Republic of Uganda

Uganda National Roads Authority

Technical Assistance to UNRA for the Establishment of a Bridge Management Unit

FINAL REPORT

(including a "road map" for establishing the bridge management unit in UNRA)

March 2009

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Appendices

for the National Roads Data Collection Project.

EXECUTIVE SUMMARY

This Final Report records the work of the technical assistance consultants that UNRA has retained to advise the road authority on establishment of a bridge management unit within UNRA.

The objectives of the technical assistance are to:

i. Recommend an appropriate institutional framework for implementing UNRA's bridge management function and a structure for the establishment of a bridge unit

ii. Review the Bridge Management System (BMS) proposed by the consultants and make recommendations for changes or additions required to meet the needs of the UNRA Bridge Unit

iii. Develop UNRA's bridge management capacity and make recommendations to consolidate capacity in the UNRA Bridge Unit and a strategy to develop bridge maintenance capacity in the private sector.

UNRA Bridge Management Study

- **Primary Objectives:**
  - Recommend a suitable institutional framework and structure for UNRA's bridge management unit
  - Review the BMS and make recommendations for changes or additions
  - Develop UNRA's bridge management capacity in UNRA bridge management unit and the private sector

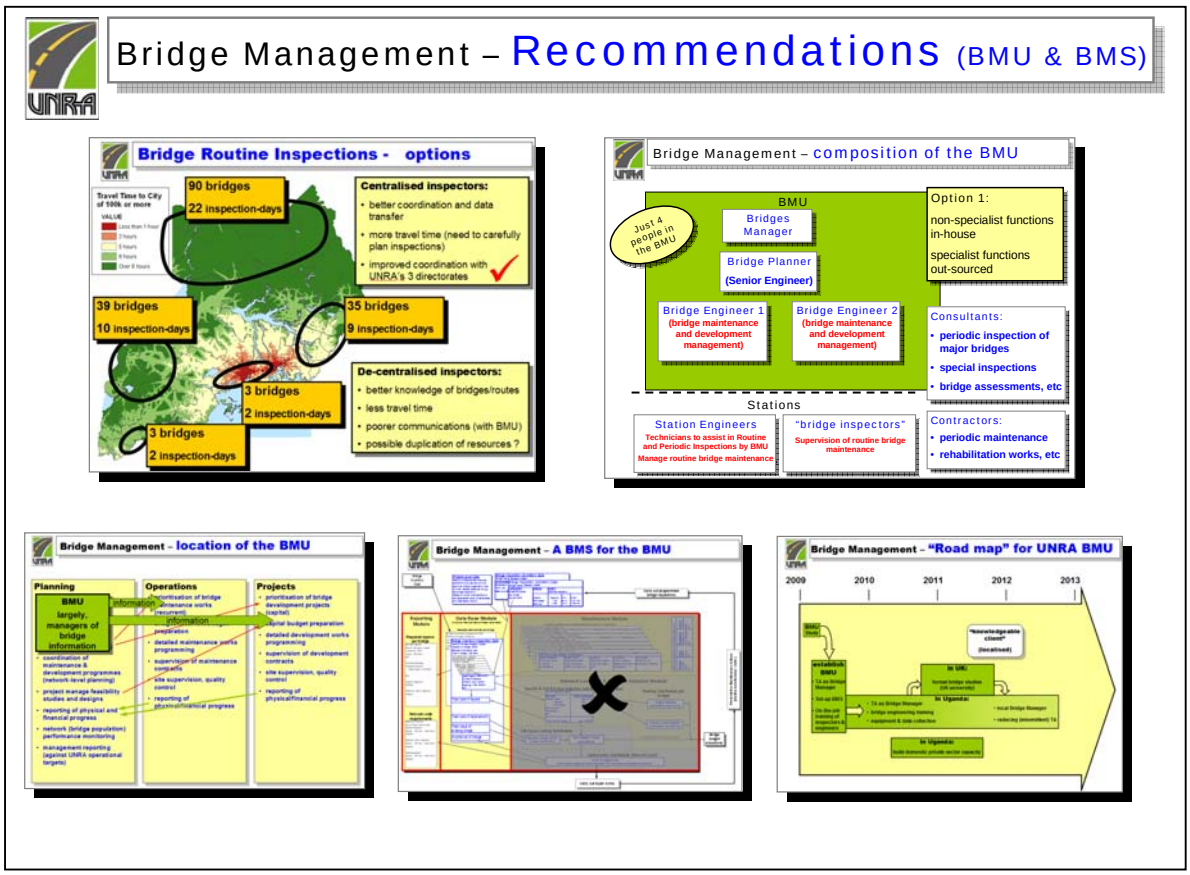
During initial meetings with UNRA it has been agreed that the technical assistance consultants will work closely with the Director Planning and the UNRA Bridge Management Team in order to ensure practicable recommendations are delivered, commensurate with realistic resource levels available to UNRA, and which are sustainable. The consultants will produce a "roadmap" of the way forward for UNRA to establish a bridge management unit, taking into consideration UNRA's policy for developing itself as a manager of highway network services and to out-source appropriate consulting and contracting activities.

Bridge Management Study Team

- **Institutional Specialist – 1 month**
  - policy, legislation, budgets, BMS, planning, organisation structure
- **Technical Specialist – 2 months**
  - operational management, design and technical standards, works programming, maintenance procedures, and BMS. Also, review of existing and planned bridge works programmes
- **Study duration: Feb & March 2009**

The consultants mobilised in early February 2009 and the assignment was completed at the end of March; The end of March deadline is imposed because the funding from the UK Government (DFID) expires at the end of their fiscal year. The study team comprises two consultants: a bridge management institutional specialist to advise on policy, legislative, budgetary, planning issues and organisation structure that will dictate the operational environment in which a bridge management unit would operate; and a bridge management technical specialist, who will advise on operational issues including inventory and condition surveys, bridge maintenance and development programmes, and design procedures and technical standards. It should be recorded that the consultants received the latest draft design report of the proposed bridge management system (BMS) within the final few days of the study and although have managed to include their comments on that proposed BMS in this report have not had the opportunity to discuss details of the report with the consultant. We have therefore included in this report our original detailed recommendations, made without sight of the National Roads Data Collection Project design report, in Section 6 of this report to enable UNRA to assess appropriateness of the BMS for future management of the nation's bridge population.

During the inception period the consultants reviewed the current state of bridge management within UNRA. This has been done by using a "best practice" bridge management cycle as a yardstick to examine UNRA's current capability and capacity in all issues related to bridge management. Our



findings have been subsequently amended to include the feedback from the Final report Workshop held on 30th March 2000 and are summarised in Section 3 of this Final Report . These findings and our initial recommendations for establishing and developing a BMU were initially presented to UNRA at the week 3 workshop. Feedback obtained at the workshop was generally positive and also highlighted additional aspects of bridge management in UNRA head office and the districts that we needed to consider. Our detailed recommendations for establishing and developing capacity in UNRA's BMU over the next 3½ years are provided in Section 4 and 5 of the report.

The top two slides summarise that **we have determined the start-up size of the BMU** based on the 207 bridges identified from the current Roughton/Prome National Roads Data Collection Project, the possibility of a further 50 bridges from the additional 9000kms of roads to be included in the Network from June 2009and having due regard to the spatial distribution of those structures. As a result of discussions held during the final workshop UNRA are of the opinion that **a total of four people will be sufficient for the initial BMU responsibilities.** When the additional 9,000 km of roads are transferred to UNRA in July 2009 additional bridges will be added to the BMU's responsibilities and the size of the BMU might need to be increased. This size of establishment assumes that although the Bridge management Unit will have responsibility for the inspections, and for the identification of maintenance priorities, added value can be gained from the l utilisation of the resources of the Regions/Stations to benefit from their local knowledge and to stimulate interest and ownership of the bridges in their area of responsibility.

The bottom-left slide summarises that we consider the BMU will primarily be responsible for the asset management the bridge stock, managing bridges information and making decisions and determining priorities for maintenance and development of bridges, based on that information, plus informing the Operations and Projects Directorates with respect to

bridgeworks programmes and priorities. Performance monitoring and evaluation information related to bridges will need to be compiled and assimilated with similar information regarding roads; using the proposed RMS system. This is done by the Planning Directorate. **It is therefore appropriate for all these reasons that the BMU to be located in the Planning Directorate**.

The bottom-right slide summarises the "road map" that we have designed for **establishing the BMU in April 2009** and subsequent development of the BMU in order to **achieve the status of** "**knowledgeable client**" **by late 2012,** fully using local staff.

Our recommendations for sources of funding for implementing the "road map" are contained in Section 5.3 of this Report. Our review of the proposed BMS and detailed recommendations on its functionality is provided in Section 6.

The assessment and recommendations from the review of the work of current consultants is provided in Section 7 and our review and recommendations for the improvement of present bridge maintenance practices within UNRA are detailed in Section 8.

1 Introduction

1.1 Background

The Government of Uganda (GoU) has received a grant from DFID and has agreed to use a portion of the proceeds of the grant towards the provision of technical assistance to the Uganda National Roads Authority (UNRA) for establishing a bridge management unit in the Planning Directorate.

Technical Assistance Services are required to review and audit the bridge inventory and condition data of national bridges collated by an on-going consultancy, establish an appropriate bridge management system (BMS), populate the database with available information and where relevant, identify additional data sets required to develop annual maintenance plans and assist UNRA to develop capacity to manage the BMS

WSP International Management Consulting has been recruited to provide the technical assistance services. A team of two bridge management specialists arrived in Uganda in early February 2009 to commence the study:

Bridge Management Institutional Specialist: Mr John Cox

Bridge Management Technical Specialist: Mr Tim Stiff

Mr Cox will be in Uganda for one month; Mr Stiff will be in Uganda for two months.

1.2 Study Objectives and Primary Deliverables

Objectives

The objectives of this TA are to:

iv. Recommend an appropriate institutional framework for implementing UNRA's bridge management function and a structure for the establishment of a bridge unit

v. Review the Bridge Management System (BMS) proposed by the consultants and make recommendations for changes or additions required to meet the needs of the UNRA Bridge Unit

vi. Develop UNRA's bridge management capacity and make recommendations to consolidate capacity in the UNRA Bridge Unit and a strategy to develop bridge maintenance capacity in the private sector.

Deliverables

During initial meetings with UNRA during the Inception Period for this study it has been agreed that the technical assistance consultants will work closely with the Director Planning and the UNRA Bridge Management Team in order to ensure practicable recommendations are delivered, commensurate with realistic resource levels available to UNRA, and which are sustainable. The consultants will produce a "roadmap" of the way forward for UNRA to establish a bridge management unit, taking into consideration UNRA's policy for developing itself as a manager of highway network services and to out-source appropriate consulting and contracting activities.

2 Our Approach to the Bridge Management Study

2.1 Priority Issues

The two priority issues that must be addressed in establishing a viable bridge management unit within a national roads authority are to ensure:

- that the ***importance of bridges is highlighted at the institutional level*** by ensuring that policies, legislation, and the budgetary process make separate provisions for bridges and roads;
- ***sustainability of the bridge management function***.

The outcome of the technical assistance study will be a roadmap describing how UNRA may progress in the coming years to establish and develop an enabling institutional environment in which the importance of bridges is suitably recognised and to develop adequate internal bridge management capacity such that UNRA becomes a "knowledgeable client" capable of professionally managing its bridges.

Our approach to this assignment is designed to address these priority issues.

2.2 Overview of UNRA's Bridge Management Responsibilities

UNRA is responsible for the development and maintenance of the national roads network in Uganda and the bridges, drainage structures and other highway engineering items on these roads.

At the 13th meeting of UNRA's Top Management Team it was decided to institute a bridge management team. This was implemented on 5th December 2008. The Bridge Management Team's Inception Report estimated that there are around 300 structures on the national road network and most bridges were constructed between 1920 and 1945. Currently, Roughton International and PROME Consultants are undertaking an inventory and condition survey of the road network, including associated structures. Our initial review of their data suggests that there are a total of 237 structures on the national highways, of which 207 are bridges; the remainder are culverts and other drainage features. The location of the bridges is shown in Figure 2.1. The data have not yet been verified by the data collection consultants but, the map is illustrative of:

- the spatial distribution of bridges on UNRA's road network
- the current total number of bridges to be managed by UNRA
- the overall condition of UNRA's bridge population (although, about 1/3 of the bridges have not yet been inspected and the other 2/3 have not been subjected to detailed structural inspections).

A lack of regular maintenance over many years has led to significant deterioration of Uganda's aged bridge population. In addition, the vehicle population has increased significantly in the past few decades and vehicle/axle loading has increased. As a result, all the national highway network bridges need thorough structural inspections at a level of detail beyond what is currently being done by the data collection consultants. However, there is no need to instigate another nationwide inspection programme: UNRA is planning to undertake several road development programmes over the coming years, as shown in Figure 2.2, which will include design and construction of bridges on those routes. This means that thorough inspections are only required on the bridges not included in any of the upcoming road programmes.

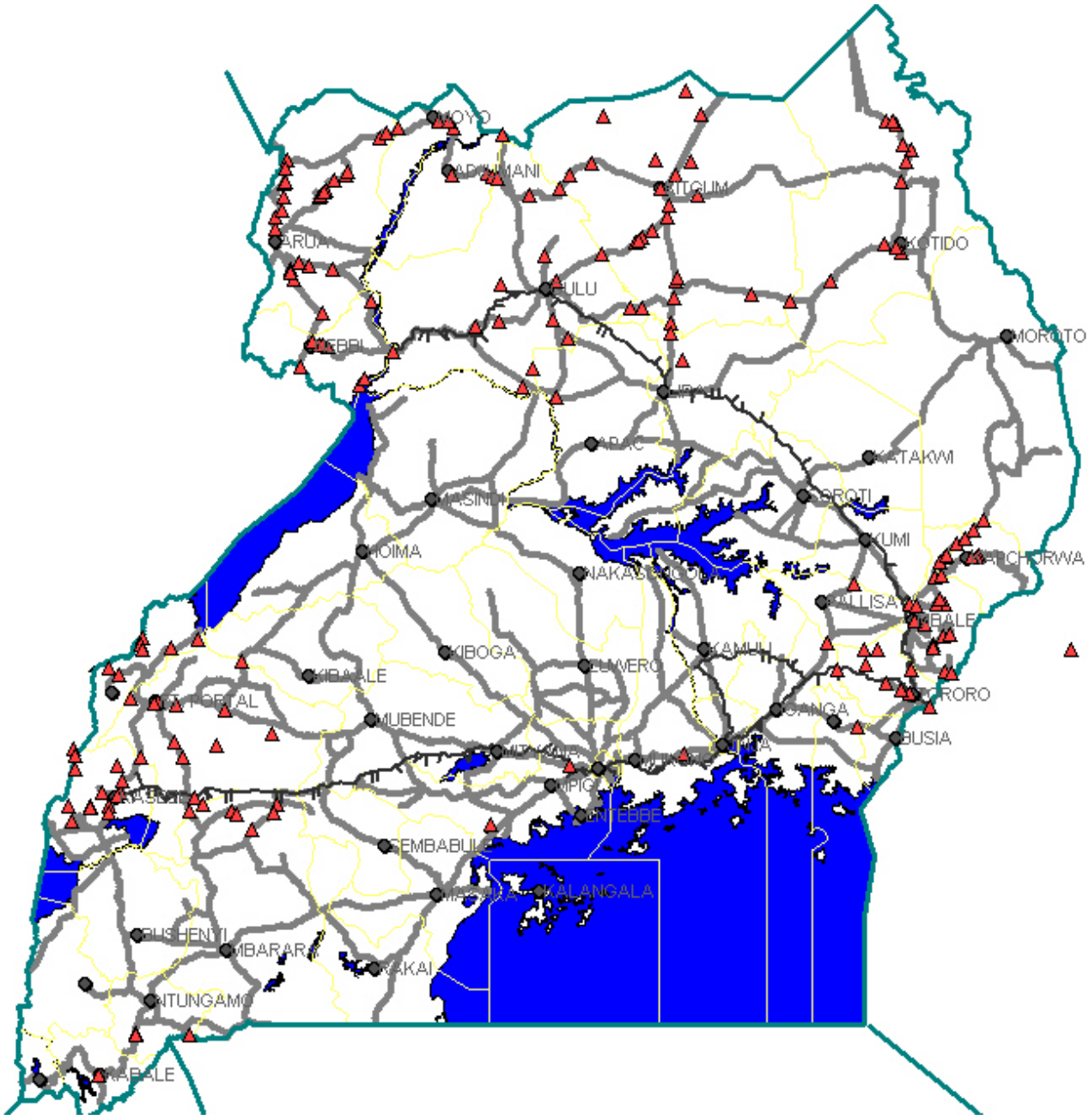


Figure 2.1: Spatial Distribution of UNRA's Bridge Management Responsibilities

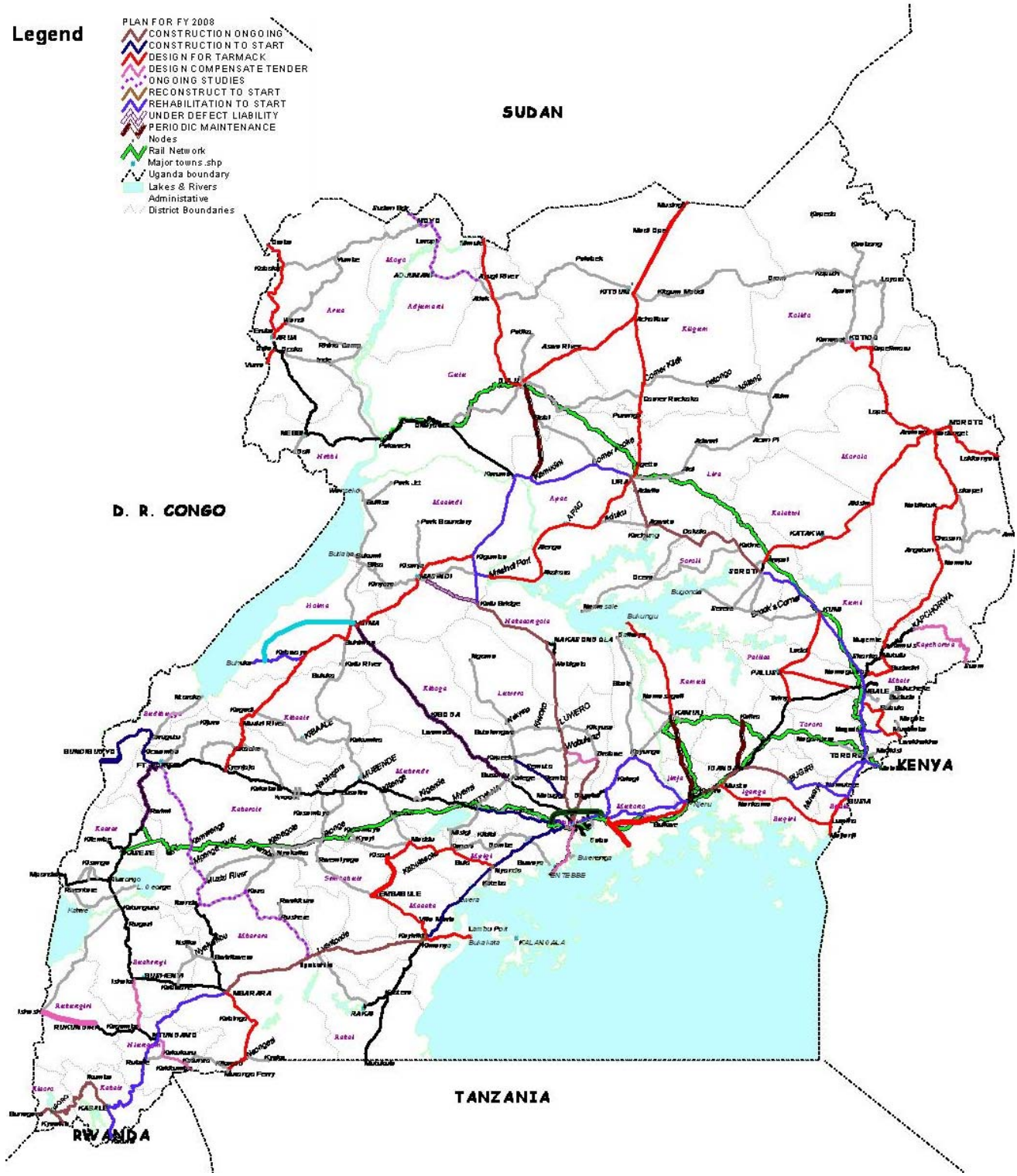


Figure 2.2: Summary of UNRA's Road Programmes for FY2008/09

A major road development programme planned for the next few years is to upgrade 9,000 km of district and community roads to national road standards. These roads are currently with the Ministry of Local Government but UNRA has received a communiqué from the Minister of Works & Transport that these roads, and the associated budget, will be transferred to UNRA from 1st July 2009. The first exercise will be to undertake inventory and condition surveys of these roads and the structures on these roads to ascertain current length, width, condition, etc, from which UNRA will be able to design the upgrading programme. It is possible that the surveys could reveal a doubling in the number of structure for which UNRA is responsible.

The fact that many bridges need to be replaced in the coming years and additional bridges will be added to the overall number means that this is an opportune time to introduce the principles of ***whole-life management*** of bridges. This means that consideration is given at the planning and design stages to the type and cost of construction and maintenance/repairs for each bridge. Decisions can therefore be made regarding:

- the appropriate type of bridge, particularly with respect to future maintainability and the costs thereof
- key maintenance features
- access for inspections and for maintenance works
- the longevity and appropriateness of materials (i.e. durability of the bridge)
- future plans for widening or upgrading the road (i.e. intended bridge life)

The objective of whole-life costing decisions in bridge management is to minimise the cost of owning and operating bridges throughout their entire life cycle. These are important considerations for discussion at the Inception Period Workshop with regard to the core competencies to be included in UNRA's bridge management unit in order that UNRA becomes a "**knowledgeable client**" with respect to managing its national bridge stock.

2.3 Approach to the Bridge Management Study

In this bridge management study we will adopt a top-down approach that considers:

- Government's policies for development of the nation's road sub-sector
- national transport plans and implications for road sub-sector
- UNRA's legal obligations
- UNRA's internal management policies for managing the road network and associated structures, including planning of development and maintenance operations
- the budgetary framework and likely future provisions for maintenance
- number, nature and condition of the bridge population
- spatial distribution of the bridge population
- how the bridge population will develop in future years (number, type and location of new bridges)
- UNRA's road planning function and how bridges are included in these activities

- the history of bridge management and practices that have been adopted to date by UNRA
- non-monetary resources available to UNRA for bridge management, including capabilities and capacity in UNRA and the domestic private sector
- current technical standards and specifications for bridges and any changes that are needed
- procurement policies
- programming and scheduling of maintenance works
- project management arrangements
- contract management and site administration arrangements, including quality control procedures
- network performance evaluation and monitoring; also feedback to UNRA for subsequent planning and operational decision-making
- MIS/IT arrangements, including BMS and other planning/management tools

From experience on previous bridge management studies, we have found the best way to discuss this wide range of issues is to consider the following:

1. **current bridge management responsibilities:** develop a map of the current bridge population and identify bridge types, age, overall condition of the main components (superstructure, substructure, etc), and in which road or bridge development programmes, if any, these bridges are already included
2. **primary bridge deterioration characteristics:** review the information from (1) to determine whether there are any possible patterns of bridge deterioration in the country; for example, due to local climatic/environmental conditions, age of the bridge, type of bridges constructed during a period that included design, material, or construction defects, localised maintenance problems, etc
3. **bridge planning procedures:** with respect to bridge planning, consider the road planning procedures and how bridgeworks are included; this will include the overall road-sector planning framework, beginning with Government's policies for socio-economic development and the implications for the transport sector and the roads sub-sector in particular; we will also examine the asset management function within UNRA
4. **bridge design procedures:** consider the design philosophies employed in country and how these correlate to axle-load controls; also, to consider the information available to permit realistic whole-life cycle management of bridges
5. **bridge maintenance regimes:** with respect to bridge maintenance, consider the annual bridge maintenance cycle and investigate the key issues at each point in the cycle; of particular importance are the arrangements for determining bridge maintenance needs and associated budgets, and managing the resources allocated for bridge maintenance
6. **bridge management resources:** with respect to inventory and condition surveys, what manpower, funding and equipment are available/required for data collection
7. **computer bridge management system (BMS):** specifications for a viable computer-based bridge management system that is compatible with available resources and bridge inspection/engineering capabilities in country

8. **a road map for improving bridge management:** agree viable arrangements for effective bridge management, in view of realistic improvements to the institutional framework, future resource levels, capabilities and capacity, and develop these into a road map for establishing and developing a sustainable bridge management unit; the road map should be time-bound and indicate likely sources of funding

2.4 The Bridge Management Cycle

Figure 2.3 summarises the annual bridge management cycle. The items in blue are the institutional issues outside that enable or constrain effective bridge management. Some institutional issues are beyond the control of a road/bridge management organisation (government policies, sector legislation, technical standards, etc), but the organisation is able to influence these by providing professional advice to the respective decision-makers in the parent ministry and/or at political level. For example, while the decision for budget allocations lies outside the road/bridge management organisation, it can inform these decisions by making appropriate business cases for adequate maintenance and development budgets. The road/bridge management organisation does have control over its own management policies (the procedures by which it compiles its budgets, procurement regulations, etc) to the extent provided for in its establishing legislation.

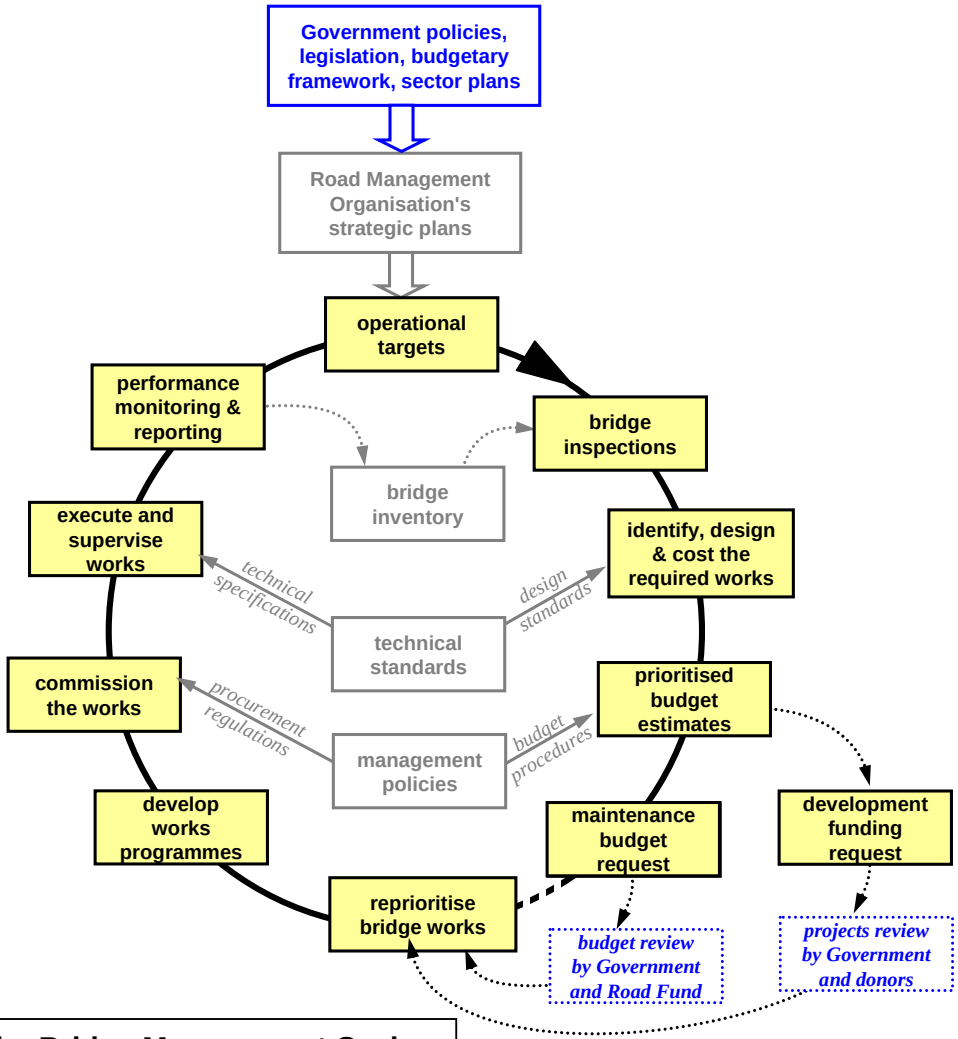


Figure 2.3: The Bridge Management Cycle

2.5 Bridge Management Workshop – Week 3

As discussed in Section 2.3, there are many issues to be considered in studying the bridge management responsibilities for UNRA and these might be best managed in the future. Our "top-down" approach to the study will be structured around the bridge management cycle. We have used the cycle to study the current situation (as discussed in Section 3) and to develop our initial ideas for the way forward. As described in our proposal for this study, our initial findings and recommendations were presented at a workshop in week 3; feedback from UNRA's senior management and advisors has been included in Section 5 of this Inception Report.

2.6 Bridge Management Workshop – Week 8

The second workshop presenting the study team's proposals to be included in the Final Report. Was held on Monday 30th March.

An open invitation to UNRA's Planning, Projects and Operations Directorates but due to a late change in date for the workshop arising from an UNRA Board Meeting and the absence of a large number of staff on site visits a total of 13 people eventually attended.

Despite the low number of attendees valuable ideas and feedback was given to the BMU Study Team and this has been incorporated in the slightly modified recommendations on the size of the Bridge Maintenance Unit and in some clarification on the difference between the ownership of the bridges and ownership of the management of the data required to develop planned bridge maintenance interventions and development coordinated with the road development programme into UNRA's operations and in so doing change the current 'reactive' crisis management into the planned management of bridges.

3 Current State Assessment

3.1 Current Bridge Management Responsibilities

Figure 3.1 illustrates the current situation with respect to bridge management within UNRA, summarised as the bridge management cycle. The items in red are the issues that we believe need the most urgent attention. Many of these are related, so the range of issues to be addressed is not that broad. In short, the lack of adequate bridge data means that UNRA is currently unable to make informed decisions regarding management of bridges on the national roads network. As soon as the quality of bridge data is improved, this will address many of the items around the bridge management cycle. Without a proactive regime of bridge inspections, UNRA can only respond to reported incidents, which means that repairs are generally carried out later than would be ideal and hence at higher cost. As with optimal road maintenance management, it is a case of the old adage: "*a stitch in time saves nine*". Many studies have been carried out[1] that demonstrate that for every dollar not spent on timely periodic road maintenance, a road agency incurs about $3-5 in rehabilitative costs; the costs are higher if maintenance is deferred to the extent that the base layers need to be reconstructed. The relationships between preventative maintenance costs and rehabilitative costs for bridges is not so straightforward because the nature and extent of repairs varies much more than for roads, but some studies[2] suggest the rate at which costs increase for bridges is as follows:

Roads: routine maintenance	periodic maintenance	rehabilitation	reconstruction
	$1	**$3-5**	**$5-8**
Bridges: routine maintenance	periodic maintenance	rehabilitation	reconstruction
$0.20	**$1**	**$40**	**$80**

It is important to point out that the time between optimal periodic maintenance of a road pavement and rehabilitating that pavement (in the absence of the periodic intervention) is quite different to the times between periodic maintenance (minor repairs) to bridges and the rehabilitation of the bridge. The time period is approximately 5-7 years for chip-and-seal roads (depending on traffic loading and environmental conditions), and 8-12 years for asphaltic concrete road pavements. For bridges, the time between periodic maintenance and rehabilitation (in the absence of such maintenance actions) could be twenty years or more[3]. Figure 3.2 indicates the relative life-spans of road pavements compared to bridges. A road management organisation's responsibilities for roads and bridges are therefore the same: **to maintain the road network to the agreed service standards by using resources efficiently** (i.e. providing value for money to its target customers, the road users).

