



**AfCAP**  
Africa Community Access Partnership



## The use of appropriate high-tech solutions for Road network and condition analysis, with a focus on satellite imagery

### Inception Report



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## ReCAP Inception Report Template

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### Abstract

This report is a lead into the programme. It should be noted that no partner countries have yet been selected, so many of the specific details of how we will work with our partners will be contained in the subsequent desk study report. The main purpose of this report is to refine the methodology and programme proposed in our bid, and to raise any further comments on the Terms of Reference that have arisen at, or since, the launch meeting.

The ToR stresses the importance of linking with other regional AFCAP projects, so we have made contacts with the Maintenance and Climate Change projects and will continue to liaise closely throughout the project period.

The methodology states the importance of the desk study in determining potential research subjects. We will use the team's experience and our contacts in the industry to scan the horizon for potential high-tech solutions that can be piloted during phase 2. In addition we will establish ground truthing in association with partner countries that is in line with local practice and with the AFCAP Maintenance project, and we will use this to compare to the satellite image assessments, which will also be carried out locally.

**Key words**

Low Volume Sealed Roads, Satellite imagery, Road Condition, High-Tech Solutions, Network, Asset Management

**RESEARCH FOR COMMUNITY ACCESS PARTNERSHIP (ReCAP)**  
*Safe and sustainable transport for rural communities*

ReCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa and Asia. ReCAP comprises the Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP). These partnerships support knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. The ReCAP programme is managed by Cardno Emerging Markets (UK) Ltd.

**See [www.research4cap.org](http://www.research4cap.org)**

## **Acknowledgements**

Airbus DS, ReCAP PMU

## **Acronyms, Units and Currencies**

£	Great Britain Pound
AFCAP	Africa Community Access Partnership
Airbus DS	Airbus Defence and Space
esa	Equivalent Standard Axles
LIDAR	Light Distance and Ranging (or Light Radar)
LVR	Low Volume Roads
LVSR	Low Volume Sealed Roads
NIAF	Nigeria Infrastructure Advisory Facility
PMU	Project Management Unit
QA	Quality Assurance
ReCAP	Research for Community Access Partnership
T <sup>2</sup>	Transportation Technology Transfer
ToR	Terms of Reference
TRID	Transport Research International Documentation
TRL	Transport Research Laboratory
UAV	Unmanned Aerial Vehicle
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)

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## **1 Executive summary**

AFCAP promotes safe and sustainable rural access in Africa through research and knowledge sharing between participating countries. The second phase which commenced in August 2014 has seen a number of regional projects, of which this project is one.

The objectives of this project are to provide a cost-effective and reliable high-tech solution for the capture of maintenance management data related to inventory and condition of a country's rural road network. This research will also keep capacity building and technology transfer as its core values, whilst striving towards uptake and embedment of the results. Other regional ReCAP projects will be consulted during this process.

Research into the use of satellite imagery for remote asset condition assessment was originally carried out by TRL in Nigeria in 2013, and will have a bearing on the methodology for this research project. The team have relevant experience in all areas of this research area, and the most promising and cost effective solutions will be selected with the first part of a peer review confirming those choices before Phase 2.

We will select at least four countries to pilot the proposed research in. They will be selected based on a set of criteria to be developed during the desk study phase. The partner countries will need to provide counterpart staff and resources to the project. The pilots will be carried out with support from the project team, and the results from these will be consolidated into a final report and high-tech solutions guideline. A scientific paper will be produced towards the end of the research and presented at appropriate conferences or seminars.

A programme has been proposed and can be seen in Chapter 8. This includes all of the main milestones, as well as the peer reviews and the potential presentation of the results at the T<sup>2</sup> conference in May 2017. It is expected that the deadlines for deliverables will be met.

## **2 Introduction**

The launch meeting for this project, GEN2070A, was held on 21<sup>st</sup> April 2016 and the start date of the contract has been set as 25<sup>th</sup> April 2016. The minutes of the meeting are given in Appendix A. The duration of the project is 12 months and the completion date is 12<sup>th</sup> May 2017. The main contact person for this project will be the ReCAP Infrastructure Research Manager. This inception report has been produced at the TRL head office and no site visits have yet been undertaken as the partner countries will only be selected during the desk study period.

A large amount of research has been carried out on low volume roads in Africa, which has led to the development of manuals, specifications, guidelines and other documents, as well as the mainstreaming of various construction and maintenance methods and techniques. This project will concentrate on high-tech solutions to asset management issues, with the aim of making the assessment, maintenance and management of low volume roads more cost effective and efficient.

## 3 Background

### 3.1 AFCAP and high-tech solutions

AFCAP is promoting safe and sustainable rural access in Africa through research and knowledge sharing between participating countries and the wider community. As part of this Programme, the development of cost effective high-tech solutions for network and condition assessment on low volume roads is to be undertaken. AFCAP has a record of producing innovative solutions through applied research, and this project will continue that record through the high-tech field.

Low Volume Roads (LVR) typically carry less than 300 vehicles per day and less than 1 million equivalent standard axles (esa) loading during their design life. They provide important links from homes, villages and farms to markets and offer the public access to health, education and other essential services. They also provide important links between rural areas and the main road network. The majority are unpaved, but there is a move towards low cost surfacing for LVRs in order to reduce maintenance costs and vehicle operating costs, and to provide all-weather access.

### 3.2 High-tech solutions

This project has been designed to scan the horizon for high-tech solutions to improve the cost effective maintenance and management of the rural road network. Technology is predominantly developed in high or medium income countries, and takes its time to be applied to low-income countries. This is often due to the lack of a conducive environment for technology development, or a lack of local capacity to embrace the technology. These will be important factors in considering which technologies to trial in Phase 2.

### 3.3 Satellite imagery for road condition

TRL and our partners Airbus DS have experience in network establishment and road condition assessment using satellite imagery, primarily from our recent project in Nigeria with the Satellite Applications Catapult. This experience will guide us in developing the methodology for assessment in this project, and in being able to assess the most cost effective and appropriate solution.

