South-East Asia Community Access Programme

LAO CONSULTING GROUP

SD & XP Consultants Group

SEACAP 21-002: Feasibility Study for a National Programme to Manage Slope Stability

Contract No SEACAP 21/02

Inception Report
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Draft 1	John Howell	23 April 2008	Tim Hunt / Gareth Hearn / Xayphone Chhonephetsarath	24 April 2008
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Abbreviations

ADB	Asian Development Bank
BAC	Basic Access Component (of the LSRSP-3)
DFID	Department for International Development (UK)
DOR	Department of Roads
DPWT	Department of Public Works and Transport (formerly DCTPC)
ESD	Environment and Social Division (of MPWT)
JICA	Japanese International Co-operation Agency
LRD	Local Roads Division (of MPWT)
LSRSP-3	Lao-Swedish Road Sector Project 3
LTSP	Lao Transport Sector Project (proposed)
MCTPC	Ministry of Communications, Transport, Post and Construction (now MPWT)
PBMC	Performance-based Maintenance Contract
PMO	Prime Minister's Office
PTD	Planning and Technical Division (of MPWT)
RAD	Roads Administration Division (of MPWT)
SEACAP	South-East Asia Community Access Programme
WB	World Bank

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1 INTRODUCTION

Through the Transport Sector Project, the World Bank is assisting the Ministry of Public Works and Transport (MPWT) of the Lao PDR to move to a sector-wide approach to the planning and management of transport infrastructure. This is wide-ranging in scope and includes both technical and institutional development. The MPWT priority investment programme for the next few years will be formulated as part of this process.

A national slope stabilisation programme has been identified as an important need for the road sector. The intention would be to align donor resources to finance this as a component of the overall sector-wide project approach. Given SEACAP 21's technical work and experience on slope stabilisation, the MPWT and the World Bank requested SEACAP to support a feasibility study to help define the nature of such a programme.

SEACAP has therefore contracted Scott Wilson to undertake the feasibility study and to identify the constraints and ways of resolving them. The study has a timeline of two months, and is due to be completed by the end of May 2008.

This Inception Report describes the establishment of the small study project, its way of working, and a number of areas where clarification is required from MPWT and the Steering Committee. These points are specifically highlighted.

Readers of this report should note that, owing to the short timeframe of the study and the fact that it is continuing at the time of writing this report, a number of activities reported here as not yet started, will in fact have been undertaken between the writing of the English version and the dissemination of the translated Lao version.

2 STUDY ACTIVITIES

2.1 Programme planning

As per the agreed terms of reference, we have already established links and held useful meetings with the following organisations.

- the Lao SEACAP Steering Committee;
- the Road Administration Division (RAD) of the MPWT;
- the Planning and Technical Division (PRD) of the MPWT;
- the Local Roads Division (LRD) of the MPWT;
- the Environmental and Social Division (ESD) of the MPWT;
- the DPWT of Khammouan Province;
- the DPWT of Attapeu Province;
- Ministry of Labour and Social Welfare;
- Public Works and Transportation Institute (PWTI);
- Asian Development Bank Resident Mission in Vientiane;
- Japanese International Co-operation Agency office in Vientiane;
- the consultants responsible for Road Maintenance Program – Phase 2: Road Management Capacity Component (Ramboll/Grontmij/Hifab); and Organisational Capacity Development Component (Vic Roads International); and
- the consultants responsible for the Lao-Swedish Road Sector Project – 3, Basic Access Component (Hifab).

Still to be contacted are the Department of Personnel of the MPWT, the Luang Prabang DPWT, and other government and consultant groups.

In discussion with the RAD, it was agreed that our areas of study would include the following sections of national road.
- Road 12 in Khammouan;
- Road 13 North in Luang Prabang; and
- Road 18B in Attapeu.

To these we will add information from additional visits made by team members to:
- Road 3 in Bokeo and Luang Namtha;
- Road 7 in Luang Prabang;
- Road 8 in Bolikhamxai; and
- Road 13 North in Oudomxai and Luang Namtha.

