

PUBLIC WORKS DEPARTMENT

Government of Uttar Pradesh, India

UTTAR PRADESH STATE ROADS PROJECT Under IBRD Loan No. 4684-IN

Technical Assistance for Implementation of Institutional Reforms in the Road Sector of Uttar Pradesh

REPORT ON COMPREHENSIVE OBJECTIVE ANALYSIS OF LONG TERM CORE ROAD NETWORK MAINTENANCE FUNDING REQUIREMENTS FOR FUTURE PLAN PROCESSES (FINAL)

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Glossary

AMC	Contract for Annual Maintenance	ODR	Other District Road
AADT	Annual Average Daily Traffic	OR	Ordinary Repairs
ADB	Asian Development Bank	PC	Premix Carpet
ADT	Average Daily Traffic	PCC	Project Coordinating Consultant
AE	Assistant Engineer	PCI	Pavement Condition Index
BC	Bituminous Concrete	PCU	Passenger Car – equivalent Unit
BM	Bituminous Macadam	PMS	Pavement Management System
BOOT	Build Own Operate Transfer	PR	Periodic Renewals
BOT	Build Operate Transfer	PWD	Public Works Department
CBR	California Bearing Ratio	RES	Rural Engineering Services
CE	Chief Engineer	RIDF	Rural Infrastructure Development Fund
CEO	Chief Executive Officer	SD	Surface Dressing
CRF	Central Road Fund	SDBC	Semi Dense Bitumen Concrete
CRRRI	Central Road Research Institute	SE	Superintending Engineer
CVD	Commercial Vehicle Density	SH	State Highway
DBC	Dense Bitumen Concrete	SRF	State Road Fund
DBM	Dense Bituminous Macadam	SRP-II	State Road Project-II
EE	Executive Engineer	SRSF	State Road Safety Fund
E-in-C	Engineer in Chief	TA	Technical Assistance
GDP	Gross Domestic Product	TCE	Tata Consulting Engineers
GNP	Gross National Product	TCS	Tata Consultancy Services
GO	Government Order	ToR	Terms of Reference
GOI	Government of India	UP	Uttar Pradesh
GoUP	Government of Uttar Pradesh	UPSBC	Uttar Pradesh State Bridge Construction Corporation
GSDP	Gross State Domestic Product	UPSRP	Uttar Pradesh State Road Project
HQ	Head Quarter	UPSHA	Uttar Pradesh State Highway Authority
IBRD	International Bank for Reconstruction and Development	VOC	Vehicle Operating Cost
IDS	Institutional Development Strategy	VR	Village Roads
IDSP	Institutional Development And Strengthening Plan	WB	World Bank
IRC	Indian Road Congress	WBM	Water Bound Macadam
ISO	International Organisation for Standardisation		
ISAP	Institutional Strengthening Action Plan		
JE	Junior Engineer		
MDR	Major District Roads		
MLA	Member of Legislative Assembly		
MMS	Maintenance Management System		
MOST	Ministry of Surface Transport		
MoSRTTH	Ministry of Shipping, Road Transport & Highways		
MoRTH	Ministry of Road Transport and Highways		
MSS	Mixed Seal Surface		
NABARD	National Bank of Agricultural and Rural Development		
NH	National Highway		
NHAI	National Highways Authority of India		

1. INTRODUCTION

As a part of the TCE “Policy Support and Institutional Development Study Final Report – June 2002” it was noted and accepted that¹;

“Maintenance planning process to be strengthened by

- *The application of techno-economic and financial criteria.*
- *Undertaking periodic review of policies, standards and effectiveness of programmes*
- *Sustainable dedicated sufficient and timely funds should be made available for maintenance related activities.*
- *The existing maintenance norms should be revised for Core Road Network, Non Core Road Network and Village Road Network, Condition responsive for Core Road Network through the application of PMS systems and preset renewal cycle and specifications for the Non-Core Road Network and Village Road Network.”*

This was subsequently translated into the following;

Objective	Decisions already taken	Progress to date	Action milestones
Rational long term roads funding planning process	Road maintenance needs to be assessed and prioritised by rational MMS means	Realistic increases in roads funding being pursued in 10 th Plan processes	Comprehensive objective analysis of long term core road network maintenance funding requirements for future plan processes

Further progress was also made with the preparations for limited MMS capability being included in the PCC services out of which the DHV Road Manager software was developed.

PWD have provided a copy of the DHV Maintenance Management System [“Road Manager”], and the TA has reviewed the applicability of this model. Unfortunately no operating manuals are available for this and the consultants were unable to either run this model or obtain details on the model operation from the consultants in question². A recent remote ‘run’ of the software, based on data collected through PWD, was deemed to be ‘suspect’ as the output indicated that there could well be errors in the data collection/entry. It is understood that PWD are unable to run the software.

¹ Annex A, Item E

² Report N° 42 – Establishing Road maintenance Management System [RMMS] featuring rational prioritisation on techno-economic criteria, and apply to core network maintenance management.

2. IDENTIFICATION OF THE CORE ROAD NETWORK

As a part of the review of the Road Fund [Report N° 5 – October 2007], the network was defined in terms of road classification and width. The details of the core road network as used and defined during the course of this project³ is given in Table 2.1

Table 2.1 : The core road network

Classification	Two Lanes	Intermediate Lane	Single Lane	Total kms
State Highways	4,376	1,441	2,737	8,554
Major District Roads	632	1,518	5,196	7,346
Other District Roads	1,313	2,015	25,851	29,179
TOTAL	6,321	4,974	33,784	45,079

Source : PWD Performance Budget

This includes roads that have been, or are in the process of being, upgraded or maintained with the assistance of the World Bank under their State Roads Project [SRP I & II] as shown in Table 2.2, by year of completion.

