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Trade and Transport Sectors

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Tedjen - Mary Road Improvement

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TRAFFIC AND ECONOMIC EVALUATION REPORT

TEDJEN TO MARY ROAD

TRAFFIC AND ECONOMIC EVALUATION REPORT

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APPENDICES

EXECUTIVE SUMMARY

1. The Government of Turkmenistan commissioned Kocks Consult GmbH, to carry out a feasibility and design study for the rehabilitation of the section of road between Tedjen and Mary. This report has been prepared by TecnEcon for Kocks Consult GmbH and covers a review of traffic data, the results of further traffic surveys and forecasts of future traffic and pavement loadings. On the basis of these forecasts and the definition of "with project" and "without project" scenarios, an economic evaluation has been undertaken of the proposed project.

2. The review of earlier traffic studies and an in depth analysis of data provided by Turkmenautoellari was compared with the data collected from classified traffic counts carried out at three locations on the road between Mary and Tedjen. The traffic surveys were conducted for a continuous 34 hour period near to Mary and for two separate six hour counts at the two other locations. The result of this comparison indicated that the previous data had probably overestimated the traffic on the road.

3. Axle load surveys were also carried out at the survey site near to Mary, weighing trucks in both directions, one day each. The results of this survey showed fairly low average values for the Equivalent Standard Axes, ESA, per vehicle.

4. The traffic data was analysed and a base estimate made for Annual Average Daily Traffic, AADT, in 1997. The road was divided into three sections; Mary to Haus Khan, Haus Khan to the junction to Seraks near Tedjen and from the junction to Seraks near Tedjen to Tedjen with estimated AADT of 2,077, 1,548 and 3,088 vehicles per day respectively. The three sections showed quite different traffic volumes, mainly as a result of the two links to Seraks leaving a section in the middle with much less traffic.

5. Forecast of future traffic were considered based on assumptions of low, medium and high growth rates. In addition, an increase in the average value of ESA per vehicle was considered. Four scenarios were then defined - low growth/existing ESA; medium growth/existing ESA; medium growth/increased ESA and high growth/increased ESA. With an assumed two year construction period and a 15 year analysis period, forecasts were made up to 2014.

6. Using the forecasts of future traffic and ESA per vehicle, one way cumulative total ESA were calculated for the pavement design. Approximately six million ESA was the cumulative total based on the medium growth/increased ESA scenario which was taken as the base case for design and evaluation purposes.

7. The economic evaluation considered a comparison between two strategies - "do minimum" and "with project" cases. In the first case, realistic assumptions were made that the road would continue to receive routine maintenance and patching as required but that it would continue to deteriorate until a full reconstruction would be required, assumed to be 2007. In the second case, it was assumed that the road would receive overlay and reconstruction as indicated from the condition survey. Overlaid sections would additionally require further overlays in 2007. Routine and normal periodic maintenance would take place, based on responses to the pavement condition.

8. Data for the existing roughness and modified structural number of the pavement were obtained from surveys carried out on the road. These were used as input into the HDM Manager model used for the economic evaluation. Cost data for construction and overlay were calculated from a detailed breakdown of the works. The costs used for construction and maintenance were economic costs, which excluded taxes and transfers.

9. Vehicle Operating Costs and the value of travel time savings were taken from the Carl Bro International report for the Ashgabat to Tedjen section to allow for consistency of data and facilitate comparison.

10. Because the lengths of road for overlay and reconstruction were not continuous sections, the sections were grouped into combined lengths for overlay sections and reconstruction sections separately for each of the three traffic links, making a notional total of six sections for the economic analysis.

11. Cost streams for the two strategies, "do minimum" and "with project" were calculated for capital, recurrent maintenance, VOC and travel time for each of the six notional sections. These were totalled for the project road as a whole and the difference between the two cost streams was calculated as a stream of benefits for the "with project" case. The Net Present Value, NPV at 15 percent and the Economic Internal Rate of Return, EIRR were calculated from the benefit stream. These showed that the NPV at 15 percent would be 8.94 million US dollars and the EIRR would be 19.4 percent.

12. Sensitivity tests were carried out assuming variations in construction and maintenance costs and traffic benefits of plus and minus twenty percent. These tests showed that the EIRR would vary from 16.2 to 23.1 percent.

13. In conclusion, the traffic studies have shown that existing traffic levels are lower than had been supposed. However, assuming realistic growth rates and a modest increase in average ESA per vehicle, the pavement should be designed to carry a cumulative total of six million ESA. On the basis of existing conditions and the forecast loading, rehabilitation treatments of overlay and reconstruction to be carried out in 1998/99 would yield an EIRR of 19.4 percent, making the project viable.

1 INTRODUCTION

In 1995, a feasibility study for road rehabilitation in the Republic of Turkmenistan was carried out with TACIS funding. On the basis of the findings of that study, the Government of Turkmenistan commissioned Kocks Consult GmbH, to carry out a feasibility and design study for the rehabilitation of the section of road between Tedjen and Mary. Similar consultancy services were commissioned for the section between Ashgabat and Tedjen which were carried out by Carl Bro International.

This report, prepared by TecnEcon for Kocks Consult GmbH, covers the review of traffic data, the results of further traffic surveys carried out in the course of the study and forecasts of future traffic and pavement loadings for the design process. On the basis of these forecasts and the definition of "with project"and "without project" scenarios, an economic evaluation has been undertaken of the proposed project. Finally, sensitivity analyses have been carried out to test the robustness of the economic evaluation.

2 REVIEW OF TRAFFIC STUDIES AND DATA

2.1 IDENTIFICATION AND PREPARATION OF A ROAD REHABILITATION PROJECT IN TURKMENISTAN

This study of the rehabilitation of the Ashgabat to Chardzou Road, the M37, was undertaken by an individual consultant, Y. Atlan, in 1994. The work covered an appraisal of the existing condition, traffic assessment and preliminary engineering design based on the forecast growth in traffic loadings.

Reference is made to a traffic survey carried out by Turkmenautoellari in August 1994 on the section between Ashgabat and Mary although the location is not specified. Table 2.1 shows the Average Daily Traffic (ADT) by vehicle type from this survey.

Table 2.1 AVERAGE DAILY TRAFFIC, AUGUST 1994, ASHGABAT TO MARY

Vehicle Type	Number
Cars	1900
Buses	170
Trucks, < 5t	730
Trucks, > 5t 2 axle, 4 tyres	420
Trucks, > 5t 2 axle, 6 tyres	240
Trucks, > 5t 3 axle	60
Trucks, > 5t 4 axle	110
Trucks, > 5t 5 axle	170
Total Light Vehicles	**3220**
Total Heavy Trucks	**580**
Total all vehicles	**3800**

Source: Indentification and Preparation of a Road Rehabilitation Project in Turkmenistan, 1994.

The number of equivalent standard axles was then calculated from assumed values for each vehicle type, as shown in Table 2.2

Table 2.2 EQUIVALENT STANDARD AXLES (ESA) IN 1994, ASHGABAT TO MARY

Vehicle Type	ESA per Vehicle	ADT	Annual ESA
Trucks, < 5t	0.02	420	1,533
Trucks, > 5t 2 axle + Buses	0.19	410	14,217
Trucks, > 5t 3 axle	0.56	60	6,132
Trucks, > 5t 4 axle	0.62	110	12,447
Trucks, > 5t 5 axle	0.94	170	29,164
TOTAL			**63,493**

Source: Indentification and Preparation of a Road Rehabilitation Project in Turkmenistan, 1994 and Consultants.

In the original study, the consultant incorrectly calculated the number of equivalent standard axles, as the one way ADT should have been used because only half the traffic uses each side of the road. Hence, the quoted value of ESA over a ten year design life assuming a growth rate of 4% should have been 762,000 ESA. In any case, with the above assumptions, the pavement loadings would be fairly insignificant.

2.2 ROAD IMPROVEMENT PROJECT, 1995

This study was carried out by Kocks Consult GmbH in association with TecnEcon Ltd in 1995. As far as the traffic aspects were concerned, existing data were used and no new traffic surveys were carried out apart from a simple origin-destination survey of international traffic at five border posts. Therefore the traffic data quoted in the report were taken from existing sources. In Table 2.3 the Annual Average Daily Traffic on the sections Mary to Haus Khan and Haus Khan to Khaka are shown for 1985 and each year between 1990 and 1994. It can be seen that there was some variation with no overall trend easily apparant.

Table 2.3 ANNUAL AVERAGE DAILY TRAFFIC, 1985 AND 1990 TO 1994

SECTION	1985	1990	1991	1992	1993	1994
Mary to Haus Khan	2733	2924	3088	3162	3300	2855
Haus Khan to Khaka	2177	2372	2476	2796	2525	2525

Source: Based on Turkmenautoellari traffic data, quoted in Road Improvement Project, 1995.

Other sources of data for 1994, however, showed higher values for the AADT, as can be seen in Table 2.4. The exact locations of the count stations were not indicated for any of the data and this could have a significant effect on the totals, particularly if the stations were close to the urban area and reflected urban/suburban traffic as opposed to inter-urban traffic.