We have agreed with the Local Roads Division that we will supplement the study of national roads by comparisons of emergency maintenance costs between national and local roads, and a limited consideration of technical, social and capacity issues relating to local roads.

Our study workplan remains unchanged from that given in our Technical Proposal of March 2008, and is shown in Annex A. This demonstrates how we expect to complete the work within the two-month period. Note that all of the study personnel are listed in the workplan, and there is no counterpart assigned from MPWT.

2.2 Information gathering

So far in the study we have drawn together data on the following main relevant matters, though we have not yet had time to complete our reviews and analysis of them.
- Landforms and geology in relation to landslides.
- Rainfall in relation to landslides.
- Laos road network lengths by road type (national/district/etc.) and by construction type (paved, gravel and earth), 2006 data.
- Slopes adjacent to roads, assessed as natural slopes, and man-made cut and fill slopes.
- Slope erosion.
- The magnitude of slope instability in Laos.
- Institutional procedures for slope maintenance in the MPWT.
- Slope instability assessment procedures in the MPWT.
- Historic landslide data, mainly from National Roads 12, 13 North and 18B.
- Expenditure on landslide remedial works per annum for 2005/06/07 by MPWT.
- Road traffic data from National Roads.
- Draft curriculum material for a rural road engineering course at the National University of Laos, under preparation by the Basic Access Component of the Lao-Swedish Road Sector Project 3.

The DPWTs that we have met with, have been requested for information on landslide occurrence (e.g. where, when, volume, duration of blockage), emergency budget expenditure, and the procedures used for landslide clearance and subsequent treatment.

Still required are the following, which may not all be available.
- Information on the staffing levels and capacities of the DOR's divisions and the Provincial DPWT offices, and the responsibilities of each category of staff. We plan to request this from the Director of the Department of Personnel.

- Further provincial data on landslide occurrence, treatment and cost, by road category.
- Data on landslide occurrence, treatment mechanisms and costs on local roads. This has been promised by the Director of the Local Roads Division.
- Information on the organisational reform and capacity development work being prepared by missions from the World Bank, as part of the proposed Lao Transport Sector Project. We will request this from the Director of the Planning and Technical Division.

A rapid assessment of Roads 12 and 18B has been carried out (see section 2.1) to add to our detailed knowledge of slope failures on Road 13 North. Some further assessments are expected to be undertaken of other national highways and perhaps some local roads if time permits. We also have information on a number of other national roads from previous visits. These include Roads 1E, 3, 4, 7 and 8, and the Nam Theun 2 access roads.

Discussions have been held with the MPWT concerning procedures for assessing slope stability, and the ways in which instability is mitigated. There is further discussion on this matter in section 3.

2.3 Analysis

This part of the study is currently underway. Its content is discussed in some detail in section 3 of this report.

There is a shortage of detailed data on landslide treatment. The records for slope stabilisation works during road construction are no longer available. Figures for landslide treatment during maintenance that were provided by the MPWT have been aggregated to the extent that the expenditure against all codes is provided as a single figure (i.e. the standard maintenance activity codes have not been listed separately, but only for emergency maintenance as a whole). There is no breakdown of clearance volumes or costs, or the type of remedial work that was undertaken. The result is that much of our analysis of costs is based on the total expenditure by road section in each Province over only three years.

2.4 Elaboration of Feasibility Study

As per the study schedule, we have planned an outline of this, but have not yet started work on it. This is because it depends too much on our analysis of the information collected, and so cannot logically be started until the middle of May.

3 PROGRESS ON ANALYSIS

3.1 Technical issues for managing slope stabilisation problems

Our site visits to the most landslide-prone roads in Laos reveal a mixed picture of slope failure causes. There are certainly instances where the design of the road has contributed to the level of instability (e.g. Road 18B). In some places it is clear that instability is related to long term slope dynamics such as river cutting (e.g. some locations on Road 13 North and Road 8). Elsewhere instability is related to material characteristics, such as the frequent failures in colluvium on Road 12. Slope over-cutting and spoil disposal have also contributed their share of damage, as is a common feature in many countries. In some locations, the absence of slope drainage and protection has inevitably led to serious erosion and slope failures following the opening up of fresh earthworks.