Table 2.2 : World Bank State Roads upgrading projects

Classification	2003	2004	2005	2006	2007	2008	Total
State Highways	604.00	353.14	283.30	77.00	643.56	794.16	2,755.16
Major District Roads			5.80	46.30	30.62	134.94	217.66
Other District Roads					11.00		11.00

Source : PWD State Roads Project

³ Report N° 3 – “Inter Agency Working Group to facilitate GoUP decisions, legislation and other actions on an effective long term ownership and funding framework”

Report N° 24 – “Suggestions to revise UP road classifications and maintenance criteria for core network and other categories.”

Report N° 5 – “Implementation of GoUP decisions on revised taxes/surcharges for Road Fund

3. MAINTENANCE

The asset value of a road network has been estimated to be around 1.5 to 3 times the Gross National Product (GNP) of a country with the costs of transport within the economy ranging from 2 percent to as high as 17 percent of Gross Domestic Product (GDP) for less developed countries. The value of such an asset; the need to maintain its functionality, coupled with both the ageing of the network and increased traffic loads have inevitably meant increased investment for both maintenance and rehabilitation.

The study *Road Maintenance and Rehabilitation: Funding and Allocation Strategies*, undertaken in co-operation with the World Bank, developed a framework for minimising user and administration costs by way of a system for the allocation of often limited funding where it would be most effective. The report identified ten observations for both governments and road administrations for resource allocation and distribution in relation to road maintenance and rehabilitation programmes, as follows;

- 1) Maintenance is an opportunity for enhancing the environment as well as safeguarding the road network asset.
- 2) Road and bridge maintenance should be pursued for the sake of the users with public participation being an essential part of the development of a road maintenance programme.
- 3) Road and bridge assets should be maintained in an economic way.
- 4) A sound analytical framework is important for delivering an economic and environmentally sound product.
- 5) User costs must be treated as important and included in any analytical framework.
- 6) Budget constraints on the expenditure of an administration are an important aspect of the analysis. Competitive maintenance and rehabilitation programmes are one important means of addressing such constraints.
- 7) The entire road budget and 'trade-offs' between alternative uses must be considered when allocating and distributing resources.
- 8) The management systems used in allocating and distributing resources must be compatible with the road administrations organisation and management style.
- 9) The methods used at the network, programme and project level must be different, but interlocking, and must use the same database.
- 10) Data systems which support the road and bridge management system must be timely and reliable.

The entire exercise of objective analysis of the long-term road network maintenance funding requirements should be based on these stated observations.

Note: The goal of maintenance is to preserve the asset not to upgrade it. However, periodical maintenance treatment should be applied only on such roads which are in maintainable state not requiring strengthening or rehabilitation.

Categories of Maintenance activities

The maintenance activities to be undertaken should also be divided into the following categories for the purpose of any objective analysis of long term road network maintenance funding requirements.

a) Ordinary Repairs:

This activity includes routine maintenance, and such identifiable items as;

- Maintenance of culverts,
- Patch repairs and crack sealing of the pavement,
- Roadside drainage,
- Repair of shoulders, medians and footpaths,
- Maintenance of highway signs, including replacement of damaged retro-reflective signs and, road furniture,
- Arboriculture and turfing,
- Pavement markings,
- Removal of litter, debris, and dead animals,
- Maintenance of bridges, which will include attendance to: bearings and joints; wearing coat; railings; minor repairs to sub structure and superstructure and, clearance of weeds etc.
- Minor repairs to structures,
- Repair and maintenance of street lighting

b) Periodic Renewal

Periodic renewal includes the provision of a renewal coat to the wearing surface for the safeguard of the road crust and, the provision of a better riding surface for road users. Periodic repairs are identified as being required based on a condition assessment of the pavement (identification of the Roughness Index). As no pavement condition assessment is available from PWD, for the purpose of identifying the maintenance funding requirement, the frequency of provision of a renewal coat has been assumed to be every five years.

c) Special Repairs

Special repairs include 'urgent' work of an original nature such as; repairs to culverts and bridges and, work connected with road safety.

d) Emergency Repairs

Emergency repairs includes work of an immediate nature that aims at the restoration of a road affected by heavy rains/floods, cyclones, landslides etc.

e) Other works

In addition to that identified above it is already clear that some roads within the network will require strengthening before they can become eligible to be included within the maintenance programme. In association with this it may also be the case that the cost of such strengthening works may exceed budget allocations and so some form of holding works may be required until such time as the roads in question can be included in the strengthening programme.

Note: Categories of maintenance activities considered here are meant for projection of long-term funding requirement. Source of funding for special repairs and emergency repairs has not been considered in this report. The source of funds will be according to the GoUP policy from time to time.

Maintenance 'Norms'

In 1997, the Ministry of Road Transport & Highways [MoRTH] established a committee to examine the restructuring and revision of existing 'norms' as these applied to the maintenance of roads in India. In October 2000, the committee submitted a report entitled *Norms for Maintenance of roads in India*. Since then a period of about 7 years has elapsed and the prices of commodities have increased many fold. Bitumen and stone aggregates are the basic ingredients for maintenance of flexible pavement, with these exhibiting an abnormally high increase in cost when looked at in today's prices. The 'norms' as recommended in this document cannot therefore be considered to be valid in the present context.

The availability of Stone aggregates in UP is scarce and therefore involves relatively long haulage distances. The average price of stone aggregate within the State is around Rs 1,200 per cubic metre - nominal size 25 mm to 13.5mm. In the case of bitumen and the calculation of unit rates, the committee identified the price at around Rs 10,000 per tonne, whereas the current market price is Rs 26,000 per tonne. However, similar steep rises in the components of labour wage rates and equipment hire charges have not taken place. Thus, based on current market prices, the 'norms' recommended by the committee have been updated. In order to update these 'norms', with relevance to UP, certain base assumptions were made. These assumptions are identified below.