1 Authors of these road studies include the World Bank, GTZ, the IRF, and various Departments of Transport in the US.

2 e.g. Maintenance Strategy Optimization of Bridge Decks Using Genetic Algorithm; Liu, Hammad and Itoh

3 The study in reference 2 suggests that, in typical conditions,

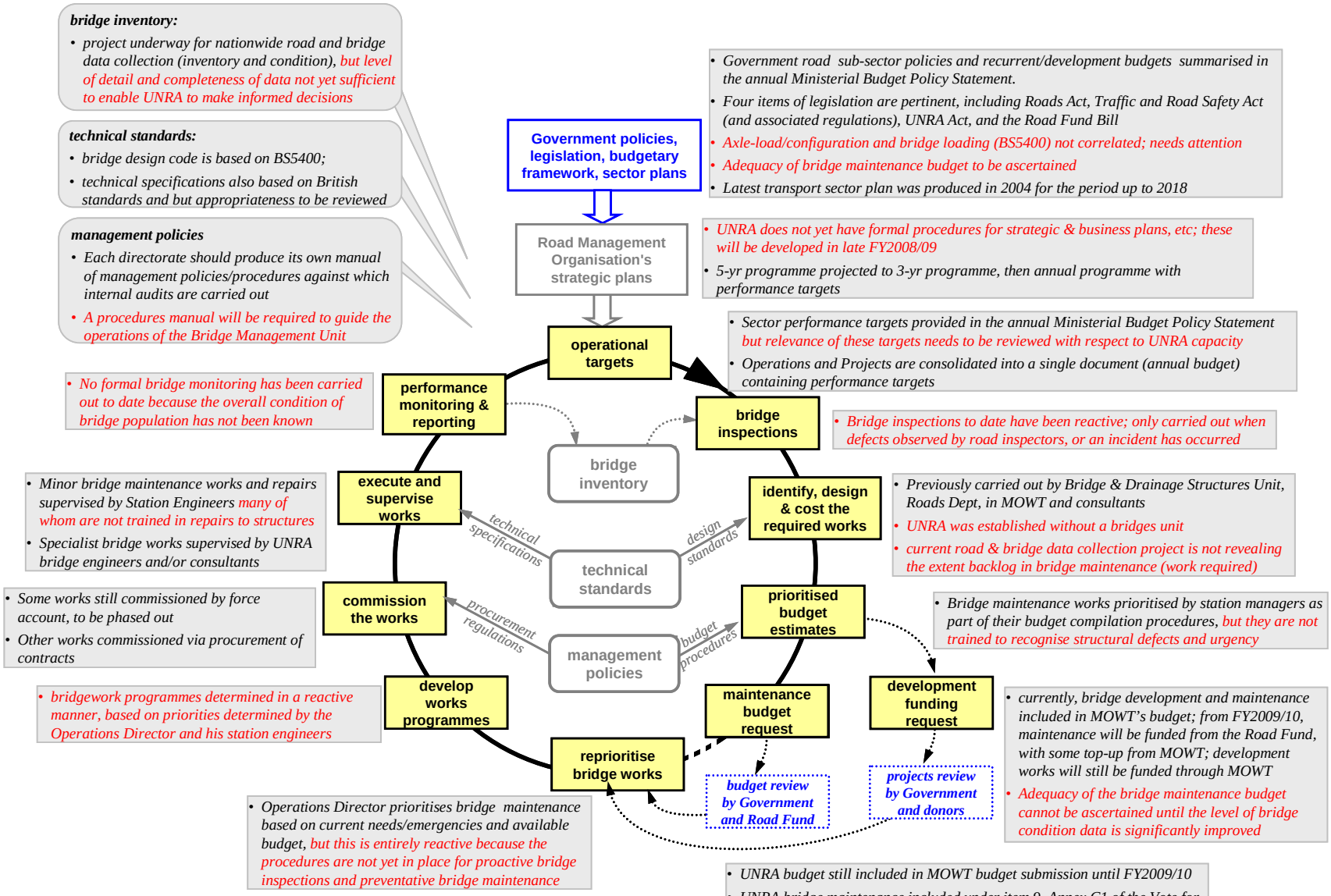


Figure 3.1: Summary of Current State Assessment of the UNRA Bridge Management Cycle

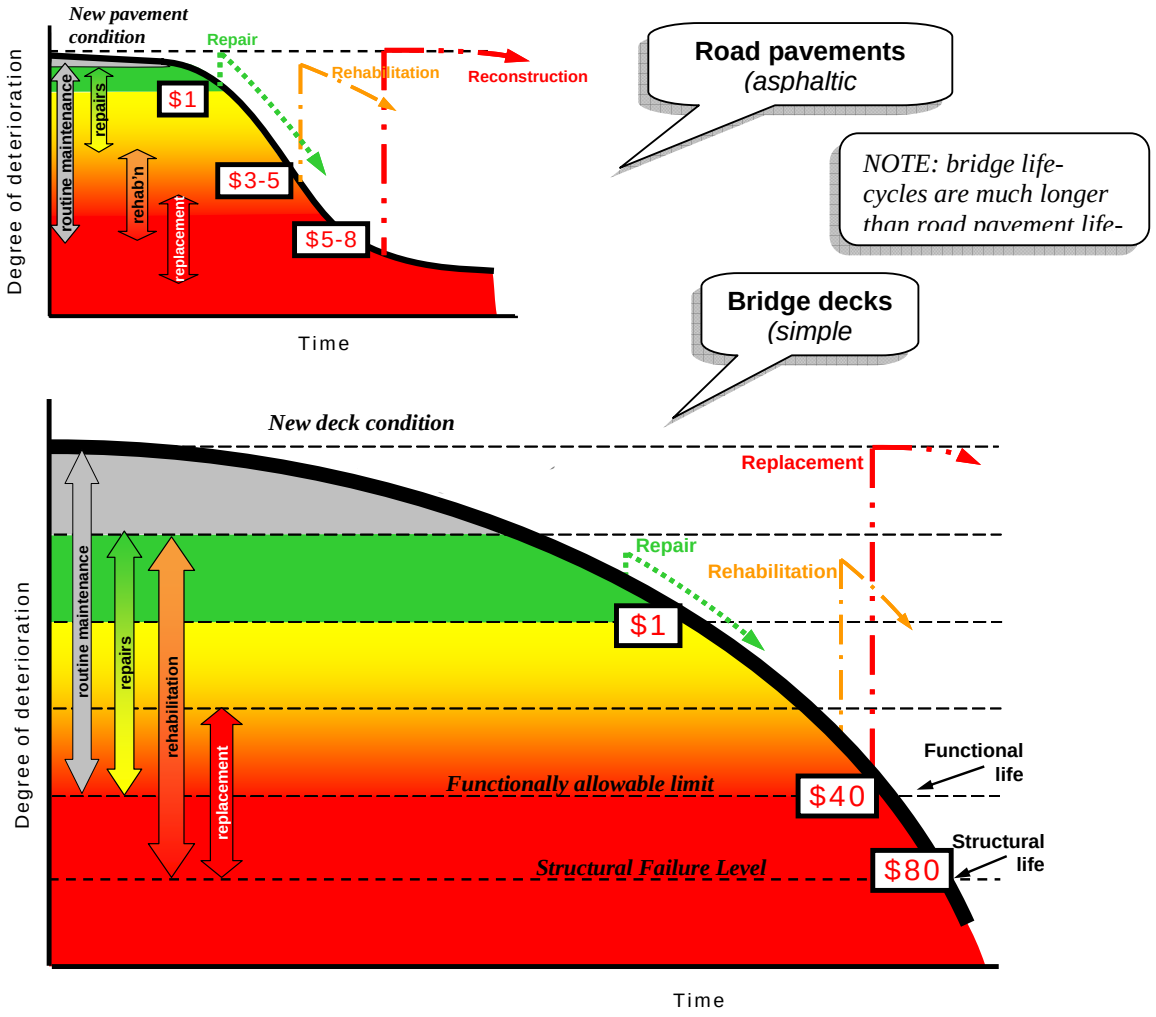
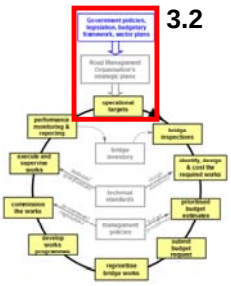
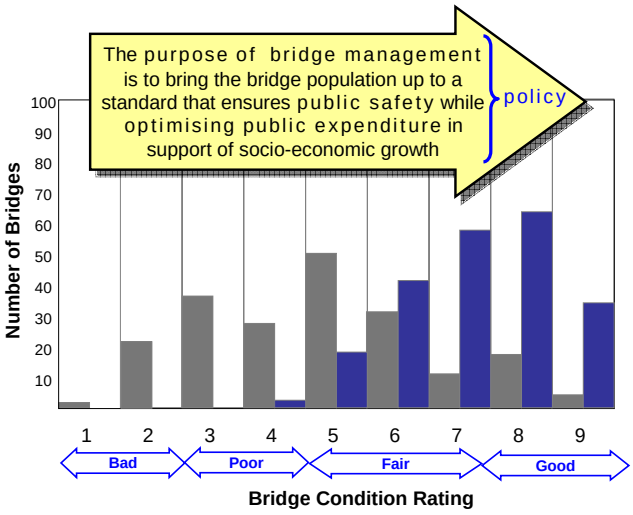


Figure 3.2: Indicative increases in expenditure incurred by a road agency when preventative maintenance (periodic repairs) are deferred



3.2 Bridge Management Policies

The starting point for effective bridge management is for Government to recognise the importance of bridges. From the foregoing discussion (Section 3.1), it can be seen that failure to provide adequate resources for preventative maintenance of bridges results in rapidly escalating costs as the bridge ages. So, Government polices should be such that the road management organisation is provided with the resources to raise the overall standard of bridges to within the "fair" to "good" range and to



maintain them in this condition for their intended economic life. The bridge management policies of the organisation should be designed to ensure that inspections are carried out at the scheduled times so that the required works are identified early and can be carried out at minimum cost in whole-life terms. By so doing, the organisation will achieve its cost-efficiency targets. Optimum expenditure on bridges (and roads) leads to minimum road transportation costs that facilitate national socio-economic growth.

3.3 Road Sector Plans and Bridge Planning Procedures

A National Transport Master Plan was produced in 2004 for the fifteen year period to 2018. This provides the overall framework for transport development in each mode, from which UNRA can extract the necessary guidance for managing the road network. For example, section 2.3.4 reviews various maintenance strategies for unpaved and paved roads and considers what combination of maintenance and development strategies will achieve the desired road network performance standards at optimum net present value (NPV). The optimum maintenance strategies are defined for low- and medium-trafficked unpaved roads, and separately for heavier-trafficked unpaved roads because these will be upgraded to paved surfaces. The report also provides optimum strategies for paved roads.

The Transport Master Plan does not mention bridges specifically, except for replacement of the Nile Crossing, but the road maintenance and development strategies indirectly imply bridge maintenance objectives. For example, upgrading a road may infer increased vehicle/axle loads and perhaps increased road width, which would have implications for improving any bridges on that route.

The Minister of Works & Transport has decreed that 9,000 km of district roads will be transferred to UNRA at the start of FY2009/10 and upgraded accordingly. It is not yet known how many bridges are on those roads, but the World Bank has agreed to fund a technical assistance programme commencing in FY2009/10 for data collection on these roads. This will enable UNRA's Planning Directorate to develop overall maintenance and development strategies for roads and bridges for the increased national road network (which currently comprises 10,800 km). The new Bridge Management Unit will need to develop bridge management strategies (maintenance and development) to complement the road management strategies.

The 2004 Master Plan has now been superseded by the 2008 National Transport Master Plan. This updated master plan does not consider road maintenance in any great detail; for example, no cost projections are given for the 15-year period, nor does the report consider road maintenance strategies in the same manner as the previous study (i.e. identifying optimum strategies based on NPV). But, the 2008 report does provide a table of planned road network investments that includes bridges (see Table 6.5 of the November 2008 report). However, no basis for these figures is given so we are unable to review how the consultant has derived the bridge investment plan, especially as the Roughton/Prome bridge data were not yet available. The updated master plan also includes an estimated US$50 million for the Second Nile Crossing at Jinja, spread over a three year construction period. The JICA Study Team responsible for the Feasibility Study for the Second Nile Crossing have now indicated that the figure is likely to be between US$60-70 million over three to four years, commencing 2011.

Our conclusion from reviewing the road sector development plans is that bridges are not yet fully considered in the network planning process. Figure 3.3 shows the current location of bridges on the national road network (summarised as red loops).

A study of bridges of 66 bridges in Northern Uganda has been carried out and designs are being prepared for 21 of these, of which 9 are located in the far North-West (Arua District) and others in the central northern area that in recent years has been inaccessible due to security reasons. But, over the coming years many roads will be upgraded that will entail functionality (load and width capacity) checks of bridges on those routes.

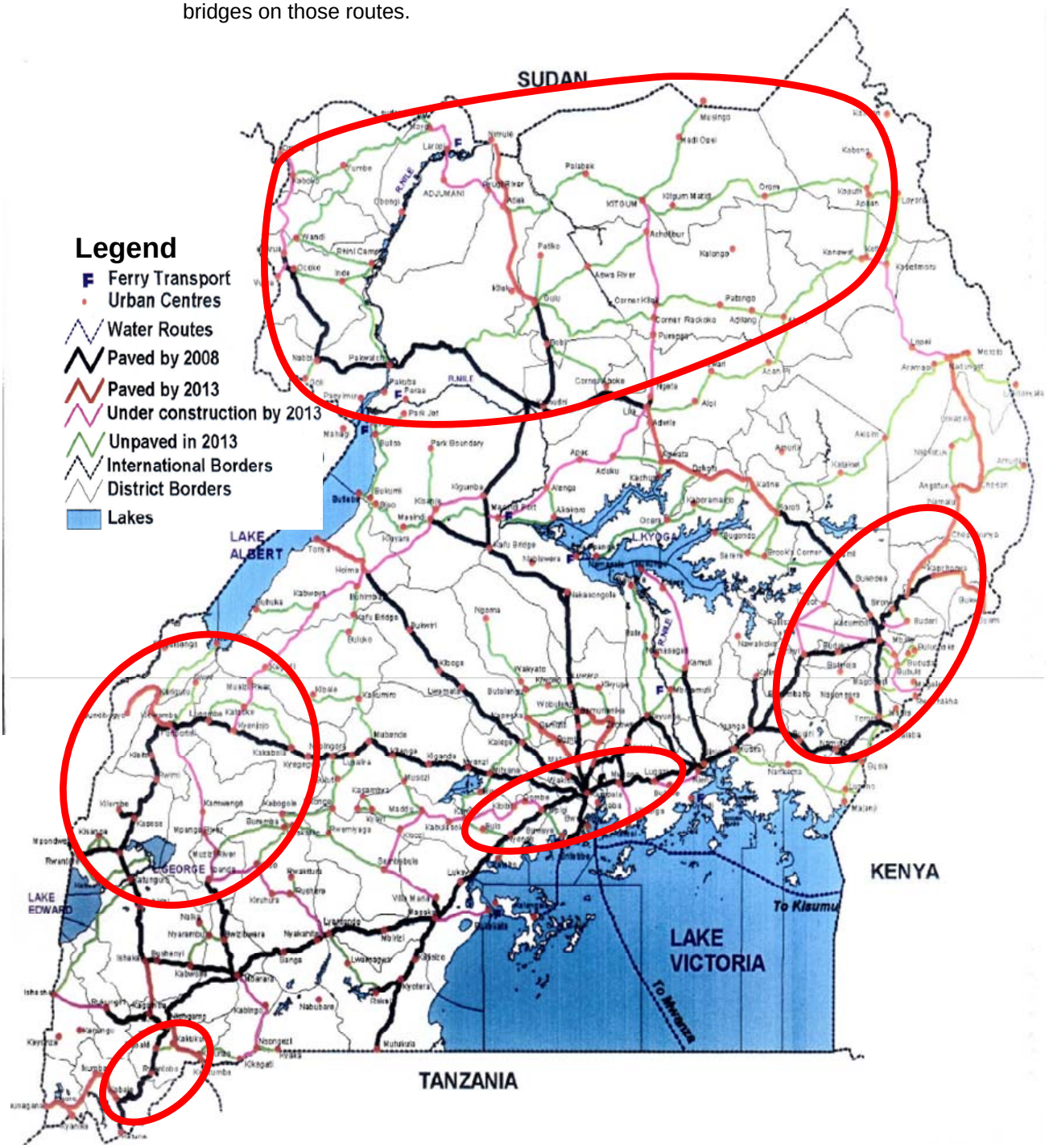


Figure 3.3: Map Showing Location of UNRA Bridges with respect to the planned development of the national road network up to 2013

It is clear from our consideration of the road and bridge planning functions in UNRA that a vital task for the BMU will be to ensure effective coordination between road and bridge planning. Also, the BMU will be responsible for establishing effective key performance indicators (KPIs) for bridge management and ensuring that these are reflected in the UNRA budgetary process, and in UNRA's network performance monitoring procedures.

3.4 Bridge Inspections

We have received preliminary bridge inventory data from Roughton/Prome. We recognise that the consultants have not yet verified their data and some field work is continuing, but from the data available (presented to us as a computer spreadsheet) we would comment as follows.

The most common bridge types appear to be simply-supported spans with composite steel-concrete or reinforced concrete decks. However, of the 207 bridges that the consultants have identified, over 50 do not yet have sufficient information regarding the type of structure. Only 27 bridges have any commentary regarding condition and none of the comments are sufficient to enable UNRA to determine the urgency of works that might be required to any bridge or the need for immediate closure or detailed inspection.

Bridge Types:	
Simply-supported, composite steel & concrete	**74**
"unknown", composite steel & concrete	**23**
Steel girder, composite steel & concrete	**7**
Simply-supported, reinforced concrete	**26**
Simply-supported, structural steel	**17**
Virendeel truss, composite steel/concrete	**4**
(number of bridges of "unknown" span	*51)*

A summary of the current bridge inventory together with information as to the bridge stocks condition on which the above table and comments have been based is included in Appendix

The only conclusions that can be drawn from the bridge data collected so far is that the training of BMU staff can initially concentrate on inspecting the common bridge types. The bridge manager position in the BMU must be an experienced bridge engineer, who can train the BMU inspectors in collecting more detailed information regarding the bridge types and their condition. The bridge manager should be able to inspect the non-common bridge types (e.g. the Virendeel trusses and multi-span bridges, etc). As shown in Figure 3.1, much of UNRA's current inability to make informed bridge management decisions stems from the lack of appropriate inventory and condition data. Addressing this issue as a first priority will enable the BMU to tackle all the other steps around the bridge management cycle.

We have had the opportunity to review the Bridge Inventory and Bridge Inspection Forms, See Appendix F, which the consultant for the National Roads Data Collection Project has adopted to gather the data required under his commission and can comment that they are generally acceptable in recording the data required to populate the BMS and enable the preparation of reports required to manage the bridge stock effectively.

Bridge Inspection Manual

It is essential that the National Roads Data Collection Project consultant prepares a detailed Bridge Inspection Manual as required under his Terms of Reference to

detail how the Inventory and Inspection Forms are to be used and coded for input into the BMS.

It is understood that to date the National Roads Data Collection Project consultant has only involved his own staff for identification and inspection of the bridges on the national road network. Training was carried out under the guidance of the consultant's bridge engineer presumably based on a Bridge Inspection Manual that was developed for use with the Africon BMS that he is proposing to provide for UNRA. It is noted that some of the Data Collection Training referred to in Section 5.4 of their Terms of Reference should be allocated specifically to the bridges.

The Bridge Inspection Manual is an essential reference tool for inspection Engineers as it defines the Condition rating scale preferably at element level, Waterway, Substructure : Abutments, Substructure: Piers, Superstructure, Roadway on Bridge, Expansion Joints, Approaches and each for each key forms the basis for the training of Bridge Inspectors.

The Bridge Inspection manual should be developed and be relevant to the Ugandan environment with photographs of typical bridges likely to be found, showing details of typical defects with the assessed condition ratings of each to enable the development of a consistent approach to the overall condition of elements and extent of the defects.

If the difference between one condition rating and the next is not adequately defined and agreed not only will it be likely that there will be a wider variation between inspections carried out on the same bridge by different inspectors but the condition rating between bridges will make it difficult for the Bridge manager to rely on any prioritization decisions that may have to be made in the likely case of a constrained maintenance budget.

It is recommended that adequate hands on training in inspection of bridges, completion of the Inventory Data Form and Field Bridge inspection forms is carried out so that the data entry and operation of the BMS can be fully understood.

3.5 Identifying, Designing and Costing Bridgeworks

Because UNRA does not currently carry out proactive bridge inspections, it is unable to implement preventative maintenance of bridges. Bridgeworks are only identified by specific bridge studies that are carried out by consultants recruited by UNRA; for example, the February 2008 study for 21 bridges in North Western Uganda.

In addition to bridge maintenance works, there is a need to effectively plan bridge development works, as discussed in Section 3.2 above. The BMU must establish effective communications with the UNRA Planning Directorate to ensure that road development plans and bridge development plans are harmonised.

3.6 Budgeting for Bridgeworks

The Ministerial Budget Policy Statement for FY2008/09 includes, on page 200, a list of 24 bridges to undergo special inspection and rehabilitation. One billion schillings has been assigned to these bridges. But, due to the uncoordinated manner in which bridge and road projects are currently compiled, and the different names that are

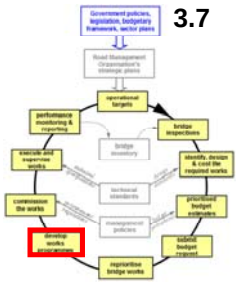
used for road sections, we are unable to verify on which roads some of these bridges are located. This problem should be resolved once the road and bridge referencing system that Roughton/Prome are developing has been finalised, adopted and all items in the national road network inventoried accordingly.

A further UShs 500 million and UShs 600 million have been assigned for the design of Agu and Awoja bridges, respectively. And UShs 5.5 billion is included in the FY2008/09 budget for repairs to the old Nile Bridge (Nubaale Bridge) at Owen Falls Dam.

Apart from these budget provisions, no other amounts are specified for bridge maintenance on the national road network. Clearly, this is due in large extent to the fact that UNRA is only just collecting data on its bridges stock and cannot be expected to estimate the required annual bridge maintenance budget until it knows for how many bridges it is responsible, and the type, size and condition of those bridges.

The budgeting procedures for UNRA are about to change, from FY2009/10, because of the establishment of a Road Fund (although, the recruitment and other set-up procedures might result in the Fund not being established until some time in 2010). It is usual these days for road authorities funded by Road Funds for maintenance works and road ministries for road development works to sign performance agreements for undertaking these works. This may well be the case for UNRA, in which case the budget compilation and performance monitoring functions need to be closely aligned to ensure that (a) the road maintenance and development programmes are developed in cognisance of the agreed levels of funding for these works, and (b) UNRA's road network performance monitoring is a constant and proactive activity that informs management of key issues related to works implementation before technical audits are carried out by the Road Fund or Ministry.

Another important consideration with respect to budgeting is the need for whole-life costing principles to be employed in order that UNRA manages the bridge population with optimal cost-efficiency. This should form part of UNRA's road network asset management plans. Every road management organisation has to work within constrained budgets and works have to be prioritised within these limitations; whole-life costs ensures that longer-term benefits are not lost for the sake of short-term priorities.



3.7 Developing Bridges Works Programmes

As mentioned previously, there is no proactive inspection of bridges, so there are no planned, preventative bridge maintenance programmes. Bridgeworks programmes are only developed for specific development works, such as the inspection, design and execution of rehabilitation works to the 24 bridges on the national roads network. But, these bridges development programmes are not yet fully coordinated with the road development programmes. As a result, bridges programmes are being designed without recourse to UNRA's road maintenance and development programmes.

There is a clear need for large-size planning charts to be displayed on the walls of the Planning, Operations and Projects Directorates so that all three directorates are working from the same, well-coordinated road and bridge programmes.

3.8 Commissioning Bridgeworks

We use the term “commissioning” works, because UNRA still utilises a combination of force account for some routine maintenance activities and tendered contracts for other works.

The level of bridge inspection data from Roughton/Prome is not in sufficient detail for us to ascertain whether routine maintenance of the bridges is carried out as part of the force account road maintenance activities. For example, we do not know if drainage holes on the bridge decks are cleaned, vegetation overgrowth cut-back, or waterways cleared.

There are no planned periodic (preventative) maintenance works carried out, so the only contracted works are repairs and rehabilitation; i.e. reactive works, occasioned by a backlog of planned maintenance. This needs to change but, planned maintenance will only be possible once the required level of bridge data has been compiled. The benefit of doing this is that budgets can then be compiled on the basis of whole-life cost decisions, resulting in minimal costs for managing the national road network’s bridge stock.

The proposed timescale that has been presented to all UNRA’s Directorates is shown below and once formally adopted must be incorporated into the Bridge Management Cycle.

The UNRA Act 2006 requires that the Executive Director submits to the Board by 31st March each year UNRA’s income and expenditure estimates for the following financial year. These estimates are either amended or approved by the Board by the 20th May and submitted to the Minister of Works for approval.

The Annual maintenance management cycle with indicative timing for each primary activity based on a financial year that begins in July

The diagram shows the point where the Government policies cascade down into a hierarchy of plans for the maintenance of the bridge stock. These plans, particularly the Strategic plan and objectives, direct the organisation in developing operational targets.

The operational targets impact on several maintenance management tasks. After undertaking asset condition surveys, or bridge condition surveys, it is the performance standards that determine the necessary works to maintain a defined level of service.

When the actual budget is confirmed it may be necessary to review the performance standards for the financial year having regard to maintenance priorities. In the case of bridges, degradation can be very slow for a number of years and then reach a ‘critical trigger point’ where the serviceability of a structure can suddenly degenerate. In addition there is of course the occasion where a single event such as vehicle impact, natural flood or earthquake can result in sudden damage to an otherwise sound structure.

Performance Standards for Routine Maintenance or Key Performance Indicators

It is apparent that historically bridge maintenance has been based on a reactive stance.

There is currently an ongoing project, National Roads Data Collection Study that is carrying out the inventory of the road network and including the Inventory of Structures and what is effectively the Routine inspection of the Bridges.

Routine Maintenance of Bridges is included in the existing recurrent budgets and at this point in time the actual activities considered as Routine maintenance are not explicitly defined.

Section 8, Review of Current Maintenance Practices sets out recommendations as to how and to address this issue.

The key dates combined with the complexity of preparing routine and perhaps prioritized periodic maintenance budgets within the required deadlines dictate the following internal timetable:-

31st August	The Director of Planning completes the collection of inventory and condition data. In the case of bridges the work identified from the periodic bridge inspections will be used to identify periodic maintenance, rehabilitation or replacement works.
30th September	The Director of Planning prepares a discussion paper on the budget priorities for submission to and discussion with the Director of Operations and the Maintenance Managers
31st October	The Director of Operations holds budget discussions with his managers in relation to regional and activity budget prioritization and sets provisional budget ceilings
7th December	The Regional Managers and their subordinate staff finalise their regional budget submissions
31st December	The Maintenance Managers review and consolidate budget submissions from Regional Managers to produce the first overall budget draft for submission to the Director of Operations
Mid January	The Director of Operations discusses and refines the general thrusts and priorities of the draft budget with Maintenance and Regional Managers having regard to the latest budget ceilings and priorities of the Minister, Board and Road Fund
31st January	The Maintenance and Regional managers amend the first draft budget as necessary and submit a second draft to the Director of Operations
Mid February	The Director of Operations reviews and amends as necessary the second draft budget and submits it to the Executive Director for UNRA TMT to review and finalise.

The format of UNRA's budget and subsequent expenditure analysis is made up of three components:-

- Non-Works expenditure – including such costs as payroll costs, administration, training, depreciation of fixed assets
- Works Related Expenditure – such as vehicle running costs, consultancy fees, field allowances
- Works Expenditure – development projects, maintenance programmes emergency works

In relation to the Bridge Management Unit which the Study Team have recommended to be part of the Technical Specialists within the Planning Directorate the Non-Works Expenditure is readily determined.

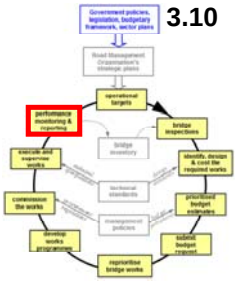
The Works Related Expenditure will include the costs of the routine and periodic bridge inspection programme, consultancy for the consultants fees for the design and supervision of periodic maintenance, rehabilitation and possibly of special structure replacement projects.

The Works Expenditure will include the cost of the works carried out and must be co-ordinated with Planning, Operations and Projects Directorates so that all three directorates are working from the same, well-coordinated road and bridge programmes.

3.9 Execute and Supervise the Works

In the short duration of the inception period for this Bridge Management Study, we have not been able to visit bridges that have recently been repaired in order for us to observe the quality of works carried out. However, it is clear that UNRA does not have adequate bridge engineering expertise in its field stations and only a recently formed Bridge Management Team that has not supervised any bridgeworks since UNRA was established in July 2008.

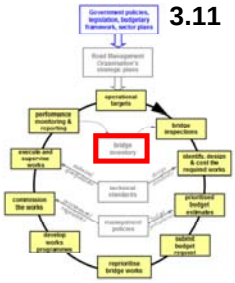
Arrangements need to be put in place to strengthen the bridge engineering capabilities within UNRA. Even if repairs, major maintenance and rehabilitation works are contracted out to consulting firms (domestic or international), UNRA needs sufficient bridge engineering expertise in-house to be able to review the designs and method/quality of works to ensure that these are carried out correctly. Failure to do so will put at risk UNRA;s ability to ensure safety of road users and value for money from procured services and works contracts.



3.10 Performance Monitoring and Evaluation

UNRA's Planning Directorate includes a Monitoring and Evaluation section that collates the monthly and quarterly reports from the Operations and Projects Directorates to develop combined reports on physical and financial progress. However, this section does not carry out any technical audits. Internal financial audits are carried out by the Internal Audit Department (IAD). IAD receives copies of the reports from the Monitoring & Evaluation section, reviews the content thereof to determine which programmes/projects are behind schedule and then investigates the reasons fro under-performance.

Performance monitoring and evaluation of the bridge population will be a responsibility of the Bridge Management Unit, as an output of its BMS. There will need to be close cooperation between the BMU and the Planning Directorate's Monitoring & Evaluation Section to ensure that both sets of data correlate. This is essential, both for knowing the current condition of the whole road network (including structures) and for guiding the police and military for transportation of wide/heavy loads.



3.11 Bridge Inventory

It is vital that a bridges database be kept up to date. Whenever there are any changes to the bridge population – due to replacement, deletion, or addition (new bridge) – the inventory should be updated to reflect these changes. Equally, if the whenever there are any major changes to a bridge – due to rehabilitation works, strengthening, down-grading ("posting", etc – then the changes should be recorded in the database. The level of detail will depend on the type of Bridge Management System (BMS). If the details held by the BMS are just at component-level (e.g. superstructure, sub-structure, foundation) then the information should be recorded and organised in such a manner that the bridge manager is able to develop ascertain the criticality of bridges in the overall population, and to single these out for special inspections, immediate works, and/or closure.

Some BMSs are designed to hold data at the element-level. Such systems include algorithms that enable the programme (along with historic condition data) to develop deterioration models and project remaining functional life of a bridge; some even have algorithms that will estimate current load carrying capacity. These BMSs require huge amounts of data to be collected and kept up to date. This is an enormously costly exercise in terms of manpower, time, vehicles and access equipment, fuel, etc. In highly constrained budget situations and where bridge inspection expertise is limited, it is better to collect component-level data in a manner that the bridge manager can make suitably informed decisions based on professional judgement (an understanding of the behaviour and performance of bridge structures similar to those on which he/she is making a decision, and structural/bridge engineering expertise include analysis and design of complete bridges and rehabilitation of individual components). The monies "saved" by not collecting element-level data for all bridges (only those where periodic and special inspections are being carried out) can be used for actual bridge maintenance activities.

The Consultant carrying out consultant for the National Roads Data Collection Project made the Field Inspection sheets for the bridges available to us to enable us to make a preliminary assessment of the size and distribution of the bridge stock. The data used had not been validated or reviewed at the time of our review and as noted in Appendix E of our review of the work a large number, approaching 30%, of the bridges inspected had no condition ratings for one or more of the key elements.

It has therefore not been feasible to make anything other than general statements about the condition

3.12 Technical Standards

We have reviewed the loading specifications for bridges on Uganda's national roads network and the code to which these bridges should be designed; the design of rehabilitation works should also confirm to these standards. Our comments are as follows:

Loading: Uganda has adopted the British Specification BS5400, which provides loading spectra. However, the Schedule (Part I and Part II) of the Traffic and Road Safety (Weighbridges) Regulations, 2004, provides axle configuration and weight limits (Part I) and truck configurations and weight limits (Part II) that do not readily correlate to BS5400 loading spectra. An exercise has been carried out to ascertain that the axle/vehicle weight limits are within the loading spectra to which Uganda's bridges are being designed.

It should be noted that the axle spacing for the truck configurations and weights (Part II) of the Traffic and Road Safety (Weighbridges) Regulations, 2004 do not Specify the allowable axle spacing so in order to carry out a comparison exercise some assumptions have been made and a minimum practicable axle spacing of 1.8 metres between centres of axles and minimum overhang of the vehicle to the outermost axle of 1.5 metres was adopted. These values followed the dimensions for a HB vehicle set out in BS 5400: Part2.

The result of this review showed that for short spans below 14 metres the Permitted Axle configuration T12 and Q16 exceeds the specified Uganda BS5400 Part 2 Ha Design Loading standard but does not exceed the 30 Units of HB loading.

In terms of permitted truck configuration; Configuration B, G, L, K exceeds the specified Uganda BS5400 Part 2 Ha Design Loading standard but, again, does not exceed the 30 Units of HB loading

In addition, since the majority of bridges on the national road network were constructed between 1920 and 1945, it is possible that many of the existing bridges might not have carrying capacity consistent with the weighbridge regulations.

Conclusion and Recommendations

Bridges should be designed to a Specified load of HA and 30 Units of HB to ensure that the design load effects from the all the Axle and Truck Configurations currently permitted under the Traffic and Road Safety (Weighbridges) Regulations, 2004 are included in the design envelope.