The team is confident of its understanding of engineering measures for slope stabilisation and protection, since this is our main technical expertise. This has been boosted for Laos by our ongoing work under the main SEACAP 21 slope stabilisation research project. We will therefore propose a range of appropriate measures for the engineering aspects of slope stabilisation and protection, and these will be reflected in the standard drawings and suggestions for future slope rehabilitation projects that will be among our final outputs.

3.2 Social impacts of slope stability problems

As the terms of reference prescribe, this part of the study will only review and attempt to quantify the main social issues. So far our assessment of the effects of landslides has shown that there is a limited impact on rural people living in mountainous areas, mainly shifting cultivators, through the loss of small areas of land on the one hand, and the sporadic and small scale generation of employment on the other. It is difficult to assess the significance of the first, and data are scarce for the second. Nevertheless, our final report will include an assessment of this issue. The situation may be clearer in relation to certain local roads, where access is the main function and slope failures are more common due to lower engineering standards. There appear to be no records of lives lost due to roadside landslides. This is the situation that would normally be expected in a country like Laos where the natural slopes are mostly stable and population pressure low enough to allow people to avoid the most dangerous areas.

There may be a problem for road management where people occupy the road reserve, particularly on the downslope side of roads in the mountains. This can obscure the landform, possibly hiding potential instability, and change the natural drainage regime. This type of settlement can pose a risk to the inhabitants themselves if it is on land of marginal stability.

3.3 Economic impacts of slope stability problems

The economic consequences of landslides on roads are typically assessed by converting the following into monetary terms:

- Costs associated with the clearing of landslide masses and repair of damage;
- Road closures and impacts on vehicle operating costs and the value of time lost;
- Loss of life and livelihoods; and
- Negative impacts on utilities (e.g. electricity poles and water pipes).

Whilst the relevance and importance of each component of the economic assessment can differ significantly between roads, some parameters apply country-wide.

Our initial assessment suggests that the economic impacts of landslides are not particularly large, but it is also clear that a number of the general assumptions that underlie the current calculations need more consideration. Further work is underway to refine this part of the study. Nevertheless, the implication is that a major programme of proactive slope stabilisation works would not be economically justifiable, and a lower cost alternative is probably more logical.

3.4 Financial implications for a slope stabilisation programme

We understand this part of the study to involve an analysis of the relative monetary value of the various slope stabilisation options available: in effect how much would a slope stabilisation programme cost. It is important here to distinguish between a reactive cost, for which we have historical data; and a proactive cost, which would be much more speculative (see also section 4.2). This will help MPWT decision makers to assess whether a programme to stabilise a particular landslide is economically worthwhile. It will clearly not be possible to undertake this to a very high level of accuracy, and so it will only provide general guidelines, with quantification adding as much rigour as possible.

4 DESIGN OF A SECTOR PROGRAMME OF CAPACITY DEVELOPMENT IN SLOPE STABILISATION: INITIAL FINDINGS AND DIRECTION

4.1 Assessment of the magnitude and impacts of slope instability

The technical assessment of slope instability appears to demonstrate the following main features.

- Slope instability is confined mainly to mountainous areas in zones of high rainfall. While this sounds obvious, it is important in that it suggests that there are no major areas of particularly weak geology (e.g. weak sediments or unconsolidated clays) that create significant problems outside the high rainfall zones.
- There is still very limited understanding of both rainfall patterns and geological lithology and structure, and a good deal more research is needed before the MPWT can be confident of the detailed situation.
- The deepest-seated slope failures appear to be associated with natural instability in steep slopes. These tend to be relatively few in number, but where they occur they are hard to resolve and can cause the loss of the entire road bench. Road construction may be an accelerating factor but is not the underlying cause. Road 8 is a good example where river toe erosion has given rise to some large deep-seated landslides, now crossed by the road.
- The vast majority slope failures are man-made in nature, in that they are related to over-steep cut slopes, and lack of slope and erosion protection. This is an inevitable consequence of road building in mountainous areas, where adequate consideration is often not given to steep slopes where construction can lead to marginal stability. This can occur in both cut and fill slopes, and is more serious in areas with higher rainfall.