Levels of ordinary maintenance

In developing the 'norms' for the required objective analysis of long-term core road network maintenance funding requirements, the levels of maintenance performance standards and, the frequency adopted for routine maintenance activities is given in Report number 24⁴, which shows a detailed analysis for 'ordinary' repairs. The levels of maintenance performance standard and frequencies of repairs have been taken from the report on "Norms for Maintenance of roads in India in October 2000"

Periodic renewals

Options for renewal have been recommended for various road classifications in Table 8.5, Report No.24⁵ The identification of the funding requirements for such renewals has therefore been based on these renewal options. The intervals for renewals are based on IRC 82-1982⁶.

Traffic

Traffic data for the entire core network of roads has not been made available by PWD. Some traffic data, for some of the roads, is however available. The required CVD ranges were therefore calculated based on this data with the range allocations being determined based on the percentage allocations identified in the given data.

The detailed calculation of costs for the various works interventions identified above, are given in Annexure - A and are summarised below in Table 3.1 for a two lane highway.

Table 3.1 : Estimated two lane highway costs for various works interventions – Rupees/km

Category	NH/SH				MDR/ODR/VR			
	<450 CVD	Between 450-1500 CVD	Between 1500-4500 CVD	More than 4500 CVD	<150 CVD	Between 150-450 CVD	Between 450-1500 CVD	More than 1500 CVD
Ordinary Repairs	153,604	169,330	199,995	223,190	66,125	68,253	75,381	83,629
Periodic Renewal	952,844	952,844	1,471,297	1,471,297	952,844	952,844	1,092,881	1,092,881
Special Repairs	165,967	168,326	250,694	254,173	152,845	153,165	175,239	176,476
Emergency Repairs	165,967	168,326	250,694	254,173	152,845	153,165	175,239	176,476
Strengthening	1,787,071	1,787,071	2,080,881	2,080,881	1,787,071	1,787,071	2,080,881	2,080,881
Holding Works	316,564	316,564	762,275	762,275	316,564	316,564	762,275	762,275

Source : Annexure - A

⁴ Tables 7.1; 7.2; 7.3

⁵ Suggestions to revise UP road classifications and maintenance criteria for core road network and other categories

⁶ Reference Table 8.2 Report No.24

4. METHODOLOGY AND ANALYSIS OF FUNDING REQUIREMENTS

As previously noted, at present the only form of Road Maintenance Management System [MMS] that exists within PWD is that of the DHV Road Manager. This is run remotely from Holland with data collected by PWD. The latest available run [output] has been noted as being "suspect" as it is believed that the data collection was not carried out in accord with the requirements despite training having been given by PWD to the consultants employed for such. The conclusions derived from an examination of this software were that "..... [it] does not fulfil all the requirements of a comprehensive MM System for PWD, as recommended by Road Maintenance Study (2000)."⁷

Maintenance requirements depend on;

- a) Structural condition of the pavement – Benkelman beam surveys, falling weight deflectometer surveys.
- b) Surface roughness – profiler, bump integrator.
- c) Surface characteristics – cracking, potholes, rutting, ravelling surveys.
- d) Drainage surveys.
- e) Traffic volume plus load and cumulative axles – traffic surveys.
- f) Road maintenance policies and practices.

An efficient "Maintenance Management System" should make optimum use of available resources. Whilst such a system can be manual, it has been recommended that a computerised system be adopted⁸. In order to develop and implement such a computer based Pavement Management System [PMS], a database is required to be established providing data on inventory, traffic and condition of the network, as identified above. The developed PMS system would then have the capability of evaluating the impact and benefits of various maintenance strategies. In the case of UP three major steps have been identified as necessary in order to implement such a system, namely;

- a. Identify or develop a computer based Highway Management System having the capability of evaluating various maintenance/works interventions whilst optimising the maintenance treatments to be undertaken.
- b. Collect road inventory and traffic data for the network, plus visual or machine based ratings of condition for pavements bridges etc., and then prepare a network database
- c. Identify and cost all routine and periodic maintenance interventions and update the costs of such on a regular basis

⁷ Report N° 42 - Establishing Road maintenance Management System [RMMS] featuring rational prioritisation on techno-economic criteria, and apply to core network maintenance management.

⁸ Report N° 42

With both this data and the availability of a suitable PMS, various maintenance scenarios could then be examined, based on both a constrained and non constrained budget, from which an annual and/or multi year maintenance works programme(s) could then be developed.

Given that such a system is not in place, then for the purpose of this analysis it has firstly been assumed that all roads within the core network are in a condition that is acceptable for both routine and periodic maintenance and that no work is required to bring them 'up to' a standard whereupon such maintenance interventions can be undertaken effectively.

In Chapter 3, the maintenance regime to be adopted for the analysis has been identified and this has been applied to the core road network as identified in Table 2.1. The resultant maintenance costs over the period 2007 to 2015 have then been derived as shown in Table 4.1. This has been termed scenario 1 and represents the 'best case' scenario.

Clearly, this may not be the case and it may well be that certain elements of the network may require strengthening works to bring these roads up to an acceptable standard for maintenance. However, as already noted, network condition data is not available and so it is not possible to estimate such requirements with any degree of accuracy.

In order to provide a complete picture of maintenance requirements, a further case has therefore been developed. This case, termed scenario 2, given in Table 4.2, represents the 'worst case' and assumes that at the outset, all roads⁹ require to be strengthened before they can be included in any maintenance programme. The 'real' maintenance requirement will therefore lie somewhere between these two extremes.

In adopting this analogy it has further been necessary to adopt some other assumptions as follows;

- a) Given the large numbers of roads that will require strengthening and the consequent cost, it has been assumed that the strengthening works cannot be completed in one year and that this will be spread over a period of five years.
- b) Roads that are not immediately included within the strengthening programme have been deemed to require 'holding works' to maintain the investment until such time as strengthening works can be undertaken. These 'holding works' have a 'life' expectancy of two years after which, if strengthening works have still not been undertaken, will be required to be undertaken a further time.
- c) Once a road has been strengthened, and for all projects included within the World Bank programme, given that data is not available on condition, a five year maintenance cycle for all core roads has been assumed.

