AFCAP

African Community Access Programme
Project MAL/016

Preparation of a Pavement Design Manual and Standard Bidding Documents for Low Volume Sealed Roads in Malawi

Inception Report

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LIST OF ABBREVIATIONS

AFCAP	African Community Access Programme
BDS	Bid Data Sheet
CBR	California Bearing Ratio
CML	Central Materials Laboratory
DCP	Dynamic Cone Penetrometer
GC	General Conditions
ITB	Instruction to Bidders
LVSR	Low Volume Sealed Road
MDD	Maximum Dry Density
MK	Malawi Kwacha
OMC	Optimum Moisture Content
OWT	Outer Wheel Track
PC	Particular Conditions
RA	Roads Authority
SADC	Southern African Development Community
SBD	Standard Bidding Documents
ToR	Terms of Reference

EXECUTIVE SUMMARY

The project to undertake the *Preparation of a Pavement Design Manual and Standard Bidding Documents for Low Volume Roads in Malawi* commenced on 10th October 2011. The main objective of this project is to develop the documentation needed by practitioners in the Roads Authority and private sector in Malawi to design low volume roads to appropriate standards and specifications that allow the use of locally available materials to the maximum extent possible. The documentation will include a pavement design manual based on the Dynamic Cone Penetrometer (DCP) method and simplified bidding documents appropriate to that class of road.

Stage 1 of the project – Review of Phase 1 Report and existing Standard Bidding Documents (SBD) – has been completed whilst Stage 2 - Preparation of Draft Manual and SBD – is underway and includes the preparation of this Inception Report.

During Stages 1 and 2 of the project, the following activities were carried out:

- The holding of a start-up meeting with the Roads Authority to review the proposed approach and methodology for carrying out the project;
- The holding of a workshop for key stakeholders from both the public and private sectors with the objectives of:
  - sensitising them to the underlying motivation for carrying out the project; and
  - discussing the draft Table of Contents for both the Pavement Design Manual and Standard Bidding Documents.
- A site visit to the demonstration project – the 17 km Likuni-Malingunde road – which will be used for training in the use of the design manual and bidding documents
- The holding of a wrap-up meeting with the Roads Authority to agree the way forward for the completion of the project, including the scope of the field investigations, laboratory testing, axle load survey and topographic survey to be undertaken by the authority.

The remaining stages of the project include:

- Completion of Stage 2 which entails the preparation of a Draft Pavement Design Manual and SBD as well as the analysis of the field and laboratory testing results from the demonstration project which are all scheduled for completion in mid-February, 2012.
- Stage 3 which entails presentation of the Draft Pavement Design Manual and SBD as well as training in the use of these documents. This stage is scheduled to take place in the latter half of March 2012.
- Stage 4 which entails preparation of Final Pavement Design Manual and SBD based on the comments received from stakeholders. This stage is scheduled for completion in early April 2012.
- Stage 5 which entails the holding of a seminar to launch the manual and SBD.

1. INTRODUCTION

Background

1.1 Based on proposals submitted to the Technical Director of the African Community Access Programme (AFCAP), acting on behalf of the UK Crown Agents for Overseas Governments and Administrations, Messrs: Michael I. Pinard and Richard Smith were appointed to undertake the preparation of a ***Low Volume Sealed Roads Design Manual*** and ***Standard Bidding Documents for Low Volume Sealed Roads in Malawi.*** This project is a follow-up to the previously completed ***Performance Review of Design Standards and Technical Specifications for Low Volume Sealed Roads in Malawi*** which was completed in May 2011.

1.2 The project commenced on 10th October 2011 and is expected to run for a period of about seven months to the end of April 2011. During this period, a number of meetings will be held with key stakeholders as part of a deliberate process of maximizing their involvement in the development of the design manual and standard bidding documents as a basis for engendering their full ownership of these documents.

Purpose

1.3 The purpose of this ***Inception Report***, one of the main outputs of Stage 2 of the project, is to:

1. Briefly review the background context of the project and to summarise the project objectives (Section 2).

2. Outline the approach to be undertaken and the scope to be covered in satisfying the Terms of Reference (ToR) and list the key deliverables of the project (Section 3).

3. Present the Work Programme to be followed in undertaking the project and summarise the activities undertaken so far (Section 4).

4. Outline the way forward for completing the remaining phases of the project (section 5).

2. UNDERSTANDING OF THE PROJECT

Background Context

Low-volume roads in Malawi

2.1 Most unpaved roads in Malawi carry relatively low volumes of traffic, typically less than 200 vehicles per day. Some paved roads with similar levels of traffic were provided with paved surfaces in the past using a range of non-standard geometric and pavement design standards. This includes five metre wide carriageways, reduced standards for horizontal and vertical alignments, the use of unstabilised gravels (laterite, quartzite and weathered granite) in the road base, and thin bituminous surfacings. These roads have generally performed well despite their perceived "non-standard" nature. Moreover, the cost of their provision has been substantially less than similar roads constructed to traditional standards.

Need for revised standards and specifications

2.2 The Malawi Roads Authority is now receiving significant resources from development partners and the government for upgrading higher traffic earth and gravel roads to paved standard. Many of these roads have low traffic volumes, with less than 200 vehicles per day. The Malawi Roads Authority requires design standards and technical specifications that are appropriate to this class of road. These standards and specifications should reflect historical experience in Malawi and the region and be acceptable to political decision makers and local consultants and contractors. The official acceptance of appropriate standards is necessary to ensure their application on a wider scale. The use of appropriate standards will lead to significant cost savings in the initial construction of paved roads, and longer term savings in the overall maintenance requirements of the road network.

Performance review of standards and specifications

2.3 The Africa Community Access Programme (AFCAP) was asked by the Malawi Roads Authority to assist with a ***Performance Review of Design Standards and Technical Specifications used on existing Low Volume Sealed Roads in Malawi.*** The Performance Review was undertaken between October 2009 and May 2011 and showed conclusively that the Low Volume Roads Design Standards adopted by the Road Authority are highly appropriate to local conditions. All of the roads investigated during the study had performed well under traffic despite the use of materials and pavement thicknesses that did not meet the requirements of Malawi's existing paved road design manuals and specifications.

2.4 The findings of the investigations carried out in Malawi support regional experience in countries such as Botswana, Zimbabwe and South Africa that calls for a different approach to the provision of low traffic rural roads. This approach is encapsulated in the SADC Guideline for Low Volume Sealed Roads (LVSR) of 2006 which promotes the need for adopting a more comprehensive and coherent approach to the use of locally available materials for low volume road construction. The major impacts of adopting such approaches include a significant reduction of life-cycle costs, a reduction in the continuous exploitation of non-renewable gravel sources, lower vehicle operating costs, environmental benefits due to reduced erosion, and health benefits due to reduced dust.

Need for a new design manual and standard bidding documents

2.5 Following completion of the ***Performance Review of Standards and Specifications for Low Volume Roads in Malawi,*** stakeholders were unanimous in their call for new national documentation to support the use of a more appropriate approach to the design of low volume roads in Malawi. They felt that without such documentation, the private sector would be constrained to designing low volume roads in Malawi to the existing standards, which are more appropriate for high volume roads.

Objectives of Project

2.6 As a follow up to Phase 1 of the project, a concluding phase – Phase 2 – is being undertaken with the objective of developing the documentation needed by practitioners in the Roads Authority and the private sector to develop appropriate designs and standards of construction for upgrading existing unpaved roads to a sealed standard. Phase 2 will be undertaken in two parts:

- Phase 2A: Preparation of Pavement Design Manual for LVSRs.
- Phase 2B: Preparation of Standard Bidding Documents for LVSRs (including Standard Specifications).

The Terms of Reference for the project are presented in Annex A.

Scope of Work

Phase 2A

2.7 The scope of work for this aspect of the project includes, but is not necessarily limited to, the following:

- Undertake a desk study of historical project reports and technical monitoring reports (where available) concerning low volume sealed road construction in Malawi.
- Undertake a review of the findings and recommendations of the Final Report prepared under Phase 1.
- Undertake an initial visit to Malawi to attend a meeting of a Technical Working Group, which will be convened by the Roads Authority to oversee the project. The Working Group will include private sector representatives and officials from other road sector institutions.
- Agree on the Table of Contents of the proposed LVSR design manual with the Working Group. During the initial visit the Consultant will also start the process for the selection of the training site for the DCP design method and provide recommendations for any laboratory testing that might be required on the site in advance of the training.
- The Consultant will assess, in discussion with the RA, the need to engage a locally based sub-consultant to assist with the fieldwork needed for the selection and design of the training site. The Consultant will provide a costed proposal to Crown Agents for the engagement of this sub-consultant.