Despite these technical problems of slope instability, the economic assessment appears not to demonstrate that widespread proactive mitigation measures are necessarily justifiable. This is because road closures are usually limited and do not affect many time-sensitive vehicle loads, and the losses of life and livelihoods seem to be minimal. The total cost of landslide clearance appears to be less than US $ 3 million per year, which is a small part of the road maintenance budget. By contrast, the cost of mitigation measures on an individual large landslide may be in the region of US $ 50,000 to 100,000, or significantly more, with no certainty of achieving a total solution (since the prediction of failure is imprecise).

4.2 Assessment of the feasibility of a slope management programme

The assessment of the technical and economic issues leads to the next stage of the study, which is an appraisal of what sort of slope management programme might be worthwhile. There are three main options.

- A pro-active slope management programme, that seeks to prevent landslides from occurring. This might typically involve extensive use of slope drainage structures to minimise the risk of landslides being triggered in marginal areas, widespread use of low cost slope protection measures (such as bio-engineering) and judicious use of heavy slope retaining structures in sites where major instability can reasonably be anticipated (such as where roads cut deeply into colluvial slopes, or there is long term undercutting by a river).

- A reactive slope management programme, that responds to slope failures or signs of them starting to be active, along the lines that are being tested by the main SEACAP 21 research project. This seeks both to avoid further damage to the road and to restore it by treating failed slopes; and also, where feasible, aims to stop incipient failures from getting worse.
- A slope management programme that attempts to prevent the most obvious failures from occurring on national roads, and reacts to all failures that occur elsewhere. While this is something of a compromise, to some extent it is the approach already adopted on national and provincial roads through the use of higher engineering standards on major roads. In this scenario, reasonable measures are adopted that aim to minimise the risk of increased slope failure.

The problem with a full pro-active slope management programme is the large ongoing cost involved in monitoring slopes and installing engineering measures to overcome the inevitable "what if..." risks that emerge. This sort of monitoring would involve regular vegetation clearance for inspection, detailed topographic and geomorphological surveys of slopes, appraisal of terrain imagery, perennial monitoring surveys, exploratory drilling and slope modelling. It is valid for high-traffic roads in an advanced economy (e.g. Hong Kong), but not in rural areas of Laos. In effect, it would mean designing costly structures with an assured factor of safety to prevent failures occurring on any slope where there is doubt about stability; this could be a large number of sites in most mountainous areas.

The questions that arise are essentially these:

- At what cost does the Government of Laos and the Lao road user expect to have trouble-free roads? And,
- What level of risk is the road user prepared to accept for a disrupted service on different categories of road?

The answers obviously depend on the relative expenditure that can be assigned, either to each category of road (e.g. national or local), or to each road section according to traffic volume. To some extent this is already addressed through the better engineering and maintenance standards applied to the higher categories of roads, but in this study we still need to set limits on what is considered acceptable. It is clear that users' expectations of service quality are not necessarily driven by economic logic. It is also a fact that the construction and maintenance costs of roads vary geographically according to site conditions.

These considerations might lead to a strategy statement for service standards that underlies the slope management programme, and runs something like as given on the next page.

Of course, the time to clear blockages is a function of the amount to be cleared and, probably more importantly, the measures that are in place for landslide clearance. It might be more economic to have a very good emergency response and let large landslides fail, than to fix large landslides. Another complicating factor is where a failure below the road actually takes out all or part of the road, and it is technically better or cheaper to keep the road closed until a new road bench can be created, rather than to risk instability on the upslope side by cutting a temporary diversion.

We request guidance from the Steering Committee and MPWT at the Inception Workshop, as to whether this approach appears valid. If it is considered so, we intend to follow it in the design of our proposed slope management programme. It would form the basis for the level of interventions and investment that we will propose.

