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RURAL ROAD SURFACING RESEARCH

SEACAP 1

Final Report

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APPENDICES

(Volume 2)

(Volume 3)

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RRST VIETNAM
SEACAP 1
FINAL REPORT

APPENDIX A

Working Paper: RRST – Rural Road Surfacing Cost Model

by

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SUMMARY

This Working Paper describes an Excel-based cost model that has been developed as part of the Rural Road Surfacing Research (RRST) carried out by Intech-TRL on behalf of MoT Vietnam with the support of DFID and World Bank as part of the second Rural Transport Project (RT2).

The model is intended as a tool to assist with the selection of appropriate rural road surface options, based on the range of local factors that will influence the feasibility and cost-effectiveness in a particular road location.

The model is in an early stage of development and is intended to be further developed with the findings of an expanded programme of research, for example, to include combinations of surface options and environments not yet studied and the results of the planned long term monitoring of the RRST relating to pavement option performance and maintenance requirements. It is also intended that the model will be able to be extended to include a Whole Life Cost component by including Vehicle Operating Cost relationships based on improved analysis of the characteristics of the range of vehicle types and conditions on the Vietnamese rural road network.

The paper discusses the following issues:-

- Introduction to the Model; inputs and outputs
- Types of pavement included
- Model Structure
- Maintenance features and assumptions
- Periodic maintenance replacement of gravel surfacing losses (based on SEACAP 4 research)
- Residual Value of Pavement
- Key Data
- Haulage Costs
- Direct Costs
- Detailed Units Costs
- Total Costs
- Road Environment
- Further Model Development
- Other discussion issues

The Cost Model is available on a CD.

1. Introduction

This decision support cost model has been designed based on MS-Excel spreadsheets in order to provide rural road authorities and design consultants with a supportive tool for their road surface and pavement selection process. The Cost Model is a required output of the RRST-1 contract. The model introduces a menu of appropriate rural road pavements with the whole life cost details (construction and maintenance costs for road managers)[1] of each option, suggesting the most appropriate options for each defined local road environment. The initial menu is based on the research findings of the RRGAP, RRST-I and RRST-II trials. It is expected that further options will be added in later model versions based on other investigations.

The cost calculation method within the model is pursuant to the current decrees and documents issued by the Government, thus the model is also very helpful in preparing cost estimates.

1.1 The essential inputs for the model

The user is able to determine the local influential factors for analysis of a particular road location by selecting from cell options for the following parameters:-

Natural factors – which are to an extent uncontrollable:

- Sub-grade geological and hydrological conditions:
  - Types of soil
  - Strength
  - Flood regime
- Road alignment longitudinal gradient
- Terrain (mountainous, midland, plain etc.)
- Annual rainfall (impact to deterioration rates of some types of pavement)
- Material sources and haulage distances to the site

Man-made factors - controllable:

- Traffic volume
- Axle load

1.2 Expected outputs

Once the surface options and influential factors are selected, the spreadsheet displays the following output information:-

- Construction cost of the selected option **per km** (with defined surface width)
- Maintenance cost per km (15 year period) in terms of present cost
- Maintenance cost per km (15 year period) in terms of NPV

[1] The cost model has been designed with the intention that a later edition will be able to accommodate an optional Vehicle Operating Cost sub-model.

1.3 Types of Pavement

There are currently 26 pavement options that may be selected within the model. From the initial RRST-1 and RRST-II investigations and trials, they are some of the most appropriate options for the rural road sector in Vietnam; they have been successfully proven and used in many countries worldwide such as China, India, South Africa, Ghana, Uganda, Nigeria, Cambodia and now in the range of conditions encountered throughout Vietnam.

The menu of pavement options has been updated and expanded at the completion of the construction phase of the rural road surfacing trial programme being carried out for the Northern Highlands region, Central Highlands region and Red River Delta region of Viet Nam (under RRST-II).

2. Model Structure and Operation

2.1 Input and Output.

This is the main model operation page (example shown in Annex 1 of this paper) and is the core facility for selecting surfacing options for analysis and the influential local factors that will determine the construction and maintenance costs for the selected parameter options. The sheet provides the cell options to input the data or select the road environment parameters.

The various road environment parameters can be selected at a range of **yellow** coloured fields which appear on a scroll arrow when clicking at the right hand side. Other **yellow** fields on related sheets are used for inputting local specific data such as material prices, haulage distances etc. Other fields will be kept untouched [2].

After selecting the equivalent road environment parameters and inputting the required data, select the yellow fields within the **"Type of Pavement"** column, then click the scroll arrow to choose one of the pavement options in the list. The related information of the selected pavement option such as construction cost, maintenance cost and whole life costing chart etc. are automatically displayed at the same page.

The Input and Output page will also provide the notices and recommendations of using different pavement options for the selected road environments at the **Red** coloured fields**.** The recommendations are pointed out based on the option “codes” of flood regimes, annual rainfall, gradients and soil types used for sub-grade .

3 Maintenance

Road Maintenance in the model consists of two principal calculated cost components:-

Routine Maintenance, and
Periodic Maintenance

[2] To avoid any change of formulas at the key fields by accident, these fields are locked.

These are added together to calculate Total Maintenance Costs. Emergency maintenance is considered to be accommodated in the adjustment for routine maintenance discussed below.

3.1 Routine Maintenance

This is calculated in two sub-components:-

Routine Maintenance based on the cost Norms, plus,
Routine Maintenance grading for earth or gravel roads only.

The first sub-component is based on the current MoT **Routine Maintenance Norms.** This page accommodates the current norms for routine maintenance and management issued by the MoT which can be used to calculate routine maintenance costs. These Norms are considered to require updating and extending to reflect actual maintenance needs and costs for a wide range of conditions. However, for the purposes of the Initial model version, they are used as the basis for calculating Routine Maintenance costs. However, a **20%** increase in the costs calculated according to the Norms is made to allow for the costs of planning and supervising the maintenance works including quality control, and any emergency maintenance works required. It is also necessary to add a cost sub-component for routine maintenance grading.

3.2 Routine Maintenance Grading

The MoT Routine Maintenance Cost Norms do not include an item for the activity of camber reshaping or grading. This is an essential component of earth and gravel road maintenance (recognized by PIARC[3] and many national road agencies). One of the problems of gravel roads in Vietnam is that this need is generally not recognized at design stage, nor in maintenance funding and implementation arrangements. The cost of this grading is calculated and added to the Maintenance costs discussed above.

3.2.1 Grading Frequency

Surface grading is required to be carried out on earth and gravel roads to restore the camber and keep it within the desirable range of 3 – 7%. It is supposed to be a routine maintenance activity to supplement the other largely labour based routine maintenance activities. Unfortunately it is usually not carried out on the existing rural road network in Vietnam, leading to premature deterioration of the roads.

As a broad guideline routine light grading should be related to traffic flows. For the Vietnam Cost Model the frequency assumed should be:-

[3] PIARC (World Road Association) International Road Maintenance Handbook.

TRAFFIC FLOW (PCU in design life)	Number of Routine Gradings/year for a gravel surfaced road	Number of Routine Gradings/year for an earth surfaced road
> $15x10^5$	Gravel surface not suitable	Earth Surface Not suitable
5 – $15x10^5$	**4**	Earth Surface Not suitable
< $5x10^5$	**2**	**4**

Reference: ORN1

Table A: Routine Maintenance Grading Assumptions

Note: a grading operation will typically consist of 6 - 8 passes of the grading machine to lightly scarify and cut the surface and redistribute the loose material to the correct crossfall/camber. It is assumed that there will be sufficient moisture retained in the material to allow it to be re-consolidated by the traffic, without the use (and additional cost) of watering or compaction equipment. See example Figure 1.

The calculation of design life PCU from traffic surveys and predictions of traffic growth should be based on the conversion factors shown in the following table.

Table B : Recommended PCU Conversion Factors for traffic flow and surfacing determination.

Type of Vehicle	Equivalent Value in PCU's for Rural Traffic Flow Calculations
Passenger Car	1.0
Motorcycle	0.1
Motorcycle-trailer	0.3
Bicycle	0.05
Animal Cart	0.2
Light Vehicle / Van	1.0
Light truck (Kong Nong)	1.5
Medium Truck (6 tyres)	2.5
Heavy Truck (> 6 tyres)	5.0
Bus (> 4 tyres)	2.5
Mini-bus (4 tyres)	1.2

3.2.2 Resources Required

A routine maintenance "unit" will be required with the following resources:-

1 No Light Motor Grader (65 – 100 hp) (or tractor towed grader)
1 No Supervisor
1 No Motor grader driver

2 No labourers (attendants)

3.2.3. Productivity

Because of the complex logistics of routine maintenance, including substantial travelling time from the operational base and between sites, relatively short lengths of road to grade, difficulties in turning the machine, the following outputs are used for the cost model:-

Output per maintenance unit full working day = **4km of road length graded**

3.3 Periodic Maintenance

The periodic maintenance costs for the range of Vietnamese environments are currently difficult to determine for the new pavement types until the results of the long term monitoring of the RRST-I and RRST-II are available. The knowledge base available from structured research does not include many of the surface types, nor the considerable range of environments experienced in Vietnam. However the RRGAP investigations (SEACAP 4) have allowed the Periodic Maintenance costs of **gravel/laterite** to be assessed and incorporated in the initial version of the model.

From the RRGAP data the following rates of annual gravel loss have been assessed to be appropriate for various conditions in Vietnam, Table C:-

TABLE C : Gravel Loss Matrix for Use in Rural Roads Cost Model

Annual expected Gravel Loss to be computed from Basic Gravel Loss (1.) adjusted for Regional (2.) and General (3.) Factors.

Terrain Region		Low delta/coastal Subject to flood	Low delta/coastal Minimal flood	Inland Flat	Rolling small hills	Hilly and mountainous
1. Basic Gravel Loss (mm/year)		40	25	30	20	35
Key Regional Factor		Poor quality material	Poor quality material	Poor quality material	Gradient	Sheet erosion (See Note I)
2. Adjustment to Basic Loss for Regional Factor		+15mm/year	+5 mm/year	+10 mm/year	2-4%: +5 mm/year 4-6%: +10 mm/year	A: +5mm/year B: +15 mm/year C: +30 mm/year
3. Further General Adjustments	3.1 Maintenance guaranteed	-30%	-30%	-30%	-30%	-30%
	3.2 Traffic Level					
	B1	+10%	+10%	+10%	+10%	+10%
	A3	+15%	+15%	+15%	+15%	+15%
	A2	+20%	+20%	+20%	+20%	+20%
	A1	+25%	+25%	+25%	+25%	+25%

Gravel loss figures based on 90% confidence level assessment of RRGAP gravel loss data.

Table C : Notes

Note I:

Sheet erosion definition; A = Gradient <2% subject to minor sheet flooding

B = Gradient 2-4% subject to regular sheet flooding

C = Gradient >4% subject to regular sheet flooding

Sheet flooding means that water covers the road surface due to flooding from surrounding ground and not just the rainwater that falls directly on the road surface.

Note 2

Data figures were recovered from provinces with annual rainfall below 3000 mm/year.

Note 3

The Table figures assume a general compliance with construction specifications.

Note 4

“Maintenance guaranteed” assumes that all drainage system and camber maintenance are arranged regularly to keep the road surface crossfall between 3 and 7%.

Note 5

Does not apply to coarse grained crushed stone macadam.

See example Figure 2

Figure 1 - **ROUTINE MAINTENANCE** GRADING

Example: 15 year analysis period, gravel road, traffic level < $5x10^5$ PCU

Grading twice each year

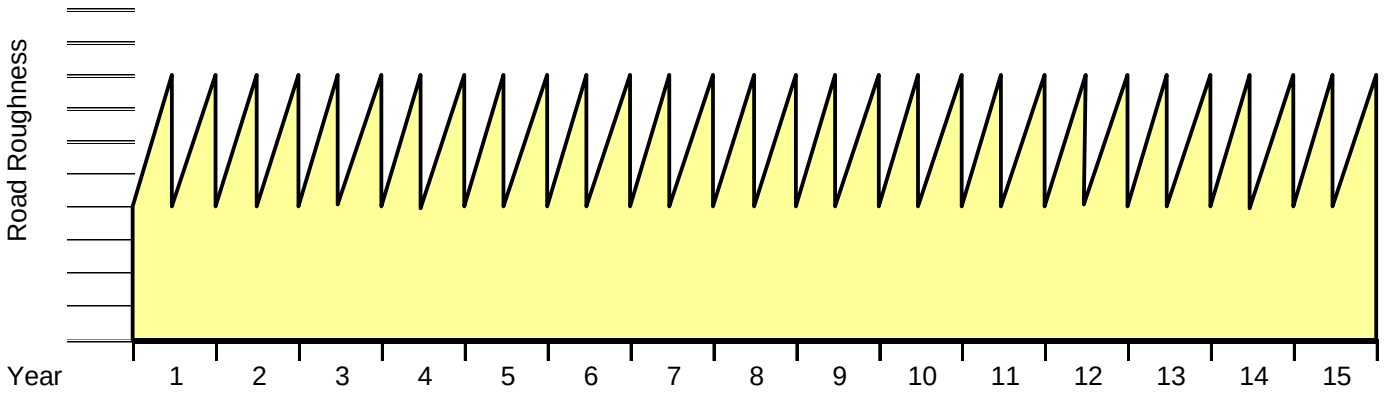
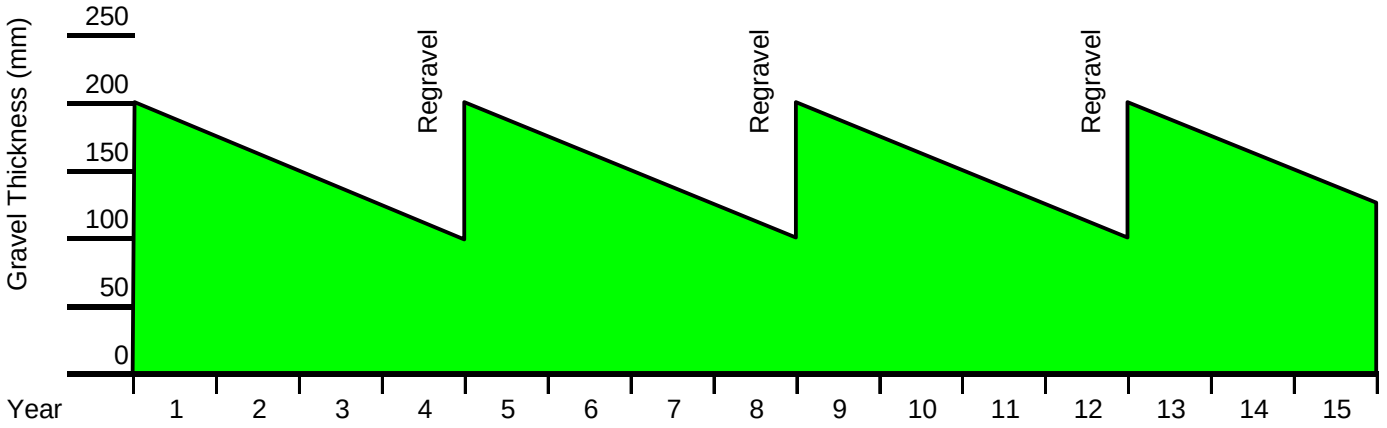


Figure 2 - GRAVEL THICKNESS **WITH** TIMELY **PERIODIC MAINTENANCE**

Example: 15 year analysis period, gravel road, coastal, minimal flood, with maintenance, traffic level A2

Gravel loss: approximately 25mm/year



The annual gravel loss using the above matrix is calculated by the model for each year and accumulated to subsequent years. When the reducing residual gravel thickness is predicted to decrease to less than 80mm in any year, the model will calculate the cost of providing additional gravel to bring the layer thickness back to the Design thickness AT THE BEGINNING OF THAT YEAR, and calculate and record it as a periodic maintenance cost for that year. The model will reset the thickness to the design thickness at the beginning of that year and start loss calculations again for that and subsequent years.

An option for **no maintenance** has been added into the model to show the affects of routine and periodic maintenance not being funded or provided in an effective way for the gravel option. It will also show the effects of inadequate drainage (either in respect to original provision or drainage maintenance). In this case the residual gravel thickness will be calculated each year at the accelerated gravel loss rate. However when the residual gravel thickness is calculated to fall below 80mm in any analysis year, the road will be shown to be **re-constructed** at the appropriate cost by the model at the start of the following year. In effect the 'No Maintenance' regime forces a 'Multiple Rehabilitation' approach which is usually more costly if the access on the road link is to be retained as all such investments invariably assume.

The Model has the facility for specifying the frequency and cost of periodic maintenance of structural paving options. Appropriate guidelines on the various surface options will be able to be developed from the results of the planned RRST long term monitoring.

For model demonstration purposes available international experience has been extended to provide some illustrative indicators for the initial model. For example, for **paved road** types incorporating structural bitumen, concrete or brick layers, the periodic maintenance costs have been entered as 5% of the initial costs of construction of the pavement layers only, and applied at a timing of 10 years after the construction of the pavement. Bitumen seal surfaces for demonstration purposes have been entered as 20% of the initial construction costs after 7 years.

For the **unsealed pavement types** (other than gravel/laterite), this includes cobble stone paving, hand packed stone, water bound macadam, etc., the periodic maintenance costs have been entered as 7% of the initial costs of construction of the pavement layers only, and applied at a timing of 6 years and again at 12 years after the construction of the pavement.

Such figures would assume that roads would be constructed initially using appropriate specifications and quality assurance regimes. The model is not able to predict the affects of poor construction practices, however increased periodic maintenance costs or frequency could be used as a proxy to model such a scenario.

It will be possible to refine the sealed pavement maintenance guidelines and relationships after the results of the planned RRST long term monitoring are obtained and analysed.

4. Residual Value of the Pavement

The residual value of the pavement at the end of the analysis period is an important factor in the asset Whole Life Costing. This is calculated as follows:

For gravel/laterite road surfaces the residual value will be the residual gravel thickness divided by the initial constructed thickness. This figure is then multiplied by the value (cost) of the initial constructed thickness of gravel surfacing for the analysis section of road.

For other paving types the residual values have been calculated as the following percentage of the initial constructed value of the **full** pavement layer. That is everything constructed above the subgrade level, but excluding shoulders. These figures can be adjusted in the model in the light of local experiences.

Table D: Residual Value Assumptions

Code	Type of road surfaces	Recommended Residual Value after 15 years (percentage)
C1	Steel reinforced concrete on Natural gravel sub-base	70
C2	Steel reinforced concrete on Lime stabilised sub-base	70
C3	Steel reinforced concrete on Cement stabilised sub-base	70
C4	Steel reinforced concrete on sand sub-base	70
C5	Bamboo reinforced concrete on sand sub-base	70
C6	Bamboo reinforced concrete on Lime stabilised	70
C7	Bamboo reinforced concrete on Cement stabilised	70
C8	Non-reinforced concrete on Natural gravel	70
C9	Non-reinforced concrete on Lime stabilised sub-base	70
C10	Non-reinforced concrete on Cement stabilised sub-base	70
C11	Emulsion seal on Lime stabilised	40
C12	Emulsion seal on Cement stabilised	40
C13	Emulsion seal on Emulsion stabilised	40
C14	Emulsion seal on Dry bound macadam sub-base	50
C15	Emulsion seal on Natural gravel with Amoured	50
C16	Two layers bitumen seal on Water bound macadam	60
C17	Sand seal on Concrete brick on Dry bound macadam	70
C18	Sand seal on Concrete brick on Natural gravel	70
C19	Burnt clay brick on Lime stabilised	60
C20	Burnt clay brick on Cement stabilised	60
C21	Emulsion sand seal on Burnt clay brick on Lime stabilised	60
C22	Emulsion sand seal on Burnt clay brick on Cement stabilised	60
C23	Mortar Dressed stone on Natural gravel sub-base	60
C24	Bitumen penetration macadam 6cm	60
C25	Water bound macadam	50
C26	Natural gravel surface/laterite	Calculate from Table A

5. Data.

This page accommodates the key data in terms of allowances, equipment use ratios, roadway and waterway transport norms and a matrix to define the appropriateness of each pavement option for various road environment conditions.

This page also provides the users with data to define the combinations of traffic, axle loads and road classifications and to recommend the component structural layer thickness of each pavement option within the menu.

6. Haulage Cost.

This page will display the material haulage costs to the site. It can be printed out to include in a cost estimate document if required.

7. Direct Cost.

This page includes all the direct costs for construction including material costs to the site, labour and equipment costs. This intermediate page is used for reference during the calculation process. It can be printed out to include in cost estimate document if required.

8. Detailed Unit Cost.

This page provides the detailed construction unit cost of each pavement option or each activity specified in the specification. This page also provides the unit costs of some routine maintenance activities such as pothole patching, deformation treatment, crazing seals etc.

9. Total Cost.

This page shows the routine maintenance cost, periodic maintenance cost and construction cost of each pavement option within the menu.

10. Road Environment

The following categorizations, codes and representations are incorporated in the model.

1. Traffic and Axle load

Ref	Equivalent standard axle	Classification of estimated traffic volume	Class of loading	Code	Number of vehicle passes during design period
1	6T	High traffic volume	A1	I	> $15x10^5$
2	6T	Medium traffic volume	A2	II	5 – $15x10^5$
3	6T	Low traffic volume	A3	III	< $5x10^5$
4	2.5T	High traffic volume	B1	I	> $15x10^5$
5	2.5T	Medium traffic volume	B2	II	5 – $15x10^5$
6	2.5T	Low traffic volume	B3	III	< $5x10^5$

Table E: Traffic and Axle Loading Categories

Note: If vehicle passes during the design period will exceed $5x10^5$, or heavy truck traffic is expected on the road (axle loads >10t), then:-

i) gravel will probably not be a viable surfacing option, and
ii) road pavements will require specific engineering design.

2. Flood

Flooding regime defined as follows:

I: No flooding
II: Sometimes (gravel may not be suitable)
III: Annual but small (gravel not suitable)
IV: Annual and big (gravel not suitable)

3. Local Soil

SS: Sandy soil
CS: Clayey soil
Gr: Gravel

4. Road Environment Codes

Codes in fact are the parameters which help the model bring about recommendations for using the selected pavement options.

1: Most suitable
2: Possible but may not be ideal
3: Not recommended

11. Outstanding Development Work on the Basic Cost Model

At the time of the writing of this Working Paper, the basic cost model is complete. The model functions incorporate all of the construction cost knowledge developed under RRST-I and RRST-II, and initial assumptions made on maintenance from the limited knowledge available on local requirements and extension of existing research knowledge elsewhere.

12. Other Discussion Issues

The basic model has been completed in terms of structure and it is possible to use in a preliminary way. However, there exist some issues to discuss and clarify as indicated below, before further development of the model:

1. Unavailability of routine maintenance norms for most of the new pavement options in Vietnam. Additionally there is the fact that the existing norms anyway need updating and expansion.
2. Vehicle operating cost relationships to be used for the Transport Whole Life Cost analysis. The available Vietnam VoC-road condition knowledge base is extremely limited.
3. For the model to be useful for considering gravel road upgrading options, there is a need to investigate the experiences and successes of the locally initiated upgrading of RT1 and RT2 roads to durable standards.

13. Further Research

Based on the above constraints the following research is justifiable:

1. The current MoT Routine Maintenance Cost Norms are very basic and restricted in extent to a limited range of circumstances and surfaces. There are obvious inconsistencies in them. There is a need to update and extend these Norms and obtain official recognition so that they can be applied in their own right, and by the Cost Model users in justification of Construction and Maintenance planning, design and implementation.

2. The VoC relationships for Vietnam available through RT2 appear to have a limited research base. They can be used for designing the VoC sub-model in the next phase of model development, however it is recommended that further work is required to develop improved VoC- road condition relationships in Vietnamese conditions.

3. Rural Sealed Road Assessment Programme (RSRAP) - This research is recommended as complementary to work undertaken on unsealed roads by the RRGAP. It would be aimed primarily at providing condition and performance data on RT1, RT2 and other rural roads that have been sealed

using provincial funds and local designs. The research would be aimed at providing the following key outputs:

- Information on the range of rural sealed pavement types and their costs,
- The condition of sealed surfaces and their performance under current construction and maintenance regimes,
- An assessment of the sustainability of current sealed surface types,
- Recommendations on the use of local sealed designs as part of a staged construction strategy within RT3,
- Added input in a rural surfacing selection matrix for use on RT3.

No firm proposals are currently in place for this research. It is one of the activities listed as a possibility within a proposed extension to SEACAP1.

14. Example Analyses

Appendix 1 contains an example analysis using the latest version of the RRST Cost Model.

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ANNEX 1 – EXAMPLE COST MODEL INPUT & RESULT SHEET

Road Environment factors and the recommended road pavement

Province: Gravel-Short Haul-WITH Maintenance-Delta

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	CS	B1	C26	Natural gravel surface	10	3.5
									Natural gravel sub-base	12	4
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group			
Suitable			1	1	1	1	1	G6			

Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	5km

Notice!	

Road name:	**Natural gravel surface**

Analysis results of the WLC

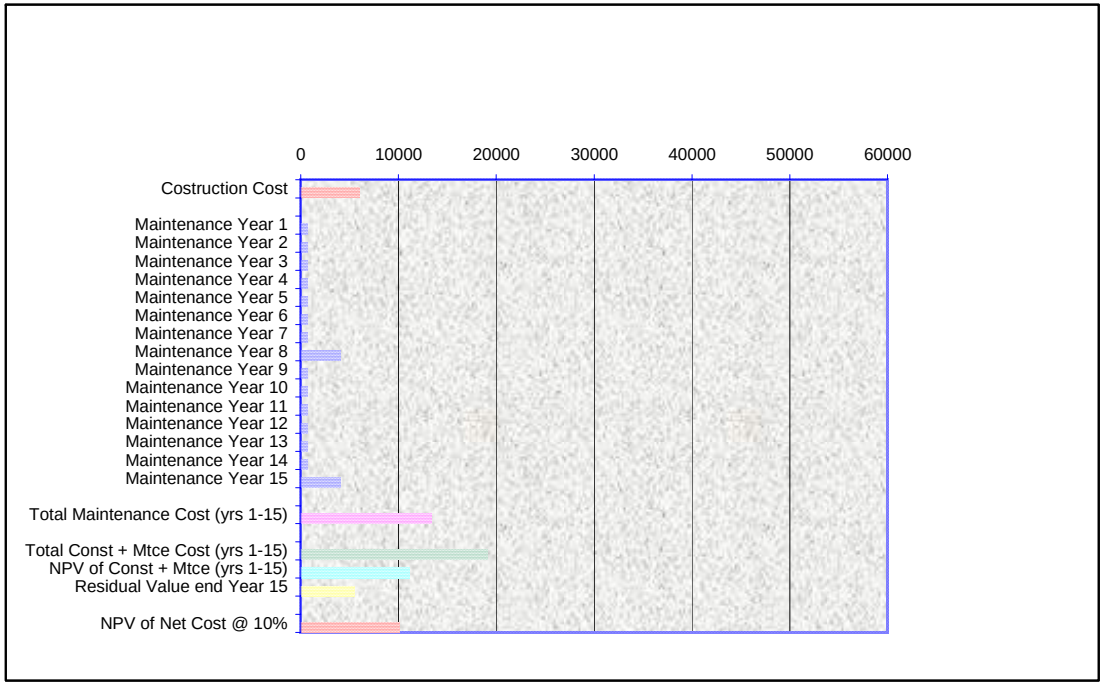
	USD
Costruction Cost	**5668**

Maintenance Year 1	427
Maintenance Year 2	427
Maintenance Year 3	427
Maintenance Year 4	427
Maintenance Year 5	427
Maintenance Year 6	427
Maintenance Year 7	427
Maintenance Year 8	3779
Maintenance Year 9	427
Maintenance Year 10	427
Maintenance Year 11	427
Maintenance Year 12	427
Maintenance Year 13	427
Maintenance Year 14	427
Maintenance Year 15	3779

Total Maintenance Cost (yrs 1-15)	13107

Total Const + Mtce Cost (yrs 1-15)	18775
NPV of Const + Mtce (yrs 1-15)	10850
Residual Value end Year 15	5153

NPV of Net Cost @ 10%	9789



SEACAP 1

FINAL REPORT

APPENDIX B

Traffic Count Data

INTRODUCTION

This Appendix includes the basic collated traffic count data for the RRST-I and RRST-II trial roads up to December 2006. In addition, Tables B1 to B5 summarise the data for each trial region.

The data was collected by a combination of Intech-TRL, ITST and local PDoT staff using standard procedures described in Chapter 4 and presented in Chapter 8 of the Main SEACAP 1 Final Report (Volume1).

	Vehicle		Truck>5t	Truck<5T	Car	Cong Nong	4-Wheel	Motorcycle	Total Motorized	Cycle	Animal/Hand Cart	Walker	**ADT (12 Hours)**	**ADT (24 Hours)**	Survey Date	Total Traffic
	ADT Factor		5	2.5	0.8	1		0.1		0.05	0.2	0.02				
Mekong	Dong Thap: Tan Thuan Tay	Daily Nos	0	0	1	0	1	1,106	1,107	1,110	0	271				2,488
	(Km 2+340)	%	0.0	0.0	0.0	0.0		44.5		44.6	0.0	10.9				
		ADT	0	0	1	0		111		56	0	5	**172**	**207**	Nov. 2004	
	Dong Thap: Tan Thuan Tay	Daily Nos	0	0	2	0	2	691	693	426	19	27				1,165
	(Km 0+683)	%	0.0	0.0	0.2	0.0		59.3		36.6	1.6	2.3				
		ADT	0	0	2	0		69		21	4	1	**96**	**116**	Oct. 2006	
	Dong Thap: Tan Thuan Tay	Daily Nos	0	0	0	0	0	1,432	1,432	904	65	44				2,445
	(Km 2+340)	%	0.0	0.0	0.0	0.0		58.6		37.0	2.7	1.8				
		ADT	0	0	0	0		143		45	13	1	**202**	**243**	Oct. 2006	
	Tien Giang: My Phuoc Tay	Daily Nos	0	3	1	0	4	744	748	687	0	127				1,562
		%	0.0	0.2	0.1	0.0		47.6		44.0	0.0	8.1				
		ADT	0	8	1	0		74		34	0	3	**120**	**144**	Nov. 2004	
	Tien Giang: My Phuoc Tay	Daily Nos	0	2	0	0	2	925	927	538	1	242				1,708
		%	0.0	0.1	0.0	0.0		54.2		31.5	0.1	14.2				

Table B1 Summary of Traffic Count Data: Mekong Trials Region

	Vehicle		Truck>5t	Truck<5T	Car	Cong Nong	4-Wheel	Motorcycle	Total Motorized	Cycle	Animal/Hand Cart	Walker	**ADT (12 Hours)**	**ADT (24 Hours)**	Survey Date	Total Traffic
	ADT Factor		5	2.5	0.8	1		0.1		0.05	0.2	0.02				
Central	Da Nang: Binh Ky	Daily Nos	0	2	0	22	24	206	230	426	0	260				916
		%	0.0	0.2	0.0	2.4		22.5		46.5	0.0	28.4				
Coastal		ADT	0	5	0	22		21		21	0	5	**74**	**89**	Nov. 2004	
	Da Nang: Binh Ky	Daily Nos	0	0	0	13	13	369	382	94	5	63				544
		%	0.0	0.0	0.0	2.4		67.8		17.3	0.9	11.6				
		ADT	0	0	0	13		37		5	1	1	**57**	**68**	Oct. 2006	
	Hue: Thong Nhat	Numbers	0	0	1	1	2	69	71	193	0	263				527
		%	0.0	0.0	0.2	0.2		13.1		36.6	0.0	49.9				
		ADT	0	0	1	1		7		10	0	5	**24**	**28**	Nov. 2004	
	Hue: Thong Nhat	Numbers	0	0	3	17	20	578	598	588	0	565				1,751

Table B2 Summary of Traffic Count Data: Central Coastal Trials Region

	Vehicle		Truck>5t	Truck<5T	Car	Cong Nong	4-Wheel	Motorcycle	Total Motorized	Cycle	Animal/Hand Cart	Walker	**ADT (12 Hours)**	**ADT (24 Hours)**	Survey Date	Total Traffic
	ADT Factor		5	2.5	0.8	1		0.1		0.05	0.2	0.02				
Central	Gia Lai: Xa Trang	Daily Nos	19	17	5	44	85	698	783	85	0	660				1,528
		%	1.2	1.1	0.3	2.9		45.7		5.6	0.0	43.2				
Highlands		ADT	95	43	4	44		70		4	0	13	**273**	**327**	July 2005	
	Gia Lai: Ia Pnol	Daily Nos	29	12	19	24	84	112	196	887	1	0				1,084
		%	2.7	1.1	1.8	2.2		10.3		81.8	0.1	0.0				
		ADT	145	30	15	24		11		44	0	0	**270**	**324**	Sept. 2006	
	Gia Lai: Chu Pah	Daily Nos	5	6	7	84	102	1,020	1,122	336	36	9				1,503
		%	0.3	0.4	0.5	5.6		67.9		22.4	2.4	0.6				
		ADT	25	15	6	84		102		17	7	0	**256**	**307**	July 2005	
	Dak Nong: Kien Duc	Daily Nos	38	27	16	18	99	1,622	1,721	44	1	154				1,920
		%	2.0	1.4	0.8	0.9		84.5		2.3	0.1	8.0				
		ADT	190	68	13	18		162		2	0	3	**456**	**547**	July 2005	
	Dak Lak: Cu Ne	Daily Nos	9	20	8	110	147	958	1,105	88	0	1,315				2,508
		%	0.4	0.8	0.3	4.4		38.2		3.5	0.0	52.4				
		ADT	45	50	6	110		96		4	0	26	**338**	**405**	Sept. 2006	
	Dak Lak: Buon Ho	Daily Nos	10	8	8	205	231	391	622	47	0	294				963

Table B3 Summary of Traffic Count Data: Central Highlands Trials Region

	Vehicle		Truck>5t	Truck<5T	Car	Cong Nong	4-Wheel	Motorcycle	Total Motorized	Cycle	Animal/Hand Cart	Walker	**ADT (12 Hours)**	**ADT (24 Hours)**	Survey Date	Total Traffic
	ADT Factor		5	2.5	0.8	1		0.1		0.05	0.2	0.02				
Red River	Hung Yen: Nhat Quang	Daily Nos	2	31	9	66	108	147	255	191	40	166				652
		%	0.3	4.8	1.4	10.1		22.5		29.3	6.1	25.5				
Delta		ADT	10	78	7	66		15		10	8	3	**196**	**236**	July 2005	
	Hung Yen: Tan Hung	Daily Nos	45	45	12	125	227	117	344	128	108	128				708
		%	6.4	6.4	1.7	17.7		16.5		18.1	15.3	18.1				
		ADT	225	113	10	125		12		6	22	3	**514**	**617**	July 2005	
	Ninh Binh: Yen Trach	Daily Nos	0	0	2	125	127	1,467	1,594	1,691	96	3,782				7,163
		%	0.0	0.0	0.0	1.7		20.5		23.6	1.3	52.8				
		ADT	0	0	2	125		147		85	19	76	**453**	**543**	July 2005	
	Ninh Binh: Thu Trung	Daily Nos	0	0	1	139	140	1,724	1,864	1,769	169	625				4,427
		%	0.0	0.0	0.0	3.1		38.9		40.0	3.8	14.1				
		ADT	0	0	1	139		172		88	34	13	**447**	**536**	July 2005	
	Ninh Binh: Yen Tu	Daily Nos	0	3	3	54	60	317	377	814	0	168				1,359
		%	0.0	0.2	0.2	4.0		23.3		59.9	0.0	12.4				
		ADT	0	8	2	54		32		41	0	3	**140**	**168**	Sept. 2006	
	Ninh Binh: Ninh Van	Daily Nos	0	3	1	54	58	456	514	615	0	1,367				2,496
		%	0.0	0.1	0.0	2.2		18.3		24.6	0.0	54.8				
		ADT	0	8	1	54		46		31	0	27	**166**	**199**	Sept. 2006	
	Ninh Binh: Dong Huong	Daily Nos	0	0	1	126	127	1,745	1,872	1,569	149	1,204				4,794
		%	0.0	0.0	0.0	2.6		36.4		32.7	3.1	25.1				
		ADT	0	0	1	126		175		78	30	24	**434**	**520**	July 2005	

Table B4 Summary of Traffic Count Data: Red River Delta Trials Region

	Vehicle		Truck>5t	Truck<5T	Car	Cong Nong	4-Wheel	Motorcycle	Total Motorized	Cycle	Animal/Hand Cart	Walker	**ADT (12 Hours)**	**ADT (24 Hours)**	Survey Date	Total Traffic
	ADT Factor		5	2.5	0.8	1		0.1		0.05	0.2	0.02				
Northern	Tuyen Quang: Lang Quan	Daily Nos	21	23	15	25	84	756	840	854	18	587				2,299
		%	0.9	1.0	0.7	1.1		32.9		37.1	0.8	25.5				
Highlands		ADT	105	58	12	25		76		43	4	12	**333**	**400**	July 2005	
	Tuyen Quang: Thang Quan	Daily Nos	1	5	4	7	17	222	239	605	5	554				1,403
		%	0.1	0.4	0.3	0.5		15.8		43.1	0.4	39.5				
		ADT	5	13	3	7		22		30	1	11	**92**	**111**	July 2005	
	Tuyen Quang: Y la	Daily Nos	92	4	7	20	123	1,041	1,164	1,087	8	279				2,538
		%	3.6	0.2	0.3	0.8		41.0		42.8	0.3	11.0				
		ADT	460	10	6	20		104		54	2	6	**661**	**793**	Sept. 2006	
	Quang Binh: Cam Lien	Daily Nos	6	5	3	12	26	450	476	254	7	12				749
		%	0.8	0.7	0.4	1.6		60.1		33.9	0.9	1.6				
		ADT	30	13	2	12		45		13	1	0	**116**	**139**	July 2005	
	Quang Binh: Ngu Hoa	Daily Nos	6	25	16	5	52	707	759	58	713	17				1,547
		%	0.4	1.6	1.0	0.3		45.7		3.7	46.1	1.1				
		ADT	30	63	13	5		71		3	143	0	**327**	**392**	July 2005	
	Quang Binh: Ngu Hoa	Daily Nos	43	29	9	19	100	891	991	661	29	503				2,184
		%	2.0	1.3	0.4	0.9		40.8		30.3	1.3	23.0				
		ADT	215	73	7	19		89		33	6	10	**452**	**542**	Sept. 2006	
	Quang Binh: Loc Ninh	Daily Nos	43	89	253	52	437	424	861	30	268	30				1,189
		%	3.6	7.5	21.3	4.4		35.7		2.5	22.5	2.5				
		ADT	215	223	202	52		42		2	54	1	**790**	**948**	July 2005	
	Ha Tinh: Dia Loi	Daily Nos	33	1	4	74	112	875	987	334	2	66				1,389
		%	2.4	0.1	0.3	5.3		63.0		24.0	0.1	4.8				
		ADT	165	3	3	74		88		17	0	1	**351**	**421**	Sept. 2006	
	Ha Tinh: Thach Minh	Daily Nos	14	1	2	39	56	477	533	647	19	75				1,274
		%	1.1	0.1	0.2	3.1		37.4		50.8	1.5	5.9				
		ADT	70	3	2	39		48		32	4	2	**198**	**238**	July 2005	

Table B5 Summary of Traffic Count Data: Northern Highlands Trials Region

RRST-I: Tien Giang Province

Province	Tien Giang				**Surveyor**	Nguyen Minh Nhat
District	Cay Lay				**Location**	Mr Can's house
Traffic class	**2-Dec-03** 6:00 to 18:00	**3-Dec-03** 6:00 to 18:00	**4-Dec-03** 6:00 to 18:00	**5-Dec-03** 6:00 to 18:00	**6-Dec-03** 6:00 to 18:00	**Daily Average**
MOTORCYCLE	730	671	711	867	743	744
CAR, 4WD, PICKUP						-
CONG NONG & TRACTOR						-
LIGHT TRUCK =< 5 TONS	2	4	4	4		3
TRUCK > 5 TONS						-
MINI-BUS/BUS						-
PEDESTRIAN, WALKER	111	119	124	172	107	127
ANIMAL/HAND CART						-
BICYCLE	620	686	667	847	613	687
TOTALS	**1,463**	**1,480**	**1,506**	**1,890**	**1,463**	**1,560**
Rain This Period?	No Rain	No Rain	No Rain	No Rain	No Rain	

Province	Tien Giang				**Surveyor**	Le Minh Duc
District	Cay Lay				**Location**	Km0+875 (RH/S)
Traffic class	**15-Oct-06** 12:00 to 18:00	**16-Oct-06** 6:00 to 18:00	**17-Oct-06** 6:00 to 18:00	**18-Oct-06** 6:00 to 12:00		**Daily Average**
MOTORCYCLE	436	863	914	561		925
CAR, 4WD, PICKUP						
CONG NONG & TRACTOR				1		0
LIGHT TRUCK =< 5 TONS			4	3		2
TRUCK > 5 TONS						
MINI-BUS/BUS						
PEDESTRIAN, WALKER	15	335	241	135		242
ANIMAL/HAND CART			1	3		1
BICYCLE	151	587	534	341		538
TOTALS	**602**	**1,785**	**1,694**	**1,044**		**1,708**
Rain This Period?						