Table 2.4 ANNUAL AVERAGE DAILY TRAFFIC, 1994

SECTION	Car	Bus	Utility	Truck 2 to 5t	Truck 5 to 8t	Truck > 8t	Total Light	Total Truck	Total Traffic
Mary - Haus Khan	2716	255	101	686	578	343	3072	1607	4678
Percentage	58%	5%	2%	15%	12%	7%	65%	35%	
Haus Khan - jnc. R7	1090	675	115	395	810	315	1880	1520	3400
Percentage	32%	20%	3%	12%	24%	9%	55%	45%	
Jnc. R7 - Tedjen	1123	327	738	594	654	763	2188	2011	4198
Percentage	27%	8%	18%	14%	16%	18%	53%	47%	

Source:Unknown, quoted in Road Improvement Project, 1995. Percentages calculated by the Consulants.

In the absence of any data, the study estimated the average value of the number of equivalent standard axles (ESA) per vehicle for different categories. These values are shown in Table 2.5.

Table 2.5 ESTIMATED ESA VALUES FROM ROAD IMPROVEMENT STUDY, 1995

Vehicle Type	ESA per Vehicle
Bus	0.4333
Truck, 2-axle, 2 to 5 tonnes payload	0.0976
Truck, 2-axle, > 5 tonnes payload	2.1735
Truck, 3-axle	1.1071
Truck, 4-axle	1.4721
Truck, 5-axle	3.1914

Source: Road Improvement Project, 1995

The Consultants on the Road Improvement Study found that because of the various political and economic changes, it was not possible to identify a trend for traffic growth from the past data. They therefore made certain assumptions for the growth in traffic which are summarised in Table 2.6.

Table 2.6 TRAFFFIC GROWTH ASSUMPTIONS, 1994 TO 2010

Vehicle Type	Average Annual Growth (%) 1994 - 2000	Average Annual Growth (%) 2001 - 2010
Car	5.0	6.0
Bus	5.0	6.0
Utility	5.0	6.0
Truck, 2-axle, 2 to 5 tonnes	5.0	6.0
Truck, 2-axle, > 5 tonnes	5.0	6.0
Truck, 3-axle	6.0	7.0
Truck, 4-axle	6.0	7.0
Truck, 5-axle	6.0	7.0
Weighted Average Growth	**5.2**	**6.2**

Source: Road Improvement Project, 1995

2.3 STUDY ON LAND TRANSPORT CORRIDORS BETWEEN CENTRAL ASIA AND EUROPE

This study was undertaken in 1995/96 by an expert from Turkmenistan and looked into the existing conditions and future potential for transit transport corridors through Turkmenistan. The study considered road, rail and ferry on the Caspian Sea and was based on a survey of existing data and other transport sector studies. As such, it reflects data used in other contemporary studies such as the Road Improvement Project reviewed above. In particular, the report quotes the traffic volumes on the section of the M37 Mary to Haus Khan and Haus Khan to Tedjen that are given in Table 2.4.

For forecasts of future traffic, the report notes that traffic growth in the past had been rather low and indicated an annual growth rate in the range 3% - 4% for roads in Turkmenistan since 1991. However, the report proposed that future growth rates would be higher and suggested 5% for the period 1996 to 2000 and 6% for 2001 to 2010.

2.4 TURKMENISTAN HIGHWAY MASTER PLAN, VOLUME 2, PART III, FEASIBILITY STUDY FOR ASHGABAT TO MARY

This study was financed in 1996 by the Turkish International Cooperation Agency, TICA to prepare a highway masterplan for Turkmenistan. It, too, relied on data quoted in previous studies to carry out the feasibility study for the rehabilitation of the road between Ashgabat and Mary. In addition to the data on traffic volumes that have already been shown in Table 2.3, the TICA study also included data for 66 sections of road throughout Turkmenistan for 1995 although there are no indications as to the locations of the survey stations. The data relevant to the sections between Tedjen and Mary are shown in Table 2.7.

Table 2.7 ANNUAL AVERAGE DAILY TRAFFIC, 1995

SECTION	Car	Bus	Utility	Truck 2 to 5t	Truck 5 to 8t	Truck > 8t	Total Light	Total Truck	Total Traffic
Mary - Haus Khan	2995	282	112	757	638	386	3389	1781	5170
Percentage	58%	5%	2%	15%	12%	7%	65%	35%	
Haus Khan - jnc R7	1202	745	127	436	894	354	2074	1684	3758
Percentage	32%	20%	3%	12%	24%	9%	55%	45%	
Jnc. R7 - Tedjen	1239	361	814	655	722	858	2414	2235	4649
Percentage	27%	8%	18%	14%	16%	18%	53%	47%	

Source:Unknown, quoted in Turkmenistan Highway Master Plan, Volume 2, Part III, Feasibility Study for Ashgabat to Mary. Percentages calculated by the Consultants.

The TICA consultants used the 1995 data to estimate the levels of service on the Ashgabat to Mary Road, concluding that at present no section had a level of service worse than C and hence there were no existing capacity problems. Growth rates similar to those assumed in the Road Improvement Project study were used to forecast future traffic levels. A summary of this analysis is shown in Table 2.8. From this it can be seen that the consultants forecasted future levels of service E on all sections. As a result, they proposed that the sections between Mary and Haus Khan and between Junction R7 and Tedjen should become a dual two lane carriageway after 2010 and the section between Haus Khan and Junction R7 should become a dual two lane carriageway after 2013.

The TICA consultants also carried out an analysis of the economic feasibility of rehabilitation of the road, not including the expansion of its capacity. For the section between Mary and Tedjen they concluded that the Internal Rate of Return (IRR) would range between 74% and 154% depending on the section and alternative strategy being considered, thus making the rehabilitation very worthwhile.

Table 2.8 EXISTING AND FUTURE TRAFFIC VOLUMES AND LEVELS OF SERVICE, TICA REPORT

Section	Car	Bus	Truck	Articulated Truck	1995		2010	
					AADT	Level of Service	AADT	Level of Service
Mary to Haus Khan								
Volume	3107	282	1395	386	5170	C	14102	E
Growth rate per annum	6%	6%	6%	7%				
Haus Khan to Junction R7								
Volume	1329	745	1330	354	3758	C	10284	E
Growth rate per annum	6%	6%	6%	7%				
Junction R7 to Tedjen								
Volume	2053	361	1377	858	4649	C	12919	E
Growth rate per annum	6%	6%	6%	7%				

Source: Turkmenistan Highway Master Plan, Volume 2, Part III, Feasibility Study for Ashgabat to Mary.

2.5 TURKMENAUTOELLARI TRAFFIC DATA

Average Daily Traffic (ADT) data classified by vehicle type were available for a survey station near Mary on the section between Mary and Haus Khan. The data were provided for every month of 1995 and January to November 1996 and are shown in Table 2.9 and are plotted in Figure 2.1. From the table and figure it can be seen that there are several anomalies in the data. For instance, the monthly variation as shown in Figure 2.1 exhibits a strange pattern comparing 1995 with 1996. Similarly, the number of trucks over 8 tonnes suddenly increases sharply in May 1996 by a factor of over three. Furthermore, although the 1995 AADT is of similar magnitude to that quoted in Table 2.7, it is not the same. Because of these inexplicable anomalies, these figures for monthly average daily traffic cannot be used with any confidence.

In Table 2.10, the data quoted in Tables 2.4 and 2.7 for the ADT in 1994 and 1995 are compared. It can be seen that the percentage distribution for both years are identical. For this to have happened on one section would be very unusual but for it to have occurred on three adjacent sections must be considered impossible. Furthermore, the growth rates on all three sections are identical, allowing for rounding errors, and with a rate of 11 percent, are extremely high. Thus these figure for 1994 and 1995 must also be viewed with suspicion and also cannot be used with any confidence.

2.6 CARL BRO TRAFFIC SURVEYS, NOVEMBER, DECEMBER 1996 AND JANUARY 1997

The Consultants working on the design and feasibility study for the section between Ashgabat and Tedjen carried out 24 hour classified traffic surveys in November and December 1996 and January 1997. A summary of these results are shown in Table 2.11. Apart from the counts taken at kilometre 0, which reflects the suburban traffic, the counts further away from Ashgabat show levels of traffic around 1800 to 2300 vehicles per day, which are considerably less than the previous studies quoted above.