Design:

The design standards adopted for the design of bridges in Uganda are the British BS 5400: Parts 1 to 10.

However the MOWHC had prepared and issued a Road Design Manual: - Volume 4 Bridge Design in July 2005. The official status of this document is not clear, as no reference has been found to its required use in any of the Terms of Reference issues by either the MOWHC or UNRA reviewed to date. The Road Design Manual on first inspection appears to be a rewrite of the British Standard BS5400 Part 2: Loads for Highway Structures, with an additional Section to define the required Seismic Design loading and replacement tables for maximum and minimum temperature relevant to the Ugandan environment.

Current Terms of Reference for the design of replacement bridges on the Network Roads reviewed under this consultancy specify Highway Loadings to be in accordance with full Ha and 30 units of HB in accordance with BS5400:-Part 2.

It should be noted however that the design curve for the Type HA Highway loading currently remains as the original BS5400: Part 2 uniform load of 30kN per linear metre of notional lane, as opposed to the current has been truncated from the current BS 5400 variable load intensity equation of $W = 336(1/L)^{0.67,}$ where W is the Uniform Distributed Loading per linear metre of notional lane, for spans up to 50 metre to the original BS5400: Part 2
Likewise the load intensity equation for spans over 30 metres have also been reduced.

Section 3.12 above has commented that the use of the original Ha loading curve in BS 5400 Part 2 together with 30 units of HB loading will at this point in time of Uganda's development be adequate to cater for the legally permitted axle and vehicle configurations.

It is necessary to be aware that the Ha design curve does not represent a single vehicle type but is a probability assessment of the likely maximum loading likely to be imposed on a bridge during its design life. This assessment is based on a statistical analysis of the likely composition of traffic and it is implicit in the calculation that there is an adequate level of load enforcement and policing to prevent a significant percentage of overweight vehicles. The assessment of traffic composition explains why it has not been necessary to increase the Ha loading curve in the UK above that identified in the 1st revision contained in BD 3701, 1981 even though permitted maximum vehicle weights have increased from 30 Tonnes to 40 Tonnes in the intervening period.

The Ugandan design code is still using the original BS 5400 Part 2 Ha loading curve. Vehicle composition may not be the same as the UK, for instance trucks in common usage on the Uganda roads often pull large trailers, and the level of weight enforcement countrywide is difficult to assess.

It is therefore not difficult to forecast, in common with global trends in other developing countries, that as the cross boarder trade increases and as a result of improved transportation corridors such as the Northern Corridor, the overall loading on bridges during their lifetime will also increase.

Consideration should therefore be given to adopting the revised loading curve as defined in the UK's Highways Agency Bridge Directive BD 3701, especially relevant for the spans up to 14 metres. Analysis of data from the bridge inventory shows that current average span of the Ugandan bridge is approximately 11 metres which means that over half the bridge stock lies within the critical loading zone where the largest changes to the Ha loading curve have been made in BD 3701.

Specifications for Bridgeworks
UNRA have inherited the Standard Specification for Road and Bridge Works that was in common usage by the MOWT & C.
The review of work by current consultants working for UNRA have shown that little awareness of the requirements of these Specifications as often material Standards for concrete and steel are quoted from ASSHTO rather than the British standards are specified on General notes drawings or on the drawings.

A review of the Standard Specification clauses relating to Bridgeworks carried out by this consultancy show evidence of ad hoc changes usually brought about by consultants or the client identifying the need to address problems that have resulted in claims during construction on previous projects.

In general the MOWT & C Specification is beginning to show its age and it is understood that several parts of the document are under review under a series of Technical Assistance Consultancies, both ongoing and planned.

The key deficiency from the Bridge Maintenance aspect and as noted in following Sections is that there are no specifications relating to routine or rehabilitation maintenance operations. This is to be expected given that the majority of what can be classed as periodic maintenance has been reactive with presumably specification of suitable materials and work methods being specified by a consultant specifically for each repair contract.

Recommendations

UNRA to develop Standard Specifications for specialist repair mortars, concrete and associated method statements for the common bridge periodic maintenance works. It would be expected that these Specifications would need to include the repair and replacement of spalling concrete and rusting reinforcement, sealing of dormant and non dormant cracks, replacement of bridge bearings including bridge jacking procedures, replacement of expansion joints, repair and painting of steel structures, sealing of joints. Determination of actual maintenance works will be dependant on a review of the common defects prevalent on the existing bridge stock identified from the results of the Periodic inspection cycles input into the BMS.

Quality Control of site works:

It is essential that bridge maintenance work once contracted is carried out to the highest possible technical standards due to the higher initial cost of the works compared with road maintenance operations and the potentially dangerous effect of poor workmanship to both road users and service life of a high value asset.

It is therefore important that both the organisation carrying out the work and the clients site supervisors have an adequate level of experience and necessary skill set to ensure that the maintenance intervention work is firstly, actually appropriate to the conditions encountered on the site, and that the work carried out is to the necessary standard, and in accordance with the specialist material manufacturers specifications.

The need to appropriate Quality Assurance and Quality Control aspects of construction work are well documented and form the basis for any control of site operations. In the case of rehabilitation works on existing structures it is essential that all parties are fully conversant with attendant risks of working on load bearing elements of these structures, and therefore it is recommended that the use of a detailed method statements showing the sequence of every important stage that will need to be carried out to successfully complete the work is submitted in good time to the supervision engineers to enable them to be fully reviewed, and modified if necessary.

There has been limited opportunity to carry out site visits to review current site practices but on the visit that were be carried out by the consultant team to a new culvert under construction on Site visit to inspect ongoing works on a twin 3.5 m clear span culvert, Lutwa Bridge on the Hoima – Buseruka - Kabaale – Kaiso Road and a recently completed Bailey Bridge, Wambabya Bridge, on the Hoima –

Kizirafumbi – Kaiso –Tonya Road common problems relating to basic site control of such critical aspects as material approvals, method statements, and sequence of working were apparent.

It is accepted from numerous references, including the UK Highways Agency Bridge Advice Note BD 5701, extracts included in Appendix that the control of construction has an equal weight on the whole life durability of a structure. Experience from many countries have shown that failure to provide adequate cover and proper curing to concrete structures has a critical effect on the performance of the structures over its lifetime and affects the future maintenance costs dramatically.

3.13 Management Policies

UNRA's internal management policies related to management of the national road network and bridges within the network should be so designed as to guide departmental staff in achieving the objectives of the organisation, as defined by its legal obligations (described in its establishment legislation), its mission and purpose, and its performance agreements with the MOWT for development works and, when established, with the Road Fund for maintenance works.

Key considerations:

- **role, responsibilities (UNRA Act = legal requirement):**
  - **"to manage the provision and maintenance of the national roads network in a more efficient and effective manner"**
  - **"efficient" refers to use of resources**
  - **"effective" refers to making appropriate decisions**
- **UNRA policies: road network managers, not implementers**
- **as "network managers", need to be "knowledgeable client"**

UNRA's policies for bridge management may be summed up by the slide we presented at the workshop on 20th February at UNRA regarding establishment of a BMU, as shown here. The keywords are "effective" and "efficient". Firstly, the BMU must have competent senior bridge engineering staff who are capable of making well-informed, technically appropriate decisions regarding the operation, maintenance, repair, rehabilitation, posting (weight restriction), and/or closure of bridges; they must also be able to review the works carried out by UNRA's consultants and contractors to ensure that those works are also technically correct. The Bridges Manager and his bridge engineers must also be capable of taking decisions that make the most efficient use of available resources (money, manpower, materials, etc), preferably on a whole-life cost basis. These skills do not currently exist in UNRA.

4 Designing a BMU for UNRA

4.1 Composition of a BMU

At the end of Section 3, we discussed management policies within UNRA and proposed the principles upon which a BMU should be established. These are summarised in the text box here.

Therefore:

- **BMU should have adequate, competent staff to:**
  - **analyse bridge condition data**
  - **determine optimal actions to be taken: "effective"**
  - **check costs and use of resources: "efficiency"**
  - **check work done by others (consultants, contractors)**

In the first instance, the BMU will need to concentrate on collecting sufficiently detailed information to be able to make informed bridge management decisions. We strongly recommend that the BMU should be established with sufficient staff to undertake its own bridge inspections, at least for the common types of bridge on the national roads network (see Section 3.3). By collecting its own bridge inspection data, the BMU will take responsibility for this data, including its own data integrity checks. Inspections of less common (or "no-standard") bridges may be contracted out to qualified consultants but the BMU still requires sufficient bridge engineering knowledge to assess whether the consultants have collected the data correctly and to the required level of detail. When all the data are entered into the BMs, the BMU Bridges Manager will need to be able to identify works on all bridge types and to prioritise works right across the bridge population.

The types of bridge inspections are summarised in the text boxes below.

Routine:

- **visual inspection**
- **once per year**
- **key components**
  - **superstructure**
  - **substructure**
  - **foundations**
- **"trigger items"**
- **simple, but essential recording format**
- **Inspection Manual**
- **Need for condition spot-checks !**

Periodic:

- **"touch distance", structural survey**
- **3-yearly**
- **key elements**
- **need bridge knowledge**
- **"trigger items"**
- **similar format to routine inspections for entering data into BMS**
- **Inspection Manual**
- **Need for condition spot-checks !**

Special:

- **analytical assessment**
- **pre-handovers & when "triggered"**
- **calculation of structural integrity of critical (or all) elements**
- **assessment of carrying capacity**
- **identification and design of remedial actions**
- **possible NDT-testing, etc**
- **Need for design, analysis checks**

Routine bridge inspections should be carried out at least once per year; in some locations twice per year would be appropriate, for example where a bridge or its water course must be kept under close observation. Routine inspections may be carried out at reasonable access distance, using binoculars where appropriate to identify "triggers" for repair works or more detailed inspections. The bridge

inspectors should be provided with a suitable Inspection Manuals that enables them to recognise the type and extent of defects that constitute these triggers. The bridge manager should arrange for spot-checks to be carried out by more qualified bridge engineers.

Periodic inspections should be carried out at “touch distance”. This clearly requires full consideration to be given to access, including the underside the superstructure (bridge soffit, beams, bearings, etc) in order that each element can be inspected to identify any trigger items. These inspections may be carried out at five year intervals for new bridges and three year intervals thereafter. The decision to switch from 5-year to 3-year intervals may be based on the level of repairs, frequency and/or severity of trigger items, or after any rehabilitative works have been carried out. Again, the Bridges Manager should arrange for spot-checks to be carried out.

Special inspections are those initiated by identification of trigger defects, or other incidents such as a vehicle colliding with part of the bridge, the upgrading of a road (hence the need to inspect the bridge and analyse its load carrying capacity), etc. Special inspections may be contracted out but, the BMU must retain a level of competence to review the work of its consultants. The BMU must become a “**knowledgeable client**” with respect to UNRA’s responsibilities for public safety and its responsibilities for managing a huge national asset that represents a very significant investment whose value and functionality must be sustained for the duration of its intended economic life.

We suggest that the Bridges Manager arranges for about 10% of routine inspections to be subject to spot-checks and about 15% of periodic inspections; the locations of the spot-checks should be selected based on the experience of the Bridges Manager and should consider geographical location (i.e. don’t overlook the more remote and difficult to access bridges!), age and type of the bridges, and also include some spot-checks on the less common bridges (where the periodic inspections might be carried out by consultants).

Routine:

207 routine inspections per year

1/4 day per inspection

= 50 inspection days + travel time

(3 months)

1 Junior Engineer + Technician

Spot-checks by

Sr Bridge Engineer + Jr Br Eng + Technician

(say, 20 checks/yr)

Periodic:

207/ 3 = 69 inspections per yr

2 days per inspection

= 140 inspection days + travel time

(7 months)

1 Senior Engineer + 1 Junior Engineer + Technician

Spot-checks by

Bridge Manager + Sr Br Eng & Technician

(say 10 checks/yr)

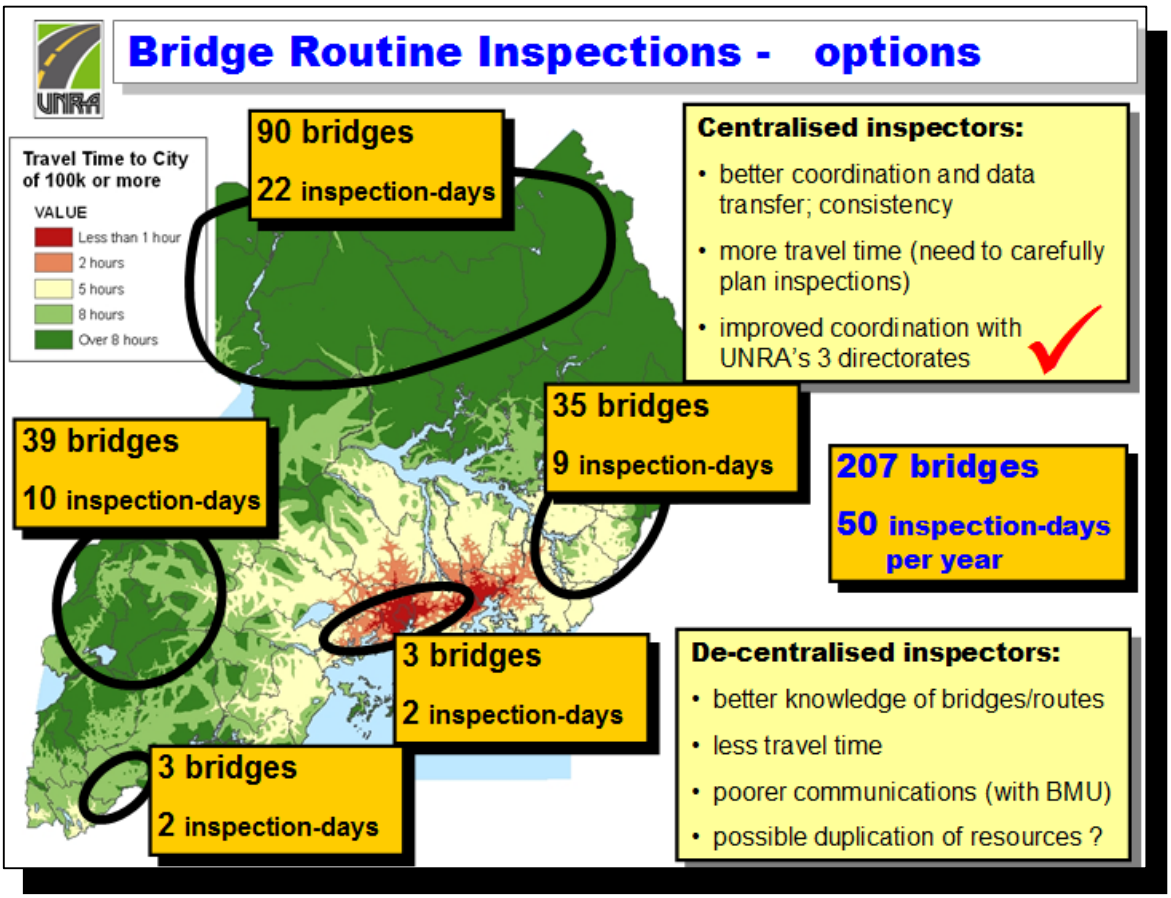
Special:

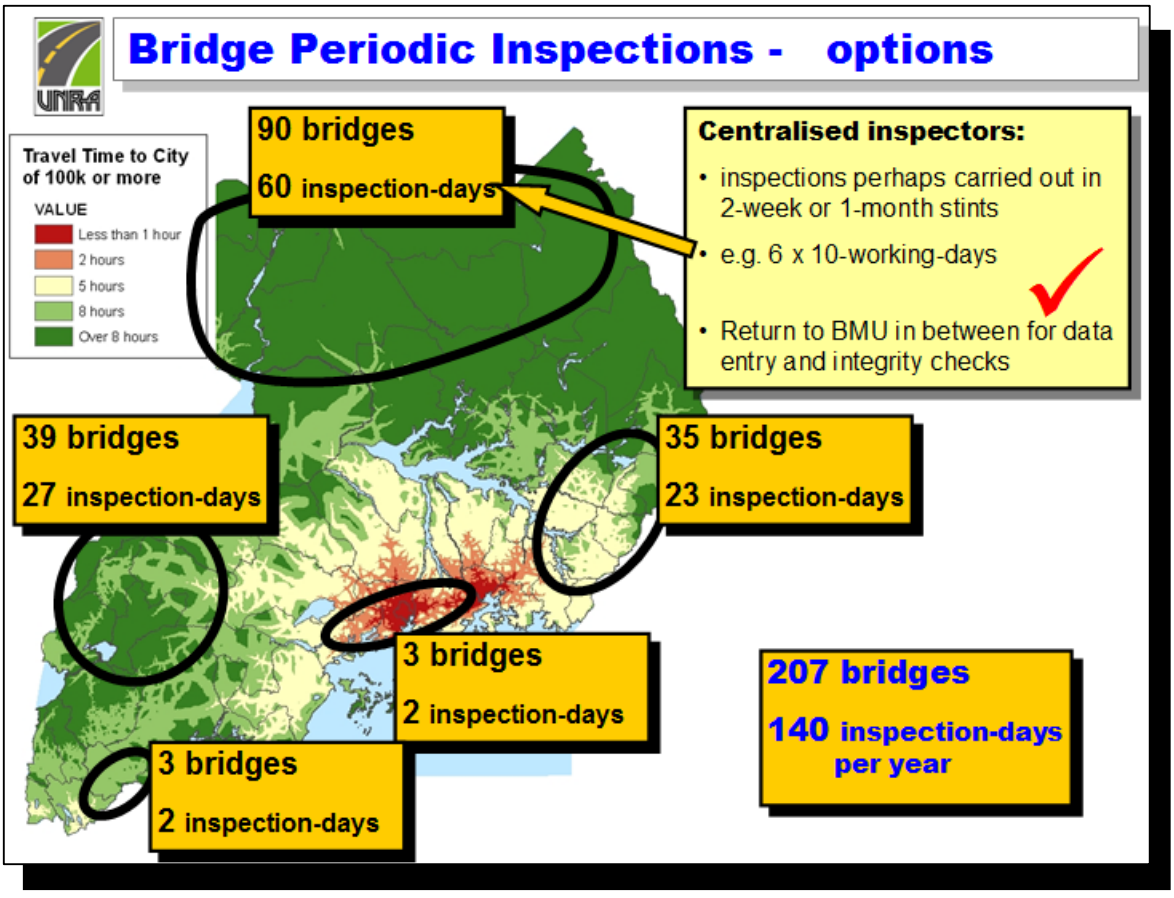
- **pre-handovers**
- **Number depends on development and number of rehab projects**
- **carried out by specialist engineers**

Special:

- **analytical assessments when triggered**
- **Number depends on population condition**
- **carried out by specialist engineers**

The maps on the two slides shown overleaf summarise the locations of the 207 bridges identified by Roughton/Prome, the travelling distances to these locations, and the times required to carry out routine and periodic inspections of these bridges.


Bridge Routine Inspections - options
Travel Time to City of 100k or more
VALUE
Less than 1 hour
2 hours
5 hours
8 hours
Over 8 hours
90 bridges
22 inspection-days
Centralised inspectors:
• better coordination and data transfer; consistency
• more travel time (need to carefully plan inspections)
• improved coordination with UNRA's 3 directorates
35 bridges
9 inspection-days
39 bridges
10 inspection-days
207 bridges
50 inspection-days per year
3 bridges
2 inspection-days
De-centralised inspectors:
• better knowledge of bridges/routes
• less travel time
• poorer communications (with BMU)
• possible duplication of resources ?
3 bridges
2 inspection-days


Bridge Periodic Inspections - options
Travel Time to City of 100k or more
VALUE
Less than 1 hour
2 hours
5 hours
8 hours
Over 8 hours
90 bridges
60 inspection-days
Centralised inspectors:
• inspections perhaps carried out in 2-week or 1-month stints
• e.g. 6 x 10-working-days
• Return to BMU in between for data entry and integrity checks
39 bridges
27 inspection-days
35 bridges
23 inspection-days
3 bridges
2 inspection-days
207 bridges
140 inspection-days per year
3 bridges
2 inspection-days

The gold text boxes with blue font summarise the estimated number of inspection days based on 4 routine inspections per day (average) and 2 days per periodic inspection (average). It is important to note that the 50 inspection-days and 140 inspection-days per year are based only on the 207 bridges identified by Roughton/Prome and do not include travelling time. For two junior bridge engineers, this equates to 25 days each of routine inspections, plus travelling time. We recommend that visits into the regions to undertake the routine inspections should be conducted to suit climatic considerations and that the results are brought back at the end of each two-week visit into the field and entered into the BMS database. Data entry should be overseen by a senior bridge engineer to ensure integrity and consistency of data. The senior bridge engineers would make separate visits into the field for the spot-checks. The junior engineers should accompany the senior engineers during these spot-checks as part of on-the-job training and capacity building in the BMU.

Two senior bridge engineers should carry out the periodic inspections, which equates to about 70 inspection-days each, plus travelling time. The Bridges Manager may instruct each senior engineer to carry out spot-checks on the other's work, but the Bridges Manager should also carry out some of the spot-checks himself.

We recommend that the bridge inspections are carried out by the BMU staff and are therefore centralised, rather than decentralising to the station staff. There are two main reasons for this: firstly, station staff could not reliably be trained to undertake periodic inspections, because they do not have the requisite structural engineering background. Even for routine inspections, the emphasis in the districts is on road maintenance; an inspector would not spend more than a few days per year carrying out routine inspections so there would be no regularity of work to hone his bridges knowledge. Any changes to district staff would require retraining. Similar problems would occur if the bridge inspections are contracted-out. Taking responsibility for bridge data within the BMU signifies "ownership" of the data on which the BMU will be making all-important technical, safety, and resource allocation decisions.

The feed back received from UNRA during the second workshop held at the end of March identified their concern on the proposed size of the unit raised the

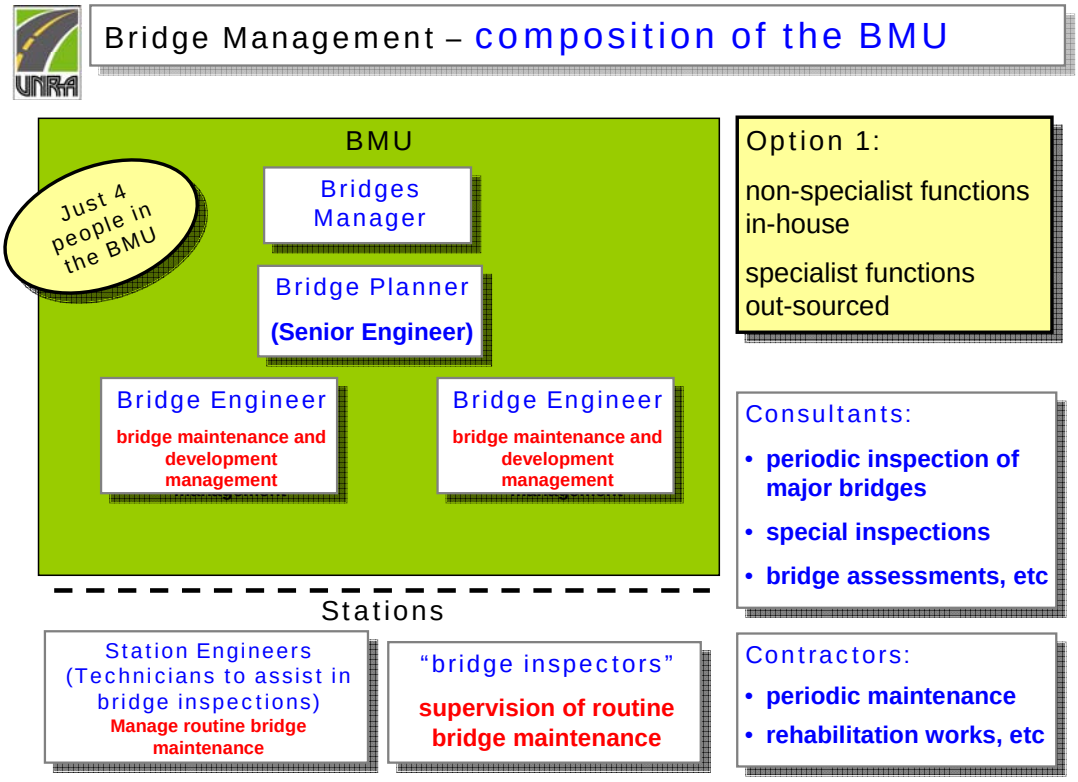
The first set of tasks for the BMU will be to develop in-house competence and adequate capacity for bridge inspections.

When the additional 9,000 km of roads are transferred to national road network and become UNRA's responsibility, UNRA will need to arrange for inventory and condition surveys to collect information on the roads and structures. This will add to the BMU's capacity requirements but, the BMU can initially be established with the capacity to manage the 207 bridges and then increase once the number of additional bridges is known. The World Bank has already agreed to provide funding for this data collection.

The Slide shown overleaf summarises our recommendations for the initial staffing in the BMU. It is possible that the Bridges Manager may initially have to be a technical assistance post. UNRA is currently recruiting a **Project Engineer – Bridge Management**. The advertisement states that this position (Grade SG4) would report to the head of the BMU (the Bridges Manager, Grade SG3), who in turn would report to the Director, Planning (SG2). In Section 5 of this report we outline the "road map" for establishing the BMU and for development of capacity over a 2½ to 3-year period to localise the Bridges Manager position. At that time, the BMU would be a

full localised "**knowledgeable client**" with respect to managing the bridge population on the national roads network.

The Project Engineer – Bridge Management would take the position of **Bridge Planner** shown in the slide below.



It would be expected that this Bridge Planner would in addition to being responsible for managing the BMS system data both acquisition and and Depending on the type of staff that UNRA is able to recruit into the lower positions, shown here as We have noted the comments from the second workshop and now propose that in order to maintain ownership of the bridges in the Regions and Stations that the BMU make use of the Technicians, previously shown as being part of the BMU HQ staffing, from the Stations.

UNRA feel that use of these existing resources in the stations will enable advantages arising from local knowledge of the area and possible some historical knowledge of individual bridge to be gained. In return the BMU will be able to establish better networking and knowledge transfer to the Station level, either using informal 'on the job' training or more formal focused training to enable a raising of standards for routine and periodic maintenance supervision.

The BMU would act as the 'Centre of Excellence' on Bridge matters, but have ownership of the bridge data to ensure that maintenance is **planned not reactive, priritized and in accordance with future road development planning, whilst ensuring an appropriate level of safety in accordance with UNRA's Strategic objectives,** whilst the Regions and Stations would have ownership of the Bridges themselves, similar to their owner ship of the road network in their Region/Station.

We have purposely developed the structure of the BMU in this manner so that it satisfies both the requirements of UNRA's bridge management function, while also providing a career path for people entering the BMU wishing to progress into higher positions within UNRA (although this would also require exposure to the road planning function at some stage).

For progressing from the Bridge Planner to the Bridges Manager position, we suggest that this should be linked to higher-level academic study. We have identified the **MSc in Bridge Engineering** course at Surrey University, UK, as ideally suited to the needs of managing the BMU. The course includes module that are of particular relevance to the common bridges types in Uganda:

Bridge Management: inspections; assessment and strengthening; maintenance strategies; whole-life costing and asset management; assessment of reinforced concrete; pre-stressed, steel and composite bridges; load testing of bridges; methods of strengthening; design of bridges for durability.

Durability of Bridges: overview of durability; the durability of concrete, metals, reinforcement in concrete and polymers; testing and monitoring structures; the assessment of structures, repair methods and materials; the design and construction of durable structures; failures of durability and their consequences.

The course also includes modules that will give the Bridges Manager the knowledge to manage UNRA's bridges consultancies as a "knowledgeable client", including:

Bridge Deck Loading and Analysis: Loading: types of load; traffic loads; application of loads; load combinations; partial safety factors; shrinkage and temperature loads; the use of influence lines. Analysis: types of bridge deck and their behaviour; distribution of loads; skew deck analysis; use of influence surfaces; computer methods (grillage, finite element, finite strip).

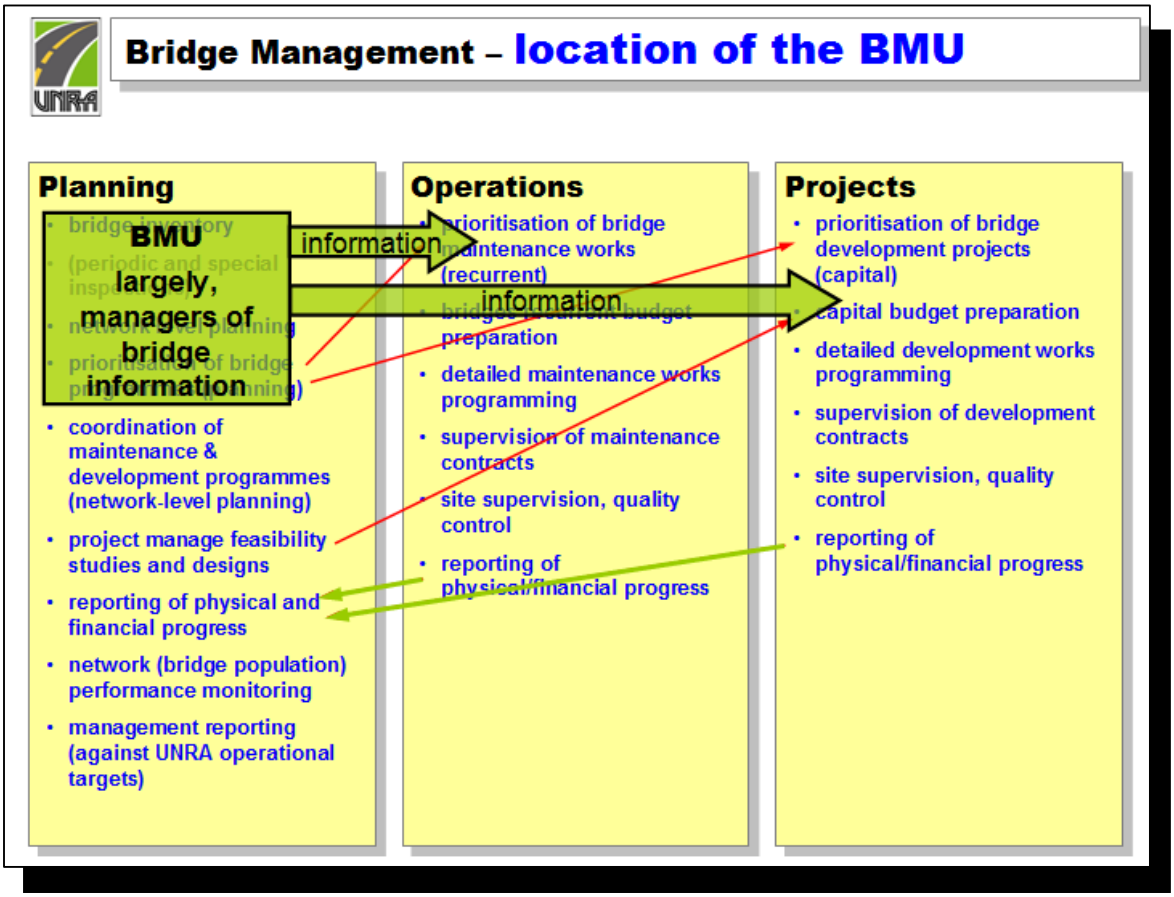
Long Span Bridges: Historical perspective and case studies; the analysis, design and construction of long span cable-supported bridges; the design of main elements - cables, towers, hangers, deck and foundations; construction processes; aerodynamic considerations.

Steel and Composite Bridge Design: Propped and unpropped construction; serviceability and ultimate limit states; design for bending, shear and combined bending and shear, continuous construction, plastic analysis; reference to current codes of practice; the design of steel plate girders for shear and bending interaction; the design of transverse stiffeners; fatigue behaviour of steel bridges and connections; appraisal to Part 10 BS 5400; means of improving fatigue performance of steel bridges; the design of bolted and welded steel bridge connections; the design of longitudinally and transversely stiffened webs and flanges for box girders; the design of plate elements, longitudinal stiffeners and cross frames.

Pre-stressed Concrete Bridge Design: Pre-stressed concrete: simple design equations; kern limits; losses; cable design; end block design; differential shrinkage; continuous beams. Box girders: design concept; construction methods; cost benefits; global analysis; pre-stress design; distortion effects; end blocks; diaphragms; reinforcement.

4.2 Location of the BMU within UNRA

We have considered the role of the BMU and discerned that it is primarily responsible for managing bridges information, and being the "Centre of Excellence" on all Bridge matters, and that must be coordinated with UNRA's road planning function which, in turn, contributes to the maintenance programmes of the Operations Directorate and the development programmes of the Projects Directorate. The Monitoring and Evaluation Manager within the Planning Directorate then receives information back from the other two directorates to inform UNRA's network performance monitoring role. **We therefore recommend that the BMU should be established within UNRA's Planning Directorate**, as shown in the slide below.


