ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction, Supervision and Baseline Monitoring of Trial Sections on Low Volume Roads in Zambia

Inception Report (Final)

Authors: M I Pinard, S Rattray, P Paige-Green and J Hongve

AFCAP Project Reference Number: ZAM2097A

July 2017

RANKIN
ENGINEERING CONSULTANTS

The views in this document are those of the authors and they do not necessarily reflect the views of the Research for Community Access Partnership (ReCAP) or Cardno Emerging Markets (UK) Ltd for whom the document was prepared

Cover Photo: Authors

Quality assurance and review table			
Version	Author(s)	Reviewer(s)	Date
5	M I Pinard, S Rattray, P Paige-Green, J Hongve	RDA	29th July, 2017
4	M I Pinard, S Rattray, P Paige-Green, J Hongve	Les Sampson	28th July, 2017
3	M I Pinard, S Rattray, P Paige-Green, J Hongve	N V Leta	21st July, 2017
2	M I Pinard, S Rattray, P Paige-Green, J Hongve	V Alavian	12th July 2017
1	M I Pinard, S Rattray, P Paige-Green, J Hongve	V Alavian	5th May, 2017

ReCAP Project Management Unit
Cardno Emerging Market (UK) Ltd
Oxford House, Oxford Road
Thame
OX9 2AH
United Kingdom

Key words

Road research, low volume roads, materials testing, pavement design, Dynamic Cone Penetrometer, bituminous surfacing design, trial sections, construction monitoring.

RESEACH FOR COMMUNITY ACCESS PARTNERSHIP (ReCAP)

Safe and sustainable transport for rural communities

ReCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa and Asia. ReCAP comprises the Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP). These partnerships support knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. The ReCAP programme is managed by Cardno Emerging Markets (UK) Ltd.

See www.afcap.org

Acronyms, Units and Currencies

AfCAP	Africa Community Access Partnership
AfDB	African Development Bank
AsCAP	Asia Community Access Partnership
DCP	Dynamic Cone Penetrometer
DN	The average penetration rate in mm/blow of the DCP in a pavement layer
GPS	Global positioning system
ReCAP	Research for Community Access Partnership
RDA	Road Development Agency
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)

Contents

Key words 3
Acronyms, Units and Currencies 4
1 Executive summary 6
2 Introduction 8
2.1 Background 8
2.2 Motivation for Project 8
2.3 Purpose and Scope 8
2.4 Project Deliverables and Milestones 9
2.5 Inception Report 9
3 Review of Terms of Reference 11
3.1 General 11
3.2 Comments 11
4 Approach, Methodology and Work Programme 12
4.1 General 12
4.2 Preparation and mobilisation 12
4.3 Inception activities 13
4.3.1 Consultations with RDA 13
4.3.2 Identification of Trial Section(s) 13
4.3.3 Inception Phase Stakeholder's Workshop 13
4.3.4 Programme versus Progress 14
4.3.5 Future Activities 14
5 Selection of Trial Sections 15
5.1 General 15
5.2 Characteristics of Project Area 15
5.3 Selection Criteria 15
5.4 Recommended Sections 17
6 Stakeholder Workshop 20
6.1 General 20
6.2 Agreements Reached 20
7 Summary and Way Forward 20
7.1 Summary 20
7.2 Way Forward 20
Annex A: Record of Kick-off Meeting 21
Annex B: Work Programme 26
Annex C: Summary of Site Observations 27
Annex D: Record of Stakeholder Workshop 31

1 Executive summary

One of the Government of Zambia's priority goals is to provide reliable rural road access for social and economic development of the country. However, there are currently no appropriate design standards applicable to such roads. As a result, at the request of the Zambia Road Development Agency (RDA), the UK Department for International Development (DFID), through the Africa Community Access Partnership (AFCAP), is supporting a project pertaining to the Design, Construction Supervision and Baseline Monitoring of Trial Sections on Low Volume Roads. The main purpose of the project is to:

- carry out the pavement design of the trial sections based on the DCP-DN method.
- construct the trial sections to a sealed standard using an appropriate seal type.
- establish a programme of long-term pavement performance monitoring.
- collect and analyse baseline data.
- ultimately, provide inputs for the development of a new pavement design manual for low volume roads in Zambia.

The project is being carried out in three phases over a 24-month period, as follows:

- Phase 1: Inception and Design (Months 1-8)
- Phase 2: Procurement and Construction (Months 9 – 16)
- Phase 3: Monitoring and Evaluation (Months 17 – 24).

This Final Inception Report marks the culmination of the preparatory stage of Phase 1 of the project. During this stage, the following activities were undertaken:

1) Activity 1.1: Preparation and Mobilisation, including a review of documents received from the RDA.

2) Activity 1.1a: Consultations with the RDA with a view to reaching agreement on the approach, methodology and detailed work programme for undertaking the project, as well as their anticipated role in its implementation.

3) Activity 1.1b: A Visit to a number of potential trial section sites as a basis for recommending the preferred site(s) for approval by the RDA.

4) Activity 1.1c: Preparation of a Draft Inception Report.

5) Activity 1.1d: Holding of a Stakeholder Workshop to discuss the recommendations presented in the Draft Inception Report.

6) Activity 1.1e: Preparation of the Final Inception Report which includes the outcome of the Stakeholder Workshop.

The main outcomes of the above activities are as follows:

1) The official start date for the project was agreed as April 17th, 2017. The first site visit took place during the week of April 26th, 2017.

2) Based on consideration of a range of variables, including traffic, climate, soil type and terrain, a potential site in Nakonde District, amongst the nine other sites visited, has been recommended to the RDA for construction of the trial sections.

3) A Stakeholder's Workshop was held on 6th July 2017, which supported the recommendations of the Consultant.

4) Consultation with the RDA confirmed that a contractor procurement process will most likely be concluded by the end of 2017, with an intention to start works by the end of March/beginning of April, 2018.

The Work Programme has been revised following agreements reached at the Stakeholder Workshop as well as confirmation received from the RDA on the status of the contractor procurement process and the likely date for the start of construction of the trial section(s).

Key Words
Rural Roads, Pavement Design, Dynamic Cone Penetrometer, Pavement Performance Monitoring, Trial Sections.

2 Introduction

2.1 Background

With the increase in the rural population, stronger rural economies and increased vehicle ownership, there has been an increased focus on the development of rural roads in Zambia. The provision of such roads is a necessary requirement for efficient transport services which invariably lead to reduced costs for agricultural inputs, higher farm gate prices, improved health care for rural communities, and easier access to education and employment opportunities.

Currently, most of the rural road network in Zambia comprises earth and gravel roads and in many areas the availability of good quality gravel wearing course material is limited or non-existent. The resulting use of poor quality gravel results in rough road surfaces and related high vehicle operating costs. Moreover, unsealed roads create dust, which damages crops, creates health risks for road-side communities, and is a hazard for road users.

In an environment in which funding for rural road provision is under increasing pressure, and availability of "traditional" materials is also decreasing, there is an urgent need to find more economical ways of providing access to the majority of the population, who live in rural areas. The importance of focus on rural access is demonstrated by investments currently being made in this sector, including the World Bank funded Improved Rural Connectivity Project.

Within the context of enabling provision of more rural roads in an environmentally optimised and sustainable manner, the UK Department for International Development (DFID), through the Africa Community Access Partnership (AfCAP) has provided resources to further the state of knowledge with regard to provision of low volume sealed roads in Zambia. This is being achieved through a project for the "Design, Construction Supervision and Baseline Monitoring of Trial Sections on Low Volume Roads in Zambia".

2.2 Motivation for Project

The success of Zambia's programme of sealing rural roads will depend on the adoption of pavement design standards, materials specifications and construction techniques that are appropriate to low volume roads. Currently, such standards do not exist and the AfCAP project is expected to provide technical solutions that will reduce the life cycle cost of rural roads yet ensure an appropriate level of service. Moreover, the outputs of the baseline monitoring to be carried out on the trial sections may influence revisions to the Pavement Design Manual for Low Volume Roads soon to be produced under a separate project that is currently being procured.

2.3 Purpose and Scope

The main purpose of the project is to:

- Carry out the pavement design of a Trial Section(s) based on the DCP-DN method.
- Construct the trial sections to a sealed standard using an appropriate seal type.
- Establish a programme of long-term pavement performance monitoring.
- Collect and analyse baseline data in a format compatible with the AfCAP back-analysis database.
- Ultimately, provide inputs for the development of a new pavement design manual for low volume roads in Zambia.

2.4 Project Deliverables and Milestones

As per the Terms of Reference, the project deliverables and milestones are summarised below:

Project Deliverable	**Timing (weeks since start of project)**
An **Inception Report** to cover preparatory activities, mobilisation of the organisation's team, confirmation of the methodology for the assignment, clarifications on the TORs and a detailed work plan.	6
A **Desk Study Report** of existing literature of pavement design for low volume rural roads including the current status of pavement design practice using the DCP-DN method etc	8
A **Sampling and Testing Report** of the construction materials found in in the project area, including the experimental design and research matrix.	16
A **Draft Design Report** which will incorporate: 1) identification process of the 3 experimental sites; 2) refined research matrix for the three sections to identify the variables to be investigated; 3) Design of road pavements and appropriate seals for the experimental sections.	24
A Final **Design Report** that will incorporate comments from RDA and AfCAP on the Draft Design Report.	32
Quarterly Progress Reports (3no.) during the construction phase which will describe activities carried out during the quarter. These will be supplemented by succinct monthly construction progress reports.	Construction phase (Weeks 33 – 64)
A **Draft Construction Report** of the construction phase including base line data collected on each site and all other data obtained including in-situ measurements & testing, laboratory results, as-built drawings.	72
A **Final Construction Report** that will incorporate comments from RDA and AfCAP on the Draft Construction Report.	80
Technical Papers (at least 2 No.) for submission to appropriate international or regional conferences.	84
A **Draft Project Report** based on completion of all project activities, including baseline surveys.	88
A **Final Project Report** that will incorporate comments from the RDA and AfCAP on the Draft Project Report.	96

2.5 Inception Report

The purpose of this Inception Report is to cover the following:

- preparatory activities;
- mobilisation of Consultant's team;
- confirmation of the methodology for the assignment, and
- clarifications on the TORs and a detailed work plan.

The Inception Report is structured as follows:

Section 1: An Executive Summary that summarises the key issues addressed in the Inception Report.

Section 2: An Introduction to the report that covers the background to the project, as well as the mobilisation of the Consultant's team, the purpose and scope of the project and the project deliverables and milestones.

Section 3: The outcome of the review undertaken of the Terms of Reference.

Section 4: The Approach, Methodology and Work Programme for the project, following the outcome of the Kick-off meeting that was held with the RDA and AfCAP at the commencement of the project.

Section 5: The outcome of the field visit to the project area, including the selection criteria used to select the trial sections and the recommended section for construction.

Section 6: The outcome of the Stakeholder's Workshop.

Section 7: A summary of the first stage of the project and the anticipated way forward to the remaining phases of the project.

Annex A: A Record of the Kick-off Meeting

Annex B: Work Programme

Annex C: Summary of Site Observations

Annex D: A Record of the Stakeholder's Workshop

3 Review of Terms of Reference

3.1 General

The original Terms of Reference (ToR) have been amended following the change in location of the Trial Section(s) from Eastern and Western Zambia to Muchinga Province. Other than that, the scope of services remain essentially the same, and cover broadly four main areas of activity, as presented in Section 2.3.

3.2 Comments

The overall objective of the project will certainly be achieved with the scope of services envisaged. However, a few early comments are warranted:

- With the Trial Section limited to a maximum of 1 km, and bearing in mind the minimum practicable length of such research sections of about 500 m, it seems most likely that a maximum of two sections would be developed. Two different seal types per section would therefore be the maximum that could be expected.
- The capacity building objectives of the project, particularly with regards to the long-term pavement performance monitoring, will require intermittent involvement of at least one local counterpart for a period of perhaps 5 – 7 years. The strong commitment of the Research Unit to ensure that the long-term monitoring is conscientiously implemented is essential to the success of the project.
- The ToR specifically indicate that the Consultant will make recommendations "for modifications to the existing materials specifications and pavement design standards for LVSRs". With a time-frame of two-years, the empirical data that would become available would not be sufficiently definitive and broadly-based to allow general recommendations to be made. However, preliminary recommendations could be made which would be subject to further validation from ongoing performance monitoring.
- The ToR also stipulate that the Consultants shall "assist the RDA staff participating in the project to prepare a minimum of two technical papers". Clearly, this activity is heavily dependent on the RDA staff who will be the authors of these papers and it is expected that appropriate staff will be allocated for this activity. Identification of opportunities that will arise over the next two years for delivering papers should therefore begin in earnest for this objective to be achieved.

4 Approach, Methodology and Work Programme

4.1 General

The outline approach for implementing the project as per the Consultant's Technical Proposal is summarized in Table 1 which shows the general scope of the study and its main components. The project has been broken down into three phases related to key aspects of its implementation, as stipulated in the ToR. Each phase includes a list of the proposed tasks considered necessary to achieve the project objectives.

Table 1: Outline scoping of project

	Phase 1: Inception & Design Weeks 1 - 35		**Phase 2: Procurement & Construction Weeks 36 - 74**		**Phase 3: Monitoring & Evaluation Weeks 75 - 98**
1.1	**Inception**	2.1	**Procurement**	**3.1**	**Monitoring**
	• Preparation & mobilisation		• Negotiations with contractors		• Monitoring plan
	• Consultations with RDA	2.2	**Supervision of construction**		• Collection baseline data
	• Site Visits to Demo Sections		• Assist RDA supervise constr.		• As-built records
	• Hold workshop		• Final inspection	**3.2**	**Revision of design stds & specs**
	➢ Inception Report	2.3	**Workshops**	**3.3**	**Reporting**
1.2	**Desk Study**		• 2 No. site workshops		➢ Final Construction Report
	• Literature review	2.4	**Reporting**	**3.4**	**Technical papers**
	➢ Desk Study Report		➢ Quarterly progress reports		• Provide guidance to RDA staff
1.3	**Research matrix & exp. design**		➢ Draft Construction Report	**3.5**	**Final Reporting**
	• Sampling prog. & test schedule		• Review by RDA and AfCAP		➢ Draft Final Project Report
	• Materials sampling & transport		**END PHASE 2**		• Review by RDA/ReCAP
	• Lab testing & supervision				➢ Final Project Report
	➢ Experimental Design & Research Matrix Report				**END PHASE 3**
	• DCP tests & site investigations				
	• Pavement & surfacing design				
	• Bidding documents				
1.4	**Design report**				
	➢ Draft Design Report				
	• Review by RDA & AfCAP				
	➢ Final Design Report				
	END PHASE 1				

4.2 Preparation and mobilisation

According to the original Work Programme, the project was scheduled to commence on 19th September 2016, followed by a preparation and mobilisation period for the project team of four weeks. This was premised on the assumption that the RDA would have secured suitable candidate projects during the Inception Stage for constructing the Trial Sections, as envisaged in the ToR. However, in the event, this was not the case and the commencement of the project was put on hold until replacement candidate projects could be identified.

After negotiations with various donors to identify possible replacement projects, AfDB agreed to finance a Trial Section(s) with a total length of 1 km on feeder roads in Muchinga Province under the T2 Great North Road rehabilitation project, which is currently under design review.

As a result of the above, the Work Programme was then revised as shown in Annex B with a project start date of 17th April 2017. The intended completion date is 28th February, 2019.

4.3 Inception activities

4.3.1 Consultations with RDA

In accordance with the revised Work Programme, a project Kick-off meeting was held with the RDA on Tuesday 25th April at the RDA offices in Lusaka to launch the project and to discuss the way forward. A record of the meeting is attached in **Annex A.**

4.3.2 Identification of Trial Section(s)

For the identification of the trial sections, the original ToR for the project were specified as follows:

- In consultation with the RDA, identification of three locations for the construction of experimental LVSR sections, where possible within current road works contracts.
- Where possible these road sections should be within reasonable proximity to Lusaka to enable effective supervision and future monitoring.
- Two of the sections were expected to be in the sand areas of western Zambia, and one in laterite areas in the eastern region.
- The selection of trial sections should represent a range of climate, terrain and soil types.
- Roads with higher traffic shall be given preference to ensure reasonable traffic loading during the monitoring period.

With the reduction in scope from three 1-km sections to one or two sections with a total length of 1 km, the achievement of the full range of objectives is no longer possible. As discussed in Section 5 below, the selection of trial sections among the feeder roads in the three districts of Chinsali, Isoka and Nakonde along the T2 Great North Road was made with the aim of fulfilling as many of these objectives as possible.

The Consultant's team travelled to Chinsali in the week starting 30th April, 2017 and, together with a representative of the RDA, inspected the various feeder roads and borrow pits in the three districts that could be potentially suitable for the trial sections.

4.3.3 Inception Phase Stakeholder's Workshop

In the original Work Programme, it was envisaged that an Inception Workshop would be held immediately after the field visit to discuss the project objectives, approach and findings from the field visit with the Stakeholders. The discussions and agreements from the workshop would then be included in the Inception Report and thus pre-empt many comments to, and subsequent revisions of, the report. However, after discussion with AfCAP, it was agreed that a Draft Inception Report would be prepared and distributed at least 2 weeks prior to the Inception Workshop to give time for Stakeholders to study the report and get acquainted with the project.

The Workshop, which was originally scheduled for 19th May, 2017, was postponed and eventually took place on 6th July, 2017.

Twenty-one persons were in attendance at the Stakeholder's Workshop, representing a cross-section of contractors, consultants and road authorities. Presentations were made on the background to the project, its scope and objectives, as well as the Consultants recommendations. There was positive support received from the participants for the project as a whole. There was also positive support received from the RDA project team after the workshop for the recommended trial sections. The record of the Inception Workshop is included in Annex D.

4.3.4 Programme versus Progress

With the submission of the Draft Inception Report on 5th May 2017, and the Final Inception Report on 12th July, 2017, the project is so far on schedule with regards to Phase One activities as per the Revised Work Programme. However, progress on Phase Two activities will be dependent on the progress on the AfDB project for upgrading of the T2 Great North Road.

4.3.5 Future Activities

The next steps in Phase One of the Work Programme are to:

- Finalise a Desk Study
- Carry out Experimental Design and Materials Testing
- Undertake site Investigations and design of trial sections

The Desk Study will be undertaken as planned and the Desk Study Report will be submitted by 12th July 2017.

