Development of Pavement and Geometric Design Standards for Low Volume Roads (Rural and Urban) In Malawi

Final Inception Phase Workshop Report

Photos: Authors, 2018

Infra Africa (Pty) Ltd, Botswana

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Cover photo: Project team.

Quality assurance and review table

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Abstract

In connection with the ReCAP-supported project on the Development of Pavement and Geometric Design Standards for Low Volume Roads (Rural and Urban) in Malawi, a 1-day Inception Workshop was held on Friday 30th November, 2018 at the Lilongwe Sunbird Hotel Conference Centre, Lilongwe. The objectives of the workshop were to: (1) provide an overview of the preparatory stages of the project; (2) outline the approach and methodology adopted for carrying out the project, (3) present the outcome of an initial literature review of relevant documents pertaining to the development of the manuals, and (4) discuss the proposed Table of Contents for the manuals.

The initial literature review has revealed that the information required to populate the Table of Contents for the Pavement Design Manual is available largely from a number of previously compiled low volume road (LVR) manuals developed under ReCAP. However, this is less the case with the pavement or geometric design of low volume roads in urban environments which have only recently been included in LVR manuals being developed under ReCAP. Recourse was made to pavement and geometric design manuals developed by other organisations for application to urban environments, including those emanating from South Africa and internationally.

The development of the Pavement Design Manual will follow the approach adopted for similar manuals produced previously under ReCAP. However, because of the different approach to the geometric design of rural as against urban roads, the Geometric Design Manual will be divided into two parts, namely: Part A: Rural Roads and, Part B: Urban Roads (Streets).

The proposed Table of Contents for the manuals was discussed and generally agreed with the Technical Steering Committee (TSC). The submission of the 1st Draft Manuals is scheduled for mid-February, 2019, with the 2-day Manuals Review Workshop to follow during the week beginning 11th March, 2019.

As a result of a 6-week delay in holding the Inception Workshop, and the allowance of a 3-week period for review of the 1st Draft Manuals by the TSC, it has been necessary to revise the Work Programme which now indicates completion of the project in Week 47, i.e. 19th July, 2019 in contrast to the previously estimated completion date in Week 38, i.e. 18 May, 2019 – a prolongation period of 9 weeks.

Key words

Low volume roads, pavement design, geometric design, urban roads, rural roads.

Acknowledgements

The authors would like to acknowledge the role paled by the Road Authority in establishing the Technical Steering Committee and undertaking all the arrangements for the holding of the workshop.

Research 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.

www.research4cap.org
**Acronyms, Initialisms, Units and Currencies**

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<td>AADT</td>
<td>Annual Average Daily Traffic</td>
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<td>CBR</td>
<td>California bearing Ratio</td>
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<td>DCP</td>
<td>Dynamic Cone Penetrometer</td>
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<td>DFID</td>
<td>Department for International Development</td>
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<td>DN</td>
<td>The average penetration rate in mm/blow of the DCP in a pavement layer</td>
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<td>DTP</td>
<td>Desktop Publishing</td>
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<td>LVR</td>
<td>Low Volume Road</td>
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1 Introduction

1.1 Background
As part of previous ReCAP activities in Malawi, a new manual for the design of low volume roads (LVRs), based on the DCP-DN method, was prepared for the Roads Authority (RA) in 2013. However, other methods of pavement design for LVRs, such as those based on the DCP-CBR and Structural Number methods, as well as geometric design for both rural and urban LVRs, are not adequately addressed in the DCP-DN or other current manuals. This shortcoming has prompted the Malawi RA to seek support from ReCAP for the preparation of two separate LVR manuals to cover both pavement and geometric design in urban and rural areas.

The aim of the new manuals is to provide all practitioners in Malawi with comprehensive guidance on the wide range of factors that need to be addressed in a holistic and environmentally optimized manner in the provision of LVRs. Moreover, the manuals are expected to serve as a standard reference and source of good practice for application to the LVR network in Malawi.