- Prepare a draft pavement design manual for LVSRs in Malawi based on the design principles developed in Phase 1 and the Table of Contents agreed with the Working Group. The manual should have an introductory chapter on the LVSR design approach and the place of LVSRs in the Malawi road hierarchy. The manual should provide detailed guidance on:
    - identification of roads that are suitable for application of the LVSR design approach;
    - analysis of existing unpaved road pavements, including appropriate insitu materials testing and the use of the Dynamic Cone Penetrometer (DCP);
    - identification and classification of locally available materials used in road upgrading;
    - choice of design life, traffic counts and estimation of traffic growth (including appropriate axle load equivalency factors for LVSRs in Malawi);
    - selection of appropriate pavement structure (including the use of the DCP design approach);
    - dealing with poor subgrade soil sections;
    - choice of surfacing seal (NB the Manual will not include detailed guidance on the design of surfacing seals), and;
    - minimum requirements for effective drainage of the road formation (NB the Manual will not include guidance for the design of cross-drainage structures or sizing drainage channels).
- Present the draft manual at a 3 day training workshop of practitioners from the Roads Authority and the private sector. It is expected that the workshop will include a field trial of the draft manual on a suitable road to be identified by the RA, enabling participants to implement the proposed design methodologies in smaller groups and to compare results.
- Prepare a Final Pavement Design Manual for LVSRs incorporating the experiences and feedback from the training workshop and the Technical Working Group.
- Participate in a launch seminar for the Manual.

(2) Phase 2B

2.8 The scope of services for this aspect of the project include, but are not necessarily limited to, the following:

- A bidding documents based as closely as possible on existing documentation used by the Roads Authority, including, at a minimum:
    - Foreword and Preface
    - Procedure for Document Changes

- Instructions to Bidders (ITB)
- Bid Data Sheet (BDS)
- Evaluation and Qualification Criteria
- Bidding Forms
- Standard Specifications for LVSRs (Specifications for base, sub-base / subgrade materials must be specific to non-conventional materials typically used in LVSR construction in Malawi)
- Standard Drawings for LVSRs
- General Conditions of Contract (GC)
- Particular Conditions (PC)
- Annex to the Particular Conditions - Contract Forms (Performance Security, Advance Payment Security, etc.)

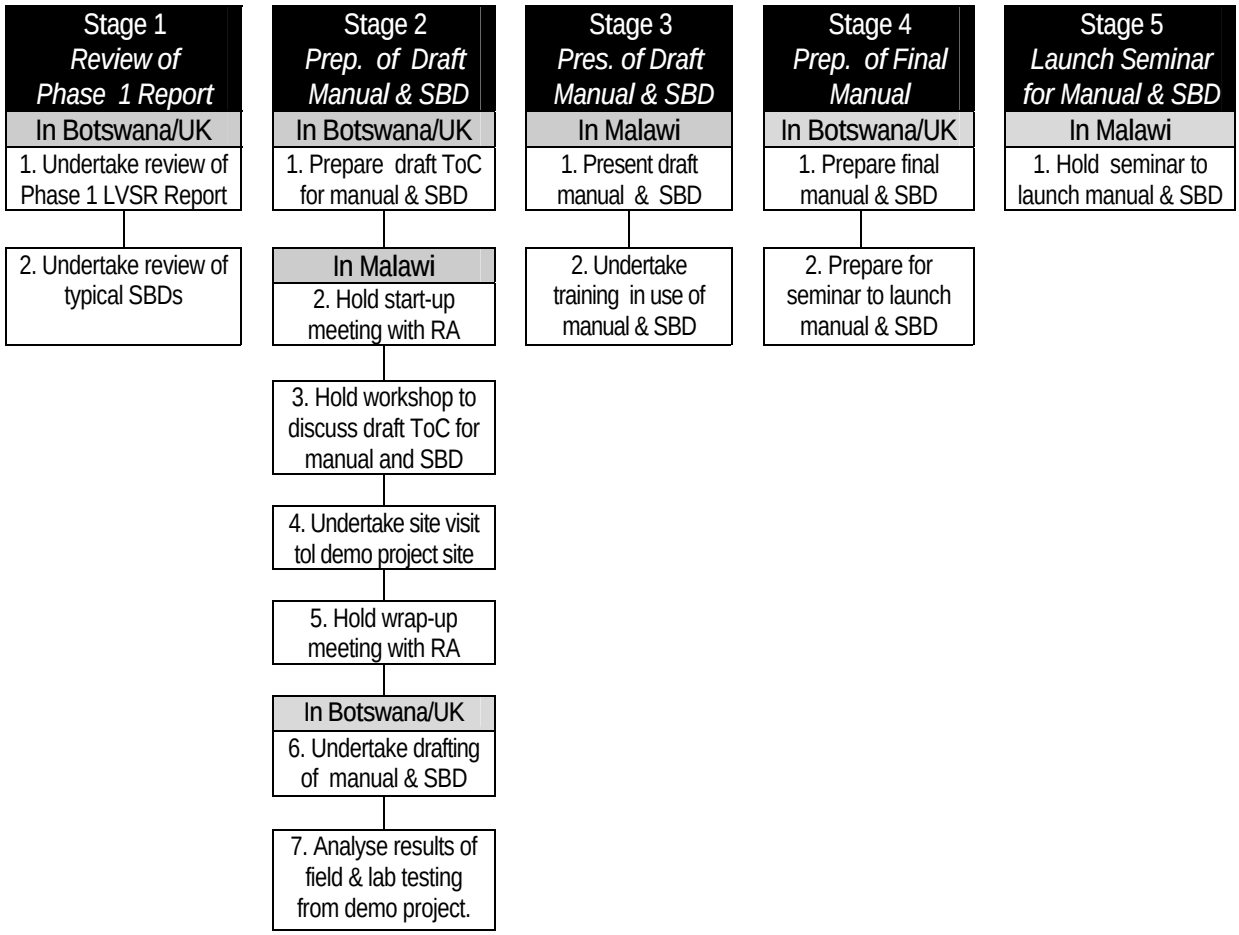
- User Guide to accompany the Standard Bidding Documents (SBDs).
- Present the draft SBDs at a 3 day training workshop of practitioners from the Roads Authority and the private sector.
- Participate in a launch seminar for the LVSR Design Manual and SBDs.

3. GENERAL APPROACH AND METHODOLOGY

General Approach

3.1 This section of the proposal outlines the Consultant's general approach and methodology for undertaking the assignment. In this regard, Table 3.1 shows the scoping of the project including its main components and streams of activity. As indicated in the figure, the assignment has been broken down into five phases that are related to the various components of the project, as may be inferred from the TOR.

Table 3-1: Overall scoping of project



Project Phases

3.2 Stage 1 – Review of Report and SBDs

- ***Objective***

  To undertake a review of the Phase 1 LVSR report and typical SBDs as a point of departure for preparing the new manual and SBDs.

- ***Output***

  The consultant's appreciation of any lessons learnt from the execution of the first phase of the project that can be beneficially taken into account in the second Phase 2 as well as aspects of the SBDs that need to be discussed with stakeholders during the sensitization meeting.

3.3 Stage 2 – Preparation of Draft Manual and SBDs

- ***Objective***

  To commence the drafting of the manual and SBDs based on the following activities:

  - Presentation of the draft ToC of the manual and SBDs to the Working Group and agreement on the final Toc as well as the layout format of the documents.
  - Selection of the location of a project (unpaved gravel road proposed for upgrading to LVR standard) which will be used to demonstrate the DCP method of pavement design.
  - Discussion and agreement on the scope of the field and laboratory testing programme for the demonstration project.

- ***Output***

  Agreement on the following:

  - The ToC and layout format for the manual and SBDs.
  - Agreement on the location of an unpaved road that will be used to demonstrate the upgrading of a gravel road to a paved LVR standard using the DCP pavement design method.
  - The scope of the field and laboratory testing work and a programme for its completion.