Dong Thap Province

Province	Dong Thap				**Surveyor**	Nguyen Minh Nhat
District	Cao Lanh Town				**Location**	Mr Nu's house
Traffic class	**25-Nov-03** 6:00 to 18:00	**26-Nov-03** 6:00 to 18:00	**27-Nov-03** 6:00 to 18:00	**28-Nov-03** 6:00 to 18:00	**29-Nov-03** 6:00 to 18:00	**Daily Average**
MOTORCYCLE	1,086	1,088	1,133	1,097	1,126	1,106
CAR, 4WD, PICKUP						
CONG NONG & TRACTOR						-
LIGHT TRUCK =< 5 TONS						-
TRUCK > 5 TONS						-
MINI-BUS/BUS			2			0
PEDESTRIAN, WALKER	269	243	282	289	274	271
ANIMAL/HAND CART						-
BICYCLE	1,164	1,134	1,066	1,092	1,094	1,110
TOTALS	**2,519**	**2,465**	**2,483**	**2,478**	**2,494**	**2,488**
Rain This Period?	No Rain	No Rain	No Rain	No Rain	No Rain	

Province	Dong Thap				**Surveyor**	Le Minh Duc
District	Cao Lanh Town					
	Location: Km0+683 (RH/S)				**Location: Km2+340(LH/S)**	
Traffic class	**12-Oct-06** 12:00 to 18:00	**13-Oct-06** 6:00 to 18:00	**14-Oct-06** 6:00 to 18:00	**Daily Average**	**15-Oct-06** 6:00 to 18:00	**Daily Average**
MOTORCYCLE	685	757	630	691	1,432	1,432
CAR, 4WD, PICKUP			5	2		-
CONG NONG & TRACTOR				-		-
LIGHT TRUCK =< 5 TONS				-		-
TRUCK > 5 TONS				-		-
MINI-BUS/BUS				-		-
PEDESTRIAN, WALKER	22	16	44	27	44	44
ANIMAL/HAND CART	13	22	21	19	65	65
BICYCLE	442	417	418	426	904	904
TOTALS	**1,162**	**1,212**	**1,118**	**1,165**		**2,445**
Rain This Period?						

Thua Thien Hue Province

Province	Thua Thien Hue				**Surveyor**	Nguyen Dinh Khoi
District	Phu Loc				**Location**	Ms Lan's House
Traffic class	**25-Nov-03** 6:00 to 18:00	**26-Nov-03** 6:00 to 18:00	**27-Nov-03** 6:00 to 18:00	**28-Nov-03** 6:00 to 18:00	**29-Nov-03** 6:00 to 18:00	**Daily Average**
MOTORCYCLE	92	79	56	61	55	69
CAR, 4WD, PICKUP					2	0
CONG NONG & TRACTOR	2			2		1
LIGHT TRUCK =< 5 TONS						-
TRUCK > 5 TONS						-
MINI-BUS/BUS						-
PEDESTRIAN, WALKER	272	281	284	309	170	263
ANIMAL/HAND CART						-
BICYCLE	254	168	255	147	142	193
TOTALS	**620**	**528**	**595**	**519**	**369**	**526**
Rain This Period?						

Province	Thua Thien Hue				**Surveyor**	Le Minh Duc
District	Phu Loc				**Location**	Km0+675 (RH/S)
Traffic class	**19-Oct-06** 6:00 to 18:00	**20-Oct-06** 6:00 to 18:00	**21-Oct-06** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	457	701	577			578
CAR, 4WD, PICKUP	5	4				3
CONG NONG & TRACTOR	11	29	11			17
LIGHT TRUCK =< 5 TONS						-
TRUCK > 5 TONS						-
MINI-BUS/BUS						-
PEDESTRIAN, WALKER	416	655	624			565
ANIMAL/HAND CART	1					0
BICYCLE	525	610	629			588
TOTALS	**1,415**	**1,999**	**1,841**			**1,752**
Rain This Period?						

Da Nang Province

Province	Da Nang				**Surveyor**	Nguyen Dinh Khoi
District	Hoa Hai				**Location**	Huynh Than's house
Traffic class	**2-Dec-03** 6:00 to 18:00	**3-Dec-03** 6:00 to 18:00	**4-Dec-03** 6:00 to 18:00	**5-Dec-03** 6:00 to 18:00	**6-Dec-03** 6:00 to 18:00	**Daily Average**
MOTORCYCLE	200	196	187	196	252	206
CAR, 4WD, PICKUP						-
CONG NONG & TRACTOR	16	20	34	22	18	22
LIGHT TRUCK =< 5 TONS	2	2	2	2	2	2
TRUCK > 5 TONS						-
MINI-BUS/BUS						-
PEDESTRIAN, WALKER	305	222	242	257	275	260
ANIMAL/HAND CART						-
BICYCLE	436	499	424	375	398	426
TOTALS	**959**	**939**	**889**	**852**	**945**	**917**
Rain This Period?	Slight rain	Light rain am	No Rain	No Rain	No Rain	

Province	Da Nang				**Surveyor**	Le Minh Duc
District	Ngu Hanh Son				**Location**	Km1+502 (RH/S)
Traffic class	**22-Oct-06** 12:00 to 18:0	**23-Oct-06** 6:00 to 18:00	**24-Oct-06** 6:00 to 18:00	**25-Oct-06** 6:00 to 12:00		**Daily Average**
MOTORCYCLE	170	375	445	116		369
CAR, 4WD, PICKUP						-
CONG NONG & TRACTOR		29		9		13
LIGHT TRUCK =< 5 TONS						-
TRUCK > 5 TONS						-
MINI-BUS/BUS						-
PEDESTRIAN, WALKER	14	82	58	34		63
ANIMAL/HAND CART		2	11	2		5
BICYCLE	16	131	89	45		94
TOTALS	**200**	**619**	**603**	**206**		**543**
Rain This Period?						

RRST-II
GIA LAI PROVINCE

Province	Gia Lai	**Surveyor**	Mai Xuan Loc
District	Dak Doa	**Location**	Mr. Duc's house
Road	Xa Trang		

Traffic class	13-Jul-05	14-Jul-05	15-Jul-05			Daily Average
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	746	696	652			698
CAR, 4WD, PICKUP	7	4	4			5
TRACTOR	29	43	60			44
LIGHT TRUCK =< 5 TONS	6	23	21			17
TRUCK > 5 TONS	9	22	26			19
MINI-BUS/BUS	-	-	-			-
WALKER	1,187	441	353			660
ANIMAL/HAND CART	-	-	-			-
BICYCLE	88	73	95			85
TOTALS	**2,072**	**1,302**	**1,211**			**1,528**
Rain This Period?	No Rain	No Rain	No Rain			

Province	Gia Lai	**Surveyor**	Nguyen Duc Xa
District	Chu Pah	**Location**	Km3 Tan son-Chu Jor
Road	Chu Pah		

Traffic class	13-Jul-05	14-Jul-05	15-Jul-05			Daily Average
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	950	1,009	1,100			1,020
CAR, 4WD, PICKUP	8	5	7			7
CONG NONG & TRACTOR	37	69	146			84
LIGHT TRUCK =< 5 TONS	1	6	12			6
TRUCK > 5 TONS	8	4	2			5
MINI-BUS/BUS						-
PEDESTRIAN, WALKER						-
ANIMAL/HAND CART	3	6	98			36
BICYCLE	378	285	346			336
TOTALS	**1,385**	**1,384**	**1,711**			**1,493**
Rain This Period?	No Rain	No Rain	No Rain			

Province	Gia Lai			**Surveyor**	Son, Thai
District	Duc Co			**Location**	Km3+00
Road	Ya Pnol				

Traffic class	**5-Sep-06** 6:00 to 18:00	**6-Sep-06** 6:00 to 18:00	**7-Sep-06** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	105	140	92			112
CAR, 4WD, PICKUP	17	24	16			19
CONG NONG & TRACTOR	25	32	16			24
LIGHT TRUCK =< 5 TONS	12	18	6			12
TRUCK > 5 TONS	29	28	30			29
MINI-BUS/BUS						-
PEDESTRIAN, WALKER	339	147	62			183
ANIMAL/HAND CART	-	4	-			1
BICYCLE						-
TOTALS	**527**	**393**	**222**			**381**
Rain This Period?	No Rain	No Rain	Rain am			

DAK NONG PROVINCE

Province	Dak Nong				**Surveyor**	Ha Sy Son
District	Dak R'Lap				**Location**	Km14+300
Road	Kien Duc-Cai Chanh					
Traffic class	**19-Jul-05** 6:00 to 18:00	**20-Jul-05** 6:00 to 18:00	**21-Jul-05** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	1,630	1,585	1,650			1,622
CAR, 4WD, PICKUP	19	15	14			16
CONG NONG & TRACTOR	15	19	21			18
LIGHT TRUCK =< 5 TONS	21	25	34			27
TRUCK > 5 TONS	37	39	37			38
MINI-BUS/BUS	2	3	4			3
WALKER	215	50	196			154
ANIMAL/HAND CART	2	-	-			1
BICYCLE	56	19	57			44
TOTALS	**1,997**	**1,755**	**2,013**			**1,922**
Rain This Period?	No rain	Rain am	Slight rain am			

DAK LAK PROVINCE

Province	Dak Lak				**Surveyor**	Y Binh Nie
District	Krong Buk				**Location**	
Road	Buon Ho-Ea Drong					
Traffic class	**26-Jul-05** 6:00 to 18:00	**20-Jul-05** 6:00 to 18:00	**21-Jul-05** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	373	408				391
CAR, 4WD, PICKUP	7	8				8
TRACTOR	193	216				205
LIGHT TRUCK =< 5 TONS	4	11				8
TRUCK > 5 TONS	9	11				10
MINI-BUS/BUS	-	-				-
WALKER	284	304				294
ANIMAL/HAND CART	-	-				-
BICYCLE	45	49				47
TOTALS	**915**	**1,007**	**-**			**961**
Rain This Period?	No rain	No rain	No rain			

Province	Dak Lak				**Surveyor**	Le Van Be
District	Ea Soup				**Location**	Km1+100
Road	Ea Soup					
Traffic class	**7-Sep-06** 6:00 to 18:00	**11-Sep-06** 6:00 to 18:00	**14-Sep-06** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	1,232	1,151	1,385			1,256
CAR, 4WD, PICKUP	8	6	10			8
CONG NONG & TRACTOR	17	18	17			17
LIGHT TRUCK =< 5 TONS	22	19	18			20
TRUCK > 5 TONS	5	8	10			8
MINI-BUS/BUS						-
PEDESTRIAN, WALKER	390	483	442			438
ANIMAL/HAND CART	23	11	10			15
BICYCLE	1,072	988	1,340			1,133
TOTALS	**2,769**	**2,684**	**3,232**			**2,895**
Rain This Period?	No Rain	No Rain	No Rain			

Province	Dak Lak			**Surveyor**	Hieu, Hung
District	Krong Buk			**Location**	Km0+500
Road	Cu Ne				

Traffic class	**4-Sep-06** 6:00 to 18:00	**6-Sep-06** 6:00 to 18:00	**8-Sep-06** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	400	945	1,028			791
CAR, 4WD, PICKUP	7	8	9			8
CONG NONG & TRACTOR	102	112	116			110
LIGHT TRUCK =< 5 TONS	23	20	18			20
TRUCK > 5 TONS	6	12	10			9
MINI-BUS/BUS						-
PEDESTRIAN, WALKER	1,450	1,375	1,120			1,315
ANIMAL/HAND CART	-	-	-			-
BICYCLE	96	84	85			88
TOTALS	**2,084**	**2,556**	**2,386**			**2,342**
Rain This Period?	No Rain	No Rain	No rain			

NINH BINH PROVINCE

Province	Ninh Binh				**Surveyor**	Dang Van Tien
District	Hoa Lu				**Location**	Km0+150
Road	Yen Trach					
Traffic class	**18-Jul-05**	**19-Jul-05**	**20-Jul-05**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	1,350	1,382	1,669			1,467
CAR, 4WD, PICKUP	2	3	1			2
CONG NONG & TRACTOR	140	144	91			125
LIGHT TRUCK =< 5 TONS	-	-	-			-
TRUCK > 5 TONS	-	-	-			-
MINI-BUS/BUS	-	-	-			-
WALKER	1,286	1,262	1,234			1,261
ANIMAL/HAND CART	118	104	66			96
BICYCLE	1,692	1,745	1,635			1,691
TOTALS	**4,588**	**4,640**	**4,696**			**4,641**
Rain This Period?	No rain	No rain	No rain			

Province	Ninh Binh				**Surveyor**	Pham Quoc Phong
District	Kim Son				**Location**	Km0+50
Road	Thu Trung					
Traffic class	**18-Jul-05**	**19-Jul-05**	**20-Jul-05**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	1,268	1,958	1,947			1,724
CAR, 4WD, PICKUP	3	-	-			1
CONG NONG & TRACTOR	179	111	127			139
LIGHT TRUCK =< 5 TONS	-	-	-			-
TRUCK > 5 TONS	-	-	-			-
MINI-BUS/BUS	-	-	-			-
WALKER	509	882	485			625
ANIMAL/HAND CART	175	153	179			169
BICYCLE	1,829	1,665	1,812			1,769
TOTALS	**3,963**	**4,769**	**4,550**			**4,427**
Rain This Period?	No Rain	No Rain	No Rain			

Province	Ninh Binh			**Surveyor**	Ngo Gia Kham
District	Kim Son			**Location**	Km0+200
Road	Dong Huong				

Traffic class	**18-Jul-05**	**19-Jul-05**	**20-Jul-05**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	2,166	1,519	1,549			1,745
CAR, 4WD, PICKUP	2	2	-			1
CONG NONG & TRACTOR	145	135	98			126
LIGHT TRUCK =< 5 TONS	-	-	-			-
TRUCK > 5 TONS	-	-	-			-
MINI-BUS/BUS	-	-	-			-
WALKER	1,338	1,300	974			1,204
ANIMAL/HAND CART	142	266	40			149
BICYCLE	1,751	1,582	1,375			1,569
TOTALS	**5,544**	**4,804**	**4,036**			**4,795**
Rain This Period?	No Rain	No Rain	No rain			

Province	Ninh Binh			**Surveyor**	Tran Xuan Thanh
District	Yen Mo			**Location**	Km0+500
Road	Yen Tu				

Traffic class	**4-Oct-06**	**5-Oct-06**	**6-Oct-06**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	307	302	341			317
CAR, 4WD, PICKUP	4	3	2			3
CONG NONG & TRACTOR	44	51	66			54
LIGHT TRUCK =< 5 TONS	3	2	3			3
TRUCK > 5 TONS	-	-	-			-
MINI-BUS/BUS	-	-	-			-
WALKER	169	151	183			168
ANIMAL/HAND CART	-	-	-			-
BICYCLE	767	697	978			814
TOTALS	**1,294**	**1,206**	**1,573**			**1,358**
Rain This Period?	No Rain	No Rain	Slight rain am			

Province	Ninh Binh				**Surveyor**	Vu Van Ha
District	Hoa Lu				**Location**	Km0+400
Road	Ninh Van Road					
Traffic class	**4-Oct-06**	**5-Oct-06**	**6-Oct-06**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	280	537	552			456
CAR, 4WD, PICKUP	2	2	-			1
TRACTOR	83	56	24			54
LIGHT TRUCK =< 5 TONS	3	4	1			3
TRUCK > 5 TONS	-	-	-			-
MINI-BUS/BUS	-	-	-			-
WALKER	509	1,352	2,240			1,367
ANIMAL/HAND CART	-	-	-			-
BICYCLE	437	610	799			615
TOTALS	**1,314**	**2,561**	**3,616**			**2,497**
Rain This Period?	No Rain	No Rain	No rain			

HUNG YEN PROVINCE

Province	Hung Yen				**Surveyor**	Vu Duc Canh
District	Phu Cu				**Location**	Tray culvert
Road	Nhat Quang					
Traffic class	**22-Jul-05** 6:00 to 18:00	**25-Jul-05** 6:00 to 18:00	**26-Jul-05** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	138	127	175			147
CAR, 4WD, PICKUP	6	8	14			9
CONG NONG & TRACTOR	54	67	78			66
LIGHT TRUCK =< 5 TONS	39	24	29			31
TRUCK > 5 TONS	-	-	6			2
MINI-BUS/BUS	-	-	-			-
WALKER	121	185	198			168
ANIMAL/HAND CART	35	40	45			40
BICYCLE	182	190	202			191
TOTALS	**575**	**641**	**747**			**654**
Rain This Period?	No rain	No rain	No rain			

Province	Hung Yen				**Surveyor**	Tran Ngoc Son
District	Tien Lu				**Location**	T Junction
Road	Tan Hung					
Traffic class	**26-Jul-05** 6:00 to 18:00	**27-Jul-05** 6:00 to 18:00	**28-Jul-05** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	100	135	115			117
CAR, 4WD, PICKUP	15	20	-			12
CONG NONG & TRACTOR	120	135	120			125
LIGHT TRUCK =< 5 TONS	55	38	50			48
TRUCK > 5 TONS	55	60	20			45
MINI-BUS/BUS	10	-	-			3
PEDESTRIAN, WALKER	125	130	130			128
ANIMAL/HAND CART	125	130	70			108
BICYCLE	140	130	115			128
TOTALS	**745**	**778**	**620**			**714**
Rain This Period?	No Rain	No Rain	No Rain			

Province	Hung Yen				**Surveyor**	Pham Minh Tuan
District	My Hao				**Location**	Thuan Xuyen village
Road	Hung Long					
Traffic class	**6-Sep-06**	**8-Sep-06**	**11-Sep-06**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	236	269	270			258
CAR, 4WD, PICKUP	2	2	2			2
CONG NONG & TRACTOR	24	36	31			30
LIGHT TRUCK =< 5 TONS	2	4	4			3
TRUCK > 5 TONS	-	3	3			2
MINI-BUS/BUS	-	-	-			-
PEDESTRIAN, WALKER	508	478	535			507
ANIMAL/HAND CART	26	40	39			35
BICYCLE	177	484	552			404
TOTALS	**975**	**1,316**	**1,436**			**1,242**
Rain This Period?	No Rain	No Rain	No rain			

Province	Hung Yen				**Surveyor**	Nguyen Minh Duc
District	Tien Lu				**Location**	
Road	Thuy Loi					
Traffic class	**6-Sep-06**	**8-Sep-06**	**12-Sep-06**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	165	137	146			149
CAR, 4WD, PICKUP	10	4	9			8
CONG NONG & TRACTOR	22	22	22			22
LIGHT TRUCK =< 5 TONS	-	-	-			-
TRUCK > 5 TONS	-	-	-			-
MINI-BUS/BUS	-	-	-			-
PEDESTRIAN, WALKER	270	230	259			253
ANIMAL/HAND CART	103	105	87			98
BICYCLE	277	303				290
TOTALS	**847**	**801**	**523**			**820**
Rain This Period?	No Rain	No Rain	No rain			

TUYEN QUANG PROVINCE

Province	Tuen Quang	**Surveyor**	Nguyen Duy Chung
District	Yen Son	**Location**	Minh Luong temple
Road	Lang Quan		

Traffic class	19-Jul-05 6:00 to 18:00	20-Jul-05 6:00 to 18:00	21-Jul-05 6:00 to 18:00	Daily Average
MOTORCYCLE	747	758	732	746
CAR, 4WD, PICKUP	14	13	17	15
CONG NONG & TRACTOR	28	22	25	25
LIGHT TRUCK =< 5 TONS	26	20	22	23
TRUCK > 5 TONS	25	18	20	21
MINI-BUS/BUS	-	-	-	-
WALKER	595	589	578	587
ANIMAL/HAND CART	19	18	17	18
BICYCLE	855	881	826	854
TOTALS	**2,309**	**2,319**	**2,237**	**2,288**
Rain This Period?	No rain	No rain	No rain	

Province	Tuyen Quang	**Surveyor**	Cao Duc Loi
District	Yen Son	**Location**	Thang Quan CPC
Road	Tan Quang		

Traffic class	19-Jul-05 6:00 to 18:00	20-Jul-05 6:00 to 18:00	21-Jul-05 6:00 to 18:00	Daily Average
MOTORCYCLE	210	243	214	222
CAR, 4WD, PICKUP	4	3	4	4
CONG NONG & TRACTOR	10	5	7	7
LIGHT TRUCK =< 5 TONS	7	5	4	5
TRUCK > 5 TONS	1	-	2	1
MINI-BUS/BUS	-	-	-	-
PEDESTRIAN, WALKER	552	542	568	554
ANIMAL/HAND CART	5	4	6	5
BICYCLE	574	605	637	605
TOTALS	**1,363**	**1,407**	**1,442**	**1,404**
Rain This Period?	No Rain	No Rain	No Rain	

Province	Tuyen Quang				**Surveyor**	Dinh Van Cau
District	Yen Son				**Location**	Km0+450
Road	Y La					
Traffic class	**12-Sep-06** 6:00 to 18:00	**13-Sep-06** 6:00 to 18:00	**14-Sep-06** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	1,091	967	1,066			1,041
CAR, 4WD, PICKUP	9	2	10			7
CONG NONG & TRACTOR	21	23	16			20
LIGHT TRUCK =< 5 TONS	9	1	2			4
TRUCK > 5 TONS	43	48	184			92
MINI-BUS/BUS	-	-	-			-
PEDESTRIAN, WALKER	306	278	253			279
ANIMAL/HAND CART	4	9	11			8
BICYCLE	1,067	1,054	1,139			1,087
TOTALS	**2,550**	**2,382**	**2,681**			**2,538**
Rain This Period?	No Rain	No Rain	No rain			

HA TINH PROVINCE

Province	Ha Tinh				**Surveyor**	Nguyen Cao Quy
District	Thach Ha				**Location**	Km2+800
Road	Thach Minh-Thach Ngoc					
Traffic class	**3-Aug-05**	**4-Aug-05**	**5-Aug-05**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	450	534	446			477
CAR, 4WD, PICKUP	-	5	1			2
CONG NONG & TRACTOR	40	45	33			39
LIGHT TRUCK =< 5 TONS	-	2	-			1
TRUCK > 5 TONS	11	15	17			14
MINI-BUS/BUS	-	-	-			-
WALKER	58	96	71			75
ANIMAL/HAND CART	16	28	13			19
BICYCLE	699	669	574			647
TOTALS	**1,274**	**1,394**	**1,155**			**1,274**
Rain This Period?	No Rain	No Rain	No Rain			

Province	Ha Tinh				**Surveyor**	Dao Xuan Hung
District	Can Loc				**Location**	Km3+700
Road	Hong Loc-Thu Loc					
Traffic class	**5-Sep-06**	**6-Sep-06**	**7-Sep-06**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	664	615	555			611
CAR, 4WD, PICKUP	16	-	9			8
CONG NONG & TRACTOR	35	21	21			26
LIGHT TRUCK =< 5 TONS	7	3	6			5
TRUCK > 5 TONS	176	165	150			164
MINI-BUS/BUS	-	-	-			-
PEDESTRIAN, WALKER	249	255	275			260
ANIMAL/HAND CART	1	13	10			8
BICYCLE	817	916	973			902
TOTALS	**1,965**	**1,988**	**1,999**			**1,984**
Rain This Period?	No Rain	No Rain	No rain			

Province	Ha Tinh				**Surveyor**	Le Danh Hai
District	Huong Khe				**Location**	Km2+00
Road	Chu Le-Dia Loi					
Traffic class	**5-Sep-06**	**6-Sep-06**	**7-Sep-06**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	901	810	914			875
CAR, 4WD, PICKUP	5	2	6			4
CONG NONG & TRACTOR	77	63	82			74
LIGHT TRUCK =< 5 TONS	-	1	-			0
TRUCK > 5 TONS	27	30	41			33
MINI-BUS/BUS	-	-	-			-
PEDESTRIAN, WALKER	82	67	49			66
ANIMAL/HAND CART	1	3	3			2
BICYCLE	337	339	327			334
TOTALS	**1,430**	**1,315**	**1,422**			**1,389**
Rain This Period?	No Rain	No Rain	No Rain			

QUANG BINH PROVINCE

Province	Quang Binh				**Surveyor**	Pham Xuan Luu
District	Le Thuy				**Location**	
Road	Cam Lien-Ngu Thuy Trung					
Traffic class	**19-Jul-05** 6:00 to 18:00	**20-Jul-05** 6:00 to 18:00	**21-Jul-05** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	436	413	502			450
CAR, 4WD, PICKUP	4	2	4			3
CONG NONG & TRACTOR	12	13	12			12
LIGHT TRUCK =< 5 TONS	6	7	2			5
TRUCK > 5 TONS	10	6	2			6
MINI-BUS/BUS	-	-	-			-
PEDESTRIAN, WALKER	8	11	18			12
ANIMAL/HAND CART	2	3	15			7
BICYCLE	258	241	262			254
TOTALS	**736**	**696**	**817**			**750**
Rain This Period?	No Rain	No Rain	No Rain			

Province	Quang Binh				**Surveyor**	Hoang Duc Thuan
District	Quang Trach				**Location**	At the middle of the road
Road	Ngu Hoa					
Traffic class	**21-Jul-05** 6:00 to 18:00	**22-Jul-05** 6:00 to 18:00	**23-Jul-05** 6:00 to 18:00			**Daily Average**
MOTORCYCLE	708	695	717			707
CAR, 4WD, PICKUP	16	19	13			16
CONG NONG & TRACTOR	5	2	7			5
LIGHT TRUCK =< 5 TONS	49	12	14			25
TRUCK > 5 TONS	4	7	6			6
MINI-BUS/BUS	-	-	-			-
PEDESTRIAN, WALKER	36	8	7			17
ANIMAL/HAND CART	723	714	701			713
BICYCLE	87	53	34			58
TOTALS	**1,628**	**1,510**	**1,499**			**1,546**
Rain This Period?	No Rain	No Rain	Slight rain			

Province	Quang Binh				**Surveyor**	Tran Van Bay
District	Dong Hoi Town				**Location**	At the middle of the road
Road	Loc Ninh					
Traffic class	**20-Jul-05**	**21-Jul-05**	**22-Jul-05**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	426	528	318			424
CAR, 4WD, PICKUP	256	198	306			253
CONG NONG & TRACTOR	78	42	37			52
LIGHT TRUCK =< 5 TONS	93	96	78			89
TRUCK > 5 TONS	25	60	45			43
MINI-BUS/BUS	-	-	-			-
PEDESTRIAN, WALKER	18	36	36			30
ANIMAL/HAND CART	366	168	270			268
BICYCLE	16	48	27			30
TOTALS	**1,278**	**1,176**	**1,117**			**1,190**
Rain This Period?	No Rain	No Rain	No Rain			

Province	Quang Binh				**Surveyor**	Nguyen Hoang Nguyen
District	Quang Trach				**Location**	Km1+500
Road	Ngu Hoa					
Traffic class	**4-Sep-06**	**6-Sep-06**	**7-Sep-06**			**Daily Average**
	6:00 to 18:00	6:00 to 18:00	6:00 to 18:00			
MOTORCYCLE	883	912	879			891
CAR, 4WD, PICKUP	11	8	9			9
TRACTOR	15	24	18			19
LIGHT TRUCK =< 5 TONS	35	17	35			29
TRUCK > 5 TONS	43	35	52			43
MINI-BUS/BUS	-	-	-			-
WALKER	499	492	519			503
ANIMAL/HAND CART	27	31	29			29
BICYCLE	680	694	608			661
TOTALS	**2,193**	**2,213**	**2,149**			**2,185**
Rain This Period?	No Rain	No Rain	No rain			

RRST VIETNAM
SEACAP 1
FINAL REPORT

APPENDIX C

RRST-I Axle Load Surveys

INTRODUCTION

Axle load surveys were carried out in Hue and Dong Thap provinces on the RRST-I trial roads, and in Tien Giang on a Provincial road close to the RRST-I trial road.

Surveys were not carried out on the Da Nang trial road as there was insufficient traffic at the time of the surveys.

The main purpose of the surveys was to determine the axle loads of the vehicles using or likely to use the trial roads, as a baseline for the long term monitoring phase of the RRST. Furthermore the axle loads will enable the equivalent axle factors to be calculated.

The methods used in this survey conform to the method detailed in ORN 40. Traffic weightings were generally conducted during the day (from 6:00 am to 6:00 pm) for a period of 3 days consecutive for each Trial site. Traffic flows in both directions were weighted and recorded.

Traffic characteristics of rural roads can be quite different from highways. Most vehicles carry goods or agricultural produce from village to market or to main road and return nearly empty. This means that sometimes each side of a wider pavement can experience different loading patterns.

Normally for axle loading surveys for a busy road such as national or provincial route, only vehicles of unladen weight of 3 tonne or higher are weighted, since light vehicles such as cars or small buses have little effect on deterioration of the road pavement structure. However, for low volume roads, the majority of traffic is light and therefore it is important that empty, partially loaded and fully loaded vehicles of all kinds are taken into account. For these reasons vehicles which have axle loading over 500kg have been weighed.

Large commercial vehicles carrying primary construction materials (stone, aggregates, earth, cement, steel etc.), timber and certain dense crops, have a potential to be substantially overloaded as the survey in Tien Giang indicates. This raises important concerns for the future design of rural road and higher category road pavements in the circumstances of Vietnam. Weak subgrades, light pavements, poor construction practices, high rainfall, high water tables and flooding, and inadequate maintenance all contribute to rapid deterioration of road infrastructure, particularly in the circumstances of frequent overloading of vehicles.

Overloading deserves much wider investigation and development of appropriate strategies for the rural road sector.

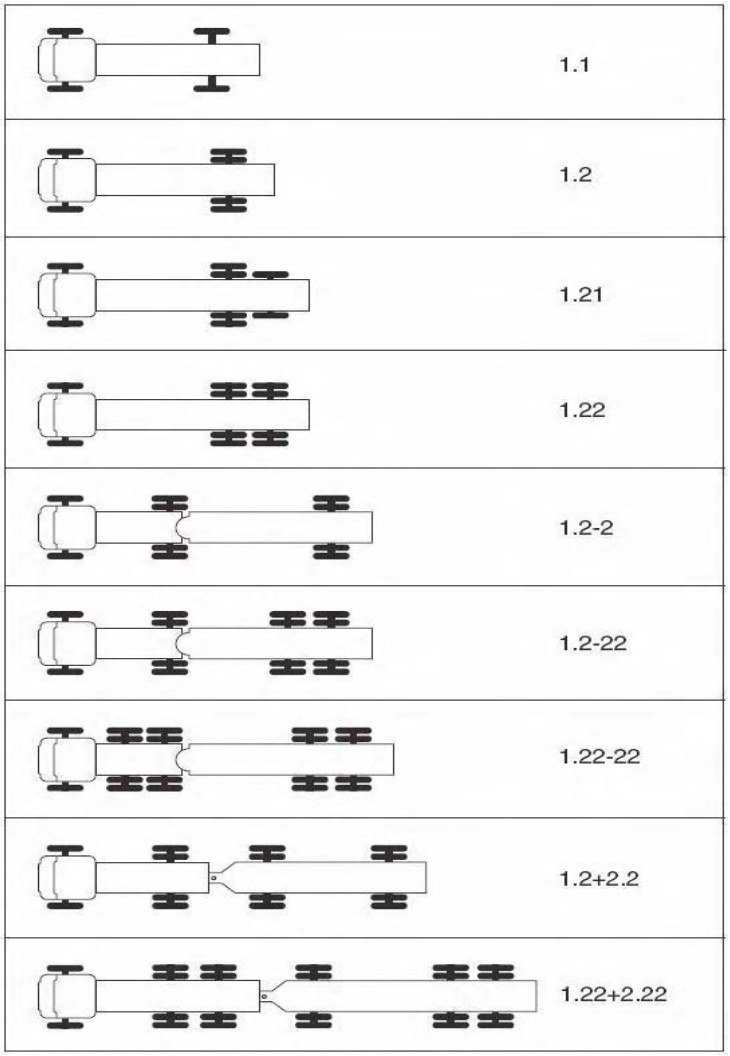


Figure 1: Axle Configuration (Extracted from ORN40)

Description of Vehicle Types

For locally made vehicles

1. Motorbike with trailer: only axle of trailer is weighted
2. Tri-Cycle trailer powered by motorbike engine. Commonly use in Dong Thap and Tien Giang
2. Bagac Mày (according to Vietnamese name): Three-wheel motorised vehicle which are mostly found in Tien Giang.
3. Small Cong Nong commonly used in Hue. It typically has payload capacity up to 2 tonne
4. Medium Cong Nom has a payload capacity up to 4 tonnes

Conventional vehicles:

1. Car (axle configuration 1.1)
2. Small bus (axle configuration 1.1): Bus with 8 to 15 seats
3. Medium bus (axle configuration 1.1): Bus with 16 to 25 seats
4. Large bus (axle configuration 1.2): Bus between 26 to 40 seats
5. Heavy bus (axle configuration 1.22): Bus between 45 to 60 seats
6. Small truck: commercial vehicle: with width 1.7 to 1.8 m and length between 3.5 to 4.5 m (2 Axle configuration 1.1 or 1.2)
7. Medium truck: commercial vehicle: with width 2.0 to 2.2 m and length between 4.5 to 6.0 m (Axle configuration 1.1 or 1.2)
8. Large truck: commercial vehicle: with width 2.2 to 2.4 m and length between 5 to 9 m (Axle configuration 1.1 or 1.2)
9. Large truck: commercial vehicle: with width 2.3 to 2.5 m and length between 6 to 10 m (Axle configuration 1.22)

AXLE LOAD SURVEY

Road Name/Number:	Tan Thuam Tay Road (D3)	**Survey Date:**	12-Oct-06
Province:	Dong Thap	**Time of survey:**	12:00 to 18:00
		Surveyor:	Heng Kackada & Le Minh Duc

No	AXIAL CONFIG	AXIAL LOADS (TONNES)				Comment on vehicle type	Type of loading
		1	2	3	4		
1	-	-	-	1.24		motorbike with trailer	mango fruit

Road Name/Number:	Tan Thuam Tay Road (D3)	**Survey Date:**	13-Oct-06
Province:	Dong Thap	**Time of survey:**	7:00 to 18:00
		Surveyor:	Heng Kackada & Le Minh Duc

No	AXIAL CONFIG	AXIAL LOADS (TONNES)				Comment on vehicle type	Type of loading
		1	2	3	4		
1	-	-	-	1.06		motorbike with trailer	mango fruit
2	-	-	-	0.88		motorbike with trailer	mango fruit
3	-	-	-	1.00		motorbike with trailer	mango fruit

Road Name/Number:	**My Phuoc Tay**	**Survey Date:**	14-Oct-06
Province:	Dong Thap	**Time of survey:**	7:00 to 18:00
		Surveyor:	Heng Kackada & Le Minh Duc

No	AXIAL CONFIG	AXIAL LOADS (TONNES)				Comment on vehicle type	Type of loading
		1	2	3	4		
1	-	0.68	0.66			Bagac Mày	Empty
2	-	-	-	0.90		motorbike with trailer	mango fruit
3	-	-	-	0.75		motorbike with trailer	mango fruit
4	-	-	-	1.22		motorbike with trailer	

AXLE LOAD SURVEY

Road Name/Number:	Provincial road No. 868	**Survey Date:**	16-Oct-06
Province:	Tien Giang	**Time of survey:**	8:00 to 14:00
		Surveyor:	Heng Kackada & Le Minh Duc

No	AXIAL CONFIG	AXIAL LOADS (TONNES)				Comment on vehicle type	Type of loading
		1	2	3	4		
1	1.2	1.8	3.2			small truck	loaded
2	1.22	10.3	14	15.50		heavy truck	loaded
3	-	-	1.44			bagac mày	loaded
4	1.1	0.94	0.66			car	
5	1.1	1.1	0.88			small bus	
6	1.1	0.82	0.78			car	
7	-	-	1.5			bagac mày	loaded
8	-	-	1			bagac mày	
9	1.2	4.32	8.96			Large Truck	loaded
10	-	-	1.8			bagac mày	loaded
11	-	-	1.12			bagac mày	loaded
12	-	-	1.12			bagac mày	
13	1.1	1.2	1.7			small truck	
14	1.2	1.74	1.5			medium truck	empty
15	1.2	1.64	2.7			small truck	
16	1.2	1.88	2.28			small truck	
17	-	-	1.44			bagac mày	
18	1.2	1.64	1.02			small truck	empty
19	1.2	2.5	3.2			medium bus	with 25 passengers
20	1.2	2.1	2.52			medium truck	
21	1.2	1.12	0.78			small truck	
22	1.2	7	10.8			large truck	petrol tanker
23	1.2	1.64	1.16			small truck	empty
24	1.2	6.52	4.04			large truck	
25	1.1	0.94	0.66			small bus	
26	1.2	2.04	3.56			medium bus	25 passengers
27	1.1	1.64	1.8			small bus	with 10 passengers
28	1.2	1.5	0.84			small truck	
29	1.2	3.32	7.28			medium truck	loaded
30	1.1	1.06	1.08			car	
31	1.2	2.74	3.14			large truck	empty
32	1.1	0.68	0.6			car	
33	1.1	1.32	1.32			car	
34	-	-	1.77			bagac mày	
35	1.2	1.5	1.2			medium truck	empty
36	1.2	3.96	5.08			large truck	petrol tanker
37	1.1	1.06	0.78			car	
38	1.2	5.6	4.6			large truck	
39	1.1	0.9	0.8			car	
40	1.1	0.82	0.6			car	
41	1.2	3.26	3.14			Large truck	partially loaded
42	-	-	1.88			Bagac Mày	fully loaded
43	1.2	1.8	2.7			small truck	
44	1.2	2.5	5.08			medium truck	
45	1.2	3.08	11.9			Large truck	
46	1.1	1	1.44			small bus	
47	1.1	0.7	0.8			car	empty
48	1.2	1.8	1.8			small truck	
49	1.2	2.04	2.16			medium truck	partially loaded
50	1.1	1.24	1.2			car	
51	1.1	1.2	1.16			car	
52	1.2	2.88	2.88			Large truck	empty

