	50.0	9.9
0+186	OWL	4.0	2.9	9.0	2.7	19.0	5.8	50.0	13.5
0+186	IWL	4.0	2.6	9.0	3.4	19.0	5.1	50.0	10.9
0+186	IWR	4.0	4.3	9.0	3.2	19.0	6.7	50.0	19.6
0+186	OWR	4.0	9.8	9.0	11.6	19.0	20.5	50.0	36.2
0+194	CL	4.0	1.9	9.0	2.5	19.0	3.6	50.0	2.9
0+250	RHS	4.0	6.5	9.0	11.6	19.0	9.7	50.0	22.1
0+300	CL	4.0	8.1	9.0	8.7	19.0	9.8	50.0	16.4
0+350	RHS	4.0	1.9	9.0	2.0	19.0	4.2	50.0	10.0
Average		**4.0**	**4.7**	**9.0**	**5.8**	**19.0**	**9.6**	**50.0**	**16.9**

Table 2.7: DCP tests on the D379 [*First Monitoring / Wet Season*]

Chainage	Location of test	DN_{base} (mm)		$DN_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN 450 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual

0+000	CL	4.0	4.7	9.0	6.5	19.0	7.4	50.0	13.6
0+020	CL	4.0	2.2	9.0	2.3	19.0	5.8	50.0	12.0
0+020	RHS	4.0	1.7	9.0	3.3	19.0	6.5	50.0	12.2
0+020	RHS	4.0	4.3	9.0	6.5	19.0	11.1	50.0	26.4
0+020	CL	4.0	2.3	9.0	3.2	19.0	3.6	50.0	9.1
0+020	CL	4.0	2.0	9.0	2.6	19.0	4.7	50.0	12.2
0+195	LHS	4.0	1.7	9.0	2.7	19.0	5.1	50.0	9.6
0+195	CL	4.0	2.1	9.0	3.1	19.0	5.9	50.0	11.3
0+195	RHS	4.0	3.7	9.0	4.9	19.0	7.2	50.0	14.7
0+195	LHS	4.0	1.8	9.0	2.8	19.0	5.8	50.0	6.6
0+250	RHS	4.0	2.7	9.0	3.8	19.0	4.6	50.0	9.6
0+300	CL	4.0	1.8	9.0	3.0	19.0	3.4	50.0	5.4
0+350	RHS	4.0	2.2	9.0	2.7	19.0	3.2	50.0	9.4
Average		**4.0**	**2.5**	**9.0**	**3.6**	**19.0**	**5.7**	**50.0**	**11.8**

Table 2.8 : DCP tests on the D379 [*Second Monitoring / Dry Season*]

Chainage	Location of test	DN$_{base}$ (mm)		DN$_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN 450 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+015	CL	4.0	3.3	9.0	6.9	19.0	7.0	50.0	15.0
0+015	CL	4.0	2.2	9.0	2.4	19.0	5.1	50.0	12.9
0+015	LHS	4.0	3.1	9.0	2.2	19.0	5.4	50.0	12.8
0+015	RHS	4.0	2.3	9.0	3.1	19.0	12.5	50.0	32.9
0+015	RHS	4.0	4.4	9.0	7.9	19.0	15.3	50.0	34.3
0+185	CL	4.0	2.0	9.0	4.1	19.0	6.1	50.0	12.3
0+185	CL	4.0	2.1	9.0	2.7	19.0	7.4	50.0	18.7
0+185	LHS	4.0	1.8	9.0	3.5	19.0	7.7	50.0	15.8
0+185	RHS	4.0	2.6	9.0	3.6	19.0	7.0	50.0	16.6
0+185	RHS	4.0	4.4	9.0	6.6	19.0	14.7	50.0	29.8
0+250	RHS	4.0	3.5	9.0	6.8	19.0	9.1	50.0	28.9
0+300	LHS	4.0	2.7	9.0	3.2	19.0	4.0	50.0	9.1
0+350	CL	4.0	3.1	9.0	4.5	19.0	9.9	50.0	25.5
Average		**4.0**	**2.9**	**9.0**	**4.4**	**19.0**	**8.5**	**50.0**	**20.3**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

2.9 Deflection measurements (D379)

Defection was measured using the Falling Weight Deflectometer (FWD) at 50 m intervals along the road, alternating between the outer wheel path and the inner wheel path. A large circular weight was used to transmit a pressure of 566 kPa to the pavement. The load imparted on the pavement therefore was measured and the stiffness parameters calculated.

The results of deflection tests carried out on the road are summarised in Table 2.10 and .

Lane 1 represents the outer LHS wheel path, Lane 2 represents the outer RHS wheel path, Lane 3 represents the inner LHS wheel path and Lane 4 represents the inner RHS wheel path.

As can be seen, the average maximum deflection has increased from 772 in baseline survey to 935 during first monitoring round.

Table 2.9: Deflection tests on the road [Baseline]

Chainage (m)	Lane No.	Elastic modulus			Normalized Deflections at Geophone Locations (µm)
		E-Base (MPa)	E-Subbase (MPa)	E-Subgrade (MPa)	D_0
0+000	1	162	125	128	727
0+017	1	9549	13706	18	598
0+030	1	416	51	115	799
0+045	1	1653	300	127	429
0+060	1	207	152	102	756
0+075	1	269	184	96	697
0+090	1	300	200	93	664
0+106	1	471	62	97	792
0+120	1	576	98	101	708
0+128	1	131	110	100	941
0+135	1	352	36	125	855
0+150	1	326	39	116	923
0+155	1	143	126	99	937
0+165	1	406	76	135	836
0+170	1	106	93	98	875
0+180	1	163	125	114	796
0+185	1	192	145	127	719
0+194	1	171	140	108	878
0+195	1	154	119	111	849
0+225	1	137	113	108	795
0+251	1	422	44	169	695
0+275	1	300	200	141	531
0+300	1	422	62	116	762
0+325	1	158	125	133	654
0+350	1	634	46	169	590
0+000	4	211	155	103	789
0+009	4	198	148	91	829
0+025	4	211	154	96	786
0+040	4	256	183	77	861
0+053	4	229	171	77	870
0+070	4	1234	210	97	819
0+085	4	183	146	86	903
0+101	4	160	129	101	876

0+115	4	270	185	96	708
Average		**269**	**129**	**108**	**772**

Table 2.10: Deflection tests on the road [First Monitoring]

Chainage (m)	Lane No.	Elastic modulus			Normalized Deflections at Geophone Locations (µm)
		E-Base (MPa)	E-Subbase (MPa)	E-Subgrade (MPa)	D_0
0+020	1	300	200	109	714
0+040	1	205	157	76	1128
0+070	1	235	165	92	892
0+100	1	300	200	113	791
0+115	1	300	200	109	782
0+130	1	246	175	88	914
0+145	1	1034	186	97	1017
0+160	1	206	147	88	1023
0+174	1	300	200	122	799
0+195	1	550	32	108	1044
0+201	1	1083	193	121	786
0+250	1	750	88	198	590
0+301	1	173	108	154	594
0+350	1	193	142	133	833
0+020	2	2069	343	80	835
0+025	2	300	200	101	833
0+041	2	1048	182	98	1009
0+071	2	211	156	86	1072
0+101	2	570	102	108	862
0+116	2	544	91	123	796
0+131	2	241	172	82	990
0+146	2	351	21	149	1177
0+161	2	1157	197	95	1041
0+175	2	588	38	129	892
0+195	2	159	120	74	1189
0+202	2	80	55	98	1086
0+251	2	419	43	181	880
0+302	2	449	62	130	856
0+352	2	535	106	132	960

0+021	3	223	159	80	1007
0+055	3	161	122	75	879
0+085	3	275	188	89	1037
0+117	3	235	176	87	898
0+147	3	552	109	100	1094
0+176	3	391	40	106	1189
0+195	3	1995	326	74	1182
0+252	3	406	69	114	948
0+020	4	235	168	90	1033
0+026	4	1106	197	117	845
0+056	4	487	61	97	970
0+086	4	223	164	87	990
0+195	4	266	185	115	839
Average		**504**	**144**	**107**	**936**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

2.10 Comparison of DN and deflection measurements

A comparison between DN values and deflection measurements is not possible as the measurements were taken at different locations.

2.11 Test pit

2.11.1 General information

Table 2.11 provides general information on the test pits excavated on the monitoring section.

Table 2.11: Test pit data

	Test Pit No.	Panel No.	Location	Date of excavation	Season
Baseline Survey	TPA-1-16	A	Right	27/10/2016	Dry Season
	TPB-1-16	B	Left	28/10/2016	
First Monitoring	TPA-1-17	A	Left, Centre, Right	01/7/2017	Wet Season
	TPB-1-17	B	Left, Centre, Right	02/7/2017	
Second Monitoring	TP1	A	N/A	N/A	N/A
	TP2	B	N/A	N/A	

2.11.2 In situ DCP tests

Table 2.11 provides a summary of DCP tests carried out in the test pit before excavation. Baseline DN values for base and subbase for TP1 were higher than the design specification but lower during the first monitoring round. This implies that the base and subbase layers of the trial section have become stronger with time.

Table 2.12: DN values for pavement layers in the test pit

	Test Pit No.	DN_{base}	$DN_{sub-base}$	$DN_{300-450}$	$DN_{450-800}$
Baseline Survey	TPA-1-16	4.7	14.1	14.2	14.2
	TPB-1-16	3.4	6.2	6.7	9.5
	Specification	**4.0**	**9.0**	**19.0**	**50.0**
First Monitoring	TPA-1-17	2.2	2.9	3.7	10.5
	TPB-1-17	1.5	2.5	4.7	9.6
	Specification	**4.0**	**9.0**	**19.0**	**50.0**
Second Monitoring	N/A	N/A	N/A	N/A	N/A

2.11.3 Layer density and moisture content

The density of the pavement layers and moisture content are summarised in Table 2.13.

The in-situ moisture content was established from samples taken to the laboratory. The insitu moisture content increases with depth.

Table 2.13: Density and moisture content (D379)

	Test Pit		Layer	Dry density (kg/m³)	MDD (kg/m³)	Relative density (%)	In situ moisture content (%)	OMC (%)	In situ moisture content as proportion of OMC
Second Monitoring	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A
First Monitoring (wet season)	TPA-1-16	OWP	Base	-	-	-	9.8	17.2	0.57
			Sub-base	-	-	-	10.6	20.3	0.52
			Subgrade	-	-	-	25.2	32.0	0.79
		IWP	Base	-	-	-	7.2	13.5	0.53
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	-	-	-
	TPA-2-16	OWP	Base	-	-	-	7.2	18.3	0.39
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	25.0	34.4	0.73
		IWP	Base	-	-	-	8.3	16.9	0.49
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	-	-	-
Baseline Survey (wet season)	TPB-1-16	OWP	Base	-	1845	-	12.4	17.2	0.72
			Sub-base	-	1540	-	22.7	20.3	1.12
			Subgrade	-	1320	-	30.8	32.0	0.94
		IWP	Base	-	1880	-	11.9	13.5	0.88
			Sub-base	-	1500	-	24.1	21.5	1.12
			Subgrade	-	1300	-	30.3	33.2	0.91
	TPB-2-16	OWP	Base	-	1685	-	15.9	18.3	0.87
			Sub-base	-	1530	-	20.7	29.6	0.70
			Subgrade	-	1210	-	31.2	34.4	0.91
		IWP	Base	-	1775	-	14.1	16.9	0.83
			Sub-base	-	1475	-	20.3	23.3	0.87
			Subgrade	-	1320	-	28.7	33.2	0.86

Notes:

1. The method of notation for the Test Pits is as follows: TPA-1-16: TP is test pit; 1 means the first test pit on panel A on extreme left; A is Panel A of the monitored section; and 16 is the year 2016 when the test pits were carried out.
2. For the First Monitoring Round, the moisture contents were taken in the base, sub-base and subgrade in the outer wheel path but in the inner wheel path moisture contents were taken in the base only.

The moisture content of the pavement reduced from the baseline to the first monitoring round, which is the likely reason for higher strengths recorded with the DCP.

2.11.4 Test pit log

The test pit logs are summarised in Table 2.14. The moisture, colour, consistency, structure, soil type and origin are described using the standard terms in the regional monitoring guideline.

Table 2.14: Test pit logs

Test Pit	Layer	Thickness mm	Moisture (first monitoring)	Moisture (baseline survey)	Colour	Consistency	Structure	Soil type	Origin	AASHTO soil classification
TPA-1-16	Surface	25	-	-	Black	Extremely hard		Cold Mix Asphalt	Local	n/a
	Base	160	9.8	12.4	Rusty red	Very hard		Neat laterite	Local	n/a
	Subbase	150	10.6	22.7	Light grey	Very hard		Granular material	Local	n/a
	Subgrade	-	25.2	30.8	Brown	hard		Natural occurring	Local	n/a
TPB-1-16	Surface	20	-	-	Black	Extremely hard		Cold Mix Asphalt	Local	n/a
	Base	140	7.2	15.9	Rusty red	Very hard		Neat laterite	Local	n/a
	Subbase	150	-	20.7	Light grey	Very hard		Granular material	Local	n/a
	Subgrade	-	25	31.2	Brown	hard		Natural occurring	Local	n/a

2.11.5 Base material properties

The properties of the base course material are summarised in Table 2.15.

Table 2.15: Base material properties (baseline survey)

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T180
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	75	50	38	44	24	20	1845	17.2	OWP = 25 IWP = 25
TPB-1-16	60	45	35	50	26	24	1685	18.3	OWP = 20 IWP = 20

The material used for the base layer is within the design specification.

2.11.6 Sub-base material properties

The properties of the sub-base material are summarised in Table 2.16.

The DN value is reported at the expected in-service moisture content.

Table 2.16: Sub-base material properties (baseline survey)

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T180
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	80	70	65	52	25	27	1540	20.3	OWP = 8 IWP = 9
TPB-1-16	80	70	65	51	25	26	1530	29.6	IWP = 6 OWP = 10

The material used for the sub-base layer is within the design specification.

2.11.7 Subgrade material properties

The properties of the Subgrade material are summarised in Table 2.17.

Table 2.17: Subgrade material properties (Baseline survey)

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T99
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	83	80	80	69	39	30	1320	32	OWP = 4 IWP = 3
TPB-1-16	80	80	70	69	39	30	1210	34.4	OWP = 3 IWP = 5

The material used for the subgrade layer is within the design specification.

2.11.8 Particle Size Distribution

The PSD for the base course and subbase material in each TP, compared with the specification envelope, are shown in Figure 2.5 and

Figure 2.6. The base and subbase materials all fit into the specification envelope as specified in ASTM D2940.

Figure 2.5: PSD for base course in TPA-1-16 and TPB-1-16

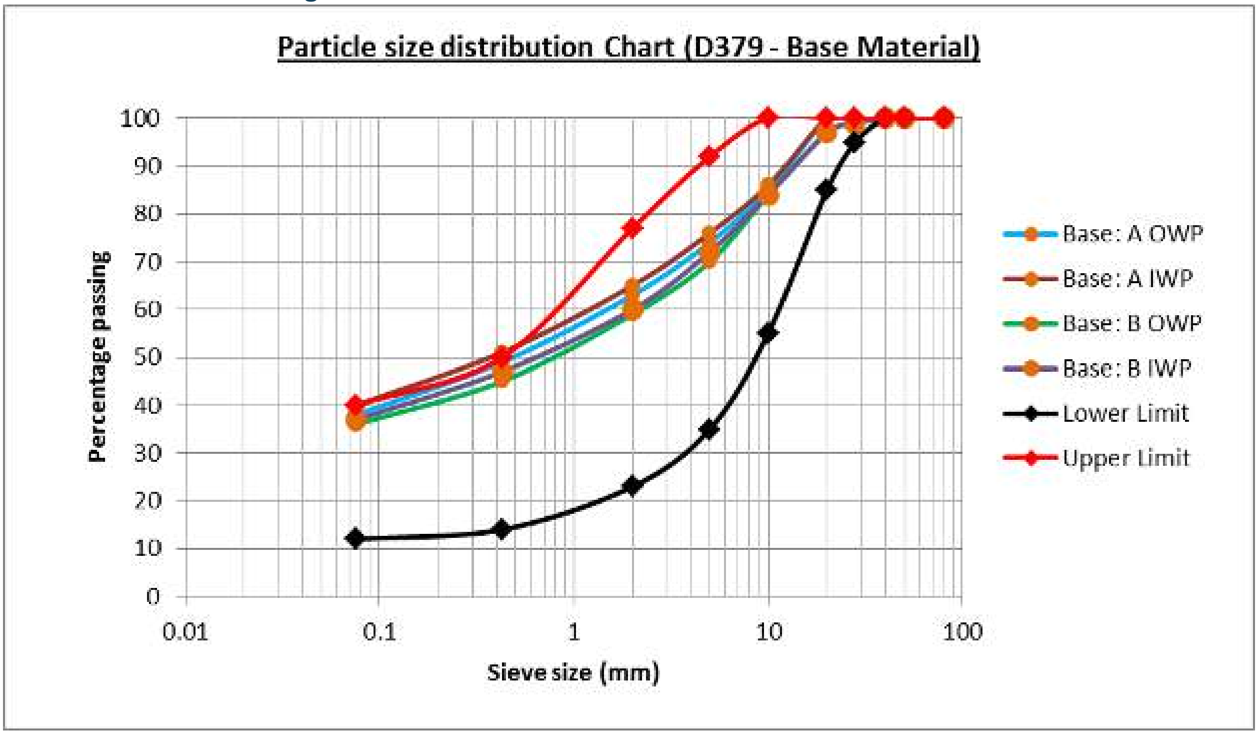
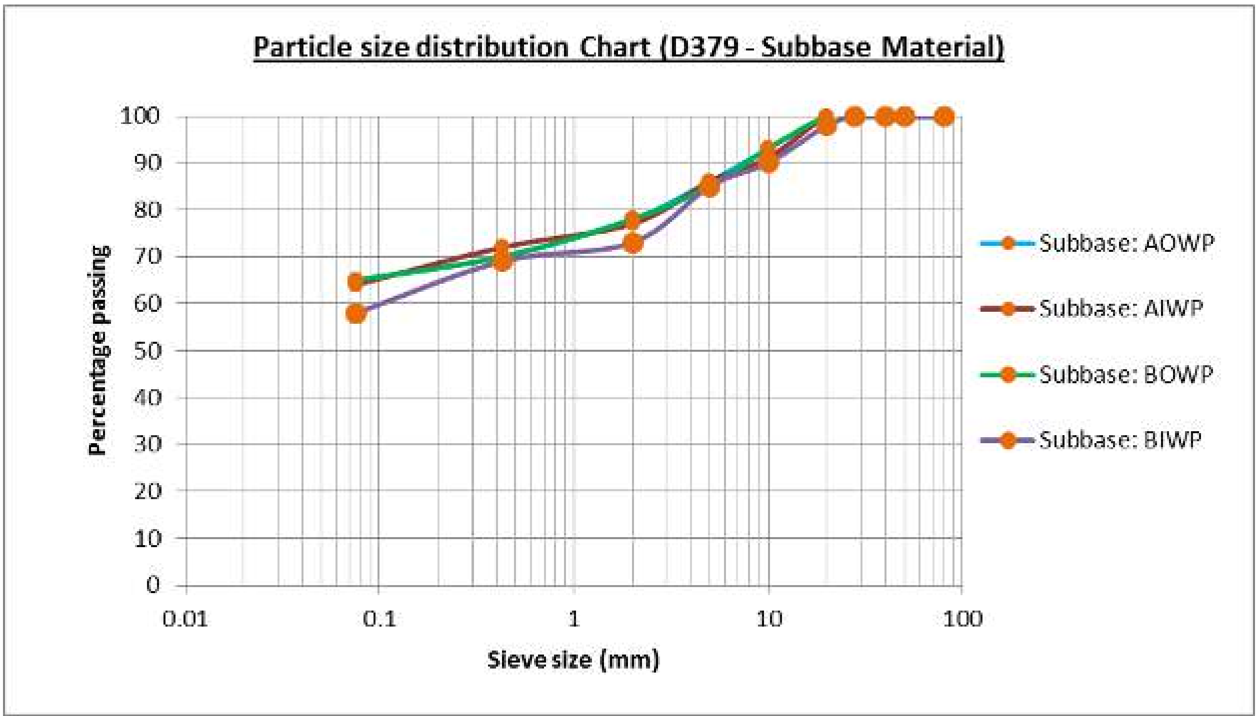


Figure 2.6: PSD for sub-base course in TPA-1-16 and TPB-1-16



2.11.9 Other TP tests

n/a

2.11.10 Discussion on test pit results

[*summarise the findings of the TP investigations including the comparison of layer thickness and materials properties to the specification and any lessons learnt for LVR pavement design*]

2.12 Rut depth

The rut depth measurements taken on the monitoring section are summarised in Table 2.18. The average rut has been decreasing over the years, which is a strange observation. We aim at making a concrete conclusion after the fourth round of monitoring. Needless to say, the rut depth measured is barely visible to the naked eye.

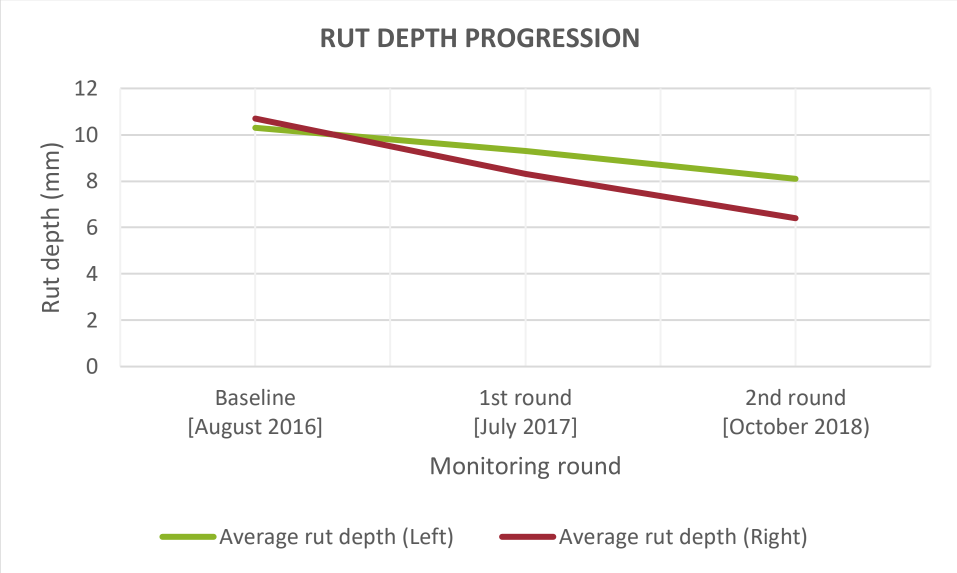
The Field data are given in Annex 4.

Table 2.18: Rut depth

Panel	Baseline [*August 2016*]		1st round [*July 2017*]				2nd round [Oct. 2018]				3rd round [*date*]	
	Left (mm)	Right (mm)	Left (mm)		Right (mm)		Left (mm)		Right (mm)		Left (mm)	Right (mm)
1	13	12	OWL	17	OWR	18	OWL	13	OWR	8		
2	7	9	OWL	8	OWR	10	OWL	13	OWR	5		
3	12	12	OWL	11	OWR	12	OWL	10	OWR	8		
4	11	10	OWL	13	OWR	6	IWL	11	OWR	3		
5	8	12	OWL	8	OWR	1	OWL	8	OWR	2		
6	10	10	OWL	9	OWR	7	IWL	8	OWR	5		
7	12	12	OWL	8	OWR	7	IWL	8	OWR	8		
8	12	11	OWL	8	OWR	10	IWL	6	OWR	8		
9	6	12	OWL	8	OWR	3	OWL	4	OWR	8		
10	12	7	OWL	3	OWR	9	OWL	0	OWR	9		
Average	10	11	9		8		8		6			
Average for section	**11**		**9**				**7**					

Figure 2.7 shows the rut depth progression over the monitoring period. The recorded rut depth in the worst of the inner wheel path and outer wheel path.

Figure 2.7: Rut depth progression (D379)



2.13 Deflection measurements (D379)

The results of deflection tests carried out on the monitoring section are summarised in Table 2.19 and .

Table 2.19: Deflection results on the monitoring section and elastic modulus (D379; First Monitoring)

Panel number	Location of test	D_0 (µm)	E_{base} (MPa)	$E_{sub\text{-}base}$ (MPa)	$E_{subgrade}$ (MPa)
1	IWL	833	300	200	101
	OWR	845	1106	197	117
2	OWL	1128	205	157	76
	IWL	1009	1048	182	98
3	IWR	879	161	122	75
	OWR	970	487	61	97
4	OWL	892	235	165	92
	IWL	1072	211	156	86
5	IWR	1037	275	188	89
	OWR	990	223	164	87
	OWL	791	300	200	113
6	IWL	862	570	102	108
	OWL	782	300	200	109
7	IWL	796	544	91	123
	IWR	898	235	176	87
8	OWL	914	246	175	88
	IWL	990	241	172	82
9	OWL	1017	1034	186	97
	IWL	1177	351	21	149
	IWR	1094	552	109	100
10	OWL	1023	206	147	88
	IWL	1041	1157	197	95
	OWR	799	300	200	122

	IWR	892	588	38	129
Average		**947.1**	**453.1**	**150.3**	**100.3**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

[*the location of the tests depends on the layout of the monitoring section*]

[*if the deflection tests were carried out during the current round of monitoring include the outputs from the FWD for all the sensors (D_0 up to D_6) in an annex and provide a reference to the annex*].

2.14 Comparison of deflection and rutting

Table 2.21 shows the deflections (D_0) and rut depths measured in each panel on the monitoring section for the first monitoring round of survey. shows the deflections (D_0) and rut depths measured in each panel on the monitoring section for baseline survey.

Table 2.20: Deflection results on the monitoring section and elastic modulus (D379; Baseline Survey)

Panel number	Location of test	D0 (µm)	Ebase (MPa)	Esub-base (MPa)	Esubgrade (MPa)
1	OWR	786	211	154	96
	OWL	799	416	51	115
2	OWR	861	256	183	77
	OWL	429	1653	300	127
3	OWR	870	229	171	77
	OWL	756	207	152	102
4	OWR	819	1234	210	97
	OWL	697	269	184	96
5	OWR	903	183	146	86
	OWL	664	300	200	93
6	OWR	876	160	129	101
	OWL	792	471	62	97
7	OWR	708	270	185	96
	OWL	708	576	98	101
8	OWR	941	131	110	100
	OWL	855	352	36	125
9	OWR	923	326	39	116
	OWL	937	143	126	99
10	OWR	836	406	76	135
	OWL	875	106	93	98
Average		**801.8**	**395.0**	**135.3**	**101.7**

Table 2.21: Deflection and rut depth measurements (First Monitoring)

Panel number	Location of test	D_0 (µm)		Rut depth (mm)		
		First Monitoring	Average for panel	Left	Right	Average
1	IWL	833	839.0	17	18	17.5
	OWR	845				
2	OWL	1128	1068.5	8	10	9
	IWL	1009				
3	IWR	879	924.5	11	12	11.5
	OWR	970				
4	OWL	892	982.0	13	6	9.5
	IWL	1072				
5	IWR	1037	939.3	8	1	4.5
	OWR	990				
	OWL	791				
6	IWL	862	822.0	9	7	6
	OWL	782				
7	IWL	796	847.0	8	7	7
	IWR	898				
8	OWL	914	952.0	8	10	8
	IWL	990				
9	OWL	1017	1096.0	8	3	9
	IWL	1177				
	IWR	1094				
10	OWL	1023	938.8	3	9	6
	IWL	1041				
	OWL	799				
	IWL	892				
Average		**947.1**	**940.9**	**9.3**	**8.3**	**8.8**

and Figure 2.8 shows the relationship between deflection and rut depth measurements on the monitoring section. There is no clear correlation between rut depth and deflection at this stage of the life of the pavement.

Figure 2.8: Correlation between deflection (D_o) and rut depth (Baseline survey)

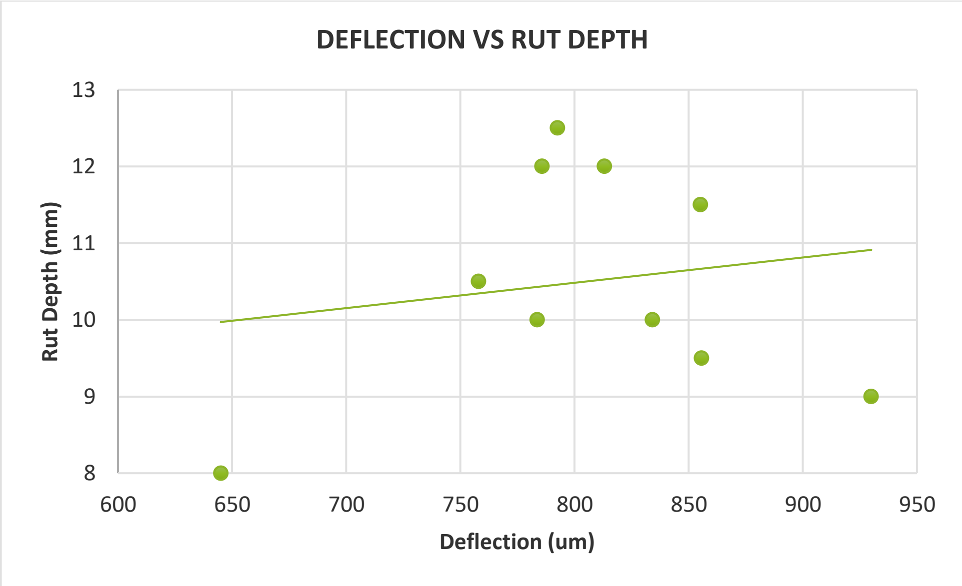
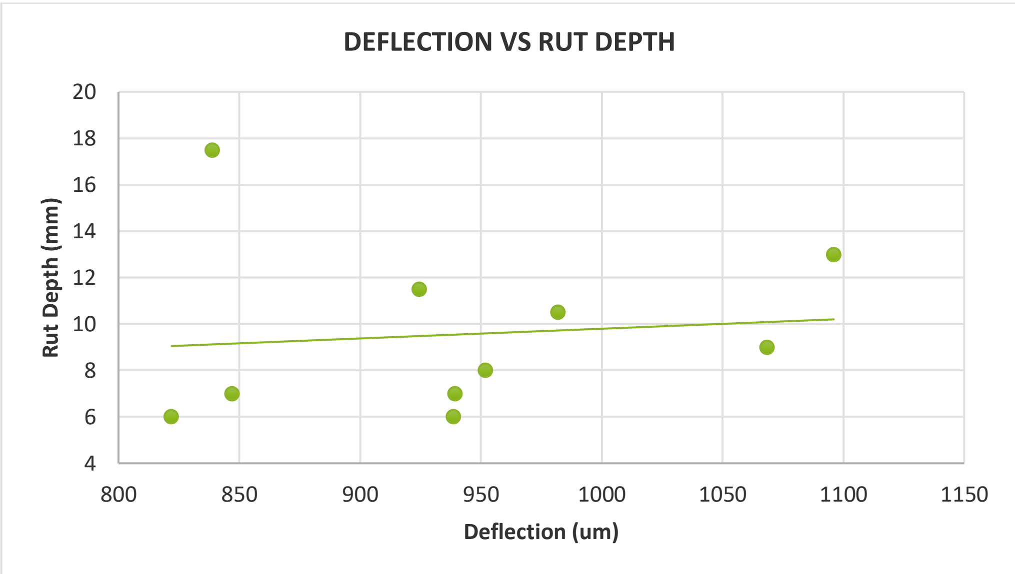


Figure 2.9: Correlation between deflection (D_o) and rut depth (First Monitoring)



2.15 Roughness

and Table 2.22 shows the roughness (IRI) measured on the monitoring section at each round of monitoring. The roughness was measured using DRIMS apparatus. Analysis done was only up to chainage 0+085 on the RHS. All roughness outputs are found in Annex 5.

Table 2.22: Roughness measurements

Monitoring round	Date	Left side		Right side		Average IRI (m/km)
		Chainage	IRI (m/km)	Chainage	IRI (m/km)	
Baseline		0+000-0+017	3.2	0+000-0+009	2.1	

	12th Jun - 20th Jun 2017	0+017-0+045	3.2	0+009-0+025	2.1	
		0+045-0+075	3.2	0+025-0+053	2.1	
		0+075-0+128	3.2	0+053-0+070	2.1	
		0+128-0+155	3.2	0+070-0+085	2.1	
		0+155-0+194				
		0+194-0+300				
		0+300-0+350				

Table 2.23: Roughness measurements

Monitoring round	Date	Left side		Right side		Average IRI (m/km)
		Chainage	IRI (m/km)	Chainage	IRI (m/km)	
Second Monitoring	1st October 2018	0+000-0+100	3.4	0+000-0+100	3.6	3.5
		0+100-0+200	3.5	0+100-0+200	3.4	3.5
		0+200-0+300	3.4	0+200-0+300	3.4	3.4
		0+300-0+400	3.6	0+300-0+400	3.5	3.6

and Figure 2.10 shows the roughness progression over the monitoring period.

Figure 2.10: Roughness progression (Baseline survey)

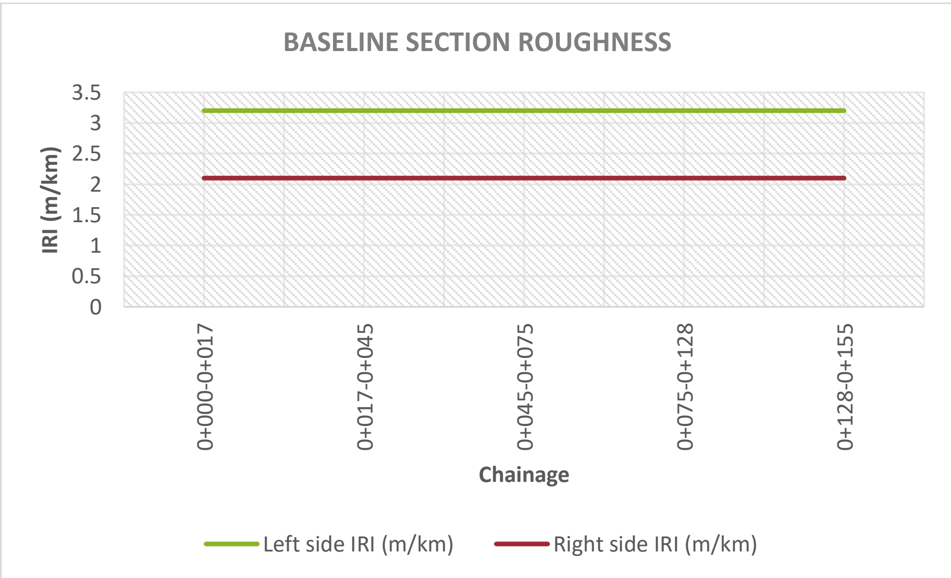
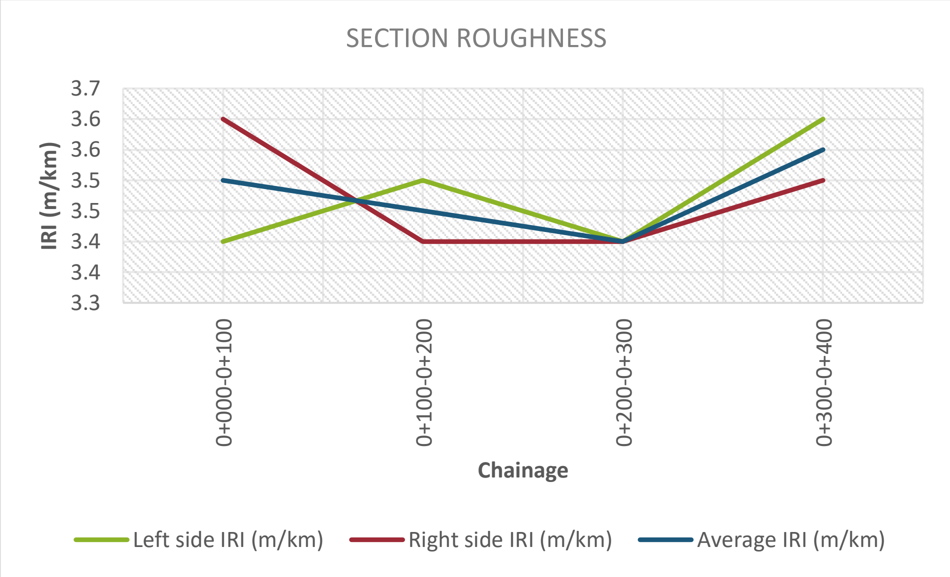


Figure 2.11: Roughness progression (Second monitoring)



2.16 Present serviceability rating

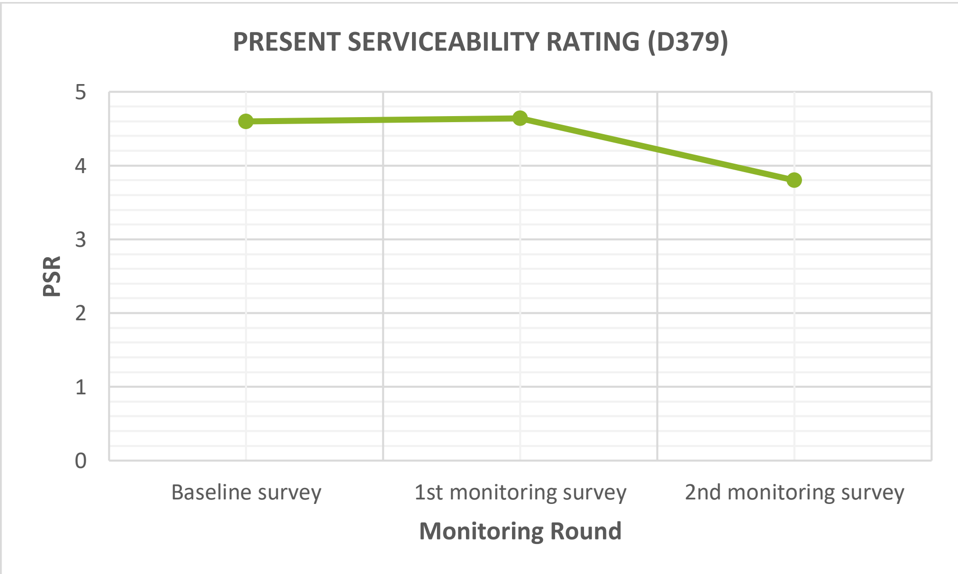
The PSR has been calculated with a scale of (1 to 5), monitoring section. Table 2.24 shows the PSR for each round of monitoring. The PSR values are for the whole trial section and not just the LTPP section. Field data for PSR are included in Annex 6.

Table 2.24: Present Serviceability Rating (D379)

Road	Baseline survey	1st monitoring survey	2nd monitoring survey	3rd monitoring survey	4th monitoring survey
D379	4.6	4.6	3.8		

The variation of the average PSR for the monitoring rounds carried out to date is shown in Figure 2.12

Figure 2.12: Variation in PSR over the monitoring rounds



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Typical photographs of defects on the monitoring section are included in Figure 2.13.

Figure 2.13: Typical defects

Fig No	Location (Km)	Defect assessment and description	Photos illustrating the pavement distress & defect
Fig 1	Km 0+000 – 0+020 main carriage way	-Blocked drainage structure, light vegetation at the shoulder and sealed cracks at the carriage way	
Fig 2	Km 0+000-0+030 LHS	- Sealed longitudinal cracks on the carriage way.	

Fig3	Km 0+050 main carriage way at the centreline	-Sealed longitudinal cracks and light vegetation at the side drains	
Fig 4	Km 0+130– 0+145 main carriage way at the centreline	-Sealed Longitudinal cracks and light vegetation at the side drains	
Fig 5	Km 0+160 – 0+175RHS	-Partially blocked culvert	

Fig6	km 0+220 – 0+300	-No visible defect	
Fig 7	Km 0+330- 0+345	-Sealed Transverse cracks on carriage way RHS and light vegetation at the shoulders and side drains	

3 Monitoring Section 2: Total – Kona Mbaya Road D382

3.1 Location

The start of the monitoring section is at chainage 0+200 from the start of the road, which is along Total – Kona Mbaya Road

The GPS coordinates at the start of the monitoring section are:

South: 0°0'12.87"

East: 36°20'41.20"

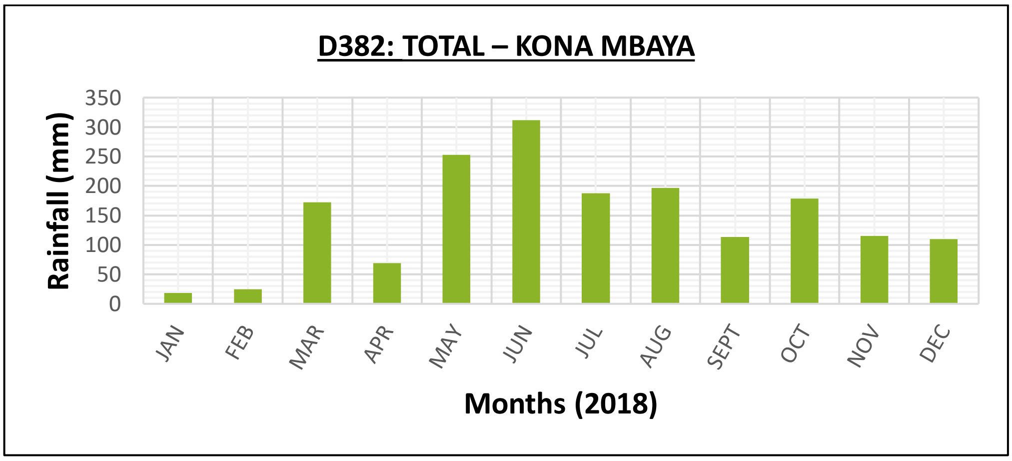
The length of the monitoring section is 950m.

The trial section is part of a longer road that has already been constructed.

3.2 Climate

Rainfall data from the nearest weather station to the site are shown in Figure 3.1 Very little rains were witnessed in January and February. The month of June experienced the highest rainfall intensity.

Figure 3.1: Rainfall Data from Baraka Academy School Station

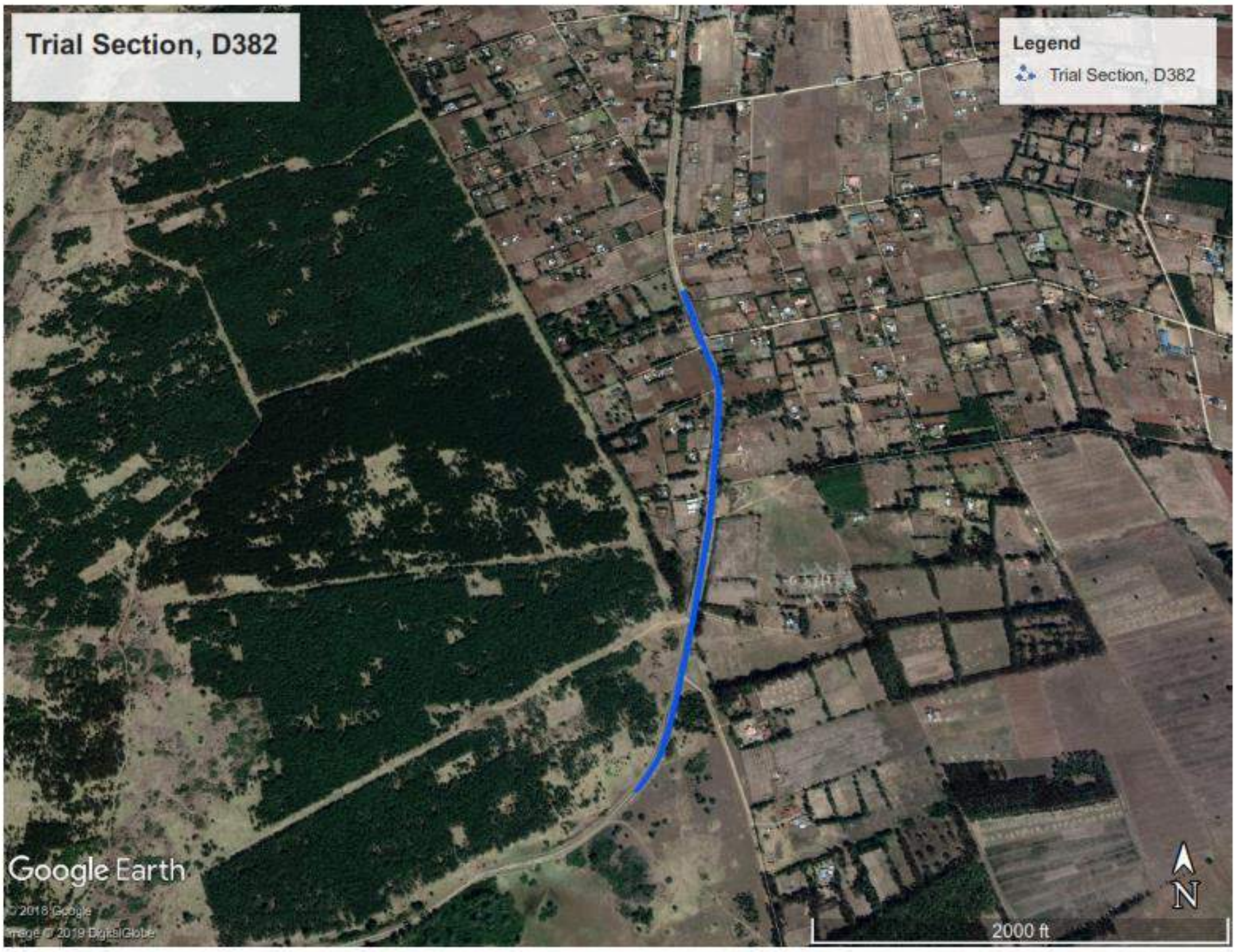


3.3 Design Details

3.3.1 Geometry

The carriageway width is 6 meters and there is no shoulder. The monitoring section is indicated in the blue line shown in Figure 3.2.

Figure 3.2: Monitoring section D382 on Total – Kona Mbaya Road



3.3.2 Pavement design and surfacing

The pavement design and surfacing are shown in Figure 3.3.

Figure 3.3: Pavement design and surfacing(D382)

20 mm Cold Mix Asphalt	
140 mm Neat quarry waste base	
260 mm Granular sub-base	
Subgrade	

The base was primed before surfacing.

The pavement was designed by Jon Hongve under AfCAP in 2012.

The traffic loading used for the design was 294,643 CESA over a design life of 15 years.

The pavement was designed according to Malawi DCP Pavement Design Manual Draft, 2011.

3.3.3 Construction

The trial section was built in 2012.

The construction works were supervised by KeRRA Nyandarua region.

The cost of construction was $ 132,555 (refer to **Error! Reference source not found.**).

A major challenge that the contractor faced during construction is the appearance of shrinkage cracks, which prompted the contractor to seal the cracks during the defect liability period.

3.3.4 Maintenance

The maintenance activities that have been carried out on the monitoring section since construction are summarised in Table 3.1.

Table 3.1: Maintenance activities

Period		Activities carried out	Maintenance cost [*local currency*]	Maintenance cost USD
From	to			
Construction	Baseline survey	*Crack sealing, Pothole patching and drainage clearing.*	-	-
Baseline survey	1st monitoring survey	*Bush Clearing and Drainage Cleaning.*	600,000*	6,000*
1st monitoring survey	2nd monitoring survey	*Bush Clearing and Drainage Cleaning.*	600,000*	6,000*
2nd monitoring survey	3rd monitoring survey			
3rd monitoring survey	4th monitoring survey			

*Estimated amount

3.4 Traffic

The traffic surveys carried out on the road are summarised in Table 3.2. The traffic survey was conducted during the month of October, 2018. The results and calculations of the survey are found in Annex 1.

Table 3.2: Traffic data

Mode	AADT (design)	AADT *[Baseline survey]*	AADT *[First Monitoring]*	AADT *[Second Monitoring]*	Estimated total since construction
Motorcycle	302	4703	484	629	517,388
Car	86	617	157	170	284,700
Minibus	177	195	138	127	350,400
Bus	1	29	1	1	87,600
Light Goods Vehicle	5	134	68	42	262,800
Medium Goods Vehicle	43	103	4	50	9,125
Heavy Goods Vehicle	5	9	0	0	21,900
Total motorised traffic	**619**	**5791**	**853**	**1021**	**1,533,913**
Total motorised traffic excluding motorcycles	**317**	**1088**	**369**	**392**	**1,016,525**

The number of motorcycles using this road is quite high. This is because of the origin of the road (Nyahururu town), to and from which people travel a lot as they go about their daily businesses such as shopping, reporting to work, going to school, going to hospital, etc

3.5 Axle loads

The results of the axle load survey carried out on the road are summarised in Table 3.3 and Table 3.4. The calculations for the VEF and ESA per day are represented in Annex 2. The ESA so obtained is for the central region of Kenya. Comparatively, the daily ESA has increased as can be seen from the survey conducted during baseline and the most recent one, first monitoring round. The increase can be attributed to economic activity throughout the region and the fact that the roads have opened up rural areas to markets and other urban centres.

Table 3.3: Traffic loading [D382, First Monitoring]

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction/modes]	Vehicle ESA [Estimated total since construction]
D382	Bus	0.50	87,600	44,029.4	72,555
	Medium Goods Vehicle	0.05	9,125	467.6	
	Heavy Goods Vehicle	1.28	21,900	28,058.2	

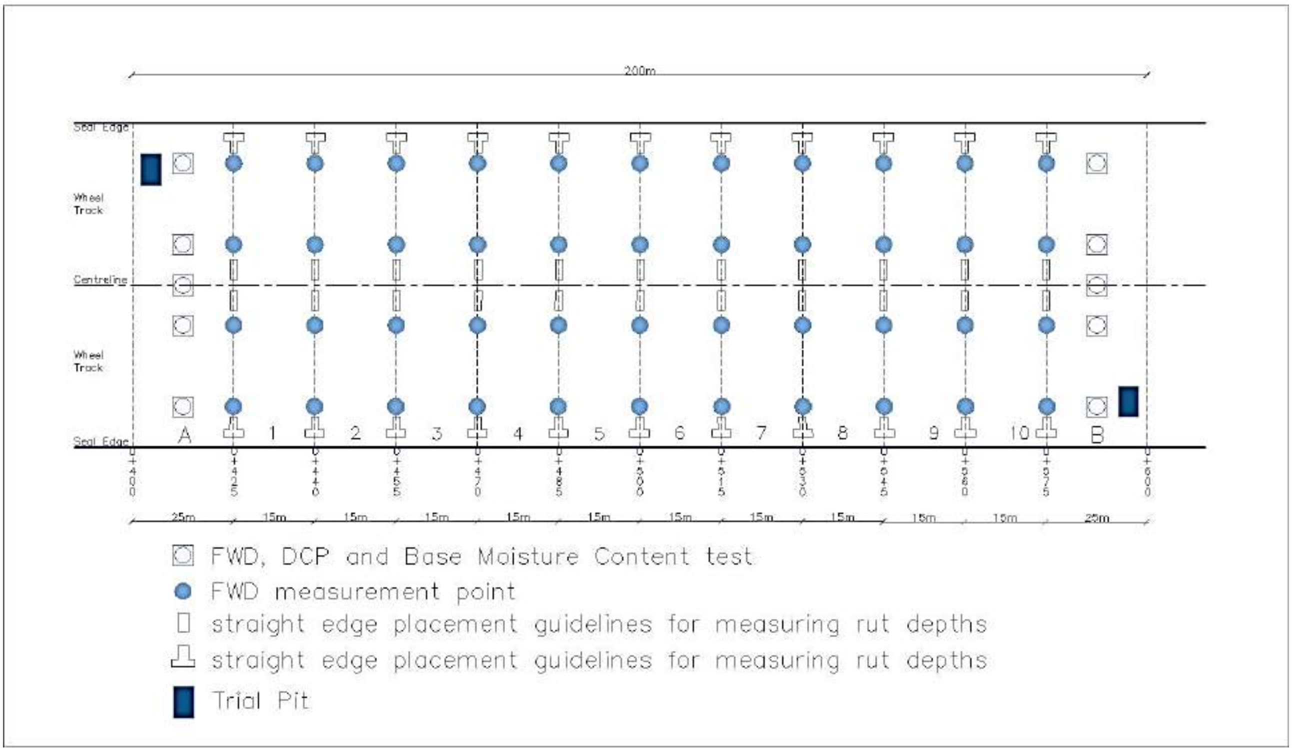
Table 3.4: Traffic loading [D382, Baseline Survey]

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction/mode]	Vehicle ESA [Estimated total since construction]
D382	Bus	0.16	87,600	14,012.6	22,948
D382	Medium Goods Vehicle	0.06	9,125	580.1	
D382	Heavy Goods Vehicle	0.38	21,900	8,355.2	

3.6 Layout of monitoring section

The layout of the monitoring section is shown in Figure 3.4.

Figure 3.4: Layout of monitoring section



3.7 Drainage Assessment

The Drainage Assessment (h) measured in each panel is given in Table 3.5.

Table 3.5: Drainage Assessment [14TH Oct. 2018]

Chainage Km	LHS			RHS		
	Side ditch	Drainage structure	Shoulders	Shoulders	Drainage structure	Side ditch
0+000 - 0+005	Grass	No structure	Eroded	Grassed	No structure	Grassed
0+005	Blocked with deposits	clogged	Eroded	Grassed	No structure	Grassed
0+005 - 0+050	Grass	No structure	Grassed	Okay	No structure	Grassed
0+050-0+100	Grass	No structure	Okay	Okay	Grassed	Grassed
0+100-0+150	Grass	No structure	Okay	Okay	Grassed	Grassed
0+150-0+200	Grass	No structure	Okay	Okay	Grassed	Grassed
0+200-0+225	Grass	No structure	Okay	Okay	Grassed	Grassed
0+225-0+240	Grass	No structure	Okay	Okay	Grassed	Grassed
0+240-0+255	Grass	No structure	Okay	Okay	Grassed	Grassed
0+255-0+270	Grass	No structure	Okay	Okay	Grassed	Grassed

0+270-0+285	Grass	No structure	Okay	Okay	Grassed	Grassed
0+285-0+300	Grass	No structure	Okay	Okay	Grassed	Grassed
0+300-0+315	Grass	No structure	Grassed	Okay	Grassed	Grassed
0+315-0+330	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+330-0+400	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+400-0+450	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+450-0+500	Poor	No structure		Edge Breaking	No structure	Grassed
0+500-0+550	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+550-0+600	Grass	No structure	Grassed	Grassed	No structure	Grassed

3.8 DCP tests (D382)

DCP Apparatus were used to carry out the tests. Across Africa Consultants team together with the MTRD team conducted the tests in this trial section. On the LTPP, the DCP tests were carried out on five points in Panel A and B respectively. However, on the remaining sections of the road, the DCP tests were done with a 50m interval alternating between inner and outer wheel paths

The results of DCP test carried out on D382 are summarised in Table 3.8, , . The Field data and layer strength diagrams are given in Annex 3.

The base and subbase layer for all the surveys conducted have given average DN values which are outside the design specification.