Table 2.9 CLASSIFIED MONTHLY AVERAGE DAILY TRAFFIC, ADJACENT MARY, 1995 AND 1996

Period	Car	Bus	Utility <2t	Truck 2t to 5t	Truck 5t to 8t	Truck >8t	Total Trucks	Percent Trucks	Total Traffic	Monthly Variation
1995										
January	2481	232	60	620	580	379	1639	38%	4352	77%
February	2105	421	95	815	810	504	2224	47%	4750	84%
March	2365	339	72	730	789	590	2181	45%	4885	87%
April	2415	384	81	742	801	604	2228	44%	5027	89%
May	2512	412	84	712	843	642	2281	44%	5205	92%
June	2615	484	91	811	922	703	2527	45%	5626	100%
July	2711	502	88	834	855	694	2471	43%	5684	101%
August	2812	564	86	802	1002	711	2601	44%	5977	106%
September	3102	542	91	787	1010	804	2692	42%	6336	113%
October	3208	554	79	785	989	784	2637	41%	6399	114%
November	3301	586	83	798	1045	824	2750	41%	6637	118%
December	3404	584	81	802	989	842	2714	40%	6702	119%
1996										
January	3202	544	78	784	898	824	2584	41%	6330	123%
February	2896	524	75	759	902	712	2448	42%	5868	114%
March	2902	529	69	715	889	706	2379	41%	5810	113%
April	3001	544	71	692	871	751	2385	40%	5930	115%
May	1989	62	34	119	295	2632	3080	60%	5131	99%
June	1511	59	29	123	302	2595	3049	66%	4619	90%
July	1601	63	32	120	298	2585	3035	65%	4699	91%
August	1599	68	30	117	270	2450	2867	63%	4534	88%
September	1580	75	27	123	286	2515	2951	64%	4606	89%
October	1520	83	23	125	265	2600	3013	65%	4616	89%
November	1601	75	28	120	271	2530	2949	64%	4625	90%
AADT 1995	**2753**	**467**	**83**	**770**	**886**	**673**	**2412**		**5632**	
AADT 1996	**2127**	**239**	**45**	**345**	**504**	**1900**	**2795**		**5161**	

Source: Turkmenautoellari

Figure 2.1 MONTHLY TRAFFIC VARIATION, 1995 & 1996 TEDJEN TO MARY

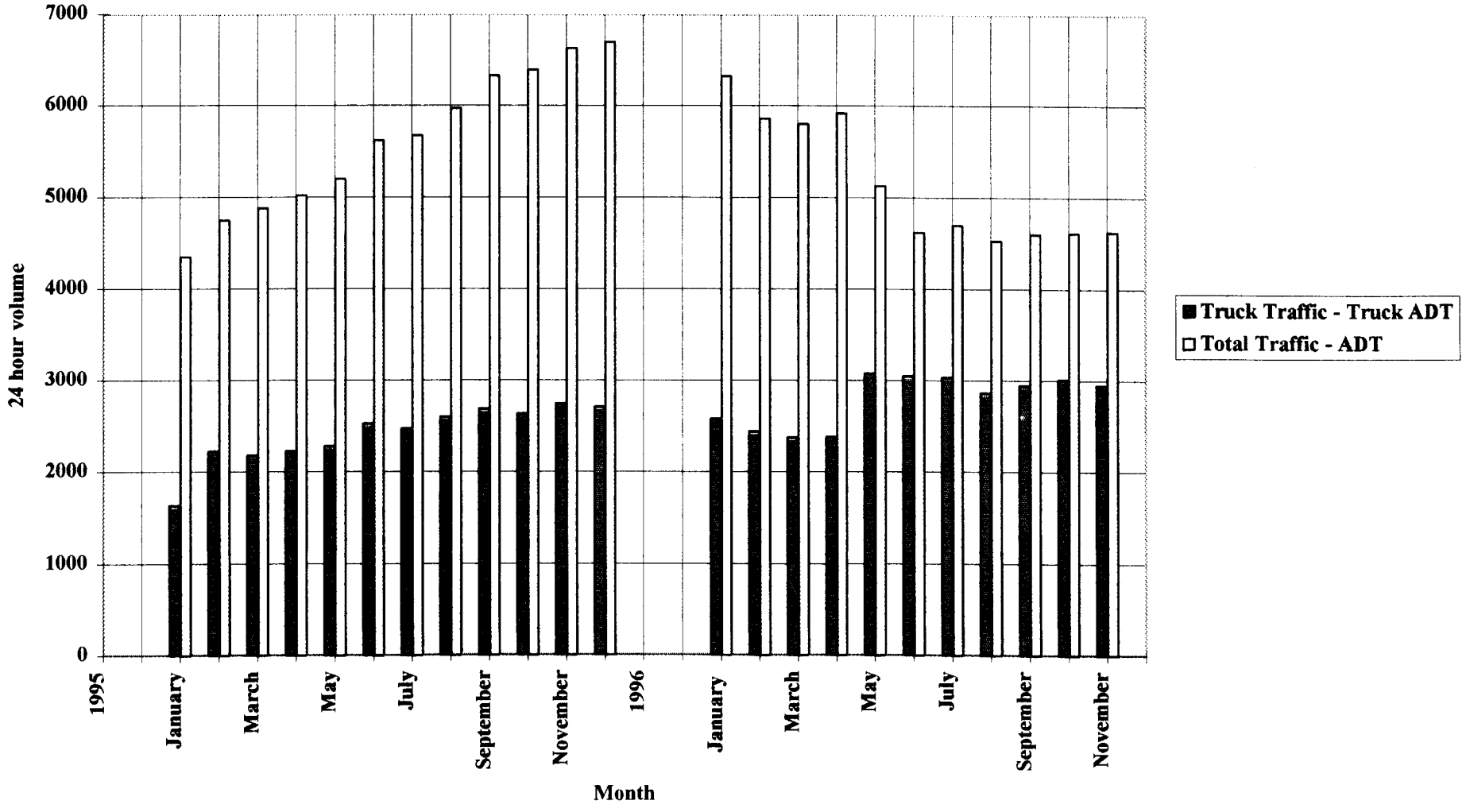

Table 2.10 COMPARISON OF TRAFFIC VOLUME, DISTRIBUTION AND INCREASE BY VEHICLE TYPE FOR 1994 AND 1995

Section	Year	AVERAGE DAILY TRAFFIC								
		Car	Bus	Utility	Truck			Total Light	Total Truck	Total Traffic
					2 to 5t	5 to 8t	> 8t			
Mary - Haus Khan	1994	2716	255	101	686	578	343	3072	1607	4678
Mary - Haus Khan	1995	2995	282	112	757	638	386	3389	1781	5170
Haus Khan - jnc. R7	1994	1090	675	115	395	810	315	1880	1520	3400
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Jnc. R7 - Tedjen	1994	1123	327	738	594	654	763	2188	2011	4198
Jnc. R7 - Tedjen	1995	1239	361	814	655	722	858	2414	2235	4649

Section	Year	PERCENTAGE DISTRIBUTION								
		Car	Bus	Utility	Truck			Total Light	Total Truck	Total Traffic
					2 to 5t	5 to 8t	> 8t			
Mary - Haus Khan	1994	58%	5%	2%	15%	12%	7%	66%	34%	100%
Mary - Haus Khan	1995	58%	5%	2%	15%	12%	7%	66%	34%	100%
Haus Khan - jnc. R7	1994	32%	20%	3%	12%	24%	9%	55%	45%	100%
Haus Khan - jnc. R7	1995	32%	20%	3%	12%	24%	9%	55%	45%	100%
Jnc. R7 - Tedjen	1994	27%	8%	18%	14%	16%	18%	52%	48%	100%
Jnc. R7 - Tedjen	1995	27%	8%	18%	14%	16%	18%	52%	48%	100%

Section	Year	PERCENTAGE INCREASE BETWEEN 1994 AND 1995								
		Car	Bus	Utility	Truck			Total Light	Total Truck	Total Traffic
					2 to 5t	5 to 8t	> 8t			
Mary - Haus Khan	1994-1995	10%	11%	11%	10%	10%	13%	10%	11%	11%
Haus Khan - jnc. R7	1994-1995	10%	10%	10%	10%	10%	12%	10%	11%	11%
Jnc. R7 - Tedjen	1994-1995	10%	10%	10%	10%	10%	12%	10%	11%	11%

Source: Road Improvement Study 1995, Turkmenistan Highway Masterplan, 1996 and Consultants analysis.

Table 2.11 ASHGABAT TO TEDJEN - TRAFFIC SURVEY COUNTS, NOVEMBER, DECEMBER 1996, JANUARY 1997

Location	Car	Bus	Truck >2t					Total Trucks	Total Light Vehcles	Total ADT	Monthly Variation Trucks	Monthly Variation All
			2 - axle	3 - axle	4 - axle	5 - axle	6 - axle					
Ashgabat Km 0												
Nov-96	11716	1107	2030	697	93	271	19	3110	12823	15933	18%	16%
Dec-96	10017	1033	1928	483	85	208	36	2740	11050	13790	4%	1%
Jan-97	8383	924	1334	430	75	195	23	2057	9307	11364	-22%	-17%
Average 3 months	10039	1021	1764	537	84	225	26	2636	11060	13696		
Ashgabat Km 70												
Nov-96	1067	226	337	166	86	128	1	718	1293	2011	-5%	-13%
Dec-96	1673	313	366	170	90	130	10	766	1986	2752	2%	19%
Jan-97	1204	187	389	206	92	83	10	780	1391	2171	3%	-6%
Average 3 months	1315	242	364	181	89	114	7	755	1557	2311		
Ashgabat Km 170												
Nov-96	604	198	506	210	96	83	3	898	802	1700	5%	-5%
Dec-96	771	195	525	184	100	120	9	938	966	1904	10%	6%
Jan-97	953	103	304	186	81	103	45	719	1056	1775	-16%	-1%
Average 3 months	776	165	445	193	92	102	19	852	941	1793		

Source: Carl Bro International

3 TRAFFIC SURVEYS

3.1 CLASSIFIED TRAFFIC COUNTS

Classified traffic counts were carried out at three locations on the road between Mary and Tedjen on 11 and 12 February 1997 as follows:

- 7 km from Mary towards Tedjen;
- at the junction with the road to Seraks at Haus Khan; and
- at the junction with the R7 near to Tedjen.