The latter two major activities are likely to be carried out simultaneously rather than consecutively as indicated in the Work Programme. These are currently scheduled to be carried out in August. However, there is strong motivation to delay these activities slightly to September 2017, to take advantage of the prospect of DCP testing at the end of the dry season. This testing would then be repeated at the start of the construction programme, which will be the end of the rainy season. In this way, valuable information on correlation of DCP with subgrade moisture content, can be demonstrated. As the site investigation activity is not on the critical path, there will be no impact on project deliverables to delay site investigations until September 2017.

5 Selection of Trial Sections

5.1 General

As stated in the Terms of Reference and discussed in Section 3 of this Inception Report, it is necessary to identify sections of road that can be used for trial sections. These must be of sufficient length to allow effective monitoring and should be compared with a control section. This control section could be either a conventional gravel road with a selected wearing course material or a conventionally designed (catalogue or CBR type design) low volume paved road, compared with the trial section designed on the basis of a Dynamic Cone Penetrometer (DCP) survey and the DCP-DN design method. In this way, the life-cycle costs of the alternatives can be directly compared, to quantify the financial benefits of the most cost-effective alternative.

5.2 Characteristics of Project Area

The project area (Muchinga Province) was identified by the Road Development Agency (RDA) as funding had already been allocated for the upgrading of various Feeder Roads branching off Trunk Road T002. The Local Councils in the Chinsali, Isoka and Nakonde districts had identified about 19 roads for upgrading to gravel road standard.

The project area is in a sub-tropical climatic zone with minimum winter temperatures of about 6°C, maximum summer temperatures of about 35°C and a mean annual rainfall of about 1 150 mm, most of which falls between November and April.

Geologically, the area is very complex, being composed primarily of Proterozoic metamorphic and igneous rocks with some Quaternary sediments. These are part of the deformed basement and folded supracrustal materials of the Irumide Belt. However, over much of the area, tropical weathering in the past has led to the formation of laterites varying from a few centimetres in thickness to many metres of competent hardpan laterites.

The topography of the area consists mostly of flat to gently rolling terrain, with large areas of indigenous forest and localised subsistence farming.

5.3 Selection Criteria

In order to ensure that the maximum benefit would be obtained from the trial projects, it is important that the actual sites are carefully selected. The sections should be at least 1 kilometre long or possibly two shorter sections of not less than 500 m. The latter eventuality would provide sufficient information and allow the incorporation of at least two variables (individually), e.g. weak and strong subgrade or flat and steep grades or possibly even different surfacing options.

It was also considered important that the selected sections carry adequate traffic to provide the normal traffic-related distress, particularly on the unpaved control sections. Without this, there would be insufficient information to determine proper life-cycle costs of the alternatives. A problem was, however, immediately encountered in that most of the roads inspected carried no traffic as they were either impassable or there was insufficient activity along their routes to attract any traffic. In fact, motorised traffic was seen on only one of the roads visited, although it should be recorded that the inspections were carried out during non-peak activity periods.

The projects highlighted by the councils were as follows:

Chinsali Municipal Council:	**Length (km)**
• Nambuluma Health Centre	0.2
• Nambuluma Primary School	0.3
• Mulakupikwa Secondary School	2.0
• Chilubanama Community School and Rural Hearth Centre	14.0
• Machango Primary School	0.2
• Kapimpa Primary School	0.2
• Lubu Farms	0.5
• Chipunga Primary School	0.25
• Kapili Primary School	0.15
• Musanya Resettlement	1.35
• Musanya Primary School	0.5
• Chifuma Primary School	0.15
• Vitondo Primary School	0.2

Lubu Farms and Kapili Primary School roads were found not viable during the exercise and hence excluded from consideration.

Isoka District Council:	**Length (km)**
• Old Great North Road to District Administrative Offices	4.0
• Old Great North Road to Lolani Village	5.5
• Old Great North Road to FRA (Mwenya Township)	5.0

Old Great North Road to FRA (Mwenya Township) road was disqualified, and was replaced with T002 – Nansala Primary School road.

Nakonde District Council:	Length (km)
• T002 – Mayembe	5.0
• T002 – Iwula – Vyonga	4.5
• T002 – Kantongo – Waitwika	5.5

After assessing T002 –Mayembe, it was found that the actual distance was 15km and not 5km as submitted and for T002 – Iwula, it was found that the actual distance was 23km and not 4.5 as submitted. After consultation with the Director of Engineering, it was agreed that instead of doing partial works on all those roads, it was better to work on only one; hence the full length of 17 km of T002-Kantongo – Waitwika road was selected.

On the basis of the selection criteria discussed above, those roads that were less than 1 km were excluded from the inspection. The remaining roads inspected were thus:

Chinsali Municipal Council:	**Length (km)**
• Mulakupikwa Secondary School	2.0
• Chilubanama Community School and Rural Health Centre	14.0
• Musanya Resettlement	1.35

Isoka District Council:	**Length (km)**
• Old Great North Road to District Administrative Offices	4.0
• Old Great North Road to Lolani Village	5.5
• T002 – Nansala Primary School road	5.4

Nakonde District Council:	**Length (km)**
• T002 – Kantongo – Waitwika – D001	17.0

5.4 Recommended Sections

During the site visit, those sections that could potentially be candidates for the Trial Project were visited and inspected. All sections less than 1 km long that had been identified by the local councils were excluded from the inspections as there would be inadequate length of road for the Trial Section and the adjacent control sections.

A summary of the locations and characteristics of the roads inspected is provided in Table 2.

Brief descriptions of the nature and conditions of the roads inspected are given in Annex C.

Following the inspections, it is proposed that the potentially most useful road for the trial project would be the Kantongo-Waitwika-D001 road for the following reasons.

1) This is currently the only road that is passable for its full length (although some areas may prove problematic for normal saloon cars)
2) There is evidence of traffic (although low) currently using the road
3) A potentially suitable borrow pit exists next to the road
4) Other potential borrow pits exist in relatively close proximity (within 15 km)
5) The road has various subgrade, wearing course and width conditions
6) The road includes flat sections and some relatively steep grades
7) Areas of the road need extensive repairs, raising of the formation and widening
8) Various sections along the road would provide suitable candidate sites for the trial project
9) The terms of reference required specifically the use of non-standard materials, a laterite as proposed for this project being a typical example.

As traffic is a key input into the design of the Trial Section, it is necessary to obtain a reliable estimate of the expected traffic over the design life of the road. Because of the current low traffic observed on the road and the potential for significant traffic diversion (see Figure 5-1) and generation, an Origin and Destination (O & D) survey should be carried out as part of the gravel road design.

Kantongo-Waitwika Road

Figure 5-1: Location map of recommended trial site

Table 2: Summary of characteristics of roads inspected

Points	Latitude	Longitude	Description	Soil type	Geology	Material types
2	-10° 06.687'	032° 40.537'	End of road Ntipo Secondary School)	Lithasol/ferralsol	Quaternary	Colluvial deposits with thin laterite hardpan
3	-10° 06.886'	032° 40.386'	Start of road (Old Great North Road to Lolani Village)	Lithasol/ferralsol	Quaternary	Colluvial deposits with thin laterite hardpan
4	-10° 07.095'	032° 40.261'	Near Ntipo school	Lithasol/ferralsol	Quaternary	Colluvial deposits with thin laterite hardpan
5	-10° 11.308'	032° 38.523'	Start of T002 – Nansala Primary School road	Lithasol/ferralsol	Nkanza quartzite, Mansha River Group, Muva	Weathered quartzites
6	-10° 11.329'	032° 38.521'	End near school	Lithasol/ferralsol	Nkanza quartzite, Mansha River Group, Muva	Weathered quartzites
7	-10° 10.901'	032° 36.484'	Start of T002 to District Admin Offices	Lithasol/ferralsol	Nkanza quartzite, Mansha River Group, Muva	Hardpan laterite, red loam, rock outcrops and boulders
8	-10° 10.908'	032° 36.493'	End of section inspected	Lithasol/ferralsol	Nkanza quartzite, Mansha River Group, Muva	Hardpan laterite, red loam, rock outcrops and boulders
9	-10° 21.518'	032° 23.981'	Start of Musanya primary school road	Ferralsol	Lubu Granite-gneiss, Basement Complex	Foliated granite gneiss
10	-10° 21.987'	032° 23.739'	Start of Musanya resettlement scheme	Ferralsol	Lubu Granite-gneiss, Basement Complex	Foliated granite gneiss
11	-10° 21.984'	032° 23.744'	End of Musanya resettlement scheme	Ferralsol	Lubu Granite-gneiss, Basement Complex	Foliated granite gneiss
12	-10° 37.746'	032° 17.615'	Start of Chilubanama Community School Road	Ferralsol	Mansha River Group, Muva	Metapsammite and metapelite
13	-10° 41.070'	032° 22.211'	End of Chilubanama Community School Road	Ferralsol	Mansha River Group, Muva	Metapsammite and metapelite
14	-10° 36.648'	032° 12.507'	Start of Mulakupikwa Secondary School road	Ferralsol	Mansha River Group, Muva	Metapsammite and metapelite
15	-10° 35.370'	032° 12.336'	End of Mulakupikwa Secondary School road	Ferralsol	Mansha River Group, Muva	Metapsammite and metapelite
16	-10° 36.178'	032° 12.411'	Mulakupikwa school	Ferralsol	Mansha River Group, Muva	Metapsammite and metapelite
17	-10° 37.168'	032° 12.858'	Borrow pit 2	Ferralsol	Mansha River Group, Muva	Metapsammite and metapelite
18	-10° 37.206'	032° 19.359'	Borrow pit 3	Ferralsol	Mansha River Group, Muva	Metapsammite and metapelite
19	-9° 29.119'	032° 38.435'	Borrow pit 15	Ferralsol	Igneous and meta-igneous	Granodiorite and tonalite (laterite hardpan)
20	-9° 22.681'	032° 43.105'	Borrow pit 16	Ferralsol	Igneous and meta-igneous	Granodiorite and tonalite (laterite hardpan)
21	-9° 29.313'	032° 38.291'	Start road Kantongo - Waitwika -D001	Ferralsol	Igneous and meta-igneous	Granodiorite and tonalite (laterite hardpan)
22	-9° 28.315'	032° 37.159'	BP along road	Ferralsol	Igneous and meta-igneous	Granodiorite and tonalite (laterite hardpan)
23	-9° 22.085'	032° 36.628'	End road Kantongo - Waitwika -D001	Ferralsol	Igneous and meta-igneous	Granodiorite and tonalite (laterite hardpan)

6 Stakeholder Workshop

6.1 General

A Stakeholder's workshop was held on July 6th, 2017, at which the project objectives were presented and recommendations made that the trial sections be established on the Kantongo-Waitwika-D001 road. There was no objection raised to the selection of this road for establishing trial sections.

Participants at the Workshop also expressed interest in learning more about the DCP-DN method of designing low-volume roads, a possibility which the AfCAP representative noted would be explored.

6.2 Agreements Reached

Based on the feedback from the Workshop, the RDA team responsible for the AfDB T002 project was consulted on the implementation of the works programme. This team also expressed their agreement to the recommendation that the trial projects be established on the Kantongo-Waitwika-D001 road, with a view to commencing the works by the end of the first quarter of 2018.

The programme of the Workshop and the Consultant's presentations are presented in **Annex D**.

7 Summary and Way Forward

7.1 Summary

The project has commenced with an initial Kick-off meeting, followed by a site inspection to identify the best potential sections for construction of the Trial Sections. Based on the site visit and the required selection criteria, the Kantongo-Waitwika – D001 road was identified as the most suitable one. Nonetheless, it is recommended that additional site(s) that offer a wider range of variables, including higher levels of traffic, are considered as they are likely to provide greater potential for satisfying the objectives of the project. The Inception Phase was completed with a Stakeholder's Workshop and finalization of the Inception Report.

7.2 Way Forward

Now that agreement has been reached on the road for the Trial Section, the following activities will commence or be finalised:

1) Obtain relevant design documents from RDA.
2) Complete a Desk Study
3) Carry out Experimental Design and Materials Testing
4) Undertake site Investigations and design of trial sections

The commencement of the Phase two activities are subject to the following:

1) Completion of the design review for the T002 project and associated works.
2) Procurement and mobilisation of the contractor.

Annex A: Record of Kick-off Meeting

Republic of Zambia **Ministry of Housing & Infrastructure Development.**		**ReCAP** Cardno Emerging Markets (UK) Ltd and Rankin Engineering Consultants

Kick off – Meeting	**Date:**25th April, 2017	**Time: 10:00 hrs**	**Project Name:** Design, Construction Supervision and Baseline Monitoring of Trial Sections on Low Volume Sealed Roads in Zambia

Minutes of the kick off meeting for the Design, Construction Supervision and Baseline Monitoring of Trial Sections on Low Volume Sealed Roads in Zambia
(Held at Road Development Agency, Offices Ridgeway, **Lusaka**)

Attendance:

No.	Name	Institution	Position	Contact
1	Eng. Thomson Banda	RDA	Senior Manager – R & D	thomsonbanda@roads.gov.zm
2	Eng. Nkululeko Leta	ReCAP	Regional Technical Manager	Nkululeko.leta@cardno.uk.com Nkululeko.leta@gmail.com
3	Eng.Phillimon Goma	RDA	Principal Engineer	pgoma@roads.gov.zm
4	Eng. Joseph Goma	RDA	Acting Senior Manager – Design	jgoma@roads.gov.zm
5	Eng. Jonas Mukwatu	RDA	Pavement Engineer	jmukwatu@roads.gov.zm
6	Eng. Michael Pinard	Rankin Engineering Consultants	Team Leader	mipinard@global.bw
7	Eng. Jon Hongve	Rankin Engineering Consultants	LVSR Design & Construction Expert	joho@operamail.com
8	Eng. Suzanne Rattray	Rankin Engineering Consultants	Project Director	srattray@rankinengineering.com

APOLOGIES:

No.	Name	Institution	Position	Contact
1	Dr. Phil Paige-Green	Rankin Engineering Consultants	Materials Expert	paigegreenconsult@gmail.com

Item	Description	Action
(1)	**Welcome Remarks and Introductions** The Chairperson called the meeting to order at 10:30 hours and welcomed everyone present. The circulated agenda was amended prior to the meeting. The revised agenda was then proposed for adoption and seconded by members.	All

(2)	**Adoption of Agenda** The following agenda was proposed and adopted: 1. Welcome Remarks and Introductions 2. Adoption of Agenda 3. Contractual issues 4. Technical Issues 5. Provision of relevant reports/data 6. Discussions 7. Any other business	All
(3) **(3.1)**	**Contractual issues** **Contract start date** The meeting was informed that the contract has not yet been signed between Messrs Cardno Emerging Markets (UK) and Rankin Engineering Consultants as the consultant noted that since the project is donor funded, it has been assumed to be VAT exempt and an LPO to facilitate VAT free invoicing is awaited. The meeting was further informed that despite the contract not having been signed, AfCAP had given the consultant approval to proceed with the project up to the end of inception phase pending resolution of the request for confirmation on VAT exemption between DFID and GRZ.	ReCAP
(3.2)	**Client Counterpart** The consultant informed the meeting that the project involved an aspect of technological transfer/ training and that the client, RDA, was required to attach an engineer to the project from inception to completion to derive full benefits of the capacity building. The team was advised that RDA management had appointed Engineer Phillimon Goma as desk officer from head office, and that the Muchinga Region, would assign the Planning Engineer to work with the consultant on the project.	RDA HQ
(3.3)	**Commencement date** The meeting was informed that the commencement date for the works cannot be put on record as the contract between Cardno and Rankin had not yet been signed.	ReCAP
(3.4)	**Lines of Communication** It was agreed in the meeting that the lines of communication for the project would be as follows: - RDA to write to ReCAP attention of the Regional Technical Manager – East & Southern Africa on all matters regarding the project. - The consultant to communicate through ReCAP, Regional Manager – East & Southern Africa on all matters regarding the project. - Messrs ReCAP would then write to RDA HQ on any matter regarding the project. The RDA HQ to write to RDA regional office on any matter concerning the	All

	project and that any requests to the Region from the Consultant or ReCAP must be via RDA HQ, marked for the desk officer.	
(4)	**Technical Issues** The Consultants provided an overview of the project including: o Introductory remarks o Project objectives and scope o Organisation chart and team members o Guiding principles for implementation o Training and capacity building	
	The Consultant commenced services on 17th April in readiness for an Inception meeting on 25th April as per the Work Programme submitted in the Technical proposal.	
	With regards to the sites, as the demonstration sections will form part of the AfDB funded project along the T2, coordination with that project team is essential. The Design review report on the T2 project, being prepared by others, is expected by mid-August.	
	A design for the demonstration sections would therefore be required by mid-July for contractor costing purposes. Rankin can provide nominal design by then.	Rankin
	There was some uncertainty as to whether demo sections should 1 x 1000m, 2 x 500m or 3 x350m. Recommendation will be informed by the impending site visit.	
	A Site visit was planned commencing Sunday 30 April with a return on Thursday 4th June. The participation of the regional RDA staff would be very beneficial. The meeting was informed that there was need to select the location of the trial sections with caution, as the stakeholders may query the criteria used.	
	A Feedback meeting with RDA will be held during T2 conference in Livingstone on Wed 10th May at 17.00 hrs to discuss the findings of the site visit.	All
	The Start of the construction works contract on the T2 is anticipated by May 2018.	
(4.1)	**Stakeholder Meeting** A stakeholder meeting was planned to take place on the 19th May, 2017. However, due to the delay in resolution of VAT exemption and signing of the contract between Cardno and Rankin, there will not be enough time for RDA to invite the Stakeholders to the meeting. The meeting will then be scheduled for a later date when the above issues have been resolved.	
(5)	**Provision of Relevant Data/Reports** The consultant requested for any documentation or reports on material investigations or road designs conducted along the T2 rehabilitation project. The client informed the meeting that documentations would be provided if available	P.Goma

	and that Engineer Phillimon Goma would coordinate the provision of the documents.	
(6)	**Discussions** There was general discussion as to the structure of the Research Unit at the RDA and the current positions filled and resources available.	
(7)	**Any Other Business** The meeting was informed that the regional office would be written to in order to assist the consultant to access the proposed project sites in Muchinga during their reconnaissance visit and they would be notified once communication had been established.	P.Goma
(8)	**Closing Remarks** The Chairperson thanked everyone present and the meeting closed at 13:00hrs. The date of next meeting was set for 11th May, 2017 in Livingstone alongside the T2 conference.	All

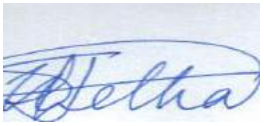
Eng. Thomson Banda CHAIRPERSON

Date…29/5/2017……..