1.2 Scope of Project
The project is being carried out in three stages with related activities as indicated below:

Stage 1: Inception Phase
1.1: Hold 1-day Kick-off meeting
1.2: Prepare Record of Meeting
1.3: Undertake Literature Review
1.4: Prepare Draft Inception Report
1.5: Hold 1-day Inception Workshop
1.6: Prepare Final Inception Workshop Report

Stage 2: Prepare Manuals
2.1: Prepare 1st Draft Manuals
2.2: Hold 2-day Manuals Review Workshop
2.3: Prepare Workshop Report
2.4: Prepare 2nd Draft Manuals
2.5: Send manuals for peer review
2.6: Prepare final manuals

Stage 3: Produce and Launch Manuals
3.1: Undertake Desk Top Publishing of manuals
3.2: Undertake printing of manuals
3.3: Prepare USBs of manuals
3.4: Submit manuals and USBs to client
3.5: Launch manuals (half day)
3.6: Prepare Launch Report

The project is currently complete to the end of Stage 1 – the preparation of this Inception Phase Workshop Report which updates the Draft Inception Report to take account of the outputs of the workshop.

1.3 Date and Venue of Workshop
The 1-day workshop was held on Friday 30th November, 2018 at the Lilongwe Sunbird Hotel Conference Centre, Old Town, Lilongwe.
1.4 Objectives of Workshop

The main objectives of the Workshop were as follows:

- To present the Draft Inception Report to members of the Technical Steering Committee (TSC) including:
  - an overview of the preparatory stages of the project;
  - an outline of the approach and methodology for carrying out the project;
  - the outcome of an initial literature review of relevant documents pertaining to the development of the Pavement and Geometric Design Manuals;
  - discussion on the proposed table of contents for both manuals.
- To discuss the remaining programme for the project including the modalities for presenting the 1st Draft Manuals at the 2-day Manuals Review Workshop.

1.5 Workshop Programme

The Workshop Programme is presented in Annex 1.

1.6 Attendance

The workshop was attended by 13 members of the TSC as well as two observers from the European Union Technical Assistance to the Rural Roads Improvement Programme (RRImP). The workshop attendance list is presented in Annex 2.

1.7 Outputs

The main outputs of the workshop include a consolidated list of comments that emanated from deliberations amongst stakeholders following the Consultant’s presentation of the Draft Inception Report; broad agreement on the structure and Table of Contents of the manuals; and discussion on the modalities for the holding of the 2-day Manuals Review Workshop.

1.8 Structure of Report

This Workshop Report documents the outcome of the workshop proceedings and is structured as follows:

Section 1 (this section): Provides the background to the project and the details of the workshop.

Section 2: Presents the workshop preliminaries including the welcome remarks by the RA.

Section 3: Provides a summary of the workshop presentations and ensuing discussions.

Section 4: Summarises the main outcomes of the workshop and the agreed way forward to the next Stage 2 of the project – the presentation of the 1st Draft Manuals at a 2-day Manuals Review Workshop.
2 Workshop Preliminaries

2.1 Welcome Remarks

The Welcome remarks were made by Eng. F. Dimu (Director of Planning – Roads Authority (RA)) on behalf of the Chief Executive Officer of the RA. Following his welcome to the workshop participants, he went on to state that:

- The scope of the assignment is essentially to develop new manuals for pavement and geometric design to ensure uniformity of standards in the provision of low volume roads (LVRs) in rural and urban areas of the country.

- A Technical Steering Committee (TSC) had been formally established and comprises representatives from a wide range of stakeholder organizations including:
  - Malawi Roads Authority
  - Ministry of Transport and Public Works – Roads Department
  - Ministry of Local Government and Rural Development
  - T2 Centre
  - University of Malawi, The Polytechnic – Department of Civil Engineering
  - Malawi Institution of Engineers
  - Directorate of Road Traffic and Safety Services
  - National Construction Industry Council
  - Association of Consulting Engineers

- He urged the TSC members to participate actively in the project meetings and to see the project through to its completion.

2.2 Opening Statement – ReCAP Regional Technical Manager (East and Southern Africa)

An opening statement was made by the ReCAP Regional Technical Manager, Eng. Henry Nkwanga, in which he stated the following:

- He was responsible, on behalf of ReCAP, for the overall management of the project.

- The consultants appointed by ReCAP all have extensive experience in the development of LVR manuals and had also been involved previously in a number of related projects in countries within the region including Malawi.

- The project started in August 2018 with the Kick-Off meeting and comprises 3 main stages as follows:
  - Stage 1: Inception
  - Stage 2: Manuals Preparation
  - Stage 3: Manuals Printing and Launch

- The manuals include a component which addresses pavement and geometric design of roads in urban areas.