## 4 Approach and methodology

### 4.1 Research objectives

The objectives of this project are:

#### 4.1.1 Research

To provide a cost-effective and reliable high-tech solution for the capture of maintenance management data related to the inventory and condition of a country's rural road network. The majority of this research is expected to be in the field of satellite imagery, but the project also has the remit to recommend any alternative high-tech solutions that are likely to be appropriate.

#### **4.1.2 Capacity building and technology transfer**

The project must enhance the capacity of relevant partner-country Road and Transport ministries, departments and agencies in the key areas covered by the project. Capacity building and technology transfer will be in the form of:

- Presentation of the findings at meetings/workshops in the partner countries;
- Presentation of the findings to the broader ReCAP member countries and community of practice (e.g. web site, newsletter and Steering Committee meetings);
- Peer reviewed papers for conferences and/or journals. The ToR requires at least two;
- Training suitable counterpart staff in identified AFCAP partner countries in the collection and use of appropriate data for rural road management.

#### **4.1.3 Uptake and embedment**

In line with the ReCAP guiding principles the project will be expected to incorporate within its programme a process for keeping relevant agencies fully informed, not only on project outcomes but also on how these outcomes can be cost-effectively utilised in normal practice.

### **4.2 Links to ReCAP logframe**

#### **4.2.1 Expected outcomes**

The main outcomes and their indicators are shown in Annex B: LogFrame. As the high-tech solutions have not yet been identified and the partner countries are yet to be selected, it is not possible to identify specific outcomes at this stage. However, this will be updated at the end of the desk study period.

#### **4.2.2 Expected outputs**

The main outputs of this work will be a guideline that describes the technologies that will be researched, project reports and a scientific paper. In addition the capacity building aspect will provide trained and experienced staff in each country who will be able to replicate the process. The project duration is 12 months, so it is important that a realistic programme is agreed and adhered to. This will require full commitment from the partner countries and mobilisation of resources at the appropriate time.

#### **4.2.3 Main tasks**

The team will explore the possibilities for high-tech solutions for road network and condition analysis, including satellite assessment, through a desk study, followed by a pilot research phase. This desk study and pilots will combine the following activities:

- *Literature review.*

A number of key documents will need to be reviewed for this project. The review will start with the documents that are already known to the team and have been quoted in our various reports and papers on the subject, for example one of the earliest papers on the subject in 1977 by Beaumont and Bevan of TRL “The use of satellite imagery for highway engineering in overseas countries”. The reports from the condition assessment project in Nigeria will of course also be referenced, along with the image collector project that was carried out as part of the Nigeria Infrastructure Advisory Facility (NIAF) programme. In addition we will review previous work that could be useful in determining assessment systems, such as the study of earthworks and landslides from aerial photographs by Heath

and McKinnon for TRL in the 1990's. We expect this initial literature review to lead on to other documents that are relevant to the project; a comprehensive review of the literature on previous work and research will lead to the identification of potential applications. We have extensive resources at hand to facilitate the literature review, such as the TRL knowledge centre and library, the Airbus DS information database and the TRID database.

- *Selection of participating countries.*

During Phase 1 we will consider all of the AFCAP countries for participation in this project. A series of criteria will be developed in order to prioritise the countries for inclusion, aimed at achieving the geographical requirements stated in the ToR and ensuring that the research is carried out to as high a standard as possible. The ToR highlighted some countries that have already shown interest, which is important as partner countries will be expected to contribute towards the research and to be proactive in that support.

- *High-tech innovative solutions.*

We are expected to propose an exhaustive list of high-tech innovative solutions for network management. When this has been established we will develop a priority matrix to assist us in selecting the technologies, methods and data sources that have the highest potential to provide cost-effective solutions. It is expected at the present time that the solutions will most likely come from the areas of Big Data, Mobile Phones, UAVs or from the use of existing established technologies that can be used in innovative ways, for example LIDAR or laser profiling. We will, however, explore all options by taking a wide remit and looking at examples from around the world and even from different sectors where the solutions could be applicable to roads.

- *Identification of a system for network identification.*

At present there are a number of automated systems that claim to be able to identify roads, both paved and unpaved, from satellite imagery. It is our understanding at the present time that none of the automated systems are refined to an extent that they do not need substantial human intervention to check the accuracy, refine the estimation of what are roads and what are not, and to generally audit the process. We will explore the different systems and recommend the most appropriate way to establish a network from satellite imagery, whether that be an automated, semi-automated or manual system. Whilst doing this we will take into consideration the potential for providing employment to local people, and the benefits that this would bring.

- *Development of a methodology for condition assessment of roads.*

For this we will use our combined experience of the project carried out in Nigeria, as well as TRL's experience of asset management and road maintenance around the world. We will consider the most cost-effective use for this type of condition assessment, but from our experience the main use for this technology at the present time is likely to be a broad assessment of the condition of the roads within the network. The condition assessment is unlikely to be in sufficient detail to be used for structural assessment and design of pavements. It will however, together with the network identification, give the country better information on its assets and allow them to plan interventions more accurately and cost effectively. It will be necessary to take into account the wet season in each country, to make sure that condition assessment of ground truthing and satellite image assessment takes place in similar conditions, especially for unpaved roads.

The methodology for this process will be to establish a baseline through ground truthing. There are many ways this can be achieved, but we will select an option that is in line with

existing condition assessment methods in each country and establish a system that is a best fit for all. The assessment will be different for paved roads and unpaved roads, due to the nature of the surface and the features that are visible on satellite imagery. We will liaise with the AFCAP maintenance project in doing this. It will be important to ensure consistency between countries for the ground truthing, so we will explore the possibilities for measuring IRI (road roughness) as a double check to ensure that the ground truthing is carried out accurately. We will also attempt to ensure consistency by establishing an audit system, which could be to use photographic or video evidence, or to physically inspect the road conditions using an independent reviewer.