Signature 

Eng. Nkululeko Leta - ReCAP

Date …29/05/2017..

Signature… 

……

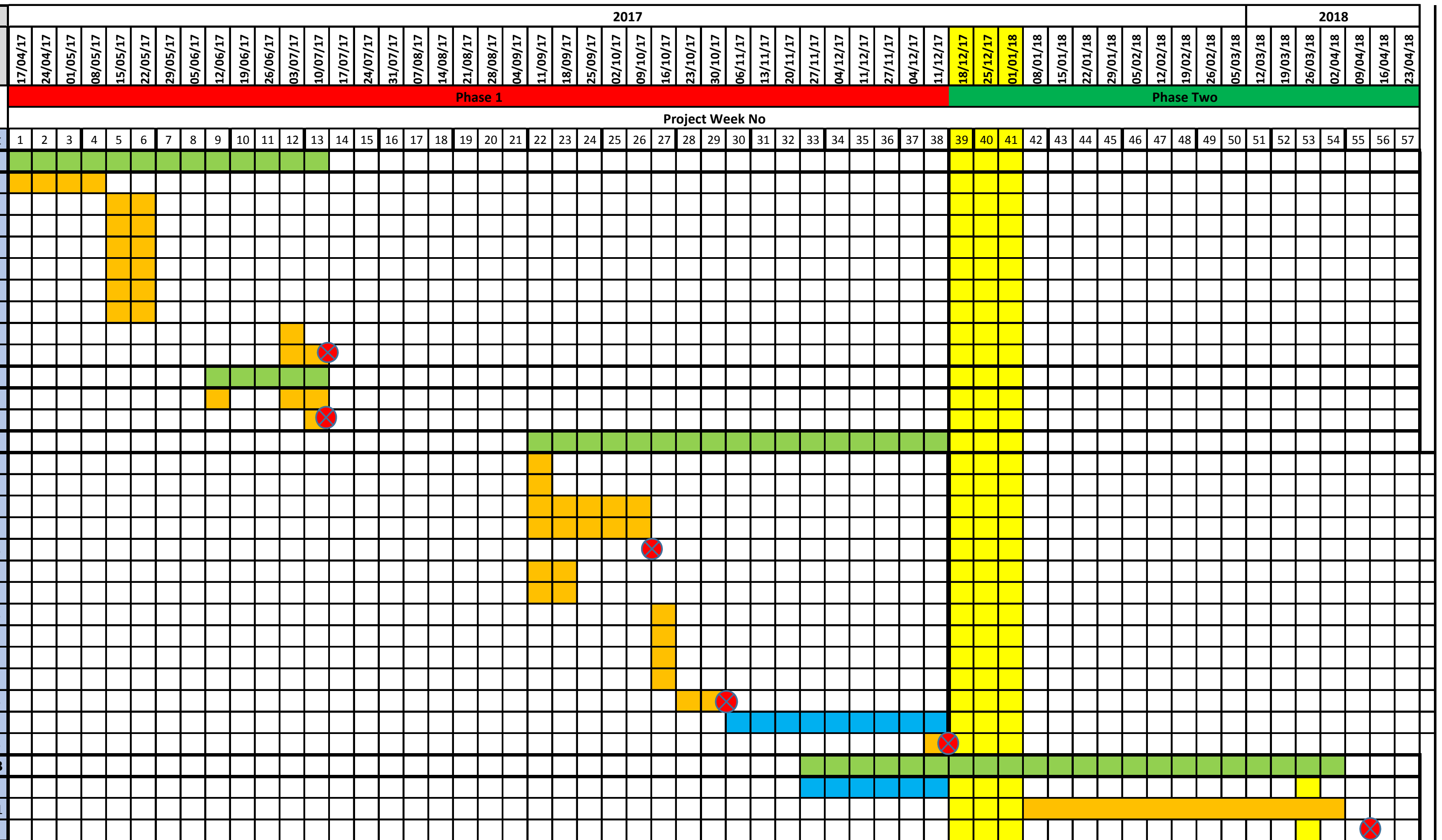
Annex B: Work Programme

ZAM2097A

Draft Work Programme

Team time inputs (days)

Activity	MP	SR	PG	DL	JH	KM	I1	I2	AH	Tot
Inception	**12**	**10**	**9**	**8**	**9**	**8**	**0**	**0**	**0**	**56**
Preparations & Mobilisation		1								1
Consultations with RDA	1	1	1	1	1	1				6
Clarification of ToR										0
Work methodology										0
Identification of candidate Trial Sections										0
Detailed Work Programme										0
Site visits to Trial Sections	6	6	6	6	6	6				36
Workshop	2	1	1	1	1	1				7
Inception Report	3	1	1		1					6
Desk Study	**7**	**2**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**13**
Literature review	4	1	1		1					7
Desk Study Report	**3**	**1**	**1**		**1**					6
Design	**2.5**	**1**	**11.5**	**11**	**15.5**	**20.5**	**0**	**0**	**3**	**65**
Research matrix & experimental design			0.5	0.5						1
Sampling programme & test schedule			0.5	0.5						1
Materials sampling & Transport to lab			5	5		5				15
Lab testing & supervision			3	5						8
Experimental design & Research matrix report	0.5		3	1					1	5.5
DCP tests & Site Investigation					11	11				22
Pavement & Seal design					2	2				4
Bidding documents	0.5	0.5	0.5			2				3.5
Particular Specifications										0
Drawings										0
Compile BoQ & Cost Estimate										0
Draft Design Report	0.5	0.5			2	0.5			2	5.5
Review by RDA & AfCAP										0
Final Design Report (End Phase 1)	1				0.5					1.5
Procurement & Construction	**5**	**0**	**5**	**5**	**20**	**22**	**66**	**0**	**0**	**123**
Negotiations with contractors										0
Supervision	5		5	5	20	20	66			121
Quarterly Reports						2				2

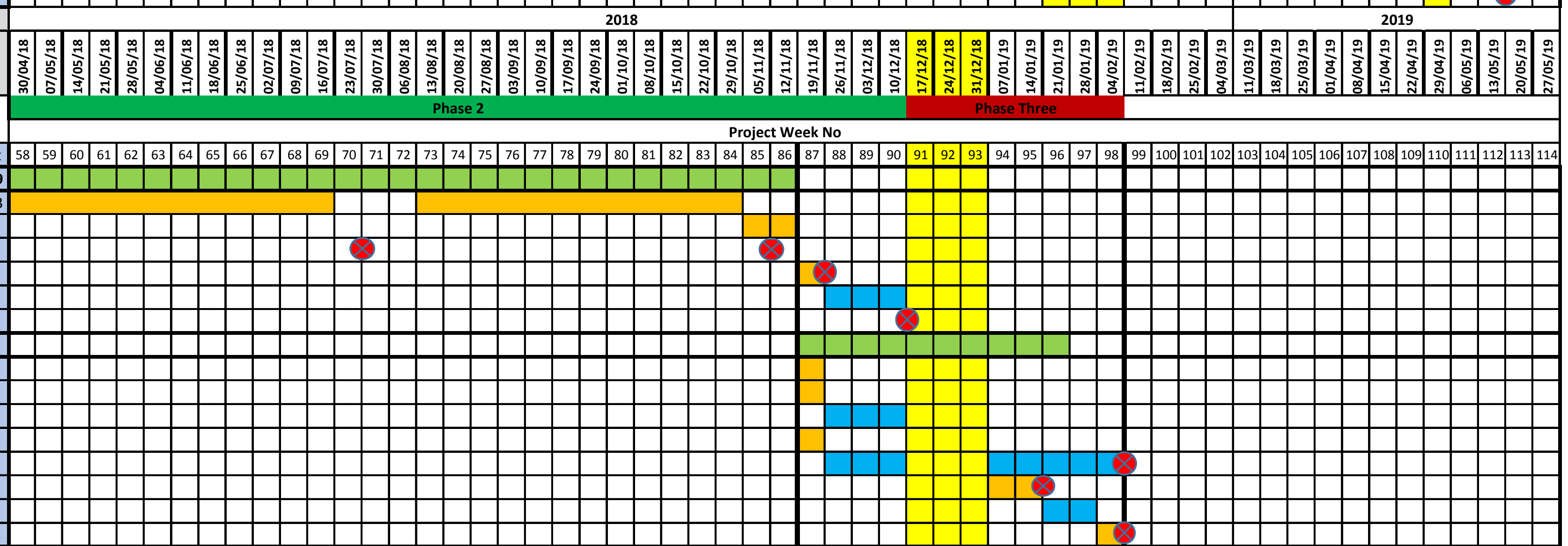


ZAM2097A

Draft Work Programme

Team time inputs (days)

Activity	MP	SR	PG	DL	JH	KM	I1	I2	AH	Tot
Procurement & Construction	**14.0**	**8**	**8**	**8**	**25.0**	**54**	**66**	**66**	**0**	**249**
Supervision	5				16	40	66	66		193
Final inspection & Site Workshops (End Phase 2)	8	8	8	8	8	8				48
Quarterly Reports						3				3
Draft Construction Report	0.5				0.5	2				3
Review by RDA & AfCAP										0
Final Construction Report	0.5				0.5	1				2
Monitoring and evaluation	**10**	**2**	**7.5**	**0.5**	**7.5**	**0.5**	**0**	**0**	**1**	**29**
Monitoring Plan & Baseline data set-up	1		1		1				1	4
Training RDA in baseline data collection	4		4		4					
Baseline data collection										
Revision of standards and specifications	1	0.5	1	0.5	1	0.5				4.5
Technical Papers										0
Draft Project Final Report	3	1	1		1					6
Review by RDA & AfCAP										0
Project Final Report (End Phase 3)	1	0.5	0.5		0.5					2.5
Subtotal	**50.5**	**23**	**43**	**32.5**	**79**	**105**	**132**	**66**	**4**	**535**
Project Management	**18**	**18**								**36**
Total days	**68.5**	**41**	**43**	**32.5**	**79**	**105**	**132**	**66**	**4**	**571**
In Zambia	**29**		**24**		**67**					



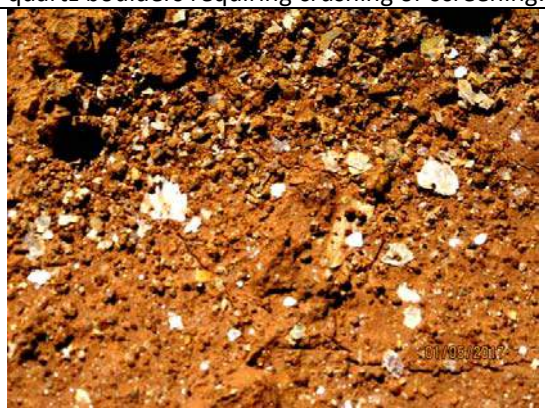
Legend: Activities by RDA/AfCAP; Milestones

- MP M. Pinard (Team Leader)
- SR S. Rattray (Project Director / Ass. Team Leader)
- I1 Inspector 1
- PG P. Paige-Green (Materials Expert)
- DL D. Linsel (Ass. Materials Expert)
- I2 Inspector Two
- JH J. Hongve (LVSR Expert)
- KM K. Mukendi (RE/Ass. LVSR Expert)
- AH Ad Hoc Expert

Annex C: Summary of Site Observations

Site	Observations
Old Great North Road to Lolani Village and Ntipo School	Mostly a narrow sandy earth track, 2 m wide. Thin in situ laterite layer on grey or red soil, mostly worn away.
	
T002 – Nansala Primary School road	Road mostly engineered earth, with side drains and raised formation of drain material.
	
T002 to District Admin Offices	Earth track of in situ laterite, red loam, rock outcrops and boulders.
	

Site	Observations
Musanya primary school road	Short sandy earth track - fit for purpose as is.
Musanya resettlement scheme road	Earth track of white sand - no traffic - fit for purpose as is.
	
Chilubanama Community School Road	White sand track about 2 m wide with channel up to 400 mm deep in places. Quartzitic gravel on ridge areas. Severe erosion and > 20 areas of impeded drainage.
	
Mulakupikwa Secondary School road	First 1 km overgrown white sandy track becoming red loamy and then rocky. 2 m wide mostly - no evidence of motorised traffic.
	

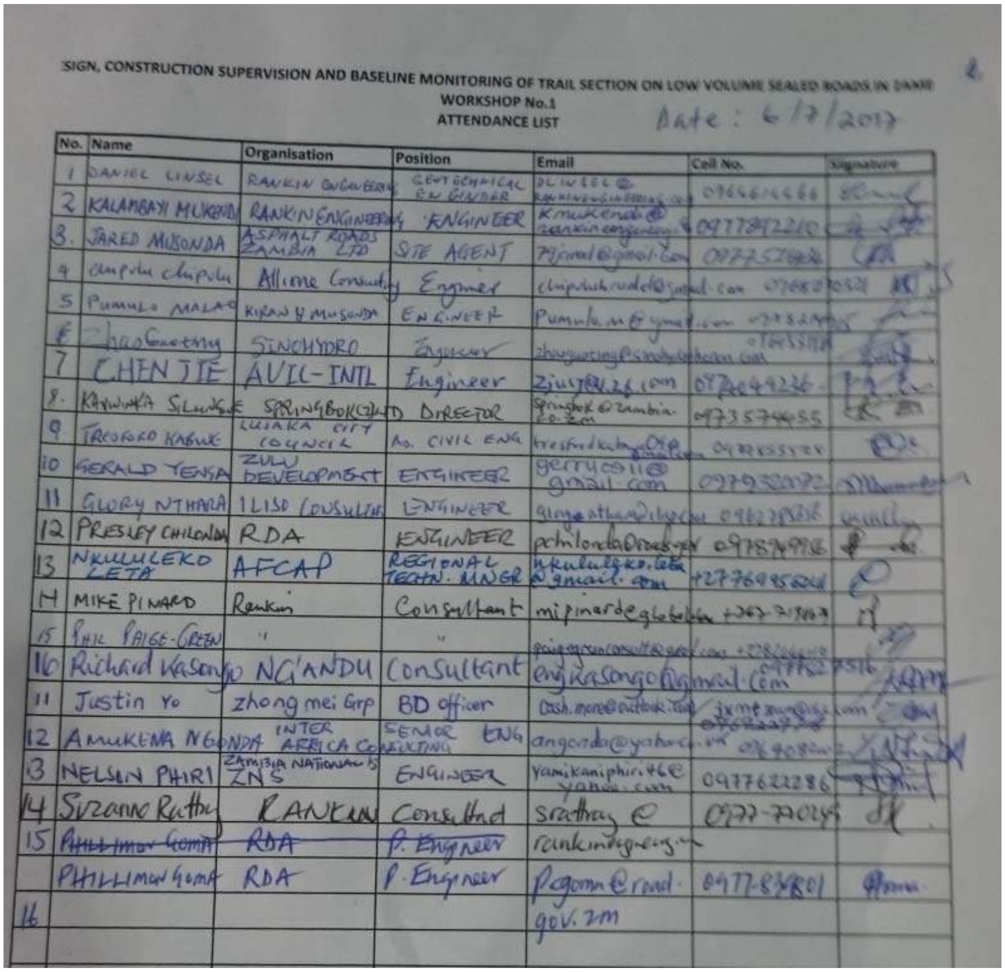
Site	Observations
Kantongo - Waitwika - D001 road	Engineered earth road with localised spot gravelling. Outcrops of rock and hardpan laterite in places on road. 2 - 3 m wide. Badly eroded in some places and good in other places. Evidence of some motorised traffic. Localised areas of weak in situ materials. Some small and narrow, but functional structures.
	
Borrow pit 2 – km 8+300 on T002 Chinsali-Isoka-Nakonde road	Weathered metamorphics with pegmatite veins. Large mica (muscovite) flakes. Oversize quartz boulders requiring crushing or screening.
	
Borrow pit 3 – km 21+800 on T002 Chinsali-Isoka-Nakonde road	Granite "quarry". Hard but weathered material with small excavation in one area. Some large muscovite flakes.
	

Site	Observations
Borrow pit 15 – km 189+150 on T002 Chinsali-Isoka-Nakonde road	Old hard laterite borrow pit. Widespread hardpan exposed.
	
Borrow pit 16 – km 200+200 on T002 Chinsali-Isoka-Nakonde road	Very good but variable laterite in large borrow pit. Need mixing and stockpiling.
	
Borrow pit at km 2.8 along Kantongo-Waitwika road	Small laterite borrow pit at km 2.8, suitable for wearing course and probably base course.
	

Annex D: Record of Stakeholder Workshop

The Inception Workshop was held on 6th July, 2017 at Mapalo Lodge in Lusaka. Twenty-one participants were in attendance. The programme of the Workshop is shown below. The workshop presentations are included in this Annex.

