



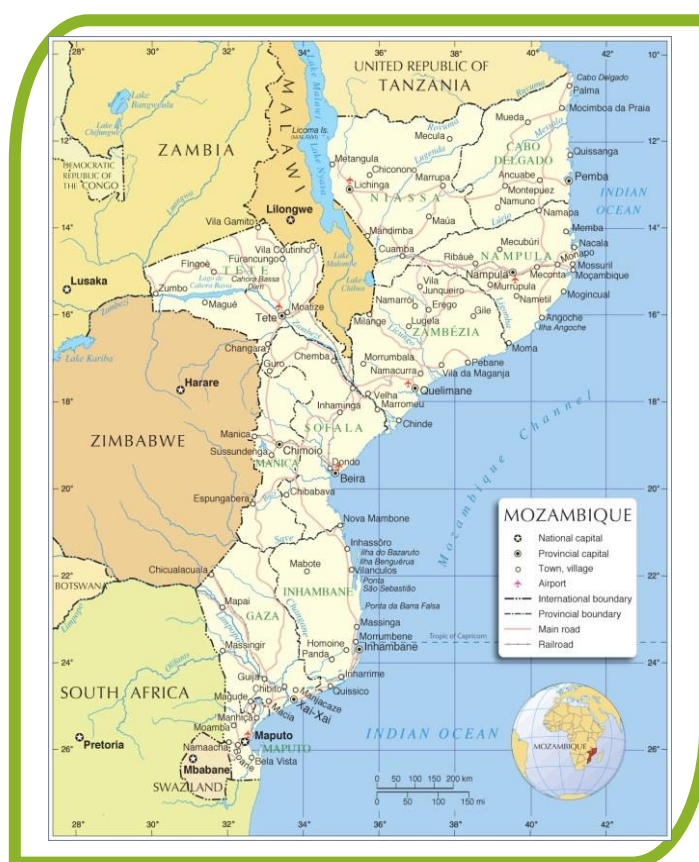
AfCAP

Africa Community Access Partnership



Technical Assistance to Mozambique Road Research Centre (Interim Phase)

Progress Report: October to December 2015



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CONTRACT REF NO. AFCAP/MOZ/2045A

January 2016



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Cover Photo: *Map of Mozambique*

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Abstract

AFCAP2 is providing technical assistance to Administração Nacional de Estradas (ANE) of Mozambique, to achieve its objective of setting up a Road Research Centre (RRC) in Maputo.

The initial phase for the establishment of the road research centre was initiated in 2013. The objectives of this phase were primarily to address institutional issues relating to the RRC, to draft a strategic research plan and a capacity and skills development plan, and to develop a 5-year business plan for the RRC. A workshop was held in Maputo in May 2014, where the plans and the progress achieved were presented. These were well received and the stakeholders supported the physical establishment of the RRC. However, despite the success of the initial activities to prepare enabling documentation and strategies, the full establishment and operationalisation of the RRC had not been realised. Therefore, a follow up “Short-Term Technical Assistance Programme” was carried out under AFCAP 2 in 2014/2015 in order to review existing plans and strategies and to map out concept notes for agreed priority research projects.

The outputs and recommendations of the “Short-Term Technical Assistance Programme” are contained in the final report dated August 2015. The report includes a list of prioritised research projects and detailed concept notes for each project. It also includes a concept note for a “Longer-Term Technical Assistance Programme” for the RRC to support its physical establishment and operationalisation, as well as pro-forma job descriptions for RRC staff, a good research practice guide and draft protocols for long-term pavement performance assessments.

In preparation of the launching of the “Longer-Term Technical Assistance Programme”, an interim-phase Technical Assistance programme has been initiated. The objectives of this 12-month Technical Assistance programme are as follows:

- 1) to make further progress with priority activities for the establishment and operationalisation of the RRC; and
- 2) to achieve the key performance indicator targets set out in the RRC Strategic Plan for the first year of operation.

This report outlines the progress that has been achieved between October and December 2015.

Key words

Road Research Centre, capacity building, Research & Development

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Safe and sustainable transport for rural communities

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See www.afcap.org

Acronyms

AFCAP	:	Africa Community Access Programme
ANE	:	Administração Nacional de Estradas
CSIR	:	Council for Scientific and Industrial Research
DFID	:	Department of International Development
DIAFI	:	Direcção de Administração e Finanças
DIMAN	:	Direcção de Manutenção
DIPLA	:	Direcção de Planificação
DIPRO	:	Direcção de Projectos
EU	:	European Union
FE	:	Fundo de Estradas
GIS	:	Geographic Information System
LEM	:	Laboratório de Engenharia de Mozambique
LNEC	:	Laboratório Nacional de Engenharia Civil
LTPP	:	Long-Term Pavement Performance
LVR	:	Low Volume Road
R&D	:	Research and Development
RRC	:	Road Research Centre
RRSC	:	Road Research Steering Committee
RRTC	:	Road Research Technical Committee
SADC	:	Southern African Development Community
TRL	:	Transport Research Laboratory

Contents

Abstract	3
Key words	3
Acronyms	5
1 Executive Summary	7
2 Long and Short-Term Objectives	8
3 Progress on Short Term Objectives (October to December 2015)	11
3.1 Inception Phase	11
3.2 Third Meeting of the Road Research Steering Committee (RRSC)	11
3.3 Visit to Road Trials in Inhambane Province	12
3.4 Meetings held on 11 December 2016	17
3.4.1 Meeting held between ANE, LEM and the AfCAP Project Team	17
3.4.2 Closure meeting with ANE	18
3.5 Concept Notes for Priority Projects	18
3.6 Other Activities	19
4 Planned Activities and Deliverables for Second Quarter	20
4.1 Activities	20
4.2 Deliverables	20
Annex A: Draft Concept Notes.....	21
Annex B: Abstracts for Conference Papers.....	41

1 Executive Summary

AFCAP2 is providing technical assistance to Administração Nacional de Estradas (ANE) of Mozambique, to achieve its objective of setting up a Road Research Centre (RRC) in Maputo.

The initial phase for the establishment of the road research centre was initiated in 2013. The objectives of this phase were primarily to address institutional issues relating to the RRC, to draft a strategic research plan and a capacity and skills development plan, and to develop a 5-year business plan for the RRC. A workshop was held in Maputo in May 2014, where the plans and the progress achieved were presented. These were well received and the stakeholders supported the physical establishment of the RRC. However, despite the success of the initial activities to prepare enabling documentation and strategies, the full establishment and operationalisation of the RRC had not been realised. Therefore, a follow up “Short-Term Technical Assistance Programme” was carried out under AFCAP 2 in 2014/2015 in order to review existing plans and strategies and to map out concept notes for agreed priority research projects.

The outputs and recommendations of the “Short-Term Technical Assistance Programme” are contained in the final report dated August 2015. The report includes a list of prioritised research projects and detailed concept notes for each project. It also includes a concept note for a “Longer-Term Technical Assistance Programme” for the RRC to support its physical establishment and operationalisation, as well as pro-forma job descriptions for RRC staff, a good research practice guide and draft protocols for long-term pavement performance assessments.

In preparation of the launching of the “Longer-Term Technical Assistance Programme”, an interim-phase Technical Assistance programme has been initiated. The objectives of this 12-month Technical Assistance programme are as follows:

- 1) to make further progress with priority activities for the establishment and operationalisation of the RRC; and
- 2) to achieve the key performance indicator targets set out in the RRC Strategic Plan for the first year of operation.

This report outlines the progress that has been achieved between October and December 2015.

2 Long and Short-Term Objectives

The objectives of the Technical Assistance programme to the Administração Nacional de Estradas (ANE) of Mozambique (interim Phase) are as follows:

1. to make further progress with priority activities for the establishment and operationalisation of RRC; and
2. to achieve the key performance indicator targets set out i.

Table 1: Critical Success Factors, Key Performance Indicators and Targets for RRC¹

Critical Success Factors	Key Performance Indicators	Targets				
		Year 1	Year 2	Year 3	Year 4	Year 5
R&D portfolio efficiency and effectiveness	No. of RRTC meetings held	4	3	3	3	3
	Compliance with RRTC directives	100%	100%	100%	100%	100%
	% of projects in active breakthrough vs. incremental projects	90%	80%	60%	60%	60%
	No. of research projects in active development	5	7	8	11	15
	No. of projects successfully completed	3	5	6	9	13
	No. of projects secured with private sector funding	0	0	2	3	5
	Value of projects funded externally to ANE as % of total	Report	Report	Report	Report	Report
	% Milestones met (i.e. % R&D objective achievements)	100%	100%	100%	100%	100%
	Released vs. planned deliverables (%)	100%	100%	100%	100%	100%
	Portfolio yearly spending against budget (%)	100%	100%	100%	100%	100%
	Cost savings attributable to R&D	-	-	Report	Report	Report
Stakeholder satisfaction with research outcomes	70%	75%	75%	80%	80%	
Ensuring effective transfer of technology to practice	No. of conference papers presented	2	3	5	8	10
	No. of journal articles published	0	1	1	3	3
	No. of industry workshops held	2	3	4	5	5
	No. of industry guidelines published	1	2	2	3	3
	No. of norms and standards published	0	1	1	2	2
	No. of demonstration projects successfully completed	1	2	3	5	7
Strengthening the skills base of the RRC	No. of Doctorates	0	0	1	2	2
	No. of Masters	1	1	2	3	4
	No. of staff classified as researchers	8	8	9	10	12
	No. of staff classified as professionals	3	3	4	5	6
	No. of staff studying towards a PhD	0	1	2	2	3
	No. of staff studying towards a Masters	1	1	2	2	3
	No. of studentships/interns	1	2	2	3	3
	No. of staff inducted at international R&D centres (secondments)	1	2	2	2	2
	Average % time spent by research staff on R&D projects	65%	65%	70%	75%	75%
Average % time spent on capacity building	20%	15%	10%	5%	5%	
Average % time spent on industry events (e.g. workshops)	5%	10%	10%	10%	10%	
Ensuring good governance	No. of RRSC meetings held	3	2	2	2	2
	Compliance with RRSC directives	100%	100%	100%	100%	100%
	Adherence to standards of good corporate governance	100%	100%	100%	100%	100%
	ISO 9000 quality system implementation	-	initiate	initiate	initiate	certify
	Adherence to standards for health, safety and environment	100%	100%	100%	100%	100%
	Collaboration with universities: No. of projects with universities	1	2	2	3	3
International R&D collaboration: No. of MoUs signed	3	4	4	6	6	

The services that the CSIR will provide are described in the Terms of Reference. They include:

1. To meet with the managers of the RRC to review progress with priority activities for the establishment of the research centre and achievement of the Key Performance Indicator targets (as set out in the business plan);

¹ Table extracted from the Draft Business Plan for the first five years of operation of the RRC.