AXLE LOAD SURVEY

Road Name/Number:	Provincial road No. 868	**Survey Date:**	17-Oct-06
Province:	Tien Giang	**Time of survey:**	8:00 to 16:00
		Surveyor:	Heng Kackada & Le Minh Duc

No	AXIAL CONFIG	AXIAL LOADS (TONNES)				Comment on vehicle type	Type of loading
		1	2	3	4		
1	1.1	1.24	0.9			small bus	
2	1.1	1.02	1.02			small bus	
3	1.1	1.32	1.2			small truck	
4	1.2	3.2	3.26			large truck	
5	1.22	5.6	10.2	10.2		heavy truck	
6	1.22	14.5	18.4	18.4		heavy truck	
7	1.2	6.46	12.4			large truck	
8	1.2	1.32	1.02			small truck	
9	1.1	1.38	1.08			small bus	
10	1.2	1.56	1.58			small truck	
11	1.1	1.2	0.96			small bus	
12	1.2	1.44	1.26			small truck	
13	-	-	0.68			bagac mày	
14	1.22	3.8	3.32	3.2		heavy truck	empty
15	1.2	1.56	2.82			small truck	
16	1.2	1.88	3.2			small truck	
17	-	1	1.38			bagac mày	
18	1.1	1.8	1.74			small bus	
19	1.2	3.08	3.14			large truck	
20	1.2	3.08	1.64			large truck	
21	1.22	5.14	8.1	8.02		heavy truck	
22	1.2	3.7	8.3			medium truck	
23	1.2	2.18	2.1			medium truck	
24	-	-	0.88			bagac mày	
25	-	-	1.66			bagac mày	
26	1.2	4.36	5.58			Large Truck	
27	1.2	2.38	2.64			medium truck	
28	1.2	2.04	3.14			small truck	
29	-	-	0.88			bagac mày	
30	1.2	1.2	2.02			small truck	
31	-	-	1.38				
32	-	-	0.82				
33	-	-	0.6				
34	1.22	5.64	4.72	4.54		heavy truck	
35	1.2	1.88	2.58			medium truck	
36	1.1	1.24	0.96			small bus	
37	-	0.82	0.66			bagac mày	
38	1.2	2.54	3.5			large truck	
39	1.2	1.8	2.22			small truck	
40	-		1.64				
41	1.2	1.94	1.74			small truck	
42	1.2	3.52	7.1			medium truck	
43	1.1	1.24	0.96			car	
44	1.2	3.2	3.56			large bus	half full
45	1.1	1	0.96			car	
46	1.1	0.88	0.72			car	
47	1.2	4.32	11.7			large truck	
48	-	0.74	1.44			bagac mày	
49	1.2	4.38	7.58			large truck	
50	1.1	0.62	0.6			car	
51	1.2	2.8	2.96			small truck	
52	1.2	2.5	2.28			medium truck	
53	1.2	1.24	1.26			small truck	
54	1.2	2.8	2.64			medium truck	
55	1.2	1.94	2.34			medium truck	
56	1.2	2.8	4.6			medium truck	
57	1.22	9.2	9.4	9.4		heavy truck	
58	1.2	2.88	3.02			medium truck	
59	-		0.74			bagac mày	
60	1.2	1.88	2.28			small truck	
61	1.2	1.8	2.88			small truck	
62	1.2	1.16	2.22			small truck	
63	1.2	2.88	2.82			medium truck	
64	1.2	3.6	7.68			medium truck	
65	1.1	1.06	1.08			small truck	
66	1.2	1.74	1.74			medium truck	
67	-		1.56			bagac mày	
68	1.1	1.64	1.64			small bus	
69	1.2	4.46	9.16			large bus	full with passengers
70	1.2	7.44	10.5			large truck	
71	1.1	0.94	0.95			car	
72	1.2	1.44	1.26			small truck	
73	1.2	2.18	3.68			medium truck	
74	1.2	3.2	4.22			large truck	
75	1.2	2.18	3.26			small truck	
76	1.2	4.38	8.4			large truck	
77	1.2	1.5	1.32			small truck	
78	1.2	1.38	1.16			small truck	
79	1.1	0.88	1.08			car	
80	1.2	1.24	1.02			small truck	

AXLE LOAD SURVEY

Road Name/Number:	**Thong Nhat Road**	**Survey Date:**	19-Oct-06
Province:	Hue	**Time of survey:**	8:00 to 12:00
		Surveyor:	Heng Kackada & Le Minh Duc

No	AXIAL CONFIG	AXIAL LOADS (TONNES)				Comment on vehicle type	Type of loading
		1	2	3	4		
1	1.1	0.88	0.66			car for meeting	
2	1.1	0.78	0.72			car for meeting	
3	1.1	0.88	0.66			return	
4	1.1	0.78	0.72			return	
5	1.1	1	1.5			small Cong Nong tractor	Laterite
6	1.1	0.6	0.63			Small Cong Nong tractor	empty
7	1.1	1.1	1.62			small Cong Nong tractor	Laterite
8	1.1	0.61	0.62			Small Cong Nong tractor	empty
9	1.1	1.74	1.96			medium truck collects rubbish every Thursday and Saturday	
10	1.1	0.98	1.5			small Cong Nong tractor	Laterite
11	1.1	0.6	0.63			Small Cong Nong tractor	empty
12	1.1	1.15	1.7			small Cong Nong tractor	Laterite

AXLE LOAD SURVEY

Road Name/Number:	**Bach Ma National Park**	**Survey Date:**	20-Oct-06
Province:	Hue	**Time of survey:**	8:00 to 17:00
		Surveyor:	Heng Kackada & Le Minh Duc

No	AXIAL CONFIG	AXIAL LOADS (TONNES)				Comment on vehicle type	Type of loading
		1	2	3	4		
1	1.2	3.88	10.3			large quarry truck	stone aggregate
2	1.1	1.56	1.08			small quarry truck	empty
3	1.2	2.82	3.44			medium quarry truck	Stone aggregate
4	1.1	1.32	1.44			small bus	
5	1.1	1.2	0.72			small bus	
6	1.2	1.7	2.7			medium quarry truck	empty
7	1.2	4.2	10.3			large quarry truck	stone aggregate
8	1.1	0.62	1.58			small Cong Nong tractor	
9	1.2	3.2	2.34			medium quarry truck	
10	1.1	1.44	1.68			small Cong Nong tractor	
11	1.2	4.26	9.4			large quarry truck	
12	1.2	3.46	5.9			medium quarry truck	stone aggregate
13	1.1	0.56	0.56			small Cong Nong tractor	empty
14	1.2	3.46	5.9			medium quarry truck	
15	1.1	1.94	2.16			medium Cong Nong tractor	
16	1.2	2.68	3.5			medium bus	25 passengers
17	1.1	2.1	2.16			medium Cong Nong tractor	stone aggregate
18	1.2	4.1	9.48			large quarry truck	stone aggregate
19	1.2	2.5	4.48			medium Cong Nong tractor	sand
20	1.2	1.8	1.68			small truck	
21	1.1	1.74	2.1			medium Cong Nong tractor	

AXLE LOAD SURVEY

Road Name/Number:	**Bach Ma National Park**	**Survey Date:**	21-Oct-06
Province:	Hue	**Time of survey:**	8:00 to 17:00
		Surveyor:	Heng Kackada & Le Minh Duc

No	AXIAL CONFIG	AXIAL LOADS (TONNES)				Comment on vehicle type	Type of loading
		1	2	3	4		
1	1.1	0.72	0.72			car	
2	1.1	0.74	0.72			small Cong Nong tractor	
3	1.2	1.56	0.75			small truck	
4	1.1	1.7	1.8			medium Cong Nong tractor	empty
5	1.1	1.06	1.2			small bus	
6	1.1	1.2	1.26			car	
7	1.1	1.74	1.26			small bus	
8	1.1	0.68	0.54			car	
9	1.1	0.82	0.94			small Cong Nong tractor	
10	1.1	2.24	3.98			medium Cong Nong tractor	sand
11	1.1	0.62	0.8			small Cong Nong tractor	empty
12	1.1	3.54	1.86			medium Cong Nong tractor	
13	1.1	1.64	1.74			medium Cong Nong tractor	
14	1.2	1.56	1.26			medium truck	
15	1.1	0.74	0.84			small Cong Nong tractor	empty

RRST VIETNAM
SEACAP 1
FINAL REPORT

APPENDIX D

RRST-I Trials Monitoring Data

APPENDIX D

RRST-I Trials Monitoring Data

Appendix D1: Monitoring Data File Listing

Introduction

This Appendix D1 contains a list of the RRST-I monitoring data sets and file types in which they are held within the overall RRSR database. A fuller description of the structure of this database is contained with Appendix G to this report.

Data Set	Files	Comment
Visual assessments	visual.xls files held within each provincial folder	Field coded data sheets transcribed onto EXCEL sheets for each monitored section
MERLIN roughness data	IRI-data.xls files held within each provincial folder.	MERLIN raw data calculated on spreadsheets
	IRI-sum.xls files held within each provincial folder	Summaries of IRI data for each monitored section
Unsealed control sections level data	Level.xls files held within each provincial folder	Tabulated cross section level data referenced to local TBMs. Plots of each cross section updated for each monitoring survey
DCP data	DCP.xls or UKDCP files held within each provincial folder.	Field DCP data transferred to electronic forms or transferred to UKDCP files for interpretation
	Summary tables in SC1-Trtial.mdb ACCESS file	Summaries of lime stabilized and unsealed carriageway DCPs summarised in tabular format

APPENDIX D

RRST-I Trials Monitoring Data

Appendix D2: Visual Assessment Comparisons

Section	5th January 2006	27th July 2006
T2	Significant cracking in 40% of bitumen seals. Single wheel track crack in 2 adjacent blocks. Cracking in shoulders. Run-off inhibited in one area.	Single isolated cracks in 7 blocks. Increase in bitumen seal cracking (70%). Significant increase in shoulder cracking with some significant erosion. Increased impeding of run-off.
T3	Minor cracking in 10% of bitumen seals. Surface erosion (aggregate showing) in 7 blocks. Cracking in 40% of shoulders, with impeded run-off in 50%. Slight erosion in 50% of shoulder.	Cracking in 20% of bitumen seals. Very slight increase in surface erosion. Significant increase in cracking and erosion of shoulders; 10-15% badly affected.
T5	No evident cracking in carriageway. Erosion of sand seal in one 70m section. Individual cracks in all shoulders. Impeded run-off 50%. Small scale erosion in 60% of shoulders.	No cracking evident in carriageway. Some decrease in shoulder cracking (vegetation and rainy season onset erosion of loose cracked materials). Increase in shoulder erosion with >20mm loss in 10% of shoulder. Some increase in run-off impeding.
T6	No cracking evident in carriageway. Intact sand seal, with only minor edge erosion. Cracks on all shoulders. Minor erosion on all shoulders, locally severe with one failure area. Impeded run-off 40-50%.	No cracking evident in carriageway. Evident decrease in shoulder cracking (vegetation and rainy season onset erosion of loose cracked materials). Significant increase in serious shoulder erosion. Increased impeded run-off.
T7	No cracking evident in carriageway. General coarsening of carriageway surface with minor aggregate loss. Impeded run-off 90%; cracking in <15% of shoulder	No change in carriageway condition. Slight increase in impeded run-off. No change in shoulder cracking with local minor erosion.
T8	Very poor visual appearance to carriageway, with slight to moderate erosion. Minor shape deterioration. Occasional cracks in shoulder. Impeded run-off 50%	Some continued deterioration of visual appearance, with locally severe erosion. Potholes at 1-2/block in 20% of carriageway. Shape deterioration. Impeded run-off increase to 80%
T9	Single transverse crack in one block. Cracking in 40% bitumen seals. Surface erosion (aggregate exposed) in last 10 blocks. Edge degradation in one block. Impeded run-off in 60% of shoulder. Occasional cracks in shoulders.	Single transverse crack in 5 blocks. Slight increased bitumen cracking with occasional depressed seals. Run-off impeded in 75-80%, with little or no shoulder deterioration.
T10	Visual appearance slight deterioration, with minor erosion and minor corrugations. Ruts formed at 5-10mm. Slight deterioration of shape. Impeded run-off; 90%.	Further deterioration of surface appearance, rut depth increase 10-15mm. Shape deterioration – some areas nearly flat. Impeded run-off 100%

Table D2.1: Visual Assessment Comparisons: Tien Giang

Section	3rd January 2006	25th July 2006
DT2	No cracks in carriageway. Minor cracking in 10% of bitumen seals. Cracks in 15% of shoulder, with minor erosion in 50%. Impeded run-off 50%	No cracks in Carriageway .Significant deterioration in bitumen seals with 40-50% either depressed or with increased cracking. Only slight increase in shoulder erosion and cracking. Impeded run-off increased to 70%
DT3	No cracks in Carriageway. Seals in good condition. Individual cracks in 50% of shoulders with minor erosion and occasional materials loss (<20mm). Impeded run-off 60%	No cracks in Carriageway. Significant deterioration in bitumen seals with 50% showing cracking and some (20%) with depressed seal. Some decrease in shoulder cracks (rainy season onset+ surface erosion). Slight improvement in impeded run-off.
DT5	No cracks in carriageway. Slight coarsening of surface texture and slight edge deterioration. Cracks in 50% of shoulders with 10% impeded run-off.	No cracks in carriageway. One pothole, with local minor aggregate loss in 2 blocks. Some increase in surface texture coarsening. Minor increase in shoulder cracks with slight local erosion. Similar impeded run-off
DT6	Two isolated areas with individual wheel track longitudinal cracking (1-3mm).Minor surface seal aggregate loss and some surface texture coarsening. Minor edge deterioration. Cracking in 10-15% shoulder with localised minor erosion. Impeded run-off 50%	No change in carriageway cracking. Increase in minor seal aggregate loss and texture coarsening (75%). Shoulder cracking similar. Slight increase in shoulder erosion. Slight improvement in impeded run-off.
DT7	No carriageway cracking. Minor surface seal aggregate loss with occasional coarsening of surface texture. Cracking in 20% of shoulders. Only minor impeded run-off.	No carriageway cracking. Significant increase in seal aggregate loss and coarsening of surface texture. Cracking in 80% shoulders with minor erosion 30-40%. Impeded run-off 40%
DT8	50-70% coarse stone exposed over most of carriageway. Loose surface material. Individual shoulder cracks 40%. Impeded run-off 15%.	Greater than 75% coarse stone exposure over almost all carriageway. Loose surface material. Surface erosion 40%, locally severe. Single potholes 35%. Shoulder cracking 75%. Impeded run-off 30%.
DT10	Carriageway shape locally uneven (as built). Cracking in shoulders 50%, with 1 area of failure (2 blocks). Small scale erosion 10%. Run-off locally impeded (10%)	No change in carriageway. Slight increase in shoulder cracking, with shoulder failure 10%. Increase in minor shoulder erosion (10-15%). Impeded run-off 10%
DT11	Shape as built. Localised cracks in carriageway (<2%) Cracks in shoulders 70%. Impeded run-off 40%.	No change in carriageway shape. Some deterioration in seal with up to 10% loss over a 70% area and 25% loss in 10% of area.. Minor brick breaks or cracks (5%); joint cracks (2%). Some shoulders less cracking due to surface erosion, other areas some increase.
DT12	Shape as built. Individual cracks in 90% of shoulders, with local erosion <5%. No impeded run-off	Shape as built. Local joint cracking (2%), 1 broken brick. Seal loss <10% in 50% of area; 25-50% loss in 10% and one 50m area with >50% loss. Decrease in cracking (50%) with increase in surface erosion. Locally significant erosion (5%). Impeded run-off 10%

Table D2.2: Visual Assessment Comparisons: Dong Thap

Section	Survey: 17 February 2006	Survey: 2nd August 2006
H2	Minor cracks in some joints. Shoulders inhibiting run-off. Silting of side drains.	Some increase in minor seal cracks; occasional depressed seals; one seal lost. Isolated erosion on shoulders. Shoulders inhibiting run-off. Silting of side drains
H3	Severe erosion of wearing surface giving very poor visual appearance. Continuous ruts 50-250mm with associated corrugations and numerous potholes. Shoulders severely eroded with 100% impeded run-off	Similar very poor surface condition, ruts 100-300mm. Drainage siltation.
H4	No carriageway cracking. Slightly coarse surface texture (as built). Occasional slight shoulder erosion. Drainage significantly impaired. Run-off OK apart from 1 block.	No change in carriageway condition, Locally slight shoulder erosion (15%). Drainage deterioration; totally ineffective 25%, elsewhere seriously impeded.
H6	Cracking in seals on joints and some very minor erosion of seal (<5%) from brick surfaces (30%). Minor erosion on shoulders with 30% showing small material loss. No run-off impeded.	Some increase in joint cracks in seal. Slight increase in shoulder erosion. Drain siltation 30%. Impeded run-off
H7	Minor cracks in seals over joints (50%). Slight erosion on all shoulders; significant in last 50m. No run-off impeded.	Slight increase in joint cracks (60%). Slight increase in shoulder erosion. No run-off impeded.
H9	No carriageway cracking. Occasional coarsening of already slightly coarse as built texture. Minor edge deterioration. No shoulder cracking. No run-off impediment.	No carriageway cracking. . No shoulder cracking. Local coarsening of surface texture (10%). Minor shoulder erosion (10%). Impeded run-off 10%.
H11	Minor cracking in 10% of joints. 2 local isolated depressed areas/ruts (as built). Small scale erosion on all shoulders with minor material loss. No impeded run-off.	Increase in joint cracking (10-15%). Slight increase in shoulder erosion.

Table D2.3: Visual Assessment Comparisons: Hue

APPENDIX D
RRST-I Trials Monitoring Data

Appendix D3: MERLIN Roughness Data

	Right			
	Date	21/07/2005	05/01/2006	27/07/2006
Bamboo Reinforced concrete	T2	5.29	4.03	4.79
Steel Reinforced concrete	T3	4.56	4.08	5.20
Training SS	T4	8.01		
Sand seal on DBM	T5	8.31	8.74	8.46
Sand seal on Lime stab soil	T6	5.13	4.33	5.74
Pen Mac	T7	7.48	7.69	7.72
WBM	T8	8.86	6.80	8.30
Bamboo Reinforced concrete	T9	4.85	4.33	4.91
Natural Gravel	T10	4.77	3.95	3.57
	Left			
	Date	21/07/2005	05/01/2006	27/07/2006
Bamboo Reinforced concrete	T2	5.50	4.20	5.36
Steel Reinforced concrete	T3	4.77	4.55	5.06
Training SS	T4	8.29	0.59	
Sand seal on DBM	T5	8.13	6.58	8.29
Sand seal on Lime stab soil	T6	5.66	3.60	4.60
Pen Mac	T7	7.32	6.78	8.61
WBM	T8	5.78	7.05	11.18
Bamboo Reinforced concrete	T9	5.37	4.42	5.76
Natural Gravel	T10	5.21	3.73	3.95
	Average	**21/07/2005**	**05/01/2006**	**27/07/2006**
Bamboo Reinforced concrete	**T2**	**5.39**	**4.12**	**5.08**
Steel Reinforced concrete	**T3**	**4.66**	**4.31**	**5.13**
Training SS	**T4**	**8.15**	**0.30**	**0.00**
Sand seal on DBM	**T5**	**8.22**	**7.66**	**8.38**
Sand seal on Lime stab soil	**T6**	**5.39**	**3.97**	**5.17**
Pen Mac	**T7**	**7.40**	**7.23**	**8.17**
WBM	**T8**	**7.32**	**6.93**	**9.74**
Bamboo Reinforced concrete	**T9**	**5.11**	**4.38**	**5.34**
Natural Gravel	**T10**	**4.99**	**3.84**	**3.76**

Table D3.1: IRI Data (m/km) Tien Giang

	Right			
	Date	16/08/2005	03/01/2006	26/07/2006
Bamboo Reinforced concrete	D2	4.45	4.47	4.43
Steel Reinforced concrete	D3	4.49	4.71	5.07
Sand seal on DBM	D5	4.80	5.92	5.17
Sand seal on Lime stab soil	D6	3.65	3.85	4.24
Pen Mac	D7	5.60	6.23	4.71
WBM	D8	6.58	5.14	7.62
Fired clay brick	D10	7.02	6.26	6.86
Sand seal on Fired clay brick / CS SB	D11	6.13	5.63	5.72
Sand seal on Fired clay brick / DBM SB	D12	6.13	5.81	5.35
	Left			
	Date	20/07/2005	03/01/2006	26/07/2006
Bamboo Reinforced concrete	D2	4.18	4.14	4.28
Steel Reinforced concrete	D3	4.36	4.27	4.77
Sand seal on DBM	D5	5.12	4.98	5.17
Sand seal on Lime stab soil	D6	3.17	3.35	3.77
Pen Mac	D7	4.69	5.56	5.52
WBM	D8	6.25	6.61	8.35
Fired clay brick	D10	5.19	6.53	8.15
Sand seal on Fired clay brick / CS SB	D11	7.11	6.50	6.22
Sand seal on Fired clay brick / DBM SB	D12	5.96	5.96	6.01
	Average	**02/08/2005**	**03/01/2006**	**26/07/2006**
Bamboo Reinforced concrete	**D2**	**4.31**	**4.31**	**4.36**
Steel Reinforced concrete	**D3**	**4.43**	**4.49**	**4.92**
Sand seal on DBM	**D5**	**4.96**	**5.45**	**5.17**
Sand seal on Lime stab soil	**D6**	**3.41**	**3.60**	**4.01**
Pen Mac	**D7**	**5.14**	**5.89**	**5.12**
WBM	**D8**	**6.41**	**5.87**	**7.99**
Fired clay brick	**D10**	**6.11**	**6.40**	**7.51**
Sand seal on Fired clay brick / CS SB	**D11**	**6.62**	**6.06**	**5.97**
Sand seal on Fired clay brick / DBM SB	**D12**	**6.05**	**5.88**	**5.68**

Table D3.2: IRI Data (m/km) Dong Thap

	Right			
Type	Date	13/06/2005	16/02/2006	01/08/2006
Bamboo Reinforced concrete	H2	4.41	4.06	4.73
Gravel	H3	7.24	17.98	11.18
Pen mac	H4	3.17	3.93	4.12
Sand seal on conc bricks	H6	5.11	5.57	6.57
Sand seal on conc bricks / DBM SB	H7	5.67	5.22	6.01
Sand seal on DBM	H9	3.93	3.79	4.60
Dressed Stone	H11	7.50	9.29	9.62
	Left			
Type	Date	13/06/2005	16/02/2006	01/08/2006
Bamboo Reinforced concrete	H2		4.17	4.55
Gravel	H3	5.91	17.98	11.57
Pen mac	H4	4.09	3.68	4.44
Sand seal on conc bricks	H6	5.43	4.92	6.26
Sand seal on conc bricks / DBM SB	H7		5.30	6.54
Sand seal on DBM	H9	3.73	3.73	3.93
Dressed Stone	H11	7.40	7.98	9.08
Type	**Average**	**13/06/2005**	**16/02/2006**	**01/08/2006**
Bamboo Reinforced concrete	**H2**	**2.21**	**4.12**	**4.64**
Gravel	**H3**	**6.58**	**17.98**	**11.38**
Pen mac	**H4**	**3.63**	**3.81**	**4.28**
Sand seal on conc bricks	**H6**	**5.27**	**5.25**	**6.42**
Sand seal on conc bricks / DBM SB	**H7**	**2.83**	**5.26**	**6.28**
Sand seal on DBM	**H9**	**3.83**	**3.76**	**4.27**
Dressed Stone	**H11**	**7.45**	**8.63**	**9.35**

Table D3.2: IRI Data (m/km) Hue

	Right	
	Date	21/07/2005
Steel Reinforced concrete	DaN2	5.38
Sand seal on Lime stab soil	DaN3	8.13
Sand seal on Lime stab soil	DaN4	5.86
Pen Mac	DaN5	5.30
WBM	DaN6	6.11
	Left	
	Date	21/07/2005
Steel Reinforced concrete	DaN2	5.32
Sand seal on Lime stab soil	DaN3	8.50
Sand seal on Lime stab soil	DaN4	6.23
Pen Mac	DaN5	5.45
WBM	DaN6	5.28
	Average	21/07/2005
Steel Reinforced concrete	**DaN2**	**5.35**
Sand seal on Lime stab soil	**DaN3**	**8.32**
Sand seal on Lime stab soil	**DaN4**	**6.05**
Pen Mac	**DaN5**	**5.38**
WBM	**DaN6**	**5.70**

Table D3.4: IRI Data (m/km) Da Nang

APPENDIX D

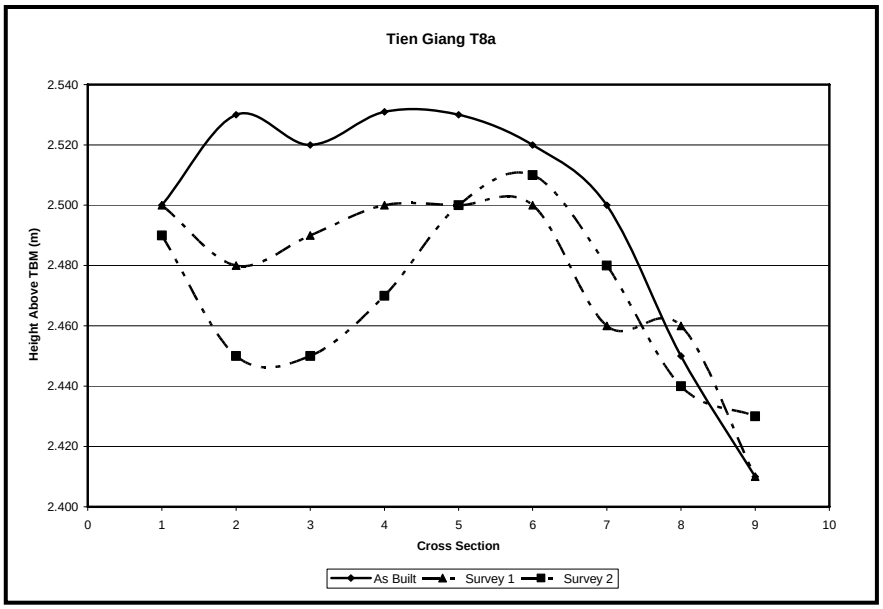
RRST-I Trials Monitoring Data

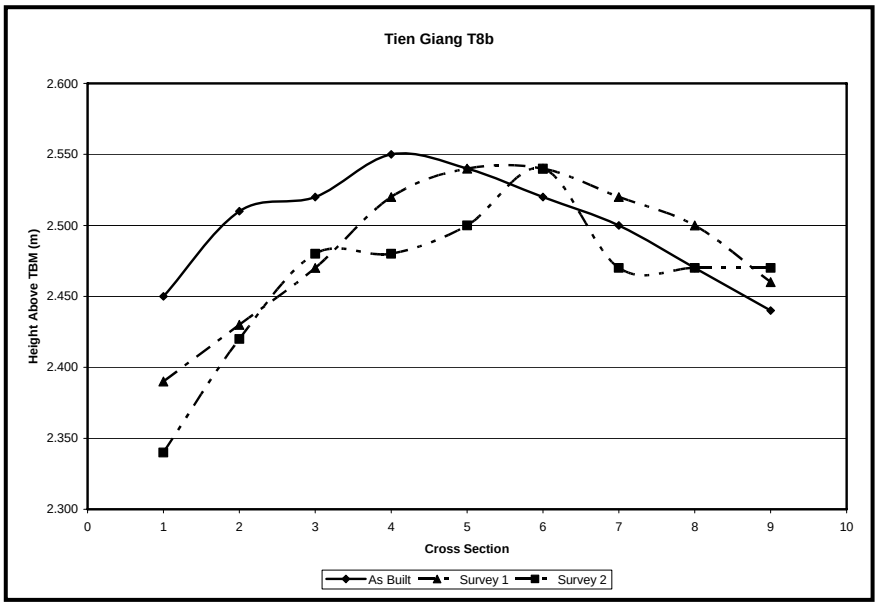
Appendix D4: Unsealed Control Section Level Data

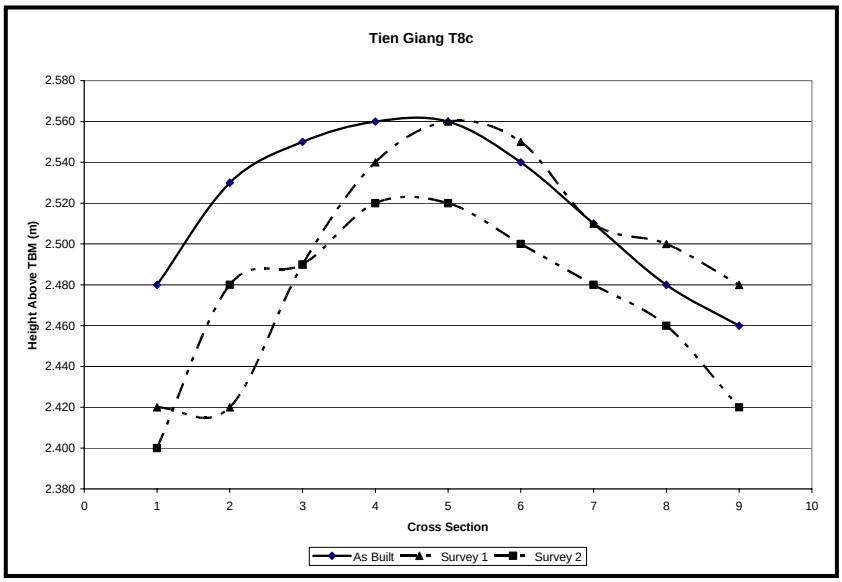
Appendix D4 contains plots of monitored cross sections of unsealed control sections in Tien Giang, Dong Thap and Hue. No follow-up monitoring to the as-built survey has as yet been completed in Da Nang.

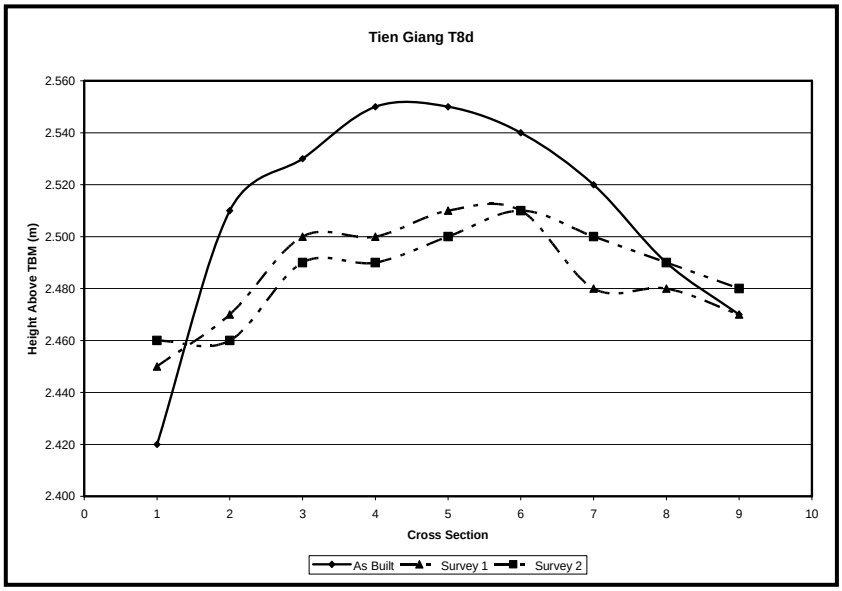
Tien Giang Trial section TG08

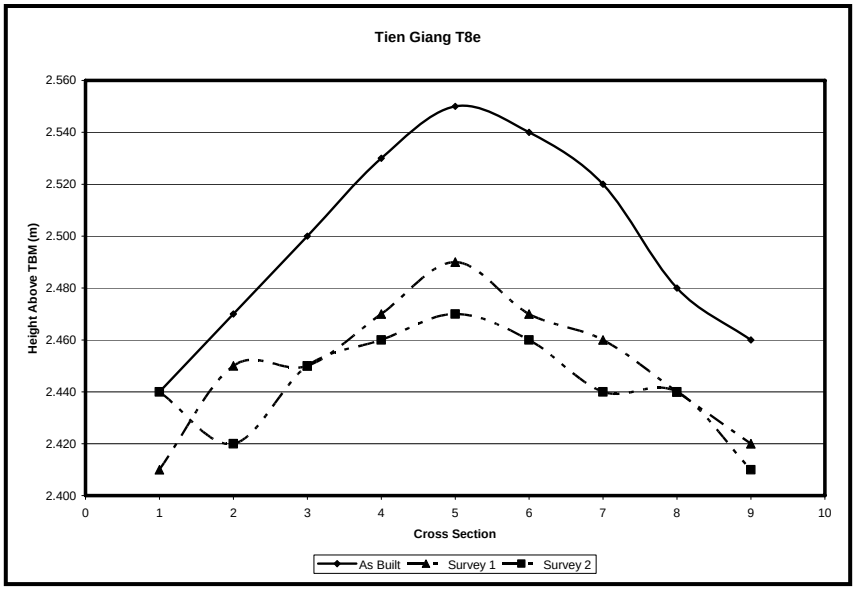
Cross sections at 5m; 20m; 40m 60m and 95m running left to right





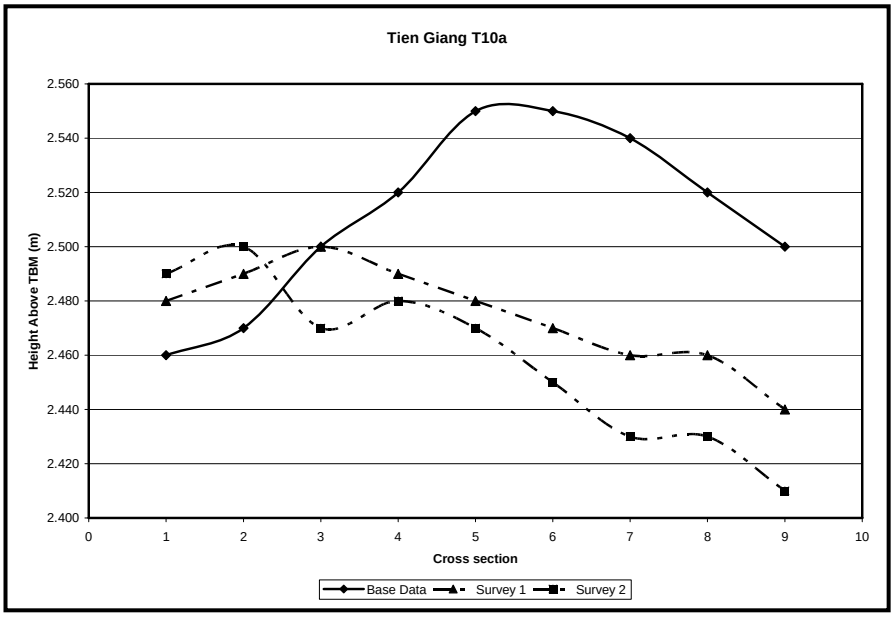

Tien Giang T8c
Height Above TBM (m)
2.580
2.560
2.540
2.520
2.500
2.480
2.460
2.440
2.420
2.400
2.380
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

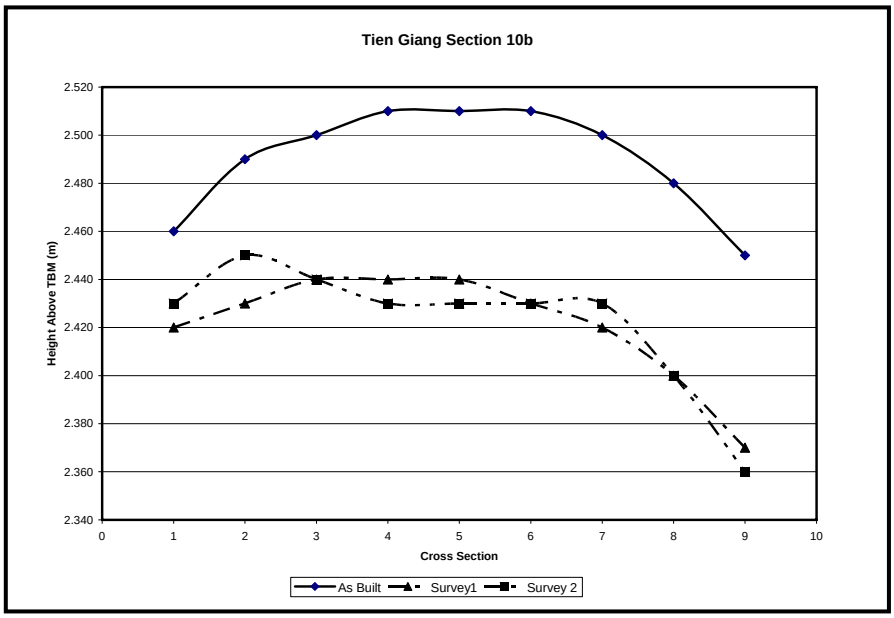

Tien Giang T8d
Height Above TBM (m)
2.560
2.540
2.520
2.500
2.480
2.460
2.440
2.420
2.400
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

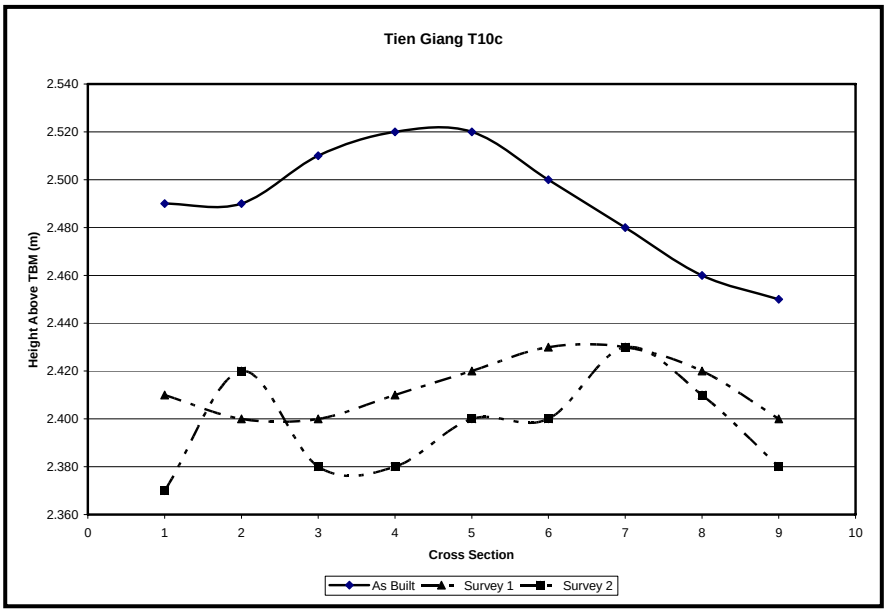

Tien Giang T8e
Height Above TBM (m)
2.560
2.540
2.520
2.500
2.480
2.460
2.440
2.420
2.400
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