Bridge Management – location of the BMU
Planning
BMU largely, managers of bridge information
coordination of maintenance & development programmes (network-level planning)
project manage feasibility studies and designs
reporting of physical and financial progress
network (bridge population) performance monitoring
management reporting (against UNRA operational targets)
information
information
Operations
prioritisation of bridge maintenance works (recurrent)
detailed maintenance works programming
supervision of maintenance contracts
site supervision, quality control
reporting of physical/financial progress
Projects
prioritisation of bridge development projects (capital)
capital budget preparation
detailed development works programming
supervision of development contracts
site supervision, quality control
reporting of physical/financial progress

5 Outline Road-Map for UNRA Bridge Management Unit

5.1 General Principles

As mentioned earlier, the lack of proactive bridge inspections is impeding UNRA's ability to effectively undertake most of the other steps in the bridge management cycle. Therefore, the first task for the BMU is to recruit and train staff in effective bridge inspections. The quality of data (degree of detail) collected from these inspections must be sufficient to enable the Bridges Manager to:

- make decisions regarding the type, extent and urgency of repairs
- make decisions regarding the need for more detailed (special inspections)
- make decisions regarding the need to place restrictions on the use of the bridge or to close the bridge until repairs, rehabilitation, or replacement is completed
- coordinate proposed bridgeworks with planned road works (maintenance or development works)
- to keep the bridges database of inventory and condition up to date, thereby reflecting the current status of the bridge population on the national road network
- to determine bridge budget requirements (recurrent and capital budgets) and to prioritise works within the allocated budget constraints
- coordinate with UNRA's road network planning function so that the Monitoring & Evaluation section in the Planning Directorate monitors the overall performance of roads links (i.e. road pavement and bridges, etc) against UNRA's performance targets described in its Strategic and Business Plans, and in its Performance Agreements with the MOWT and the Road Fund.

After the BMU has developed suitable capabilities in bridge inspections, the emphasis of training can shift to bridge engineering. In other words, we will first train BMU staff to collect bridges information and then train them in what to do with this information. Much of this bridge engineering training should be on-the-job in order to:

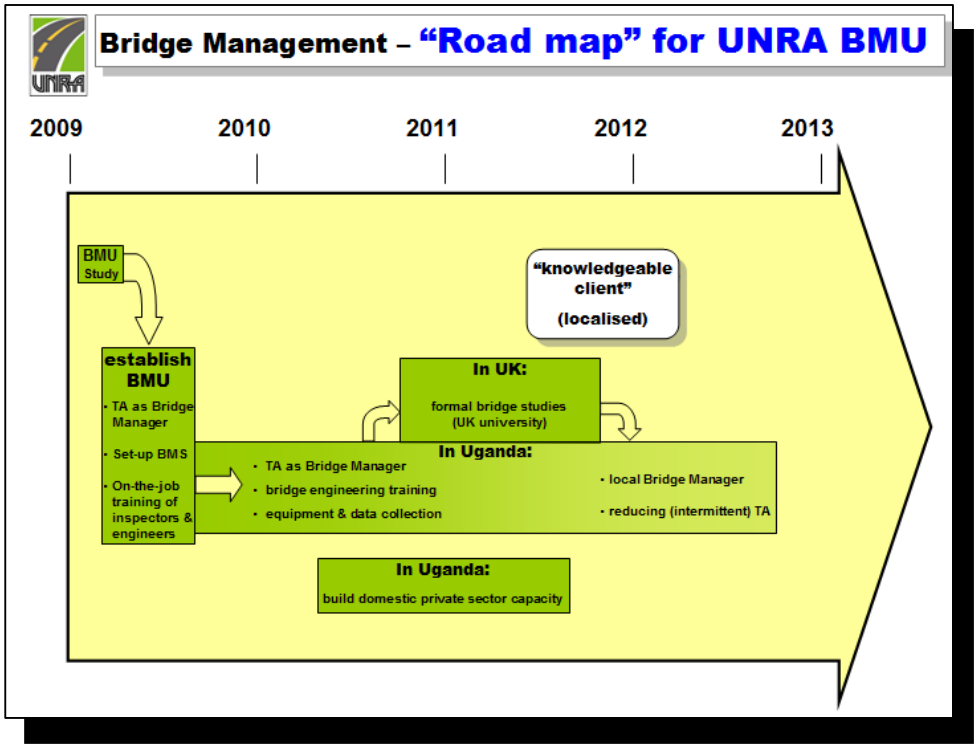
- ensure that the bridge engineering training reflects the day-to-day needs of managing the bridges on the national road network
- concentrates on practical solutions within the resource envelope available to the BMU, rather than academic principles
- develops a team approach to bridge management by defining daily tasks and mentoring the BMU staff, thereby encouraging interest in the importance of managing these bridges and career development

Finally, the training and technology transfer must lead to establishment of adequate capability within the BMU to effectively manage the work of consultants; for example, the current studies for the Second Nile Crossing and for the 24 bridges in North-West Uganda.

5.2 Progressive Capacity Building

In describing a "road map" for establishment and development of UNRA's BMU, we have borne in mind the above objectives and developed a "road map" that provides a progressive approach to building capacity from inspections to engineering solutions. The Bridge Planner and bridge engineers (and technicians) in the BMU will be trained in these items but, in parallel, the Bridges Manager will mentor the Bridge Planner in setting up and using the BMS for effective bridge data management, compilation of bridges budgets, prioritisation of bridgeworks across the whole bridges population, and performance monitoring and evaluation.

The "road map" is shown below as a time chart of linked activities. It commences with the current Study for Establishing the BMU (this Inception Report and our Final Report, which will be submitted at the end of March 2009), leading – without discontinuity – to **establishment of the BMU in April 2009**.



A flexible technical assistance arrangement of 9 man-months shared between two specialist is proposed for assisting UNRA in establishing the BMU, setting up appropriate management procedures, including making necessary provisions for coordination with the Asset Management and Monitoring & Evaluation functions within the Planning Directorate, and effective coordination with the Projects and Operations Directorates. And these coordination roles need to tie-in to UNRA's strategic and business plans.

The technical assistance should commence in April 2009 so that the urgent bridge management issues identified during the BMU Study can be addressed without any delay. In addition, the BMU Study consultants are already assisting UNRA in reviewing current bridges studies and continuity of this support is an important requirement as these studies are at feasibility and early design stages. A gap in the

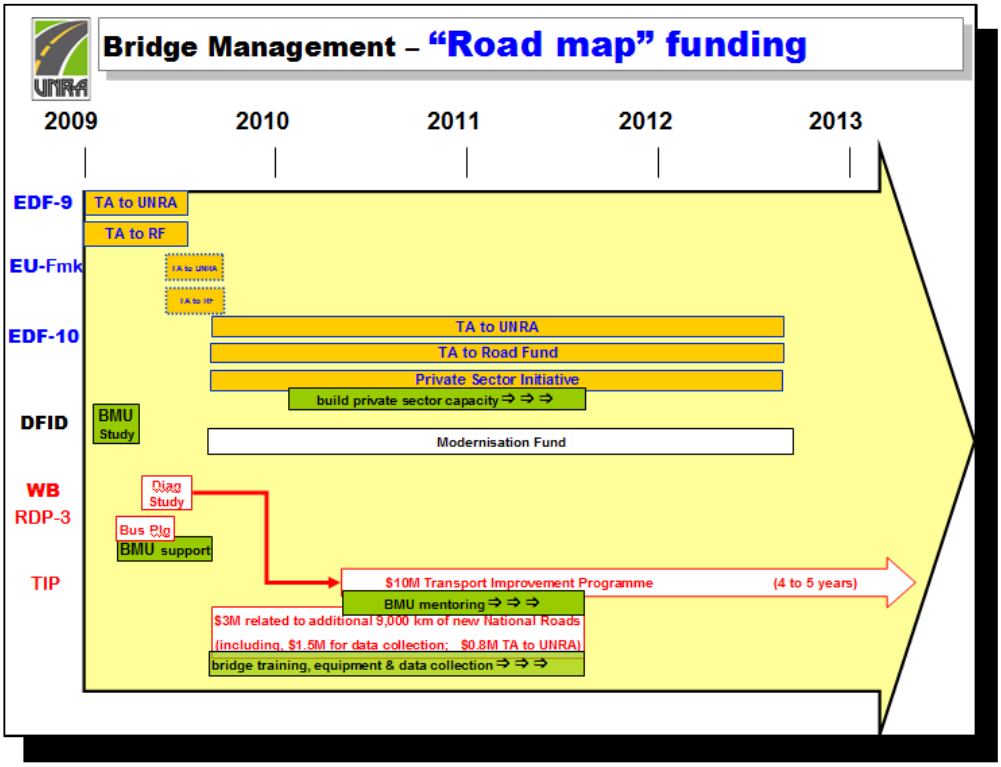
detailed bridge management knowledge in UNRA (by not having adequate technical assistance for a period of time) could mean that UNRA misses opportunities to comment on and rectify bridge design decisions that would result in increased costs and/or bridge management difficulties at a later stage.

Following on from the 9 man-month technical assistance would be a substantial post of Bridges Manager also as a technical assistance post. Our recommendation is that the post should be full-time from late 2009 until late 2011. During this time, the Bridges Manager would train the bridge inspectors and bridge engineers, while also mentoring the Bridge Planner in on-the-job issues related to bridge management. The Bridge Planner would then complete a formal academic course in bridge management. Upon return to UNRA in late 2011, the Bridge Planner would be promoted to Bridges Manager and the technical assistance post would be wound-down via intermittent inputs – possibly over a six to nine month period depending on the practical issues and volume of work to be addressed at that time.

In parallel to the capacity building measures for the BMU, the "road map" includes capacity building to the domestic private sector in Uganda for both consultants and contractors. Depending on the quality of people in the private sector, UNRA can consider whether to out-source some of the bridge inspections or to keep those responsibilities in-house and which work might be out-sourced.

5.3 Funding Sources for implementing the BMU "Road Map"

The slide below shows the possible sources of funding for implementing the "road map", beginning with the 9-man-months of technical assistance to set-up the BMU and guide its initial activities. The current BMU Study is being funded by DFID. It is likely that the follow-on 9 man-months will be funded by either the World Bank or DFID. See Appendix E for the Draft terms of Reference for this Consultancy.



It is has been agreed that two World Bank funded projects will commence in 2009:

- the 2-year approximately US$3 million, which will include $1.5 million for road and bridge data collection on the 9,000 km of roads being transferred to UNRA, and $0.8 million for technical assistance

- the 4-5 year US$10 million Transport Improvement Programme (which has now been renamed to the **Transport Sector Development Programme**), and

We suggest that the former project, which is expected to start first, should be used to fund the position of the Bridge Manager full-time from late 2009 until late 2011 (i.e. 2 man-years), and then a reduced input of, say, up to 6 man-months (0.5 man-year) over the following nine months, by which time the local Bridges Manager should be in position and full capable of managing the BMU. The same project would be used to fund the 12-month academic course (although, in practice, this might come from DFID's Modernisation Fund which would be managed under the World Bank project).

The European Union funding, EDF-10, is expected to commence in mid-2009 and will include three streams of funding:

- technical assistance to UNRA

- technical assistance to the Road Fund, and

- private sector initiatives

We suggest that funding under the private sector initiative should be used for development of domestic private sector consultants and contractors.

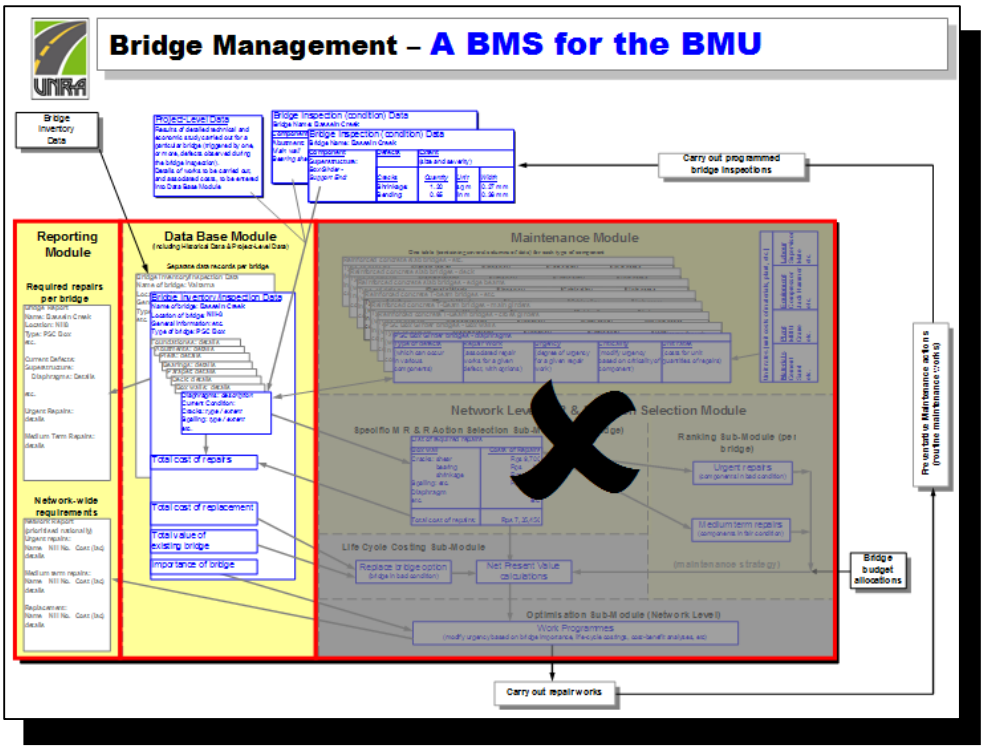
6 A BMS for the BMU

6.1 Primary Features of Bridge Management Systems (BMSs)

Many computer-based bridge management software are now available. The first generation of BMSs merely held inventory and condition data but could not process the data to assist bridge managers in making informed bridge management decisions. These systems were just a convenient means of storing large amounts of data and perhaps simple sorting of the data. Effectively, these systems provided a readily available history of the bridge stock and current state reports but had no processing capabilities to produce work orders or to predict future condition. Most of these first generation systems recorded bridge data at the component-level, with element-level data only being provided for items that were found to require immediate works (thereby improving the quality of information for the current state reports).

The second generation of BMSs included improved reporting modules based on simple internal data processing that helped bridge managers to produce annual budgets, prioritise works, etc. These systems included improved facilities for recording defects and required works, and other bridge criteria, so that they could produce simple prioritised work lists. Some systems also included an ability to enter total allocated budgets from which they would then produce an annual bridge maintenance works programme within the prescribed budget.

The third generation of system, which came onto the market from the early to mid-1990s, included modules that would assess current load carrying capacity and estimate remaining functional life. In order to do this, they required element-level data for a whole bridge to be entered. The more advanced versions included defaults where data were not available. As shown in the slide below, the amount of



data required for these third generation systems increased enormously. In addition to detailed information on each bridge element, they also required bridge deterioration models to be calibrated for the locations of the bridges. For bridge management jurisdictions that cover only a city, district or state, this is not too difficult to achieve. But, when the jurisdiction includes a whole country that has different climatic and environmental conditions in different regions, the calibration of deterioration models becomes a huge exercise in itself. Not only is it very expensive to collect the level of data for initial setting-up of these BMSs (detailed bridge inventory at element-level, condition of each element, and the climatic/environmental parameters), but it becomes a huge burden on the bridge managers to keep this information up to date. As soon as the database of bridges and their condition contains outdated information – even for a few bridges – the system can no longer be used to obtain reliable predictions of bridge condition, budgets, remaining life, etc.

6.2 Recommendations for a BMS for UNRA

In view of the logistical and resource difficulties associated with the more advanced third generation BMSs, we recommend that the BMU should only be provided with a good second generation system.

The essence of a BMS is that it should assist bridge managers in making informed bridge management decisions. A meeting was convened on 26th February 2009 at UNRA between the Planning Directorate and Roughton International / Africon regarding the BMS proposed by these consultants and the bridges data collection exercise. The BMU Study consultants were invited to attend this meeting to advise UNRA on these issues.

In summary, the level of bridges data collected to date is insufficient for the purposes of the BMU. Further data need to be collected, which can be entered into the BMS, that will enable the BMS to trigger actions that need to be taken by BMU personnel. These actions might be:

- just routine maintenance until the next inspection or incident
- an immediate follow-up, detailed inspection (a “special inspection”)
- minor repairs to be carried out before the next periodic inspection minor repairs might be defined as repairs for which there is a standard action that does not require a specific design for these works
- major repairs to be carried out within the current financial year (or start of the subsequent financial year, if the inspection was undertaken near the end of the current year); major repairs would be defined as repairs for which a specific design is required
- urgent repairs to be carried out, for example, within a few weeks
- immediate closure of the bridge for reasons of public safety, until a special inspection has confirmed that it is safe to re-open the bridge – perhaps after rehabilitative measures have been completed

If the BMS is also to be used to help prioritise bridge works, in conjunction with UNRA’s road planning function, then the BMS should also hold information regarding traffic levels and diversion distances (or be linked to a road management

system with such information). If not, then along with the more major actions triggered by the BMS, there should be an action that causes the BMU Bridge Planner to liaise with the road planning section in the Planning Directorate, as well as the Operations and Projects Directorates, to ensure that any major works are not carried out inconsistent with actions planned for the adjacent roads.

The National Roads Data Collection Project consultant only made the Draft Design Report for the proposed BMS system available with the last few days of the consultancy.

We have therefore included in this report the recommendations for the BMS

Our original recommendations arose from were based on discussions at the meeting in UNRA on 26th February, we understand that it comprises a simple data entry module that links to a roads database. As a guide for UNRA, we would recommend that the BMS should comprise the following features.

Module	Key Features
Inventory Module **(data entry interface)**	The inventory information will record the bridge details as a descriptive "snapshot" of the bridge at a moment in time. It is important that the inventory records (bridge components and elements) provide sufficient information so that future inspectors can record defects against relevant bridge items. The inventory details should provide a unique identifier that also facilitates changes to the road length (e.g. due to realignment) and geospatial location of the bridge. Since the inventory records a bridge at a moment in time, sufficient photos should be taken to record the primary bridge features, especially items that are likely to need close attention in future; this will help the bridge manager to ascertain if an inspection was carried out in sufficient detail when he checks returned inspection forms.
Inspection (Condition and Urgency) Module **(data entry interface)**	The type of inspection must be entered; e.g. routine, periodic or special. If it is a special inspection, then the reason for the inspection must also be entered into the system (e.g. was the special inspection triggered by defects observed during a routine or periodic inspection, due to an incident that damaged a bridge component, etc). The bridge inspection information will be different for routine, periodic and special inspections. This means that different data entry screens will be required, but there should be sufficient commonality between screens so that data entry does is not unnecessarily duplicated. The level of information to be entered must be consistent with two objectives: **Next Actions:** the inspection information must inform the bridge manager what next actions are required for each bridge, even if

	that next action is simply the next type of inspection (routine or periodic, noting that special inspections will be triggered by incidents) **Priority:** the information that triggers "next action" must also indicate the degree of urgency so that the bridge manager can use professional judgement to prioritise the actions based on his available budget, other resources, and workload (other priorities)
Database Module	This module stores relevant information from the inventory and inspection (data entry) modules. The data must be stored in a manner that permits a bridge manager to interrogate the system to locate information on individual bridges, bridges on a road section, bridges in a geographical area, bridges of a certain type/age/etc. The database should also enable information relating to specific inspections to be extracted; for example, the last set of periodic inspections carried out in a certain year; the last special inspection for a particular bridge, etc.
Works (Costs and Budgets) Module **(data entry interface)**	This module enables sufficient data to be entered so that "unconstrained budgets" can be determined for the BMS. That is to say, it will accept information that describes work to be done on the bridges and the associated costs (even if these costs are entered as lump sums for each work item, rather than relying on the BMS to calculate costs from unit prices).
Maintenance, Repair and Rehabilitation (MR&R) Module	By combining this information with the urgency of the action (from the condition/inspection module) the bridge manager can compile his annual budget. It is possible that the total costs of all required actions exceeds the available budget, in which case the bridges manager "draws a line" under the accumulated costs of prioritised actions. The BMS should therefore ensure that all urgent items are prioritised such that they are included in the list of works within the "constrained budget". Any urgent items not included in the available budget should be flagged so that the bridges manager knows how much additional budget he needs to obtain – as a matter of urgency. At this time, we do not recommend that the MR&R module include predictive capabilities, such as deterioration models from which future condition and anticipated expenditure patterns can be generated, estimates of remaining functional life, etc.
Reporting Module **(output formats)**	The reporting module should enable a variety of reports to be produced (on screen and hard copy), ranging from charts and maps showing bridge condition to structured data reports for budget compilation, works programming (based on the Inspection (condition and urgency) and Works (costs and budgets) modules.

The Terms of reference for this Consultancy required that the Consultant review the proposed Bridge management system being provided by the consultant for the National Roads Data Collection Project.

Our comments on the National Roads Data Collection Project consultants Draft design report for the RMS and the associated BMS is summarised below together with our recommendations for the recommended Input and Output features for an appropriate BMS for UNRA.

We have begun the review by examining the Standard Inventory and Standard Inspection Forms, and gone on to identify the Bridge Management System Inputs, Outputs and algorithms for the appropriate framework for UNRA's Bridge management system reflecting the current capacity of the Bridge Management Unit resources, expected short and medium development of the Units capacity with emphasis on the avoidance of 'black box' system architecture enabling a more practical hands on understanding to be used by the Bridge Managers and his staff.

Bridge Management Specialists study comments on RMS Design Report 0.2 (Draft) received on Friday 27th March 2009

From consideration of Figure 5 of the above report that showing RMS System overview, and Paragraph 3.9 showing the Bridge Management system overview that is now appears following UNRA's feedback comments on the first design report and the subsequent meetings between the BMS study team which the Bridge management system has been incorporated into the dTIMS Asset Management Database via a Bridge Data Entry Module.
The input of the Bridge Inventory and Bridge Inspection forms are now clearly identified on the System overview diagrams.

It is noted however that the final paragraph of Section 3.9 Bridge Management System (BMS) , Page 30 of the report indicate that the Bridge Data Entry Module and dTIMS are configured to match UNRA's current bridge inspection forms.

It is not clear if these forms are the MOWT & C forms included in the Study's Terms of Reference or the forms used to date by the Data Study Team which are based on the Africon forms.
These forms have been reviewed by the BMS Study Team and are generally found to be acceptable for use by UNRA.
However If the Africon based forms are to be adopted the forms need to incorporate some additional data entry fields previously identified by the Bridge Management Unit Study Team, such as length and condition of detour routes.

It is important that the data entry criteria are incorporated into a Bridge Inspection Manual that incorporates both the BMS user manual and describes the indicators for deriving the Bridge

component Condition rating which are key values needed to arrive at reliable indicators if these are to be used for preparing overall required maintenance budgets.

It is also noted that the dTims will be able to produce pre-printed Bridge inspection forms and it is assumed that the system will be able to be easily configured to produce the type of outputs showed in the following figures at both the Network Project level.

The dTIMS also more significantly introduces what is called a Life Cycle Cost Analyser, (LCCA) which has been identified as the 'engine' of the Bridge management System.
This LCCA will produce the Bridge Rating calculation based on condition ratings for the main components of the bridge, (approach, waterway, substructure, superstructure and roadway), and an Overall Deficiency Index which can be used to rank or prioritise bridges based on user defined criteria including the Level of Service provided to the Public, Condition of the Bridge and Importance of the Bridge.

Appendix C of the Design report describe the calculations that it is proposed to use to derive each of the above Ranking Formula.

The criteria for determining such factors as Number of Lane Factor, Minimum acceptable clear deck width, Vertical Clearance limits, (thought to be of minor relevance in the Ugandan environment where most structures are Under Bridges) are easily understood and therefore change to coincide with UNRA's overall Strategic Objectives.
However it is important to note that there are number of Ranking Variables /General Constants, listed in the Table listed in the Table listed in clause 2.4 that have been proposed without any clear rationale.
The Data Study consultant should clarify the rationale behind the choice of these values and a Sensitivity study using a range of constant values should then be carried out once the BMS has been populated to identify how each one affects the overall calculated Deficiency Rating at both Project level and Network level.

Failure to calibrate the system could result in a 'Black Box' BMS system that may not be compatible with UNRA's overall strategic objectives and if not fully understood will not be able to be changed to accord to the changing needs of the organization.

It is the BMS study teams general conclusion on the BMS that too much complication in a BMS system will remove the Bridge management Team manger from the bridge management process due to the complexity of the parameters of the BMS.

We would therefore recommend that the BMS should comprise the following features:-.

Inputs, Outputs and Algorithms for a Framework for UNRA's Bridge Management System reflecting current capacity of Bridge Management Unit resources

Project Level Outputs :- Individual Bridge, Elements or Components Level

PRIMARY OUTPUT	SECONDARY OUTPUT
General Queries	List and count meeting specified criteria
Inspection History	List and count bridge that are overdue for inspection
Test History	List and count bridge that are substandard
Maintenance History	List and count bridges that are in the poorest condition state
Traffic History	List and count bridges with traffic restrictions
Condition History	Budget needed for the optimal maintenance programme
Load carrying capacity & History	Routing of heavy, high wide or long vehicles
Posting History	Cost rates for different maintenance options
Optimal Maintenance Programme	The number of bridges with deferred maintenance due to a sub-optimal budget
Prediction of variation of condition with time	The long term cost of deferring maintenance due to a sub-optimal budget
The effect of maintenance and/or strengthening on the future rate of change of change of condition and or load carrying capacity	The prioritized maintenance programme for a given sub-optimal budget
	The prioritized maintenance programme based on other constraints
	Predictions of load carrying capacity for a specified budget
Cost of Optimal Maintenance Programme	Prediction of the condition for a specified budget/maintenance programme
Estimation of the cost of maintenance based on the load carrying capacity and condition	History of different types of maintenance
	History of the occurrence of different types of defect
	History of the occurrence of substandard bridge
	History and performance of different element and component types
	History of performance of different maintenance methods

Outputs that will not be available until historical data has been recorded

Project Level Outputs
Input data and Algorithms required to satisfy Project Level Outputs

OUTPUT	ALGORITHM	INPUTS	COMMENTS
A1 - General Queries	Database Query	**Inventory**	**Required** i.e No of Virendeel Truss bridges on Network
A2 - Inspection History	Database Query	**Date of Inspection** **Type of Inspection** **Extent/Severity** **Occurrence of defects**	**Required**
A3 – Maintenance History	Database Query	**Date of maintenance** **Location of maintenance** **Type of maintenance** **Area maintained** **Cost of maintenance** **Immediate effect of maintenance on load carrying capacity/condition**	**Required** but only comprehensively available from installation of BMS
A4 - Traffic History	Database Query	**Duration and extent of any traffic delays** **Date of survey** **Flow rate** **% HGV's** **Alternate Route** **Additional time/distance**	**Optional** but recommended. Alternative route length required to be in the Inventory Time/distance generated from dTIMS roads management system
A5 – Load carrying capacity History	Database Query	**Assessment of Load carrying capacity** **Date** **Load carrying capacity** **Test history**	**Required**
A6 – Post history	Database Query	**Start and finish dates for any load, height, width restrictions**	**Required**
A7 – Predicting the variation of load carrying capacity with time	Markov Chain or Neural Network Models	**Outputs A2 to A5**	**Not recommended** in current BMS as no historical date to populate

OUTPUT	ALGORITHM	INPUTS	COMMENTS
A8 – Predicting the variation of condition with time	Markov Chain or Neural Network Models	**Outputs A2, A3, A4, & A6**	**Not recommended** in current BMS as no historical data to populate
A9 – Estimating the cost of maintenance	Neural Network Models	**Outputs A2, A3, & A5**	**Required but with facility for manual input ofdata**
A10 – Estimating the cost of Traffic Delays	HDM4/dTIMS	**Outputs A3 to A6**	**Not recommended** in current BMS as no historical data to populate but
A11 – Optimal maintenance programme		**Outputs A7 to A10**	**Not recommended** in current BMS as no historical data to populate

Input Data and Algorithms required to satisfy the Network Level (entire bridge stock or subsets of the stock) outputs

OUTPUT	ALGORITHM	INPUTS	REMARKS
B1 – List /count of bridges satisfying specific criteria	Relational database processing	Inventory	
B2 - List /count of bridges overdue for inspection	Relational database processing	Output A2 Date for next inspection	
B3 - List /count of bridges that are substandard	Relational database processing	Outputs A5	
B4 - List /count of bridges in the poorest condition state	Relational database processing	Outputs A2	
B5 - List /count of bridges with traffic restrictions	Relational database processing	Outputs A5 and A6	
B6 – Budget for optimal programme		**Output A11**	Not available in current BMS as no historical date to populate
B7 – No. of bridges with deferred maintenance		**Outputs A11 and B9**	Not available in current BMS as no historical date to populate
B8 – Long term cost of Maintenance	**Neural Network Dynamic Programming**	**Outputs A7 to A11**	Not available in current BMS as no historical date to populate
B9 – Prioritized maintenance Programming	**Neural Network Dynamic Programming**	**Outputs A7 to A11 Budget Constraints**	Not available in current BMS as no historical date to populate

7 Review of work of current consultants

Projects Reviewed

We have had the opportunity to carry out detailed reviews on five consultant's designs and outputs during this consultancy.

These are :-

Construction of 21 Bridges in North and North Eastern Uganda - Phase 1. Lot 1:- Drawings and contract documents for the Aswa Bridge designed by Norplan (Uganda) now renamed as Newplan

The Strategic Bridge Study of 24 Bridges by Gauff Consultants (Uganda)

Engineering design report and contract drawings of two multi-span bridges and a number of culverts

Consultancy Services for the National Roads Data Collection Study by Roughton International in association with Prome Consultants Uganda.

Feasibility Study on the Second Nile Crossing at Jinja, review of Progress Report No.1 and Second Meeting of the Steering Committee held on Wednesday 18th February 2009 carried out by the JICA Study Team made up of Oriental Consultants Co. Ltd, (OCCL)

Detailed comments are contained in the working papers included in **Appendix H**.

7.2 Conclusions of the reviews

- The information on the contract drawings is commonly not comprehensive enough to avoid a large input from the site supervision team (which may be inexperienced) and will have little backup from the bridge design teams. The potential for contractor's claims and site mistakes affecting the service life and whole life cost of the bridge is therefore unnecessary high.

- The setting out data is spread over a number of drawings and is often inconsistent leading to site delays and possibility of mistakes.

- It is common for borehole locations not being shown on the plan and even though a borehole log is included on the drawing, the level of borehole is not stated making its of little relevance to the Contractor at the time of tender and therefore increasing the possibility of claims for unforeseen ground conditions later in the contract.

- BS 5400: Part 2 Ha and HB loading is often not being interpreted correctly, especially the accidental wheel loading for verges and loads on buried culverts.

- Composite steel beams/concrete deck slab design is in common usage but the steelwork details are basic. For instance the bracing adopted is often inefficient, en

The bracing at supports is being omitted, critical fabrication details such as full strength but weld details at flange thickness changes are not provided, poor fatigue details at transverse stiffeners. No consideration is generally given for the need to pre-camber fabricated girders to cater for dead load deflection from the deck slab concrete prior to the section acting compositely. The deflection allowance can only be given by the designer.

- The use of approach slabs is inconsistent, some consultants use them, some don't
- The detailing of the structure for earthquakes seems to have not been taken into account. Even Acceleration Coefficient Level I structures require a minimum length of support, and a robust method of transferring earthquake loads from the deck is not clear.
- Little or no consideration is currently given to future maintenance. For instance bearings are not on plinths, there is no abutment bearing shelf drainage provision, no back of wall drainage or waterproofing of buried surfaces, no provision or space for jacking the deck when bearings need to be replaced during the life of the bridge.
- Reinforcement detailing practices are outdated with no awareness of the need to stagger laps especially in walls to avoid internal restraint issues and premature cracking.
- Reinforcement spacing is generally too large at 200mm, and will result in the lack of crack control due to early thermal cracking whilst the concrete is immature and has little tensile tolerance. Overall affect will be the onset of early corrosion and loss of serviceability of the structure.
- Lack of any consideration of water management on the structure especially the lack of such details as drips to encourage water to fall off the structure instead of running over the concrete and steel surfaces, and thereby encouraging the earlier than necessary onset of corrosion.
- Lack of awareness of the need to consider the overall articulation of the bridge resulting in elastomeric bearings being required to have excessive deflection to accommodate resultant temperature movement with predicable shortening of their serviceable lives and the need for early replacement.
- General lack of awareness on the construction process, especially the need to make details easy to construct and generally repetitious. For instance one design consultant has different thicknesses of marginally different height wingwalls, presumably to save material, another details shear links in the top slab and walls of a buried culvert when a small increase in slab thickness would make the structure safer, due to reduction in the potential for brittle failure under shear forces, and quicker and easier to construct.

7.3 Recommendation for improvement of consultants current design outputs

- The Terms of Reference need to be clear as to what is required from the commission so as to avoid confusion that enables the Consultant to dumb down the outputs

- The need to be a 'knowledgeable client' is clear from the limited dealings with the consultants to date.

- Consultant's Inception reports must be checked against their Technical bid submissions to ensure the consultant's project team is aware of the project requirements and anticipate delivering to the Terms of Reference.