08.30 – 09.00	- Registration
09.00 – 09.05	- Welcome and Opening - RDA Representative
09.05 – 09.10	- Introductory Remarks - AfCAP Representative
09:10 – 09:45	Consultants Presentation - Project Background and Objectives - Approach and Methodology to Implementation - Programme - *Discussion*
09.45 – 10.30	- Activities Carried out to Date Inception meeting Site Visit/Selection of Recommended Trial Section(s) *Discussion*
10.30 – 11.00	- Coffee/Tea break
11.00 – 11.45	- Design, Construction and Monitoring of Trials Section(s) Training and Capacity Building *Discussion*
11.45 – 12.15	- Way Forward: Impending Activities - Roles and Responsibilities - *Discussion*
12.15 – 12.30	- Closing Remarks AfCAP Representative RDA Representative



SIGN, CONSTRUCTION SUPERVISION AND BASELINE MONITORING OF TRAIL SECTION ON LOW VOLUME SEALED ROADS IN ZAMB[illegible]

WORKSHOP No.1

ATTENDANCE LIST

Date : 6/7/2017

No.	Name	Organisation	Position	Email	Cell No.	Signature
1	DANIEL LINSEL	RANKIN ENGINEERING	GEOTECHNICAL ENGINEER	[illegible]	0966614666	
2	KALAMBAYI MUKENDI	RANKIN ENGINEERING	ENGINEER	kmukendi@rankinengineering[illegible]	0977892210	
3.	JARED MUSONDA	ASPHALT ROADS ZAMBIA LTD	SITE AGENT	[illegible]@gmail.com	[illegible]	
4	Chipulu chipulu	Alliance Consultancy	Engineer	[illegible]@gmail.com	[illegible]	
5	PUMULO MALAO	KIRAN & MUSONDA	ENGINEER	Pumulo.m@gmail.com	[illegible]	
6	Zhao Guoting	SINOHYDRO	Engineer	[illegible]	[illegible]	
7	CHEN JIE	AVIC-INTL	Engineer	[illegible]	[illegible]	
8.	KAYWAKA SILUNGWE	SPRINGBOK (Z) LTD	DIRECTOR	springbok@zambia.co.zm	0973574455	
9	TRESFORD KABWE	LUSAKA CITY COUNCIL	As. CIVIL ENG	[illegible]	[illegible]	
10	GERALD YENGA	ZULU DEVELOPMENT	ENGINEER	gerryco11@gmail.com	[illegible]	
11	GLORY NTHARA	ILISO CONSULTING	ENGINEER	[illegible]	[illegible]	
12	PRESLEY CHILONDA	RDA	ENGINEER	pchilonda@roads.gov[illegible]	[illegible]	
13	NKULULEKO LETA	AFCAP	REGIONAL TECHN. MNGR	nkululeko.leta@gmail.com	+2776[illegible]	
14	MIKE PINARD	Rankin	Consultant	mipinard@[illegible]	+267 [illegible]	
15	PHIL PAIGE-GREEN	"	"	[illegible]	+27[illegible]	
16	Richard Kasongo	NG'ANDU	Consultant	engkasongo@gmail.com	[illegible]	
11	Justin Yo	zhong mei Grp	BD officer	[illegible]	[illegible]	
12	AMUKENA NGONDA	INTER AFRICA CONSULTING	SENIOR ENG	angonda@yahoo[illegible]	[illegible]	
13	NELSON PHIRI	ZAMBIA NATIONAL ZNS	ENGINEER	yamikaniphiri[illegible]@yahoo.com	0977622286	
14	Suzanne Rathbun	RANKIN	Consultant	srathbun@rankinengineering[illegible]	0977-[illegible]	
15	~~Phillimon Goma~~	~~RDA~~	~~P. Engineer~~			
	PHILLIMON GOMA	RDA	P. Engineer	pgoma@roads.gov.zm	0977-83[illegible]01	
16						

Figure D-1: Sign-up sheet

Figure D-2: Workshop in Progress

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Stakeholders' Workshop
Lusaka, Zambia, 6th July 2017

Consultants' Presentations

Rankin Engineering
Consultants

Outline Programme

08.30 – 09.00	- Registration
09.00 – 09.05	- Welcome and Opening - RDA Representative
09.05 – 09.10	- Introductory Remarks - AfCAP Representative
09.10 – 09.45	Consultants Presentation - Project Background and Objectives - Approach and Methodology to Implementation - Programme - *Discussion*
09.45 – 10.30	- Activities Carried out to Date Inception meeting Site Visit/Selection of Recommended Trial Section(s) - *Discussion*
10.30 – 11.00	**- Coffee/Tea break**
11.00 – 11.45	- Design, Construction and Monitoring of Trials Section(s) - Training and Capacity Building - *Discussion*
11.45 – 12.150	- Way Forward: Impending Activities - Roles and Responsibilities - *Discussion*
12.15 – 12.30	- Closing Remarks AfCAP Representative RDA Representative

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Project Background and Objectives

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

Background

UKaid
from the British people

- More inclusive economic growth necessitates an increased focus on the development of rural roads in Zambia.

- These invariably lead to reduced costs for agricultural inputs, higher farm gate prices, improved health care for rural communities, and easier access to education and employment opportunities.

Rankin Engineering Consultants

Background

- The importance of focus on rural access is demonstrated by investments currently being made in this sector, including the World Bank funded Improved Rural Connectivity Project.

Rankin Engineering Consultants

Background

- Rural road network in Zambia comprises mostly earth and gravel roads
- Supply of good quality gravel wearing course material is becoming depleted, or may not exist.
- The resulting use of poor quality gravel results in rough road surfaces and related high vehicle operating costs.

Rankin Engineering Consultants

Background

- Unsealed roads create dust, which damages crops, creates health risks for road-side communities, and is a hazard for road users.

- There is an urgent need to find more economical ways of providing access to the majority of the population, who live in rural areas.

Rankin Engineering Consultants

Background

Within the context of enabling provision of more rural roads in an environmentally optimised and sustainable manner, the UK Department for International Development (DFID), through the Africa Community Access Programme (AfCAP) has provided resources to further the state of knowledge with regard to provision of low volume sealed roads in Zambia.

Rankin Engineering Consultants

Background

- This is being achieved through financing of a project for the “Design, Construction Supervision and Baseline Monitoring of Trial Sections on Low Volume Roads in Zambia”.

- The success of Zambia’s programme of sealing rural roads will depend on the adoption of pavement design standards, materials specifications and construction techniques that are appropriate to low volume roads.

Rankin Engineering Consultants

Background

- The AfCAP project is expected to provide technical solutions to reduce the life cycle cost of rural roads at an appropriate level of service.

- Project outputs will also provide information relevant to development of a Pavement Design Manual for Low Volume Roads

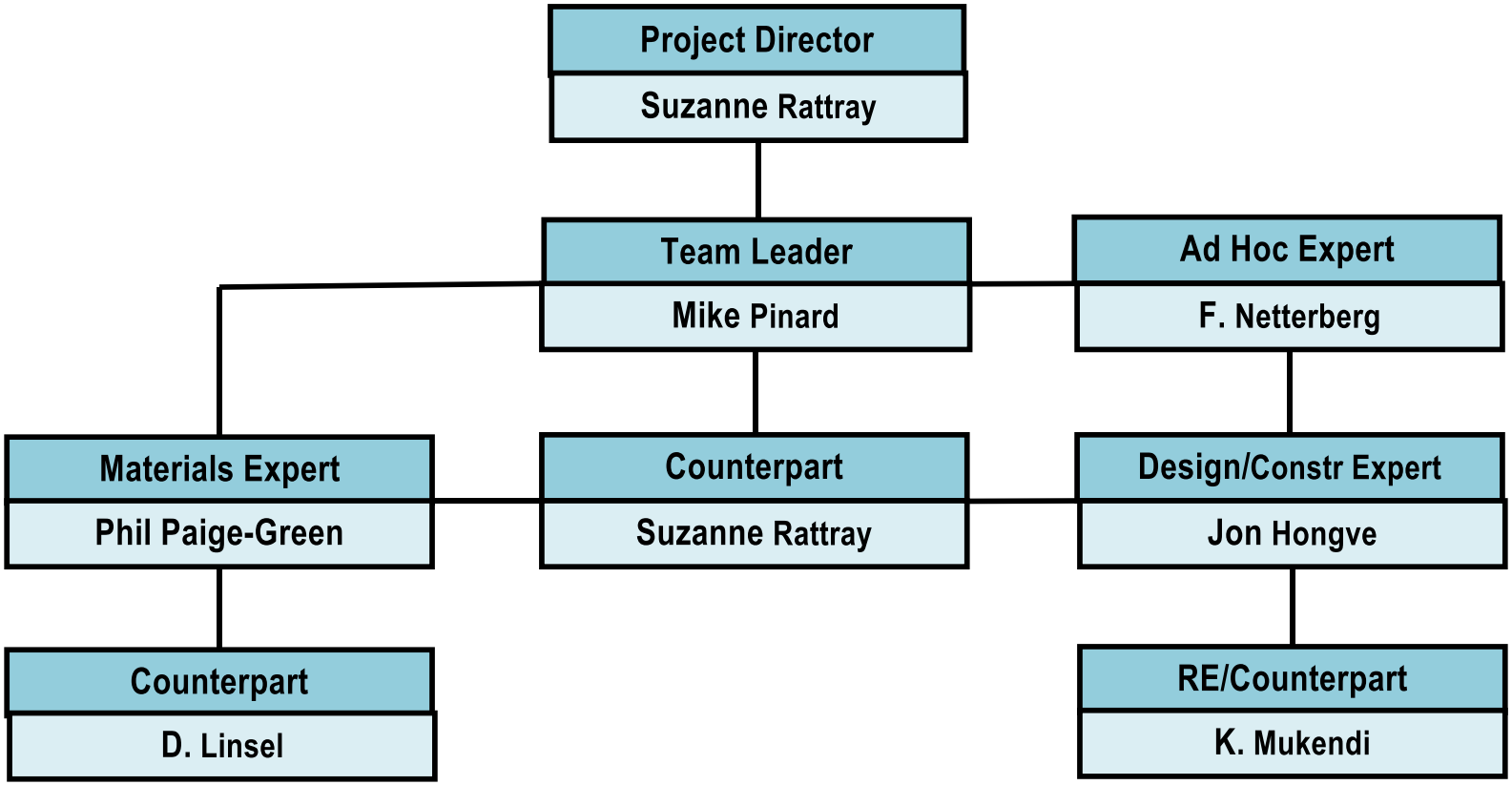
Rankin Engineering Consultants

Project Procurement

- June 2016 – Invitation to Tender
- Original intention for projects in Eastern and Western Zambia
- Tenders submitted in August 2016
- Offer accepted in November 2016
- Scope changes delayed contract till April 2017

Rankin Engineering Consultants

Consultant's Organisation Chart



Rankin Engineering Consultants

Project Objectives

- To carry out pavement design of Low Volume Sealed Roads (LVSR) using the DCP-DN method
- Construction of trial sections to sealed standard, using various seal types and using locally-available materials

Rankin Engineering Consultants

Project Objectives

- Establishment of an experimental research matrix
- Training and capacity building component
  - RDA Research Unit - on research procedures and supervision of construction and technical monitoring in accordance with regional protocols.

Rankin Engineering Consultants

Project Objectives

- Training and capacity building component – cont'd
  - Private sector, construction industry, as well as academic and training institutions.
  - Dissemination of the findings of the study through visits to the demonstration sites, workshops, and conference papers.

Rankin Engineering Consultants

Project Objectives

- At the completion of construction, baseline data will be collected and a programme of long-term pavement performance monitoring (LTPP) will be established.

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Approach and Methodology Implementation

Rankin Engineering Consultants

Traditional Approaches to LVR Provision

- Have stemmed from technology and research carried out over 40 years ago in very different environments
- Generally inappropriate for application to tropical and sub-tropical countries where locally prevailing circumstances very different in terms of climate, traffic, materials and road users.
- Technology, research and knowledge about LVSRs have advanced significantly in the region thro' research carried out over past 20 -30 years
  - question much of the accepted wisdom on LVSR provision and show quite clearly the need to revise conventional approaches.
- New, more appropriate, approaches to the provision of low-volume roads are now required if Zambia is to improve road transport efficiency and attain its broader goals of socio-economic growth, development and poverty alleviation.

Developments in LVR Technology

- Approach informed by significant developments that have taken place in various aspects of LVRs in past few decades based on UK-supported LVR research and investigations carried out in Asia and Africa under the SEACAP and AFCAP programmes respectively.

- Outputs of these programmes have questioned many of the accepted approaches to the provision of LVRs and have shown quite clearly the need to revise them in line with new developments.

- This has led to an increasing move away from the conservative, and often inappropriate, approaches of the past to more progressive approaches informed by research and performance-based evidence

Rankin Engineering Consultants

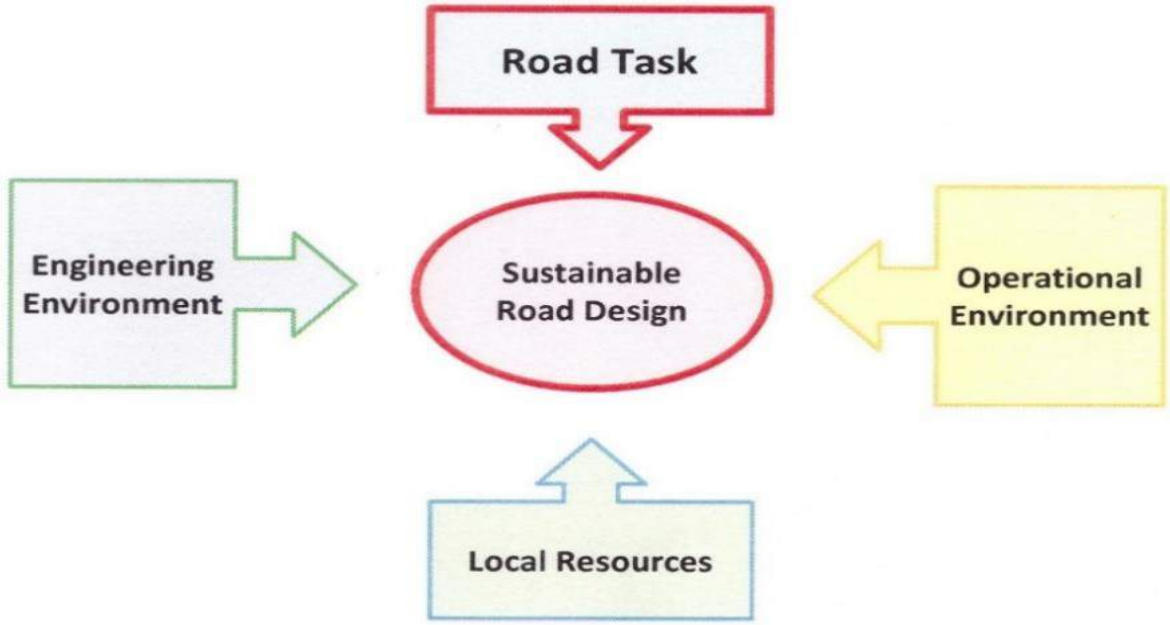
New Approaches to LVR Provision

- An environmentally optimised design (EOD) approach to the provision of LVRs.
- The DCP-DN method of pavement design.
- Modified specifications for the use of “non-standard” pavement materials, including laterites, sands and calcretes.
- A number of labour-friendly surfacings such as Cold Mix Asphalt and Otta Seals that can be constructed with locally available, naturally occurring aggregates.
- Improved methods for compaction quality control using the Dynamic Cone Penetrometer (DCP).

Rankin Engineering Consultants

Environmentally Optimised Design

- To obtain optimal results from investments in road infrastructure in Zambia, important to adopt an approach that is guided by appropriate local standards and conditions.
- International research has highlighted the benefits of applying the principles of EOD to the provision of LVRs in a manner that is compatible with the local road environment.



Rankin Engineering Consultants

Elements of EOD

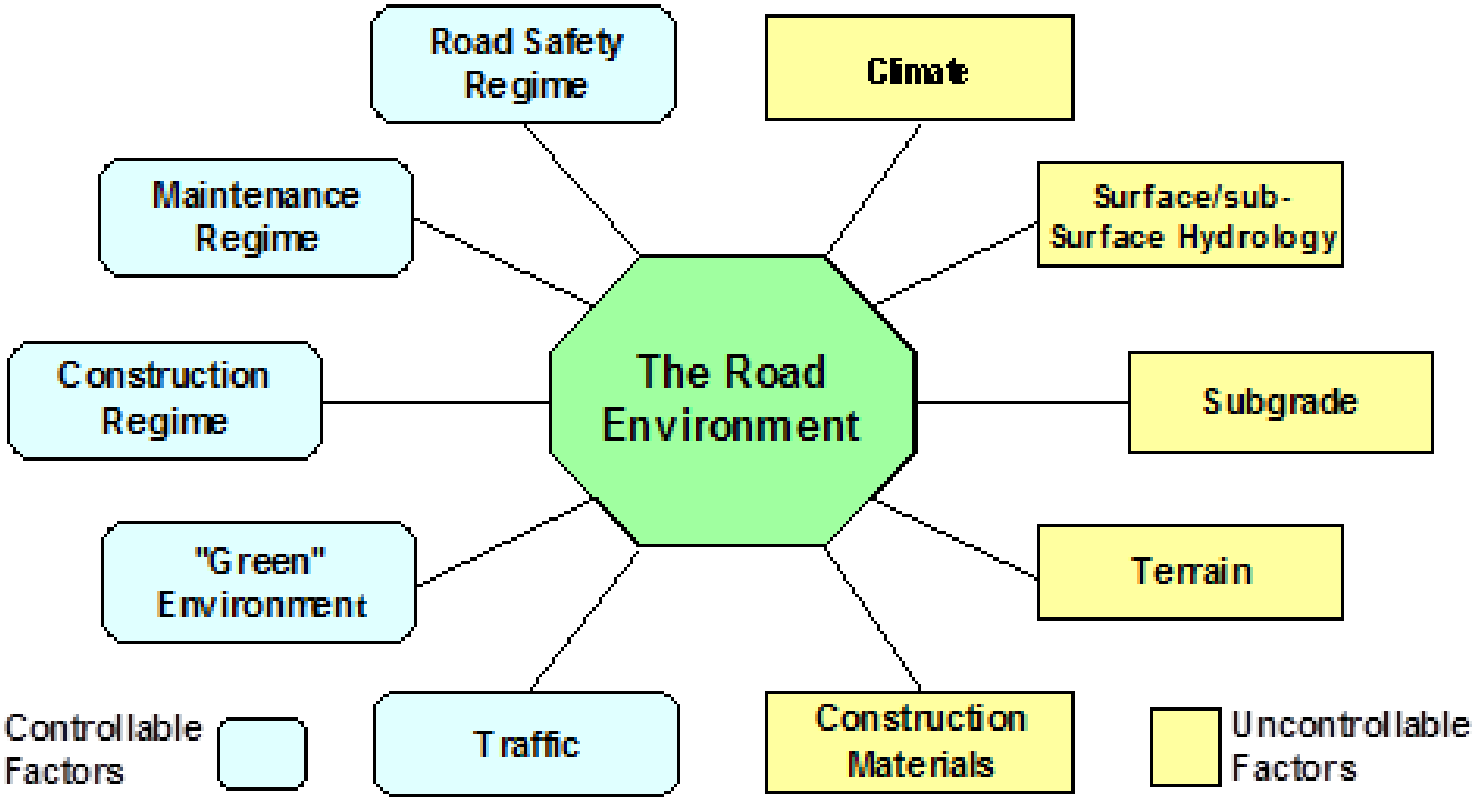
1. **Task based:** LVRs must suit their identified function and the nature of the traffic (the people as well as the vehicles) which will pass along them, by applying appropriate standards.