Potential draft strategy statement for MPWT' service standards for landslide mitigation

The Government of the Lao PDR aspires to a national highway network that remains free of landslides. However, in view of the terrain and climate of the country, economic considerations mean that it must be accepted that, in mountainous areas with high rainfall, the management of slopes may be limited so that the following standards apply.

Category	***In most years***	***In years of exceptional rain***
National	*Occasional blockages may occur for up to 3 hours.*	*Blockages for up to 3 hours may be common, with possible occasional blockages for up to 12 hours.*
Provincial	*Occasional blockages may occur for up to 6 hours.*	*Blockages for up to 6 hours may be common, with possible occasional blockages for up to 1 day.*
District	*Blockages for up to 6 hours may be common, with occasional blockages for longer.*	*Blockages may be common, some exceeding 12 hours. The complete loss of small sections of the road is possible.*
Village / Rural	*Blockages for up to 3 hours may be common, with occasional blockages for longer.*	*Blockages may be common, some exceeding 1 day. The complete loss of small sections of the road is possible.*

Damage to roads in exceptional conditions beyond these limits will be deemed a national disaster. The MPWT will review these standards periodically and amend them as the national economic situation improves.

4.3 Review of the MPWT's capacity to manage slope instability

The following paragraphs record our understanding of the MPWT's capacity and procedures for managing slope instability. We request the assistance of the steering committee and MPWT to correct this where necessary, through discussion at the Inception Workshop.

At present the MPWT has no specialists in geotechnical engineering or other aspects of slope investigation and stabilisation, although a number of individuals have an encouraging interest in the topic. Neither do the provincial DPWTs nor the body of consultants and contractors have much recognised expertise in this area.

In the majority of cases for slope instability above the road, the normal practice is that the slope is allowed to fail and the main effort is focussed on clearing the landslide debris as quickly as possible, perhaps with some minor slope trimming. After the emergency has passed, the appropriate DPWT Maintenance Engineer carries out an inspection and makes a decision as to whether any remedial structure is required. If it is, it most commonly consists of a breast wall in masonry or reinforced concrete.

Slope instability below the road usually manifests itself by the presence of cracks adjacent to or within the road surface. Although the road surface may be repaired, in general no other proactive work is carried out until the slope fails. After failure, which may include part of the road, an inspection is carried out by the DPWT and a decision made concerning the need and type of remedial work, which is likely to include the construction of a masonry or reinforced concrete retaining wall.

The practice of using performance-based maintenance contracts was introduced from financial year 2007-08, and now covers approximately 2,800 km of the 7,000 km national road network. The decision-making process for response to slope instability under this system is understood to consist of the procedures shown in the flow chart on the next page.

Our assessment so far suggests that the MPWT's procedures are essentially sound, but the following technical weaknesses exist in the system.

- DPWT staff are qualified highway engineers with no special training on slope dynamics and management.
- There are very few options in the guidelines to assist the DPWT engineers in their diagnosis of the problem and design of a cure.
- There are no specialists in the MPWT or the private sector on whom to call for advice.
- There are no apparent geotechnical or hazard based procedures in place for prioritisation

It is therefore suggested that this study should focus on the possible ways to fill these gaps.

4.4 Proposed slope management programme

It is too early to comment on this in detail, except to say that it will be designed in accordance with the findings of the analysis described above, once that has been completed. It will include estimated costs, expected outputs and suggested arrangements for implementation, and will be designed to fit into the Lao Transport Sector Project that is in preparation by the MPWT.

Based on the initial assessments summarised above, we appear to be moving in a direction where the slope management programme would have the following main elements.

1. A suite of guidelines for due diligence and best practice preventative measures designed to avoid situations developing that might later give rise to the development of landslides and earthworks failures (particularly appropriate slope formation grades, and drainage and bio-engineering works) to be implemented as routine on slopes meeting specific criteria.
2. A programme that sets out to identify the locations of hazardous slopes along the road network and identify measures that might be taken to reduce each hazard, and the priority for doing so. This will be aided by the initial inventory we are preparing as part of this study.
3. Procedures for site investigation and assessment of the best-practice response to failures that have already occurred.
4. The training and other capacity development measures that are considered necessary in order to implement the proposed programme. This should cover ministry personnel, provincial departmental personnel and contractors.
5. Possible options for one-off rehabilitation projects. These are most likely to be based on single roads or Provinces, and the options will be informed by the inventory of slope failures that we are preparing.

