

**FEDERAL REPUBLIC OF ETHIOPIA**

**ETHIOPIAN ROAD AUTHORITY**



**Revision of the Drainage Design Manual in Ethiopia**  
**(Contract Reference: AFCAP/ETH/005/T)**

**FIRST WORKSHOP REPORT**

**Harmony Hotel, Addis Ababa, Ethiopia**

**27 February 2012**

**Submitted to:** Ethiopian Road Authority  
Addis Ababa

**Attention:** The Director General

**Submitted by:** AFCAP Core Management Unit  
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## **Executive Summary**

The Africa Community Access Programme (AFCAP) is a research programme funded by the UK Government's Department of International Development (DFID under the auspices of UKaid) for safe and sustainable rural access in Africa. AFCAP is being managed by a Crown Agents Core Management Group (CMG). As part of the programme, AFCAP were requested by the Ethiopian Road Authority (ERA) to assist in the updating and expanding the existing suite of road design manuals, standard specifications and bidding documents, including incorporating the specific requirements of low volume roads.

As part of this work, AFCAP commissioned ME Consulting Engineers Ltd (MECE) to review and update the existing ERA 2002 drainage manual. MECE organised a stakeholder workshop to obtain experiences of practitioners and identify where the perceived shortfalls exist in the current manual and what research and available information now exists that can be incorporated into the manual. This report summarizes issues raised and recommendations made by the technical group at the workshop.

## **Minutes of first Stakeholder Workshop for the Road Drainage Design Manual in Ethiopia**

**Date:** 27 February 2012

**Location:** Harmony Hotel - Addis Ababa

### **Attendees:**

1. Dr Manaye Ewunetu (ME Consulting)
2. Mr Brian Cafferkey (ME Consulting)
3. Dr Daniel Tulu (Mekelle University)
4. Ato Frew Bekele (ERA)
5. Ato Alemayehu Ayele (ERA)
6. Dr Alemgena Araya (ERA)
7. W/ro Amarech Fikera (Net)
8. Ato Amdemicael Menkir (CORE)
9. Ato Biazin Haile (Beza Consult)
10. Ato Biruk Berhane (Private)
11. Ato Dawit Dejene (CWCE)
12. Ato Engda Zemedagegnehu (Private)
13. W/ro Genet Alemayeu (ERA)
14. Ato Ismail Enderis (Private)
15. Ato Kassahun Seyoum (Private)
16. Ato Mekari Zemedagegnehu (Net)
17. Ato Yared Made (SABA)

**Time:** 9.00 to 17.30

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**Purpose of the Workshop Meeting:** To obtain experiences of practitioners and identify where the perceived shortfalls exist in the current manual and what research and available information now exists that can be incorporated into the manual. The workshop provided an opportunity for the lead author to take on board the issues raised and incorporate as many of the points raised within the revised document as possible.

## **1.0 Introduction:**

ME Consulting (MEC) hereafter referred to as the “Lead Author” gave a quick overview of the proposed layout of the manual and stated that it was not fixed. In addition the new document was going to be a living document which means that any chapters can be updated at any time once new data or policies become available. However a full review of the manual should be undertaken within 5 years.

## **2.0 Policy**

The lead Author proposed that any drainage policy would need to be supported by current legislation (Proclamation). To date the Lead Author has been unable to locate legislation which specifically deals with drainage (land drainage or highway drainage). A number of proclamation’s which are perceived to be relevant to this work are identified below, however further work is required to confirm this. The Lead Author is to work with other government bodies and confirm with the Ethiopia Roads Authority (ERA) what other Proclamation’s are relevant.

- Water Resources management, Proclamation 300/2002;
- Environmental Pollution Control, Proclamation No.300/2002 ;
- Water Resources Management Proclamation: 2000;
- Public Health Proclamation No.200/2000; and
- Environmental Impact Assessment, Proclamation No.299/2002.

Feedback from the stakeholders at the workshop confirmed the following:

- 1 Policy is underdeveloped – no clear guidance;
- 2 Environmental Impact Assessments are undertaken but the recommendations made are not followed up (not enforced);
- 3 No one body has responsibility for monitoring or enforcing the current proclamations and it appears that this responsibility falls between the various government departments. Clarification on who is responsible is required;
- 4 No real policy on surface water drainage both at national or regional level;

- 5 Currently just discharge runoff into the nearest watercourse (no attenuation of peak flows for the post development scenario). Recommendation for a policy to be incorporated within the updated document to address this; and
- 6 Municipality and ERA have responsibility for roads and the standards must be consistent between both.