- He looked forward to the deliberations ensuing from the Inception Workshop which would provide a key input to Stage 2 - the preparation of the 1st Draft manuals.

- There was need for local ownership of the manuals which would require buy-in through close involvement of stakeholders in the process of their development. It was therefore important that the members of the TSC remain closely involved in all stages of the development of the manuals.
As a result of the 6-week delay in holding the workshop, there was a need to, as far as possible, get back on track with the programme.

2.3 Consultant’s Remarks

The Team Leader for the Consultants, Eng. Mike Pinard, thanked the chairman of the meeting for his Welcome Remarks and then introduced the core members of the project team. He then went on to state that:

- The project team looked forward to working collaboratively and constructively with the TSC to ensure that the final manuals will meet the expectations of all stakeholders.
- The TSC was expected to play a full role in the development of the manuals through prior review of all project documents and active involvement in workshop discussions. By so doing, they would assume ultimate ownership of the final documents leading to their implementation in practice.
- The workshop afforded an opportunity for the TSC to consider carefully the outline Table of Contents in order to reach agreement on it, as a basis for the Consultant’s subsequent preparation of the 1st Draft Manuals.
- The focus of the manuals is on the pavement and geometric design of LVRs in rural and urban environments.
- The project is currently nearing the end of Stage 1 – Inception Phase which will be concluded by the preparation of an Inception Workshop Report. The report will include an agreed outline Table of Contents for the drafting of the manuals as discussed at the workshop.
- The remaining stages of the project include the drafting of the manuals for presentation to the TSC, updating of the manuals based on the comments emanating from the Manuals Review Workshop, and finalizing the manuals following an external peer review process and, finally, the printing and launching of the manuals at a half-day workshop for all key stakeholders.
3 Workshop Presentations and Deliberations

3.1 General

Brief PowerPoint presentations were made by the Consultant on the general aspects of the project including the Preparatory Activities undertaken, the Approach and Methodology adopted in undertaking the project, including the manner of undertaking the literature review, and the Programme for its execution. Thereafter, the main focus of the workshop, for which most of the time on the programme was allocated, was on the presentation and discussion of the outline Table of Contents (ToC) for the Pavement and Geometric Design Manuals.

During the course of the presentation of the ToC of the manuals, a number of comments were made, and clarifications sought, by the TSC members on the scope of the manuals as well as on the content of the various chapters presented. In this regard, a summary is presented below of the most important issues discussed and agreements reached.

3.2 Literature Review

3.2.1 General Approach

The approach adopted by the Consultants in undertaking the initial literature review was as follows:

- Consider the proposed contents of the manuals as indicated in the Terms of Reference.
- Develop an idealised ToC based on prior experience of developing similar manuals, but customised to the Malawian environment.
- Undertake a literature review to fill any gaps in information required to satisfy the contents of the ToC.

3.2.2 Outcome of Literature Review - Pavement Design

Apart from the Malawi DCP Design Manual, there are no other national design guidelines specifically related to the design of LVRs in Malawi. As a result, the information required to populate the ToC for the Pavement Design Manual was obtained largely from a number of previously compiled LVR manuals for rural roads that have been developed under ReCAP. However, this is not the case for urban LVRs for which recourse was made to a number of other manuals in the region, especially South Africa, and international.

3.2.3 Outcome of Literature Review - Geometric Design

The main focus of the literature review for the Geometric Design Manual was on both rural and urban roads, with greater attention to the latter which has only relatively recently been covered in ReCAP manuals. The information required to populate the ToC for this manual required extensive review of other manuals produced in the region, particularly South Africa and internationally, e.g. Australia.

Because of the difference in approach to the geometric design of rural as against urban roads, it is proposed to divide the Geometric Design Manual into two parts, namely: Part A: Rural Roads and, Part B: Urban Roads (Streets).
3.3 Pavement Design Manual

3.3.1 General
Prior to the presentation of the outline Table of Contents for the Pavement Design Manual, the Consultant mentioned the following points in relation to development of this document:

- Low volume roads are currently defined as those roads which, over their design life, are required to carry up to about 300 motor vehicles per day, and less than about 1.0 million equivalent standard axles (MESA) in one direction.
- The manuals are to apply to all LVRs in Malawi, regardless of their classification, i.e. to primary, secondary and tertiary roads.
- The scope of the manuals will focus on topics normally included in such documents. This would exclude such topics as maintenance operations/procedures, construction issues such as borrow pit management, quality assurance and control, technical auditing, etc., which are generally the subject of separate, self-standing manuals.
- The information required to populate the ToC for the Pavement Design Manual, as regards rural roads, is available largely from a number of previously compiled LVR manuals that have been developed under ReCAP. However, this is not the case for urban LVRs for which recourse was made to a number of other manuals developed in the region and internationally.