When the ground truthing is complete we will acquire the satellite imagery for condition assessment. The most appropriate level of resolution for the satellite images will have been determined during the desk study phase. We will recommend a maximum time difference between the ground truthing and the satellite image acquisition, based on our experience of road maintenance on paved and gravel roads. Our partners, Airbus DS, are experts in satellite interpretation and we will together determine a set of criteria and rules for the assessment of condition from the satellite images. These are likely to be based on the Nigeria project mentioned earlier, using visible features such as:

- Road width
- Wheel tracking
- Colour and shading
- Any specific features that are visible

We will also monitor carefully the cost of satellite image assessment, including the training, image costs, manpower and resources requirements. This will be the key factor in determining the cost effectiveness of the system.

#### *4.2.4 Liaison with other AFCAP projects*

We have a remit to liaise with other AFCAP projects, such as the maintenance project and the climate change project. We have had initial discussions already with both projects and there are likely to be significant synergies with and between them, especially the maintenance project. Whether the synergies can be exploited will depend mainly on the countries to be included and the nature of the roads, environment and materials used. If there is an overlap in partner countries with the maintenance project, then the main area of synergy would be the ground truthing. The maintenance project is likely to categorise the condition of the roads at five levels, from very good to very poor, so we will consider whether that fits with the methodology we will develop during the desk study. We expect to be able to work in at least one of the same countries as the maintenance project.

#### *4.2.5 Partnerships and links with others*

It is our intention to explore other links with professionals and companies in this field, as we mentioned in our bid. This will include governmental bodies such as remote sensing centres, as well as private enterprises who may be interested in the research. In addition we will contact local Universities to see if they have any similar research programme under way. This area of technology is rapidly expanding so we believe that this avenue of opportunity is well worth exploring.

#### *4.2.6 Counterpart resources*

The ToR calls for participating countries to provide counterpart resources for the project research. It is envisaged that for the satellite condition assessment the partner countries will need to provide resources to carry out the ground truthing. This will involve a system of assessing the road condition of a sample number of roads within a given area. This

ground truthing will be expected to provide a basic assessment of the road condition based on a set of criteria that will be developed during the desk study. The main principle will be visual assessment, but it may be possible to include roughness and video/photograph image collection, mainly for auditing purposes. When selecting partner countries it is essential that they give a firm commitment to providing sufficient resources, in full and on time.

#### *4.2.7 Counterpart staff*

Counterpart staff will be essential to the success of this project. We expect at least one member of staff to be assigned from each partner country and their role will be to:

- Liaise directly with the team when not in country.
- Advise the team on appropriate areas to carry out the pilot studies and gain all necessary permissions and licences to undertake the studies.
- Advise on appropriate agencies, teams, etc. to carry our pilot studies and arrange for their selection, mobilisation and operation.
- Arrange appropriate pilot activities in-country at the direction of the Team Leader. This could include arranging teams of local staff to carry out ground truthing.
- Collect, backup and transfer all data collected as part of the research.
- Assist with the arranging of seminars, workshops and meetings as necessary.

We will draw up a comprehensive list of tasks during the desk study phase. It is presumed that these staff will be seconded to the project on a part-time basis, as workload dictates, until the completion in May 2017. However, it is expected that the counterpart staff will be available full-time during the periods when the TRL team are in-country.

#### *4.2.8 Capacity building*

Capacity building is a core aspect of all AFCAP projects. We will carefully consider the capacity of potential partner countries to participate in the trials, as a minimum level of existing capacity will be necessary. We will, however, provide sufficient training and associated training materials for the countries to be able to participate fully and to replicate the technology in the future. To this end we will endeavour to develop a system that fits well with existing and established methodologies already used in those countries. This will assist with the sustainability and cost effectiveness of the system.

### **4.3 Summary of deliverables**

A summary of the main deliverables is shown below:

#### *4.3.1 General*

There are general tasks that result in deliverables, but are not milestones as such. These include the progress reports, the training and capacity building required, etc. These items will be highlighted to the PMU as they are completed.

#### *4.3.2 Inception report*

This inception report includes a more detailed methodology and programme, plus additional comments on the ToR.

#### **4.3.3 Desk study report**

The desk study report will contain a detailed literature review, the countries selected to be partner countries and a justification of how they were selected, partners for remote sensing supply, and a detailed programme of the pilot phase of the project. We will also endeavour at this stage to get commitments from partner countries to provide counterpart staff and resources.

#### **4.3.4 Pilot phase report**

This report will contain details of the high-tech solutions that were trialled, plus the extent of the network and condition assessment by satellite imagery.

#### **4.3.5 Guideline for high-tech solutions**

This guideline will be a comprehensive guide to all of the solutions trialled during the project. Included in this will be a detailed methodology for using satellite imagery to assess paved and unpaved road conditions.

#### **4.3.6 Scientific paper**

It is not possible at this stage to predict the detailed content of the scientific paper, but it will be focused on the most appropriate and cost effective solutions from the trials.

#### **4.3.7 Final report**

The final report will contain a summary of all the activities carried out during the project, plus analysis of the results, conclusions, recommendations and a way forwards.

## **5 Inception phase**

The inception phase was quite short, at two weeks, and was carried out at TRL offices in the UK. As the partner countries have not yet been selected and no site visits have taken place, the inception report has been based on the launch meeting, the original proposal and the negotiations following award of the tender. The main activities have been to establish links with other ReCAP projects, hold an initial meeting between the team members and review the ToRs in more detail.

## **6 Revised workplan**

The proposed programme for the project is shown in Annex B.

The inception period will be complete by June 2016, after which feedback will be sought and the work of carrying out the pilots will commence. It is expected that the partner countries will be agreed early in the inception period and in consultation with other AFCAP regional projects. Counterpart engineers will be confirmed soon after so that they can start work on planning the pilots, in association with the team.

The proposed start date for the first part of the Peer review is 6<sup>th</sup> July 2016. The peer review will assess the recommendations contained in the desk study report and confirm which high-tech solutions should be taken forward into Phase 2. TRL will resource and arrange the peer review, as allowed for in the ToR. A period of approximately three days has been allowed for this initial peer review, the final seven days will be used following the production of the high-tech solutions guideline.