- UNRA should develop a Bridge Design Specification incorporating specific requirements on maintenance aspects,

- UNRA needs to develop Standard Details and good practice for detailing of such bridge elements as drips, chamfers, bearing plinths, reinforcement detailing, structure and substructure drainage standards, parapet details etc.

- Consideration should be given for developing designs for standard bridge decks for a discrete range of spans, and alternative construction types, steel composite, reinforced concrete slabs or concrete beams, post tensioned concrete beams simply supported decks, (perhaps using Integral designs) of 15, 20, and 25 metres (Current average span range of the Ugandan bridge stock is just 10.7 metres) but care will be needed in substructure design as both height and allowable bearing pressure will have to be considered.

- Develop standard design for a range of box culverts up to 3 metres, then details for multi spans and associated wingwalls

8 Review of present bridge maintenance practices

8.1 Conclusions on Issues identified during discussions with Operations, and Planning Directorates

- Routine maintenance was not carried out to any great extent by the MOWT & C
- Bridge maintenance is currently still being carried out by UNRA on an emergency (reactive) or ad hoc basis. The Nalubaale bridge (Owan Fall Dam Bridge) slabs are a good example of where regular inspection would have identified the development of a reoccurring fault before it became an emergency situation.
- The work that is defined as Routine maintenance activities and carried out twice a year is currently not specified, although is allocated to each bridge each year
- A sum of 500,000 Ugandan shillings for Routine bridge maintenance is included in the maintenance budget, but there is no definition as to what work is expected to be carried out under 'Routine bridge maintenance, and to what specification.
- There are no standard specifications for common bridge repairs. Usually it is up to the Station Engineers, or occasionally the Bridge expert in Planning to decide on what is required.
- Understanding of bridge maintenance operations is variable between the Stations Engineers with evidence that some Stations are carrying out operations such as deck slab and other concrete repairs which are more akin to Periodic or emergency repairs with no design input to ensure that the repair is appropriate.
- There is currently no procedure to enable Station Engineering staff to be able to seek guidance or advice on particular bridge maintenance issues.
- Development of potentially dangerous defects are unreported due to an overall lack of knowledge. Key 'triggers' of structural condition are not reported, often leading to the need for emergency maintenance.
- There is a need to identify 'trigger' events, including emergency damage, from feedback inspection at the local level reporting to the central Bridge Management Unit as efficiently and reliably as possible, to enable the need for corrective maintenance activities to be efficiently initiated.
- Projects let to consultants to carry out bridge inspections, and design rehabilitation, or other maintenance interventions usually result in replacement of structures or lack of adequate inspection to determine the appropriate maintenance intervention with regard to whole life costing considerations.

8.2 Recommendations

- Define extent and frequency of expected Routine Bridge Maintenance operations to be carried out by Stations or Regions and incorporate into Road and Bridge Maintenance Manual. See Fig 8.1 for suggest Routine Bridge Maintenance Operations

- Identify and train Station staff on 'trigger' defects that require reporting and feedback to Bridge Maintenance Unit on Standard Feedback form to record work carried out and identifies ongoing issues.

- Develop standard specifications for common Routine and Periodic bridge repairs and carry out 'refresher' training of staff involved in carrying out or supervising bridge maintenance or new construction operations.

- UNRA BMU to carry out internal Workshops and Seminars to sensitise UNRA Station staff to bridge maintenance and bridge construction issues

- Develop and use appropriate Terms of reference for the engagement of Consultants that emphasise the need to consider preservation of the valuable bridge asset using appropriate rehabilitation designs that may include the to replacement of the structure as a last resort.

Suggested definitions of Routine Bridge Maintenance Operations to be carried out by Stations and 'triggers' requiring BMU consultation

Maintenance Objective	Possible Effect of Defect	Routine Maintenance Activity	Issue to be raised to Bridge Management Unit for confirmation of proposed action.
Maintain the road surface in a sound condition	Increased dynamic loading on structural elements	Fill surfacing potholes on deck Re-grade gravel surfacing Remove obstructions (concrete or other spillages) Repair of localised surface damage to concrete deck slab using approved repair procedure and materials.	Review of proposed detail for deck slab repair where slab is suspected to be cracked or deformed due to loading
Maintain Road profile	Water ponding on the deck Loss of serviceability and increase in the safety hazard to road users due to unexpected manoeuvring to avoid any standing water Loss of utility and increase in safety hazard to pedestrians due to splashing from traffic and increased conflict from pedestrians using carriageway to avoid water	Re-grade gravel road	In the case of ponding being a new occurrence the problem may be indicative of a more potentially serious problem arising from abutment or pier settlement or scour or failure of the foundations
Maintain Drainage system	Effects of water ponding on the deck as listed above. Ingress of water through micro cracks and voids in concrete surface Erosion of approach embankments either end of bridge due to excessive surface water run-off Water build-up behind abutments causing increase in horizontal loading and potential for sliding or rotational failure of abutments.	Clean out existing deck drainage system Repair damaged or missing deck drainage pipes Check that drainage outfall pipes are deposing the water clear of the structural elements. Check on blockage and discharge of lower level of weep-holes on abutments and wingwalls	Report on excessive water flowing from abutment weep-holes as Report on any new signs of movement or cracking or deformation of structural elements

Maintenance Objective	Possible Effect of Defect	Routine Maintenance Activity	Issue to be raised to Bridge Management Unit for confirmation of proposed action.
Remove vegetation from structure	Obstruction of road users view Loss of useful deck cross-section due to traffic clearance distance from perceived hazard. Penetration of roots between structural elements causing physical damage and encouraging the retention of water, and possible detrimental chemical elements (sulphates, chlorides, fuel residues)	Cut grub and remove all vegetation from bridge deck, abutments, and approaches.	-
Repair damage to railings and parapet systems	Vehicular and pedestrian safety hazard (especially at night). Damage to the parapet fixings and bridge elements supporting the railing/parapet will accelerate reinforcement corrosion and concrete degradation of edge supports.	Repair metal railings and concrete post and rails and any guardrails on the approach or departure to the bridge.	Report to BMU where no parapet system has been provided. Periodic Maintenance Design required
Paint metal railings	Vehicular and pedestrian safety hazard (especially at night). Corrosion and loss of strength of supporting post and rails	Repaint using standard paint system Section 6900 of the Specification and noting requirements of Clause 6910 (Painting Galvanized metal Surfaces) where necessary. Standard white and black chevron pattern to finishing coat.	-
Maintain road signs at narrow bridges	Vehicular and pedestrian safety hazard (especially at night).	Clean existing signs where provided Erect signs on narrow structures (less than 6.5 metres of carriageway)	-

Maintenance Objective	Possible Effect of Defect	Routine Maintenance Activity	Issue to be raised to Bridge Management Unit for confirmation of proposed action.
Clean and paint concrete approach blocks where provided at narrow structures	Vehicular and pedestrian safety hazard (especially at night). Increased accident potential and potential damage to structure	Clean and paint existing blocks (White or retro-reflective paint on approach traffic faces	-
Maintain River training works	Increased scour of foundations leading to movement of substructure and eventual bridge closure.	Minor loss of protection can be repaired either using new materials with a high standard of workmanship if repaired	Large loss of protection may indicate a change in river flow patterns that may require some review and design.
Maintain Expansion joints	Hazard to vehicular traffic Increased dynamic loading on structural elements Potential damage to deck slab Increased leakage of water and debris onto bearings, if any, and abutment bearing area. Potential for the loss of bridge articulation, due to 'locking' of deck against the abutment back wall and attendant potential failure of wall, horizontal cracking of mass concrete abutments under large horizontal loading	Clean out debris from expansion joint Replace failed expansion joints with welded cover plate or 'Compression strip' type joint	Periodic Maintenance Design for more effective and lower maintenance expansion joint system may be required. Refer issue to BMU for review of performance of Expansion joint system and identification of similar problems on other structures.
Repair of vehicle impact damage to structural elements of through trusses, Bailey Type bridges	Loss of capacity to carry dead or imposed loading leading to loss of structure	Dependant on structure and extent of damage	Refer all accident damage resulting in noticeable deformation of any structural elements to BMU for recommendation on actions as soon as possible.

Maintenance Objective	Possible Effect of Defect	Routine Maintenance Activity	Issue to be raised to Bridge Management Unit for confirmation of proposed action.
Sealing of cracks/repair of concrete honeycombing	Depending on the location of the cracking it may be indicative of a bigger problem with the structure and a loss of load capacity. Cracking is either 'live' (still happening, or 'dead (no further movement noticed)	Dependant on structure and extent of damage	Refer all occurrences of new cracking damage to main deck members to BMU for recommendation on actions as soon as possible.

Bridge Routine Maintenance Operations :-Record of Work carried out

Network Link Road Name		
Region/Station		
Bridge Name		**km**
GPS Bridge Co-ordinates	**E**	**N/S**

Maintenance Activity	Recommended Interval	Date Maintenance Activity carried out	Carried out under the supervision of:-	Comments to Bridge Management Unit (See Reporting Guidelines for mandatory BMU review of proposed maintenance action)
Inspect and Maintain Drainage System	Every six months			
Remove vegetation from structure	Every six months			
Repair damage to parapet and railings	Inspect every month Repair as necessary			
Painting Metal safety barriers and railings	Two year intervals			
Maintain Road Advance warning Traffic signs at narrow bridges	Inspect every month Clean/Repair/Replace as necessary			
Clean and paint concrete or other type of approach blocks	Inspect every month Clean/Repair/Replace as necessary			
Maintain River Training works	Inspect every month Repair/Replace as necessary			
Maintain Expansion Joints	Inspect every month Clean/Repair/Replace as necessary			

Structural Defect Report	Date of Inspection (Inspect every two months)	Brief description of extent (attach photos or sketch if possible)
Vehicle impact damage		
Identification of new cracks		
Increase in deflection of deck		
Identified movement of abutment/piers		
Cracking/potholing in deck slab		
Earthquake/Flood event		
Scour of footings		

Approved by:

_____ _____

Manager **Date**

9 Detailed Work Plan

9.1 Terms of Reference

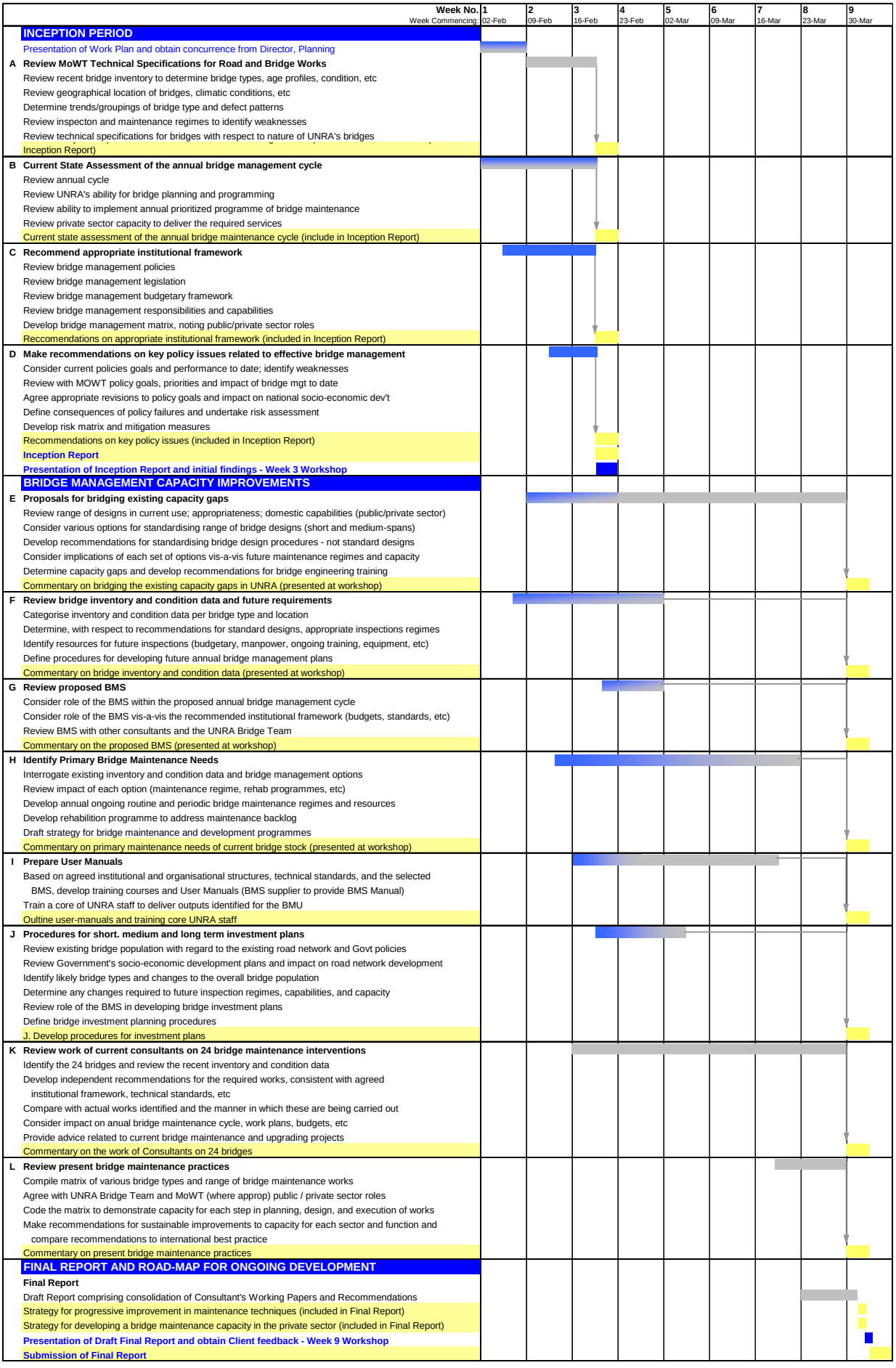
The terms of reference for the BMU Study clearly describe the overall objectives and specific activities for the study. This Final Report records the work carried out during the study, including the workshop at the end of weeks 3 and 8 at which the Consultants' recommendations were presented and UNRA feedback obtained. Agreements reached at the end of the workshop are included in this Final.

9.2 Detailed Work Plan

The work plan shown overleaf provides more information and refines the timescale for certain tasks and deliverables.

The Consultants are adopting a flexible approach to the study, taking on additional bridge management related tasks, as appropriate, to ensure that UNRA receive optimal support at this stage of considering the role, responsibilities, resource requirements, and future management policies for its Bridge management Unit.

UNRA - Establishment of a Bridge Management Unit: Work Plan



Appendices

Appendix A: TERMS OF REFERENCE

1. Introduction

The Government of Uganda (GoU) has received a grant from DFID and intends to apply a portion of the proceeds of the grant towards the provision of technical assistance to the Uganda National Roads Authority (UNRA) for establishing a bridge management unit in the Planning Directorate.

Technical Assistance Services are required to review and audit the bridge inventory and condition data of national bridges collated by an on-going consultancy, establish an appropriate bridge management system (BMS), populate the database with available information and where relevant, identify additional data sets required to develop annual maintenance plans and assist UNRA to develop capacity to manage the BMS.

2. Background

Uganda's national road network presently totals some 11,000km of which some 3,200km is paved. There is a substantial programme of upgrading from a sealed pavement to asphalt surfaced pavement and upgrading from an unpaved gravel pavement to a sealed pavement. There are approximately 300 bridges (drainage structures of span greater than 6 meters) on the national highways network, of which at least 30% of the bridges are in urgent need of replacement. In the past, periodic maintenance of bridges has been poor due to lack of capacity and inadequate funds. Consultants (Roughton International and Africon) have been engaged to collect the inventory and condition data for the national road network, including the bridges, and are tasked to set up an integrated network management system, dTIMS. An UNRA Bridge Team has been set up to oversee the work of the above consultants and to assist with establishing the Bridge Unit.

Until June 2008 the bridge network was maintained by the MOWT but since the establishment of UNRA on 1 July 2008 responsibility for management of bridges was transferred to UNRA. In pursuit of its mission "To develop and maintain a national roads network that is responsive to the economic development needs of Uganda, to the safety of all road users, and to the environmental sustainability of the national roads corridors". UNRA is keen to establish bridge management capacity with a view to undertaking a programme of backlog maintenance and developing annual maintenance plans for its bridge network.

3. Description of the Assignment

The assignment comprises input from a Bridge Management Specialist with extensive developing countries experience to undertake an institutional needs assessment with a view to establishing a Bridge Unit in UNRA. A large part this TA will require UNRA-wide consultations to define the overall bridge function of the new Bridge Unit and to develop simple systems and procedures for some of the key activities of the Bridge Unit. The Specialist will work closely with the UNRA Bridge Team and report to the Director, Planning.

4. Objectives

The objectives of this TA are to:

i) Recommend an appropriate institutional framework for implementing UNRA's bridge management function and a structure for the establishment of a bridge unit
ii) Review the Bridge Management System (BMS) proposed by Consultants and make recommendations for changes or additions required to meets the needs of the UNRA Bridge Unit.
iii) Develop UNRA's bridge management capacity and make recommendations to consolidate capacity in the UNRA bridge unit and a strategy to develop bridge maintenance capacity in private sector.

5. Scope of Technical Assistance Services

The Bridge Management Specialist will work under the direction of UNRA's Director of Planning and in close liaison with the Projects and Operations Directorates and in particular with the Manager of technical Services. He/she will also work closely with the UNRA Bridge Team and conduct consultative workshops in week 3 and in week 10 of his assignment. The TA Specialist will develop a plan of work in the 1st week of the assignment and seek concurrence from the Director, Planning.

Some of the tasks expected of the TA specialist are:

A. Review the MoWT General Specifications for Road and Bridge Works and in particular the current standards for bridge development and maintenance.
B. Undertake a current state assessment of the annual bridge maintenance cycle, UNRA's capacity to plan, programme and implement an annual prioritized programme of bridge maintenance, and private sector capacity to deliver the required services.
C. Recommend for UNRA's consideration an appropriate institutional framework for implementing UNRA's bridge management function.
D. Make recommendations on key policy issues related to the effective management of the national bridge asset and where relevant changes that may be required to existing bridge maintenance specification.
E. Make proposals for bridging the existing capacity gaps in UNRA, including proposals for developing standard type designs and bridge details for short- medium span bridges.
F. Review bridge inventory and condition data presently being collected by Consultants and if necessary make specific recommendation for future updates and additional data required to develop annual bridge maintenance plans.
G. Review the proposed BMS and make recommendations to make it compatible with the proposed institutional framework for UNRA's bridge function. This activity will require consultation with the Consultants and the UNRA Bridge Team
H. Based on available bridge data, identify the primary maintenance needs of the current bridge stock and in consultation with UNRA, develop a draft strategy to deal with the backlog and periodic maintenance needs on the national bridge network.
I. Prepare user-manuals and train a core of UNRA staff to deliver outputs identified for the Bridge Unit.
J. Develop procedures for preparing short, medium and long term investment plans.
K. Check the work of Consultants engaged for the design of maintenance intervention on 24 bridges and make recommendations for UNRA's consideration. If required, provide specific advice on current bridge upgrading and maintenance projects.
L. Review present bridge maintenance practice; recommend a strategy for progressive improvement in maintenance techniques and for developing a specialist bridge maintenance capacity in the private sector.

6. Human Resource Input

The suitable candidate for this assignment shall be a qualified Civil Engineer with in-depth experience in the design, construction and maintenance of bridges in developing countries. Experience in establishing a bridge management capacity in a National Roads Agency is mandatory.

7. Timing

The TA consultant shall commence inputs in early January 2009 and complete the assignment by March 31st.

8. Reporting and Other Outputs

The Specialist shall prepare and submit the following documents (all in English) to the client, all in an original and ten copies:

- A Draft Inception Report to include outline approach of the assignment, the findings of institutional needs analysis along with proposed structure for the UNRA Bridge Unit will be presented at the first workshop.

- Working papers will be produced to facilitate UNRA-wide discussions and to obtain decision on institutional issues identified in the course of this assignment.
- A Draft Final Report at end of week 10 to include outcomes of the assignment and a route map for on-going development of the Bridge Unit will be presented at the 2nd workshop.
- Workshop feedback and comments on the Draft Final will be incorporated into the Final Report.

9. Data, Local Services and Facilities to be provided by the Client

The client shall provide the consultant with all relevant reports and other documentation.

The client will assist in the facilitation, and with the co-operation of other Government Ministries, Departments and Agencies, as required, for carrying out the assignment and liaison as necessary. The client will give the consultant assistance to gain access to all information required for the proper conduct and completion of the assignment.

The client will provide office space and other facilities in accordance with WSP's contract, including the use of project cars for the purpose of local travel.

10. Consultants Obligation

The consultant shall provide a laptop and cell phone and will be responsible for his/her own professional indemnity.

Appendix B: RECORD OF KEY MEETINGS HELD DURING THE CONSULTANCY

Date	With Whom	Purpose of Meeting
2nd Feb 2009	UNRA TA Team Mr Michael Green Mr Nigel Lightbody Mr Bharat Patal Mr Steve Kekwick	Introductory Meeting with current WSP TA Team working in UNRA to discuss objectives, logistics of Bridge Management Project and introduction to UNRA's organisational and management procedures, and security travel and accommodation arrangements.
3rd Feb 2009	UNRA Director Planning, Mr David Luyimbazi Mr Jonathan Tugume Mr Jonathan Wazimbe Mr Valentine Mugisha Mr Charles Kizoto	Introductory meeting with the Director Planning and the UNRA Bridge Management Team to discuss the current status of bridge management in UNRA. Also for the consultants to advise UNRA of their intended approach to the study. Following the meeting, the consultants issued a detailed list of the initial information required for the study; the BMT members will arrange collection of this information for the consultants
4th Feb 2009	UNRA Executive Director, Eng Peter W Ssebanakitta	Introductory discussions regarding the consultants' intended approach to the study and deliverables
4th Feb 2009	UNRA Director Projects, Mr Okiror James	Introductory discussions regarding the consultants' intended approach to the study
4th Feb 2009	UNRA Director Operations, Mr Benjamin Ssebbugga-Kimeze	Introductory discussions regarding the consultants' intended approach to the study
4th Feb 2009	UNRA (all staff) Introduction by UNRA Human Resources Manager Mz.Jane Gatale	Introductions to all staff in all departments of UNRA
5th Feb 2009	UNRA Director Planning, Mr David Luyimbazi	Detailed discussions regarding road network and bridge management planning procedures previously in MOWT and recently in RAFU and UNRA. Reviewed the status of the BMT delivering information to the consultants. Received list of UNRA names from Director Planning who the consultants should contact to obtain outstanding information, maps, etc
5th Feb 2009	Roughton International, PROME Africon, Mr Dag Vegger Mr Shane Canavan Ms Yaa Boadi	Consultants accompanied by Mr Charles Kizito, UNRA, to ascertain approach and status of the road and bridge inventory/condition surveys. Bridge data collection completed but not yet entered into the BMS database. Agreed that UNRA will provide graduate engineer to enter the primary bridge data into a computer spreadsheet so that the study consultants can begin a preliminary assessment of the Uganda bridge population by 10th Feb 2009.
9th Feb 2009	Mr Jonathan Tugume, Bridge Engineer, UNRA	Consultants discussed with Mr Tugume the situation regarding Nalubaale Bridge, Jinja and planned a site visit
10th Feb 2009	UNRA Director Planning, Mr David Luyimbazi	Consultants received copy of the 2004 National Transport Master Plan for reviewing the sector-level plans within should inform UNRA's bridge management (planning) function
12th Feb 2009	Mr Jonathan Tugume, Bridge Engineer, UNRA	Consultants visited Nalubaale Bridge, Jinja to carry out visual inspection and give opinion regarding current condition and repair options. Also, viewed the upstream bridge piers and gave opinion

Date	With Whom	Purpose of Meeting
	Mr George Kyobe Inyensiko, Station Engineer, Jinja	regarding the repairs proposed by Mott MacDonalds
13th Feb 2009	UNRA Director Planning, Mr David Luyimbazi	Discussion regarding detailed road planning procedures (functional management of Planning Directorate), progress to date on the Bridge Management Study, and issues regarding availability of information/data.
16th – 20th Feb 2009	UNRA Planning Directorate staff, including: Mr Jonathan Tugume Mr Jonathan Wazimbe Mr Valentine Mugisha Mr Charles Kizoto Mr Jeremy Bassy Aguma Mr Mathias Ofumbi	Various discussions regarding road network and bridge planning, asset management principles employed in UNRA, network monitoring and performance evaluation, etc
17th Feb 2009	UNRA Chief Internal Auditor Mr Peter Kirimunda	Discussions regarding role of UNRA's internal audit function with respect to reviewing management procedures, due process, and overall performance (including identifying the reasons for sub-performance)
18th Feb 2009	Minister for Works & Transport, JICA Study Team for the Second Nile Crossing UNRA senior bridge and other staff Ministry of Finance Representative Jinja district representative	Second Steering Committee Meeting, at which the JICA Study Team presented their Progress Report No.1 regarding the Feasibility Study on Construction of a New Bridge Across the River Nile at Jinja.
20th Feb 2009	UNRA Executive Director, Eng Peter W Ssebanakitta UNRA Director Operations, Mr Benjamin Ssebbugga-Kimeze UNRA Director Planning, Mr David Luyimbazi Mr Charles Kizoto Mr Jonathan Wazimbe Mr Valentine Mugisha Mr Benjamin Olobu Mr Kausime Enid Mr Donald Lupimbazi Mr Namuwonge Harriet Mr Tony Coleman (WSP)	The Bridge Management Study Team presented their initial findings and recommendations, which summarised the intended draft Inception Report. The presentation included a review of the current institutional framework for bridge management, a review of the current bridge data collection exercise, recommendations for future inspection regimes, proposed composition of a BMU, where within UNRA the BMU should reside, outline specifications for a computer-based Bridge Management System (BMS), and a "road map" for establishing and developing the BMU through to full localisation within a three year period, and possible funding sources. Feedback from the presentation audience was noted and has been incorporated into the Consultant's draft Inception Report, dated 27th February 2009.

Date	With Whom	Purpose of Meeting
20th Feb 2009	JICA Study Team for the Second Nile Crossing UNRA senior bridge and other staff	Second meeting with the JICA Study team in order to review in greater detail the bridge design options and design parameters they are studying for each of the three route alternatives. The Bridge Management Study consultants provided a list of points for discussion. The results of these issues were recorded and submitted to the Director, Planning, UNRA on 23rd February 2009. At the meeting, the JICA Study Team requested a further meeting to discuss whole-life costing issues.
23rd Feb 2009	UNRA Road Maintenance Managers: Mr Justine Ongom Odongo Mr William E Musumba	Brief discussion regarding road maintenance management in UNRA and outlying stations
24th Feb 2009	DFID, Mr Rob Rudy	Courtesy visit to financial sponsor of the Bridge Management Study to provide DFID with a progress report, outcome of the consultants' presentation to UNRA on 20th Feb and plans for completion of the Study. In particular, discussed the "road map" for establishing and development of the UNREA Bridge Management Unit and associated funding arrangements, including the need for continuity (in terms of time and approach) for follow-on consultancy services commencing March 2009 for 9 man-months of support services to the BMU.
24th Feb 2009	Mr Benjamin Olobu, UNRA Technical Services Manager	Discussion regarding how UNRA is using the 2004 National Transport Master Plan in its road management (planning) function; learnt that this has been superseded by an updated national transport master plan for the 15-year period from 2008 to 2023
26th Feb 2009	UNRA Director Planning, Mr David Luyimbazi Mr Charles Kizoto, Asset Management Engineer, UNRA Mr Gar Vegger, Roughton International Mr Kevin McPhearson, Africon	The BMU Study consultants were invited to join UNRA's meeting with the data collection consultants to advise UNRA on issues related to collection of bridges data, the outline specifications for a suitable BMS for the BMU, and the consultants comments on the BMS proposed by Roughton/Africon.
27th Feb.2009	UNRA Director Planning Mr David Luyimbazi Mr Jonathan Tugume, Bridge Engineer, UNRA Emmanuel Mugamba Project Director Gauff Consultants (U) Ltd Jonathan Kariuki Team Leader Gauff Consultants (U) Ltd Richard Malinga, Highway Engineer	Attendance to discuss issues reviewed by BMU study consultants and UNRA Planning team relating to recommended treatment of the 24 bridges making up the Study of Strategic Bridge Structures on National Road Networks project. Several issues were discussed with BMU study consultant acting as Chairman of the meeting after Mr Luyimbazi was called away from the meeting. See Working paper for detailed comments on Gauff's inception report
2nd Mar. 2009	Mr Gar Vegger, Roughton International Mr Charles Kizoto,	Follow on meeting concerning issues on the that were raised at the meeting of 26th February concerning outline specifications for the BMS for UNRA.

Date	With Whom	Purpose of Meeting
	Asset Management Engineer, UNRA Yaa Boadi, Roughton International	Confirmed that proposed Africon Inventory Forms, and Inspection Forms are acceptable for adoption by UNRA subject to the provision of the accompanying Bridge Inspection manual, and training necessary to successfully input the data into the Bridge management system. It was again pointed out that the projects TOR are clear on the need for the BMS to be fully functional with the RMS Dtims.
3rd Mar. 2009	Eng. George Bwanga Jonathan Tugum Tim Stiff UNRA Masaki Tatsumi Tonoyuki Konishi Kazuya Urano Tetsero Izawa JICA Anthony Mwase Counterpart, JICA CAA	Attendance at a preview run-through of the intended presentation by JICA 2nd Nile Crossing Study Team to the Focus Group meeting to be held in Jinga on 6th March.
4th Mar 2009	Samuel Wonekha Moses Museerwa CAA Eng. George Bwanga Jonathan Tugum Tim Stiff UNRA Masaki Tatsumi Tonoyuki Konishi Kazuya Urano Tetsero Izawa JICA Anthony Mwase Counterpart, JICA CAA	Meeting at CAA Entebbe to discuss effects of Jinja Airport obstacle limitation surfaces and any proposals to increase the existing runway length or orientation may have on the various bridge options currently being examined by JICA's Second Nile crossing feasibility study team. Issues discussed included ned to confirm the interpretation of the cAA regulations, understand CAA's plans for the extension or reorientation of the runway etc.
5th Mar.2009	UNRA Director Planning, Mr David Luyimbazi Mr Benjamin Olobu Human Resources Manager Mz. Jane Gatale	Tim Stiff BMU Consultant was invited to be part of the interview panel for the position of Project Engineer (Bridges). He helped formulate questions and model answers and participated in the interview process for the selection of a candidate from the two candidates for the position.
12th Mar.2009	Tony Coleman UNRA Road Maintenance Advisor	Detailed discussions regarding road network and bridge management planning practice in RAFU and UNRA. Reviewed the status of the Road Management manual resulting in the need to identify Routine Bridge maintenance operations. Examples of some stations carrying out ad hoc periodic maintenance without any guidance from the UNRA Bridge Management Team
13th Mar. 2009	JICA Study Team	Request from UNRA Project manger for attendance at the Technical Transfer Programme broadly addressing Topographical Survey including ariel mapping, Meteorological Survey, Geotechnical investigation and Hydraulogy.
13th Mar. 2009	UNRA Director Projects James Okiror	Detailed discussions concerning roles of Planning and Projects in the procurement, design, and contract implementation phases. Discussion on methods with dealing with design changes, site problems relating to bridges and structures of a specialist nature

Date	With Whom	Purpose of Meeting
		outside UNRA's current capacity.
16th Mar. 2009	**UNRA,** Mr Jonathan Tugume, Bridge Engineer, UNRA George Kyobe Inyensiko Station Engineer Jinja Station Benice Uganda, Maintenance Engineer Jinja Station **Spencon Services Ltd** Narendra Bavisity Director Harhshingh Supervisor Keunzro, Site Engineer	Consultants visited Nalubaale Bridge, Jinja to carry out visual inspection and assist in preliminary meeting with the contractors representatives to discuss emergency repair works to the propped cantilever road slabs , approximately 4 number that are showing extreme deflections under heavy truck traffic. Discussion on site and briefing by contractor that dry pack work had been carried out on two prior occasions, the last being to the area now showing signs of deflection had been carried out between 8 and 9 years ago. This new information is reassuring as it is now clearer that the problem with slab movement has been a continuing issue since construction of the dam and may therefore not be indicative of a sudden failure or breakage of the precast beam bearing surface. The contractor is however to install access platforms adjacent to the slabs that are causing concern and a further site meeting is to be confirmed for the 26th March to enable the UNRA Engineers to inspect the seating gap before confirming the emergency repair method. Subsequent inaugural meeting at the Jinja Station Office to discuss contract arrangements, site handover etc.
19 Mar. 2009	Mr Jonathan Tugume, Bridge Engineer, UNRA Eng. Mwizeerwa Buturo Sam Station Engineer, Hoima Sam Muhoozi Engineer, Masindi	Site visit to inspect ongoing works on a twin 3.5 m clear span culvert, Lutwa Bridge on the Hoima – Buseruka - Kabaale – Kaiso Road and a recently completed Bailey Bridge, Wambabya Bridge, on the Hoima – Kizirafumbi – Kaiso –Tonya Road. Meeting with contractors site manager, and site engineer, and informal discussions and review of on –site procedures, material approvals, method statements construction sequence, Quality control and Quality Assurance procedures. Inspection of recently erected Bailey Bridge, Wambabya Bridge, on the Hoima – Kizirafumbi – Kaiso –Tonya Road. No ballast wall has been provided on this 24 metre span Bailey Bridge, and there is a substantial amount of fill required to raise the existing (gravel) road level up to the new deck level. The bridge had been erected by launching over the existing (timber) bridge. The existing bridge is still standing under the new span. The reinforced concrete abutments look well constructed above the existing abutments.
20th Mar 2009	Mr Jonathan Tugume, Bridge Engineer, UNRA Emmanuel Mugamba Project Director Gauff Consultants (U) Ltd Jonathan Kariuki Team Leader Gauff Consultants (U) Ltd Richard Malinga, Highway Engineer	Attendance at meeting to discuss issues on Gauff's Supplementary tto the Inception report where the selection of structures to be replaced was again reviewed using a more consistent selection of criteria. The Supplementary to the Inception Report had reviewed by BMU study consultants and UNRA Planning team relating to recommended treatment of the 24 bridges making up the Study of Strategic Bridge Structures on National Road Networks project. See BMU Consultant Working paper for detailed comments on Gauff's Supplementary inception report. Replacement of 5 structures agreed, consultant is to provide detailed breakdown for Geotech estimate to enable an addendum for the cost of the soil investigation to be submitted to the Contracts committee and allow the Consultant to mobilise the Central materials Laboratory to carry out the investigations.