At the site near to Mary, the count was carried out for a continuous period of 34 hours, providing a full 24 hour count and a second 10 hour count for the daylight hours. At the other two locations, six hour counts were undertaken within the period that counting was going on near Mary so that factors could be applied to estimate the full 24 hour volumes.

The counts near Mary were made for each direction separately. At the other two locations, however, full turning counts were made, allowing the two way volumes on each leg of the junction to be calculated.

The traffic was classified into the following categories:

- Agricultural tractor;
- Car;
- Bus;
- Utility van;
- 2 axle truck, <5 tonnes;
- 2 axle truck, >5 tonnes;
- 3 axle truck;
- 4 axle truck;
- 5 axle truck;
- 6 axle truck; and
- Other, which would mainly cover motorcycles.

The survey forms used in these counts are shown in Appendix A - Traffic Survey Results. The data collected at the three sites are shown in Tables A.1 to A.12 in Appendix A. A summary of the results is shown in Table 3.1

Table 3.1 SUMMARY OF CLASSIFIED TRAFFIC COUNTS

Location and Time Period	Agri Tractor	Car	Bus	Utility <2t	Truck >2t					Other	Total Trucks	Total Light Vehicles	Total
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
Mary													
24 hour count													
Mary to Tedjen	57	589	62	13	152	66	12	71	0	10	302	730	1032
Tedjen to Mary	58	567	55	30	133	49	24	45	0	10	251	72	971
Total two way*	114	1155	116	42	283	115	36	116	0	20	550	1447	1997
Mary													
10 hour count													
Mary to Tedjen	52	307	32	7	78	31	9	43	0	11	161	409	570
Tedjen to Mary	30	262	34	9	65	28	7	24	0	7	124	342	466
Total two way	82	569	66	16	143	59	16	67	0	18	285	751	1036
Haus Khan													
6 hour count													
Two way to Mary	36	260	30	8	108	41	7	47	0	1	203	335	538
Two way to Tedjen	32	219	23	6	64	18	7	14	0	3	103	283	386
Two way to Seraks	14	53	9	2	48	25	0	33	0	2	106	80	186
Near Tedjen													
6 hour count													
Two way to Mary	19	273	16	2	78	33	10	27	0	3	148	313	461
Two way to Tedjen	32	521	33	5	158	51	18	27	0	7	254	598	852
Two way to Seraks	35	302	17	3	106	18	8	0	0	4	132	361	493

* Totals differ due to rounding errors
Source: Traffic Surveys

3.2 AXLE LOAD SURVEYS

At the same time as the classified counts, axle load surveys were conducted at the same location just outside Mary. The eastbound trucks were weighed on the 11 February 1997 and westbound on 12 February. The period of weighing was continuous between 08.30 and 18.00 on both days and the sample weighed represented virtually 100 percent of all trucks that passed. Thus the average value of ESA per vehicle for each category of vehicle reflects the proportion of load, partially loaded and empty vehicles that was in the traffic stream on the survey days. A summary of the axle load data and the calculated equivalent standard axles is shown in Table 3.2.

In addition, the Consultants also carried out an axle load survey in November 1996 just outside Ashgabat on the Ashgabat to Mary Road. The results of this survey are also included in Table 3.2.

Table 3.2 RESULTS OF AXLE LOAD SURVEYS

Vehicle Type		Number Weighed	Total ESA	Average ESA	Maximum ESA	Minimum ESA
Date	11 & 12/2/97		Location	Mary 7 km		
Eastbound: Tedjen to Mary						
Bus		4	3.20	0.80	1.76	0.01
Truck	2 - axle	69	38.28	0.55	26.82	0.00
Truck	3 - axle	16	1.47	0.09	0.33	0.01
Truck	4 - axle	15	34.65	2.31	8.77	0.24
Truck	5 - axle	20	39.70	1.99	4.80	0.06
Average all trucks		120	114.11	0.95	26.82	0.00
Westbound: Mary to Tedjen						
Bus		0	0.00	0.00	0.00	0.00
Truck	2 - axle	85	10.85	0.13	2.29	0.00
Truck	3 - axle	25	7 33	0.29	5.14	0.00
Truck	4 - axle	8	19.16	2.40	10.26	0.06
Truck	5 - axle	34	23.98	0.71	10.62	0.02
Average all trucks		152	61.33	0.40	10.62	0.00
Date	27 & 28/11/96		Location	Ashgabat		
Eastbound: Ashgabat to Tedjen						
Bus						
Truck	2 - axle	169	21.60	0.13	5.05	0.00
Truck	3 - axle	103	51.64	0.50	5.43	0.01
Truck	4 - axle	15	40.90	2.73	8.50	0.02
Truck	5 - axle	37	182.02	4.92	62.11	0.06
Average all trucks		323	296.16	0.92	62.11	0.00
Westbound: Tedjen to Ashgabat						
Bus						
Truck	2 - axle	165	63.53	0.39	4.18	0.00
Truck	3 - axle	82	21.62	0.26	4.04	0.01
Truck	4 - axle	13	45.99	3.54	9.51	0.07
Truck	5 - axle	29	34.97	1.21	8.40	0.04
Average all trucks		289	176.41	0.61	9.51	0.00

Source: Consultants' axle load surveys

4 ANALYSIS OF BASE YEAR TRAFFIC

4.1 ESTIMATE OF ANNUAL AVERAGE DAILY TRAFFIC (AADT)

The results of the traffic surveys described in section 3 have been analysed to produce estimates of AADT at the three survey locations.

For the location near Mary, the traffic survey data has been presented as:

- a 24 hour total, covering the period 08.00 on 11 February to 08.00 on 12 February; and

- a 10 hour total, covering the period 08.00 on 12 February to 18.00 on 12 February.

The data for the 10 hour period has been multiplied by the 10 to 24 hour factor from the 24 hour count to produce an estimate of the 24 hour volume for the second day. An average has then been taken to produce an estimate of Average Daily Traffic, ADT, near to Mary.

For the location near to Tedjen, at the junction of R7, the 6 hour count on the 11 February has been converted into an estimated 24 hour total by using the 6 to 24 hour factors from the Mary 24 hour count. As the numbers are small an adjustment was made to allow for the time of transit between the two stations as trucks counted in the period 12.00 to 13.00 that were coming from Mary would have been counted in the period 11.00 to 12.00. Similarly, trucks going towards Mary that were counted in the period 17.00 to 18.00 would not appear at Mary until the period 18.00 to 19.00. The factors that were used and the adjustments that were made are shown in Table 4.1.

For the location near to Haus Khan, the 6 hour count on the 12 February has been converted into an estimated 24 hour total by using the 6 to 24 hour factors from the Mary 24 hour count estimated for 12 February. In this case it was not necessary to make any adjustments. The factors that were used are shown in Table 4.2.

The estimated 24 hour totals at each of the three locations has been used to produce an average value for the section, see Table 4.3. As turning counts were taken at Haus Khan and Junction R7 near Tedjen, two-way volumes were derived for each leg, hence the estimated traffic on the sections Mary to Haus Khan and Haus Khan to Junction R7 near Tedjen are the average of the traffic at each end of the section. Only the section from the Junction R7 near Tedjen to Tedjen is based on the traffic from a single source. It should be noted though, that as the road approaches Tedjen, there will be an increasing volume of suburban traffic although it is very unlikely that this would increase the estimated number of equivalent standard axles as the majority of the increased traffic would be light passenger vehicles.