3.3.2 Scope of Manual
As indicated in the Final Inception Report, the proposed ToC of the Pavement Design Manual is as follows:

- Chapter 1 - General Introduction
- Chapter 2 - Approach to Design
- Chapter 3 - Physical Environment
- Chapter 4 - Site Investigations
- Chapter 5 - Materials
- Chapter 6 - Traffic
- Chapter 7 - Hydrology and Drainage Structures
- Chapter 8 - Drainage and Erosion Control
- Chapter 9 - Structural Design: Paved Roads
- Chapter 10 - Structural Design: Unpaved Roads
- Chapter 11 - Surfacing
- Chapter 12 - Life-Cycle costing
- Chapter 13 - Practical Considerations

3.3.3 General Discussion and Agreements Reached
The following is a summary of the main comments made by the TSC on the Pavement Design Manual:

1. Chapter 1 – General Introduction: No major comments
2. Chapter 2 – Approach to Design of Low Volume Roads: Consider combining Section 2.3 – Characteristics (of LVRs) with Section 2.2 – Definition (of LVRs).
   Consultant’s response: *The Definition and the Characteristics of LVRs are quite separate issues. Nonetheless, this suggestion will be considered at the drafting stage.*
3. Chapter 3 - Physical Environment: The TSC Coordinator is to provide the Consultants with various maps of the physical environment of Malawi including: Topography, Geology, Soils, Climate (Rainfall) and Hydrology.
Consultant’s response: The Consultant looks forward to receiving this information as soon as possible to facilitate the drafting of the chapter.

4. Chapter 4 - Site Investigations: After Section 1 – Introduction, consider placing Section 3 - Site Investigation Methods ahead of Section 2 – Preliminary Site Investigations and Section 3 – Detailed Site Investigations. The role of the Engineer versus that of the Technician should also be considered in the undertaking site investigations.

Consultant’s response: The Consultant will consider these suggestions in the drafting of the chapter.

5. Chapter 5 - Materials: Section 5.5 – Materials Prospecting should be introduced after Section 5.1 – Introduction rather than after Section 5-2 – Material types and Section 5.3 – Use of Locally Available materials.

Consultant’s response: The Consultant will consider these suggestions in the drafting of the chapter.

6. Chapter 6 – Traffic: No major comments.

7. Chapter 7 – Hydrology and Drainage Structures: What type of bridges are addressed in Section 7.12 – Bridges.

Consultant’s response: Section 7.12 will deal with short-span (< 10 m length) bridges only.

6. Chapters 8 to 13: No major comments.

3.4 Geometric Design Manual

3.4.1 General

Prior to the presentation of the outline Table of Contents for the Geometric Design Manual, the Consultant mentioned the following points in relation to the development of this document:

- The geometric design of urban roads was being addressed for the first time under ReCAP in that previous manuals focused only on rural roads. This required an extensive review of other manuals produced in the region, including South Africa, and internationally, e.g. Australia.

- The approach to the geometric design of rural and urban roads is quite different in that the former is based largely on traffic volumes (AADT) whereas the latter is based primarily on a functional road/street classification approach.

- As mentioned above, because of the difference in approach to the geometric design of rural as against urban roads, it is proposed to divide the Geometric Design Manual into two parts, namely: Part A: Rural Roads and, Part B: Urban Roads (Streets).