Date	With Whom	Purpose of Meeting
26th Mar2009	Mr Jonathan Tugume, Bridge Engineer, UNRA George Kyobe Inyensiko Station Engineer Jinja Station Benice Uganda, Maintenance Engineer Jinja Station **Spencon Services Ltd** Narendra Bavisity Director Harhshingh Supervisor Keunzro, Site Engineer	Consultants visited Nalubaale Bridge, Jinja to carry out visual inspection of the slab to joint gap following the erection by the Contractor, Spencom Services of an access platform supported off the dam wall.. The inspection confirmed that the supplementary angle installed under the previously rehabilitation work was loose. Several resin anchored bolts were observed to be loose and all the dry pack had fallen out of the slab/angle joint gap. Steel shim packing was still in place and it is thought that the presence of these shims are causing a point load on the angle that has resulted, on the repeated traffic loading being transferred to the angle at one end rather than being distributed along the entilre length of angle. It was concluded that the proposed repair method was appropriate as long as any steel packing shims were removed and the slab to precast beam bearing surface was pressure grouted whilst traffic was kept off the structute until the resin hardened.
27th Mar 2009	UNRA Board JICA 2nd Nile Crossing Feasibility Study Team	Attendance requested for the presentation to the UNRA Board on the “Selection of Optimum Solution to cross the River Nile at Jinja”
30th Mar 2009	UNRA Director Planning, Mr David Luyimbazi Mr Charles Kizoto Mr Jonathan Tugume Mr Jonathan Wazimbe Mr Benjamin Olobo Mr Chris Manyindi Mr Godfrey Ssambwa Mr Tibaijuka Godwin Mr Michael Green (WSP) Mr Nigel Lightbody Mr. Bharat Patel (WSP) MZ Pamela Ayebare Mr Tony Coleman (WSP)	The Bridge Management Study Team presented their findings and recommendations, which summarised the intended Final Report. The presentation included a review of the current institutional framework for bridge management, a review of the current bridge data collection exercise, recommendations for future inspection regimes, proposed composition of a BMU, where within UNRA the BMU should reside, outline specifications for a computer-based Bridge Management System (BMS), and a “road map” for establishing and developing the BMU through to full localisation within a three year period, and possible funding sources. Two key issues that came out of the feedback was UNRA’s desire to ensure that ownership of the Bridges remained in the Regions/Stations. Therefore it was thought that the Centralized BMU should use the Station technicians to assist in the routine and periodic bridge inspections. It was accepted that the BMU needed ownership of the inspection data. UNRA Asset Management Manager also wanted clarification as to how the BMU and BMS would be managed within the wider context. Asset management. The constructive Feedback from the presentation audience was gratefully noted and has been incorporated into the Consultant’s Final Report, dated 31st March 2009.

Appendix C: RECORD OF KEY DOCUMENTATION REVIEWED DURING THE CONSULTANCY

Title	Source
Managing the National Roads Bridges, Inception Report of the UNRA Bridge Management Team regarding the Formation of the UNRA Bridge Management Unit, December 2008	UNRA
The Uganda National Roads Authority Act, 2006 Acts Supplement to the Uganda Gazette No.36 Volume XCVIX dated 8th June 2006	Acts Supplement No.5
The Uganda Road Fund Bill, 2007 Bills Supplement to the Uganda Gazette No.52 Volume C dated 21st September 2007	Bills Supplement No.15
Inception Report, Reform Implementation Team Advisors, Technical Assistance to the Ministry of Works & Transport, April 2007	WSPimc
Bridge Management System, Field Inspection Sheet, Revised 28 July 2008	Africon
Bridge Management System, Inventory Data Sheet, Revised 28 July 2008	Africon
RMS Design Report, Establishment of a National Roads Databank and Road Asset Management System for the Uganda National Roads Authority, Version 0.2, December 2008	Roughton International & Prome Consultants
National Roads Data Collection for UNRA, **Working Paper Number 4, Location Referencing System**, 3rd February 2009	Roughton International & Prome Consultants
The Roads Act, 1949 Commencement: 14th April 1949	Cap 358
The Traffic and Road Safety Act, 1970 Commencement: 1st January 1971	Cap 360
The Traffic and Road Safety Act, 1998 Commencement: 11 September 1998; 15 March 1999; (except ss. 107, 108, 109, 110); see section 1.	Cap 361
The Traffic and Road Safety (Weighbridges) Regulations, 2004 (Under Section 178 of the Traffic Act and Road Safety Act, Cap 361)	Statutory Instruments Supplement No.21
Uganda Axle Load Survey 22 September 2008	UNRA
Road Sector Development Programme Phase 2 Consultancy Services for Preparation of the National Transport Master Plan Including a Master Plan for Greater Kampala Metropolitan Area, Draft Final Report, September 2004	TAHAL Consulting Engineers

Title	Source
Preparation of the National Transport Master Plan Including a Transport Master Plan for Greater Kampala Metropolitan Area, Draft Report, November 2008	International Development Consultants
Consultancy Services for Construction Supervision of 21 Bridges in North Western Uganda Design Review Report, February 2008	Saba Engineering
Consulting Services for the Study of Strategic Bridge Structures on the National Road Network Inception Report , February 2009	Gauff Consultants (U) Ltd
Consulting Services for the Study of Strategic Bridge Structures on the National Road Network Supplementary to the Inception Report , March 2009	Gauff Consultants (U) Ltd
Consultancy Services for Design, Tender Assistance and Construction supervision of the Atiak – Moyo - Sudan Boarder Road Contact RDP/HW/CS013 Engineering Design Report, February 2009 Materials Report, February 2009	VKE International Consulting Engineer in Assoc. with Kagga
The Feasibility Study on the Construction of a New Bridge across the River Nile at Jinja Progress Report No 1, January 2009	Oriental Consultants Co. Ltd, Japan Engineering Consultants Co. Ltd
Tender for emergency Remedial Works on Nalubaale Bridge Tender Documents, July 2008	Spencom Services Ltd
Tender for emergency Remedial Works on Nalubaale Bridge Contract Agreement, March 2009	UNRA
Draft Design Report for the Consultancy Services for the National Roads Data Collection Study O.2 March 29th 2009	Roughton International in association with Prome Consultants Uganda.

Appendix D: INITIAL INFORMATION REQUIREMENTS

The following list was issued by the Consultants to the Director Planning on 4th February 2009.

Government Policies & Sector Planning

- Government's overall development goals (objectives, plans per economic sector, current status, poverty reduction strategy paper, etc)
- Regional integration policies and other initiatives that impact on the road network of Uganda (e.g. regional highway networks, cross-border commitments, etc)
- Policies for: roads and bridges (planning, development and maintenance)
- Policies for traffic management and road safety
- Policies for environmental management
- Policies for procurement (consultancy services, contractors, equipment, etc)
- Policies for financial management (overall funding, sources, procedures for collection and allocation of funds, breakdown of funding sources, assessment of actual income vs overall requirements, timeliness of receipts, etc)
- National transport policies and network development plans (defining the balance of passenger/freight traffic between each transport mode)

Sector Legislation

- Road sector legislation (including which organisations are responsible for parts of the road network)
- Traffic, vehicle, axle load and road safety legislation, etc
- Up to date road network inventory and condition data (roads, bridges, tunnels, signs/signals/markings, etc), including maps of existing and planned network
- 5-Year road network development plans
- Road network maintenance plans (annual and periodic)
- List of current projects and their status
- Organisation structure and role (function) of each department

Sector Budgetary Framework

- Government appropriations for recurrent budget and how this is split between roads, bridges, ferries, etc
- Government appropriations for capital (development) budget and how this is split between roads, bridges, ferries, etc
- Arrangements with sector donors (grants, loans, etc associated with bridges … also for roads, so that we can identify correlation between road and bridge planning and management)

UNRA Legislation, Regulations and Management Policies

- UNRA establishment Act and associated regulations (composition of the Board, UNRA's responsibilities, etc)
- Policies for corporate management
- Policies for human resource management and development (recruitment, training, career progression & succession planning, retirement, redundancies, etc)
- Policies for MIS/IT and overview of current arrangements

Technical Standards & Working Practices

- Technical standards for road and bridge works (geometric standards, materials standards, design codes, etc)
- Historic and current bridge management practices (planning, design, inspections, works execution, supervision, monitoring & Feedback, reporting, etc)

Bridges Information

- Inventory and condition data of whole bridge population
- Geographic location (maps), age and type of structure
- Maintenance history for bridge population as a whole and for special bridges in particular
- Current budget and bridge management/planning arrangements
- Planned budget (routine & periodic maintenance, rehabilitation projects, etc)
- Bridge inspection regime and maintenance planning arrangements

Quality Management

- Quality assurance arrangements for internal procedures, contract management, project management, etc
- QC arrangements for materials (standards, location and capabilities of laboratories, etc)

Appendix E:

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TERMS OF REFERENCE FOR TA TO ESTABLISH A BRIDGE MANAGEMENT UNIT

1. Introduction

Until June 2008 the bridges on Uganda's national road network were maintained by the Ministry of Works & Transport (MOWT) but, since the establishment of UNRA on 1 July 2008, responsibility for management of bridges was transferred to UNRA. In pursuit of its mission "To develop and maintain a national roads network that is responsive to the economic development needs of Uganda, to the safety of all road users, and to the environmental sustainability of the national roads corridors", UNRA is keen to establish bridge management capacity with a view to undertaking a programme of backlog maintenance, and developing and implementing annual bridge maintenance plans.

A recent study funded by DFID has identified the key issues related to management of the bridges on Uganda's national road network and has made recommendations with respect to establishment and initial development of a Bridge Management Unit within UNRA. The Government of Uganda (GoU) has now received additional funding from the World Bank towards the cost of setting up and initial development of the Bridge Management Unit (BMU).

Technical assistance services are required to assist UNRA in recruiting staff into the BMU, to provide training on bridge inspections, to develop an appropriate operational computer-based Bridge Management System (BMS), to develop bridge works programmes and overall capacity in bridge engineering in UNRA. The Technical Assistance will establish effective working relationships between the BMU and UNRA's four directorates for purposes of designing and implementing bridgeworks programmes and for monitoring and evaluating performance of the bridge stock while also determining training needs to develop UNRA as a "knowledgeable client" with respect to bridge management.

2. Background

Uganda's national road network currently totals some 11,000km of which some 3,200km is paved. There are over 200 bridges and drainage structures (of span greater than 1.5 meters) on the national highways network, of which at least 30% of the bridges are in urgent need of rehabilitation or replacement. In the past, routine maintenance of bridges has been neglected, while periodic maintenance has been poor due to lack of capacity and inadequate funds. UNRA is designing a substantial road programme for upgrading 2,000km from an unpaved gravel pavement to a sealed pavement. This programme will result in the need for new bridges and the strengthening and/or upgrading of others.

Consultants (Roughton International and Africon) have been engaged to collect the inventory and visual condition data for the national road network, including the bridges and drainage structures. An UNRA Bridge Management Team has been set up to oversee the work of the consultants, but the level of bridge data collected to date is insufficient to enable UNRA to make fully informed decisions with regard to maintenance, repair or upgrading of existing bridges on the national road network.

The recent DFID-funded bridge management study, carried out by WSP International Management Consultants, has made recommendations concerning an appropriate institutional framework for establishing and operating a viable Bridge Management Unit within UNRA. The two-man team reviewed the data collected by Roughton and Africon (the number and type of bridges) and made recommendations on the number and qualifications of staff required for a BMU, the future centralisation of bridge inspections, the outline specifications for a computer-based BMS, and the role of the private sector. UNRA-wide consultations were undertaken to ensure that the institutional, managerial and technical recommendations for setting up and operating the new Bridge Management Unit are viable and sustainable, given UNRA's resource constraints and current capabilities in the domestic private sector. These recommendations were summarised into a "road map" describing the establishment and development over a three year period of an effective BMU in UNRA.

3. Description of the Assignment

The assignment comprises input from a two Bridge Management Specialists with combined high-level technical and managerial experience to guide UNRA in setting up the BMU within the second quarter of 2009. The specialists will work closely with the UNRA Bridge Management Team and report to the Director, Planning. Once established, the Bridge Management Unit will replace UNRA's current Bridge Management Team.

The assignment will initially concentrate on assisting UNRA with finalising the management arrangements for the BMU, including determination of a Bridge Investment Plan, suitable annual maintenance budgets together with suitable modifications to UNRA's budgeting and accounting systems, and development of procedures for bridge maintenance inspections, determination of maintenance and repair works, development and submission of annual budgets, works programming and commissioning, and works supervision and monitoring performance of the bridge population. Concurrently, the assignment will assist UNRA in identifying and recruiting suitable candidates into the BMU. Depending on the level of capability and experience among the recruited senior BMU staff, the consultants will refine the "road map" by detailing a programme of on-the-job and formal (perhaps academic) training to ensure adequate competence is secured within the BMU within a three-year period commencing second quarter 2009.

4. Objectives

The objectives of the technical assistance are to:

i) Assist UNRA senior management in defining and implementing appropriate management arrangements to enable a Bridge Management Unit to be established within the second quarter 2009, and to operate with its own budget from start of the financial year 2009/10.

ii) Assist UNRA;s Planning Directorate to incorporate bridge management requirements, performance indicators and institutional development arrangements into UNRA's formal strategic and business planning processes.

iii) Assist UNRA to identify and recruit suitable personnel into the Bridge Management Unit.

iv) Develop and implement a programme of informal and formal training in bridge inspections, planning, engineering and management to establish sustainable capability within UNRA as a "knowledgeable client" with respect to bridge management within a three year period.

v) Guide UNRA in determining the requirements for, and in implementing, capacity building measures in the domestic private sector for carrying out bridge maintenance and repair works.

5. Scope of Technical Assistance Services

The Bridge Management Unit will be established within UNRA's Directorate of Planning. The technical assistance is required to develop effective formal communication arrangements between the BMU, Directorate of Planning, Directorate of Operations, Directorate of Projects, and the Directorate of Finance and Administration The technical assistance will draft these arrangements and then convene a senior management workshop to finalise and agree the procedures to be put in place, assignment of responsibilities for inter-directorate communications, decision-making and accountability for all aspects of planning, budgeting, commissioning, and implementing bridgeworks, and for inclusion of bridge performance in the network performance monitoring function carried out by the Planning Directorate.

The technical assistance will comprise a two-man team with specialist experience in developing countries in the fields of institutional development, capacity building, road authority management, strategic and business planning, budgeting processes in road authorities, and in bridge planning, engineering and management. One of the consultants will act as bridge manager to head up the BMU during the period of the technical assistance services. The other consultant will provide intermittent short-term support either in Uganda or from his/her home office, concentrating on the Strategic Planning and institutional issues that will ensure that the BMU is fully integrated into the senior management functions of UNRA.

Some of the tasks expected of the technical assistance are:

A. Review the findings of the DFID-funded bridge management study and develop these into firm plans for establishment of the BMU within the second quarter 2009 and subsequent development of bridge management capacity in UNRA.

B. Discuss these plans with senior management from all four UNRA directorates at a workshop and agree the resources and inter-directorate management arrangements for the effective functioning of the BMU, including integration in UNRA's asset management and network performance management functions.

C. Draft job descriptions for each the of the key positions in the BMU, identify from within UNRA and/or the domestic private sector suitable candidates for recruitment into the BMU, work with UNRA's HR department(?) to agree terms and conditions for employment of BMU staff, and assist UNRA in the recruitment process.

D. Prepare Framework Terms of Reference for use by the BMU in the procurement of Consultants to carry out Bridge Assessment and Design projects, and Project Management and Construction supervision.

E. Prepare Model Specifications for an appropriate range of recurrent maintenance activities, together with associated Method of Measurement and Model Bills of Quantities, and framework for developing unit costing required to prepare Annual Bridge maintenance budgets.

F. Review or develop as necessary Bridge Standard Design Detail drawings for such items as necessary and adopting International 'best practice' that would be appropriate in the local context with the overall objective to improve the maintainability and service life of the structures and minimize Whole Life costs.

G. Review existing Ugandan MOWT Bridge Design Manual and make recommendations on any improvements

H. Design and implement a programme of training for bridge inspections, supported by a relevant and adequately illustrated Bridge Inspector's Manual. It is likely that bridge inspection capacity in the BMU will concentrate on the most common bridges types (superstructure, substructure and foundations); the technical assistance will therefore institute sustainable procedures for conducting inspections of the non-common bridge types.

I. On-the-job training of bridge inspectors will culminate in development of a computer database of adequate detail to enable the BMU's bridge manager to develop a bridge improvement programme, comprising removal of backlog maintenance, repairs, rehabilitation and/or replacement.

J. The process of capacity building will initially concentrate on bridge inspections but progress into developing the BMU's bridge engineering knowledge such that minor repairs and periodic maintenance activities can be designed in-house, while major repairs and rehabilitative works will be contracted-out but with proficiency within the BMU to conduct professional reviews of the designs produced by others.

K. Using the bridges database developed by the BMU's bridge inspectors, the bridges manager (long-term consultant) will define the nature of bridge engineering training required to develop this filed of competence within the BMU, and will provide suitable in-house training to the BMU's bridge engineers for the remainder of the assignment. The bridge inspectors will be included in some of this training, where relevant, in order to improve their level of understanding and the effectiveness of bridge inspections.

L. The professional bridge expertise within the BMU will, within the three year period, be developed to the extent that the unit is capable of advising UNRA on major bridge proposals (e.g. the Second Nile Crossing), taking into consideration loading conditions, design procedures, constructability, and future inspection and maintenance. Thus, whole-life bridge engineering principles will form a core part of capacity development within the BMU. It is not be possible to develop this level of competence within the 9-month technical assistance, but the consultants are expected to detail the training requirements and submit a costed training programme to UNRA senior management demonstrating how this will be achieved over the next three years.

M. The technical assistance will consider other major road improvement and development programmes planned by UNRA and advise on expansion of the BMU to meet the capacity requirements imposed by the envisaged increase in workload.

6. Human Resource Input

The suitable candidates for this assignment shall be qualified Civil/Structural Engineers with in-depth experience in the planning, design, construction, inspection and maintenance of bridges in developing countries. Experience in establishing a bridge management capacity in a National Roads Agency is mandatory. In addition, the candidates shall possess in-depth knowledge of the management functions within a roads authority, including strategic and business planning, budgeting, development of recurrent and capital works plans, asset management, and network performance monitoring and evaluation.

The assignment is expected to be split as follows: 3 months for a bridge management institutional advisor and 6 months for a bridge management technical advisor. But, there it is anticipated that there will be considerable overlap and integration of the two roles.

7. Timing

The technical assistance shall commence in early April 2009.

8. Reporting and Other Outputs

The two bridge management advisors shall prepare and submit the one electronic and one hard copy of the following documents (all in English):

- A draft implementation plan at the end of the first month, in place of an inception report, that outlines the arrangements to be put in place for establishment of the BMU, followed by a senior management workshop to agree these arrangements and the associated timetable and budget. The budget will include the costs of all equipment necessary to develop a fully functional BMU, including bridge access equipment for inspections and repairs, and appropriate testing equipment, including appropriate spares.
- A detailed training plan for development of bridge inspection and bridge engineering capacity in the BMU, with a cost schedule that can be incorporated into the BMU's budget for the subsequent three financial years and included in UNRA's annual budgets. The cost schedule shall identify sources of funding for in-house (on-the-job) training, and domestic and international training requirements.
- An interim report, after three months, to inform UNRA senior management of completion of establishing the BMU, including a status report on the recruitment and training of the bridge inspectors, progress in bridge inspections and development of the bridges database, and the agreed training programme and associated cost schedule.
- A Bridge Inspector's Manual, covering all the common types of bridges on UNRA's national road network, with clear illustrations to aid identification of important defects that would trigger more detailed inspections. The manual should also provide guidance to the bridge inspectors and bridge engineers in the BMU for determining the nature, extent and cost of repairs and/or maintenance actions. The Bridge Inspector's Manual shall be completed during the first five months of the assignment. It shall be developed in a participatory manner, involving the BMU's inspectors and engineers so that the contents are fully understood and readily applied.
- Working papers will be produced on an as-needed basis to support the training of bridge inspectors and bridge engineers and to facilitate UNRA-wide discussions regarding integration of the BMU into the broader road network management functions. Additional, short formal papers will be required to assist UNRA in approaching funding agencies for subsequent financial support to the BMU during its three year development period and for development of domestic private sector capacity to undertake bridge maintenance and repairs.
- A draft Final Report four weeks before the end of the assignment recording the progress made during the Technical Assistance and detailing the way forward. The contents of the report will be presented to UNRA senior management and feedback obtained to enable the consultant to deliver the Final Report before the consultant leaves Uganda at the end of the assignment.

9. Data, Local Services and Facilities to be provided by the Client

The client shall provide the consultant with all relevant reports and other documentation. The four directors of UNRA will provide sufficient information to the consultants so that viable and sustainable arrangements can be designed and agreed for integration of the BMU into the wider UNRA management functions. Since the BMU will be established within the Planning Directorate, the Director, Planning, will be responsible for keeping the UNRA Executive Director fully informed of progress, key issues and agreements reached within senior management for establishment of the BMU.

The client will assist in the facilitation, and with the co-operation of other Government Ministries, Departments and Agencies, as required, for effective execution of the assignment. The client will give the consultant assistance to gain access to all information required for the proper conduct and completion of the assignment.

The client will provide office space for the two-man technical assistance team and make arrangements for accommodating the BMU within the UNRA building.

The client will provide all necessary means for travel in Uganda, including the use of UNRA or rented vehicles within Kampala and for up-country travel for purposes of bridge inspections, meetings with station engineers, training of bridge inspectors and engineers, and other bridge management functions associated with establishment and development of the BMU.

10. Consultants Obligation

The technical assistance consultant shall provide their own notebook computers and cell phones.

Appendix F: Copies of the Data Collection Consultants Bridge Inventory and Bridge Inspection Forms

Appendix G: Comprehensive Equipment List required for detailed bridge inspections for bridge assessment or special inspections:

All Bridges:-

A. Measurement and test equipment

1. **Flashlight (small – waterproof heavy duty) with spare batteries**
2. **Flashlight (large - waterproof heavy duty) with spare batteries**
3. **30-metre long fibre tape**
4. **2 5/3 -metre long steel tape**
5. **Protractor**
6. **One metre long folding ruler**
7. **One-metre long spirit level (Metal Builders level)**
8. **3 metre long ranging, or surveying rod**
9. **Plumb bob**
10. **Compass**
11. **Crack width gauges plastic**
12. **Binoculars**
13. **Wire brush for removal of light rust**
14. **Masking Tape**
15. **Steel plate caliper gauges**
16. **Knife, rubber mallet (for sounding concrete), 0.5 kg Engineers hammer, scissors**
17. **Bush knife, machete or similar tools for clearing light bush and vegetation**
18. **Wrench, wrenches, screwdriver, iron mug**
19. **Metal Thermometer Celsius thermometer range 0^{o}c to 100^{o}c**

B. Labour safety (Protective Equipment)

1. **Site Safety boots with steel toe-caps and steel sole plates**
2. **Thigh length boots (Waders)**
3. **Leather gloves**
4. **Safety harness for working at height**
5. **Safety Helmets and Safety glasses**
6. **High Visibility Safety jackets (yellow with reflective strips)**
7. **Lifejackets, and Life-ring**
8. **First-aid kit (with at least one person qualified in First Aid)**
9. **Raincoats**
10. **Soap and cotton rags for cleaning hand and cleaning equipment**
11. **Mobile phone with car/vehicle phone charger**
12. **Traffic signs warning of workers adjacent to the road, including traffic cones.**
13. **Signal flags or stop/go boards as necessary (N.B Safety officer to determine level of traffic control required and therefore provision of equipment in Item 13 and 14 for each particular site)**

C. Access equipment

1. **10-metre rope ladder**
2. **2-metre long extension ladder**
3. **20 – 30 metre lengths of light rope**
4. **Hand held radio kit**
5. **Hand held loudspeaker**
6. **Rubber boat with oars two man capacity (150 kilograms)**
7. **Equipment box**
8. **Vehicles for inspection**

D. Equipment for documentation

1. **Camera (Minimum Specification of Digital Camera:- 3 Million Pixels resolution, 4 times zoom facility with 128mb memory card) with sufficient spare batteries or battery charger**
2. **Field book**
3. **Waterproof Document case**
4. **Chalks, crayons Waterproof, pencil, pen or paint for marking concrete or steel**
5. **Stock of new Bridge Inspection Forms**
6. **Waterproof A4 size Clipboard**
7. **Current version of Bridge Inspection Manual**
8. **Plastic bags**

II. List of additional equipment possibly required for bridge assessment and special inspection dependant on defects requiring more detailed investigation:

In addition to the equipment required for regular inspection, it may be necessary to have access to the following additional equipment:-

1. **Paint Thickness gauges**
2. **Concrete cover-meter with facility for locating reinforcement bars and estimating size.**
3. **Concrete test hammer (Schmidt Hammer type),with calibration anvil and concrete surface preparation rubbing kit and calibration charts.**
4. **Hand-held drill with masonry drill bits, maximum size 12mm diameter**
5. **Colour indicator liquid (Phenophthalein)(Carbonation depth of concrete)**
6. **Indicator liquid spray bottle**
7. **Concrete powder collector**
8. **Automatic Level and metric levelling staff**
9. **Theodolite, Total Station type with Electronic Distance Measuring, EDM prisms, reflectors and tripods.**
10. **Concrete coring machine (100mm minimum core size)**
11. **3 KW electric generator (110 volts maximum) with spare fuel cans, extension cables and junction boxes.**
12. **Plastic Sample Bags various sizes for concrete dust samples and bulk samples**
13. **Half-Cell Potentiometer Test equipment consisting of Electric tenzomet cells and resistant plate, Lever tenzomet, Indicator and clamp set. (Half cell test to be carried out in accordance with ASTM C 876)**
14. **Electric deformation meter**
15. **3-D fluctuation meter**
16. Water dipmeter
17. Deflectormeter
18. Dynamic Trainmeter (SDA – 830) (3 dimensions)
19. Water speed meter
20. **Tachymeter**
21. **Surface roughness tester**
22. **Ultrasonic concrete tester**

Appendix H:- Selected extract from UK Highways Agency Bridge Advice Note Ba 5701:- Design for Durability

2. FACTORS AFFECTING DURABILITY

General

2.1 A survey of 200 highway concrete bridges, commissioned by the Department of Transport, The Maunsell Report (reference 1), identified a number of factors which contributed to the inadequate durability of many of the Department's structures. Most of them were in areas where amendments to existing specification requirements, or to inspection and maintenance procedures, should provide improved durability of structures in the future. The most important of these are briefly discussed below. However, there are a number of important aspects relating to durability which need to be addressed by improvements in conceptual design or in design detailing; these topics are often not adequately dealt with in BS 5400, and are discussed further in this document.

Drainage, Joints and Waterproofing

2.2 By far the most serious source of damage is salty water leaking through joints in the deck or service ducts, and poor, faulty or badly maintained drainage systems. Of crucial importance is the provision of a positive, well designed, detailed and constructed drainage system for managing water from the deck, and into a drainage system. Particular attention should be given to detailing through deck drainage, and to ensure that all systems can be maintained. Work undertaken by Highways Agency and the County Surveyor's Society and published by the Transport Research Laboratory (reference 12) provides detailed guidance on water management, and designers are strongly advised to consult this document. Advice on the design of expansion joints is given in Chapter 5 and methods of eliminating deck joints are suggested in Chapter 3.

2.3 Also of crucial importance is the provision of an effective waterproofing system on the bridge deck. The most important properties of an effective waterproofing system are its waterproofing ability and its bond to the deck. It should be noted that if bonding is effective over the whole deck area, then any local lack of watertightness in the waterproofing layer is incapable of causing significant damage to the deck. Further advice is given in Chapter 5. Reference should be made to BD 47/BA 47 'Waterproofing and surfacing of concrete bridge decks'.

2.4 An observed source of damage in highway structures is the splashing or spraying of salty water from de-icing salts on to bridge abutments, piers, parapet edge beams and deck soffits. Advice is given in paragraph 5.18 on the provision of additional concrete cover to reinforcement and impregnation to waterproof these areas.

Workmanship

2.5 A number of aspects of poor workmanship in concrete bridges were highlighted in the Maunsell Report. The most critical of these, from the point of view of durability, was the failure to achieve the specified concrete cover to steel reinforcement. This was found to be an extremely frequent problem, and was the cause of a great deal of deterioration, especially when it occurred in association with joint leakage etc. For further advice on concrete cover see paragraph 5.2.

2.6 Curing of concrete is probably the second most critical aspect of workmanship revealed by the survey. The vital role of curing in providing a dense concrete cover to the steel reinforcement cannot be emphasised too strongly. Problems of poor compaction, honeycombing etc, were in themselves less significant although they might compound the effects of other inadequacies. Compliance with the Specification for Highway Works (MCHW 1) would eliminate these problems in future.

Cracking

2.7 It was found that cracking due to early thermal effects was a widespread problem. For advice on this see paragraph 5.3.

2.8 Cracking and damage due to Alkali Silica Reaction (ASR) was found to be rare.

Appendix I: WORKING PAPERS OF THE REVIEW OF THE WORK OF CURRENT CONSULTANTS ON BRIDGE DESIGN AND MAINTENANCE PROJECTS

Construction of 21 Bridges in North and North Eastern Uganda - Phase 1. Lot 1

ASWA BRIDGE, KITGUM

Preliminary Drawing Review Notes on Norplan (Uganda) (now renamed Newplan) Contract Design Drawings Requested to be reviewed by Bharat Patel, 11 February 2009.

