



AfCAP
Africa Community Access Partnership



Finalisation of the Design Manual for Low Volume Roads for the Ethiopia Roads Authority (ERA)

Report on Manuals Launch Meeting held on 28th
February 2017



Author: RN Geddes

10th March 2017



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

Cover Figure: Meeting Participants

<i>Quality assurance and review table</i>			
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Abstract

AFCAP has supported the Ethiopian Roads Authority (ERA) in finalising the Low Volume Roads Design Manual. The manual was published in draft form in 2011. The assignment included rectifying typing errors and incorrect cross-references throughout Parts A, B, C, D, E and G of the LVR Design Manual, responding to technical comments provided by users of the manual, and incorporating new technical content reflecting developments in LVR technology since 2011. Several major changes were made including combining the previous Part B and Part D into a new Part B for the Design of Low Volume Roads, the introduction of a new Part D on the Construction of LVRs, and the development of a new field maintenance handbook for use at the wereda level. The manual was renamed “Manual for Low Volume Roads” to reflect its wider application beyond road design.

The purpose of this report is to record the proceedings of the Launch Meeting for the manual held at the Hilton Hotel in Addis Ababa on 28th February 2017.

Key words

Low Volume Roads, Manuals, Maintenance, Ethiopia

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1 Introduction

1.1 Background

The Africa Community Access Programme (AFCAP) is a programme of research and knowledge dissemination funded by the UK government through the Department for International Development (DFID). AFCAP provided support to Ethiopia through the Ethiopian Roads Authority (ERA) for the preparation of new design manuals, specifications, standard drawings and bidding documents for Low Volume Roads (LVRs) as well as the updating of the existing 2002 series of road design manuals for high volume roads and the development of a new Geotechnical Design Manual and Route Selection Manual.

The Design Manual for LVRs was published in draft form in May 2011 and distributed for use. An independent review was undertaken in October 2013 of the use of the new manual and ERA collected comments from users of the manual, which were made available to AFCAP management in November 2014. It was agreed that there was a need to start a process of updating and finalising the LVR Design Manual. It was agreed that this should be undertaken by the original drafting team. Civil Design Solutions (CDS) of Mauritius was contracted by AFCAP management to manage the updating process.

1.2 Updating Process

The project team visited Addis Ababa from 17th to 19th November 2015 to discuss the comments received from users of the manual and from the independent review of its use. Responsibility was assigned to each team member to affect the agreed changes.

The first drafts of the updated manuals were discussed at a three-day Peer Review Group meeting in Addis Ababa from 23rd to 27th February 2016. Each of the Lead Authors and the Expert Reviewers presented the changes in their area of responsibility and this was followed by a discussion period.

Following the February 2016 Peer Group meetings several suggestions were accepted by ERA for restructuring of the LVR manual. They were as follows:

- Combine the existing Parts B and D to make the manual more user-friendly.
- Restructure Part A to accommodate sections from the current Part B.
- Develop a new Part D on “Construction of LVRs” to incorporate section on construction related topics from Parts B, D and E.
- Develop specifications for road maintenance for inclusion in Part G (Road Maintenance).
- Prepare a new “Field Guide” on road maintenance for use at the wereda level.
- Rename the document “Manual for Low Volume Roads”.

Final drafts of the manual underwent an “Executive Review” process by two rural roads experts based in Ethiopia. Changes recommended by the Executive Review group were incorporated in the manual and the documents published using desktop publishing software. Many of the original figures were redrawn to improve the quality of the final document and some new photographs introduced to increase the local relevance of the document.

Sample hard copies were printed and used as final check copies. Several corrections were made and the final versions published.

Two hard copies of each part of the completed manual were presented to ERA management at a “launch” event held at the Hilton Hotel on Addis Ababa on 28th February 2017.

2 Manuals Launch Meeting

2.1 Attendance

The launch meeting was attended by 54 practitioners from ERA, the Road Fund, and private sector organisations. The attendance list is included in Annex A. The meeting was also attended by members of the local press including national television.

2.2 Programme

The programme for the launch meeting is shown in Figure 2.1. The launch meeting was facilitated by the Director of the ERA Road Research Centre.

Time	Item	Responsibility
09:00	Welcoming Address	ERA Director General
09:30	ReCAP Support to Ethiopia and the Regional Context	ReCAP Regional Technical Manager
10:00	Process for updating the manuals	Consultant Team Leader
10:20	Presentation of the Updated Manual: Part A, B, C and D	Consultant Team Leader
10:50	Coffee Break	
11:20	Presentation of the Updated Manual: Part E, G and the Maintenance Field Guide	Consultant Team Leader
11:50	Handover of hardcopies and electronic version	ReCAP Regional Technical Manager
12:00	Closure of meeting	ERA Director General
12:30	Lunch	ERA Communication Dir.

Figure 2.1: Meeting Programme



Figure 2.2: Scenes from the Launch Meeting

2.3 Opening Remarks

Opening remarks were made by the Director General of ERA based on a press release prepared by AfCAP management (see Annex B). The DG described the background to the project, the role of ERA as a regulatory body in the roads sector, the importance of a different approach to the provision of Low Volume Roads, and the importance of reliable roads to connect rural communities to basic services such as education, health, administrative offices and markets. He reported that the manual will be used extensively by the Regional Road Authorities in the expansion of the rural road network as well as maintain existing road assets. The new maintenance handbook is prepared in a simplified format for use by wereda road management.

2.4 ReCAP Support to Ethiopia and the Regional Context

The ReCAP Regional Technical Manager (Southern and East Africa) presented the regional context and AfCAP support to Ethiopia (see Annex C). He summarised the aims and expected outcomes of ReCAP, the focus on the uptake of research for practical application and embedment of the results of research into norms and standards, and the importance of capacity building for local partners and local ownership of the projects. He listed past and current projects supported by ReCAP.

2.5 Presentation of the Updated Manual

The Regional Technical Manager's presentation was followed by a presentation of the completed documents by the Team Leader of the CDS Advisory Team. The presentation of the Team Leader focussed on the key areas of change to the 2011 version of the manual including:

- Combining the old Part B and Part D into a new Part B (Design of Low Volume Roads).
- The inclusion of the DCP/DN pavement design method, modification to the CBR pavement design method with the use of structural numbers, and introduction of the new DCP/CBR method for upgrading unpaved roads.
- Rationalisation of the approach to the estimation of flow in water courses and a design procedure for fords.
- The development of the new Part D, which includes material on construction from the old Parts B, D and E as well as new material, for example on borrow pit management.
- The reformatting of Part G (Maintenance) and inclusion of new specifications for routine maintenance.
- The development of a new Field Maintenance Guide.

The presentation of the Team Leader is included in Annex D.

2.6 Handover of the Manual

Following the presentations, the AfCAP Regional Technical Manager formally handed over hard copies of the completed manuals to the ERA Director of Operations. The meeting was closed and the participants adjourned for lunch.