2. To formulate and implement prioritised 'quick win' projects, with particular focus on the monitoring of all trial sections that were constructed under AFCAP 1 and establishment of knowledge management databases.
3. To identify specific areas of support needed to resolve constraints to the achievement of priority activities and targets and provide this support where possible; this may include (amongst others):
 - Assistance with the organisation of steering committee meetings;
 - Assistance with the organisation technical committee meetings;
 - Preparing staff job descriptions;
 - Assessing candidates for research posts;
 - Identifying IT requirements and preparing specifications for procurement;
 - Design of knowledge databases;
 - Identifying laboratory and site testing equipment requirements and preparing specifications for procurement;
 - Preparing Terms of Reference for research projects, identifying funding, and appointing consultants as necessary;
 - Identifying suitable conferences and preparing abstracts and papers;
 - Identifying appropriate topics for industry workshops and arranging venues, speakers, facilitators etc.;
 - Assisting with the organisation of knowledge sharing events for example field visits and study tours;
 - Identifying and contacting other public entities and drafting collaboration agreements;
 - Identifying appropriate international organisations, making contact and drafting Memoranda of Understanding;
 - Identifying and maximising opportunities for research centre participation in relevant programmes and activities being implemented by ANE.
4. At the end of the assignment, to revise and update the existing research centre business plan in collaboration with the research centre management.
5. To prepare an inception report, brief progress reports every two months, and a final report at the end of the assignment.

In the Inception Report for this project, the following activities were planned for the period October to December 2015:

- Appraisal of the status quo, identification of priorities and drafting of Inception Report (first trip to Mozambique, October).
- Review budget for RRC and develop template, and propose an organogram for the RRC (October, 4th week).
- Assist in the review of one abstract on calcrete mapping and one on performance of trial sections, both of which will be submitted to the International Conference on Transport and Road Research to be held in Kenya in March 2016.
- Review all previous documentation available on the trial sections constructed in the Inhambane Province (November, 2nd week).
- Draft a new Concept Note for *Road Trials, Demonstrations and Monitoring*, and combine the Concept Notes for the *Mapping of natural materials in road construction and development of a database* and the *Use of local materials in roads* into a new Concept Note, and send both Concept Notes to ANE/RRC for their comments (November, 3rd or 4th week).

- Finalise the Action Plans, incorporating the comments received from the members of the RRTC and produce a document for circulation to the members of the RRSC (November, 4th week).
- Second trip to Mozambique (December, 2nd week, 5 days):
 - Assist the working group on general issues relating to the establishment of the RRC;
 - Finalise discussions on the above two Concept Notes;
 - Preparation for the RRSC meeting;
 - Visit to the trial sections in the Inhambane Province;
 - Identify the laboratory resources required by the RRC in the short term in line with the demands of the projects and prepare an action/ implementation plan;
 - Monitor the establishment of dedicated offices for the RRC;
 - Receive feedback from the meeting of the RRSC and adjust Action Plans (amongst other activities that emanated from the RRSC meeting).
- Draft quarterly report (December).

Progress against the above objectives and activities are outlined in the sections below.

3 Progress on Short Term Objectives (October to December 2015)

3.1 Inception Phase

During the Inception Phase (October 2015), meetings were held at ANE in Maputo with, in order of sequence:

- Eng Hilario Tayob , Eng Luis Fernandes and Eng Joana Guiuele, members of the working group appointed by ANE to fast track the establishment of the RRC;
- Eng Silvestre Elias, Director of Direcção de Manutenção (DIMAN);
- Mr Henrique Filimone, the Director-General of Laboratório de Engenharia de Mozambique (LEM).

The discussions centred on the prioritisation of needs and the development of action agendas for the following:

- Priority research and development projects, which include the following:
 - Review of the Mozambican Design Standards for Roads;
 - Mapping of Materials for Road Construction and Development of a Database;
 - Use of Local Materials in Roads (to be combined with the former);
 - Continued Monitoring of Existing Trial sections and Establishment of new Road Trials;
 - Use of Road Works to Enhance Community Water Supplies in Mozambique;
 - Protocols for Improving the Proficiency of Material Testing Laboratories.
- Establishment of the RRC:
 - Institutional location of the RRC;
 - Structure of the RRC;
 - Staff complement of the RRC;
 - Career ladder and remuneration structure;
 - Budget of the RRC;
 - Physical location;
 - Laboratory facilities and resource requirements;
 - Knowledge management and IT requirements;
 - KPI targets;
 - Meetings of the Road Research Steering Committee (RRSC) and the Road Research Technical Committee (RRTC); and
 - Collaboration between ANE and LEM

The outcomes of the above, inclusive of the Action Agenda for the 12-month Technical Assistance Programme, are provided in the Inception Report dated October 2015.

3.2 Third Meeting of the Road Research Steering Committee (RRSC)

The AfCAP Consultant provided assistance to ANE with the drafting of the agenda and the preparation of slides for the third meeting of the RRSC.

The RRSC met on Tuesday, 8 December 2015 in the Executive Boardroom of ANE. The meeting was attended by:

- Henrique Filimone, Director-General of LEM (Chair)
- Atanasio Mugunhe, Director-General of ANE
- Nkululeko Leta, AfCAP Regional Manager

- Silvestre Elia, Director of ANE-DIMAN
- Miguel Coanoi of ANE
- Agostinho Notece of ANE
- Mr Malte, representative of the European Union (EU)
- Carlos Cumbane of LEM
- Rocha Lobo of Consultec
- Benoit Verhaeghe, AfCAP Consultant
- Joana Guiuele of ANE-DIMAN (Scribe)

Eng Fernandes presented a status report on the establishment of the RRC in which he addressed (inter alia):

- the key priority activities, namely the provision of facilities for laboratory testing; the establishment of the information centre; the implementation of operating systems; capacity building and training of research staff; and the implementation of priority projects;
- the Working Group that has been appointed to facilitate and expedite the establishment of the RRC, comprising of: Eng Hilario Tayob (Leader), Eng Luis Fernandes and Eng Joana Guiuele appointed by ANE; and Americo Ocuia Dimande, Carlos Rodrigues Cumbana and Santos Aurelio Cuinica appointed by LEM;
- the need for developing a budget for the RRC in which all assumptions are clearly substantiated;
- the suggestion for the Road Fund to allocate one per cent of the budget for the construction, rehabilitation and maintenance of roads in order to fund projects of the RRC;
- the poor status of the Central Laboratory of ANE, and therefore the necessity to make use of the LEM laboratories, initially;
- the intention for LEM to function as the road materials reference laboratory for Mozambique;

He then presented an overview of the priority projects that will be initiated in 2016, the planned activities of the AfCAP Technical Assistance Programme (Interim Phase) to support the establishment and operationalisation of the RRC, and the performance indicators that will be used to gauge the degree of progress that has been achieved.

The discussions that followed centred on the priority projects, i.e. Road Ponds, mapping of aggregate resources and construction of trial sections. With respect to the latter, Mr Malta stated that EU funding could possibly be made available for the construction of experimental sections using laterites on the Milange-Mocuba contract.

The Chairperson recommended that three RRSC meeting be held in 2016 (April, July and September) to steer the establishment of the RRC and monitor its progress.

3.3 Visit to Road Trials in Inhambane Province

A visit was undertaken to the trial sections constructed in Inhambane Province (8 to 10 December 2015). The following were noted on the Cumbana-Chacane trial sections:

- *Construction* was not done uniformly along the length of most of the trial sections, resulting in variable performance. This was attributed to poor quality control on site, delays caused by unavailability of materials on site, contractor being inexperienced in the use of the applied technologies and construction techniques, and equipment problems (e.g. blocked nozzles on spray bar of binder distributor). The variable quality of the trial sections will make interpretation of data on the performance of

the different types of pavements difficult, unless significant effort is invested in capturing as built data (i.e. field and laboratory studies as part of a back-analysis study).

An example is shown below (Macadam section), illustrating the impact of the contractor getting to know how to construct a Macadam (on the left) and after acquiring the skills to do so (but notice the non-uniform application of the emulsion using hand-spraying techniques):



*Towards start of construction
(high number of fixed potholes)*



Toward end of construction

It is recommended that much tighter quality control measures be implemented in the construction of all future trial sections. The execution of these new trial sections should also be coupled with a well-designed and elaborate laboratory testing programme to capture as much as-built data as possible to support future performance assessments and back-analyses.

- *Monitoring* of the test sections was unfortunately discontinued. Some of the sections (e.g. armoured base with sand seal surfacing) displayed transverse and block cracking, but it may not be known when the cracks initiated and how they progressed over time, and to what extent they contributed to secondary distresses such as pothole formation as a consequence of, for instance, water ingress into the base layer. It should be noted that there are probably other causes and mechanisms that contributed to the formation of potholes, but these seem not to have been identified at this stage. As noted above, a back-analysis study will be required.
- *Riding quality* was not optimal. Again, this could possibly be attributed to the construction operations (stop/start, type and quality of construction equipment, etc).

- *Maintenance*, for instance the repair of potholes, was not done optimally. In most cases, the pothole filling material protruded above the surface of the road, increasing road roughness and also causing vehicles to inflict dynamic loads on the pavement after having hit the repair, possibly leading to the formation of additional potholes. An example is shown below:



- With respect to the pavement technologies demonstrated on the Cumbana-Chacane trial sections, the following:
 - A sand seal on “red sand”, even if the red sand is well compacted, is not a viable option. The base layer is too fine and too loose to provide a platform that can “anchor” the sand seal. This is shown in the picture below:



- On the other hand, an armoured base, produced by placing a single layer of coarse calccrete aggregate on the red sand layer and compacting it into the sand layer, provides a cost-effective alternative that can be considered for low-volume roads. As shown in the picture below, the coarse texture of the base layer provides a suitable “anchor” for either a single or a double sand seal:



- The calcrete Macadam surfaced with a sand seal seems to provide a durable and tough wearing course (see picture below). However, the coarseness of the material may have contributed to the roughness of the layer, which in turn affects riding quality.



- A 50% sand / 50% calcrete blended base course, surfaced with a calcrete Otta seal and capped with a sand seal also seems to provide a cost-effective alternative that maximises the use of available resources. However, good quality control is required on site, especially with respect to the Otta seal. Whereas the above combination, with a binder application rate of approximately 1.8 l/m^2 for the Otta seal, resulted in a section producing fair to good performance, the same combination but with a binder application rate of 1.3 l/m^2 instead of 1.8 l/m^2 significantly affected the performance of the trial section (notice the number of repaired potholes on the left climbing lane).