The traffic counts are considerably lower than those quoted in previous studies and also when compared with previous traffic counts. There can be several reasons for this:

- there has been a decrease in traffic volumes;

- the seasonal variation factors are very high;

Table 4.1 FACTOR OF 6 HOUR TO 24 HOUR FOR COUNTS AT JUNCTION R7 MEAR TEDJEN

Time Period	Agri Tractor	Car	Bus	Utility <2t	Truck >2t					Other	Total Trucks	Total Light Vehicles	Total
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
12:00 to 18:00	48	332	41	11	82	41	11	22	0	7	156	439	595
Adjustment					10	-4	3	18			27		27
Total 24 hr	114	1155	116	42	283	115	36	116	0	20	550	1447	1997
6 hour factor	2.38	3.48	2.83	3.82	3.08	3.11	2.57	2.90	0.00	2.86	3.01	3.30	3.21

Source: Consultants' traffic surveys

Table 4.2 FACTOR OF 6 HOUR TO 24 HOUR FOR COUNTS AT HAUS KHAN

Time Period	Agri Tractor	Car	Bus	Utility <2t	Truck >2t					Other	Total Trucks	Total Light Vehicles	Total
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
11:00 to 17:00	42	337	40	11	91	32	12	43	0	12	178	442	620
Adjustment													
Total 24 hr est.	113	1167	117	43	244	126	41	116	0	42	527	1481	2008
6 hour factor	2.68	3.46	2.92	3.92	2.68	3.94	3.42	2.69	0.00	3.47	2.96	3.35	3.24

Source: Consultants' traffic surveys

Table 4.3 ESTIMATED 24 HOUR TOTALS

Section	Location	Agri Tractor	Car	Bus	Utility <2t	Truck >2t					Other	Total Trucks	Total Light Vehcles	Total
						2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
Mary to Haus Khan	Mary day 1	114	1155	116	42	283	115	36	116	0	20	550	1447	1997
	Mary day 2	113	1167	117	43	244	126	41	116	0	42	527	1481	2008
	Average	114	1161	117	43	264	121	39	116	0	31	540	1466	2006
	Haus Khan	97	900	88	31	343	161	24	127	0	3	655	1119	1774
	Average	106	1031	103	37	304	141	32	122	0	17	599	1294	1893
Haus Khan to Saraks Junction near Tedjen	Haus Khan	86	758	67	24	207	71	24	38	0	10	339	945	1284
	Tedjen	45	950	45	8	266	103	26	78	0	9	473	1056	1529
	Average	66	854	56	16	237	87	25	58	0	10	407	1002	1409
Saraks Junction near Tedjen to Tedjen	Tedjen	76	1813	93	19	503	159	46	78	0	20	786	2021	2807

Source: Consultants' traffic surveys

- the locations of survey sites has been too close to urban areas; or
- there have been errors in the collection or analysis of the traffic data.

Whatever the reason, it seems reasonable to be confident that the traffic survey conducted by the Consultants do reflect the current levels of traffic. They are broadly consistent with the survey data collected by Carl Bro in the period November 1996 to January 1997 and are consistent within the three sites at which counts were undertaken. It is proposed therefore that these data are used as the basis for forecasting future traffic demand on the road between Tedjen and Mary.

However, some allowance has to be made for the fact that the traffic surveys were carried out in the winter period and therefore do not reflect the higher volumes of traffic that could be expected in the summer period. Without data on seasonal variations and assuming that February is likely to be lower than the average for the year because of the winter effects, it has been assumed that the Annual Average Daily Traffic (AADT) is 10 percent higher than that observed in February. Hence, estimates of the AADT on each section have been made by increasing the ADT from the February traffic surveys by 10 percent. The resulting values are shown in Table 4.4.

The traffic analysis has been carried out for the ten categories of vehicles to permit comparison with previous reports. However, for the input in the economic evaluation model HDM Manager, slightly different categories are required. Furthermore, in order to facilitate comparison with the Carl Bro study for the section Ashgabat to Tedjen, the same categories used by them in their HDM Manager analysis have been adopted. Table 4.4 has been modified to take account of this and the resulting traffic volumes by vehicle type for use in the economic evaluation are shown in Table 4.5.

Table 4.4 ESTIMATED AVERAGE ANNUAL DAILY TRAFFIC, AADT

Section	Source	Agri Tractor	Car	Bus	Utility <2t	Truck >2t					Other	Total Trucks	Total Light Vehcles	Total
						2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
Mary to Haus Khan	Survey	105	1030	102	37	303	141	31	121	0	17	596	1292	1888
	Est. AADT	116	1133	112	41	334	155	34	133	0	19	656	1421	2077
Haus Khan to Saraks Junction near Tedjen	Survey	66	854	56	16	237	87	25	58	0	9	406	1001	1407
	Est. AADT	72	939	62	17	260	95	27	64	0	10	447	1101	1548
Junction to Seraks near Tedjen to Tedjen	Survey	76	1813	93	19	503	159	46	78	0	20	786	2021	2807
	Est. AADT	84	1994	103	21	553	174	51	86	0	22	865	2223	3088

Source: Consultants

Table 4.5 ESTIMATED AVERAGE ANNUAL DAILY TRAFFIC, AADT, CLASSIFIED INTO CATEGORIES FOR ECONOMIC EVALUATION

Section	Car	Utility Etc.	Bus	Medium Truck	Heavy Truck	Articulated Truck	Total Light Vehcles	Total Trucks	Total All Vehicles
Mary to Haus Khan	1133	175	112	334	155	168	1421	656	2077
Haus Khan to Saraks Junction near Tedjen	939	100	62	260	95	91	1101	447	1548
Junction to Seraks near Tedjen to Tedjen	1994	127	103	553	174	137	2223	865	3088

Source: Consultants

4.2 ESTIMATE OF ANNUAL NUMBER OF EQUIVALENT STANDARD AXLES (ESA)

A comparison of the axle load survey results with previous estimates is shown in Table 4.6. The values from the two surveys conducted by the Consultants are for the eastbound direction as this was the heaviest. As can be seen, the values vary considerably which implies that any forecasts need to be viewed with caution.

Table 4.6 COMPARISON OF ESA VALUES

Vehicle Type	Estimates 1994 ESA per Vehicle	Estimates 1995 ESA per Vehicle	Axle Load Survey 1996 ESA per Vehicle	Axle Load Survey 1997 ESA per Vehicle
Bus	0.19	0.43		0.80
Trucks, < 5t	0.02	0.10		
Trucks, > 5t 2 axle	0.19	2.17	0.13	0.55
Trucks, > 5t 3 axle	0.56	1.11	0.50	0.09
Trucks, > 5t 4 axle	0.62	1.47	2.73	2.31
Trucks, > 5t 5 axle	0.94	3.19	4.92	1.99

Source: Various, see Tables 2.4, 2.7 and 3.2.

Using the survey values and the estimated AADT on each section of the road, the base year loadings have been calculated expressed in the number of equivalent standard axles, ESA. These results are shown in Table 4.7 for the eastbound direction as this was the more heavily laden. Table 4.8 shows the survey results for the four categories of heavy vehicles used in the economic evaluation.

Table 4.7 BASE YEAR PAVEMENT LOADINGS IN ESA

Section	Vehicle Type	Average ESA	ADT	Annual ESA
Mary to Haus Khan	Eastbound			
	Bus	0.80	56	16377
	Truck 2 - axle	0.55	167	33783
	Truck 3 - axle	0.09	77	2595
	Truck 4 - axle	2.31	17	14472
	Truck 5 - axle	1.99	67	48301
	TOTAL		384	115529
Haus Khan to Junction R7	Eastbound			
	Bus	0.80	31	9027
	Truck 2 - axle	0.55	130	26365
	Truck 3 - axle	0.09	48	1598
	Truck 4 - axle	2.31	14	11508
	Truck 5 - axle	1.99	32	23112
	TOTAL		254	71610
Junction R7 to Tedjen	Eastbound			
	Bus	0.80	51	15001
	Truck 2 - axle	0.55	277	56004
	Truck 3 - axle	0.09	87	2924
	Truck 4 - axle	2.31	25	21464
	Truck 5 - axle	1.99	43	31205
	TOTAL		484	126599

Source: Consultants' traffic and axle load surveys.

Table 4.8 AVERAGE ESA PER VEHICLE FROM SURVEY FOR CATEGORIES USED IN ECONOMIC EVALUATION

Vehicle Category	Average ESA per vehicle
Bus	0.80
Medium truck	0.55
Heavy Truck	0.09
Articulated Truck*	2.12

* Using weighted average for 4 and 5 axle

5 FUTURE TRAFFIC FORECASTS

5.1 FORECAST SCENARIOS

Because of the severe economic changes in the region, the historic data is not a good indicator of growth trends. Therefore, forecast scenarios have been developed, taking account of growth rates proposed in previous studies and providing a range within which it could be reasonably expected that future traffic could lie. Low, Medium and High growth rate scenarios have been used with different rates used for light, mainly people carrying vehicles and medium to heavy trucks used by freight.