The high-tech solution pilots will be carried out from July 2016 and are expected to be complete by the end of December 2016, in time to be fully included in the Trials Report. The research on network and condition analysis by satellite imagery will also start in July 2016, but are expected to extend until February 2017.

The final month of the project will be quite intensive, with finalisation of the guidelines, writing of the scientific paper and production of the final report, as well as any dissemination activities.

### **6.1 Deliverables**

The proposed milestones for deliverables are as shown in the ToR and have been highlighted in the programme with a prefix of 'D' and are shown in purple.

## **7 Management approach**

TRL will be assuming responsibility for the management of this project. As key consultant we will manage the project in terms of programming, arranging resourcing requirements, producing and delivering reports and all other administration with the client. TRL will also be the first point of contact with the PMU during the project.

Both TRL and Airbus DS have substantial backstopping resources to support the implementation of the project. They have worked together very successfully on the TIM project in Nigeria, which was very similar to this project, and we are therefore confident that we have provided a coordinated and cohesive team to produce the deliverables, with extensive support structures in our respective home offices.

TRL and Airbus DS can draw on their respective pools of expertise in head office to support and supplement the project team. In terms of management support TRL has a wide range of experts and managers who are able to provide backstopping to this project. For example, we have other internal departments and groups who can support in the areas of:

- Technology development and quality assurance
- Design and materials
- Asset management
- Transportation

Based on TRL's system of project management a Technical Referee (TR) has been appointed. The TR will monitor the quality of the research, the reports and other documentation that will be produced during the execution of the project. There will also be the appointment of an internal project manager who will ensure that the deliverables are submitted on time, whilst assuming other responsibilities such as financial control.

TRL maintains a project / programme management system which has been instrumental in the timely delivery of projects to time and within budget. The system has two aspects, computer based and manual. These two components are complementary and can provide either a detailed status or a general overview of progress at any time.

### **7.1 Responsibilities**

TRL will be responsible for the following:

- Technical assistance from the project team. Although the project team are the specialists, many of the outputs will be essentially produced by the partner country counterpart staff as they will be carrying out ground truthing and satellite

image assessment. The team are therefore responsible for training the counterparts and ensuring that the quality of their outputs is in line with the expected quality from the project.

- Overall management and quality control of the project. Despite TRL being in overall control of the project management, there will be a heavy reliance on the counterpart staff and administrations to ensure that the activities during the pilot studies are carried out on time.
- Provision of satellite imagery and project resources. There is a budget of £20,000 for project resources, which will be provided mainly through Airbus DS as a supplier of satellite imagery.
- Capacity Building. TRL have the responsibility throughout this project to train counterpart staff in all aspects of the technologies chosen.
- Analysis of results. The analysis of results will also be carried out in close collaboration with counterpart staff.
- Production of project inception report, progress reports and a final report.
- Production of a technical guideline for the technologies researched.
- Production of a scientific paper for presentation at relevant conferences or seminars and for publication in a relevant journal.

Partner countries will be responsible for the following:

- Providing necessary data and information to allow the country selection process to be carried out in a fair and productive way.
- Providing dedicated counterpart staff.
- Providing resources for ground truthing of road condition in the pilot areas and any other surveys related to the proposed high-tech solutions, including staff, vehicles, tools, etc.
- Providing any necessary travel and subsistence for local staff to carry out ground truthing and other activities.
- Exploring the possibility of providing any satellite imagery that could be available and useful for the project, from local sources.
- Provision of introductions to any third parties who may be able to provide information for, or assist with, the project.
- Assisting with reporting and being willing to present the results of the research at relevant conferences and seminars.
- Being proactive in promoting the results of the research and maintaining any partnerships and links that are established through the course of the project.

## **8 Technical inputs and budget**

### **8.1 Staffing**

We do not envisage any changes in staff at this time and we believe this is unlikely through the project period. However, as a significant part of the research is yet to be identified in detail, it may be desirable to make some small adjustments later in the programme if a specific skill or speciality is required.

We have adjusted the staff inputs table slightly, as can be seen in Table 2. Staffing inputs may change slightly depending on the outcome of Phase 1 and the desk study, but at the present time this is the best estimate based on the ToR and inception inputs. The overall time inputs for all staff will remain the same.

**Table 2: Staff Inputs**

STAFFING	Inception	Desk Study & report	Pilot high-tech solutions	Guideline for use of high-tech solutions	Peer Review	Stakeholder Workshop	Final Report/ Scientific Paper	Total Time Inputs
	Phase 1		Phase 2		Phase 3			(Days)
	(Days)	(Days)	(Days)	(Days)	(Days)	(Days)	(Days)	
Project Leader (Robin Workman)	10	45	65	20	0	5	15	160
Specialist Researcher (Andrew Otto)	1	5	21	3	0	2	0	32
IT Advisor (Alex Irving)	2	13	18	3	0	2	0	38
Peer Reviewer	0	3	0	0	7	0	0	10
<b>Total (Days)</b>	<b>13</b>	<b>66</b>	<b>104</b>	<b>26</b>	<b>7</b>	<b>9</b>	<b>15</b>	<b>240</b>

In Table 3, below, the inputs have also been slightly altered to match the inputs in Table 2 and to take account of the fact that the project started on 25<sup>th</sup> April half way through a month.

**Table 3: Staff inputs per month**

Staff / Month	Month number and number of days input per month												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr/ May
<b>R. Workman</b>	5	22	20	15	15	10	8	10	8	10	14	14	9
<b>A. Otto</b>	1	3	2	6	4	6	0	6	0	2	0	0	2
<b>A. Irving</b>	1	6	7	4	0	6	3	6	3	0	0	0	2

## 8.2 Budget

The budget was renegotiated before the launch meeting and has been confirmed as £299,470, which is a lump sum of £269,470 and reimbursables of £30,000. We do not foresee any changes to the budget.