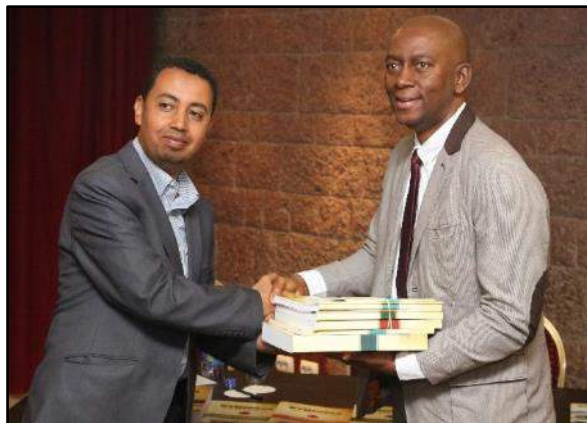


Figure 2.3: Handover of Completed Manuals

Annex A: Attendance at Meeting

Launching of Design Manual for Low Volume Roads
Ethiopian Road Authority with AFCAP and UKaid

February 28, 2017 Hilton, Addis Ababa

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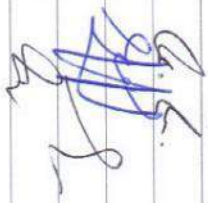
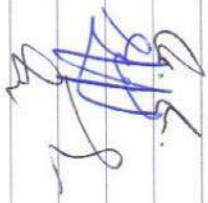
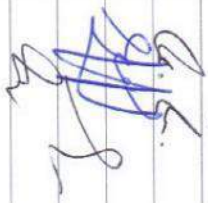
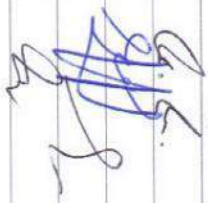


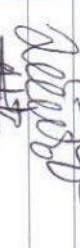









Ethiopian Road Authority with AfCAP and UKaid

February 28, 2017 Hilton, Addis Ababa

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Ethiopian Road Authority with AfCAP and UKaid

February 28, 2017 Hilton, Addis Ababa

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Ethiopian Road Authority with AFCAP and UKaid

February 28, 2017 Hilton, Addis Ababa

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Annex B: Press Release



Joint press statement

Tuesday 28 February

Addis Abeba,

For immediate release

Launching of the Ethiopian Roads Authority Design Manuals for low Volume Roads

Improving the provision of Low Volume Roads towards sustainability in Ethiopia

Today the Ethiopian Roads Authority (ERA) officially launches its Design Manual for Low Volume Roads. The Manual, originally released in draft form in 2011, has been in use for some time and updated following feedback provided by users of the Manual. The final version the manuals includes a whole new field maintenance handbook for use at the wereda-level.

ERA, as a regulatory body is responsible for planning and formulating long and short-term plans and programs for road construction, design and maintenance. To fulfil its mission of provision of safe, comfortable and adequate road infrastructure to support the socio-economic development of the nation, developing and updating of design manuals, guidelines and specifications is mandatory. This manual, which is the first of its kind dedicated to Low Volume roads, is the result of ERA's effort in this regard.

The construction of Low Volume Roads using specifications developed for high volume roads tends to be expensive as use of locally available materials are restricted since they do not satisfy the requirements of the specification. Therefore, the development of design manuals for Low Volume roads has many advantages with respect to cost minimization through using locally available materials and low cost methods of construction. These manuals are, thus, very important in the expansion of rural road network in cost effective manner.

Connecting rural communities in Ethiopia to basic services such as education, health, administrative offices and markets throughout the year is an important requirement for their socio-economic development. As traffic is low on the rural roads connecting these communities, their provision should be cost-effective and sustainable. The Manual addresses the methods and technologies to be used to achieve this.

It is expected that these manuals will be extensively used by the Regional Road Authorities in the expansion of the rural road network as well as maintain their existing road assets. Especially, the maintenance handbook is prepared in a very simplified manner so that wereda road management personnel can easily apply it in their maintenance and management of their road network.



The development of the revised Manual has been supported by the Africa Community Access Partnership (AfCAP), a rural transport oriented research programme funded by UKAid. Much of the technical content reflecting new developments in LVR technology since the initial release of the Manual in 2011, stems from AfCAP supported research throughout Sub-Saharan Africa. The research covered the performance of different types of pavement, maintenance techniques, use of local materials and other local resources and an array of other aspects relevant to sustainable provision of low volume roads.

ERA, through its Road Research Centre have been coordinating and facilitating the development of the manuals and would like to encourage its wider use amongst professionals and stakeholders in the road sector. With the application of the principles and guidance on the provision and maintenance of Low Volume Roads provided in the Manual, the Ethiopian Road Authority will be able to further optimise the provision of safe and sustainable rural road infrastructure for its rural communities.

About the Africa Community Access Partnership (AfCAP)

AfCAP is a six-year research programme (2014-2020), funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa. The AfCAP partnership 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. AfCAP is brought together with the Asia Community Access Partnership (AsCAP) under the Research for Community Access Partnership (ReCAP), managed by Cardno Emerging Markets (UK) [Ltd. www.research4cap.org](http://www.research4cap.org)

Annex C: Presentation by the ReCAP Regional Manager



Launch of Updated Design Manuals for Low-Volume Roads in Ethiopia

Official Launch: Addis Ababa, Ethiopia, 28th February 2017

Nkululeko Leta

Regional Technical Manager, East & Southern Africa



Content

- ReCAP – An Overview
- Ethiopia Projects Summary
- Way Forward

Official Launch, 28 February 2017, Addis Ababa, Ethiopia



Background

- ReCAP 2014 to 2020
- Following the success of:
 - South East Asia Community Access Project (SEACAP) 2004-2009,
 - Africa Community Access Programme (AfCAP 1) 2008-2014,
- DFID initiated a second phase under ReCAP:
 - AfCAP, Africa Community Access Partnership
 - AsCAP, Asia Community Access Partnership



Official Launch, 28 February 2017, Addis Ababa, Ethiopia



Aims and Outcomes

- AIM: Build on the programme of high quality research established under SEACAP and AfCAP (1) and take this forward to **a sustainable future** in which the results of the research influence policy and are incorporated into practice.
- OUTCOME: “**Evidence-based, cost effective and reliable low volume rural roads and transport services** that are strengthened, promoted and influencing policy and practice in Africa and Asia”.

Official Launch, 28 February 2017, Addis Ababa, Ethiopia



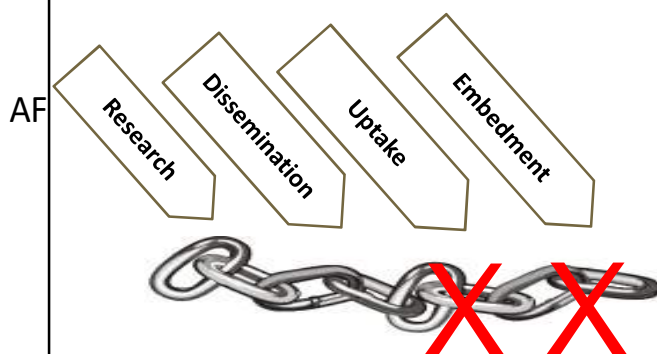
Key Principles

- Focus on the **uptake** of research for practical application and **embedding** of the results of research into norms and standards
- **Capacity Building integral to all projects**
- Fundamental underpinning principle that whilst ReCAP may facilitate, support and advise on the research projects, the initial **ideas and concepts must originate from, and be owned by, the partner countries**

Official Launch, 28 February 2017, Addis Ababa, Ethiopia



Lessons Learnt



- Home for the research in each partner country - focal point for sustainable knowledge management and transfer.
- Undertaking and disseminating research is not enough; uptake and embedment essential.
- Research, capacity building and knowledge transfer not as separate activities

Official Launch, 28 February 2017, Addis Ababa, Ethiopia



Budget

- Total budget over six years is £24.2 million
- £17.4 million for AfCAP (12 countries)
- £6.8 million for AsCAP (5 countries)
- Similar percentage split (70/30) between infrastructure and other theme areas



Official Launch, 28 February 2017, Addis Ababa, Ethiopia



AfCAP

South Africa and Nigeria provide research resources

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Official Launch, 28 February 2017, Addis Ababa, Ethiopia



Current Project Portfolio

Area	Programme	Number of Projects
National Projects	AfCAP	65
	AsCAP	15
Regional Projects	AfCAP	17
	AsCAP	3
Cross cutting (eg gender mainstreaming, safety, knowledge management)		20
Other (smaller projects eg conference support, Meetings etc)		54

Official Launch, 28 February 2017, Addis Ababa, Ethiopia



AfCAP Regional Projects

Project Title	Status
Asset Management	Underway
Climate Resilience	Underway
Back Analysis of Existing LVSRs	Underway
High tech solutions/Satellite Imagery	Underway
Benefits Analysis System	Underway
Leadership Development Programme	Underway
Benefit analysis system (scoping)	Complete
Integrated Pavement Design Systems	Approved in principle
Materials Database	In Procurement
Accelerated testing of trial sections	Approved in principle
Effect of "First Mile"	In Procurement
Stabilisers for unpaved roads	Approved in principle