The combination of a 50% sand / 50% calcrete blended base course, surfaced with a calcrete Otta seal and capped with a sand seal has now been used by the ANE Provincial delegation in Inhambane to upgrade a number of unpaved roads. Two such roads were visited: one in the town of Maxixe, and one connecting Inhambane to Barra (Barra road). Whereas the section in Maxixe was found to be in very good condition, two main issues were noted on the Barra road:

- a. Before the sand seal capping is applied, one should ensure that the emulsion used in the Otta seal has properly cured. If not adequately cured, the sand seal may be worn off by the action of traffic as shown on the left in the picture below:



Several edge breaks were noticed. It is unclear whether these were caused by traffic and/or water action, or due to construction. This will require further investigation. In any event, the provision of good drainage is of vital importance in the safeguarding of low-volume roads.

3.4 Meetings held on 11 December 2016

3.4.1 Meeting held between ANE, LEM and the AfCAP Project Team

The purpose of the meeting was to introduce the staff members of LEM who became part of the Working Group established by ANE to expedite the establishment of the RRC, review the priority projects and agree on an action agenda.

The meeting was attended by:

- Luis Fernandes (ANE – Chair)
- Joana Guiuele (ANE)
- Americo Ocuca Dimande (LEM)
- Carlos Rodrigues Cumbana (LEM)
- Santos Aurelio Cuinica (LEM)
- Nkululeko Leta (AfCAP)
- Benoit Verhaeghe (AfCAP Consultant)

After a review and discussion on the priority projects, it was agreed that Concept Notes for the following four projects should be prepared during December 2015, for discussion and finalisation at the next meeting of the RRTC to be held in January 2016:

- Mapping of Materials for Road Construction and Development of a Database;
- Continued Monitoring of Existing Trial sections and Establishment of new Road Trials;
- Use of Road Works to Enhance Community Water Supplies in Mozambique;
- Protocols for Improving the Proficiency of Material Testing Laboratories.

With respect to the proposed mapping project, the following were noted:

- Candidate Provinces for the first phase should be identified (the Inhambane Province was recommended for the pilot);
- The available capacity within the Province(s) (e.g. staff of Delegação Provincial da ANE and laboratories) need to be assessed, as well as the availability of field equipment.

LEM indicated their willingness to be involved in all four projects.

3.4.2 Closure meeting with ANE

At the closure meeting, attended by Luis Fernandes, Joana Guiuele and Benoit Verhaeghe, issues relating to staffing, capacity building, office space, laboratory resources and operational planning were discussed.

Staffing: the Working Group currently consists of six members, three from ANE and three from LEM (cf. Section 3.2). An internal advert was sent out by ANE in October to attract at least three additional members (two engineers and one technologist). To date, two people have responded, namely Rubina Normahomed and Raquel Damiao. As noted previously, the purpose of the Working Group is to expedite the establishment of the RRC, but it is expected that all members of the Working Group will eventually also become part of the staff complement of the RRC. Hence, they should all be included in the capacity building and skills development programme and be involved in the execution of the Priority Projects. With respect to training, it was noted that all researchers should acquire basic knowledge on laboratory testing and the processing of laboratory data, and hence they should be included in such training programmes.

The issue of office space, especially for LEM staff, was raised. The current understanding is that LEM staff would retain their office space in LEM, but that project offices would be established at the RRC, to be shared between ANE and LEM staff. This was considered important for the cultivation of team spirit, the sharing of knowledge and expertise among team members (internal capacity building), and to facilitate project management and support project execution.

With respect to laboratory resources, the Working Group undertook to revisit the list of laboratory equipment provided in the Business Plan, and prioritise the items in line with their immediate needs². This list will be sent to the Consultant in January 2016, for evaluation and possible integration in the Concept Note on Capacity Building and Skills Development.

Finally, it was requested that an Operational Plan for the RRC be drafted. It should contain (inter alia) action plans for the execution of projects; capacity building plans; and workshops/seminars to be organised by the RRC, as well as conferences that the RRC should be involved in. A draft version of the Operation Plan should be made available in February.

3.5 Concept Notes for Priority Projects

Based on discussions held in October and December 2015 with ANE, and following the outcomes of the third meeting of the RRSC, the following four Concept Notes were drafted during December 2015 (see Annex A):

- Mapping of Materials for Road Construction and Development of a Database;
- Continued Monitoring of Existing Trial sections and Establishment of new Road Trials;
- Use of Road Works to Enhance Community Water Supplies in Mozambique;
- Protocols for Improving the Proficiency of Material Testing Laboratories.

The Concept Notes have been sent to the AfCAP Regional Manager and to the members of the ANE Working Group for their comments.

² Note: Laboratory equipment that was acquired for the execution of road works has already been allocated to Provincial laboratories.

These will be further discussed with ANE in January 2016 and tabled at the third meeting of the RRTC for endorsement.

3.6 Other Activities

Two abstracts for papers have been prepared and submitted to the organisers of the International Conference on Transport and Road Research to be held in Kenya in March 2016. The abstracts are reproduced in Annex B.

A template for the development of a budget for the RRC has been prepared and has been submitted to ANE. The template will be evaluated by ANE and populated with data to produce a first-cut budget for discussion in January 2016. Further improvements will be made to the template based on their recommendations. The budget will be populated with data when more clarity has been obtained on the scope of the priority projects that will be undertaken, the operational requirements of the information centre and the scope of the capacity and skills development programme.

4 Planned Activities and Deliverables for Second Quarter

4.1 Activities

The following activities are planned for the period January to March 2016:

- Third trip to Mozambique (late January, 4 days):
 - Assistance with the setting up of the RRTC meeting to be held during that week;
 - Assist the working group on general issues relating to the establishment of the RRC (e.g. office accommodation, budgets, laboratory resources, branding);
 - Monitor status of approval of first two projects and, if approved, assist with the setting up of projects;
 - Assess staff composition and preparation of job descriptions and training requirements;
 - Develop a Concept Note for *Capacity building and skills development*;
 - Review and finalise the four Concept Notes prepared in December;
 - Assist in getting collaborative partners (e.g. universities) involved in the implementation of the RRC research agenda;
 - Preliminary interactions with ANE's IT department and information centre staff to obtain information on the current status quo.
- Brief the CSIR Knowledge Management and IT specialists and schedule interactions to be held between CSIR Knowledge Management and IT specialists and their counterparts in ANE (February).
- Fourth trip to Mozambique (early March, 4 days):
 - Assist the working group on general issues relating to the establishment of the RRC;
 - Assistance with the setting up of the RRTC and RRSC meetings (to be held in April);
 - Monitor status of approval of projects and monitor execution of projects, inclusive of capacity building initiatives;
 - Assist with identification of topics for debate at national workshops;
 - Assist with the identification of conferences and the drafting of abstracts and papers;
 - Interactions between CSIR Knowledge Management and IT specialists and their counterparts in ANE to initiate the mapping of knowledge management and IT requirements, and reporting on the outcomes of these meetings.
- Draft quarterly report (March).

4.2 Deliverables

The Technology Assistance programme is expected to produce the following deliverables in the Second Quarter (January to March 2016):

- Status report on the resourcing of the RRC (staff and equipment);
- Concept Note for capacity building programme;
- Status report on implementation of projects;
- Report on status of collaboration between the RRC and universities;
- Report on meetings held on knowledge management at IT infrastructure;

The above will be integrated in the second Quarterly Progress Report to be submitted on 31 March 2016.

Annex A: Draft Concept Notes

PROJECT CONCEPT NOTE

Project Title: Mapping of Materials for Road Construction and Development of a Database
Country/Countries/Region: Mozambique, Inhambane Province
Project Background: <p>One of the biggest difficulties in planning and designing a cost-effective and economical road is the location of suitable materials for the different pavement layers. Some work undertaken by TRL Ltd for AfCAP was done recently in Inhambane Province specifically on the location of calcretes and mostly on the basis of remote sensing, studies of geomorphological maps and field observations. Inhambane is a particularly troublesome province in relation to materials as the entire province consists of Cenozoic sedimentary materials (less than 65 million years old), mostly sands with some localised pedogenic materials, namely calcretes. Although some interesting results were found in the recent study, it was recommended that the study needs to be extended significantly to other material types and the entire Province of Inhambane “mapped” for possible material usage in future.</p> <p>The mapping should not be limited to materials that meet traditional specifications, namely those that are typically used for roads carrying fair amounts of traffic. Local materials, despite not conforming to traditional material requirements, can perform satisfactorily and result in significant cost savings and environmental benefits, especially when used on low-volume paved and unpaved roads. Hence, all material sources that could potentially be used in roads should be mapped, inclusive of alternative materials such as industrial by-products. Together with the mapping of the location of the materials, general testing should be carried out and a database of the sources and potential uses of the materials developed. Recommendations on how marginal materials could be rendered suitable for use in road construction (e.g. through blending, modification and/or stabilisation) should also be provided in the database.</p> <p>This Concept Note describes the methodology for carrying out this work for Inhambane Province only. Once this has been completed and the systems set up, the study should be extended to other provinces in Mozambique. Ultimately, a GIS-based map showing the likely locations and size of potential borrow pits or quarries in Mozambique with links to their typical properties and potential uses should be available for the entire country.</p>
Concise Project Purpose: <p>The main objective of the project is to extend the ground-work carried out by TRL Ltd in the Inhambane Province on the location and identification of calcretes for road construction. The existing work has mainly been restricted to a number of the main roads and covers a narrow strip running approximately north by north west to south by south east through the central part of Inhambane Province. It also only concentrated on calcrete. Hence, methodologies need to be developed and adopted as part of this study to map all potential materials that can be used in road construction and produce GIS maps.</p> <p>A second objective is to identify which local materials can be used for road construction and develop recommendations and ultimately also appropriate specifications for their use. This would especially be applicable to marginal materials. For instance, extensive work on the use of local sands has been carried out under a AfCAP project and possible sources of sand for use in structural layers should therefore also be assessed in this proposed project.</p> <p>A third objective is to capacitate staff at ANE (inclusive of the ANE Provincial Delegation in Inhambane Province) and LEM to undertake road material mapping studies within Inhambane Province as well as in other provinces in Mozambique.</p>
Previous or Related Work:

Project AFCAP/MOZ/091: Identification and Mapping of Calcrete Deposits in Inhambane Province and Preparation of a Calcrete Classification System and Specifications for the Use of Calcrete in Road Construction in Mozambique (Final Report, produced in March 2013 by TRL Limited, UK, in association with InfraAfrica (Pty) Ltd, Botswana and Hearn Geoserve Ltd, is available on the ReCAP website: www.afcap.org)