⁹ This nevertheless does exclude all past and current works being undertaken under the World Bank State Roads Project as it is assumed that these have been designed and constructed to a standard that will permit maintenance strategies to be implemented

The Analysis

Scenario 1, the “best case” scenario, indicates that both routine and periodic maintenance requirements range between a figure of Rs 820 crore to Rs 934 crore over the period 2008 to 2015. This lies within the boundaries of the amount dedicated for maintenance from the Road Fund which, in 2007, was recorded at Rs 1,450 crore.

In the case of scenario 2, some 42,000 kilometres of road are assumed to require strengthening which, it has been further assumed, would be spread over a five year period. Roads that are not included in the strengthening programme would receive holding works.

This ‘worst case’ analysis emphasises the need for a network inventory of condition, as clearly some roads may not require strengthening and can immediately be placed in the maintenance programme as are those roads under the World Bank State Roads Programme. In the initial years strengthening and holding works dominate the expenditure programme and it is only after five years that roads begin to ‘come on stream’ for periodic maintenance. The cost of this scenario ranges from an immediate high of Rs 2,000 crore and Rs 1,300 crore in the early years, falling to around Rs 850 crore in the latter part of the analysis period. The analysis for scenario 1 and 2 are shown in Tables 4.1 and 4.2, respectively.

Whilst after the initial years, cost requirements for both maintenance and strengthening/holding works could be covered by the road fund, it should be noted that;

- a) Under the Act, and as given in the 1998 Government Road Development Policy, the Road Fund is to be used for maintenance and not for strengthening and holding works.
- b) The analysis has only dealt with the core road network of some 46,000 kilometres of road. In overall terms, this only represents around 37% of the PWD given network of some 125,000 kilometres and, 17% of the total network amounting to around 276,000 kilometres.

Note: Roads having inadequate crust thickness and not fit to receive periodic renewal should not be included in periodic renewal programme. Such roads should be included for strengthening after carrying out proper investigations and testing.

Table 4.1 : Scenario 1 - Cost in Crores

Routine Maintenance kms		Cost in Crores							
		2008	2009	2010	2011	2012	2013	2014	2015
State Highways									
2 Lanes	1,620.84	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40
Intermediate	1,441.00	19.75	19.75	19.75	19.75	19.75	19.75	19.75	19.75
Single Lane	2,737.00	30.90	30.90	30.90	30.90	30.90	30.90	30.90	30.90
World Bank	2,755.16	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49
Major District Roads									
2 Lanes	414.34	2.81	2.81	2.81	2.81	2.81	2.81	2.81	2.81
Intermediate	1,518.00	7.71	7.71	7.71	7.71	7.71	7.71	7.71	7.71
Single Lane	5,196.00	22.01	22.01	22.01	22.01	22.01	22.01	22.01	22.01
World Bank	217.66	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
Other District Roads									
2 Lanes	1,302.00	8.82	8.82	8.82	8.82	8.82	8.82	8.82	8.82
Intermediate	2,015.00	10.24	10.24	10.24	10.24	10.24	10.24	10.24	10.24
Single Lane	25,851.00	109.48	109.48	109.48	109.48	109.48	109.48	109.48	109.48
World Bank	11.00	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Sub TOTAL		304.18	304.18	304.18	304.18	304.18	304.18	304.18	304.18
Periodic Maintenance kms									
State Highways									
2 Lanes	1,620.84	37.61	37.61	37.61	37.61	37.61	37.61	37.61	37.61
Intermediate	1,441.00	26.27	26.27	26.27	26.27	26.27	26.27	26.27	26.27
Single Lane	2,737.00	34.02	34.02	34.02	34.02	34.02	34.02	34.02	34.02
World Bank	2,755.16	88.87	51.96	41.68	11.33	94.69	116.84	88.87	51.96
Major District Roads									
2 Lanes	414.34	7.90	7.90	7.90	7.90	7.90	7.90	7.90	7.90
Intermediate	1,518.00	22.73	22.73	22.73	22.73	22.73	22.73	22.73	22.73
Single Lane	5,196.00	53.05	53.05	53.05	53.05	53.05	53.05	53.05	53.05
World Bank	217.66	0.00	0.00	0.55	4.41	2.92	12.86	0.00	0.00
Other District Roads									
2 Lanes	1,302.00	24.81	24.81	24.81	24.81	24.81	24.81	24.81	24.81
Intermediate	2,015.00	30.17	30.17	30.17	30.17	30.17	30.17	30.17	30.17
Single Lane	25,851.00	263.91	263.91	263.91	263.91	263.91	263.91	263.91	263.91
World Bank	11.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00
Sub TOTAL		589.34	552.43	542.71	516.22	599.13	630.18	589.34	552.43
TOTAL MAINTENANCE		893.52	856.61	846.89	820.40	903.31	934.36	893.52	856.61