Again, we request the guidance of the Steering Committee and MPWT at the Inception Workshop as to whether we should move forward on this basis, or alter our approach.

Flow chart of PBMC procedures for routine and emergency maintenance

Preparation and contracting

Routine maintenance	**Emergency maintenance**
The DPWT Engineer will estimate the cost of carrying out maintenance over a 3-year period according to the following headings. 131 Clearing of ditches by hand tools. 132 Clearing of ditches by machine. 133 Clearing of culverts. 134 Repair of culverts. 135 Repair of erosion damage. 136 Repair of retaining wall. 137 Repair of ditch linings.	The DPWT Engineer will estimate the cost of carrying out maintenance over a 3-year period according to the following headings; this requires an estimate of the possible extent of landslides and other repairs that might occur. 311 Removal of landslides. 312 Emergency culvert repair. 314 Erosion damage repair. 315 Repair of collapsed road embankment 316 Blasting.

For both routine works and the repair of anticipated emergency problems, the DPWT Engineer will estimate the cost of rehabilitation and improvement works over a 3-year period according to the following headings.

435 Erosion protection by gabions.
436 Erosion protection by rocks.
437 Erosion protection by vegetation.

Having derived quantities under the various MACs and applied the MPWT's recommended unit rates, the DPWT will seek MPWT approval and invite a number of contractors (minimum three) to bid for the PBM contract.

Once the bids are received they are subjected to the normal scrutiny by a bid evaluation committee, the necessary MPWT approvals sought and the contractor instructed to carry out the work.

Quarterly payments are based on measured quantities, which means that the PBM contracts are effectively re-measurement contracts.

Implementation supervision and monitoring

Routine maintenance	**Emergency maintenance**
A joint inspection is carried out [at what frequency?]	Following an unusual event, the contractor must attempt to open the road and at the same time call for a joint inspection.
Agreed maintenance work must commence within 12 hours of the joint inspection.	If the landslide is of such magnitude that the contractor fails to open the road within 12 hours, he must obtain outside assistance to clear the debris as quickly as possible.
If the work is not carried out within certain periods, penalty clauses apply.	If the landslide is large and occurs under exceptional climatic circumstances, then the DPWT and MPWT can apply to the Prime Minister's Office (PMO) to have the event declared as a National Disaster.
	The DPWT, MPWT and the contractor agree on the scope of work, and quantities and costs.
	The DPWT and MPWT apply to the PMO.
	The PMO then consults with the Department of Meteorology and Hydrology for an opinion.
	If this accords, then special emergency funds are made available (additional to the PBMC amounts) and the contractor is instructed to carry out the work as an extension to the PBM contract.
	If the work is too great for a single contractor to handle, then other contractors may also be appointed.

ANNEX A: PROJECT WORKPLAN

No	Task	Apr				May					Total mm	
		1-6	7-13	14-20	21-27	28-4	5-11	12-18	19-25	26-31	Laos	HO
1	Project planning											
2	Information gathering											
3	Analysis											
3	Capacity development											
4	Elaboration of feasibility study											
5	Dissemination											
6	Project reporting											
International Staff												
Position	Name											
Team Leader/Capacity Developer	John Howell										1.00	0.50
Geotechnical Engineer	Tim Hunt										0.65	0.25
Engineering Geologist/Training	Gareth Hearn										0.60	0.40
Economist	Julian Aubert											0.50
Local Professional Staff												
Position	Name											
Deputy Team Leader	Xayphone Chonephetsarath										1.00	
Economist	Minevanh Pholsena										0.75	
Design Draughtsman 1											1.00	
Design Draughtsman 2											1.00	