Official Launch, 28 February 2017, Addis Ababa, Ethiopia



Previous AfCAP Projects in Ethiopia

- Preparation of new design manuals, specifications, standard drawings and bid documents for low volume roads (2011);
- Updating of ERA 2002 series of road design manuals for all road categories, included Geometric Design Manual, Site Investigation Manual, Bridge Design Manual;
- Development of new manuals: Geotechnical Design Manual and Route Selection Manual;
- Updating and revision of the 2002 version of the Standard Drawings and Specifications (2015)



AfCAP Projects in Ethiopia (cont'd)

- Training and Capacity Building for the design and construction of surfacing seals;
- Development of a guideline for surface sealing in Ethiopia;
- Design, construction and monitoring of the demonstration road sections related to the design philosophy of the LVR Manual (2014);
- Investigation of the Use of Cinder Gravels for use in the pavement layers (on-going);
- LTPP monitoring of existing experimental sections (on-going);
- Capacity Building of Road Research Centre (on-going)

AF

e



Way Forward/ Exit Strategy

Reality is that AfCAP as a programme is not sustainable

- Based around the development, institutionalisation and support of sustainable national research capacity
- Regional organisations have to take responsibility (eg ARMFA, ASANRA)
- For research coordination in Africa, ARTReF has an important role
 - Supported by AfCAP to start-up the Forum since September 2014
 - Business plan for sustainable finance and management being developed

Official Launch, 28 February 2017, Addis Ababa, Ethiopia



Thank you for your attention




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Annex D: Presentation by the CDS Team Leader







Finalisation of the Manual for Low Volume Roads for the Ethiopia Roads Authority

Manual Launch Meeting
28th February 2017




Background to the Assignment





- LVR Design Manual was published in 2011.
- ERA subsequently published new manuals and guidelines for high traffic roads: LVR Manual must be compatible.
- New LVR design manuals in South Sudan, Malawi, Tanzania and Mozambique.
- Development of the DCP design approach for LVRs (paved and unpaved).
- Need for a more holistic approach to LVR road provision (e.g. planning and construction related issues).
- Increasing focus on maintenance of rural roads (URRAP).



Private and confidential 2

Objectives of the Assignment



Prepare a final print-ready master document of the ERA Manual for Low Volume Roads that is approved by ERA and representatives of the peer and executive review groups.



Process for Manual Updating



- Meeting in March 2015 to identify priority projects for AfCAP funding: urgent need to update manual
- Comments received from users of the 2011 draft manual + independent review of Oct 2013.
- Visit of advisory team in November 2015 to obtain feedback and agree strategy
- First draft of revised manuals presented to Peer Review Group in February 2016 and June 2016 (Part D - Construction)
- Second draft of manual submitted to Executive Review Group in July 2016.
- Comments from ERG incorporated
- Desktop publishing
- Launch of manuals.



Manual Updating Team

- Ato Alemayehu and Ato Deribachew (ERA RRC)
- Peer Review Group
- Efrem Gegziabher and Bizuneh Kebebe (Exec Review Group)
- Les Sampson and Nkululeko Leta (ReCAP)
- Rob Geddes (Team Leader)
- John Rolt (geometrics, DCP/CBR pavement design)
- Mike Pinard (planning, construction, DCP/DN pavement design)
- Gareth Hearn (geotechnics)
- Manaye Ewunetu (hydrology)
- Rob Petts (maintenance)
- Kingstone Gongerah (maintenance).



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Manual Updating Team



Peer Review Group – February 2016



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6

Major Changes

1. Manual renamed “Manual for Low Volume Roads”.
2. Part B now incorporates the old Part B and Part D.
3. New Part D “Construction of LVRs”: includes construction sections from old Part B, D and E and new material.
4. Part G:
 - Converted from A5 to A4 size
 - Restructured to include “defect” and “maintenance activity” on a single sheet
 - New specifications for rural road maintenance included.
5. New field guide for wereda road maintenance (simplified Part G).



Private and confidential

7

Structure of the Manual

Part A: Introduction to Low Volume Road Design

Part B: Design standards for Low Volume Roads

Part C: Complementary Interventions

Part D: Explanatory notes for low volume road design

Part E: Explanatory notes and design standards for small structures

Part F: Trail Bridges Manual

Part G: Road Maintenance Booklet

Part A: Introduction to Low Volume Roads

Part B: Design of Low Volume Roads

Part C: Complementary Interventions

Part D: Construction of Low Volume Roads

Part E: Explanatory Notes and design standards for small structures

Part F: Trail Bridges Manual

Part G: Maintenance of Low Volume Roads

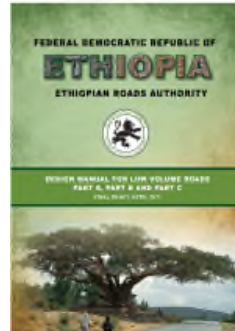
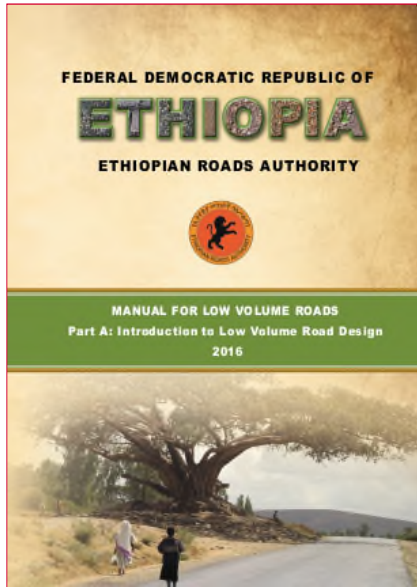
“Manual for Low Volume Roads”

Wereda Road Maintenance Guide



8

Part A: Introduction to Low Volume Roads



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Part A: Introduction to Low Volume Roads



- Context and Scope
 - Road network classification
 - Context sensitivity
 - Low volume road design principles (earth, gravel, paved)
- Policy and Legislative Controls
- Planning (process and tools).



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Part A: Introduction to Low Volume Roads



Road classification system

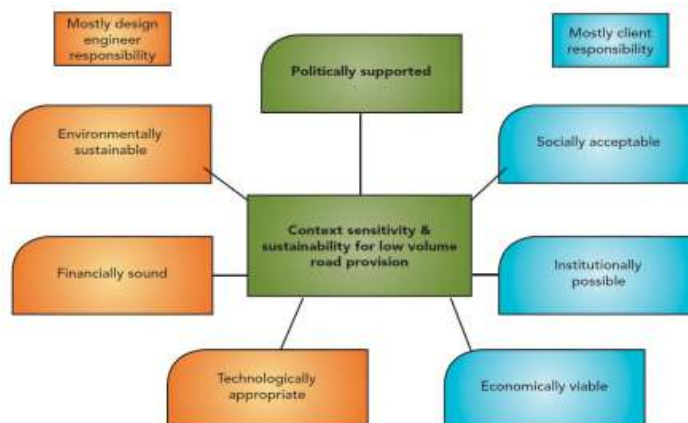
Road Functional Classification					Geometric Standard	Level of Service	AADT
				LINK TRUNK	DC8	A	>10,000
					DC7		3,000 - 10,000
					DC6	B	1,000 - 3,000
					DC5		300 - 1,000
FEEDER	COLLECTOR	MAIN ACCESS		LOW VOLUME	DC4	C	150 - 300
					DC3		75 - 150
		DC2	25 - 75				
		DC1	D		<25		
		Track					



Part A: Introduction to Low Volume Roads



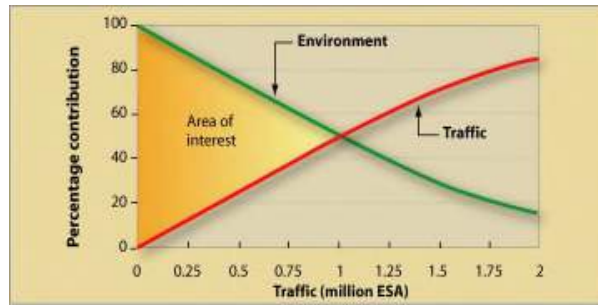
Context sensitivity and sustainability of LVRs