Action for Lead Author and ERA to confirm relevant Proclamations and incorporate relevant policy as identified above.

### **Climate Change**

The Lead Author quoted the “Initial National Communication of Ethiopia to the United Nations Framework Convention on Climate Change on climate change” which was published in (2001). The aforementioned document stated the following:

- *“Mean annual rainfall shows large spatial and temporal variation. It is characterized by large spatial variation and ranges from about 2000 mm over some pocket areas in Southwest to about less than 100mm over the Afar lowlands in the Northeast;”*
- *“Trend analysis of annual rainfall shows that rainfall remained more or less constant when averaged over the whole country, however a declining trend has been observed over the Northern half of the country and Southwestern Ethiopia;”.*
- *“On the other hand an increasing trend in annual rainfall has been observed in central Ethiopia.”*

The question was put to the stakeholders as to whether climate change was relevant within the manual.

Feedback from the stakeholders at the workshop confirmed the following:

- 1 It was considered important and yes it should be included within the manual;
- 2 Design life of bridges is 100 years and as such it would be prudent to take climate change into account;
- 3 It was stated that Dr. Semu Ayalew has undertaken recent work in this area for Ethiopia and this work should be incorporated into the manual for the different regions where possible;
- 4 In addition the Ethiopian Electric and Power Corporation (EEPCCO) also have undertaken work in this areas;
- 5 It was concluded by the stakeholders that climate change should be taken into account, however this should be based on latest work undertaken. Concerns were also voiced about another factor to a flow/discharge calculation that is at best an estimate. It was recommended that any additional factors may render a scheme (bridge or

culvert) unviable and therefore a degree of proportionality may be required with respect to the risk and consequence of failure.

### **3.0 Data Requirements**

The Lead Author stated that acquiring the relevant data will be one of its biggest challenges. Following issue of a letter requesting data from the relevant government bodies, the response to date has not been encouraging. As such The Lead Author is proposing to meet them personally week commencing the 27<sup>th</sup> February 2012 to request the data. The purpose of this exercise is to expedite the data collation process and update the manual with the most recent data and work undertaken to date.

The issues the Lead Author have with any data received are as follows:

- Data sources and quality;
- Data limitations;
- Data gaps (data gaps will be filled where possible); and
- Confidentiality.

Feedback from the stakeholders at the workshop confirmed the following:

- a) Some research has been undertaken but it is located in different regions and as such will be difficult to obtain in the timeframe;
- b) Identifying what has been done in the catchments, dams, irrigation Land Use Maps, Soil Maps, research on time of concentration (Tc), ground water maps and geology maps ;
- c) Recent work would also need to be reviewed; and
- d) Data Resolution is crude and needs enhancement.

The Lead Author will be undertaking a data gathering exercise to ensure that the revised manual will incorporate the most up to date information.

### **4.0 Hydrology**

It is acknowledged that there is a lack of data when it comes to undertaking hydrological analysis within the various catchments in Ethiopia. Of the methods outlined within the current drainage manual the Rational Method and SCS methods are the ones recommended due to lack of data.

One other consideration to be taken account of is catchment characteristics and what has changed from 1997/2002 to present day.

Feedback from the stakeholders at the workshop confirmed the following:

- 1 It would be good if some form of analysis could be undertaken on flood events so that an understanding on what probability/return periods we are dealing with. This would require utilising existing gauge stations and building more on the major watercourses and areas that are sensitive to flooding. This however also requires the data to be recorded accurately and stored correctly for future use; and
- 2 It was confirmed by the steering group that the main methods used were the Rational Method and SCS Method.

The following limitations were identified for the two methods:

### **Rational Method**

- 1 More guidance/clarification is required in relation to the Time of Concentration ( $T_c$ ) and the values used. It is understood that recent research has been undertaken on runoff coefficients from urban areas and this recent research should be incorporated into the manual;
- 2 Rational method could be extended from  $0.5\text{km}^2$  to  $0.8\text{km}^2$  based on experiences to date. In addition it was stated that when the  $T_c$  exceeds 30 minutes the Rational Method is not to be used; however
- 3 Other members stated that the Rational Method was not that accurate where a catchment contained a high percentage of rural area;
- 4 Further clarification as to when calculations should change between Sheet Flow, Shallow Concentrated Flow and Open Channel calculation is required;
- 5 A review of current practice with respect to freeboard on structures. This is likely to be dictated by financial constraints and the consequence of the flooding;