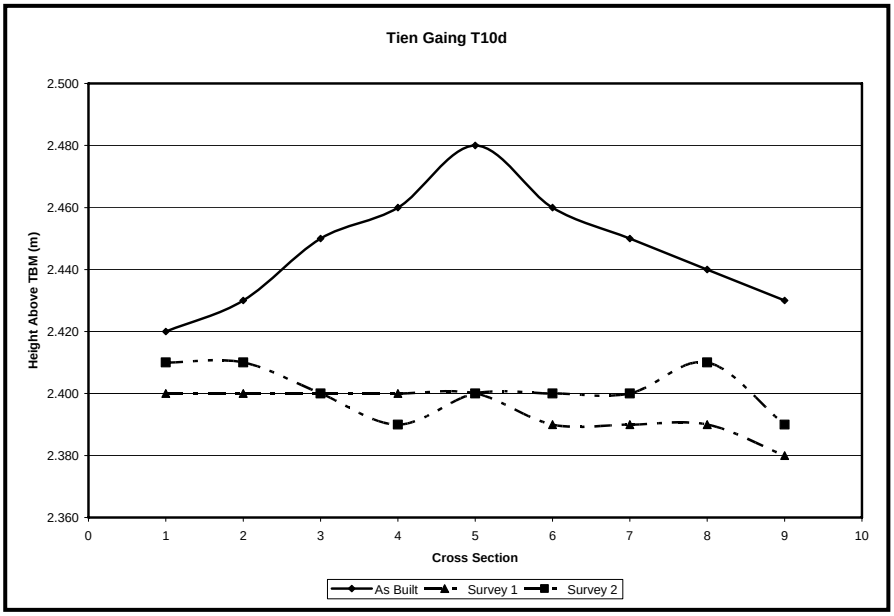
Tien Giang Trial section TG10

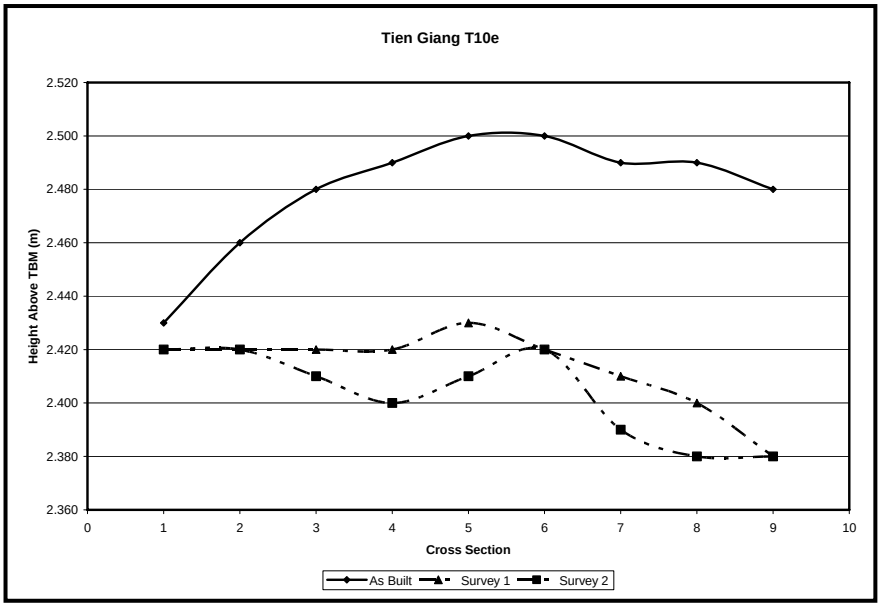
Cross sections at 5m; 20m; 40m 60m and 95m running left to right





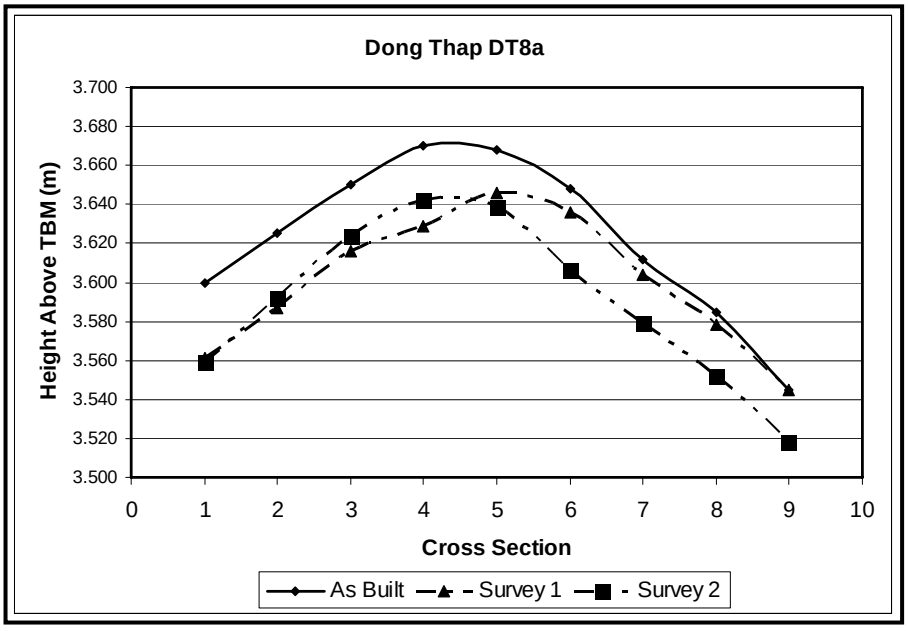

Tien Giang T10c
Height Above TBM (m)
2.540
2.520
2.500
2.480
2.460
2.440
2.420
2.400
2.380
2.360
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

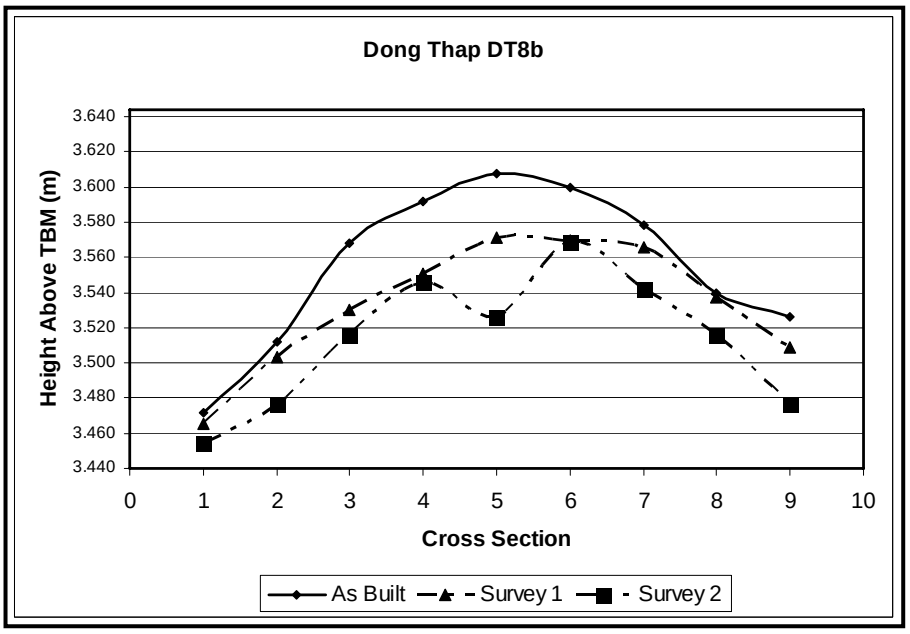

Tien Gaing T10d
Height Above TBM (m)
2.500
2.480
2.460
2.440
2.420
2.400
2.380
2.360
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

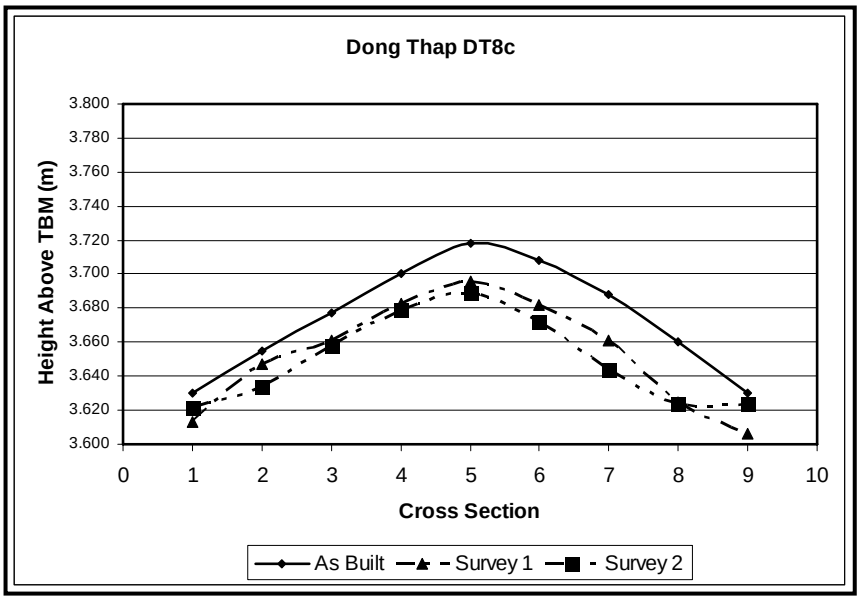

Tien Giang T10e
Height Above TBM (m)
2.520
2.500
2.480
2.460
2.440
2.420
2.400
2.380
2.360
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

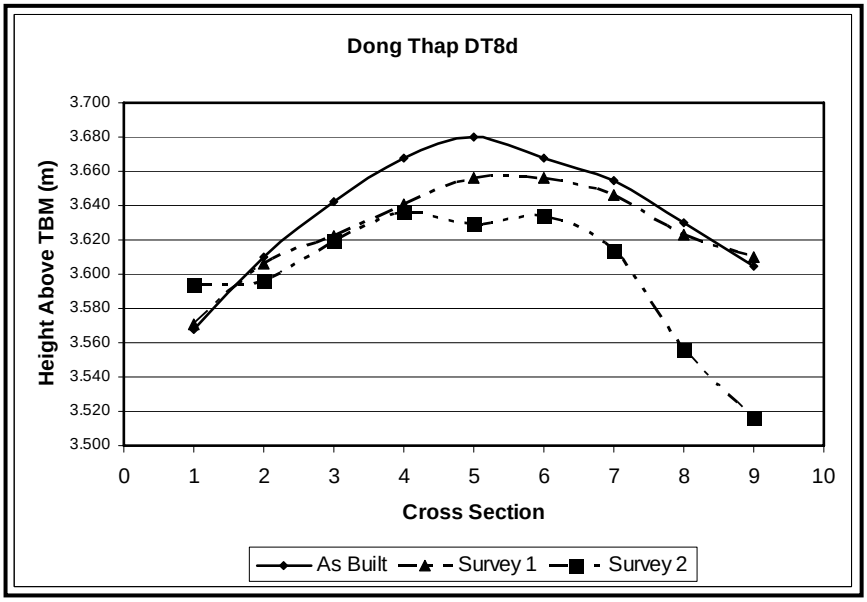
Dong Thap Trial section DT08

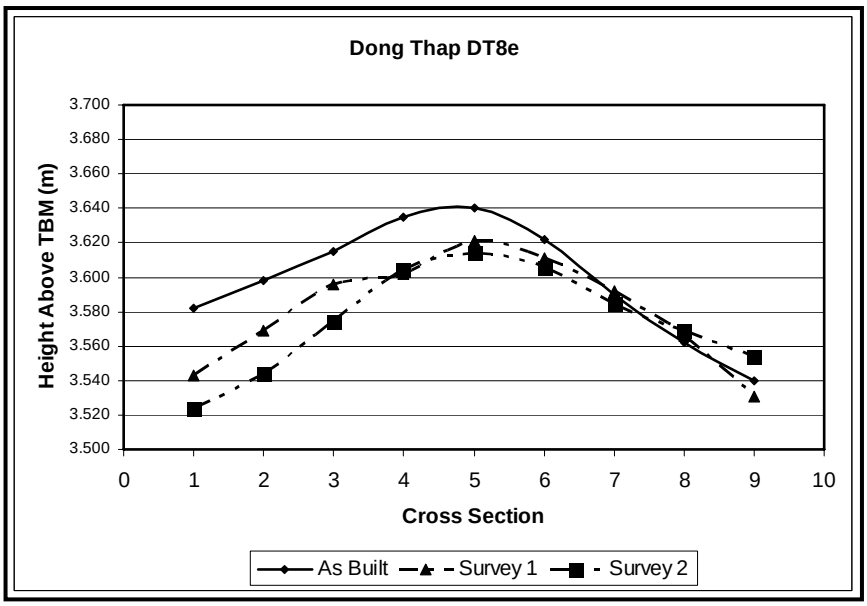
Cross sections at 5m; 20m; 40m 60m and 95m running left to right





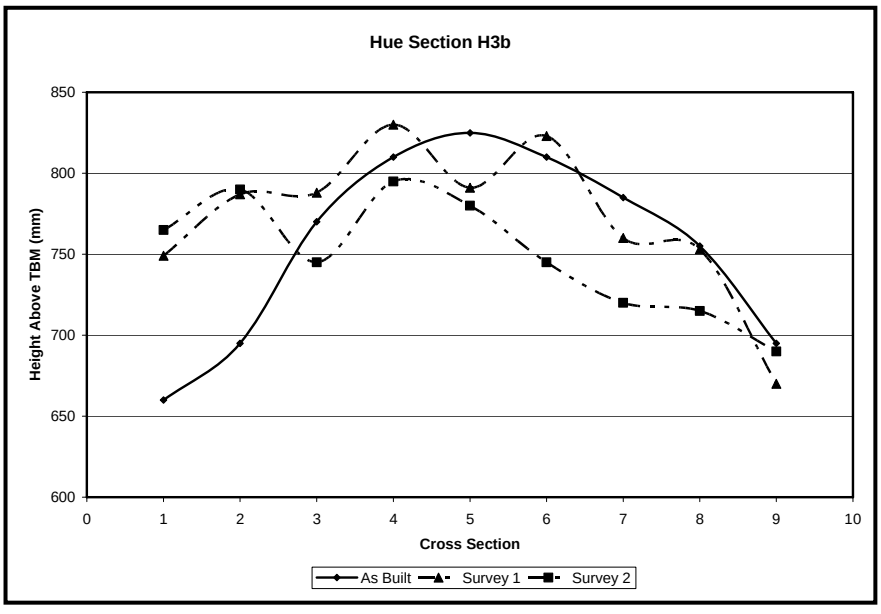

Dong Thap DT8c
Height Above TBM (m)
3.800
3.780
3.760
3.740
3.720
3.700
3.680
3.660
3.640
3.620
3.600
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

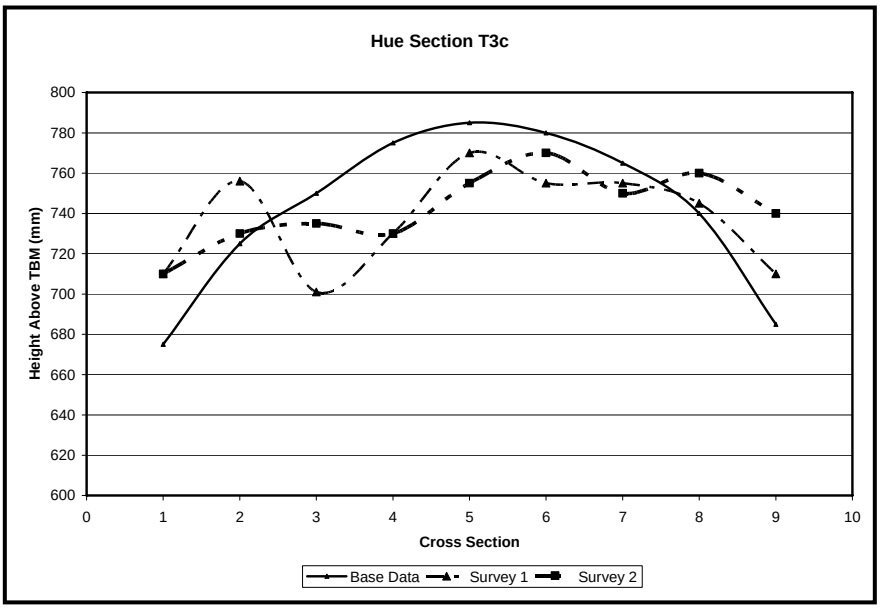

Dong Thap DT8d
Height Above TBM (m)
3.700
3.680
3.660
3.640
3.620
3.600
3.580
3.560
3.540
3.520
3.500
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

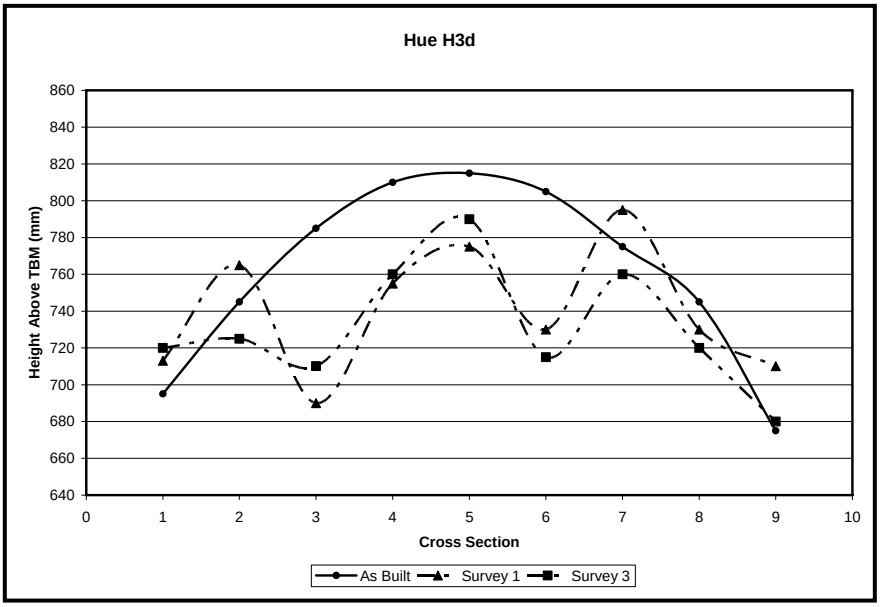

Dong Thap DT8e
Height Above TBM (m)
3.700
3.680
3.660
3.640
3.620
3.600
3.580
3.560
3.540
3.520
3.500
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 2

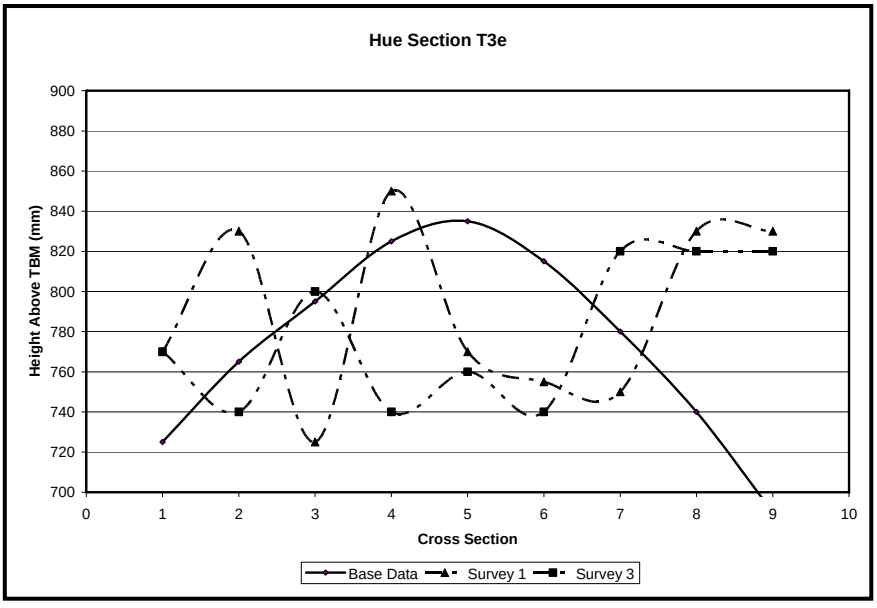
Hue Trial section TG03

Cross sections at 5m; 20m; 40m 60m and 95m running left to right




Hue Section T3c
Height Above TBM (mm)
800
780
760
740
720
700
680
660
640
620
600
0 1 2 3 4 5 6 7 8 9 10
Cross Section
Base Data
Survey 1
Survey 2


Hue H3d
Height Above TBM (mm)
860
840
820
800
780
760
740
720
700
680
660
640
0 1 2 3 4 5 6 7 8 9 10
Cross Section
As Built
Survey 1
Survey 3


Hue Section T3e
Height Above TBM (mm)
900
880
860
840
820
800
780
760
740
720
700
0 1 2 3 4 5 6 7 8 9 10
Cross Section
Base Data
Survey 1
Survey 3

APPENDIX D

RRST-I Trials Monitoring Data

Appendix D5: Dynamic Cone Penetration Data

DCP data is held in a combination of:

1. EXCEL data form with raw penetration data converted to CBR%
2. ukdcp files where layer strengths may be seen plotted either with depth or in a standard report format
3. ACCESS tables of summarised CBR information for specific trial sections of interest, such as the lime stabilised base sections or the unsealed gravel control sections.

Only stabilized base and unsealed gravel section carriageway sections are suitable for DCP monitoring, elsewhere on the other sections only shoulders of stabilised or gravel are monitored with DCP testing.

Table D5.1 summarises the available information for each monitoring section

	DCP Data Available		Data Format		
	Shoulders	Carriageway	As Built data	Survey-1	Survey-2
TG02			.ukdcp files	.xls files	.xls files
TG03			.ukdcp files	.xls files	.xls files
TG05			.ukdcp files	.xls files	.xls files
TG06			.ukdcp files	.ukdcp and .xls files	.xls files
TG07			.ukdcp files	.xls files	.xls files
TG08			.ukdcp files	.xls files	.xls files
TG09			.ukdcp files	.xls files	.xls files
TG10			.ukdcp files	.ukdcp and .xls files	.xls files
DT02			.ukdcp and .xls files	.xls files	.xls files
DT03			.ukdcp and .xls files	.xls files	.xls files
DT04			.ukdcp and .xls files	.xls files	.xls files
DT05			.ukdcp and .xls files	.xls files	.xls files
DT06			.ukdcp and .xls files	.xls files	.xls files
DT07			.ukdcp and .xls files	.xls files	.xls files
DT08			.ukdcp and .xls files	.xls files	.xls files
DT09			.ukdcp and .xls files	.xls files	.xls files
DT10			.ukdcp and .xls files	.xls files	.xls files
DT11			.ukdcp and .xls files	.xls files	.xls files
DT12			.ukdcp and .xls files	.xls files	.xls files
H02			.ukdcp files	.xls files	.xls files
H03			.ukdcp files	.xls files	.xls files
H04			.ukdcp files	.xls files	.xls files
H06			.ukdcp files	.xls files	.xls files
H07			.ukdcp files	.xls files	.xls files
H09			.ukdcp files	.xls files	.xls files
H11			.ukdcp files	.xls files	.xls files
DaN02			.xls files	.xls files	.xls files
DaN03			.xls files	.xls files	.xls files
DaN04			.xls files	.xls files	.xls files
DaN05			.xls files	.xls files	.xls files
DaN06			.xls files	.xls files	.xls files

Table D5.1: Details of DCP Files

APPENDIX D

RRST-I Trials Monitoring Data

Appendix D6: Lime Stabilisation Performance Data

Appendix D6: Lime Stabilisation Performance Data

1 Lime Stabilised Base and Sub-base

As noted in Section 7.2 of the main text, some significant deterioration has been monitored in the in situ strength of the lime stabilised trial sections in Dong Thap (DT06) and Tien Giang (TG06).

For comparison purposes Tables D6.1 and D6.2 summarise the **average** base and sub-base CBR values for sections DT06 and TG06.

Key points to emerge from a study of the monitoring data are:

1. Significant deterioration in strength between July 2005 and January 2006, with a levelling off of the deterioration between January 2006 and July 2006
2. The strength profiles after the initial as built survey sometimes show considerable horizontal and vertical variation, with a general retention of strength within the top 50-75mm, Figure D6.1,
3. Some profiles show a significant weaker zone at the bottom of the base layer, particularly in TG06, Figure D6.2

The cause of this deterioration is currently not clear. Based on experience reported on other similar situations the potential causes could include a combination of one or more of the following reasons discussed below;

Insufficient Lime. Laboratory strength testing of actually used soil and lime gave more than adequate soaked CBR values. ITST in separate research programmes have also used and reported similar percentages for base stabilisation (6-8%) in the Mekong region[1]. Although the general level of lime may have been adequate it is possible that locally within each layer there may have been deficiencies; see “poor initial mixing” below.

Poor initial mixing: It has to be acknowledged that the use of local agricultural machinery will not produce as even a mix as conventional construction equipment. The construction and immediate post construction data show generally more that adequate strength, however there are significant variations. There are also localised indications of poor mixing at depths below 120mm (Figure D6.2) and at the ends of the trial sections.

Poor curing: Adequate curing of lime stabilised pavement layers is essential and this was emphasised both in the contract documents and during site supervision. There were some initial problems in encouraging the contractors to undertake adequate curing, but generally after the construction of the training sections the curing was reported as adequate for the carriageways. The general deterioration pattern at depth would seem to argue against poor curing as being a major contributory factor

Poor compaction: Site supervision records show that the specified compaction procedures were generally adhered to, and in situ construction testing records would generally agree with this. In situ density records refer of course only to the top 100mm of each layer and it is possible that compaction levels may have dropped off in the bottom 50mm. Some in situ DCP profiles may also indicate this.

Water-table variations. The period July-January, during which time the initial deterioration took place, coincides with the rainy season in the Mekong area and a significant rise in the water table. Previously these roads had been subject to shallow flooding during the rainy seasons and their general level had been raised slightly (400-500mm) for the trials. No flooding was reported on the road surface sections in the 2005-2006 rainy season. However, on the assumption that the a normal flood conditions prevailed during the 2005-2006 rainy season, it is likely that water levels rose to at least within 200-400mm of the road surface and associated embankment saturation to even high levels. It is possible that this saturation has had a deleterious effect (possible carbonation) on the lime stabilisation, below 75-100mm depth.

[1] (ITST South Research Reports Documentation)

2 Lime Stabilised Shoulders

Lime stabilised shoulders were constructed on most of the Mekong region trial roads and in general terms they also showed significant deterioration, as indicated in the visual descriptions in Appendix D2. In addition to issues discussed above, there are number of additional factors to take into account with respect to shoulder deterioration, namely:

1. In most cases the shoulders were constructed after the carriageway, with lighter mixing equipment that may not have allowed adequate full width or depth mixing.
2. Different sources of soil, some of it highly plastic and occasionally organic were sometimes used, particularly in Tien Giang.
3. The shoulders are likely to have been subjected to motor cycle traffic on some sections (D06 and TG06) whilst the main carriageway was protected during the curing period.

The contractors were advised of the above problems (1) and (2) and written notes to this effect were issued.

3 Recommendations

Due to the need to develop economic, local-resource-based roadwork solutions, further research is recommended on the use of lime stabilised local soils in the Mekong region, this is should include the following activities:

1. Inclusion of other lime stabilised sections outside the RRST programme within future monitoring programmes.
2. Detailed re-evaluation of all existing data on lime stabilisation testing in the Mekong region.
3. Digging of inspection and sampling pits into the monitoring sections TG06 and D06 to ascertain detailed material condition profiles within the base and sub-base layers. This could be incorporated within a future monitoring phase.

I

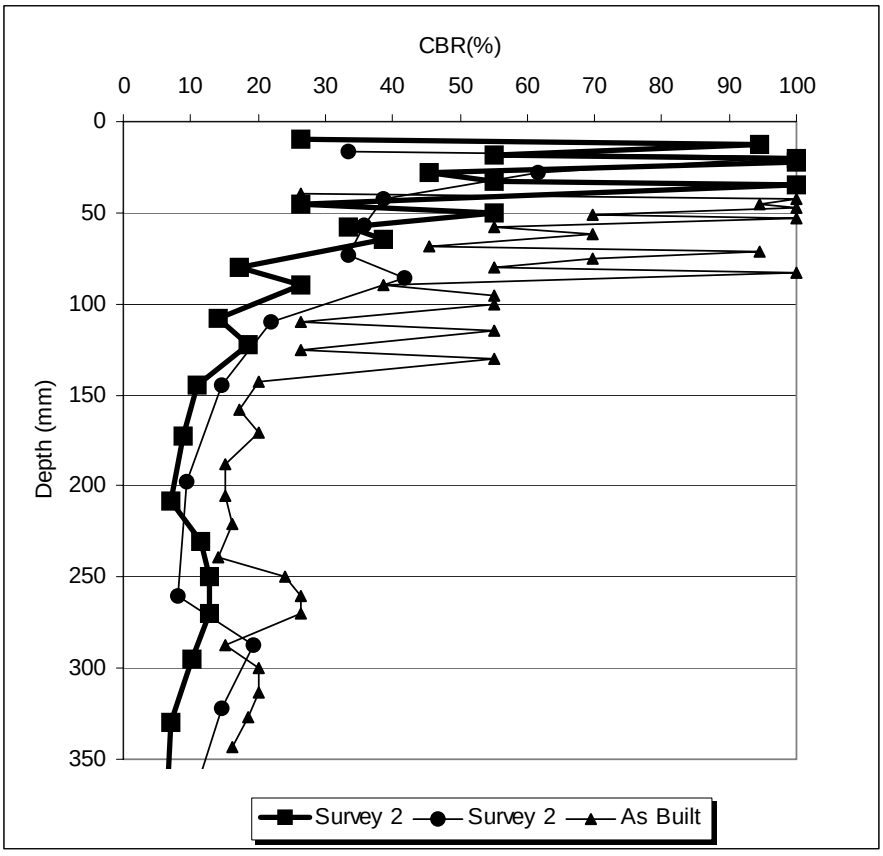


Figure D6.1: DCP-CBR Surveys Dong Thap Chainage 0.928, Centre Line

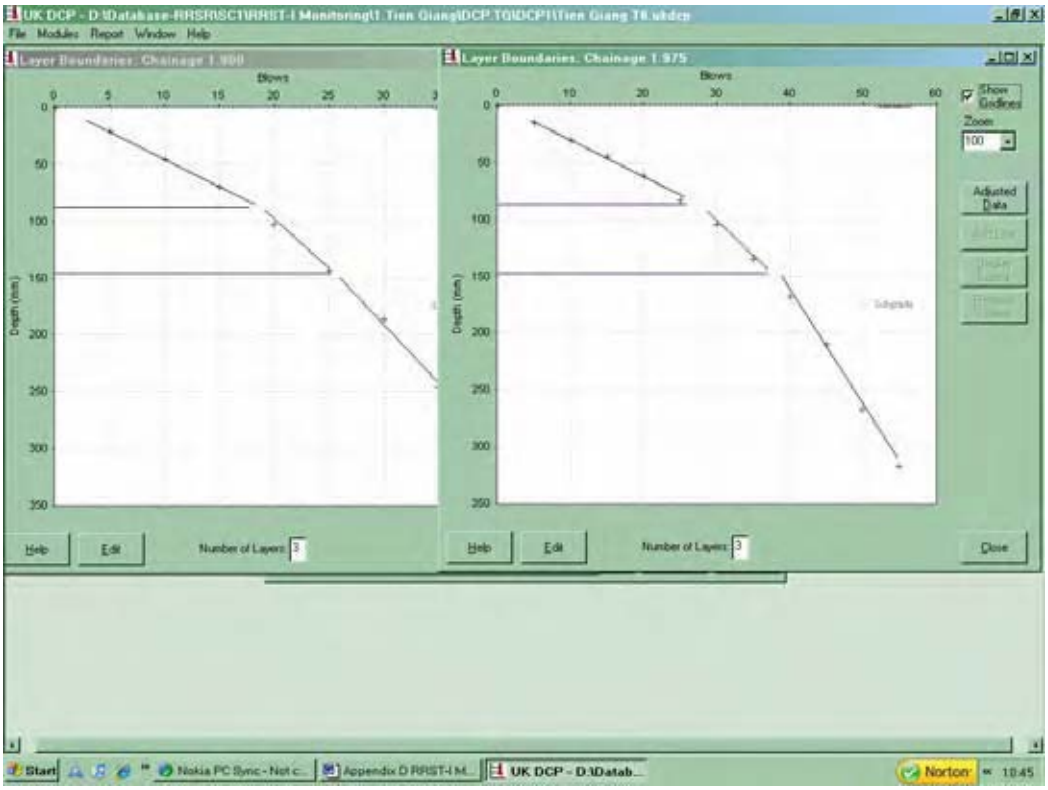


Figure D6.2: Lower strength layer within stabilised base; Section TG06, As Built Survey
Plot from UKDCP interpretation shows Ch 1.900 CBR=70 to 90mm; CBR=40 below that
Ch 1.975 CBR=88 to 90mm; CBR=45 below that

			Base			Sub Base			Shoulder		
Section	Chain	Loc	CW-B-07-05	CW-B-01-06	CW-B-07-06	CW-Sb-07-05	CW-Sb-01-06	CW-Sb-07-06	Sh-07-05	Sh-01-06	Sh-07-06
TG06	1.805	L	50		32	32		22	14	10	11
TG06	1.805	C	64	32	33	39	13	20			
TG06	1.805	R	70	44	10	31	16	5	8	6	2
TG06	1.825	L	69	27	30	29	14	15	12	7	14
TG06	1.825	C	84	30	21	28	18	19			
TG06	1.825	R	62	58*	28	28	14	10	52	10	12
TG06	1.850	L	43	13	24	32	5	15	12	12	20
TG06	1.850	C	61	18	28	24	6	15			
TG06	1.850	R	87	20	23	30	3	12	24	20	8
TG06	1.875	L	45	20	20	24	5	11	11	8	11
TG06	1.875	C	64*	20*	23	29	4	10			
TG06	1.875	R	98*	15	24	30	4	11	11		6
TG06	1.900	L	52	12	12	20		15	33		8
TG06	1.900	C	79	21	21	40		12			
TG06	1.900	R	53*	10	20	22		12	21		15
TG06	1.925	L	77*	12	18	26		9	69		7
TG06	1.925	C	70	34	14	32		6			
TG06	1.925	R	87	27	27	34		10	20		7
TG06	1.950	L	71	20	34	35		10	19		40
TG06	1.950	C	100*	22	19	35		8			
TG06	1.950	R	65	15	20	33		8	20		
TG06	1.975	L	114*	27		46			67		
TG06	1.975	C	74*	20		28					
TG06	1.975	R	64	22		24			24		
TG06	1.995	L	54			20			30		
TG06	1.995	C	62			32					
TG06	1.995	R	58			35			16		

Table D6.1: Average DCP-CBR Values for Section TG06; Tien Giang

Note CBRs Marked * indicate average over a 120-150mm layer thickness rather than a full 150mm thickness

			Base			Sub Base			Shoulder		
Section	Chain	Loc	CW-B-07-05	CW-B-01-06	CW-B-07-06	CW-Sb-07-05	CW-Sb-01-06	CW-Sb-07-06	Sh-07-05	Sh-01-06	Sh-07-06
D06	0.763	L	52*	30	30*	17	14	15	19	10	25
D06	0.763	C	53*	30*	20*	16	10	10			
D06	0.763	R	34	40*	15*	14	12	5	28	2	3
D06	0.783	L	66*	30	50	13	6	14	27	15	15
D06	0.783	C	57*	35	25*	14	10	10			
D06	0.783	R	63*	20	30*	13	10	8	20	17	15
D06	0.808	L	52*	10	25*	10	3	5	28	2	12
D06	0.808	C	72*	15	15*	15	3	8			
D06	0.808	R	70*	25*	20*	15	3	10	46	30	25
D06	0.833	L	35*	20*	15	21	8	7	25	10	4
D06	0.833	C	66		45	27		15			
D06	0.833	R	76*		40*	24		8	25	25	2
D06	0.858	L	49*	40*	30*	15	15	14	50	10	20
D06	0.858	C	46*	16	25	14	6	10			
D06	0.858	R	67	17	50*	32	15	22	26	7	15
D06	0.883	L	75	65	60	36	25	25	75	10	20
D06	0.883	C	58	75*	45*	31	40	18			
D06	0.883	R	59*	25*	35*	29	12	30	7	7	15
D06	0.908	L	95*	40	50*	15	14	10	52	35	45
D06	0.908	C	57	35	35	16	10	11			
D06	0.908	R	45	30	30*	21	20	8	40	10	12
D06	0.928	L	31		35*	19		11	22		35
D06	0.908	C	33		25*	18		10			
D06	0.908	R	35		20*	23		17	14		15

Table D6.2: Average DCP-CBR Values for Section DT06; Dong Thap

Note CBRs Marked * indicate average over a 120-150mm layer thickness rather than a full 150mm thickness

RRST VIETNAM
SEACAP 1
FINAL REPORT

APPENDIX E

RRST-II As Built Survey Data

Appendix E1: Intech-TRL Quality Assurance Summaries

Appendix E2: ITST Monitoring Section Pavement Condition Data

APPENDIX E

RRST-II As Built Survey Data

Appendix E1: Intech-TRL Quality Assurance Summaries

Information for the following tables was collected as part of the Intech-TRL Quality Control and Quality Assurance activities for RRST-II. Details for individual roads are included within Intech-TRL RRST-II Module 2 Report[1].

Aspect	Code	Quality Assessment
Carriageway	A	No quality problems identified
	B	Slight problem – some action may be required
	C	Major problem – Completion/ repair in contract guarantee period
Shoulder	A	No quality problems identified
	B	Slight problem – some action may be required
	C	Major problem – Completion/ repair in contract guarantee period
Road Geometry	A	Geometry acceptable
	B	Slight problem – some action may be required
	C	Major problem – Completion/ repair in contract guarantee period
Inspection Pit	A	No quality problems identified
	B	Slight problem – some action may be required
	C	Major problem – Completion/ repair in contract guarantee period
Laboratory Test		
Material quality	A	Satisfactory
	B	Some unsatisfactory criteria
	C	Unsatisfactory
Results received	A	Full data as required
	B	Insufficient data but not considered significant
	C	Significant data missing
Site test		
Quality	A	Satisfactory
	B	Some local weak areas
	C	Unsatisfactory
Results received	A	Full data as required
	B	Insufficient data but not considered significant
	C	Significant data missing
Daily worksheet	A	Full data as required
	B	Insufficient data but not considered significant
	C	Significant data missing

Key to Quality Assessment Codes

[1] RRST-II Construction Summary Report (Module 2), Intech-TRL, September 2006.