## 9 Further comments on ToR

- In our bid we stated in section 2.1.8 that we assumed the Provisional Sums would be reimbursed as part of the lump sum and that no proof of purchase would be required, as this was not defined in the ToR. In the contract it states that provisional sums will be reimbursable up to the limits specified, but it does not specify what proof of payment is required. TRL will follow the client’s rules and regulations for procurement, but if quotations are required prior to purchase it should be noted that items such as satellite imagery will need to be single sourced as the type and quality of image will be specified and it is likely that satellites will need to be tasked to provide imagery.
- We have noted that the payment schedule is loaded to pay 40% of the lump sum in the final month of the project. We would propose a more even payment throughout the project in order to facilitate cash flow, with payments still based on deliverables but with the progress reports included. Our proposal is shown in Table 1.

**Table 1: Proposed payment schedule**

<b>Deliverable (Reports)</b>	<b>Payment schedule</b>	<b>Week No.</b>	<b>Deadline</b>	<b>Fees to be paid (£) plus reimbursables</b>
Inception Report	10%	2	9 <sup>th</sup> May 2016	<b>26,947.00</b>
Desk study report to identify appropriate technologies for piloting in phase 2	20%	10	4 <sup>th</sup> July 2016	<b>53,894.00</b>
Progress report 1 showing satisfactory progress towards milestones	10%	20	12 <sup>th</sup> September 2016	<b>26,947.00</b>
Progress report 2 showing satisfactory progress towards milestones	10%	28	7 <sup>th</sup> November 2016	<b>26,947.00</b>
Trials report as part of Phase 2	15%	36	3 <sup>rd</sup> January 2017	<b>40,420.50</b>
Guideline for the use of appropriate high-tech solutions for rural road network inventory and road condition assessment	15%	48	27 <sup>th</sup> March 2017	<b>40,420.50</b>
Final Project Report, including stakeholder workshop, peer review, presentation(s), and paper(s) on findings for submission to an appropriate conference, journal or meeting as agreed with the AFCAP PMU	20%	52	24 <sup>th</sup> April 2017	<b>53,894.00</b>
<b>Total</b>	<b>100%</b>			<b>269,470.00</b>

A graph of cash flow can be seen in Figure 1, which shows three lines:

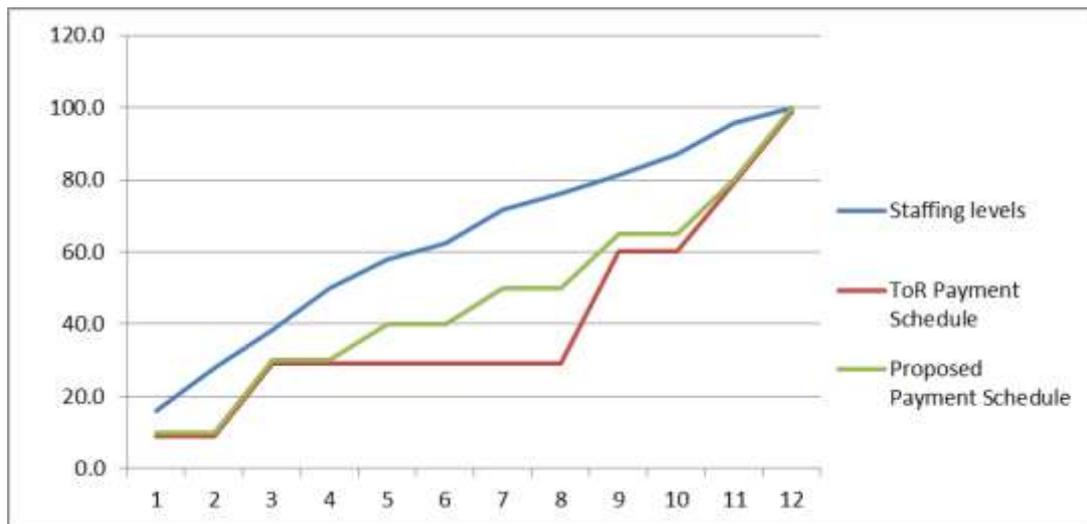
Blue – The cumulative levels of staffing inputs proposed throughout the project, as per the revised staffing levels in Table 3 below.

Red – The original payment schedule shown in the ToR.

Green – The proposed payment schedule, shown in Table 1, above.

The staffing level has been used as a proxy for the expenditure throughout the project, as this is the main expenditure by TRL. It should also be noted that the provisional sums of imagery will be used in months 5 to 8, and the workshop sum in the final month. It can be seen that the staffing inputs are constant throughout the project, whereas the original payment schedule lags behind significantly in the middle part of the project. For example in month 8 on the original schedule, approximately 75% of staffing has been used, but only 30% of payments will have been made. The Proposed payment schedule in green shows less diversity and a more even cash flow throughout, but with the payments still slightly behind the expenditure. Our proposal is that this proposed schedule be considered.

**Figure 1: Cash flow graph**



- We note that the trials report is scheduled to be delivered in week 36. According to our programme the high-tech solution trials should be complete by then, but the methodology for condition assessment will most likely take longer. In that case the report will fully cover the high-tech solutions and will provide an up-to-date assessment of the satellite imagery trials. These will be fully covered in the guideline and the final report.
- We also note that the T<sup>2</sup> conference is due to take place in Zambia from 8<sup>th</sup> – 10<sup>th</sup> May 2017. The timing of this conference and the fact that the participants will be practitioners of low volume roads from across Africa, makes it an ideal forum to present the scientific paper, based on the results of this research. If Zambia is selected as a partner it could even be possible to have a demonstration of the results. We will take this into consideration when assessing countries for involvement in the project.
- We also note that the contract end date is 12<sup>th</sup> May, which would allow for participation at the T<sup>2</sup> conference within the project period.
- TRL will require assistance from the partner countries and the ReCAP PMU for contacts in country, visas, logistics, etc. This assistance will be sought in the first instance through the ReCAP Infrastructure Research Manager.