Project AFCAP/GEN/028/C: Research Consultancy Services for the Development of Guidelines on the Use of Sand in Road Construction in the SADC region (Final Report, produced in July 2014 by InfraAfrica (Pty) Ltd, Botswana, TRL Ltd, UK, Paige-Green Consulting, RSA, CPP Botswana (Pty) Ltd and Frank Netterberg, RSA, is available on the ReCAP website: www.afcap.org)

Project Methodology:

The basic system developed by TRL under the AfCAP programme should be consulted as the launching pad for the material location and database. The principles developed for calcrete materials are sound, but this project will require extending the findings to different materials with additional testing of the fundamental material properties. The project will be carried out in a number of phases:

- i. Review the work carried out by TRL and other similar studies undertaken to obtain a thorough understanding of the remote sensing and botanical indicator principles applied. Check, using the literature and through consultation, if there are any other techniques that could complement these, e.g. soil mapping, digital terrain modelling, etc.
- ii. Obtain any additional and/or newer remote sensing data for Inhambane Province. Apply as many of the principles identified as possible to a small selected area in the Province (preferably a problematic area) and develop a desk study base map based purely on accessible information that addresses all materials in the area. A good knowledge of the requirements of the different materials for road construction purposes will be necessary.
- iii. The research team will then need to visit the area assessed and carry out a detailed investigation of the local soils and geology, to confirm which of the techniques or principles employed works best for which materials. This will entail significant probing, pitting and sampling. Ideally, a three dimensional map of the upper 1.5 to 3.0 m of the entire area should be developed. Field investigations will involve use of the calcrete probe, test pitting and soil profiling (Brink and Bruin method) and sampling at selected sites showing potentially useful materials of any kind (calcrete, sands, gravels). Laboratory testing will include normal grading, Atterberg limits, CBR testing and aggregate strength (ACV, AIV, 10% FACT, etc). X-ray diffraction (XRD) studies of some of the materials may also be useful. This would be carried out by LEM and/or ANE.
- iv. Based on the results obtained from the "pilot area", the optimum assessment techniques should be identified. These must then be applied to a desk-study of a second selected area. Only those sites that show positive potential should then be evaluated and the success rate of the process determined. Areas that weren't successful should be investigated to determine "what went wrong"?
- v. Once the process has been adequately fine-tuned, the entire province should be "mapped" and sampled according to the method developed.
- vi. The results of the material location and sampling must then be placed in a database linked to a GIS such that anyone requiring material information in the province can quickly access the available data. This database should include information on the potential use of the materials as well as potential treatments to render them suitable (i.e. for marginal materials).
- vii. Prepare a manual on the use of the system and the database including a method for users to supply all additional data to the database manager for addition to the existing information.
- viii. Once this has been successfully completed, the process should be applied to the other provinces in Mozambique. This would be different projects in different phases

Human Resources ReCAP Funded:

A service provider should be appointed with specialist knowledge on material mapping techniques, material assessments and the cost-effective application of local materials in the construction of low to high-volume roads. One of the main responsibilities of the service provider is to transfer knowledge and expertise to Mozambican engineers who will then assume responsibility for the implementation of the materials mapping processes to other regions in Inhambane Province as well as to other provinces in Mozambique. Hence, the capacity building and implementation programme will have to involve engineers from the ANE Provincial Delegation, LEM and especially staff from the ANE Road Research Centre, as well as university students willing to be involved in this study as part of their post-graduate studies.

It will be expected that the service provider spends 90 days of productive time in-country (Inhambane Province, predominantly) and 10 days outside the country over a period of 18 months to provide specialist support and build local capacity.

Parallel Resources – non ReCAP Funded:

The project team should consist of at least three researchers (two concentrating on the materials location and sampling side, the other on the GIS and database development aspects) sourced from the ANE Road Research Centre who would work side by side. The project would require full-time input from a lead researcher but less input from the other researcher and GIS specialist.

It would be essential that the researchers involved in this project liaise closely with other government institutions, such as Soils, Agriculture, Geological, Survey and universities in order to gain maximum benefit from the relatively “high tech” and rapidly developing science of remote sensing and satellite observation, amongst others.

For maximum benefits, the lead researcher should be an experienced Materials Engineer or Engineering Geologist (preferably with a Masters but minimum BEng or BSc (Hons)), while the other researchers should be a road materials engineer and a GIS expert, the latter qualified at least at Honours level.

In addition, at least two experienced field technicians would be required together with laboratory and field testing staff/labour. They should be sourced from ANE and LEM. The field technicians should be experienced in routine field testing (test pitting and profiling), sampling and sample management and should be trained in the use of the calcrete probe, sample management and other skills required for this project.

Other Resources:

The resources needed initially would be mostly related to the GIS and means of analysing and interpreting the remote sensing data, particularly multi-spectral satellite or air-borne imagery. This would require purchasing such imagery and the software required for analysis and the resources to analyse relatively large files. Ideally, such skills and other resources should be sourced from within ANE.

Field testing and sampling equipment would be normal apparatus except for the custom-made calcrete probe similar to the one used by TRL in their investigation. A mechanical excavator capable of excavating trenches to a depth of 3 m will need to be available for the sampling and means of transporting large quantities of sample back to ANE/LEM laboratories for testing will be required.

Project Outputs, Impacts and Uptake Strategy:

A number of benefits will be achieved by having such a materials database. Firstly, the design of new and rehabilitated roads will be able to make use of the identified materials which can provide the optimum design based on the best local materials available. As the properties and extent of these will be known, the chances of delays and claims will be significantly reduced.

The time normally required to locate materials at the pre-tender and tender stage will be reduced and more confidence will be held in the materials proposed.

This project would also assist in developing new technologies which would later be extended to

application in the other provinces. Participating researchers in the ANE Road Research Centre would develop experience that can assist when consultants cannot find suitable materials. The GIS system and database should ultimately become integral parts of the Road Asset Management System.

Once the database for Inhambane Province has been completed, the data must be made available to anyone involved in projects in the Province.

It is proposed that a workshop be organised two months after project initiation to discuss and agree on the mapping principles that will be adopted for Inhambane Province. It is also proposed that a final workshop be held at the completion of the mapping study to share the outputs and outcomes of the project as well as lessons learnt, the latter to benefit the rollout of the materials mapping to the other provinces.

Other provinces should be introduced to the process and the same procedure can be followed for each of these. It must be noted, however, that other provinces have totally different geological features (e.g. Tete Province has almost all Palaeozoic and early Mesozoic geology (hard rock older than about 200 million years)) which may require development of the process from first principles each time. The ReCAP service provider appointed for this study should provide some general guidance on these issues to the project team of the Road Research Centre.

The following AfCAP Logical Framework indicators would apply:

- **Outcome Indicator 1:** Improved engineering practices in road construction
- **Outcome Indicator 4:** Concrete example of change influenced by AfCAP applied to #km of road
- **Output Indicator 1.1:** Practices supporting cost-effective LVRR construction and maintenance
- **Output Indicator 2.1:** % research projects led by African researchers
- **Output Indicator 2.5:** % research projects led by female researchers (potentially)

Key Contacts:

Administração Nacional de Estradas (ANE)

- Direcção de Manutenção (DIMAN)
- Direcção de Planificação (DIPLA)
- Direcção de Projectos (DIPRO)
- Delegação Provincial da ANE- Inhambane
- ANE staff who contributed to the calcrete mapping study: Francisco Menheche & Joana Guiuele
- ANE staff associated with the Road Research Centre: Luis Fernandes, Hilario Tayob, Raquel Langa and Rubina Normahomed.

Laboratório de Engenharia de Moçambique (LEM)

- LEM staff who contributed to the calcrete mapping study: Carlos Cumbane

Other organisations in Mozambique:

- Ministério dos Recursos Minerais e Energia
- Direcção Nacional de Geologia
- Instituto Nacional de Investigação Agronómica
- Universidade Eduardo Mondlane (UEM)

International experts who were involved or contributed to the calcrete mapping study:

- Tony Greening (TRL Ltd, UK)
- Michael Pinard (Infra Africa (Pty) Ltd, Botswana)
- Gareth Hearn (Hearn Geoserve Ltd)
- Frank Netterberg (South Africa)

Key References:

TRL Ltd. 2012. Technical Review Report. Identification and mapping of calcrete deposits in Inhambane Province and preparation of a calcrete classification system and specifications for the use of calcrete in road construction in Mozambique, AFCAP/MOZ/091.

TRL Ltd. 2013. Final Report. Identification and mapping of calcrete deposits in Inhambane Province and

preparation of a calcrete classification system and specifications for the use of calcrete in road construction in Mozambique, AFCAP/MOZ/091.

Infra Africa (Pty) Ltd. 2014. Final Report. Research consultancy services for the development of guidelines on the use of sand in road construction in the SADC region, AFCAP/GEN/028/C.

Pinard, MI, and Netterberg, F. 2012. Comparison of Test Methods and Implications on Materials Selection for Road Construction. 2nd AfCAP Practitioners Conference, 3 - 5 July 2012, Maputo.

Other Relevant Information:

The following recommendations made in the Final Report of AFCAP/MOZ/091 with respect to extending the study on calcrete mapping should be noted:

- 1) Excavate further the trial pits in the proven calcrete deposits.
- 2) Collect samples at each of these additional trial pits and carry out the tests previously scheduled.
- 3) Take samples from some of the borrow areas in the mapped Lacustrine Limestone between Mabote and Tome and carry out the same tests on these for comparison.
- 4) Undertake a trial pit investigate of the remaining suspected calcrete locations and collect samples for testing.
- 5) Carry out a probing investigation of the 36 additional potential calcrete locations identified from the Google Earth imagery and listed in the Final Report.
- 6) Continue to use existing stereo aerial photographs to provide details of subtle terrain differences.
- 7) Use ASTER imagery to assist in future calcrete prospecting.
- 8) Extend the methodology applied in this study to other provinces where there is a potential presence of calcrete. According to the rainfall map of Mozambique this would include Gaza, Maputo and Tete Provinces.
- 9) More comprehensive testing needs to be undertaken to evaluate the suitability of the calcretes in Inhambane Province for use in road construction.
- 10) One standard national method for materials testing should be introduced in both public and private sector laboratories so that results are comparable and be related to specifications for use in road pavements in Mozambique.
- 11) No specifications for the use of calcretes in Mozambique are currently available. If imported specifications are adopted, then care should be taken in high rainfall areas. It is important that appropriate materials testing standards are used or results corrected as appropriate.
- 12) Information on the location, type, properties and quantities of road building materials prospected, should be recorded in the GIS database together with a record of unsuccessful prospecting to prevent future duplication of effort.