Item No	Drawing Number	Drawing Title	Issues
1		**General Preliminary Comments**	The logical layout of the drawings make it difficult to find information without continuously having to look through all the drawings. It would be better to lay out the drawings into Concrete Construction (CC) details for the abutments, CC for the piers, CC for the Decks, then Reinforcement details for the Abutment, RD for Piers, RD for the Deck etc, then Steelwork details for the Deck and perhaps a miscellaneous detail drawings for the bearings and plinths, back of wall drains, expansion joint details etc
			There are no details shown for water drip shedders on the Parapet overhangs, and deck soffits, no chamfers to external corners. Tops of the wingwalls and abutments shelves should have slopes front to back to reduce water flow down the front face. If Numerous construction joints are used as shown for the pier they should be a feature detailed to make the inevitable lines and grout loss at each joint give sufficient protection to the rebar. The joints will also look better. There are no comments on required concrete surface finish for the various concrete faces. The Specification has numerous finishes and surely if the deck is not to be surfaced a textured finish is required to provide an acceptable level of skid resistance. Maintainable back of wall drainage should be provided. No waterproofing to the buried concrete faces has been provided and would help extend the life of the structure
2	**3023.21\AS\SP-01**	**Site Plan Details**	Show Co-ordinates and Levels of Boreholes on Drawing.
			North Arrow required, Stream flow direction
			Treatment of the Existing Bridge and Road-i.e.. is the existing bridge to be demolished if so details of extent of work required. Ditto for Road closure
			Check that the road alignment and earthwork details tie-in with bridge alignment details
3	**3023.21\AS\SP-02**	**Site Plans details, Setting Out Data**	Setting out data cumbersome and does not give all the required detail. Current better practice is to give each pier/abutment an unique Setting Out Point usually centreline of structure longitudinally and centreline of substructure or even centreline of bearings and dimension everything off that. This SOP

			can be the reference for a number of drawings.
			The relationship of the bridge setting out points and the Horizontal Alignment of the road needs to be shown to show that the road fits on the bridge. It is assumed that the road is straight over the bridge but something needs to confirm this.
4	**3023.21\AS\SP-03**	**Existing sections in River Bed**	Some ideas of water level would be good. Tidal or seasonal variation
			North Arrow required, Stream flow direction
5	**3023.21\AS\GA-01**	**Bridge General Arrangement**	General Notes:- All references to BS will now be out of date as they are being Phased out to EN's. How is this dealt with? Use equivalent version of EN?
			Note 3:- How is the Contractor meant to price for the comment that if soft ground is encountered Pile shall be recommended.
			Note 4:- Min cement content looks low and w/c ratio high
			Note 5:- Need to clarify difference between nominal cover and minimum cover especially as bar schedules have been produced by designer. Nominal is usually minimum plus 5mm
			Note 6:- do they still produce Conc. to old BS. In general how is the use of superseded BS's dealt with?
			Not 7:- Design code should be BS5400 for bridges, not BS8110 more buildings orientated
			Note 11:- How does the Contractor price for this?
			Note 14:- These laps look wasteful. Code lap if not actually calculated is 40 times the maximum bar diam lap Thus T10 would have 400 lap not 500 shown, and T16 would have 625mm lap not 800 shown
			Notes 3 and 16 are again confusing. What note in his pricing is the Contractor required to make?
			Note 16 Suggests advance soils investigation-assumed bearing capacity in Design report is 200kpa whereas actual seems nearer 168kpa at 3m depth. Soils report - BH 2 at 3 metre depth shows hard pan (rocky strata, but BC of 168kpa and penetration refused?
			What is the bridge articulation. There are expansion joints both ends but are the piers fixed and designed for temperature expansion flexure?
			Section BB:- What is the deck surfacing if any and what thickness has been allowed. How ids residual camber allowed for? It would clearer to show dimensions for road cross-section on the Section BB and CC than plan
			Girder Deck Detail:- Why show stud spacing here and not details of the slab downstand?
			Girder End Detail seem to imply that there is no deck surfacing as the concrete deck is at the same

			level; as the road surfacing.
			Shear Connections seem over specified
			Where are the details for scour protection for the piers.
			Abutment Protection seems out of proportion to pier protection
			Where are the details referred to on the drawing for the guardrails?
6	**3023.21\AS\GA-02**	**Abutment and Wingwalls General Arrangement Drawings**	There should be a benching detail shown for the granular backfill to roadwork's embankment assuming that the road embankment will be built first and abutment backfill placed subsequently. Space between footing and lowest bench should be 1000 minimum to enable a pedestrian roller to be used.
			Backfill should finish at least 150mm below back of wall
			Abutment and footing Footing Plan:- the setting out for the abutment and wingwall is not complete enough to set the walls out correctly. See comments on Setting out points (Item 3 above)
			Why are there no joints between the Abutment and wingwalls. There will be cracking due to change in footing thickness and angle of action.
			Why so many weepholes and no proper (maintainable/roddable pipe) back of wall drainage
			Weephole numbers excessive . Back of wall drainage sshould be detailed.
			Approach Slab and corbel detail - review the need for pavement on top of concrete approach slab
			A note on how to deal with weephole and reinforcement conflict is required.
7	**3023.21\AS\GA-03**	**Pier General Arrangement Drawings**	Why show one detail of the Approach slab attachment to the abutment without referencing the drawing where all the details can be found.
			Usual Blinding concrete is C9 or C12. C20 seems high unless you need a high cement contact due to aggressive ground conditions.
			75mm of anti scouring full height of pier? Does this work or does it crack off. Alternative of using higher strength concrete or admixtures to reduce water/cement concrete to provide better scour resistance. Alternative protective paints or waterproofing system
			Why give details of Scour depth below river bed shown on the drawing. No use to the contractors as this is a design issue and the level has been decided at the design stage.
			What does Section CC add to the drawing information?
			Bearing levels, bearing locations and bearing plinth details should be shown somewhere, if not on this drawing, a reference to where they can be found is needed
8	**3023.21\AS\SR-01**	**Deck Slab Rebar and Bar Bending Details**	The first drawing for the deck should show all the relevant dimensions for the concrete outline.
			There should be a deck construction/pour sequence or has it been designed to be poured at the same time. More usual for a continuous deck to have midspan pours than pours over the piers especially with slow concrete production.
			Beam centrelines should be shown to help understand where the bearings will sit in relation to reinforcement etc.

9	**3023.21\AS\SR-01-A**	**Deck Slab Rebar and Bar Bending Schedules**	Bar Schedules are to an obsolete BS but may still be relevant for Uganda.
10	**3023.21\AS\SR-01-B**	**Abutment and Wingwall Rebar and Bar Bending Schedules**	Bar Schedules are to an obsolete BS but may still be relevant for Uganda.
11	**3023.21\AS\SR-01-C**	**Abutment and Wingwall Rebar and Bar Bending Schedules**	Bar Schedules are to an obsolete BS but may still be relevant for Uganda.
12	**3023.21\AS\SR-02**	**Abutment Rebar Details**	Abutment Concrete Construction drawing showing abutment concrete outline is usual
			The abutment and pilecap slabs are shown as being the same thickness on this drawing. Other drawings show then to be different. Bar Schedules will be wrong.
			Cross sections showing location of bars required.
13	**3023.21\AS\SR-03**	**Pier Rebar Details**	There should be cross-steel linking the reinforcement in each face of the pier for the plastic design of the piers under earthquake loading. Also more cross steel for basic BS5400 code requirements
			Bearing positions and reinforcement to plinths should either be shown on this drawing or at least be referenced to where it is shown
			Show kickers/construction joints at pier/footing
14	**3023.21\AS\SR-04**	**Abutment, Wingwall Footing Rebar and Approach Slab Details**	
			Why is approach slab so deep below Finished road level?
			Detail for kerbs required and tie it at deck where upstand changes.
			Sections Scattered through drawings SR-02 -Sr-04 not user friendly.
			Where is the side slopes of the embankment specified. They look a bit steep and no erosion protection/grassing?

15	**3023.21\AS\SR-05**	**Abutment and Wingwall Rebar Details**	The sections shown for the reinforcement sections should also be the basis for the Concrete Construction Drawing. The reinforcement should have staggered laps in the walls. There should be steel provided in the face of the footings to control early thermal cracking.
			Show position of construction joints on sections
16	**3023.21\AS\SR-06**	**Expansion Joint Details**	Expansion joint detail is not maintainable. The effective gap available for expansion is 75 minus 45 due to plate put on to retain neoprene tube. If this is the order of magnitude why not use an integral abutment as the British HA requirements and do away with any expansion joint. Expansion joint details shown will not work and be a maintenance nightmare. Bearings:- There is no detail showing how the bearing is attached to the sub-structure, or to the steel beam flange and also how to deal with any beam pre-camber. the bearing should be on a plinth high enough to allow access for its replacement sometime in the life of the bridge. There should be some bearing shelf drainage provided on the abutment to take away water from the expansion joint etc.
17	**3023.21\AS\SF-01**	**Abutments, Piers and Wingwalls: Formwork Drawings**	This drawing is better titled as Concrete Construction drawing and should be split between the Abutment Concrete Construction Details, Pier Construction Details, Deck Slab construction details as some details are repeated on this drawing already shown on others. This causes room for errors and confusion.
18	**3023.21\AS\SS-01**	**Details of Steel Girders**	The girders need to have bracing at each support. It is not allowed in the BS 5400 code to have bracing not matching the support position. There is far to much intermediate bracing . It is mainly plan bracing whereas vertical bracing restraining the top flange at midspan when casting the Top Slab is more efficient. For Instance H type bracing at greater centres would be a cleaner option. Section I-I is not drawn correctly and therefore does not add anything to the understanding of the drawing. The cross bracing section size is far bigger than required . Welding the angles to the bottom flange is a bad fatigue detail and it is the top flange that requires bracing against lateral torsional buckling at mid span during concrete deck slab casting. All the cross bracing is redundant once the deck slab is cast. Grade 50 Steel is designation from Superseded BS.
19	**3023.21\AS\SS-02**	**Girder Connection Details**	Bearing Performance requirements need to be stated i.e. vertical Capacity, rotational capacity, Shear capacity rather than Specified design. Bearing Stiffeners should be fitted between flanges. Detail At Stiffener can be cut back at bottom to give space for installation of the stiffener. Ditto Cross bracing on the Cross-Bracing. Girder Splice Detail with 32mm diameter bolts looks far greater than required. Check both the minimum spacing and edge distance for 32mm diameter bolts. Minimum Edge spacing is 1.25 diam, i.e. 80. The bearing anchor embedment looks cumbersome and does not provide sufficient positive lateral restraint under earthquake loading forces, and it is doubtful that the 20mm bolt anchorages will slide in the slot if that was the designers intention. Dailey flexing of the bolts under daytime nightime temperature changes will result in eventual breakage of these bolts. Why is stiffeners required for the cross bracing? Horizontal force couple in bracing is usually 15% of the maximum vertical bending moment.
20	**Calculations**	**Pier Footings**	Input Parameters suspect. Stub Height of 3 metres, Column is 7.0 metres Also base friction if 0.5 may be too high. Discrepancy between Geotech Report Bearing Pressure of 168 kpa and 200kpa assumed for the design.

21		**Determination of Bending Moments and Shears**	
			It is not clear what carriageway cross-section is being used. 7.3 metres carriageway minimum?
			BS8110 has been used instead of BS5400. Some will be the same but treatment of Slab design, Load Factors loading combinations will be different.
			Bearing Design is to AASTO but should be to BS5400 part 9

Consultancy Services for the National Roads Data Collection Study
Bridge Maintenance Specialist Comments on Roughton's Inception Report vs. the Terms of Reference January 2008

Item	Subject	Issue	Action
1	**Bridge Inventory**	The Africon Sheets currently being used do not capture as much details as the Inventory Sheets in the TOR, Annex G However some items identified on the Annex G Forms are not important for bridge management e.g. direction of traffic flow. There are also a number of Items e.g. Design Load as "% of MS18" which are inappropriate.	For fully informed bridge management decisions the appropriate level of inventory detail is somewhere between the Africon and UNRA forms and should additional information such as road diversion lengths
2	**Bridge Inspections**	The Africon Inspection Sheet is suitable as it both collects information on the type and extent of defects allowing cost estimates and therefore budgets can be produced, as well as recording degree of urgency required for priority of action. Overall Bridge condition rating, this is on the last page of the Inspection Form at component level but with the important Foundation Component omitted The Africon Inspection form is detailed enough to cater for the level of inspection detail expected to be available over the shorter and longer term horizons of UNRA's BMU. The main issues that are apparent from current inspection records from Roughton's is:- The information required on the Africon Form has not be gathered for all of the bridges in the current inventory. (In the ordre of 50 Number bridges out of a total of 207 bridges have substantial amounts of existing condition information missing on the Inspection Forms sampled from that project. There currently is no Bridge Inspection Manual available for the Training of UNRA Bridge Inspectors or explaining the Bridge Rating Classification criteria for each element and component of the bridge.	Include Foundation Component in Overall Condition Rating Summary on last Sheet. Prepare Bridge Inspection Manual suitable for the local conditions.
3	**Bridge Management System**	Africon's Data Entry Module of the BMS and the dTIMS needs to be developed to be consistent with the agreed level of detail for the inventory and Africon Inspection Forms. The TOR for the Road Data collection Project RDCP (Page 5-3) states that the Bridge Management System shall have the same functionality as the RMS which is clearly described in the RDCP TOR, page 5-78. We recommend that the minimum functionality level shall be as summarized in the BMU Inception Report:-	1) Agree Inventory Form (suggested Africon's Form plus some additional data from UNRA's/Ministry's Forms plus Diversion route lengths. 2) Inspection Form from Africon can be adopted as Standard Form 3)The required inventory and Condition Data for all the Bridges needs to be collected and validated as necessary. 4) A Bridge Inspection Manual showing Inspection condition rating examples, and which can be used as a Training Aid needs to be Produced. Ideally

Item	Subject	Issue	Action
			some of the Data collection Training referred to on Page 5.4, fifth paragraph from the head of the page should be allocated to the data collection related specifically to the Bridges. 5) The BMS and dTIMS is to be configured to meet the requirements of Appendix II of the RDCP contrcat, including the functionality of the

Summary of Recommendations for Minimum Characteristics of a suitable BMS for UNRA's Bridge Management Unit

	Module	Key Features
	Inventory Module(data entry interface)	The inventory information will record the bridge details as a descriptive "snapshot" of the bridge at a moment in time. It is important that the inventory records (bridge components and elements) provide sufficient information so that future inspectors can record defects against relevant bridge items The inventory details should provide a unique identifier that also facilitates changes to the road length (e.g. due to realignment) and geospatial location of the bridge Since the inventory records a bridge at a moment in time, sufficient photos should be taken to record the primary bridge features, especially items that are likely to need close attention in future; this will help the bridge manager to ascertain if an inspection was carried out in sufficient detail when he checks returned inspection forms.
	Inspection (Condition and Urgency) Module data entry interface)	The type of inspection must be entered; e.g. routine, periodic or special. If it is a special inspection, then the reason for the inspection must also be entered into the system (e.g. was the special inspection triggered by defects observed during a routine or periodic inspection, due to an incident that damaged a bridge component, etc). The bridge inspection information will be different for routine, periodic and special inspections. This means that different data entry screens will be required, but there should be sufficient commonality between screens so that data entry does is not unnecessarily duplicated.
	(	The level of information to be entered must be consistent with two objectives
		Next Actions: the inspection information must inform the bridge manager what next actions are required for each bridge, even if that next action is simply the next type of inspection (routine or periodic, noting that special inspections will be triggered by incidents)
		Priority: the information that triggers "next action" must also indicate the degree of urgency so that the bridge manager can use professional judgement to prioritise the actions based on his available budget, other resources, and workload (other priorities)
	Database Module	This module stores relevant information from the inventory and inspection (data entry) modules. The data must be stored in a manner that permits a bridge manager to interrogate the system to locate information on individual bridges,

Item	Subject	Issue	Action
		bridges on a road section, bridges in a geographical area, bridges of a certain type/age/etc. The database should also enable information relating to specific inspections to be extracted; for example, the last set of periodic inspections carried out in a certain year; the last special inspection for a particular bridge, etc.	
	Works (Costs and Budgets) Module (data entry interface)	This module enables sufficient data to be entered so that "unconstrained budgets" can be determined for the BMS. That is to say, it will accept information that describes work to be done on the bridges and the associated costs (even if these costs are entered as lump sums for each work item, rather than relying on the BMS to calculate costs from unit prices).	
	Maintenance, Repair and Rehabilitation (MR&R) Module	By combining this information with the urgency of the action (from the condition/inspection module) the bridge manager can compile his annual budget. It is possible that the total costs of all required actions exceeds the available budget, in which case the bridges manager "draws a line" under the accumulated costs of prioritised actions. The BMS should therefore ensure that all urgent items are prioritised such that they are included in the list of works within the "constrained budget". Any urgent items not included in the available budget should be flagged so that the bridges manager knows how much additional budget he needs to obtain – as a matter of urgency. At this time, we do not recommend that the MR&R module include predictive capabilities, such as deterioration models from which future condition and anticipated expenditure patterns can be generated, estimates of remaining functional life, etc.	
	Reporting Module (output formats)	The reporting module should enable a variety of reports to be produced (on screen and hard copy), ranging from charts and maps showing bridge condition to structured data reports for budget compilation, works programming (based on the Inspection (condition and urgency) and Works (costs and budgets) modules.	

Study of Strategic Bridge Structures on National Road Networks
UNRA Comments on Gauff Consultants (U) Ltd Inception Report dated February 2009

Key personnel present at the meeting	Emmanuel Mugamba, Jonathan Kariuki, Richard Malinga GAUFF		
	David Luyimbazi , Jonathan Tugume, Tim Stiff UNRA		

Item	Clause Number	Issue	Action
1	3	Work Programme shows a very tight schedule but no comments in the Inception Report on if programme is on Progress or otherwise, or any reasons for delays etc.	Confirm progress and reason for any delays
		The work program to be detailed to the level of activity and timing at each bridge site to enable the client to monitor progress	Detailed activity work program and sequencing to be issued to the client.
		Detailed Inspection Report Shown to commence in the third week in February and includes geotechnical, hydrology and topographical surveys for requisite bridges	Consultant should proceed to implement program. Execution of topographical and geotechnical surveys with respect to all category one bridges requiring to be planned intime to avoid delays.
2	4.1	Initial Technical Findings - reference is made to a systematic assessment of the existing condition and level of damage. These inspections were used to generate both the proposed scope of the works and Priority. In order for the Client to make informed decisions more details of the Inspection results, condition assessment and element rating system etc is needed. Standard UNRA inspection forms should be used to capture and record inspections findings Also input from client is required to identify structures that are on road sections to be upgraded or rehabilitated etc, to assist in prioritization	All inspections should be carried out systematically using existing UNRA bridge inspection forms (attached). Inspection records for the structures should be submitted to client for discussion and to enable required level of intervention of bridges to be selected. Consultant to submit by 06 March 2009 a detailed case on all bridges that require replacement to enable Client to make an informed decision on the way forward. Consultant to secure UNRA draft investment plan for reference.
3	4.2	Structure Priority Criteria and List of proposed treatment needs to be backed up with more detail from visual inspection results. The adequacy of the structure shaould be based on the structural and geometric capacity to meet present and future traffic and environmental loads.	Inspection records for the structures should be submitted to client for discussion and to satisfy the client of the requisite interventions proposed. For bridges to be replaced, the informations shall be required along with the advance report 0f 06 March 09 while the details on the rest of the structures to be subitted together with the detailed inspection report as stated under 14.2.1 of inception report.
		Criteria for selected treatments need to be agree	Bailey bridge structures should be considered as candidates for replacement unless it is demonstated that the bridges can sufficiently meet present and future loading /service levels. A case in point is Mpondwe bridges which shall otherwise require design for a new structure.

Item	Clause Number	Issue	Action
4	**Table 4.2**	Location of Bridges	Locations of Kateleng Steel Bridge and Lodoketianyisigia Bridges and others bridges in the Karamoja region are attached.
		Mpondwe Bridge	*Demonstrate limitations of the newly installed bailey bridge. Confirm adequacy of the existing mass concrete abutments to support new and widened reinforced concrete deck. Client to guide on posibility of locating new structure further upstream.*
		Nyamugasani bridge	*Consultant's recommendation to replace two additional bridges along the way to Nyamugasani acknowlwdged. Explore use of standardised bridge design for adoption on this and the other two bridges identified in critical condition along the same road. The bridges can then be packaged under similar lot for construction*
		Rukooki bridge	*Bridge was modified during recent upgrading project. Consultant's inspection to confirm that no major interventions are required.*
		Mpanga	*Confirm location of this bridge as Km 15 + 500 (Fort portal - Kyenjojo-Mubende)*
		Muzizi	*Client apprecients urgent need for new bridge but a detailed inspection report and case / justification required*
		Nkusi	*Proposed Repair to be confirmed after Detailed inspection*
		Kafu	*Proposed Repair to be confirmed after Detailed inspection*
		Aswa Steel bridge	*Proposed intervention be confirmed after Detailed inspection, and Hydrological assesment*
		Awoja	*Proposed intervention to be confirmed after Detailed inspection; Works tender dossiers to conform to EU requirements*
		Apak	*Proposed intervention be confirmed after Detailed inspection, and Hydrological assesment. Confirm adequacy of geometric and hydraulic capacity*
		Packwach	*Proposed Repairs to be confirmed after Detailed inspection*
		Karuma	*Proposed Repairs to be confirmed after Detailed inspection*
		Malaba	*Proposed Repairs to be confirmed after Detailed inspection*
		Manafa	*Proposed Repairs to be confirmed after Detailed inspection*
		Ngenge	*Proposed intervention be confirmed after Detailed inspection, and Hydrological assesment. Prioritisation and level of intervention to make consideration of the proposed upgrading of the road*
		Amudat	*No description of the bridge included, need to Confirm location of the bridge*
		Lopeli Steel bridge	*Proposed Repairs to be confirmed after Detailed inspection confirm*

Item	Clause Number	Issue	Action
			bridge location
		Kangole Bridge	*Proposed Repairs to be confirmed after Detailed inspection confirm bridge location*
		Nakasowan Steel bridge	*Proposed Repairs to be confirmed after Detailed inspection confirm bridge location*
		Kateleng steel bridge	*Proposed Repairs to be confirmed after Detailed inspection confirm bridge location*
		Lodoketinnayisigia	*Proposed Repairs to be confirmed after Detailed inspection confirm bridge location*
5	**Table 5.1**	Summary of initial findings:- agreement with client on initial findings is critical for sucessful performance of consultancy.	Review conditions and treatments with reference to Visual Inspection results, photographs etc. Detailed inspection and a case for replacement of the 5 (or more) structure to be submitted by 06 march 2009 to guide the client in making decision of the structures that require replacement
6		**7 - Geotechnical Investigations**	
		Material tests including insitu non destructive test for concrete are expected to be done to confirm the adequacy of existing concrete structures	Consultants to undertake insitu non destructive testing of concrete
		Geotechnical investigations shall be required for structures to be replaced. A detailed brakdown of the expected type, scope, and number of tests per site, to be carried out should be determinied and submitted to the client.	The submission should show clearly the extra provision required over and above the consultant's financial provisions under the contract and present these for the client to secure neccesary funds.
7		**8 . Surveys and mapping**	
		Topographical surveys to be executed for all new bridge locations	Submit to Client under a separate cover any extra provisions required over and above the 05 number of sites allowed for under the contract, for consideration of addendum
8		**10 - Bridge Cross-sections**	
		Need to agree on a standardised cross section for the proposed new bridges	The Consultant should submit to Client for approval at an appropriate stage, a typical/ standard cross section. All new bridges to be designed for Class 1 paved carriageway crossection viz 7.0m widths excluding footpaths. This is necessary to ensure that bridges are designed to meet geometric and structural needs for tomorrow.
9		**11 - Structural Design**	
		Structural design to BS 5400 proposed	Consultant to refer to the existing Ministry of Worksand Transport Draft Bridge design Manual. UNRA has no objection to the proposed use of BS5400 or Ugandan version of Bridge design code. For design

Item	Clause Number	Issue	Action
			loads, Consider full HA and 37.5 units of HB. The consultant is requested to flag up any descripancies and limitations encountered using the Ministry's design manual.
10		**15:- Issues for discussion with the Client**	
		The identification of the correct structures should be by name, chainage and road link and GPS co-ordinates,	Client to verify intended structures included
		Need to agree on the final number of structures to be replaced.	The consultant's advance inspection report and a case justification for the proposed need to replace given structures will facilitate the client in making the final decision on the actual number of bridges to be replaced
		No fast tracking of Awoja, Mpondwe and Muzizi bridges shall be pursued.	Noteworthy, the named bridges will be tendered immediately after design.
		The Consultant requested to present any detailed cost build-up as to how this figure of 12 million per site for geotechnical investigations was arrived at, e.g what depth of boreholes, type and number of tests, etc as well as not schedule of rates to see how cost has been estimated.	Consultant is required to present more detailed proposals for agreement with Client on Scope of works before work commences
		The identification of the correct structures should be by name, chainage and road link and GPS co-ordinates,	Client to verify intended structures included
		Need to agree on the final number of structures to be replaced.	The consultant's advance inspection report and a case justification for the proposed need to replace given structures will facilitate the client in making the final decision on the actual number of bridges to be replaced
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		The Consultant requested to present any detailed cost build-up as to how this figure of 12 million per site for geotechnical investigations was arrived at, e.g what depth of boreholes, type and number of tests, etc as well as not schedule of rates to see how cost has been estimated.	Consultant is required to present more detailed proposals for agreement with Client on Scope of works before work commences

Study of Strategic Bridge Structures on National Road Networks
Bridge Maintenance Specialist Comments on Gauff Consultants (U) Ltd Supplement to the Inception Report dated March 2009

Item	Clause Number	Issue	Action
		General Comments on Consultants Report	
		1) The Sketches are not to an acceptable standard, for example they have do not have a North Point or referencing such as North Abutment etc, Text is too small to read in some cases and level of detail is inconsistant between one structure and the next. Some have plan views showing widths, others do not etc.	
		2) Photographs should be referenced to the plan to be more useful in interpreting the information being presented by the Consultant	
		3) The report is full of unsubstantuated comments e.g "the Cost of rehabilitation is not much lower than the provision of a new bridge". Such a statement needs at least a basic cost comparison and some assessment of the work and cost of the rehabilitation works to justify it. Also comments that "the bridge is deemed to be structurally inadequate" needs the presentation of some evidence. e.g extensive cracking of slab, beams, signs of cracking	More care is necessary from the Consultant in the presentation of information and consistency of recommendations is required to enable the Client to make informed decisions based on facts, not on expediency
		4) As discussed in the meeting the standard UNRA Bridge Inspection sheet should be used for the presentation of the bridge inspections, rather than a condition index that is non standard and cannot be incorporated into the BMS currently being developed.	
		Reasons for Constructing New Bridges (Note the various criteria described in Paragraphs 3 should be set out for each structure so that the arguments are clear to interpret)	
1	**3.1**	**Structural Capacity**	
		The use of **approximate** engineering judgment is not what the client is paying for. It is expected that engineering judgment based on the visual inspection of the bridge's assessed condition to carry existing loading patterns, specifically any signs of deterioration or distress of structural elements is being used to come up with reasoned recommendations, not guesses	More care required in reviewing the report before submission to the client
	3.2	**Geotechnical**	
		There is nothing in the report that refers to foundation types despite the Consultant using the paragraph to justify choice of structural treatments. Behavior of the existing substructures especially signs of settlements, ground movements etc	More care in reviewing the report before submission to the client
	3.3	**Hydrology/Hydraulics**	
		Site observations of flood levels, erosion patterns and local catchments characteristics together with local residents comments	

Item	Clause Number	Issue	Action
		should be logically set out for each structure.	
	3.4	Review of acceptability of the existing horizontal and vertical alignment of the approach roads	The report on each bridge should follow a standrd layout as paragraph 3 perhaps for clarity of thought and understanding.
2		**COMMENTS ON INDIVIDUAL BRIDGES IDENTIFIED AS CANDIDATES FOR REPLACEMENT**	
	4.1	**MPONDWE BRIDGE**	
		Existing Bridge is a Bailey Type Truss Bridge	
		The consultants statement concerning the structures load capacity being unknown is incorrect, as each Bailey Type deck has reference numbers on the main structural elements enabling its specified load capacity to be checked with the manufacturers. See attached extract from such an e-mail enquiry carried out 3 weeks ago.	Establish if the road is identified for any development in the next 5 - 10 Year programme. Establish pedestrian traffic usage. Look at providing separate pedestrian footway alongside existing bridge.
		Bailey structures have a design life exceeding 50 years, subject to regular inspection and periodic maintenance, about the same design life as proposed structure, see following clause 4.1.2) The deck width is shown as the standard 4.2 metre wide deck with no footpath.	
	4.1.3	Recommendations	
		Justification for steel composite bridge at existing level not made. Is the bridge ok from the hydrology point of view, width of existing approach road is shown as 5.5 m wide so are there any plans to develop/rehabilitate/widen the road to a full two lane standard?.	Possibly provide design for replacement bridge Provide dimensioned sketch of proposed deck cross-section and span layout Provide details of soil investigation proposals
3	**5**	**NYAMUGASANE BRIDGE**	
		Settlement seems to be the issue here. The photographs are not indexed so it is unnecessary difficult to get an overall picture of problems	Provide dimensioned sketch of proposed deck cross-section and span layout. Provide details of soil investigation proposals
4	**6**	**MUZIZI BRIDGE**	
		No photographs of damage have been included in the report and extent of damage to deck is not evident on the sketch What function does the metal strips referred to on sketch perform?. Comments about cost of rehabilitation being not much lower than provision of new bridge is unsubstantiated	Provide dimensioned sketch of proposed deck cross-section and span layout. Provide details of soil investigation proposals

Item	Clause Number	Issue	Action
5	**7**	**ASWA BRIDGE**	
		Is there any proposals for the improvement/rehabilitation of the Lira -Kitgum Road. If so what is the programme, 5 years or 10 years etc. Design of the replacement bridge recommended Again assumption about raising bridge to increase hydraulic efficiency is subservient to increasing the waterway width if the bridge is the constraint on flow. Proposed bridge cross-section and span layout not proposed by the Consultant.	Consideration on construction sequence of new bridge due to height of existing water even in dry season. Use of existing substructure not possible due to unknown load capacity and deck widening. Provide dimensioned sketch of proposed deck cross-section and span layout Provide details of soil investigation proposals
6	**8**	**AWOJA BRIDGE**	
	8.1	Hydraulic capacity of the bridge can only be increased by increasing the span. Raising the bridge adds little to increasing hydraulic capacity Agreed that the existing bridge needs replacement Consultant has not indicated what the new deck would consist of. The existing substructure should not be used as no assessment can be made of load capacity and using composite steel beams and slab will require the provision of bearings on the intermediate support cross-beam whose load capacity is unknown. Suggest that removal of intermediate piers and using two 15metre span continuous deck with one central pier would be optimum solution. Integral bridge design should be adopted with no movement joints.	Provide dimensioned sketch of proposed deck cross-section and span layout. Provide details of soil investigation proposals
7	**9**	**NGENGE BRIDGE**	
		As noted at the Inception report meeting the water level both sides of the structure is similar and the surrounding area is at a similar level to the road and banks. However it is apparent that the width of the structure is substantially smaller than the width of river so the span of the replacement structure needs to be increased. The two options are 1) Provide additional structures each side of the existing structure to provide the missing waterway width or 2) replace the existing structure with a larger span bridge at a higher level. The report does not include any sketch of the structure layout so recommendations on expected span cannot be certain.	Provide details of soil investigation proposals Provide dimensioned sketch of existing structure and proposed span layout

Item	Clause Number	Issue	Action
8	**Cost of Geotechnical Investigation**	A detailed breakdown and cost details of the work recommended for the Geotechnical Investigation proposed by the consultant has previously been requested and needs to be presented to the client urgently for review, agreement and to enable the client to justify the additional cost of the contract. This is still not enclosed.	Detailed cost breakdown required before approval by the client for additional expenditure
9		**APAK BRIDGE**	
		Why is this bridge not considered for replacement. Age 1935 and spalling of concrete of deck slab would appear to make this a candidate? Abutment cracked, piers eroded and reports of overtopping.	Needs further investigation
10		**LODOKETINAYISIGIA BRIDGE**	
		What was agreed about the location of this bridge. It must be on the Kaabong - Kapedo Road and was reported as being in danger of collapse. Why has it disappeared from the treatment list?	Needs further investigation

Proposed 2nd Bridge across the Nile at Jinja

Bridge Management Specialist Team comments on JICA Consultant Team, Oriental Consultants Co. Ltd, (OCCL) Progress Report No.1 and Second Meeting of the Steering Committee held on Wednesday 18th February 2009

	Issue with report Page/Presentation Slide Page No.	Response for Consultant if raised during the Steering Committee Meeting	Recommended Action	Action Agreed at Technical Meeting 20 February 2009
1	Consideration of the alternative alignments are based on proposed design standards including design speeds, desirable and minimum radius of horizontal curves, visibility distances etc. The presentation seemed to imply that these had been discussed and agreed with UNRA?. Page 8-7 of the Progress Report No.1 appears to show that the Typical Cross-section of both the approach road and Bridge are tentative.	Implication that design standards have been discussed and agreed with UNRA.	Confirmation that UNRA have agreed relevant Design Standards for both the road and bridge. Confirm that bridge should be designed for 45 units of HB due to its importance. The proposal to use active pressure Query about using active pressure for substructure design. More usual to use at-rest pressure to reflect effects of compaction during construction. Also seismic effects need to be reviewed. Confirm road and bridge cross-sections	JAICA Team is to submit road and bridge Cross-sections to Technical Team UNRA for consultation with other stakeholders and final agreement.
2	The various options of the road alignment are described in the presentation as a rural road. It is in fact an International Trunk Road, Class A, with design Class 1a Paved, designed to a rural road design speed. Referring to it as a Rural road will lead to confusion with stakeholders	-	Ensure any presentation refers to correct Ugandan Road designation and that proposed road is dual carriageway standard.	Noted

	Issue with report Page/Presentation Slide Page No.	Response for Consultant if raised during the Steering Committee Meeting	Recommended Action	Action Agreed at Technical Meeting 20 February 2009
3	One key aim of the Progress report was to select the best alternative alignment for the three routes identified. In order to do this the Consultant has compared the alternative bridge construction alternatives under three headings, Engineering, Social Environmental and Cost Effectiveness, with each criteria being weighted. .	There are a number of issues here:- Within the Engineering heading, there are 4 criteria that are all weighted equally and in the case of the cable stayed designs the difference between a cable stayed bridge and a similar reinforced concrete arch design is not wide enough. In addition it is not felt that whole life costing methods have been used to bring out the advantages and disadvantages of each type of bridge. We suggest that there should be adequate weighting within the Engineering score to reflect the whole-life inspection and maintenance issues between the different bridge types. Consideration should be given to accessibility for inspections; e.g. the designs with piers in water would mean underwater inspections in fact flowing water. (so C1 is best in this regard, as an access boat would be required to access the central piers on the island in option C2). Also, the detailed cost analyses between alternatives A1 and A2, on slides 14-17, compare each A1 against A2=100. There is no way to compare the different A2s against each other. The actual costs should be included on these slides so that we can compare the lifetime	Ugandan EIA Consultant should have been engaged almost 2 months ago. Contract now expected to be agreed within 2 weeks but there will be little input into the 2nd Public Consultation. Ensure UNRA contract procedures are completed and the EIA Consultant is engaged as soon as possible. Ensure that whole life costing techniques and “maintainability” are used when selecting the preferred option, and this should include access, inspection, and maintenance costs, not just construction costs. It would be recommended that in view of the scour effects visible on the existing pier concrete that no piers should be constructed in the waterway if at all possible. If this is not possible careful consideration of alternative ways to reduce the affect of long term erosion of the concrete on the structural integrity should be an important consideration.	The need for this issue to be addressed urgently had been identified and discussed at the 2nd Steering committee meeting held on 18th February. It had been agreed that UNRA Project Manger is to press for Contract to be approved by Contracts Committee at the earliest opportunity and for the EIA consultant to be engaged as soon as practicable. JAICA is to liaise with UNRA’s technical representatives to agree key parameters to be included in whole life costing, including the provision for access, maintenance regimes, discounting rate for NPV etc. Technical committee and JAIAC consultant reached agreement that bridge span layout options that required the construction of piers in the existing river cross-section be discounted as viable options due to the high construction and maintenance risk associated with their construction in the deep, fast flowing water. Span options that could be

	Issue with report Page/Presentation Slide Page No.	Response for Consultant if raised during the Steering Committee Meeting	Recommended Action	Action Agreed at Technical Meeting 20 February 2009
		maintenance costs against each other and against the construction costs. In addition the Socio Environment with a weighting of 40 seems to have only taken notice of the number of facilities and factories directly affected by the road alignment. The EIA Consultant has still to be engaged and therefore hardly any EIA will have started before the programmed 2nd Public Consultation in early March at which time the consultant expects to confirm the optimum route out of the current 3 Options.		accommodated with minimal extension of the existing islands would however remain under consideration. This decision will result in the current option selected in the Consultants Progress Report No.1, for Route A2 to be replaced with amended 3 span PC Cable stayed span layout. JAICA is to submit an amendment to UNRA and Steering committee for inclusion in Progress Report No 1..
4	Page 21 of Presentation Hand Out implies that existing 2 lane bridge is under capacity. The bridge may be crowded during peak flow times but roads are designed for average flow.	-	Observation	No action required
5	Page 22 of Presentation Hand-out proposes restrictions on the access for pedestrians and bicycles on the existing and proposed structures.	-	Confirm proposals and new road and bridge cross-sections	UNRA to liaise with stakeholders to confirm traffic management proposals, and advise JAICA study team of design parameters. It was felt by the UNRA team that provision may need to be made for local light vehicular traffic, cars and taxis, to continue to use the

	Issue with report Page/Presentation Slide Page No.	Response for Consultant if raised during the Steering Committee Meeting	Recommended Action	Action Agreed at Technical Meeting 20 February 2009
				existing bridge on the dam alignment subject to the satisfactory repairs being carried out.
6	The Obstacle Limitations zone for Jinja Airport affects the available height of the cable stayed towers.	A report is rumoured to exist in the CAA detailing the extension and possible realignment of the Jinja Airport runway. This may affect the bridge alternatives as the existing Obstacle Limitations have been used to date. is	Study Team have asked for confirmation that current and future Obstacle Limitation Zone is to be enforced by relevant authorities.	UNRA is to arrange a meeting with CAA as soon as possible to confirm current and any future Obstacle Limitations Zone(s), including any proposals for runway upgrading or extension that may affect current route options.
7	Appendix 5 Comparison of Bridge locations and the preliminary bridge layouts imply a number of expansion joints catering for large movements. These joints will have a long term maintenance liability and consideration should be given to ensuring that the joints can be replaced without extensive work and spare parts or joints, or even a long term maintenance contract from the supplier is included under the construction contract.	-	Raise access and maintenance issues at an early enough stage to be incorporated into the design. Also consider active monitoring of bridge condition, load cells for measuring applied live load etc. Cathodic protection of substructure in contact with water etc.	JAICA is to continue to discuss these issues as design route and bridge selection processes become more refined.
8	From the geology report, we assume that the bridge sites are all in hard-rock locations and no significant scouring of the river banks will take place. In which case, the spans can be determined from the current regime width of the	-	Obtain clarification from study Team on preliminary foundation assumptions.	See Paragraph No 3 above.