SUMMARIES OF QUALITY ASSURANCE ASSESSMENTS

NOTE: Lab = Laboratory

Tuyen Quang

Road No	Road name	Chainage		Trial Option	Trial/ Control Section (T/C)	Construction Quality Assessment				Construction Data Assessment					Monitor sections
						Carriageway	Shoulder Condition	Road Geometry	Inspection Pit	Site Testing Results		Lab Testing Results		Daily Work Sheets	
		From	To							Results Received	Layer Quality	Results Received	Material Quality		
1	Hoang Khai	0.000	0.500	NH7	C	A	A	B	A	A	A	C	B	-	√
		0.500	2.000	NH8	C	A	A	B	A	A	A	C	B	-	√
		2.000	2.500	NH7	C	A	A	B	A	A	A	B	B	-	√
		2.500	3.810	NH5	T	B	A	A	A	A	A	C	B	-	√
2	Lang Quan	0.000	1.000	NH5	T	B	A	B	A	B	A	C	B	-	
		1.000	2.000	NH1d	T	B	C	A	A	B	A	C	A	-	
		2.000	3.000	NH7	C	A	A	B	A	A	A	C	B	-	
		3.000	3.750	NH2c	T	B	A	B	A	C	A	C	B	-	
		3.750	4.500	NH2d	T	B	A	B	A	B	A	B	B	-	
3	Nong Tien	0.000	0.400	NH7	C	A	A	A	A	A	A	C	A	-	
		0.400	0.900	NH5	T	B	A	A	A	A	A	B	B	-	
4	Thang Quan	0.000	1.000	NH1d	T	B	A	A	A	A	A	C	A	-	
		1.000	1.750	NH7	C	A	A	A	A	A	A	B	B	-	
5	Y La	0.000	0.600	NH7	C	A	C	B	A	A	A	C	B	-	
		0.600	1.100	NH5	T	C	A	B	C	B	A	C	B	-	√
		1.100	1.650	NH7	C	C	C	A	A	A	A	C	B	-	

Ha Tinh

Road No	Road name	Chainage		Trial Option	Trial/ Control Section (T/C)	Construction Quality Assessment				Construction Data Assessment					Monitor sections
						Carriageway Condition	Shoulder Condition	Road Geometry	Inspection Pit	Site Testing Results		Lab Testing Results		Daily Work Sheets	
		From	To							Results Received	Layer Quality	Results Received	Material Quality		
1	Chu Le – Dia Loi	0.000	2.300	NH7b	C	B	A	A	A	A	A	A	A	A	√
		2.300	2.800	NH2b	T	B	A	B	A	B	A	C	A	A	√
2	Ghenh Tang–Duc Hoa	0.000	0.683	NH2b	T	B	B	A	A	B	A	B	B	A	
		0.741	1.840	NH1b	T	B	B	A	A	B	A	B	A	A	
3	Hong Loc – Thu Loc	0.000	1.633	NH7a	C	B	A	A	A	A	A	1	A	A	
		1.633	2.233	NH2b	T	A	A	B	A	A	A	B	A	A	√
		2.233	3.983	NH1b	T	B	A	A	A	A	A	B	A	A	√
		3.983	6.950	NH7a	C	B	A	A	B	A	A	A	A	A	
4	Thach Minh – Thach Ngoc	0.000	1.000	NH1a	T	B	B	A	A	A	A	B	A	A	√
		1.000	2.000	NH2a	T	B	B	A	A	A	A	B	A	A	√
		2.000	2.950	NH5	T	A	B	A	A	B	A	B	B	A	√
		2.950	3.250	NH7c	C	B	B	A	A	B	A	B	A	A	√
		3.250	3.550	NH5	T	A	B	A	A	B	A	B	B	A	
		3.550	5.350	NH7c	C	B	A	A	A	B	A	B	A	A	
		5.350	5.850	NH7b	C	A	A	A	A	B	B	B	A	A	√
5	Xuan Hoi	0.000	1.000	NH7a	C	A	A	A	A	B	A	B	A	A	
		1.000	1.900	NH1b	T	A	B	B	A	B	A	B	B	A	

Quang Binh

Road No	Road name	Chainage		Ref No	Trial Option	Trial/ Control Section (T/C)	Construction Quality Assessment				Construction Data Assessment					Monitor sections
							Carriageway Condition	Shoulder Condition	Road Geometry	Inspection Pit	Site Testing Results		Lab Testing Results		Daily Work Sheets	
		From	To								Results Received	Layer Quality	Results Received	Material Quality		
1	Cam Lien – Ngu Thuy Trung	0.000	0.500	1	NH7	C	B	B	A	B	B	2	B	A	A	
		0.500	1.000	2	NH4b	T	B	B	B	A	B	A	B	A	A	√
		1.000	2.000	3	NH2b	T	B	B	B	A	B	A	B	B	A	√
		2.000	3.000	4	NH4b	T	A	B	B	A	B	A	B	A	A	√
		3.000	4.000	5	NH5	T	A	B	A	A	B	A	B	A	A	
		4.000	5.061	6	NH4b	T	B	B	A	A	B	A	B	B	A	
		5.061	6.061	7	NH5	T	B	A	A	A	B	A	B	B	A	√
		6.061	6.500	8	NH7	C	B	B	A	A	B	A	B	B	A	√
2	Loc Ninh	0.000	0.470	1	NH7	C	A	A	A	B	B	A	A	A	A	
		0.470	1.036	2	NH3	T	B	A	B	A	B	A	A	B	A	
3	Ngu Hoa	0.000	0.506	1	NH7	C	A	B	A	A	B	A	C	-	A	
		0.506	1.506	2	NH4	T	A	B	A	A	B	A	C	-	A	√
		1.506	2.506	3	NH5	T	A	A	B	A	B	A	C	-	A	√
		2.506	3.513	4	NH4	T	A	B	B	A	B	A	C	-	A	
		3.513	5.155	5	NH1b	T	B	A	A	A	B	A	C	-	A	√
		5.155	5.655	6	NH7	C	A	B	B	B	B	A	C	-	A	

Ninh Binh

Road No	Road name	Chainage		Trial Option	Trial/ Control Section (T/C)	Construction Quality Assessment				Construction Data Assessment					Monitor sections
						Carriageway Condition	Shoulder Condition	Road Geometry	Inspection Pit	Site Testing Results		Lab Testing Results		Daily Work Sheets	
		From	To							Results Received	Layer Quality	Results Received	Material Quality		
1	Do Quy	0.000	1.500	RR12	C	B	B	A	-	A	A	B	A	A	
		1.500	2.000	RR3	T	A	A	A	A	A	A	A	A	A	
2	Dong Huong	0.000	1.500	RR12	C	B	B	A	-	A	A	A	A	A	√
		1.500	2.000	RR3	T	B	B	A	A	A	A	B	A	A	√
3	Gia Phu	0.000	0.400	RR12	C	A	A	A	A	B	A	B	B	A	
		0.400	0.900	RR3	T	A	A	B	A	A	A	B	B	A	
		0.900	1.170	RR12	C	A	A	A	-	B	A	B	B	A	
4	Ninh Giang	0.000	0.850	RR12	C	A	B	A	-	A	A	B	B	A	
		0.850	1.350	RR10	T	B	A	A	A	A	A	B	B	A	
		1.350	2.482	RR12	C	A	A	A	-	A	A	B	B	A	
5	Ninh Van	0.000	1.200	RR12	C	A	A	A	-	B	A	B	B	A	
		1.200	1.700	RR3	T	A	A	A	A	A	A	A	A	A	
		1.700	3.415	RR12	C	A	A	A	-	B	A	B	B	A	
		3.415	3.915	RR10	T	A	A	A	-	A	A	A	A	A	
6	Thu Trung	0.000	2.000	RR12	C	A	B	A	-	B	A	B	A	A	
		2.000	3.000	RR8	T	A	A	A	A	A	A	A	A	A	
		3.000	3.990	RR12	C	A	B	A	-	B	A	B	A	A	
7	Tien Phong	0.000	1.266	RR12	C	A	A	A	-	A	A	C	A	A	
		1.266	1.766	RR1	T	A	A	A	A	A	A	A	B	A	
		1.766	3.032	RR12	C	A	A	A	-	A	A	C	A	A	
8	Trai Giong	0.000	0.680	RR12	C	A	A	A	-	A	A	B	A	A	
		0.680	1.180	RR1	T	A	A	A	A	A	A	B	A	A	
		1.180	2.950	RR12	C	A	A	A	-	A	A	B	A	A	
		2.950	3.450	RR3	T	A	A	A	A	A	A	A	A	A	
9	Yen Trach	0.000	0.500	RR3	T	B	B	A	B	A	A	A	B	A	
		0.500	1.100	RR12	C	A	A	A	A	A	A	A	B	A	√
		1.100	1.600	RR5	T	A	A	A	-	A	A	A	B	A	√
		1.600	2.330	RR12	C	A	B	A	-	A	A	A	B	A	√
10	Yen Tu	0.000	0.500	RR10	T	B	A	A	C	A	A	B	A	A	√
		0.500	1.355	RR12	C	A	A	A	A	A	A	B	A	A	√

Hung Yen

Road No	Road name	Chainage		Trial Option	Trial/ Control Section (T/C)	Construction Quality Assessment				Construction Data Assessment					Monitor sections
		From	To			Carriageway Condition	Shoulder Condition	Road Geometry	Inspection Pit	Site Testing Results		Lab Testing Results		Daily Work Sheets	
										Results Received	Layer Quality	Results Received	Material Quality		
1	Hung Long	0.000	1.000	RR12	C	A	B	A	A	A	A	A	B	A	
		1.000	1.500	RR9	T	A	B	A	A	A	A	A	A	A	√
		1.500	2.250	RR15	C	A	B	A	A	A	A	A	A	A	√
2	Nhat Quang	0.000	0.750	RR6	T	B	B	A	A	A	A	B	A	A	√
		0.750	2.500	RR7	T	C	B	A	C	A	A	B	C	A	√
		2.500	4.000	RR15	C	A	B	A	A	A	A	A	A	A	√
		4.000	4.500	RR12	C	A	B	A	A	A	A	B	A	A	√
3	Tan Hung	0.000	1.350	RR2	T	B	A	A	A	A	A	B	A	A	√
		1.350	2.182	RR4	T	B	B	A	A	A	A	A	A	A	√
4	Thuy Loi	0.000	0.420	RR7	T	C	B	A	C	A	A	A	C	A	√
		0.565	0.990	RR12	C	A	B	A	A	A	A	A	B	A	
5	Van Nhue	0.000	0.850	RR8	T	A	A	A	A	A	A	A	A	A	
		0.850	1.850	RR12	C	A	A	A	A	A	A	A	B	A	
		1.850	2.167	RR15	C	A	A	A	A	A	A	A	A	A	

Gia Lai

Road No	Road name	Chainage		Trial Option	Trial/ Control Section (T/C)	Construction Quality Assessment				Construction Data Assessment					Monitor sections
		From	To			Carriageway Condition	Shoulder Condition	Road Geometry	Inspection Pit	Site Testing Results		Lab Testing Results		Daily Work Sheets	
										Results Received	Layer Quality	Results Received	Material Quality		
1	Ya Hoi	0.000	0.500	CH1	T	B	B	B	A	A	A	B	A	A	
		0.500	1.400	CH2a	T	B	B	B	B	A	A	B	A	A	
2	Ia Pnol	0.000	1.000	CH5	T	B	A	A	A	A	A	B	A	A	√
		1.000	2.000	CH1	T	B	B	A	A	A	A	B	A	A	√
		2.000	3.000	CH6	T	B	A	B	A	A	A	B	B	A	√
		3.000	4.000	CH9	C	A	A	A	A	A	A	B	A	A	√
3	Xa Kroong	0.000	0.500	CH1	T	B	B	A	A	A	A	B	A	A	
		0.500	1.100	CH2a	T	B	B	B	A	A	A	B	A	A	
		1.100	2.000	CH9	C	B	B	B	A	A	A	B	A	A	
4	Xa Song An	0.000	0.500	CH1	T	A	B	B	A	A	A	B	A	A	
		0.500	1.000	CH2a	T	A	B	B	A	A	A	B	A	A	
		1.000	2.500	CH9	C	B	B	B	A	A	A	B	A	A	
5	Xa Trang	0.000	1.500	CH6	T	B	A	B	A	A	A	C	B	A	√
		1.500	2.000	CH9	C	A	A	B	A	A	A	A	B	A	√
		2.000	2.500	CH2a	T	A	B	A	A	A	A	B	B	A	√
		2.500	3.000	CH6	T	A	A	B	A	A	A	C	B	A	√

Dak Lak

Road No	Road name	Chainage		Trial Option	Trial/ Control Section (T/C)	Construction Quality Assessment				Construction Data Assessment					Monitor sections
						Carriageway Condition	Shoulder Condition	Road Geometry	Inspection Pit	Site Testing Results		Lab Testing Results		Daily Work Sheet	
		From	To							Results Received	Layer Quality	Results Received	Material Quality		
1	Buon Ho	3.700	4.166	CH8b	C	B	B	B	A	A	A	B	A	A	
		5.100	5.316	CH8b	C	B	A	B	A	A	A	B	A	A	
		8.600	9.100	CH5	T	A	B	B	A	A	A	B	B	A	√
		9.100	10.100	CH4	T	B	B	B	A	A	A	C	B	A	√
		10.100	12.600	CH3	T	B	B	B	A	A	A	B	A	A	√
		12.600	14.980	CH3	T	A	B	A	A	B	A	B	B	A	
2	Cu Ne	0.000	1.000	CH5	T	C	B	A	C	A	A	B	A	A	√
		1.000	1.873	CH8b	C	A	A	2	A	A	A	A	A	A	√
		2.073	2.573	CH2b	T	C	C	C							
		2.573	4.500	CH9	C	C	C	C							
3	Easoup	0.000	0.500	CH2b	T	B	B	B	A	A	A	B	B	A	√
		0.500	2.000	CH8b	C	B	B	A	B	A	A	B	A	A	√
		2.000	4.000	CH8b	C	B	A	B	B	A	A	B	A	A	

Dak Nong

Road No	Road name	Chainage		Trial Option	Trial/ Control Section (T/C)	Construction Quality Assessment				Construction Data Assessment					Monitor sections
		From	To			Carriageway Condition	Shoulder Condition	Road Geometry	Inspection Pit	Site Testing Results		Lab Testing Results		Daily Work Sheet	
										Results Received	Layer Quality	Results Received	Material Quality		
1	Kien Duc – Cai Chanh														
	Pk 1	0.000	1.300	CH7a	T	C	B	B	C	A	A	C	B	B	√
		1.300	2.750	CH7c	T	C	B	B	C	A	A	C	B	B	√
	Pk 2	2.750	5.350	CH7	T	B	A	B	A	B	A	C	B	A	
	Pk 3	5.350	6.785	CH7	T	C	B	B	A	B	A	C	-	A	√
		6.785	7.41	CH2b	T	B	C	B	A	B	A	C	-	A	√
	Pk 4	0.000	0.700	CH7b	T	B	A	B	A	B	A	C	-	A	√
		0.700	1.000	CH8	C	A	B	A	A	B	A	C	-	A	√
		1.000	1.600	CH7	T	B	B	A	A	B	A	C	-	A	√
		1.600	2.500	CH7a	T	B	B	B	A						
	Pk 5	2.500	3.000	CH7	T	C	B	B	A	B	A	C	-	B	√
		3.000	4.000	CH9	C	B	A	B	A	B	A	C	-	B	√

RT2 - RRST II

SUMMARIES OF QUALITY ASSURANCE COMMENTS
(Construction quality comments)

Tuyen Quang

Road No	Road name	Chainage		Section No	Trial Option	Comments
		From	To			
1	Hoang Khai	0.000	0.500	1	NH7	- Sections 1, 2 & 3; Inadequate pavement cross-fall. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 4: 100m (training length) of seal is in poor condition and it is recommended that it should be rehabilitated by the contractor during guarantee period.
		0.500	2.000	2	NH8	
		2.000	2.500	3	NH7	
		2.500	3.810	4	NH5	
2	Lang Quan	0.000	1.000	1	NH5	- Section1: Surface seal constructed with out-of-specification materials and significant sections have a very poor or missing second seal. It is recommended that the contractor reconstructs the second chipping seal during the guarantee period. - Sections 1, 3, 4 & 5; Inadequate pavement cross-fall. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Sections 2, 4 & 5: Concrete surface has not been grooved as per specification. No action recommended at this stage. - Section 2: Very little apparent bitumen on significant lengths of the specified sealed shoulder. Recommended that the contractor re-sealed these lengths as per specification. - Sections 3 ,4 & 5: Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor.
		1.000	2.000	2	NH1d	
		2.000	3.000	3	NH7	
		3.000	3.750	4	NH2c	
		3.750	4.500	5	NH2d	
3	Nong Tien	0.000	0.400	1	NH7	- Section 2: 100m (training length) of seal is in poor condition and it is recommended that it should be rehabilitated by the contractor during guarantee period.
		0.400	0.900	2	NH5	
4	Thang Quan	0.000	1.000	1	NH1d	- Section 1: Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor.
		1.000	1.750	2	NH7	
5	Y La	0.000	0.600	1	NH7	- Section 1 shoulders and Section 3 (branch-off) carriageway incomplete. DCC supervisors should confirm completion. - Sections 1 & 2: Inadequate pavement cross-fall. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 2: 200m (training length) of seal is in poor condition and it is recommended that it should be rehabilitated by the contractor during guarantee period. - Section 2 (approximate chainage 0+850): 20-30m of seal is cracked – inspection pit showed poor quality sub-grade containing organic material. It is recommended that this section be re-constructed as per specification.
		0.600	1.100	2	NH5	
		1.100	1.650	3	NH7	

Ninh Binh

Road No	Road name	Chainage		Section No	Trial Option	Comments
		From	To			
1	Do Quy	0.000	1.500	1	RR12	- Section 1: Loose stone chippings on the road surface. Requires further rolling-in by the Contractor.
		1.500	2.000	2	RR3	- Section 1: Some lengths of shoulder still require completion and then final DCP testing.
2	Dong Huong	0.000	1.500	1	RR12	- Section 1: Loose stone chippings on the road surface. Requires further rolling-in by the Contractor.
		1.500	2.000	2	RR3	- Section 2: Expansion/contraction joints require final sand bitumen sealing. - Section 2: Some lengths of shoulder still require completion and then final DCP testing.
3	Gia Phu	0.000	0.400	1	RR12	- Inadequate pavement cross-fall. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor.
		0.400	0.900	2	RR3	
		0.900	1.170	3	RR12	
4	Ninh Giang	0.000	0.850	1	RR12	- Section 1: Shoulders require compaction and final DCP testing.
		0.850	1.350	2	RR10	- Section 2: Loose chip seal material. Further rolling-in by the Contractor.
		1.350	2.482	3	RR12	
5	Ninh Van	0.000	1.200	1	RR12	
		1.200	1.700	2	RR3	
		1.700	3.415	3	RR12	
		3.415	3.915	4	RR10	
6	Thu Trung	0.000	2.000	1	RR12	- Sections 1 & 3: Some lengths of shoulder still require completion and then final DCP testing.
		2.000	3.000	2	RR8	
		3.000	3.990	3	RR12	
7	Tien Phong	0.000	1.266	1	RR12	
		1.266	1.766	2	RR1	
		1.766	3.032	3	RR12	
8	Trai Giong	0.000	0.680	1	RR12	- Section 1: Some sections of embankment slope are too steep due to land acquisition issues.
		0.680	1.180	2	RR1	
		1.180	2.950	3	RR12	
		2.950	3.450	4	RR3	
9	Yen Trach	0.000	0.500	1	RR3	- RR3: Contraction and expansion joint seals need to topped up by the Contractor.
		0.500	1.100	2	RR12	- RR3: Inspection pits showed deficiency in some of sand bedding layer. No action is recommended at this time.
		1.100	1.600	3	RR5	
		1.600	2.330	4	RR12	- RR12: Some shoulder material appeared excessively clayey. Contractor should repair any erosion of shoulders during guarantee period.
10	Yen Tu	0.000	0.500	1	RR10	- Section RR10 has deficient bitumen content and poor sealing. It is recommended that the Contractor be required to rehabilitate this seal during the guarantee period.
		0.500	1.355	2	RR12	- Section RR10 has been constructed with a poor quality (clayey) sub-base. This could cause early road base failure. This section is recommended for monitoring.

Hung Yen

Road No	Road name	Chainage		Section No	Trial Option	Comments
		From	To			
1	Hung Long	0.000	1.000	1	RR12	- Sections 1, 2 & 3. Shoulders require further compaction. This action should be confirmed by the DCC supervisor.
		1.000	1.500	2	RR9	
		1.500	2.250	3	RR15	
2	Nhat Quang	0.000	0.750	1	RR6	- Section 1. Some Irregular rough surface. No action recommended at this time. - Sections 1,2,3& 4. Shoulders require further compaction. This action should be confirmed by the DCC supervisor. - Section 2. Loose surface material. - Section 2: Cross-check on brick strengths shows 25% below revised minimum strengths. Recommend survey of road condition during guarantee period. Contractor then to repair or replace any poor areas. - Section 2. Areas of poor or deficient sand seal. Recommend assessment of condition durig guarantee period and reseal if necessary. - Section 1,2. Weak and eroding shoulders. Recommend assessment and repair during guarantee period.
		0.750	2.500	2	RR7	
		2.500	4.000	3	RR15	
		4.000	4.500	4	RR12	
3	Tan Hung	0.000	1.350	1	RR2	- Section 1. Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor. - Section 2. Cracks in concrete. These should be sealed/repaired by the contractor. - Section 2. Shoulder requires completion (60m). This action should be confirmed by the DCC supervisor.
		1.350	2.182	2	RR4	
4	Thuy Loi	0.000	0.420	1	RR7	- Section 1. Shoulder requires compaction by vibrating plate in some difficult access areas. - Section 2. Erosion of shoulder on embankment next to water (60m). Repair recommended. - Section 1. Test results indicate brick strengths 25% below revised minimum strengths. Recommend survey of road condition during guarantee period. Contractor then to repair or replace any poor areas. - Section 1. Areas of poor or deficient sand seal. Recommend assessment of condition during guarantee period and reseal if necessary.
		0.565	0.990	2	RR12	
5	Van Nhue	0.000	0.850	1	RR8	
		0.850	1.850	2	RR12	
		1.850	2.167	3	RR15	

Ha Tinh

Road No	Road name	Chainage		Section No	Trial Option	Comments
		From	To			
1	Chu Le – Dia Loi	0.000	2.300	1	NH7b	- Section 1. Loose surface material. Excess material should be rolled in or cleaned off.
		2.300	2.800	2	NH2b	- Section 2. Aggregate exposed on concrete surface, possibly poor construction procedures. Recommend review of condition after 6 months. - Section 2. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor
2	Ghenh Tang–Duc Hoa	0.000	0.683	1	NH2b	- Sections 1 & 2. Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor. - Sections 1 & 2. Shoulders require further compaction. This action should be confirmed by the DCC supervisor.
		0.741	1.840	2	NH1b	
3	Hong Loc – Thu Loc	0.000	1.633	1	NH7a	- Section 1. Loose surface material. Excess material should be rolled in or cleaned off. - Section 2. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 3. Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor. - Section 4. Local erosion/loss of second seal chippings at 5-10mm. Recommend contractor repair these areas in dry season. - Section 4. Excess penetration of bitumen into base. No action recommended at present. Surface condition to be reviewed after 6 months.
		1.633	2.233	2	NH2b	
		2.233	3.983	3	NH1b	
		3.983	6.950	4	NH7a	
4	Thach Minh – Thach Ngoc	0.000	1.000	1	NH1a	- Sections 1 & 2. Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor. - Sections 1 & 3. Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Section 2. Some cracking in slabs. Repair recommended. - Sections 2, 4 & 5. Shoulders incomplete. Completion should be confirmed by the DCC supervisor. - Section 4. Second seal missing in areas. Recommend contractor reseal poor areas. - Section 6. Loose surface material. Excess material should be rolled in or cleaned off.
		1.000	2.000	2	NH2a	
		2.000	2.950	3	NH5	
		2.950	3.250	4	NH7c	
		3.250	3.550	5	NH5	
		3.550	5.350	6	NH7c	
		5.350	5.850	7	NH7b	
5	Xuan Hoi	0.000	1.000	1	NH7a	- Section 1. About 15m of the training section surface requires further rolling.
		1.000	1.900	2	NH1b	- Section 2. Shoulder incomplete. Completion should be confirmed by DCC supervisor. - Section 2. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor.

Quang Binh

Road No	Road name	Chainage		Section No	Trial Option	Comments
		From	To			
1	Cam Lien – Ngu Thuy Trung	0.000	0.500	1	NH7	- Sections 1, 6 & 7. Loose surface material. Excess material should be rolled in or cleaned off. - Sections 1, 2, 3, 4, 5 & 8. Material with high clay content out of specification. Recommend condition be assessed at end of guarantee period and repaired if necessary. - Section 1. Excess penetration of bitumen into base. No action recommended at present. Surface condition to be reviewed after 6 months. - Section 2. Some oversize in roadbase. No action recommended at present. - Sections 2, 3 & 4. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 3. Aggregate exposed on concrete surface, possibly poor construction procedures. Recommend review of condition after 6 months. - Section 3. Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor. - Sections 5 & 6. Shoulders require shaping. - Section 8. Second seal lost in some areas. Recommend that contractor reseal these areas.
		0.500	1.000	2	NH4	
		1.000	2.000	3	NH2b	
		2.000	3.000	4	NH4	
		3.000	4.000	5	NH5	
		4.000	5.061	6	NH4	
		5.061	6.061	7	NH5	
		6.061	6.500	8	NH7	
2	Loc Ninh	0.000	0.470	1	NH7	- Section 1. Excess penetration of bitumen into base. No action recommended at present. Surface condition to be reviewed after 6 months. - Section 2. Last 100m Loose surface material. Excess material should be rolled in or cleaned off. - Section 2. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor.
		0.470	1.036	2	NH3	
3	Ngu Hoa	0.000	0.506	1	NH7	- Sections 1, 2, & 4, Shoulder material too sandy and liable to erosion. Recommend assessment of condition after 6 months. - Sections 3, 4 & 6. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 5. Last 50m. Poor quality concrete. Recommend assessing condition after 6 months. - Section 5. Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor. - Section 6. Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Section 6. Some oversize in road base. No action recommended at present.
		0.506	1.506	2	NH4	
		1.506	2.506	3	NH5	
		2.506	3.513	4	NH4	
		3.513	5.155	5	NH1b	
		5.155	5.655	6	NH7	

Gia Lai

Road No	Road name	Chainage		Section No	Trial Option	Comments
		From	To			
1	Ya Hoi	0.000	0.500	1	CH1	- Sections 1 & 2. Aggregate exposed on concrete surface, possibly poor construction procedures. Recommend review of condition after 6 months. - Sections 1 & 2. No specified grooving on surface of concrete. No action recommended at this time. - Sections 1 & 2. Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Sections 1& 2. Cross-fall not to specification. No action recommended at this time. - Section 2. Local cracks to be sealed- e.g. block 134-135 - Section 2. Possible small thickness variation below 20cm at junctions. Recommend monitoring for cracking after 6 months.
		0.500	1.400	2	CH2	
2	Ia Pnol	0.000	1.000	1	CH5	- Section 1: Loose surface sand from additional sand seal to either rolled in or cleaned off. - Section 1. Second seal chippings not to specification. Recommended that road surface condition be assessed again within guarantee period and repaired if necessary. - Section 2 No Specified grooving on surface of concrete. No action recommended at this time. - Section 2. Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Section 3. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 3. Some oversize aggregate in road base. No action recommended at this time.
		1.000	2.000	2	CH1	
		2.000	3.000	3	CH6	
		3.000	4.000	4	CH9	
3	Xa Kroong	0.000	0.500	1	CH1	- Sections 1 & 2: No specified grooving on surface of concrete. No action recommended at this time - Sections 1 & 2: Aggregate exposed on concrete surface, possibly poor construction procedures. - Recommend review of condition after 6 months. - Sections 1 & 2. Joints between concrete slabs require topping up with bitumen-sand seal. This action should be confirmed by the DCC supervisor. - Sections 1& 2: Shoulder material sandy and susceptible to erosion. Recommend contractor repair any erosion within guarantee period. - Sections 1 & 2. Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Sections 2 & 3. Inadequate pavement cross-fall. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 3. Some gravel out of specification. Condition after 6 months should be assessed.
		0.500	1.100	2	CH2	
		1.100	2.000	3	CH9	
4	Xa Song An	0.000	0.500	1	CH1	- Sections 1 & 2. Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Sections 1, 2 & 3. Inadequate pavement cross-fall. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 3. Approximately 70m of gravel construction not yet complete due to causeway construction.
		0.500	1.000	2	CH2	
		1.000	2.500	3	CH9	
5	Xa Trang	0.000	1.500	1	CH6	- Section 1. Seal chippings are coarser than specification. Recommended that road surface condition be assessed again with guarantee period and repaired if necessary. - Sections 1, 2 & 4. Inadequate pavement cross-fall. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 3. Very variable material grading leading to possible erosion. Recommended that condition be assessed again within guarantee period and repaired if necessary.
		1.500	2.000	2	CH9	
		2.000	2.500	3	CH2	
		2.500	3.000	4	CH6	

Dak Lak

Road No	Road name	Chainage		Section No	Trial Option	Comments
		From	To			
1	Buon Ho	3.700	4.166	1	CH8b	- Sections 1, 2 & 5. Loose surface material. Excess material should be rolled in or cleaned off . - Sections 1 & 3.. Soil on top of macadam shoulders should be cleaned off. - Sections 1, 2, 3, 4, & 5. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 4. Poor quality sand seal. Recommend reseal within 6months. - Section 4. Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Sections 5 & 6. Shoulder material clayey and eroded. Recommend repair by contractor.
		5.100	5.316	2	CH8b	
		8.600	9.100	3	CH5	
		9.100	10.100	4	CH4	
		10.100	12.600	5	CH3	
		12.600	14.980	6	CH3	
2	Cu Ne	0.000	1.000	1	CH5	- Section 1. First 500m requires to be resealed. Top seal chippings are too fine and not enough emulsion in place. Seal overall is too thin (4-6mm only). - Section 1. Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Section 2. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. Cu Ne road package 2 was incomplete at the time of survey. - Section 3. Sub-base only complete. - Section 4. First layer (10cm) of gravel only.
		1.000	1.873	2	CH8b	
		2.073	2.573	3	CH2	
		2.573	4.500	4	CH9	
3	Easoup	0.000	0.500	1	CH2	- Section 1. No surface grooves. No action recommended. - Section 1. Local damage to shoulders; poor material used in repair. Recommend replace with good material. - Sections 1 & 3. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Sections 2 & 3. Loose surface material. Excess material should be rolled in or cleaned off. - Section 2 Shoulders require shaping. This action should be confirmed by the DCC supervisor. - Sections 2 & 3. Some oversize in road base. No action recommended.
		0.500	2.000	2	CH8b	
		2.000	4.000	3	CH8b	

Dak Nong

Road No	Road name	Chainage		Section No	Trial Option	Comments
		From	To			
1	Kien Duc – Cai Chanh					
	Pk 1	0.000	1.300	1	CH7a	- Sections 1 & 2. Thin seal with out-of-specification chippings over significant length (>200m). Recommend reseal over lengths to be confirmed by DCC. Elsewhere loose surface chippings. Recommend either roll in or clean off. Seal to be re-assessed within guarantee period. - Sections 1 & 2. Shoulders require completion. This action should be confirmed by the DCC supervisor. - Sections 1 & 2. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor.
		1.300	2.750	2	CH7c	
	Pk 2	2.750	5.350	1	CH7	- Seal chippings out of specification. Seal condition to be assessed within guarantee period. - Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor.
	Pk 3	5.350	6.785	1	CH7	- Section 1. Thin seal with out-of-specification chippings and loose material over significant length (>200m). Recommend reseal over lengths to be confirmed by DCC. - Section 1. Some shoulders require completion or shaping. This action should be confirmed by the DCC supervisor. - Sections 1 & 2.Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 2. Some edge damage to pavement. Contractor should repair. - Section 2. Shoulders not constructed over 50% of section. Completion to be confirmed by DCC.
		6.785	7.41	2	CH2	
	Pk 4	0.000	0.700	1	CH7b	- Sections 1, 3 & 4. Seal chippings out of specification. Seal condition to be assessed within guarantee period. - Sections 1 & 4. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Sections 2 & 3. Some shoulders require shaping. This action should be confirmed by the DCC supervisor.
		0.700	1.000	2	CH8	
		1.000	1.600	3	CH7	
		1.600	2.500	4	CH7a	
	Pk 5	2.500	3.000	1	CH7	- Sections 1. Seal with out-of-specification chippings, second seal effectively missing over significant lengths. Recommend reseal over lengths to be confirmed by DCC. - Section 1. Some shoulders require shaping. This action should be confirmed by the DCC supervisor. - Section 1 & 2. Cross-fall not to specification. No action is recommended at this stage. Any damage due to edge flooding during guarantee period to be repaired by contractor. - Section 2. Some material out of specification. QCC to cross check with laboratory results.
		3.000	4.000	2	CH9	

APPENDIX E

RRST-II As Built Survey Data

Appendix E2: ITST Monitoring Section Pavement Condition Data

The initial "As Built" survey of identified RRST-II monitoring sections was completed by ITST as part of the RRST-II Module Contract with SEACAP. The fieldwork was undertaken following a short on-site training period organized by Intech-TRL. Data collection progress and summaries of results are included within the Final ITST Project Report.

For completeness sake Table E2.1 describes the nature and location of this ITST data within the RRSR Database, whilst Table E2.2 lists the location of each monitoring section.

Intech-TRL had a contractual responsibility to select the monitoring sections and advise ITST on fieldwork and data collation procedures. Intech-TRL also reviewed the data sets in general terms to ensure their completeness and commented on apparent discrepancies. Intech-TRL had no means of cross-checking raw data sets and can accept no responsibility for their accuracy.

Data Set	**Files**	**Comment**
Visual assessments	visual.xls files held within each provincial folder	Field coded data sheets transcribed onto EXCEL sheets for each monitored section
MERLIN roughness data	IRI-data.xls files held within each provincial folder.	MERLIN raw data calculated on spreadsheets
	IRI-sum.xls files held within each provincial folder	Summaries of IRI data for each monitored section
Unsealed controls section level data	Level.xls files held within each provincial folder	Tabulated cross section level data referenced to local TBMs.
DCP data	DCP.xls files held within each provincial folder.	Field DCP data transferred to electronic forms.