Concept Note Submitted by: B Verhaeghe on behalf of the *Centro de Investigação Rodoviária* (Road Research Centre)

Organisation: Administração Nacional de Estradas (ANE)

Date: December 2015

Concept Note Reviewed by (PMU)

Date:

PROJECT CONCEPT NOTE

Project Title:

Continued Monitoring of Existing Trial sections and Establishment of new Road Trials

Country/Countries/Region:

Mozambique

Project Background:

A number of trial sections have been constructed in Mozambique under several programmes, including AfCAP, designed to demonstrate and verify different options in design, material utilisation and construction methods for particularly low-volume roads. Examples of these include (Phase-3 RRIP Projects – see Section on *Previous or Related Work*):

- Zero-Mopeia road in Zambezia Province
- Inhacufera-Machaze road in Manica Province
- Cumbana-Chacane road in Inhambane Province
- Chinhacanine-Nalazi road in Gaza Province
- Maragra-Machubo road in Maputo Province

A review of the outcomes of all trial sections constructed in Mozambique will be necessary. Useful data has been obtained from both old and newer trial sections. Some of them have been monitored over time and should therefore have as-built information and performance data that can be used as a benchmark to assess future performance. Thus several data sets should be available to initiate the project.

However, the available data contained in the as-built documents and reports (i.e. baseline data), as well as performance data, may not be consistent between the projects and over the monitoring periods. Also, the establishment of these trial sections may not necessary have been geared towards providing the data that will enable researchers to assess the impact of other factors that can influence the performance of the pavements (e.g. traffic, environmental and societal data). The extraction of information for back analysis may therefore be difficult without a framework for guidance. It is therefore necessary that a protocol for establishing and monitoring trial section to guide the collection of the required data, including consistent condition assessments of the trial sections, is developed to ensure proper analysis.

There is thus a need to evaluate the existing trial sections in order to determine the quality of monitoring data and which sections will provide quality data in future. To effectively undertake such a research project, it is therefore necessary to have a systematic method of evaluation and monitoring in place for the existing as well as new trial sections, which will include condition assessment over a number of years.

This Concept Note is for the development of a framework for assessing the quality of data obtained from existing trial sections, for the establishment of new trial sections and for the systematic collection and recording of condition and performance data generated during the monitoring period of trial sections. The Concept Note describes the elements, approach and resources required to carry out the project.

Concise Project Purpose:

The ultimate goal of the project is the assessment of the outcomes of existing trial sections and the development and implementation of protocols for establishing and monitoring of trial sections in a systematic way. In order to achieve this goal, the project has been subdivided into three main tasks with specific activities as outlined in the Project Methodology section of this Concept Note.

The objective of the **first** task is to evaluate the nature and quality of information available from the existing trial sections. An in-depth review (including an updated back-analysis) of the existing trial sections will be undertaken. The objective of the **second** task of the project is to develop guidelines/protocols to ensure that the establishment of trial sections and collection of the

information is standardised. The objective of the **third** task is to establish new trial sections, and to collect data on the old and new trial sections on a continuous basis over a number of years according to the monitoring processes provided in the guidelines/protocols developed as part of Task 2.

Previous or Related Work:

Mozambique Rural Road Investment Programme (RRIP) Phases 1, 2 and 3, funded by ANE/SIDA/AfCAP

The World Bank identified poor accessibility as one of the main causes of high transport costs and slow socio-economic development in Africa to the extent that Africa is lagging behind all other continents in terms of development. Accessibility is a major issue in sub-Saharan Africa and Mozambique is no exception. ANE embarked on a RRIP in 2008. The Programme was supported by SIDA, which provided the funding for construction, including site supervision, and AfCAP, which provided technical assistance for research, application of innovative solutions, development of guidelines, communication and mainstreaming.

Targeted interventions on low-volume rural roads in Mozambique, funded by AfCAP

Linked to the above RRIP. The main objective of the AfCAP project was to contribute to the RRIP being carried out by ANE and which was aimed at improving the Mozambican unpaved road network by increasing passability and all-weather access, and reducing long-term maintenance costs. AfCAP support was provided for the development of sustainable designs and construction techniques, which culminated in the construction of trial sections that were monitored over a period of time (< 2 years).

Back-analysis of previously constructed low-volume rural roads in Mozambique, funded by AfCAP

Linked to the above RRIP. The RRIP did not provide sufficient data to carry out a retrospective evaluation of previously constructed roads. The Back-Analysis project was initiated to evaluate the performance of low-volume sealed roads constructed at least ten years ago. The criteria used for their selection included: road classification, traffic levels, age of the road, construction type and pavement condition. At the end, 21 sections on 8 roads in 6 provinces were selected for the study.

Project Methodology:

It is recommended that the proposed project be undertaken as outlined below:

TASK 1: *Review of existing trial sections:*

Main activities to include:

- Extensive review of existing trial sections. This should include the study of all construction/as-built documentation and any back-analysis studies carried out.
- Assessment of the accessible information on the trial sections. It should be noted that data collected from the different trial sections may not be in the same format. The analysis of these data should provide the research team with a better understanding of data collection methods used and also assist in decision-making on whether all existing sections should be included as candidates for further monitoring. Hence, the gathering of additional as-built information (i.e. baseline data) where such information is not available or found to be unreliable should also be conducted as part of this task.
- In-depth review of a sample of ongoing trial sections, including a back-analysis where required. It is advisable to conduct this review to compare as-built works with the original final designs to establish reliability of information. Information should be validated with those who have been involved on the projects.

TASK 2: *Development of guidelines/protocol for establishing and monitoring trial sections*

This task can be carried out in parallel with Task 1. Main activities should include:

- Review and analysis of all available national and international guidelines and protocols on the establishment and monitoring of trial sections. These guidelines and protocols should

provide the required information to develop new guidelines on the establishment of trial sections and data collection, which should be based on best proven practices. It should be borne in mind that different protocols are required for different types of road investigations, e.g. structural design, materials usage, surfacing types, traffic loading evaluation gravel loss on unpaved roads, drainage effectiveness and societal impacts.

- Evaluation of data collection methods: the method of data collection is critical for future back-analysis in order to achieve the objectives of the project. The appropriateness of the format for data collection should be evaluated against best practice. This task should involve peer review of the identified data elements.
- Drafting of guidelines/protocols: work is to focus on the development of the draft guidelines/protocols based on the review of existing guidelines/protocols. The research team will further examine, improve, and finalise the structure and embark on the development of the guidelines/protocols taking into account the variability of the data formats.
- Finalisation of the guidelines/protocols: existing and current trial sections will be used for testing the protocols for monitoring the sections. The exercise should provide insight into the process. The guidelines/protocols will establish a benchmark for basic levels of managing the monitoring process of the trial sections.

Task 3: Ongoing monitoring

This task will include the continued monitoring of existing trial sections and the establishment of new trial sections. The establishment and the commitment of resources to a long-term monitoring strategy of the trial sections will be critical to achieving the objectives of the project. The period of monitoring may be project specific, but guidance will be provided in the developed guidelines/protocols. The monitoring of the performance of the trial sections should be over a period of at least two years for unpaved roads and 5 years for paved roads. Climatic conditions may dictate the frequency of performance data collection.

Human Resources ReCAP Funded:

A service provider should be appointed with specialist knowledge on all aspects of long-term performance assessments of experimental/trial sections, inclusive of: the planning, design and construction of sections; the setting up of a monitoring programme; the establishment of baseline data; performance monitoring of the sections (incl. the capturing of traffic and environmental data); data management (incl. capturing, validation and storage of data in a fit-for-purpose database); data processing and analysis; and reporting formats.

The service provider will assist the research team in the successful completion of the first two tasks outlined in the section "Research Methodology", as well as the initiation of the third task over at least one of the monitoring periods of the existing trial sections, but ideally also including the first monitoring cycle of new trial sections that are designed in line with the protocols developed in Task 2.

One of the key responsibilities of the service provider is to transfer knowledge and expertise to Mozambican engineers involved in the design, construction and performance monitoring of trial sections. This capacity building and training programme will have to involve engineers from the ANE Provincial Delegation, LEM and especially staff from the ANE Road Research Centre, as well as university students willing to be involved in this project as part of their post-graduate studies. This programme should include specialist advice/guidance, hands-on training on site, workshops, as well as training courses presented to ANE, LEM and ANE Provincial Delegation staff at a central location (e.g. Maputo or Chimoio).

The most expedient and cost-effective way to achieve the required level of knowledge transfer on a practical (field) level, is for the service provider to focus its efforts on one province only (e.g. Inhambane Province, which has a number of established trial sections).

It will be expected that the service provider will spend 100 days (20 weeks) of productive time in-country (in the Provinces of Maputo and Inhambane, predominantly) and 15 days (3 weeks) outside the country over a period of 24 months to provide specialist support and build local capacity. The

time spent outside the country should be devoted to the compilation of reports (i.e. Inception Report, progress reports, workshop and training reports and Final Report) as well as the preparation of workshop and training material.

Parallel Resources – non ReCAP Funded:

It is envisaged that two (but ideally three) researchers, who are individuals fully employed by the ANE Road Research Centre, will undertake the work, supported by at least two technicians. The project would be led by a senior researcher who should be an individual with a background in research, preferably on the assessment of road performance, in addition to being an experienced pavement engineer or materials specialist. Preferably, the other researcher(s) should have at least a Bachelor degree in engineering.

It would be essential that the researchers involved in this project liaise with staff from the ANE Provincial Delegations that have been involved in the construction and performance monitoring of the trial sections. Other parties involved in the establishment of trial sections, such as consultants and contractors, should also be consulted.

Experienced field technicians would also be required, together with laboratory and field testing staff/labour. They should be sourced from ANE and LEM. The field technicians should be experienced in routine and specialised field testing to support the research team in gathering and capturing quality data on the composition and performance of the trial sections, as well as on traffic and environmental factors (i.e. weather data).

Other Resources:

The project team needs to identify and characterise the field equipment that has been used in the past to assess the condition of the existing trial sections that have been monitored. For instance, the riding quality on the experimental section on the Cumbana-Chacane road in Inhambane Province was assessed by using a calibrated vehicle mounted hump integrator. Hence, all future investigations on that project should be making use of the same equipment in order to be able to relate previous measurements to future ones, and therefore be able to characterise the evolution of pavement performance over time. The above equally applies to all monitoring methods, techniques and equipment that have been used on trial sections in the past; all future monitoring needs to be based on the use of the same principles and equipment.