## **10 Community access**

### **10.1 Gender**

Throughout this research we will focus strongly on gender and social inclusion issues. We will encourage our local partners to use women wherever possible in the ground truthing and image assessment processes, as well as in the identification and testing of high-tech solutions. We believe that there will be significant opportunities for women to be involved and we will support this with additional training as and when necessary. For example the research in Nigeria included remote condition assessments both for ground truthing (via Image collector data) and for satellite image assessment. This means that traditional methods of assessment, which would have involved travelling to remote and dangerous locations, could now be carried out in an office environment, opening up more opportunities for female analysts who would find it culturally and practically more difficult to travel than their male counterparts.

### **10.2 Other marginalised groups or beneficiaries**

It is unclear what the opportunities for marginalised groups will be until the countries are selected. We will however take the opportunity to include them wherever possible.

## **11 M&E Plan**

We will develop a Quality Assurance Plan which will be a living document updated throughout the project, and will have the input and commitment of all team members. We will be relying on outputs from four or five partner countries, so the management and quality control for this needs to be appropriate and defensible.

In particular for the ground truthing it is important that a standard process of surveying the road condition is developed, and that all staff are trained to a similar standard, which presupposes that staff have to be competent in low volume road technology. To this end we will work with partner countries to select the appropriate staff and design the training courses to suit. We will explore the use of mobile phone/tablet technology to take pictures and video of the road condition, in order to audit data. In Nigeria this was achieved using the image collector, but mobile phones will be more cost effective. We will use geo-referencing with GPS to locate the assessed areas.

In terms of satellite image assessment, a similar principle applies. Staff will need a certain level of computer literacy and will be given a standard set of rules and criteria by which to judge the road condition. When comparing the two data sets we will ensure that the comparison is summarised for the same locations, by using mapping and GPS coordinates for both ground truthing and satellite image assessment, ensuring that direct comparisons can be made and an overall % condition figure is not the only outcome.

Both of these assessment processes will be regularly monitored by sending data to the project team, as well as by physical audits on site and of image assessment. Incorrect data will lead to incorrect results, so we will check and monitor data quality very closely. A methodology will be developed for carrying out ground truthing and satellite image assessment with strict steps and checks built in. We will monitor and audit the progress of the results as they are produced. A database will be developed, similar to our research in Nigeria on the Catapult project, designed to store and analyse the data. This will be regularly backed up.

## **12 Risks**

The risks that we outlined in our proposal are still essentially valid. They will be further refined when the partner countries have been chosen. The risk matrix can be seen in Annex D and the risks are outlined below:

### **12.1 Operational risks**

There is a heavy reliance on the partner countries to provide counterpart staff, data, resources, workshop organisation and possibly satellite imagery. The selection of appropriate research subjects will play a large part in achieving the objectives of the research, which is why we have recommended a short peer review at the end of Phase 1.

Although there is a provisional sum for data, we will minimise the funds each country needs to spend on this by exploring alternative sources of funding if the provisional sum is not adequate. Airbus DS is a world expert in imagery data, so we will use their experience to select the most appropriate areas and gain the best value for money.

Data location can be an issue, so we will use GPS geo-referencing to locate roads that are ground truthed, which can be plotted against the mapping to be produced, but this is still dependent on the field operator carrying out their duties properly.

Lack of uptake is also a risk, although indications we had following presentations on this subject have been very positive. We have recommended processes to address this. Conflict can also be a risk for the project, either existing or conflicts that may arise during the project.

### **12.2 Health and safety**

The key team members may need to travel to remote areas to train in ground truthing or to carry out technical audits, so this aspect will be assessed for each country. TRL uses International SOS to inform and advise on all security measures in countries where we work, and we are confident that our procedures are sufficient to ensure safety in-country.

## **Annex A: Minutes of Launch Meeting**

### **GEN2070A – High-Tech Solutions Project Launch Meeting**

**OtB Offices, 46 Loman Street, London**

**Thursday 21<sup>st</sup> April 2016, 14:00**

#### **Meeting Minutes**

##### **Present:**

Jasper Cook	AFCAP PMU
Les Sampson	AFCAP PMU
Bill McMahon	TRL
Robin Workman	TRL

##### **Technical presentation and discussion**

Robin Workman started the meeting by making a presentation on previous projects that TRL had undertaken related to high-tech solutions for roads in Africa, plus ideas for the current project under ReCAP.

The selection of countries was discussed. Although TRL has to consider all countries in AFCAP, it has some experience already that will help in this choice. A matrix will be developed to decide which countries would be most appropriate, based on the criteria in the ToR and more to be developed during the desk study. It was agreed that this should be one of the first tasks.

It was also agreed that TRL would liaise closely with the AFCAP Asset Management project, both in terms of methodology and countries to be selected, as there could be some synergies and efficiencies of scale. Les and Jasper also suggested some previous references who had done previous work in the field.

The inception report will essentially contain a revised methodology, further comments on the ToR and a revised and more detailed programme. It was noted that there is no break between Phases 1 and 2, so the project is expected to continue through. A workshop will be organised in Phase 3 to present the findings, plus a scientific paper will be produced.

An essential part of the methodology is to carry out training in-country for the satellite condition assessment, which will be initially be carried out by all team members. The follow up will then be mainly by the Team Leader and Researcher. The aim is to develop a system that is replicable and sustainable.

TRL noted that they are confident that results will be produced. Experience in Nigeria had shown that the satellite condition assessment had good correlation, despite the relatively small sample size. Robin noted that he had recently attended a seminar on drones, and that this technology had developed so rapidly over the past couple of years that it now also represents potential for a high-tech solution.