3.4.2 Scope of Manual

As indicated in the Final Inception Report, the proposed ToC of the Geometric Design Manual is as follows:

Part A – Rural Roads
- Chapter 1 – General Introduction
- Chapter 2 – Approach to Design
- Chapter 3 - Fundamental Design Considerations
- Chapter 4 - Traffic Volume and Composition
- Chapter 5 - Cross Section
- Chapter 6 - Alignment Design
- Chapter 7 - Road Safety
- Chapter 8 - Detailed Design Standards
Part B – Urban Roads (Streets)

- Chapter 1 – General Introduction
- Chapter 2 – Approach to Design
- Chapter 3 - Fundamental Design Considerations
- Chapter 4 - Traffic Volume and Composition
- Chapter 5 - Storm Water Drainage
- Chapter 6 - Cross Section
- Chapter 7 - Alignment Design
- Chapter 8 - Intersections
- Chapter 9 - Road Safety
- Chapter 10 - Roadside Furniture and Ancillary Matters

3.4.3 General Discussion and Agreements Reached

The following is a summary of the main comments made by the TSC on the Geometric Design Manual:

Part A – Geometric Design of Rural Roads

1. Chapter 1 – General Introduction: No major comments
2. Chapter 2 – Approach to Design: No major comments
3. Chapter 3 – Fundamental Design Considerations: In comparison with the Final Inception Report, the topics of Political and Economic Considerations appear to be missing.
   Consultant’s Response: These topics will be included in Chapter 3.
4. Chapters 4 – 8: No major comments

Part B – Geometric Design of Urban Roads

1. Chapter 1 – General Introduction: No major comments.
2. Chapter 2 – Approach to Design: No major comments.
3. Chapter 3 – Fundamental Design Considerations: Need to consider design for disability access.
   Consultant’s Response: This important topic will be considered in Chapter 3.
4. Chapters 4 – Traffic Volume and Composition: Need to provide guidance on carrying out traffic counts at intersections, including a Traffic Count proforma.
   Consultant’s response: Such guidance will be provided, together with a Traffic Count proforma.
5. Chapters 5 – 10: No major comments.

3.4.4 Indicative Table of Contents

Based on the discussions emanating from the Consultant’s presentation of the outline Table of Contents for the manuals, the indicative ToC that will be followed in drafting the Pavement and Geometric Design Manuals is presented in Annex 3. It should be stressed, however, that during the process of drafting the manuals, small changes to the ToC may occur.
4 Summary and Way Forward

4.1 General

Following the deliberations on the outline Table of Contents of the Pavement and Geometric Design Manuals, the following items were discussed:

- Programme
- Procedure for submitting the 1st Draft Manuals
- Holding of the 2-day Manuals Review Workshop

4.2 Programme

The impact of the 6-week delay in holding the Inception Workshop is that the Work Programme will need to be amended accordingly. In addition, it was mentioned by the TSC that:

(a) They would require a period of 3 weeks to review the 1st Draft Manuals which was not included in the original programme.

(b) General elections are to be held in Malawi on 19 May, 2019. This event will preclude the holding of any project-related activities in the build-up to, and the aftermath of, the elections, since it will be very difficult for Government officers to participate in such activities during these periods. Based on these considerations, the Work Programme has been revised as presented in Annex 4.

In view of the above, the revised programme now shows completion of the project in Week 47, i.e. 19th July, 2019 in contrast to the previously estimated completion date in Week 38, i.e. 18 May, 2019 – a prolongation period of 9 weeks.

4.3 Procedure for Reviewing 1st Draft Manuals

It was agreed at the workshop that the TSC would be allowed 3 weeks to review the 1st Draft Manuals before the holding of the workshop. In keeping with previously agreed procedures, both the TSC and ReCAP PMU would then undertake a collective review of the manuals, and provide comments on them, only after the workshop is held. This procedure will not only save much time in terms of commenting on a few hundred pages of text but, also, both parties (the TSC and RECAP PMU) will be in a better position to comment on the manuals after they have been presented at the Manuals Review Workshop.

4.4 Holding of the 2-Day Manuals Review Workshop

The Consultant suggested that every effort should be made by the TSC Coordinator to ensure that all members of the TSC receive the 1st Draft Manuals well in advance of the workshop so as to be able to participate fully in the proceedings. The tentative date suggested for the holding of the workshop, subject to subsequent approval by all parties, is during the week beginning 11th March, 2019.