Part A: Introduction to Low Volume Roads



Environmentally Optimised Design



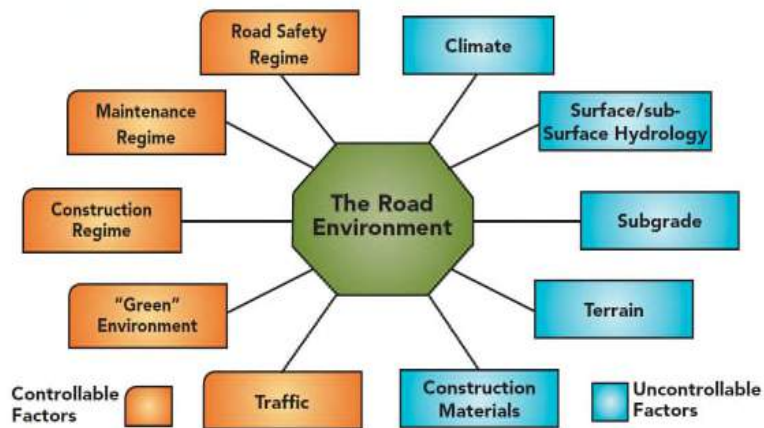
Contribution to Deterioration



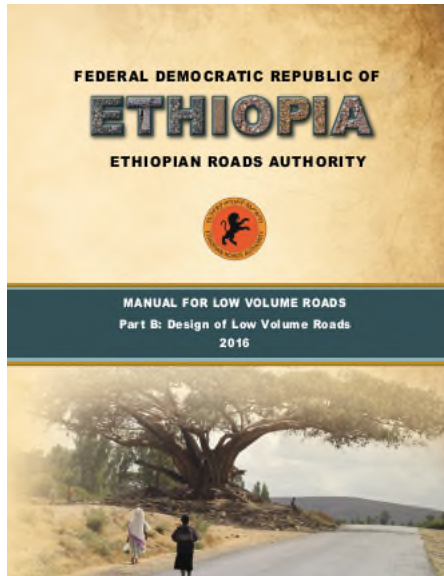
Part A: Introduction to Low Volume Roads



Environmentally Optimised Design



Part B: Design of Low Volume Roads



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Part B: Design of Low Volume Roads

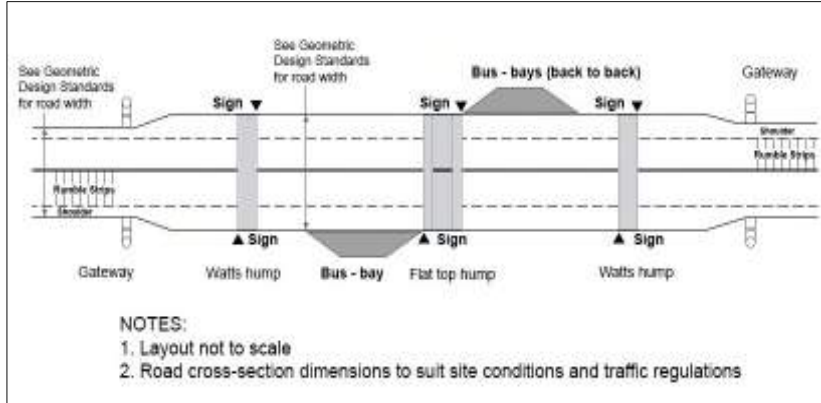
- General Introduction
- Site Investigation for Route Selection and Design
- Subgrade
- Construction Materials
- Roadside Slope Stabilisation
- Traffic
- Geometric Design
- **Road Safety**
- **Drainage**
- **Pavement Design for Paved Roads**
- Pavement Design for Unpaved Roads
- Surfacing
- **Life Cycle Costing**



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Part B: Road Safety



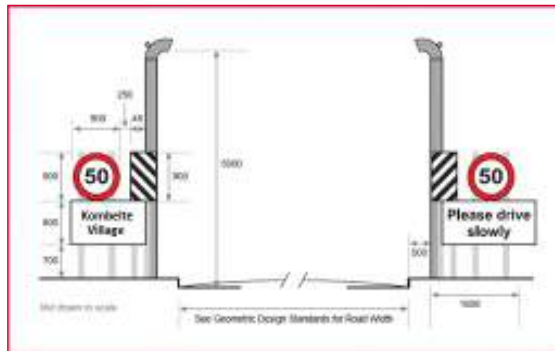
Village Treatment



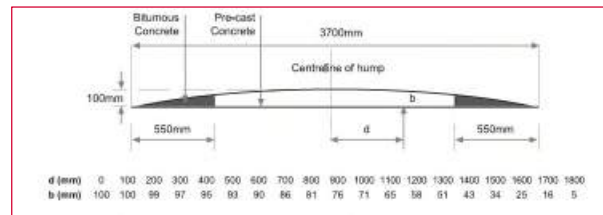
Part B: Road Safety



Gateway



Watts Profile Hump



Part B: Drainage Design



1. Text aligned with ERA Drainage Design Manual (2013): more detail added, especially on the application and limitations of various flood estimation methods
2. New table for Design Flood Return Periods, method of dealing with high risk situations
3. Updated 24h Rainfall Depth vs Frequency data & new IDF Curves.

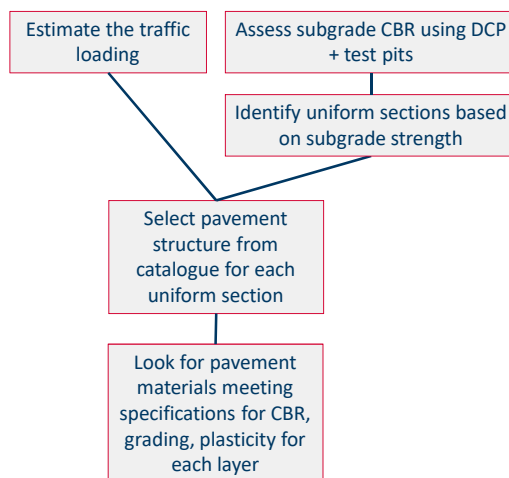
Structure type	Geometric design standard							
	DC4		DC3		DC2		DC1	
	Design	Check	Design	Check	Design	Check	Design	Check
Side drains	10	25	5	10	5	10	2	5
Fords and drifts	10	25	5	10	5	10	2	5
Culvert diameter <2m	15	25	10	25	10	25	5	10
Large culvert diameter >2m	25	50	15	25	10	25	5	10
Gabion abutment bridge	25	50	20	25	15	25	-	-
Short span bridge (<10m)	25	50	25	50	15	25	10	25
Masonry arch bridge	50	100	25	50	25	50	-	-
Medium span bridge (15m–50m)	50	100	50	10	25	50	-	-
Long span bridge >50m	100	200	100	200	50	100	-	-



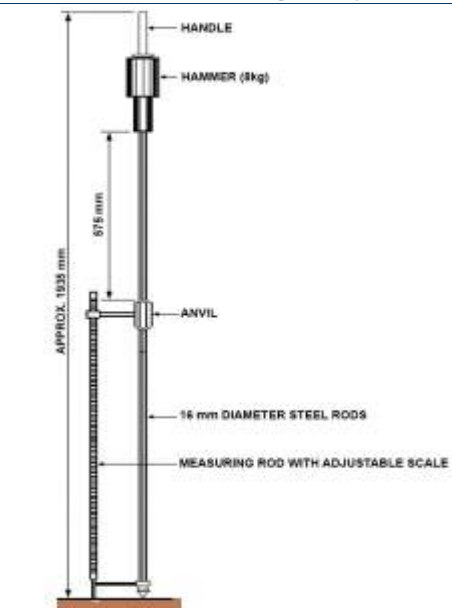
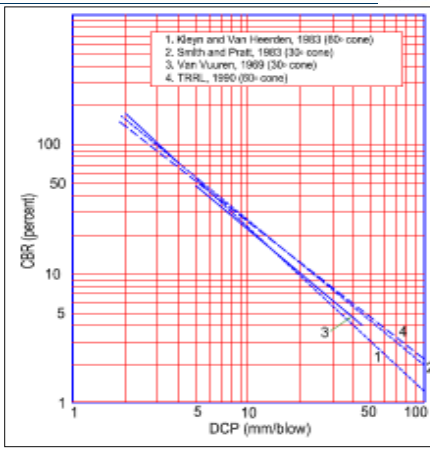
Part B: Pavement Design (old method)