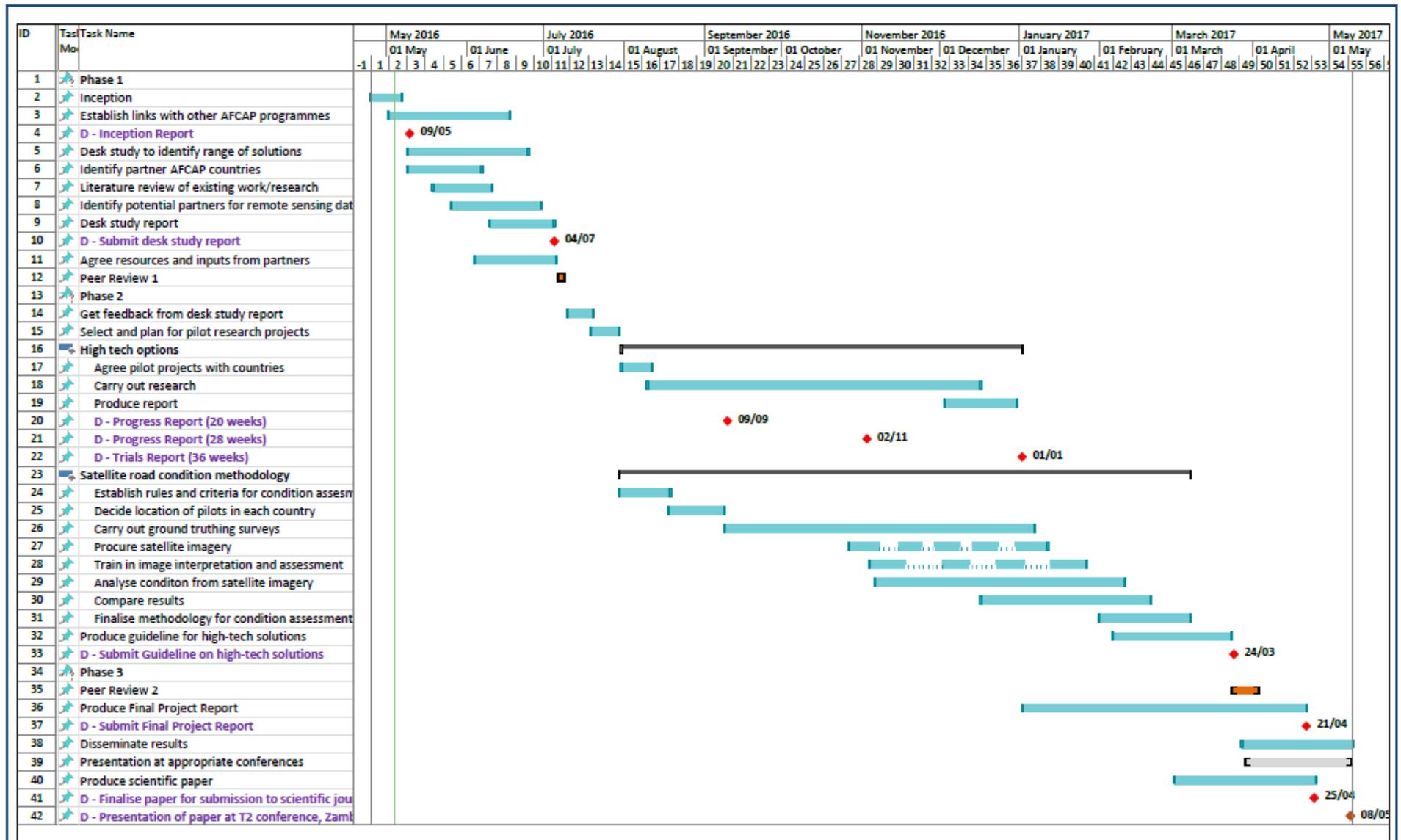
Les also noted that ReCAP expect that there will be no change in staffing. TRL clarified the roles of the proposed staff and confirmed that all staff proposed in the bid are at present available and expected to work on the project.

## **Administration**

- Start date of project: potentially 25<sup>th</sup> April 2016, subject to the contract being signed. At present some minor issues are being negotiated.
- Inception Report due two weeks after start date. However, Les requested that the inception report be finalised before the next ReCAP steering group meeting in Zambia from 17<sup>th</sup> – 19<sup>th</sup> May 2016. RW will provide some slides for this meeting.
- Les will be the main contact for all technical and management correspondence, so reporting will be direct to Les.
- Les and Jasper want to make this project successful and should be considered as part of the extended project team.
- Quality assessment of the project will be as defined within the ReCAP QA system; initial reviews will be undertaken by Les with additional review and comment by Jasper as the Technical Team leader.
- Leta and Paulina can be involved when we need contacts in a country or when we need to carry out the pilots, but they should be contacted via Les in the first instance.
- All contractual, financial and procurement matters should be addressed to Gerome and Edson, but copied to Les and Jasper.
- Milestone approval forms must accompany deliverables, will require Robin's signature and will go to Les for approval, then to procurement for payment.
- Les noted that the reporting must now be linked to the AFCAP logframe, he will send a copy to TRL.

Meeting closed at 3.30pm

Annex B: Work Plan



## Annex C: LogFrame

Intervention Logic	Indicator	Source of Verification	Baseline (Date)	Milestone 1 4 July 2016	Milestone 2 24 March 2017	End of Project 12 May 2017	Assumptions
Outcome: Sustained increase in evidence base for more cost effective and reliable low volume rural road and transport services, promoted and influencing policy and practice in Africa and Asia	1. SUSTAINABILITY: Partner Government and other financiers co-funding research with ReCAP. Contributions in kind (K) and Core Contributions (C)	Partner countries (not yet identified)	October 2016	Not possible to calculate until countries have been selected	Not possible to calculate until countries have been selected	Not possible to calculate until countries have been selected	
	2. Concrete examples of change (applied or formally adopted), influenced by ReCAP research that will be allied to approximately 1,000km of road in focus countries.	Partner countries (not yet identified)	N/A				
	3. Number of citations in academic articles of ReCAP peer reviewed articles and/or working papers, conference papers etc.	Scientific journals	Beyond end of project				
Output 1: RESEARCH and UPTAKE:	1.1 LVRR: Number of peer reviewed papers generated from ReCAP	Project reports/records	May 2017				