4.5 Way Forward

The following action items were agreed:

1) The TSC is to provide the following to the Consultant as soon as possible:
   a. The names, designations and organizations represented by all TSC members.
   b. Documents/reports pertaining to:
i. The Malawi physical environment
   - Topographic map
   - Geological map
   - Soils map
   - Rainfall map
   - Hydrological map
ii. Revised Road Classification System (even if in draft form)
iii. Physical Planning Report
iv. Town Planning Act
v. Environmental Act
vi. Building Regulations (City Council)
vii. Any other relevant documents

4.6 Closure

In his closing remarks, the ReCAP Regional Technical Manager (East and Southern Africa), Eng. Henry Nkwanga:

- Expressed his satisfaction at the in-depth discussions that emanated from the workshop deliberations.
- Lauded the good turnout of the TSC members and urged their continuing involvement in the remainder of the project.
- Looked forward to insightful comments on the 1st Draft Manuals from the TSC, whilst recognizing that there would also be subsequent opportunities for commenting on the draft manuals before their completion.
- Emphasized the importance of TSC coordinator in maintaining effective, timeous and continuing communications with all stakeholders on developments of the manuals.
- Suggested that a Dropbox folder be established for the TSC Coordinator as a repository of all project documents which can then be shared, as appropriate, with other TSC members and stakeholders.
- Thanked the TSC members and Consultants for their contributions to the workshop and the RA for organising the venue for the workshop.
- Looked forward to the next stage of the project – the holding of the 2-day Manuals Review Workshop.

In his closing remarks, the Consultant’s Team Leader:

- Thanked the members of the TSC for their constructive participation in the proceedings of the workshop.
- Urged the TSC Coordinator to expedite the submission of the various documents and reports that have been requested by the Consultant.
- Thanked the RA for hosting the workshop, including all the supporting arrangements made in so doing.

In his closing remarks, the RA representative, Eng. Francis Dimu:
• Thanked the members of the TSC for coming to the meeting and exhorted them to continue to be fully engaged in all aspects of the development of the manuals, including participation in future meetings and review of the 1st Draft Manuals.

• Thanked the Consultants for their informative presentations at the workshop and their responses/clarifications to the various comments made by the TSC.

• Thanked the ReCAP project manager for his oversight guidance and management of the project.

The workshop was concluded at 17.30 hours.
## Annex 1  List of Workshop Participants

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Organisation</th>
<th>Position</th>
<th>E-mail</th>
<th>Cell No.</th>
</tr>
</thead>
<tbody>
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</table>
Annex 2    Workshop Programme

**Development of Pavement and Geometric Design Standards for Low Volume Roads (Rural and Urban) in Malawi**

Inception Workshop

**Venue:** Sunbird Lilongwe Hotel Conference Centre    **Date:** Friday 30 November, 2018

**Programme**

08:30 – 09:00    - Registration of Participants

09.00 – 09.10    - Welcome and Opening Remarks
    - RA Representative/ReCAP Representative

09.10 – 10.00    - Consultant’s Presentation
    - Preparatory Activities
    - Approach and Methodology
    - Programme
    - Discussion

10.00 – 10.30    - Coffee/Tea Break

10.30 – 12.30    - Consultant’s Presentation
    - Literature Review
    - Table of Contents: Pavement Design
    - Discussion

12.30 – 13.30    - Lunch

13.30 – 15.30    - Consultant’s Presentation
    - Table of Contents: Geometric Design (Rural Roads)
    - Table of Contents: Geometric Design (Urban Roads)
    - Discussion

15.30 – 16.00    - Coffee/Tea Break

16.00 – 16.30    - Workshop Closure
    - Closing Remarks – ReCAP Technical Manager
    - Consultant’s Team Leader
    - RA Representative

*******************************************************************************
Annex 3  Outline Table of Contents

PAVEMENT DESIGN
1  INTRODUCTION
   1.1  Background
   1.2  Purpose and Scope
   1.3  Development
   1.4  Structure
   1.5  Updating of the Manual

2  APPROACH TO DESIGN OF LOW VOLUME ROADS (LVRs)
   2.1  Introduction
   2.2  Definition
   2.3  Characteristics
   2.4  Design Principles

3  PHYSICAL ENVIRONMENT
   3.1  Introduction
   3.2  Physical Features
   3.3  Climate

4  SITE INVESTIGATIONS
   4.1  Introduction
   4.2  Site Investigation Methods
   4.3  Preliminary Site Investigations
   4.4  Detailed Site Investigations

5  MATERIALS
   5.1  Introduction
   5.2  Material Types
   5.3  Use of Locally Available Materials
   5.4  Materials Prospecting
   5.5  Materials Testing
   5.6  Construction Material Requirements
   5.7  Materials Improvement and Processing