### **SCS Method**

- 1 No up to date Land Cover Map/Land Use Map is available. The Lead Author to source this data if possible;
- 2 While a soil map exists, it is at a large scale, therefore it is proposed to look at trying to update the current Soil map with recent work undertaken on the River basins, which apparently has more up to date data on soils for the various river basins.
- 3 Some guidance on curve numbers to be used is also required;
- 4 Calibration of the curve number based on a flood event should also be looked at;
- 5 There appears to be a big difference in flows calculated when looking at the hydrological condition of soil groups when categorised as Poor, Fair or Good.

Some clarification on choice would be useful; Dr. Admasu Gebeyehu is likely to have some information on this.

- 6 A review of the backwater effect calculation and existing criteria to be undertaken;
- 7 An allowance for the shape of the catchment should also be made;
- 8 There is no real data in the Arid and semi-arid regions, update on data here would be beneficial;
- 9 Scale of maps to be improved if possible; and
- 10 Request from stakeholder group to use real examples within the document.

### **Other Issues**

- 1 Advice as to when watercourses should be modelled, as an example, small, medium, large watercourses and Major Rivers;
- 2 An assessment of the Geology Maps should be undertaken and assessed against current soil maps to establish if a correlation exists between bed rock and soil coverage;
- 3 Guidance on Slope/Area method would be useful – water marks and anecdotal evidence. Key to this method is the good recording and reporting of flood events;
- 4 The inclusion of a topographical survey template would be useful together with criteria as to when required;
- 5 An example of a routing method using hydraulic modelling will also be required to take account of storage within the catchment;

Request from the Lead Author to the Stakeholders is the request for examples of the methods used, problems encountered, and process by which these problems were overcome.

### **5.0 Hydraulic Design**

Following initial review of the hydraulic section of the manual, it was concluded by the Lead Author that this section could do with less theory and more practical examples. However it is proposed to replicate this theory in the appendix section of the manual.

The proposed sections under this chapter are as follows:

- Open Channels;
- Culverts;
- Bridges;
- Subsurface drainage; and

- Energy dissipation.

Feedback from the stakeholders at the workshop confirmed the following:

### **Open Channels**

- 1) No preferred channel type;
- 2) Main issue silt deposition and erosion problems;
- 3) Types of channels used within urban and rural areas are as follows:
  - Rectangular concrete channels and U shaped concrete channels in urban areas (issue with land take);
  - Trapezoidal channels in rural areas; and
  - V shaped channels in areas where the substrata is dominated by rock.

Silt traps and check dams are provided to improve the design life of the channel.

### **Culverts**

As with the hydraulic section of the manual, it was concluded by the Lead Author that this section could do with less theory and more practical examples. However, it is proposed to replicate this theory in the appendix section of the manual.

Feedback from the stakeholders at the workshop confirmed the following:

- 1) There are three main types of culverts used which are as follows:
  - Pipe Culvert;
  - Box Culvert; and
  - Slab Culvert.
- 2) The stakeholder group requested whether other forms of culvert could be used for example Corrugated galvanized steel culverts. This would be looked at within the manual but design life, design life and site conditions will also need to be looked at when considering alternative culverts.
- 3) Backwater calculation to be made more user-friendly and not reliant on Nomographs. Original work to be retained but will look at simplifying initial calculations for various scenarios on culvert design.

### **Bridge**

During a number of site visits it was observed that several bridge decks were located within the cross section of the dry water course. This has the obvious implication of obstructing flows during periods of high flows, irrespective of hydrology carried out for a specific flood event. It is proposed that as a minimum the soffit of any bridge deck be set at a level which corresponds to top of bank.

Feedback from the stakeholders at the workshop confirmed the following:

- 1) The criteria to which bridges and culverts are selected over one another to be reviewed. What is the consequence of failure or increase flood risk;
- 2) Look at the requirements with respect to scour (calculated scour depth then multiplied by 3); and
- 3) Need also to look at standard piers proposed.

The designs for bridges and culverts need to be proportionate with respect to its end use.

### **Sub-Surface Drainage**

It was identified that not a lot of sub-surface drainage design is undertaken. The areas identified were where ground water is an issue. Some of the issues to be addressed are identified below:

- 1) Land Drainage;
- 2) French Drains;
- 3) Suitability of location (Clay or Sandy substrata);
- 4) Existing ground water levels;
- 5) Permeability of the soil; and
- 6) Design life.