Table E2.1: RRST-II As Built Data Sets

Province	Road	Id-Ref	From	To	Type	Length(m)	Design	Refrence
Dak Lak	Buon Ho	Bh3	8.800	8.900	Trial	100	CH5	DL(2)-1
Dak Lak	Buon Ho	Bh4	9.700	9.800	Trial	100	CH4	DL(2)-2
Dak Lak	Buon Ho	Bh5	11.500	11.600	Trial	100	CH3	DL(2)-3
Dak Lak	Buon Ho	Bh6	13.200	13.300	Trial	100	CH3	DL(2)-4
Dak Lak	Cu Ne	Cn1	0.150	0.250	Trial	100	CH5	DL(1)-1
Dak Lak	Cu Ne	Cn2	1.600	1.700	Control	100	CH8b	DL(1)-2
Dak Lak	Ea Soup	Es1	0.220	0.320	Trial	100	CH2b	DL(3)-1
Dak Lak	Ea Soup	Es1	0.150	0.230	Trial	80	CH2b	DL(3)-1a
Dak Lak	Ea Soup	Es2	1.200	1.300	Control	100	CH8b	DL(3)-2
Dak Nong	Kien Duc	Kd01	0.045	0.145	Trial	100	CH7	DN(1)-1
Dak Nong	Kien Duc	Kd02	1.600	1.700	Trial	100	CH7a	DN(1)-2
Dak Nong	Kien Duc	Kd03	4.000	4.100	Trial	100	CH7	DN(1)-3
Dak Nong	Kien Duc	Kd04	5.850	5.950	Trial	100	CH7	DN(1)-4
Dak Nong	Kien Duc	Kd05	6.900	7.000	Trial	100	CH2b	DN(1)-5
Dak Nong	Kien Duc	Kd06	0.060	0.160	Trial	100	CH7b	DN(2)-1
Dak Nong	Kien Duc	Kd07	0.800	0.900	Control	100	CH8	DN(2)-2
Dak Nong	Kien Duc	Kd08	1.200	1.300	Trial	100	CH7	DN(2)-3
Dak Nong	Kien Duc	Kd10	2.700	2.800	Trial	100	CH7	DN(2)-4
Dak Nong	Kien Duc	Kd11	3.250	3.450	Control	100	CH9	DN(2)-5a
Dak Nong	Kien Duc	Kd11	3.675	3.775	Control	100	CH9	DN(2)-5b
Gia Lai	Ia Pnol	Ip1	0.400	0.500	Trial	100	CH5	GL(1)-1
Gia Lai	Ia Pnol	Ip2	1.900	2.000	Trial	100	CH1	GL(1)-2
Gia Lai	Ia Pnol	Ip3	2.200	2.300	Trial	100	CH6a	GL(1)-3
Gia Lai	Ia Pnol	Ip4	3.000	3.200	Control	200	CH9	GL(1)-4
Gia Lai	Xa Trang	Xtr1	0.900	1.000	Trial	100	CH6	GL(2)-1
Gia Lai	Xa Trang	Xtr2	1.700	1.800	Control	100	CH9	GL(2)-2
Gia Lai	Xa Trang	Xtr2	1.500	1.600	Control	100	CH9	GL(2)-2a
Gia Lai	Xa Trang	Xtr3	2.060	2.160	Trial	100	CH2a	GL(2)-3
Gia Lai	Xa Trang	Xtr4	2.200	2.300	Trial	100	CH9	GL(2)-4
Ha Tinh	Chu Le	CL1	0.100	0.200	Control	100	NH7b	HT(3)-1
Ha Tinh	Chu Le	CL2	2.600	2.700	Trial	100	NH2b	HT(3)-2
Ha Tinh	Hong Loc	Hl1	0.050	0.150	Control	100	NH7a	HT(2)-1
Ha Tinh	Hong Loc	Hl2	1.710	1.810	Trial	100	NH2b	HT(2)-2
Ha Tinh	Hong Loc	Hl3	2.700	2.800	Trial	100	NH1b	HT(2)-3
Ha Tinh	Thac Minh	Tm1	0.100	0.200	Trial	100	NH1a	HT(1)-1
Ha Tinh	Thac Minh	Tm2	1.300	1.400	Trial	100	NH2a	HT(1)-2
Ha Tinh	Thac Minh	Tm3	2.050	2.150	Trial	100	NH5	HT(1)-3
Ha Tinh	Thac Minh	Tm6	4.000	4.100	Control	100	NH7c	HT(1)-4
Ha Tinh	Thac Minh	Tm7	5.700	5.800	Control	100	NH7b	HT(1)-5
Hung Yen	Hung Long	Hlg2	1.200	1.300	Trial	100	RR9	HY(3)-1
Hung Yen	Hung Long	Hlg3	1.800	1.900	Control	100	RR15	HY(3)-2a
Hung Yen	Hung Long	Hlg3	1.500	1.600	Control	100	RR15	HY(3)-2
Hung Yen	Nhat Quang	Nq1	0.650	0.750	Trial	100	RR6	HY(2)-1
Hung Yen	Nhat Quang	Nq2	1.050	1.250	Trial	200	RR7	HY(2)-2a
Hung Yen	Nhat Quang	Nq2	0.750	0.850	Trial	100	RR7	HY(2)-2
Hung Yen	Nhat Quang	Nq3	2.600	2.700	Control	100	RR15	HY(2)-3
Hung Yen	Nhat Quang	Nq4	4.000	4.100	Control	100	RR12	HY(2)-4
Hung Yen	Tan Hung	Th1	1.250	1.350	Trial	100	RR2	HY(1)-1
Hung Yen	Tan Hung	Th2	1.350	1.450	Trial	100	RR4	HY(1)-2
Hung Yen	Thuy Loi	Tl1	0.050	0.150	Trial	100	RR7	HY(4)-1
Ninh Binh	Dong Huong	Dh1	1.300	1.400	Control	100	RR12	NB(1)-1
Ninh Binh	Dong Huong	Dh1	1.400	1.500	Control	100	RR12	NB(1)-1a
Ninh Binh	Dong Huong	Dh2	1.500	1.600	Trial	100	RR3	NB(1)-2
Ninh Binh	Ninh Van	Nv4	3.700	3.600	Trial	100	RR10	NB(4)-1
Ninh Binh	Yen Trach	Yt2	1.000	1.100	Control	100	RR12	NB(2)-1a
Ninh Binh	Yen Trach	Yt2	0.600	0.700	Control	100	RR12	NB(2)-1
Ninh Binh	Yen Trach	Yt3	1.300	1.400	Trial	100	RR5	NB(2)-2
Ninh Binh	Yen Trach	Yt3	1.500	1.600	Trial	100	RR5	NB(2)-2a
Ninh Binh	Yen Trach	Yt4	1.800	1.900	Control	100	RR12	NB(2)-3
Ninh Binh	Yen Trach	Yt4	1.600	1.700	Control	100	RR12	NB(2)-3a
Ninh Binh	Yen Tu	Ynt1	0.200	0.300	Trial	100	RR10	NB(3)-1
Ninh Binh	Yen Tu	Ynt2	1.100	1.200	Control	100	RR12	NB(3)-2
Ninh Binh	Yen Tu	Ynt2	0.500	0.600	Control	100	RR12	NB(3)-1

Table E2.2: RRST-II Monitoring Sections

Province	Road	Id-Ref	From	To	Type	Length(m)	Design	Refrence
Quang Binh	Cam Lien	CmL2	0.900	1.000	Trial	100	NH4b	QB(2)-1
Quang Binh	Cam Lien	CmL3	1.005	1.105	Trial	100	NH2b	QB(2)-2
Quang Binh	Cam Lien	CmL4	2.000	2.100	Trial	100	NH4b	QB(2)-3
Quang Binh	Cam Lien	CmL7	5.900	6.000	Trial	100	NH5	QB(3)-1
Quang Binh	Cam Lien	CmL8	6.000	6.100	Control	100	NH7	QB(3)-1
Quang Binh	Ngu Hoa	Ng2	0.600	0.700	Trial	100	NH4	QB(1)-1
Quang Binh	Ngu Hoa	Ng3	2.200	2.300	Trial	100	NH5	QB(1)-1
Quang Binh	Ngu Hoa	Ng5	3.910	4.010	Trial	100	NH1b	QB(1)-1
Tuyen Quang	Lang Quan	Lq1	0.750	0.950	Trial	100	NH5	TQ(1)-1
Tuyen Quang	Lang Quan	Lq2	1.000	1.100	Trial	100	NH1d	TQ(1)-2
Tuyen Quang	Lang Quan	Lq3	2.100	2.200	Control	100	NH7	TQ(1)-3
Tuyen Quang	Lang Quan	Lq4	3.000	3.100	Trial	100	NH2c	TQ(1)-4
Tuyen Quang	Lang Quan	Lq5	3.775	3.875	Trial	100	NH2d	TQ(1)-5
Tuyen Quang	Y La	Y12	0.600	0.700	Trial	100	NH5	TQ(2)-1a
Tuyen Quang	Y La	Yl2	0.300	0.400	Trial	100	NH5	TQ(2)-1

Table E2.2: RRST-II Monitoring Sections (Ctnd)

RRST VIETNAM
SEACAP 1
FINAL REPORT

APPENDIX F

RRST-I Falling Weight Deflectometer (FWD) Survey

RRST FINAL REPORT

SHEET 1

APPENDIX G

SUMMARY OF RRST-I FWD SURVEYS, July 2006

HUE Province

TRIAL SECTION	LAYER 1	LAYER 2	Pavement thickness (cm)	Resilient Modulus E1 (Mpa)	Resilient Modulus E2 (Mpa)	Resilient Modulus Subgrade Mr (Mpa)	Effective Resilient Modulus Ep (Mpa)
H2	Bamboo Reinforced Concrete on sand bedding layer	Natural Gravel Sub - base	30.3	22,279	146	21	437
H4	Penetration macadam	Water bound macadam	26.5	1,431	234	20	205
H6	Sand emulsion seal on concrete bricks on sand bedding layer	Natural Gravel Sub - base	32.6	472	159	33	125
H7	Sand emulsion seal on concrete bricks on sand bedding layer	Dry bound macadam	32.2	280	185	19	163
H9	Sand emulsion seal on stone chip emulsion seal on 7cm armouring layer	Natural Gravel Sub - base	28.4	223	179	18	126
H11	20cm Mortared dressed stone on sand bedding layer	Natural Gravel Sub - base	33.3	2,344	200	17	334
H3	Natural Gravel base	Natural Gravel Sub - base	20.4	285	216	22	218

RRST FINAL REPORT

SHEET 2

APPENDIX G

SUMMARY OF RRST - I FWD SURVEYS, July 2006

DA NANG Province

TRIAL SECTION	LAYER 1	LAYER 2	Pavement thickness (cm)	Resilient Modulus E1 (Mpa)	Resilient Modulus E2 (Mpa)	Resilient Modulus SubgradeM r (Mpa)	Effective Resilient Modulus Ep (Mpa)
DaN2	Steel Reinforced Concrete on sand bedding layer	Sand Sub - base	30.1	10,211	190	16	356
DaN3	Sand emulsion seal on stone chip emulsion seal on cememt stabilised local soil	Cement stabilised local soil Sub-base	31.0	1,434	583	18	340
DaN4	Sand emulsion seal on stone chip emulsion seal on cememt stabilised local soil	Emulsion stabilised local soil Sub-base	31.0	707	339	14	230
DaN5	Penetration macadam	Water bound macadam	26.5	358	352	17	221

RRST FINAL REPORT

SHEET 3

APPENDIX G

SUMMARY OF RRST - I FWD SURVEYS, July 2006

TIEN GIANG Province

TRIAL SECTION	LAYER 1	LAYER 2	Pavement thickness (cm)	Resilient Modulus E1 (Mpa)	Resilient Modulus E2 (Mpa)	Resilient Modulus SubgradeM r (Mpa)	Effective Resilient Modulus Ep (Mpa)
T2	Bamboo Reinforced Concrete on sand bedding layer	Lime stabilised local soil Sub-base	32.3	18,884	99	15	312
T3	Steel Reinforced Concrete on sand bedding layer	Lime stabilised local soil Sub-base	32.5	15,480	120	15	311
T5	Sand emulsion seal on stone chip emulsion seal on Dry bound macadam	Sand Sub-base	33.4	356	88	20	160
T6	Sand emulsion seal on stone chip emulsion seal on lime stabilised local soil	Lime stabilised local soil Sub-base	31.0	116	59	17	57
T7	Penetration macadam	Water bound macadam	26.6	2,574	155	18	157
T9	Bamboo Reinforced Concrete on sand bedding layer	Sand Sub-base	30.3	18,265	72	15	322

RRST FINAL REPORT

SHEET 4

APPENDIX G

SUMMARY OF RRST - I FWD SURVEYS, July 2006

DONG THAP Province

TRIAL SECTION	LAYER 1	LAYER 2	Pavement thickness (cm)	Resilient Modulus E1 (Mpa)	Resilient Modulus E2 (Mpa)	Resilient Modulus SubgradeM r (Mpa)	Effective Resilient Modulus Ep (Mpa)
D2	Bamboo Reinforced Concrete on sand bedding layer	Lime stabilised local soil Sub-base	32.0	14,622	137	17	359
D3	Steel Reinforced Concrete on sand bedding layer	Lime stabilised local soil Sub-base	32.1	32,022	112	22	455
D5	Sand emulsion seal on stone chip emulsion seal on Dry bound macadam	Fines stone Sub-base	33.4	281	47	21	137
D6	Sand emulsion seal on stone chip emulsion seal on lime stabilised local soil	Lime stabilised local soil Sub-base	31.0	411	112	15	74
D7	Penetration macadam	Water bound macadam	26.3	4,216	107	16	109
D10	Mortared fired clay bricks on sand bedding layer	Cement stabilised local soil Sub-base	30.0	5,885	137	20	258
D11	Sand emulsion seal on fired clay bricks on sand bedding layer	Cement stabilised local soil Sub-base	28.7	324	188	19	142
D12	Sand emulsion seal on fired clay bricks on sand bedding layer	Dry bound macadam Sub-base	28.1	523	346	23	228

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APPENDIX G

The RRSR Database

Appendix G1 **Overall Database Content**

Appendix G2 **ACCESS Database Content**

APPENDIX G

The RRSR Database

Appendix G1: Overall Database Content

This Appendix G1 contains a list of the current RRSR database folders and a summary of the key files contained in them, Table G1.1.

The main file **"*Database-RRSR***" contains information from three principal SEACAP programmes

1. RRST-I trials - SEACAP 1
2. RRST-II trials – SEACAP 1
3. RRGAP road condition survey – SEACAP 4

Data from programmes 1 and 3 were collected and assessed under the direct management of Intech-TRL. Data from programme 2 were collected and collated by ITST under a direct contract with SEACAP for which Intech-TRL had an overall planning and management role, but no direct responsibility for information quality assurance.

It is likely that as the SEACAP monitoring programme develops the file structure particularly that of ***"RRST-II Monitoring"*** will expand.

Database-RRSR Folders			File descriptions
SC1			
	Environment		.xls tables or relevant rainfall and traffic data
	RRST Costs		.xls tables of RRST-I and RRST-I construction costs
	RRST-1 Monitoring		ACCESS database file of trials data
		1.Tien Giang	
		DCP.TG	.ukdcp and .xls files of DCP field testing
		IRI-TG	Interpreted data files from MERLIN testing
		Levels-TG	.xls level data and cross section plots
		Visual-TG	Tabulated coded visual condition data in .xls files
		2.Dong Thap	
		DCP.TG	.ukdcp and .xls files of DCP field testing
		IRI-TG	Interpreted data files from MERLIN testing
		Levels-TG	.xls level data and cross section plots
		Visual-TG	Tabulated coded visual condition data in .xls files
		3.Hue	
		DCP.TG	.ukdcp and .xls files of DCP field testing
		IRI-TG	Interpreted data files from MERLIN testing
		Levels-TG	.xls level data and cross section plots
		Visual-TG	Tabulated coded visual condition data in .xls files
		4.DaNang	
		DCP.TG	.ukdcp and .xls files of DCP field testing
		IRI-TG	Interpreted data files from MERLIN testing
		Levels-TG	.xls level data and cross section plots
		Visual-TG	Tabulated coded visual condition data in .xls files
	RRST-II Monitoring		
		1.Tuyen Quang	As built monitoring section data in .xls files
		2.Hung Yen	As built monitoring section data in .xls files
		3.Ninh Binh	As built monitoring section data in .xls files
		4. Ha Tinh	As built monitoring section data in .xls files
		5. Quang Binh	As built monitoring section data in .xls files
		6. Gia Lai	As built monitoring section data in .xls files
		7.Dak Lak	As built monitoring section data in .xls files
		8.Dak Nong	As built monitoring section data in .xls files
SC4			
	RRGAP-Data		ACCESS database file of unsealed road condition field data
		Lab_Data	.xls files of laboratory tests on unsealed road material samples

Table G1.1 Database Files

APPENDIX G

The RRSR Database

Appendix G2: ACCESS Database Content

The RRSR database contains 2 ACCESS files comprising data tables, data input forms and some pre-designed associated queries and report. The latter may of course be re-designed to suit user needs. The 2 ACCESS files and their associated data tables are summarised in Table G2.1.

SCAP1-Trials	
Tables	
Sections	Location and construction data on each trial section
Monitoring	General information on each monitoring section
Labtest-RRST-I	Laboratory test data from RRST-I trials
RRGAP-2005	
Tables	
Road	Data on each road surveyed
Profile	Condition data on each profile
PDOT	Background road environment information

TableG2.1: ACCESS Data Tables

Information is laid out within each data table as shown in Figure G2.1. This data may be sorted, queried and reported using standard ACCESS tools.

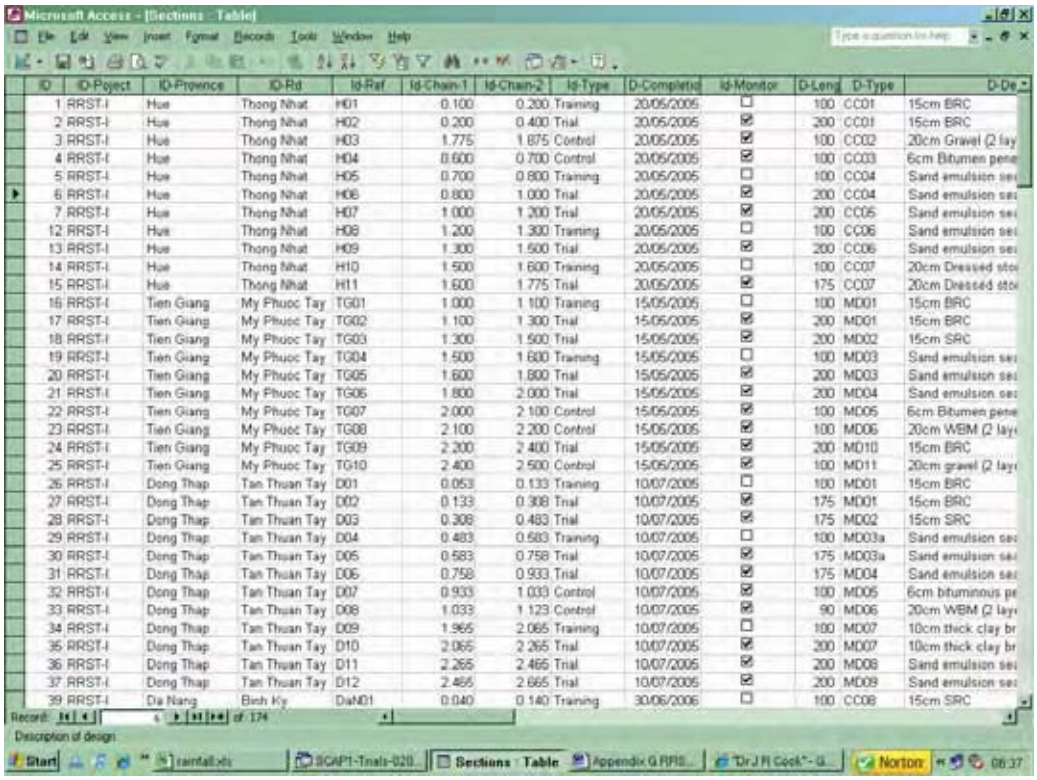

Figure G2.1: Screen Print of Sections Table in SEACAP1-Trials.mdb

Descriptions of fields within each data table may be accessed by clicking on the “design view” option in each data table; example Figure G2.2.

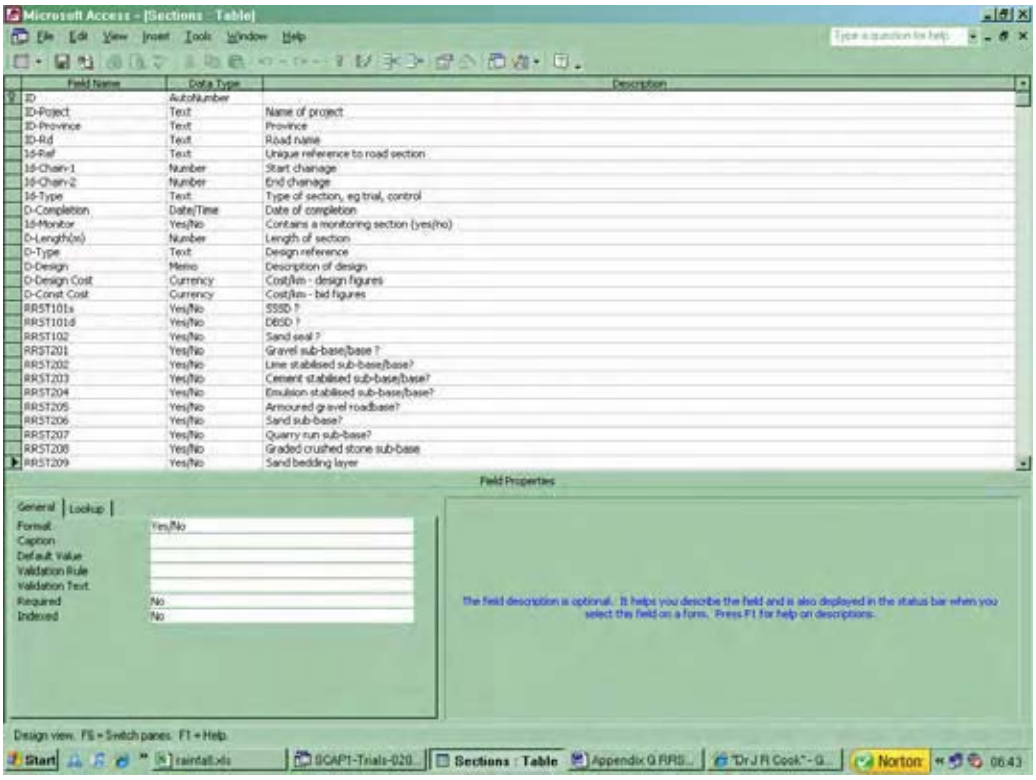

Figure G2.2: Design View of "Sections" Table in SACAP1-Trials.mdb

Data may be entered, as well as viewed and edited using input forms designed for key data tables, for examples see Figures G2.3 to G2.5. Input forms in RRGAP-2005.mdb are available in Vietnamese as well as English.

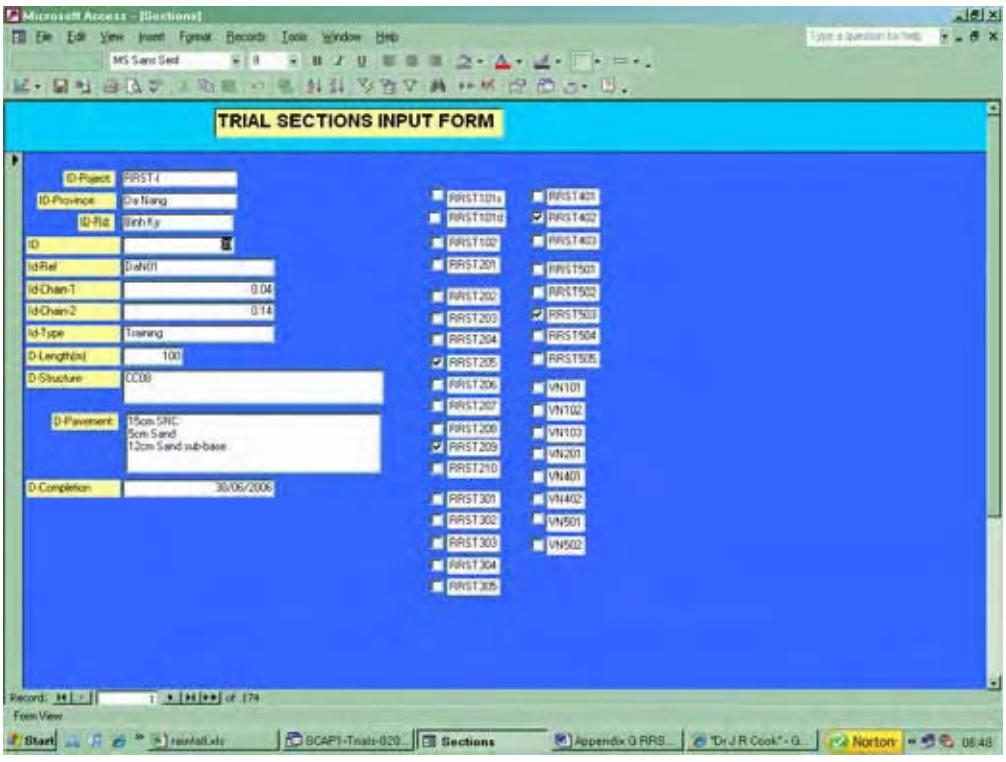

Figure G2.3: "Sections" Input Form in SEACAP1-Trials.mdb

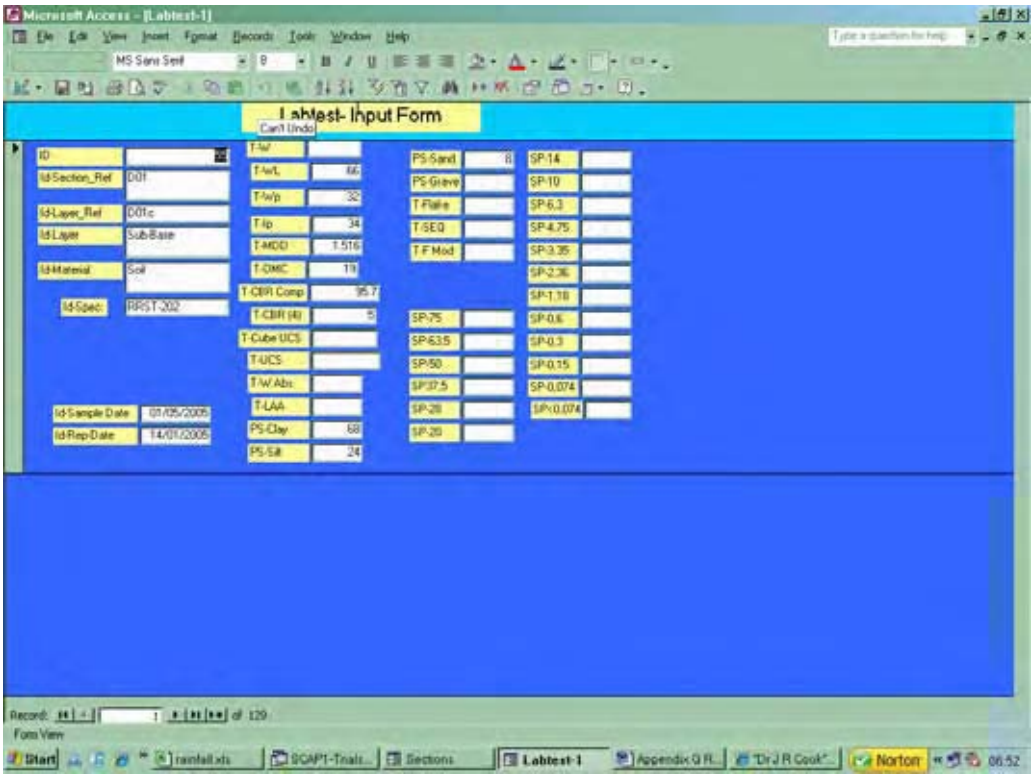

Figure G2.4: "Labtest" Input Form in SEACAP1-Trials.mdb

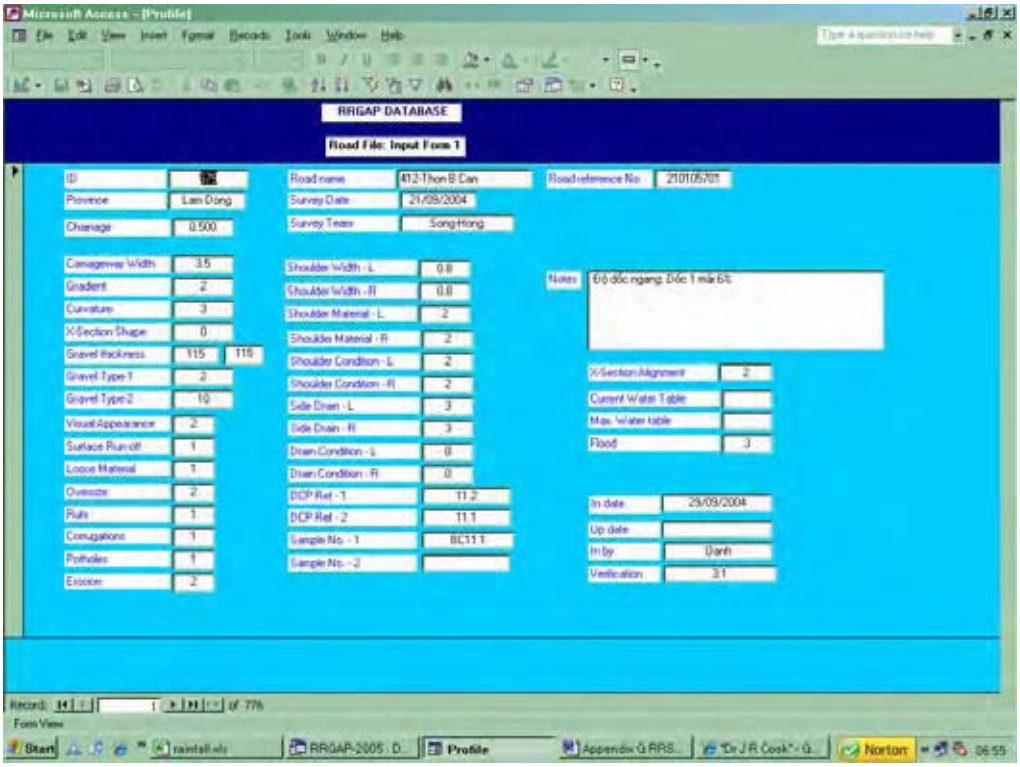

Figure G2.5: "Sections" Input Form in RRGAP-2005.mdb

Data from the information table may either reported using ACCESS tools, as per example Figures G2.6, or by exporting into EXCEL Format.

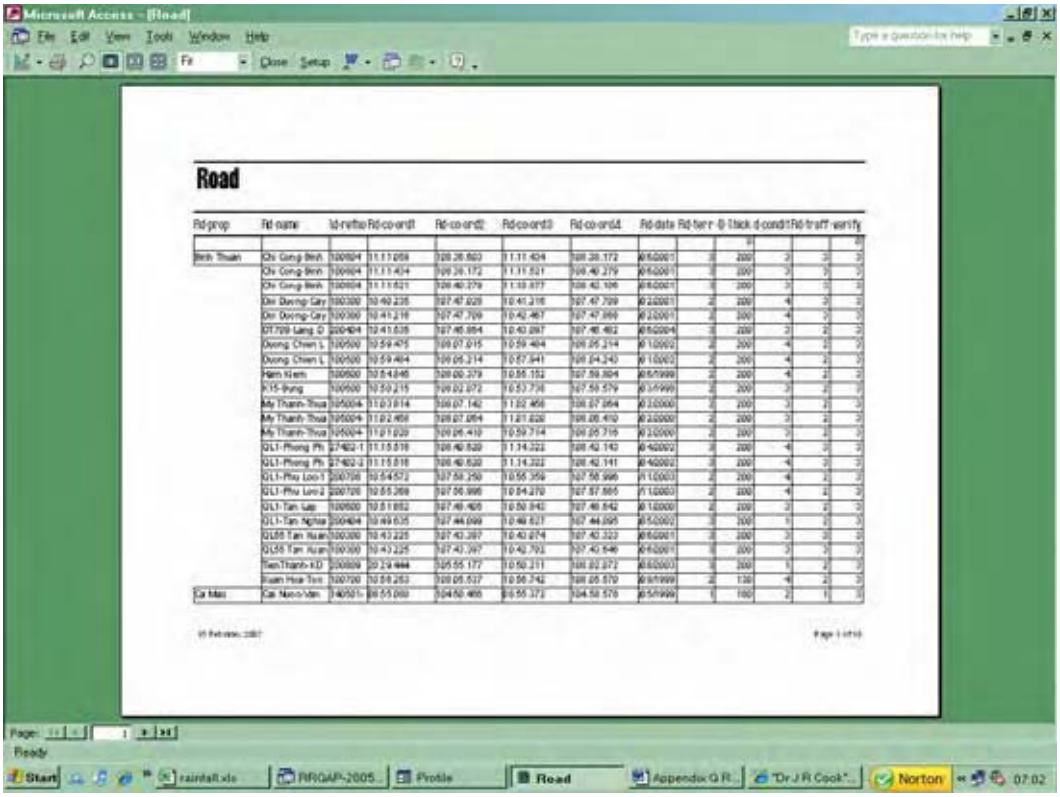

Figure G2.6: Typical Report Form from RRGAP-2005mdb

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APPENDIX H

Outline Surfacing Option Selection Procedures

1 INTRODUCTION

The following sections outline a general procedure for selecting appropriate low volume rural road pavements. This outline procedure is based on research work undertaken as part of the Rural Road Surfacing Research (RRSR) programme by Intech-TRL, in conjunction with other available international experience.

It is anticipated that this outline will be upgraded with the experiences and knowledge to be obtained from the planned RRST-I and RRST-II trials monitoring programme.

2 PRINCIPLES

The procedures for the selection of low volume rural roads are based on two key principles:

1. The pavements must be fit for purpose in terms of traffic volume and axle loads,
2. The pavements should be compatible with the governing road environment factors.

The above two principles are an extension of the traditional approach to pavement design which is based predominantly on traffic/axle load and sub-grade strength. Experience is increasingly indicating that in the case of low volume rural roads this approach is inadequate and that additional road environment factors must be taken into account if the selected designs are to be sustainable in engineering, social and economic terms. The factors proposed for consideration in pavement selection are summarised in Table G1 below.

Factor	Description
Construction Materials	The nature, engineering character and location of construction materials are key aspects of the road environment assessment.
Climate.	The prevailing climate will influence the supply (and movement) of water. Climate impacts upon the road in terms of direct erosion through run-off, influence on the groundwater regime (hydrology), the moisture regime within the pavement, and accessibility for maintenance.
Surface and sub-surface hydrology**.**	It is often the interaction of water, within and adjacent to the road structure that has an over-arching impact on the road performance.
Terrain	The terrain, whether flat, rolling or mountainous, reflects the geological and geomorphological history. Apart from its obvious influence on the long section geometry (grade) of the road, the characteristics of the terrain will also reflect and influence the occurrence and type of soils present.
Sub-Grade Conditions	The sub-grade is essentially the foundation layer for the pavement and as such the assessment of its condition is fundamental.
Traffic/Axle loads	Due consideration needs to be given to the influence of traffic on the performance of the structure, including vehicle types, size, loading and user behaviour . The deterioration of paved roads caused by traffic results primarily from both the magnitude of the individual wheel loads and the number of times these loads are applied. However, road environment, and construction and maintenance regimes can influence rates of surface and pavement deterioration.
Construction Regime	The construction regime governs whether or not the road design is applied in an appropriate manner. Key elements include: • Appropriate plant use • Selection and placement of materials • Quality assurance • Compliance with specification • Technical supervision
Maintenance Regime	All roads, however designed and constructed will require varying degrees of regular maintenance to ensure that the design life is reached. Achieving this will depend on the maintenance strategies adopted, the timeliness of the interventions, the local capacity and available funding to carry out the necessary works.

.**Table G1: Road Environment Factors**

3 GENERAL APPROACH

A two phase selection approach is proposed (Figure G1) as follows:

Phase I: Identification of appropriate pavement types compatible with the road environment.

Phase II: Detailed design of the selected pavement components (e.g. layer thicknesses) compatible with engineering standards and requirements – i.e. traffic, axle load and sub-grade strength.

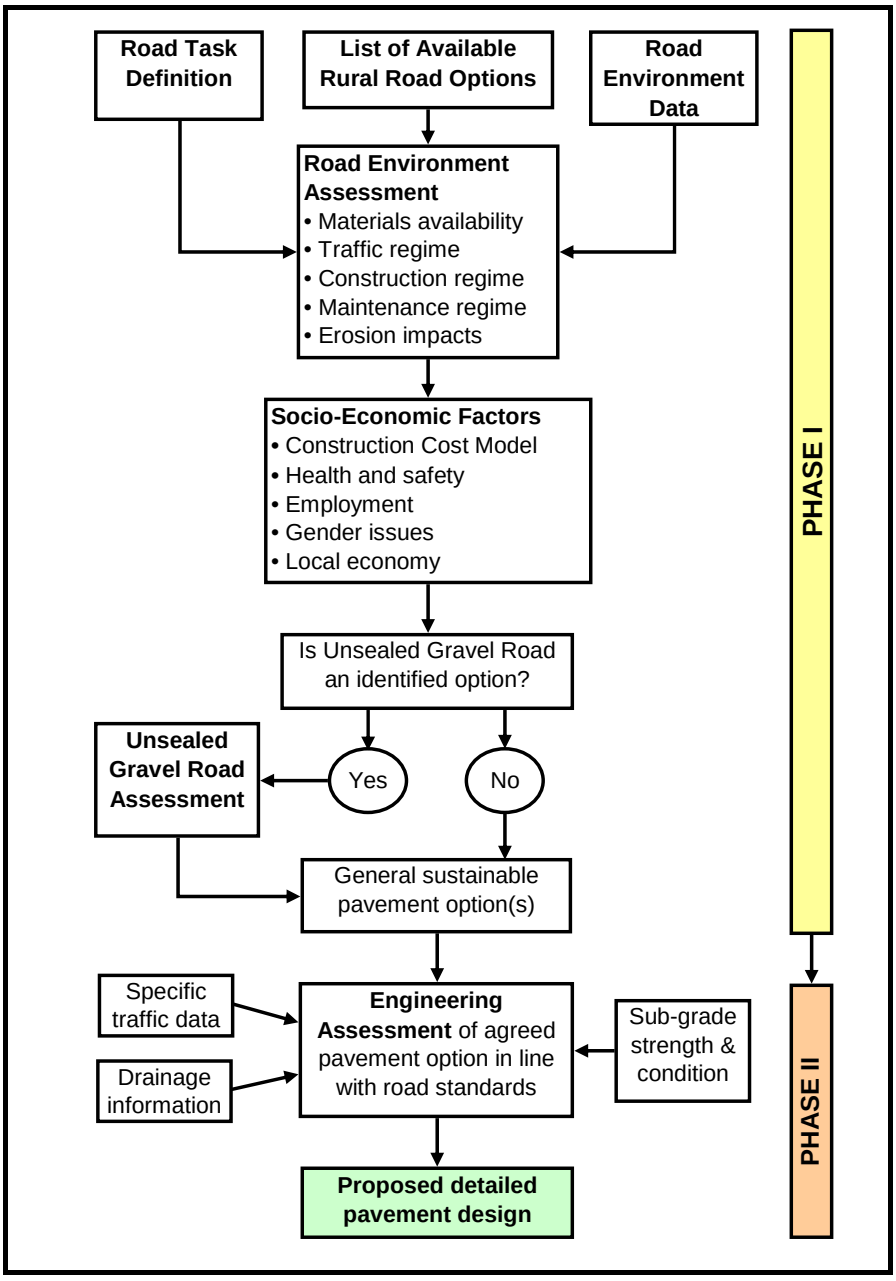


Figure G1: General Selection Process

4 PHASE-I Activities

1. Define the **task** required to be fulfilled by the road. This should include undertaking some form of **traffic survey** and an assessment of likely **axle loads.**
2. Collate a preliminary list of potential **paving options**. This list may be a long list of all possible options, or it could be a modified list based on regional factors.
3. Undertake a **road environment survey** of the proposed route or road to be upgraded. This may be carried out using a combination of standard forms (as used in RRST-I and RRST-II) and in situ testing with either a Dynamic Cone Penetrometer (DCP) or Modulus apparatus. Data from DCP testing can be interpreted in terms of either California Bearing Ratio (CBR) or Resilient Modulus using established formulae. Key information to be collected includes:
    - Gradient
    - Sub-grade strength
    - Sub-grade soil types
    - Local material availability, hauls and costs
    - Existing road condition
    - Apparent water table
4. Collect **background information** from provincial and district authorities on:-
    - Rainfall
    - Flooding and specific problem road sections
    - Maintenance operations (arrangements, achievements & constraints)
    - Construction company capabilities
    - Previous experience with roads in the area
5. Collate and assess all data using relevant **RRSR matrices and tables** (see TablesG2 –G5) and carry forward a shortened list for Social, Economic and Stakeholder Review. If unsealed gravel surfacing is an identified option, refer to Section 6 on **Guidance Gravel Surfacing Selection Flow Chart**, Figure G2. A suggested further assessment (Figure G3) is also proposed.
6. Undertake a **Social, Economic and Stakeholder Review** to produce a final short list of suitable design options and carry this forward to Phase II. The use of the **RRSR Cost Model** is recommended as part of a ranking process in terms of **Whole-Life Costs.**
7. The foregoing procedure may identify particular sections of the route which would justify a different paving approach (e.g. flood prone, steep hill, village housing, high water table, etc.). It may be appropriate to apply a differential or spot improvement solution to more demanding locations/sections.

5 PHASE – II Activity

1. Where relevant use appropriate Vietnamese standards to define pavement layer thicknesses.
2. Where this is not possible refer to RRSR Guidance Notes (SEACAP 1 Report) on special case options (eg bricks, cobble stones, stone setts).
3. Design pavement drainage in accordance with relevant Vietnamese standard and the assess drainage requirements.
4. For special cases, e.g. expected high axle loading, refer to international guidance documentation.

Primary Engineering Filter																												
	Seals and Load Bearing Surfaces										**Bases**									**Sub-Bases**						**Shoulders**			
Economically available Materials	Sand seal	Chip seal	Penetration macadam	Steel reinforced concrete	Bamboo reinforced concrete	Engineering clay bricks	Concrete bricks	Stone setts	Unsealed wet/dry macadam	Unsealed gravel	Waterbound macadam	Drybound macadam	Natural gravel	Armoured gravel	Cement stabilised soil	Lime stabilisede soil	Emulsion stabilised soil	Waterbound macadam	Drybound macadam	Natural gravel	Cement stabilised soil	Lime stabilisede soil	Emulsion stabilised soil	Macadam	Natural gravel	Cement stabilised soil	Lime stabilisede soil
Crushed stone aggregate		√	√	√	√		√		√		√	√		√				√	√					√				
Stone blocks								√																				
Laterite gravel										√			√	√						√					√			
Colluvial/alluvial gravel										√			√	√						√					√			
Weathered rock														√						√					√			
Fired clay bricks						√																						
Clay soil						√										√						√						√
Sand	√			√	√		√								√		√				√		√			√		
Cement				√	√		√								√						√					√		
Lime																√						√						√
Bitumen			√																									
Bitumen Emulsion	√	√															√						√					

√ Indicates suitable for evaluation

Table G2: Materials Selection Matrix

Secondary Engineering Filters																												
	Seals and Load Bearing Surfaces										**Bases**							**Sub-Bases**						**Shoulders**			
	Sand seal	Chip seal	Penetration macadam	Steel reinforced concrete	Bamboo reinforced concrete	Engineering clay bricks	Concrete bricks	Stone setts	Unsealed wet/dry macadam	Unsealed gravel	Waterbound macadam	Drybound macadam	Natural gravel	Armoured gravel	Cement stabilised soil	Lime stabilisede soil	Emulsion stabilised soil	Waterbound macadam	Drybound macadam	Natural gravel	Cement stabilised soil	Lime stabilisede soil	Emulsion stabilised soil	Macadam	Natural gravel	Cement stabilised soil	Lime stabilisede soil
Traffic																												
Light Traffic	√	√	√			√	√		√	√	√	√	√	√	√	√		√	√	√	√	√	√				
Moderate traffic	√	√	√	√	√	√	√	√	√		√	√	√	√	√		√	√	√	√	√	√	√				
Heavry traffic (overload risk)		√	√	√	√						√	√						√	√	√	√						
Construction Regime																												
High labour-base content	√	√		√	√	√	√	√																				
Intermedite machinary			√	√	√				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Low cost	√									√			√	√	√	√				√	√	√		√	√		√
Moderate cost		√	√			√	√	√	√		√	√						√	√				√	√		√	
High cost				√	√												√											
Maintenace Requirement																												
Low				√	√	√	√	√			√	√	√	√	√	√												
Moderate	√	√	√														√							√		√	√
High									√	√															√			
Erosion Regime (See Table)																												
A Low erosion regime	√	√	√	√	√	√	√	√	√	√														√	√	√	√
B Moderate erosion regime		√	√	√	√	√	√	√																√			
C High erosion regime			√	√	√			√																			
D Very high erosion regime			√	√	√			√																			

√ Indicates suitable for evaluation

Table G3: Secondary Engineering Matrix

Indicative Category	Traffic Description
Light	Mainly non-motorised, motorbikes & less than 25 motor vehicles per day, with few medium/heavy vehicles. No access for overloaded vehicles. Typical of a Rural Road with individual axle loads up to 2.5 tonne (Class A & B roads).
Moderate	Up to about 100 motor vehicles per day including up to 20 medium (10 tonne) goods vehicles, with no significant overloading. Typical of a Rural Road with individual axle loads up to 6 tonne (Class VI roads).
High	Accessible by all vehicle types including heavy and multi-axle (3 axle +) trucks, construction & timber materials haulage routes. Specific design guidance to be developed.