6  TRAFFIC
   6.1  Introduction
   6.2  Surveys
   6.3  Procedure for Determining Design Traffic
   6.4  Design Example

7  HYDROLOGY AND DRAINAGE STRUCTURES
   7.1  Introduction
   7.2  Design Storm
   7.3  Methods of Design
   7.4  Flow Velocity
   7.5  Water Crossings and Associated Structures
   7.6  Low-Level Water Crossings
   7.7  Culverts
   7.8  Vented Drifts and Causeways
   7.9  Submersible Bridge
   7.10 Masonry Arch Culverts
7.11 Embanked Crossings
7.12 Bridges
7.13 Structure Selection
7.14 Scour Control
7.15 Downstream Protection

8 DRAINAGE AND EROSION CONTROL
8.1 Introduction
8.2 Sources of Moisture in a Pavement
8.3 External Drainage
8.4 Internal Drainage
8.5 Types of Erosion
8.6 Erosion Control Measures

9 STRUCTURAL DESIGN OF PAVED ROADS
9.1 Introduction
9.2 Design of Roads with Non-Structural Surfacings
9.3 Design of Roads with Non-Discrete Surfacings
9.4 Design of Roads with Discrete Element Surfacings
9.5 Pavement Design in Urban and Peri-Urban Environments

10 STRUCTURAL DESIGN OF UNPAVED ROADS
10.1 Introduction
10.2 Earth Roads
10.3 Gravel Roads
10.4 Treated Gravel Roads

11 SURFACINGS
11.1 Introduction
11.2 Bituminous Surfacings
11.3 Non-Bituminous Surfacings

12 LIFE CYCLE COSTING
12.1 Introduction
12.2 Life-Cycle Cost Analysis
12.3 Selection of Design Standard

13 PRACTICAL CONSIDERATIONS
13.1 Introduction
13.2 Environmental Issues
13.3 Pavement Cross-Section
13.4 Labour vs. Equipment
13.5 Compaction
13.6 Quality Assurance and Control
13.7 Borrow Pit Management
13.8 Maintenance
13.9 Overload Control
GEOMETRIC DESIGN: PART A – RURAL ROADS

1 INTRODUCTION
1.1 Background
1.2 Purpose and Scope
1.3 Development
1.4 Structure
1.5 Updating of the Manual

2. APPROACH TO DESIGN OF LOW VOLUME RURAL ROADS
2.1 Introduction
2.2 Definition
2.3 Characteristics
2.4 Design Principles

3 FUNDAMENTAL DESIGN CONSIDERATIONS
3.1 Introduction
3.2 Principal Factors Affecting Design Standards
3.3 Cost and Level of Service
3.4 Alignment and Route Controls
3.5 Design Vehicle
3.6 Administrative and Functional Considerations
3.7 Traffic Volume and Composition
3.8 Terrain/Topography
3.9 Design Speed
3.10 Roadside Population
3.11 Pavement Type
3.12 Land Use and Physical Features
3.13 Economic/Financial Considerations
3.14 Construction technology
3.15 Climate and Soil Type
3.16 Road Safety

4. TRAFFIC VOLUME AND COMPOSITION
4.1 Introduction
4.2 Design Traffic
4.3 Traffic Growth and Forecasting
4.4 Design Year
4.5 Traffic Size
4.6 Construction Traffic
4.7 Non-Motorised Traffic

5 CROSS SECTION
5.1 Introduction
5.2 Road Width
5.3 Right of Way
5.4 Camber and Cross-fall
5.5 Side slopes and Low Embankment
5.6 Side Drains
5.7 Shoulder, Flush Kerbs and Edge Beams
5.8 Single Lane Roads and Passing Places
6 ALIGNMENT DESIGN
6.1 Introduction
6.2 Design Speed and Geometry
6.3 Components of Horizontal Design
6.4 Vertical Alignment
6.5 Situations to Avoid
6.6 Coordination of Horizontal and Vertical Alignment
6.7 Balance

7 DETAILED DESIGN STANDARDS
8.1 Paved Roads
8.2 Unpaved Roads
8.3 Selection of Design Standards

8 ROAD SAFETY
7.1 Introduction
7.2 Road Safety Audits and Assessments
7.3 Traffic Composition
7.4 Roadway Features
7.5 Roadside Features
7.6 Traffic Calming
7.7 Road Markings, Signage and Lighting
7.8 Road Bridges and Crossing Structures (next to road way)