It has been assumed that the cars, utility vehicles and buses will grow at a slower rate than the medium, heavy and articulated trucks for the period 1997 to 2002 inclusive. Thereafter, with the Low Growth scenario, it has been assumed that the same growth rates will continue to apply throughout the rest of the forecast period of 2003 to 2014. With the Medium and High Growth scenarios, it has been assumed that the light vehicles will grow at a slightly lower rate for the first five years than the next twelve years. However, for the medium, heavy and articulated trucks it has been assumed that they will grow at a slightly higher rate in the first five years than the next twelve years. This is to reflect the reality that economic growth will first be seen by growth in freight traffic before its impact is seen in increased personal travel. The resulting growth rates for each scenario are shown in Table 5.1

Table 5.1 FORECAST GROWTH RATE SCENARIOS

Scenario	Annual Growth rates, percent per annum					
	Cars	Utility	Buses	Trucks >2t		
				Medium	Heavy	Articulated
Low Growth						
1997 to 2002	4.0%	4.0%	4.0%	5.0%	5.0%	5.0%
2002 to 2014	4.0%	4.0%	4.0%	5.0%	5.0%	5.0%
Medium Growth						
1997 to 2002	5.0%	5.0%	5.0%	7.0%	7.0%	7.0%
2002 to 2014	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
High Growth						
1997 to 2002	6.0%	6.0%	6.0%	8.0%	8.0%	8.0%
2002 to 2014	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%

Source: Consultants

The results of the axle load survey and comparison with other values quoted in previous studies as well as experience in other countries indicates that an increase in average values by vehicle type could be expected. In particular, the value for 3 axle trucks from the survey seems to be very low, reflecting a very high percentage of empties, probably because the survey was carried out during the winter. An allowance for this has therefore been made by assuming a growth in the average values over the five year period between 1997 and 2002. The levels assumed for 2002 are broadly consistent with other surveys and international experience. The resulting values for the average ESA per vehicle for each of the years between 1997 and 2002 are shown in Table 5.2. These increases in ESA values have only been applied to the Medium and High Growth scenarios and for comparative purposes two Medium Growth scenarios have been developed, one with increased ESA per vehicle and one without.

Table 5.2 FORECAST INCREASES IN ESA/VEHICLE 1998 TO 2002

	Average ESA/vehicle 1997	Future Average ESA Per Vehicle				
		1998	1999	2000	2001	2002
Eastbound: Tedjen to Mary						
Bus	0.80	0.80	0.80	0.80	0.80	0.80
Medium Truck	0.55	0.64	0.73	0.82	0.91	1.00
Heavy Truck	0.09	0.42	0.76	1.09	1.42	1.75
Articulated Truck*	2.12	2.25	2.37	2.50	2.62	2.75

* weighted average of 4 and 5 axle trucks
Source: Consultants

5.2 FUTURE TRAFFIC

Using the assumptions and scenarios described in 5.1, forecasts have been made of future traffic and the resulting cumulative number of equivalent axle loads on each of the sections, Mary to Haus Khan, Haus Khan to Junction to Seraks near Tedjen and Junction to Seraks near Tedjen to Tedjen. A two year construction period has been assumed with an opening in 2000. Thereafter, a 15 year analysis period has been used. Because the economic evaluation model used, HDM-Manager, is limited in the number of variables that can be used, weighted values of the growth rates and average ESA per vehicle have been calculated from the more detailed values derived in the four scenarios. Table 5.3 shows these weighted values. The detailed forecasts are shown in Tables B.1.1 to B.4.3 in Appendix B. Summaries of the forecast AADT and the one way cumulative ESA are shown in Tables 5.4, 5.5 and 5.6.

The forecast AADT indicate that even with the High Growth scenario, it is unlikely that there will be a need to increase the capacity before 2014 as the level of service for a two lane road will still only be Level C, using the same method as the TICA consultants.

Table 5.3 WEIGHTED AVERAGE GROWTH RATES AND ESA PER VEHICLE

Scenario	Factor	Cars	Utility etc.	Buses	Trucks >2t		
					Medium	Heavy	Articulated
Low Growth Rate	Weighted Average Growth Rate	4.55%	4.55%	4.55%	5.69%	5.69%	5.69%
	Weighted Average ESA/Vehicle			0.80	0.55	0.09	2.12
Medium Growth Rate	Weighted Average Growth Rate	5.70%	5.70%	5.70%	6.29%	6.29%	6.29%
	Weighted Average ESA/Vehicle			0.80	0.55	0.09	2.12
Medium Growth Rate Increased ESA/Vehicle	Weighted Average Growth Rate	5.70%	5.70%	5.70%	6.29%	6.29%	6.29%
	Weighted Average ESA/Vehicle			0.80	0.99	1.71	2.73
High Growth Rate Increased ESA/Vehicle	Weighted Average Growth Rate	6.70%	6.70%	6.70%	7.00%	7.00%	7.00%
	Weighted Average ESA/Vehicle			0.80	0.99	1.71	2.73

Source: Consultants

Table 5.4 COMPARISON OF ALTERNATIVE FORECASTS OF FUTURE AADT AND ONE WAY CUMULATIVE ESA

SECTION: MARY TO HAUS KHAN

Year	Scenario 1 Low Growth		Scenario 2 Medium Growth		Scenario 3 Medium Growth Increased ESA/vehicle		Scenario 4 High Growth Increased ESA/vehicle	
	AADT Vehicles/day	Cumulative One Way Million ESA	AADT Vehicles/day	Cumulative One Way Million ESA	AADT Vehicles/day	Cumulative One Way Million ESA	AADT Vehicles/day	Cumulative One Way Million ESA
1997	2077		2077		2077		2077	
2000	2358	0.14	2448	0.14	2448	0.21	2496	0.21
2001	2459	0.28	2587	0.30	2587	0.46	2654	0.46
2002	2566	0.43	2733	0.46	2733	0.76	2821	0.76
2003	2677	0.58	2897	0.63	2897	1.07	3019	1.07
2004	2793	0.75	3071	0.81	3071	1.40	3230	1.41
2005	2914	0.92	3255	1.01	3255	1.75	3456	1.77
2006	3040	1.10	3451	1.21	3451	2.12	3698	2.16
2007	3172	1.29	3658	1.43	3658	2.51	3957	2.57
2008	3309	1.49	3877	1.66	3877	2.93	4234	3.01
2009	3453	1.70	4110	1.91	4110	3.37	4530	3.49
2010	3603	1.91	4357	2.17	4357	3.84	4848	3.99
2011	3759	2.14	4618	2.44	4618	4.33	5187	4.53
2012	3922	2.38	4895	2.73	4895	4.86	5550	5.11
2013	4093	2.63	5189	3.04	5189	5.42	5939	5.73
2014	4271	2.90	5500	3.37	5500	6.01	6354	6.40

Source: Consultants

Table 5.5 COMPARISON OF ALTERNATIVE FORECASTS OF FUTURE AADT AND ONE WAY CUMULATIVE ESA

SECTION: HAUS KHAN TO JUNCTION TO SERAKS NEAR TEDJEN

Year	Scenario 1 Low Growth		Scenario 2 Medium Growth		Scenario 3 Medium Growth Increased ESA/vehicle		Scenario 4 High Growth Increased ESA/vehicle	
	AADT Vehicles/day	Cumulative One Way Million ESA	AADT Vehicles/day	Cumulative One Way Million ESA	AADT Vehicles/day	Cumulative One Way Million ESA	AADT Vehicles/day	Cumulative One Way Million ESA
1997	1548		1548		1548		1548	
2000	1755	0.08	1822	0.09	1822	0.13	1858	0.13
2001	1831	0.17	1924	0.18	1924	0.29	1975	0.29
2002	1910	0.26	2032	0.28	2032	0.47	2100	0.48
2003	1992	0.36	2153	0.39	2153	0.67	2247	0.67
2004	2077	0.46	2283	0.50	2283	0.88	2404	0.89
2005	2167	0.57	2420	0.62	2420	1.10	2572	1.11
2006	2260	0.68	2565	0.75	2565	1.33	2752	1.36
2007	2357	0.79	2719	0.88	2719	1.58	2945	1.62
2008	2459	0.91	2882	1.02	2882	1.84	3151	1.90
2009	2565	1.04	3055	1.17	3055	2.12	3372	2.19
2010	2675	1.18	3238	1.33	3238	2.42	3608	2.51
2011	2791	1.32	3432	1.50	3432	2.73	3860	2.85
2012	2911	1.46	3638	1.68	3638	3.06	4131	3.22
2013	3037	1.62	3857	1.87	3857	3.41	4420	3.61
2014	3168	1.78	4088	2.07	4088	3.78	4729	4.03

Source: Consultants

Table 5.6 COMPARISON OF ALTERNATIVE FORECASTS OF FUTURE AADT AND ONE WAY CUMULATIVE ESA

SECTION: JUNCTION TO SERAKS NEAR TEDJEN TO TEDJEN

Year	Scenario 1 Low Growth		Scenario 2 Medium Growth		Scenario 3 Medium Growth Increased ESA/vehicle		Scenario 4 High Growth Increased ESA/vehicle	
	AADT Vehicles/day	Cumulative One Way Million ESA	AADT Vehicles/day	Cumulative One Way Million ESA	Vehicles/day	Cumulative One Way Million ESA	AADT Vehicles/day	Cumulative One Way Million ESA
1997	3088		3088		3088		3088	
2000	3501	0.15	3633	0.15	3633	0.24	3707	0.24
2001	3652	0.30	3835	0.32	3835	0.52	3940	0.52
2002	3808	0.46	4050	0.50	4050	0.86	4188	0.86
2003	3971	0.63	4293	0.68	4293	1.21	4481	1.22
2004	4142	0.81	4550	0.88	4550	1.59	4794	1.60
2005	4320	0.99	4823	1.09	4823	1.99	5130	2.02
2006	4505	1.19	5113	1.31	5113	2.41	5489	2.46
2007	4699	1.39	5420	1.55	5420	2.86	5873	2.93
2008	4901	1.61	5745	1.80	5745	3.34	6284	3.43
2009	5112	1.83	6089	2.06	6089	3.84	6724	3.97
2010	5332	2.07	6455	2.34	6455	4.37	7195	4.55
2011	5561	2.32	6842	2.64	6842	4.94	7699	5.17
2012	5801	2.58	7253	2.96	7253	5.54	8238	5.83
2013	6051	2.85	7688	3.29	7688	6.18	8814	6.54
2014	6312	3.13	8149	3.65	8149	6.85	9431	7.29

Source: Consultants

5.3 LOADINGS FOR PAVEMENT DESIGN

The traffic surveys show that there is a decrease in traffic volumes on the middle section near Haus Khan. This is caused particularly by heavy trucks turning off to take the road to Seraks. Close to Tedjen, on the section between Tedjen and the turning to Seraks, there is an increase in traffic, mainly because of the influence of the nearby villages that are linked to Tedjen.