Table G4: Definition of Indicative Traffic Regime

	Annual Rainfall (mm)			
	<1000	**1000-2500**	**2500-4000**	**>4000**
Gradient				
Flat <1%	A	A	B	C
Moderate 1-3%	A	B	B	C
High 3-6%	B	C	C	D
Very High >6%	C	C	D	D

Erosion Potential

A	Low
B	Moderate
C	High
D	Very High

Table G5: Definition of Erosion Potential

.6 Unsealed Gravel Road Assessment

Decision Management System for the Evaluation of the suitability of Gravel/laterite as a rural road surface option.

INTRODUCTION

The Decision Management System is based on the research carried out in Vietnam under the SEACAP 4 Rural Roads Gravel Assessment Programme (RRGAP), and SEACAP 1 Rural Road Surfacing Trials (RRST) by Intech-TRL under DFID and SEACAP support programmes for the Ministry of Transport.

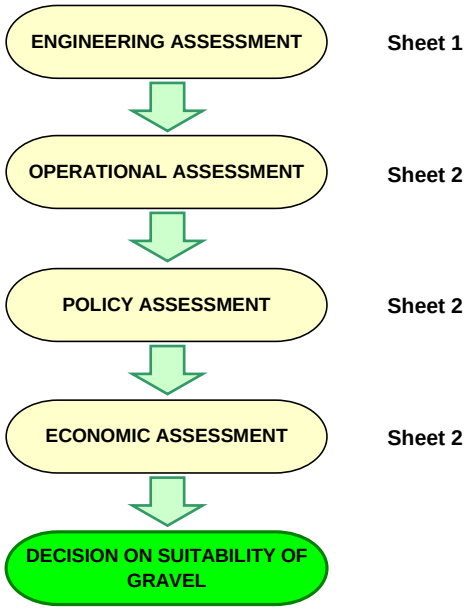
Natural gravel is often the cheapest method of upgrading an earth road to a better quality surface. However, a number of factors mean that in many circumstances, it is not the most appropriate rural road surface.

The Decision Management System guides the user through the objective process of assessing the various factors that influence the suitability of gravel for a specific rural road, or section of the road.

Often the varying physical conditions and traffic along a route, including problem sections, will justify a composite approach. This may determine that some sections should be designed with different surfaces, pavement types or standards to achieve the most cost-effective and sustainable use of the limited resources available for the route.

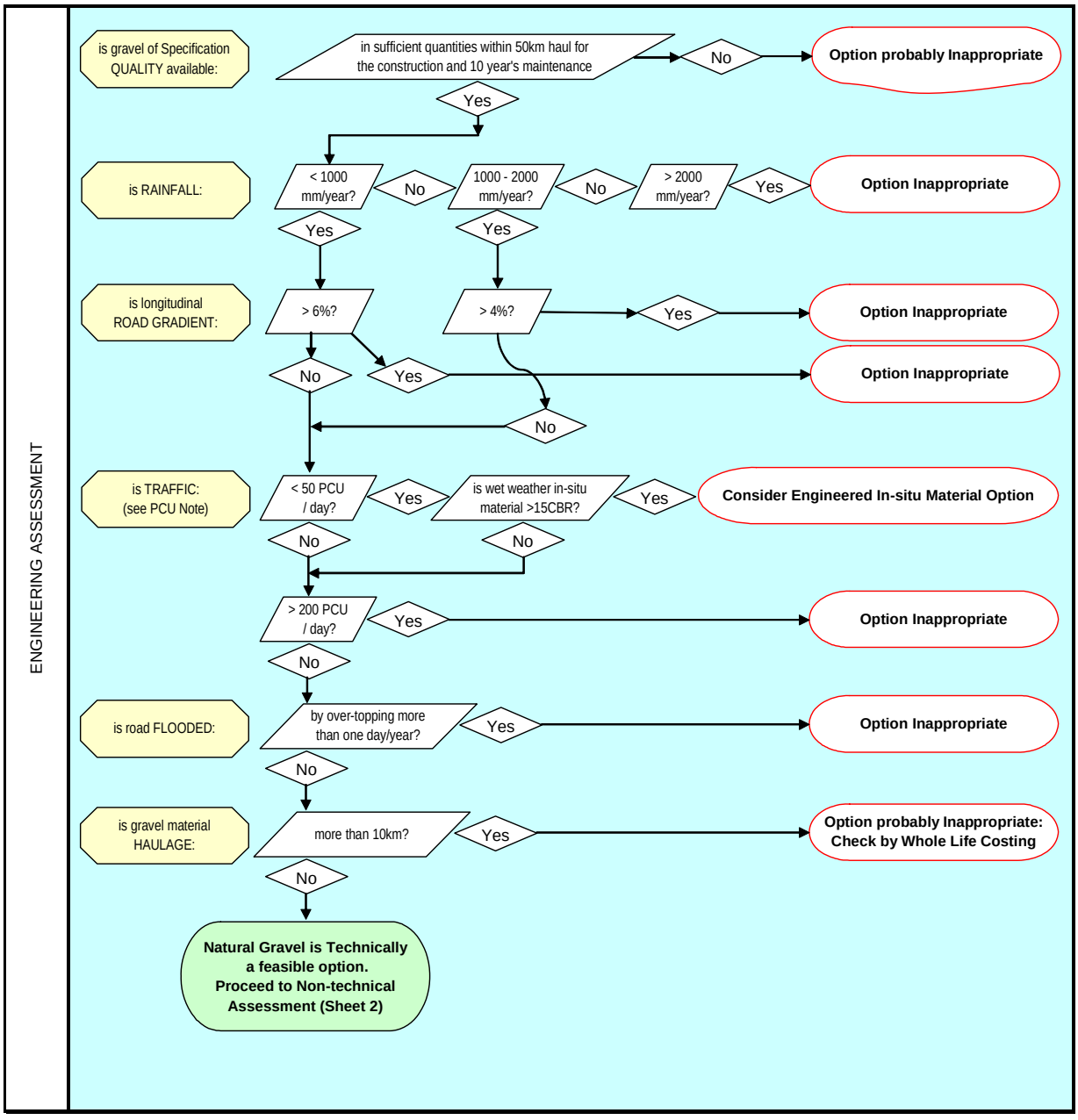
When gravel is assessed not to be the most suitable option, the separate Matrices (Tables G2 and G3) of Surfacing Option Filters will further guide the user to identify the most appropriate surface options for detailed analysis (in Phase II of the process).

The Process:-



Decision Flow Chart for the Consideration of Natural Gravel as a Rural Road Surface Option

SHEET 1 - Engineering Assessment

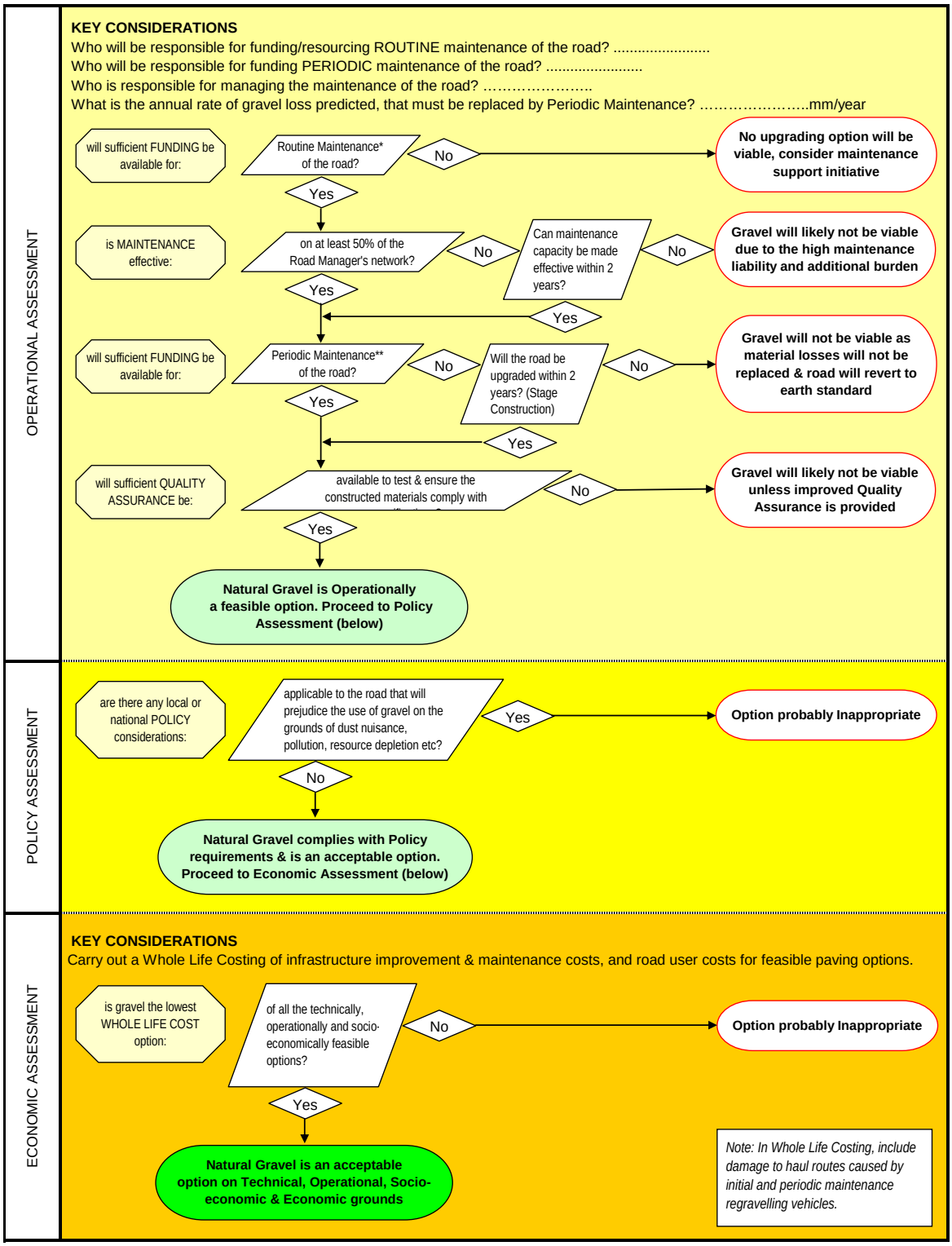


NOTES: PCU = Passenger Car Unit (other vehicle types to be converted from traffic surveys and maximum predicted daily flows for next 3 years).
CBR = California Bearing Ratio - Strength in situ measured by DCP, or to be decided by visual assessment
DCP = Dynamic Cone Penetrometer
Engineered Insitu Material = Earth Road Standard with maintained camber and effective drainage system

Figure G2: Engineering Decision Flow Chart

Decision Flow Chart for the Consideration of Natural Gravel as a Rural Road Surface Option

SHEET 2 - Operational, Socio-economic and Economic Assessment



NOTES: * Routine Maintenance funding includes voluntary labour contributions by the community
** Periodic Maintenance includes the regular and timely re-gravelling to replace the predicted gravel losses

Figure G3: Suggested Gravel Operational & Socio-Economic Decision Flow Chart

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APPENDIX I

RRST Cost Model
Whole Life Costing
Sample Analysis

SCENARIO ANALYSIS OPTION SURFACE/PAVING		TERRAIN	MAINTENANCE PROVIDED	MATERIALS HAUL DISTANCE (km)	ROAD GRADIENT	RAINFALL (mm/year)	SUB- GRADE CBR	TRAFFIC	AXLE LOADING	COMMENTS
1	Gravel	Delta	Yes	5km	<4%	1,500	<5%	B1	2.5t	Good gravel application
2	Gravel	Delta	No	5km	<4%	1,500	<5%	B1	2.5t	Sort haul, no maintenance
3	Gravel	Delta	Yes	100km	<4%	1,500	<5%	B1	2.5t	Long haul with maintenance
4	Gravel	Delta	No	100km	<4%	1,500	<5%	B1	2.5t	Long haul, no maintenance
5	Gravel	Mountain	Yes	5km	5%	2,500	>15%	B1	2.5t	Adverse conditions with maintenance
6	Gravel	Mountain	No	5km	5%	2,500	>15%	B1	2.5t	Adverse conditions, no maintenance
7	DBST on Waterbound Macadam	Delta	Yes	5km	<4%	1,500	<5%	B1	2.5t	Low cost durable surfacing
8	DBST on Waterbound Macadam	Delta	Yes	100km	<4%	1,500	<5%	B1	2.5t	Low cost durable surfacing
9	DBST on Waterbound Macadam	Mountain	Yes	5km	5%	2,500	<5%	B1	2.5t	Low cost durable surfacing
10	Steel Re-Concrete on Cement Stabilised Base	Delta	Yes	5km	<4%	1,500	<5%	B1	2.5t	High quality, low maintenance surfacing
11	Steel Re-Concrete on Cement Stabilised Base	Delta	Yes	100km	<4%	1,500	<5%	B1	2.5t	High quality, low maintenance surfacing

TABLE 1: WLC ANALYSIS SCENARIOS

Scenario No 1

Road Environment factors and the recommended road pavement

Province: Gravel-Short Haul-WITH Maintenance-Delta

Road environment					Gradient Condition	Local soils	MOT Road Classsificatio	Type of Pavement	Pavement Structure	Thichness of Layers (cm)	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall							
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	CS	B1	C26	Natural gravel surface Natural gravel sub-base	10 12	3.5 4
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group			
Suitable			1	1	1	1	1	G6			

Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	5km

Notice!	

Road name:	Natural gravel surface

Analysis results of the WLC

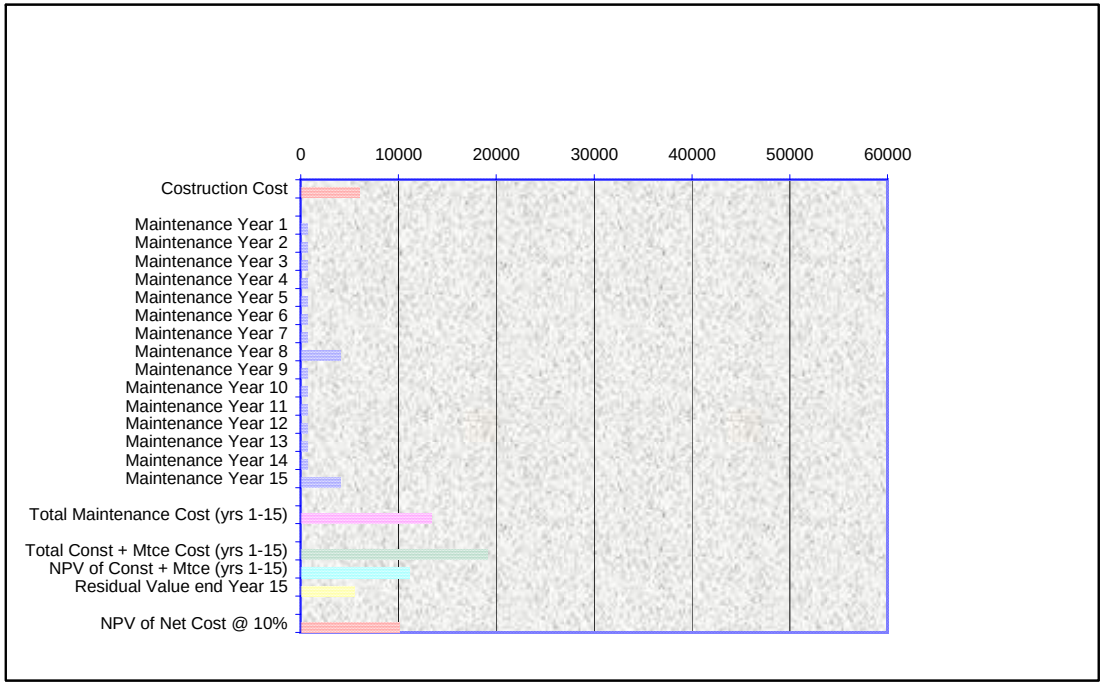
	USD
Costruction Cost	**5668**

Maintenance Year 1	427
Maintenance Year 2	427
Maintenance Year 3	427
Maintenance Year 4	427
Maintenance Year 5	427
Maintenance Year 6	427
Maintenance Year 7	427
Maintenance Year 8	3779
Maintenance Year 9	427
Maintenance Year 10	427
Maintenance Year 11	427
Maintenance Year 12	427
Maintenance Year 13	427
Maintenance Year 14	427
Maintenance Year 15	3779

Total Maintenance Cost (yrs 1-15)	13107

Total Const + Mtce Cost (yrs 1-15)	18775
NPV of Const + Mtce (yrs 1-15)	10850
Residual Value end Year 15	5153

NPV of Net Cost @ 10%	9789



Annual Gravel Loss: 20mm

SCENARIO No 2

Road Environment factors and the recommended road pavement

Province: Gravel-Short Haul-WITHOUT Maintenance-Delta

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	CS	B1	C26	Natural gravel surface	10	3.5
									Natural gravel sub-base	12	4
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group			
Not recommended			1	1	1	1	3	G6			

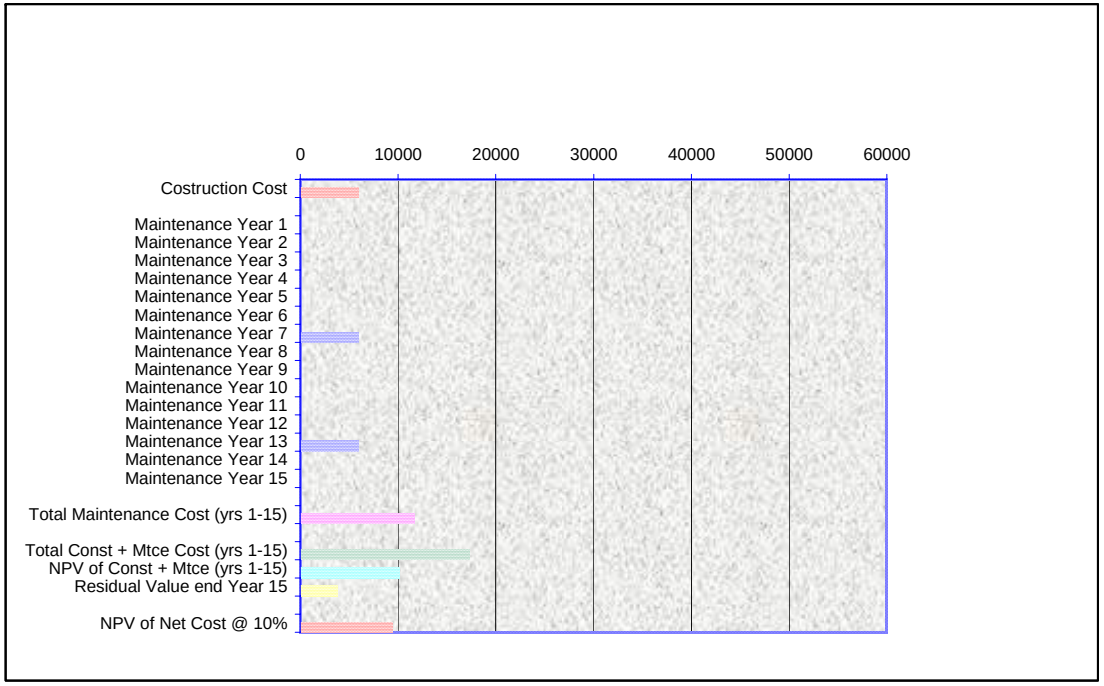
Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	5km

Notice!	**This is NO MAINTENANCE option**

Road name:	**Natural gravel surface**

Analysis results of the WLC

		USD
Costruction Cost		**5668**
Maintenance Year 1		0
Maintenance Year 2		0
Maintenance Year 3		0
Maintenance Year 4		0
Maintenance Year 5		0
Maintenance Year 6		0
Maintenance Year 7	Reconstruct	5668
Maintenance Year 8		0
Maintenance Year 9		0
Maintenance Year 10		0
Maintenance Year 11		0
Maintenance Year 12		0
Maintenance Year 13	Reconstruct	5668
Maintenance Year 14		0
Maintenance Year 15		0
Total Maintenance Cost (yrs 1-15)		11337
Total Const + Mtce Cost (yrs 1-15)		17005
NPV of Const + Mtce (yrs 1-15)		9818
Residual Value end Year 15		3543
NPV of Net Cost @ 10%		9088



Annual Gravel Loss: 28mm

SCENARIO No 3

Road Environment factors and the recommended road pavement

Province: Gravel-Long Haul-WITH Maintenance-Delta

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	CS	B1	C26	Natural gravel surface	10	3.5
									Natural gravel sub-base	12	4
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group			
Suitable			1	1	1	1	1	G6			

Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	100km

Notice!	

Road name:	**Natural gravel surface**

Analysis results of the WLC

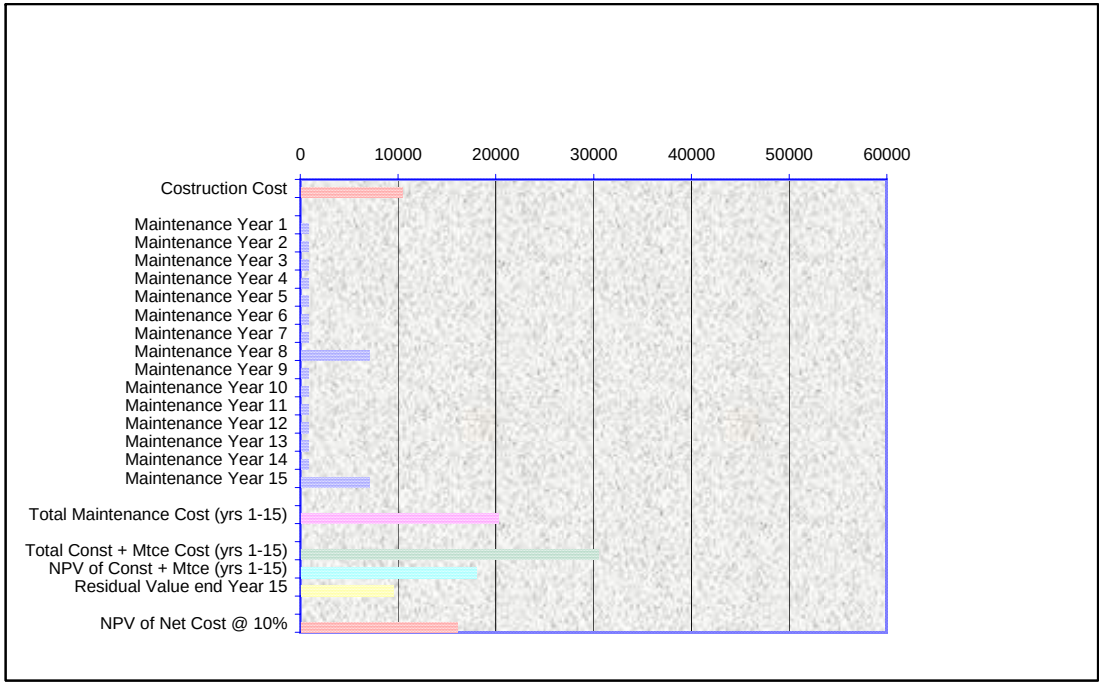
	USD
Costruction Cost	**10157**

Maintenance Year 1	495
Maintenance Year 2	495
Maintenance Year 3	495
Maintenance Year 4	495
Maintenance Year 5	495
Maintenance Year 6	495
Maintenance Year 7	495
Maintenance Year 8	6771
Maintenance Year 9	495
Maintenance Year 10	495
Maintenance Year 11	495
Maintenance Year 12	495
Maintenance Year 13	495
Maintenance Year 14	495
Maintenance Year 15	6771

Total Maintenance Cost (yrs 1-15)	19977

Total Const + Mtce Cost (yrs 1-15)	30134
NPV of Const + Mtce (yrs 1-15)	17685
Residual Value end Year 15	9233

NPV of Net Cost @ 10%	15783



Annual Gravel Loss: 20mm

SCENARIO No 4

Road Environment factors and the recommended road pavement

Province: Gravel-Long Haul-WITHOUT Maintenance-Delta

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	CS	B1	C26	Natural gravel surface	10	3.5
									Natural gravel sub-base	12	4
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group			
Not recommended			1	1	1	1	3	G6			

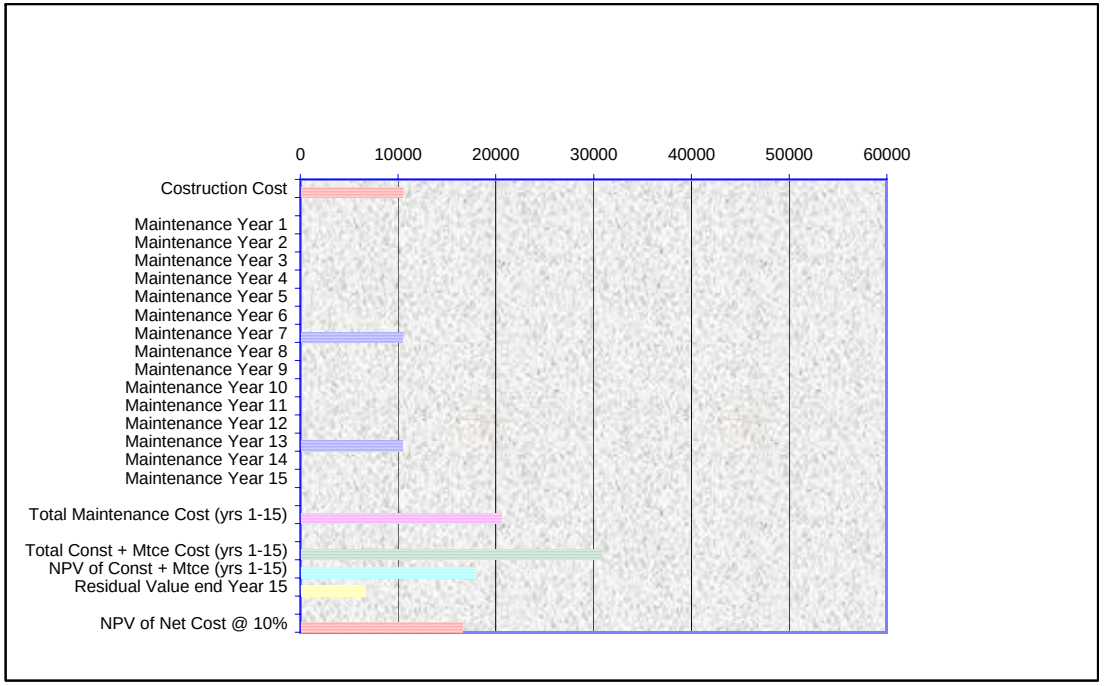
Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	100km

Notice!	**This is NO MAINTENANCE option**

Road name:	**Natural gravel surface**

Analysis results of the WLC

		USD
Costruction Cost		**10157**
Maintenance Year 1		0
Maintenance Year 2		0
Maintenance Year 3		0
Maintenance Year 4		0
Maintenance Year 5		0
Maintenance Year 6		0
Maintenance Year 7	Reconstruct	10157
Maintenance Year 8		0
Maintenance Year 9		0
Maintenance Year 10		0
Maintenance Year 11		0
Maintenance Year 12		0
Maintenance Year 13	Reconstruct	10157
Maintenance Year 14		0
Maintenance Year 15		0
Total Maintenance Cost (yrs 1-15)		20313
Total Const + Mtce Cost (yrs 1-15)		30470
NPV of Const + Mtce (yrs 1-15)		17591
Residual Value end Year 15		6348
NPV of Net Cost @ 10%		16284



Annual Gravel Loss: 28mm

SCENARIO No 5

Road Environment factors and the recommended road pavement

Province: Gravel-Short Haul-WITH Maintenance-Mountains-Gradient

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR>15%	I	>2000 (mm/year)	4-6%	Gr	B1	C26	Natural gravel surface	10	3.5
									Natural gravel sub-base	15	4
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group			
Not recommended			1	3	3	1	1	G6			

Type of terrain region	Hilly and Mountainous
Parameters for using equipment	Hilly and Mountainous
Haul distance of primary materials	5km

Notice!	

Road name:	**Natural gravel surface**

Analysis results of the WLC

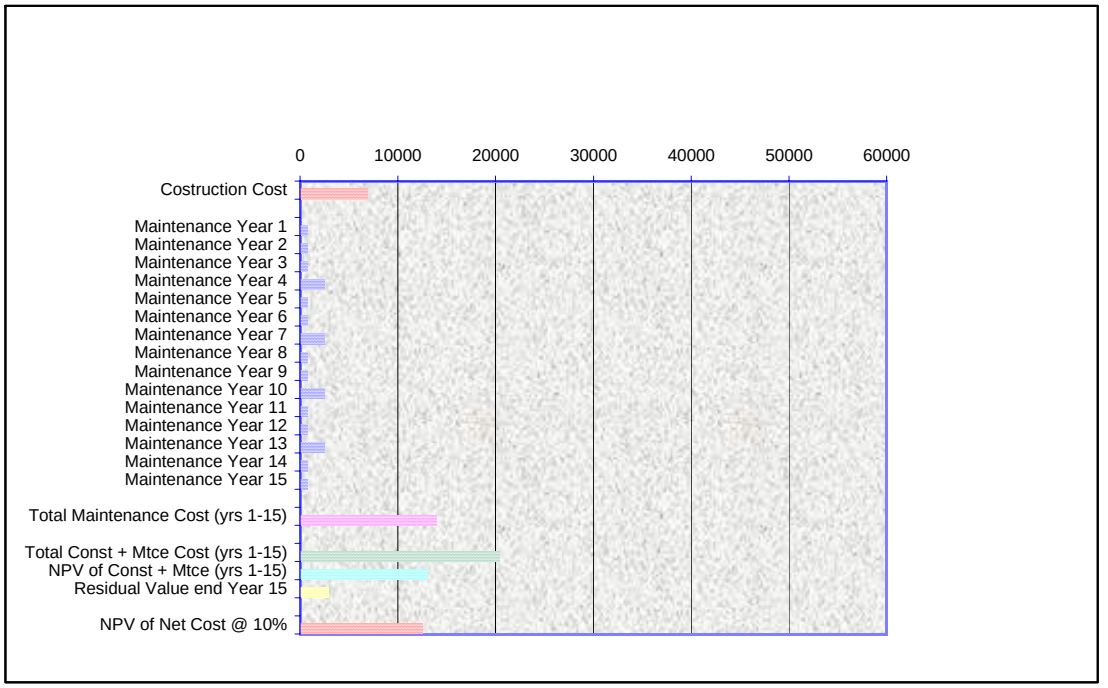
	USD
Costruction Cost	**6529**

Maintenance Year 1	445
Maintenance Year 2	445
Maintenance Year 3	445
Maintenance Year 4	2176
Maintenance Year 5	445
Maintenance Year 6	445
Maintenance Year 7	2176
Maintenance Year 8	445
Maintenance Year 9	445
Maintenance Year 10	2176
Maintenance Year 11	445
Maintenance Year 12	445
Maintenance Year 13	2176
Maintenance Year 14	445
Maintenance Year 15	445

Total Maintenance Cost (yrs 1-15)	13595

Total Const + Mtce Cost (yrs 1-15)	20124
NPV of Const + Mtce (yrs 1-15)	12713
Residual Value end Year 15	2612

NPV of Net Cost @ 10%	12175



Annual Gravel Loss: 50mm

SCENARIO No 6

Road Environment factors and the recommended road pavement

Province: Gravel-Short Haul-WITHOUT Maintenance-Mountains-Gradient

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR>15%	I	>2000 (mm/year)	4-6%	Gr	B1	C26	Natural gravel surface	10	3.5
									Natural gravel sub-base	15	4
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group			
Not recommended			1	3	3	1	3	G6			

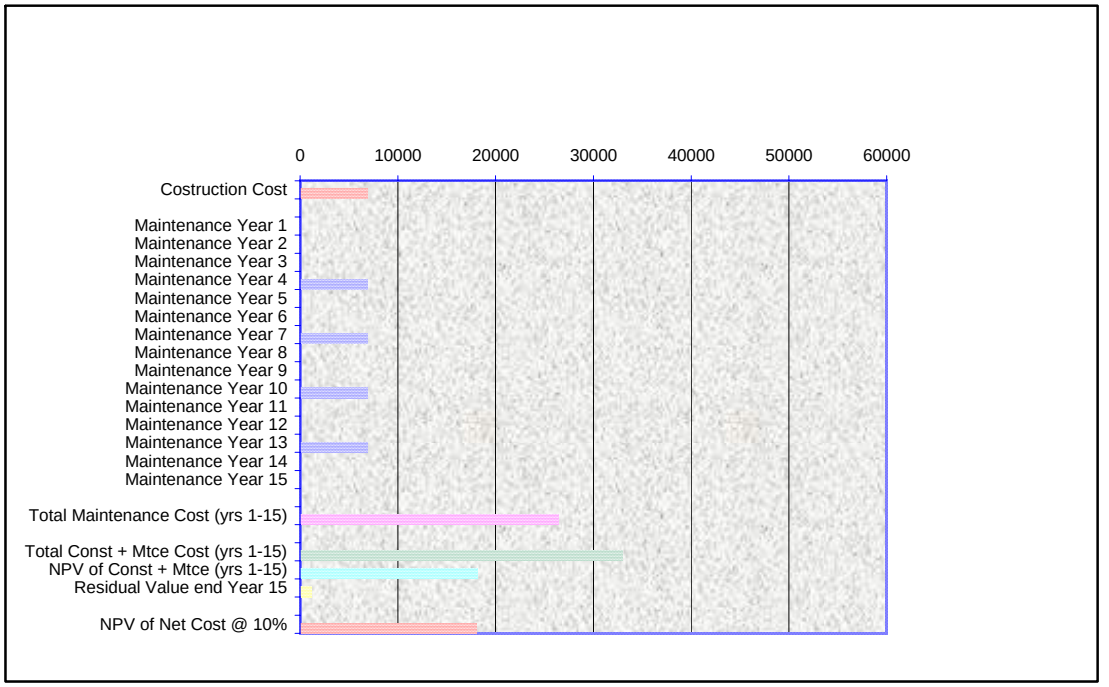
Type of terrain region	Hilly and Mountainous
Parameters for using equipment	Hilly and Mountainous
Haul distance of primary materials	5km

Notice!	**This is NO MAINTENANCE option**

Road name:	**Natural gravel surface**

Analysis results of the WLC

		USD
Costruction Cost		**6529**
Maintenance Year 1		0
Maintenance Year 2		0
Maintenance Year 3		0
Maintenance Year 4	Reconstruct	6529
Maintenance Year 5		0
Maintenance Year 6		0
Maintenance Year 7	Reconstruct	6529
Maintenance Year 8		0
Maintenance Year 9		0
Maintenance Year 10	Reconstruct	6529
Maintenance Year 11		0
Maintenance Year 12		0
Maintenance Year 13	Reconstruct	6529
Maintenance Year 14		0
Maintenance Year 15		0
Total Maintenance Cost (yrs 1-15)		26116
Total Const + Mtce Cost (yrs 1-15)		32645
NPV of Const + Mtce (yrs 1-15)		17870
Residual Value end Year 15		888
NPV of Net Cost @ 10%		17687



Annual Gravel Loss: 72mm

SCENARIO No 7

Road Environment factors and the recommended road pavement

Province: DBST on Waterbound Macadam-Short Haul-WITH Maintenance-Delta

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	CS	B1	C16	Double layers bitumen seal	2	3.5
									Water bound macadam base	8	3.5
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group	Water bound macadam sub-base	8	4
Suitable			1	1	1	1	1	G2			

Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	5km

Notice!	

Road name:	**Two layers bitumen seal on Water bound macadam**

Analysis results of the WLC

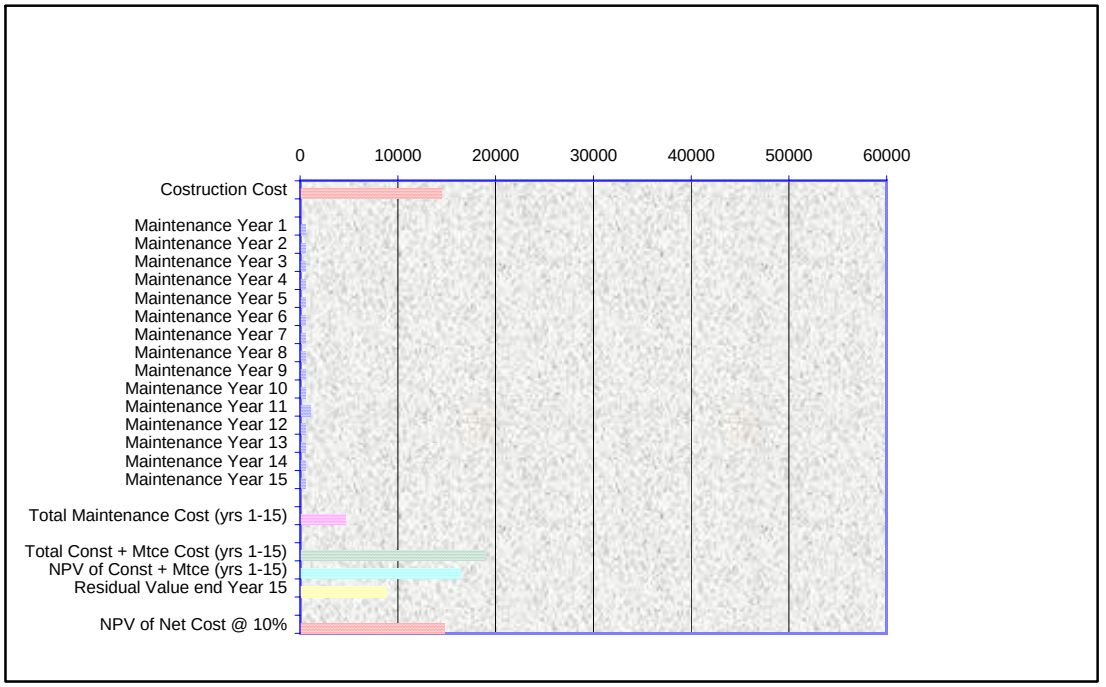
	USD
Costruction Cost	**14138**

Maintenance Year 1	262
Maintenance Year 2	262
Maintenance Year 3	262
Maintenance Year 4	262
Maintenance Year 5	262
Maintenance Year 6	262
Maintenance Year 7	262
Maintenance Year 8	262
Maintenance Year 9	262
Maintenance Year 10	262
Maintenance Year 11	707
Maintenance Year 12	262
Maintenance Year 13	262
Maintenance Year 14	262
Maintenance Year 15	262

Total Maintenance Cost (yrs 1-15)	4381

Total Const + Mtce Cost (yrs 1-15)	18519
NPV of Const + Mtce (yrs 1-15)	16152
Residual Value end Year 15	8483

NPV of Net Cost @ 10%	14405



SCENARIO No 8

Road Environment factors and the recommended road pavement

Province: DBST on Waterbound Macadam-Long Haul-WITH Maintenance-Delta

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	CS	B1	C16	Double layers bitumen seal	2	3.5
									Water bound macadam base	8	3.5
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group	Water bound macadam sub-base	8	4
Suitable			1	1	1	1	1	G2			

Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	100km

Notice!	