Table 3.6: DCP tests on the D382 [*Baseline / Wet Season*]

Chainage	Location of test	DN_{base} (mm)		$DN_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN450 - 600 (mm)		DN 600 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+000	CL	3.2	6.2	6.0	7.8	12.0	9.5	36.0	10.6	50.0	10.0
0+050	CL	3.2	6.4	6.0	6.9	12.0	6.5	36.0	7.7	50.0	8.7
0+100	CL	3.2	4.6	6.0	5.3	12.0	3.4	36.0	11.3	50.0	6.7
0+150	RHS	3.2	11.3	6.0	11.1	12.0	18.7	36.0	18.7	50.0	12.4
0+200	CL	3.2	5.6	6.0	6.6	12.0	11.3	36.0	10.3	50.0	14.8
0+250	RHS	3.2	18.7	6.0	18.6	12.0	17.0	36.0	14.9	50.0	18.5
0+300	CL	3.2	5.0	6.0	7.0	12.0	7.3	36.0	4.0	50.0	5.2
0+350	RHS	3.2	5.7	6.0	9.0	12.0	15.2	36.0	9.1	50.0	11.2
0+400	CL	3.2	7.7	6.0	12.0	12.0	7.1	36.0	8.4	50.0	8.7
0+408	CL	3.2	15.9	6.0	10.1	12.0	21.1	36.0	28.8	50.0	15.1
0+408	IWL	3.2	8.6	6.0	14.2	12.0	11.0	36.0	5.7	50.0	9.5
0+408	OWL	3.2	7.7	6.0	12.7	12.0	5.7	36.0	5.4	50.0	11.8
0+408	IWR	3.2	6.3	6.0	14.4	12.0	19.5	36.0	18.9	50.0	17.1
0+408	OWR	3.2	13.4	6.0	20.7	12.0	14.0	36.0	14.1	50.0	11.3
0+412	RHS	3.2	8.0	6.0	17.0	12.0	13.6	36.0	17.1	50.0	13.9
0+578	OWR	3.2	6.2	6.0	14.5	12.0	11.1	36.0	13.5	50.0	19.6
0+578	IWR	3.2	4.7	6.0	11.7	12.0	14.6	36.0	11.1	50.0	13.5
0+578	OWL	3.2	4.4	6.0	10.2	12.0	16.4	36.0	13.6	50.0	16.6
0+578	IWL	3.2	5.2	6.0	5.8	12.0	7.4	36.0	14.7	50.0	10.3
0+578	CL	3.2	5.6	6.0	9.9	12.0	6.9	36.0	11.6	50.0	12.2
0+585	RHS	3.2	5.8	6.0	15.9	12.0	21.8	36.0	28.6	50.0	13.0
0+600	RHS	3.2	4.6	6.0	6.7	12.0	7.0	36.0	5.3	50.0	11.1

0+650	CL	3.2	8.8	6.0	13.1	12.0	10.9	36.0	7.1	50.0	12.9
0+700	RHS	3.2	7.8	6.0	16.4	12.0	13.3	36.0	6.4	50.0	8.8
0+750	CL	3.2	6.9	6.0	9.5	12.0	6.5	36.0	6.3	50.0	8.9
0+800	RHS	3.2	4.3	6.0	6.0	12.0	5.0	36.0	3.4	50.0	0.4
0+850	CL	3.2	9.2	6.0	12.8	12.0	9.9	36.0	7.0	50.0	10.1
0+900	RHS	3.2	10.0	6.0	14.4	12.0	15.3	36.0	33.5	50.0	21.6
0+950	CL	3.2	13.5	6.0	10.7	12.0	15.7	36.0	17.5	50.0	17.0
Average		**3.2**	**7.9**	**6.0**	**11.4**	**12.0**	**11.8**	**36.0**	**12.6**	**50.0**	**12.1**

Table 3.7: DCP tests on the D382 [*First Monitoring / Wet Season*]

Chainage	Location of test	DN_{base} (mm)		$DN_{sub\text{-}base}$ (mm)		DN 300 - 450 (mm)		DN450 - 600 (mm)		DN 600 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+000	CL	3.2	6.4	6.0	5.5	12.0	8.0	36.0	10.4	50.0	14.9
0+050	RHS	3.2	5.6	6.0	6.4	12.0	9.2	36.0	9.6	50.0	9.7
0+100	LHS	3.2	3.8	6.0	6.0	12.0	3.5	36.0	11.7	50.0	8.3
0+150	RHS	3.2	5.1	6.0	5.1	12.0	11.2	36.0	14.7	50.0	15.9
0+200	CL	3.2	3.8	6.0	5.0	12.0	6.7	36.0	11.5	50.0	10.2
0+250	RHS	3.2	3.2	6.0	5.4	12.0	7.4	36.0	10.9	50.0	10.9
0+300	CL	3.2	4.1	6.0	5.1	12.0	7.6	36.0	4.4	50.0	9.0
0+350	RHS	3.2	5.2	6.0	8.5	12.0	10.9	36.0	8.8	50.0	12.0
0+400	CL	3.2	7.5	6.0	9.8	12.0	7.2	36.0	8.4	50.0	10.6
0+410	CL	3.2	5.5	6.0	10.6	12.0	15.7	36.0	14.9	50.0	18.5
0+410	CL	3.2	5.4	6.0	9.9	12.0	11.4	36.0	8.8	50.0	7.2
0+410	LHS	3.2	5.8	6.0	9.0	12.0	9.4	36.0	7.4	50.0	3.8
0+410	RHS	3.2	5.1	6.0	9.0	12.0	9.9	36.0	8.8	50.0	13.5
0+410	RHS	3.2	5.6	6.0	11.0	12.0	13.2	36.0	13.3	50.0	10.0
0+579	LHS	3.2	3.6	6.0	7.4	12.0	7.4	36.0	6.9	50.0	8.6
0+579	CL	3.2	5.5	6.0	5.8	12.0	6.3	36.0	10.2	50.0	9.6
0+579	LHS	3.2	4.2	6.0	7.7	12.0	10.0	36.0	8.9	50.0	8.6
0+579	RHS	3.2	3.3	6.0	8.6	12.0	12.2	36.0	10.1	50.0	11.9
0+579	RHS	3.2	3.6	6.0	9.2	12.0	9.2	36.0	11.8	50.0	9.6
0+600	RHS	3.2	4.2	6.0	7.2	12.0	10.2	36.0	7.6	50.0	9.2
0+650	CL	3.2	4.0	6.0	9.7	12.0	6.6	36.0	4.4	50.0	10.0
0+700	CL	3.2	5.7	6.0	8.0	12.0	18.9	36.0	9.4	50.0	7.8
0+750	CL	3.2	3.4	6.0	4.1	12.0	3.4	36.0	3.0	50.0	4.0
0+800	RHS	3.2	7.2	6.0	10.2	12.0	5.8	36.0	5.2	50.0	3.0
0+850	CL	3.2	6.3	6.0	10.6	12.0	7.4	36.0	6.4	50.0	13.9
0+900	LHS	3.2	8.9	6.0	14.5	12.0	11.0	36.0	18.3	50.0	24.9
0+950	CL	3.2	5.6	6.0	6.9	12.0	11.0	36.0	16.2	50.0	15.9
Average		**3.2**	**5.1**	**6.0**	**8.0**	**12.0**	**9.3**	**36.0**	**9.7**	**50.0**	**10.8**

Table 3.8: DCP tests on the D382 [*Second Monitoring / Dry Season*]

Chainage	Location of test	DN_{base} (mm)		$DN_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN450 - 600 (mm)		DN 600 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+000	LHS	3.20	4.18	6.00	14.11	12.00	23.72	36.00	26.27	50.00	17.93
0+050	RHS	3.20	4.29	6.00	5.92	12.00	6.80	36.00	9.35	50.00	14.04
0+100	CL	3.20	4.14	6.00	7.89	12.00	6.34	36.00	4.79	50.00	11.07
0+150	RHS	3.20	5.72	6.00	6.51	12.00	13.38	36.00	18.76	50.00	16.23
0+200	CL	3.20	3.40	6.00	5.55	12.00	9.63	36.00	11.95	50.00	13.86
0+250	RHS	3.20	4.82	6.00	9.98	12.00	10.89	36.00	13.80	50.00	11.25
0+300	LHS	3.20	6.01	6.00	5.90	12.00	9.65	36.00	7.29	50.00	9.74
0+350	RHS	3.20	5.63	6.00	9.70	12.00	11.51	36.00	10.63	50.00	10.07
0+400	RHS	3.20	8.99	6.00	17.84	12.00	11.02	36.00	12.12	50.00	16.90
0+415	CL	3.20	8.74	6.00	16.83	12.00	21.80	36.00	22.60	50.00	28.20
0+415	CL	3.20	8.24	6.00	11.68	12.00	15.52	36.00	6.03	50.00	4.99
0+415	LHS	3.20	6.16	6.00	14.28	12.00	7.32	36.00	4.33	50.00	8.04
0+415	RHS	3.20	7.67	6.00	16.49	12.00	20.03	36.00	6.90	50.00	11.18
0+415	RHS	3.20	7.85	6.00	18.24	12.00	22.09	36.00	20.06	50.00	14.95
0+580	CL	3.20	6.73	6.00	14.87	12.00	13.20	36.00	10.00	50.00	10.15
0+580	CL	3.20	7.86	6.00	12.63	12.00	9.01	36.00	15.36	50.00	22.03
0+580	LHS	3.20	4.45	6.00	13.90	12.00	13.21	36.00	12.32	50.00	14.15
0+580	RHS	3.20	3.54	6.00	10.43	12.00	11.66	36.00	6.37	50.00	7.97
0+580	RHS	3.20	5.10	6.00	14.18	12.00	9.12	36.00	10.65	50.00	13.78
0+600	RHS	3.20	3.83	6.00	5.31	12.00	9.72	36.00	3.19	50.00	3.09
0+650	CL	3.20	7.54	6.00	16.26	12.00	14.25	36.00	6.77	50.00	18.48
0+700	RHS	3.20	8.25	6.00	12.25	12.00	16.84	36.00	7.30	50.00	7.66
0+750	CL	3.20	5.06	6.00	6.76	12.00	5.33	36.00	1.57	50.00	6.09
0+800	RHS	3.20	5.76	6.00	9.83	12.00	7.49	36.00	4.58	50.00	0.78
0+850	CL	3.20	7.81	6.00	18.76	12.00	10.87	36.00	7.43	50.00	15.61
0+900	RHS	3.20	8.75	6.00	15.97	12.00	11.33	36.00	16.18	50.00	15.51
0+950	CL	3.20	5.03	6.00	8.69	12.00	14.27	36.00	14.45	50.00	18.92
Average		**3.20**	**6.13**	**6.00**	**11.88**	**12.00**	**12.44**	**36.00**	**10.78**	**50.00**	**12.69**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

3.9 Deflection measurements (D382)

Defection was measured using the Falling Weight Deflectometer (FWD) at 50 m intervals along the road, alternating between the outer wheel path and the inner wheel path. A large circular weight was used to transmit a pressure of 566 kPa to the pavement. The load imparted on the pavement therefore was measured and the stiffness parameters calculated.

The results of deflection tests carried out on the road are summarised in and Table 3.9.

Lane 1 represents the outer LHS wheel path, Lane 2 represents the outer RHS wheel path, Lane 3 represents the inner LHS wheel path and Lane 4 represents the inner RHS wheel path.

As can be seen, the average maximum deflection has increased slightly from baseline survey to first monitoring round.

Table 3.9: Deflection tests on the road [Baseline]

Chainage (m)	Lane No.	Elastic modulus			Normalized Deflections at Geophone Locations (µm)
		EBase (MPa)	ESubbase (MPa)	ESubgrade (MPa)	D_0
0+000	1	1263	215	171	752
0+050	1	1048	180	122	780
0+150	1	438	94	147	940
0+251	1	1158	192	144	867
0+350	1	1074	192	142	760
0+560	1	1942	339	80	1128
0+562	1	297	32	145	885
0+650	1	189	72	81	1212
0+748	1	830	150	93	1306
0+752	1	2500	300	85	1733
0+850	1	578	105	171	994
0+851	1	2500	300	88	1560
0+950	1	1914	342	63	1312
0+951	1	1946	344	92	1032
1+000	1	915	165	112	996
0+000	2	1195	215	174	792
0+100	2	1104	186	200	767
0+200	2	433	77	164	1050
0+300	2	1007	171	109	1220
0+424	2	2500	300	93	1716
0+454	2	302	82	107	1151
0+485	2	1192	203	109	1032
0+514	2	546	107	165	1053
0+545	2	453	80	206	1682
0+575	2	1964	345	68	1204
0+699	2	1721	311	69	1752
0+800	2	326	79	99	1689
0+900	2	1790	317	77	1629
1+000	2	423	100	137	1014
0+100	3	207	21	145	1145
0+201	3	210	23	239	969
0+301	3	222	29	252	862
0+400	3	515	93	216	679
0+425	3	2500	300	71	1553
0+455	3	973	170	132	885
0+486	3	916	165	117	981
0+516	3	233	25	249	862
0+545	3	388	80	123	1029
0+577	3	1956	339	71	1106

0+650	3	876	156	113	1064
0+751	3	293	71	105	1529
0+851	3	1832	310	90	1209
0+952	3	1956	341	91	969
0+049	4	480	87	177	768
0+149	4	264	31	177	889
0+248	4	179	15	547	1024
0+349	4	436	52	171	650
0+408	4	2021	340	65	1039
0+440	4	1360	231	97	869
0+470	4	389	98	133	970
0+499	4	2014	336	82	1074
0+533	4	1007	170	99	1331
0+560	4	1961	343	79	1090
Average		**1070**	**178**	**135**	**1105**

Table 3.10: Deflection tests on the road [First Monitoring]

Chainage (m)	Lane No.	Elastic modulus			Normalized Deflections at Geophone Locations (µm) D_0
		EBase (MPa)	ESubbase (MPa)	ESubgrade (MPa)	
0+050	1	483	100	141	1163
0+100	1	1502	218	104	1280
0+150	1	798	124	184	1054
0+201	1	592	124	168	1215
0+251	1	1713	247	118	968
0+301	1	536	97	141	1074
0+352	1	1435	211	155	1133
0+400	1	1398	210	226	1020
0+410	1	588	122	153	1334
0+428	1	1661	240	141	908
0+443	1	1691	242	117	968
0+458	1	1624	242	129	1087
0+473	1	2133	290	121	877
0+488	1	1732	252	137	910
0+502	1	408	96	113	1388
0+518	1	1439	213	164	1116
0+533	1	1373	202	85	1567
0+548	1	783	134	190	898
0+563	1	1490	226	166	1072
0+577	1	787	141	177	1076
0+579	1	1572	230	92	1288
0+603	1	793	142	196	1106
0+653	1	331	33	142	1061
0+704	1	1573	224	131	1077

0+754	1	1312	197	108	1689
0+804	1	469	102	130	1144
0+854	1	1461	218	92	1450
0+904	1	329	79	95	1409
0+954	1	537	101	146	1063
0+403	2	1471	216	158	1127
0+505	2	1524	229	139	1166
0+580	2	2041	278	102	1213
0+606	2	1544	223	97	1228
0+907	2	1872	254	95	1584
0+051	3	811	137	208	976
0+101	3	1801	265	129	854
0+151	3	2021	274	148	996
0+202	3	492	111	147	1270
0+252	3	242	15	607	1242
0+302	3	964	153	221	1152
0+353	3	784	117	203	987
0+401	3	1383	209	195	1128
0+410	3	2094	286	173	806
0+410	3	1467	222	160	1089
0+429	3	530	112	137	1225
0+444	3	1750	254	94	1104
0+459	3	1600	236	103	1221
0+474	3	1512	221	149	1033
0+489	3	1574	234	122	1099
0+503	3	521	100	135	1261
0+520	3	683	132	180	1016
0+535	3	384	96	116	1388
0+550	3	459	108	131	1261
0+565	3	414	98	115	1385
0+578	3	1497	223	113	1302
0+579	3	1440	212	157	1141
0+604	3	1500	227	125	1248
0+654	3	421	98	127	981
0+705	3	1364	201	88	1729
0+756	3	346	88	108	1375
0+807	3	1544	230	122	1174
0+855	3	1603	234	92	1198
0+905	3	427	85	120	1847
0+956	3	399	91	115	1151
0+402	4	1426	212	135	1261
0+504	4	1495	224	138	1166
0+579	4	1964	266	97	1252
0+579	4	477	109	128	1322
0+605	4	1641	241	105	1201
0+655	4	342	83	98	1394

0+706	4	1324	197	98	1713
0+856	4	1541	233	84	1426
0+906	4	1425	211	88	1488
Average		**1160**	**179**	**141**	**1200**

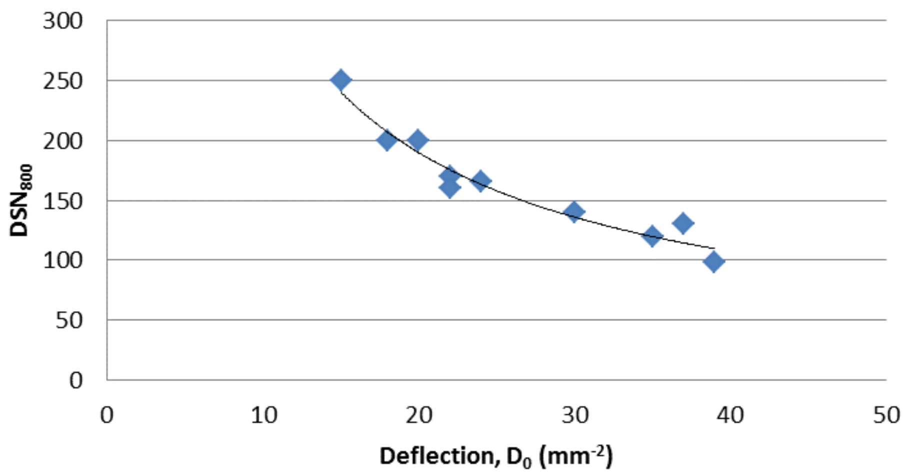
Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

3.10 Comparison of DN and deflection measurements

The graph in Figure 3.5 shows the comparison between DN values and deflection measurements at the same measurement points.

Figure 3.5: DSN_{800} versus D_0



[insert a graph showing wet season and dry season comparisons between DSN_{800} and deflection]

[add any comments on the degree of correlation between the deflection and DCP measurements].

3.11 Test pit

3.11.1 General information

Table 3.11 provides general information on the test pits excavated on the monitoring section.

Table 3.11: Test pit data (D382)

	Test Pit No.	Panel No.	Location	Date of excavation	Season
Baseline Survey	TPA-1-16	A	Right	05/11/2016	Dry Season
	TPB-1-16	B	Left	05/11/2016	
First Monitoring	TPA-1-17	A	Left, Centre, Right	03/7/2017	Wet Season
	TPB-1-17	B	Left, Centre, Right	03/7/2017	
Second Monitoring	TP1	A	N/A	N/A	N/A
	TP2	B	N/A	N/A	

3.11.2 In situ DCP tests

Table 3.12 provides a summary of DCP tests carried out in the test pit before excavation. The DN values obtained during the first monitoring round show a decrease. However, these DN values are higher than the design specification. This implies that the pavement layers are weaker as compared to design specification.

Table 3.12: DN values for pavement layers in the test pit (D382)

	Test Pit No.	DN_{base}	$DN_{sub\text{-}base}$	$DN_{300\text{-}450}$	$DN_{450\text{-}600}$	$DN6_{600\text{-}800}$
Baseline Survey	TPA-1-16	7.6	9.8	17.7	28.2	38.1
	TPB-1-16	1.9	2.5	3.6	4.2	2.0
	Specification	**3.2**	**6.0**	**12.0**	**36.0**	**50.0**
First Monitoring	TPA-1-17	4.7	14.1	14.2	14.2	13.8
	TPB-1-17	3.4	6.2	6.7	7.2	9.5
	Specification	**3.2**	**6.0**	**12.0**	**36.0**	**50.0**
Second Monitoring	N/A	N/A	N/A	N/A	N/A	N/A

3.11.3 Layer density and moisture content

The density of the pavement layers and moisture content are summarised July in Table 3.13.

The in-situ moisture content was established from samples taken to the laboratory. The insitu moisture content increases with an increase in depth.

Table 3.13: Density and moisture content (D382)

	Test Pit		Layer	Dry density (kg/m^3)	MDD (kg/m^3)	Relative density (%)	In situ moisture content (%)	OMC (%)	In situ moisture content as proportion of OMC
Second Monitoring	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A
First Monitoring	TPA-1-16	OWP	Base	-	-	-	18.0	16.2	1.11
			Sub-base	-	-	-	20.5	21.0	0.98
			Subgrade	-	-	-	20.8	25.3	0.82
		IWP	Base	-	-	-	17.6	17.6	1.00
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	-	-	-
	TPA-2-16	OWP	Base	-	-	-	15.3	16.1	0.95
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	21.4	21.6	0.99
		IWP	Base	-	-	-	16.0	19.6	0.82
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	-	-	-

	Test Pit		Layer	Dry density (kg/m³)	MDD (kg/m³)	Relative density (%)	In situ moisture content (%)	OMC (%)	In situ moisture content as proportion of OMC
Baseline Survey	TPB-1-16	OWP	Base	-	1555	-	23.3	16.2	1.44
			Sub-base	-	1500	-	15.6	21.0	0.74
			Subgrade	-	1395	-	22.1	25.3	0.87
		IWP	Base	-	1525	-	17.6	17.6	1.00
			Sub-base	-	1460	-	22.9	23.3	0.98
			Subgrade	-	1370	-	22.6	24.6	0.92
	TPB-2-16	OWP	Base	-	1565	-	17.3	16.1	1.07
			Sub-base	-	1535	-	19.6	21.8	0.90
			Subgrade	-	1455	-	21.9	21.6	1.01
		IWP	Base	-	1510	-	15.7	19.6	0.80
			Sub-base	-	1512	-	20.2	18.4	1.10
			Subgrade	-	1423	-	21.7	21.2	1.02

3.11.4 Test pit log

The test pit logs are summarised in Table 3.14. The moisture, colour, consistency, structure, soil type and origin are described using the standard terms in the regional monitoring guideline.

Table 3.14: Test pit logs

Test Pit	Layer	Thickness mm	Moisture (First monitoring)	Moisture (baseline survey)	Colour	Consistency	Structure	Soil type	Origin	AASHTO soil classification
TPA-1-16	Surface	20	-	-	Black	Extremely hard		Cold Mix Asphalt	Local	n/a
	Base	150	18	23.3	Light grey	Very hard		Composite ETB	Local	n/a
	Subbase	150	20.5	15.6	Light grey	Hard		Granular material	Local	n/a
	Subgrade	-	20.8	22.1	Brown	hard		Natural occurring	Local	n/a
TPB-1-16	Surface	20	-	-	Black	Extremely hard		Cold Mix Asphalt	Local	n/a
	Base	150	15.3	17.3	Light grey	Very hard		Composite ETB	Local	n/a
	Subbase	270	-	19.6	Light grey	Hard		Granular material	Local	n/a
	Subgrade	-	21.4	21.9	Brown	hard		Natural occurring	Local	n/a

3.11.5 Base material properties

The properties of the base course material are summarised in Table 3.15

The DN value is reported at the expected in-service moisture content.

Table 3.15: Base material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T180
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	45	35	28	45	26	19	1555	16.2	OWP = 19 IWP = 18
TPB-1-16	45	36	30	44	24	20	1565	16.1	OWP = 18 IWP = 20

[*report the CBR at the specified compaction density (x) soaked*]

[*report the DN value at the specified density (x) and expected in service moisture content*]

[*include any observations on the actual materials properties compared with the design specification*] Design specifications not available as the road was not among the roads under research project.

3.11.6 Sub-base material properties

The properties of the sub-base material are summarised in Table 3.16

The DN value is reported at the expected in-service moisture content.

Table 3.16: Sub-base material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T180
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	85	78	68	44	21	23	1500	21	OWP = 6 IWP = 8
TPB-1-16	85	78	70	45	22	23	1535	21.8	OWP = 6 IWP = 4

[*report the CBR at the specified compaction density soaked*]

[*report the DN value at the specified density and expected in service moisture content*]

[*include any observations on the actual materials properties compared with the design specification*] Design specifications not available as the road was not among the roads under research project.

3.11.7 Subgrade material properties

The properties of the Subgrade material are summarised in Table 3.17

The DN value is reported at the expected in-service moisture content.

Table 3.17: Subgrade material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T99
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	48	35	26	54	25	23	1395	25.3	OWP = 5 IWP = 5
TPB-1-16	33	8	2	46	19	27	1455	21.6	OWP = 5 IWP = 5

[*include any observations on the actual materials properties compared with the design specification*] Design specifications not available as the road was not among the roads under research project.

3.11.8 Particle Size Distribution

The PSD for the base course and subbase course material in each TP, compared with the specification envelope, are shown in Figure 3.6 and Figure 3.7 respectively. The base and subbase materials all fit into the specification envelope except for a small portion of the course particles on the base material as specified in ASTM D2940.

Figure 3.6: PSD for base course in TPA-1-16 and TPB-1-16

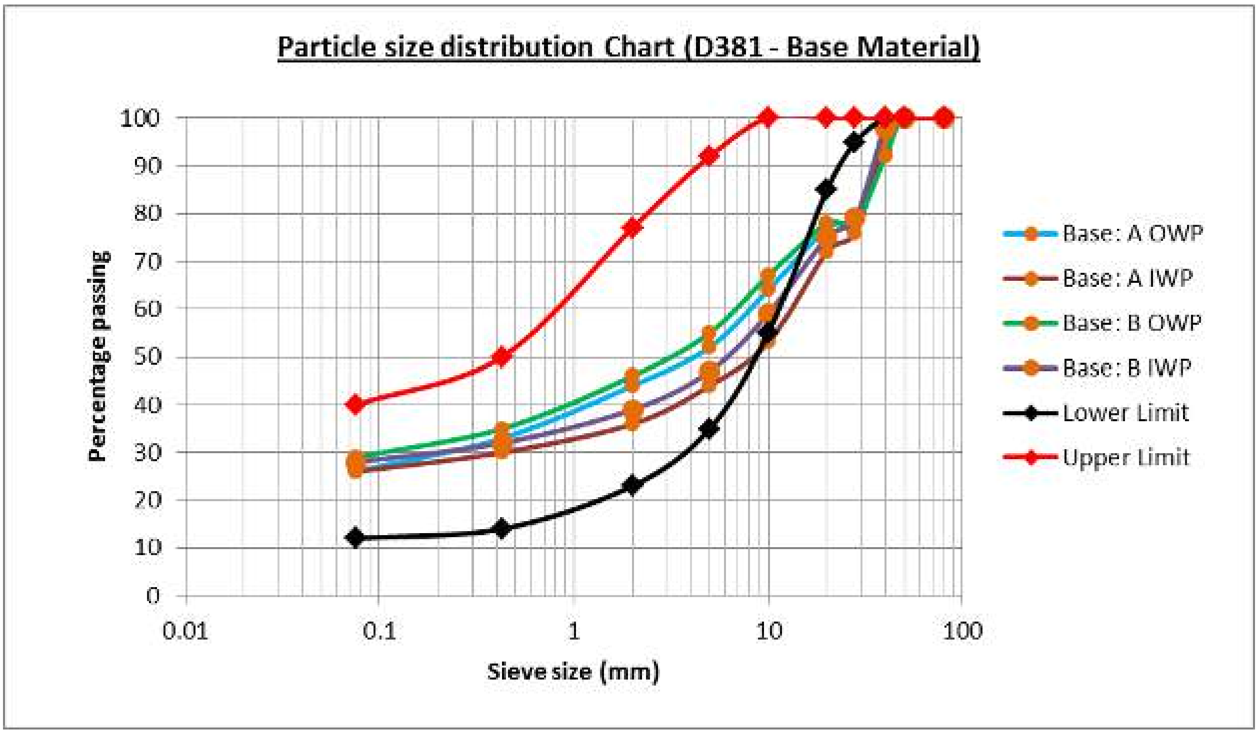
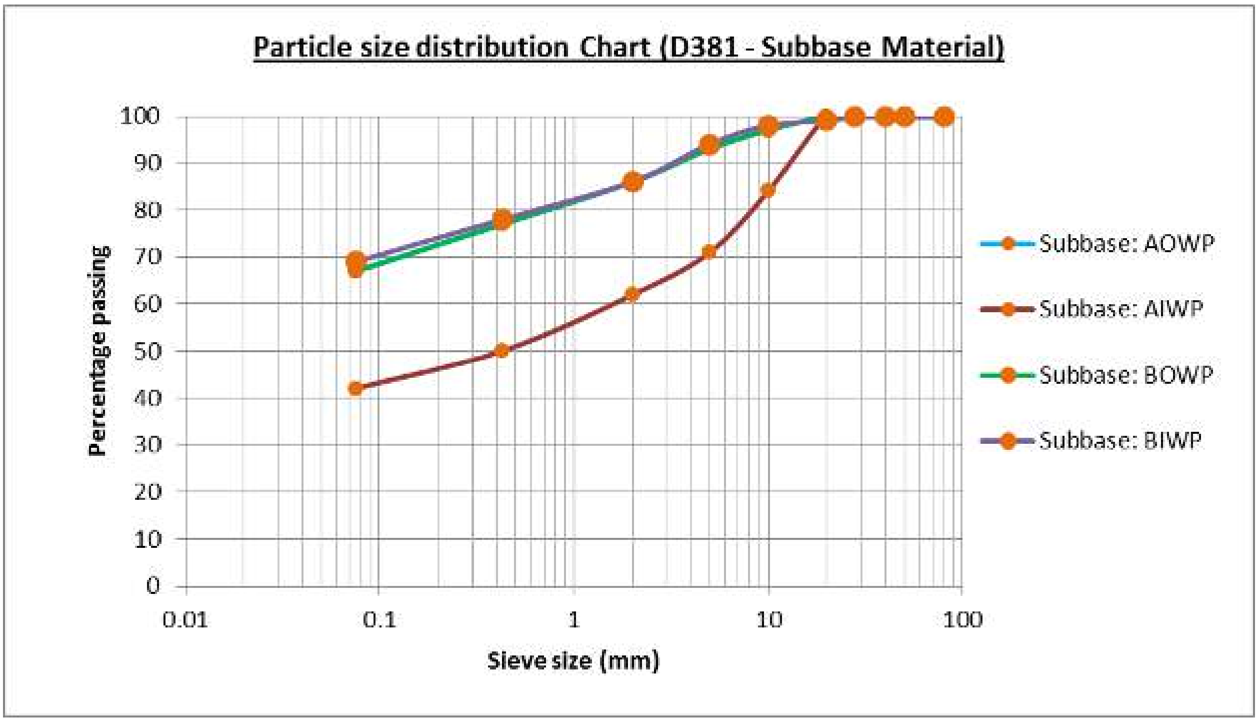


Figure 3.7: PSD for sub-base course in TPA-1-16 and TPB-1-16



3.11.9 Other TP tests

n/a

3.11.10 Discussion on test pit results

Test pit investigations show that the pavement surface is weaker than specified under low volume hence development of numerous potholes. The weaker pavement surface may be due to a thin layer or an increase in traffic more than what is expected under LVSR [*summarise the findings of the TP investigations including the comparison of layer thickness and materials properties to the specification and any lessons learnt for LVR pavement design*]

3.12 Rut depth

The rut depth measurements taken on the monitoring section are summarised in Table 2.18. It is observed that rutting has increased over time from baseline survey running through to second monitoring round. An average rut of 18.8 which was measured during the second monitoring round is critical for LVSR.

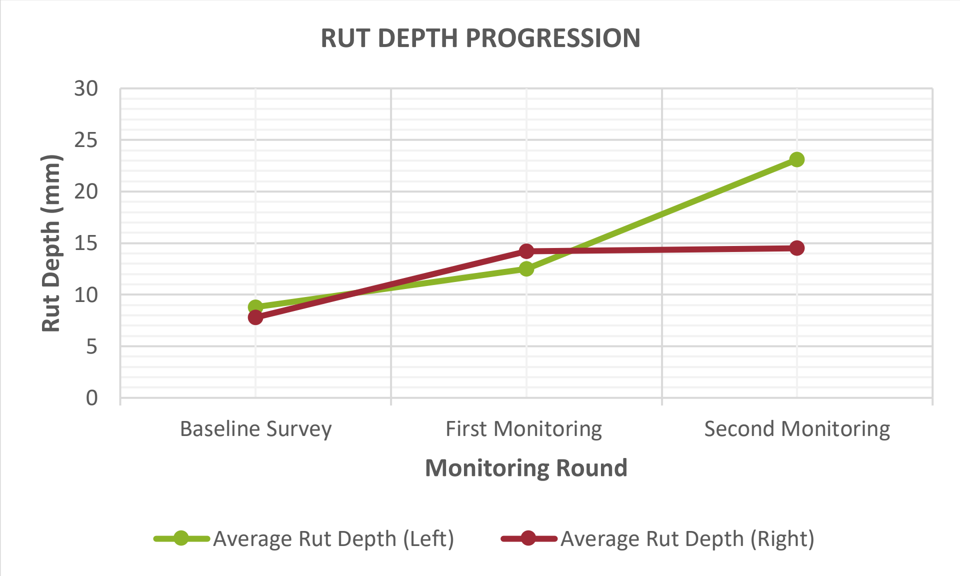
The Field data are given in Annex 4.

Table 3.18: Rut depth

Panel	Baseline [*August 2016*]		1st round [*July 2017*]				2nd round [*Oct. 2018]*				3rd round [*date*]	
	Left (mm)	Right (mm)	Left (mm)		Right (mm)		Left (mm)		Right (mm)		Left (mm)	Right (mm)
1	7	4	OWL	15	OWR	11	OWL	30	OWR	31		
2	8	6	OWL	7	OWR	6	OWL	20	IWR	8		
3	9	12	OWL	18	OWR	20	OWL	13	OWR	18		
4	9	12	OWL	16	OWR	18	OWL	15	OWR	20		
5	8	8	OWL	8	OWR	17	OWL	15	OWR	10		
6	12	6	OWL	19	OWR	14	OWL	23	OWR	13		
7	12	2	OWL	12	OWR	14	OWL	32	IWR	12		
8	3	12	OWL	12	OWR	19	OWL	32	OWR	10		
9	12	10	IWL	8	OWR	14	OWL	23	OWR	9		
10	8	6	OWL	10	OWR	9	OWL	28	OWR	14		
Average	9	8	13		14		23		15			
Average for section	**8**		**13**				**19**					

Figure 2.7 shows the rut depth progression over the monitoring period.

Figure 3.8: Rut depth progression (D382)



3.13 Deflection measurements (LTTP section)

The results of deflection tests carried out on the monitoring section are summarised in and Table 3.19.

Table 3.19: Deflection results on the monitoring section and elastic modulus (Baseline Survey)

Panel number	Location of test	D_0 (µm)	E_{base} (MPa)	$E_{sub-base}$ (MPa)	$E_{subgrade}$ (MPa)
1	IWR	1553	2500	300	71
2	OWR	869	1360	231	97
	IWL	1151	302	82	107
3	IWR	885	973	170	132
4	OWR	970	389	98	133
	IWL	1032	1192	203	109
5	IWR	981	916	165	117
	OWR	1074	2014	336	82
6	IWL	1053	546	107	165
7	IWR	862	233	25	249
8	OWR	1331	1007	170	99
9	IWL	1682	453	80	206
	IWR	1029	388	80	123
10	OWL	1128	1942	339	80
	OWR	1090	1961	343	79
	OWL	885	297	32	145
	IWL	1204	1964	345	68
Average		**1104.6**	**1084.5**	**182.7**	**121.3**

Table 3.20: Deflection results on the monitoring section and elastic modulus (First Monitoring)

Panel number	Location of test	D_0 (µm)	E_{base} MPa)	$E_{sub\text{-}base}$ (MPa)	$E_{subgrade}$ (MPa)
1	OWL	908	1661	240	141
	IWR	1225	530	112	137
2	OWL	968	1691	242	117
	IWR	1104	1750	254	94
3	OWL	1087	1624	242	129
	IWR	1221	1600	236	103
4	OWL	877	2133	290	121
	IWR	1033	1512	221	149
5	OWL	910	1732	252	137
	IWR	1099	1574	234	122
6	OWL	1388	408	96	113
	IWR	1261	521	100	135
	OWR	1166	1495	224	138
	IWL	1166	1524	229	139
7	OWL	1116	1439	213	164
	IWR	1016	683	132	180
8	OWL	1567	1373	202	85
	IWR	1388	384	96	116
9	OWL	898	783	134	190
	IWR	1261	459	108	131
10	OWL	1072	1490	226	166
	IWR	1385	414	98	115
Average		**1141.6**	**1217.3**	**190.0**	**132.8**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

3.14 Comparison of deflection and rutting

and Table 3.21 show the deflections (D_0) and rut depths measured in each panel on the monitoring section during the first monitoring round and baseline survey respectively. The rut depth measurements in are the most recent measurements as recorded in Table 3.18.

Table 3.21: Deflection and rut depth measurements (Baseline Survey)

Panel number	Location of test	D_0 (µm)		Rut depth (mm)		
		Baseline Survey	Average for panel	Left	Right	Average

1	IWR	1553	1553.0	7	4	5.5
2	OWR	869	1010.0	8	6	7.0
	IWL	1151				
3	IWR	885	885.0	9	12	10.5
4	OWR	970	1001.0	9	12	10.5
	IWL	1032				
5	IWR	981	1027.5	8	8	8.0
	OWR	1074				
6	IWL	1053	1053.0	12	6	6.0
7	IWR	862	862.0	12	2	2.0
8	OWR	1331	1331.0	3	12	7.5
9	IWL	1682	1355.5	12	10	11.0
	IWR	1029				
10	OWL	1128	1076.8	8	6	7.0
	OWR	1090				
	OWL	885				
	IWL	1204				
Average		**1104.6**	**1115.5**	**8.8**	**7.8**	**7.5**

Table 3.22: Deflection and rut depth measurements (First Monitoring)

Panel number	Location of test	D_0 (µm)		Rut depth (mm)		
		First Monitoring	Average for panel	Left	Right	Average
1	OWL	908	1066.5	15	11	13.0
	IWR	1225				
2	OWL	968	1036.0	7	6	6.5
	IWR	1104				
3	OWL	1087	1154.0	18	20	19.0
	IWR	1221				
4	OWL	877	955.0	16	18	17.0
	IWR	1033				
5	OWL	910	1004.5	8	17	12.5
	IWR	1099				
6	OWL	1388	1245.3	19	14	16.5
	IWR	1261				
	OWR	1166				
	IWL	1166				
7	OWL	1116	1066.0	12	14	13.0
	IWR	1016				
8	OWL	1567	1477.5	12	19	15.5
	IWR	1388				
9	OWL	898	1079.5	8	14	11.0
	IWR	1261				

10	OWL	1072	1228.5	10	9	9.5
	IWR	1385				
Average		**1141.6**	**1131.3**	**12.5**	**14.2**	**13.4**

and Figure 3.9 show the relationship between deflection and rut depth measurements on the monitoring section. As can be noticed, there is no clear correlation between rut depth and deflection at this stage of the life of the pavement.

Figure 3.9: Correlation between deflection (D₀) and rut depth (Baseline Survey)

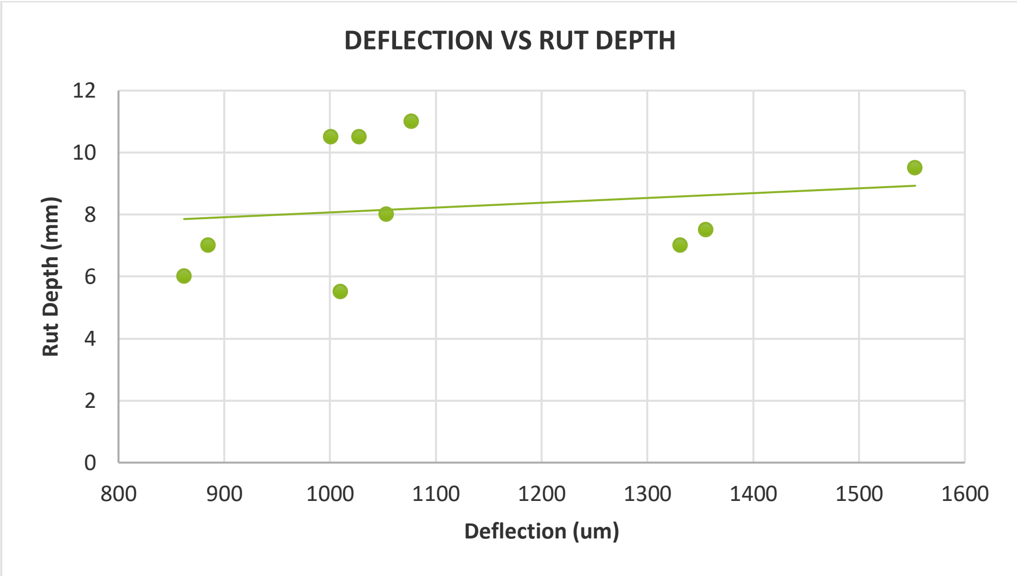
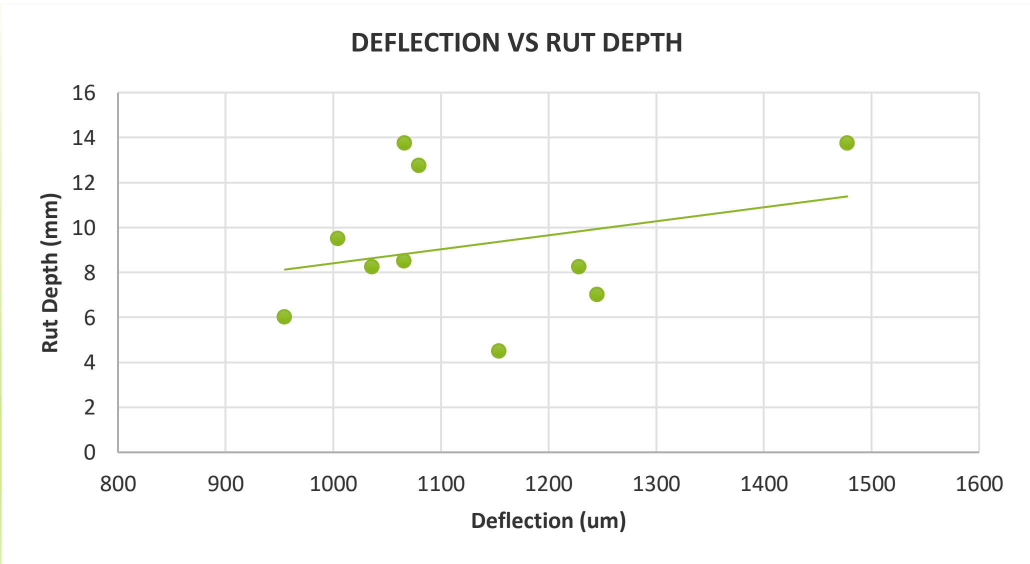


Figure 3.10: Correlation between deflection (D_o) and rut depth (First monitoring)



3.15 Roughness

and Table 3.23 show the roughness (IRI) measured on the monitoring section at each round of monitoring. The roughness was measured using drims apparatus. The data for the RHS only terminates on chainage 0+560 as presented from the output of the drims apparatus. All roughness outputs are found in Annex 5.

Table 3.23: Roughness measurements (Baseline Survey)

Monitoring round	Date	Left side		Right side		Average IRI (m/km)
		Chainage	IRI (m/km)	Chainage	IRI (m/km)	
Baseline	12th Jun - 20th Jun 2017	0+000-0+100	2.4	0+000-0+049	2.4	
		0+100-0+201	2.4	0+049-0+408	2.4	
		0+201-0+400	2.4	0+408-0+440	2.4	
		0+400-0+455	2.4	0+440-0+499	2.9	
		0+455-0+486	2.9	0+499-0+533	2.9	
		0+486-0+516	2.9	0+533-0+560	2.4	
		0+516-0+577	2.7			
		0+577-0+751	2.9			
		0+751-0+952	2.4			

Table 3.24: Roughness measurements (Second Monitoring)

Monitoring round	Date	Left side		Right side		Average IRI (m/km)
		Chainage	IRI (m/km)	Chainage	IRI (m/km)	
Second Monitoring	1st October 2018	0+000-0+100	10.1	0+000-0+100	10.1	10.1
		0+100-0+200	6.2	0+100-0+200	10.1	8.2
		0+200-0+300	8.0	0+200-0+300	8.0	8.0
		0+300-0+400	6.6	0+300-0+400	6.6	6.6
		0+400-0+500	6.8	0+400-0+500	9.3	8.1
		0+500-0+600	11.5	0+500-0+600	14.8	13.2
		0+600-0+700	11.5	0+600-0+700	12.2	11.9
		0+700-0+800	6.5	0+700-0+800	6.5	6.5
		0+800-0+900	6.8	0+800-0+900	6.8	6.8
		0+900-1+000	6.1	0+900-1+000	10.5	8.3

and Figure 3.11 show the roughness progression over the monitoring period.

Figure 3.11: Roughness progression (Baseline survey)

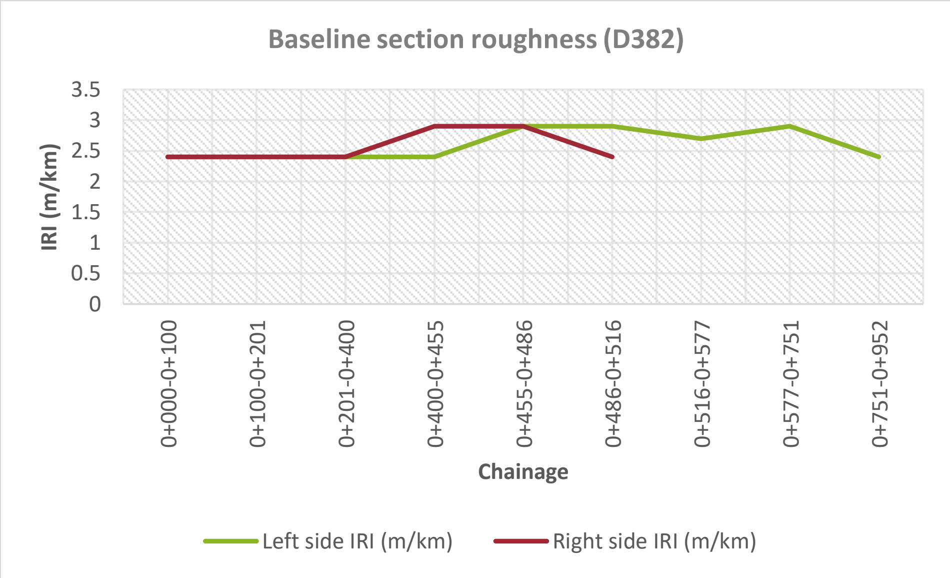
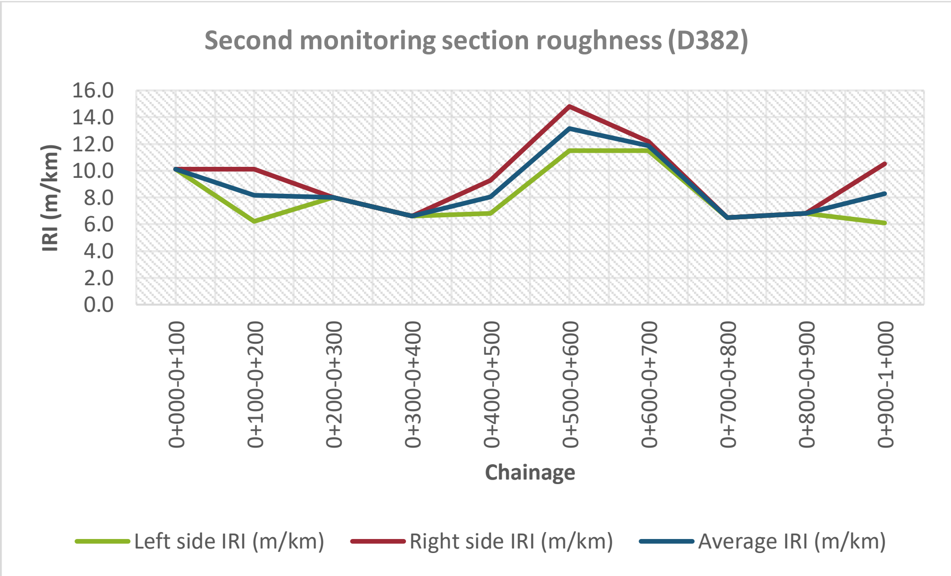


Figure 3.12: Roughness progression (Second monitoring)



3.16 Present serviceability rating

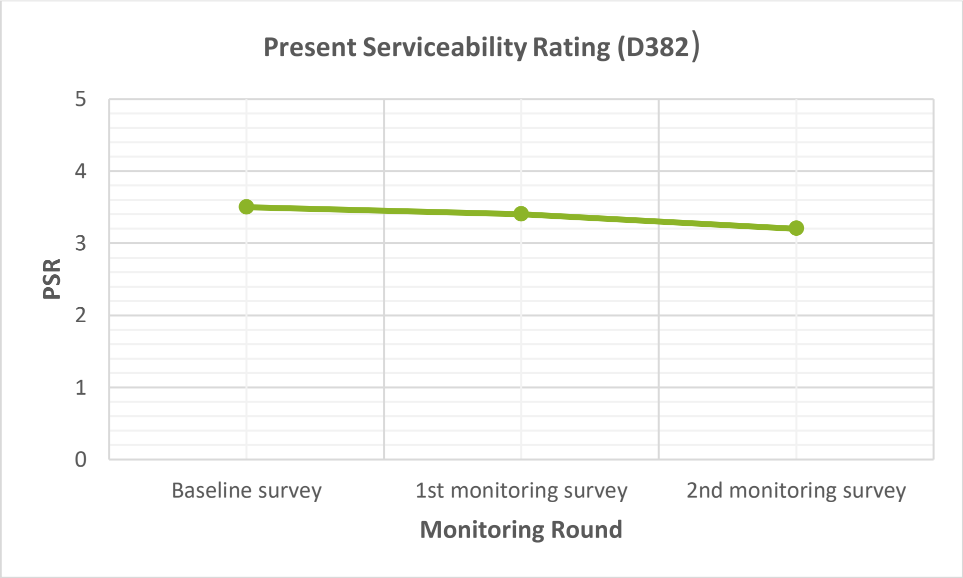
The PSR has been calculated with a scale of (1 to 5) for the entire monitoring section. Table 3.25 shows the PSR for each round of monitoring. Field data for PSR is illustrated in Annex 6.

Table 3.25: Present Serviceability Rating (D382)

Road	Baseline survey	1st monitoring survey	2nd monitoring survey	3rd monitoring survey	4th monitoring survey
D382	3.5	3.4	3.2		

The variation of the average VCI for the monitoring rounds carried out to date is shown in Figure 3.13

Figure 3.13: Variation in PSR over the monitoring rounds



Typical photographs of defects on the monitoring section are included in Figure 3.14

Figure 3.14: Typical defects

Fig No	Location (Km)	Defect assessment and description	Photos illustrating the pavement distress & defect
Fig 1	Km 0+000 – 0+200 main carriage way	-Alligator cracks	

Fig 2	Km 0+080 main carriage way centreline	-Fatigue cracks and Pothole	
Fig 3	Km 0+050	-Partially blocked culvert	
Fig 4	Km 0+080	-Pothole developing due to thin surfacing	

Fig 5	Km 0+530 RHS	-Alligator cracks	
Fig6	Km 0+530 – 0+560 RHS	-Patch along the RHS edge	
Fig 7	Km 0+560 RHS	- Fatigue cracks	

Fig 8	Km 0+600 – 0+700	-Light vegetation and soil deposits in the RHS side drain	
Fig 9	Km 0+700 – 0+800	- Light vegetation on the LHS shoulder	
Fig10	Km 0+600-0+650 RHS	-Edge subsidence -Ponding of water in the rut.	

Fig 11	Km 0+650 – 0+800	-Fatigue cracks and deformation	
Fig 11	Km 0+800 – 0+850	-Pothole and Fatigue cracks	
Fig 12	Km 0+850 – 0+900 LHS outer wheel path	A long patch	

Fig 13	Km 0+900 – 0+950 RHS	Fatigue cracks deformation and eroded side drain	

4 Monitoring Section 3: Muthuaini-Munungaini D435

4.1 Location

The start of the monitoring section is at chainage 0+000 from the start of the road, which is at Ihururu – Njoguini junction.

The GPS coordinates at the start of the monitoring section are:

South: 0° 24'37.49"

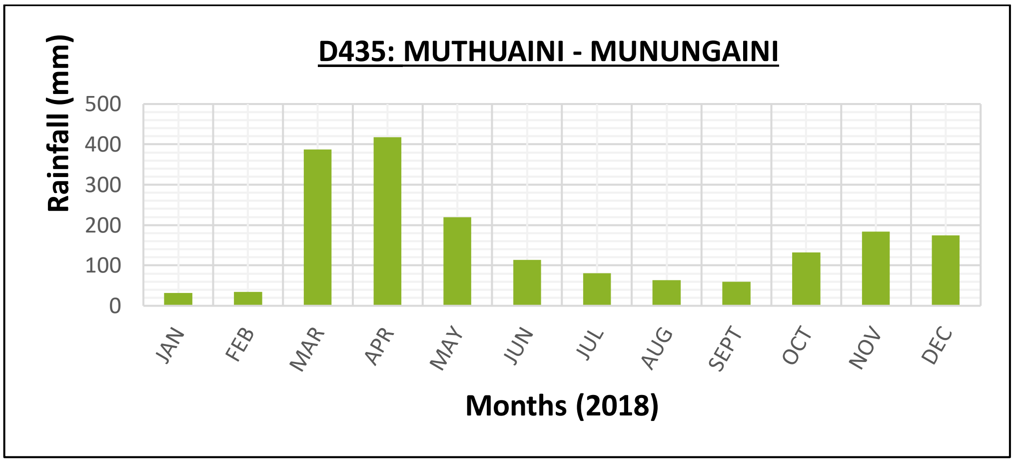
East: 36°53'34.02"

The length of the monitoring section is 640m.

4.2 Climate

Rainfall data from the nearest weather station to the site are shown in Figure 4.1. Long rains were experienced in March and April.

Figure 4.1: Rainfall Data from Ihururu Academy Station

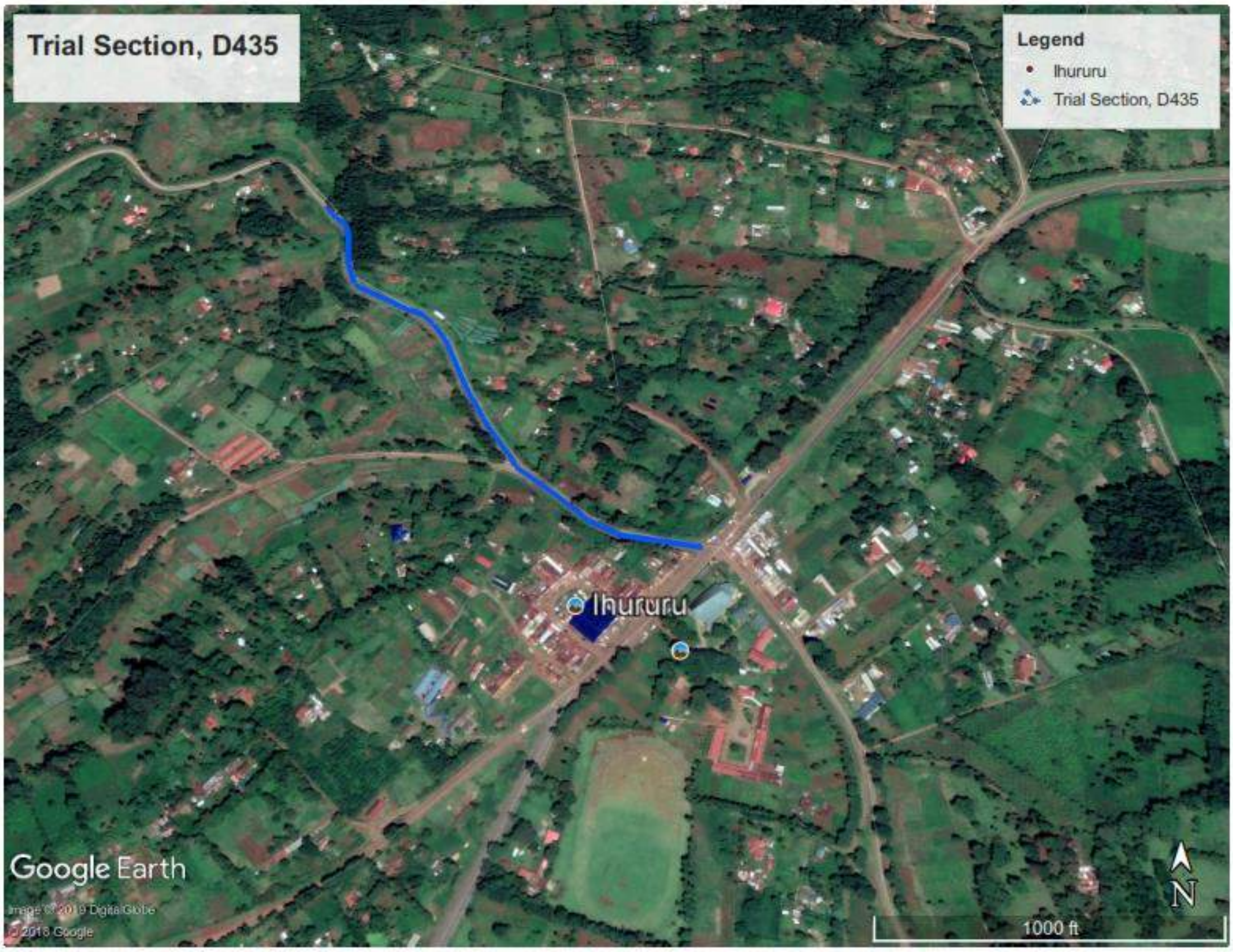


4.3 Design Details

4.3.1 Geometry

The carriageway width is 6 meters and there is no shoulder. The monitoring section is indicated in the blue line shown in Figure 4.2.

Figure 4.2: Monitoring section D435 on Muthuaini - Munungaini road



4.3.2 Pavement design and surfacing

The pavement design and surfacing are shown in Figure 4.3.

Figure 4.3: Pavement design and surfacing (D435)

20 mm Cold Mix Asphalt	
150 mm Neat laterite base	
250 mm Granular subbase	
Subgrade	

The base was primed before surfacing.

The pavement was designed by Jon Hongve under AfCAP in 2012.

The traffic loading used for the design was 157,524 CESA over a design life of 15 years.

The pavement was designed according to Malawi DCP Pavement Design Manual Draft, 2011.

4.3.3 Construction

The trial section was built in 2015.

The construction works were supervised by KeRRA Kiambu region.

The cost of construction was $ 132,825 (refer to **Error! Reference source not found.**).

The trial section was constructed during the rainy season hence the rainfall washed away the emulsion before bonding could be completed. As a result, ravelling occurred, which is still evident.

4.3.4 Maintenance

The maintenance activities that have been carried out on the monitoring section since construction are summarised in Table 4.1.

Table 4.1: Maintenance activities

Period		Activities carried out	Maintenance cost [*local currency*]	Maintenance cost USD
From	to			
Construction	Baseline survey	drainage clearing.	-	-
Baseline survey	1st monitoring survey	Bush clearing and drainage cleaning.	400,000.00*	4,000.00*
1st monitoring survey	2nd monitoring survey	Bush clearing and drainage cleaning.	400,000.00*	4,000.00*
2nd monitoring survey	3rd monitoring survey			
3rd monitoring survey	4th monitoring survey			

*Estimated amount

4.4 Traffic

The traffic surveys carried out on the road are summarised in Table 4.2. The traffic survey was conducted during the month of October, 2018. The results and calculations of the survey are found in Annex 1.

Table 4.2: Traffic data (D435)

Mode	AADT (design)	AADT *[Baseline Survey]*	AADT *[First Monitoring]*	AADT *[Second Monitoring]*	Estimated total since construction
Motorcycle	196	495	589	504	1,138,800
Car	85	191	195	149	481,800
Minibus	43	33	45	42	65,700
Bus	2	0	0	1	365
Light Goods Vehicle	3	38	46	34	98,550
Medium Goods Vehicle	31	17	10	14	37,230
Heavy Goods Vehicle	0	3	1	1	12,045
Total motorised traffic	**360**	**777**	**885**	**746**	**1,834,490**
Total motorised traffic excluding motorcycles	**164**	**282**	**296**	**242**	**695,690**

There is a noted fluctuation in the total motorised traffic over time. This can be attributed to the different seasons, which imply different economic activities when monitoring is done in the area.

4.5 Axle loads

The results of the axle load survey carried out on the road are summarised in Table 4.3 and Table 4.4. The calculations for the VEF and ESA per day are represented in Annex 2. The ESA so obtained is for the central region of Kenya. Comparatively, the daily ESA has increased as can be seen from the survey conducted during baseline and the most recent one, first monitoring round. The increase can be attributed to economic activity throughout the region and the fact that the roads have opened up rural areas to markets and other urban centres.