The pavement loadings are directly proportional to the values used for the average ESA per vehicle, hence the scenarios that assume an increase in average ESA values show a significant increase in cumulative pavement loadings. These are shown in Figures 5.1, 5.2 and 5.3 for the three sections respectively, showing that there is little difference between the medium and high growth scenarios assuming the increase in average ESA per vehicle.

Overall, there is little difference in pavement loadings between the two end sections but the cumulative ESA for the middle section are nearly half that on the other two sections. However, it would not be prudent to design this section on the lower values as these are based on the assumption that the border crossing at Seraks will remain the preferred route for international transit traffic and more importantly that the road will remain open to traffic. This is a crucial assumption as it is understood that this road is in a poorer condition than the road that comes to the junction near Tedjen.

As there is little difference in the cumulative ESA between the medium and high growth scenarios, the pavement design should be based on a one way cumulative total of 6 million ESA over the fifteen year period 2000 to 2014.

Figure 5.1 Forecast One Way Cumulative Equivalent Standard Axles

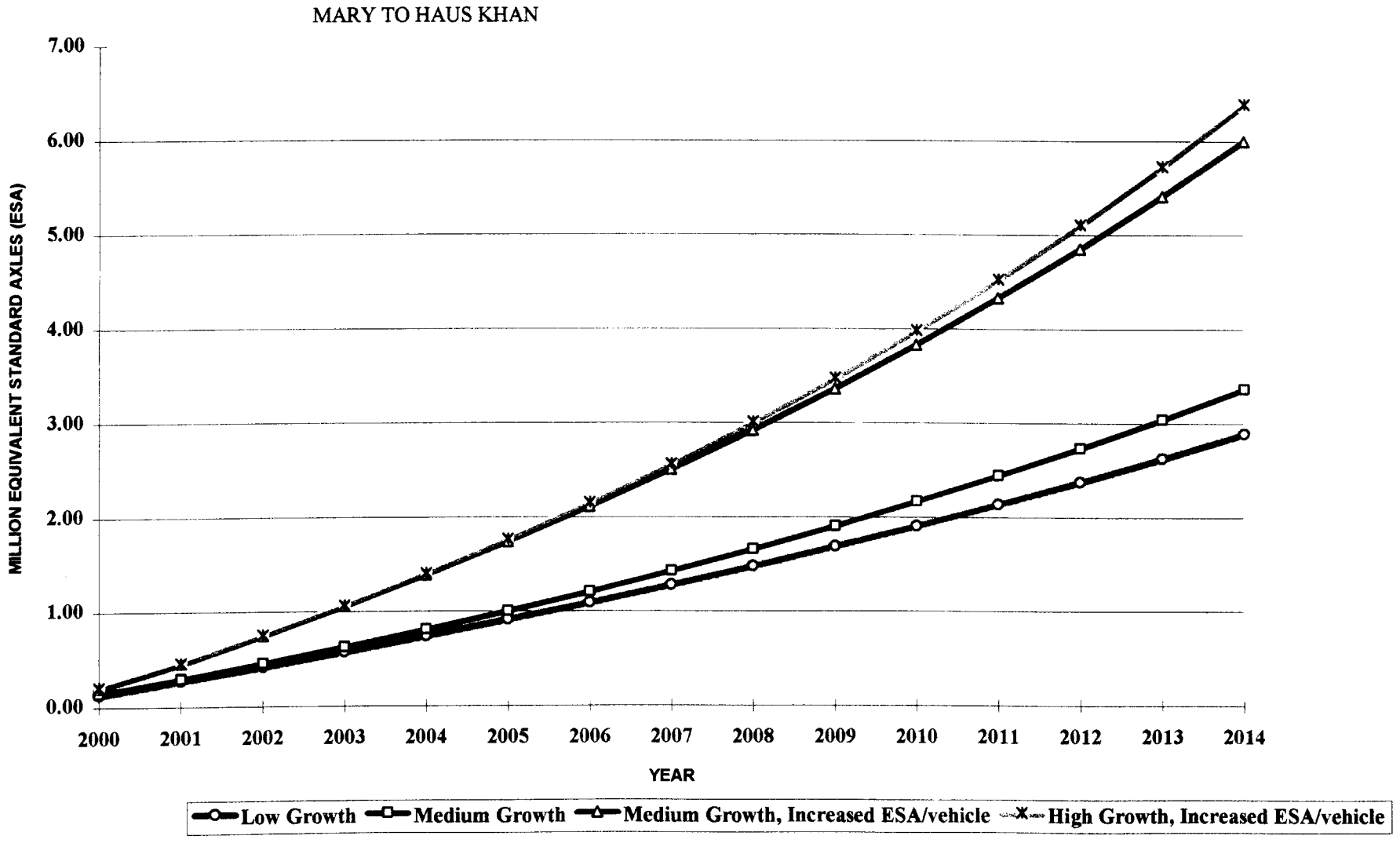


Figure 5.2 Forecast One Way Cumulative Equivalent Standard Axles

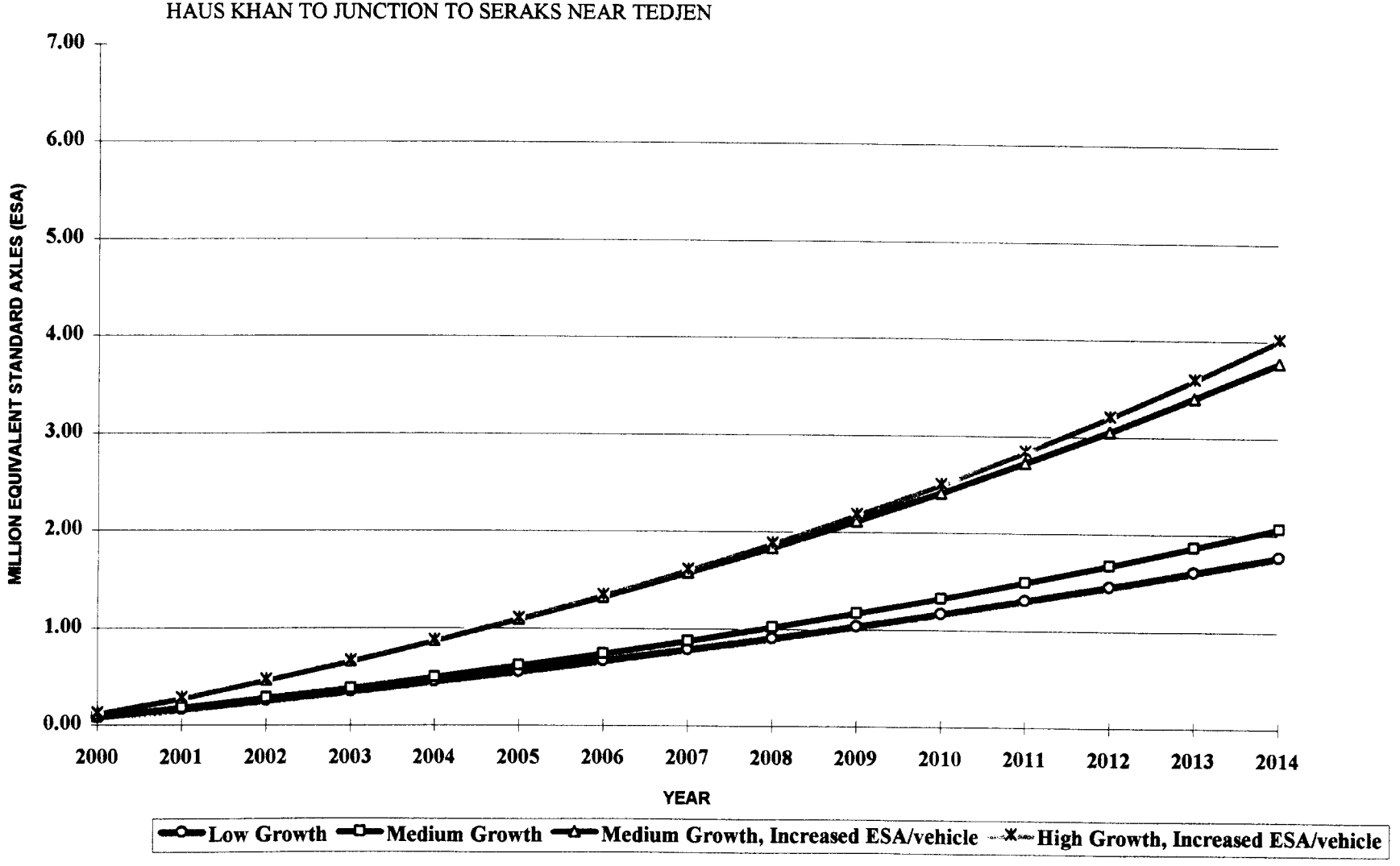
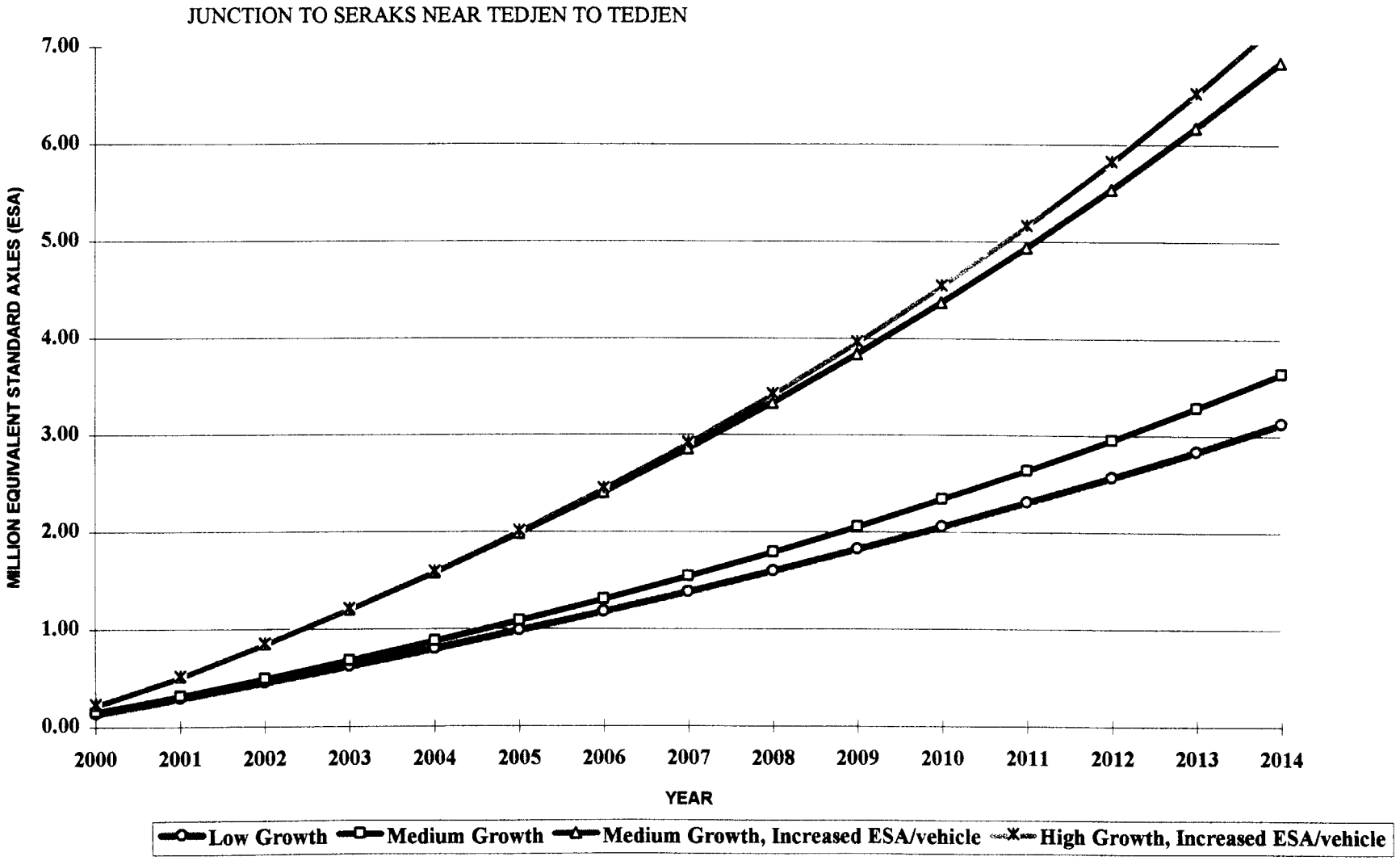


Figure 5.3 Forecast One Way Cumulative Equivalent Standard Axles



6 PROJECT DEFINITION

6.1 EXISTING ROAD

The existing road between Tedjen and Mary has been surveyed and its condition recorded, see engineering report. From this it can be seen that a considerable proportion is in a poor state, with a fairly high level of roughness. The road can be divided into the three traffic sections referred to in the earlier chapters, which result from the two links to the Iranian border at Seraks, causing the section in between to carry less traffic, particularly heavy goods vehicles. There is little road side friction as any developments are usually set well back and the road by passes Haus Khan.

From the surveys, the road is not very homogeneous, making it difficult for both the definition of the existing condition and future proposals for treatment. A fuller description of the roughness and structural numbers are given in the engineering report. For the purposes of the economic evaluation, the data has been processed for the sections identified for overlay and reconstruction and are shown in Table C.1 in Appendix C.

6.2 DEFINITION OF PROJECT

From the analysis of the survey data, sections were identified either for overlay or for reconstruction. These are shown in Table C.1 in Appendix C, which also includes details of the recommended thickness of overlay and identifies short sections for realignment. Because the lengths of road for overlay and reconstruction were not continuous sections, for the economic analysis, the sections were grouped into combined lengths for overlay sections, numbered 1A, 2A and 3A and reconstruction sections, numbered 1B, 2B and 3B for each of the three traffic links respectively.

The weighted values for roughness and the modified structural number have been calculated from the detailed data in Table C.1 for each of the summary lengths and are shown in Table 6.1. Also shown are the weighted values of the projected modified structural numbers following the rehabilitation.