Pavement design method



Part B: Pavement Design – Dynamic Cone Penetrometer

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Part B: Pavement Design (new method – DCP/CBR)

DCP/CBR design method for New Roads



```

graph TD
    A[Estimate the traffic loading] --> C[Select pavement structure at each test point from catalogue]
    B[Assess subgrade CBR using DCP + test pits] --> C
    C --> D[Identify uniform sections based on SN of required pavement at each test point]
    D --> E[Provide the pavement required for each uniform section]
    E --> F[Look for pavement materials meeting specifications for CBR, grading, plasticity for each layer]
        
```

DCP/CBR design method for Upgrading Existing Roads

```

graph TD
    G[Estimate the traffic loading] --> I[Find required SN at each test point from catalogue]
    H[Assess existing pavement and sub-grade CBR (DCP + test pits)] --> J[Calculate the SN for the existing pavement at each test point]
    I --> K[Assess structural deficiency at each test point]
    J --> K
    K --> L[Identify uniform sections based on structural deficiency]
    L --> M[Take action depending on structural deficiency (%ile)]
        
```

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Part B: Pavement Design – DCP/DN Method

DCP/DN design method for upgrading existing roads

Estimate the traffic loading

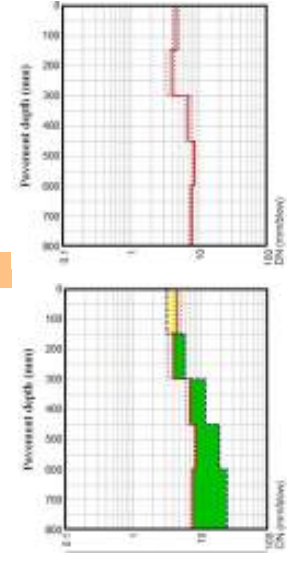
Assess the existing pavement and subgrade - DN profile with depth (uniform sections)




Compare the actual strength profile with required profile from the catalogue

Determine how to make up deficiency

Look for materials with required DN values for new layers

DN = mm/blow



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Part B: Pavement Design – DCP/DN

DCP/DN design method for upgrading existing roads

Estimate the traffic loading

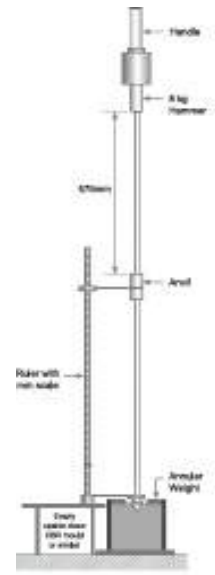
Assess the existing pavement and subgrade - DN profile with depth (uniform sections)




Compare the actual strength profile with required profile from the catalogue

Determine how to make up deficiency

Look for materials with required DN values for new layers

DN = mm/blow



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Part B: Pavement Design

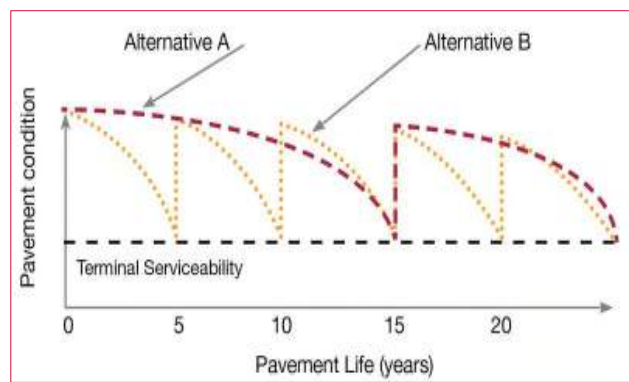


1. DCP/CBR method for new roads and upgrading existing roads

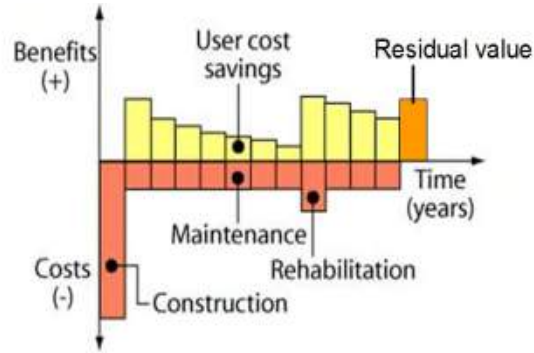
2. DCP/DN method for upgrading existing roads



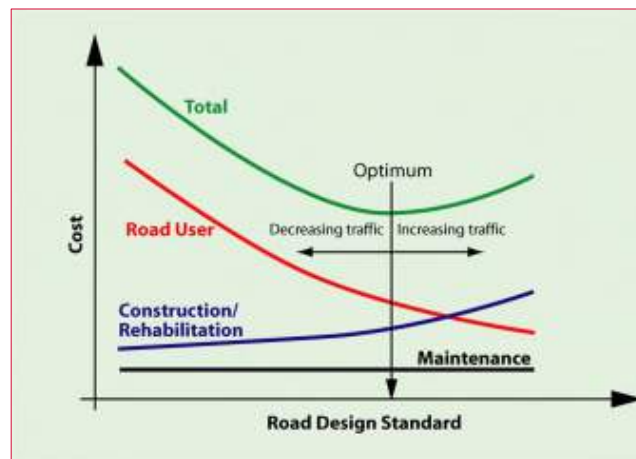
Part B: Life Cycle Costing



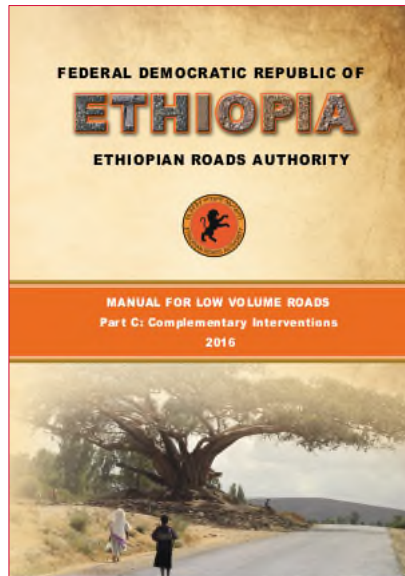
Part B: Life Cycle Costing



Part B: Life Cycle Costing



Part C: Complementary Interventions



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Part C: Complementary Interventions

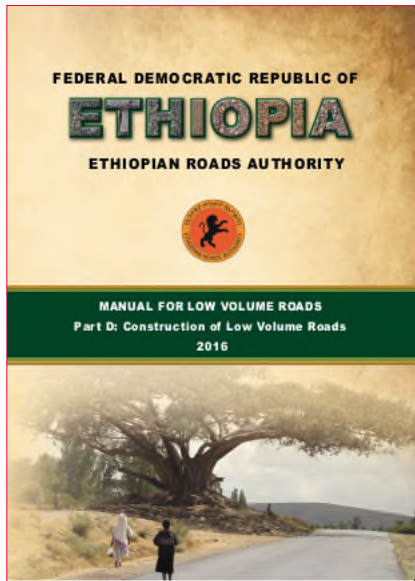


- Planning and identification of complementary interventions
- Community participation
- Contract provisions to support complementary interventions
- Supervision, monitoring and enforcement.