Table 4.2 : Scenario 2 - Cost in Crores

Routine Maintenance kms		Cost in Crores							
		2008	2009	2010	2011	2012	2013	2014	2015
State Highways									
2 Lanes	1,620.84	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40
Intermediate	1,441.00	19.75	19.75	19.75	19.75	19.75	19.75	19.75	19.75
Single Lane	2,737.00	30.90	30.90	30.90	30.90	30.90	30.90	30.90	30.90
World Bank	2,755.16	61.49	61.49	61.49	61.49	61.49	61.49	61.49	61.49
Major District Roads									
2 Lanes	414.34	2.81	2.81	2.81	2.81	2.81	2.81	2.81	2.81
Intermediate	1,518.00	7.71	7.71	7.71	7.71	7.71	7.71	7.71	7.71
Single Lane	5,196.00	22.01	22.01	22.01	22.01	22.01	22.01	22.01	22.01
World Bank	217.66	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
Other District Roads									
2 Lanes	1,302.00	8.82	8.82	8.82	8.82	8.82	8.82	8.82	8.82
Intermediate	2,015.00	10.24	10.24	10.24	10.24	10.24	10.24	10.24	10.24
Single Lane	25,851.00	109.48	109.48	109.48	109.48	109.48	109.48	109.48	109.48
World Bank	11.00	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Sub TOTAL		304.18	304.18	304.18	304.18	304.18	304.18	304.18	304.18
Periodic Maintenance kms									
State Highways									
2 Lanes	1,620.84	0.00	0.00	0.00	0.00	0.00	37.61	37.61	37.61
Intermediate	1,441.00	0.00	0.00	0.00	0.00	0.00	26.27	26.27	26.27
Single Lane	2,737.00	0.00	0.00	0.00	0.00	0.00	34.02	34.02	34.02
World Bank	2,755.16	88.87	51.96	41.68	11.33	94.69	116.84	88.87	51.96
Major District Roads									
2 Lanes	414.34	0.00	0.00	0.00	0.00	0.00	7.90	7.90	7.90
Intermediate	1,518.00	0.00	0.00	0.00	0.00	0.00	22.73	22.73	22.73
Single Lane	5,196.00	0.00	0.00	0.00	0.00	0.00	53.05	53.05	53.05
World Bank	217.66	0.00	0.00	0.55	4.41	2.92	12.86	0.00	0.00
Other District Roads									
2 Lanes	1,302.00	0.00	0.00	0.00	0.00	0.00	24.81	24.81	24.81
Intermediate	2,015.00	0.00	0.00	0.00	0.00	0.00	30.17	30.17	30.17
Single Lane	25,851.00	0.00	0.00	0.00	0.00	0.00	263.91	263.91	263.91
World Bank	11.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00
Sub TOTAL		88.87	51.96	42.23	15.74	98.65	630.18	589.34	552.43
TOTAL MAINTENANCE		393.05	356.14	346.42	319.92	402.83	934.36	893.52	856.61

Strengthening kms		Cost in Crores							
		2008	2009	2010	2011	2012	2013	2014	2015
State Highways									
2 Lanes	1,620.84	61.74	61.74	61.74	61.74	61.74	0.00	0.00	0.00
Intermediate	1,441.00	43.13	43.13	43.13	43.13	43.13	0.00	0.00	0.00
Single Lane	2,737.00	55.85	55.85	55.85	55.85	55.85	0.00	0.00	0.00
World Bank	2,755.16								
Major District Roads									
2 Lanes	414.34	14.81	14.81	14.81	14.81	14.81	0.00	0.00	0.00
Intermediate	1,518.00	42.63	42.63	42.63	42.63	42.63	0.00	0.00	0.00
Single Lane	5,196.00	99.49	99.49	99.49	99.49	99.49	0.00	0.00	0.00
World Bank	217.66								
Other District Roads									
2 Lanes	1,302.00	46.54	46.54	46.54	46.54	46.54	0.00	0.00	0.00
Intermediate	2,015.00	56.59	56.59	56.59	56.59	56.59	0.00	0.00	0.00
Single Lane	25,851.00	494.97	494.97	494.97	494.97	494.97	0.00	0.00	0.00
World Bank	11.00								
Sub TOTAL		915.74	915.74	915.74	915.74	915.74	0.00	0.00	0.00
Holding Works kms									
State Highways									
2 Lanes	1,620.84	64.17	0.00	32.08	0.00	0.00	0.00	0.00	0.00
Intermediate	1,441.00	44.82	0.00	22.41	0.00	0.00	0.00	0.00	0.00
Single Lane	2,737.00	58.05	0.00	29.02	0.00	0.00	0.00	0.00	0.00
World Bank	2,755.16								
Major District Roads									
2 Lanes	414.34	10.49	0.00	5.25	0.00	0.00	0.00	0.00	0.00
Intermediate	1,518.00	30.21	0.00	15.10	0.00	0.00	0.00	0.00	0.00
Single Lane	5,196.00	70.49	0.00	35.25	0.00	0.00	0.00	0.00	0.00
World Bank	217.66								
Other District Roads									
2 Lanes	1,302.00	32.97	0.00	16.49	0.00	0.00	0.00	0.00	0.00
Intermediate	2,015.00	40.10	0.00	20.05	0.00	0.00	0.00	0.00	0.00
Single Lane	25,851.00	350.72	0.00	175.36	0.00	0.00	0.00	0.00	0.00
World Bank	11.00								
Sub TOTAL		702.02	0.00	351.01	0.00	0.00	0.00	0.00	0.00
Total Annual Cost of Works									
Routine Maintenance		304.18	304.18	304.18	304.18	304.18	304.18	304.18	304.18
Periodic Maintenance		88.87	51.96	42.23	15.74	98.65	630.18	589.34	552.43
Strengthening Works		915.74	915.74	915.74	915.74	915.74	0.00	0.00	0.00
Holding Works		702.02	0.00	351.01	0.00	0.00	0.00	0.00	0.00
GRAND TOTAL		2,010.81	1,271.88	1,613.17	1,235.67	1,318.58	934.36	893.52	856.61

5. FOCUS GROUP MEETING

Focus Group (FG) meeting was convened on 19th February 2008.

Focus Group desired to include the following at suitable places in the Report so as to make it more explicit:

1. Periodical maintenance treatment should be applied only on such roads which are in maintainable state not requiring strengthening or rehabilitation.
2. Categories of maintenance activities considered in this report are meant for projection of long-term funding requirement. Source of funding for special repairs and emergency repairs has not been considered in this report. The source of funds will be according to the GoUP policy from time to time.
3. Roads having inadequate crust thickness and not fit to receive periodic renewal should not be included in periodic renewal programme. Such roads should be included for strengthening after carrying out proper investigations and testing.
4. The treatment types (in Table A-8 under Annexure) has been assumed for strengthening are meant for projecting long-term funds requirement only and not to be confused with the treatment to be decided after carrying detailed site investigations and engineering designs. Design of overlay for strengthening existing pavement should be done in accordance with relevant IRC standards, sound engineering practices and site conditions.