2. **Local resource based:** Design must be compatible with the construction materials that are readily available within appropriate specifications, and within the capacities of the engineers and technicians who will design the roads, and the contractors who will construct them, and within the means of the roads agency to maintain them, involving local communities, where possible.

3. **Environmentally Compatible:** Suitable for, and where necessary, adapted to the local road environment factors.

Rankin Engineering Consultants

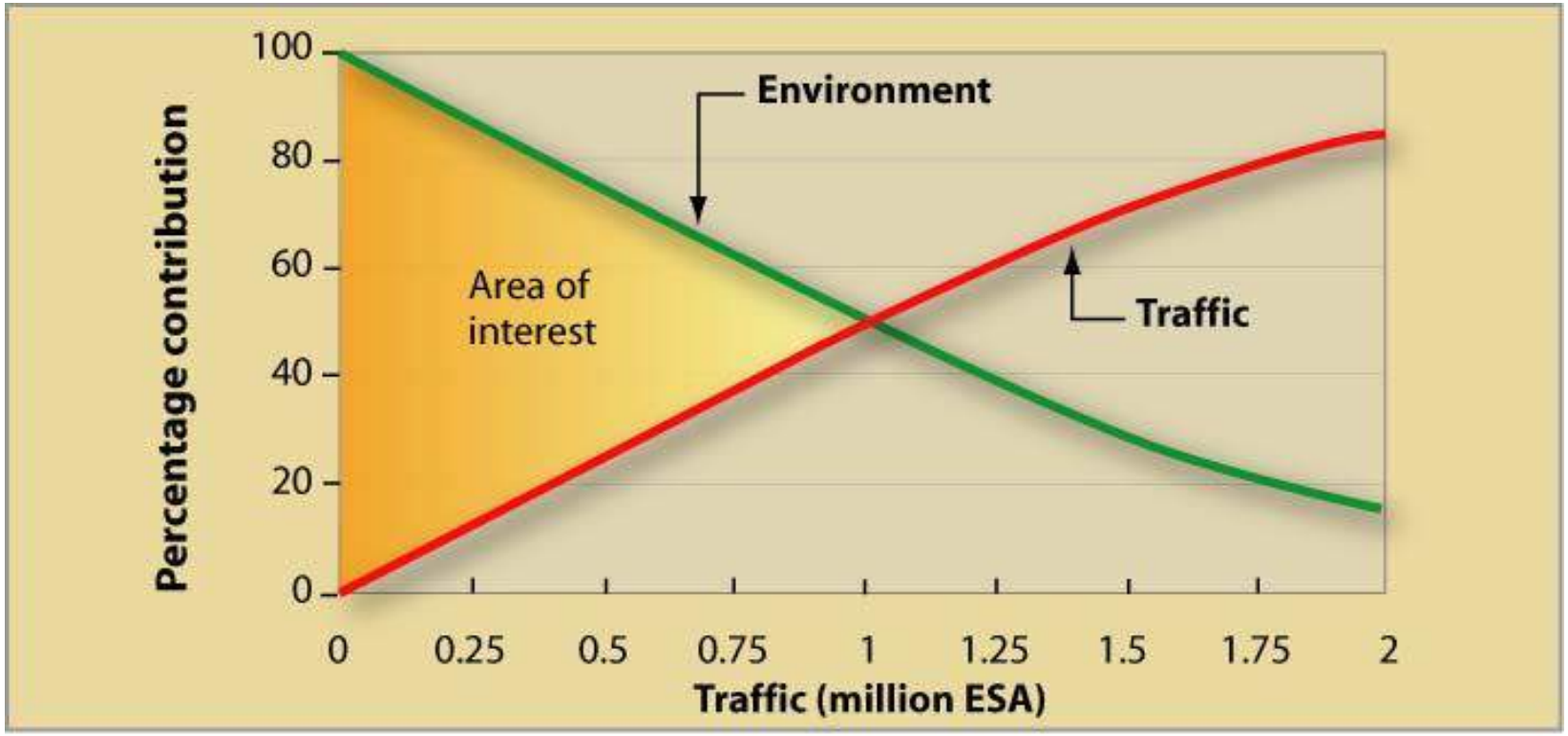
Road Environment Factors



The design of every LVR project is context sensitive in relation to the impact of various road environment factors that uniquely affect their design

Rankin Engineering Consultants

Dominant Mode of Deterioration



Deterioration of a LVR is driven primarily by environmental factors, with traffic being a lesser factor in deterioration

Use of Non-Standard Materials

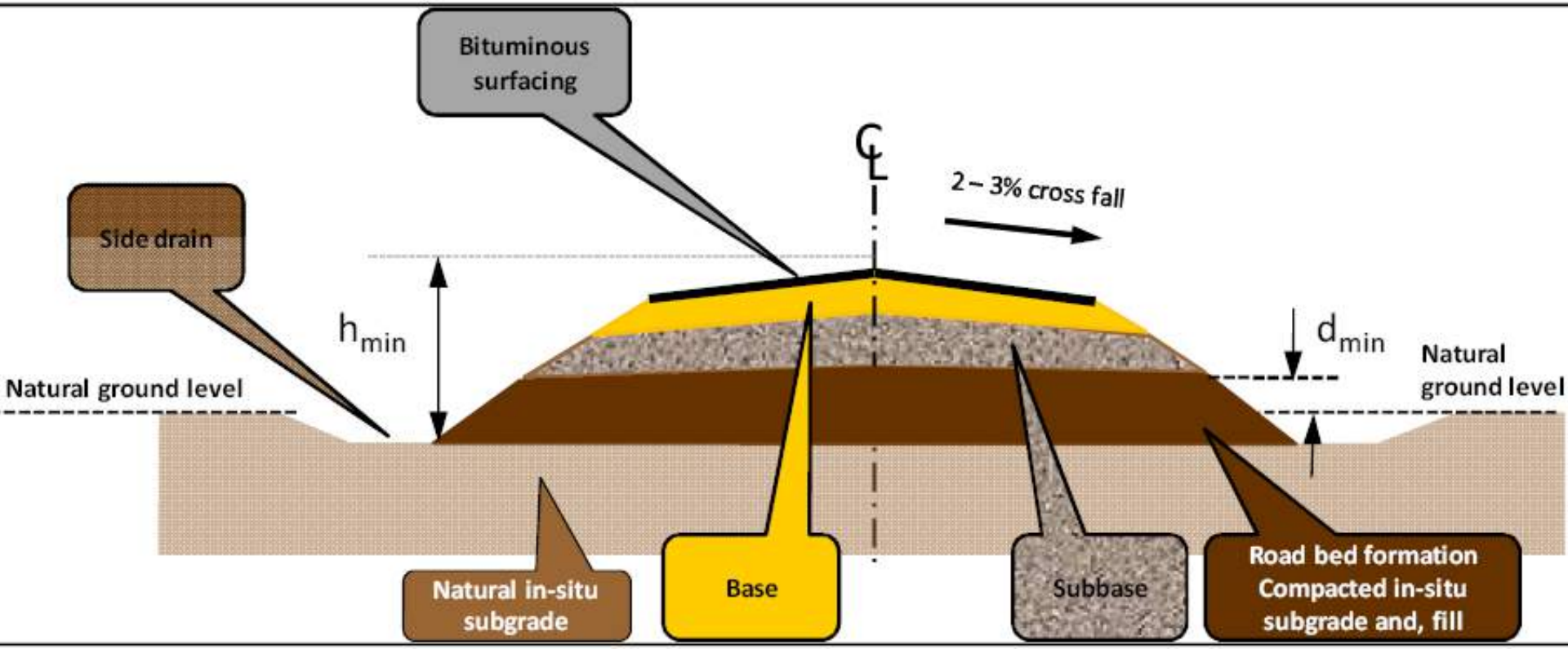
- Locally available, but possible non-standard, materials should play a significant role within LVSR Standards and Specifications. Unfortunately, force of habit and rigid application of conventional specifications & lack of innovation have suppressed the more wide-spread use of local materials

- Need to make specifications fit the materials rather than materials fit the specifications. In other words – "*what appropriate road can I build with these materials" rather than "Where can I find materials to meet these general specs".*

Optimization of Local Moisture Conditions

Ensure adequate drainage – fundamental!

- h_{min} and d_{min}
- h_{min} > 750 mm
- d_{min} > 150 mm

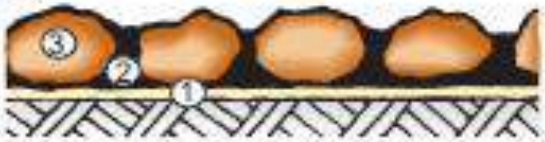


Bituminous Surfacing Options

Menu of surfacing options for consideration

SAND SEAL
1 Prime
2 Binder
3 Sand

SINGLE SURFACE DRESSING
1 Prime
2 Binder
3 Stone

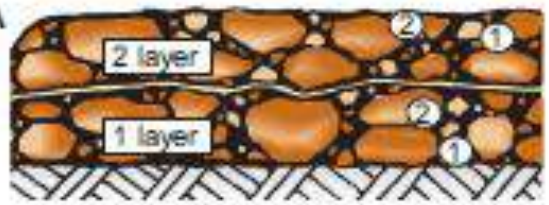


DOUBLE SURFACE DRESSING
1 Prime
2 Binder
3 Large Stone
4 Binder
5 Small Stone

CAPE SEAL
1 Prime
2 Binder
3 Stone
4 Slurry

SINGLE OTTA SEAL
No Prime
1 Binder
2 Graded aggregate

DOUBLE OTTA SEAL
No Prime
1 Binder
2 Graded aggregate



COLD MIX ASPHALT
1 Tack
2 Asphalt Premix

ReCAP
Research for Community Access Partnership

Cold Mix Asphalt

UKaid
from the British people

Examples of Non-Bituminous Surfacings


Cobble stone


Burnt clay brick


Concrete Blocks


Concrete Strip Roads


Reinforced concrete

New Approaches to LVR Provision

- In moving new developments from research to practice, critically important to undertake effective technology transfer in terms of dissemination of findings through demonstration projects, development of new manuals and capacity building.

- Attainment of above requirements is an integral aspect of the proposed the project and reflected in approach and methodology for undertaking the project.

- New approach of much importance to Zambia where a number of large rural roads investment programmes are already under way which offer tremendous scope for substantially reducing the life-cycle costs of such roads whilst still providing an appropriate level of service.

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Programme

Rankin Engineering Consultants

Outline Scoping of Project

	Phase 1: Inception & Design Weeks 1 - 35		Phase 2: Procurement & Construction Weeks 36 - 74		Phase 3: Monitoring & Evaluation Weeks 75 - 98
1.1	**Inception**	2.1	**Procurement**	3.1	**Reporting**
	• Preparation & mobilisation		• Negotiations with contractors		➢ Quarterly progress reports
	• Consultations with RDA	2.2	**Supervision of construction**		➢ Draft Construction Report
	• Site Visits to Demo Sections		• Assist RDA supervise constr.		• Review by RDA and AfCAP
	• Hold workshop		• Final inspection	3.2	**Monitoring**
	➢ Inception Report	2.3	**Workshops**		• Monitoring plan
1.2	**Desk Study**		• 2 No. site workshops		• Collection baseline data
	• Literature review		**END PHASE 2**		• As-built records
	➢ Desk Study Report			3.3	**Revision of design stds & specs**
1.3	**Research matrix & exp. design**			3.4	**Reporting**
	• Sampling prog. & test schedule				➢ Final Construction Report
	• Materials sampling & transport			3.5	**Technical papers**
	• Lab testing & supervision				• Provide guidance to RDA staff
	➢ Experimental Design & Research Matrix Report			3.6	**Final Reporting**
	• DCP tests & site investigations				➢ Draft Final Project Report
	• Pavement & surfacing design				• Review by RDA/ReCAP
	• Bidding documents				➢ Final Project Report
1.4	**Design report**				**END PHASE 3**
	➢ Draft Design Report				
	• Review by RDA & AfCAP				
	➢ Final Design Report				
	END PHASE 1				

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Discussion

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Inception Activities

Rankin Engineering Consultants

Kick-off Meeting

- 25th April 2017 in Lusaka
- Consultant's team comprising Suzanne Rattray, Mike Pinard, Jon Hongve in attendance
- Apologies from Phil Paige-Green
- AfCAP representative
- RDA Representatives

Rankin Engineering Consultants

Kick-off Meeting

- The RDA introduced the counterpart on this project is Eng. Phillimon Goma, Principal Engineer, Research and Development.
- For the next phase of the project in Muchinga Region, support will be assigned by the Regional Manager

Rankin Engineering Consultants

Kick-off Meeting

Demonstration sections

- Will form part of the AfDB funded programme off the T2 between Chinsali and Nakonde
- Coordination with this project is required
- A nominal design for the demonstration sections will be provided to enable the AfDB project to reflect those costs

Rankin Engineering Consultants

Kick-off Meeting

Road List from Muchinga

- The Councils of Chinsali, Isoka and Nakonde provided RDA with a list of priority roads for inclusion under AfDB funded programme
- A screening exercise was carried out to identify possible candidate sections
- At the start-up meeting, it was agreed that only 1 or 2 sections would be selected to total 1km.

Rankin Engineering Consultants

Site Visit to Muchinga

- The full project team undertook the site visit during the week of 30th April.
- The team was accompanied by Eng. Wanzi Zulu from Muchinga Region
- Project roads in all three districts, as well as known material sources, were inspected.

Rankin Engineering Consultants

Feedback Meeting

Follow- up meeting on May 17, 2017

- A brief follow-up meeting between the Consult and, RDA and AfCAP representatvie was held on the sidelines of the T2 conference in Livingstone
- The findings of the field-visit, were presented.
- The next slides will give details of the selection of demonstration sections.

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Site Visit/Selection of Recommended Sections

Rankin Engineering Consultants

Selection Criteria

1. Sites must be carefully selected - to get maximum benefit from the demonstration projects
2. Sections should be 500 m to 1 kilometre long - preferably two shorter sections of not less than 500 m.
3. Two sections would provide sufficient information
4. Also allow the incorporation of at least two variables (individually), e.g. weak and strong subgrade or flat and steep grades plus two different surfacing options

Selection Criteria

1. Selected sections must carry adequate traffic to provide the normal traffic-related distress
2. Most of the roads inspected carried no traffic - either impassable or insufficient activity along their routes to attract any traffic

Identified Roads

		Length (km)
1.	Chinsali Municipal Council:	
2.	Nambuluma Health Centre	0.2
3.	Nambuluma Primary School	0.3
4.	Mulakupikwa Secondary School	2.0
5.	Chilubanama Community School and Rural Health Cen	14.0
6.	Machango Primary School	0.2
7.	Kapimpa Primary School	0.2
8.	Lubu Farms	0.5
9.	Chipunga Primary School	0.25
10.	Kapili Primary School	0.15
11.	Musanya Resettlement	1.35
12.	Musanya Primary School	0.5
13.	Chifuma Primary School	0.15
14.	Vitondo Primary School	0.2

Identified Roads

Isoka District Council:

	Length (km)
Old Great North Road to District Administrative Offices	4.0
Old Great North Road to Lolani Village	5.5
Old Great North Road to FRA (Mwenya Township)	5.0

Old Great North Road to FRA (Mwenya Township) road was disqualified, and was replaced with T002 – Nansala Primary School road.

Nakonde District Council:

	Length (km)
T002 – Mayembe	5.0
T002 – Iwula – Vyonga	4.5
T002 – Kantongo – Waitwika	5.5

Summary of characteristics of roads inspected (example of table)

Points	Latitude	Longitude	Description	Soil type	Geology	Material types
2	-10° 06.687'	032° 40.537'	End of road Ntipo Secondary School)	Lithasol/ferral sol	Quaternary	Colluvial deposits with thin laterite hardpan
3	-10° 06.886'	032° 40.386'	Start of road (Old Great North Road to Lolani Village)	Lithasol/ferral sol	Quaternary	Colluvial deposits with thin laterite hardpan
4	-10° 07.095'	032° 40.261'	Near Ntipo school	Lithasol/ferral sol	Quaternary	Colluvial deposits with thin laterite hardpan
5	-10° 11.308'	032° 38.523'	Start of T002 – Nansala Primary School road	Lithasol/ferral sol	Nkanza quartzite, Mansha River Group, Muva	Weathered quartzites

Inspection Examples

T002 to District Admin Offices

Earth track – in situ laterite, red loam, rock outcrops and boulders

Musanya resettlement scheme road

Earth track of white sand - no traffic - fit for purpose as is.

Kantongo - Waitwika - D001 road

Engineered earth road -localised spot gravelling. Rock and hardpan outcrops in places on road. <3 m wide. Eroded with localised weak in situ soil

Borrow Pits ??