One of the outcomes of Task 2 (*Development of protocols/guidelines*) will be specified evaluation methods and equipment that will have to be deployed for the condition assessment of experimental/trial sections on low to high-volume roads. This might necessitate the procurement of additional equipment. Hence, provision should be made for the acquisition of such equipment. This said, most of the equipment that would be required would be expected to be similar to those that will be used to assess the condition of the road network as a whole, as input into the ANE Road Asset Management System.

Project Outputs, Impacts, & Uptake Strategy:

The deliverables from this project will be short to long term. The estimated time to completion after commencement of project is indicated for each main task. This will however be influenced by the availability of the required skills:

- **Task 1:** Review of existing trial sections, inclusive of additional testing and back-analyses where required (approximately 6 months);
- **Task 2:** Development of guidelines/protocols: The core outputs of this task will be guidelines/ protocols for the establishment of the trial/demonstration sections, systematic collection and recording of data generated during the monitoring period of the sections, including quality assurance of data. This task could be done in parallel with Task 1 (approximately 5 months);
- **Task 3:** On-going activities on established and new trial sections for monitoring (and updating) information for back-analysis (longer term: at least 48 months)

On-going revision of the guidelines/protocols is required following their implementation through actual use on road projects, based on a thorough assessment of feedback received, in order to improve the guidelines/protocols. It is expected that processed information obtained from trial sections will be used to promote the wider implementation of successful road products and/or methods of construction and will assist in developing or improving specifications.

Relevant AfCAP Logical Framework Indicators:

- **Impact Indicator 3:** Proportion of classified network that is paved
- **Outcome Indicator 1:** ENGINEERING: National policies, manuals and documents approved and published
- **Outcome Indicator 4:** Concrete example of change influenced by AfCAP applied to #km of road
- **Outcome Indicator 5:** Affordable solutions
- **Output Indicator 2.1:** % of Projects Led by Africans

Key Contacts:

Administração Nacional de Estradas (ANE)

- Direcção de Manutenção (DIMAN)
- ANE Provincial Delegations in relevant provinces
- ANE staff involved in the monitoring of trial sections: Luis Fernandes
- Other ANE staff associated with the Road Research Centre: Hilario Tayob, Joana Guiuele, Raquel Langa and Rubina Normahomed.

Laboratório de Engenharia de Mozambique (LEM)

- Staff associated with the Road Research Centre: Dr Américo Dimande, Carlos Cumbane and Santos Cuinica.

International experts who were involved or contributed to the monitoring of previous trial sections:

- Kenneth Mukura, Dr John Rolt, Andrew Otto (TRL Ltd, UK)

Key References:

- MUKURA, K. 2012. Mozambique RRIP Phase 3 Supervision and Monitoring: Final Report. Report RPN2139, TRL/ANE.
- MUKURA, K, ROLT, J. AND OTTO, A. 2013. Targeted Interventions on Low Volume Rural Roads in Mozambique: Consolidated Construction Report. AFCAP/MOZ/001
- MUKURA, K, ROLT, J. AND OTTO, A. 2013. Targeted Interventions on Low Volume Rural Roads in Mozambique, Phase 2: Final Report. AFCAP/MOZ/001/C
- ROLT, J., MUKURA, K., DANGARE, F. AND OTTO, A. 2013. Back Analysis of Previously Constructed Low Volume Rural Roads in Mozambique: Final Report. AFCAP/MOZ/001/G
- VERHAEGHE, B, MGANGIRA, M and RAMPERSAD, A. 2015. Establishment of a Road Research Centre in Mozambique: Short-term technical assistance programme (Final report). AFCAP/MOZ/2011A

Concept Note Submitted by: B Verhaeghe on behalf of the *Centro de Pesquisa Rodoviária* (Road Research Centre)

Organisation: Administração Nacional de Estradas (ANE)

Date: December 2015

Concept Note Reviewed by (PMU)

Date:

PROJECT CONCEPT NOTE

<p>Project Title: Use of Road Works to Enhance Community Water Supplies in Mozambique (Phase 3)</p>
<p>Country/Countries/Region: Mozambique</p>
<p>Project Background:</p> <p>Many rural communities in Mozambique have poor access to water, particularly in the dry season. The task of walking long distances to collect water is often left to women and children.</p> <p>Resettlement of communities alongside upgraded and rehabilitated primary, secondary and tertiary roads has occurred throughout Mozambique. This has resulted in linear villages often with no focal point spread over long distances and, except at designated growth points, often lacking in basic utility services, especially water supply. Climate, relief, geology and soils often exacerbate the precarious water supply situation with regard to both surface and underground resources, which can result in low, unreliable and seasonal yields especially during the dry season.</p> <p>Experience in Mozambique has shown that road works can be used to enhance community water supplies for domestic (other than drinking) and other uses. For example, crossing structures built on waterways can be designed to retain water during the rains. The stored water can be used by local communities in the dry season, thus reducing the period when long trips must be made to collect water. The stored water also helps to re-charge ground water reserves.</p> <p>Water is also stored in materials borrow-pits established during the construction of roads. This water is often used by local communities, but access to the water by the community is seldom considered by the contractors responsible for opening borrow-pits and rehabilitating them at the end of the construction period.</p> <p>The small bodies of water retained by crossing structures and in borrow-pits have become known as <i>Road Ponds</i>.</p>
<p>Concise Project Purpose:</p> <p>The purpose of the overall project is to undertake research on using road works to enhance community water supplies on a larger scale in Mozambique. It is expected that the research will also have applications in other African countries.</p> <p>The research is being carried out in phases:</p> <ul style="list-style-type: none">• Phase 1: Feasibility study of possible interventions (completed);• Phase 2: Establishment of pilot projects through the identification of suitable sites (completed)• Phase 3: Implementation of at least two pilot projects, and technical monitoring over a two year period. <p>Phase 3 is the subject of this Concept Note. It involves the construction of demonstration structures and borrow-pit improvements, and monitoring and evaluation of the impact of the works on the communities. The involvement of the project team will be limited to the provision of technical assistance and oversight of the construction process to ensure compliance with the specifications developed in Phase 2. The project team shall also obtain the necessary Environmental Impact Assessment (EIA) licences and the necessary approvals from relevant authorities.</p> <p>The project team shall monitor the behaviour of the ponds over one full rainy season, including their durability, their operation and management and their impact on the local environment, the local economy, social and community development, and the health and safety of the community and road users.</p>

Depending on the outcomes of Phase 3, a **fourth phase** may be agreed on for the Implementation of Road Ponds on a wider scale, the production of manuals for the design, construction and utilisation of community Road Ponds, and the dissemination thereof.

Previous or Related Work:

The overall project was designed to be completed in phases:

- **Phase 1:** Feasibility study of possible interventions;
- **Phase 2:** Establishment of pilot projects through the identification of suitable sites for:
 - the construction of structures for research and demonstration purposes, preparation of engineering designs and tender documents;
 - the identification of suitable borrow pit sites where water may be stored with appropriate design for harvesting the water; and
 - establishing participatory, representative community Road Pond committees at each of the sites.
- **Phase 3:** Implementation of at least two pilot projects, and technical monitoring over a two year period (subject of this Concept Note).

Phase 1 has been completed and the Final Report distributed to stakeholders. The report is available on the AfCAP website (www.afcap.org). The outcome of the feasibility study was that communities in arid regions are highly supportive of improved water supplies in their area through the construction of Road Ponds, but there are health risks associated with stagnant water that need to be considered.

Phase 2 has also been completed and its Final Report, excluding the appendices, is available on the AfCAP website (www.afcap.org). Four pilot project sites have been identified each of in the Provinces of Inhambane and Manica. Detailed technical designs and tender documentation have been produced, and sociological surveys have been conducted.

Project Methodology:

Two implementation projects have been identified (cf. Final Report of Phase 2 for the location of the Project Sites). The first project will be located on Site MAN/1: Saibrera - Improved Borrow Pit in the Province of Manica. The second project will be located on Site INH/3: Inhamussua - Road Dam in the Province of Inhambane. It is assumed that the construction of both projects would be completed within a period of 3 months.

The Project Team will be required to fulfil the following tasks:

- Project and tender preparation (15 man-days of input):
 - Meetings with ANE in Maputo to finalise the programme;
 - Coordination with ANE representatives in the Provinces of Inhambane and Manica;
 - Finalisation of tender documentation;
 - Assist ANE representatives in the Provinces of Manica and Inhambane with the tendering process;
 - Coordination of meetings with the project steering committee and relevant agencies (i.e. water, health, environment) for their inputs and approvals.
- Project mobilisation (10 man-days of input):
 - Monitor site establishment in the Provinces of Manica and Inhambane;
 - Check setting out of structures – provision of assistance to the contractors where necessary.
- Project supervision (15 days per month over a period of 3 months, including reporting on both projects):
 - Regular visits to each Site – monitor work progress and quality;
 - Hold site meeting with ANE representatives, contractors and involved authorities as well as beneficiaries (local communities);
 - Assure quality (in all aspects), verify invoicing by the contractors, etc;

- Assist the site agent to issue necessary instructions for remedial work, etc;
- Prepare a comprehensive project report for both sites.
- Long-term assessment of efficacy of the Road Ponds, drafting of final report and stakeholder workshop (10 man-days every six month over a period of two years, plus 10 man-days for the Interim and Final Report, and 5 man-days for the stakeholder workshop):
 - Six-monthly assessment and reporting of the structural and functional performance of the Road Ponds, including an appraisal of tangible as well as intangible benefits to the local beneficiaries (communities);
 - Compilation of an Interim Report (as input into the stakeholder workshop) and Final Report (incorporating the feedback from the stakeholder workshop);
 - Stakeholder workshop at which the outcomes of Phases 1 to 3 and a future roadmap are presented.

Human Resources ReCAP Funded:

None identified at this stage. The implementation phase will be undertaken by ANE, with leadership and coordination provided by staff of the ANE Road Research Centre.

Parallel Resources – non ReCAP Funded:

The project team will consist of two structural/geotechnical engineers. For maximum benefit, one of the engineers should be a senior, while the second can be a junior civil engineer. Around 80 percent of the input will be provided by the senior engineer.

It is anticipated that the project duration should not exceed 15 months. The estimated manpower input is as follows:

- Senior engineer: 85 man-days
- Researcher/engineer: 20 man-days

Other Resources:

None identified at this stage.