Intervention Logic	Indicator	Source of Verification	Baseline (Date)	Milestone 1 4 July 2016	Milestone 2 24 March 2017	End of Project 12 May 2017	Assumptions
Generation, validation and updating of evidence for effective policies and practices to achieve safe, all-season, climate-resilient, equitable and affordable LVRR and transport services in African and Asian countries.  (Low Volume Rural Roads : LVRR / TS – Transport Services)	supported or related LVRR research projects made available in open access format.						
	1.2. TS: Number of peer reviewed papers generated from ReCAP supported or related LVRR research projects made available in open access format.	As above	As above				
	1.3 Engineering Research: National policies, manuals, guidelines and/or research outputs that have been fully incorporated into Government/Ministerial requirements, specifications and recommended good practice as a result of ReCAP engineering research (including climate change adaptation and AfCAP and SEACAP adaptations).	Partner country government records (countries not yet identified)	Guidelines produced at end of project so incorporation is not possible within the timeframe of the project				

Intervention Logic	Indicator	Source of Verification	Baseline (Date)	Milestone 1 4 July 2016	Milestone 2 24 March 2017	End of Project 12 May 2017	Assumptions
	To include introduction of new policies and modification to existing policies.						
	<p>1.4 TRANSPORT SERVICES Research: National policies, regulations and/or practices for rural transport services modified or introduced as a result of ReCAP research (including road safety and gender and AFCAP and SEACAP research )</p> <p>To include introduction of new policies and modification to existing policies.</p>	Partner country government records (countries not yet identified)	Possibly N/A – but may be included, based on the outputs of phase 1.				
	1.6. LVRR and TS information generated for dissemination, and disseminated, that is not peer reviewed. Total to include research papers, final research reports, workshop reports,	Project reports	May 2017				

Intervention Logic	Indicator	Source of Verification	Baseline (Date)	Milestone 1 4 July 2016	Milestone 2 24 March 2017	End of Project 12 May 2017	Assumptions
	<p>manuals and guidelines.</p> <p><b>CHECK IF THIS IS TO BE PART OF Service Provider Reporting</b></p>						
<p>Output 2:</p> <p>CAPACITY BUILDING: The building of sustainable capacity to carry out research on low volume rural roads, and rural transport services in African and Asian countries.</p>	<p>2.1. African / Asian experts or institutions taking lead roles in ReCAP Research Projects.</p>	Project reports	May 2016				
	<p>2.3. Research projects with female researcher inputs at senior technical level.</p>	N/A	N/A				
<p>Output 3:</p> <p>KNOWLEDGE: Generated evidence base of LVRR and transport services knowledge is widely disseminated and easily accessible by policy makers and practitioners (including education and training institutions).</p>	<p>3.2. ReCAP generated knowledge presented and discussed at high level international development debates and conferences</p>	Proceedings of conferences	May 2017				
	<p>3.3. ReCAP generated knowledge disseminated through significant workshops and dedicated training, virtually or physically, that are rated by participants as</p>	Project reports and feedback from partner countries	April 2017				

*Inception Report*

Intervention Logic	Indicator	Source of Verification	Baseline (Date)	Milestone 1 4 July 2016	Milestone 2 24 March 2017	End of Project 12 May 2017	Assumptions
	effective..						

## Annex D: Risk Matrix

Programme Risk Assessment and Mitigation Matrix				Very High	High	Medium	Low
Potential Risk	Risk Grading <sup>1</sup>		Description of risk	Proposed Management and mitigation actions			
	Probability	Impact					
<b>A. Programme Management Risks</b>							
A1: Implementation delays due to hazards / risks at country level	M	M	<p>Details unknown until partner countries are selected.</p> <p>Generic risks for Africa are a lack of commitment from partner countries, both politically and financially, natural disasters or environmental issues that interrupt the project activities.</p>	<p>The key team members may need to travel to remote areas to train in ground truthing or to carry out technical audits, so this aspect will be assessed for each country. TRL uses International SOS to inform and advise on all security measures in countries where we work, and we are confident that our procedures are sufficient to ensure safety in-country.</p>			
A2: Financial fraud	L	M	<p>Unknown until partner countries are selected, but it can be assumed that any partner countries in Africa will bear some risk of corruption and fraud.</p>	<p>Established strong financial management and monitoring systems and practices which will be tailored for use within the project. These measures will include:</p> <ul style="list-style-type: none"> <li>- Anti-bribery and anti-corruption undertakings in all supplier contracts</li> <li>- Payments of expenses against original third party receipts</li> <li>- Payment of suppliers consistent with sub-contracts</li> <li>- Periodic independent audits of the Programme Funds</li> </ul>			
<b>B. Risks associated with Research</b>							
B1. Commitment	M	M	Lack of commitment from partner countries	Select partner countries carefully, gain written firm commitments against specific commitments. Involve PMU at all stages.			
B2. Counterpart resources	M	M	Counterpart resources are not forthcoming	Monitor progress closely. Flag up issues as soon as they arise and gain support from PMU as necessary.			

<sup>1</sup> **Probability** = the likelihood of this risk occurring despite the management and mitigation activities being in place. **Impact:** = the effect on the ability of the programme to achieve its objectives without major revision or review.

Programme Risk Assessment and Mitigation Matrix				Very High	High	Medium	Low
Potential Risk	Risk Grading <sup>1</sup>		Description of risk	Proposed Management and mitigation actions			
	Probability	Impact					
B3. Research acceptable	L	M	Research recommendations and solutions in phase 1 are not accepted by PMU	Maintain close contact with PMU during desk study phase, research potential solutions carefully and ensure full justification is given			
B4. Cost of resources	L	M	Costs of imagery and resources for pilot trials are more than the provisional sum	Select pilot areas within the scope of the project. Use Airbus DS experience to ensure that image costs do not exceed budget.			
B5. Research leads to more work than expected	L	M	Risk that some of the high-tech solutions will require more research than planned when pilot stage is under way.	Research scope carefully, design pilots to be within the scope of available resources and staff inputs. Close liaison with PMU.			