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Part D: Construction



New!




Part D: Construction

- Project Implementation
- Road Construction
- Borrow Pit Management
- Construction of Small Structures
- Quality Assurance and Control
- Technical Auditing



Part D: Project Implementation




Procurement Process

Works

- Guiding Principles
- Use of Model Documents
- Call for Tenders
- Tender Evaluation
- Award of Contract

Supervision Services

ERA Standard Bidding Documents
not included in manual but
referred to in text



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Part D: Road Construction




3.1 Introduction

3.2 Construction Strategy

3.3 Construction Equipment

3.4 Utilising Natural Gravel and Soils

3.5 Roadbed Preparation and Subgrade Construction

3.6 Compaction

3.7 Surfacing

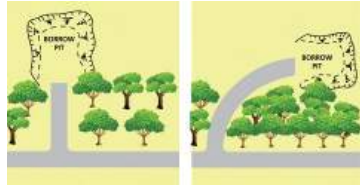
Awareness of key issues



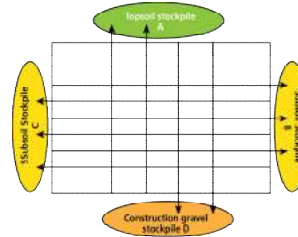



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Part D: Borrow Pit Management



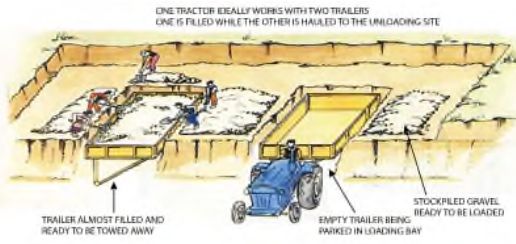
Location



PROFILE
 A Topsoil approx. 150mm thick
 B Subsoil approx. 200mm thick
 C Subsoil approx. 400mm thick
 D Gravel usually 750-2000mm depth thick

EXTRACTION ROUTINE A-B+C+D
REHABILITATION ROUTINE C+B+A

Source: IRL 1999



TRAILER ALMOST FILLED AND READY TO BE TOWED AWAY

EMPTY TRAILER BEING PARKED IN LOADING BAY

STOCKPILED GRAVEL READY TO BE LOADED

ONE TRACTOR IDEALLY WORKS WITH TWO TRAILERS
 ONE IS FILLED WHILE THE OTHER IS HAULED TO THE UNLOADING SITE

Labour Based

Procedure

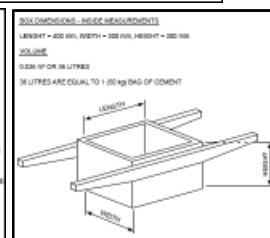
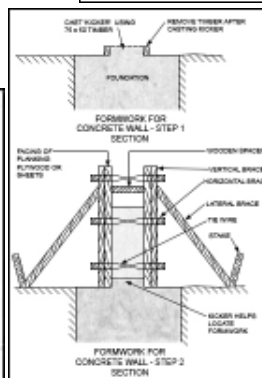
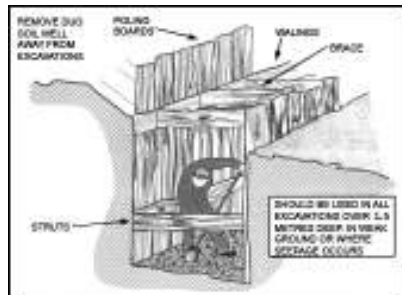
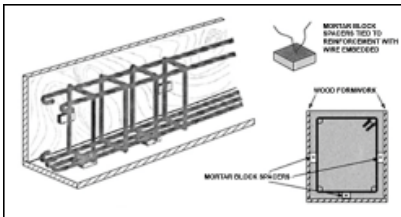
- More efficient operation
- Avoid environmental and social impacts
- Avoid contamination of construction materials.



Part D: Construction of Small Structures



- Setting out
- Excavations
- Formwork
- Concrete
- Steel
- Timber



Part D: Quality Assurance and Control



APPROACH TO QA/QC

- Components of a Total Quality Management System

QUALITY CONTROL ISSUES

- Frequency of laboratory testing
- Layer thickness control
- Compaction control
- Final finish.

- Awareness of importance of QA and QC
- Framework for achieving quality on site



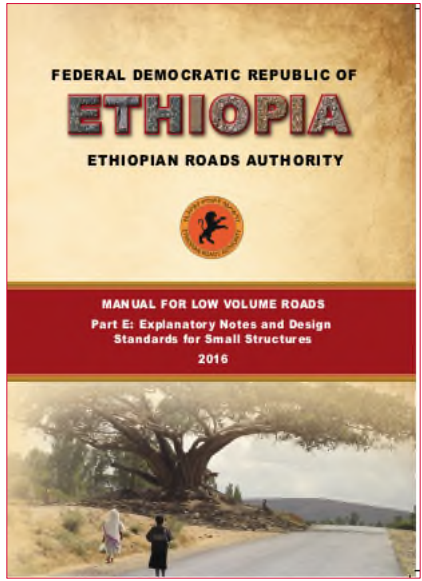
Part D: Technical Auditing



- **What is a Technical Audit?**
A formal, systematic procedure for undertaking an independent, objective, assessment of a project compliance with required standards and specifications.
- **What is the difference between technical auditing and supervision/quality control?**
- **Why undertake a Technical Audit?**
To ensure that construction works and supervision services are carried out in an efficient and effect manner and to the highest possible standards.
- **Who participates in Technical Audits?**
- **What are the steps in the audit process?**

- Awareness of role and importance of Technical Auditing
- Framework for achieving quality on projects

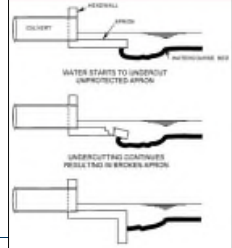
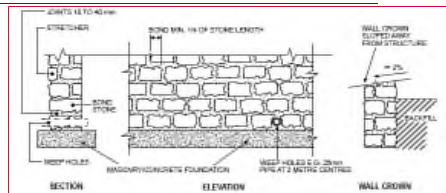
Part E: Design Standards for Small Structures



Part E: Design Standards for Small Structures



- Project planning
 - Design criteria
 - Structural options
 - Site selection and appraisal
 - Watercourse characteristics
 - Materials
 - Structure design
- **Construction and Maintenance** chapters relocated to Part D and Part G.
 - **Hydrology** consolidated in Part B.



Part E: Design Procedure for Fords

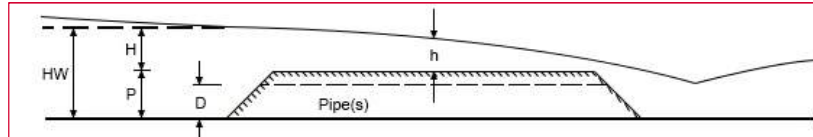


Figure E.8.23: Crossing Profile of a Vented Ford

$$h \text{ (max)} = 31\text{cm}$$

$$H = h/0.6 = 52\text{cm}$$

$$Q_{\text{vent}} = Q_e - Q_{\text{top}} \quad (\text{E.4.1})$$

$$Q_e \text{ is the total design flow}$$

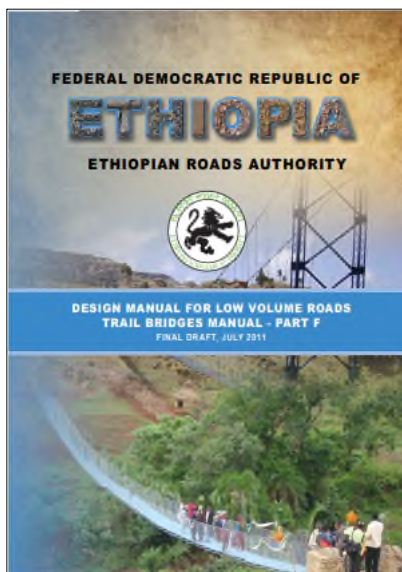
$$Q_{\text{top}} \text{ is the flow over the ford} = 4.83 L^{0.251} H^{1.67} \quad (\text{E.4.2})$$