Project Outputs, Impacts, & Uptake Strategy:

Phase 3 of this project is aimed at quantifying the potential benefits of physically implementing the recommendations of Phases 1 and 2. If successful by demonstrating the efficacy of Road Ponds to alleviate the water constraints of rural communities living adjacent to roads, this project would yield significant impact both in the social and micro-economic sphere by improving the quality of life of these rural communities.

The deliverables of Phase 3 will include:

- Inception and monthly progress reports on the construction of the two Road Ponds;
- As-built report on the two completed Road Pond projects;
- Six-monthly progress reports on the efficacy of both Road Ponds;
- Pre-workshop interim report as input for the stakeholder workshop;
- Final report, including feedback from the stakeholder workshop and recommendations on a way forward (i.e. Phase 4: Implementation of Road Ponds on a wider scale and production of manual)

If the pilot/demonstration projects are shown to be successful, wider implementation of the Road Pond concept in Mozambique (e.g. on the other project sites identified in the Final Report of Phase 2 as a point of departure) and across other appropriate countries in Africa is likely to ensue.

Relevant AfCAP Logical Framework Indicators:

- **Outcome Indicator 4:** Concrete example of change influenced by AfCAP
- **Outcome Indicator 5:** Affordable solutions
- **Output Indicator 2.1:** % of Projects Led by Africans

Key Contacts:

Ministério das Obras Públicas, Habitação e Recursos Hídricos (MOPHRH)

Administração Nacional de Estradas (ANE)

- Direcção de Manutenção (DIMAN)
- ANE Provincial Delegations in relevant provinces
- ANE staff associated with the Road Research Centre: Luis Fernandes, Hilario Tayob, Joana Guiuele, Raquel Langa and Rubina Normahomed.

Laboratório de Engenharia de Moçambique (LEM)

- LEM staff associated with the Road Research Centre: Dr Américo Dimande, Carlos Cumbane and Santos Cuinica.

Serviço Distrital de Atividades Económicas (SDAE)

Serviço Distrital de Planeamento e Infraestrutura (SDPI)

Conselho de Regulação do Abastecimento de Água (CRA)

Direcção Nacional de Abastecimento de Água e Saneamento(DNAAS)

Direcção Provincial das Obras Públicas, Habitação e Recursos Hídricos (DPOPHRH)

Key References:

Eduardo Mondlane University. 2011. Using Road Works to Enhance Community Water Supplies in Mozambique, Phase 1 Final Report – Feasibility study. AFCAP/MOZ/004/A

Stange Consult GmbH. 2012. Use of Works to Enhance Community Water Supplies in Mozambique: Pre-Inception Report Report. AFCAP/MOZ/054/B

Stange Consult GmbH. 2013. Use of Works to Enhance Community Water Supplies in Mozambique: Final Design Report. AFCAP/MOZ/054/B

Other Relevant Information:

Design criteria for the identification of Road Ponds (small dams) was conceptualised as follows:

- In the near vicinity there should be beneficiaries in need of water, and therefore the Road Ponds should serve and meet socio-economic requirements;
- The Road Ponds should be technically feasible in terms of their water harvest potential and storage capacity and construction;
- The road should cross a defined watercourse preferably on an embankment, incorporating drainage structures, that can be raised, or, in the case of borrow pits, the borrow pit should have been rehabilitated (preferably), be of a regular size and consistent depth – there should also be evidence of water having collected in the borrow pit and inflow from outside the immediate confines of the borrow pit;
- The road approaches should be suitable, i.e. at sufficient grade, to optimise the basin size and depth, and to minimise embankment length;
- There should be a recognisable spillway;
- Locally availability of suitable construction materials, and especially in the case of borrow pits, availability of clayey materials for sealing the pit base;
- The construction costs can potentially be included into an ANE budget.

The provision of Ponds and/or dams requires a multi-sectorial approach as a number of different ministries and authorities need to be involved in the process. The main organisations are Water, Health, Environment and Local Government and there needs to be close liaison and cooperation between the ministries and authorities regarding the implementation.

It has been agreed that environmental and health requirements will follow normal practice using already established procedures for planning of small community based projects. The communities' activities are to follow the National Water Policy Rules.

Taking account of the fact that ANE is a Road Authority and should not be expected to manage water resources, it has been agreed during Phase 2 that:

- ANE will be responsible for the design and construction of the ponds/dam infrastructure and the water extraction infrastructure, with any necessary specialist inputs being provided by the responsible authorities (i.e. Health, Environment, Water, Agriculture and/or Local Government) and the project team.
- The Construction Work will be put out to tender and carried out by contract.
- ANE would arrange for the contractors carrying out the pond/dam work, with assistance provided by the project team, to provide a training course for the Water Management Committee personnel.
- On completion, the responsible Authority for the region will take over the ponds/dams and make arrangements for the final handover of the ponds/dams to the community and provide any further support or inputs which may be needed to maintain the ponds and dams.
- ANE would remain responsible for any items which affect the road such as:
 - Drains and channels taking water from the road to a pond or dam;
 - Embankments being used as dams which are part of the road carriageway; and
 - Drainage structures used to take water from of the pond/dam across the road.

Concept Note Submitted by: B Verhaeghe on behalf of the *Centro de Pesquisa Rodoviária* (Road Research Centre)

Organisation: Administração Nacional de Estradas (ANE)

Date: December 2015

Concept Note Reviewed by (PMU)

Date

PROJECT CONCEPT NOTE

Project Title:

Protocols for Improving the Proficiency of Material Testing Laboratories

Country/Countries/Region:

Mozambique

Project Background:

Laboratory tests performed on presumably identical materials under ostensibly identical conditions do not necessarily yield identical results. This is attributed to unavoidable random errors inherent in every test procedure as factors that may influence the outcome of the test cannot all be absolutely controlled.

The inherent variability in testing procedures is normally expressed in terms of the repeatability and reproducibility of the testing procedure. *Repeatability* refers to tests performed at short intervals in one laboratory by one operator, using the same equipment on one sample. *Reproducibility* refers to tests performed in different laboratories on supposedly identical samples, which implies different equipment, different operators and a different testing environment.

Laboratory test methods should be repeatable and reproducible to provide meaningful results. Laboratories often do not produce similar results on so-called identical materials and these differences have to be minimized so that data produced by the various laboratories may be used with a degree of confidence by technicians, engineers, geologists and others.

Some factors that may contribute to the variability of a test procedure are:

- the operator
- the equipment used
- the calibration of the equipment
- the testing environment

It may be that laboratory personnel are not carrying out testing as prescribed by the methods for various reasons, e.g., they may not be suitably trained, lack knowledge and understanding of the method, lack interest and motivation, etc. The condition of the equipment used is also of utmost importance. The equipment must be suited to the testing procedure, be in good working order and calibrated according to international standards. The environment where the test is carried out must also comply with test requirements. Often temperatures, lighting, ventilation, etc. are prescribed in the various test methods.

In the practical interpretation of test data, and especially where these data are used for quality control purposes, this inherent variability has to be taken into account. If this is not done it could happen that the difference between a test result and a value specified by contract may be within the scope of unavoidable random errors.

This Concept Note outlines the methodology and resources required to implement a proficiency testing scheme in selected laboratories. This methodology may be used in future reproducibility studies.

Concise Project Purpose:

The main objective of the project is to identify the repeatability and reproducibility of the principal test methods currently being carried out in Mozambican laboratories. This will identify where intervention is needed for improving test results and also the type of intervention required, be it operator, equipment, testing environment, better test method description or other reasons.

It should also be determined how the test results of the Mozambican laboratories compare with those of internationally accredited (ISO/IEC 17025) laboratories by including one/several of these laboratories in the proficiency testing scheme.

The project will and evaluate existing laboratories' testing competence and make recommendations for their improvement if required, and implement a proficiency testing scheme.

Previous or Related Work:

Not applicable.

Project Methodology:

The project will be carried out in a number of phases.

- i. Develop protocols for proficiency testing*
 - a. Literature survey
 - b. Draft protocol for proficiency testing scheme.
 - c. Discuss with protocols with shareholders.
 - d. Finalise protocol.
- ii. Planning*
 - a. Identify laboratories which should participate in the proficiency testing. This would include all ANE and LEM laboratories.
 - b. Determine which tests methods are the most pertinent for assessment. Initially, only the most important methods should be evaluated. Later, the exercise can be extended to other, less commonly used methods.
 - c. Identify the materials to be used in the testing. These should be those materials that are commonly used in road construction in Mozambique and should include materials that are known to be troublesome during testing, e.g. single-sized sands, black cotton soils, etc.
- iii. Proficiency process*
 - a. Visit participating laboratories to determine their current capabilities and :
 - i. Determine their equipment status.
 - ii. Create an awareness of the importance of the proficiency exercise.
 - iii. Calibrate testing procedures between laboratories. Ensure that the same test methods are in use at participating laboratories.
 - iv. Suggest changes and improvements where necessary.
 - b. Preparation of materials.
 - i. Identical samples have to be prepared for testing by the participating laboratories. This should be done by one laboratory, preferably the Control Laboratory (LEM).
 - ii. Samples to be collected and prepared to internationally accepted standards (quartering, riffing, weighing, etc.)
 - iii. Samples should be numbered and randomly selected for distribution to the various laboratories.
 - iv. Packaging materials should be such as to avoid any possible contamination to or loss of samples.
 - c. Time frames for testing should be determined.
 - d. A trial run using one sample and one method, to highlight any oversights and to ensure that the process functions smoothly, should be carried out.
 - e. Distribution of samples by the main laboratory to the participating laboratories.
 - f. Once testing has been completed the results need to be collated and statistically analysed to determine obvious outliers.
 - g. Significant differences in the results (if present) must be investigated to determine the reason(s) for such differences. This will be done by visiting the affected laboratory and studying the way the method is carried out. Anomalies to the testing procedures will then be corrected.
 - h. Repeat the proficiency testing procedure where required to determine improvements to results.
- iv. Write up the results and make final recommendations on a proficiency testing scheme.*

Laboratory testing should include the normal classification tests (Atterberg limits and grading), material compaction (OMC/MDD), material strength (CBR) and aggregate strength (ACV, AIV,

Treton, 10% FACT, etc) where appropriate. The samples selected should be sufficiently variable in properties to provide a range of test results.

The protocols will inform the frequencies at which the round robin tests will be conducted for the test methods that will form part of the proficiency testing scheme. These frequencies will be guided by international practices as well as the initial results obtained from the proficiency testing scheme.

Human Resources ReCAP Funded:

A service provider should be appointed who has specialist knowledge of materials testing and is accustomed to designing, implementing and taking part in proficiency testing schemes, implemented according to international standards. The provider should also be knowledgeable in the running of a laboratory according to the principles of an international accreditation body such as ISO/IEC (ISO 17025: General requirements for the competence of testing and calibration laboratories).