The Chairman of the Focus Group could not attend the meeting but report was later discussed with him on the telephone. The Chairman endorsed the observations made by the Focus Group members and desired that the observations be incorporated in the Final Report.

6. PRESENTATION TO PROJECT STEERING COMMITTEE

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PWD FOCUS GROUP H	
Sri N.K. Kanodia	Chief Engineer, Faizabad Zone, Faizabad
Sri Devendra Kumar	SE (Planning), Lucknow
Sri Daya Shanker Raj	EE CD-2, Fatehgarh, Farukhabad
Sri Harendra Nath Pandey	EE Asthayeel Khand (Pr. P), Amroha
Sri S.K. Rastogi	EE BDD-11, PWD, Lucknow
Sri P.K. Srivastava	EE P.D., Sultanpur
Sri F.I.F. Hashmi	AE Planning Division, Lucknow
Sri Yogesh Mathur	SE Bulandshahar
Sri P.K. Saxena	EE
LEA International Ltd. and LEA Associates South Asia Pvt. Ltd.	
Mr. S. K. Pancholy	Contract and Procurement Specialist
Mr. Trevor Snellgrove	Transport Economist



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TCE Recommendations in IDS final report:

Strengthen the maintenance planning process by

- *the application of techno-economic and financial criteria*
- *undertaking periodic review of policies, standards and effectiveness of programmes*
- *sustainable dedicated sufficient and timely funds be made available for maintenance related activities*
- *revising the existing maintenance norms for core, non core and village road network through the application of PMS and preset renewal cycle and specifications for the non core and village road network*



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GoUP has decided to:

“assess the road maintenance needs by Rational MMS means”.

Action milestone targeted by GoUP:

“Comprehensive objective analysis of long term core road network maintenance funding of future plan processes”



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Core Road Network considered

Classification	Length in Kilometer			
	Two Lanes	Intermediate Lane	Single lane	Total
State Highways	4,376	1,441	2,737	8,554
Major District Roads	632	1,518	5,196	7,346
Other District Roads	1,313	2,015	25,851	20,179
Total	6,321	4,974	33,784	45,079



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Network roads included in upgrading project with the WB assistance

Classification	2003	2004	2005	2006	2007	2008	Total
State Highways	604.00	353.14	283.30	77.00	643.56	794.16	2,755.16
Major District Roads			5.80	46.30	30.62	134.94	217.66
Other District Roads					11.00		11.00



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Objective Analysis of the long-term road network maintenance funding requirements should be based on following:

1. Maintenance enhances the environment and safeguards the road network asset.
2. Maintenance of roads and bridges should be for the sake of users.
3. Develop road maintenance programme with public participation
4. Maintain the assets in economical way
5. Use a sound analytical frame work for delivering an economical and environmentally sound output.
6. User costs is important input in any analytical framework
7. Consider in analysis the Budget constraint for maintenance



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Objective Analysis of the long-term road network maintenance funding requirements should be based on following (Contd...)

8. For allocating and distributing resources consider entire budget and “trade offs” between alternatives uses
9. Use management systems in allocating and distributing the resources which are compatible with the Road administration organization and management style.
10. Methods used at the network, programme and project level must be different but interlocking and use the same data base
11. Data systems which support the Road and Bridge Management system must be timely and reliable



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Categories of maintenance

1. Ordinary Repairs
2. Periodical renewals - Frequency considered 5 years
3. Special repairs
4. Emergency repairs
5. Other works



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Maintenance norms

MORT&H Committee of Norms Report October 2000

Since then the prices have increased considerably especially bitumen, fuel, cement and crusher grit.

Therefore the norms recommended by the Committee had been updated

Level of ordinary maintenance

Frequency, Serviceability level and frequency of periodical renewal in accordance with Report No.24



Report No. 45 : Report on Comprehensive Objective Analysis of Long Term Core Road Network Maintenance Funding Requirements for Future Plan Processes

Maintenance Cost in Rs per KM

Estimated two lane highway costs for various works interventions – Rupees / km

Category	NH / SH				MDR / ODR / VR			
	<450 CVD	Between 450-1500 CVD	Between 1500-4500 CVD	More than 4500 CVD	<150 CVD	Between 150-450 CVD	Between 450-1500 CVD	More than 1500 CVD
Ordinary Repairs	153,604	169,330	199,995	223,190	66,125	68,253	75,381	83,629
Periodic Renewal	952,844	952,844	1,471,297	1,471,297	952,844	952,844	1,092,881	1,092,881
Special Repairs	165,967	168,326	250,694	254,173	152,845	153,165	175,239	176,476
Emergency Repairs	165,967	168,326	250,694	254,173	152,845	153,165	175,239	176,476
Strengthening	1,787,071	1,787,071	2,080,881	2,080,881	1,787,071	1,787,071	2,080,881	2,080,881
Holding Works	316,564	316,564	762,275	762,275	316,564	316,564	762,275	762,275



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Methodology and Analysis of Funding Requirements

Maintenance requirements depend on;

- a) Structural condition of the pavement – Benkelman beam surveys, falling weight deflectometer surveys.
- b) Surface roughness – profiler, bump integrator.
- c) Surface characteristics – cracking, potholes, rutting, ravelling surveys.
- d) Drainage surveys.
- e) Traffic volume plus load and cumulative axles – traffic surveys.
- f) Road maintenance policies and practices



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Following major steps identified for Implementing PMS in UP:

- a) Identify or develop a computer based Highway Management System having the capability of evaluating various maintenance/works interventions whilst optimising the maintenance treatments to be undertaken.
- b) Collect road inventory and traffic data for the network, plus visual or machine based ratings of condition for pavements bridges etc., and then prepare a network database
- c) Identify and cost all routine and periodic maintenance interventions and update the costs of such on a regular basis



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Assumptions

In the absence a developed PMS for analyzing the fund requirements following assumptions are made:

- 1. Scenario No.1, the best scenario:** All roads in the core network are in a condition that is acceptable for routine and periodic maintenance and no work is required to bring them up to a standard whereupon such maintenance intervention can be undertaken effectively.
- 2. Scenario No.2 the Worst case:** It is assumed that at the outset all roads require to be strengthened before the can be included in the maintenance programme



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Other Assumptions

3. All Strengthening works cannot be completed in a year but will be spread over 5 years
4. Roads that are not immediately included in strengthening programme have been deemed to require 'holding works' to maintain the investments until such time the strengthening work can be undertaken.
5. Once the road has been strengthened and included under WB works would have maintenance cycle of 5 years



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Analysis

Scenario - 1 : Routine and periodic maintenance requirement
Range: Rs 820 crores to 934 crores for period 2008 to 2015
Lies within the limits of Road fund (2007 fund – 1450 crores)

Scenario – 2 :

42000 km requires strengthening

Strengthening would be carried out in period spread over 5 years

Roads not included in strengthening programme would receive holding works.

Cost range: Immediate high Rs.2000 crores to 1300 crores in early years falling to around Rs.850 crores in the later years



ANNEXURE - A : COST CALCULATIONS FOR MAINTENANCE AND OTHER WORKS ITEMS

a) Ordinary Repairs:

The cost per kilometre for NH/SH, two lane highways with paved shoulders has been calculated based on the information contained within the "Report of the Committee on Norms for Maintenance of Roads in India, Annex XXIV G - MoRTH, 2001."

However, rates for the following items have been based on the report "Standard Data Book for Analysis of Rates (First Revision), MoRTH, 2003" as detailed below:

- Pot holes repair – Section 3004.2 , Page 282
- Patch repair - Section 3004.2 , Page 282
- Slurry seal – Section 516 , Page 153
- Fog seal – Section 518 , Page 159
- Repair of ruts and undulations = 1.5 times the cost patch repairs

The cost per kilometre for two lane MDR/ODR/VR, without paved shoulders, has been calculated using information contained in "Report of the Committee on Norms for Maintenance of Roads in India, Annex. XXIX D - MoRTH, 2001."

The cost of other lane configurations has been derived using the conversion factors given in Section 6.17.1 and Section 6.17.2 of "Report of the Committee on Norms for Maintenance of Roads in India, MoRTH, 2001." In Table A-1 the cost per kilometre for ordinary repairs and different traffic levels is shown.

Table A-1 : Estimated ordinary [routine] maintenance costs per kilometer (in Rupees)

Category	NH/SH				MDR/ODR/VR			
	<450 CVD	Between 450-1500 CVD	Between 1500-4500 CVD	More than 4500 CVD	<150 CVD	Between 150-450 CVD	Between 450-1500 CVD	More than 1500 CVD
Single lane without paved shoulder	95,576	105,361	124,441	138,874	41,328	42,658	47,113	52,268
Intermediate lane without paved shoulder	116,057	127,938	151,107	168,633	49,594	51,190	56,536	62,722
Two lane without paved shoulder	153,604	169,330	199,995	223,190	66,125	68,253	75,381	83,629

Source : Consultants estimate

b) Periodic Renewal

The treatments to be used for the various traffic levels in terms of CVD's are as given in Table A-2 and A-3 with the costs by road type given in Table A-4:.

Table A-2 : Periodic maintenance interventions

Category	Commercial Vehicles per Day			
	< 450	450 – 1500	1500 – 4500	> 4500
NH/SH	2 coats of Surface Dressing	2 coats of Surface Dressing	30 mm Bituminous Concrete	30 mm Bituminous Concrete
	< 150	150 - 450	450 – 1500	> 1500
MDR/ODR/VR	2 coats of Surface Dressing	2 coats of Surface Dressing	25 mm Semi-Dense Bituminous Concrete	25 mm Semi-Dense Bituminous Concrete

Source : Report No. 24

Table A-3 : Life cycle recommendations for periodic renewals

Type of treatment/ category of road	Traffic intensity in CVD	MR-1	SD-1/ SD-2	PC+ SC	20 mm MSS	25 mm SDBC	25 mm BC	40/50 mm BC for heavy traffic
NH/SHs (Normal)	>4500	-	-	-	-	-	5/4- a	5/4 - a
	1500-4500	-	-	-	-	5/4- a	5/4 – a	-
	450-1500	-	-	-	5/4- a	5/4 - a	-	-
	<450	-	-	5/4- a	5/4 - a	-	-	-
MDR/ODR/VR (Normal)	>1500	-	-	-	-	5/4 a	5/4 a +	-
	450-1500	-	-	-	5/4 a	5/4 a	-	-
	150-450	-	-	-	5/4 a	5/4 a	-	-
	<150	5/4 a	5/4 a	5/4 a	-	-	-	-

Source : Report No. 24

Table A-4 : Estimated periodic maintenance costs per kilometer (in Rupees)

Category	NH/SH				MDR/ODR/VR			
	<450 CVD	Between 450-1500 CVD	Between 1500-4500 CVD	More than 4500 CVD	<150 CVD	Between 150-450 CVD	Between 450-1500 CVD	More than 1500 CVD
Single lane without paved shoulder	510,452	510,452	788,195	788,195	510,452	510,452	585,472	585,472
Intermediate lane without paved shoulder	748,663	748,663	1,156,019	1,156,019	748,663	748,663	858,692	858,692
Two lane without paved shoulder	952,844	952,844	1,471,297	1,471,297	952,844	952,844	1,092,881	1,092,881

Source : Consultants estimate

c) Special Repairs

The cost per kilometre for Flood Damage Repairs has been taken as 15% of (OR + PR), as recommended in Section 6.17 of "Report of the Committee on Norms for Maintenance of Roads in India, MoRTH, 2001." The costs per kilometer are shown in Table A-5

Table A-5 : Costs per/km for repairs for flood damage (in Rupees)

Category	NH/SH				MDR/ODR/VR			
	<450 CVD	Between 450-1500 CVD	Between 1500-4500 CVD	More than 4500 CVD	<150 CVD	Between 150-450 CVD	Between 450-1500 CVD	More than 1500 CVD
Single lane without paved shoulder	90,904	92,372	136,895	139,060	82,767	82,967	94,888	95,661
Intermediate lane without paved shoulder	129,708	131,490	196,069	198,698	119,738	119,978	137,284	138,212
Two lane without paved shoulder	165,967	168,326	250,694	254,173	152,845	153,165	175,239	176,476

d) Emergency Repairs

The cost per kilometre for Special/Emergency Repairs has been taken as 15% of (OR + PR), as recommended in Section 6.17 of "Report of the Committee on Norms for Maintenance of Roads in India, MoRTH, 2001." The costs per kilometer are shown in Table A-6.