Road name:	**Two layers bitumen seal on Water bound macadam**

Analysis results of the WLC

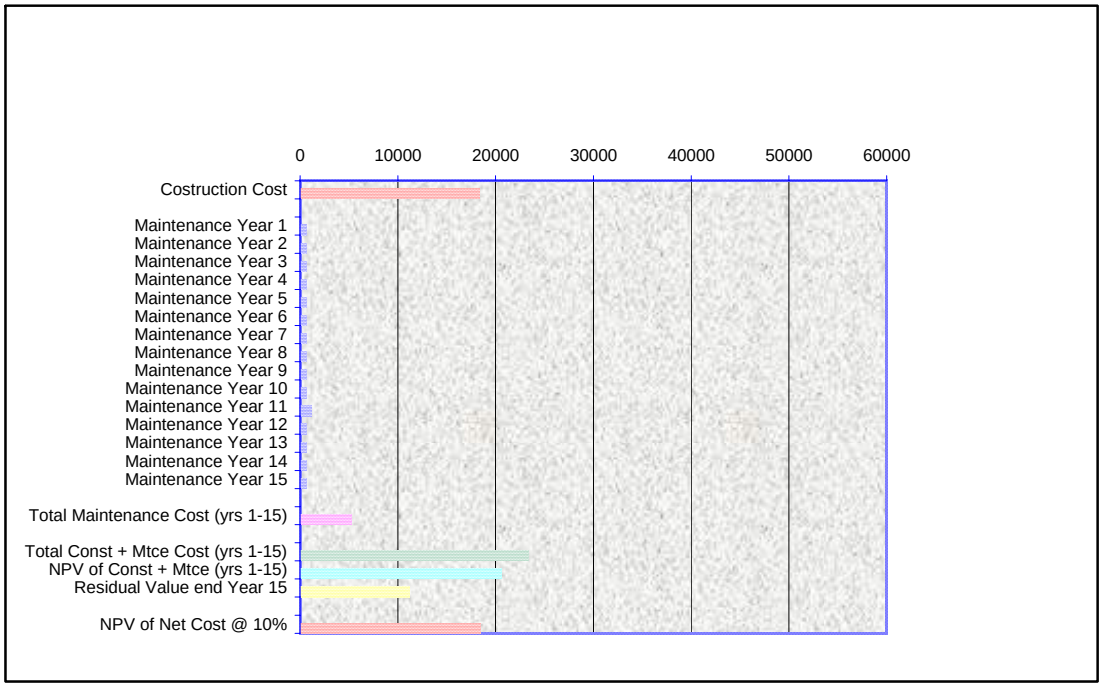
	USD
Costruction Cost	**18046**

Maintenance Year 1	289
Maintenance Year 2	289
Maintenance Year 3	289
Maintenance Year 4	289
Maintenance Year 5	289
Maintenance Year 6	289
Maintenance Year 7	289
Maintenance Year 8	289
Maintenance Year 9	289
Maintenance Year 10	289
Maintenance Year 11	902
Maintenance Year 12	289
Maintenance Year 13	289
Maintenance Year 14	289
Maintenance Year 15	289

Total Maintenance Cost (yrs 1-15)	4949

Total Const + Mtce Cost (yrs 1-15)	22995
NPV of Const + Mtce (yrs 1-15)	20304
Residual Value end Year 15	10828

NPV of Net Cost @ 10%	18073



SCENARIO No 9

Road Environment factors and the recommended road pavement

Province: DBST on Waterbound Macadam-Short Haul-WITH Maintenance-Mountain

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	>2000 (mm/year)	4-6%	Gr	B1	C16	Double layers bitumen seal	2	3.5
									Water bound macadam base	8	3.5
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group	Water bound macadam sub-base	8	4
Suitable			1	1	1	1	1	G2			

Type of terrain region	Hilly and Mountainous
Parameters for using equipment	Hilly and Mountainous
Haul distance of primary materials	5km

Notice!	

Road name:	**Two layers bitumen seal on Water bound macadam**

Analysis results of the WLC

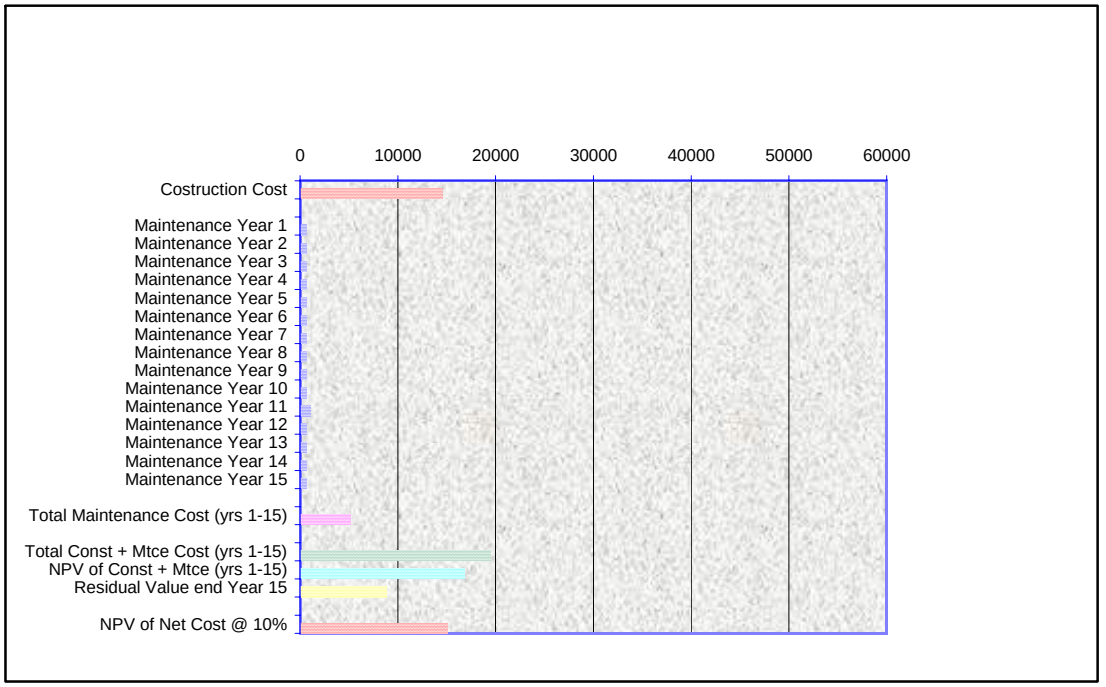
	USD
Costruction Cost	**14281**

Maintenance Year 1	295
Maintenance Year 2	295
Maintenance Year 3	295
Maintenance Year 4	295
Maintenance Year 5	295
Maintenance Year 6	295
Maintenance Year 7	295
Maintenance Year 8	295
Maintenance Year 9	295
Maintenance Year 10	295
Maintenance Year 11	714
Maintenance Year 12	295
Maintenance Year 13	295
Maintenance Year 14	295
Maintenance Year 15	295

Total Maintenance Cost (yrs 1-15)	4850

Total Const + Mtce Cost (yrs 1-15)	19131
NPV of Const + Mtce (yrs 1-15)	16523
Residual Value end Year 15	8569

NPV of Net Cost @ 10%	14758



SCENARIO No 10

Road Environment factors and the recommended road pavement

Province: Steel Reinforced Concrete-Short Haul-WITH Maintenance-Delta

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	SS	B1	C3	Steel reinforce concrete	10	3.5
									Sand bedding layer	5	3.5
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group	Cement stabilised sub-base	15	
Suitable			1	1	1	1	1	G1			

Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	5km

Notice!	

Road name:	**Steel reinforce concrete on Cement stabilised sub-base**

Analysis results of the WLC

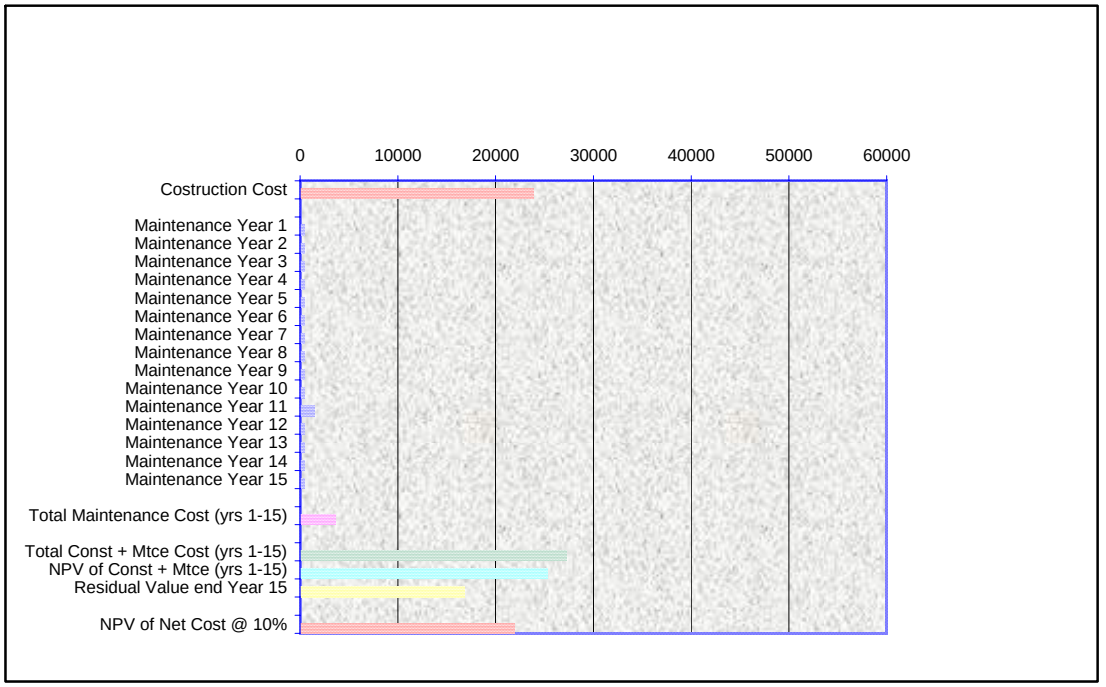
	USD
Costruction Cost	**23579**

Maintenance Year 1	155
Maintenance Year 2	155
Maintenance Year 3	155
Maintenance Year 4	155
Maintenance Year 5	155
Maintenance Year 6	155
Maintenance Year 7	155
Maintenance Year 8	155
Maintenance Year 9	155
Maintenance Year 10	155
Maintenance Year 11	1179
Maintenance Year 12	155
Maintenance Year 13	155
Maintenance Year 14	155
Maintenance Year 15	155

Total Maintenance Cost (yrs 1-15)	3351

Total Const + Mtce Cost (yrs 1-15)	26930
NPV of Const + Mtce (yrs 1-15)	25009
Residual Value end Year 15	16505

NPV of Net Cost @ 10%	21609



SCENARIO No 11

Road Environment factors and the recommended road pavement

Province: Steel Reinforced Concrete-Long Haul-WITH Maintenance-Delta

Road environment					Gradient	Local soils	MOT Road	Type of	Pavement Structure	Thichness	Width
Traffic	Axle load	SG Strength	Flood	Annual Rainfall	Condition		Classsificatio	Pavement		of Layers (cm)	
I	2.5	CBR<5%	I	1000-2000 (mm/year)	2- 4%	SS	B1	C3	Steel reinforce concrete	10	3.5
									Sand bedding layer	5	3.5
Use recommendation of Pavement			F.Code	AR.Code	G.Code	LS.Code	Mt.ce Code	Mt.ce group	Cement stabilised sub-base	15	
Suitable			1	1	1	1	1	G1			

Type of terrain region	Low delta/coastal, Minimal flood
Parameters for using equipment	Low delta
Haul distance of primary materials	100km

Notice!	

Road name:	**Steel reinforce concrete on Cement stabilised sub-base**

Analysis results of the WLC

	USD
Costruction Cost	**26852**

Maintenance Year 1	156
Maintenance Year 2	156
Maintenance Year 3	156
Maintenance Year 4	156
Maintenance Year 5	156
Maintenance Year 6	156
Maintenance Year 7	156
Maintenance Year 8	156
Maintenance Year 9	156
Maintenance Year 10	156
Maintenance Year 11	1343
Maintenance Year 12	156
Maintenance Year 13	156
Maintenance Year 14	156
Maintenance Year 15	156

Total Maintenance Cost (yrs 1-15)	3520

Total Const + Mtce Cost (yrs 1-15)	30372
NPV of Const + Mtce (yrs 1-15)	28336
Residual Value end Year 15	18796

NPV of Net Cost @ 10%	24464

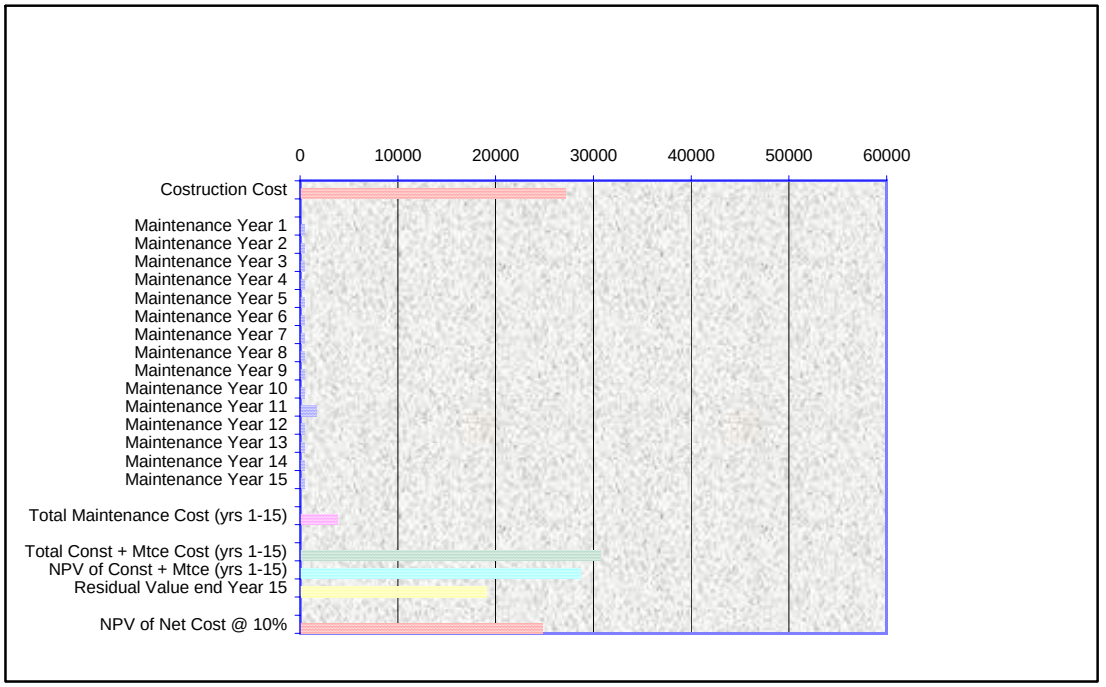


TABLE 2: SAMPLE VEHICLE OPERATING COSTS

Based on RT2 VOC Model 1999 data

VEHICLE SAMPLE: Motorcycle

Type of Road Surface	**Maintained Bitumen/Concrete (IRI = 5)**	**Maintained Gravel (IRI = 8)**	**Un-Maintained Gravel (IRI = 12)**
Vehicle Operating Cost US$/vehicle-km	0.01949	0.02411	*0.03000 (Estimated)*

Additional VoC compared to Maintained Bitumen/Concrete		**US$/km/year** and **NPV** over 15 years at 10%	**US$/km/year** and **NPV** over 15 years at 10%
500 Motorcycles/day	-	US$843 US$5,989	*US$1,918* *US$13,625*
1,000 Motorcycles/day	-	US$1,686 US$11,978	*US$3,836* *US$27,250*
1,500 Motorcycles/day	-	US$2,529 US$17,968	*US$5,754* *US$40,874*
2,000 Motorcycles/day	-	US$3,373 US$23,957	*US$7,672* *US$54,499*

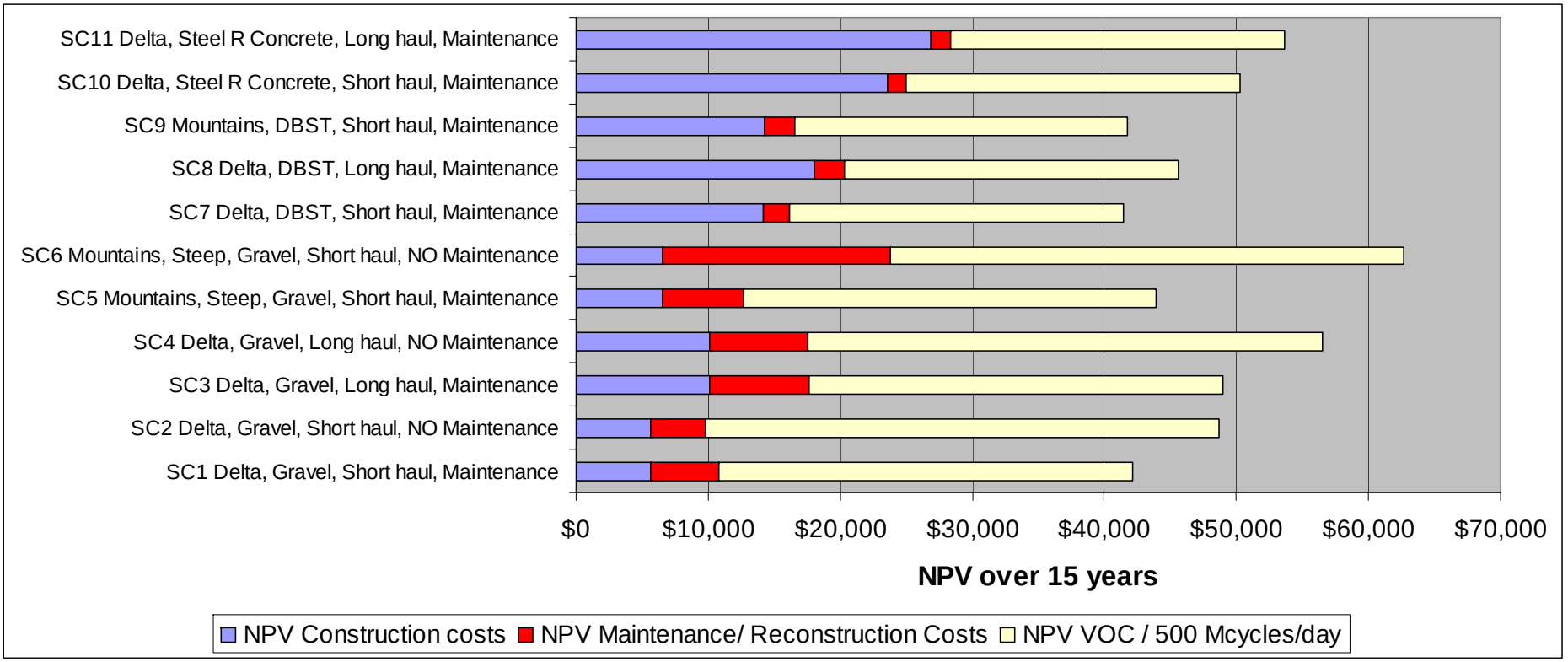


FIGURE 1: WLC ANALYSIS FOR TRAFFIC FLOW OF 500 MOTORCYCLES PER DAY

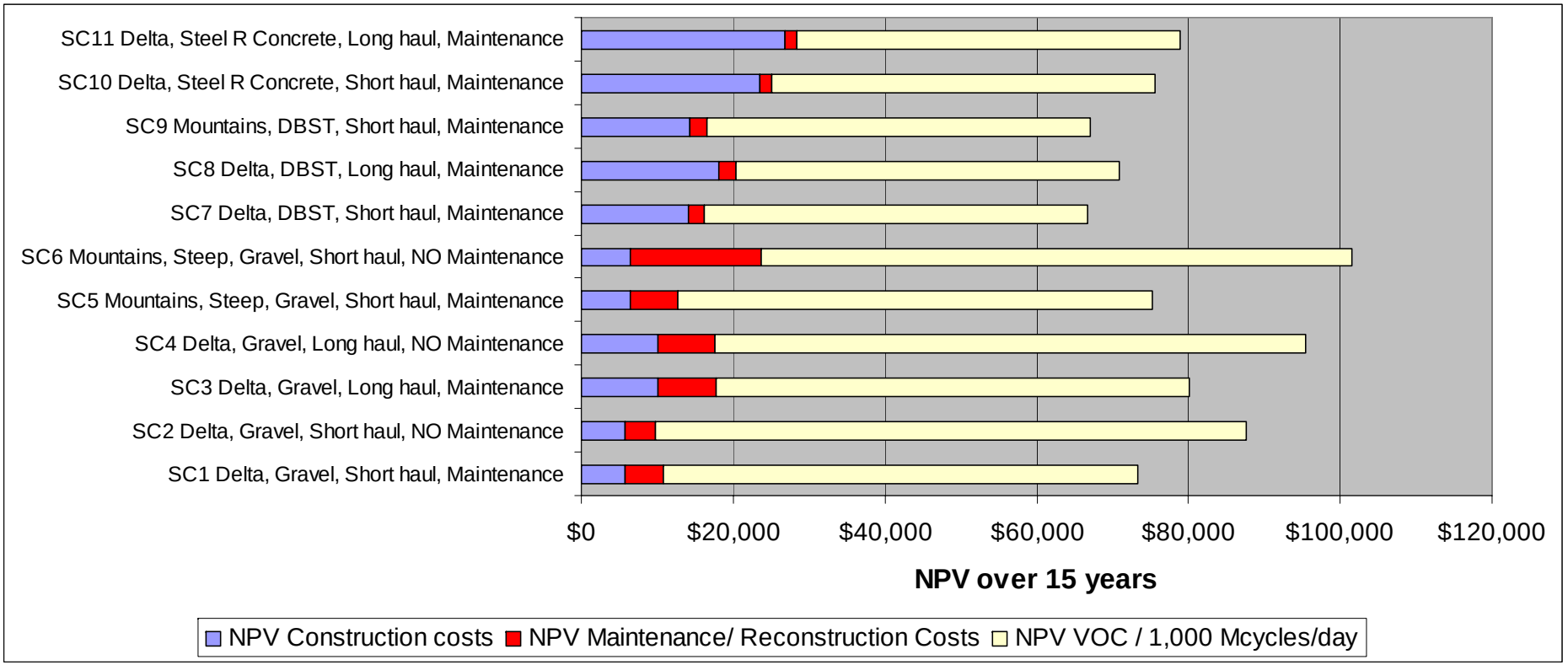


FIGURE 2: WLC ANALYSIS FOR TRAFFIC FLOW OF 1,000 MOTORCYCLES PER DAY

RRST VIETNAM
SEACAP 1
FINAL REPORT

APPENDIX J

Recommended Further RRSR Initiatives:

The various items summarized in the following schedules have been identified as either **essential** (Schedule 1) or **desirable** (Schedule 2) by the project stakeholders for the completion of the RRSR programme to achieve the stated aims. These are in accordance with the inter-related and inter-dependent components of the research programme agreed at the inception stage. Some of the items are required for effective dissemination and mainstreaming of the SEACAP 1 rural road surfacing research already carried out and related initiatives.

Since compilation of this schedule, Items 2, 5 and 7 have recently been assigned to be delivered by Intech-TRL.

The initial component of Item 3 (interim assessment) has been assigned to be delivered by TRL. The Longer Term Monitoring (Item 4) is now an item requiring early attention.

1. RRSR Continuation Work – Components required for Follow Up and Mainstreaming

Activity	Work under Current Contracts	Work Required	Comment
1. Pavement Design Guide	Selection matrix and flow-charts for pavement selection developed for RRST-I options.	Formal revision of the MoT Rural Design Guide in conjunction with a revival of the incomplete RT2 Rural Road Standards programme for RT3.	Rural road standards were highlighted by project partners as a key issue in the RT2 Mission report of August-Sept 2005.
2. Trial Pavement Monitoring Guide	Standard sheets and procedures developed for use by Intech-TRL for RRST-I.	A practical guide on how to conduct condition monitoring for the RRST options and how to store and interpret the data.	Requested by RRSR Steering Committee. **This work has now been contracted** as an addition to the current SEACAP 1, RRST contract. This will also be a useful benchmark for other regional surfacing research initiatives.
3 Trial Pavement Monitoring for RRST-I and RRST-II Initial Monitoring	a. Initial Short Term monitoring for RRST-I undertaken and database established. b. Recommendations regarding selection of monitoring sections for RRST-II.	Regular monitoring of RRST-I and RRST-II trial sections. Interpretation of data. Training required for local consultants. QA of data by experienced consultants.	Monitoring of RRST-I has been identified since programme inception as Module 6. Monitoring of RRST-II sections is an essential part of the overall RRSR programme. Interim Monitoring (Module 6.1) to mid 2007 **has been contracted**.

4 Trial Pavement Monitoring for RRST-I and RRST-II Long Term Monitoring	See above.	Module 6.2 (Long Term Monitoring) is an essential component to complete the RRSR programme. It will monitor and interpret the performance and maintenance requirements of a representative selection of trial pavements. This will allow design recommendations to be finalized and Whole Life Cost guidelines to be developed as an essential input to rural road investment decision making.	The Long Term Monitoring should continue for at least a further 4 years. This work **needs to be arranged urgently to ensure integrity and continuity of the RRSR programme**.
5. Rural Road Maintenance Guidelines Update	Procedures outlined for use in specific RRST-I provinces.	Formalisation of province-specific advice into formal guidelines (to complement existing Commune Maintenance Handbook prepared under RT2) for the RRST surface options.	Requested by RRSR Steering Committee. **This work has now been contracted** as an addition to the current SEACAP 1, RRST contract.
		Updating, expansion and finalization of the MoT Province-District rural road maintenance guidelines that were commenced as an initiative under RT2	Requested by MoT
6. Rural Road Maintenance Cost Norms	None.	Updating and expansion of MoT Rural Road Maintenance Cost Norms to include the range of RRSR surface options.	Current MoT Rural Road Maintenance Norms are extremely limited, constraining maintenance initiatives – requiring updating and expansion.
7. Trial Pavements Construction Guide	RRST-I and RRST-II specifications updated.	Short practical guides on the construction procedures for the RRST options; illustrated by examples from RRST-I and RRST-II experience. Aimed at small contractors.	Requested by RRSR Steering Committee. **This work has now been contracted** as an addition to the current SEACAP 1, RRST contract.

8. Construction Supervision Guide	Materials from training workshops for RRST-I and RRST-II.	A companion volume to Item 7 above aimed at contractor supervision and quality control. Associated training documents.	Not yet specifically requested by MoT but recent RRST-II performance by supervisors highlights the need for some form of basic guide and training on a national basis.
9. Mainstreaming RRST into MoT programmes – e.g. RT3	Information exchange and feedback workshops. Submission of recommendations for revised specifications and norms to MoT.	Working with RRST Steering Committee to ensure take-up of options in RT3 and other rural road programmes Mainstreaming initiative aimed at the provincial authorities to ensure demand and take-up at this level. Close liaison with VRA and MARD for possible overlap at District and provincial road level.	An essential element for the overall project aims. Requires follow through from the work already achieved. Complementary support required for academic institution mainstreaming.
10. Maintenance of Knowledge dissemination through MoT Rural Roads Research Website	Establishment and population of website:- http://portal.mt.gov.vn:8089/ruraltransport/rrsr/	Continue to manage the website and post new RRSR and other relevant material as it becomes available.	Consideration should be given to "back-up" arrangements by making material available through gTKP. Websites need active management for credibility and usefulness.

2. RRSR Continuation Work – Identified Desirable Complementary Components

Activity	Work under Current Contracts	Work Required	Comment
11. Further Development of Surfacing Options Cost model	Provide basic cost model for provincial decisions on rural road surface options based on construction and anticipated maintenance costs only.	1. Develop cost model into complete Whole Life Cost model, including investigations, development and incorporation of Local Vehicle Operating Cost relationships. 2. Incorporate RRST pavement performance and maintenance monitoring experiences in the model. 3. Expand the cost model to pavement and environment options not included in the trials to date.	Identified as required by World Bank. 2006 draft WB Transport Strategy document identifies life cycle costing as essential for efficient resource allocation. Existing Vietnam Rural Road VoC knowledge base is extremely limited. Performance and maintenance knowledge from long term monitoring to be incorporated in the model. Model also needs to encompass all feasible technical options for PDoT selection process.
12. Repeat surveys of RRGAP	SEACAP 4 carried out a "snapshot in time" survey of the RT1 and RT2 gravel roads (over 700 sites).	Repeat survey of the same gravel road sites.	Identified as desirable by World Bank. Will help develop a more comprehensive understanding of the influencing factors.
13. Rural Sealed Road Assessment Programme (RSRAP) Survey of RT2 upgraded roads	No investigations required.	To investigate a selected range of upgrading from gravel to paved standard carried out by provincial administrations. Make recommendations for future upgrading policy and strategy.	Identified as desirable by World Bank. Details and knowledge of the performance of these upgrading strategies required to support the paving discussion and decision making.
14. International Dissemination of RRSR knowledge	Not specific.	Active dissemination through a knowledge consolidation document (e.g. regional guideline), articles, papers, web posting, and training/ dissemination events etc..	Suggest initiatives through SEACAP practitioners and other forums to maximize impact of the research investments made to date. Consideration should be given to consolidating the knowledge from the various SEACAP initiatives into an authoritive publication.

15. Axle loading	Surveys of RRST-I sites.	Investigate true extent of overloading. Develop a pragmatic strategy for minimizing the impact on rural road infrastructure investments.	Identified as a serious issue on many rural roads in Vietnam.
16. Investigation of RRST-II road failure in Dak Lak Province	None.	The trial road has exhibited a number of failed sections soon after opening. Thought to be related to very large increase in heavily loaded trucks.	Request made by MoT and PDoT to help with investigations.

RRST VIETNAM
SEACAP 1
FINAL REPORT

APPENDIX K

RRSR Documentation Schedule

Reports of Rural Road Surfacing Research Programme

No.	Reports	Date of issue
I	**Rural Road Gravel Assessment Programme**	
1	**Scoping Study Report for RRGAP**	December/03
2	Inception Report - RRGAP	August/04
3	Module 2- Working Document Training	October/04
4	Module 3- Working Document - Data Collection	January/05
5	Module 4 - Working Document - Data Analyis	February/05
6	**Module 4 - Final Report - Data Analyis**	July/05
II	**Rural Road Surfacing Trials**	
7	Inception Report for Rural Road Surfacing Research Phase II	July 03
8	Progress Report for Rural Road Surfacing Research Phase II	September 03
9	Progress Report for Rural Road Surfacing Research Phase II	November 03
10	Progress Report No.4 for Rural Road Surfacing Research Phase II	February 04
11	Progress Report No.5 for Rural Road Surfacing Research Phase II	April 04
12	Progress Report No.6 for Rural Road Surfacing Research Phase II	July/04
13	Progress Report No.7 for Rural Road Surfacing Research Phase II	September/04
14	Progress Report No.8 for Rural Road Surfacing Research Phase II	November/04
15	Progress Report No.9 for Rural Road Surfacing Research Phase II	January/05
16	Progress Report No.10 for Rural Road Surfacing Research Phase II	March/05
17	Progress Report No.11 for Rural Road Surfacing Research Phase II	July/05
18	Progress Report No.12-13 for Rural Road Surfacing Research Phase II	October/05
19	Progress Report No.14-15 for Rural Road Surfacing Research Phase II & III	February/06
20	**RRST-I Trials Construction Report - Rural Road Surfacing Research Phase II**	July/06
21	**RRST-II Trial Design Report - Rural Road Surfacing Research Phase III**	May/06
22	RRST-II Progress Summary No.1 - Rural Road Surfacing Research Phase III	April/06
23	RRST-II Interim Progress Report - Rural Road Surfacing Research Phase III	May/06
24	RRST-II Interim Progress Report - Rural Road Surfacing Research Phase III	July/06
25	**RRST-II Construction Summary Report-Rural Road Surfacing Research Phase III**	September/06

TECHNICAL PAPERS

2006, R Petts, J Cook, P Tuan, B Dzung, H Kackada, Rural Road Surfacing Research for Sustainable Access and Poverty Reduction in South East Asia, IRC Seminar, India.

2006, R Petts, J R Cook, & P G Tuan. Rural Road Paving for Manageable Maintenance. PIARC – CIGR International Seminar on Maintenance of Rural Roads: Stakes and Perspectives. Rabat, Morocco.

2006 J R Cook, R Petts, B T Dzung, P G Tuan, Rural Road Surfacing Research for Sustainable Access and Poverty reduction in Vietnam.2nd Annual ITST Conference, Hanoi, Vietnam.

2005 . B T Dzung, J R Cook R Petts & P G Tuan. .Rural Road Surfacing Research: Initial outputs of Phase I and information on Phase-II. International Seminar on Integrating Vietnam Transport Engineering with the World, Vietnam Bridge and Road Association, Ha Long, Vietnam.

2005 J R Cook, R Petts, & D M Tam. The performance of low-volume unsealed rural roads in Vietnam. PIARC seminar on Sustainable Access and Local Resource Solutions, Siem Reap, Cambodia.

2005. R Petts, J R Cook, P G Tuan & B T Dung. From road surfacing problems to mainstreaming new techniques in national standards: rural road research in Vietnam. PIARC seminar on Sustainable Access and Local Resource Solutions, Siem Reap, Cambodia.

2005. R Petts, J R Cook,B T Dzung, Heng Kackada. Providing Sustainable Access through road works techniques suitable for Small & Medium Enterprises. Development Studies Association, Annual Conference, UK, September 2005.

2004. R Petts, J R Cook, B T Dung, Heng Kackada Providing sustainable access through road works techniques suitable for small & medium enterprises. CAFEO-22 , Yangon, Myanmar.

2004. J R Cook, D M Tam & P G Tuan. The use of local natural materials for sustainable rural road construction in Vietnam. Ministry of Transport National Conference, Hanoi, Vietnam.

2004. J Howell, J R Cook, P G Tuan Low-Cost Bio Engineering of Rural Access Slopes for Vietnam.CAFEO-22 , Yangon, Myanmar.

In addition a substantial contribution was made to the World Bank publication **Surfacing Alternatives for Unsealed Rural Roads**, February 2006.

An article by Robert Petts was published in the May 2005 edition of the Asia-Pacific Development Review entitled “Sealed Fate for Gravel?” describing the SEACAP rural road surfacing research.

ADDITIONAL FORMAL PRESENTATIONS

2006, R Petts, Vietnam Rural Road Surfacing Research (RRSR) SEACAP 1 SEACAP 4: Background and Rationale. SEACAP 1 Dissemination Workshop, Hanoi, Viet Nam

2006, J R Cook, Rural Road Surfacing Trials (RRST): Framework, Preparations and Design. SEACAP 1 Dissemination Workshop, Hanoi, Viet Nam.

2006, Pham Gia Tuan. Rural Road Surfacing Trials (RRST): Construction Implementation. SEACAP 1 Dissemination Workshop, Hanoi, Viet Nam.

2006, Bach The Dzung. Summary of Surfacing Options Trialed. SEACAP 1 Dissemination Workshop, Hanoi, Viet Nam.

2006, J R Cook, Technical Recommendations. SEACAP 1 Dissemination Workshop, Hanoi, Viet Nam.

2006, Pham Gia Tuan, RRST Cost Norms and Cost Model. SEACAP 1 Dissemination Workshop, Hanoi, Viet Nam.

2006, R Petts, RRSR Outputs, Future work and Outstanding Issues. SEACAP 1 Dissemination Workshop, Hanoi, Viet Nam.

2006, J R Cook.: Vietnam Rural Road Surfacing Research (RRSR) SEACAP 1 SEACAP 4: Outcomes & Impacts. SEACAP Practitioners Meeting, Phnom Penh, Cambodia.

2006, R Petts, series of presentations on SEACAP and rural road surfacing research to students and lecturers at Institute of Technology, Cambodia, Phnom Penh, May 2006.

2006, R Petts, series of presentations on SEACAP and rural road surfacing research to AusAid and ARRB in Australia, February 2006.

2006, R Petts, Presentation on SEACAP and rural road surfacing research to gTKP Seminar at Tunis, February 2006.

2005, R Petts, Presentation on SEACAP and rural road surfacing research to inaugural AFCAP meeting in Harare, Zimbabwe, September 2005.

2005, R Petts. Progress on Rural Road Surfacing Trials. MoT-DFID Workshop on Updating the Vietnam Rural Transport Strategy, Quang Binh, Vietnam.

2005, P G Tuan. The Rural Road Gravel Assessment Programme and New Guidelines on Gravel Use. MoT-DFID Workshop on Updating the Vietnam Rural Transport Strategy, Quang Binh, Vietnam.

2005, J R Cook.: Progress on RRST, SEACAP1 and SECAP4. SEACAP Practitioners Meeting, Hanoi, Vietnam.

2005, R Petts, Presentations on rural road surfacing research at the Institute of Technology, Cambodia for GMSARN, AIT, and ASIAN FOUNDATION, April 2005.

2005, R Petts, Presentations on SEACAP and rural road surfacing research to ADB, World Bank, UNDP, LFRTD, Lanka IFG, ITDG, MoT and RDA, Sri Lanka, June 2005.

2004. J R Cook: Preliminary Proposals for Vietnam Rural Road Standards. MoT Workshop on Rural Road Standards, Hanoi, Vietnam.

2004. J R Cook. Presentation: Natural Gravels in Vietnam Low Volume Rural Road Pavements. SEACAP 17 Workshop Vientiane, Laos.

2004 R Petts. Surfacing Trials for Rural Transport. MoT Science and Technology Conference, Hanoi Vietnam.

2004 Pham Gia Tuan. The Rural Road Gravel Assessment Programme. 4th IFG Meeting, Kunming, China.

2003, B T Dzung. Rural Road Maintenance Handbook – Essential Material for Districts an Communes. 3rd IFG Meeting, Colombo, Sri Lanka.

TRAINING MATERIAL

1. RRGAP

- General survey procudures
- Field data collection form 1
- Use of the Dynamic Cone Penetrometer (DCP)

2. RRST-I

- Road Environment Survey Guidelines
- MERLIN Guide

3. RRST-II

- Knowledge Exchange on RRST Site Supervision

TELEVISION TRANSMISSIONS

1. BBC World, Earth Report, Hands On, Documentary “Cross Country Traffic – Cambodia and Vietnam”, 2006, in English.
2. VTV Documentary “Story About Rural Roads”, 2005, in Vietnamese and English.
3. VTV Documentary film on Rural Access and Poverty Reduction, 2004, in Vietnamese.