One of the main responsibility of the service provider will be to assist with designing the proficiency testing scheme and to transfer knowledge and expertise to Mozambican laboratory personnel on how to implement a proficiency testing scheme and to evaluate the test results obtained. Hence, the capacity building and implementation programme will have to involve laboratory personnel from the ANE Road Research Centre and LEM.

It is envisaged he the service provider will spend 40 days of productive time in the country (Maputo Province, predominantly) and 5 days outside the country over a period of 10 months to provide specialist support and develop local capacity.

Parallel Resources – non ReCAP Funded:

The project team would consist of a senior engineer as the project manager (ideally a LEM representative of the Road Research Centre), a senior technician, a technician and staff of the various laboratories participating in this study. A statistician should be used for the statistical analysis of the test results. However, engineering personnel may also do this, using procedures designed for statistically evaluating test results available in international standards such as BS, ASTM, AASHTO, etc.

It is anticipated that the project duration should not exceed 10 months for the pilot programme. The estimated manpower input is estimated as follows:

- Researchers: 75 man-days
- Technicians: 115 man-days
- Statistician: 20 man-days

Other Resources (6 Lines)

It will be prudent to start the proficiency testing concentrating on the more pertinent test methods and it should therefore include normal classification tests (Atterberg limits and grading), material compaction (OMC/MDD), material strength (CBR) and aggregate strength (ACV, AIV, Treton, 10% FACT, etc) where appropriate. To this end, the laboratories identified to take part in the scheme should all have the equipment required to conduct these tests.

All equipped Mozambican laboratories should be identified to take part in the scheme. It would be advisable for more laboratories to participate in the proficiency testing; however, this is not always possible. International laboratories, of good standing, should also be included in the proficiency testing as this will enhance the validity of the test results. Several such SANAS accredited laboratories are present in South Africa.

The statistical evaluation of the results should be done in accordance with procedures available in international standards such as ISO 5725 (E); BS ISO 13528:2015; ASTM E 2489-1, as well as others.

Project Outputs, Impacts, & Uptake Strategy:

The project is aimed at improving the reliability of the test methods evaluated and ensuring consistent test results. Design engineers and client bodies require reliable and comparable test results to predict and assess the field performance of road building materials. Inter-laboratory variability may lead to conflict over product acceptance. Quality data is also a requisite to understanding the field performance of the materials when compared to design parameters (and implications if standards are not met).

The implication of using unsuitable material or rejecting material that is acceptable is costly.

In the case where an unsuitable material is used, failure of the road layer may result, which will lead to costly rehabilitation or, at worst, total reconstruction of the road. There are also social and other economic consequences as the traveling public may be inconvenienced by the failure and the subsequent rehabilitation or reconstruction of the road and, also, vehicle operating costs may increase as a result of the poor condition of the roadway.

In the event of good material being classified as unsuitable by errant test methods or test result interpretation, other materials have to be procured at additional cost. These costs could include: identification of a suitable source, additional material testing, transporting these materials over distances that are in all likelihood further from the construction site than originally envisaged, likely construction delays, etc.

In addition, the testing laboratories will benefit from the improvements required by or brought about by proficiency testing and provide laboratory testing that is in line with international practices and standards and test results that can be used with confidence. An objective of the ANE Road Research Centre is to set up a materials database and it is essential that only accurate test results are used to populate this.

At a later stage the laboratories may wish to become accredited according to the International Standards Organisation's standard "ISO 17025", and proficiency testing is a requirement of that accreditation body.

The deliverables from this project will be both short term (quick win) and medium term:

- In the short term protocols for proficiency testing will be developed;
- Laboratories taking part in the testing will be evaluated and a condition and required improvements reported on;
- Report on the testing results; and
- In the longer term (medium term) provide a fully operational proficiency testing scheme.

Proficiency testing is an ongoing process and in the long term, results from future reproducibility studies will be available.

Relevant AfCAP Logical Framework Indicators:

- **Outcome Indicator 1: ENGINEERING:** National policies, manuals and documents approved and published
- **Outcome Indicator 5:** Affordable solutions
- **Output Indicator 2.1:** % of Projects Led by Africans

Key Contacts:

Administração Nacional de Estradas (ANE)

- Director-Geral: Atanasio Mugunhe
- Direcção de Manutenção (DIMAN)
- Delegações Provinciais da ANE (laboratórios provinciais)
- ANE staff associated with the Road Research Centre: Luis Fernandes, Hilario Tayob, Joana Guiuele, Raquel Langa and Rubina Normahomed.

<p>Laboratório de Engenharia de Moçambique (LEM)</p> <ul style="list-style-type: none">• Director-Geral: Henrique Filimone• LEM staff associated with the Road Research Centre: Dr Américo Dimande, Carlos Cumbane and Santos Cuinica. <p>Instituto Nacional de Normalização e Qualidade</p> <p>South African National Accreditation System (SANAS)</p>
<p>Key References:</p> <p>ASTM E 2489-11: Standard Practice for Statistical Analysis of One-Sample and Two-Sample Interlaboratory Proficiency Testing Programs.</p> <p>BS ISO 13528:2015: Statistical methods for use in proficiency testing by inter-laboratory comparison.</p> <p>ISO 5725-1: 2012 Accuracy (trueness and precision) of measurement methods and results -- Part 1: General principles and definitions.</p> <p>ISO 13528:2015 Statistical methods for use in proficiency testing by inter-laboratory comparison.</p> <p>ISO/IEC 17043:2010. Conformity assessment -- General requirements for proficiency testing. (www.iso.org)</p>
<p>Other Relevant Information:</p> <p>None identified at this stage.</p>
<p>Concept Note Submitted by: : B Verhaeghe on behalf of the <i>Centro de Pesquisa Rodoviária</i> (Road Research Centre)</p> <p>Organisation: Administração Nacional de Estradas (ANE)</p> <p>Date: December 2015</p>
<p>Concept Note Reviewed by (PMU)</p> <p>Date</p>

GENERAL NOTE:

Prior to the preparation of materials for distribution and assessment of laboratories it is important to ensure that all laboratories to be evaluated should be at the same level in terms of testing procedures, the condition of the equipment used, calibration of the equipment, etc.

Annex B: Abstracts for Conference Papers

PERFORMANCE MONITORING OF LOW VOLUME SEALED ROADS IN MOZAMBIQUE

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Abstract

Roads are the backbone of the Mozambican economy and they are expensive to construct and maintain. Everything that can be done should be done to ensure their sustainability.

The objectives of this paper are to present the monitoring process that was undertaken on previously constructed low-volume sealed roads and to discuss the actions required to expand the monitoring process to other low-volume sealed roads, through the training and mentoring of ANE personnel, standardisation and the creation of a database for research.

In order to obtain performance data, the initial monitoring exercises were carried out on some experimental sections between February 2011 and March 2013 with the involvement of TRL. Due to unforeseen circumstances and various reasons, the monitoring was not pursued by ANE after March 2013.

On some of the earlier sites, monitoring surveys were carried out at approximately 6-month intervals. Up to 5 surveys were carried out on some of the older sites, but as little as 1 or 2 surveys were carried out on the newer sites. The sites that were constructed towards the end of AFCAP 1 were not monitored at all and there was also no baseline survey carried out.

It is very important to continuously monitor the performance of the sections in order to determine what works and what doesn't. This will help in the formulation of performance-based specifications for low-volume sealed roads. ANE, in association with TRL, developed performance-based specifications for unpaved roads through the Engineering Standards Project. The current specifications for low-volume sealed roads need adaptation to the Mozambique situations and will most certainly need refinement in future.

As a result, performance data need to be collected on a continual basis. Some of the sections were designed to fail in order to determine the limits for the specifications and such information is therefore vital to the development of robust specifications for low-volume sealed roads.

ANE intends to continue with the monitoring that was initiated under AFCAP 1 and also to develop a monitoring regime for all sites, including those that have not yet been monitored. The recently established Road Research Centre in ANE will spearhead the monitoring exercise.

However, since ANE attaches great value to this exercise, it will be important to ensure that the monitoring is carried out properly, which also includes the standardisation of data collation. The use of appropriate analysis methodologies is also critical, as is overall research data management.

Keywords research, data, performance, monitoring

MAPPING OF NATURAL MATERIALS FOR ROAD CONSTRUCTION AND DEVELOPMENT OF A DATABASE

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Abstract

Mozambique has a road network comprising of about 30.000 km of which 24.000 are unpaved roads and 6.000 km are paved roads. The Government of Mozambique has over many years endeavoured to improve the road network in order to ensure all weather accessibility, particularly for the rural population.

One of the greatest challenges is the ever increasing cost of constructing and maintaining roads, with one of the most critical reasons being the fact that Mozambique has a serious lack of good quality road building materials.

The scarcity of good road building materials is the single most problematic aspect of road provision which is likely to affect any current and future road programme that will be carried out by the national road authority (ANE), districts and others.

Due to that, the landed cost of road building materials is very high owing to the significant hauling distances and procurement costs. As such, it may be difficult to minimise the cost of construction if this issue is not resolved. Under the previous programmes implemented in the country there was a major focus on the use of locally available materials aimed at minimising the cost of construction and maintenance.

The Rural Road Investment Programme (RRIP), initiated by ANE in 2007, was a pilot phase to investigate how locally available materials can be used in the Mozambican environment, mainly for construction, rehabilitation and maintenance of low volume roads.

Faced with this problem, ANE initiated a materials mapping project with technical assistance from TRL, which involved the prospection of calcrete deposits in the Inhambane Province. The project involved a number of key activities:

1. Surveys – there were geological surveys carried out, which included remote sensing (i.e. satellite imagery), assessment of geological maps, walk-through surveys, probing, etc.
2. Trial pitting – this involved the excavation of test pits to expose any deposits of calcrete and to assess the quality and quantity of the deposits.
3. Sampling – many samples were collected and coded according to the different deposits which were discovered.
4. Testing – the materials were sent to several laboratories for testing. The objective was to determine the properties of the materials and also evaluate their suitability for use in road construction.
5. The ultimate output was the mapping of calcrete deposits with details of properties and potential usage. This information is vital for current and future projects.

Having learnt and benefited from the Calcrete Mapping Project carried out in Inhambane Province under AFCAP, ANE plans to continue with the mapping of materials in Mozambique, covering other provinces and materials. Material mapping is long overdue and is now a major priority for ANE. The high cost of materials has already affected many road programmes over many years, and hence material mapping needs to start urgently.

Keywords

mapping, testing, natural materials, deposits,