Table 4.3: Traffic loading (D435, First Monitoring)

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction/modes]	Vehicle ESA [Estimated total since construction]
D435	Bus	0.50	365	183.5	17,523
	Medium Goods Vehicle	0.05	37,230	1,908.0	
	Heavy Goods Vehicle	1.28	12,045	15,432.0	

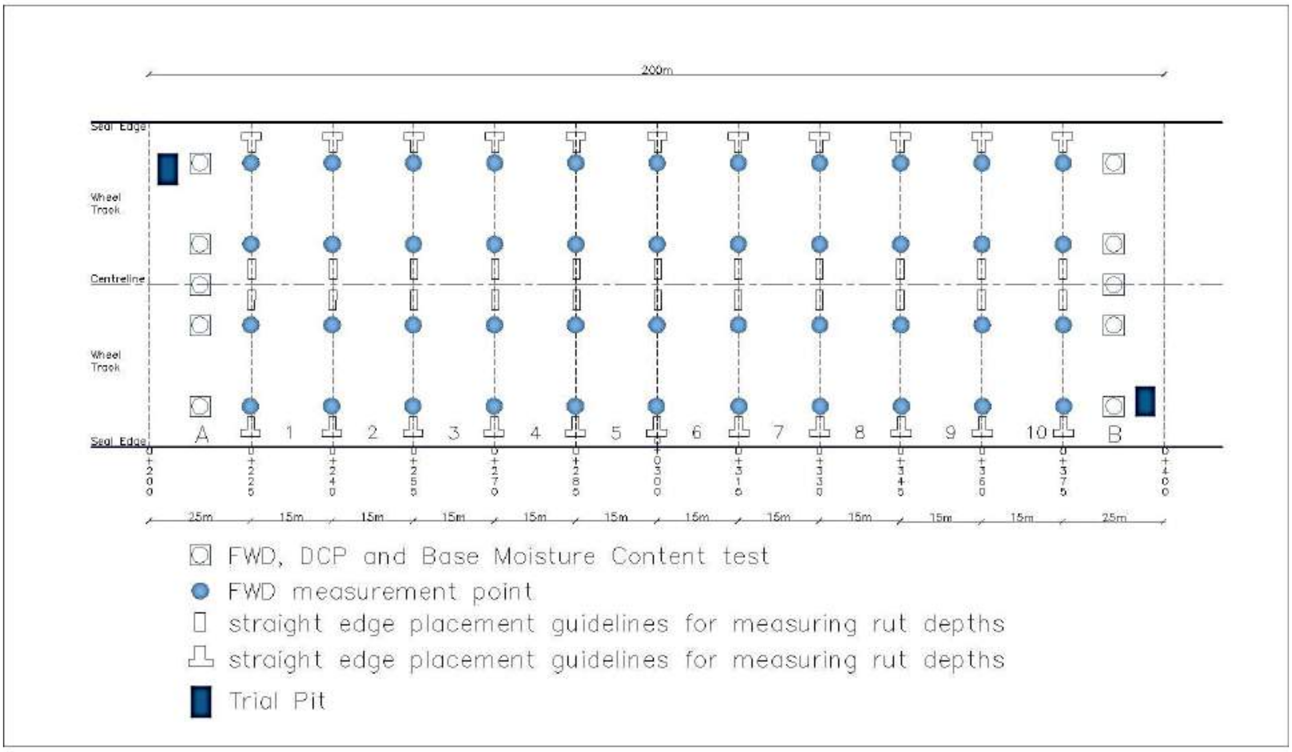
Table 4.4: Traffic loading (D435, Baseline Survey)

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction/mode]	Vehicle ESA [Estimated total since construction]
D435	Bus	0.16	365	58.4	7,021
	Medium Goods Vehicle	0.06	37,230	2,367.0	
	Heavy Goods Vehicle	0.38	12,045	4,595.4	

4.6 Layout of monitoring section

The layout of the monitoring section is shown in Figure 4.4.

Figure 4.4: Layout of monitoring section



4.7 Drainage Assessment

The Drainage Assessment (h) measured in each panel is given in Table 4.5.

Table 4.5: Drainage Assessment [12TH Oct. 2018]

Chainage Km	LHS			RHS		
	Side ditch	Drainage structure	Shoulders	Shoulders	Drainage structure	Side ditch
0+000	Grass	No structure	Edge Breaking	Grassed	No structure	Grassed
0+015	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+030	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+050	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+075	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+085 - 0+100	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+150	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+150 - 0+200	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+203	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+208	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+225 - 0+235	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+240 - 0+270	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+270	Grass	No structure	Grassed	Grassed	Partially Blocked	Grassed
0+273 - 0+285	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+285 - 0+300	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+315 - 0+330	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+345 - 0+350	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+360 - 0+375	Grass	No structure	Grassed	Grassed	No structure	Grassed

0+386	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+403	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+400 - 0+450	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+452	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+525	Grass	No structure	Grassed	Edge Breaking	No structure	Grassed
0+550	Grass	No structure	Grassed	Grassed	No structure	Grassed

4.8 DCP tests (D435)

DCP Apparatus were used to carry out the tests. Across Africa Consultants team together with the MTRD team conducted the tests in this trial section. On the LTPP, the DCP tests were carried out on five points in Panel A and B respectively. However, on the remaining sections of the road, the DCP tests were done with a 50m interval alternating between inner and outer wheel paths.

The results of DCP test carried out on D435 are summarised in Table 4.8, ,and . The Field data and layer strength diagrams are given in Annex 3.

Except for the baseline survey that had the average DN value for the base layer was outside the design specification, all the other layers are within the specification envelop.

Table 4.6: DCP tests on the D435 [*Baseline Survey, Wet Season*]

DN_{base} (mm)		$DN_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN450 - 600 (mm)		DN 600 - 800 (mm)	
Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual
3.2	4.1	6.0	4.2	12.0	6.7	36.0	9.1	50.0	4.2
3.2	5.3	6.0	6.9	12.0	6.8	36.0	7.6	50.0	5.7
3.2	7.7	6.0	4.2	12.0	15.6	36.0	16.7	50.0	21.3
3.2	4.5	6.0	5.6	12.0	9.3	36.0	9.1	50.0	10.0
3.2	5.2	6.0	6.6	12.0	5.1	36.0	7.5	50.0	11.1
3.2	2.3	6.0	4.3	12.0	4.1	36.0	8.5	50.0	5.7
3.2	2.0	6.0	2.9	12.0	2.8	36.0	1.9	50.0	2.0
3.2	1.2	6.0	2.1	12.0	2.5	36.0	2.7	50.0	3.0
3.2	2.1	6.0	4.5	12.0	2.9	36.0	5.8	50.0	8.8
3.2	1.2	6.0	5.3	12.0	3.5	36.0	5.9	50.0	5.4
3.2	3.0	6.0	3.9	12.0	4.7	36.0	6.6	50.0	6.3
3.2	3.0	6.0	3.9	12.0	4.7	36.0	6.6	50.0	6.5
3.2	6.8	6.0	6.3	12.0	11.6	36.0	6.5	50.0	7.0
3.2	1.3	6.0	0.2	12.0	0.2	36.0	0.2	50.0	0.2
3.2	4.8	6.0	12.8	12.0	7.9	36.0	5.4	50.0	5.3
3.2	3.3	6.0	3.2	12.0	3.8	36.0	6.9	50.0	4.5
3.2	3.4	6.0	12.8	12.0	7.9	36.0	5.5	50.0	5.3
3.2	8.0	6.0	10.1	12.0	13.1	36.0	6.3	50.0	7.5
3.2	1.7	6.0	5.7	12.0	6.4	36.0	5.4	50.0	6.0
3.2	1.6	6.0	5.9	12.0	6.1	36.0	5.4	50.0	6.2
3.2	**3.6**	**6.0**	**5.6**	**12.0**	**6.3**	**36.0**	**6.5**	**50.0**	**6.6**

Table 4.7: DCP tests on the D435 [*First monitoring round, Wet Season*]

Chainage		DN_{base} (mm)	$DN_{sub-base}$ (mm)	DN 300 - 450 (mm)	DN 450 - 600 (mm)	DN 600 - 800 (mm)

	Location of test	Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+000	CL	3.2	6.5	6.0	6.2	12.0	10.8	36.0	17.6	50.0	23.2
0+100	CL	3.2	3.8	6.0	2.5	12.0	11.2	36.0	13.7	50.0	24.9
0+150	RHS	3.2	3.8	6.0	6.0	12.0	7.4	36.0	7.7	50.0	8.1
0+200	CL	3.2	1.7	6.0	3.5	12.0	5.3	36.0	7.5	50.0	7.8
0+200	RHS	3.2	1.4	6.0	3.1	12.0	2.5	36.0	1.0	50.0	0.6
0+200	LHS	3.2	1.4	6.0	3.4	12.0	3.5	36.0	2.2	50.0	6.6
0+200	RHS	3.2	1.4	6.0	2.7	12.0	2.0	36.0	3.4	50.0	10.2
0+200	RHS	3.2	1.8	6.0	3.7	12.0	7.8	36.0	8.9	50.0	3.3
0+380	CL	3.2	1.0	6.0	3.8	12.0	6.1	36.0	6.6	50.0	9.7
0+380	CL	3.2	1.1	6.0	2.0	12.0	5.8	36.0	6.5	50.0	6.9
0+380	RHS	3.2	1.3	6.0	1.3	12.0	4.2	36.0	5.7	50.0	9.6
0+380	RHS	3.2	0.6	6.0	0.2	12.0	0.2	36.0	0.2	50.0	0.2
0+380	RHS	3.2	0.8	6.0	0.4	12.0	0.4	36.0	0.4	50.0	0.4
0+450	CL	3.2	1.1	6.0	2.4	12.0	5.9	36.0	5.9	50.0	9.5
0+500	RHS	3.2	3.3	6.0	5.2	12.0	12.6	36.0	16.2	50.0	13.7
0+500	RHS	3.2	2.7	6.0	4.7	12.0	7.9	36.0	4.0	50.0	0.9
0+550	CL	3.2	1.6	6.0	4.2	12.0	3.9	36.0	5.9	50.0	8.1
Average		**3.2**	**2.1**	**6.0**	**3.3**	**12.0**	**5.7**	**36.0**	**6.7**	**50.0**	**8.4**

Table 4.8: DCP tests on the D435 [*Second monitoring round, Dry Season*]

Location of test	DN_{base} (mm)		$DN_{sub\text{-}base}$ (mm)		DN 300 - 450 (mm)		DN 450 - 600 (mm)		DN 600 - 800 (mm)	
	Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual
CL	3.2	2.6	6.0	4.4	12.0	8.6	36.0	4.9	50.0	8.6
LHS	3.2	5.7	6.0	17.7	12.0	19.9	36.0	19.1	50.0	21.3
RHS	3.2	6.9	6.0	6.5	12.0	13.0	36.0	13.4	50.0	15.3
LHS	3.2	2.7	6.0	2.6	12.0	4.4	36.0	6.0	50.0	10.2
CL	3.2	3.3	6.0	2.4	12.0	7.2	36.0	9.6	50.0	7.6
CL	3.2	2.3	6.0	4.2	12.0	5.6	36.0	5.9	50.0	6.0
LHS	3.2	2.2	6.0	4.1	12.0	5.0	36.0	3.4	50.0	5.5
RHS	3.2	2.5	6.0	4.5	12.0	3.9	36.0	5.3	50.0	10.2
RHS	3.2	3.8	6.0	3.3	12.0	4.2	36.0	5.0	50.0	10.5
CL	3.2	2.9	6.0	3.1	12.0	8.8	36.0	8.5	50.0	17.2
CL	3.2	1.6	6.0	2.3	12.0	4.2	36.0	4.2	50.0	7.7
LHS	3.2	1.4	6.0	2.0	12.0	3.4	36.0	3.2	50.0	7.1
RHS	3.2	1.2	6.0	2.8	12.0	5.5	36.0	7.8	50.0	8.3
RHS	3.2	1.9	6.0	4.2	12.0	8.0	36.0	8.3	50.0	11.6
CL	3.2	3.9	6.0	8.5	12.0	11.8	36.0	11.9	50.0	15.2
LHS	3.2	2.7	6.0	3.3	12.0	5.3	36.0	7.7	50.0	7.0
RHS	3.2	3.5	6.0	8.1	12.0	11.1	36.0	6.5	50.0	3.3
LHS	3.2	1.5	6.0	4.1	12.0	2.7	36.0	3.6	50.0	2.4
	3.2	**2.9**	**6.0**	**4.9**	**12.0**	**7.4**	**36.0**	**7.5**	**50.0**	**9.7**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

4.9 Deflection measurements (D435)

Defection was measured using the Falling Weight Deflectometer (FWD) at 50 m intervals along the road, alternating between the outer wheel path and the inner wheel path. A large circular weight was used to transmit a pressure of 566 kPa to the pavement. The load imparted on the pavement therefore was measured and the stiffness parameters calculated.

The results of deflection tests carried out on the road are summarised in and Table 4.9.

As can be seen, the average maximum deflection has increased slightly from baseline survey to first monitoring round.

Table 4.9: Deflection tests on D435 (Baseline Survey)

Chainage (m)	Lane No.	Elastic Modulus (MPa)			Maximum Deflection D_o (µm)
		EBase (MPa)	ESubbase (MPa)	ESubgrade (MPa)	
0+003	1	300	200	214	388
0+099	1	300	200	153	437
0+200	1	343	583	116	439
0+225	1	2437	435	124	282
0+255	1	1059	252	186	500
0+285	1	729	252	152	466
0+315	1	495	1203	141	323
0+345	1	986	242	189	434
0+375	1	593	249	144	608
0+500	1	1163	349	242	428
0+600	1	943	227	168	474
0+050	2	669	253	142	608
0+150	2	300	200	98	518
0+240	2	586	127	268	351
0+270	2	713	262	153	468
0+300	2	892	242	178	409
0+330	2	269	189	154	537
0+360	2	300	200	118	433
0+400	2	1217	266	207	429
0+449	2	300	200	126	426
0+550	2	290	87	167	596
0+051	3	478	344	139	645
0+150	3	300	200	98	589
0+240	3	422	464	134	400
0+270	3	714	307	173	443
0+300	3	300	200	158	385

0+330	3	943	268	193	438
0+360	3	483	652	127	362
0+401	3	972	216	171	443
0+450	3	467	306	133	468
0+551	3	528	88	229	409
0+000	4	469	111	277	418
0+051	4	484	332	140	647
0+100	4	300	200	121	468
0+200	4	430	498	159	374
0+225	4	738	3896	115	290
0+255	4	1160	282	216	429
0+285	4	1111	261	212	428
0+315	4	484	87	208	431
0+345	4	547	96	260	372
0+375	4	387	940	99	458
0+500	4	1143	550	266	408
0+600	4	300	200	134	485
Average		**652**	**389**	**167**	**450**

Table 4.10: Deflection tests on D435 (First monitoring round)

Chainage (m)	Lane No.	Elastic Modulus (MPa)			Maximum Deflection
		EBase (MPa)	ESubbase (MPa)	ESubgrade (MPa)	Do (µm)
0+000	1	518	148	214	493
0+007	1	700	504	175	491
0+049	1	702	276	164	716
0+100	1	719	94	137	692
0+150	1	300	200	115	645
0+200	1	300	200	199	501
0+225	1	593	1477	138	416
0+251	1	450	251	123	738
0+272	1	617	295	156	539
0+302	1	504	334	149	571
0+332	1	961	263	183	499
0+376	1	300	200	122	585
0+377	1	421	267	113	844
0+452	1	300	200	127	610
0+504	1	903	802	292	403
0+001	2	300	200	199	500
0+050	2	842	264	171	712
0+101	2	476	439	123	526
0+150	2	300	200	115	641
0+201	2	300	200	138	526
0+226	2	532	1267	142	373
0+257	2	300	200	127	620
0+273	2	678	278	157	504

0+303	2	622	290	152	553
0+333	2	300	200	152	540
0+374	2	300	200	112	612
0+378	2	565	1144	153	368
0+453	2	452	260	125	627
0+505	2	300	200	414	435
0+002	3	430	91	246	548
0+049	3	562	87	164	748
0+051	3	231	171	128	725
0+151	3	300	200	123	605
0+200	3	300	200	143	602
0+227	3	831	2058	162	293
0+258	3	653	278	159	573
0+286	3	724	267	167	776
0+317	3	408	989	143	429
0+347	3	300	200	160	545
0+363	3	300	200	130	554
0+403	3	516	394	161	471
0+503	3	300	200	187	555
0+554	3	748	235	153	691
0+004	4	1136	410	212	310
0+152	4	300	200	118	671
0+242	4	548	640	163	398
0+287	4	442	337	135	645
0+318	4	300	200	129	575
0+348	4	1050	255	197	506
0+352	4	300	200	141	583
0+404	4	300	200	180	456
0+555	4	513	231	128	789
Average		**501**	**367**	**160**	**564**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

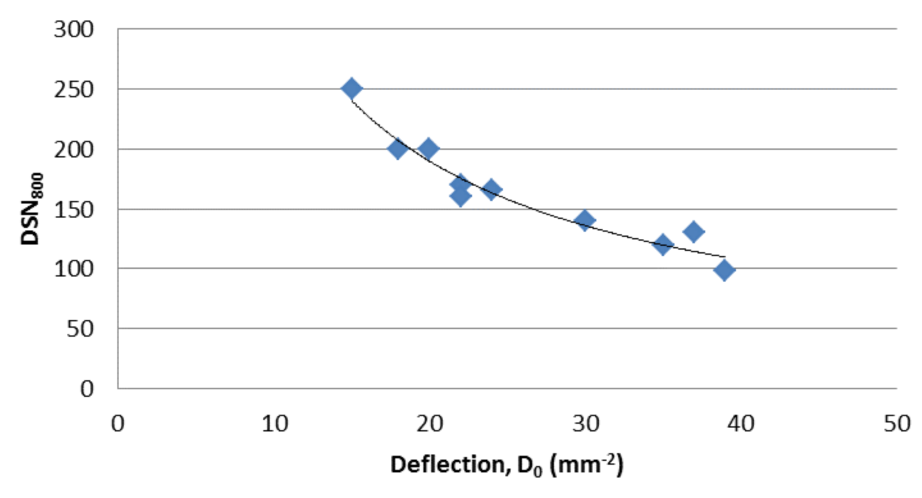
[*add rows to the table as necessary*]

[*add any comments or observations on the amount of deflection measured*]

4.10 Comparison of DN and deflection measurements

The graph in Figure 4.5 shows the comparison between DN values and deflection measurements at the same measurement points.

Figure 4.5: DSN_{800} versus D_0



[insert a graph showing wet season and dry season comparisons between DSN_{800} and deflection]

[add any comments on the degree of correlation between the deflection and DCP measurements].

4.11 Test pit

4.11.1 General information

Table 4.11 provides general information on the test pits excavated on the monitoring section.

Table 4.11: Test pit data (D435)

	Test Pit No.	Panel No.	Location	Date of excavation	Season
Baseline Survey	TPA-1-16	A	Right	03/11/2016	Dry Season
	TPB-1-16	B	Left	03/11/2016	
First Monitoring	TPA-1-17	A	Left, Centre, Right	28/06/2017	Wet Season
	TPB-1-17	B	Left, Centre, Right	28/06/2017	
Second Monitoring	TP1	A	N/A	N/A	N/A
	TP2	B	N/A	N/A	N/A

4.11.2 In situ DCP tests

Table 4.12 provides a summary of DCP tests carried out in the test pit before excavation. All of the DN values are within the design specification. It implies that the pavement is still performing relatively well as compared to other trial sections under this research.

Table 4.12: DN values for pavement layers in the test pit (D435)

	Test Pit No.	DN_{base}	$DN_{sub\text{-}base}$	$DN_{300\text{-}450}$	$DN_{450\text{-}600}$	$DN_{600\text{-}800}$
Baseline Survey	TPA-1-16	3	3.9	4.7	6.6	6.3
	TPB-1-16	3	3.9	4.7	6.6	6.5
	Specification	**3.2**	**6**	**12**	**36**	**50**
First Monitoring	TPA-1-17	1.5	2.8	1.9	1.2	1.2
	TPB-1-17	0.9	3.7	6	8	8
	Specification	**3.2**	**6**	**12**	**36**	**50**

	Test Pit No.	DN_{base}	$DN_{sub-base}$	$DN_{300-450}$	$DN_{450-600}$	$DN_{600-800}$
Second Monitoring	N/A	N/A	N/A	N/A	N/A	N/A

4.11.3 Layer density and moisture content

The density of the pavement layers and moisture content are summarised in Table 4.13.

The in-situ moisture content was established from samples taken to the laboratory. Generally, insitu moisture content increases with an increase in depth.

Table 4.13: Density and moisture content (D435)

	Test Pit	Wheel Path	Layer	Dry density (kg/m³)	MDD (kg/m³)	Relative density (%)	In situ moisture content (%)	OMC (%)	In situ moisture content as proportion of OMC
Second Monitoring	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
First Monitoring	TPA-1-16	OWP	Base	-	-	-	8.1	8.3	0.98
			Sub-base	-	-	-	14.3	12.1	1.18
			Subgrade	-	-	-	15.8	26.0	0.61
		IWP	Base	-	-	-	8.0	8.1	0.99
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	-	-	-
	TPA-2-16	OWP	Base	-	-	-	4.8	9.4	0.51
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	18.0	25.1	0.72
		IWP	Base	-	-	-	5.1	8.6	0.59
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	-	-	-
Baseline Survey	TPB-1-16	OWP	Base	-	2095	-	8.0	8.3	0.96
			Sub-base	-	1730	-	9.1	12.1	0.75
			Subgrade	-	1350	-	13.1	26.0	0.50
		IWP	Base	-	2100	-	7.9	8.1	0.98
			Sub-base	-	1745	-	16.3	11.6	1.41
			Subgrade	-	1330	-	19.3	24.5	0.79
	TPB-2-16	OWP	Base	-	2065	-	8.0	9.4	0.85
			Sub-base	-	1695	-	19.4	14.2	1.37
			Subgrade	-	1365	-	21.6	25.1	0.86
		IWP	Base	-	2070	-	7.7	8.6	0.90
			Sub-base	-	1670	-	17.6	14.6	1.21
			Subgrade	-	1370	-	21.8	28.5	0.76

4.11.4 Test pit log

The test pit logs are summarised in Table 4.14. The moisture, colour, consistency, structure, soil type and origin are described using the standard terms in the regional monitoring guideline.

Table 4.14: Test pit logs

Test Pit	Layer	Thickness mm	Moisture 1st monitoring	Moisture baseline survey	Colour	Consistency	Structure	Soil type	Origin	AASHTO soil classification
TPA-1-16	Surface	25	-	-	Black	Extremely hard		Cold Mix Asphalt	Local	n/a
	Base	200	8.1	8	Dark grey	Very hard		Neat weathered basalt	Local	n/a
	Subbase	150	14.3	9.1	Light grey	Very hard		Natural gravel	Local	n/a
	Subgrade	-	15.8	13.1	Brown	hard		Natural occurring	Local	n/a
TPB-1-16	Surface	25	-	-	Black	Extremely hard		Cold Mix Asphalt	Local	n/a
	Base	150	4.8	8	Dark grey	Very hard		Neat laterite	Local	n/a
	Subbase	150	-	19.4	Light grey	Very hard		Natural gravel	Local	n/a
	Subgrade	-	18	21.6	Brown	hard		Natural occurring	Local	n/a

4.11.5 Base material properties

The properties of the base course material are summarised in Table 4.15.

The DN value is reported at the expected in-service moisture content.

Table 4.15: Base material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T180
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	12	10	9	50	26	24	2095	8.3	OWP = GCS IWP = GCS
TPB-1-16	17	12	10	41	23	18	2065	9.4	OWP = GCS IWP = GCS

The material used for the base is within the design specification.

[*report the CBR at the specified compaction density (x) soaked*]

[*report the DN value at the specified density (x) and expected in service moisture content*]

[*include any observations on the actual materials properties compared with the design specification*]

4.11.6 Sub-base material properties

The properties of the sub-base material are summarised in Table 4.16.

The DN value is reported at the expected in-service moisture content.

Table 4.16: Sub-base material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T180
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	65	65	55	52	25	27	1730	12.1	OWP = 16 IWP = 13
TPB-1-16	68	65	60	42	17	25	1695	14.2	OWP = 14 IWP = 15

It is observed that the material used for the subbase is within the design specification

[*report the CBR at the specified compaction density soaked*]

[*report the DN value at the specified density and expected in service moisture content*]

[*include any observations on the actual materials properties compared with the design specification*]

4.11.7 Subgrade material properties

The properties of the Subgrade material are summarised in Table 4.17.

The DN value is reported at the expected in-service moisture content.

Table 4.17: Subgrade material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T99
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TPA-1-16	90	85	80	69	35	34	1350	26	OWP = 5 IWP = 5
TPB-1-16	85	80	75	48	22	26	1365	25.1	OWP = 4 IWP = 6

It is observed that the material used for the subgrade is within the design specification.

[*report the CBR at the specified compaction density soaked*]

[*report the DN value at the specified density and expected in service moisture content*]

[*include any observations on the actual materials properties compared with the design specification*]

4.11.8 Particle Size Distribution

The PSD for the base course material in each TP, compared with the specification envelope, are shown in Figure 4.6 and Figure 4.7. The base and subbase materials all fit into the specification envelope except for a small portion of the course particles on the base material on outer wheel path of panel B and panel A, as specified in ASTM D2940.

Figure 4.6: PSD for base course in TPA-1-16 and TPB-1-16

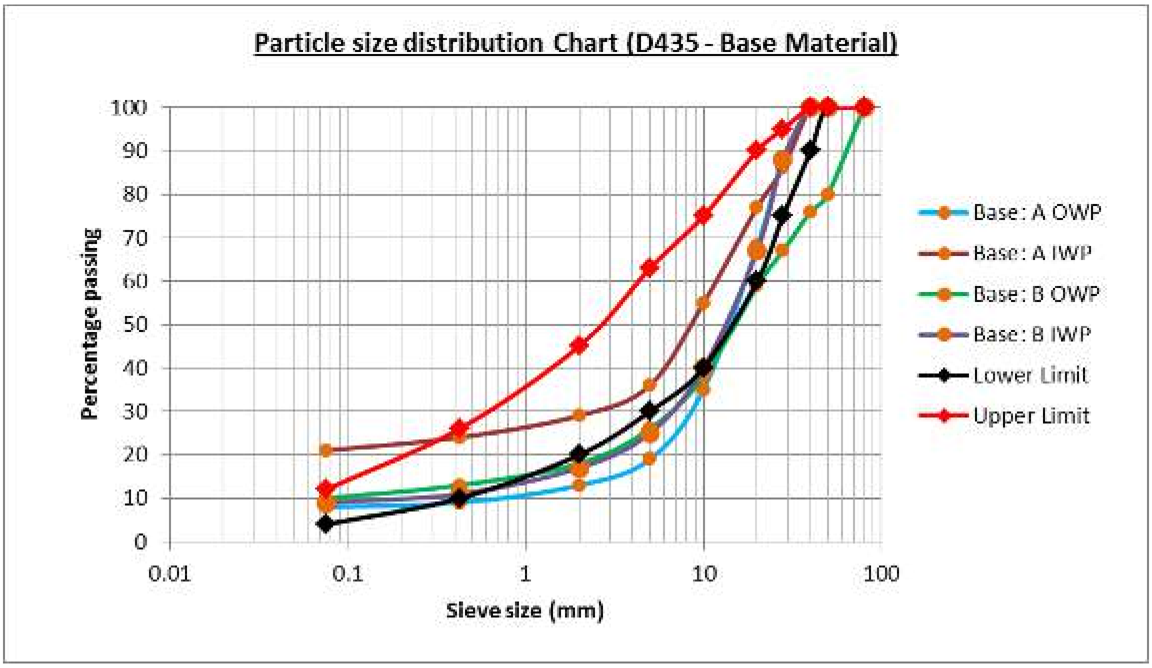
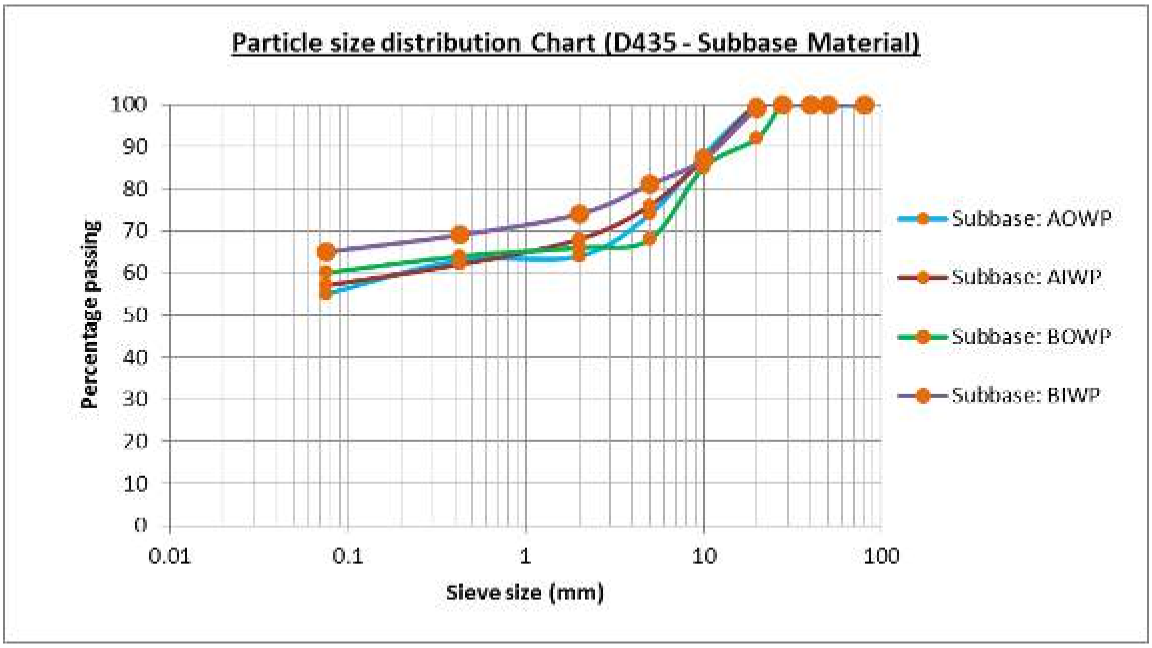


Figure 4.7: PSD for sub-base course in TPA-1-16 and TPB-1-16



4.11.9 Other TP tests

n/a

4.11.10 Discussion on test pit results

Generally, the pavement layers are performing to expectations. The materials used in the construction of the pavement layers are within specification save for the ravelling which took place between chainage 0+200 to 0+400 [*summarise the findings of the TP investigations including the comparison of layer thickness and materials properties to the specification and any lessons learnt for LVR pavement design*]

4.12 Rut depth

The rut depth measurements taken on the monitoring section are summarised in Table 4.18. The average rut has been decreasing over the years, which is a strange observation. We aim at making a concrete conclusion after the fourth round of monitoring. Needless to say, the rut depth measured is barely visible to the naked eye.

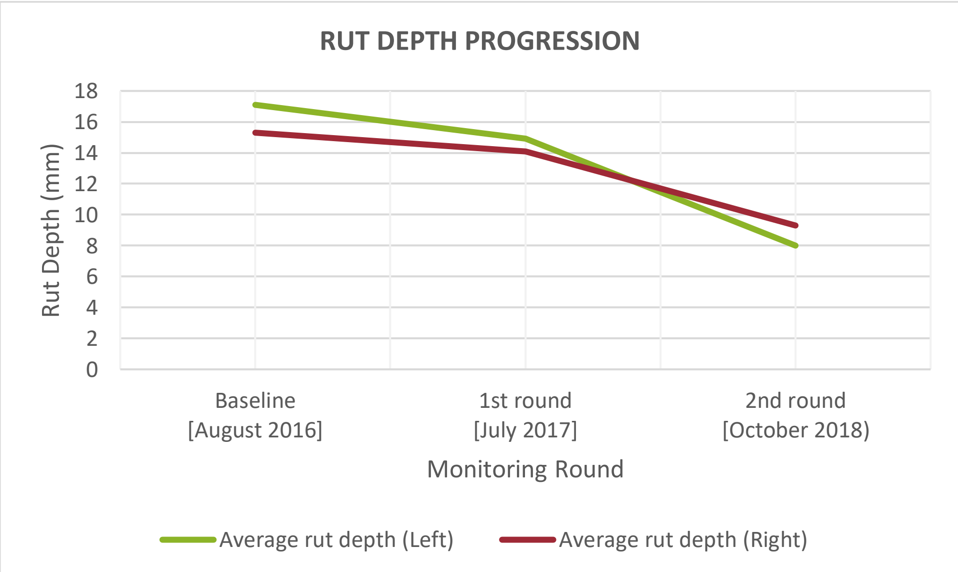
The Field data are given in Annex 4.

Table 4.18: Rut depth (D435)

Panel	Baseline [*August 2016*]		1st round [*July 2018*]				2nd round [*Oct. 2018*]				3rd round [*date*]	
	Left (mm)	Right (mm)	Left (mm)		Right (mm)		Left (mm)		Right (mm)		Left (mm)	Right (mm)
1	14	7	IWL	15	IWR	10	OWL	0	IWR	12		
2	23	22	OWL	5	OWR	15	OWL	8	IWR	10		
3	22	20	IWL	17	OWR	22	OWL	10	OWR	15		
4	18	9	OWL	20	OWR	15	OWL	6	IWR	9		
5	28	18	IWL	20	OWR	9	OWL	14	IWR	4		
6	12	19	IWL	20	OWR	8	OWL	10	IWR	6		
7	12	21	OWL	10	IWR	15	OWL	9	IWR	15		
8	12	20	IWL	12	OWR	12	OWL	13	IWR	9		
9	24	9	IWL	15	IWR	15	OWL	0	IWR	10		
10	6	8	IWL	15	OWR	20	IWL	11	IWR	10		
Average	17	15	15		14		8		10			
Average for section	**16**		**15**				**9**					

Figure 4.8 shows the rut depth progression over the monitoring period.

Figure 4.8: Rut depth progression (D435)



4.13 Deflection measurements (LTTP section)

The results of deflection tests carried out on the monitoring section are summarised in and Table 4.19.

Table 4.19: Deflection results on the LTPP section and elastic modulus on D435 (Baseline Survey)

Panel number	Location of test	D_0 (µm)	E_{base} MPa)	$E_{sub\text{-}base}$ (MPa)	$E_{subgrade}$ (MPa)
1	OWL	282	2437	435	124
	OWR	290	738	3896	115
2	IWL	351	586	127	268
	IWR	400	422	464	134
3	OWL	500	1059	252	186
	OWR	429	1160	282	216
4	IWL	468	713	262	153
	IWR	443	714	307	173
5	OWL	466	729	252	152
	OWR	428	1111	261	212
6	IWL	409	892	242	178
	IWR	385	300	200	158
7	OWL	323	495	1203	141
	OWR	431	484	87	208
8	IWL	537	269	189	154
	IWR	438	943	268	193
9	OWL	434	986	242	189
	OWR	372	547	96	260
10	IWL	433	300	200	118
	IWR	362	483	652	127
	OWL	608	593	249	144
	OWR	458	387	940	99
Average		**420.3**	**743.1**	**504.8**	**168.3**

Table 4.20: Deflection results on the LTPP section and elastic modulus on D435 (First monitoring)

Panel number	Location of test	D_0 (µm)	E_{base} MPa)	$E_{sub\text{-}base}$ (MPa)	$E_{subgrade}$ (MPa)
1	OWL	416	593	1477	138
	IWL	373	532	1267	142
	IWR	293	831	2058	162
2	OWR	398	548	640	163
	OWL	738	450	251	123
3	IWL	620	300	200	127
	IWR	573	653	278	159
4	OWL	539	617	295	156
	IWL	504	678	278	157
5	IWR	776	724	267	167
	OWR	645	442	337	135
6	OWL	571	504	334	149
	IWL	553	622	290	152

7	IWR	429	408	989	143
	OWR	575	300	200	129
8	OWL	499	961	263	183
	IWL	540	300	200	152
9	IWR	545	300	200	160
	OWR	506	1050	255	197
10	OWR	583	300	200	141
	IWR	554	300	200	130
	IWL	612	300	200	112
Average		**538.3**	**532.4**	**485.4**	**149.0**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

[*the location of the tests depends on the layout of the monitoring section*]

[*if the deflection tests were carried out during the current round of monitoring include the outputs from the FWD for all the sensors (D_0 up to D_6) in an annex and provide a reference to the annex*].

4.14 Comparison of deflection and rutting

Table 4.22 and shows the deflections (D_0) and rut depths measured in each panel on the monitoring section. The rut depth measurements in Table 4.18 are the most recent measurements as recorded.

Table 4.21: Deflection and rut depth measurements D435 (Baseline survey)

Panel number	Location of test	D_0 (µm)		Rut depth (mm)		
		Baseline Survey	Average for panel	Left	Right	Average
1	OWL	282	286.0	14	7	10.5
	OWR	290				
2	IWL	351	375.5	23	22	22.5
	IWR	400				
3	OWL	500	464.5	22	20	21.0
	OWR	429				
4	IWL	468	455.5	18	9	13.5
	IWR	443				
5	OWL	466	447.0	28	18	23.0
	OWR	428				
6	IWL	409	397.0	12	19	15.5
	IWR	385				
7	OWL	323	377.0	12	21	16.5
	OWR	431				
8	IWL	537	487.5	12	20	16.0

	IWR	438				
9	OWL	434	403.0	24	9	16.5
	OWR	372				
10	IWL	433	465.3	6	8	7.0
	IWR	362				
	OWL	608				
	OWR	458				
Average		**420.3**	**415.8**	**17.1**	**15.3**	**16.2**

Table 4.22: Deflection and rut depth measurements D435 (First monitoring round)

Panel number	Location of test	D_0 (µm)		Rut depth (mm)		
		First Monitoring	Average for panel	Left	Right	Average
1	OWL	416	360.7	15	10	12.5
	IWL	373				
	IWR	293				
2	OWR	398	568.0	5	15	10.0
	OWL	738				
3	IWL	620	596.5	17	22	19.5
	IWR	573				
4	OWL	539	521.5	20	15	17.5
	IWL	504				
5	IWR	776	710.5	20	9	14.5
	OWR	645				
6	OWL	571	562.0	20	8	14.0
	IWL	553				
7	IWR	429	502.0	10	15	12.5
	OWR	575				
8	OWL	499	519.5	12	12	12.0
	IWL	540				
9	IWR	545	525.5	15	15	15.0
	OWR	506				
10	OWR	583	583.0	15	20	17.5
	IWR	554				
	IWL	612				
Average		**538.3**	**544.9**	**14.9**	**14.1**	**14.5**

and Figure 4.9 shows the relationship between deflection and rut depth measurements on the monitoring section. There is no clear correlation between rut depth and deflection at this stage of the life of the pavement.

Figure 4.9: Correlation between deflection (D_o) and rut depth D435 (Baseline survey)

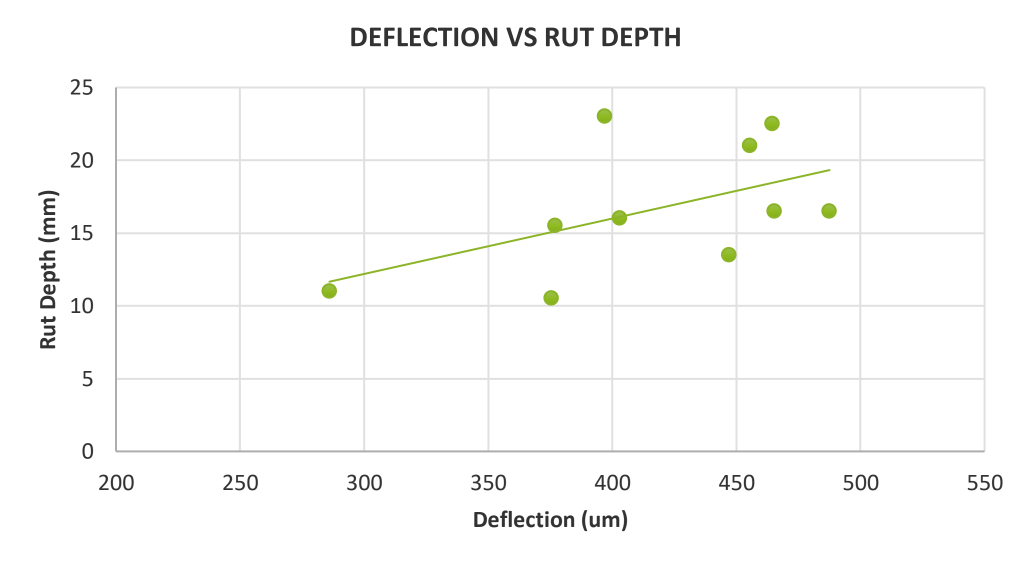
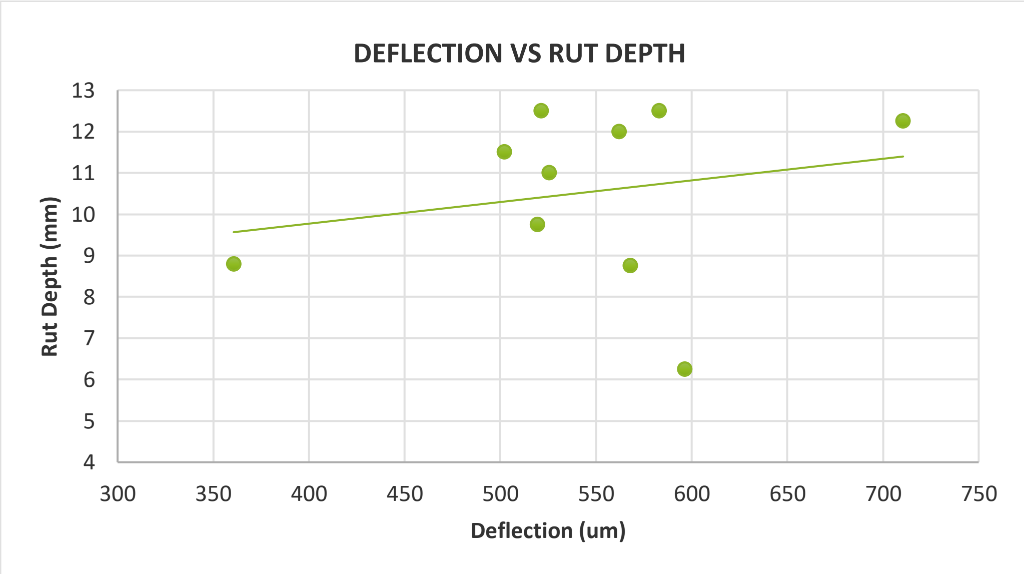


Figure 4.10: Correlation between deflection (D_o) and rut depth D435 (First monitoring round)



4.15 Roughness

and Table 4.23 shows the roughness (IRI) measured on the monitoring section at each round of monitoring. The roughness was measured using drims method. The trial sections' roughness has increased from baseline as compared to second monitoring round. All roughness outputs are found in Annex 5.

Table 4.23: Roughness measurements (Baseline survey)

Monitoring round	Date	Left side		Right side		Average IRI (m/km)
		Chainage	IRI (m/km)	Chainage	IRI (m/km)	
Baseline		0+000-0+051	7.2	0+000-0+050	7.2	
		0+050-0+099	7.2	0+050-0+150	3.5	

	12th Jun - 20th Jun 2017	0+099-0+225	3.5	0+150-0+240	3.5	
		0+225-0+240	3.5	0+240-0+300	3.7	
		0+240-0+255	3.5	0+300-0+330	3.7	
		0+255-0+285	3.7	0+330-0+360	3.7	
		0+285-0+300	3.7	0+360-0+400	2.8	
		0+300-0+345	3.7	0+400-0+449	2	
		0+345-0+360	3.7	0+449-0+550	2.6	
		0+360-0+375	3.7			
		0+375-0+450	2.8			
		0+450-0+500	2			

Table 4.24: Roughness measurements (Second Monitoring)

Monitoring round	Date	Left side		Right side		Average IRI (m/km)
		Chainage	IRI (m/km)	Chainage	IRI (m/km)	
Second Monitoring	1st October 2018	0+000-0+100	7.8	0+000-0+100	10.1	9.0
		0+100-0+200	3.7	0+100-0+200	10.1	6.9
		0+200-0+300	3.8	0+200-0+300	8.0	5.9
		0+300-0+400	3.8	0+300-0+400	6.6	5.2
		0+400-0+500	3.5	0+400-0+500	9.3	6.4
		0+500-0+550	3.0	0+500-0+550	14.8	8.9

and Figure 4.11 shows the roughness progression over the monitoring period.

Figure 4.11: Roughness progression (Baseline survey)

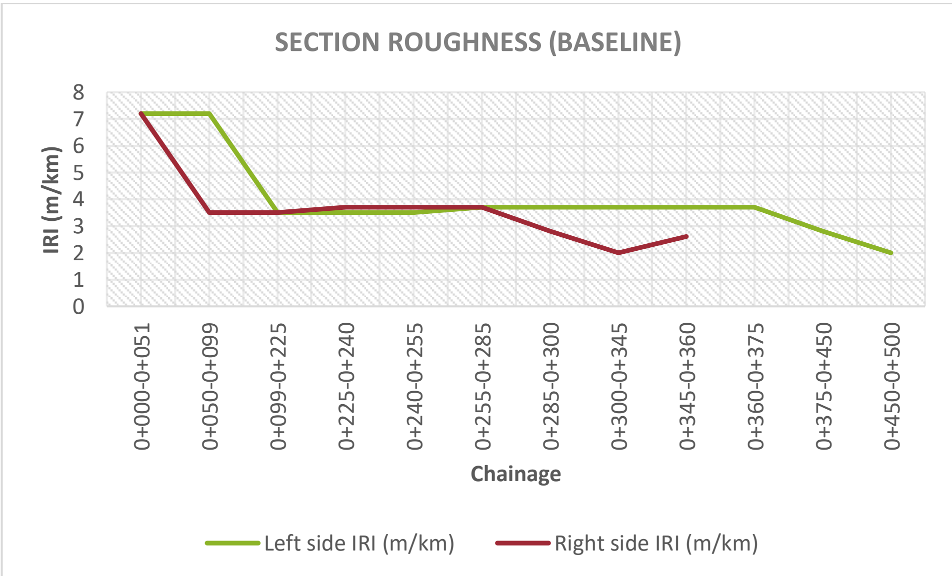
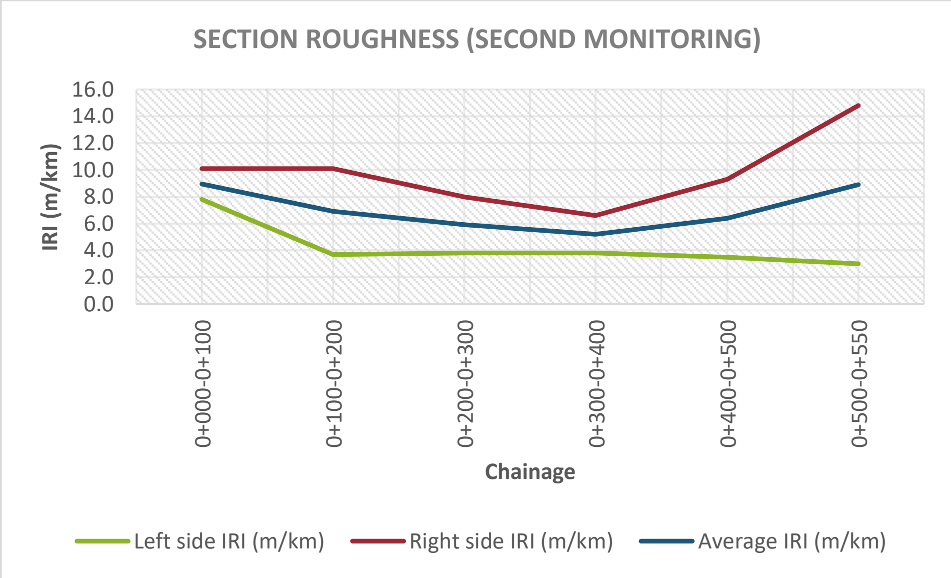


Figure 4.12: Roughness progression (Second monitoring)



4.16 Present serviceability rating

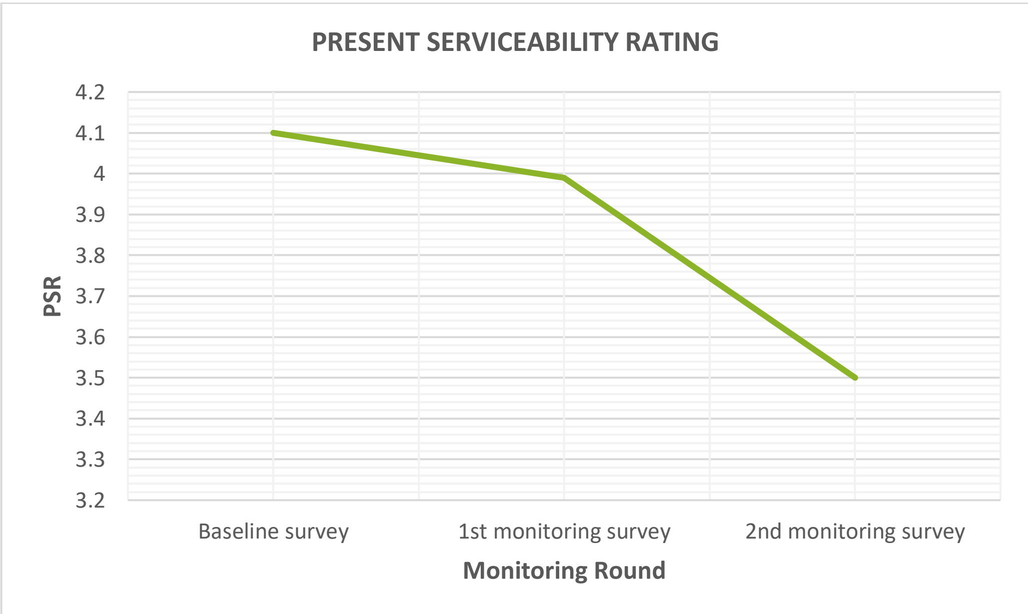
The present serviceability rating has been calculated for the entire trial section. Table 4.25 shows the PSR for each round of monitoring. The breakdown of the PSR is represented in Annex 6.

Table 4.25: Present Serviceability Rating (D435)

Baseline survey	1st monitoring survey	2nd monitoring survey	3rd monitoring survey	4th monitoring survey
4.10	3.99	3.50		

The variation of the average PSR for the monitoring rounds carried out to date is shown in Figure 4.13.

Figure 4.13: Variation in PSR over the monitoring rounds



Typical photographs of defects on the monitoring section are included in Figure 4.14.

Figure 4.14: Typical defects 2nd monitoring round (D435)

Fig No	Location (Km)	Defect assessment and description	Photos illustrating the pavement distress & defect
Fig 1	Km 0+000 – 0+050	-Rough texture because of rainfall during the pavement's construction	
Fig 2	Km 0+015	-Pothole and ravelling	
Fig 3	Km 0+015	-Pothole and ravelling	

Fig 4	Km 0+100 – 0+150	-Ravelling at LHS	
Fig 5	Km 0+150LHS	-Rough Texture due to because of rainfall during the pavement's construction	
Fig 6	Km 0+225 RHS	-Potholes in section A of the LTPP	

Fig 7	Km 0+270 RHS	-Partially blocked access culvert	
Fig 8	Km 0+273 – 0+300 RHS	- Rough Texture because of rainfall during the construction of the road	
Fig 9	Km 0+315 – 0+350RHS	- Rough Texture due to Ravelling	

Fig 10	Km 0+403 RHS	-Pothole developing on the carriage way	
Fig 11	Km 0+445 – 0+520	-No visible defect	
Fig 12	Km 0+525	- Edge breaking at inner curve	
Fig 13	Km 0+550	-No visible defect on the carriage way -Slight vegetation on the road shoulder	

5 Monitoring Section 4: Kangari - Kinyona Road E511

5.1 Location

The start of the monitoring section is at chainage 0+000 from the start of the road, which is at Kaharati – Kangari Road.

The GPS coordinates at the start of the monitoring section are:

South: 0°46'16.41"

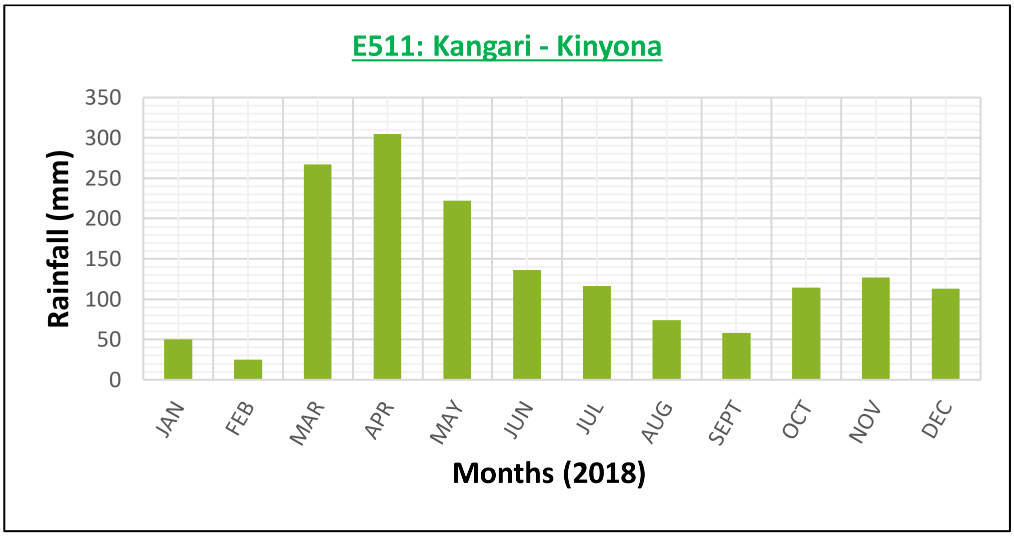
East: 36°50'24.00"

The length of the monitoring section is 920 m

5.2 Climate

Rainfall data from the nearest weather station to the site are shown in Figure 5.1. Long rains were experienced between March and April.

Figure 5.1: Rainfall Data from Kangari Homestead Station

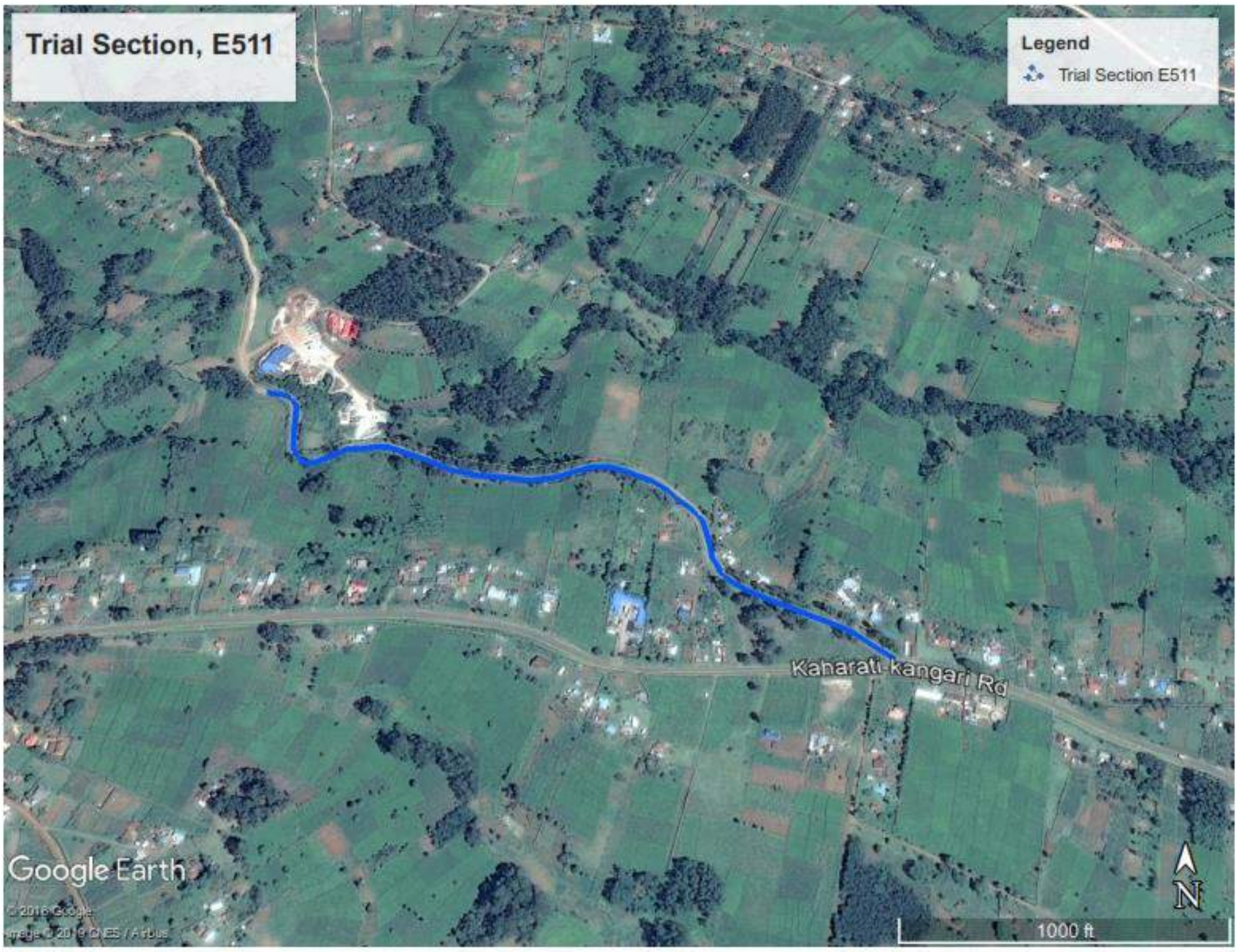


5.3 Design Details

5.3.1 Geometry

The carriageway width is 6 meters and there is no shoulder. The monitoring section is indicated in the blue line shown in Figure 5.2.

Figure 5.2: Monitoring section E511 on Kangari - Kinyona Road



5.3.2 Pavement design and surfacing

The pavement design and surfacing are shown in Figure 5.3.

Figure 5.3: Pavement design and surfacing (E511)

20 mm Cold Mix Asphalt	
150 mm Neat laterite base	
250 mm Granular subbase	
Subgrade	

The base was primed before surfacing.

The pavement was designed by Jon Hongve under AfCAP in 2012.

The traffic loading used for the design was 53,984 CESA over a design life of 15 years.

The pavement was designed according to Malawi DCP Pavement Design Manual Draft, 2011.

5.3.3 Construction

The trial section was built in 2014.

The construction works were supervised by KeRRA Kiambu region.

The cost of construction was $ 203,988 (refer to **Error! Reference source not found.**).

5.3.4 Maintenance

The maintenance activities that have been carried out on the monitoring section since construction are summarised in Table 5.1.

Table 5.1: Maintenance activities

Period		Activities carried out	Maintenance cost [*local currency*]	Maintenance cost USD
From	to			
Construction	Baseline survey	drainage clearing.	-	-
Baseline survey	1st monitoring survey	Bush clearing and drainage cleaning.	600,000.00*	6,000.00*
1st monitoring survey	2nd monitoring survey	Bush clearing and drainage cleaning.	600,000.00*	6,000.00*
2nd monitoring survey	3rd monitoring survey			
3rd monitoring survey	4th monitoring survey			

*Estimated amount

5.4 Traffic

The traffic surveys carried out on the road are summarised in Table 5.2. The traffic survey was conducted during the month of October, 2018. The results and calculations of the survey are found in Annex 1.