Table A-6 : Costs per/km for special/emergency repairs (in Rupees)

Category	NH/SH				MDR/ODR/VR			
	<450 CVD	Between 450-1500 CVD	Between 1500-4500 CVD	More than 4500 CVD	<150 CVD	Between 150-450 CVD	Between 450-1500 CVD	More than 1500 CVD
Single lane without paved shoulder	90,904	92,372	136,895	139,060	82,767	82,967	94,888	95,661
Intermediate lane without paved shoulder	129,708	131,490	196,069	198,698	119,738	119,978	137,284	138,212
Two lane without paved shoulder	165,967	168,326	250,694	254,173	152,845	153,165	175,239	176,476

e) Strengthening

The treatments to be used for the various traffic levels in CVD are as given in Table A-7 with the costs by road type in Table A-8:

Table A-7 : Treatment types for various traffic levels

Category	Commercial Vehicles per Day			
	< 450	450 - 1500	1500 - 4500	> 4500
NH/SH	50 mm Bituminous Macadam	50 mm Bituminous Macadam	50 mm Dense Bituminous Macadam	50 mm Dense Bituminous Macadam
	< 150	150 - 450	450 - 1500	> 1500
MDR/ODR/VR	50 mm Bituminous Macadam	50 mm Bituminous Macadam	50 mm Dense Bituminous Macadam	50 mm Dense Bituminous Macadam

The aforesaid treatment types assumed for strengthening are meant for projecting long-term funds requirement only and not to be confused with the treatment to be decided after carrying detailed site investigations and engineering designs. Design of overlay for strengthening existing pavement should be done in accordance with relevant IRC standards, sound engineering practices and site conditions.

Table A-8 : Cost per kilometer for Strengthening (in Rupees)

Category	NH/SH				MDR/ODR/VR			
	<450 CVD	Between 450-1500 CVD	Between 1500-4500 CVD	More than 4500 CVD	<150 CVD	Between 150-450 CVD	Between 450-1500 CVD	More than 1500 CVD
Single lane without paved shoulder	957,360	957,360	1,114,758	1,114,758	957,360	957,360	1,114,758	1,114,758
Intermediate lane without paved shoulder	1,404,128	1,404,128	1,634,978	1,634,978	1,404,128	1,404,128	1,634,978	1,634,978
Two lane without paved shoulder	1,787,071	1,787,071	2,080,881	2,080,881	1,787,071	1,787,071	2,080,881	2,080,881

f) Holding works

The treatments to be used for the various traffic levels in CVD are as given in Table A-9 with the costs by road type in Table A-10:

Table A-9 : Treatment types for various traffic levels

Category	Commercial Vehicles per Day			
	< 450	450 – 1500	1500 – 4500	> 4500
NH/SH	2nd coat of Surface Dressing	2nd coat of Surface Dressing	2 coats of Surface Dressing	2 coats of Surface Dressing
	< 150	150 – 450	450 - 1500	> 1500
MDR/ODR/VR	2nd coat of Surface Dressing	2nd coat of Surface Dressing	2 coats of Surface Dressing	2 coats of Surface Dressing

Table A-10 : Cost per kilometer for Holding works (in Rupees)

Category	NH/SH				MDR/ODR/VR			
	<450 CVD	Between 450-1500 CVD	Between 1500-4500 CVD	More than 4500 CVD	<150 CVD	Between 150-450 CVD	Between 450-1500 CVD	More than 1500 CVD
Single lane without paved shoulder	169,588	169,588	408,362	408,362	169,588	169,588	408,362	408,362
Intermediate lane without paved shoulder	248,729	248,729	598,930	598,930	248,729	248,729	598,930	598,930
Two lane without paved shoulder	316,564	316,564	762,275	762,275	316,564	316,564	762,275	762,275

The cost for the treatments used in the above works have been calculated based on the information contained within, “Standard Data Book for Analysis of Rates (First Revision), MoRTH, 2003”

- i) 2 coats of Surface Dressing – Section 510, Page 141.
- ii) 2nd coat of Surface Dressing – Section 510, Page 141.
- iii) Bituminous Concrete – Section 509, Page 139.
- iv) Semi-Dense Bituminous Concrete – Section 508, Page 135.
- v) Bituminous Macadam – Section 504, Page 125.
- vi) Dense Bituminous Macadam – Section 507, Page 132.

g) Rates

The rates used for labour are as follows:

- Mate – Rs.115 per day
- Mazdoor – Rs.100 per day

Finally, the rates for plant and machinery have been taken from Chapter 17 of the “Standard data book for analysis of rates (first revision), MoRTH, 2003”. The rates for materials have been derived from actual rates collected from contractors as follows:

- i) Cost of bitumen (80/100) Rs. 25,000 per tonne
- ii) Cost of bitumen (60/70) Rs. 26,000 per tonne
- iii) Cost of bituminous emulsion Rs. 28,000 per tonne
- iv) Cost aggregates (above 20mm) Rs. 1,100 per cubic metre
- v) Cost aggregates (10 – 20 mm) Rs. 1,200 per cubic metre
- vi) Cost aggregates (below 10 mm) Rs. 1,250 per cubic metre
- vii) Other rates have been escalated at the rate of 5% per year, to date.