It was also proposed to look into sub-structure drainage but this will be covered under a separate series.

### **Energy Dissipaters**

From discussions at the meeting it was identified that there was no one preferred method of assessing the requirements for dissipaters and actual type of dissipater.

Feedback from the stakeholders at the workshop confirmed the following:

- 1) Review current practices; and
- 2) Provide a calculation that will assess requirements for an energy dissipater.

This will help with reducing sediment load and erosion.

### **Co-ordination of Areas of Expertise.**

It is reported that the Municipalities use the ERA manual for the design of roads within the urban environment. Designation of where the Municipalities start and finish and where ERA takes over responsibility of the road would be useful.

It was clear from the stakeholders that there was a lack of co-ordination between the various disciplines (Highway Engineer, Drainage Engineer, Geo-technical Engineer, Environmental

Consultant, Hydrologist and Project Managers and Directors). A structure for roles and responsibilities and lines of communication between the various parties would be useful. Co-ordination between all parties needs to start at pre planning (decision for location of route) so all risk from the various specialists can be taken on board at the outset and the risks managed.

The various specialists need to be involved from pre planning right through to delivery of the project on site. This allows for informed decisions to be made as circumstances on site require technical input or redesign from the various specialist's as the project progresses.

## **6.0 Storm Water Drainage Facilities**

Discussions at the meeting identified a number of shortcomings within the manual. The issues mainly fell under the standardisation of details and the number of calculations required for basic design. At present no attenuation of surface water (pre and post development) occurs.

Feedback from the stakeholders at the workshop confirmed the following:

### **Pipes**

- 1) There appears to be no standard with respect to specifying the minimum size of pipe size, manholes etc. In addition, the calculations required for the spacing of gullies can be made more simply once we obtain standard gully sizes and types.
- 2) Main issues are as follows:
  - Sediment control within the pipe system (silt traps – sumps in M/H's)
  - Erosion control at outfalls; and
  - Pollution (Water quality).

### **Ponds**

- 1) Discussion was undertaken on Ponds (dry and wet), Detention basins, Infiltration basins and wetlands. The practices of these will be looked at during the review process. An option with the ponds would be to use them as source of water supply.

## **7.0 Construction**

One of the main issues discussed in section relates to co-ordination of the various specialists. This can be undertaken in the pre planning of a project, which can identify the relevant mitigation to be put in place to address the following:

- Control of Erosion;
- Sediment Control; and
- Pollution Control.

Best practices on site will reduce the above risks and minimise the damage to the environment. A section on construction best practices will cover the above points. The steering group agreed this would be a relevant chapter to include.

## **8.0 Operation and Maintenance**

To ensure the final system operates efficiently and effectively an operation and maintenance procedure will need to be in place. This will look at access arrangements, health and safety, disposal of material and frequency of maintenance. It will also look at current practice and what can be done to improve current operation and maintenance regimes. It was agreed by the steering group that this chapter would be useful.

## **9.0 Cost benefit Analysis**

It was considered by the Lead Author that a section on cost benefit should be included. This chapter could go into great detail but it was concluded that a basic analysis would be sufficient for now. This would lead to informed decisions being made on an economical basis. One of the key elements is ensuring accurate relative costs of the various structures and then applying a safety factor (optimum bias) of between 30% and 60 %.

Two methods could be used which are as follows:

- Net present value
- Cost benefit analysis

What would be required for this analysis is, accurate relative costs of the schemes proposed, a Discount Rate and Inflation Rate. This exercise is then relatively straight forward to work out.

## **10.0 Web Based Support**

It would be beneficial to all parties that an online database be provided or at least the relevant links which would cover the following data sources:

- Rainfall data;
- Gauge station data;
- Soils maps;
- Land use data maps;
- Geology Maps;
- Ground water map

- Recent reports; and
- Historical flood events.

One of the issues with this proposal is who will take ownership of the website and keep it update. One option put forward is to charge a nominal fee to pay for its upkeep and data sources received by other donor agencies.

In addition to the above, a number of technical software options were discussed. No conclusion was reached and a separate discussion with ERA will be undertaken.

**Lead Author comment**

Within the time and budgetary constraints of this project, reasonable endeavours will be used to address the above issues raised by the stakeholders.

**Time and date of next meeting to be confirmed.**