Table 5.2: Traffic data (E511)

Mode	AADT (design)	AADT *[Baseline Survey]*	AADT *[First Monitoring]*	AADT *[Second Monitoring]*	Estimated total since construction
Motorcycle	207	334	315	367	667,950
Car	34	93	57	129	123,735
Minibus	75	62	34	36	63,510
Bus	6	0	1	0	365
Light Goods Vehicle	11	69	73	50	181,770
Medium Goods Vehicle	10	16	12	22	22,995
Heavy Goods Vehicle	2	13	3	2	37,230
Total motorised traffic	**345**	**587**	**495**	**607**	**1,097,555**
Total motorised traffic excluding motorcycles	**138**	**253**	**180**	**240**	**429,605**

There is a noted fluctuation in the total motorised traffic over time. This can be attributed to the different seasons, which imply different economic activities when monitoring is done in the area.

5.5 Axle loads

The results of the axle load survey carried out on the road are summarised in Table 5.3 and Table 5.4. The calculations for the VEF and ESA per day are represented in the Annex 2. The ESA so obtained is for the central region of Kenya. Comparatively, the daily ESA has increased as can be seen from the survey conducted during baseline and the most recent one, first monitoring round. The increase can be attributed to economic activity throughout the region and the fact that the roads have opened up rural areas to markets and other urban centres.

Table 5.3: Traffic loading (E511, Second Monitoring)

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction/mode]	Vehicle ESA [Estimated total since construction]
E511	Bus	0.50	365	183.5	49,061
E511	Medium Goods Vehicle	0.05	22,995	1,178.4	
E511	Heavy Goods Vehicle	1.28	37,230	47,699.0	

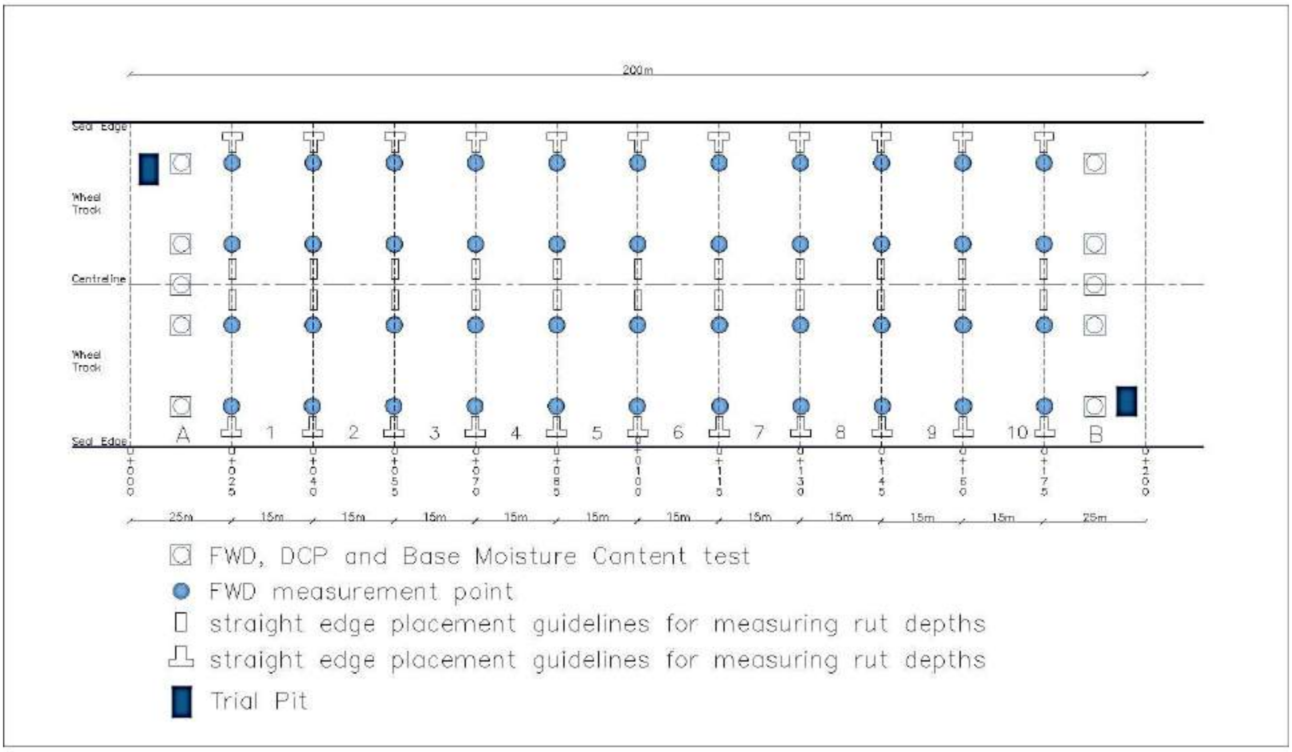
Table 5.4: Traffic loading (E511, Baseline Survey)

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction/mode]	Vehicle ESA [Estimated total since construction]
E511	Bus	0.16	365	58.4	15,724
E511	Medium Goods Vehicle	0.06	22,995	1,462.0	
E511	Heavy Goods Vehicle	0.38	37,230	14,203.9	

5.6 Layout of monitoring section

The layout of the monitoring section is shown in Figure 5.4.

Figure 5.4: Layout of monitoring section



5.7 Drainage Assessment

The Drainage Assessment (h) measured in each panel is given in Table 5.5.

Table 5.5: Drainage Assessment [11TH Oct 2018]

Chainage Km	LHS			RHS		
	Side ditch	Drainage structure	Shoulders	Shoulders	Drainage structure	Side ditch
0+000 - 0+025	Grass	No structure	Okay	Edge Breaking	No structure	Grassed
0+018	Grass	No structure	Okay	Okay	No structure	Grassed
0+025 - 0+040	Grass	No structure	Okay	Okay	No structure	Grassed
0+040	Grass	No structure	Okay	Okay	Grassed	Grassed
0+040 - 0+055	Grass	No structure	Okay	Okay	Grassed	Grassed
0+055 - 0+070	Grass	No structure	Okay	Okay	Grassed	Grassed
0+070 - 0+085	Grass	No structure	Okay	Okay	Grassed	Grassed
0+085 - 0+100	Grass	No structure	Okay	Okay	Grassed	Grassed
0+100 - 0+115	Grass	No structure	Okay	Okay	Grassed	Grassed
0+115 - 0+130	Grass	No structure	Okay	Okay	Grassed	Grassed
0+130 - 0+145	Grass	No structure	Okay	Okay	Grassed	Grassed
0+145	Grass	No structure	Grassed	Okay	Grassed	Blocked with deposits
0+160- 0+175	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+190	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+175 - 0+200	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+200 - 0+250	Poor	No structure		Edge Breaking	No structure	Grassed
0+250 - 0+300	Grass	No structure	Grassed	Grassed	No structure	Grassed

0+300 - 0+350	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+350 - 0+400	Grass	No structure	Grassed	Grassed	No structure	Grassed
0+400 - 0+450	Grass	No structure	Vegetation	Grassed	No structure	Grassed
0+495	Grass	No structure	Vegetation	Grassed	No structure	Grassed
0+450 - 0+500	Grass	No structure	Vegetation	Grassed	No structure	Grassed
0+500 - 0+550	Vegetation	No structure	Grassed	Vegetation	No structure	Vegetation
0+550 - 0+600	Grass	clogged	Grassed	Vegetation	No structure	Vegetation
0+600 - 0+650	Light Vegetation	clogged	Grassed	Vegetation	No structure	Vegetation
0+650 - 0+700	Deposits	clogged	Grassed	Vegetation	No structure	Vegetation
0+700 - 0+750	Deposits	Partially clogged	Grassed	Vegetation	No structure	Vegetation
0+750 - 0+800	Vegetation	clogged	Grassed	Eroded	No structure	Vegetation
0+800 - 0+850	Vegetation	clogged	Grassed	Eroded	No structure	Grassed

5.8 DCP tests (E511)

DCP Apparatus were used to carry out the tests. Across Africa Consultants team together with the MTRD team conducted the tests in this trial section. On the LTPP, the DCP tests were carried out on five points in Panel A and B respectively. However, on the remaining sections of the road, the DCP tests were done with a 50m interval alternating between inner and outer wheel paths.

The results of DCP test carried out on E511 are summarised in Table 5.8,, . The Field data and layer strength diagrams are given in Annex 3.

Except for the baseline survey that had high average DN values, the other surveys have shown average DN values which are within the design specification.

Table 5.6: DCP tests on E511 [*Baseline Survey, Wet Season*]

Chainage	Location of test	DN_{base} (mm)		$DN_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN 450 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+000	OWL	4.0	6.2	9.0	10.6	19.0	22.8	50.0	32.2
0+008	IWL	4.0	4.0	9.0	7.6	19.0	21.6	50.0	32.0
0+008	CL	4.0	3.9	9.0	2.2	19.0	8.3	50.0	14.0
0+008	IWR	4.0	2.0	9.0	1.2	19.0	1.2	50.0	1.2
0+008	OWR	4.0	3.0	9.0	5.2	19.0	14.2	50.0	17.4
0+185	RHS	4.0	3.9	9.0	12.1	19.0	28.0	50.0	35.4
0+185	OWL	4.0	4.2	9.0	3.6	19.0	5.7	50.0	20.1
0+185	IWL	4.0	3.4	9.0	7.6	19.0	17.6	50.0	31.3
0+185	CL	4.0	3.6	9.0	2.1	19.0	15.7	50.0	29.9
0+186	IWR	4.0	3.4	9.0	1.7	19.0	11.0	50.0	25.5
0+200	OWR	4.0	8.3	9.0	11.8	19.0	18.0	50.0	35.9
0+250	CL	4.0	4.2	9.0	5.6	19.0	11.5	50.0	30.4
0+300	CL	4.0	4.7	9.0	6.9	19.0	20.3	50.0	38.5
0+000	RHS	4.0	3.7	9.0	2.4	19.0	12.5	50.0	21.7
0+008	CL	4.0	5.8	9.0	15.7	19.0	20.1	50.0	29.6
0+008	RHS	4.0	4.1	9.0	3.2	19.0	5.7	50.0	10.7
0+008	CL	4.0	16.5	9.0	10.7	19.0	30.5	50.0	40.0
0+008	RHS	4.0	16.5	9.0	10.7	19.0	30.5	50.0	40.0

0+185	CL	4.0	4.5	9.0	9.6	19.0	2.6	50.0	8.1
0+185	RHS	4.0	6.5	9.0	35.7	19.0	15.8	50.0	8.1
0+185	CL	4.0	7.8	9.0	18.6	19.0	28.0	50.0	33.3
0+650	RHS	4.0	2.6	9.0	6.6	19.0	12.8	50.0	20.5
0+700	CL	4.0	2.6	9.0	8.6	19.0	17.4	50.0	14.3
0+750	CL	4.0	3.9	9.0	5.7	19.0	2.7	50.0	8.6
0+800	RHS	4.0	3.0	9.0	9.3	19.0	7.6	50.0	19.2
Average		**4.0**	**5.3**	**9.0**	**8.6**	**19.0**	**15.3**	**50.0**	**23.9**

Table 5.7: DCP tests on E511 [*First monitoring round, Wet Season*]

Chainage	Location of test	DN_{base} (mm)		$DN_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN 450 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+000	CL	4.0	4.7	9.0	5.0	19.0	15.2	50.0	33.8
0+008	RHS	4.0	1.6	9.0	1.3	19.0	1.4	50.0	1.4
0+008	RHS	4.0	2.2	9.0	6.5	19.0	17.7	50.0	29.0
0+008	CL	4.0	3.5	9.0	5.2	19.0	17.5	50.0	25.4
0+008	CL	4.0	1.9		2.7	19.0	10.7	50.0	27.5
0+008	LHS	4.0	3.4	9.0	7.1	19.0	22.2	50.0	39.7
0+185	CL	4.0	2.1	9.0	4.0	19.0	15.5	50.0	36.6
0+185	CL	4.0	1.9	9.0	3.8	19.0	17.8	50.0	25.1
0+185	LHS	4.0	3.0	9.0	4.3	19.0	7.2	50.0	24.4
0+185	RHS	4.0	2.0	9.0	2.4	19.0	9.4	50.0	23.7
0+185	RHS	4.0	2.1	9.0	5.6	19.0	8.2	50.0	26.7
0+200	RHS	4.0	3.4	9.0	6.7	19.0	15.5	50.0	36.8
0+250	CL	4.0	3.2	9.0	2.9	19.0	9.5	50.0	19.5
0+300	CL	4.0	5.0	9.0	10.0	19.0	17.7	50.0	33.7
Average		**4.0**	**2.8**	**9.0**	**4.8**	**19.0**	**13.3**	**50.0**	**27.4**

Table 5.8: DCP tests on E511 [*Second monitoring round, Dry Season*]

Chainage	Location of test	DN_{base} (mm)		$DN_{sub-base}$ (mm)		DN 300 - 450 (mm)		DN 450 - 800 (mm)	
		Design	Actual	Design	Actual	Design	Actual	Design	Actual
0+001	CL	4.0	4.2	9.0	13.9	19.0	28.2	50.0	41.3
0+001	CL	4.0	2.5	9.0	8.6	19.0	27.3	50.0	34.1
0+001	LHS	4.0	3.3	9.0	4.1	19.0	12.6	50.0	25.4
0+001	RHS	4.0	2.3	9.0	3.9	19.0	17.7	50.0	26.2
0+001	RHS	4.0	2.2	9.0	6.2	19.0	21.7	50.0	28.9
0+180	CL	4.0	2.6	9.0	4.5	19.0	10.8	50.0	30.1
0+180	CL	4.0	2.1	9.0	2.8	19.0	0.6	50.0	0.6
0+180	LHS	4.0	2.6	9.0	4.5	19.0	14.9	50.0	23.9

0+180	RHS	4.0	2.3	9.0	1.5	19.0	12.2	50.0	27.1
0+180	RHS	4.0	4.1	9.0	9.7	19.0	11.9	50.0	39.7
0+250	LHS	4.0	3.7	9.0	3.6	19.0	12.0	50.0	30.5
0+300	RHS	4.0	4.5	9.0	9.1	19.0	11.5	50.0	24.4
0+350	LHS	4.0	4.0	9.0	4.5	19.0	6.9	50.0	13.5
0+400	CL	4.0	6.9	9.0	5.2	19.0	11.5	50.0	19.7
0+450	LHS	4.0	4.0	9.0	3.8	19.0	4.0	50.0	33.3
0+500	RHS	4.0	3.3	9.0	6.4	19.0	18.0	50.0	29.5
0+550	LHS	4.0	2.6	9.0	2.8	19.0	1.8	50.0	11.6
0+600	RHS	4.0	5.1	9.0	6.0	19.0	19.3	50.0	29.1
0+650	LHS	4.0	2.2	9.0	6.7	19.0	13.2	50.0	25.1
0+700	RHS	4.0	3.3	9.0	6.5	19.0	14.3	50.0	31.3
0+750	LHS	4.0	3.0	9.0	6.1	19.0	6.4	50.0	27.4
0+800	CL	4.0	3.3	9.0	8.1	19.0	7.5	50.0	21.3
0+850	LHS	4.0	2.3	9.0	5.8	19.0	5.8	50.0	17.9
0+900	CL	4.0	3.4	9.0	7.6	19.0	21.6	50.0	26.3
Average		**4.0**	**3.3**	**9.0**	**5.9**	**19.0**	**13.0**	**50.0**	**25.8**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

[*add rows to the table as necessary*]

[*if no value is available enter N/A in the table cell*]

[*include any observations on the in situ DN values compared with the design specification*].

5.9 Deflection measurements (E511)

Defection was measured using the Falling Weight Deflectometer (FWD) at 50 m intervals along the road, alternating between the outer wheel path and the inner wheel path. A large circular weight was used to transmit a pressure of 566 kPa to the pavement. The load imparted on the pavement therefore was measured and the stiffness parameters calculated.

The results of deflection tests carried out on the road are summarised in and Table 5.9.

Lane 1 represents the outer LHS wheel path, Lane 2 represents the outer RHS wheel path, Lane 3 represents the inner LHS wheel path and Lane 4 represents the inner RHS wheel path.

The average maximum deflection has gone up slightly.

Table 5.9: Deflection tests on E511 (Baseline Survey)

Chainage (m)	Lane No.	Elastic Modulus (MPa)			Maximum Deflection D_o (µm)
		EBase (MPa)	ESubbase (MPa)	ESubgrade (MPa)	
0+000	1	171	150	35	1255
0+025	1	87	120	23	2301
0+055	1	261	188	45	1111

0+085	1	58	115	19	2716
0+115	1	133	134	30	1597
0+145	1	237	188	37	1099
0+175	1	173	150	36	1293
0+200	1	122	130	26	1589
0+300	1	321	80	113	1100
0+400	1	316	85	120	914
0+500	1	166	145	33	1469
0+600	1	96	113	24	2166
0+700	1	1898	322	54	1409
0+801	1	1665	300	49	1148
0+900	1	1966	310	72	1046
0+040	2	125	144	31	1719
0+070	2	94	125	24	2263
0+100	2	85	120	24	2086
0+130	2	122	127	26	1863
0+159	2	1595	285	33	1625
0+250	2	1639	290	38	1383
0+348	2	1031	180	129	723
0+451	2	1627	290	43	1343
0+550	2	286	213	46	843
0+648	2	1875	296	34	1846
0+750	2	138	113	53	1119
0+850	2	259	187	47	1089
0+040	3	156	152	29	1435
0+070	3	82	123	24	2098
0+099	3	125	126	28	1783
0+130	3	1938	300	34	1597
0+160	3	212	177	37	1139
0+250	3	1981	294	30	1690
0+350	3	1190	209	122	1053
0+450	3	267	188	54	913
0+549	3	273	192	49	902
0+650	3	127	141	30	1953
0+750	3	157	131	46	1110
0+852	3	250	176	64	809
0+000	4	143	147	32	1411
0+025	4	102	120	23	2292
0+055	4	134	147	32	1475
0+084	4	101	122	25	1851
0+114	4	1959	300	29	1780
0+144	4	1938	297	36	1623
0+175	4	114	126	27	1772
0+200	4	115	125	26	1923
0+299	4	1985	311	60	1151
0+400	4	1094	196	110	780

0+499	4	167	145	35	1326
0+600	4	97	115	24	2378
0+700	4	219	171	41	1210
0+800	4	186	150	35	1297
0+900	4	330	34	124	897
Average		**592**	**178**	**45**	**1477**

Table 5.10: Deflection tests on E511 (First monitoring round)

Chainage (m)	Lane No.	Elastic Modulus			Maximum Deflection D_0 (µm)
		EBase (MPa)	ESubbase (MPa)	ESubgrade (MPa)	
0+008	1	88	123	23	2199
0+025	1	108	127	27	1834
0+034	1	91	129	25	1963
0+065	1	97	128	25	1981
0+094	1	132	141	22	2286
0+100	1	117	136	29	1604
0+109	1	119	135	28	1670
0+125	1	158	150	26	1567
0+139	1	174	152	34	1529
0+160	1	238	178	43	1211
0+170	1	176	148	34	1511
0+186	1	190	160	37	1438
0+196	1	113	122	27	1784
0+246	1	1672	281	49	1240
0+296	1	173	128	59	1084
0+347	1	1191	210	131	751
0+398	1	219	153	107	769
0+448	1	203	151	51	1043
0+499	1	133	131	30	1542
0+549	1	584	33	74	1108
0+599	1	98	120	25	1866
0+650	1	1875	300	35	1919
0+701	1	143	127	42	1308
0+751	1	173	134	54	1169
0+807	1	2000	300	34	1530
0+861	1	225	157	65	933
0+004	2	119	139	29	1772
0+008	2	1912	303	30	2016
0+055	2	300	200	52	1059
0+085	2	80	129	22	2168
0+145	2	206	169	41	1241
0+155	2	177	145	36	1337
0+186	2	112	127	25	2068
0+553	2	300	200	51	976

0+603	2	1879	332	26	2352
0+008	3	103	142	25	1913
0+026	3	77	128	22	2175
0+040	3	106	129	26	1895
0+70	3	67	116	21	2424
0+095	3	132	134	29	1696
0+101	3	154	153	23	1723
0+110	3	139	134	29	1663
0+130	3	141	151	27	1638
0+140	3	1640	296	45	1339
0+161	3	300	200	52	992
0+175	3	212	167	40	1313
0+186	3	225	171	41	1320
0+197	3	121	140	27	1756
0+248	3	1642	284	45	1264
0+298	3	303	45	95	1193
0+348	3	1287	221	153	687
0+402	3	1091	188	124	991
0+449	3	178	134	52	1092
0+500	3	1684	288	43	1248
0+550	3	609	62	81	883
0+600	3	1937	300	32	1752
0+651	3	1944	312	34	1738
0+703	3	1928	323	68	1367
0+752	3	237	171	58	1002
0+809	3	1640	282	32	1579
0+862	3	961	174	97	794
0+008	4	122	135	29	1921
0+049	4	168	159	36	1431
0+080	4	111	130	27	1770
0+115	4	150	144	33	1477
0+186	4	97	118	24	2192
0+201	4	155	150	30	1574
0+252	4	1617	288	34	1689
0+302	4	1131	206	108	940
0+352	4	1265	224	108	986
0+452	4	229	161	71	868
0+502	4	182	154	36	1475
0+552	4	255	173	69	804
0+602	4	150	154	28	1539
0+653	4	1937	312	45	1602
0+753	4	172	134	50	1188
Average		**555**	**175**	**46**	**1483**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left

- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

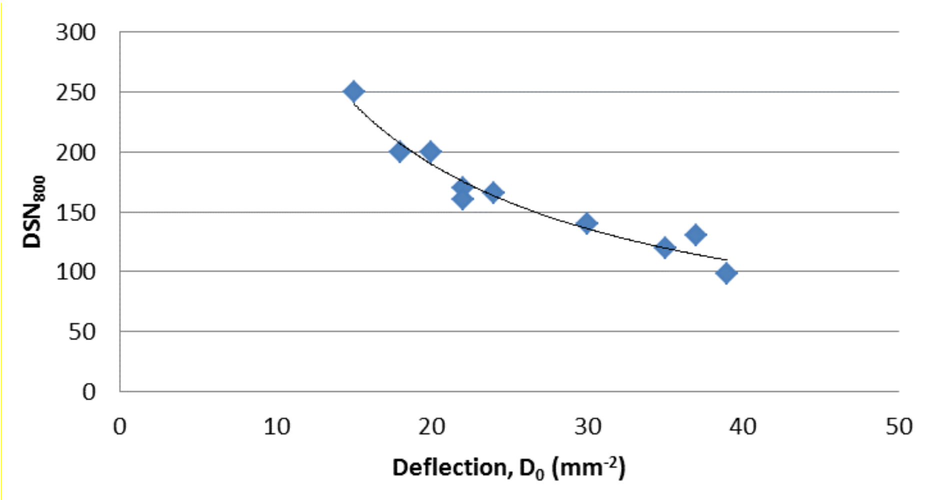
[*add rows to the table as necessary*]

[*add any comments or observations on the amount of deflection measured*]

5.10 Comparison of DN and deflection measurements

The graph in Figure 5.5 shows the comparison between DN values and deflection measurements at the same measurement points.

Figure 5.5: DSN_{800} versus D_0 (First monitoring round)



[insert a graph showing wet season and dry season comparisons between DSN_{800} and deflection]

[add any comments on the degree of correlation between the deflection and DCP measurements].

5.11 Test pit

5.11.1 General information

Table 5.11 provides general information on the test pits excavated on the monitoring section.

Table 5.11: Test pit data (E511)

	Test Pit No.	Panel No.	Location	Date of excavation	Season
Baseline Survey	TPA-1-16	A	Right	29/10/2016	Dry Season
	TPB-1-16	B	Left	29/10/2016	
First Monitoring	TPA-1-17	A	Left, Centre, Right	29/06/2017	Wet Season
	TPB-1-17	B	Left, Centre, Right	29/06/2017	
Second Monitoring	TP1	A	N/A	N/A	N/A
	TP2	B	N/A	N/A	N/A

5.11.2 In situ DCP tests

Table 5.12 provides a summary of DCP tests carried out in the test pit before excavation. As can be observed, baseline survey subbase DN value for TP1 was higher than the design specification. However, this reduced during the first monitoring round

Table 5.12: DN values for pavement layers in the test pit (E511)

	Test Pit No.	DN_{base}	$DN_{sub\text{-}base}$	$DN_{300\text{-}450}$	$DN_{450\text{-}800}$
Baseline Survey	TPA-1-16	3.9	12.1	28	37.5
	TPB-1-16	4.2	5.6	11.5	33.8
	Specification	**4**	**9**	**19**	**50**
First Monitoring	TPA-1-17	1.9	1.9	12.1	26.6
	TPB-1-17	1.9	3	23.4	23.4
	Specification	**4**	**9**	**19**	**50**
Second Monitoring	N/A	N/A	N/A	N/A	N/A

5.11.3 Layer density and moisture content

The density of the pavement layers and moisture content are summarised in Table 5.13

The in-situ moisture content was established from samples taken to the laboratory. Generally, insitu moisture content increases with an increase in depth.

Table 5.13: Density and moisture content (E511)

	Test Pit	Wheel Path	Layer	Dry density (kg/m³)	MDD (kg/m³)	Relative density (%)	In situ moisture content (%)	OMC (%)	In situ moisture content as proportion of OMC
Second Monitoring	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
First Monitoring	TPA-1-16	OWP	Base	-	-	-	13.5	13.2	1.02
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	28.0	30.0	0.93
		IWP	Base	-	-	-	11.9	17.8	0.67
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	-	-	-
	TPA-2-16	OWP	Base	-	-	-	9.8	15.3	0.64
			Sub-base	-	-	-	14.3	17.2	0.83
			Subgrade	-	-	-	30.1	34.6	0.87
		IWP	Base	-	-	-	9.7	16.2	0.6
			Sub-base	-	-	-	-	-	-
			Subgrade	-	-	-	-	-	-
	TPB-1-16	OWP	Base	-	1780	-	-	13.2	-
			Sub-base	-	1730	-	-	14.6	-
			Subgrade	-	1325	-	25.3	30.0	0.84
		IWP	Base	-	1740	-	16.8	17.8	0.94
			Sub-base	-	1690	-	-	17.3	-
			Subgrade	-	1300	-	24.5	35.6	0.69

	Test Pit	Wheel Path	Layer	Dry density (kg/m³)	MDD (kg/m³)	Relative density (%)	In situ moisture content (%)	OMC (%)	In situ moisture content as proportion of OMC
Second Monitoring	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Baseline Survey	TPB-2-16	OWP	Base	-	1765	-	-	15.3	-
			Sub-base	-	1770	-	-	17.2	-
			Subgrade	-	1290	-	21.6	34.6	0.62
		IWP	Base	-	1795	-	-	16.2	-
			Sub-base	-	1800	-	12.1	16.3	0.74
			Subgrade	-	1365	-	22.2	34.0	0.65

5.11.4 Test pit log

The test pit logs are summarised in Table 5.14. The moisture, colour, consistency, structure, soil type and origin are described using the standard terms in the regional monitoring guideline.

Table 5.14: Test pit logs

Test Pit	Layer	Thickness mm	Moisture 1st monitoring	Moisture baseline survey	Colour	Consistency	Structure	Soil type	Origin
TPA-1-16	Surface	25	-	-	Black	Extremely hard		Cold Mix Asphalt	Local
	Base	165	13.5	-	Rusty red	Very hard		Neat laterite	Local
	Subbase	150	-	-	Light grey	Very hard		Granular material	Local
	Subgrade	-	28	25.3	Brown	hard		Natural occurring	Local
TPB-1-16	Surface	25	-	-	Black	Extremely hard		Cold Mix Asphalt	Local
	Base	150	9.8	-	Rusty red	Very hard		Neat laterite	Local
	Subbase	150	14.3	-	Light grey	Very hard		Granular material	Local
	Subgrade	-	30.1	21.6	Brown	hard		Natural occurring	Local

5.11.5 Base material properties

The properties of the base course material are summarised in Table 5.15

The DN value is reported at the expected in-service moisture content.

Table 5.15: Base material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T180
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TP1	50	32	25	40	23	17	1780	13.2	OWP = 25 IWP = 20
TP2	65	30	22	40	23	17	1765	15.3	OWP =24 IWP = 25

Material used for the base is within design specifications.

[*report the CBR at the specified compaction density (x) soaked*]

[*report the DN value at the specified density (x) and expected in service moisture content*]

[*include any observations on the actual materials properties compared with the design specification*]

5.11.6 Sub-base material properties

The properties of the sub-base material are summarised in Table 5.16.

The DN value is reported at the expected in-service moisture content.

Table 5.16: Sub-base material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T180
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TP1	67	50	49	56	40	16	1730	14.6	OWP = 21 IWP = 19
TP2	68	52	40	38	18	20	1770	17.2	OWP = 21 IWP = 20

Material used for the subbase is within design specifications.

[*report the CBR at the specified compaction density soaked*]

[*report the DN value at the specified density and expected in service moisture content*]

[*include any observations on the actual materials properties compared with the design specification*]

5.11.7 Subgrade material properties

The properties of the Subgrade material are summarised in Table 5.17.

The DN value is reported at the expected in-service moisture content.

Table 5.17: Subgrade material properties

Test Pit	ASTM D6913			ASTM D4318			Comp. T180		AASHTO T99
	% passing sieve			Atterberg limits			MDD (kg/m³)	OMC %	4-day soaked CBR (%)
	2	0.425	0.075	LL %	PL %	PI %			
TP1	65	50	40	54	26	28	1325	30	OWP = 4 IWP = 8
TP2	66	52	40	58	30	28	1290	34.6	OWP = 8 IWP = 13

Material used for the subgrade is within design specifications.

[*report the CBR at the specified compaction density soaked*]

[*report the DN value at the specified density and expected in service moisture content*]

[*include any observations on the actual materials properties compared with the design specification*]

5.11.8 Particle Size Distribution

The PSD for the base course material in each TP, compared with the specification envelope, are shown in Figure 5.6 and Figure 5.7. All base and subbase materials are within the specification envelope, as specified in ASTM D2940.

Figure 5.6: PSD for base course in TPA-1-16 and TPB-1-16

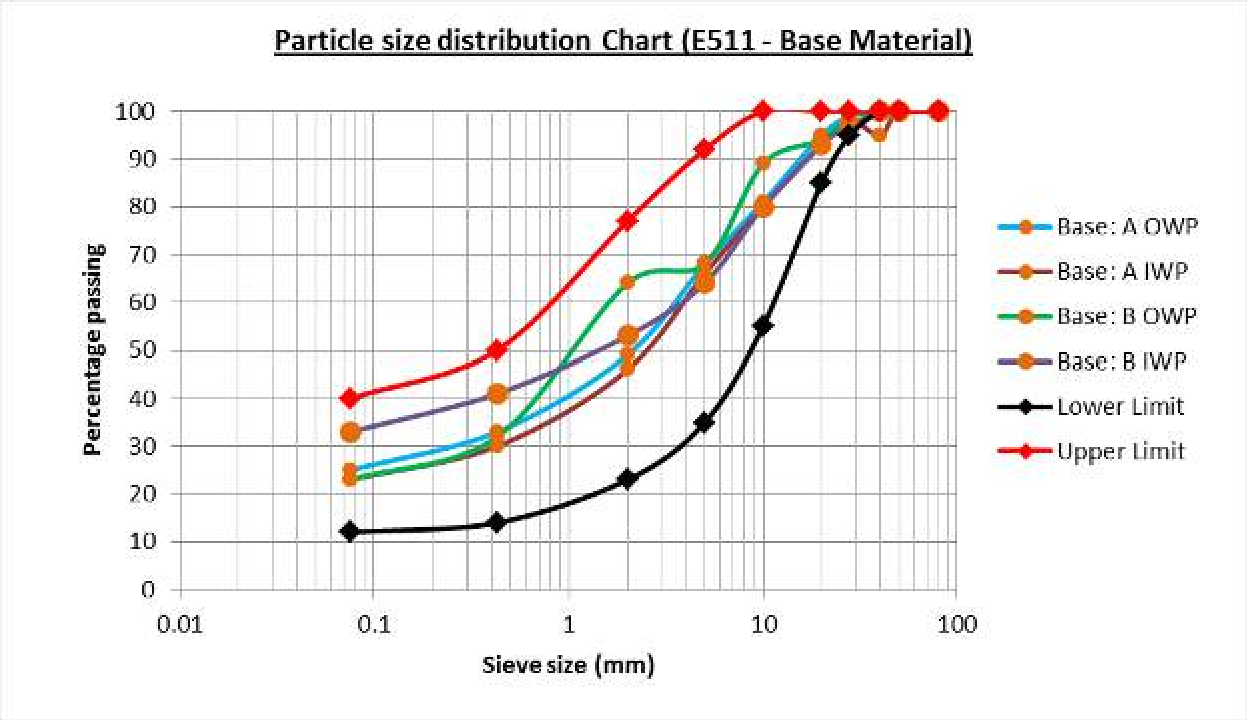
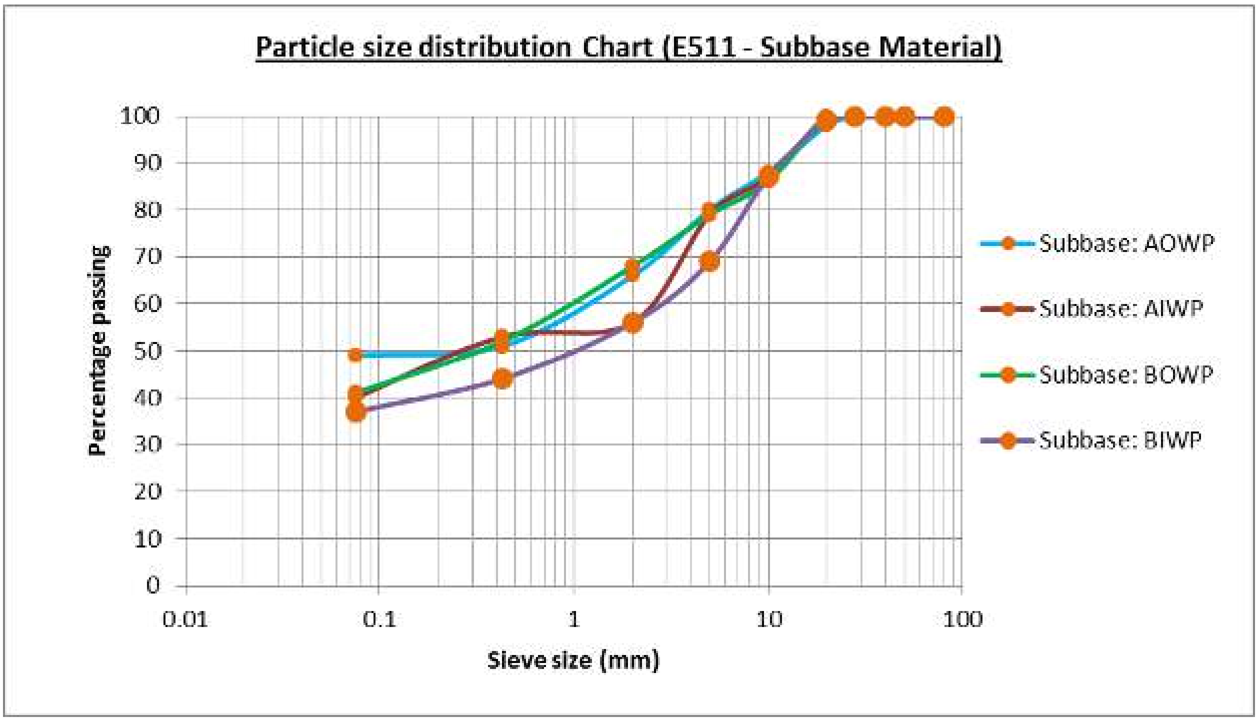


Figure 5.7: PSD for sub-base course in TPA-1-16 and TPB-1-16



5.11.9 Other TP tests

n/a

5.11.10 Discussion on test pit results

It is observed that the materials used for the construction of the trial sections' pavement layers are stronger than specified. From the traffic and axle load results recorded on the road, the road should be classified under high volume. However, with the high-volume characteristic the road is performing better with a low volume design specification. [*summarise the findings of the TP investigations including the comparison of layer thickness and materials properties to the specification and any lessons learnt for LVR pavement design*]

5.12 Rut depth

The rut depth measurements taken on the monitoring section are summarised in Table 2.18. Rut measured during the monitoring rounds shows that it reduced from first monitoring round to second monitoring round. However, the average rut increased from baseline survey to first monitoring round. The increase in rut can be attributed to heavy trucks which used the road section for the water project which is located at the end of the trial section.

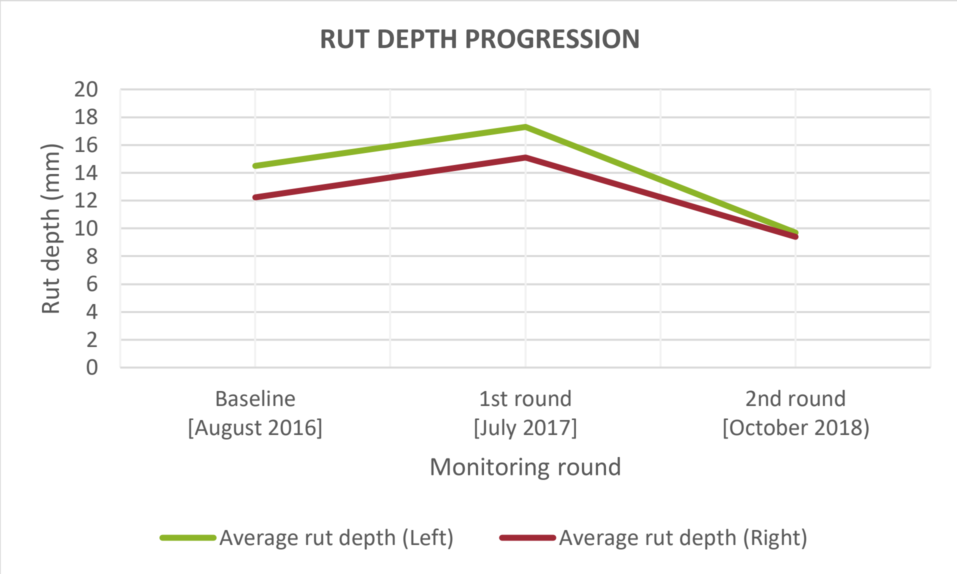
The Field data are given in Annex 4.

Table 5.18: Rut depth (E511)

Panel	Baseline [*August 2016*]		1st round [*July 2017*]				2nd round [*Oct. 2018*]				3rd round [*date*]	
	Left (mm)	Right (mm)	Left (mm)		Right (mm)		Left (mm)		Right (mm)		Left (mm)	Right (mm)
1	-	-	OWL	18	IWR	10	OWL	5	OWR	10		
2	12	12	OWL	17	OWR	8	IWL	15	IWR	2		
3	-	-	OWL	16	OWR	15	OWL	15	IWR	8		
4	-	-	OWL	25	OWR	28	OWL	23	OWR	10		
5	20	17	OWL	19	OWR	16	IWL	10	OWR	8		
6	-	-	OWL	20	OWR	35	OWL	8	IWR	10		
7	-	-	OWL	13	OWR	16	IWL	8	OWR	35		
8	11	11	OWL	16	OWR	13	OWL	0	OWR	2		
9	15	9	OWL	12	OWR	6	OWL	8	OWR	6		
10	-	-	OWL	17	OWR	4	IWL	5	IWR	3		
Average	**15**	**12**	**17**		**15**		**10**		**9**			
Average for section	**13**		**16**				**10**					

Figure 2.7 shows the rut depth progression over the monitoring period.

Figure 5.8: Rut depth progression (E511)



5.13 Deflection measurements (LTTP section)

The results of deflection tests carried out on the monitoring section are summarised in Table 2.19 and 5.20.

Table 5.19: Deflection results on the LTPP section and elastic modulus on E511 (Baseline Monitoring)

Panel number	Location of test	D_0 (µm)	E_{base} MPa)	$E_{sub-base}$ (MPa)	$E_{subgrade}$ (MPa)
1	OWL	2301	87	120	23
	OWR	2292	102	120	23
2	IWL	1719	125	144	31
	IWR	1435	156	152	29
3	OWL	1111	261	188	45
	OWR	1475	134	147	32
4	IWL	2263	94	125	24
	IWR	2098	82	123	24
	OWR	1851	101	122	25
5	OWL	2716	58	115	19
	IWR	1783	125	126	28
6	IWL	2086	85	120	24
	OWR	1780	1959	300	29
7	OWL	1597	133	134	30
	IWL	1863	122	127	26
8	IWR	1597	1938	300	34
	OWR	1623	1938	297	36
9	OWL	1099	237	188	37
	IWL	1625	1595	285	33
10	IWR	1139	212	177	37
	OWL	1293	173	150	36

	OWR	1772	114	126	27
Average		**1750.8**	**446.9**	**167.5**	**29.6**

Table 5.20: Deflection results on the LTPP section and elastic modulus on E511 (First monitoring round)

Panel number	Location of test	D_0 (µm)	E_{base} MPa)	$E_{sub-base}$ (MPa)	$E_{subgrade}$ (MPa)
1	OWL	1834	108	127	27
	IWR	2175	77	128	22
	OWL	1963	91	129	25
2	IWR	1895	106	129	26
	OWR	1431	168	159	36
3	IWL	1059	300	200	52
	OWL	1981	97	128	25
4	OWR	1770	111	130	27
5	IWL	2168	80	129	22
	OWL	2286	132	141	22
	IWR	1696	132	134	29
6	OWL	1604	117	136	29
	IWR	1723	154	153	23
	OWL	1670	119	135	28
	IWR	1663	139	134	29
7	OWR	1477	150	144	33
	OWL	1567	158	150	26
8	IWR	1638	141	151	27
	OWL	1529	174	152	34
	IWR	1339	1640	296	45
9	IWL	1241	206	169	41
	IWL	1337	177	145	36
10	OWL	1211	238	178	43
	IWR	992	300	200	52
	OWL	1511	176	148	34
	IWR	1313	212	167	40
Average		**1618.2**	**211.7**	**153.5**	**32.0**

Location of test:

- OWL - Outer Wheel Path Left
- IWL - Inner Wheel Path Left
- CL - Centreline
- IWR - Inner Wheel Path Right
- OWR - Outer Wheel Path Right

[*the location of the tests depends on the layout of the monitoring section*]

[*if the deflection tests were carried out during the current round of monitoring include the outputs from the FWD for all the sensors (D_0 up to D_6) in an annex and provide a reference to the annex*].

5.14 Comparison of deflection and rutting

Table 5.22 and shows the deflections (D_0) and rut depths measured in each panel on the monitoring section. The rut depth measurements in Table 5.22 are the most recent measurements as recorded in Table 5.18

Table 5.21: Deflection and rut depth measurements E511 (Baseline survey)

Panel number	Location of test	D_0 (μm)		Rut depth (mm)		
		Baseline Survey	Average for panel	Left	Right	Average
1	OWL	2301	2296.5	12	12	12
	OWR	2292				
2	IWL	1719	1577	-	-	-
	IWR	1435				
3	OWL	1111	1293	-	-	-
	OWR	1475				
4	IWL	2263	2070.667	20	17	18.5
	IWR	2098				
	OWR	1851				
5	OWL	2716	2249.5	-	-	-
	IWR	1783				
6	IWL	2086	1933	-	-	-
	OWR	1780				
7	OWL	1597	1730	-	-	-
	IWL	1863				
8	IWR	1597	1610	11	11	11
	OWR	1623				
9	OWL	1099	1362	15	9	12
	IWL	1625				
10	IWR	1139	1401.333	-	-	-
	OWL	1293				
	OWR	1772				
Average		**1750.8**	**1752.3**	**14.5**	**12.3**	**13.4**

Table 5.22: Deflection and rut depth measurements E511 (First monitoring round)

Panel number	Location of test	D_0 (μm)		Rut depth (mm)		
		Baseline Survey	Average for panel	Left	Right	Average
1	OWL	1834	1990.7	18	10	14.0
	IWR	2175				
	OWL	1963				
2	IWR	1895	1663.0	17	8	12.5
	OWR	1431				
3	IWL	1059	1520.0	16	15	15.5
	OWL	1981				
4	OWR	1770	1770.0	25	28	26.5

5	IWL	2168	2050.0	19	16	17.5
	OWL	2286				
	IWR	1696				
6	OWL	1604	1665.0	20	35	27.5
	IWR	1723				
	OWL	1670				
	IWR	1663				
7	OWR	1477	1522.0	13	16	14.5
	OWL	1567				
8	IWR	1638	1502.0	16	13	14.5
	OWL	1529				
	IWR	1339				
9	IWL	1241	1289.0	12	6	9.0
	IWL	1337				
10	OWL	1211	1256.8	17	4	10.5
	IWR	992				
	OWL	1511				
	IWR	1313				
Average		**1618.2**	**1622.8**	**17.3**	**15.1**	**16.2**

and Figure 5.9 shows the relationship between deflection and rut depth measurements on the monitoring section. There is no clear correlation between rut depth and deflection at this stage of the life of the pavement.

Figure 5.9: Correlation between deflection (D_o) and rut depth E511 (Baseline survey)

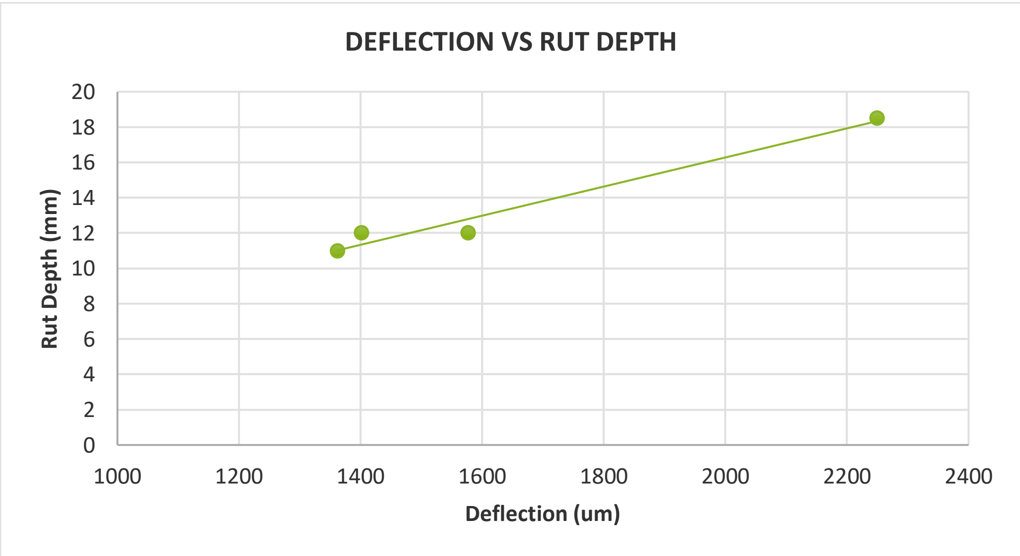
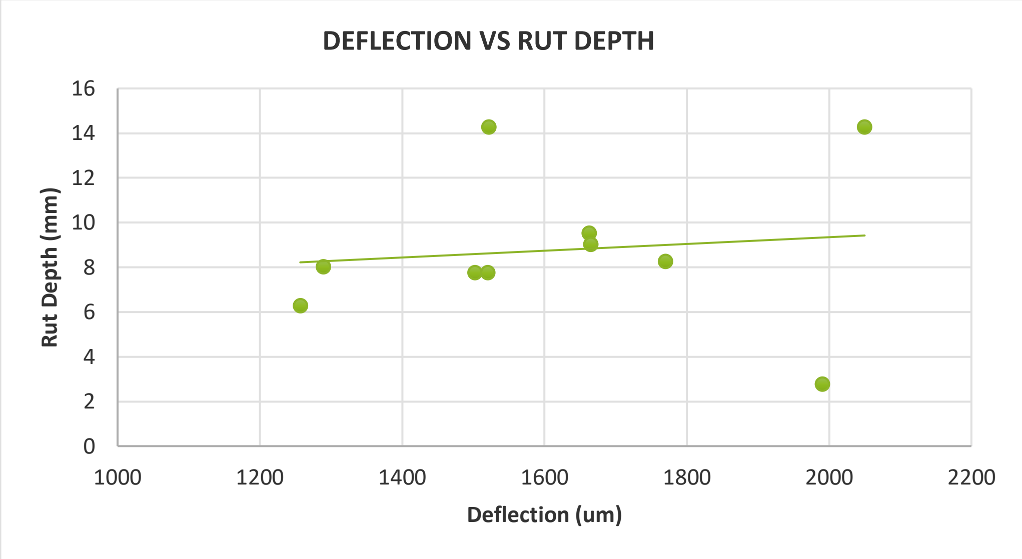


Figure 5.10: Correlation between deflection (D_o) and rut depth E511 (First monitoring round)



5.15 Roughness

and Table 5.23 shows the roughness (IRI) measured on the monitoring section at each round of monitoring. The roughness was measured using drims method. Generally, the roughness of the trial section has increased since baseline survey. All roughness outputs are found in Annex 5.

Table 5.23: Roughness measurements (Baseline Survey)

Monitoring round	Date	Left side		Right side		Average IRI (m/km)
		Chainage	IRI (m/km)	Chainage	IRI (m/km)	
Baseline	12th Jun - 20th Jun 2017	0+000-0+020	1.9	0+000-0+020	3.9	2.9
		0+020-0+040	2.5	0+020-0+040	2.9	2.7
		0+040-0+060	2.2	0+040-0+060	2.9	2.6
		0+060-0+080	1.7	0+060-0+080	3.0	2.4
		0+080-0+100	1.7	0+080-0+100	8.0	4.9
		0+100-0+120	2.0	0+100-0+120	2.9	2.5
		0+120-0+140	2.0	0+120-0+140	2.9	2.5
		0+140-0+160	1.6	0+140-0+160	8.0	4.8
		0+160-0+180	1.6	0+160-0+180	3.0	2.3
		0+180-0+200	1.9	0+180-0+200	4.8	3.4
		0+200-0+220	2.8	0+200-0+220	2.9	2.9
		0+220-0+240	2.5	0+220-0+240	8.0	5.3
		0+240-0+260	2.5	0+240-0+260	2.9	2.7
		0+260-0+280	2.2	0+260-0+280	3.9	3.1
		0+280-0+300	2.5	0+280-0+300	3.2	2.9
		0+300-0+320	2.0	0+300-0+320	2.9	2.5
		0+320-0+340	1.9	0+320-0+340	8.0	5.0
		0+340-0+360	1.7	0+340-0+360	2.9	2.3
		0+360-0+380	1.9	0+360-0+380	3.0	2.5
		0+380-0+400	2.0	0+380-0+400	8.0	5.0
		0+400-0+420	3.8	0+400-0+420	2.0	2.9
		0+420-0+440	2.3	0+420-0+440	2.9	2.6

		0+440-0+460	2.8	0+440-0+460	8.0	5.4
		0+460-0+480	2.3	0+460-0+480	8.0	5.2
		0+480-0+500	2.5	0+480-0+500	2.6	2.6
		0+500-0+520	2.8	0+500-0+520	2.2	2.5
		0+520-0+540	2.5	0+520-0+540	8.0	5.3
		0+540-0+560	2.0	0+540-0+560	2.0	2.0
		0+560-0+580	2.9	0+560-0+580	3.0	3.0
		0+580-0+600	2.9	0+580-0+600	2.5	2.7
		0+600-0+620	3.0	0+600-0+620	1.9	2.5
		0+620-0+640	3.3	0+620-0+640	2.0	2.7
		0+640-0+660	2.8	0+640-0+660	2.5	2.7
		0+660-0+680	1.7	0660-0+680	2.6	2.2
		0+680-0+700	2.0	0+680-0+700	2.8	2.4
		0+700-0+720	2.3	0+700-0+720	2.0	2.2
		0+720-0+740	2.6	0+720-0+740	2.9	2.8
		0+740-0+760	1.4	0+740-0+760	1.9	1.7
		0+760-0+780	2.3	0+760-0+780	2.9	2.6
		0+780-0+800	2.5	0+780-0+800	2.3	2.4
		0+800-0+820	4.1	0+800-0+820	2.0	3.1
		0+820-0+840	2.3	0+820-0+840	2.6	2.5
		0+840-0+860	1.9	0+840-0+860	2.5	2.2
		0+860-0+880	2.5	0+860-0+880	2.3	2.4
		0+880-0+900		0+880-0+900	2.5	2.5

Table 5.24: Roughness measurements (Second Monitoring)

Monitoring round	Date	Left side		Right side		Average IRI (m/km)
		Chainage	IRI (m/km)	Chainage	IRI (m/km)	
Second Monitoring	1st October 2018	0+000-0+100	11.8	0+000-0+100	11.8	11.8
		0+100-0+200	6.8	0+100-0+200	11.8	9.3
		0+200-0+300	3.5	0+200-0+300	9.9	6.7
		0+300-0+400	3.5	0+300-0+400	3.9	3.7
		0+400-0+500	4.2	0+400-0+500	4.4	4.3
		0+500-0+600	4.3	0+500-0+600	3.6	4.0
		0+600-0+700	3.1	0+600-0+700	3.1	3.1
		0+700-0+800	4.6	0+700-0+800	3.2	3.9
		0+800-0+900	3.8	0+800-0+900	5.8	4.8
		0+900-0+920	5.9	0+900-0+920	5.9	5.9

Figure 5.12 and shows the roughness progression over the monitoring period.

Figure 5.11: Roughness progression (Baseline)

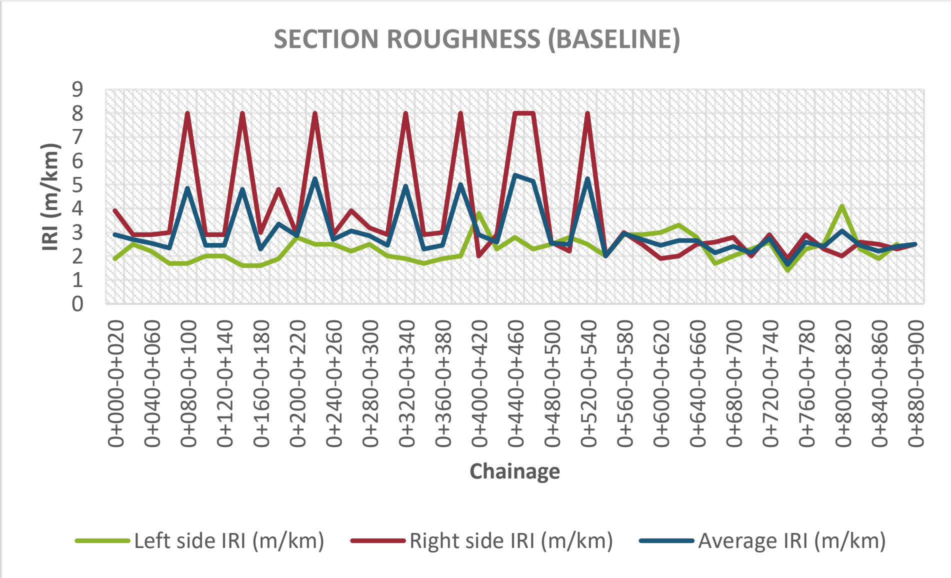
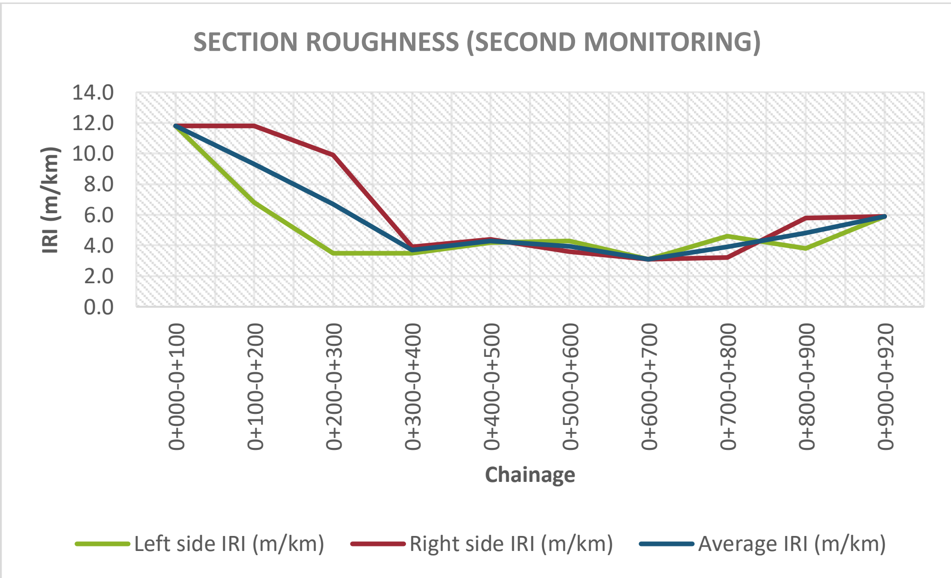


Figure 5.12: Roughness progression (Second monitoring)



5.16 Present serviceability rating

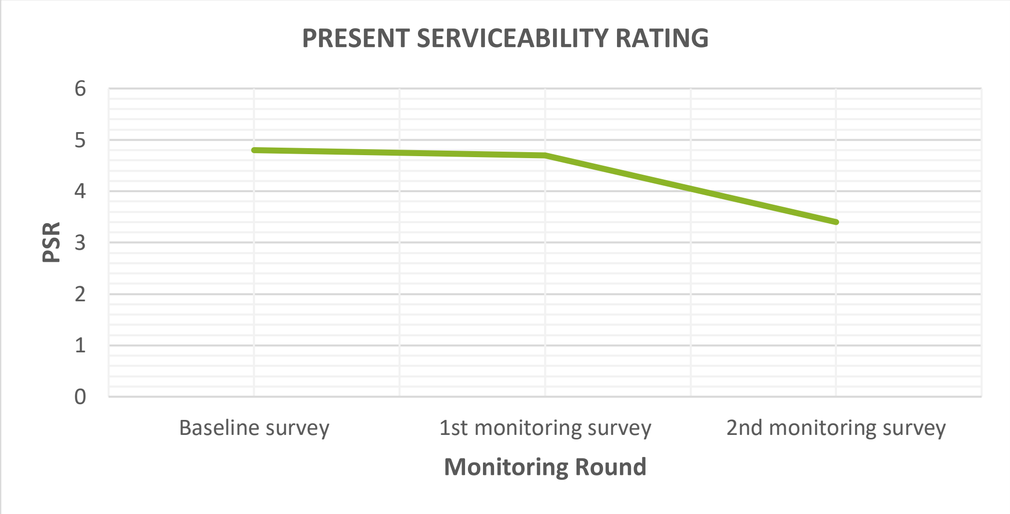
The present serviceability rating has been calculated for the monitoring section. Table 5.25 shows the PSR for each round of monitoring. The breakdown of the PSR is represented in Annex 6.