3.4 Stage 3 – Presentation of Draft Manual and SBDs

- ***Objective***

  To present the draft manual and SBDs to stakeholders for their comments in the course of which training will be provided on the use of these documents.

- ***Outputs***

  Comments from stakeholders arising from the presentation of the manual and SBDs and the related training on their use which will be used as inputs for finalising the documents. .

3.5 Stage 4 – Preparation of Final Manual and SBDs

- ***Objective***

  To finalise the manual and SBDs based on comments from stakeholders arising from the prior presentation of these documents and the training in their use.

- ***Outputs***

  - A pavement design manual based on the DCP design method and SBDs for LVRs that have the full ownership of stakeholders from their involvement in all stages of the development of these documents.
  - Capacity building and technology transfer amongst stakeholders.

3.6 Stage 5 – Launch Seminar for Manual and SBDs

- ***Objective***

  To launch the manual and SBDs to a cross section of stakeholders with the primary objective of raising awareness of its existence and the benefits to be derived from its use in Malawi.

- ***Outputs***

  An informed cross-section of stakeholders – Road Authority, Ministry of Transport and Public Infrastructure, consultants, contractors, materials suppliers, etc. – who are aware of the existence of a new manual for the design of LVRs based on the DCP method as well as SBDs for use with such roads. .

Outputs and Deliverables

3.7 In accordance with the ToR, the main reporting outputs of the project are as follows:

Output	Time Schedule
1. Inception 1 Report	End Week 4
2. Draft Design Manual	End Week 20
3. Draft Progress Report	End Week 20
4. Final Design Manual	End Week 26
5. Final Report	End Week 26

4. WORK PROGRAMME AND PROGRESS

Programme

4.1 The work programme envisaged for achieving the objectives of the consultancy comprises five phases with the related activities as shown in Table 4-1. Whilst the programme is broadly indicative of the timing of carrying out the various activities indicated, minor amendments may be necessary depending on the situation on the ground.

Activities Undertaken

4.5 The activities undertaken so far on the project are as indicated in Phases 1 and 2 of the Overall Scoping of the Project presented in Table 3.1. The outcome of these activities is summarised below:

Activities 1.1

4.6 This activity was undertaken by the consultants from their respective home bases and entailed, essentially, reviewing the Phase 1 LVSR project and SBDs used on LVRs in Malawi as a basis for formulating the overall scoping of these documents.

Activity 2.1

4.7 Prior to their arrival in Malawi, the consultants had prepared a draft ToC for both the design manual and SBDs for presentation and discussion at the stakeholder workshop which was to be held on Wednesday 18 October, 2011.

Activity 2.2

4.7 A start-up meeting was held on Tuesday 18 October, 2011, with the Project Coordinator, Eng.. Placid Kasakatira, Director of Planning and Design, and the Project Liaison Officer, Eng. Sharmey Banda, Senior Roads Engineer, Planning and Design, at which the programme for the remainder of the week was discussed and agreed.

4.8 Immediately following the meeting, a preliminary visit was made to the site of the potential demonstration project – the approx. 17 km Likuni-Malingunde unpaved road located on the outskirts of Lilongwe in the Dowa District – to ascertain its suitability for this purpose. . Details emanating from the site visit are discussed under Activity 2.4, para. 4.14.

Table 4.1 – Work Programme

Year➢	2011												2012															
Month➢	October				November				December				January				February				March				April			
Week No.➢	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	28	29
Week beginning Monday➢	10	17	24	31	7	14	21	28	05	12	19	26	02	09	16	23	30	06	13	20	27	05	12	19	26	02	09	16	23
Stage 1: Review of Phase 1 Report and SBDs	S.1																												
1. Undertake review of Phase 1 Report																													
Stage 2: Preparation of Draft Manual and SBDs		Stage 2													Stage 2														
1. Prepare draft ToC for manual																													
2. Hold start-up meeting with RA																													
3. Hold workshop to present and agree draft ToC with WG																													
3. Select demo project and agree fieldwork & lab testing																													
4. Prepare and submit Inception Report				♦							Christmas/New Year Break																		
4. Undertake fieldwork and lab testing (CML)																													
5. Prepare and submit draft manual																				♦									
6. Analyse results of fieldwork & lab testing																													
7. Client review of draft manual and SBD(Working Group)																													
Stage 3: Presentation of Draft Manual and SBDs																								S.3					
1. Present draft manual																													
2. Undertake training workshop in use of manuals																													
Stage 4: Preparation of Final Manual and SBDs																										Stage 4			
1. Prepare and submit final manual																											♦		
2. Prepare for launch seminar																													
Stage 5: Launch Seminar for Manual and SBDs																												S.5	
1. Launch seminar																													

Key: ♦ Report submission Activities undertaken by consultant in Botswana Activities undertaken by consultant in Malawi Activities undertaken by WG or CML in Malawi

Activity 2.3

4.10 A stakeholder workshop was held at the conference centre of the Lilongwe Hotel on Wednesday 19 October, 2011 for which the agenda is shown in Annex B. The workshop was attended by some 16 participants from a wide cross-section of organisations from both the public and private sectors, including the Ministry of Transport, the Roads Authority, the Roads Fund Administration, the National Construction Industry Council, the University of Malawi, Consultants, Contractors and materials Suppliers (see Annex C).

4.11 The workshop was opened by Eng. Paul Kulemeka whose remarks may be summarized as follows:

- The SADC Guideline on Low volume Sealed Roads, much as it was a watershed document in terms of advocating a more comprehensive approach to the use of locally available materials for low volume road construction, had not yet been operationalised in the SADC region.

- .There were still a number of challenges to be overcome due to lack of proper documentation on the design of low volume roads. However, Malawi was happy to facilitate the move from the SADC LVSR vision to practice by means of the development of a pavement design manual and standard bidding documents for such roads.

- The project should be taken seriously by all stakeholders who should be viewed as the custodians of the LVSR approach with a responsibility to convince others of the need for pursuing sustainable approaches to road provision, especially as gravels used on unpaved roads were getting scarce. The adoption of such would facilitate the economic development of the country in a sustainable manner.

- The Roads Authority is grateful to AFCAP for the support that they have provided to Malawi which is aimed at reducing road transport costs by promoting rational, appropriate and affordable designs for low volume roads, including the development of appropriate standard bidding documents.

4.1.2 PowerPoint presentations were then made by the consultant to sensitise stakeholders to the underlying motivation for carrying out the project, the proposed approach and methodology to be adopted, the programme for the project and the anticipated role and involvement of national stakeholders. The draft Table of Contents for both the pavement design manual and the standard bidding documents were then presented for discussion (see Annex D for proposed ToC).

4.1.3 The following were some of the important issues arising from the discussions following the consultant's PowerPoint presentations.

Phase 2A – Pavement Design Manual

- The design manual applies specifically to existing low volume gravel roads and not to LVRs on new alignments. This point should be emphasized in the Introduction section of the manual.

- The pavement design approach will be based on the DCP method. The DCP programme to be used will be that developed by CSIR – WIN DCP ver. 5. This programme is freely downloadable from the CSIR website.

- The alignment to be followed should be at the discretion of the design engineer. The over-riding principle is that the alignment should dictate the speed and not vice versa. Moreover, the existing alignment should be used as much as possible.

- Road Safety requires particular attention. Noteworthy that "well engineered" alignments tend to have more accidents than "reasonably engineered" alignments.

- The proposed draft Table of Contents, although not firmly fixed, is fine to commence drafting of manual. However, the following topics should be added to Section 9 – Practical Considerations:

  - Environmental issues
  - Outline of life-cycle cost analysis procedure (for evaluating alternative competing options, e.g. Cape Seal versus Graded Aggregate (Otta) Seal.

- Drainage structures for LVRs are very important. However, the design of such structures will not be dealt with in the manual. Rather, reference should be made to the gTKP guideline on "Design Standards for Small Structures" which deals with the planning, design, construction and maintenance of small drainage and other structures for LVRs. This document is freely downloadable from the AFCAP website.

- The manual shall be laid out in a 2-column format similar to the Tanzania Pavement and Materials Design - 1999.

Phase 2B – Standard Bidding Documents

Scope of SBD:

- There will be a standard specification but the possibility of including a particular specification will be considered during the drafting of the standard specification.