	Issue with report Page/Presentation Slide Page No.	Response for Consultant if raised during the Steering Committee Meeting	Recommended Action	Action Agreed at Technical Meeting 20 February 2009
	river? But, it is not clear from the presentation slides whether scour depths (i.e. future levels of the river bed) have been allowed for and the foundations/bridge options costed accordingly.			

Appendix J: Summary of current bridge inventory and condition index from consultant for the National Roads Data Collection Project.

No	Bridge Name	GPS Coordinates		Type of Deck Material	Span Type	Span Length (m)	Superstructure	Condition Index			Type of Span	Type of Deck Material
								Waterway	Substructure	Superstructure		
1	Kahenge Bridge	30.05029	0.83156	6	1	15.84	1	8	8	9	Simply supported span	Composite Steel and concrete
2	Mirama hill-Kakitumba	30.45917	-1.05164	6	1	Nil	1	5	9	9	Simply supported span	Composite Steel and concrete
3	Kategule Bridge	30.21936	0.99060	98	1	3.40	1	8	8	8	Simply supported span	Other
4	Omungenyi Bridge	30.20699	0.95836	6	1	30.90	1	5	8	8	Simply supported span	Composite Steel and concrete
5	Katinda Ntugamo	30.22308	0.92710	6	1	30.80	1	5	8	8	Simply supported span	Composite Steel and concrete
6	Kemyenda	30.18481	-1.03783	6	1	13.12	1	5	8	8	Simply supported span	Composite Steel and concrete
7	Rubanga Bridge	30.18308	-1.05320	6	1	13.10	1	7	8	8	Simply supported span	Composite Steel and concrete
8	Minera River Bridge 2	29.01141	0.90576	3	2	6.50	1	7	9	8	Simply supported span	Reinforced concrete
9	Minera river Bridge 1	29.01145	0.90604	6	1	6.20	1	8	8	8	Simply supported span	Composite Steel and concrete
10	Kyanamira	29.99560	-1.25812	6	1	10.11	1	9	9	8	Simply supported span	Composite Steel and concrete
11	Kasiega	30.08651	0.17390	6	1	18.70	1	9	9	9	Simply supported span	Composite Steel and concrete
12	Kyanyampara	29.85701	0.04860	6	1	8.20	1	8	9	8	Simply supported span	Composite Steel and concrete
13	Kyarumba	29.94990	0.12291	6	1	Nil	1	8	4	8	Simply supported span	Composite Steel and concrete
14	Dungulwa bridge	29.95283	0.11626	98	1	8.40	5	8	7	5	Vierendeel truss	Other
15	Kitekena	30.09338	0.33300	7	1	6.70	1	2	0	1	Simply supported span	Timber
16	Kyanya Bridge	29.07708	0.33348	6	1	8.10	1	9	9	9	Simply supported span	Composite Steel and concrete
17	Nyamwambwa Kilembe Bridge	30.01267	0.19793	6	1		1	9	9	9	Simply supported span	Composite Steel and concrete
18	Namugasani River Bridge	29.84316	0.12349	6	3	8.19 8.50 8.20	1	8	8	8	Simply supported span	Composite Steel and concrete
19	Ishasha Border	29.62819	0.72721	3	3	11.20 114.85 11.00	1	8	4	3	Simply supported span	Reinforced concrete
19	Rwizi Bridge	29.8678	0.42309	3	4	6.24 6.20 6.07 6.03	1	4	8	8	Simply supported span	Reinforced concrete
20	Tungwe Bridge	29.72390	0.57500	98	3	10.18 18.70 18.71	1	9	9	8	Simply supported span	Other
21	Rwapunu	29.87593	0.38356	3	4	6.24 6.20 6.07 6.03	1	9	9	9	Simply supported span	Reinforced concrete
22	Nyamwiru Bridge	29.87073	0.31313	3	3	6.30 6.13 6.07	1	9	9	9	Simply supported span	Reinforced concrete
23	Katonga	32.00754	0.03417	3	3	8.20 18.60 8.20	1	5	7	7	Simply supported span	Reinforced concrete
24	Buyala	32.41831	0.32932	3	1	31.10	1	n/a	7	7	Simply supported span	Reinforced concrete
25	Kazinga channel bridge	30.04868	0.12506	6	3	8.50 43.00 9.30	1	8	8	8	Simply supported span	Composite Steel and concrete
26	Sebwe	30.11681	0.25200	6	1	11.20	1	8	9	9	Simply supported span	Composite Steel and concrete
27	Mobuku			6	2	15.30	1	9	9	9	Simply supported span	Composite Steel and concrete
28	Rwimi Bridge	30.21132	0.37330	3	1	16.40	1	9	n/a ?	6	Simply supported span	Reinforced concrete
29	Mpondwe Bridge	29.2702	0.40135	5	1	18.50	1	9	9	9	Simply supported span	Structural Steel
30	Kitagata bridge	30.16064	0.67801	6	1	3.00	1	8	8	8	Simply supported span	Composite Steel and concrete
	Agago-Irish crossing (vented drift)	33.54766	2.72239	3	1	38.20	Nil	n/a	n/a ?	n/a	Unknown	Reinforced concrete
31	Kisanja-Park Junction section (39-76)km 1st bridge	31.71662	-2.05932	Nil	1	20.00	1		n/a ?	n/a	Simply supported span	Unknown
32	Kisanja-Park Junction section (39-76)km 2nd bridge	31.71623	-2.09725	5	1	20.00	Nil		n/a ?	n/a	Unknown	Structural Steel
33	Kisanja-Park Junction section (39-76)km 3rd bridge Sambiya	31.70621	-2.14854	Nil	Nil	Nil	Nil		n/a ?	n/a	Unknown	Unknown
34	Sambiya	31.69725	-2.17847	5	1	Nil	Nil		n/a ?	n/a	Unknown	Structural Steel
35	Mpanga	30.3935	0.64334	6	3	10.00 9.30 10.00	Nil				Unknown	Composite Steel and concrete
36	Mpanga Missing from 1st data extract	30.29529	0.65868	6	4	4.10 4.10 4.10 4.10	Nil		n/a		Unknown	Composite Steel and concrete

No	Bridge Name	GPS Coordinates		Type of Deck Material	Span Type	Span Length (m)	Superstructure	Condition Index			Type of Span	Type of Deck Material
								Waterway	Substructure	Superstructure		
37	Mpanga	30.27816	0.65693	6	2	7.95 7.96	Nil				Unknown	Composite Steel and concrete
38	Kirumya	30.09556	0.79578	5	1	18.50	Nil				Unknown	Structural Steel
39	Wassa	30.36326	0.93501	5	1	18.55	1	7	8	8	Simply supported span	Structural Steel
40	Dura	30.37998	0.45846	2	1	15.55	1	8	8	8	Simply supported span	Precast units (cell structures)
41	Rwimi Bridge	30.21144	0.37334	4	1	16.30	1	9	8	9	Simply supported span	Precast beams
42	Sogaha	30.88137	0.4947	3	2	10.10 14.50	1	5	8	8	Simply supported span	Reinforced concrete
43	Waiga	31.47589	-1.99265	5	3	4.30 10.00 4.30	1	7	7	7	Simply supported span	Structural Steel
44	Karuma	32.23983	-2.24251	6	3	Nil	Nil	8	n/a ?	n/a	Unknown	Composite Steel and concrete
45	Muzizi	30.72976	0.87111	6	4	5.20 9.40 9.00 5.20	1	2	n/a ?	2	Simply supported span	Composite Steel and concrete
46	Kafu	32.04175	-1.544222	6	3	23.40 27.20 23.40	1	7	7	7	Simply supported span	Composite Steel and concrete
47	Titi	32.02074	-1.82617	6	1	24.50	1	6	7	7	Simply supported span	Composite Steel and concrete
48	Muhokya double box culvert	30.04358	0.08835	3	2	3.30	1	8	9	9	Simply supported span	Reinforced concrete
50	Nyamwamba	30.10499	0.19444	6	1	15.20	1	7	8	9	Simply supported span	Composite Steel and concrete
49	Nchwera	29.80123	0.45853	under construction	Nil	Nil	Nil				Unknown	Unknown
50	Mwanyare	29.99348	1.26129	6	1	15.59	1	6	7	9	Simply supported span	Composite Steel and concrete
51	Katuna border Box culvert	30.0118	1.42477	3	3	3.88 3.89 3.90	1	8	9	9	Simply supported span	Reinforced concrete
52	Busyoro Bridge MPC's	30.91473	0.13246	Nil	1	13.00	Nil	8	8	n/a	Unknown	Unknown
53	Kabobo MPC's	30.50481	0.98259	98	1	9.90	1	8	9	8	Simply supported span	Other
54	Nyabisheke MPC's	30.68030	0.09652	98	1	12.70	Nil	7	n/a ?	n/a	Unknown	Other
55	Ekyambu MPC's	30.53119	0.133323	98	1	10.38	Nil	9	n/a ?	n/a	Unknown	Other
56	Rushango Bridge	30.70616	0.08447	6	2	Nil	1	8	8	7	Simply supported span	Composite Steel and concrete
57	Retuma Bridge MPCs	30.78266	0.00575	98	1	10.95	Nil	8	n/a ?	n/a	Unknown	Other
58	Kabagole bridge	30.89299	0.09238	3	2	3.20	1	7	7	7	Simply supported span	Reinforced concrete
59	Mpanga Bridge	30.46205	0.10060	6	1	11.50	1	8	8	8	Simply supported span	Composite Steel and concrete
60	Nyabikurungu Bridge	30.48619	0.17105	6	1	Nil	1	8	9	9	Simply supported span	Composite Steel and concrete
61	Nyakambu Bridge	30.60029	0.43450	6	1	7.50	1	8	n/a ?	7	Simply supported span	Composite Steel and concrete
62	Kamiira Bridge	30.42458	0.37448	6	1	7.00	1	7	n/a ?	8	Simply supported span	Composite Steel and concrete
63	Ruizi Bridge	30.64398	0.61821	6	3	10.14 30.80 12.20	1	7	9	8	Simply supported span	Composite Steel and concrete
64	Alah	31.07238	2.90322	7	2	7.00	6	6	6	6	Steel girder frame	Timber
65	Olemika	31.01925	2.91477	6	1	7.88	Unaccessible	8	n/a ?	n/a	Unknown	Composite Steel and concrete
66	Ora 2	31.39265	2.71812	7	1	7.85	Unaccessible	6	n/a ?	n/a	Unknown	Timber
67	Ora 1	31.39275	2.71768	7	1	24.50	Unaccessible	7	n/a ?	n/a	Unknown	Timber
68	No name	31.20069	2.88667	6	1	9.60	Unaccessible	6	n/a ?	n/a	Unknown	Composite Steel and concrete
69	Dacha	31.26223	3.36241	7	1	7.10	6	6	6	6	Steel girder frame	Timber
70	Jure	31.27777	3.38173	7	1	7.50	Nil	n/a	6	6	Unknown	Timber
71	Enyau	31.12416	3.25213	6	4	8.60 8.00 8.30 8.35	7	8	7	7	End span of a continuous type bridge	Composite Steel and concrete

No	Bridge Name	GPS Coordinates		Type of Deck Material	Span Type	Span Length (m)	Superstructure	Condition Index			Type of Span	Type of Deck Material
								Waterway	Substructure	Superstructure		
72	Oru	31.13517	3.26572	6	5	6.85 6.70 6.70 6.68 6.65	7	7	8	7	End span of a continuous type bridge	Composite Steel and concrete
73	Ozoro	31.16380	3.28794	7	1	3.40	Unaccessible	6	n/a ?	n/a	Unknown	Timber
74	Nyetre	31.15046	3.27828	7	1	3.20	Unaccessible	7	6	n/a	Unknown	Timber
75	Ore	31.20379	3.33704	7	1	7.00	5	6	6	5	Vierendeel truss	Timber
76	Cala	31.81457	3.60426	6	2	7.00 7.00	1	7	8	8	Simply supported span	Composite Steel and concrete
77	Enyau	30.9053	3.08998	6	2	9.55 9.35	3	7	3	3	Supported cantilevered construction	Composite Steel and concrete
78	Inve	30.90546	3.15209	5	2	9.00 9.00	3	6	4	3	Supported cantilevered construction	Structural Steel
79	Oluffe	30.93408	3.18879	5	2	9.00 9.00	4	6	4	4	Lattice girder truss	Structural Steel
80	Kochi	30.96041	3.44298	6	1	6.60	Unaccessible	3	n/a ?	n/a	Unknown	Composite Steel and concrete
81	Apa	30.95673	3.3968	5	1	9.50	6	5	6	6	Steel girder frame	Structural Steel
82	Yoo	30.94842	3.32616	5	2	7.80 7.80	1	8	7	7	Simply supported span	Structural Steel
83	Oru	30.95289	3.33356	6	2	9.60	6	6	6	6	Steel girder frame	Composite Steel and concrete
84	Nyawa	31.53522	3.60911	6	4	7.00 6.70 6.70 7.00	1	8	7	7	Simply supported span	Composite Steel and concrete
85	Kochi	31.43885	3.55960	5	4	8.00	1	6	7	7	Simply supported span	Structural Steel
86	Yii	31.47105	3.58040	6	1	7.00	Unaccessible	n/a	n/a ?	n/a	Unknown	Composite Steel and concrete
87	Ebikwa	31.74441	3.64572	6	2	6.00	1	7	7	7	Simply supported span	Composite Steel and concrete
88	Eyiagwea	32.01658	3.35755	6	1	7.50	Unaccessible	n/a	n/a ?	n/a	Unknown	Composite Steel and concrete
89	Surumu	31.80835	3.36976	6	1	6.85	1	6	6	7	Simply supported span	Composite Steel and concrete
90	Eria	31.99367	3.37767	6	2	7.00 8.00	5	6	5	5	Vierendeel truss	Composite Steel and concrete
91	Amua	31.78939	3.64082	6	2	8.50	6	7	7	7	Steel girder frame	Composite Steel and concrete
92	Aguyi	30.99514	2.82979	6	1	15.80	1	7	8	8	Simply supported span	Composite Steel and concrete
93	Wiki	30.98087	2.87997	6	1	16.80	1	6	7	7	Simply supported span	Composite Steel and concrete
94	Ozuya	30.98414	2.86768	3	1	8.70	1	6	8	8	Simply supported span	Reinforced concrete
95	Ayii	30.94304	3.25488	5	2	9.20 9.00	1	6	7	8	Simply supported span	Structural Steel Structural Steel
96	Nyarwodho	31.03002	2.37698	5	3	6.42 4.30 7.50	Unaccessible	Unaccessible	Unaccessible	Unaccessible	Unknown	
97	Ora	31.14042	2.65620	6	1	43.70	1	7	8	8	Simply supported span	Composite Steel and concrete
98	Namthini	31.09003	2.51172	6	1	15.65	1	6	7	8	Simply supported span	Composite Steel and concrete
99	Achwera	31.17251	2.48283	6	1	15.80	1	6	7	8	Simply supported span	Composite Steel and concrete
100	Akaba	31.14156	2.4908	6	1	10.80	1	6	8	8	Simply supported span	Composite Steel and concrete
101	Kivuje	31.33563	2.28998	6	1	8.50	6	n/a	6	6	Steel girder frame	Composite Steel and concrete
102	Boro	31.35743	2.32036	6	3	6.50 7.80 6.50	Unaccessible	Unaccessible	Unaccessible	Unaccessible	Unknown	Composite Steel and concrete
103	Albert Nile	31.50803	2.45838	6	3		Unaccessible	7	Unaccessible	Unaccessible	Unknown	Composite Steel and concrete
104	Ayugi	32.04112	3.34846	6	4	8.85 8.80	6	7	6	6	Steel girder frame	Composite Steel and concrete
105	Nyarwodho	31.12818	2.49501	6	1	10.85	1	6	8	8	Simply supported span	Composite Steel and concrete
106	Kibimba	33.8912	0.53546	Nil	5		Unaccessible	7	Unaccessible	Unaccessible	Unknown	Unknown
	Dopeths-Irish Crossing (vented Drift)	34.02877	3.01139	3	1	30.60	n/a	n/a	n/a ?	n/a	Unknown	Reinforced concrete
107	Longoromit	34.16583	3.49901	5	1	15.60	1	8	8	8	Simply supported span	Structural Steel
108	Lokwakal	34.11482	2.97244	5	1	30.70	1	7	8	9	Simply supported span	Structural Steel
109	Apaan	34.11878	3.33111	5	1	21.70	1	8	9	9	Simply supported span	Structural Steel
110	Lochom	34.14489	3.43822	5	1	15.60	1	8	8	9	Simply supported span	Structural Steel
111	Kathile bridge	34.08832	3.62874	Nil	1	16.00	1	8	9	8	Simply supported span	Unknown
112	Nariamabune	34.03651	3.64617	Nil	1	30.60	1	8	1	8	Simply supported span	Unknown
113	Kathile 2 Bridge	34.07473	3.64268	Nil	1	16.00	1	8	8	8	Simply supported span	Unknown
114	Kaabong Bridge	34.12912	3.51958	6	2	13.43	1	8	8	8	Simply supported span	Composite Steel and concrete
115	Kanawati Bridge	34.09213	2.99581	5	1	12.70	1	8	8	8	Simply supported span	Structural Steel
116	Loyoroit Bridge	33.75137	2.82162	5	1	28.00	1	8	8	8	Simply supported span	Structural Steel
117	Bunamubi	Nil	Nil	4	1	20.60	1	7	8	8	Simply supported span	Precast beams
118	Manafwa	34.36958	1.00816	7	1	9.70	1	n/a	2	3	Simply supported span	Timber

No	Bridge Name	GPS Coordinates		Type of Deck Material	Span Type	Span Length (m)	Superstructure	Condition Index			Type of Span	Type of Deck Material
								Waterway	Substructure	Superstructure		
119	Manafwa	Nil	Nil	6	2	10.00 10.40	1	7	8	8	Simply supported span	Composite Steel and concrete
120	Aturukuko	34.15886	0.70288	6	1	6.40	Unaccessible	7	Unaccessible	Unaccessible	Unknown	Composite Steel and concrete
121	Cheptui	34.34418	1.40638	Collapsed	Nil	Nil	Nil	n/a	1	0	Unknown	Unknown
122	Namikhoma	34.37463	0.81184	6	1	6.00	1	7	7	8	Simply supported span	Composite Steel and concrete
123	Namunyiri	34.34407	0.81450	6	1	7.00	1	7	8	7	Simply supported span	Composite Steel and concrete
124	Yembe/mbigi	34.32879	1.30795	6	1	15.70	1	7	7	7	Simply supported span	Composite Steel and concrete
125	Nagongera	34.04212	0.76041	Nil	1	5.60	Nil	7	Unaccessible	Unaccessible	Unknown	Unknown
126	Pakam	34.11858	0.72211	6	1	6.40	Unaccessible	7	Unaccessible	Unaccessible	Unknown	Composite Steel and concrete
127	Magodes	34.16996	0.82746	3	1	6.90	1	7	7	8	Simply supported span	Reinforced concrete
128	Nkola	33.93055	0.93055	6	1	7.35	Nil	6	Unaccessible	Unaccessible	Unknown	Composite Steel and concrete
129	Yemjyon	34.51513	1.41462	6	1	12.00	1	7	8	8	Simply supported span	Composite Steel and concrete
130	Nakulumutu	33.99614	0.93141	6	1	4.60	Unaccessible	Unaccessible	Unaccessible	Unaccessible	Unknown	Composite Steel and concrete
131	Mpologoma	33.79028	0.82699	5	5	20.60	1	8	7	7	Simply supported span	Structural Steel
132	Ngenge	34.50797	1.40678	6	1	15.75	1	7	8	8	Simply supported span	Composite Steel and concrete
133	Manafwa	34.99026	0.92833	Nil	Nil		1	6	Unaccessible	Unaccessible	Simply supported span	Unknown
134	Upper Atari	34.48239	1.40713	6	1	15.70	1	7	8	8	Simply supported span	Composite Steel and concrete
135	Nakwazi	33.93542	0.8545	3	1	5.45	1	7	Unaccessible	7	Simply supported span	Reinforced concrete
136	Tabakonyi	34.40410	1.47084	6	1	12.00	1	8	9	8	Simply supported span	Composite Steel and concrete
137	Malaba	34.26831	0.63742	3	3	10.50 11.00 10.50	1	8	8	7	Simply supported span	Reinforced concrete
138	Sipi	34.31430	1.38249	6	1	7.50	1	8	8	8	Simply supported span	Composite Steel and concrete
139	Chesebere	34.34961	1.41475	6	1	7.65	1	7	7	9	Simply supported span	Composite Steel and concrete
140	Hatari	34.44419	1.5002	6	1	7.70	1	7	Unaccessible	7	Simply supported span	Composite Steel and concrete
141	Seretyo	34.49402	1.53895	Nil	1	7.70	Unaccessible	Unaccessible	Unaccessible	Unaccessible	Unknown	Unknown
142	Girik	34.54359	1.59832	6	3	7.00 10.00 7.00	5	7	5	5	Vierendeel truss	Composite Steel and concrete
143	Ayago	32.99620	2.41695	6	3	10.70	Nil	7	7	Unaccessible	Unknown	Composite Steel and concrete
144	Awoo	32.40350	2.52472	7	2	7.80 7.60	1	5	7	7	Simply supported span	Timber
145	Ayago	32.05547	2.61781	6	3	6.20 5.40 6.40	6	5	7	6	Steel girder frame	Composite Steel and concrete
146	Akaku	31.92931	2.58932	6	2	6.20	1	n/a	7	7	Simply supported span	Composite Steel and concrete
147	Tochi	32.33308	2.62471	6	1	18.50	1	n/a	7	7	Simply supported span	Composite Steel and concrete
148	Odek	32.72911	2.68015	3	2	1.90	1	6	7	7	Simply supported span	Reinforced concrete
149	Aswa	32.78622	2.68729	5	3	9.10 8.70 9.10	1	7	7	8	Simply supported span	Structural Steel
150	Unyama	32.28854	2.95505	6	2	6.15 6.12	1	4	6	7	Simply supported span	Composite Steel and concrete
151	Unyama Unyama-paicho	32.34534	2.82153	6	2	4.70	1	6	7	7	Simply supported span	Composite Steel and concrete
152	Unyama Bibia-Nimule	32.07346	3.57118	Nil	3	9.90 11.00 9.50	1	7	7	8	Simply supported span	Unknown
153	Aswa	32.58131	2.95842	98	29	2.30	Nil	6	5	Unaccessible	Unknown	Other
154	Lwele	34.19991	1.15295	6	1	Nil	Unaccessible	Unaccessible	Unaccessible	Unaccessible	Unknown	Composite Steel and concrete
155	Kado	34.34398	1.16506	3	1	6.90	1	7	?	7	Simply supported span	Reinforced concrete
156	Lisi	34.28582	0.95719	6	1	8.20	Nil	?	?	?	Unknown	Composite Steel and concrete
157	Muyembe	34.29660	0.33469	6	1	15.80	Nil	?	?	?	Unknown	Composite Steel and concrete
158	Simu	34.28722	1.29856	3	1	9.90	Nil	?	?	?	Unknown	Reinforced concrete
159	Sironko	34.25698	0.23634	6	1	13.80	Nil	7	?	?	Unknown	Composite Steel and concrete
160	Nabuyonga	34.24121	1.06060	3	1	5.80	Nil	?	?	?	Unknown	Reinforced concrete
161	Namatala	34.17249	0.10866	6	1	10.40	6	7		6	Steel girder frame	Composite Steel and concrete
162	Mpologoma	33.73775	0.96674	3	2	16.75	1	9	Unaccessible	8	Simply supported span	Reinforced concrete
163	Manafa	34.28042	0.94069	3	3	5.60 5.60 7.20	Nil				Unknown	Reinforced concrete
164	Tsutsu	34.33165	0.99753	6	1	8.00	Nil	7	?	?	Unknown	Composite Steel and concrete
165	Nabuyonga Mbale-Namunsi			3	3	5.50	1	8	8	8	Simply supported span	Reinforced concrete
166	Sonoli River bridge	34.29993	1.16023	6	1	6.50	Nil	?	?	?	Unknown	Composite Steel and concrete

No	Bridge Name	GPS Coordinates		Type of Deck Material	Span Type	Span Length (m)	Superstructure	Condition Index			Type of Span	Type of Deck Material
								Waterway	Substructure	Superstructure		
167	Mihu	34.31843	1.19069	7	1	3.60	Unaccessible	Unaccessible	Unaccessible	Unaccessible	Unknown	Timber
168	Sironko	34.32283	1.18590	2	1	20.60	Unaccessible	Unaccessible	Unaccessible	Unaccessible	Unknown	Precast units (cell structures)
169	Namazo	34.18687	1.07782	6	1	7.00	Nil	7	?	?	Unknown	Composite Steel and concrete
170	Fika Salaama River Bridge	34.15733	1.16472	6	1.0	4.00		?	?	?		Composite Steel and concrete
171	Ogwapoke	33.03469	3.43732	6	2	2.80	1	8	8	8	Simply supported span	Composite Steel and concrete
172	Tochi Kamdini	32.3420	2.22713	6	1	30.50	1	8	8	8	Simply supported span	Composite Steel and concrete
173	Aswa Bridge	32.93663	2.60651	6	1	31.10	1	8	8	8	Simply supported span	Composite Steel and concrete
174	Aringa	33.00471	0.39552	6	2	3.30	1	6	8	8	Simply supported span	Composite Steel and concrete
175	Tee-Iconga Missing from Ist data extract	32.17131	2.27357	3	1	?	98	8	8	7	Other	Reinforced concrete
176	Ayitunga bridge	32.93246	2.55183	6	1	6.10	1	7	8	8	Simply supported span	Composite Steel and concrete
177	Lakaye	33.08722	3.68057	3	1	4.10	4	8	8	4	Lattice girder truss	Reinforced concrete
178	Limu	32.59145	3.66866	6	1	5.40	1	8	8	8	Simply supported span	Composite Steel and concrete
179	Lagwel	32.85343	3.44089	6	1	5.00	1	8	8	8	Simply supported span	Composite Steel and concrete
180	Agago	33.34919	2.75472	6	2	7.80 6.90	6	8	8	6	Steel girder frame	Composite Steel and concrete
181	Otaka	32.06379	2.80602	6	1	9.20	1	8	8	8	Simply supported span	Composite Steel and concrete
182	Apak	32.22081	2.37073	6	4	6.90 12.30 12.50 4.80	1	7	8	8	Simply supported span	Composite Steel and concrete
183	Lanyang	32.95800	3.36720	6	2	7.85 7.10	1	8	8	7	Simply supported span	Composite Steel and concrete
184	Acholi Bur	32.91412	3.14612	3	1	4.40	1	8	7	8	Simply supported span	Reinforced concrete
185	Agora	32.96245	2.82143	3	1	4.50	1	8	7	8	Simply supported span	Reinforced concrete
186	Agago tum	32.96449	2.83983	3	6	5.20 5.00 5.00 5.00 5.00 5.20	7	7	8	7	End span of a continuous type bridge	Reinforced concrete
187	Atup	32.94984	2.73757	6	2		1	8	8	8	Simply supported span	Composite Steel and concrete
188	Dure	32.92642	3.21020	6	1	5.40	1	8	8	8	Simply supported span	Composite Steel and concrete
189	Kitgum-Matidi	33.06913	3.26035	6	8	4.40 5.00 5.00 4.60 5.00 4.60 5.00 4.60	1	7	8	8	Simply supported span	Composite Steel and concrete
190	Ogeng	32.78352	3.04559	3	2	7.40	1	8	8	8	Simply supported span	Reinforced concrete
191	Atanga	32.75542	3.01925	3	1	4.40	1	8	8	7	Simply supported span	Reinforced concrete
192	Ajan	32.76745	3.03069	3	5	5.20	Nil	?	?	?	Unknown	Reinforced concrete
193	Awich	32.41333	3.36943	5	1	10.40	1	8	8	6	Simply supported span	Structural Steel
194	Unyama	32.20808	3.26605	5	1	30.60	6			Tilted structure	Steel girder frame	Structural Steel
195	Atika	32.84151	3.08105	6	1		1	8	8	8	Simply supported span	Composite Steel and concrete
196	Aswa	32.36237	3.29915	5	4	12.58 30.80 30.80 12.58	1	9	8	8	Simply supported span	Structural Steel
197	Pager	32.87949	3.30088	6	3	7.90 8.10 7.90	1	7	8	8	Simply supported span	Composite Steel and concrete
198	Burkung	32.52350	3.43054	5	1	12.55	1	8	8	7	Simply supported span	Structural Steel
199	Okura	33.01454	3.79757	6	1	7.70	1	8	9	9	Simply supported span	Composite Steel and concrete
200	Arwama	33.08751	3.67923	3	1	4.60	1	4	8	8	Simply supported span	Reinforced concrete
201	Ladot	33.87263	1.26756	3	1	7.00	1	7	n/a ?	n/a	Simply supported span	Reinforced concrete