Borrow pit 16 – km 200+200

Borrow pit at km 2.8 along Kantongo-Waiwika road

Selected Road

1. Considered all options
2. Most suitable candidate road

Kantongo-Waitwika-D001 road

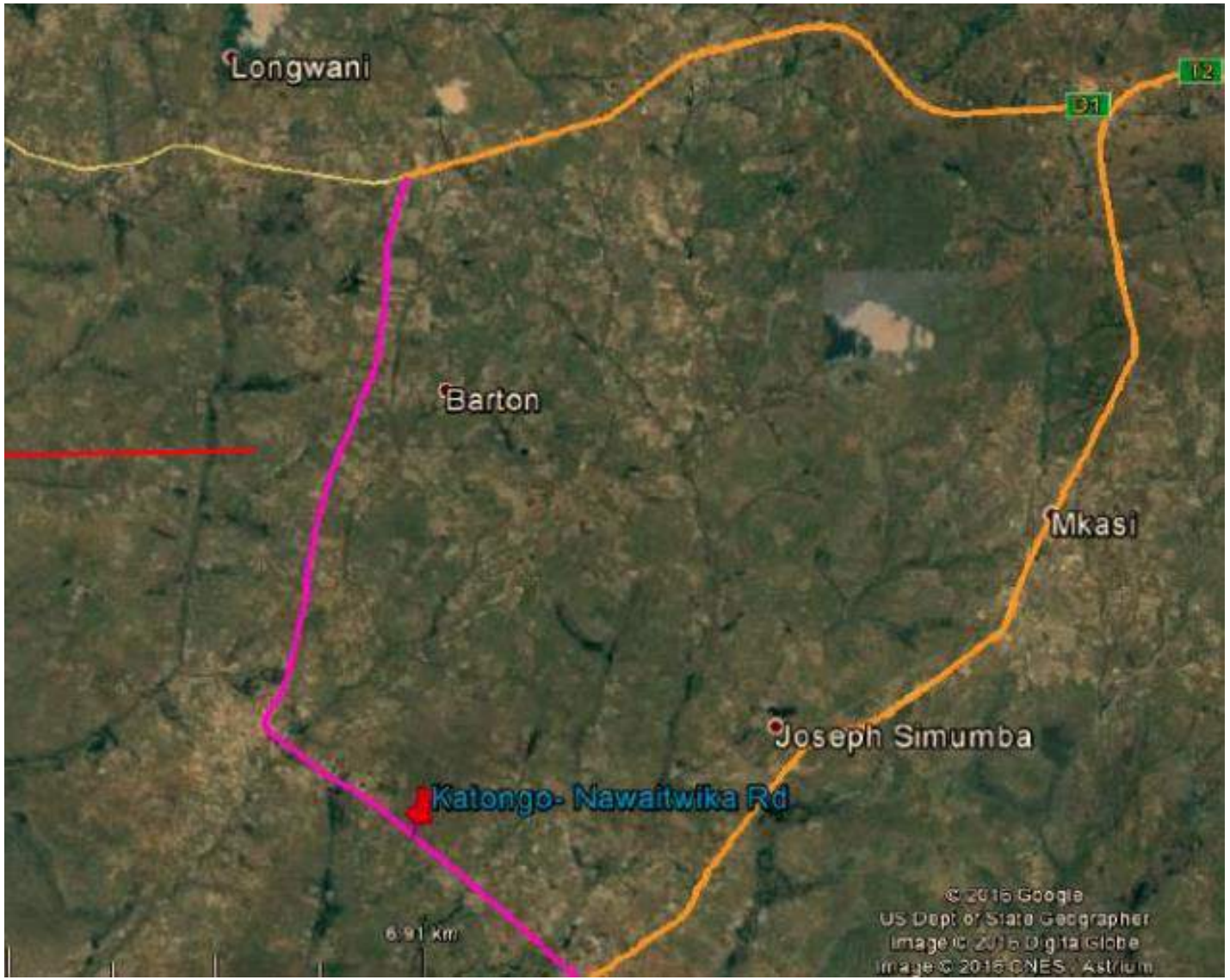
Recommendation

1. This is currently the only road that is passable for its full length (although some areas may prove problematic for normal saloon cars)
2. There is evidence of traffic (although low) currently using the road
3. A potentially suitable borrow pit exists next to the road
4. Other potential borrow pits exist in relatively close proximity (within 15 km
5. The road has various subgrade, wearing course and width conditions

Recommendation

6. The road includes flat sections and some relatively steep grades
7. Areas of the road need extensive repairs, raising of the formation and widening
8. Various sections along the road would provide suitable candidate sites for the demonstration project
9. The terms of reference required specifically the use of non-standard materials, a laterite as proposed for this project being a typical example.

Road Location



ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Discussion

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Design, Construction and Monitoring of Trial Section(s)

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

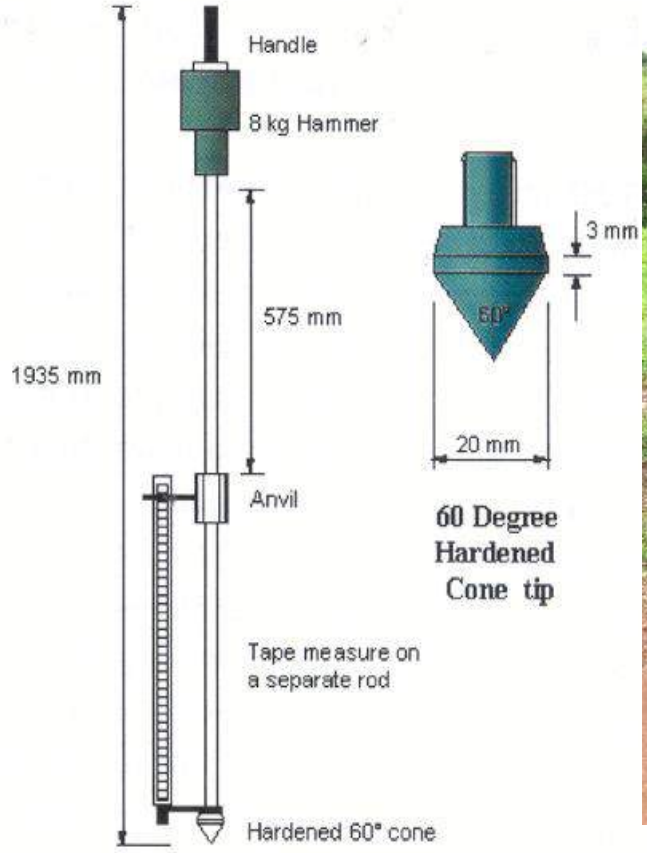
UKaid
from the British people

Design Aspects

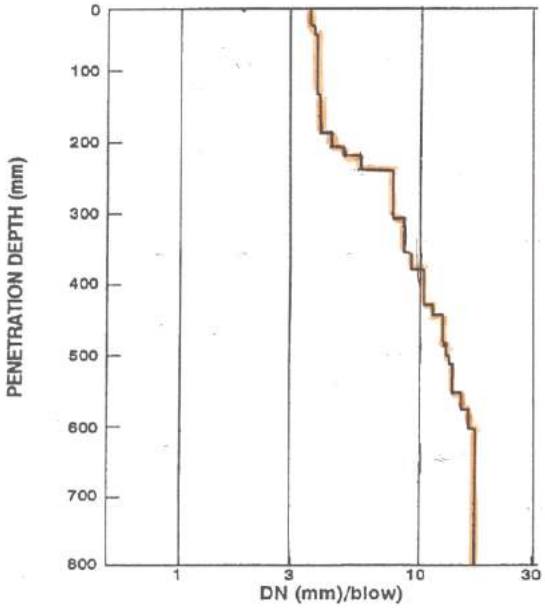
Design of Low Volume Roads

- General approach to the design of LVRs differs in a number of respects from that of HVRs.
  - conventional pavement designs generally directed at relatively high levels of service requiring numerous layers of selected materials.
  - significant reductions in the cost of the pavement for LVRs can be achieved by:
    - reducing the number of pavement layers and/or layer thicknesses
    - using local materials more extensively as well as lower cost, more appropriate, surfacing options and construction techniques.

The Dynamic Cone Penetrometer (DCP)



DCP test in process



DCP – Gender Friendly!!!

DCP test in process

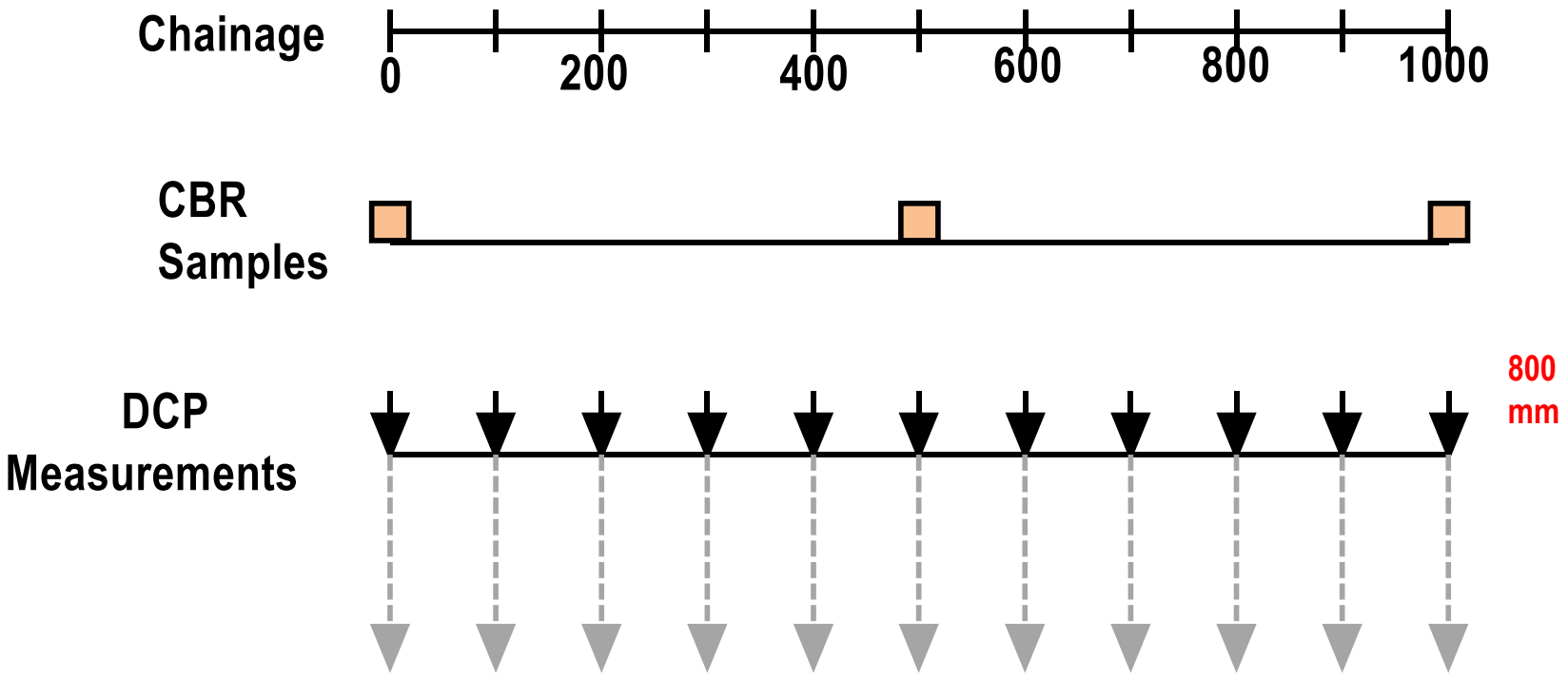
CBR – Very Poor Reproducibility

- The CBR test is notoriously inaccurate with low reproducibility
- Does not correlate well with performance

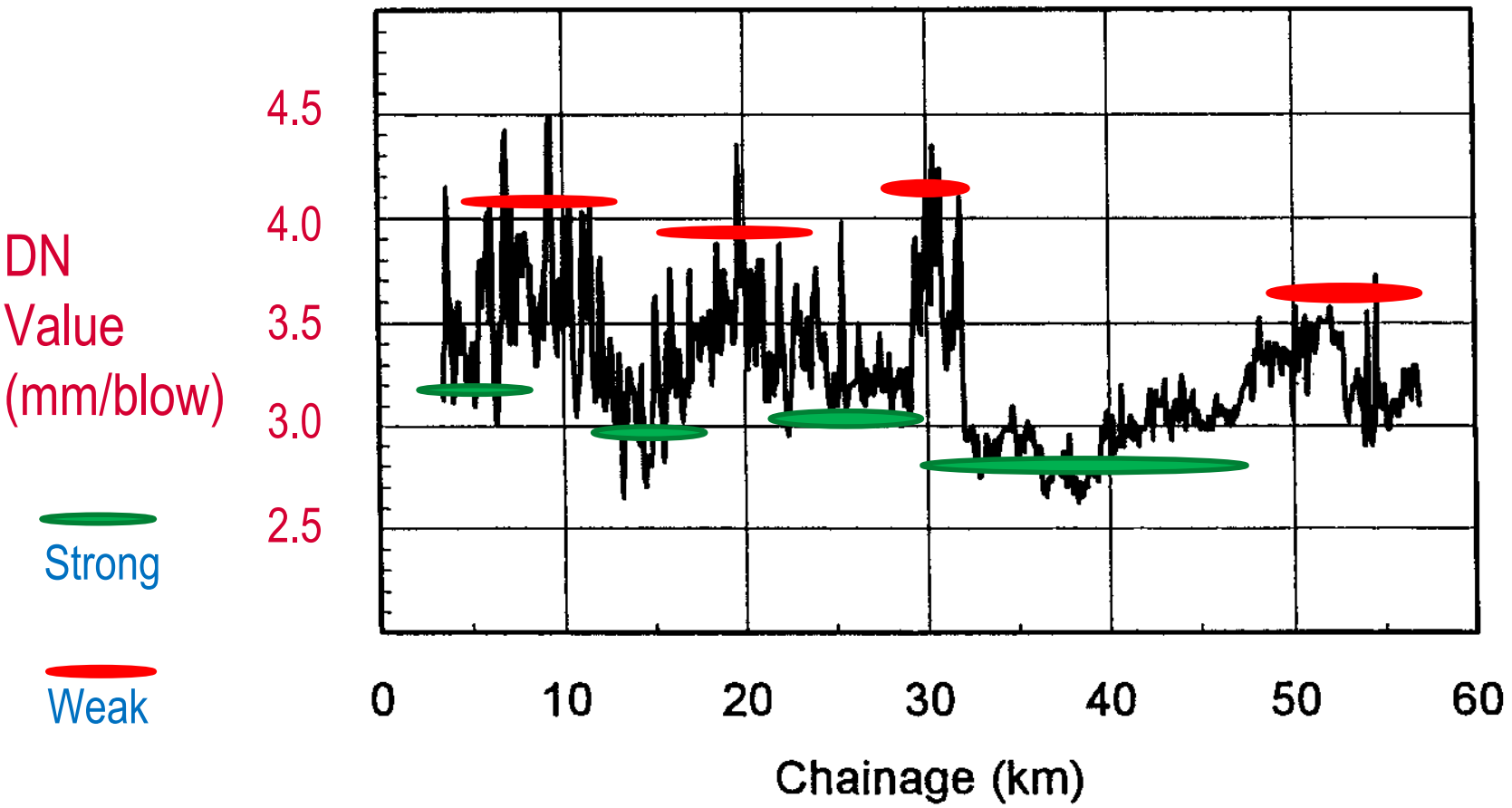
Standard deviation (σ) = 10^{w} where w = $(1.4771-0.9853^{CBR})$

CBR	σ	95% confidence	Range
10	4	± 8	2 – 18
30	7	± 14	16 – 44
60	12	± 24	36 – 84
80?	16	± 32	58 – 122

Site Investigations: DCP Vs CBR



Characterisation of Existing Road



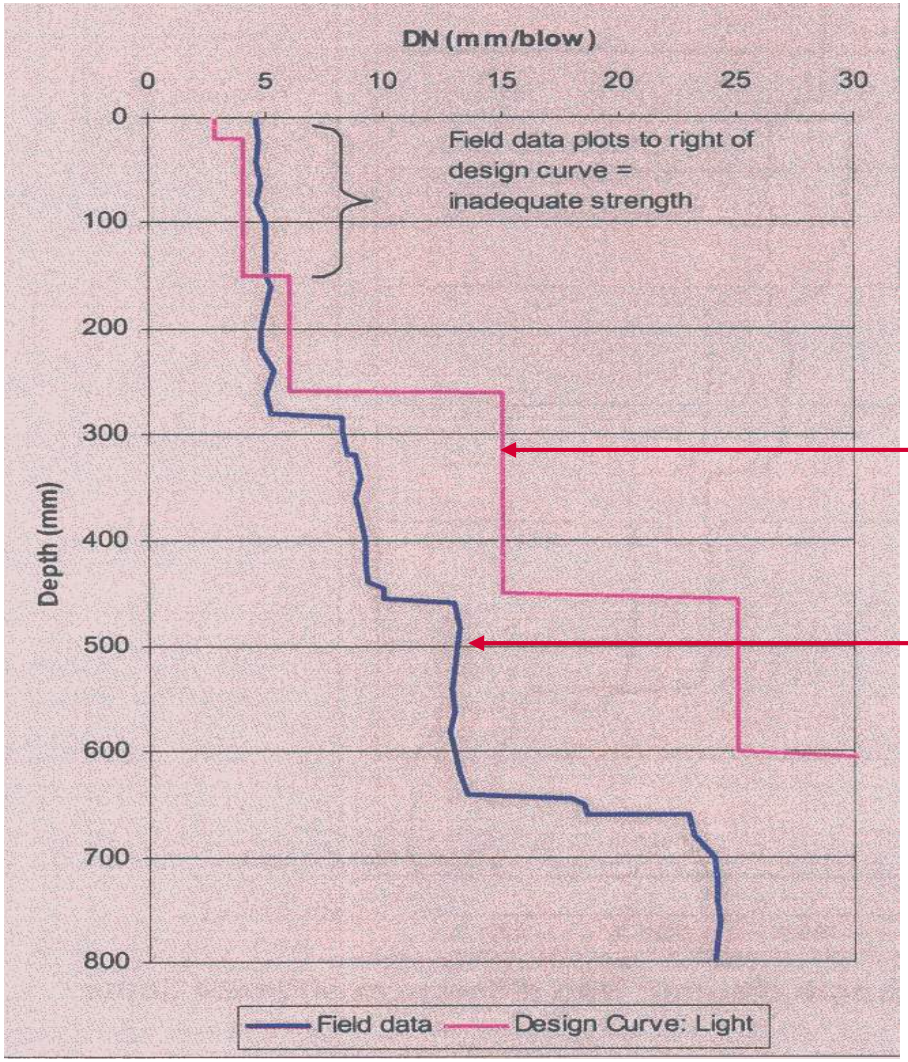
DCP provides a good "picture" of in situ ground conditions

Allows uniform sections to be determined

DCP Design Catalogue

Traffic Class E80 x 10^6	LE 0.01 0.003 – 0.010	LE 0.03 0.010 – 0.030	LE 0.1 0.030 – 0.100	LE 0.3 0.100 – 0.300	LE 0.7 0.300–0.700	LE 1.0 0.700 – 1.0
0- 150mm Base ≥ 98% MAASHTO	DN ≤ 8	DN ≤ 5.9	DN ≤ 4	DN ≤ 3.2	DN ≤ 2.6	DN ≤ 2.5
150-300 mm Subbase ≥ 95% MAASHTO	DN ≤ 19	DN ≤ 14	DN ≤ 9	DN ≤ 6	DN ≤ 4.6	DN ≤ 4.0
300-450 mm subgrade ≥ 95% MAASHTO	DN ≤ 33	DN ≤ 25	DN ≤ 19	DN ≤ 12	DN ≤ 8	DN ≤ 6
450-600 mm In situ material	DN ≤ 40	DN ≤ 33	DN ≤ 25	DN ≤ 19	DN ≤ 14	DN ≤ 13
600-800 mm In situ material	DN ≤ 50	DN ≤ 40	DN ≤ 39	DN ≤ 25	DN ≤ 24	DN ≤ 23
DSN 800	≥ 39	≥ 52	≥ 73	≥ 100	≥ 128	≥ 143