- Plant may be owned or leased by a contractor tendering for road projects.

- Although the SADC general specification or the RA specification are well understood by contractors, the unique nature of the LVSR approach, which is more similar to maintenance work rather than new construction or upgrading, means that the majority of the SADC spec is not applicable. Thus, a standard specification applicable only to LVSR will be produced and included in the SBD.

Instructions to Bidders

- Works contracts are awarded on lowest price after correction of errors and exclusion of non-responsive bids. However, a preference for local contractors should be considered as this is a requirement of Govt. of Malawi procurement guidelines and is usual a 10% financial preference. The RA agreed to supply consultant with an example of the local consultant preference clause for inclusion in the SBD.

Bid Data Sheet

- As regards eligibility criteria, the NCIC contractor registration will be used which takes account of the contractor's experience of road construction in Malawi, available experienced staff and appropriate equipment such as: grader, water bowser, heavy roller and surfacing equipment appropriate to specified surface type.

- Alternative designs to be allowed where they are financially beneficial and not technically inferior.

Bidding Forms

- Sub-contracting to be allowed to a maximum of about 40%of the contract value which may need to be increased in the case of specialist surfacing works where that item may constitute a very high proportion of the total value of the project. Thus, it will left to the person preparing the bid document to decide on the % of sub-contracting allowable depending on the details of the work involved. Guidance notes will be included.

- Joint ventures to be allowed and catered for in the SBD and user guide.

Standard Specifications

- The Subgrade, Sub-base and Base sections be renamed to reflect the nature of LVSR work. Series 400 to be renamed.

- There will be a section for selected fill material and also for reinforcement, which is ser. 800 in RA Spec.

Standard Drawings

- Both A4 and A3 size drawings will be prepared within a sample document as a basis for deciding on the preferred size.

Bill of Quantities (BoQ)

- The BoQ will cover all the relevant requirements, including the details of the method of measurement.

Activity 2.4

4.14 Following the conclusion of the workshop, all delegates were taken to the site of the potential demonstration project road – the approx. 17 km unpaved Likuni-Malingunde road which is located on the outskirts of Lilongwe in the Lilongwe District. The location of the road is shown in Figure 1.

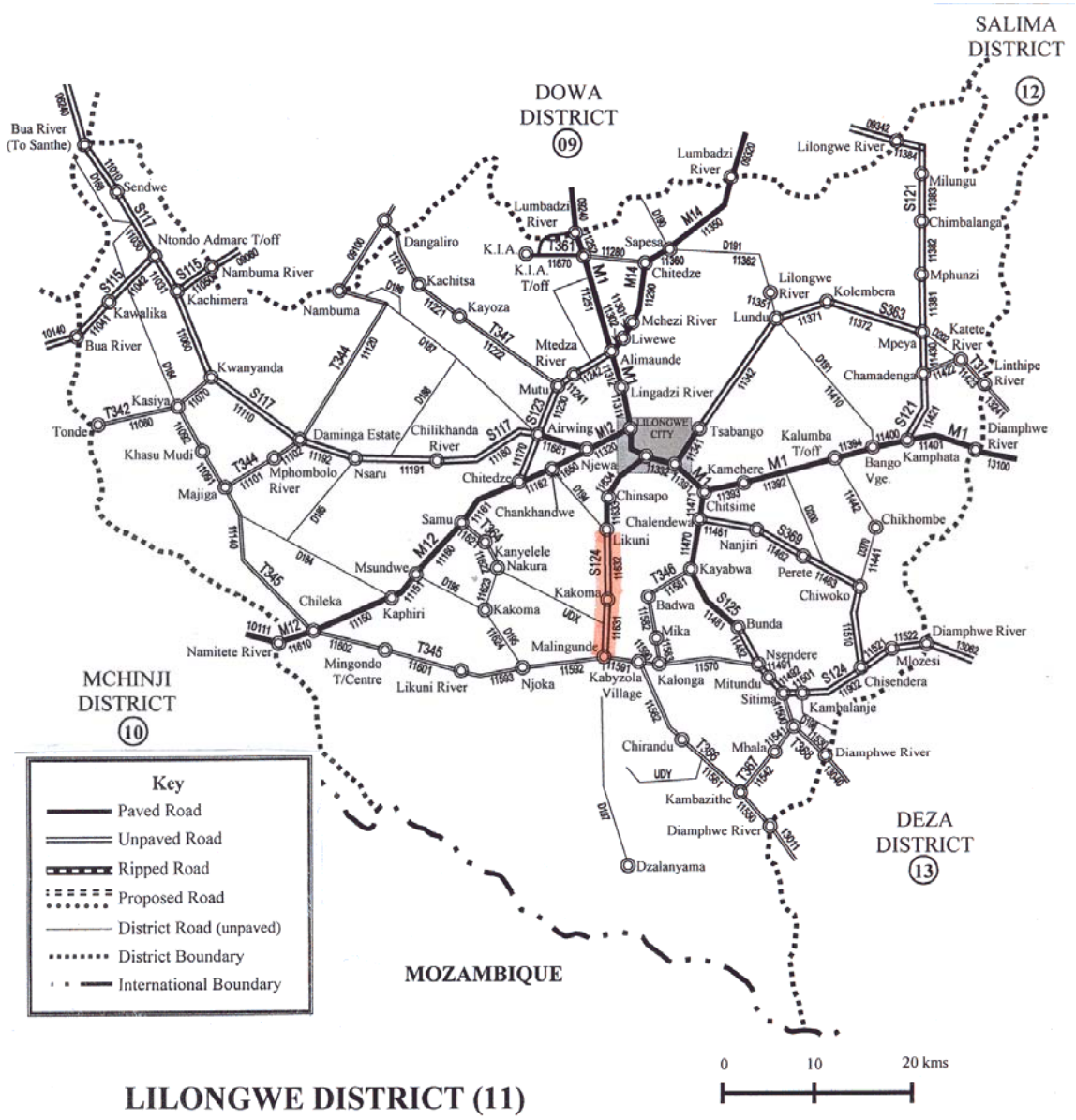


Figure 1 – Location of demonstration project: Lukini- Malingunde road

4.15 The Likuni-Malingunde secondary road carries approx. 260 vpd of which approx. 28% are commercial vehicles. The wearing course along most of the road is a typical laterite gravel found extensively in Malawi whilst the running surface over the southern-most 5 km to the Kamazu Dam is a red sandy clay, also a typical naturally occurring material used extensively as the subgrade for roads in Malawi. Gradients along the road are flat to moderate and drainage varies from good to poor. This road runs through a number of settlements along its length and its various features make it ideally suited to be used as the demonstration project (see photos in Annex E).

Activity 2.5

4.16 A wrap-up meeting was held with the RA on Friday 21 October, 2011, at which the following issues were discussed:

(a) **Project correspondence:** All project correspondence would be channeled through M. Pinard and would be directed to the Director of Planning and Design (P. Kasakatira) and copied to the Senior Engineer Planning and Design (S. Banda). The consultants should not communicate directly with the Working Group.

(b) **Phase 1 Final Report:** Although not formerly communicated, the Phase 1 Final Report had been approved and the requisite number of hard copies should be sent to the RA, as well as soft copies that would be circulated by the RA to WG members.

(c) **DCPs:** The DCP's used by CML were badly worn and needed to be replaced. There was little likelihood of getting the shafts made locally. M. Pinard to raise the matter with AFCAP (R. Geddes) to explore the possibility of AFCAP supplying 2 No. DCPs. Failing that, the DCP survey would commence in November in which case the outcome would be used for demonstration purposes only rather than for design. M. Pinard to provide details of the DCP survey and laboratory testing. (See Annex F for details).

(d) **Axle load survey:** In view of the importance of using reliable vehicle equivalence factors for determining reliable traffic loading for design purposes (cumulative ESAs), the RA would undertake an axle load survey in the vicinity of the demonstration project. M. Pinard to provide details. (See Annex G for details).

(e) **Topographic survey:** A topographic survey would be undertaken by the RA to pick up the main features on the demonstration project road, including:
   a. Centreline chainage and levels at 200m intervals
   b. Cross-sections levels at appropriate intervals to pick up the main features along the road, such as changes in gradient, drainage details, etc. (See Annex H for details).