PART B – URBAN ROADS (STREETS)

1 INTRODUCTION
1.1 Background
1.2 Purpose and Scope
1.3 Development
1.4 Structure
1.5 Updating of the Manual

2 APPROACH TO DESIGN
2.1 Introduction
2.2 Definition
2.3 Characteristics
2.4 Design Principles

3 FUNDAMENTAL DESIGN CONSIDERATIONS
3.1 Introduction
3.2 Planning Considerations
3.4 Basic Design Parameters
3.5 Implementation of Designs

4 TRAFFIC VOLUME AND COMPOSITION
4.1 Introduction
4.2 Design Hour and Design Hour Traffic
4.3 Traffic Information
4.4 Traffic Projections
5. STORMWATER DRAINAGE
5.1 Introduction
5.2 Design Flood Frequencies
5.3 Planning Aspects
5.4 Design Aspects

6 CROSS SECTION
6.1 Introduction
6.2 Components
6.3 Nominal Street Widths
6.4 Camber and Cross-fall
6.5 Lanes
6.6 Shoulders and Parking
6.7 Verges and Sidewalks
6.8 Medians and Outer Separators
6.9 Utilities and Drainage
6.10 Typical Cross Sections

7 ALIGNMENT DESIGN
8.1 Introduction
8.2 Sight Distance
8.3 Vertical Alignment
8.4 Horizontal Alignment

8. INTERSECTIONS
8.1 Introduction
8.2 Intersection Sight Distance
8.3 Types of Intersection
8.4 Angles of Skew
8.5 Intersection Spacing
8.6 Functional Area at Intersections
8.7 Kerbing and Intersection Bellmouth
8.8 Corner Splays
8.9 Intersection Related Aspects
8.10 Selection of Intersection Control

9 ROAD SAFETY
9.1 Introduction
9.2 Road Safety Audits and Assessments
9.3 Traffic Calming
9.4 Road Marking, Signage and Lighting
9.5 Public Transport Facilities
9.6 Miscellaneous road safety matters.

10 ROADSIDE FURNITURE AND ANCILIARY MATTERS
10.1 Introduction
10.2 Bus stop Laybys and Shelters
10.3 Guardrails and Pedestrian Barriers
10.4 Landscaping
10.5 Railway Crossings
10.6 Small Structures
10.7 Waste Removal
Annex 4 – Revised Work Programme

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<thead>
<tr>
<th>Stage 1: Inception</th>
<th>1 St Draft Manuals Write-up</th>
<th>Stage 3: Produce and Launch Manuals</th>
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<tr>
<td>Kick-off meeting</td>
<td>1st Draft Manuals Write-up</td>
<td>DTP</td>
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<tr>
<td>Literature Review</td>
<td>TSC Review of 1st Draft Manuals</td>
<td>Printing</td>
</tr>
<tr>
<td>Prepare Draft Inception Report</td>
<td>Manual Review Workshop</td>
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<td>Inception Phase Workshop</td>
<td>Manual Review Workshop Report</td>
<td>Submission of Hard Copies and USBs</td>
</tr>
<tr>
<td>Team/TSC meeting</td>
<td>Peer Review of Final Draft Manuals</td>
<td>Preparation of launch</td>
</tr>
<tr>
<td>Final Inception Report</td>
<td>Preparation of Peer Review comments</td>
<td>Official launch/handover of manuals</td>
</tr>
</tbody>
</table>

- **Stage 1: Inception**
  - Kick-off meeting
  - Literature Review
  - Prepare Draft Inception Report
  - Inception Phase Workshop
  - Team/TSC meeting
  - Final Inception Report

- **Stage 2: Preparation of Manuals**
  - 1st Draft Manuals Write-up
  - TSC Review of 1st Draft Manuals
  - Manual Review Workshop
  - Manual Review Workshop Report
  - Peer Review of Final Draft Manuals
  - Preparation of Final Draft Manuals
  - Incorporation of Peer Review comments

- **Stage 3: Produce and Launch Manuals**
  - DTP
  - Printing
  - USBs
  - Submission of Hard Copies and USBs
  - Preparation of launch
  - Official launch/handover of manuals
  - Preparation of Official Launch Report

Milestone Meetings/Workshops
Reports (not milestones)

MAL2144A