Integration of In Situ and Required Strength Profiles



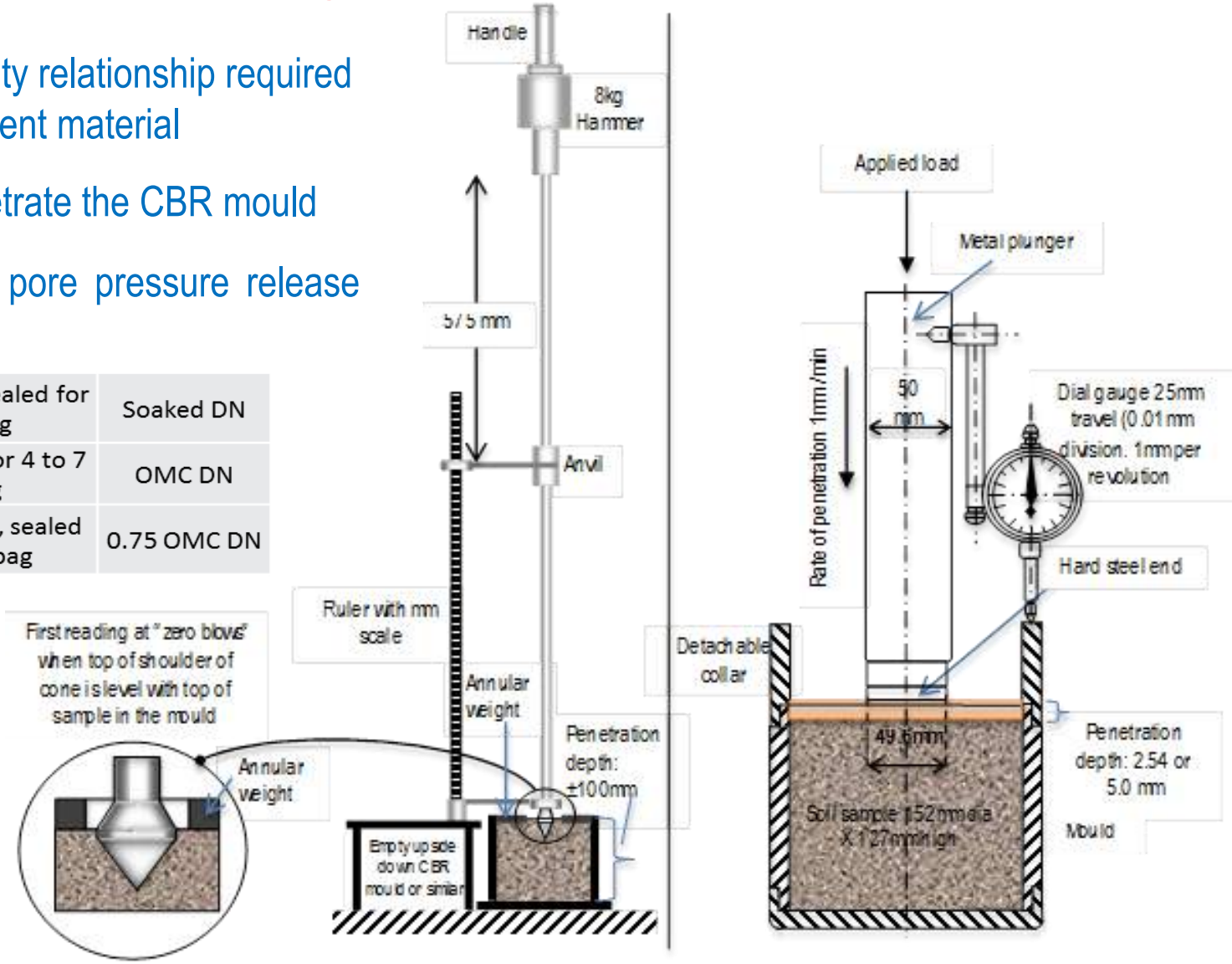
Required strength profile

In situ strength profile

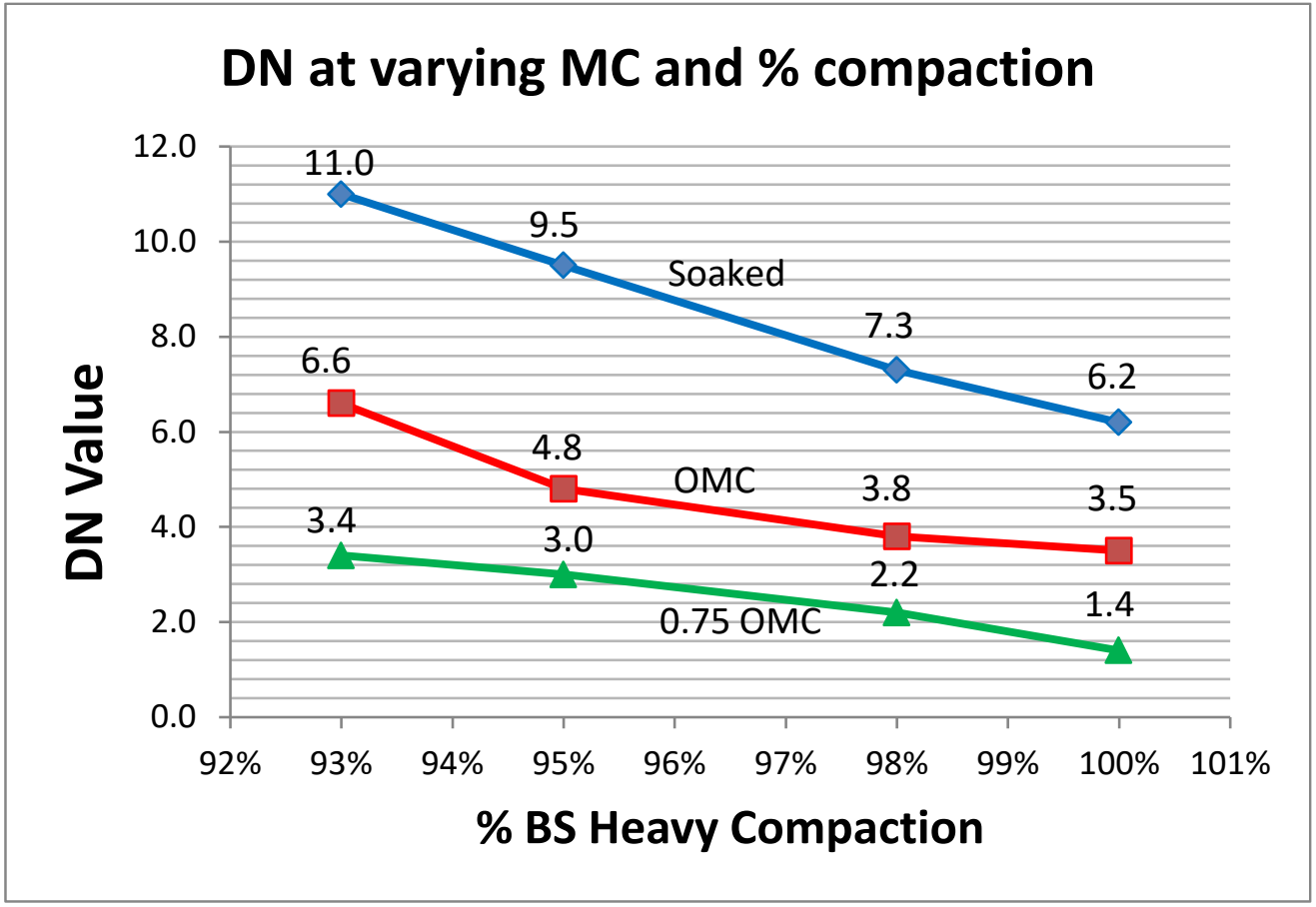
DCP. CBR Testing

- DN/moisture/density relationship required for suitable pavement material
- DCP used to penetrate the CBR mould
- Takes in account pore pressure release during testing

4 days soaked sample , sealed for 4 days in plastic bag	Soaked DN
Sample at OMC, sealed for 4 to 7 days in plastic bag	OMC DN
Oven sample (0.75OMC), sealed for 4 days in plastic bag	0.75 OMC DN

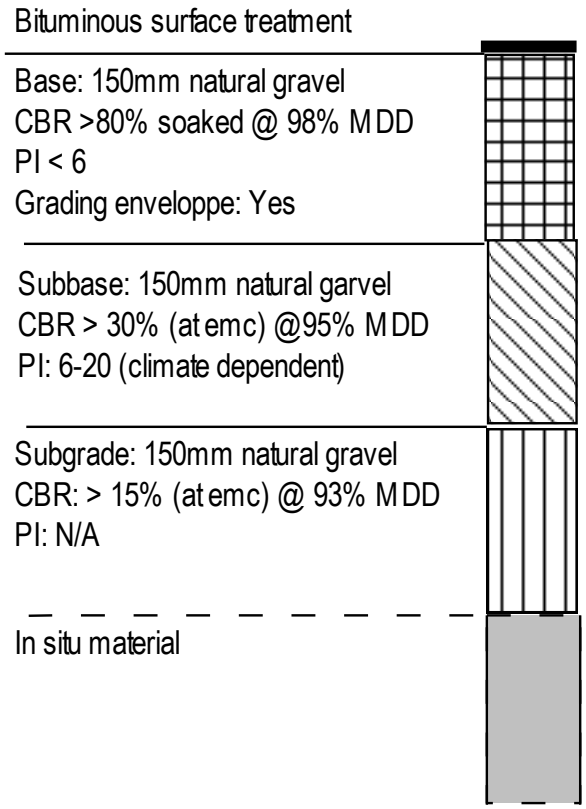


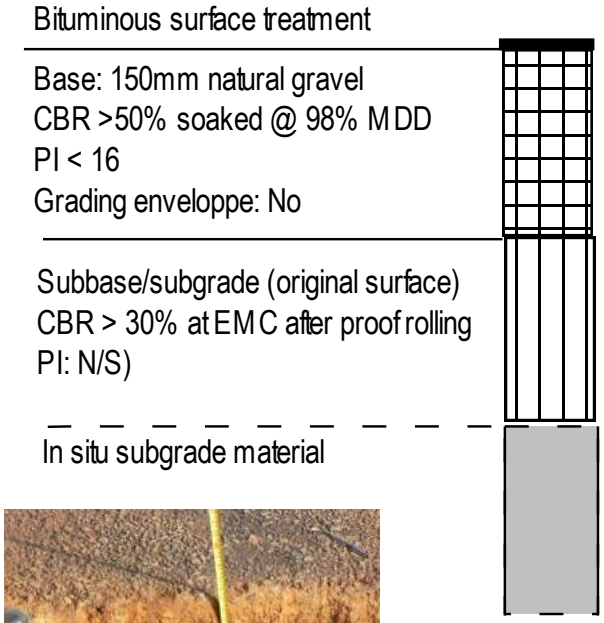
DN/Density/Moisture Relationship



Strength gain with increase in density and reduction in moisture

Pavement Structure: HVRs vs LVRs





Typical 2-layer LVR pavement structure : Ntchisi (school) road

Typical traditional 3-layer pavement structure (left) and 2-layer LVR structure (right)

Examples of DCP Designed Roads

1990

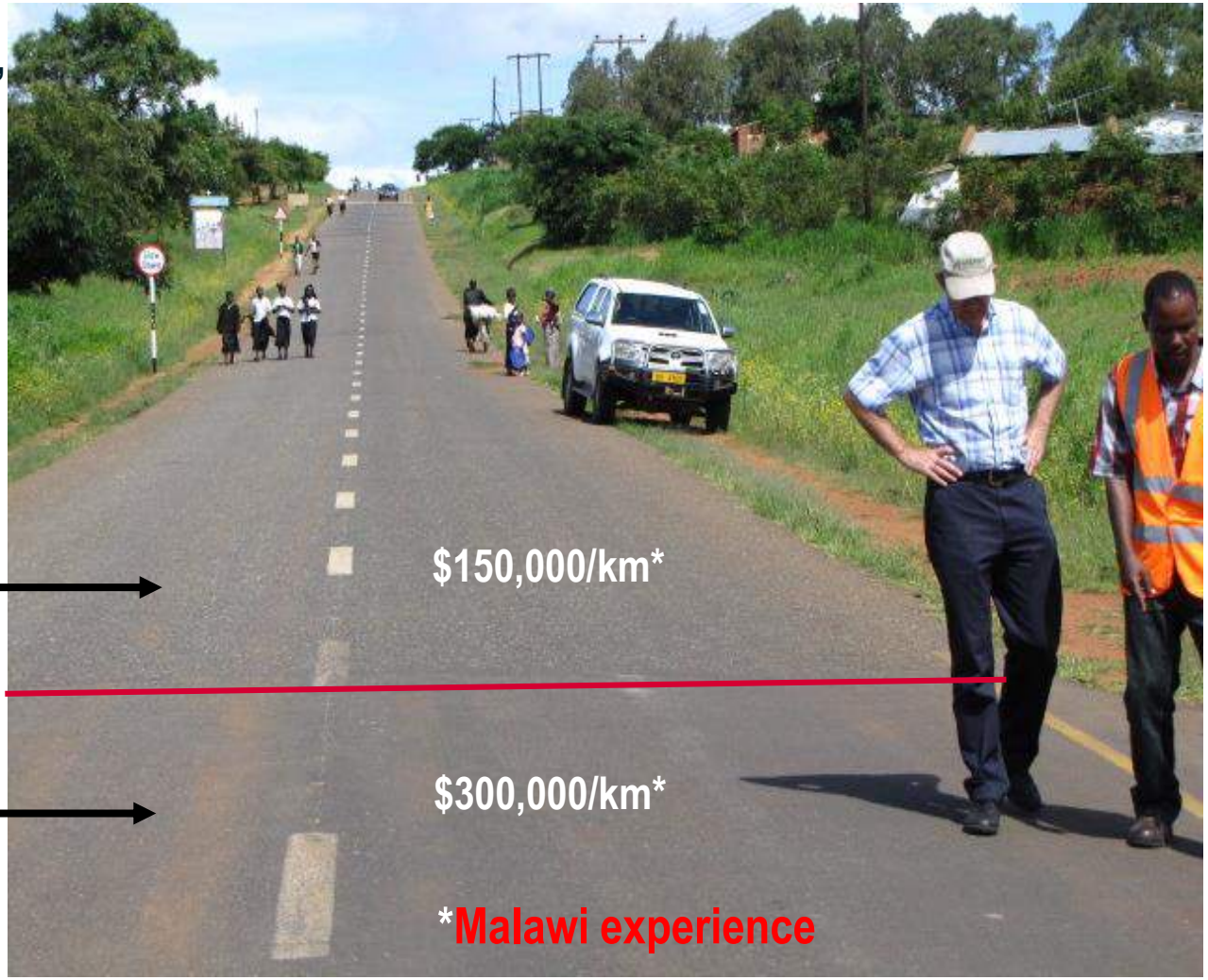
South Africa – Forest Area

2014

Examples of DCP Designed Roads

Benefits of Adopting New Approaches

- Application of locally derived, appropriate technology
- Reduced life cycle costs of LVSR provision
- Facilitating socio-economic growth and development and poverty alleviation



ReCAP
Research for Community Access Partnership

UKaid
from the British people

Construction Aspects

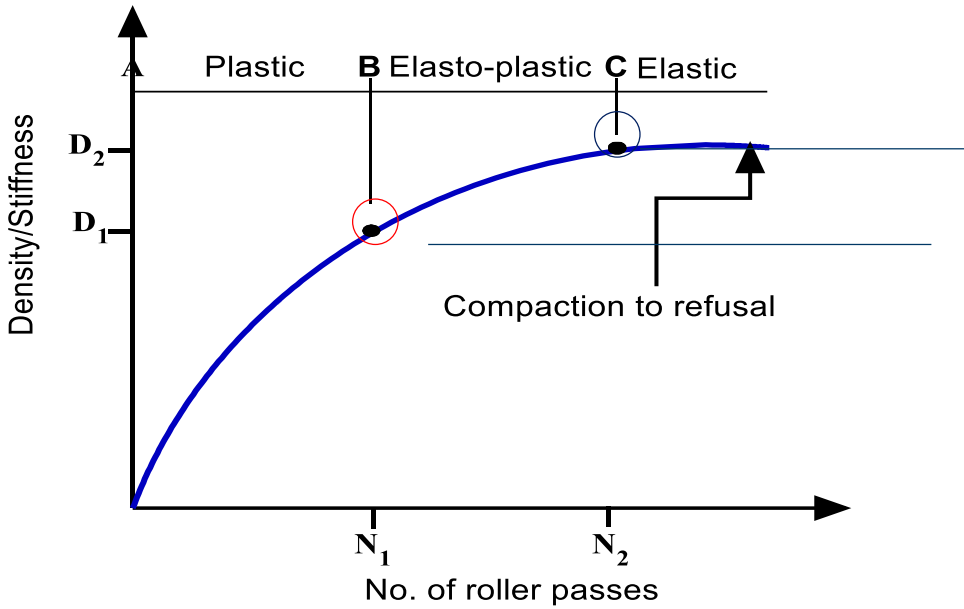
Site Quality Control Procedure

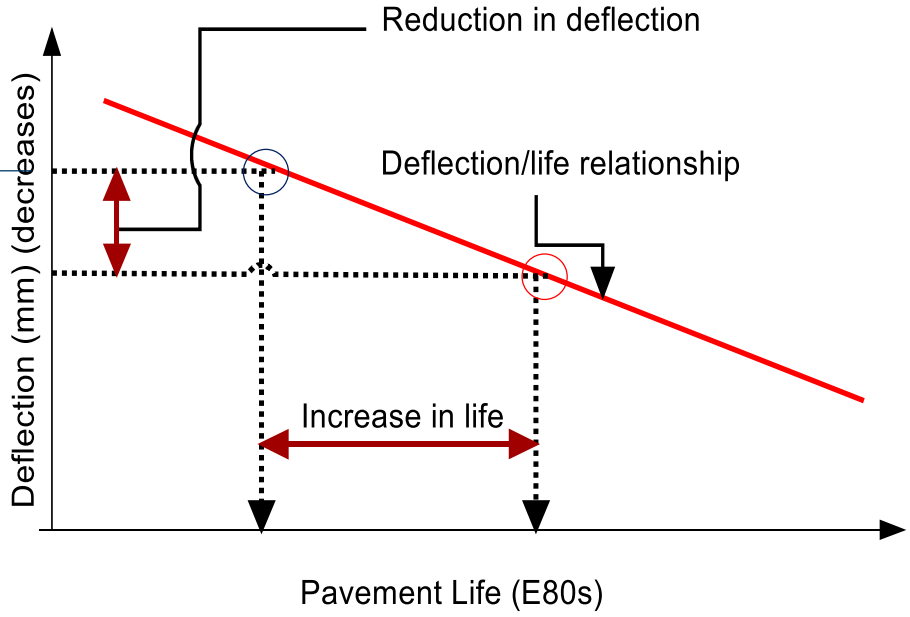
- Quality Plan (QP).
- Quality Assurance (QA).
- Quality Control (QC).
- Production Control (PC).
- Acceptance Control (AC).