(f) **Project coordination:** There would be no need for providing a local consultant to help with the coordination of the field work as Eng. S. Banda would provide oversight management of all project activities to ensure an adequate level of quality assurance.

(g) **Project information:** Eng. S. Banda to provide the consultants with the following:
   a. Location map for demonstration project (collected by consultant)
   b. Historical traffic data for the demonstration project road
   c. Historical rainfall data in the vicinity of the project road
   d. Typical LVR design (collected by consultant).

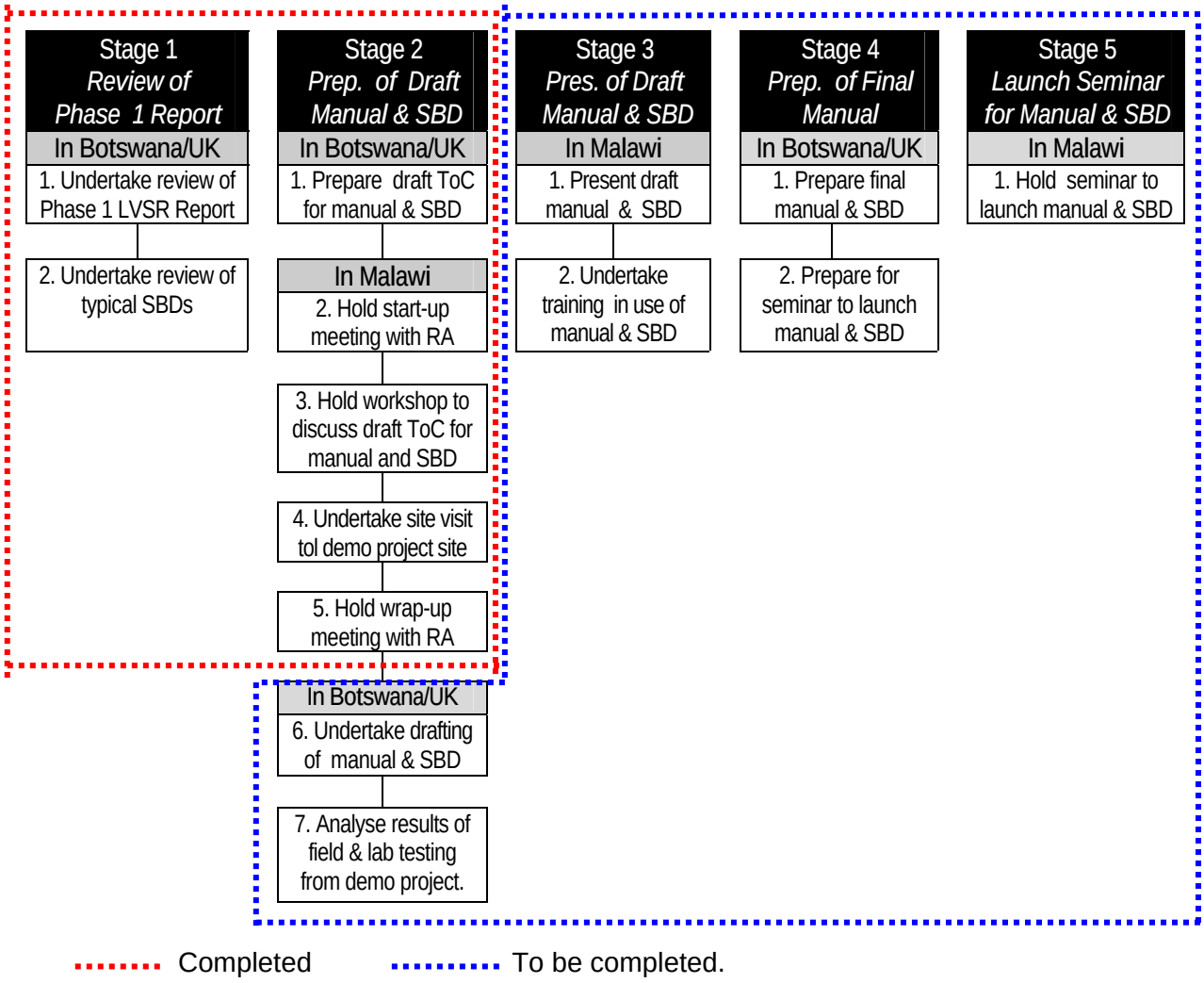
4.17 The consultants thanked the RA for their support during the week which, in their view, made the visit a successful one. In turn, the RA thanked the consultants for a good start to the project.

5. WAY FORWARD AND SUMMARY

Remaining Stages of Programme

5.1 The remaining stages of the programme are indicated in Table 5-1 and described in detail below.

Table 5-1: Status of completion of programme



5.2 The remaining stages of the programme are summarized below.

- **Stage 2 – Preparation of Draft Pavement Design Manual and SBD (In Botswana/UK):** Following completion of the initial components of this stage in Malawi (Stages 2.1 to 2.5), the remaining components (Stages 2.6 and 2.7) entail the drafting of the Pavement Design Manual and Standard Bidding Documents which are scheduled for completion in mid-February, 2012. This includes the analysis of the field and laboratory testing results from the demonstration project which will be used for training in the use of the manual.

- **Stage 3 – Presentation of Draft Pavement Design Manual and SBD.** This is scheduled to take place in the latter half of March 2012, following the RA's review of the draft documents. This activity will be followed by training for stakeholders in the use of the manual and SBD.

- **Stage 4 – Preparation of Final Pavement Design Manual and SBD.** Based on the comments received from stakeholders, the manual and SBD will be finalized in early April 2012..

- **Stag 5 – Launch Seminar:** A seminar to launch the manual and SBD is schedules for mid-April, 2011 and will mark the culmination of the project

Risk Management

5.2 The main risk associated with the project is that the fieldwork will not be undertaken as programmed. Should this occur, there might be a prolongation to the project, as the presentation of the pavement design manual and SBD immediately precede the training in the use of those documents which, in turn, requires prior completion of the fieldwork and laboratory testing.

Way Forward

5.4 The way forward to completion of the project has been discussed and agreed with the Project Coordinator and the requirements are well understood. It is therefore anticipated that the remaining phases will proceed on schedule as per the project programme.

Summary

5.5 Stage 1 of the project has been completed, culminating in the preparation of this Inception Report. During Phase 1, the following activities were carried out:

- The holding of a start-up meeting with the Client and stakeholders;
- Collection of all documentation relevant to the project;
- A site visit to various LVSR roads to facilitate the selection of a manageable number for detailed monitoring and investigation;
- Development of a fieldwork and laboratory testing programme to be carried out by CML;
- Initiation of field investigation at one of the selected LVSR roads.

ANNEXES

Annex A

Terms of Reference

Research Consultancy to Undertake a Performance Review of Design Standards, Technical Specifications and Bidding Documents for existing Low Volume Sealed Roads in Malawi

Phase 2A – Preparation of a Low Volume Sealed Roads Design Manual

1 Background

The Malawi Roads Authority is receiving significant resources from the government and development partners for maintenance and upgrading of earth roads to paved standard. Many of these roads have low traffic volumes, with less than 200 vehicles per day. The Malawi Roads Authority requires design standards and technical specifications that are appropriate to this class of road traffic. These standards and specifications should reflect historical experience in Malawi and the region and be acceptable to political decision makers and local consultants and contractors.

In recent years several roads with low traffic levels have been provided with a paved surface using a range of non-conventional geometric and pavement design standards. This includes five metre wide carriageways, reduced standards for horizontal and vertical alignments, the use of unstabilised gravel in the road base, and thin bituminous surfacings. The existing horizontal alignment was used without improvement to take advantage of the existing consolidated road base. The existing earth/gravel running surface was reshaped without necessarily affecting consolidation and then proof-rolled / compacted to act as the sub-base.

The Africa Community Access Programme (AFCAP) was asked by the Malawi Roads Authority to assist with a **Performance Review of Design Standards and Technical Specifications** used on the existing Low Volume Sealed Roads (LVSR) in Malawi[1]. The Performance Review was undertaken between October 2009 and May 2011. The objectives of the study were to: undertake a review of performance of existing LVSRs; review the design standards and specifications used for the construction of the LVSRs; provide recommendations for the development of manuals and other official documentation needed to facilitate the use of appropriate standards by the Roads Authority, its consultants and contractors, and; gain acceptance of the LVSR approach amongst decision makers using an evidence-based approach.