Table 5.25: Present serviceability rating

Baseline survey	1st monitoring survey	2nd monitoring survey	3rd monitoring survey	4th monitoring survey
4.80	4.70	3.40		

The variation of the average PSR for the monitoring rounds carried out to date is shown in Figure 5.13

Figure 5.13: Variation in PSR over the monitoring rounds



Typical photographs of defects on the monitoring section are included in Figure 5.14

Figure 5.14: Typical defects 2nd monitoring round (E511)

Fig No	Location (Km)	Defect assessment and description	Photos illustrating the pavement distress & defect
Fig 1	Km 0+000 – 0+300	-Light vegetation at side drains	
Fig 2	Km 0+020– 0+025 RHS	-Eroded shoulders and edge breaking	

Fig 3	Km 0+145	-Blocked culvert	
Fig 4	Km 0+000 – 0+200 LHS	- Fatigue and hair cracks	
Fig 5	Km 0+300 – 0+350	- Alligator cracks	

Fig 6	Km 0+200 – 0+450	-Blocked side drain with deposits of soil	
Fig 7	Km 0+350 LHS	-Edge subsidence due to poor drainage	
Fig 8	Km 0+350 - 0+400 LHS	-Silted side drain hindering free flow of water along the drain and enhancing accumulation of deposits	

Fig 9	Km 0+450 LHS	-Blocked side drain and Vegetation causing obstruction	
Fig 10	Km 0+450 – 0+800	-No visible defect on the carriage way - light vegetation at shoulders and side drains	
Fig 11	Km 0+650 LHS	-Edge deformation and subsidence	

Fig 12	Km 0+750 LHS	- Vegetation on the shoulder and side drain	
Fig 13	Km 0+753 RHS	-Edge breaking	
Fig 14	Km 0+775 LHS	-Potholes, cracks, Vegetation and soil deposits at the side drain	

Fig 15	Km 0+850 LHS	-Edge breaking at corner and light vegetation at the side drain	
Fig 16	Km 0+800 – 0+850	-Deposits blocking the LHS side drain -Light vegetation at the RHS and thus no drainage structure -No visible defects on the carriage way.	

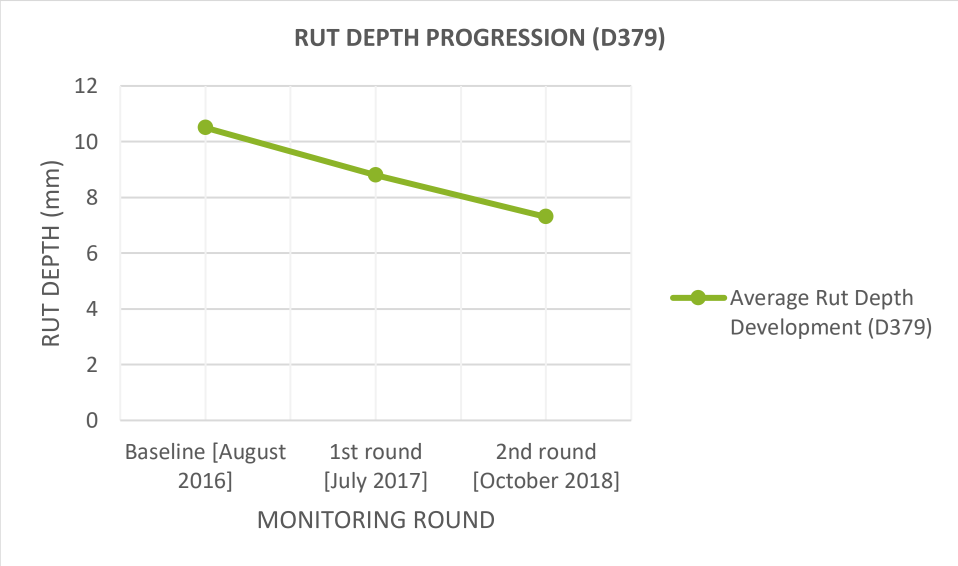
6 Comparison of the performance of the monitoring sections

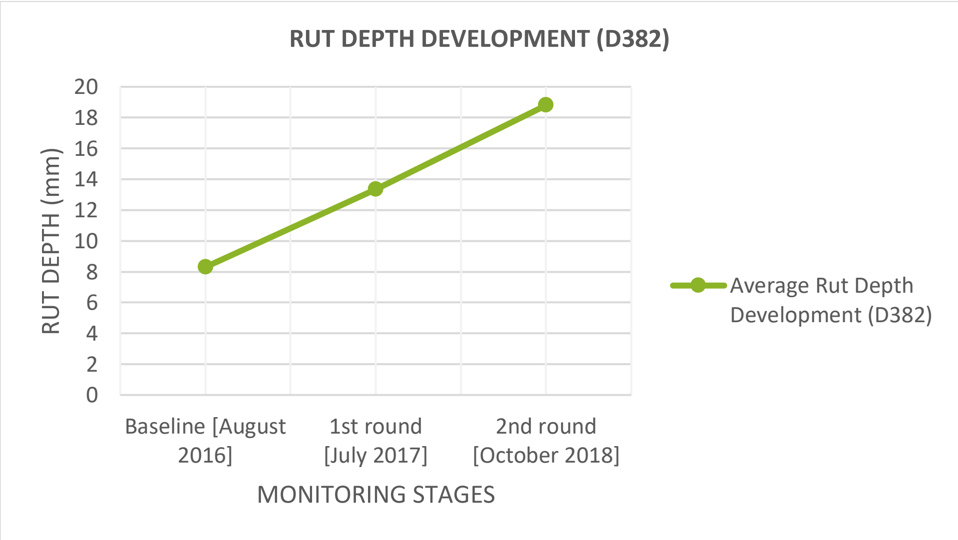
[*Provide comparisons between the performance of the different monitoring sections such as the examples given below. Report separately on comparisons of performance between trial sections and control sections on the same road.*]

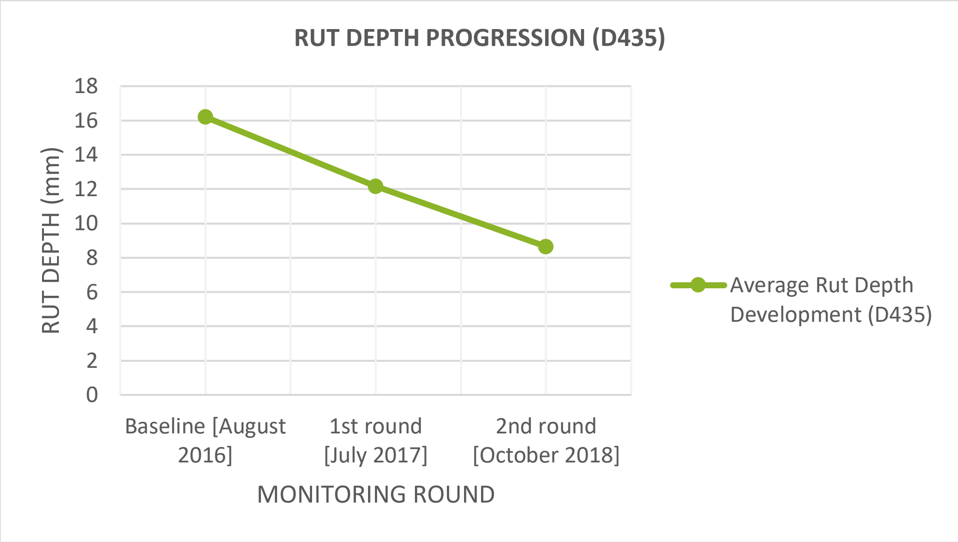
6.1 Rut Depth

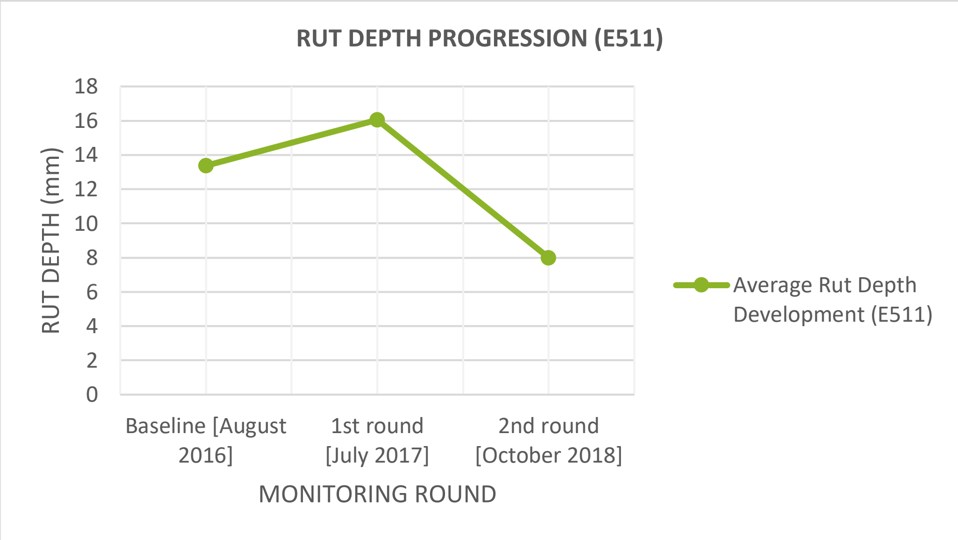
Figure 6.1 shows the progression of average rut depth of all of the sections that are being monitored under the project.

Figure 6.1: Average rut depth progression





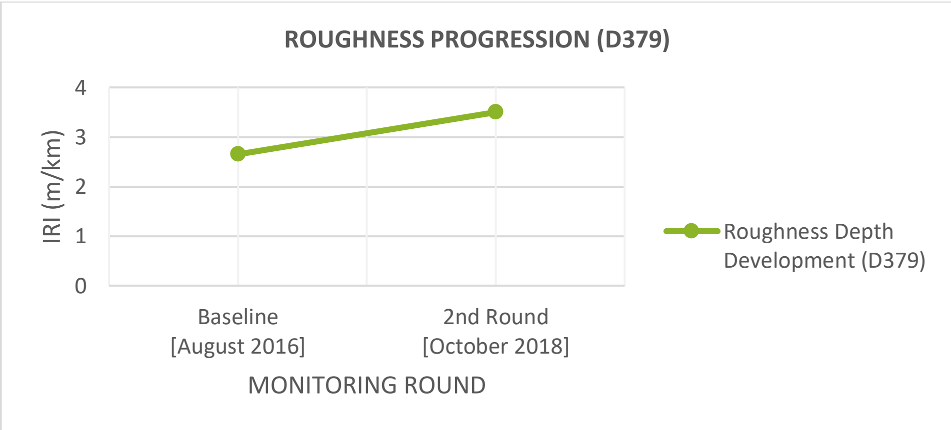


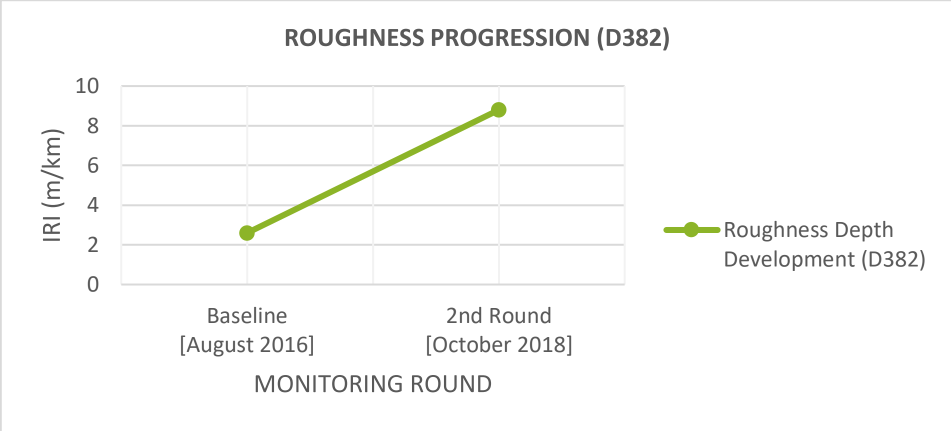


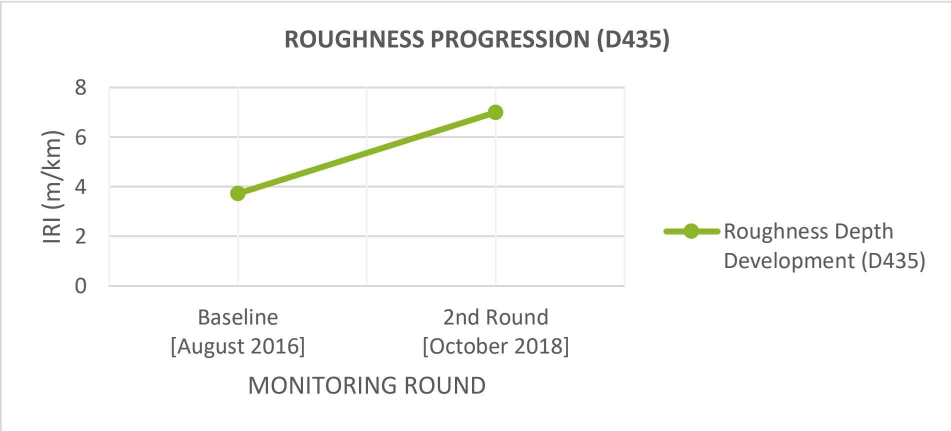
6.2 Roughness

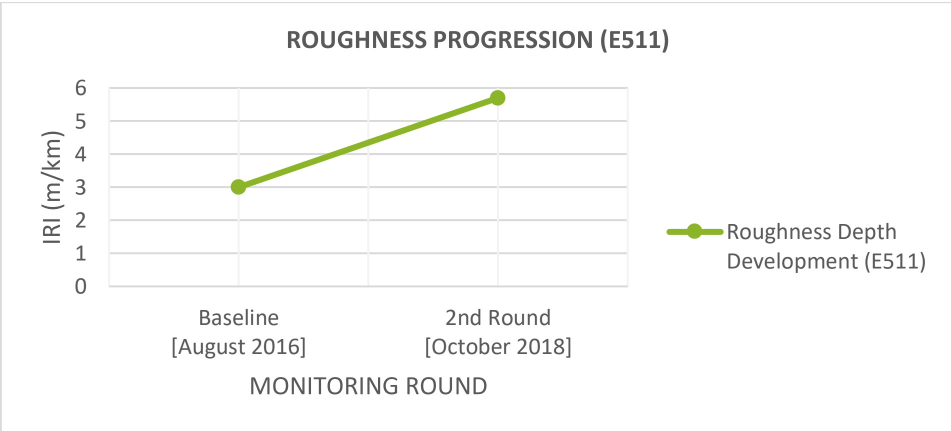
Figure 6.2 Shows the variation of roughness of all of the sections that are being monitored under the project.

Figure 6.2: Roughness progression for all monitoring sections





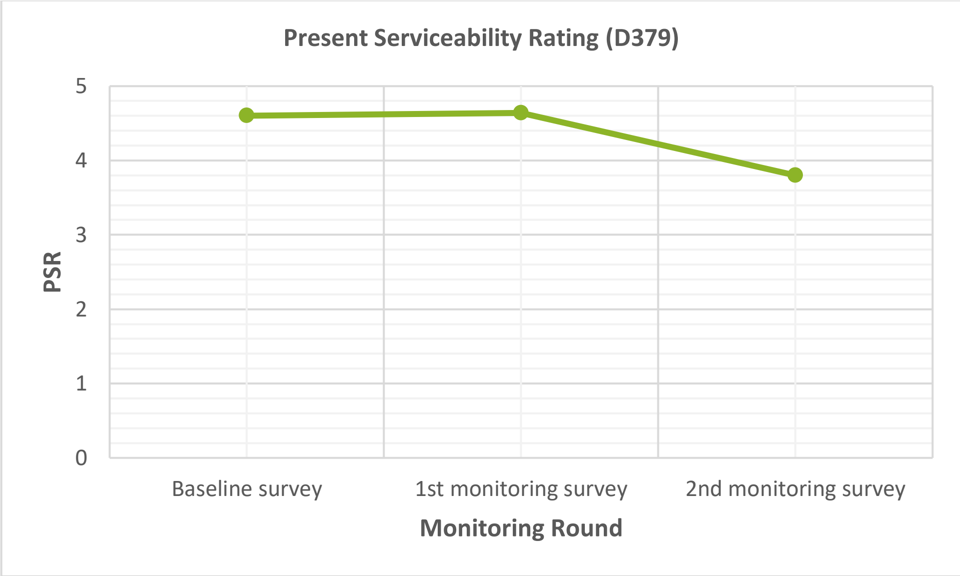


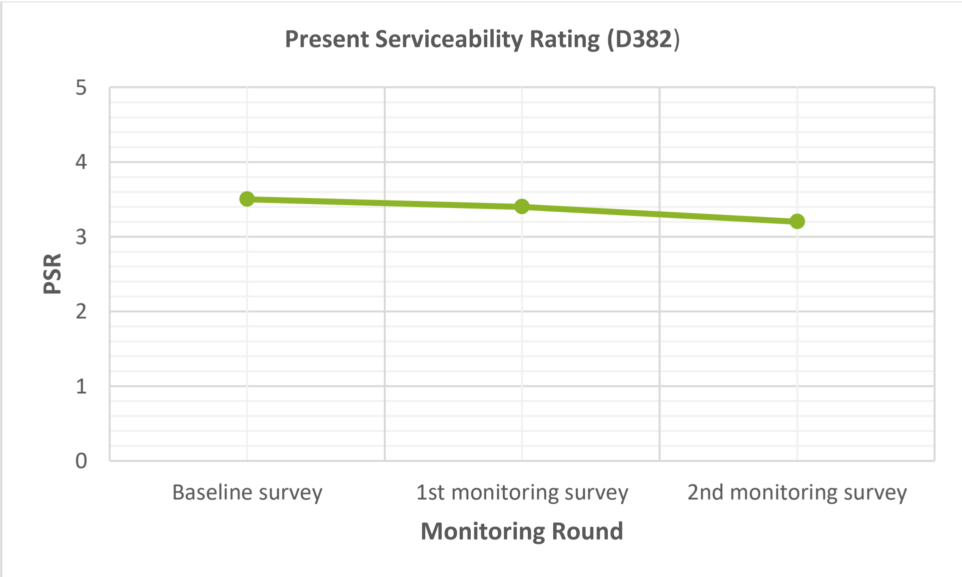


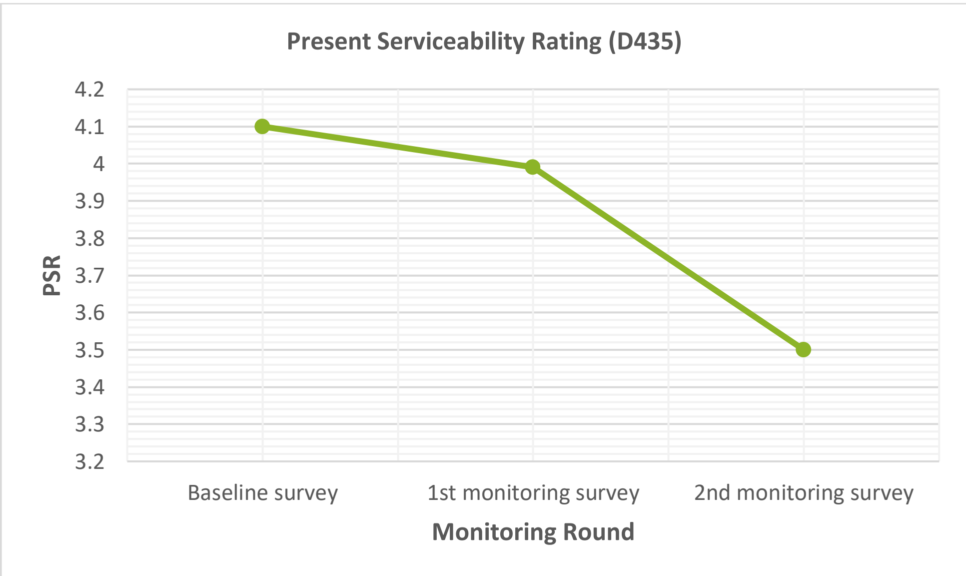
6.3 Present serviceability rating

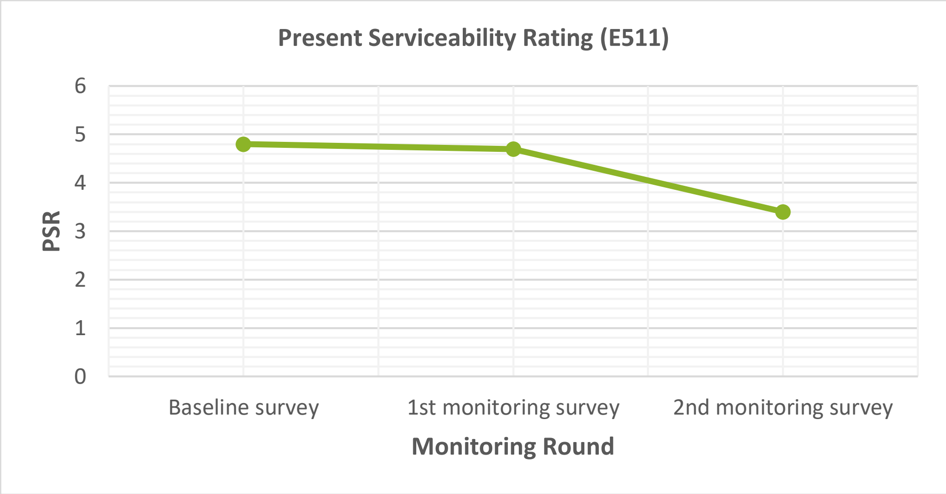
Figure 6.3 shows the variation in the PSR for all of the sections that are being monitored under the project.

Figure 6.3: Variation in PSR









6.4 Analysis of Results

[*Comment on the comparative performance of the different monitoring sections over the monitoring period, taking into account the pavement design, maintenance inputs, traffic, terrain, climate, subgrade etc. and any implications for the design of low volume roads*]

7 References

1. MTRD., & TRL. (2017). *Pavement Design Guideline for Low Volume Sealed Roads* (First Edition ed.). Nairobi: Government Press.
2. J. H., & E. A., Eng. (2012). R*esearch Project for Establishment of Appropriate Design Standards for Low Volume Sealed Roads in Kenya* (Vol. Design Report). Nairobi: Government Press.

8 Annexes

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ANNEX 1: TRAFFIC COUNT ANALYSIS

D379

ACROSS AFRICA CONSULTANTS LTD

Monitoring and evaluation of low volume roads trial sections in Kenya

Survey Station No. 001 -D379 -Wamwangi-Karatu Road

			Motorcycle		Cars		Minibus		Bus		Light goods vehicles		Medium goods vehicles		Heavy goods vehicles		Total	
Day	**Date**	**Time**	**To Wamwangi**	**To Karatu**	**To Wamwangi**	**To Karatu**	**To Wamwangi**	**To Karatu**	**To Wamwangi**	**To Karatu**	**To Wamwangi**	**To Karatu**	**To Wamwangi**	**To Karatu**	**To Wamwangi**	**To Karatu**	**To Wamwangi**	**To Karatu**
Day 1	10/9/2018	6.00 am - 7.00 am	15	10	5	3	3	3	0	0	1	1	0	0	0	0	24	17
		7.00 am - 8.00 am	8	3	7	3	0	1	0	0	1	0	0	0	0	0	16	7
		8.00 am - 9.00 am	10	3	5	4	1	0	0	0	1	2	0	0	0	0	17	9
		9.00 am - 10.00 am	10	8	4	2	1	0	0	0	0	1	0	1	0	0	15	12
		10.00 am - 11.00 am	18	16	1	7	0	3	0	0	0	2	0	2	0	0	19	30
		11.00 am - 12.00 pm	6	9	3	1	0	1	0	0	0	0	0	0	0	0	9	11
		12.00 pm - 1.00 pm	8	16	2	4	1	0	0	0	0	1	0	0	0	0	11	21
		1.00 pm - 2.00 pm	8	9	1	4	0	0	0	0	0	2	0	2	0	0	9	17
		2.00 pm - 3.00 pm	11	14	5	3	0	3	1	0	1	0	1	0	0	0	19	20
		3.00 pm - 4.00 pm	16	13	3	3	2	0	0	0	1	0	2	1	0	0	24	17
		4.00 pm - 5.00 pm	9	12	5	4	1	0	0	0	0	1	1	0	0	0	16	17
		5.00 pm - 6.00 pm	7	13	3	6	1	1	0	0	2	1	1	0	0	0	14	21
		Total	**126**	**126**	**44**	**44**	**10**	**12**	**1**	**0**	**7**	**11**	**5**	**6**	**0**	**0**	**193**	**199**
Day 2	10/10/2018	6.00 am - 7.00 am	4	2	2	1	1	2	0	0	0	1	0	0	0	0	7	6
		7.00 am - 8.00 am	10	8	7	2	0	0	0	0	2	0	0	0	0	0	19	10
		8.00 am - 9.00 am	20	12	6	5	1	0	0	0	1	0	0	0	0	0	28	17
		9.00 am - 10.00 am	17	11	5	3	1	1	0	0	1	0	0	0	0	0	24	15
		10.00 am - 11.00 am	8	12	3	4	1	1	0	0	0	1	0	0	0	0	12	18
		11.00 am - 12.00 pm	18	17	5	6	0	0	0	0	1	3	0	1	0	1	24	28
		12.00 pm - 1.00 pm	14	19	3	6	1	0	0	0	2	4	0	1	0	0	20	30
		1.00 pm - 2.00 pm	16	15	3	1	0	1	0	0	0	2	1	1	0	0	20	20
		2.00 pm - 3.00 pm	16	10	1	2	1	1	0	0	0	1	3	0	0	0	21	14
		3.00 pm - 4.00 pm	10	3	6	6	1	1	0	0	0	0	0	0	0	0	17	10
		4.00 pm - 5.00 pm	12	15	4	4	1	0	0	0	2	1	0	1	0	0	19	21
		5.00 pm - 6.00 pm	9	16	2	6	1	2	0	0	2	1	0	0	0	0	14	25
		Day Totals	**154**	**140**	**47**	**46**	**9**	**9**	**0**	**0**	**11**	**14**	**4**	**4**	**0**	**1**	**225**	**214**
		6.00 pm- 7.00 pm	13	19	4	11	0	1	0	0	0	1	2	0	0	0	19	32
		7.00 pm - 8.00 pm	11	11	2	5	0	0	0	0	0	1	0	0	0	0	13	17
		8.00 pm - 9.00 pm	7	12	1	6	1	1	0	0	0	1	0	1	0	0	9	21
		9.00 pm - 10.00 pm	4	3	0	0	0	0	0	0	0	1	0	0	0	0	4	4
		10.00 pm - 11.00 pm	3	6	0	0	0	0	0	0	0	0	0	0	0	0	3	6

		11.00 pm - 12.00 am	3	5	0	2	0	0	0	0	0	0	0	0	0	0	3	7
		12.00 am - 1.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.00 am - 2.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2.00 am - 3.00 am	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
		3.00 am - 4.00 am	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
		4.00 am - 5.00 am	1	2	4	2	1	1	0	0	0	0	0	0	0	0	6	5
		5.00 am - 6.00 am	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0
		Night Totals	**44**	**58**	**11**	**26**	**4**	**3**	**0**	**0**	**0**	**4**	**2**	**1**	**0**	**0**	**61**	**92**
Day 3	10/11/2018	6.00 am - 7.00 am	9	10	8	3	2	1	0	0	1	1	0	0	0	0	20	15
		7.00 am - 8.00 am	13	7	9	4	0	0	0	0	0	0	0	0	0	0	22	11
		8.00 am - 9.00 am	15	21	6	3	0	0	0	0	1	1	0	0	0	0	22	25
		9.00 am - 10.00 am	15	10	7	2	1	1	0	0	0	1	0	1	0	0	23	15
		10.00 am - 11.00 am	9	11	4	1	0	1	0	0	1	1	0	1	0	0	14	15
		11.00 am - 12.00 pm	15	7	3	1	3	2	0	0	0	1	1	3	0	0	22	14
		12.00 pm - 1.00 pm	17	20	2	5	0	0	0	0	0	0	2	1	0	0	21	26
		1.00 pm - 2.00 pm	17	11	2	4	0	0	0	0	1	1	0	0	0	0	20	16
		2.00 pm - 3.00 pm	15	16	4	4	1	0	0	0	2	0	2	0	0	0	24	20
		3.00 pm - 4.00 pm	9	7	3	8	2	1	0	0	2	2	0	1	0	0	16	19
		4.00 pm - 5.00 pm	5	12	8	1	1	1	0	0	2	1	1	1	0	0	17	16
		5.00 pm - 6.00 pm	7	11	3	3	1	2	0	0	0	1	0	0	0	0	11	17
		Total	**146**	**143**	**59**	**39**	**11**	**9**	**0**	**0**	**10**	**10**	**6**	**8**	**0**	**0**	**232**	**209**
Day 4	10/12/2018	6.00 am - 7.00 am	6	10	5	2	2	2	0	0	0	1	0	0	0	0	13	15
		7.00 am - 8.00 am	14	13	9	2	0	0	0	0	4	0	0	0	0	0	27	15
		8.00 am - 9.00 am	5	15	3	3	0	0	0	0	1	1	0	0	0	0	9	19
		9.00 am - 10.00 am	18	16	4	0	4	1	0	0	0	1	0	0	0	0	26	18
		10.00 am - 11.00 am	20	18	5	13	0	6	0	0	2	1	0	1	0	0	27	39
		11.00 am - 12.00 pm	13	21	0	4	1	0	0	0	1	0	0	0	0	0	15	25
		12.00 pm - 1.00 pm	17	17	4	8	0	1	0	0	1	2	1	0	0	0	23	28
		1.00 pm - 2.00 pm	11	14	4	16	2	1	0	0	1	0	0	0	0	0	18	31
		2.00 pm - 3.00 pm	8	12	12	8	3	0	0	0	1	0	0	1	0	0	24	21
		3.00 pm - 4.00 pm	12	20	9	1	0	2	0	0	0	1	1	0	0	0	22	24
		4.00 pm - 5.00 pm	9	13	4	1	0	0	0	0	0	1	0	0	0	0	13	15
		5.00 pm - 6.00 pm	15	15	6	4	1	1	0	0	1	1	0	0	0	0	23	21
		Total	**148**	**184**	**65**	**62**	**13**	**14**	**0**	**0**	**12**	**9**	**2**	**2**	**0**	**0**	**240**	**271**
Day 5	10/13/2018	6.00 am - 7.00 am	7	3	6	2	3	1	0	0	1	1	0	1	0	0	17	8
		7.00 am - 8.00 am	15	14	3	1	0	0	0	0	1	0	1	0	0	0	20	15
		8.00 am - 9.00 am	24	11	3	1	0	0	0	0	1	0	1	0	0	0	29	12
		9.00 am - 10.00 am	27	25	3	6	0	2	0	0	5	1	1	1	0	0	36	35
		10.00 am - 11.00 am	10	18	8	4	0	0	0	0	1	2	0	0	0	0	19	24

		11.00 am - 12.00 pm	21	25	3	5	0	0	0	0	0	1	0	2	0	0	24	33
		12.00 pm - 1.00 pm	17	17	4	6	1	1	0	0	2	0	0	0	0	0	24	24
		1.00 pm - 2.00 pm	15	23	5	9	1	0	0	0	3	1	0	0	0	0	24	33
		2.00 pm - 3.00 pm	11	17	3	16	0	4	0	0	1	3	1	0	0	0	16	40
		3.00 pm - 4.00 pm	18	25	12	9	2	4	0	0	0	0	1	1	0	0	33	39
		4.00 pm - 5.00 pm	16	15	8	9	0	0	0	0	0	0	0	0	0	0	24	24
		5.00 pm - 6.00 pm	14	17	6	10	0	0	0	0	0	4	0	0	0	0	20	31
		Day Totals	**195**	**210**	**64**	**78**	**7**	**12**	**0**	**0**	**15**	**13**	**5**	**5**	**0**	**0**	**286**	**318**
		6.00 pm- 7.00 pm	14	10	6	5	1	1	0	0	2	1	0	0	0	0	23	17
		7.00 pm - 8.00 pm	22	20	12	15	3	1	0	0	4	3	0	0	0	0	41	39
		8.00 pm - 9.00 pm	6	8	3	4	0	0	0	0	4	0	0	0	0	0	13	12
		9.00 pm - 10.00 pm	2	6	1	3	1	0	0	0	0	1	0	0	0	0	4	10
		10.00 pm - 11.00 pm	5	6	1	0	0	1	0	0	0	1	0	0	0	0	6	8
		11.00 pm - 12.00 am	1	2	0	2	0	0	0	0	0	0	0	0	0	0	1	4
		12.00 am - 1.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.00 am - 2.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2.00 am - 3.00 am	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
		3.00 am - 4.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4.00 am - 5.00 am	0	0	1	0	0	0	0	0	1	1	0	0	0	0	2	1
		5.00 am - 6.00 am	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
		Night Totals	**51**	**53**	**24**	**30**	**5**	**3**	**0**	**0**	**11**	**7**	**0**	**0**	**0**	**0**	**91**	**93**
Day 6	10/14/2018	6.00 am - 7.00 am	1	4	3	1	0	0	0	0	0	1	0	0	0	0	4	6
		7.00 am - 8.00 am	5	6	3	0	0	0	0	0	0	1	1	0	0	0	9	7
		8.00 am - 9.00 am	12	12	4	4	2	2	0	0	0	0	1	1	0	0	19	19
		9.00 am - 10.00 am	18	20	4	5	0	0	0	0	1	0	0	0	0	0	23	25
		10.00 am - 11.00 am	15	13	3	6	0	1	0	0	0	1	0	2	0	0	18	23
		11.00 am - 12.00 pm	13	14	9	7	0	1	0	0	0	1	0	0	0	0	22	23
		12.00 pm - 1.00 pm	16	18	3	2	1	0	0	0	0	0	0	0	0	0	20	20
		1.00 pm - 2.00 pm	13	25	4	3	0	0	0	0	0	4	0	1	0	0	17	33
		2.00 pm - 3.00 pm	8	16	7	2	0	0	0	0	0	0	0	1	0	0	15	19
		3.00 pm - 4.00 pm	10	20	8	12	0	0	0	0	1	1	0	0	0	0	19	33
		4.00 pm - 5.00 pm	18	27	4	3	0	0	0	0	2	0	0	0	0	0	24	30
		5.00 pm - 6.00 pm	22	27	4	4	0	1	0	0	0	0	0	0	0	0	26	32
		Total	**151**	**202**	**56**	**49**	**3**	**5**	**0**	**0**	**4**	**9**	**2**	**5**	**0**	**0**	**216**	**270**
Day 7	10/15/2018	6.00 am - 7.00 am	12	6	9	2	1	1	0	0	1	1	0	0	0	0	23	10
		7.00 am - 8.00 am	11	7	7	2	0	0	0	0	4	4	0	1	0	0	22	14
		8.00 am - 9.00 am	10	5	7	2	0	0	0	0	1	1	1	0	0	0	19	8
		9.00 am - 10.00 am	19	21	5	1	0	0	0	0	0	1	0	0	0	0	24	23
		10.00 am - 11.00 am	14	15	2	5	1	0	0	0	0	0	0	4	0	0	17	24
		11.00 am - 12.00 pm	24	17	3	1	0	0	0	0	3	1	1	0	0	0	31	19

		12.00 pm - 1.00 pm	13	16	1	6	0	0	0	0	1	1	0	1	0	0	15	24
		1.00 pm - 2.00 pm	9	20	0	1	0	0	0	0	2	1	1	0	0	0	12	22
		2.00 pm - 3.00 pm	12	20	8	5	0	0	0	0	0	1	0	0	0	0	20	26
		3.00 pm - 4.00 pm	11	17	7	7	0	0	0	0	2	1	0	0	0	0	20	25
		4.00 pm - 5.00 pm	7	9	1	2	0	0	0	0	0	1	0	0	0	0	8	12
		5.00 pm - 6.00 pm	21	30	8	3	1	2	0	0	3	2	0	0	0	0	33	37
		Total	**163**	**183**	**58**	**37**	**3**	**3**	**0**	**0**	**17**	**15**	**3**	**6**	**0**	**0**	**244**	**244**

Traffic Survey Summary Sheet - Road D379 - Wamwangi - Karatu Road																		
	Tue		**Wed**		**Thur**		**Fri**		**Sun**		**Mon**		**Sat**					
	10/09/18		**10/10/18**		**10/11/18**		**10/12/18**		**10/13/18**		**10/14/18**		**10/15/18**					
	Day 1	**24-hour Equivalent**	**Day 2**	**Night**	**Day 3**	**24-hour Equivalent**	**Day 4**	**24-hour Equivalent**	**Day 6**	**24-hour Equivalent**	**Day 7**	**24-hour Equivalent**	**Day 5**	**Night**	**Weekday 24-hour factor**	**Weekend 24-hour factor**	**Total**	**ADT**
Motorcycles	252	339	294	102	289	389	332	447	353	444	346	466	405	104	1	1	2,991	**427**
Cars	88	123	93	37	98	137	127	178	105	145	95	133	142	54	1	1	1,041	**149**
Minibus	22	31	18	7	20	28	27	38	8	11	6	8	19	8	1	1	168	**24**
Commercial vehicles for pavement design																		
Bus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Light goods vehicles	18	21	25	4	20	23	21	24	13	21	32	37	28	18	1	2	202	**29**
Medium goods vehicles	11	15	8	3	14	19	4	6	7	7	9	12	10	0	1	1	80	**11**
Heavy goods vehicles	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**0**
Total	**392**	**529**	**439**	**153**	**441**	**596**	**511**	**692**	**486**	**628**	**488**	**657**	**604**	**184**			**4,483**	**640**

D382

ACROSS AFRICA CONSULTANTS LTD

Monitoring and evaluation of low volume roads trial sections in Kenya

Survey Station No. 003 -D382 - Total - Kona Mbaya Road

			Motorcycle		Cars		Minibus		Bus		Light goods vehicles		Medium goods vehicles		Heavy goods vehicles		Total	
Day	**Date**	**Time**	**To Kona Mbaya**	**To Total**	**To Kona Mbaya**	**To Total**	**To Kona Mbaya**	**To Total**	**To Kona Mbaya**	**To Total**	**To Kona Mbaya**	**To Total**	**To Kona Mbaya**	**To Total**	**To Kona Mbaya**	**To Total**	**To Kona Mbaya**	**To Total**
Day 1	10/18/2018	6.00 am - 7.00 am	14	16	2	3	1	3	1	2	1	1	2	0	0	0	21	25
		7.00 am - 8.00 am	24	31	5	4	3	4	1	1	3	1	2	1	0	0	38	42
		8.00 am - 9.00 am	7	27	5	5	2	7	0	0	2	3	3	4	0	0	19	46
		9.00 am - 10.00 am	17	21	9	5	6	5	0	0	2	2	1	1	0	0	35	34
		10.00 am - 11.00 am	17	18	3	4	14	5	0	0	5	4	1	1	0	0	40	32
		11.00 am - 12.00 pm	22	24	3	4	4	4	0	0	4	3	0	1	0	0	33	36
		12.00 pm - 1.00 pm	24	24	3	5	2	5	0	0	1	1	5	2	0	0	35	37
		1.00 pm - 2.00 pm	25	16	7	4	3	5	0	0	3	2	2	4	0	0	40	31
		2.00 pm - 3.00 pm	23	20	6	9	4	7	0	0	4	1	0	0	0	0	37	37
		3.00 pm - 4.00 pm	25	17	10	6	3	3	0	0	2	3	4	2	0	0	44	31
		4.00 pm - 5.00 pm	25	24	3	7	6	4	1	1	1	2	5	3	0	0	41	41
		5.00 pm - 6.00 pm	28	28	3	3	6	6	1	2	1	3	0	2	0	0	39	44
		Total	**251**	**266**	**59**	**59**	**54**	**58**	**4**	**6**	**29**	**26**	**25**	**21**	**0**	**0**	**422**	**436**
Day 2	10/19/2018	6.00 am - 7.00 am	11	25	3	1	10	2	1	2	0	1	1	0	0	0	26	31
		7.00 am - 8.00 am	18	31	2	3	7	13	1	1	0	2	3	2	0	1	31	53
		8.00 am - 9.00 am	10	13	4	3	4	8	0	0	1	1	4	1	0	0	23	26
		9.00 am - 10.00 am	19	23	3	9	7	7	0	0	0	3	1	1	0	0	30	43
		10.00 am - 11.00 am	25	25	8	5	2	3	0	0	3	1	1	2	0	0	39	36
		11.00 am - 12.00 pm	18	24	3	2	5	6	0	0	3	1	1	2	0	0	30	35
		12.00 pm - 1.00 pm	20	12	4	7	1	5	0	0	1	0	2	2	0	0	28	26
		1.00 pm - 2.00 pm	21	13	3	10	5	3	0	0	3	1	5	1	0	0	37	28
		2.00 pm - 3.00 pm	16	18	4	5	4	2	0	0	3	2	0	4	0	0	27	31
		3.00 pm - 4.00 pm	21	21	9	5	4	4	0	0	3	2	1	3	0	0	38	35
		4.00 pm - 5.00 pm	21	25	5	3	4	6	2	2	1	2	1	0	0	0	34	38
		5.00 pm - 6.00 pm	40	30	11	3	10	11	0	0	3	3	1	1	0	0	65	48
		Day Totals	**240**	**260**	**59**	**56**	**63**	**70**	**4**	**5**	**21**	**19**	**21**	**19**	**0**	**1**	**408**	**430**
		6.00 pm- 7.00 pm	35	25	7	5	8	3	0	0	0	3	1	7	0	0	51	43
		7.00 pm - 8.00 pm	22	14	6	3	4	7	0	0	1	1	0	1	0	0	33	26
		8.00 pm - 9.00 pm	9	5	2	4	5	2	0	0	0	0	0	1	0	0	16	12
		9.00 pm - 10.00 pm	11	11	0	1	1	0	0	0	0	0	2	0	0	0	14	12
		10.00 pm - 11.00 pm	6	1	3	0	1	0	0	0	0	0	0	0	0	0	10	1
		11.00 pm - 12.00 am	3	4	0	1	0	0	0	0	0	1	0	0	0	0	3	6

		12.00 am - 1.00 am	1	2	1	2	1	0	0	0	0	0	0	0	0	0	3	4
		1.00 am - 2.00 am	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0
		2.00 am - 3.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3.00 am - 4.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4.00 am - 5.00 am	0	1	1	2	0	2	0	0	0	0	0	0	0	0	1	5
		5.00 am - 6.00 am	2	2	0	0	0	0	0	0	0	0	1	0	0	0	3	2
		Night Totals	**90**	**65**	**21**	**18**	**20**	**14**	**0**	**0**	**1**	**5**	**4**	**9**	**0**	**0**	**136**	**111**
Day 3	10/20/2018	6.00 am - 7.00 am	12	18	2	3	0	6	0	0	0	0	0	0	0	0	14	27
		7.00 am - 8.00 am	20	24	1	3	2	1	0	0	1	0	2	2	1	0	27	30
		8.00 am - 9.00 am	12	25	2	5	3	7	0	0	0	0	0	0	0	0	17	37
		9.00 am - 10.00 am	15	20	3	10	1	6	0	0	3	3	2	4	0	0	24	43
		10.00 am - 11.00 am	12	18	5	8	4	6	2	1	0	1	0	2	0	0	23	36
		11.00 am - 12.00 pm	20	18	12	8	3	4	0	0	1	0	3	2	0	0	39	32
		12.00 pm - 1.00 pm	25	21	11	6	6	4	0	0	1	0	2	0	0	0	45	31
		1.00 pm - 2.00 pm	19	14	8	4	5	3	0	0	0	0	2	3	0	0	34	24
		2.00 pm - 3.00 pm	27	19	11	12	2	2	0	0	1	2	0	0	0	0	41	35
		3.00 pm - 4.00 pm	18	22	8	2	11	4	0	0	0	0	0	1	0	0	37	29
		4.00 pm - 5.00 pm	30	28	10	11	3	7	0	1	3	1	2	2	0	0	48	50
		5.00 pm - 6.00 pm	21	17	3	2	8	7	0	0	1	1	3	2	0	0	36	29
		Total	**231**	**244**	**76**	**74**	**48**	**57**	**2**	**2**	**11**	**8**	**16**	**18**	**1**	**0**	**385**	**403**
Day 4	10/21/2018	6.00 am - 7.00 am	8	13	2	2	0	0	0	0	1	1	0	2	0	0	11	18
		7.00 am - 8.00 am	6	6	2	1	3	2	0	0	0	0	1	0	0	0	12	9
		8.00 am - 9.00 am	19	20	5	4	3	6	0	0	1	0	1	1	0	0	29	31
		9.00 am - 10.00 am	19	17	8	13	5	5	0	0	0	1	2	1	0	0	34	37
		10.00 am - 11.00 am	23	23	8	11	3	6	0	0	3	2	1	1	0	0	38	43
		11.00 am - 12.00 pm	12	13	9	6	3	3	0	0	2	2	1	2	0	0	27	26
		12.00 pm - 1.00 pm	17	16	11	5	3	5	0	0	2	1	0	0	0	0	33	27
		1.00 pm - 2.00 pm	18	19	3	9	5	4	0	0	1	3	1	1	0	0	28	36
		2.00 pm - 3.00 pm	17	11	6	7	4	3	0	0	1	1	2	1	0	0	30	23
		3.00 pm - 4.00 pm	16	22	11	9	3	4	0	0	2	3	0	1	0	0	32	39
		4.00 pm - 5.00 pm	18	16	6	7	4	5	0	0	0	0	1	1	0	1	29	30
		5.00 pm - 6.00 pm	41	23	6	17	7	3	0	0	3	4	2	3	0	0	59	50
		Day Totals	**214**	**199**	**77**	**91**	**43**	**46**	**0**	**0**	**16**	**18**	**12**	**14**	**0**	**1**	**362**	**369**
		6.00 pm- 7.00 pm	24	33	3	10	2	5	0	0	2	1	0	0	0	0	31	49
		7.00 pm - 8.00 pm	17	11	2	9	4	3	0	0	2	1	0	1	0	0	25	25
		8.00 pm - 9.00 pm	11	11	3	3	3	0	0	0	0	1	0	1	0	1	17	17
		9.00 pm - 10.00 pm	3	8	2	4	1	0	0	0	0	1	0	0	0	0	6	13
		10.00 pm - 11.00 pm	4	4	2	1	1	1	0	0	0	0	0	1	0	0	7	7
		11.00 pm - 12.00 am	2	0	0	0	0	1	0	0	0	0	0	0	0	0	2	1
		12.00 am - 1.00 am	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	2

		1.00 am - 2.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2.00 am - 3.00 am	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
		3.00 am - 4.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4.00 am - 5.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		5.00 am - 6.00 am	7	6	1	0	0	1	0	0	1	0	1	0	0	0	10	7
		Night Totals	**70**	**75**	**13**	**27**	**11**	**11**	**0**	**0**	**5**	**4**	**1**	**3**	**0**	**1**	**100**	**121**
Day 5	10/22/2018	6.00 am - 7.00 am	24	28	4	4	1	4	3	2	0	1	2	1	0	0	34	40
		7.00 am - 8.00 am	12	17	9	6	4	3	0	0	1	1	1	0	0	0	27	27
		8.00 am - 9.00 am	10	29	6	11	3	12	0	0	0	4	0	2	0	0	19	58
		9.00 am - 10.00 am	22	10	6	6	4	2	0	0	1	2	0	2	0	0	33	22
		10.00 am - 11.00 am	17	27	5	9	5	6	0	0	2	3	2	0	0	0	31	45
		11.00 am - 12.00 pm	16	20	4	5	3	2	0	0	0	2	5	1	0	0	28	30
		12.00 pm - 1.00 pm	25	17	3	13	3	5	0	0	3	2	0	3	0	0	34	40
		1.00 pm - 2.00 pm	19	9	1	3	2	2	0	0	2	2	1	0	0	0	25	16
		2.00 pm - 3.00 pm	16	16	5	2	2	3	0	0	2	3	3	0	0	0	28	24
		3.00 pm - 4.00 pm	20	24	7	6	5	3	0	0	0	0	3	2	0	1	35	36
		4.00 pm - 5.00 pm	21	28	11	6	5	4	2	1	2	1	4	2	0	0	45	42
		5.00 pm - 6.00 pm	28	21	5	3	4	2	0	1	3	1	0	2	0	1	40	31
		Total	**230**	**246**	**66**	**74**	**41**	**48**	**5**	**4**	**16**	**22**	**21**	**15**	**0**	**2**	**379**	**411**
Day 6	10/23/2018	6.00 am - 7.00 am	15	19	3	3	3	3	1	1	1	1	2	2	0	0	25	29
		7.00 am - 8.00 am	14	24	0	3	2	7	1	2	1	0	0	0	0	0	18	36
		8.00 am - 9.00 am	15	15	3	3	1	9	0	0	0	2	1	0	0	0	20	29
		9.00 am - 10.00 am	21	24	6	6	6	7	0	0	1	3	8	0	0	0	42	40
		10.00 am - 11.00 am	26	20	4	5	1	4	0	0	1	4	6	2	0	0	38	35
		11.00 am - 12.00 pm	25	28	13	6	5	5	0	0	2	1	4	1	0	0	49	41
		12.00 pm - 1.00 pm	18	22	2	0	2	4	0	0	1	2	4	4	0	0	27	32
		1.00 pm - 2.00 pm	20	13	5	3	1	2	0	0	1	0	1	2	0	0	28	20
		2.00 pm - 3.00 pm	16	15	3	8	3	3	0	0	2	0	1	2	0	0	25	28
		3.00 pm - 4.00 pm	18	8	4	9	4	3	0	0	1	0	0	1	0	0	27	21
		4.00 pm - 5.00 pm	15	21	4	7	5	3	1	1	3	4	2	1	0	0	30	37
		5.00 pm - 6.00 pm	24	18	7	8	5	6	1	1	2	3	3	4	0	0	42	40
		Total	**227**	**227**	**54**	**61**	**38**	**56**	**4**	**5**	**16**	**20**	**32**	**19**	**0**	**0**	**371**	**388**
Day 7	10/24/2018	6.00 am - 7.00 am	12	13	1	2	1	3	1	1	0	0	0	0	0	0	15	19
		7.00 am - 8.00 am	16	29	2	2	2	5	1	2	0	0	2	1	0	0	23	39
		8.00 am - 9.00 am	14	24	1	1	3	5	0	0	0	2	1	0	0	0	19	32
		9.00 am - 10.00 am	33	26	4	9	3	7	0	0	1	1	3	1	0	0	44	44
		10.00 am - 11.00 am	18	19	3	10	2	2	0	0	0	2	2	1	0	0	25	34
		11.00 am - 12.00 pm	14	16	9	5	3	4	0	0	4	1	0	4	0	0	30	30
		12.00 pm - 1.00 pm	24	23	7	3	3	5	0	0	1	3	4	0	0	0	39	34

		1.00 pm - 2.00 pm	19	11	4	5	3	1	0	0	0	0	3	3	0	0	29	20
		2.00 pm - 3.00 pm	15	16	6	4	3	5	0	0	1	0	5	2	0	0	30	27
		3.00 pm - 4.00 pm	35	32	4	7	7	5	0	0	2	2	2	1	0	0	50	47
		4.00 pm - 5.00 pm	24	27	6	8	4	5	1	1	3	4	0	2	0	0	38	47
		5.00 pm - 6.00 pm	25	14	3	2	3	3	0	0	1	2	2	1	0	0	34	22
		Total	**249**	**250**	**50**	**58**	**37**	**50**	**3**	**4**	**13**	**17**	**24**	**16**	**0**	**0**	**376**	**395**

	Thur		Fri		Sat		Mon		Tue		Wed		Sun					
	10/18/18		10/19/18		10/20/18		10/21/18		10/22/18		10/23/18		10/24/18					
	Day 1	**24-hour Equivalent**	**Day 2**	**Night**	**Day 3**	**24-hour Equivalent**	**Day 5**	**24-hour Equivalent**	**Day 6**	**24-hour Equivalent**	**Day 7**	**24-hour Equivalent**	**Day 4**	**Night**	**Weekday 24-hour factor**	**Weekend 24-hour factor**	**Total**	**ADT**
Motorcycles	517	677	500	155	475	642	476	624	454	595	499	654	413	145	1	1	4,404	**629**
Cars	118	158	115	39	150	186	140	187	115	154	108	145	168	40	1	1	1,192	**170**
Minibus	112	141	133	34	105	131	89	112	94	118	87	109	89	22	1	1	889	**127**
Commercial vehicles for pavement design																		
Bus	10	0	9	0	4	0	9	0	9	0	7	0	0	0	0	0	9	**1**
Light goods vehicles	55	63	40	6	19	24	38	44	36	41	30	35	34	9	1	1	296	**42**
Medium goods vehicles	46	61	40	13	34	39	36	48	51	68	40	53	26	4	1	1	351	**50**
Heavy goods vehicles	0	0	1	0	1	0	2	0	0	0	0	0	1	1	0	0	3	**0**
Total	**858**	**1,100**	**838**	**247**	**788**	**1,022**	**790**	**1,014**	**759**	**976**	**771**	**995**	**731**	**221**			**7,144**	**1,021**

D435

ACROSS AFRICA CONSULTANTS LTD

Monitoring and evaluation of low volume roads trial sections in Kenya

Survey Station No. 004 -D435 - Muthuaini - Munungaini Road

Day	Date	Time	Motorcycle		Cars		Minibus		Bus		Light goods vehicles		Medium goods vehicles		Heavy goods vehicles		Total	
			To Ihururu	To Njoguini	To Ihururu	To Njoguini	To Ihururu	To Njoguini	To Ihururu	To Njoguini	To Ihururu	To Njoguini	To Ihururu	To Njoguini	To Ihururu	To Njoguini	To Ihururu	To Njoguini
Day 1	10/18/2018	6.00 am - 7.00 am	2	0	1	1	2	0	1	1	0	0	1	0	0	0	7	2
		7.00 am - 8.00 am	5	1	4	4	3	0	0	0	0	1	0	0	0	0	12	6
		8.00 am - 9.00 am	8	10	6	1	0	0	0	0	1	2	0	0	0	0	15	13
		9.00 am - 10.00 am	9	13	2	3	0	1	0	0	2	1	0	0	0	0	13	18
		10.00 am - 11.00 am	11	6	4	2	0	3	0	0	1	1	1	0	0	0	17	12
		11.00 am - 12.00 pm	9	4	5	2	1	0	0	0	1	1	1	0	0	0	17	7
		12.00 pm - 1.00 pm	5	5	4	1	0	0	0	0	2	0	0	0	0	0	11	6
		1.00 pm - 2.00 pm	7	7	1	1	0	0	0	0	2	0	0	0	0	0	10	8
		2.00 pm - 3.00 pm	12	9	3	1	0	1	0	0	0	4	0	1	0	0	15	16
		3.00 pm - 4.00 pm	7	4	2	1	1	0	0	0	1	0	1	0	0	0	12	5
		4.00 pm - 5.00 pm	4	11	3	1	1	1	0	0	0	0	0	0	0	0	8	13
		5.00 pm - 6.00 pm	7	5	2	3	1	1	1	1	0	0	0	0	0	0	11	10
		Total	**86**	**75**	**37**	**21**	**9**	**7**	**2**	**2**	**10**	**10**	**4**	**1**	**0**	**0**	**148**	**116**
Day 2	10/19/2018	6.00 am - 7.00 am	1	0	0	0	1	0	1	1	1	1	0	0	0	0	4	2
		7.00 am - 8.00 am	4	4	1	1	3	0	0	0	2	1	0	0	0	0	10	6
		8.00 am - 9.00 am	8	9	2	2	0	0	0	0	0	1	0	0	0	0	10	12
		9.00 am - 10.00 am	11	12	6	6	0	0	0	0	1	2	0	2	0	0	18	22
		10.00 am - 11.00 am	8	10	3	7	2	0	0	0	4	4	1	0	0	0	18	21
		11.00 am - 12.00 pm	15	15	3	0	3	0	0	0	2	2	0	0	0	1	23	18
		12.00 pm - 1.00 pm	11	6	2	1	0	0	0	0	0	0	0	1	0	0	13	8
		1.00 pm - 2.00 pm	12	9	2	1	0	0	0	0	2	4	1	0	0	0	17	14
		2.00 pm - 3.00 pm	13	13	2	1	0	0	0	0	0	1	0	1	0	0	15	16
		3.00 pm - 4.00 pm	20	14	2	2	1	0	0	0	1	1	3	1	0	0	27	18
		4.00 pm - 5.00 pm	7	10	3	6	1	0	0	0	1	3	2	0	0	0	14	19
		5.00 pm - 6.00 pm	12	5	3	4	1	1	1	1	0	1	0	0	0	0	17	12
		Total	**122**	**107**	**29**	**31**	**12**	**1**	**2**	**2**	**14**	**21**	**7**	**5**	**0**	**1**	**186**	**168**
Day 3	10/20/2018	6.00 am - 7.00 am	2	0	2	1	0	0	0	0	0	0	0	0	0	0	4	1
		7.00 am - 8.00 am	4	2	1	0	1	1	0	0	2	2	0	0	0	0	8	5
		8.00 am - 9.00 am	8	8	2	2	2	1	0	0	2	2	1	0	0	0	15	13