Calculate number and size of pipes to accommodate Q_{vent}

$$\text{The exit velocity } V_e = Q_{\text{vent}} / (\pi D^2 / 4) < 3\text{m/s}$$



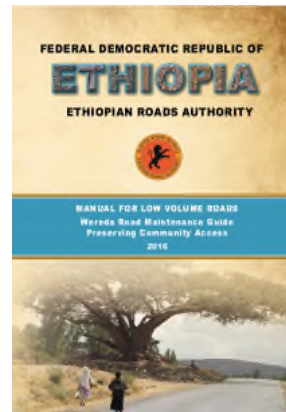
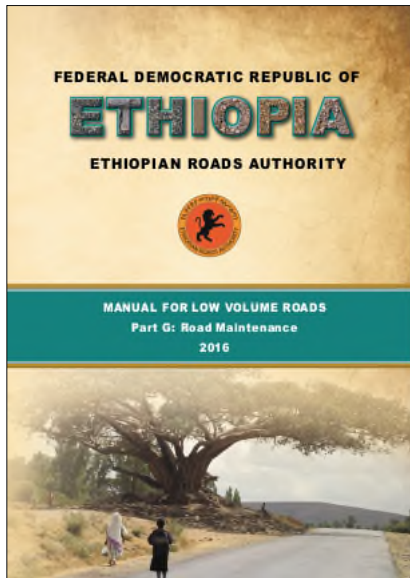
Part F: Trail Bridges Manual



No changes



Part G: Road Maintenance



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Part G: Road Maintenance



- The Purpose of Maintenance
- Maintenance Activities
 - Regular (Routine) Maintenance
 - Occasional (Periodic) Maintenance
- Prioritisation
- Planning and Productivity
- Maintenance of Bridges & Structures (Annex)
- Specifications for Maintenance of Low Volume Roads (Annex)



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Part G: Maintenance Activities



Table G.6.1: Roadside Activities

Defect	Maintenance Activity
1-01 Grass on shoulder or in drain requires cutting	1-01 Cut grass (manual or mechanised)
1-02 Trees and bushes growing on roadside	1-02 Bush clearing
2-01 Shoulder uneven or eroded, or does not drain properly	2-01 Shoulder rehabilitation (manual)
2-02 Shoulder uneven or eroded, or does not drain properly	2-02 Shoulder rehabilitation (mechanised)
2-03 Shoulder uneven or eroded, or does not drain properly (minor)	2-03 Shoulder Blading (mechanised)
3-01 Shoulder erosion	3-01 Plant grass and water it



Part G: Maintenance Activities



Table G.6.2: Drainage Activities

Defect	Maintenance Activity
4-01 Culvert/Drift silted/obstructed	4-01 Culvert/Drift Cleaning
4-02a Drain silted	4-02a Drain Cleaning (manual)
4-02b Drain silted	4-02b Drain Cleaning (mechanised)
5-01 Drain or slope eroded (minor)	5-01 Repair Erosion Damage (selected fill)
5-02a Drain or slope eroded (major)	5-02a Repair Erosion Damage (rock fill)
5-02b Slope eroded (major)	5-02b Terracing or Wattling
6-01 Mortared Masonry damaged	6-01 Mortared Masonry Repair
6-02 Dry Masonry damaged	6-02 Dry Masonry Repair
7-01 Gabion structure damaged	7-01 Gabion Structure Repair
8-01 Erosion in drain	8-01 Build stone/wooden scour check



Part G: Maintenance Activities



Defect 1-01 1-02	Grass, weeds, bushes or trees overgrown on the roadside	
Development, if neglected	<ul style="list-style-type: none"> Damage (ditches) cannot be cleared. Surface water can pond at the edge of the road and weaken the road surface. It is an obstruction at the edge of the road. The visibility for road users is reduced, with increased risk of accidents with pedestrians or animals. Increased fire hazard in the dry season. 	
Maintenance Activities	<p>1-01 Grass Cutting (Manual or Mechanical)</p> <p>1-02 Bush Clearing</p>	<p>These activities may be required individually or together. With the exception of road verges, these are Regular Maintenance activities, involving control of grass, weeds, bushes and trees where these are not controlled by annual grazing. They may be required as a prelude to other maintenance activities or more often where the climate causes vegetation to grow rapidly.</p>
Grass Cutting	<p>Required in the roadside, fenced regions. Grass and weeds should be cut at least once a year after vegetation reaches full growth or according to local experience. The vegetation should be trimmed by hand, scythe, scythe, lawnmower, or other hand tools will be required.</p> <p>Alternatively, the grass may be cut by mechanised methods, such as by tractor powered mowers.</p>	
Bush control & Trees	<p>Any bushes on the road shoulder or trees should be cut down. Dead or leaning trees, within the right of way which may fall on the roadway or block the drainage system, or block sight lines should be removed. The felling of trees, or the removal of large branches or heights of more than 2 metres above ground level can be hazardous. This work should only be carried out under expert supervision or by experienced workers. Trees should be felled using one- or two-man axes or axes. Ladders should be used for climbing trees, and ropes should be used to restrain trees and control falling. Falls should be halted when the tree is finally toppled. All debris should be removed and disposed of safely.</p>	
Disposal of debris	<p>All cuttings and debris should be disposed of safely so that there is no risk of items being tracked on the road.</p>	

Herbicides	<p>Herbicides (weed killers) are chemical agents intended to destroy or reduce vegetation growth. It is not recommended that herbicides or any chemical methods be used to control roadside vegetation. Herbicides can cause pollution of crops, rivers and streams and drinking water supplies. They are often dangerous to health and require spraying in their safe use. They are expensive, and in all cases, they may not always produce satisfactory results.</p>	
Burning	<p>Do not burn roadside vegetation to control its growth or the debris from bush clearing activities. The results may be more harmful than allowed.</p> <ul style="list-style-type: none"> The fire could spread and destroy valuable vegetation (trees, grass or crops), and traffic signs. Vegetation may grow faster after burning. Smoke and fumes blowing across the road are dangerous for traffic. 	

Part G: Maintenance Activities



Defect 4-01	Culvert or Drift silted or obstructed with debris	
Development, if neglected	<p>The intended waterway opening will be so reduced that flood water cannot flow as intended. Flood water will back up or pond on the upstream side of the culvert/drift and may eventually over-flow the road embankment. The road is then in danger of being retained, only.</p>	
Maintenance Activities	4-01 Culvert or Drift Clearing	
<p>In order to function properly, a culvert must retain the full opening down to complete length. In addition, the upstream approaches and the downstream area must be free of obstructions. Standing debris from branches, bushes, etc. carried by water is a great danger to culverts. The debris may completely block the culvert inlet. The following Regular Maintenance activities may be required:</p> <ul style="list-style-type: none"> Clear any silt, soil or debris from inside the culvert. Sinking or lifting of culverts, especially those with openings smaller than 1 metre, carries a particular problem. These culverts can be cleaned by pulling a cable of rope through, to which is attached any suitable object (eg a bucket). Alternatively, a long handled brush and spade can be used. If the silted condition continues despite regular clearing, it may be necessary to reconstruct the culvert at a higher level or enlarge it. Material and debris from the culvert must be spread or dumped where they cannot cause an obstruction to water flow, preferably on the downstream side of the culvert, and away from the watercourse. Drifts should be cleared of debris and also upstream and downstream areas. The Maintenance task is best carried out before the rain and after any heavy rainfalls. 		