The study showed conclusively that the Low Volume Roads Design Standards adopted by the Road Authority are highly appropriate to local conditions. All of the roads investigated during the study had performed well under traffic despite the use of materials and pavement thicknesses that did not meet the requirements of Malawi's existing paved road design manuals and specifications. The research supported regional experience in countries such as Botswana, Zimbabwe, South Africa and Malawi that calls for a different approach to the

[1] AFCAP is a research programme funded by the UK government, which is promoting safe and sustainable rural access in Africa. AFCAP supports 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 management of AFCAP has been contracted by DFID to Crown Agents

provision of low traffic rural roads. This approach is encapsulated in the SADC Guideline for Low Volume Sealed Roads (LVSR) of 2006. The Guideline calls for a more comprehensive and coherent approach to the use of locally available materials for low volume road construction. The major impacts of adopting such approaches include a significant reduction of life-cycle costs, a reduction in the continuous exploitation of non-renewable gravel sources, lower vehicle operating costs, environmental benefits due to reduced erosion, and health benefits due to reduced dust.

Government and private sector representatives that attended the stakeholders' workshop in Lilongwe in May 2011 were unanimous in their call for new national documentation to support the use of the Low Volume Roads design standards. Without this documentation, the private sector is constrained to designing paved roads in Malawi to the existing standards, which are more appropriate to highly trafficked roads.

Under Phase 1, the project has verified the appropriateness of LVSR design standards applied in Malawi, and has contributed to greater awareness of the need for these appropriate standards. The study gained support amongst key decision makers and practitioners in the sector for Phase 2, which involves the preparation of the documentation needed to bring the LVSR design approach into standard industry practise in Malawi. The study highlighted the importance of realistic factors for the estimation of equivalent axle loads for typical traffic on LVSRs in Malawi, and the need for minimum drainage standards for the road formation, and the benefits to be gained from higher levels of compaction of the pavement layers.

2 Goal

The overall goal of the project is to reduce road transport costs in Malawi by promoting rational, appropriate and affordable design for low volume roads that comprise a substantial proportion of the road network in the country.

3 Objectives

The objective of Phase 2 is to develop the documentation needed by practitioners in the Roads Authority and the private sector to develop appropriate designs and appropriate standards of construction for upgrading existing roads to LVRS standard. Phase 2 will be undertaken in two parts:

- Phase 2A: Preparation of Pavement Design Manual for LVSRs.
- Phase 2B: Preparation of Standard Bidding Documents for LVSRs (including Standard Specifications).

4 Scope of the Services (Phase 2A)

The Consultant will:

- Undertake a review of the findings and recommendations of the Final Report prepared under Phase 1.
- Undertake an initial visit to Malawi to attend a meeting of a Technical Working Group, which will be convened by the Roads Authority to oversee the project. The Working Group will include private sector representatives and officials from other road sector institutions.

- Agree on the Table of Contents of the proposed LVSR design manual with the Working Group. During the initial visit the Consultant will also start the process for the selection of the training site for the DCP design method and provide recommendations for any laboratory testing that might be required on the site in advance of the training.
- The Consultant will assess, in discussion with the RA, the need to engage a locally based sub-consultant to assist with the fieldwork needed for the selection and design of the training site. The Consultant will provide a costed proposal to Crown Agents for the engagement of this sub-consultant.
- Prepare a draft pavement design manual for LVSRs in Malawi based on the design principles developed in Phase 1 and the Table of Contents agreed with the Working Group. The manual should have an introductory chapter on the LVSR design approach and the place of LVSRs in the Malawi road hierarchy. The manual should provide detailed guidance on:
  - identification of roads that are suitable for application of the LVSR design approach;
  - analysis of existing unpaved road pavements, including appropriate insitu materials testing and the use of the Dynamic Cone Penetrometer (DCP);
  - identification and classification of locally available materials used in road upgrading;
  - choice of design life, traffic counts and estimation of traffic growth (including appropriate axle load equivalency factors for LVSRs in Malawi);
  - selection of appropriate pavement structure (including the use of the DCP design approach);
  - dealing with poor subgrade soil sections;
  - choice of surfacing seal (NB the Manual will not include detailed guidance on the design of surfacing seals), and;
  - minimum requirements for effective drainage of the road formation (NB the Manual will not include guidance for the design of cross-drainage structures or sizing drainage channels).
- Present the draft manual at a 3 day training workshop of practitioners from the Roads Authority and the private sector. It is expected that the workshop will include a field trial of the draft manual on a suitable road to be identified by the RA, enabling participants to implement the proposed design methodologies in smaller groups and to compare results.
- Prepare a Final Pavement Design Manual for LVSRs incorporating the experiences and feedback from the training workshop and the Technical Working Group.
- Participate in a launch seminar for the Manual.

5 Transfer of Knowledge/Training

Capacity building and transfer of knowledge are key components of this assignment. The Consultant is required to work in close collaboration with staff of the Roads Authority and the Central Materials Laboratory of the Ministry of Transport and Public Infrastructure that will be assigned to the project, as well as private sector practitioners.

The assignment is a component of a set of inter-related projects across Africa as part of the AFCAP programme. The Consultant is required to share and exchange knowledge and experiences between other projects within the AFCAP programme.

6 Minimum Experience requirements

The assignment will be carried out by an international consultant with considerable experience in the design and construction of low volume sealed roads in Africa. The expert should have skills and experience in the following areas:

i. Pavement design for low volume sealed roads using locally available materials
ii. Use of the DCP design method
iii. Design of thin bituminous seals for low volume sealed roads
iv. Construction of LVSRs in the SADC region
v. Excellent communication skills and training/capacity building experience.

7 Consultant Inputs

The Consultant is required to provide 50 days input to the project as detailed below. This will include two 10 day visits to Malawi to initiate the project and to finalise the draft report and to prepare for and conduct the workshop, and a shorter visit for the launch of the Manual. The remaining time has been allowed for home-based work including document preparation, report writing and travel preparations.

Stage 1: Review of Phase 1 report	**1 day**
Stage 2: Preparation of Draft Manual	
• Preparation of ToC	**1 day**
• Visit to present and finalise ToC (travel to/from Malawi)	**2 days**
• Presentation, discussion and agreement of ToC	**2 days**
• Selection of demonstration project, discussion of field surveys and lab testing requirements, initiation of field and lab work, selection of local consultant	**5 days**
• Drafting of Manual	**22 days**
Stage 3: Presentation of Draft Manual at training workshop, including field trial of draft manual	**10 days**
Stage 4: Preparation of Final Pavement Design Manual	**3 days**
Stage 5: Preparations and participation in launch seminar for the manual.	**4 days**
Total	**50 days**

A separate budget will be provided by AFCAP for the engagement of a locally-based sub-consultant to assist with fieldwork for the selection and design of the training site.

8 Assignment Period

The total duration of the assignment is expected to be 24 weeks.

9 Facilities, services and resources to be provided by the Consultant and Host Agency

The Consultant is responsible for arranging his own travel to Lilongwe and within the city. The Consultant is required to provide his own accommodation and subsistence requirements in Malawi. The Consultant is also responsible for providing for his own office facilities and support including computers, printing, coping, etc., as well as office consumables and communications.

The Roads Authority will be providing a vehicle for the use of the Consultant on field trips outside Lilongwe. The Consultant will provide fuel for the vehicle. The Roads Authority will provide for the accommodation and subsistence costs when necessary for RA staff accompanying the Consultant on field trips.

The Roads Authority will liaise with the Central Materials Laboratory for the use of CML equipment in the workshop trials.

The Roads Authority will be responsible for organising the meetings of the Technical Working Group, the stakeholder workshop and the launch seminar with financial assistance from AFCAP.

Crown Agents will procure two licensed copies of the CSIR WIN 5 DCP Design Package (or similar software proposed by the Consultant) for use in the training exercises and to be handed over to the Roads Authority on completion of the project.