		9.00 am - 10.00 am	6	8	5	4	0	0	0	0	0	1	1	0	0	0	12	13
		10.00 am - 11.00 am	12	11	8	2	0	1	0	0	1	0	0	0	0	0	21	14
		11.00 am - 12.00 pm	11	12	2	2	5	0	0	0	1	0	0	1	0	0	19	15
		12.00 pm - 1.00 pm	15	15	2	1	2	1	0	0	0	1	0	1	1	0	20	19
		1.00 pm - 2.00 pm	10	13	0	2	0	0	0	0	1	1	2	0	0	0	13	16
		2.00 pm - 3.00 pm	7	10	4	2	0	0	0	0	1	3	2	1	2	0	16	16
		3.00 pm - 4.00 pm	14	12	2	4	0	0	0	0	2	0	0	1	0	0	18	17
		4.00 pm - 5.00 pm	12	8	1	0	0	0	0	0	2	2	2	0	0	0	17	10
		5.00 pm - 6.00 pm	25	22	8	4	1	0	0	0	3	1	1	0	1	0	39	27
		Day Total	**126**	**121**	**37**	**24**	**11**	**4**	**0**	**0**	**15**	**13**	**9**	**4**	**4**	**0**	**202**	**166**
		6.00 pm- 7.00 pm	32	35	9	11	0	2	0	0	2	2	0	0	0	0	43	50
		7.00 pm - 8.00 pm	36	43	4	10	1	1	0	0	2	1	0	0	0	0	43	55
		8.00 pm - 9.00 pm	16	21	2	2	0	2	0	0	1	1	0	0	0	0	19	26
		9.00 pm - 10.00 pm	15	20	5	9	2	1	0	2	0	1	0	0	0	0	22	33
		10.00 pm - 11.00 pm	5	10	3	3	1	2	0	0	0	0	0	0	0	0	9	15
		11.00 pm - 12.00 am	9	7	0	4	0	0	0	0	1	0	0	0	0	0	10	11
		12.00 am - 1.00 am	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	5
		1.00 am - 2.00 am	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	3
		2.00 am - 3.00 am	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
		3.00 am - 4.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4.00 am - 5.00 am	0	1	0	0	0	0	0	0	2	0	0	0	0	0	2	1
		5.00 am - 6.00 am	2	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0
		Night Total	**115**	**142**	**23**	**41**	**5**	**8**	**0**	**2**	**8**	**7**	**0**	**1**	**0**	**0**	**151**	**201**
Day 4	10/21/2018	6.00 am - 7.00 am	0	1	0	1	2	0	0	0	0	0	1	0	0	0	3	2
		7.00 am - 8.00 am	10	4	2	3	1	0	0	0	1	1	0	0	0	0	14	8
		8.00 am - 9.00 am	7	11	3	0	1	0	0	0	1	0	0	0	0	0	12	11
		9.00 am - 10.00 am	11	8	11	5	3	1	0	0	1	0	0	0	0	0	26	14
		10.00 am - 11.00 am	22	20	4	6	0	0	0	0	1	0	0	1	0	0	27	27
		11.00 am - 12.00 pm	11	13	6	2	0	2	0	0	1	0	0	0	0	0	18	17
		12.00 pm - 1.00 pm	17	19	7	6	1	0	0	0	0	0	0	0	0	0	25	25
		1.00 pm - 2.00 pm	19	15	4	3	1	1	0	0	3	0	0	0	0	0	27	19
		2.00 pm - 3.00 pm	20	19	7	8	0	0	0	0	1	2	0	0	0	0	28	29
		3.00 pm - 4.00 pm	19	17	8	8	0	1	0	0	1	1	1	2	2	0	31	29
		4.00 pm - 5.00 pm	27	25	5	9	0	0	0	0	1	0	0	0	0	0	33	34
		5.00 pm - 6.00 pm	24	35	6	5	2	0	0	0	0	0	0	0	0	0	32	40
		Total	**187**	**187**	**63**	**56**	**11**	**5**	**0**	**0**	**11**	**4**	**2**	**3**	**2**	**0**	**276**	**255**
	10/22/2018	6.00 am - 7.00 am	3	2	4	1	2	0	1	1	0	0	1	1	0	0	11	5

		7.00 am - 8.00 am	21	22	13	4	3	0	0	0	2	1	1	1	0	0	40	28
		8.00 am - 9.00 am	15	15	3	1	1	0	0	0	0	0	1	1	0	0	20	17
		9.00 am - 10.00 am	13	14	3	3	0	0	0	0	0	0	1	0	0	0	17	17
		10.00 am - 11.00 am	20	19	4	4	0	2	0	0	4	0	0	1	0	0	28	26
		11.00 am - 12.00 pm	18	18	6	0	1	0	0	0	1	1	0	1	0	0	26	20
		12.00 pm - 1.00 pm	16	22	2	3	0	0	0	0	0	2	0	2	0	0	18	29
		1.00 pm - 2.00 pm	14	12	5	4	0	0	0	0	4	0	1	0	0	0	24	16
		2.00 pm - 3.00 pm	13	20	1	2	0	0	0	0	1	2	1	2	0	0	16	26
		3.00 pm - 4.00 pm	24	21	7	8	0	1	0	0	4	1	3	2	0	0	38	33
		4.00 pm - 5.00 pm	22	23	4	6	1	1	0	1	1	1	2	1	0	1	30	34
		5.00 pm - 6.00 pm	28	31	4	8	1	1	1	0	2	2	0	1	0	0	36	43
Day 5		**Day Total**	**207**	**219**	**56**	**44**	**9**	**5**	**2**	**2**	**19**	**10**	**11**	**13**	**0**	**1**	**304**	**294**
		6.00 pm- 7.00 pm	21	24	4	7	2	3	0	0	1	2	2	0	0	0	30	36
		7.00 pm - 8.00 pm	19	22	5	9	1	2	0	0	0	3	1	0	0	0	26	36
		8.00 pm - 9.00 pm	17	26	2	5	1	4	0	0	1	1	0	1	0	0	21	37
		9.00 pm - 10.00 pm	7	15	1	4	0	1	0	0	1	0	0	0	0	0	9	20
		10.00 pm - 11.00 pm	7	11	0	3	0	2	0	0	0	0	0	1	0	0	7	17
		11.00 pm - 12.00 am	0	5	0	0	0	1	0	0	0	0	0	0	0	0	0	6
		12.00 am - 1.00 am	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	2
		1.00 am - 2.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2.00 am - 3.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3.00 am - 4.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4.00 am - 5.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		5.00 am - 6.00 am	1	0	0	2	1	3	0	0	0	0	0	0	0	0	2	5
		Night total	**73**	**105**	**12**	**30**	**5**	**16**	**0**	**0**	**3**	**6**	**3**	**2**	**0**	**0**	**96**	**159**
Day 6	10/23/2018	6.00 am - 7.00 am	0	7	2	6	1	3	0	1	1	0	1	0	0	0	5	17
		7.00 am - 8.00 am	10	7	7	3	2	0	0	0	1	1	2	1	0	0	22	12
		8.00 am - 9.00 am	21	9	4	3	4	0	0	0	1	0	0	1	0	0	30	13
		9.00 am - 10.00 am	16	8	9	4	1	0	0	0	0	0	1	1	0	0	27	13
		10.00 am - 11.00 am	15	13	5	9	1	4	0	0	2	0	0	0	0	0	23	26
		11.00 am - 12.00 pm	17	14	3	4	3	2	0	0	1	2	0	0	0	0	24	22
		12.00 pm - 1.00 pm	26	23	7	13	0	0	0	1	1	0	0	1	0	0	34	38
		1.00 pm - 2.00 pm	11	15	0	5	1	0	0	0	1	0	0	0	0	0	13	20
		2.00 pm - 3.00 pm	21	21	4	5	0	1	0	0	0	2	1	0	0	0	26	29
		3.00 pm - 4.00 pm	18	19	5	6	3	2	0	0	2	0	2	2	0	0	30	29
		4.00 pm - 5.00 pm	31	22	10	7	3	0	1	0	2	1	0	1	0	0	47	31
		5.00 pm - 6.00 pm	23	25	11	8	1	2	1	0	2	1	1	1	0	0	39	37
		Total	**209**	**183**	**67**	**73**	**20**	**14**	**2**	**2**	**14**	**7**	**8**	**8**	**0**	**0**	**320**	**287**

Day 7	10/24/2018	6.00 am - 7.00 am	1	1	3	2	5	0	1	1	0	0	0	0	0	0	10	4
		7.00 am - 8.00 am	11	9	7	2	3	0	0	0	1	2	1	1	0	0	23	14
		8.00 am - 9.00 am	16	10	6	4	1	0	0	0	2	1	0	0	0	0	25	15
		9.00 am - 10.00 am	23	23	10	3	1	0	0	0	2	0	0	0	0	0	36	26
		10.00 am - 11.00 am	15	18	6	1	0	3	0	0	3	1	0	0	0	0	24	23
		11.00 am - 12.00 pm	20	22	2	6	2	0	0	0	2	0	0	0	0	0	26	28
		12.00 pm - 1.00 pm	18	11	4	7	0	0	0	0	0	1	0	1	0	0	22	20
		1.00 pm - 2.00 pm	16	16	2	3	0	1	0	0	0	0	0	0	0	0	18	20
		2.00 pm - 3.00 pm	12	20	2	5	0	0	0	0	0	1	0	1	0	0	14	27
		3.00 pm - 4.00 pm	12	23	8	4	0	1	0	0	1	2	2	1	0	0	23	31
		4.00 pm - 5.00 pm	25	22	10	11	0	1	0	0	1	2	0	1	0	0	36	37
		5.00 pm - 6.00 pm	25	20	2	9	0	0	1	1	2	1	1	0	0	0	31	31
		Total	**194**	**195**	**62**	**57**	**12**	**6**	**2**	**2**	**14**	**11**	**4**	**5**	**0**	**0**	**288**	**276**

Traffic Survey Summary Sheet - Road D435 - Muthuaini - Mungungaini Road																		
	Thur		Sat		Fri		Mon		Sun		Tue		Wed					
	10/18/18		10/19/18		10/20/18		10/21/18		10/22/18		10/23/18		10/24/18					
	Day 1	24-hour Equivalent	Day 3	Night	Day 2	24-hour Equivalent	Day 5	Night	Day 4	24-hour Equivalent	Day 6	24-hour Equivalent	Day 7	24-hour Equivalent	Weekday 24-hour factor	Weekend 24-hour factor	Total	ADT
Motorcycles	161	228	247	257	229	325	426	178	374	763	392	556	389	552	1	2	3,531	**504**
Cars	58	82	61	64	60	85	100	42	119	244	140	199	119	169	1	2	1,046	**149**
Minibus	16	40	15	13	13	33	14	21	16	30	34	85	18	45	3	2	295	**42**
Commercial vehicles for pavement design																		
Bus	4	0	0	2	4	0	4	0	0	0	4	0	4	0	0	0	6	**1**
Light goods vehicles	20	26	28	15	35	46	29	9	15	23	21	28	25	33	1	2	236	**34**
Medium goods vehicles	5	6	13	1	12	15	24	5	5	5	16	19	9	11	1	1	99	**14**
Heavy goods vehicles	0	0	4	0	1	1	1	0	2	2	0	0	0	0	1	1	8	**1**
Total	**264**	**383**	**368**	**352**	**354**	**504**	**598**	**255**	**531**	**1,067**	**607**	**886**	**564**	**809**	**9**	**10**	**5,223**	**746**

E511

ACROSS AFRICA CONSULTANTS LTD

Monitoring and evaluation of low volume roads trial sections in Kenya

Survey Station No. 002 - E511 - Kangari - Kinyona Road

Day	Date	Time	Motorcycle		Cars		Minibus		Bus		Light goods vehicles		Medium goods vehicles		Heavy goods vehicles		Total	
			To Kinyona	To Kangari	To Kinyona	To Kangari	To Kinyona	To Kangari	To Kinyona	To Kangari	To Kinyona	To Kangari	To Kinyona	To Kangari	To Kinyona	To Kangari	To Kinyona	To Kangari
Day 1	10/9/2018	6.00 am - 7.00 am	6	5	0	1	1	5	0	0	2	0	1	0	0	0	10	11
		7.00 am - 8.00 am	13	11	2	6	0	4	0	0	2	2	0	0	0	0	17	23
		8.00 am - 9.00 am	18	9	7	3	2	1	0	0	3	2	1	1	0	0	31	16
		9.00 am - 10.00 am	16	16	3	5	0	0	0	0	3	8	1	1	0	0	23	30
		10.00 am - 11.00 am	15	16	1	5	2	1	0	0	4	1	1	1	0	0	23	24
		11.00 am - 12.00 pm	14	21	0	4	0	0	0	0	2	0	2	3	0	0	18	28
		12.00 pm - 1.00 pm	5	6	3	1	0	0	0	0	2	1	1	0	0	0	11	8
		1.00 pm - 2.00 pm	16	12	3	4	1	0	0	0	2	2	1	1	0	0	23	19
		2.00 pm - 3.00 pm	5	6	3	0	0	0	0	0	0	1	5	0	0	0	13	7
		3.00 pm - 4.00 pm	13	12	3	2	2	0	0	0	1	4	0	3	0	0	19	21
		4.00 pm - 5.00 pm	1	3	2	1	0	0	0	0	0	1	1	0	0	0	4	5
		5.00 pm - 6.00 pm	5	12	1	7	2	4	0	0	1	2	0	1	0	0	9	26
		Total	**127**	**129**	**28**	**39**	**10**	**15**	**0**	**0**	**22**	**24**	**14**	**11**	**0**	**0**	**201**	**218**
Day 2	10/10/2018	6.00 am - 7.00 am	5	4	1	2	0	1	0	0	0	0	1	0	0	0	7	7
		7.00 am - 8.00 am	8	10	6	1	0	4	0	0	1	0	2	0	0	0	17	15
		8.00 am - 9.00 am	5	8	1	3	0	0	0	0	0	2	0	0	0	0	6	13
		9.00 am - 10.00 am	15	15	5	3	0	0	0	0	2	3	1	1	0	0	23	22
		10.00 am - 11.00 am	20	14	32	2	10	0	1	0	6	1	1	1	0	0	70	18
		11.00 am - 12.00 pm	40	20	51	2	20	0	0	0	2	0	0	0	0	0	113	22
		12.00 pm - 1.00 pm	31	21	12	2	0	3	0	0	6	0	0	2	0	0	49	28
		1.00 pm - 2.00 pm	12	12	5	3	1	0	0	0	1	2	0	1	0	0	19	18
		2.00 pm - 3.00 pm	15	7	6	8	2	3	0	0	2	4	2	0	0	0	27	22
		3.00 pm - 4.00 pm	3	6	3	12	3	5	0	0	5	5	1	0	0	0	15	28
		4.00 pm - 5.00 pm	8	17	7	39	1	8	0	0	2	5	0	1	0	0	18	70
		5.00 pm - 6.00 pm	16	19	5	21	2	4	0	0	5	7	0	2	0	0	28	53
		Total	**178**	**153**	**134**	**98**	**39**	**28**	**1**	**0**	**32**	**29**	**8**	**8**	**0**	**0**	**392**	**316**
Day 3	10/11/2018	6.00 am - 7.00 am	10	5	2	2	1	4	0	0	0	0	0	0	0	0	13	11
		7.00 am - 8.00 am	13	17	1	4	0	5	0	0	1	2	1	1	0	0	16	29

		8.00 am - 9.00 am	12	16	1	4	1	0	0	0	5	2	0	1	0	0	19	23
		9.00 am - 10.00 am	6	6	2	4	1	1	0	0	2	3	0	1	0	0	11	15
		10.00 am - 11.00 am	9	11	3	1	0	0	0	0	0	5	2	1	0	1	14	19
		11.00 am - 12.00 pm	15	17	8	5	4	3	0	2	4	0	0	1	0	0	31	28
		12.00 pm - 1.00 pm	12	10	2	0	0	0	0	0	2	0	0	2	0	0	16	12
		1.00 pm - 2.00 pm	17	11	8	3	1	3	0	0	1	0	1	0	0	0	28	17
		2.00 pm - 3.00 pm	12	11	3	0	1	4	0	0	1	2	2	0	0	0	19	17
		3.00 pm - 4.00 pm	14	7	7	10	2	3	0	0	1	1	2	0	0	0	26	21
		4.00 pm - 5.00 pm	23	10	3	10	2	6	0	0	0	1	0	4	0	0	28	31
		5.00 pm - 6.00 pm	12	8	4	2	3	0	0	0	1	2	3	0	0	0	23	12
		Day Total	**155**	**129**	**44**	**45**	**16**	**29**	**0**	**2**	**18**	**18**	**11**	**11**	**0**	**1**	**244**	**235**
		6.00 pm- 7.00 pm	12	23	6	3	2	1	0	0	0	0	0	1	0	0	20	28
		7.00 pm - 8.00 pm	20	6	5	7	0	1	0	0	2	1	1	2	0	0	28	17
		8.00 pm - 9.00 pm	9	8	4	0	2	0	0	0	0	0	1	1	0	0	16	9
		9.00 pm - 10.00 pm	0	0	3	3	0	0	0	0	0	0	0	1	0	0	3	4
		10.00 pm - 11.00 pm	1	3	1	0	0	0	0	0	0	0	0	0	0	0	2	3
		11.00 pm - 12.00 am	1	1	1	1	0	0	0	0	0	0	0	0	0	0	2	2
		12.00 am - 1.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.00 am - 2.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2.00 am - 3.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3.00 am - 4.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4.00 am - 5.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		5.00 am - 6.00 am	1	2	0	1	2	0	0	0	0	0	0	0	0	0	3	3
		Night Total	**44**	**43**	**20**	**15**	**6**	**2**	**0**	**0**	**2**	**1**	**2**	**5**	**0**	**0**	**74**	**66**
Day 4	10/12/2018	6.00 am - 7.00 am	8	4	1	3	1	3	0	0	1	2	0	0	0	0	11	12
		7.00 am - 8.00 am	12	14	1	7	0	4	0	0	3	1	2	0	0	0	18	26
		8.00 am - 9.00 am	4	5	2	0	0	0	0	0	0	2	0	1	0	0	6	8
		9.00 am - 10.00 am	18	16	3	5	0	2	0	0	0	2	3	1	0	0	24	26
		10.00 am - 11.00 am	12	15	5	3	3	1	0	0	5	8	0	2	0	0	25	29
		11.00 am - 12.00 pm	10	13	3	1	1	0	0	0	1	0	0	0	0	0	15	14
		12.00 pm - 1.00 pm	16	10	5	5	0	1	0	0	3	3	0	0	0	0	24	19
		1.00 pm - 2.00 pm	8	13	2	2	1	0	0	0	1	3	1	2	0	0	13	20
		2.00 pm - 3.00 pm	10	7	6	2	0	0	0	0	3	1	3	1	2	0	24	11
		3.00 pm - 4.00 pm	13	13	1	5	0	0	0	0	0	3	1	0	1	0	16	21
		4.00 pm - 5.00 pm	10	12	0	6	1	1	0	0	0	1	0	0	0	0	11	20
		5.00 pm - 6.00 pm	12	16	4	2	1	2	0	0	2	1	0	2	0	0	19	23
		Total	**133**	**138**	**33**	**41**	**8**	**14**	**0**	**0**	**19**	**27**	**10**	**9**	**3**	**0**	**206**	**229**
Day 5	10/13/2018	6.00 am - 7.00 am	6	3	1	3	1	1	0	0	0	1	0	0	0	0	8	8
		7.00 am - 8.00 am	13	10	0	1	0	1	0	0	2	1	0	0	0	0	15	13
		8.00 am - 9.00 am	11	11	2	8	0	1	0	0	3	0	2	1	0	0	18	21

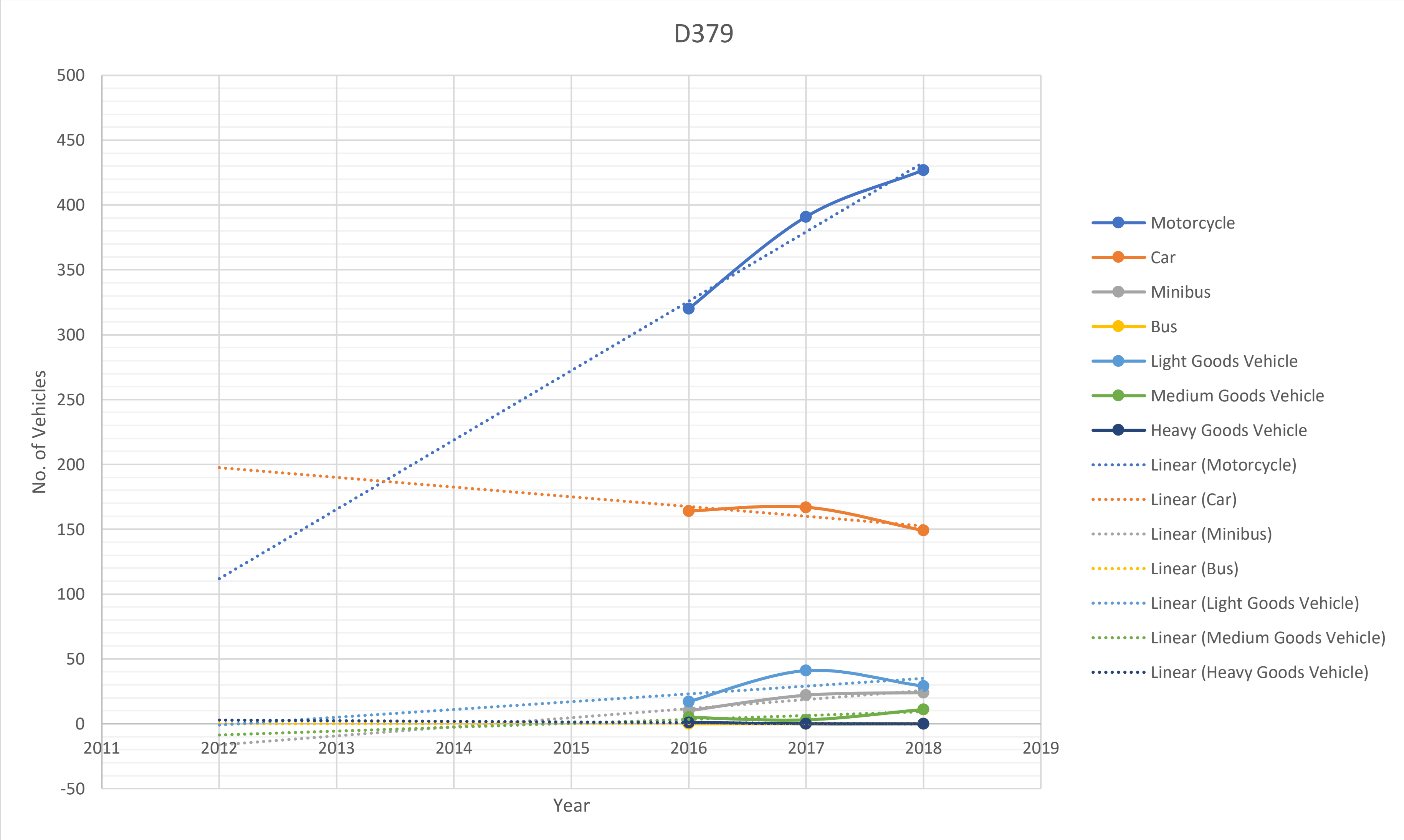
		9.00 am - 10.00 am	5	16	2	2	0	1	0	0	2	3	0	1	0	0	9	23
		10.00 am - 11.00 am	13	11	3	8	2	0	0	0	3	3	0	1	0	0	21	23
		11.00 am - 12.00 pm	14	15	1	2	1	2	0	0	2	1	1	4	0	0	19	24
		12.00 pm - 1.00 pm	7	4	5	1	0	0	0	0	5	2	0	0	0	0	17	7
		1.00 pm - 2.00 pm	12	16	4	2	2	1	0	0	3	3	1	3	0	0	22	25
		2.00 pm - 3.00 pm	10	8	2	0	0	0	0	0	4	0	0	0	0	0	16	8
		3.00 pm - 4.00 pm	9	16	1	4	1	0	0	0	4	2	0	1	0	0	15	23
		4.00 pm - 5.00 pm	10	11	2	3	0	2	0	0	3	1	0	1	0	0	15	18
		5.00 pm - 6.00 pm	11	20	5	3	0	1	0	0	4	3	0	0	0	1	20	28
		Total	**121**	**141**	**28**	**37**	**7**	**10**	**0**	**0**	**35**	**20**	**4**	**12**	**0**	**1**	**195**	**221**
Day 6	10/14/2018	6.00 am - 7.00 am	6	1	0	0	2	0	0	0	0	2	0	0	0	0	8	3
		7.00 am - 8.00 am	6	6	5	1	0	1	0	0	2	1	0	0	0	0	13	9
		8.00 am - 9.00 am	11	10	0	2	0	2	0	0	0	1	0	0	1	1	12	16
		9.00 am - 10.00 am	8	5	1	3	1	0	0	0	0	1	1	1	0	0	11	10
		10.00 am - 11.00 am	6	9	4	0	1	0	0	0	0	1	2	0	0	0	13	10
		11.00 am - 12.00 pm	11	11	3	3	0	0	0	0	2	1	0	0	0	0	16	15
		12.00 pm - 1.00 pm	6	9	2	2	0	3	0	0	2	3	0	0	0	0	10	17
		1.00 pm - 2.00 pm	8	10	1	1	0	1	0	0	1	0	0	1	0	0	10	13
		2.00 pm - 3.00 pm	11	13	3	4	0	0	0	0	1	0	1	0	0	0	16	17
		3.00 pm - 4.00 pm	12	17	0	2	1	2	0	0	2	1	0	0	0	0	15	22
		4.00 pm - 5.00 pm	13	6	5	0	2	0	0	0	0	2	0	0	0	0	20	8
		5.00 pm - 6.00 pm	17	16	2	8	0	1	0	0	0	1	0	0	1	1	20	27
		Day Total	**115**	**113**	**26**	**26**	**7**	**10**	**0**	**0**	**10**	**14**	**4**	**2**	**2**	**2**	**164**	**167**
		6.00 pm- 7.00 pm	23	15	3	6	1	0	0	0	1	1	0	0	0	0	28	22
		7.00 pm - 8.00 pm	21	14	4	4	0	0	0	0	1	1	0	0	0	0	26	19
		8.00 pm - 9.00 pm	6	7	3	1	0	0	0	0	1	0	0	0	0	0	10	8
		9.00 pm - 10.00 pm	5	4	4	0	0	0	0	0	0	0	0	0	0	0	9	4
		10.00 pm - 11.00 pm	1	1	2	0	0	0	0	0	1	0	0	0	0	0	4	1
		11.00 pm - 12.00 am	2	1	1	0	0	1	0	0	0	0	0	0	0	0	3	2
		12.00 am - 1.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.00 am - 2.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2.00 am - 3.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3.00 am - 4.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		4.00 am - 5.00 am	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		5.00 am - 6.00 am	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
		Night Total	**58**	**44**	**17**	**11**	**1**	**1**	**0**	**0**	**4**	**2**	**0**	**0**	**0**	**0**	**80**	**58**
Day 7	10/15/2018	6.00 am - 7.00 am	10	6	0	1	4	2	0	0	0	0	0	0	0	0	14	9
		7.00 am - 8.00 am	17	22	4	3	0	4	0	0	0	1	0	0	0	0	21	30
		8.00 am - 9.00 am	11	12	2	8	0	1	0	0	3	2	1	1	2	1	19	25
		9.00 am - 10.00 am	12	19	0	5	0	1	0	0	4	2	2	3	0	0	18	30

		10.00 am - 11.00 am	14	14	4	3	0	0	0	0	3	3	0	2	1	0	22	22
		11.00 am - 12.00 pm	8	5	1	0	0	0	0	0	0	2	0	0	0	0	9	7
		12.00 pm - 1.00 pm	11	10	2	0	2	0	0	0	4	1	0	1	0	0	19	12
		1.00 pm - 2.00 pm	20	14	2	3	0	0	0	0	2	1	2	1	0	0	26	19
		2.00 pm - 3.00 pm	11	5	5	2	2	1	0	0	0	2	3	1	0	0	21	11
		3.00 pm - 4.00 pm	6	6	1	1	1	1	0	0	0	0	0	0	0	0	8	8
		4.00 pm - 5.00 pm	12	12	2	0	0	1	0	0	4	3	1	1	2	0	21	17
		5.00 pm - 6.00 pm	10	15	6	4	0	4	0	0	1	3	0	1	0	0	17	27
		Total	**142**	**140**	**29**	**30**	**9**	**15**	**0**	**0**	**21**	**20**	**9**	**11**	**5**	**1**	**215**	**217**

Traffic Survey Summary Sheet - Road E511 - Kangari - Kinyona Road																			
	Tue		Wed		Friday		Thur		Sat		Sun		Mon					
	10/9/18		10/10/18		10/11/18		10/12/18		10/13/18		10/14/18		10/15/18					
	Day 1	24-hour Equivalent	Day 2	24-hour Equivalent	Day 4	24-hour Equivalent	Day 3	Night	Day 5	24-hour Equivalent	Day 6	Night	Day 7	24-hour Equivalent	Weekend 24-hour factor	Weekday 24-hour factor	Total	ADT
Motorcycles	256	334	331	432	271	354	284	87	262	379	228	102	282	368	1	1	2,569	**367**
Cars	67	93	232	323	74	103	89	35	65	100	52	28	59	82	2	1	906	**129**
Minibus	25	29	67	79	22	26	45	8	17	19	17	2	24	28	1	1	254	**36**
Commercial vehicles for pavement design																		
Bus	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	2	**0**
Light goods vehicles	46	50	61	66	46	50	36	3	55	69	24	6	41	44	1	1	348	**50**
Medium goods vehicles	25	33	16	21	19	25	22	7	16	16	6	0	20	26	1	1	156	**22**
Heavy goods vehicles	0	0	0	0	3	3	1	0	1	1	4	0	6	6	1	1	15	**2**
Total	**419**	**540**	**708**	**922**	**435**	**561**	**479**	**140**	**416**	**584**	**331**	**138**	**432**	**556**			**4,250**	**607**

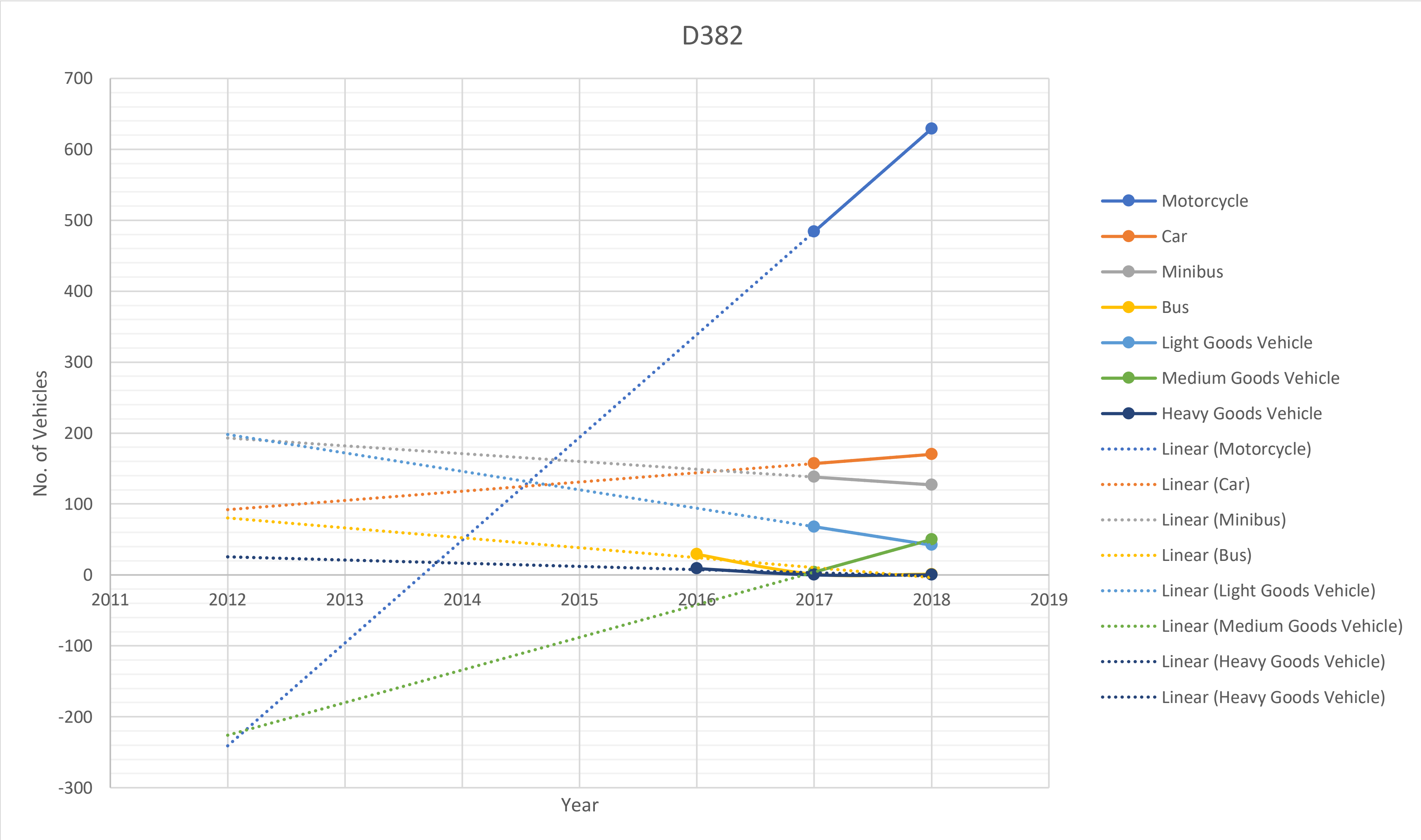
ESTIMATED TOTAL TRAFFIC SINCE CONSTRUCTION

D379



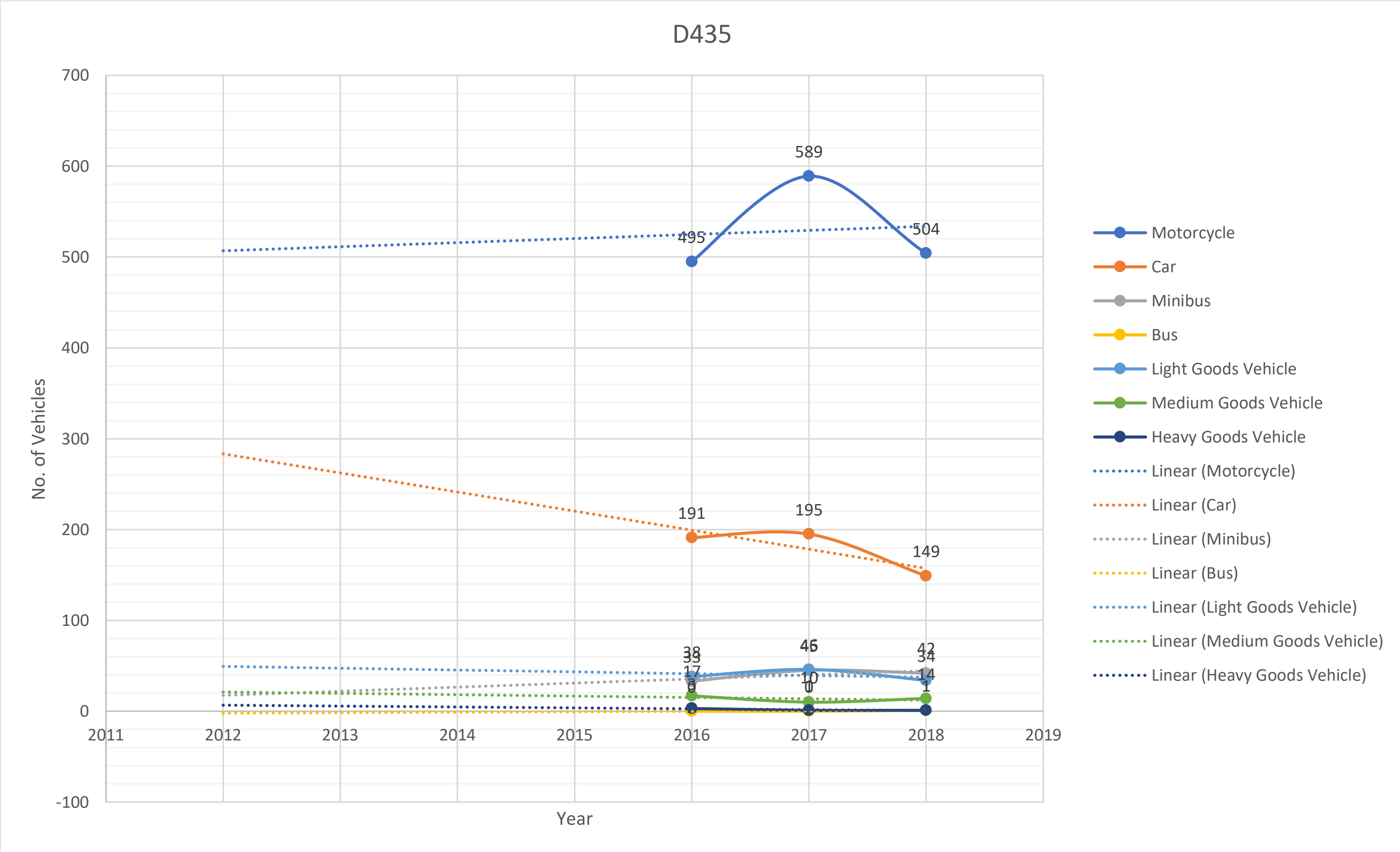
	2012	2016	2017	2018	Area under Graph (Average Daily Traffic since construction)	No of days in a year	Estimated total since construction
Motorcycle		320	391	427	1620	365	591,300
Car		164	167	149	1050	365	383,250
Minibus		10	22	24	53	365	19,163
Bus		0	0	0	0	365	-
Light Goods Vehicle		17	41	29	120	365	43,800
Medium Goods Vehicle		5	3	11	30	365	10,950
Heavy Goods Vehicle		1	0	0	1	365	365

D 3 8 2


D382
700
600
500
400
300
200
100
0
-100
-200
-300
No. of Vehicles
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year
Motorcycle
Car
Minibus
Bus
Light Goods Vehicle
Medium Goods Vehicle
Heavy Goods Vehicle
Linear (Motorcycle)
Linear (Car)
Linear (Minibus)
Linear (Bus)
Linear (Light Goods Vehicle)
Linear (Medium Goods Vehicle)
Linear (Heavy Goods Vehicle)
Linear (Heavy Goods Vehicle)

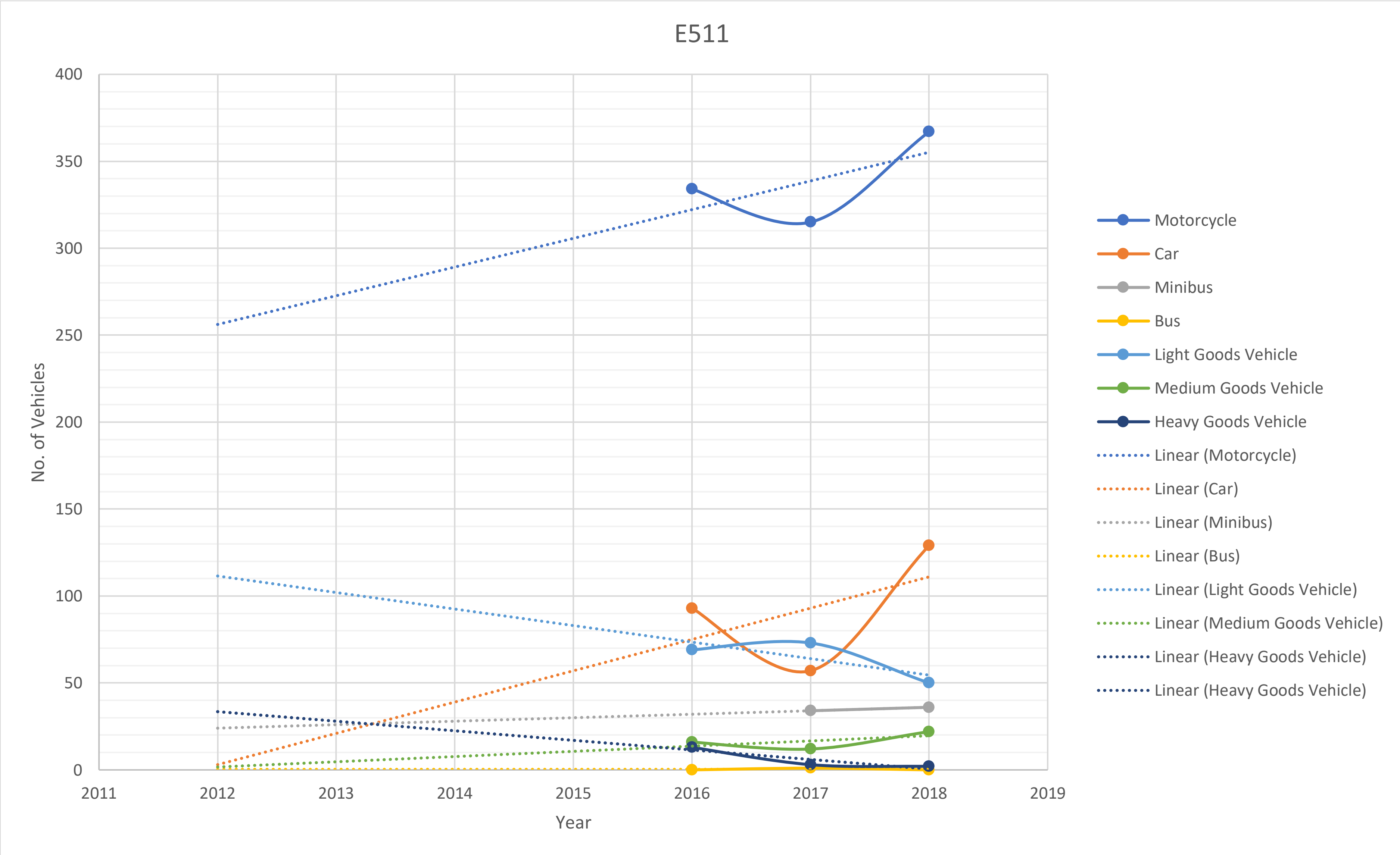
	2012	2016	2017	2018	Area under Graph (Average Daily Traffic since construction)	No of days in a year	Estimated total since construction
Motorcycle			484	629	1417.5	365	517,388
Car			157	170	780	365	284,700
Minibus			138	127	960	365	350,400
Bus		29	1	1	240	365	87,600
Light Goods Vehicle			68	42	720	365	262,800
Medium Goods Vehicle			4	50	25	365	9,125
Heavy Goods Vehicle		9	0	0	60	365	21,900

D 4 3 5


D435
700
600
500
400
300
200
100
0
-100
No. of Vehicles
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year
589
495
504
191
195
149
Motorcycle
Car
Minibus
Bus
Light Goods Vehicle
Medium Goods Vehicle
Heavy Goods Vehicle
Linear (Motorcycle)
Linear (Car)
Linear (Minibus)
Linear (Bus)
Linear (Light Goods Vehicle)
Linear (Medium Goods Vehicle)
Linear (Heavy Goods Vehicle)

	2012	2016	2017	2018	Area under Graph (Average Daily Traffic since construction)	No of days in a year	Estimated total since construction
Motorcycle		495	589	504	3120	365	1,138,800
Car		191	195	149	1320	365	481,800
Minibus		33	45	42	180	365	65,700
Bus		0	0	1	1	365	365
Light Goods Vehicle		38	46	34	270	365	98,550
Medium Goods Vehicle		17	10	14	102	365	37,230
Heavy Goods Vehicle		3	1	1	33	365	12,045

E 5 1 1


E511
400
350
300
250
200
150
100
50
0
No. of Vehicles
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year
Motorcycle
Car
Minibus
Bus
Light Goods Vehicle
Medium Goods Vehicle
Heavy Goods Vehicle
Linear (Motorcycle)
Linear (Car)
Linear (Minibus)
Linear (Bus)
Linear (Light Goods Vehicle)
Linear (Medium Goods Vehicle)
Linear (Heavy Goods Vehicle)
Linear (Heavy Goods Vehicle)

	2012	2016	2017	2018	Area under Graph (Average Daily Traffic since construction)	No of days in a year	Estimated total since construction
Motorcycle		334	315	367	1830	365	667,950
Car		93	57	129	339	365	123,735
Minibus			34	36	174	365	63,510
Bus		0	1	0	1	365	365
Light Goods Vehicle		69	73	50	498	365	181,770
Medium Goods Vehicle		16	12	22	63	365	22,995
Heavy Goods Vehicle		13	3	2	102	365	37,230

ANNEX 2: AXLE LOADS

DATA

Road ID	Lane	Index	Time	Date	Vehicle Type Code	Vehicle Reg. No.	Goods Carried Or Service Type	Axle Config.	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6	VEF	Origin	Destination	Front Axle tyre pressure	Front Axle tyre pressure 2	tare weight
D435	LHS	165	06	16/1/2018	0	KBJ033J	Empty	1.2	3280	3200					0.03	Ihururu	Kahigani			
E511	LHS	217	08	18/01/18	AT	KBV573Z	Cement	1.1.2.2.2.2	5600	6600	10200	8300	8300	8300	6.39	Athi River	Kinyona	120	120	15000
E511	RHS	210	12	18/01/18	AT	KBV573Z	Empty	1.2	4880	4760	5000	4800	4860	5040	0.59	Kinyona	Nairobi	120	120	15000
E511	RHS	207	08	18/01/18	AT	KCA683R	Tractor	1.2.2.2.2.2	5200	7800	8600	1100	7500	7500	3.50	Kanja	Makombo	120	120	_
D435	RHS	185	07	16/1/2018	BUS	KBJ033J	Passengers	1.2	4100	3900					0.08	Njoguini	Ihwa	100	_	
D435	RHS	201	17	16/1/2018	BUS	KBJ033J	Empty	1.2	3280	3200					0.03	Kahigaini	Ihururu	100	3310	
D379	LHS	285	09	22/01/18	BUS	GKS261	Passengers	1.2	4800	9600					2.12	Kabete	Karatu	90	90	_
D379	RHS	295	10	22/01/18	BUS	GKS261	Empty	1.2	4800	4800					0.18	Karatu	Kabete	90	90	
D379	RHS	300	16	22/01/18	BUS	GKS261	Passengers	1.2	4800	9600					2.12	Karatu	Kabete	90	90	_
D379	LHS	291		22/01/18	BUS	GKS261	Empty	1.2	4800	4800					0.18	Gatundu	Karatu	90	90	_
E511	RHS	215	18	18/01/18	BUS	KBU753F	Empty	1.2	1800	3600					0.03	Kinyona	Kangari	80	80	6450
D435	LHS	111	07	15/1/2018	BUS	KBB870T	Empty	1.2	2100	3300					0.02	Ihawa	Njoguini	70	80	
D435	RHS	143	08	15/1/2018	BUS	KBB870T	Students	1.2	2180	3400					0.02	Njoguini	Ihwa	70	80	
D435	LHS	140	17	15/1/2018	BUS	KBJ033J	Students	1.2	3400	4400					0.08	Ihururu	Njoguini	100	100	
D381	RHS	2	07	10/01/18	BUS	KAK977Q	Students	1.2	6129	7360					0.88	Busara	Nyahururu	100	110	6090
D381	RHS	1	07	10/01/18	BUS	KCG840Z	Pass	1.2	4400	5680					0.25	Ngano	Nyahururu	100	100	4800
D381	RHS	3	10	10/01/18	BUS	KBU885J	Empty	1.2	6129	7360					0.88	Boiman	Nyahururu	90	110	5800
D381	LHS	21	16	10/01/18	BUS	KCF611U	Pass	1.2	2560	5040					0.12	Nyahururu	Boiman	100	110	4800
D381	LHS	22	16	10/01/18	BUS	KBU888T	Empty	1.2	2560	5040					0.12	Nyahururu	Boiman	110	110	4800
D381	RHS	23	06	11/01/18	BUS	KAK977Q	Students	1.2	6480	8200					1.35	Boiman	Nyahururu	100	100	9910
D381	RHS	26	07	11/01/18	BUS	KAK977Q	Students	1.2	6460	8400					1.46	Boiman	Nyahururu	100	100	9910
D381	RHS	25	07	11/01/18	BUS	KCB847Z	Students	1.2	4660	6700					0.48	Boiman	Nyahururu	100	100	7200
D381	LHS	60	17	11/01/18	BUS	KCG842Z	Pass	1.2	4640	7000					0.57	Nyahururu	Busara	100	100	4800
D381	RHS	36	17	11/01/18	BUS	KCF611U	Empty	1.2	2860	4960					0.11	Boiman	Nyahururu	100	110	4800
D381	LHS	62	18	11/01/18	BUS	KBV388A	Empty	1.2	4640	6720					0.49	Nyahururu	Baraka	100	100	
D381	RHS	38	18	11/01/18	BUS	KBK979F	Empty	1.2	3240	3440					0.04	Busara	Nyahururu	75	75	3500
D381	LHS	64	19	11/01/18	BUS	KCG842Z	Empty	1.2	4560	6560					0.44	Nyahururu	Busara	100	100	4800
D381	LHS	65	19	11/01/18	BUS	KAG730N	Empty	1.2	2320	2760					0.01	Nyahururu	Boiman	80	90	2900
D381	RHS	37		11/01/18	BUS	KAK977Q	Pass	1.2	6480	9200					2.03	Busara	Nyahururu	100	110	4800
D381	RHS	27		11/01/18	BUS	KBK979F	Students	1.2	4600	5960					0.31	Boiman	Nyahururu	70	70	3000
D381	LHS	59		11/01/18	BUS	KCF611U	Students	1.2	2920	5200					0.14	Nyahururu	Boiman	100	110	4800
D381	RHS	24		11/01/18	BUS	KAN877K	Students	1.2	2860	4940					0.11	Boiman	Nyahururu	100	110	4800
D381	LHS	63		11/01/18	BUS	KBK979F	Empty	1.2	3240	3440					0.04	Nyahururu	Busara	75	75	3500
D381	LHS	61		11/01/18	BUS	KAM081K	Empty	1.2	2960	2920					0.02	Nyahururu	Baraka	70	80	2440
D381	RHS	67	06	12/01/18	BUS	KAK977Q	Students	1.2	6480	8140					1.31	Baraka	Nyahururu	100	110	9910
D381	LHS	86	06	12/01/18	BUS	KAK977Q	Passengers	1.2	6480	8140					1.31	Nyahururu	Baraka	100	110	9910
D381	RHS	68	06	12/01/18	BUS	KAN877K	Students	1.2	6480	8040					1.26	Baraka	Nyahururu	110	110	9960
D381	LHS	85	06	12/01/18	BUS	KAN877K	Passengers	1.2	6480	8040					1.26	Nyahururu	Baraka	110	110	9960
D381	LHS	87	06	12/01/18	BUS	KCG842Z	Passengers	1.2	4680	7060					0.59	Nyahururu	Busara	100	100	4800
D381	RHS	71	07	12/01/18	BUS	KAK977Q	Students	1.2	6480	8100					1.29	Baraka	Nyahururu	100	100	9910

D381	LHS	90	07	12/01/18	BUS	KAK977Q	Passengers	1.2	6500	7860					1.18	Nyahururu	Baraka	100	110	9910
D381	RHS	70	07	12/01/18	BUS	KCG842Z	Sand	1.2	4680	7060					0.59	Baraka	Nyahururu	100	100	4800
D381	RHS	80	16	12/01/18	BUS	KAK977Q	Empty	1.2	5980	7320					0.84	Baraka	Nyahururu	100	100	9910
D381	LHS	101	16	12/01/18	BUS	KCF611U	Passengers	1.2	2720	5600					0.19	Nyahururu	Boiman	100	110	4800
D381	LHS	104	17	12/01/18	BUS	KAN877K	Students	1.2	6880	9520					2.41	Nyahururu	Baraka	110	110	9960
D381	LHS	103	17	12/01/18	BUS	KAK977Q	Students	1.2	7969	8320					1.95	Nyahururu	Baraka	100	110	9910
D381	RHS	83	17	12/01/18	BUS	KAN877K	Empty	1.2	5860	8420					1.35	Baraka	Nyahururu	110	110	9960
D381	RHS	84	17	12/01/18	BUS	KBE673Y	Timber	1.2	4240	7320					0.65	Ngano	Nyahururu	70	75	2800
D381	RHS	82	17	12/01/18	BUS	KCG842Z	Students	1.2	4680	7060					0.59	Baraka	Nyahururu	100	100	4800
D381	LHS	102	17	12/01/18	BUS	KCG842Z	Passengers	1.2	4520	6920					0.53	Nyahururu	Busara	100	100	4800
D381	RHS	81	17	12/01/18	BUS	KCF611U	Empty	1.2	2720	4600					0.08	Boiman	Nyahururu	100	110	4800
D381	LHS	105	18	12/01/18	BUS	KAK977Q	Students	1.2	7969	8320					1.95	Nyahururu	Baraka	100	110	9910
D381	LHS	107	18	12/01/18	BUS	KCG842Z	Students	1.2	4960	6760					0.52	Nyahururu	Busara	100	100	4800
D381	LHS	106	18	12/01/18	BUS	KAQ444Z	Empty	1.2	3440	6320					0.33	Nyahururu	Busara	120	120	_
E511	RHS	208	09	18/01/18	HGV	KCC427Z	Empty	1.2	5400	4700	5400				0.39	Kinyona	Mairi	120	120	12800
E511	LHS	220	10	18/01/18	HGV	KCC437Z	Concrete Mixer	1.2	7000	4700					0.57	Mairi	Kinyona	120	120	12800
E511	RHS	214	17	18/01/18	HGV	KBG055E	Empty	1.2	4200	3600	3700				0.10	Kinyona	Nairobi	110	110	10000
E511	RHS	239	12	19/01/18	HGV	KCG922E	Empty	1.2	5700	4200	4600				0.32	Site	Nairobi	120	120	11000
E511	LHS	234	16	19/01/18	HGV	KCH661N	Dust	1.2	6500	8400	8000				2.36	Nairobi	Site	120	120	9090
E511	RHS	243	16	19/01/18	HGV	KBX184Z	Firewood	1.2	2700	6100	7000				0.76	Forest	Makomboki	100	100	10110
E511	LHS	233	16	19/01/18	HGV	KCB295Y	Empty	1.2	6600	3700	3500				0.43	Kangari	Kinyona	100	100	13000
E511	LHS	275	13	20/01/18	HGV	KAU779D	Cement	1.2	3100	2700					0.02	Mairi	Yabaki	80	80	4500
E511	RHS	253	13	20/01/18	HGV	KBR033Y	Empty	1.2	2700	2700					0.01	Ichiche	Makomboki	120	120	4600
E511	RHS	254	14	20/01/18	HGV	KCJ081U	Hard Cores	1.2	5600	8500	9200				3.03	Site	Makomboki	120	80	9950
E511	RHS	257	15	20/01/18	HGV	KCG322W	Logs	1.2	4400	9100					1.66	Kinyona	Nairobi	120	80	4500
E511	LHS	278	15	20/01/18	HGV	KCJ081U	Empty	1.2	3700	2900					0.04	Makomboki	Site	120	120	9950
D435	RHS	149	14	15/1/2018	HGV	KBD809G	Water	1.2	5900	9200	9200				3.58	Kabage	Ihururu	110	80	
D435	RHS	164	19	15/1/2018	HGV		Logs	1.2	6000	8000	7900				1.99	Forest	Giakanja	110	100	
D381	LHS	14	11	10/01/18	HGV	KAP580R	Maize	1.2	3900	4020					0.08	Kinamba	Boiman	75	80	2560
D381	LHS	52	12	11/01/18	HGV	KBB635U	Keg Cans	1.2	6460	6280	6640				1.03	Nyahururu	Nairobi	110	110	8970
D381	LHS	92	09	12/01/18	HGV	KCD946E	Ballast	1.2	6440	14240	14160				24.01	Nyahururu	Boiman	100	110	10500
D381	LHS	96	14	12/01/18	HGV	KCD491E	Ballast	1.2	6420	13990	14000				22.50	Nyahururu	Boiman	110	120	10500
E511	LHS	223	15	18/01/18	HGV	KBG055E	Fuel	1.2.2	6500	7300	7200				1.50	Nairobi	Kinyona	110	1106	10000
E511	RHS	238	09	19/01/18	HGV	KCD295Y	Empty	1.2.2	5700	4800	4800				0.37	Kinyona	Kangari	100	100	13000
E511	LHS	228	10	19/01/18	HGV	KCB295Y	Steel	1.2.2	6500	4900	5400				0.60	Kangari	Kinyona	100	100	13000
E511	LHS	266	08	20/01/18	HGV	KCH332B	Quary Dust	1.2.2	7200	9200	9600				4.27	Mlolongo	Site	110	110	10000
E511	LHS	265	08	20/01/18	HGV	KCJ250E	Quaary Dust	1.2.2	6400	7300	8600				2.16	Mlolongo	Site	100	100	9130
E511	RHS	246	09	20/01/18	HGV	KCH332B	Empty	1.2.2	3800	2900	4000				0.08	Site	Mololongo	110	110	10000
E511	RHS	245	09	20/01/18	HGV	KCJ250Q	Empty	1.2.2	3800	2700	3400				0.06	Site	Mololongo	100	100	9130
E511	LHS	269	10	20/01/18	HGV	KCJ081U	Empty	1.2.2	3700	2900					0.04	Makomboki	Site	120	120	9950
E511	LHS	270	10	20/01/18	HGV	KCJ081U	Empty	1.2.2	3700	2900					0.04	Makomboki	Site	120	120	9950
E511	RHS	251	11	20/01/18	HGV	KCJ081U	Hard Cores	1.2.2	5600	8200	8400				2.29	Site	Makomboki	120	120	9950
E511	RHS	250	11	20/01/18	HGV	KCJ081U	Hard Cores	1.2.2	6000	8000	8000				0.2	Site	Makomboki	120	120	9950
E511	LHS	277	14	20/01/18	HGV	KCJ081U	Empty	1.2.2	3700	2900	2700				0.04	Makomboki	Site	120	120	9950
E511	RHS	260	15	20/01/18	HGV	KCJ081U	Hard Cores	1.2.2	6400	8700	9600				3.67	Kinyona	Makomboki	120	120	9900
E511	LHS	283	16	20/01/18	HGV	KCG922E	Quarry Dust	1.2.2	9000	10600	11000				8.45	Ikumbi	Kinyona			