Part G: Maintenance Activities



Defect 7-01	Gabion structures damaged	
Development, if neglected	Further damage to structure or trackbed, slope or structural failure.	
Maintenance Activities	<p>7-01 Gabion Structure Repair</p>	
<p>Gabions are usually made of the coarsest mesh baskets, although they may also be made from welded mesh sheets, galvanized chainlink fencing and woven wire depending on the circumstances and the available materials. The baskets are hand filled with rock and stones between 12 and 30 cm size. In this way they offer good stability but will allow some settlement. Repairs may be required due to scouring or breaking of the basket due to excessive force due to sliding movement, or settlement of the stones within the basket. Gabions are designed to allow some settlement. Repairs should aim to ensure that the stones continue to be compacted. Repair will normally consist of repairing the baskets, re-packing the stones inside, topping up stones if necessary and re-anchoring the top of the gabion. It may be necessary to assess the edge material near baskets or deformed areas, and any suitable sand mesh or woven fabric can be used for this. Where a gabion face is required to be retained or protected, the procedure for building a new gabion face should be used as follows. The gabion baskets are normally supplied folded for transport with the top wire in the top position. Gabions should be assembled as for a conventional structure, with any suitable material removed and replaced with good soil, stone or gravel, and compacted. The baskets should be erected in their final position.</p>		

Cables should be tensioned together using 3 mm binding wire, securing all edges away 15 mm with a suitable long-life fastening wire should be chosen (light with a good all-weather duty cycle and secured with modular hooks (1 and 2). The same gables' only should be fixed (not to act as an anchorage). The connected baskets should be stretched and fastened with wire and pegs to achieve the required slope (3). If they should be carried out by hand using hand durable stones not larger than 200 mm and not smaller than the size of (1) (2) (3). The stone size range is 125 to 200 mm. The stones should be tightly packed by hand (not dumped) in the baskets by treatment with a minimum of water. Rows of 7 metre height should be fixed to 12 metre height. Maximum bearing area should then be fixed and tensioned with a sandbag to keep the vertical faces even and free of bulges (4 and 5). Further covering should be fixed after 10 days to 20 (the gable 300 mm length (rows) should be covered at most height only 200 (300 mm deep gabions do not require internal bracing). The stones should be carefully sorted to about 3 to 5 cm above the top of the face to allow for settlement. Suitable material can be used to fill the voids on the top face but no more void or small stones should be allowed. The top wire, free, closed and protected tightly over the stones, is completely using condition (if necessary (6)). The corners should be thoroughly secured to ensure that the mesh covers the whole area of the face. The top should then be securely secured to the top of the mesh covering stones. If necessary to prevent the top from being over-anchored.



Part G: Maintenance Activities



Defect 12-01	Road surface rutted or uneven with potholes, and does not drain to shoulder (Major: +3cm)	
Development, if neglected	Road becomes very rough, slowing and damaging traffic. Water ponds on road surface. Road surface loss increases and danger of total gravel layer loss and road being impassable.	
Maintenance Activities	<p>12-01 (Bake Gravel Road (heavy)</p> <p>Heavy grading may be carried out with a motor grader or a tractor based grader. However, the task will also require a road or self-propelled waterway and compaction equipment. The task may also be achieved using labour and hand tools by selecting the method of Maintenance activity 12-02.</p>	
Preparation	<p>Packing activity 12-02 or 12-02 of large potholes or depressions should be carried out in advance of the grading. Areas of standing water should be drained. The preparation will cover the work and make the road surface flat longer.</p>	
Grading	<p>Using a motor or tractor based grader it is vital necessary to verify the existing surface to suit the bottom of any surface defects and remove the material for regrading.</p>	<p>The grader works on one side of the road at a time and works to grades about 200 metres long to compact and settle paving stones. Heavy Chiselling will require additional passes to achieve the required surface. Work should be completed on one side of the road at a time. An even number of passes should be used to avoid a bias to the right or left. Normally, initial grading passes are required to bring to level in from the edges of the road. Spreading passes redistribute the material away from the crown. The initial passes create the texture of the surface irregularity and deposit a vertical joint beyond the centre line.</p> <p>Additional passes may be required.</p>
Finishing	<p>The road or self-propelled water carrier water the surface with water. If required, the water or sprayed back across the road depending on the material to give the correct texture. It should apply a layer of water may be required to obtain the correct moisture content for compaction.</p>	
Machine Alternatives	These help direct traffic and grader turning, and remove large stones and other unwanted material from the path of, or behind, the grader.	

Part G: Maintenance Specifications



DEFECT 1-02	ACTIVITY
	Bush Clearing m ²
<p>Scope of works: Improve visibility to maintain safe sight distance, visibility of road signs, road markers, animals and pedestrians within the road reserve.</p>	
<p>Specifications:</p> <ul style="list-style-type: none"> Place warning signs and safety devices Cut, uproot and remove bushes to ensure that all bushes are cleared Workmen must ensure that no damage is caused to fixed objects such as road furniture when removing debris and cut or uprooted during clearing Backfill and compact to density of surrounding ground all excavated holes dug during removal of roots Collect and clear all cut roots and debris from drains, carriageway and road reserve, load and dispose to designated sites Measure and record the length and width of area cleared Remove temporary road signs and safety devices. <p>Description of bill item:</p> <p>1-02: Clearing of bush, shrubs and roots on the side of the road to improve visibility and road safety. Unit of measurement shall be in m² of area of bush cleared.</p>	



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Part G: Maintenance Specifications



DEFECT 7-01	ACTIVITY
	Gabion structure repair m ³
<p>Scope of works: Repair damaged gabion baskets and re-estate.</p>	
<p>Specifications:</p> <ul style="list-style-type: none"> Place warning signs and safety devices Dismantle damaged gabion and clear the site for repair Measure the area and volume of work required to make good the damaged extent of gabions Shape the gabion basket into a regular shape with all sides straight and symmetrical Place gabion against a firm excavated wall or next to an existing gabion basket Secure the gabion by tying it to the adjacent gabion(s) Fit bracing ties as necessary Fill the gabion basket manually with hard durable stones no larger than 250mm but no smaller than the size of the mesh wire forming the gabion Pack the stones tightly against each other to form a solid structure Slightly overfill the basket to allow for settlement of the stones Tack the gabion lid with tying wire and firmly secure the lid to the sides using tying wire. Remove all loose debris and signage. <p>Description of bill item:</p> <p>7-01: Repair damaged gabion baskets and re-estate. Unit of measurement shall be volume in m³ of gabion repaired.</p>	



Private and confidential

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Part G: Maintenance Specifications



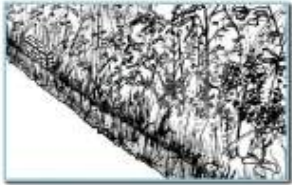
DEFECT 12-01	ACTIVITY
	Blade gravel road carriageway (heavy) m
<p>Scope of works: Mechanical grading gravel, scarify and move the material into a windrow and then mix and spread into required profile.</p>	
<p>Specifications:</p> <ul style="list-style-type: none"> • Place warning signs and safety devices • Rip and scarify the existing road surface and push into a windrow towards the centre of the road • Additional material can be added if necessary • Water and mix the material thoroughly • Spread the material and compact forming the required profile • Remove loose stones and windrows from the carriageway • Remove traffic signs and safety devices. 	
<p>Description of bill item: 12-01: Heavy grading of road surface to correct deep ruts, corrugations, potholes and camber. Unit of measurement shall be in carriageway-m of road graded.</p>	




Field Maintenance Guide



DEFECT 1:
Trees, bushes, grass overgrown on the side and shoulder of the road




ACTIVITY 1:
Bush clearing and grass cutting



Dispose of cuttings safely. Do not leave in the ditch or burn.

Seasonal Priority:

ACTIVITY 1:
Mechanical grass cutting






Field Maintenance Guide




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DEFECT 7:
Ditches damaged




DEFECT 8:
Erosion in ditches



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ACTIVITY 7:
Ditch structure repair

Soil guarantee from Regional Flood Authority on repair works. Refer to the IWA IWR Manual Part 13 for detailed instructions on gully work. For 80 metres of the individual stone or mesh must be larger than the gully at the end wall.



Seasonal Priority:

ACTIVITY 8:
Repair erosion in ditches and build stone or mesh abutts



Seasonal Priority:



Thanks to all who helped to make this project a success