10 Reporting

The Consultant will submit the following reports:

i. A draft Design Manual within nine weeks of the start of the assignment.
ii. A draft progress report concurrently with the submission of the draft Manual. The draft report should summarise activities undertaken by the Consultant, discuss any assumptions and important considerations underpinning the approaches outlined in the Manual, and provide recommendations for Phase 2B (Bidding Documents).
iii. A final Design Manual within 2 weeks of the second visit.
iv. A Final Report concurrently with the final Design Manual.

All reports should be submitted to the Roads Authority in hard copy (4 copies) and electronically to the Roads Authority and AFCAP. All reports shall be in English.

11 Assignment Management and Administration

The Consultant is expected to maintain close liaison with the Director of Planning and Design in the Malawi Roads Authority at all stages of the assignment, including regular updates on progress and the formulation of plans and draft recommendations.

The Consultant will report to the Technical Manager of the Africa Community Access Programme (AFCAP) for all technical aspects of the implementation of the project and submission of deliverables. For all contractual and administrative matters the Consultant will report to the AFCAP Procurement Manager.

12 Scope of the Services (Phase 2B)

- Undertake a review of the findings and recommendations of the Final Report prepared under Phase 1.

- Prepare draft Standard Bidding Documents (SBDs) for LVSRs in Malawi based on the LVSR design principles developed in Phase 1.

13 Deliverables

- A bidding documents based as closely as possible on existing documentation used by the Roads Authority, including, at a minimum:
- Foreword and Preface
- Procedure for Document Changes
- Instructions to Bidders (ITB)
- Bid Data Sheet (BDS)
- Evaluation and Qualification Criteria
- Bidding Forms
- Standard Specifications for LVSRs (Specifications for base, sub-base / subgrade materials must be specific to non-conventional materials typically used in LVSR construction in Malawi)
- Standard Drawings for LVSRs
- General Conditions of Contract (GC)
- Particular Conditions (PC)
- Annex to the Particular Conditions - Contract Forms (Performance Security, Advance Payment Security, etc.)
- User Guide to accompany the Standard Bidding Documents (SBDs).
- Present the draft SBDs at a 3 day training workshop of practitioners from the Roads Authority and the private sector.
- Participate in a launch seminar for the LVSR Design Manual and SBDs.

Annex B – Workshop Programme

AGENDA

08.00 – 8.30	Registration of Participants
08.30 – 08.40	Opening Remarks by Roads Authority
08.40 – 08: 45	Introduction to LVSR Project Phase 2 by Mr Rob Giddes , Technical Manager
09.00 – 10.30	Presentation by the International Consultant on: • Sensitising the TWG to the overall purpose and scope of the project and the general approach and methodology proposed for undertaking it; • Summarising the outcome of Phase 1 of the project; • Agreeing the outline Table of Contents of the proposed LVSR design manual as well as the format and layout of the document
10.30 – 10.50	**Coffee/Tea Break/Group Photograph .**
10.50 – 12.00	Presentation Continued… • Agreeing the outline Table of Contents for the Standard Bidding Documents and Standard Specifications for LVSRs as well as the format and layout of the document • Agreeing the training site for the DCP design method and the approach to carrying out the training. • Agreeing the modus operandi for undertaking the project and the role of the WG in its execution • Any other matters
12.00 – 12.30	Plenary Discussion - Facilitator
12.30 – 13.30	**Lunch Break .**
13.30 – 15.30	Field Visit to Likune-Malingunde Road
15:30 - 16.15	Discussion, Resolutions and Closing Remarks at the end of the field visit
16.15	Return to LILONGWE CITY.

Annex C
List of Workshop Participants

No	Name	Designation	Address	Phone	E-Mail Address
1	Jephta Chagunda	Facilitator			
Ministry of Transport					
2	Tops Masimbi	Materials	P/Bag 16 LL	0999212701	topsmasimbi@gmail.com
Roads Authority					
3	Eng. Paul J Kulemeka	CEO	P/Bag B346 LL 3	0888836561	pkulemeka@ra.org.mw
4	Eng. Placid Kasakatira	Dir. Design & Planning	P/Bag B 346, LL	0888835915	pkaskatira@ra.org.mw
5	Eng. Benjamin Kapoteza	Director Construction	P/Bag B 346, LL	0888831313	bkapoteza@ra.org.mw
6	Eng. Joey Malota	Senior Engineer	P/Bag B 346, LL	0888843190	Jmalota@ra.org.mw
7	Eng. Sharmey Banda	Senior Engineer (P)	P/Bag 346, LL	0888843907	sbanda@ra.org.mw
Road Fund Administration					
8	O. Kondowe	Highway Eng. Planning	P/Bag B 346, LL	0888843903	okondowe@ra.org.mw
9	Eng. Douglas Kalinde	Procurement Specialist	P/Bag B 346, LL		dkalinde@ra.org.mw
11	Sangwani Gondwe	Technical Auditor	Box 369, LL	0888 302 833	sgondwe@rfamw.com
NCIC					
12	Peter Nyirenda	Registration Officer	NCIC	0999252141	Peter.nyirenda@ncic.mw
University of Malawi					
13	Dr. Ignasio Ngoma	Dir. T2 Center/Pres MIE	P/Bag 303, BT	0888841947	ingoma@poly.ac.mw
Contractors					
14	Eng. Trevor Hiwa	Dir. Romano Con. Engrs		0888842503	trevorhiwa@romana-engineers.mw
15	Mr. Francis Kavwenje	Contracts Manager	Master Constr.	0999913723	francis.kavwenje@yahoo.com
Road Materials Suppliers					
16	Mr. Richard Dilawo	M. D. Dika Constr.	Box 1122 LL	0999870533	richarddilawo@gmail.com
17	Mr. Lapton Mdala	Bitumat Ltd,	P/Bag 748, LL	0888613017	lmndala@gmail.com

Annex D – Draft Table of Contents

Pavement Design Manual

Standard Bidding Documents

Table of Contents

Contents of SBD

1. Foreward and Preface

The foreword, by the CEO of the roads authority, will introduce and endorse the concept of sealing low volume roads.

The preface will provide the user of the SBD with enough background to the technical standards for LVSR to appreciate the philosophy driving their formulation and requirements for implementation

2. Procedure for Document Changes

To ensure that as the document develops through use all improvements are communicated to all users a simple Quality Assurance (QA) procedure will be incorporated into the document. A Master Copy of the document lodged within RA HQ will act as the reference document with all changes logged on a register sheet within the document and a new Version Number issued. A register of all copies of the document in use, logged in the same place, will allow these changes to be communicated to all SBD users. If a user is unsure if they have the latest version a call to HQ to check on the Master Copy Version Number will answer this question immediately.

By ensuring that all users of the SBD are working with the latest version will ensure that there is a consistency of approach to all LVSR contracts. This leads to confidence within all parties involved in a contract and promotes value for money and harmonious working relationships.

3. Instructions to Bidders (ITB)

The ITB will contain the information as listed below, which is common to construction contracts:

- **Eligibility** and Responsibility **of bidders**
- Tender documents
- Examination of Site and Documents and Official Site Visit
- Obscurity of meaning
- Circular Letters
- BoQ and Bid Price, Currency and Payment
- Validity and Acceptance of Bid
- Additional Information
- Format and Signing of Bids
- Bid Delivery and Late Bids
- Modification / Withdrawal of Bids and Bid Opening
- Confidentiality of Bid Process and Clarification of Bids
- Determination of Responsiveness and Correction of Errors
- **Evaluation and Comparison of Bids and Award Criteria**
- Notification of Award and Signing of Agreement
- Performance Security

4. Bid Data Sheet (BDS)

The BDS will contain the information as listed below, which is common to construction contracts:

- Summary of major bid requirements
- Critical dates and times
- Language and currency
- Insurance requirements

5. Evaluation and Qualification Criteria

Financial Qualification criteria will be registration of Contractors with the National Construction Industry Council (NCIC) at the relevant financial level.

Technical qualification will be through proof of ownership or access to the specialist equipment required to carry out the work and experience and qualifications of the firm as a whole and it's key members of staff.