E511	RHS	261	16	20/01/18	HGV	KCJ081U	Quarry Dust	1.2.2	6000	6800	7600				1.39	Site	Makomboki	120	120	9950
E511	RHS	262	16	20/01/18	HGV	KCJ264E	Empty	1.2.2	4000	2900	3200				0.06	Site	Makomboki	110	110	_
E511	LHS	281	16	20/01/18	HGV	KCJ081U	Empty	1.2.2	3700	2900	2700				0.04	Makomboki	Site			
E511	LHS	284	17	20/01/18	HGV	KCJ250E	Quarry Dust	1.2.2	6800	7500	7600				1.81	Machakos	Site			
D435	RHS	144	11	15/1/2018	HGV	KBD809G	Water	1.2.2	5900	9200	9200				3.58	Kabage	Ihururu	110	110	
D435	LHS	127	11	15/1/2018	HGV	KBD809G	Empty	1.2.2	3200	3200	2100				0.03	Ihururu	Kabage	110	110	
D435	LHS	133	13	15/1/2018	HGV	KBD809G	Empty	1.2.2	3200	3200	2100				0.03	Ihururu	Kabage	110	110	
D435	LHS	138	16	15/1/2018	HGV	KCC624N	Empty	1.2.2	3800	3600	3700				0.08	Ihururu	Njoguini	110	110	
D435	LHS	139	17	15/1/2018	HGV	KBD809G	Empty	1.2.2	3280	3200	2000				0.03	Ihururu	Njoguini	110	110	
D381	RHS	35		11/01/18	HGV	KBY318N	H/Core	1.2.2	5480	7160	7040				1.21	Olkalau	Nyahururu	110	120	9000
D381	RHS	72	10	12/01/18	HGV	KCD946E	Empty	1.2.2	4880	4160	3920				0.18	Boiman	Nyahururu	100	110	10500
D381	RHS	79	16	12/01/18	HGV	KCD946E	Stones	1.2.2	6480	10640	10600				6.75	Boiman	Nyahururu	100	110	10500
D379	RHS	322	08	24/01/18	HGV	KBY311A	Firewood	1.2.2	4600	5480	5280				0.38	Githoya	Gatundu	100	100	_
D379	LHS	315	08	24/01/18	HGV	KBY311A	Empty	1.2.2	3760	4720	4880				0.21	Kamwangi	Githoya	100	100	_
E511	LHS	271	11	20/01/18	MGV	KBY967X	Empty	1.2	3000	3700					0.04	Ikumbi	Kinyona	80	80	7000
D435	RHS	188	11	16/1/2018	MGV	KAB068U	Logs	1.2	4700	9800					2.31	Forest	Nyeri	80	5490	
D435	RHS	187	11	16/1/2018	MGV	KBX458K	Logs	1.2	2800	7400					0.64	Park	Nyeri	110	3500	
D435	RHS	190	13	16/1/2018	MGV	KBC653G	Logs	1.2	3700	8500					1.20	Animal Forest	Ngeri	100	2950	
D435	RHS	189	13	16/1/2018	MGV	KAJ819K	Logs	1.2	2300	7000					0.49	Park	Ngeri	80	2800	
D435	RHS	193	14	16/1/2018	MGV	KAK539M	Firewood	1.2	3600	4900					0.12	Forest	Nyeri	80	2900	
D435	RHS	192	14	16/1/2018	MGV	KAK992F	Maize Stalks	1.2	3100	4300					0.07	Kabage	Nyeri	70	3100	
D435	RHS	191	14	16/1/2018	MGV	KCA078M	Firewood	1.2	2500	3000					0.02	Animal Forest	Mathari	70	2650	
D435	RHS	194	15	16/1/2018	MGV	KBC182S	Firewood	1.2	4900	7800					0.90	Forest	Nyeri	100	5400	
D435	RHS	195	16	16/1/2018	MGV	KWG660	Logs	1.2	2600	6380					0.33	Forest	Nyeri	90	5015	
D435	RHS	200	17	16/1/2018	MGV	KAC550J	Logs	1.2	4500	15000					15.21	Forest	Nyeri	110	6130	
D435	RHS	197	17	16/1/2018	MGV	KCJ313X	Firewoods	1.2	5600	8200					1.18	Forest	Nyeri	120	7200	
D435	RHS	198	17	16/1/2018	MGV	KBX458K	Logs	1.2	2900	7400					0.64	Park	Nyeri	110	3500	
D435	RHS	196	17	16/1/2018	MGV	KKM465	Logs	1.2	3000	6600					0.39	Forest	Nyeri	100	_	
D435	RHS	199	17	16/1/2018	MGV	KBJ033J	Passengers	1.2	4100	3900					0.08	Njoguini	Ihwa	100	_	
D435	RHS	202	17	16/1/2018	MGV	KZY851	Empty	1.2	1700	2000					0.00	Njoguini	Nyeri	70	2500	
D435	RHS	205	18	16/1/2018	MGV	KUE508	Logs	1.2	2200	10600					3.18	Forest	Nyeri	90	4530	
D435	RHS	204	18	16/1/2018	MGV	KBC653G	Logs	1.2	3200	8400					1.13	Park	Nyeri	100	2950	
D435	RHS	203	18	16/1/2018	MGV	KAJ819K	Logs	1.2	2400	7400					0.63	Park	Nyeri	80	2800	
D379	RHS	294	09	22/01/18	MGV	KBK183E	Coffee	1.2	4600	7440					0.72	Karatu	Ruiru	65	70	3000
D379	LHS	286	09	22/01/18	MGV	KBR098K	Bread	1.2	2720	2800					0.01	Mangu	Karatu	70	70	3120
D379	RHS	296	11	22/01/18	MGV	KBV826N	Empty	1.2	2600	2600					0.01	Karatu	Nairobi	70	70	3000
D379	RHS	297	12	22/01/18	MGV	KBA628G	Timber	1.2	3920	6040					0.29	Githua	Mangu	100	100	4700
D379	RHS	298	14	22/01/18	MGV	KAD386R	Timber	1.2	5680	8200					1.19	Karatu	Ruiru	90	90	_
D379	RHS	299	16	22/01/18	MGV	KCM482R	Animal Feeds	1.2	3100	4880					0.11	Karatu	Juja	70	70	2500
D379	RHS	301	16	22/01/18	MGV	KCM482R	Feeds	1.2	2840	3500					0.03	Karatu	Gatundu	70	70	2500
D379	LHS	292		22/01/18	MGV	KCM482R	Animal Feeds	1.2	3160	5360					0.16	Ruiru	Karatu	70	70	2500
D379	LHS	287		22/01/18	MGV	KBA628G	Timbver	1.2	3640	5040					0.14	Mangu	Githua	100	100	4700
D379	LHS	289		22/01/18	MGV	KAN427X	Hay	1.2	3080	4000					0.05	Gatundu	Rugeri	90	90	3370
D379	LHS	290		22/01/18	MGV	KCK196Q	Assorted Goods	1.2	2680	3800					0.04	Gatundu	Karatu	70	80	3310
D379	LHS	293		22/01/18	MGV	KAN427X	Hay	1.2	2880	3520					0.03	Gatundu	Karatu	90	90	3370

D379	LHS	288		22/01/18	MGV	KAG175V	Empty	1.2	2720	2180					0.01	Gatundu	Rugeri	70	80	3000
D379	RHS	302	08	23/01/18	MGV	KBC533Q	Empty	1.2	2600	1840					0.01	Mbogoro	Gatundu	60	65	4500
D379	LHS	310	09	23/01/18	MGV	KCL052R	Assorted Goods	1.2	2680	3000					0.02	Gatundu	Karatu	70	70	3200
D379	RHS	304	10	23/01/18	MGV	KAD854A	Empty	1.2	4840	3320					0.11	Ruvuri	Gatundu	100	100	5400
D379	RHS	303	10	23/01/18	MGV	KCL052R	Empty	1.2	2580	2900					0.01	Karatu	Gatundu	70	70	3200
D379	LHS	311	11	23/01/18	MGV	KCJ436L	Bread	1.2	2360	3200					0.02	Gakoe	Karatu	60	60	2800
D379	LHS	313	13	23/01/18	MGV	KAM979T	Firewood	1.2	3760	7360					0.64	Kimunyu	Ruburi	70	70	3200
D379	LHS	312	13	23/01/18	MGV	KAM252Z	Firewood	1.2	3320	7260					0.60	Rwambure	Ruburi	70	70	2700
D379	RHS	305	14	23/01/18	MGV	KAM252Z	Empty	1.2	2680	3680					0.03	Ruburi	Ruiru	70	70	2700
D379	RHS	306	15	23/01/18	MGV	KAM979T	Empty	1.2	3120	3520					0.04	Ruburi	Kimunyu	70	70	3200
D379	RHS	308	16	23/01/18	MGV	KAB067P	Empty	1.2	4480	4520					0.13	Karatu	Mang'U	100	100	_
D379	LHS	314	16	23/01/18	MGV	KAB067P	Empty	1.2	4480	4520					0.13	Kiahora	Karatu	100	100	_
D379	RHS	307	16	23/01/18	MGV	KCF583N	Animal Feeds	1.2	2800	2800					0.02	Ruburi	Thika	80	100	3100
D379	RHS	309	17	23/01/18	MGV	KAW090G	Timber	1.2	4880	6800					0.53	Karatu	Gatundu	80	90	3500
D379	LHS	316	08	24/01/18	MGV	KAY116T	Empty	1.2	2800	2680					0.01	Juja	Ruburi	80	80	2900
D379	LHS	317	09	24/01/18	MGV	KUZ168	Ballast	1.2	3640	8600					1.26	Gatundu	Ruburi	90	100	_
D379	RHS	323	09	24/01/18	MGV	KUZ168	Empty	1.2	3400	3680					0.05	Ruburi	Gatundu	90	100	_
D379	LHS	318	10	24/01/18	MGV	KCJ436L	Bread	1.2	1900	2760					0.01	Nairobi	Karatu	60	70	2800
D379	LHS	319	12	24/01/18	MGV	KAQ221U	Animal Feeds	1.2	5460	8280					1.21	Thika	Gatheyi	100	100	4490
D379	RHS	324	12	24/01/18	MGV	KAS917F	Hay	1.2	3600	3880					0.06	Ruburi	Gatundu	70	70	2900
D379	RHS	325	13	24/01/18	MGV	KAY116T	Pinneaples	1.2	3640	3720					0.05	Ruburi	Gatundu	80	80	2900
D379	LHS	320	14	24/01/18	MGV	KAN427X	Empty	1.2	360	3600					0.02					3370
D379	RHS	326	15	24/01/18	MGV	KAB067P	Empty	1.2	4680	4600					0.15	Ruburi	Kiaura	100	100	_
D379	LHS	321	16	24/01/18	MGV	KAB067P	Empty	1.2	4680	4600					0.15	Kiaura	Ruburi	100	100	_
D379	RHS	327	16	24/01/18	MGV	KZJ051	Empty	1.2	3460	3600					0.05	Ruburi	Gatundu	100	100	4700
D379	LHS	328	09		MGV	KAY116T	Manure	1.2	3320	5240					0.15	Juja	Thunguri	80	80	2900
E511	RHS	206	07	18/01/18	MGV	KCM108S	Steel	1.2	6400	12800					7.75	Kanja	Makombo	480	100	9500
E511	LHS	218	08	18/01/18	MGV	KAE666W	Empty	1.2	3200	2800					0.02	Mairi	Kinyona	100	100	5030
E511	LHS	219	09	18/01/18	MGV	KAZ005G	Empty	1.2	3000	3600	4900				0.13	Kangari	Kinyona	100	100	4800
E511	LHS	221	10	18/01/18	MGV	KCP108S	Empty	1.2	7900	4100					0.89	Makomboki	Kanja	80	100	9500
E511	RHS	209	10	18/01/18	MGV	KBY215Z	Bread	1.2	2000	2200					0.00	Kinyona	Thika	70	70	3200
E511	LHS	222	13	18/01/18	MGV	KBX477E	Empty	1.2	3800	4300					0.09			100	120	7280
E511	RHS	212	14	18/01/18	MGV	KAG880M	Potatoes	1.2	1800	3600					0.03	Kinyona	Kangari	70	70	2750
E511	RHS	211	14	18/01/18	MGV	KAM659C	Empty	1.2	1700	1700					0.00	Mununga	Kabati	80	80	2900
E511	RHS	213	15	18/01/18	MGV	KBY976X	Tea Leaves	1.2	3400	5000					0.13		Ikumbi	80	80	7000
E511	LHS	224	17	18/01/18	MGV	KBY976X	Empty	1.2	3200	3200					0.03	Ikumbi	Kinyona	80	80	70000
E511	RHS	216	18	18/01/18	MGV	KBX477E	Empty	1.2	3800	4300					0.09	Kinyona	Kangari	100	120	7280
E511	LHS	225	18	18/01/18	MGV	KAG880M	Firewood	1.2	2700	3000					0.02	Mairi	Kinyona	70	70	2750
E511	LHS	226	08	19/01/18	MGV	KCD972E	Chemicals	1.2	6000	8300					1.30	Athi River	Site	110	110	4600
E511	LHS	227	08	19/01/18	MGV	KKW573F	Empty	1.2	3200	2900					0.02	Mairi	Kinyona	100	100	5030
E511	RHS	236	09	19/01/18	MGV	KBD196P	Empty	1.2	2300	2900					0.01	Kinyona	Kangari	90	90	4300
E511	RHS	237	09	19/01/18	MGV	KCC663N	Empty	1.2	2000	2400					0.01	Kinyona	Nairobi	70	80	3200
E511	LHS	230	11	19/01/18	MGV	KCB245B	Oil	1.2	3600	4600					0.10	Nairobi	Site	80	90	3310
E511	LHS	229	11	19/01/18	MGV	KAC096D	Text Books	1.2	2400	2100					0.01	Nairobi	Kinyona	80	80	3480
E511	LHS	231	12	19/01/18	MGV	KBY967X	Tea Leaves	1.2	2900	3700					0.04	Ikumbi	Kinyona	80	80	7000
E511	LHS	232	13	19/01/18	MGV	KBD196P	Empty	1.2	2300	2900					0.01	Kangari	Kinyona	90	90	4300

E511	RHS	240	13	19/01/18	MGV	KCD972E	Empty	1.2	2500	2700					0.01	Site	Maragua	110	110	4600
E511	RHS	242	15	19/01/18	MGV	KBY967X	Tea Leaves	1.2	3400	5400					0.17	Kinyona	Ikumbi	80	80	7000
E511	RHS	241	15	19/01/18	MGV	KAM659C	Maize Floor	1.2	1800	2000					0.00	Kinyona	Kabati	80	100	2900
E511	LHS	235	17	19/01/18	MGV	KCJ760M	Empty	1.2	3600	4400					0.09	Makomboki	Site	100	110	4500
E511	LHS	267	08	20/01/18	MGV	KCD935Z	Blocks	1.2	5500	4900					0.26	Thika	Kinyora	100	120	4900
E511	RHS	244	09	20/01/18	MGV	KCC663D	Empty	1.2	1800	2300					0.00	Site	Nairobi	70	70	3200
E511	RHS	247	10	20/01/18	MGV	KCH108C	Steel	1.2	5900	8400					1.34	Site	Makomboki	110	70	9500
E511	RHS	249	10	20/01/18	MGV	KCD935Z	Empty	1.2	2400	2800					0.01	Kinyona	Thika	100	120	4900
E511	RHS	248	10	20/01/18	MGV	KBN915F	Eggs	1.2	2400	1500					0.00	Kinyona	Kaitite	70	120	3470
E511	LHS	268	10	20/01/18	MGV	KCC653D	Empty	1.2	1800	2300					0.00	Mairi	Site	70	70	3200
E511	LHS	273	13	20/01/18	MGV	KCM108S	Empty	1.2	6600	4000					0.42	Kangari	Site	110	110	9500
E511	RHS	255	14	20/01/18	MGV	KCJ081U	Hard Cores	1.2	4800	8500	9600				3.30	Site	Makomboki	120	120	9950
E511	RHS	256	14	20/01/18	MGV	KBY976X	Tea Leaves	1.2	3400	4400					0.08	Kinyona	Ikumbi	80	120	7000
E511	LHS	276	14	20/01/18	MGV	KCJ081U	Empty	1.2	3700	2900	2700				0.04	Makomboki	Site	120	120	9950
E511	RHS	259	15	20/01/18	MGV	KAM659C	Empty	1.2	1800	1800					0.00	Kinyona	Nairobi	80	120	2900
E511	LHS	282	16	20/01/18	MGV	KBV454K	Manure	1.2	5600	5500					0.35	Makomboki	Site			
E511	RHS	263	16	20/01/18	MGV	KAR985M	Animal Feeds	1.2	1600	4200					0.05	Kinyona	Nairobi	70	80	3210
D435	RHS	110	13	14/01/18	MGV	KBG991K	Milk	1.2	1700	2000					0.00	Kanjora	Ihururu	70	70	
D435	LHS	112	07	15/1/2018	MGV	KCE683D	Empty	1.2	1900	2400					0.01	Ihururu	Kahigaini	100	100	
D435	RHS	142	07	15/1/2018	MGV	KCE683D	Empty	1.2	1900	2400					0.01	Kahigaini	Hugoini	100	100	
D435	LHS	116	08	15/1/2018	MGV	KAB068V	Tractor	1.2	2200	5000					0.11	Nyeri	Abedare	110	100	
D435	LHS	117	08	15/1/2018	MGV	KAC550J	Empty	1.2	3700	3800					0.06	Nyeri	Kabage	90	100	
D435	LHS	118	08	15/1/2018	MGV	KWK660	Empty	1.2	3100	3300					0.03	Nyeri	Kabage	110	100	
D435	LHS	122	08	15/1/2018	MGV	KBS081Z	Empty	1.2	2400	3000					0.01	Nyeri	Kabage	100	130	
D435	LHS	114	08	15/1/2018	MGV	KUE508	Empty	1.2	2400	2700					0.01	Nyeri	Park	90	110	
D435	LHS	115	08	15/1/2018	MGV	KBC653G	Empty	1.2	2200	2700					0.01	Nyeri	Kabage	90	100	
D435	LHS	121	08	15/1/2018	MGV	KBX458K	Empty	1.2	1700	2800					0.01	Nyeri	Kabage	70	110	
D435	LHS	119	08	15/1/2018	MGV	KAK992F	Empty	1.2	2500	1900					0.01	Nyeri	Park	90	80	
D435	LHS	113	08	15/1/2018	MGV	KZY851	Empty	1.2	1900	2100					0.00	Nyeri	Park	70	70	
D435	LHS	120	08	15/1/2018	MGV	KCA078M	Empty	1.2	2000	1100					0.00	Ihururu	Kabage	70	70	
D435	LHS	123	09	15/1/2018	MGV	KBS081Z	Empty	1.2	2500	2800					0.01	Nyeri	Kabage	120	130	
D435	LHS	124	09	15/1/2018	MGV	KCC234Y	Empty	1.2	2400	2800					0.01	Nyeri	Kabage	120	100	
D435	LHS	125	10	15/1/2018	MGV	KKM465	Empty	1.2	2200	2600					0.01	Nyeri	Kabage	100	100	
D435	LHS	126	10	15/1/2018	MGV	KAJ819K	Empty	1.2	1900	1800					0.00	Nyeri	Kabage	80	80	
D435	LHS	128	11	15/1/2018	MGV	KBS001P	Desks	1.2	1900	2000					0.00	Nyeri	Kabage	70	80	
D435	RHS	147	12	15/1/2018	MGV	KAB068U	Logs	1.2	4600	7800					0.87	Forest	Nyeri	90	100	
D435	RHS	145	12	15/1/2018	MGV	KBX458K	Logs	1.2	2900	6500					0.36	Forest	Nyeri	100	110	
D435	RHS	146	12	15/1/2018	MGV	KAK992F	Logs	1.2	2400	5900					0.23	Forest Park	Nyeri	70	80	
D435	LHS	130	12	15/1/2018	MGV	KCJ313X	Empty	1.2	2800	4200					0.06	Nyeri	Kabage	120	120	
D435	LHS	131	12	15/1/2018	MGV	KBR439P	Tea	1.2	2300	3500					0.02	Gathuthi	Kajora	100	100	
D435	LHS	129	12	15/1/2018	MGV	KAC396K	Empty	1.2	1600	1300					0.00	Ihururu	Kabage	80	80	
D435	RHS	148	13	15/1/2018	MGV	KUE508	Logs	1.2	2300	10600					3.18	Forest	Ruringu	90	110	
D435	LHS	132	13	15/1/2018	MGV	KBS001P	Empty	1.2	1900	1400					0.00	Ihururu	Kabage	70	80	
D435	RHS	150	14	15/1/2018	MGV	KAJ819K	Logs	1.2	2200	7200					0.56	Forest	Nyeri	80	100	
D435	LHS	134	14	15/1/2018	MGV	KBX458R	Empty	1.2	2400	2800					0.01	Ihururu	Kabage	100	110	
D435	LHS	135	14	15/1/2018	MGV	KAK992F	Empty	1.2	1900	1900					0.00	Nyeri	Kabage	70	80	

D435	RHS	152	15	15/1/2018	MGV	KWK660	Logs	1.2	3500	14400					12.62	Forest	Nyeri	100	110	
D435	RHS	151	15	15/1/2018	MGV	KBC653G	Logs	1.2	2200	9200					1.68	Forest	Gatitu	100	100	
D435	LHS	137	15	15/1/2018	MGV	KAB068U	Empty	1.2	2800	2800					0.02	Nyeri	Forest	80	100	
D435	LHS	136	15	15/1/2018	MGV	KAP239C	Empty	1.2	1800	1900					0.00	Nyeri	Njoguini	70	70	
D435	RHS	153	16	15/1/2018	MGV	KAC550J	Logs	1.2	2700	15600					18.07	Forest	Nyeri	110	120	
D435	RHS	154	16	15/1/2018	MGV	KBS081Z	Firewood	1.2	4200	10200					2.72	Forest	Nyeri	120	120	
D435	RHS	155	16	15/1/2018	MGV	KAK992F	Logs	1.2	5900	5700					0.42	Kabage	Nyeri	80	80	
D435	RHS	156	16	15/1/2018	MGV	KKM465	Logs	1.2	2600	6600					0.38	Kabage	Nyeri	100	100	
D435	RHS	157	17	15/1/2018	MGV	KKM465	Logs	1.2	2700	9200					1.69	Kabage	Nyeri	110	110	
D435	RHS	158	17	15/1/2018	MGV	KBX458K	Logs	1.2	3300	3300					0.03	Njoguini	Ihururu	100	100	
D435	RHS	162	18	15/1/2018	MGV	KWK660	Logs	1.2	2900	14400					12.61	Kabage	Nyeri	90	100	
D435	RHS	160	18	15/1/2018	MGV	KCC234Y	Logs	1.2	5900	13500					9.65	Kabage	Nyeri	120	130	
D435	RHS	163	18	15/1/2018	MGV	KAB624W	Logs	1.2	4900	13200					8.62	Kabage	Nyeri	80	100	
D435	LHS	141	18	15/1/2018	MGV	KWK660	Empty	1.2	2500	3300					0.02	Ihururu	Kabage	90	100	
D435	RHS	159	18	15/1/2018	MGV	KAC396K	Firewoods	1.2	2100	3000					0.01	Kabage	Huruma	80	80	
D435	RHS	161	18	15/1/2018	MGV	KZY851	Empty	1.2	1900	2100					0.00	Park	Nyeri	70	70	
D435	LHS	167	07	16/1/2018	MGV	KAC550J	Empty	1.2	3100	3500					0.03	Nyeri	Park	110	110	
D435	LHS	168	07	16/1/2018	MGV	KAB065W	Empty	1.2	3100	3500					0.03	Nyeri	Park	80	100	
D435	LHS	169	07	16/1/2018	MGV	KBX458K	Empty	1.2	2300	2700					0.01	Nyeri	Park	100	110	
D435	LHS	166	07	16/1/2018	MGV	KCE683D	Empty	1.2	1800	2300					0.00	Nyeri	Park	100	100	
D435	LHS	172	08	16/1/2018	MGV	KAK992K	Empty	1.2	1900	2300					0.00	Nyeri	Park	70	80	
D435	LHS	170	08	16/1/2018	MGV	KBG653G	Empty	1.2	2100	1900					0.00	Nyeri	Park	100	100	
D435	LHS	171	08	16/1/2018	MGV	KZY851	Empty	1.2	1700	2000					0.00	Nyeri	Park	70	70	
D435	LHS	173	09	16/1/2018	MGV	KAJ819K	Empty	1.2	2000	2000					0.00	Nyeri	Park	80	80	
D435	LHS	174	09	16/1/2018	MGV	KKM465	Empty	1.2	1600	1600					0.00	Nyeri	Park	100	100	
D435	LHS	176	10	16/1/2018	MGV	KWG660	Empty	1.2	2300	3200					0.02	Nyeri	Park	90	100	
D435	LHS	175	10	16/1/2018	MGV	KAG960F	Empty	1.2	2250	2680					0.01	Nyeri	Park	90	100	
D435	LHS	177	11	16/1/2018	MGV	KCA076M	Empty	1.2	2260	2580					0.01	Nyeri	Park	80	85	
D435	LHS	178	12	16/1/2018	MGV	KBC182S	Empty	1.2	2400	2600					0.01	Nyeri	Park	100	120	
D435	LHS	180	13	16/1/2018	MGV	KCJ313X	Empty	1.2	3600	3400					0.04	Nyeri	Forest	120	120	
D435	LHS	179	13	16/1/2018	MGV	KBX458K	Empty	1.2	2300	2700					0.01	Nyeri	Animal Park	100	110	
D435	LHS	181	14	16/1/2018	MGV	KUE508	Empty	1.2	2600	3300					0.02	Nyeri	Forest	90	110	
D435	LHS	182	15	16/1/2018	MGV	KAB068U	Empty	1.2	3100	3500					0.03	Nyeri	Park	80	100	
D435	LHS	183	15	16/1/2018	MGV	KAJ819K	Empty	1.2	2000	2000					0.00	Nyeri	Park	80	80	
D435	LHS	184	16	16/1/2018	MGV	KBC653G	Empty	1.2	2100	1900					0.00	Nyeri	Park	100	100	
D381	LHS	10	06	10/01/18	MGV	KAQ961Q	Empty	1.2	2920	3200					0.02	Nyahururu	Ngano	80	85	2800
D381	LHS	12	07	10/01/18	MGV	KAK977Q	Student	1.2	6129	7360					0.88	Nyahururu	Busara	100	110	6090
D381	LHS	11	07	10/01/18	MGV	KAC284	Empty	1.2	3240	2800					0.02	Nyahururu	Boiman	70	80	2500
D381	LHS	13	10	10/01/18	MGV	KCC726W	Empty	1.2	2820	3660					0.03	Nyahururu	Boiman	100	110	3310
D381	RHS	4	11	10/01/18	MGV	KAQ961Q	Milk	1.2	3920	4120					0.08	Boiman	Nyahururu	90	100	2800
D381	RHS	5	11	10/01/18	MGV	KCF887Q	Empty	1.2	3760	4160					0.08	Busara	Nyahururu	90	100	5800
D381	LHS	15	12	10/01/18	MGV	KCE701W	Empty	1.2	4160	5080					0.16	Nyahururu	Boiman	120	120	15000
D381	LHS	16	12	10/01/18	MGV	KBZ647J	Empty	1.2	4320	4720					0.14	Nyahururu	Boiman	110	120	4500
D381	RHS	6	13	10/01/18	MGV	KAU527U	Empty	1.2	3040	2320					0.01	Boiman	Nyahururu	75	80	3200
D381	RHS	8	14	10/01/18	MGV	KCH612B	Animal/Feeds	1.2	4000	6000					0.28	Nakuru	Nyahururu	90	100	3220
D381	RHS	7	14	10/01/18	MGV	KAG730N	Milk	1.2	4200	4280					0.10	Ngano	Nyahururu	80	90	2900
D381	LHS	17	14	10/01/18	MGV	KBV526H	Empty	1.2	3600	3720					0.05	Nyahururu	Boiman	80	100	4620

D381	LHS	19	14	10/01/18	MGV	KBU919F	Empty	1.2	3760	2600					0.04	Othaya	Ngano	100	100	3900
D381	LHS	18	14	10/01/18	MGV	KBH317P	Empty	1.2	3400	3080					0.03	Kinamba	Ngano	70	80	3000
D381	LHS	20	14	10/01/18	MGV	KBY384P	Empty	1.2	3000	2640					0.02	Maralal	Boiman	110	110	3800
D381	RHS	9	16	10/01/18	MGV	KBB515S	Assorted Cables	1.2	6160	8040					1.19	Nakuru	Nyahururu	100	100	6280
D381	RHS	28	09	11/01/18	MGV	KBK344Y	Empty	1.2	3080	3200					0.03	Boiman	Nyahururu	70	70	3000
D381	LHS	47	09	11/01/18	MGV	KBK344Y	Empty	1.2	3080	3200					0.03	Nyahururu	Boiman	70	70	3000
D381	LHS	49	10	11/01/18	MGV	KBJ683J	Empty	1.2	2960	2820					0.02	Nyahururu	Olkalou	110	120	3500
D381	LHS	50	11	11/01/18	MGV	KAP021U	Empty	1.2	2640	3440					0.03	Nyeri	Boiman	90	90	2300
D381	RHS	29	12	11/01/18	MGV	KAQ961N	Milk	1.2	3200	4640					0.09	Boiman	Nyahururu	85	85	2800
D381	LHS	53	13	11/01/18	MGV	KBJ986T	Animal Feeds	1.2	4080	6080					0.30	Nyahururu	Boiman	75	80	2800
D381	RHS	30	13	11/01/18	MGV	KAG730N	Milk	1.2	4040	5840					0.26	K/Londi	Nyahururu	80	90	2900
D381	RHS	31	14	11/01/18	MGV	KAP021U	Potatoes	1.2	2760	4580					0.08	Boiman	Mwingi	100	120	2900
D381	LHS	55	14	11/01/18	MGV	KCE557V	Empty	1.2	3840	2840					0.04	Nyahururu	Boiman	110	120	3400
D381	LHS	56	15	11/01/18	MGV	KAG865T	Empty	1.2	3040	6480					0.36	Nyahururu	Ngano	70	80	2800
D381	RHS	33	15	11/01/18	MGV	KAQ961N	Firewood	1.2	2840	3880					0.04	Boiman	Nyahururu	80	80	2800
D381	LHS	58	16	11/01/18	MGV	KBW093Z	Empty	1.2	4040	4920					0.14	Nyahururu	Boiman	120	120	3800
D381	RHS	34	16	11/01/18	MGV	KBW093Z	Empty	1.2	4480	3640					0.09	Boiman	Nyahururu	120	120	3800
D381	RHS	40	19	11/01/18	MGV	KCE623Y	Potatoes	1.2	5520	11920					5.55	K/Londi	Meru	120	120	3310
D381	RHS	39	19	11/01/18	MGV	KBC113G	Potatoes	1.2	3360	6000					0.26	K/Londi	Maralal	80	90	2900
D381	RHS	32		11/01/18	MGV	KCH080A	Potatoes	1.2	3880	8320					1.10	Boiman	Nyahururu	80	80	2800
D381	LHS	54		11/01/18	MGV	KAQ961N	Empty	1.2	2720	3840					0.04	Nyahururu	Boiman	80	85	2800
D381	LHS	51		11/01/18	MGV	KBK527E	Empty	1.2	2640	3400					0.03	Nyeri	Boiman	80	80	8970
D381	LHS	57		11/01/18	MGV	KAU527U	Cement	1.2	2880	3000					0.02	Nyahururu	Boiman	75	80	3200
D381	LHS	48		11/01/18	MGV	KCH080A	Empty	1.2	2920	2800					0.02	Nyeri	Boiman	100	120	3310
D381	RHS	66	06	12/01/18	MGV	KBY330N	Peas	1.2	4280	6280					0.35	Lord	Nyahururu	110	110	4600
D381	RHS	69	07	12/01/18	MGV	KBR176Y	Students	1.2	6120	12760					7.58	Baraka	Ngomongo	100	120	4500
D381	LHS	88	07	12/01/18	MGV	KBB152G	Empty	1.2	3520	3960					0.06	Nyahururu	Nakuru	120	120	4800
D381	LHS	89	07	12/01/18	MGV	KAQ961N	Empty	1.2	2480	3200					0.02	Nyahururu	Boiman	80	85	2800
D381	LHS	91	08	12/01/18	MGV	KAS024Q	Animal Feeds	1.2	3800	6440					0.37	Nyahururu	Boiman	70	70	3000
D381	RHS	74	11	12/01/18	MGV	KBB069C	Water	1.2	4200	4980					0.16	Bahati	Nyahururu	70	70	3380
D381	RHS	73	11	12/01/18	MGV	KAQ961N	Milk	1.2	3320	4160					0.06	Boiman	Nyahururu	80	85	2800
D381	LHS	93	11	12/01/18	MGV	KBR051P	Empty	1.2	3280	4000					0.06	Nyahururu	Ngano	110	120	4900
D381	LHS	94	12	12/01/18	MGV	KAJ132E	Assorted Goods	1.2	4680	4520					0.15	Nyahururu	Busara	80	80	2640
D381	RHS	75	12	12/01/18	MGV	KBY286F	Empty	1.2	3840	2600					0.04	Boiman	Nyahururu	110	120	3200
D381	RHS	76	13	12/01/18	MGV	KAG73ON	Milk	1.2	4560	6440					0.41	Lord	Nyahururu	80	90	2900
D381	LHS	95	13	12/01/18	MGV	KCJ446A	Empty	1.2	3720	6340					0.34	Nakuru	Boiman	120	120	5110
D381	LHS	97	14	12/01/18	MGV	KAQ835Z	Maize Stalks	1.2	4880	8600					1.34	Nyahururu	Baraka	110	120	4530
D381	RHS	77	15	12/01/18	MGV	KBR176Y	Sand	1.2	6640	13380					9.44	Nakuru	Ngomongo	100	120	4500
D381	RHS	78	15	12/01/18	MGV	KAQ835Z	Empty	1.2	4160	3800					0.08	Baraka	Nyahururu	110	120	4530
D381	LHS	98	15	12/01/18	MGV	KBV441N	Empty	1.2	3120	3960					0.05	Nyahururu	Boiman	100	120	4500
D381	LHS	99	15	12/01/18	MGV	KBY330N	Empty	1.2	2360	1840					0.00	Nyahururu	Lord	110	110	4600
D381	LHS	100	16	12/01/18	MGV	KBR176Y	Empty	1.2	3320	4120					0.06	Nyahururu	Boiman	110	120	4500
D381	LHS	109	18	12/01/18	MGV	KAG730N	Empty	1.2	2920	2640					0.02	Nyahururu	Lord	80	90	2900
D381	LHS	108	18	12/01/18	MGV	KBY286F	Empty	1.2	2760	2600					0.01	Nyahururu	Boiman	110	120	3200
E511	LHS	279	15	20/01/18	MGV	KBY967X	Quarry Dust	1.2.	3700	3700					0.06	Makomboki	Site	80	80	7000

E511	RHS	252	12	20/01/18	MGV	KCJ081U	Hard Cores	1.2.2	6000	7500	8300				1.97	Site	Nairobi	120	120	9950
E511	LHS	274	13	20/01/18	MGV	KCJ081U	Empty	1.2.2	3700	2900	2700				0.04	Makomboki	Site	120	120	9950
E511	RHS	258	15	20/01/18	MGV	KCJ081U	Hard Cores	1.2.2	4800	7200	9400				2.50	Kinyona	Makomboki	120	120	9950
E511	LHS	280	16	20/01/18	MGV	KCJ264Q	Quarry Dust	1.2.2	6000	10600	9800				5.65	Makomboki	Site	110	110	7000
E511	RHS	264	17	20/01/18	MGV	KCJ250Q	Empty	1.2.2	3800	2700	3400				0.06	Site	Mlolongo	100	100	9130
D435	RHS	186	07	16/1/2018	MGV	KCE683D	Empty		1800	2300					0.00	Ihwa	Njoguini	100	3310	
E511	LHS	272	11	20/01/18		KCJ081U	Empty	1.2.2	3700	2900					0.04	Makomboki	Site	120	120	9950

BUS VEF & ESA

Axle Config.	Axle 1	Axle 2
1.2	4800	9600
1.2	4800	4800
1.2	4800	9600
1.2	4800	4800
1.2	6129	7360
1.2	4400	5680
1.2.2	6129	7360
1.2.2	2560	5040
1.2	2560	5040
1.2	6480	8200
1.2	6460	8400
1.2	4660	6700
1.2	4640	7000
1.2	2860	4960
1.2	4640	6720
1.2	3240	3440
1.2	4560	6560
1.2	2320	2760
1.2	6480	9200
1.2	4600	5960
1.2	2920	5200
1.2	2860	4940
1.2	3240	3440
1.2	2960	2920
1.2	6480	8140
1.2	6480	8140
1.2	6480	8040
1.2	6480	8040
1.2	4680	7060
1.2	6480	8100
1.2	6500	7860
1.2	4680	7060
1.2	5980	7320
1.2	2720	5600
1.2	6880	9520
1.2	7969	8320
1.2	5860	8420
1.2	4240	7320
1.2	4680	7060
1.2	4520	6920
1.2	2720	4600
1.2	7969	8320

1.2	4960	6760
1.2	3440	6320
1.2	4100	3900
1.2	3280	3200
1.2	2100	3300
1.2	2180	3400
1.2	3400	4400
1.2	1800	3600
Average (kilograms)	**4619.1**	**6328.0**
Measured mass (tonnes)	**4.6**	**6.3**
Equivalent Factor	**0.1**	**0.4**
Vehicle Equivalence Factor	**0.5**	

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction
D379	Bus	0.50	221	111
D382	Bus	0.50	87,600	44029
D435	Bus	0.50	365	183
E511	Bus	0.50	365	183

MGV VEF & ESA

Axle Config.	Axle 1	Axle 2
1.2	4600	7440
1.2	2720	2800
1.2	2600	2600
1.2	3920	6040
1.2	5680	8200
1.2	3100	4880
1.2	2840	3500
1.2	3160	5360
1.2	3640	5040
1.2	3080	4000
1.2	2680	3800
1.2	2880	3520
1.2	2720	2180
1.2	2600	1840
1.2	2680	3000
1.2	4840	3320
1.2	2580	2900
1.2	2360	3200
1.2	3760	7360
1.2	3320	7260
1.2	2680	3680
1.2	3120	3520
1.2	4480	4520
1.2	4480	4520
1.2	2800	2800
1.2	4880	6800
1.2	2800	2680
1.2	3640	8600
1.2	3400	3680
1.2	1900	2760
1.2	5460	8280
1.2	3600	3880
1.2	3640	3720
1.2	360	3600
1.2	4680	4600
1.2	4680	4600
1.2	3460	3600
1.2	3320	5240
1.2	2920	3200
1.2	6129	7360
1.2	3240	2800
1.2	2820	3660
1.2	3920	4120
1.2	3760	4160
1.2	4160	5080
1.2	4320	4720
1.2	3040	2320
1.2	4000	6000
1.2	4200	4280
1.2	3600	3720
1.2	3760	2600
1.2	3400	3080
1.2	3000	2640
1.2	6160	8040
1.2	3080	3200
1.2	3080	3200
1.2	2960	2820
1.2	2640	3440
1.2	3200	4640
1.2	4080	6080
1.2	4040	5840
1.2	2760	4580
1.2	3840	2840
1.2	3040	6480
1.2	2840	3880
1.2	4040	4920
1.2	4480	3640
1.2	5520	11920
1.2	3360	6000
1.2	3880	8320
1.2	2720	3840
1.2	2640	3400
1.2	2880	3000
1.2	2920	2800
1.2	4280	6280
1.2	6120	12760
1.2	3520	3960
1.2	2480	3200
1.2	3800	6440
1.2	4200	4980
1.2	3320	4160
1.2	3280	4000
1.2	4680	4520
1.2	3840	2600
1.2	4560	6440

1.2	3720	6340
1.2	4880	8600
1.2	6640	13380
1.2	4160	3800
1.2	3120	3960
1.2	2360	1840
1.2	3320	4120
1.2	2920	2640
1.2	2760	2600
1.2	4700	9800
1.2	2800	7400
1.2	3700	8500
1.2	2300	7000
1.2	3600	4900
1.2	3100	4300
1.2	2500	3000
1.2	4900	7800
1.2	2600	6380
1.2	4500	15000
1.2	5600	8200
1.2	2900	7400
1.2	3000	6600
1.2	4100	3900
1.2	1700	2000
1.2	2200	10600
1.2	3200	8400
1.2	2400	7400
1.2	1700	2000
1.2	1900	2400
1.2	1900	2400
1.2	2200	5000
1.2	3700	3800
1.2	3100	3300
1.2	2400	3000
1.2	2400	2700
1.2	2200	2700
1.2	1700	2800
1.2	2500	1900
1.2	1900	2100
1.2	2000	1100
1.2	2500	2800
1.2	2400	2800
1.2	2200	2600
1.2	1900	1800

1.2	1900	2000
1.2	4600	7800
1.2	2900	6500
1.2	2400	5900
1.2	2800	4200
1.2	2300	3500
1.2	1600	1300
1.2	2300	10600
1.2	1900	1400
1.2	2200	7200
1.2	2400	2800
1.2	1900	1900
1.2	3500	14400
1.2	2200	9200
1.2	2800	2800
1.2	1800	1900
1.2	2700	15600
1.2	4200	10200
1.2	5900	5700
1.2	2600	6600
1.2	2700	9200
1.2	3300	3300
1.2	2900	14400
1.2	5900	13500
1.2	4900	13200
1.2	2500	3300
1.2	2100	3000
1.2	1900	2100
1.2	3100	3500
1.2	3100	3500
1.2	2300	2700
1.2	1800	2300
1.2	1900	2300
1.2	2100	1900
1.2	1700	2000
1.2	2000	2000
1.2	1600	1600
1.2	2300	3200
1.2	2250	2680
1.2	2260	2580
1.2	2400	2600
1.2	3600	3400
1.2	2300	2700
1.2	2600	3300

1.2	3100	3500
1.2	2000	2000
1.2	2100	1900
	1800	2300
1.2	3000	3700
1.2	6400	12800
1.2	3200	2800
1.2	3000	3600
1.2	7900	4100
1.2	2000	2200
1.2	3800	4300
1.2	1800	3600
1.2	1700	1700
1.2	3400	5000
1.2	3200	3200
1.2	3800	4300
1.2	2700	3000
1.2	6000	8300
1.2	3200	2900
1.2	2300	2900
1.2	2000	2400
1.2	3600	4600
1.2	2400	2100
1.2	2900	3700
1.2	2300	2900
1.2	2500	2700

1.2	3400	5400	
1.2	1800	2000	
1.2	3600	4400	
1.2	5500	4900	
1.2	1800	2300	
1.2	5900	8400	
1.2	2400	2800	
1.2	2400	1500	
1.2	1800	2300	
1.2	6600	4000	
1.2	4800	8500	
1.2	3400	4400	
1.2	3700	2900	
1.2	1800	1800	
1.2	5600	5500	
1.2	1600	4200	
1.2.	3700	3700	
Average (kilograms)	**2668.9**	**3552.0**	**0.0**
Measured mass (tonnes)	**2.7**	**3.6**	**0.0**
Equivalent Factor	**0.012**	**0.039**	**0.000**
Vehicle Equivalence Factor	0.1		

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction
D379	Medium Goods Vehicle	0.05	10950	561.2
D382	Medium Goods Vehicle	0.05	9,125	467.6
D435	Medium Goods Vehicle	0.05	37230	1908.0
E511	Medium Goods Vehicle	0.05	22995	1178.4

HGV VEF & ESA

Axle Config.	Axle 1	Axle 2	Axle 3
1.2.2	3280	3200	2000
1.2.2	3200	3200	2100
1.2.2	3200	3200	2100
1.2.2	3700	2900	2700
1.2.2	3700	2900	2700
1.2.2	4000	2900	3200
1.2.2	3800	2700	3400
1.2	6600	3700	3500
1.2.2	3800	3600	3700
1.2	4200	3600	3700
1.2.2	4880	4160	3920
1.2.2	3800	2900	4000
1.2	5700	4200	4600
1.2.2	5700	4800	4800
1.2.2	3760	4720	4880
1.2.2	4600	5480	5280
1.2	5400	4700	5400
1.2.2	6500	4900	5400
1.2	6460	6280	6640
1.2	2700	6100	7000
1.2.2	5480	7160	7040
1.2.2	6500	7300	7200
1.2.2	6000	6800	7600
1.2.2	6800	7500	7600
1.2	6500	8400	8000
1.2.2	6000	8000	8000
1.2.2	5600	8200	8400
1.2.2	6400	7300	8600
1.2	5600	8500	9200

1.2.2	7200	9200	9600
1.2.2	6400	8700	9600
1.2.2	6480	10640	10600
1.2.2	9000	10600	11000
1.2	6420	13990	14000
1.2	6440	14240	14160
1.2	6000	8000	7900
1.2	5900	9200	9200
1.2.2	5900	9200	9200
1.2	3900	4020	
1.2	7000	4700	
1.2	3100	2700	
1.2.2	3700	2900	2700
1.2.2	3700	2900	2700
1.2.2	3800	2700	3400
1.2.2	3000	3600	4900
1.2.2	6000	7500	8300
1.2.2	4800	7200	9400
1.2.2	4800	8500	9600
1.2.2	6000	10600	9800
1.2	2700	2700	
1.2	4400	9100	
1.2	3700	2900	
1.2.2	3700	2900	
1.2.2	3700	2900	
Average (kilograms)	**5517**	**6402**	**7169**
Measured mass (tonnes)	**5.5**	**6.4**	**7.2**
Equivalent Factor	**0.226**	**0.410**	**0.645**

Vehicle Equivalence Factor	**1.3**

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction	Road
D379	Heavy Goods Vehicle	2 Axles	1.28	365	468
D382	Heavy Goods Vehicle	3 Axles	1.28	21,900	28058
D435	Heavy Goods Vehicle	4 Axles	1.28	12045	15432
E511	Heavy Goods Vehicle	5 Axles	1.28	37230	47699

SUMMARY (VEF & ESA)

Road	Mode	VEF	Number of vehicles	Vehicle ESA [Estimated total since construction/modes]	Vehicle ESA [Estimated total since construction]
D379	Bus	0.50	221	111.1	1,140
D379	Heavy Goods Vehicle	1.28	365	467.6	
D379	Medium Goods Vehicle	0.05	10,950	561.2	
D382	Bus	0.50	87,600	44,029.4	72,555
D382	Heavy Goods Vehicle	1.28	21,900	28,058.2	
D382	Medium Goods Vehicle	0.05	9,125	467.6	
D435	Bus	0.50	365	183.5	17,523
D435	Heavy Goods Vehicle	1.28	12,045	15,432.0	
D435	Medium Goods Vehicle	0.05	37,230	1,908.0	
E511	Bus	0.50	365	183.5	49,061
E511	Heavy Goods Vehicle	1.28	37,230	47,699.0	
E511	Medium Goods Vehicle	0.05	22,995	1,178.4	

ANNEX 3: DCP

DATA

D379

UKDCP Test Data Sheet														
Project name	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)	Wamwangi - Karatu (D379)
Test number	6	1	1	1	4	5	7	8	9	10	11	12	13	14
Chainage (km)	0.000	0.020	0.020	0.020	0.020	0.020	0.195	0.195	0.195	0.195	0.195	0.250	0.300	0.350
Location	C/W	C/W	C/W	C/W	C/W	C/W	C/W	C/W	C/W	C/W	C/W	C/W	C/W	C/W
Lane number	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Offset (m)		1.9	1.0	0.0	0.9	2.2	1.9	0.8		0.9	0.0	1.7	0.5	0.5
Direction	LHS	LHS(OWP) Panel A	LHS(IWP)	LHS	RHS(IWP)	RHS(OWP)		LHS(IWP)	RHS(OWP)	RHS (IWP)	Centre	RHS(OWP)	LHS(IWP)	RHS(IWP)
Zero error (mm)	72	72	72	72	72	72	72	72	72	72	72	72	72	72
Test date (dd/mm/yyyy)	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017	28/7/2017
Remarks														
Layers removed														
Surface type	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Surface moisture														
Surface thickness (mm)														
Surface condition														
Surface strength coefficient														
Base type														
Base thickness (mm)														

Base condition																												
Base strength coefficient																												
	Blows	Depth (mm)		Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)
	0	80	0	78	0	80	0	80	0	80	0	80	0	83	0	83	0	85	0	80	0	80	0	86	0	80	0	80
	5	94	5	88	5	91	5	93	5	94	5	90	5	95	5	93	5	97	5	88	5	93	5	95	5	94	5	90
	5	109	5	97	5	101	5	102	5	100	5	98	5	100	5	103	5	112	5	98	5	100	5	103	5	100	5	100
	5	128	5	106	5	110	5	113	5	110	5	116	5	107	5	112	5	130	5	108	5	110	5	110	5	108	5	110
	5	148	5	114	5	122	5	123	5	118	5	133	5	116	5	121	5	150	5	120	5	118	5	119	5	114	5	118
	5	173	5	120	5	132	5	137	5	126	5	152	5	215	5	132	5	174	5	132	5	125	5	130	5	120	5	128
	5	200	5	131	5	140	5	148	5	135	5	175	5	132	5	142	5	195	5	143	5	135	5	140	5	128	5	140
	5	333	5	141	5	150	5	157	5	144	5	200	5	137	5	154	5	214	5	152	5	142	5	153	5	131	5	150
	5	265	5	153	5	158	5	169	5	150	5	230	5	139	5	165	5	228	5	166	5	153	5	167	5	135	5	160
	5	300	5	165	5	168	5	180	5	156	5	270	5	146	5	178	5	238	5	182	5	162	5	180	5	142	5	174
	5	335	5	180	5	178	5	191	5	164	5	302	5	150	5	188	5	265	5	196	5	170	5	194	5	150	5	184
	5	364	5	192	5	185	5	200	5	174	5	330	5	154	5	198	5	282	5	214	5	177	5	210	5	158	5	197
	5	393	5	205	5	196	5	210	5	176	5	356	5	158	5	208	5	300	5	230	5	188	5	215	5	167	5	210
	5	426	5	218	5	205	5	220	5	183	5	390	5	164	5	218	5	324	5	243	5	195	5	240	5	178	5	221
	5	460	5	229	5	217	5	229	5	188	5	430	5	170	5	228	5	348	5	260	5	200	5	258	5	188	5	230
	5	498	5	239	5	224	5	238	5	194	5	489	5	180	5	242	5	378	5	278	5	210	5	274	5	200	5	239
	5	545	5	250	5	234	5	250	5	199	5	560	5	187	5	255	5	408	5	290	5	220	5	290	5	208	5	250
	5	600	5	265	5	248	5	258	5	206	5	663	5	198	5	272	5	432	5	305	5	228	5	310	5	216	5	260
	5	660	5	280	5	258	5	269	5	212	5	810	5	205	5	288	5	463	5	320	5	236	5	330	5	224	5	272
	5	724	5	295	5	264	5	275	5	218	5	980	5	18	5	303	5	507	5	332	5	243	5	350	5	232	5	285
	5	810	5	316	5	273	5	284	5	228			5	228	5	316	5	552	5	350	5	250	5	370	5	247	5	300
	5	880	5	333	5	280	5	292	5	240			5	240	5	330	5	613	5	370	5	260	5	390	5	260	5	318
	5	950	5	353	5	290	5	303	5	250			5	248	5	343	5	674	5	390	5	271	5	403	5	275	5	330
	5	1042	5	370	5	303	5	314	5	265			5	258	5	360	5	742	5	413	5	282	5	421	5	290	5	340
			5	380	5	312	5	328	5	280			5	268	5	378	5	827	5	440	5	293	5	444	5	304	5	359
			5	390	5	328	5	338	5	296			5	278	5	400	5	925	5	470	5	304	5	463	5	307	5	370
			5	400	5	344	5	352	5	317			5	288	5	425	5	1056	5	500	5	322	5	487	5	333	5	380
			5	413	5	358	5	364	5	330			5	300	5	453			5	540	5	338	5	514	5	343	5	390
			5	425	5	376	5	379	5	348			5	315	5	483			5	584	5	355	5	544	5	354	5	400
			5	440	5	394	5	398	5	365			5	330	5	513			5	642	5	375	5	575	5	364	5	410
			5	454	5	408	5	418	5	386			5	346	5	555			5	702	5	397	5	615	5	374	5	422
			5	475	5	424	5	435	5	411			5	360	5	595			5	772	5	420	5	653	5	385	5	433
			5	496	5	34	5	476	5	440			5	380	5	634			5	856	5	447	5	698	5	398	5	444
			5	522	5	463	5	505	5	470			5	398	5	682			5	948	5	480	5	747	5	410	5	463
			5	553	5	489	5	538	5	507			5	420	5	742			5	1015			5	800	5	422	5	475

			5	586	5	518	5	580	5	550			5	441	5	811							5	859	5	434	5	494
			5	621	5	545	5	623	5	596			5	465	5	878							5	928	5	450	5	518
			5	656	5	581	5	673	5	645			5	490	5	980							5	1004	5	464	5	540
			5	696	5	623	5	738	5	700			5	523	5	1067							5	1064	5	482	5	566
			5	744	5	668	5	809	5	762			5	560											5	501	5	600
			5	798	5	720	5	884	5	830			5	595											5	527	5	638
			5	856	5	789	5	957	5	920			5	635											5	553	5	682
			5	923	5	882			5	983			5	680											5	580	5	730
			5	1007	5	1000							5	730													5	782
													5	782													5	840
													5	840													5	905
													5	895													5	978
													5	953													5	1038

D382

Table 0.1

UK DCP Test Data Sheet																											
Project name	LORD - KONA BAHATI D382																										
Test number	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Chainage (km)	0+000	0+050	1+100	0+150	0+200	0+250	0+300	0+350	0+400	PT1 PANEL A	PT2 PANEL A	PT3 PANEL A	PT4 PANEL A	PT5 PANEL A	PT1 PANEL B	PT2 PANEL B	PT3 PANEL B	PT4 PANEL B	PT5 PANEL B	0+600	0+650	0+700	0+750	0+800	0+850	0+900	0+950
Location	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY
Lane number																											
Offset (m)																											
Direction	CL	RHS	LHS	RHS	LHS	RHS	CL	RHS	CL	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5	RHS	LHS	RHS	LHS	RHS	LHS	RHS	LHS
Zero error (mm)	68	73	76	73	67	68	65	63	71	67	66	63	76	73	70	73	70	65	63	67	75	67	73	65	70	63	67
Test date (dd/mm/yyyy)	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018	13/10/2018
Remarks																											
Layers removed	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Surface type	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Surface moisture	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Surface thickness (mm)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Surface condition	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate
Surface strength coefficient																											
Base type	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste	Neat Quarry waste
Base thickness (mm)	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
Base condition	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Base strength coefficient																											

	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)
	0	78	0	78	0	84	0	80	0	73	0	78	0	73	0	70	0	85	0	75	0	75	0	71	0	82	0	86	0	75	0	78	0	74	0	73	0	71	0	71	0	82	0	78	0	78	0	69	0	76	0	73	0	78
	5	105	5	91	5	103	5	103	5	88	5	94	5	90	5	83	5	106	5	100	5	103	5	98	5	101	5	111	5	88	5	90	5	90	5	90	5	85	5	80	5	102	5	96	5	88	5	83	5	87	5	91	5	90
	5	126	5	110	5	124	5	130	5	100	5	113	5	103	5	103	5	141	5	145	5	132	5	133	5	128	5	150	5	111	5	103	5	110	5	110	5	110	5	98	5	118	5	133	5	100	5	111	5	102	5	121	5	110

	5 144	5 128	5 146	5 163	5 115	5 138	5 108	5 130	5 182	5 193	5 156	5 173	5 168	5 182	5 143	5 140	5 136	5 120	5 131	5 111	5 142	5 170	5 116	5 148	5 133	5 156	5 143
	5 155	5 148	5 163	5 196	5 130	5 158	5 156	5 154	5 246	5 243	5 196	5 197	5 210	5 227	5 181	5 186	5 158	10 143	5 144	5 126	5 167	5 218	5 138	5 176	5 168	5 205	5 158
	5 170	5 170	5 186	5 220	5 148	5 183	5 184	5 190	5 331	5 318	5 278	5 217	5 269	5 304	5 222	5 236	5 178	10 165	5 168	5 152	5 168	5 300	5 164	5 202	5 220	5 300	5 166
	5 184	5 196	5 200	5 248	5 167	5 208	5 210	5 225	5 432	5 425	5 307	5 239	5 348	5 407	5 290	5 318	5 195	10 203	5 180	5 173	5 222	5 344	5 200	5 232	5 323	5 365	5 180
	5 200	5 220	5 218	5 278	5 187	5 244	5 230	5 275	5 434	5 535	5 344	5 315	5 464	5 520	5 368	5 354	5 223	10 267	5 220	5 193	5 310	5 368	5 230	5 277	5 400	5 420	5 215
	5 230	5 248	5 248	5 314	5 207	5 289	5 245	5 330	5 454	5 650	5 415	5 396	5 545	5 622	5 461	5 398	5 271	10 388	5 295	5 211	5 384	5 445	5 260	5 330	5 454	5 465	5 248
	5 278	5 280	5 280	5 345	5 222	5 338	5 257	5 368	5 477	5 755	5 504	5 450	5 578	5 720	5 486	5 436	5 354	10 508	5 364	5 234	5 457	5 535	5 280	5 385	5 503	5 532	5 301
	5 345	5 315	5 326	5 380	5 243	5 400	5 278	5 433	5 518	5 920	5 546	5 460	5 613	5 790	5 518	5 477	5 418	10 593	5 410	5 257	5 528	5 587	5 318	5 425	5 546	5 615	5 338
	5 458	5 344	5 366	5 433	5 266	5 452	5 308	5 483	5 571		5 590	5 467	5 630	5 860	5 554	5 531	5 468	10 633	5 456	5 278	5 570	5 617	5 360	5 458	5 573	5 695	5 380
	5 583	5 365	5 408	5 504	5 290	5 504	5 345	5 538	5 628		5 622	5 470	5 660		5 597	5 594	5 550	10 683	5 503	5 293	5 585	5 637	5 388	5 492	5 609	5 775	5 448
	5 718	5 392	5 427	5 588	5 318	5 562	5 388	5 592	5 697		5 633	5 476	5 688		5 653	5 682	5 608	10 738	5 543	5 318	5 608	5 658	5 417	5 525	5 651	5 850	5 523
	5 792	5 418	5 446	5 688	5 350	5 638	5 435	5 642	5 791		5 640	5 480	5 757		5 720	5 788	5 665	10 830	5 601	5 350	5 635	5 678	5 448	5 558	5 688		5 597
	5 874	5 460	5 476	5 786	5 386	5 703	5 488	5 698	5 868		5 652	5 488	5 807		5 772	5 904	5 720		5 652	5 390	5 672	5 701	5 480	5 586	5 745		5 665
		5 500	5 514	5 848	5 432	5 762	5 533	5 755			5 665	5 490			5 815		5 790		5 712	5 430	5 735	5 718	5 505	5 608	5 836		5 750
		5 525	5 548		5 478	5 815	5 563	5 803			5 685	5 496					5 870		5 772	5 485	5 838	5 744	5 510	5 625			5 850
		5 545	5 567		5 534		5 597	5 848			5 708	5 500							5 850	5 538		5 790	5 525	5 638			
		5 578	5 578		5 590		5 635	5 890			5 730	5 510								5 567		5 836	5 530	5 653			
		5 630	5 594		5 650		5 675				5 755	5 517								10 583			10 534	5 665			
		5 690	5 605		5 720		5 722				5 785	5 535								10 596			10 538	5 678			
		5 760	5 625		5 788		5 770				5 810	5 552								10 610			10 542	5 689			
		5 835	5 654		5 858		5 820					5 570								10 620			20 549	5 699			
		5 900	5 688									5 585								10 632			20 560	10 708			
			5 733									5 600								10 641			20 575	20 718			
			5 792									5 620								10 653			20 589	20 718			
			5 851									5 645								10 663			10 605				
												5 680								10 677			5 616				
												5 740								10 691			5 625				
												5 790								10 710			10 649				
												5 810								10 732			10 675				
																				10 763			5 688				
																				10 801			5 704				
																							5 720				
																							5 734				
																							5 760				
																							5 796				
																							5 836				