Item to be Controlled

- Quality of the materials
- Construction control (primarily compaction standard)
- Environment (particularly drainage)
- Maintenance standard (drainage and surfacing)

Benefits of Increased Compaction





Compaction to "refusal"

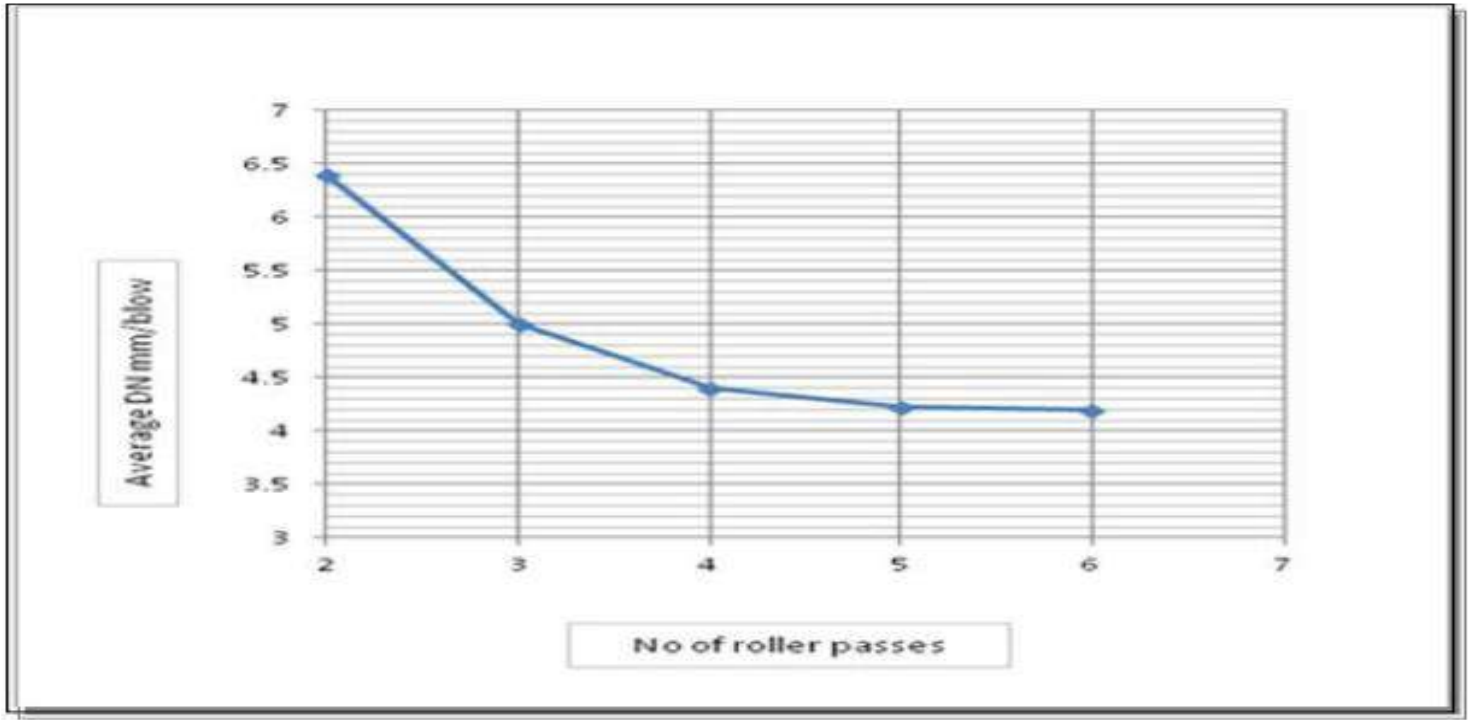
Deflection/life relationship

Level of compaction in pavement layers influences pavement life – increasing compactive effort is often economically justified

Determination of Target DN

No of roller passes	2	3	4	5	6
Average DN mm/blow	6.4	5	4.4	4.22	4.19

Average DN with increasing no of roller passes



Appreciation of Risk Factors

Five main risks:

- Drainage
- Material quality
- Construction control
- Maintenance
- Traffic (overloading)

- Relax ONE and keep control of others. Risk increases BUT probably acceptable
- Relax TWO and risk possible failure

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Monitoring Aspects

General

1. Regularly obtain information on performance of the demonstration section
2. Comprehensive monitoring and data recording programme
3. Compare with a conventional control section
4. Life-cycle cost analysis

Monitoring Programme

1. Depends on actual demonstration sections
2. Definitely structural design of demo section
   - Control will be unpaved
3. Compare construction, maintenance and vehicle operating costs
4. Representative section within each demo section
5. Carefully marked (permanently - boards)

Monitoring of Control Section

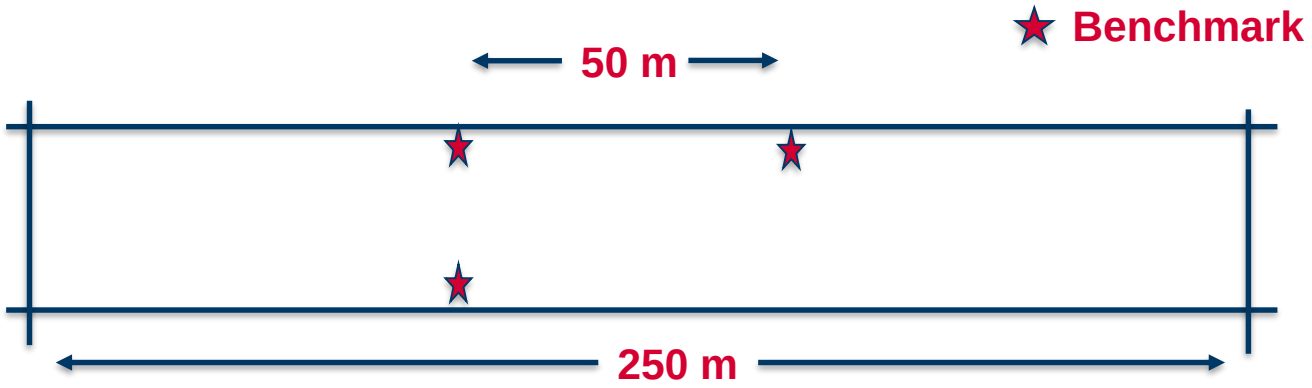
1. **Unpaved road:**
   - Riding quality
   - Gravel loss
   - Visual condition
   - Maintenance requirements and costs
   - Traffic (and speed?)

Monitoring of demonstration section

1. **Structural capacity**
   - Deflection
   - DCP
   - Rut depths
   - Visual condition
   - Moisture variations

Unpaved Section

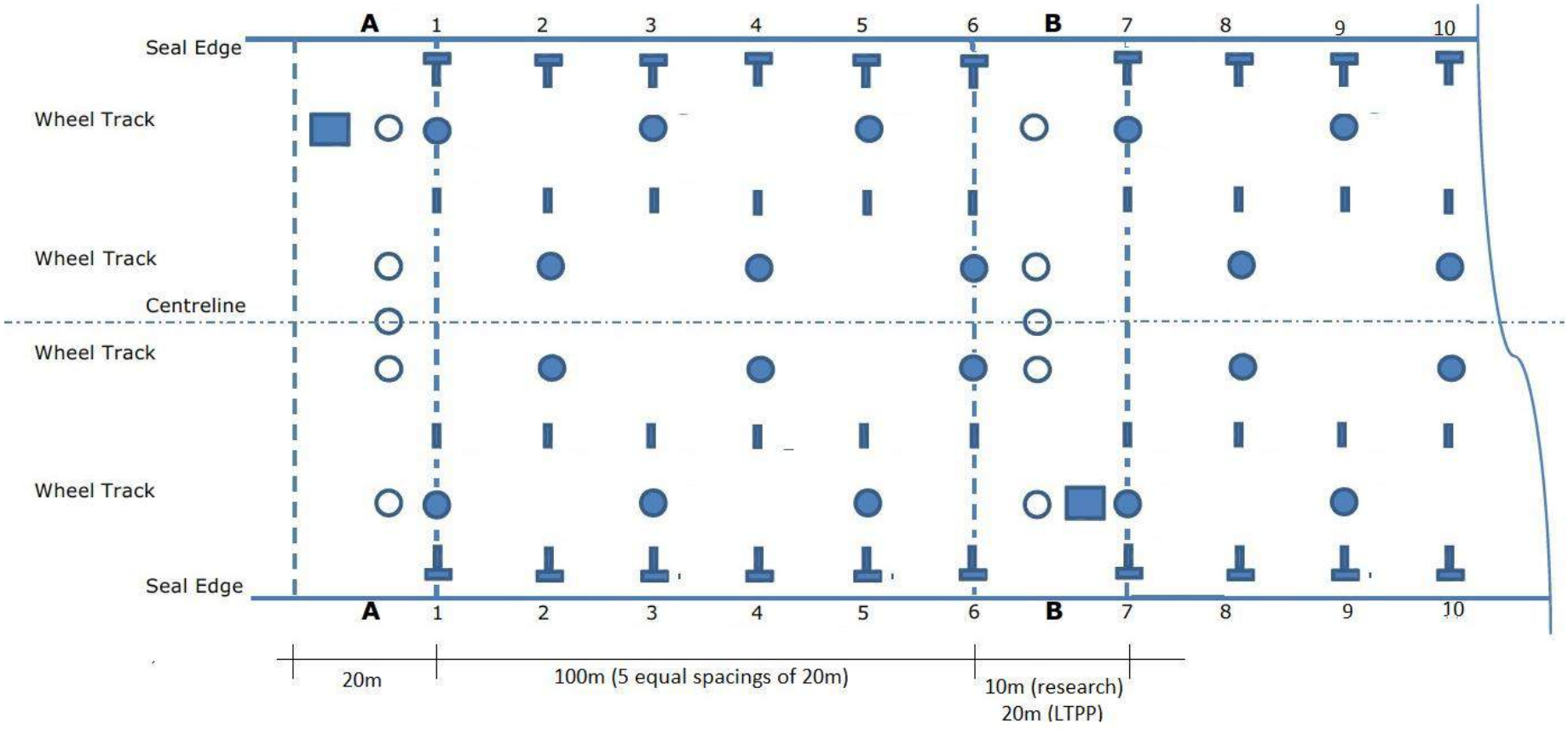
1. 250 -300 m representative/uniform section
   - Material properties (during construction)
   - Visual condition 1 x per month
   - Riding quality 1 x per month
2. 50 m gravel loss section (rod and level survey every 4 months)



Paved Sections

1. 250 m representative/uniform section
   - Material properties (during construction)
   - Construction quality (during construction especially density)
   - Riding quality (1 x 6 months)
   - Visual condition (1 x 6 months)
   - Rut depths (1 x per 6 months)
   - Deflections (end of wet and dry seasons)
   - Moisture content and DCP (wet and dry seasons)

Paved Sections



FWD measurement point, on existing wheel paths or if no wheel tracks visible then it should be estimated

Straight edge placement guidelines for measuring rut depths

Straight edge placement guidelines for measuring rut depths

FWD, DCP, and Base Moisture Content test locations **(TEMPORARY MARK WITH CHALK)**

FWD, DCP, and Trial-Pit locations **(TEMPORARY MARK WITH CHALK)**

Other Information

1. Traffic counts (1 x per year – unless seasonal)
2. Periodic density measurements (every 3 or 4 years)
3. All maintenance activities
   - What was done
   - Cost
4. Weather (rainfall and temperatures)

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Training and Capacity Building

Rankin Engineering Consultants

Training and Capacity Building

- Strategy for long-term sustainability of LVSR technology in Zambia is ***through effective capacity building.***
- Integration of capacity building throughout project life-cycle and in all project activities.
- Strategy is directed at all stakeholders.

Rankin Engineering Consultants

Training and Capacity Building

- Project delivery is anchored in a local consulting firm
- All international team members have a local counterpart
- 85% of input to project from the local team
- RDA have dedicated counterpart on the project

Rankin Engineering Consultants

Training and Capacity Building

- Training ongoing during the design and construction phases
- Workshops, conferences and other information dissemination activities planned and ongoing
- Academia, consultants, contractors and road authorities invited to engage with the project learning

Rankin Engineering Consultants

Design Phase

- Local counterpart from Consultant and RDA staff to be trained on DCP-DN design method.
- Experimental matrix to be developed in collaboration with local counterpart and RDA staff

Rankin Engineering Consultants

Supervision Phase

- Local contractors to be trained on construction methodology for LVSRs.
- Counterpart staff and RDA staff to be trained on construction quality control methods for LVSR
- Counterpart staff and RDA to be trained on performance monitoring

Rankin Engineering Consultants

Capacity Building

- Capacity building for long-term pavement performance monitoring, will require intermittent involvement of at least one local counterpart for a period of perhaps 5 – 7 years.
- The strong commitment of the Research Unit is essential to the success of the project.

Rankin Engineering Consultants

Capacity Building

- Specific requirement of ToR for Consultant to assist RDA to prepare at least 2 Technical Papers.
- Opportunities for presentation of these papers is being investigated.
- T2 conference in Mozambique (2019) is one opportunity under consideration

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Discussion

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

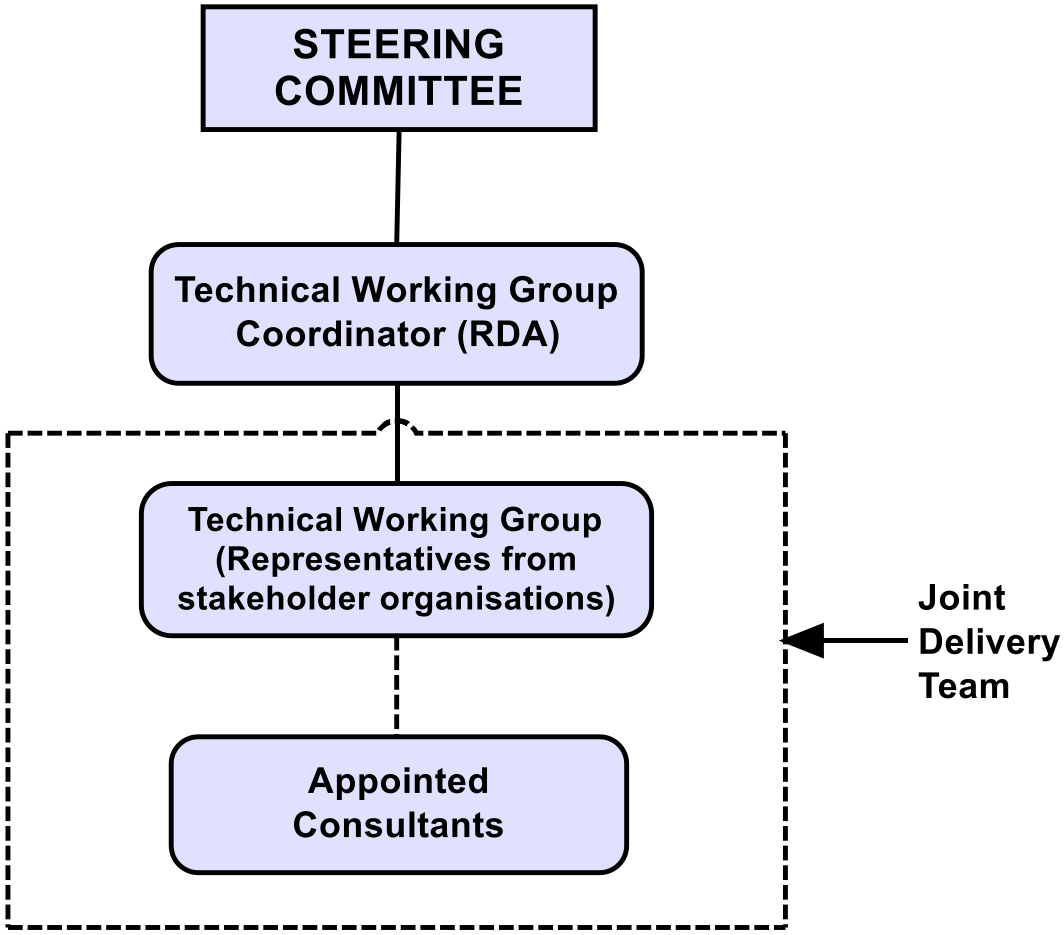
UKaid
from the British people

Design, Construction Supervision and Baseline Monitoring of Trial Sections in Zambia

Way Forward-Impending Activities

Rankin Engineering Consultants

Roles and Responsibilities



Rankin Engineering Consultants

Roles and Responsibilities

RDA

- Identification of key stakeholders
- Formation of Technical Working Group
- Embedment of project in works contract
- Implementation of long-term performance monitoring
- Integration of learning throughout the organization
- Preparation of technical papers

Rankin Engineering Consultants

Roles and Responsibilities

Appointed Consultants

- Design of research methodology
- Implementation of design elements
- Training of works contractor
- Supervision of construction
- Analysis of performance data
- Assisting RDA with preparation of technical papers
- Dissemination activities

Rankin Engineering Consultants

ReCAP
Research for Community Access Partnership

UKaid
from the British people

Thank You!

Rankin Engineering Consultants