6. Bidding Forms

The following forms will be included in the SBD as are common to construction contracts in Malawi and elsewhere:

- Form of Bid
- Certificate of site visit
- Agreement

- Normal working hours, Labour rates, Material Prices and Plant Hire Rates
- Plant to be used and Personnel to be employed
- Proposed sub-contractors and memorandum of procedure
- Camp, offices, workshop and stores

7. Standard Specifications

The following sections will be included in the standard specification, numbered in line with current RA specifications:

- Ser. 100 - General
- Ser. 200 - Site Clearance and Earthworks
- **Ser. 300 - Drainage**
- **Ser. 400 - Subgrade, Sub-base and Bases**
- **Ser. 500 - Surfacing**
- Ser. 700 - Formwork & surface finish for Structures
- Ser. 900 - Concrete for Structures
- Ser. 1300 - Miscellaneous for Structures ???
- Ser. 1400 - Miscellaneous for Roadworks ???
- **Ser. 1600 - Testing of Materials and Quality Control**

The highlighted sections on Drainage, Subgrade, Sub-base and Bases, Surfacing and Testing will require the most work, to be done in conjunction with Mike Pinard and his work on the design guide.

The miscellaneous sections can probably be dispensed with and the addition of sections for Signs and Road Markings and Safety at Roadworks introduced.

8. Standard Drawings

The following standard drawings were suggested as being sufficient to cover the work involved in LVSR construction:

- Strip plan format – road width, drains, sections
- Road cross-sections, various options
- Pavement construction, various options
- Drainage Structures, range of sizes, appropriate technology
- Traffic management at roadworks

Other drawings may be needed on a contract by contract basis and will be prepared following the design work.

9. General Conditions of Contract

The GC will be based on the current RA conditions for small contracts. A list of the 63 clause headings is contemplated.

10. Particular Conditions of Contract (PC)

The PC will of course follow the GC and will be presented in a tabular form which allows the person preparing the bidding document to see clearly that all the required information has been entered and is correct.

11. Bill of Quantities (BoQ)

The BoQ will be prepared as appropriate for the requirements of the Pavement Design Manual and the design guide and will use bill items with a more global coverage rather than splitting work items into smaller tasks.

Annex E – Site Visit Photographs

Section of well-formed and drained sandy clay running surface (no gravel wearing course) in good condition near Malingunde

Section of gravel road on moderate gradient showing some rutting, deformation and drain erosion

Section of badly rutted and pot holed, gravel section of road in low-lying, poorly drained area

Section of recently graveled section of road in very good condition in reasonably well drained area

Well formed and drained, gravelled section of road exhibiting gravel loss after one year

Section of road on relatively steep gradient showing severe erosion of drain downstream of scour check

ANNEX F

Field Investigations and Laboratory Testing Programme

(a) DCP measurements

(1) Two sets of DCP measurements are to be undertaken, one set in the dry season and the other set in the wet season, at the intervals and off-sets shown in Figure F1 below;

(2) The locations in the wet season are the same as in the dry season, except that the actual penetration point should be displaced by about 150 mm,

(3) Each DCP measurement should be undertaken to a depth of at least 800mm;

(4) Where penetration refusal is encountered, the test should be repeated approximately 150 mm away from the original hole;

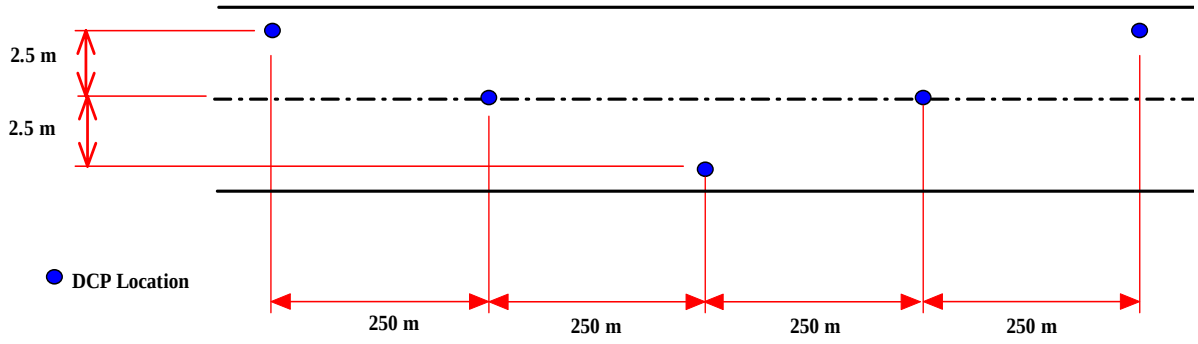
(5) The penetration readings are to be recorded every 5 blows;

(6) The normal precautions should be observed when undertaking the DCP measurements, including:

a. The DCP assemblage to be maintained in a vertical position throughout the entire measurement process

b. The sliding weight to be lifted slowly to the top of the Top Rod before it is released. During the lifting process, the underneath of the Top Handle should not be hit with any force.

(7) The DCP measurements to be recorded in an Excel spreadsheet.



(b) Materials Sampling and Laboratory Testing

(1) During the DCP measurements, samples should be taken for moisture content determination only at every 1 km location, i.e. km 1, 2, 3….to the end of the road. During sampling, the following should be observed:

a. Remove the loose material from the surface and then sample the full depth of the wearing course, whatever its thickness.

b. After removal of the wearing course, sample the underlying layer to a depth of 150 mm (if there is no wearing course, sample the top layer only to a depth of 150 mm after removing the loose material on the surface;

c. Ensure that the samples are placed in a sample bag and securely sealed, prior to the determination of ist moisture content in the laboratory. , i.e. Bulk samples to be from each uniform section along the road for laboratory testing

(2) Based on a CUSUM analysis of the DCP results to be undertaken by the consultant, the uniform sections of the road will be determined (3 or 4 uniform sections are anticipated). On this basis, bulk sampling will be undertaken in each layer of the road, i.e. the gravel wearing course and the underlying sandy clay subgrade, or the sandy clay wearing course where there is no gravel in place.

(3) 5 No. bulk samples should be obtained from **each** of the borrow pits envisaged for use as the wearing course on the Lukini-Malingunde road for testing as below.

(4) The bulk samples from both the road and the borrow pit (s) should be large enough to enable the following laboratory tests to be undertaken **in triplicate;**

Layer	Number of Tests by Type						
	Atterbergs	Linear Shrinkage	Grading	MDD/OMC	CBR (Soaked)	CBR (Unsoaked)	CBR (0.75 OMC)
WC	3	3	3	3	3	3	3
SB/SG	3	3	3	3	3	3	3
Total	6	6	6	6	6	6	6

N.B. WC = Wearing course; SB = Subbase; SG = Subgrade

Annex G

Axle Load Surveys

1. The objective of the axle load surveys is to obtain a reasonably reliable indication of the average vehicle equivalency factor for the types vehicles likely to use the Lukini-Malingunde road.

2. All commercial vehicles (mass > 1500 kg) should be weighed whatever their state of loading, i.e. full, half-full, empty.

3. The survey should be carried out generally in compliance with TRL Overseas Road Note 40 – *A guide to axle load surveys and traffic counts for determining traffic loading on pavements.*

4. The survey should be undertaken on a straight, level section of the paved road north of Likuni.

5. The survey should be carried out for a total of 7 days, for half-day at a time over say 3 months.

Annex H

Topographic Surveys

1. The objective of the topographic survey is to obtain a reasonable indication of various features of the road that would influence the approach to its design. For example:

   (a) Is the existing road formation adequate for the finished road level after placement of the gravel wearing course, or does it have to be raised to satisfy minimum drainage requirements (Drainage Factor);

   (b) Are there existing longitudinal drains at a minimum depth below the finished road level, or do they have to be deepened and/or the road embankment raised in order to satisfy the minimum drainage requirements (Drainage Factor);

   (c) Are the gradients along the road mild, moderate or steep? This will influence the value of the Drainage Factor and the need or otherwise for the introduction of scour checks or lined drains lined;

   (d) From a road safety perspective, is the horizontal alignment adequate in terms of curvature or will some curve easing be required or will proper signage alone be sufficient?

:

2. The RA should undertake the type of topographic survey normally undertaken for LVRs, bearing in mind the need to the type of information indicated above which could have a bearing on the approach to the design of the demonstration project. This should include:

   (a) A chainage survey which is a priority for fixing the locations of the DCP measurement points as well as for other purposes (e.g. fixing the locations of cross-sections, etc.);

   (b) A level survey – required for establishing, particularly, low-lying sections where additional fill may be required;

   (c) Cross-sections – at least where there are discernible changes in the main features of the road