D435

UK DCP Test Data Sheet																		
Project name	MUTHUAINI - MUNUNGAINI D435																	
Test number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Chainage (km)	0+020	0+050	1+100	0+150	PT1 PANEL A	PT2 PANEL A	PT3 PANEL A	PT4 PANEL A	PT5 PANEL A	PT1 PANEL B	PT2 PANEL B	PT3 PANEL B	PT4 PANEL B	PT5 PANEL B	0+400	0+450	0+500	0+550
Location	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY
Lane number																		
Offset (m)																		
Direction	LHS	CL	RHS	CL	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5	LHS	CL	RHS	CL
Zero error (mm)	69	66	68	68	70	70	68	74	80	78	81	77	69	79	81	79	71	74
Test date (dd/mm/yyyy)	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018	12/10/2018
Remarks																		
Layers removed	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Surface type	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Surface moisture	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Surface thickness (mm)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Surface condition	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Surface strength coefficient																		
Base type	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt	Neat Wethered Basalt
Base thickness (mm)	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Base condition	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Base strength coefficient																		

Test 1 Blows	Test 1 Depth (mm)	Test 2 Blows	Test 2 Depth (mm)	Test 3 Blows	Test 3 Depth (mm)	Test 4 Blows	Test 4 Depth (mm)	Test 5 Blows	Test 5 Depth (mm)	Test 6 Blows	Test 6 Depth (mm)	Test 7 Blows	Test 7 Depth (mm)	Test 8 Blows	Test 8 Depth (mm)	Test 9 Blows	Test 9 Depth (mm)
0	78	0	71	0	74	0	73	0	74	0	81	0	78	0	80	0	86
3	88	10	91	5	82	5	83	5	88	5	88	5	81	5	85	5	101
3	100	5	105	5	88	5	97	5	100	5	92	5	88	5	90	5	110
5	120	5	125	3	106	5	115	5	110	5	100	5	97	5	97	5	121
5	135	5	145	3	127	5	132	5	124	5	110	5	103	5	107	5	137
5	148	5	170	3	158	5	147	5	138	5	125	5	111	5	114	5	154
10	156	5	205	3	178	5	159	5	155	5	139	5	122	5	121	5	174

Test 10 Blows	Test 10 Depth (mm)	Test 11 Blows	Test 11 Depth (mm)	Test 12 Blows	Test 12 Depth (mm)	Test 13 Blows	Test 13 Depth (mm)	Test 14 Blows	Test 14 Depth (mm)	Test 15 Blows	Test 15 Depth (mm)	Test 16 Blows	Test 16 Depth (mm)	Test 17 Blows	Test 17 Depth (mm)	Test 18 Blows	Test 18 Depth (mm)
0	91	0	88	0	89	0	81	0	89	0	85	0	83	0	78	0	83
5	105	5	95	5	100	5	92	5	97	5	96	5	97	5	95	5	88
5	118	5	103	5	107	5	101	10	105	5	113	5	110	5	114	5	93
5	133	5	116	5	114	5	108	10	118	5	136	5	122	5	131	5	97
5	152	5	125	5	130	10	115	10	135	5	153	5	133	5	148	10	107
5	170	5	134	5	136	10	123	5	145	5	176	5	143	5	167	10	125
5	181	5	140	5	143	10	133	5	155	5	196	5	160	5	184	10	143

10	168	5	280	3	198	5	174	5	178	5	152	5	133	5	129	5	195	5	194	5	151	5	148	10	138	5	164	5	218	5	173	5	201	10	150
10	182	5	377	3	218	5	188	5	200	5	166	5	144	5	138	5	220	5	207	5	158	10	158	10	150	5	172	5	235	5	186	5	215	10	163
10	195	5	477	3	234	5	198	5	218	5	180	5	152	5	147	5	244	5	222	5	163	10	164	10	157	5	180	5	260	5	201	5	233	10	170
10	210	5	575	3	245	5	207	5	225	5	191	5	166	5	160	5	258	5	235	5	171	10	169	10	175	5	188	5	295	5	210	5	259	10	184
5	230	5	669	3	252	5	215	5	230	5	203	5	175	5	173	5	268	5	247	5	178	20	190	10	187	5	200	5	343	5	225	5	299	10	201
3	235	5	774	5	268	5	225	10	235	5	213	5	188	5	193	5	278	5	260	5	187	10	198	10	196	5	211	5	396	5	243	5	343	10	222
5	242	5	882	5	288	5	234	10	240	5	220	5	197	5	207	5	287	5	273	5	194	10	209	10	207	5	222	5	450	5	258	5	393	10	238
10	250	5	990	5	322	5	243	10	250	5	230	5	210	5	224	5	297	5	288	5	198	10	220	10	217	5	235	5	493	5	270	5	417	10	253
10	270			5	368	5	251	10	260	5	244	5	225	5	241	5	310	5	301	5	203	10	230	10	228	5	253	5	577	5	288	5	460	10	288
10	285			5	430	5	260	10	271	5	258	5	233	5	260	5	334	5	315	5	210	10	238	10	241	5	270	5	630	5	300	5	536	5	307
10	311			5	493	5	272	10	281	5	273	5	242	5	284	5	350	5	328	5	217	10	245	10	258	5	288	5	677	5	321	5	560	5	330
5	331			5	567	5	282	10	294	5	284	5	248	5	303	5	371	5	345	10	230	10	255	10	277	5	313	5	725	5	342	5	573	5	356
5	373			5	634	5	294	10	315	5	298	5	257	5	321	5	390	5	368	10	253	10	263	5	290	5	331	5	808	5	355	5	603	5	383
5	433			5	694	5	305	10	350	5	321	5	268	5	347	5	411	5	383	10	277	10	276	5	299	5	351			5	365	5	645	5	404
5	483			5	765	5	315	5	374	5	346	5	280	5	373	5	428	5	400	10	297	10	293	5	310	5	372			5	381	5	673	5	415
5	500			5	848	5	330	5	408	5	376	5	297	5	399	5	448	5	438	10	312	5	305	5	325	5	402			5	405	5	688	5	423
5	511					5	344	5	437	5	415	5	314	5	421	5	470	5	497	10	333	5	312	5	343	5	436			5	433	5	712	5	430
5	524					5	362	5	478	5	445	5	340	5	438	5	490	5	531	5	345	5	319	5	365	5	476			5	450	5	756	5	434
5	540					5	388	5	512	5	468	5	375	5	455	5	513	5	565	5	360	5	328	5	383	5	522			5	473	5	778	10	448
5	564					5	418	5	558	5	488	5	415	5	470	5	535	5	603	5	372	5	334	5	400	5	567			5	500	5	781	10	467
5	588					5	436	5	605	5	510	5	450	5	485	5	554	5	643	5	386	5	343	5	418	5	614			5	533	10	784	10	487
5	610					5	454	5	654	5	535	5	465	5	508	5	576	5	695	5	413	5	355	5	440	5	653			5	575		ROCK	10	524
5	628					5	470	5	705	5	554	5	480	5	525	5	598	5	756	5	441	5	371	5	463	5	686			5	627			5	541
5	658					5	490	5	730	5	567	5	492	5	540	5	622	5	854	5	465	5	387	5	496	5	728			5	650			5	558
5	688					5	509	5	755	5	594	5	504	5	558	5	648			5	480	5	417	5	535	5	779			5	674			5	574
5	721					5	531	5	780	5	627	5	515	5	575	5	680			5	497	5	429	5	583	5	846			5	692			5	587
5	755					5	554	5	824	5	667	5	531	5	595	5	710			5	513	5	448	5	625					5	720			5	598
5	804					5	580			5	695	5	550	5	636	5	751			5	527	5	468	5	654					5	735			5	613
						5	608			5	715	5	575	5	661	5	811			5	543	5	484	5	684					5	770			5	630
						5	638			5	730	5	593	5	688					5	565	5	500	5	712					5	811			5	650
						5	678			5	745	5	610	5	711					5	588	5	508	5	756									5	675
						5	724			5	767	5	631	5	745					5	611	10	517	5	800									5	696
						5	78			5	797	5	642	5	790					5	635	10	531											5	720
						5	832			5	837	5	651	5	860					5	650	10	557											5	738
												5	660							5	670	10	590											5	748
												5	666							5	690	5	607											5	750
												10	686							5	711	5	620											5	758
												5	700							5	738	5	635											5	768
												5	718							5	772	5	650											5	778
												5	740							5	818	5	665											5	788
												5	765									5	684											5	796
												5	795									5	703											5	804
												5	830									5	725												
																						5	754												

												5 794 5 835							

E511

Table 0.2

UK DCP Test Data Sheet																								
Project name	KANGARI - KINYONA E511																							
Test number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Chainage (km)	PT1 PANEL A	PT2 PANEL A	PT3 PANEL A	PT4 PANEL A	PT5 PANEL A	PT 1 PANEL B	PT 2 PANEL B	PT3 PANEL B	PT4 PANEL B	PT5 PANEL B	0+250	0+300	0+350	0+400	0+450	0+500	0+550	0+600	0+650	0+700	0+750	0+800	0+850	0+900
Location	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY	CARRIAGE WAY
Lane number																								
Offset (m)																								
Direction	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5	POINT 1	POINT 2	POINT 3	POINT 4	POINT 5	CL	RHS	CL	LHS	CL	RHS	CL	RHS	CL	RHS	CL	LHS	CL	LHS
Zero error (mm)	70	73	70	70	71	65	69	65	63	59	65	63	62	83	69	74	62	60	69	70	70	63	80	80
Test date (dd/mm/yyyy)	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018	11/10/2018
Remarks																								
Layers removed	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Surface type	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Surface moisture	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Surface thickness (mm)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Surface condition	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate	Modorate
Surface strength coefficient																								
Base type	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel	Neat Lateritic Gravel
Base thickness (mm)	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Base condition	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Base strength coefficient																								

Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)
0	75	0	80	0	76	0	76	0	78	0	73	0	74	0	72	0	65	0	69	0	71	0	70
5	90	5	92	5	78	5	82	5	85	5	79	5	82	5	83	5	78	5	80	5	89	5	85
5	105	5	98	5	86	5	91	5	95	5	85	5	87	5	90	5	85	5	87	5	100	5	101
5	124	5	110	5	92	5	93	5	105	5	90	5	94	5	99	5	97	5	98	5	118	5	122
5	148	5	125	5	105	5	105	5	120	5	96	5	101	5	109	5	108	5	113	5	140	5	144
5	172	5	143	5	114	5	120	5	136	5	115	5	109	5	123	5	115	5	135	5	162	5	165
5	192	5	156	5	127	5	131	5	152	5	124	5	120	5	139	5	126	5	157	5	182	5	188
5	218	5	169	5	144	5	144	5	165	5	135	5	132	5	150	5	137	5	178	5	201	5	218
5	236	5	182	5	156	5	156	5	172	5	150	5	145	5	160	5	149	5	205	5	215	5	250
5	283	5	195	5	174	5	167	5	180	5	160	5	156	5	173	5	159	5	236	5	223	5	289

Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)	Blows	Depth (mm)
0	67	0	92	0	77	0	80	0	70	0	65	0	70	0	75	0	80	0	71	0	80	0	83
5	79	5	105	5	90	5	87	5	80	5	80	5	80	5	80	5	90	5	85	5	90	5	94
5	87	5	138	5	100	5	92	5	85	5	100	5	87	5	85	5	98	5	92	5	100	5	100
5	100	5	170	5	125	5	102	5	92	5	120	5	92	5	95	5	105	5	100	5	109	5	113
5	118	5	206	5	147	5	112	5	100	5	142	5	97	5	105	5	121	5	115	5	115	5	128
5	135	5	250	5	166	5	130	5	105	5	170	5	105	5	117	5	133	5	125	5	123	5	143
5	163	5	290	5	185	5	142	5	115	5	200	5	112	5	121	5	143	5	143	5	130	5	160
5	185	5	310	5	207	5	160	5	123	5	240	5	120	5	148	5	158	5	165	5	144	5	183
5	209	5	320	5	228	5	175	5	134	5	288	5	129	5	161	5	170	5	183	5	156	5	203
5	228	5	332	5	250	5	193	5	144	5	305	5	137	5	176	5	185	5	200	5	168	5	220

	5	365	5	204	5	192	5	180	5	184	5	178	5	167	5	187	5	172	5	295	5	232	5	338	5	238	5	345	5	270	5	210	5	166	5	320	5	145	5	195	5	209	5	220	5	179	5	241
	5	494	5	209	5	215	5	195	5	185	5	190	5	177	5	203	5	184	5	345	5	238	5	398	5	250	5	364	5	293	5	237	5	170	5	332	5	156	5	213	5	226	5	238	5	191	5	253
	5	680	5	215	5	248	5	208	5	188	5	205	5	186	5	217	5	197	5	376	5	245	5	454	5	264	5	383	5	307	5	253	5	180	5	345	5	169	5	232	5	247	5	260	5	203	5	262
	5	903	5	225	5	264	5	215	5	192	5	218	5	195	5	236	5	211	5	405	5	251	5	507	5	280	5	430	5	322	5	275	5	182	5	365	5	184	5	248	5	276	5	292	5	216	5	274
			5	236	5	288	10	220	5	200	5	238	5	206	5	253	5	225	5	439	5	258	5	583	5	302	5	480	5	336	5	293	5	205	5	407	5	199	5	270	5	311	5	335	5	233	5	296
			5	247	5	303	10	225	5	210	5	252	5	219	5	272	5	238	5	500	5	268	5	685	5	330	5	550	5	355	5	320	5	216	5	525	5	215	5	305	5	353	5	402	5	250	5	343
			5	249	5	316	10	229	5	220	5	270	5	233	5	290	5	250	5	658	5	281	5	825	5	364	5	628	5	374	5	357	5	232	5	667	5	230	5	342	5	363	5	430	5	265	5	405
			5	253	5	338	10	232	5	225	5	290	5	250	5	306	5	260	5	883	5	294	5	1000	5	390	5	708	5	395	5	420	5	245	5	812	5	250	5	384	5	373	5	460	5	285	5	520
			5	255	5	354	10	239	5	234	5	310	5	262	5	325	5	273			5	326			5	421	5	816	5	410	5	515	5	255	5	972	5	265	5	450	5	398	5	485	5	309	5	643
			5	260	5	370	10	242	5	240	5	335	5	272	5	348	5	283			5	344			5	455	5	945	5	428	5	645	5	265			5	285	5	530	5	415	5	520	5	349	5	768
			5	266	5	390	10	250	5	250	5	364	5	287	5	388	5	289			5	366			5	495			5	440	5	780	5	277			5	305	5	665	5	438	5	555	5	389	5	915
			5	274	5	413	10	263	5	262	5	392	5	313	5	460	5	292			5	396			5	534			5	453	5	965	5	290			5	359	5	830	5	473	5	630	5	421		
			5	285	5	463	5	270	5	276	5	411	5	334	5	546	5	298			5	440			5	601			5	465			5	301			5	410	5	1030	5	515	5	740	5	440		
			5	320	5	560	5	281	5	294	5	432	10	336	5	645	5	300			5	514			5	665			5	484			5	320			5	480			5	552	5	880	5	456		
			5	400	5	664	5	295	5	320	5	480	10	340	5	766	20	311			5	634			5	730			5	508			5	333			5	554			5	632	5	1050	5	480		
			5	545	5	794	5	300	5	354	5	584	10	342	5	910	30	328			5	778			5	804			5	545			5	349			5	652			5	720			5	510		
			5	720	5	958	5	309	5	435	5	728	10	348			30	340			5	983			5	878			5	625			5	365			5	785			5	926			5	555		
			5	888			5	325	5	560	5	905		ROCK			30	370							5	955			5	796			5	377			5	950							5	610		
							5	350	5	700							10	390											5	1067			5	391											5	691		
							5	405	5	840							5	425															5	400											5	800		
							5	492	5	1035							5	510															5	409											5	910		
							5	612									5	610															5	417														
							5	738									5	761															5	426														
							5	880									5	906															5	435														
							5	1050																									5	440														
																																	10	450														
																																	10	459														
																																	10	466														
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																																	10	501														
																																	5	517														
																																	5	539														
																																	5	589														
																																	5	642														
																																	5	705														
																																	5	770														
																																	5	830														
																																	5	898														
																																	5	970														

ANALYSIS OUTPUT

D379

Averages from	Weighted Average
Percentiles from	Normal Distribution

DCP Test Point nr	DCP Test Point Name	Survey date	Chainage (km)	Road Side	Distance (m) from centre line (CL)	DSN450 (Blows)	DSN800 (Blows)	Ratio (%)	Weighted Average DCP Number, DN in mm/blow											
									0-150 mm			151-300 mm			301-450 mm			451-800 mm		
									20P	Mean	80P	20P	Mean	80P	20P	Mean	80P	20P	Mean	80P
1	Test 1	10/10/2018	0.015	CL	2.5	92	117	79	2.750	3.300	3.840	5.650	6.940	8.240	5.540	6.950	8.350	12.430	14.960	17.490
2	Test 2	10/10/2018	0.015	CL	1.2	170	201	85	1.780	2.150	2.520	1.760	2.440	3.120	4.550	5.080	5.610	9.390	12.880	16.370
3	Test 3	10/10/2018	0.015	LHS	0	154	184	84	2.430	3.080	3.720	1.810	2.240	2.680	4.180	5.370	6.570	9.830	12.750	15.680
4	Test 4	10/10/2018	0.015	RHS	1.2	141	151	93	1.900	2.340	2.790	2.540	3.070	3.590	2.750	12.480	22.210	30.410	32.920	35.430
5	Test 5	10/10/2018	0.015	RHS	2.5	70	80	87	3.130	4.430	5.730	6.800	7.910	9.030	12.590	15.260	17.920	28.730	34.300	39.870
6	Test 6	10/10/2018	0.185	CL	2.5	151	182	83	1.410	1.960	2.520	3.200	4.060	4.930	5.610	6.100	6.590	9.840	12.300	14.760
7	Test 7	10/10/2018	0.185	CL	1.2	155	174	89	1.750	2.090	2.420	2.290	2.700	3.110	5.240	7.400	9.560	16.000	18.680	21.360
8	Test 8	10/10/2018	0.185	LHS	0	155	179	87	1.450	1.800	2.150	2.670	3.460	4.250	6.570	7.710	8.840	13.050	15.770	18.490
9	Test 9	10/10/2018	0.185	RHS	1.2	131	154	85	1.940	2.580	3.220	2.970	3.550	4.130	5.840	7.000	8.160	13.010	16.550	20.090
10	Test 10	10/10/2018	0.185	RHS	2.5	71	83	85	3.610	4.360	5.110	5.120	6.610	8.100	11.870	14.730	17.590	24.410	29.760	35.110
11	Test 11	10/10/2018	0.25	RHS	0	90	102	88	2.650	3.500	4.360	5.870	6.750	7.630	4.920	9.060	13.210	26.220	28.930	31.650
12	Test 12	10/10/2018	0.3	LHS	0	156	196	79	1.870	2.700	3.530	2.620	3.240	3.850	3.030	4.030	5.030	7.550	9.060	10.580
13	Test 13	10/10/2018	0.35	CL	0	102	117	87	2.720	3.130	3.530	3.710	4.460	5.200	7.470	9.890	12.310	19.270	25.500	31.730
							Average		2.261	2.878	3.495	3.616	4.418	5.220	6.166	8.543	10.919	16.934	20.335	23.739

Table 0.3

Averages from	Weighted Average
Percentiles from	Normal Distribution

Pavement Layer (mm)	Required DN value for TLC 0.01	Section no. 1 0.015 to 0.35 km
0-150	<= 8 (9)	3.2 (80P)
150-300	<= 19 (22)	4.9 (80P)
300-450	<= 33 (35)	11 (80P)
450-800	<= 50	23 (80P)

- Inadequate (non-compliance) in situ layer
- Adequate (marginal compliance) in situ layer(s) that need to be improved
- Adequate (full compliance) in situ layer(s)

D382

Averages from	Weighted Average
Percentiles from	Normal Distribution

DCP Test Point nr	DCP Test Point Name	Survey date	Chainage (km)	Road Side	Distance (m) from centre line (CL)	DSN450 (Blows)	DSN800 (Blows)	Ratio (%)	Weighted Average DCP Number, DN in mm/blow: 0-150 mm 20P	Mean	80P	151-300 mm 20P	Mean	80P	301-450 mm 20P	Mean	80P	451-600 mm 20P	Mean	80P	601-800 mm 20P	Mean	80P
1	Test 1	13/10/2018	0	LHS	0	57	75	77	3.100	4.180	5.250	10.030	14.110	18.190	22.710	23.720	24.730	25.450	26.270	27.080	14.060	17.930	21.790
2	Test 2	13/10/2018	0.05	RHS	0	85	118	72	3.620	4.290	4.950	5.180	5.920	6.660	5.490	6.800	8.120	7.040	9.350	11.660	13.270	14.040	14.810
3	Test 3	13/10/2018	0.1	CL	0	82	137	60	3.440	4.140	4.840	6.900	7.890	8.870	4.940	6.340	7.740	3.370	4.790	6.220	9.960	11.070	12.180
4	Test 4	13/10/2018	0.15	RHS	0	61	82	75	5.020	5.720	6.420	6.020	6.510	7.010	11.480	13.380	15.280	17.450	18.760	20.080	13.190	16.230	19.270
5	Test 5	13/10/2018	0.2	CL	0	89	116	77	2.960	3.400	3.840	4.690	5.550	6.410	8.640	9.630	10.610	11.150	11.950	12.750	13.700	13.860	14.020
6	Test 6	13/10/2018	0.25	RHS	0	62	90	68	3.870	4.820	5.770	8.600	9.980	11.360	10.240	10.890	11.530	12.530	13.800	15.060	10.540	11.250	11.970
7	Test 7	13/10/2018	0.3	LHS	0	78	120	66	3.740	6.010	8.280	4.150	5.900	7.650	9.030	9.650	10.270	6.570	7.290	8.020	9.480	9.740	10.010
8	Test 8	13/10/2018	0.35	RHS	0	58	92	63	4.370	5.630	6.890	8.460	9.700	10.940	10.390	11.510	12.620	10.240	10.630	11.030	9.110	10.070	11.030
9	Test 9	13/10/2018	0.4	RHS	0	51	76	68	6.400	8.990	11.570	16.100	17.840	19.590	5.490	11.020	16.540	10.980	12.120	13.260	15.370	16.900	18.440
10	Test 10	13/10/2018	0.415	CL	2.7	34	48	71	7.300	8.740	10.180	13.550	16.830	20.120	21.560	21.800	22.040	21.960	22.600	23.240	23.250	28.200	33.150
11	Test 11	13/10/2018	0.415	CL	1.5	47	123	39	4.740	8.240	11.740	7.870	11.680	15.480	12.770	15.520	18.270	3.730	6.030	8.340	4.560	4.990	5.420
12	Test 12	13/10/2018	0.415	LHS	0	101	170	59	4.920	6.160	7.400	11.180	14.280	17.380	2.450	7.320	12.200	3.170	4.330	5.490	5.080	8.040	10.990
13	Test 13	13/10/2018	0.415	RHS	1.5	39	82	48	5.690	7.670	9.650	13.130	16.490	19.850	17.090	20.030	22.960	4.320	6.900	9.470	9.460	11.180	12.900
14	Test 14	13/10/2018	0.415	RHS	2.7	35	56	63	5.850	7.850	9.850	16.060	18.240	20.420	21.330	22.090	22.840	19.730	20.060	20.390	13.180	14.950	16.720
15	Test 15	13/10/2018	0.58	CL	2.7	50	86	59	5.070	6.730	8.400	13.800	14.870	15.950	7.900	13.200	18.490	8.250	10.000	11.750	8.540	10.150	11.750
16	Test 16	13/10/2018	0.58	CL	1.5	54	73	74	5.690	7.860	10.040	9.100	12.630	16.170	7.890	9.010	10.140	13.230	15.360	17.500	21.040	22.030	23.010
17	Test 17	13/10/2018	0.58	LHS	0	58	85	69	3.660	4.450	5.230	11.240	13.900	16.560	10.940	13.210	15.490	10.740	12.320	13.900	12.520	14.150	15.780
18	Test 18	13/10/2018	0.58	RHS	1.5	76	129	59	2.410	3.540	4.670	8.240	10.430	12.620	10.770	11.660	12.550	4.660	6.370	8.080	6.480	7.970	9.460
19	Test 19	13/10/2018	0.58	RHS	2.7	62	91	68	3.290	5.100	6.920	13.130	14.180	15.230	8.760	9.120	9.470	9.550	10.650	11.740	12.270	13.780	15.300
20	Test 20	13/10/2018	0.6	RHS	0	88	253	35	3.050	3.830	4.600	4.090	5.310	6.530	8.550	9.720	10.900	0.500	3.190	5.880	2.350	3.090	3.840
21	Test 21	13/10/2018	0.65	CL	0	50	87	58	4.080	7.540	11.000	15.080	16.260	17.430	13.410	14.250	15.080	4.790	6.770	8.750	15.510	18.480	21.450
22	Test 22	13/10/2018	0.7	RHS	0	44	99	45	5.870	8.250	10.630	8.360	12.250	16.140	15.750	16.840	17.930	4.230	7.300	10.370	5.780	7.660	9.540
23	Test 23	13/10/2018	0.75	CL	0	93	285	33	3.630	5.060	6.490	5.500	6.760	8.020	4.130	5.330	6.520	0.840	1.570	2.300	4.300	6.090	7.880
24	Test 24	13/10/2018	0.8	RHS	0	64	447	14	4.710	5.760	6.810	8.620	9.830	11.030	6.350	7.490	8.620	3.250	4.580	5.910	0.250	0.780	1.310
25	Test 25	13/10/2018	0.85	CL	0	47	82	58	4.630	7.810	10.980	16.670	18.760	20.860	9.090	10.870	12.650	6.510	7.430	8.360	12.520	15.610	18.710
26	Test 26	13/10/2018	0.9	RHS	0	44	66	67	5.130	8.750	12.360	13.330	15.970	18.620	9.790	11.330	12.860	15.540	16.180	16.810	15.090	15.510	15.930
27	Test 27	13/10/2018	0.95	CL	0	65	86	76	3.370	5.030	6.690	7.410	8.690	9.970	13.450	14.270	15.090	13.630	14.450	15.270	17.710	18.920	20.130
								Average	4.430	6.131	7.831	9.870	11.880	13.891	10.755	12.444	14.131	9.386	10.780	12.174	11.058	12.691	14.326

Averages from	Weighted Average
Percentiles from	Normal Distribution

Pavement Layer (mm)	**Required DN value for TLC 0.01**	**Section no.**
		1
		0 to 0.95 km
0-150	<= 8 (9)	7.3 (80P)
150-300	<= 19 (22)	12 (80P)
300-450	<= 33 (35)	13 (80P)
450-600	<= 40	11 (80P)
600-800	<= 50	13 (80P)

Inadequate (non-compliance) in situ layer

Adequate (marginal compliance) in situ layer(s) that need to be improved

Adequate (full compliance) in situ layer(s)

D435

Averages from	Weighted Average
Percentiles from	Normal Distribution

DCP Test Point nr	DCP Test Point Name	Survey date	Chainage (km)	Road Side	Distance (m) from centre line (CL)	DSN450 (Blows)	DSN800 (Blows)	Ratio (%)	Weighted Average DCP Number, DN in mm/blow														
									0-150 mm			151-300 mm			301-450 mm			451-600 mm			601-800 mm		
									20P	Mean	80P	20P	Mean	80P	20P	Mean	80P	20P	Mean	80P	20P	Mean	80P
1	Test 1	12/10/2018	0.02	CL	0	160	216	74	1.600	2.610	3.620	1.710	4.370	7.030	5.340	8.590	11.840	4.080	4.870	5.660	7.260	8.570	9.890
2	Test 2	12/10/2018	0.05	LHS	0	52	69	75	2.610	5.660	8.710	15.860	17.670	19.480	19.690	19.860	20.030	18.750	19.120	19.490	21.040	21.290	21.540
3	Test 3	12/10/2018	0.1	RHS	0	69	93	74	4.880	6.850	8.820	4.220	6.470	8.720	12.190	12.980	13.770	12.550	13.430	14.310	13.970	15.290	16.600
4	Test 4	12/10/2018	0.15	LHS	0	158	204	78	2.180	2.700	3.220	1.830	2.620	3.410	3.530	4.350	5.170	4.920	5.950	6.990	9.410	10.230	11.050
5	Test 5	12/10/2018	0.21	CL	2.7	171	215	79	2.560	3.330	4.110	1.110	2.350	3.580	6.320	7.180	8.040	9.310	9.590	9.870	5.850	7.590	9.330
6	Test 6	12/10/2018	0.21	CL	1.5	139	205	68	1.850	2.320	2.790	2.980	4.230	5.470	4.400	5.550	6.710	4.490	5.920	7.350	4.360	5.990	7.610
7	Test 7	12/10/2018	0.21	LHS	0	164	256	64	1.670	2.150	2.620	2.400	4.140	5.880	2.980	5.030	7.070	2.410	3.370	4.330	4.190	5.510	6.830
8	Test 8	12/10/2018	0.21	RHS	1.5	146	201	73	1.680	2.460	3.250	3.850	4.460	5.060	3.210	3.870	4.520	3.700	5.310	6.920	7.150	10.230	13.300
9	Test 9	12/10/2018	0.21	RHS	2.7	130	181	72	2.950	3.760	4.570	2.420	3.330	4.230	3.870	4.160	4.460	4.290	5.020	5.750	8.610	10.500	12.390
10	Test 10	12/10/2018	0.38	CL	2.7	121	151	80	2.520	2.930	3.350	2.550	3.130	3.710	6.560	8.770	10.970	7.320	8.470	9.630	14.190	17.160	20.130
11	Test 11	12/10/2018	0.38	CL	1.5	203	267	76	1.260	1.640	2.030	1.890	2.340	2.790	3.300	4.240	5.180	3.780	4.240	4.700	6.110	7.700	9.300
12	Test 12	12/10/2018	0.38	LHS	0	288	366	79	0.730	1.350	1.970	1.200	1.980	2.770	2.120	3.420	4.720	2.830	3.160	3.480	5.740	7.090	8.430
13	Test 13	12/10/2018	0.38	RHS	1.5	229	274	84	0.870	1.240	1.620	1.930	2.780	3.620	4.080	5.490	6.890	6.500	7.830	9.160	7.350	8.310	9.270
14	Test 14	12/10/2018	0.38	RHS	2.7	141	178	80	1.460	1.900	2.340	3.530	4.220	4.910	7.100	8.040	8.970	7.360	8.270	9.190	9.870	11.610	13.350
15	Test 15	12/10/2018	0.4	CL	0	72	99	73	3.320	3.910	4.490	6.780	8.510	10.230	9.120	11.830	14.550	9.300	11.910	14.510	12.840	15.200	17.560
16	Test 16	12/10/2018	0.45	LHS	0	135	188	72	2.310	2.710	3.110	2.660	3.300	3.930	4.460	5.260	6.070	5.500	7.650	9.790	5.620	7.030	8.440
17	Test 17	12/10/2018	0.5	RHS	0	79	453	18	3.230	3.460	3.690	6.580	8.070	9.560	7.770	11.120	14.480	4.200	6.500	8.800	0.440	3.300	6.160
18	Test 18	12/10/2018	0.55	LHS	0	222	369	60	1.130	1.500	1.860	3.040	4.080	5.120	1.770	2.680	3.580	2.890	3.570	4.260	1.390	2.400	3.410
							Average		2.156	2.916	3.676	3.697	4.892	6.083	5.989	7.357	8.723	6.343	7.454	8.566	8.077	9.722	11.366

Averages from	Weighted Average
Percentiles from	Normal Distribution

Pavement Layer (mm)	Required DN value for TLC 0.01	Section no. 1 0.02 to 0.55 km
0-150	<= 8 (9)	3.2 (80P)
150-300	<= 19 (22)	5.9 (80P)
300-450	<= 33 (35)	7.5 (80P)
450-600	<= 40	7.6 (80P)
600-800	<= 50	11 (80P)

Legend	
(pink)	Inadequate (non-compliance) in situ layer
(orange)	Adequate (marginal compliance) in situ layer(s) that need to be improved
(green)	Adequate (full compliance) in situ layer(s)

E511

Averages from	Weighted Average
Percentiles from	Normal Distribution

DCP Test Point nr	DCP Test Point Name	Survey date	Chainage (km)	Road Side	Distance (m) from centre line (CL)	DSN450 (Blows)	DSN800 (Blows)	Ratio (%)	Weighted Average DCP Number, DN in mm/blow											
									0-150 mm			151-300 mm			301-450 mm			451-800 mm		
									20P	Mean	80P	20P	Mean	80P	20P	Mean	80P	20P	Mean	80P
1	Test 1	11/10/2018	0.01	CL	2.7	55	64	87	3.560	4.220	4.880	9.520	13.890	18.270	24.270	28.160	32.050	38.230	41.320	44.410
2	Test 2	11/10/2018	0.01	CL	1.5	124	134	92	1.910	2.460	3.020	3.290	8.640	13.990	23.540	27.270	30.990	33.030	34.100	35.180
3	Test 3	11/10/2018	0.01	LHS	0	113	127	89	2.200	3.330	4.460	3.030	4.090	5.150	7.340	12.560	17.780	21.390	25.410	29.420
4	Test 4	11/10/2018	0.01	RHS	1.5	191	204	93	1.640	2.250	2.850	0.940	3.920	6.900	14.110	17.660	21.210	24.600	26.170	27.730
5	Test 5	11/10/2018	0.01	RHS	2.7	133	145	92	1.500	2.170	2.840	2.200	6.170	10.150	18.060	21.660	25.260	25.870	28.920	31.970
6	Test 6	11/10/2018	0.18	CL	2.7	122	134	91	1.890	2.640	3.400	3.650	4.450	5.250	5.170	10.810	16.460	25.740	30.140	34.540
7	Test 7	11/10/2018	0.18	CL	1.5	443	1026	43	1.700	2.070	2.440	1.420	2.810	4.210	0.600	0.600	0.600	0.600	0.600	0.600
8	Test 8	11/10/2018	0.18	LHS	0	108	123	88	2.110	2.580	3.050	3.120	4.460	5.810	12.580	14.870	17.160	20.600	23.870	27.140
9	Test 9	11/10/2018	0.18	RHS	1.5	245	258	95	2.020	2.340	2.650	0.780	1.510	2.250	6.940	12.230	17.530	23.420	27.070	30.730
10	Test 10	11/10/2018	0.18	RHS	2.7	75	84	89	3.010	4.120	5.230	7.760	9.670	11.570	5.180	11.920	18.650	34.160	39.680	45.190
11	Test 11	11/10/2018	0.25	LHS	0	115	127	91	3.020	3.660	4.290	2.010	3.580	5.150	8.270	12.000	15.730	24.900	30.490	36.080
12	Test 12	11/10/2018	0.3	RHS	0	65	81	81	3.640	4.450	5.270	7.420	9.070	10.720	10.430	11.480	12.530	19.090	24.380	29.670
13	Test 13	11/10/2018	0.35	LHS	0	102	129	80	3.000	3.980	4.960	3.160	4.540	5.920	6.060	6.900	7.740	12.190	13.490	14.790
14	Test 14	11/10/2018	0.4	CL	0	74	92	80	5.530	6.880	8.230	3.080	5.210	7.350	9.720	11.500	13.280	16.270	19.720	23.170
15	Test 15	11/10/2018	0.45	LHS	0	122	136	90	3.320	4.010	4.690	3.240	3.780	4.320	2.760	4.030	5.300	21.260	33.290	45.320
16	Test 16	11/10/2018	0.5	RHS	0	90	102	88	2.310	3.260	4.210	3.870	6.400	8.930	14.750	17.990	21.240	25.540	29.530	33.520
17	Test 17	11/10/2018	0.55	LHS	0	245	277	88	1.520	2.620	3.720	2.320	2.800	3.270	1.060	1.810	2.560	9.810	11.570	13.320
18	Test 18	11/10/2018	0.6	RHS	0	74	86	86	3.900	5.060	6.210	3.510	6.040	8.580	13.590	19.340	25.100	27.770	29.060	30.340
19	Test 19	11/10/2018	0.65	LHS	0	117	132	89	1.600	2.210	2.810	3.800	6.740	9.670	11.650	13.200	14.750	20.090	25.050	30.010
20	Test 20	11/10/2018	0.7	RHS	0	94	106	89	2.160	3.260	4.370	4.960	6.470	7.980	12.610	14.310	16.010	27.440	31.340	35.250
21	Test 21	11/10/2018	0.75	LHS	0	112	128	87	2.170	3.010	3.850	4.320	6.080	7.850	4.940	6.420	7.890	16.540	27.380	38.220
22	Test 22	11/10/2018	0.8	CL	0	95	114	83	2.580	3.300	4.020	5.210	8.100	10.990	4.940	7.530	10.110	15.630	21.290	26.950
23	Test 23	11/10/2018	0.85	LHS	0	127	148	86	1.850	2.310	2.760	4.070	5.840	7.620	4.350	5.840	7.330	13.960	17.940	21.920
24	Test 24	11/10/2018	0.9	CL	0	85	98	86	2.700	3.410	4.120	4.280	7.610	10.940	18.350	21.580	24.810	24.500	26.320	28.140
							Average		2.535	3.317	4.097	3.790	5.911	8.035	10.053	12.986	15.920	21.776	25.755	29.734

Averages from	Weighted Average
Percentiles from	Normal Distribution

Pavement Layer (mm)	**Required DN value for TLC 0.01**	**Section no.**
		1
		0.01 to 0.9 km
0-150	<= 8 (9)	3.8 (80P)
150-300	<= 19 (22)	7.1 (80P)
300-450	<= 33 (35)	15 (80P)
450-800	<= 50	29 (80P)

(pink)	Inadequate (non-compliance) in situ layer
(orange)	Adequate (marginal compliance) in situ layer(s) that need to be improved
(green)	Adequate (full compliance) in situ layer(s)

ANNEX 4: RUT DEPTH DATA

D379

MATERIALS TESTING AND RESEARCH DIVISION CENTRAL LABORATORIES				
RUT DEPTH DATA				
ROAD NAME	WAMWANGI - KARATU D379			
TEST DONE BY:	MTRD STAFF		Date :	10/10/2018
LENGTH OF STRAIGHT EDGE USED:		3.0M		
CHAINAGE	LEFT HAND SIDE LANE		RIGHT HAND SIDE LANE	
	OWP	IWP	IWP	OWP
0+000	11	5	3	11
0+025	20	3	6	8
0+040	13	3	6	8
0+055	13	3	0	5
0+070	10	6	8	8
0+085	6	11	3	3
0+100	8	0	2	2
0+115	4	8	2	5
0+130	6	8	0	8
0+145	3	6	0	8
0+160	4	4	3	8
0+175	0	0	8	9
0+200	8	0	4	6
0+250	5	10	0	3
0+300	8	7	15	2
0+350	5	9	20	0

D382

MATERIALS TESTING AND RESEARCH DIVISION CENTRAL LABORATORIES				
RUT DEPTH DATA				
ROAD NAME	LORD - KONA BAHATI, D382			
TEST DONE BY:	MTRD STAFF		Date :	13.10.18
LENGTH OF STRAIGHT EDGE USED:		3.0M		
CHAINAGE	LEFT HAND SIDE LANE		RIGHT HAND SIDE LANE	
	OWP	IWP	IWP	OWP
0+000	10	0	15	10
0+050	20	10	0	0
0+100	0	10	15	8
0+150	15	0	13	13
0+200	7	0	6	3
0+250	13	11	0	3
0+300	13	0	0	11
0+350	11	6	8	8
0+400	15	8	7	21
0+425	35	8	6	40
0+440	30	18	15	31
0+455	20	14	8	5
0+470	13	4	10	18
0+485	15	0	0	20
0+500	15	0	0	10
0+515	23	10	5	13
0+530	32	13	12	10
0+545	32	14	7	10
0+560	23	10	8	9
0+575	28	12	11	14
0+600	23	10	5	5
0+650	23	0	8	13
0+700	20	8	10	0
0+750	17	12	10	6
0+800	18	9	14	13
0+850	47	13	0	11
0+900	23	0	10	20
0+950	23	13	8	20

D435

MATERIALS TESTING AND RESEARCH DIVISION CENTRAL LABORATORIES				
RUT DEPTH DATA				
ROAD NAME	MUTHUAINIO - MUNUNGAINI D435			
TEST DONE BY:	MTRD STAFF		Date :	12.10.18
LENGTH OF STRAIGHT EDGE USED:		3.0M		
CHAINAGE	LEFT HAND SIDE LANE		RIGHT HAND SIDE LANE	
	OWP	IWP	IWP	OWP
0+000	6	14	10	20
0+050	15	10	8	10
0+100	4	10	5	5
0+150	6	5	0	8
0+200	20	0	12	16
0+225	8	12	8	6
0+240	0	0	12	0
0+255	8	0	10	0
0+270	10	0	8	15
0+285	6	0	9	7
0+300	14	0	4	0
0+315	10	5	6	0
0+330	9	4	15	0
0+345	13	5	9	0
0+360	0	0	10	9
0+375	10	11	10	4
0+400	11	0	40	25
0+450	6	0	10	10
0+500	0	0	0	5

0+550	0	0	8	0

E511

MATERIALS TESTING AND RESEARCH DIVISION CENTRAL LABORATORIES				
RUT DEPTH DATA				
ROAD NAME	KANGARI - KINYONA,E511			
TEST DONE BY:	MTRD STAFF		Date :	10/10/2018
LENGTH OF STRAIGHT EDGE USED:		3.0M		
CHAINAGE	LEFT HAND SIDE LANE		RIGHT HAND SIDE LANE	
	OWP	IWP	IWP	OWP
0+000	3	5	0	6
0+025	6	5	3	5
0+040	5	4	3	10
0+055	4	15	2	0
0+070	15	5	8	7
0+085	23	2	2	10
0+100	7	10	3	8
0+115	8	0	10	5
0+130	5	8	5	35
0+145	0	0	0	2
0+160	8	6	6	6
0+175	0	5	3	2
0+200	2	2	10	5
0+250	0	0	2	8
0+300	15	0	0	6
0+350	35	8	0	8
0+400	15	8	3	10
0+450	8	15	4	13
0+500	15	13	0	8
0+550	20	6	0	30
0+600	0	0	0	20
0+650	8	2	4	8
0+700	16	10	4	10
0+750	6	4	3	10
0+800	3	3	0	10
0+850	7	0	8	0
0+900	20	5	6	6

ANNEX 5: ROUGHNESS

DATA

ROAD NAME	RID	DISTANCE	IRI	LATITUDE	LONGITUDE	ALTITUDE	SPEED
Total - Kona Mbaya Road	D382	0	10.1	-0.00228	36.34462	2398.884	4.8
Total - Kona Mbaya Road	D382	200	8	-0.00409	36.34493	2397.072	43
Total - Kona Mbaya Road	D382	300	6.6	-0.00494	36.34522	2398.017	44
Total - Kona Mbaya Road	D382	700	6.5	-0.00526	36.34526	2399.082	51.6
Total - Kona Mbaya Road	D382	800	6.8	-0.0044	36.34501	2401.384	42.5
Total - Kona Mbaya Road	D382	0	10.1	-0.00228	36.34462	2398.884	4.8
Total - Kona Mbaya Road	D382	0	10.1	-0.00228	36.34462	2398.884	4.8
Total - Kona Mbaya Road	D382	0	6.2	-0.01155	36.34414	2393.918	0
Total - Kona Mbaya Road	D382	100	10.1	-0.00321	36.34468	2400.637	24.5
Total - Kona Mbaya Road	D382	100	6.2	-0.01063	36.34448	2389.401	52
Total - Kona Mbaya Road	D382	200	8	-0.00409	36.34493	2397.072	43
Total - Kona Mbaya Road	D382	200	8	-0.00409	36.34493	2397.072	43
Total - Kona Mbaya Road	D382	200	5.6	-0.00974	36.34469	2388.906	58.4
Total - Kona Mbaya Road	D382	300	6.6	-0.00494	36.34522	2398.017	44
Total - Kona Mbaya Road	D382	300	6.6	-0.00494	36.34522	2398.017	44
Total - Kona Mbaya Road	D382	300	6.5	-0.00886	36.34487	2391.509	52.3
Total - Kona Mbaya Road	D382	400	6.8	-0.00584	36.3453	2395.455	51
Total - Kona Mbaya Road	D382	400	9.3	-0.00797	36.34503	2395.145	40.7
Total - Kona Mbaya Road	D382	500	11.5	-0.00674	36.34521	2388.086	50.6
Total - Kona Mbaya Road	D382	500	14.8	-0.00708	36.34515	2391.841	19
Total - Kona Mbaya Road	D382	600	11.5	-0.00763	36.34509	2389.514	46.4
Total - Kona Mbaya Road	D382	600	12.2	-0.00616	36.34525	2396.673	48.8
Total - Kona Mbaya Road	D382	700	6.5	-0.00526	36.34526	2399.082	51.6
Total - Kona Mbaya Road	D382	700	6.2	-0.00855	36.34494	2386.535	51.4
Total - Kona Mbaya Road	D382	700	6.5	-0.00526	36.34526	2399.082	51.6
Total - Kona Mbaya Road	D382	800	6.8	-0.0044	36.34501	2401.384	42.5
Total - Kona Mbaya Road	D382	800	6.1	-0.00943	36.34479	2386.682	53
Total - Kona Mbaya Road	D382	800	6.8	-0.0044	36.34501	2401.384	42.5
Total - Kona Mbaya Road	D382	900	10.5	-0.00347	36.34473	2402.766	7
Total - Kona Mbaya Road	D382	900	6.1	-0.01031	36.3446	2387.29	61
Total - Kona Mbaya Road	D382	1000	6.8	-0.01123	36.34437	2392.256	6.3
Kangari - Kinyona	E511	0	6.8	-0.77133	36.84013	2162.551	9.4
Kangari - Kinyona	E511	0	11.8	-0.76795	36.83358	2100.296	4.9
Kangari - Kinyona	E511	0	6.8	-0.77133	36.84013	2162.551	9.4
Kangari - Kinyona	E511	0	11.8	-0.76795	36.83358	2100.296	4.9
Kangari - Kinyona	E511	100	6.8	-0.77082	36.83936	2157.301	52.6

Kangari - Kinyona	E511	100	6.8	-0.77082	36.83936	2157.301	52.6
Kangari - Kinyona	E511	100	11.8	-0.76857	36.83408	2105.137	26.3
Kangari - Kinyona	E511	200	3.5	-0.77041	36.83854	2155.394	51.7
Kangari - Kinyona	E511	200	9.9	-0.76874	36.83473	2109.158	43.8
Kangari - Kinyona	E511	300	3.5	-0.76961	36.83818	2153.988	43.7
Kangari - Kinyona	E511	300	3.9	-0.769	36.8356	2113.066	55.4
Kangari - Kinyona	E511	400	4.2	-0.76905	36.83749	2150.053	48.3
Kangari - Kinyona	E511	400	4	-0.76917	36.83652	2117.203	60.6
Kangari - Kinyona	E511	500	4.3	-0.76916	36.83661	2142.104	57.8
Kangari - Kinyona	E511	500	3.6	-0.76906	36.8374	2125.506	46.2
Kangari - Kinyona	E511	600	3.1	-0.76903	36.83574	2133.227	60.8
Kangari - Kinyona	E511	600	3.1	-0.76955	36.83813	2135.968	49.1
Kangari - Kinyona	E511	700	4.6	-0.76873	36.83494	2128.779	52.1
Kangari - Kinyona	E511	700	3.2	-0.77035	36.83848	2146.881	50.9
Kangari - Kinyona	E511	800	3.8	-0.77081	36.83936	2153.327	16.4
Kangari - Kinyona	E511	800	5.8	-0.76885	36.83411	2120.627	31.9
Kangari - Kinyona	E511	800	3.8	-0.77081	36.83936	2153.327	16.4
Kangari - Kinyona	E511	900	5.9	-0.76804	36.83377	2109.634	9.7
Kangari - Kinyona	E511	900	5.9	-0.76804	36.83377	2109.634	9.7
Kangari - Kinyona	E511	920	11.8	-0.76795	36.83358	2100.296	4.9
Kangari - Kinyona	E511	900	5.9	-0.76804	36.83377	2109.634	9.7
Mairi-Karega- Kaharati	C540	0	6.8	-0.77133	36.84013	2162.551	9.4
Mairi-Karega- Kaharati	C540	100	6.8	-0.77082	36.83936	2157.301	52.6
Mairi-Karega- Kaharati	C540	800	3.8	-0.77081	36.83936	2153.327	16.4
Ngano-Ngano	G23263	0	6.7	-0.10849	36.27628	2730.887	0
Ngano-Ngano	G23263	500	10.3	-0.10852	36.27708	2719.253	10
Sambugo-Kianjata	D1317	0	5.7	-0.10853	36.28169	2694.089	0
Sambugo-Kianjata	D1317	0	6.7	-0.10849	36.27628	2730.887	0
Sambugo-Kianjata	D1317	0	6.7	-0.10849	36.27628	2730.887	0
Sambugo-Kianjata	D1317	100	5.7	-0.10852	36.28076	2696.445	47.9
Sambugo-Kianjata	D1317	100	6.7	-0.10848	36.27724	2723.441	43.5
Sambugo-Kianjata	D1317	200	6.3	-0.10851	36.27986	2700.659	48.7
Sambugo-Kianjata	D1317	200	10.1	-0.10847	36.27813	2716.717	36.7
Sambugo-Kianjata	D1317	300	8.1	-0.10851	36.27897	2706.144	36
Sambugo-Kianjata	D1317	300	17.2	-0.10845	36.27901	2712.63	33.9
Sambugo-Kianjata	D1317	400	11.3	-0.10852	36.27807	2713.92	36.7
Sambugo-Kianjata	D1317	400	13.3	-0.10849	36.27988	2698.096	31.2
Sambugo-Kianjata	D1317	500	10.3	-0.10852	36.27708	2719.253	10
Sambugo-Kianjata	D1317	500	5.5	-0.10847	36.28088	2693.725	12.7
Sambugo-Kianjata	D1317	500	10.3	-0.10852	36.27708	2719.253	10

ANNEX 6: PRESENT SERVICEABILITY RATING

PSR RATINGS

PSR Ratings

A: General Appearance

Grade	Points
V. good	4 to 5
Good	3 to 4
Fair	2 to 3
Poor	1 to 2
V. Poor	0 to 1

B: Texture

Grade	Points
V. Coarse	0 to 2
Coarse	2 to 4
Preferable	4 to 5
Smooth	2 to 4
V. smooth	0 to 2

C: Bitumen condition

Grade	Points
V. Stiff (brittle)	0 to 2
Stiff	2 to 4
Intermediate	4 to 5
Soft	2 to 4
V. soft (plastic)	0 to 2

D: Potholes

Grade	Points
0 Pot holes	5
1 Pot hole	4
2-3 Pot holes	3
4-6 Pot holes	2
7-10 Pot holes	1
> 10 pot holes	0

E: Surface irregularity

Grade	Points
Even	5
1 Location	4
2-3 Locations	3
4-5 Locations	2
Over 5 Locations	1
Entire road bumpy	0

F: Rutting

Grade	Points
No Rutting	5
1 Location	4
2-3 Locations	3
4-5 Locations	2
Over 5 Locations	1
Entire length	0

G: Cracking

Grade	Points
No cracks	5
1 Location	4
2-3 Locations	3
4-6 Locations	2
7-10 Locations	1
> 10 Locations	0

PSR Rating

Average points	%	Rating
4.5 to 5.0	80-100	V. Good
3.5 to 4.5	60-80	Good
2.5 to 3.5	40-60	Fair
1.5 to 2.5	25-40	Poor
0 to 1.5	0-25	V. Poor

Personal Serviceability Rating (PSR) **Form 1**

Road :	Wamwangi - Karatu Road D379
Section:	Km 0+000 - Km 0+400 main carriage way
Pavement Structure: **Date of Survey:**	10/10/2018
Surfacing	Road Seal (Cold AC)
Base	Neat Lateritic Gravel
Sub-base	Neat gravel

		A	B	C	D	E	F	G	Point summary				
		Point score											
Sub- Section	Length (Km)	General appearance	Surface texture	Bitumen condition	Pot holes	Surface irregularity	Rutting	Cracking	Sum of (∑) Points A-G Max: 40	Average points	%	Remarks	PSR
1. 0+000 - 0+025(PANEL A)	0.025	4.0	4.5	4.0	4.0	4.0	4.0	3.0	27.5	3.9	68.8	**Good**	**3.9**
2. 0+025 - 0+175(LTPP SECTION)	0.15	3.5	4.5	4.0	3.5	4.0	4.0	3.5	27	3.9	67.5	**Good**	**3.9**
3. 0+175 - 0+200 (PANEL B)	0.025	3.5	4.5	4.0	4.0	4.0	4.0	3.0	27	3.9	67.5	**Good**	**3.9**
2. 0+200 - 0+400	0.2	4.0	4.5	4.0	3.0	3.0	3.0	2.0	23.5	3.4	58.8	**Fair**	**3.4**
Total rd. length and ∑ PSR	**0.4**	**15**	**18**	**16**	**14.5**	**15**	**15**	**11.5**	**105**	**15**	**262.5**		**15**
Average PSR		**3.8**	**4.5**	**4.0**	**3.6**	**3.8**	**3.8**	**2.9**	**26.3**	**3.8**	**65.6**	**Good**	**3.8**

Personal Serviceability Rating (PSR) Form 1

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Road :	Lord - Konabahati Road D382
Section:	Km 0+000 - Km 0+950 main carriage way

Pavement Structure: **Date of Survey:** 13/10/2018

Surfacing	Road Seal (Cold AC)
Base	Neat Quarry waste
Sub-base	Neat gravel

		A	B	C	D	E	F	G	Point summary				
		Point score											
Sub- Section	Length (Km)	General appearance	Surface texture	Bitumen condition	Pot holes	Surface irregularity	Rutting	Cracking	Sum of (∑) Points A-G Max: 40	Average points	%	Remarks	PSR
1. 0+000 - 0+400	0.4	3.0	4.0	4.0	2.0	4.0	3.0	2.0	22	3.1	55.0	**Fair**	**3.1**
2. 0+400 - 0+425(PANEL A)	0.025	2.5	4.0	4.0	3.0	3.5	3.0	2.0	22	3.1	55.0	**Fair**	**3.1**
3. 0+425 - 0+575 (LTPP)	0.15	3.5	4.0	4.0	4.0	3.5	2.5	3.0	24.5	3.5	61.3	**Good**	**3.5**
4. 0+575 - 0+600 (PANEL B)	0.025	2.5	4.0	4.0	3.0	3.5	3.0	2.5	22.5	3.2	56.3	**Fair**	**3.2**
5. 0+600 - 0+950	0.35	3.0	4.0	4.0	2.0	3.5	2.5	2.0	21	3.0	52.5	**Fair**	**3.0**
Total rd. length and ∑ PSR	**0.95**	**14.5**	**20**	**20**	**14**	**18**	**14**	**11.5**	**112**	**16**	**280**		**16**
Average PSR		**2.9**	**4.0**	**4.0**	**2.8**	**3.6**	**2.8**	**2.3**	**22.4**	**3.2**	**56.0**	**Fair**	**3.2**

Personal Serviceability Rating (PSR) **Form 1**

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Road : Muthuaini - Munungaini Road D435

Section: Km 0+000 - Km 0+600 main carriage way

Pavement Structure: **Date of Survey:** 12/10/2018

Surfacing	Road Seal (Cold AC)
Base	Neat wethered Basalt
Sub-base	Neat gravel

		A	B	C	D	E	F	G	Point summary				
	Point score												
Sub- Section	Length (Km)	General appearance	Surface texture	Bitumen condition	Pot holes	Surface irregularity	Rutting	Cracking	Sum of (∑) Points A-G Max: 40	Average points	%	Remarks	PSR
1. 0+000 - 0+200	0.2	3.0	4.0	4.0	4.0	4.0	4.0	3.5	26.5	3.8	66.3	**Good**	**3.8**
2. 0+200 - 0+225(PANEL A)	0.025	3.0	3.5	4.0	4.0	3.0	3.5	3.5	24.5	3.5	61.3	**Good**	**3.5**
3. 0+225 - 0+375 (LTPP)	0.15	3.0	4.0	4.0	3.0	3.5	4.0	3.0	24.5	3.5	61.3	**Good**	**3.5**
4. 0+375 - 0+400 (PANEL B)	0.025	3.0	3.5	4.0	4.0	3.0	4.0	3.0	24.5	3.5	61.3	**Good**	**3.5**
5. 0+400 - 0+550	0.15	3.0	3.0	4.0	2.0	3.5	4.0	2.0	21.5	3.1	53.8	**Fair**	**3.1**
Total rd. length and ∑ PSR	**0.55**	**15**	**18**	**20**	**17**	**17**	**19.5**	**15**	**121.5**	**17**	**303.75**		**17.357**
Average PSR		**3.0**	**3.6**	**4.0**	**3.4**	**3.4**	**3.9**	**3.0**	**24.3**	**3.5**	**60.8**	**Good**	**3.5**

Personal Serviceability Rating (PSR) **Form 1**

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Road : Kangari - Kinyona Road E511

Section: Km 0+000 - Km 0+900 main carriage way

Pavement Structure: **Date of Survey:** 11/10/2018

Surfacing	Road Seal (Cold AC)
Base	Neat Lateritic Gravel
Sub-base	Neat gravel

		A	B	C	D	E	F	G	Point summary				
		Point score											
Sub- Section	Length (Km)	General appearance	Surface texture	Bitumen condition	Pot holes	Surface irregularity	Rutting	Cracking	Sum of (∑) Points A-G Max: 40	Average points	%	Remarks	PSR
1. 0+000 - 0+025(PANEL A)	0.025	3.5	4.0	4.0	4.5	4.0	4.0	3.5	27.5	3.9	68.8	**Good**	**3.9**
2. 0+025 - 0+175(LTPP SECTION)	0.15	3.5	3.5	4.0	4.0	3.5	3.5	2.0	24	3.4	60.0	**Fair**	**3.4**
3. 0+175 - 0+200 (PANEL B)	0.025	3.5	4.0	4.0	3.0	3.0	3.5	3.5	24.5	3.5	61.3	**Good**	**3.5**
4. 0+200 - 0+900	0.7	3.0	3.0	4.0	2.0	2.0	3.0	1.0	18	2.6	45.0	**Fair**	**2.6**
Total rd. length and ∑ PSR	**0.9**	**13.5**	**14.5**	**16**	**13.5**	**12.5**	**14**	**10**	**94**	**13**	**235**		**13.429**
Average PSR		**3.4**	**3.6**	**4.0**	**3.4**	**3.1**	**3.5**	**2.5**	**23.5**	**3.4**	**58.8**	**Fair**	**3.4**