Table 6.1 WEIGHTED VALUES OF ROUGHNESS AND MODIFIED STRUCTURAL NUMBERS

	Section 1A	**Section 1B**	**Section 2A**	**Section 2B**	**Section 3A**	**Section 3B**
Between chainages	0+000 to 9+862		9+862 to 73+490		73+490 to 142+527	
Average roughness	4.31	6.28	4.90	5.35	6.59	6.96
Average SN (existing)	2.84	3.79	2.28	1.94	2.52	2.22
Average SN (future)	3.47	6.82	3.01	6.82	3.29	6.82

Source: Consultants

Because of the fairly poor quality of material used in the past, the sections selected for overlay treatment initially were assumed to require further overlay in 2007. Apart from this, resealing, patching and routine maintenance operations were assumed to continue in response to deterioration of the pavement under the traffic loading. The detailed maintenance strategy and the maintenance policies associated with it for the "with project" case are described in the input data for the HDM model in Appendix D.

6.3 DEFINITION OF "WITHOUT PROJECT" SCENARIO

A realistic "without" project scenario has to be defined as the base case against which any rehabilitation is to be tested. Despite a shortage of funds, Turkmenautoellari appear to have carried out routine maintenance and patching, probably due to the importance of the road. It was assumed therefore that a minimum maintenance effort would continue until the road had deteriorated to such an extent that it would be impossible to continue to patch and only a full reconstruction would be feasible. Because the reality is that the sections vary considerably, the use of a weighted average as the basis for determining when a full reconstruction could no longer be delayed would lead to apparent differences in the year for intervention for the different summary sections. It was assumed therefore that the reconstruction would be fixed by schedule and would take place in 2007, by which time long sections would be in a very poor state with very high levels of roughness. The detailed maintenance strategy and the maintenance policies associated with it for the "do minimum" case are described in the input data for the HDM model in Appendix D.

7 ECONOMIC EVALUATION

7.1 INTRODUCTION

The economic evaluation model that was used was HDM Manager, an updated variant of the HDM-III model. The model was used to produce outputs for the two strategies - do minimum and the overlay/reconstruction project. Separate runs were made for each of the six sections and then the resulting cost streams were added to give the overall total for the complete road. The two sets of cost streams were then compared to give the benefits of the project from which the Net Present Value, NPV and the Economic Internal Rate of Return were calculated. Appendix D contains a print out of all the input data that was used in running HDM Manager and Appendices E and F give the output cost streams for the "do minimum" and "with project" cases respectively.

7.2 CONSTRUCTION AND MAINTENANCE COSTS

The detailed economic construction costs from the engineering report were used to produce estimations of construction costs in the "With Project" case for each of the summary sections based on the definition of the amount of work described in Appendix C. The general, drainage, signalisation, dayworks, provisional and contingencies costs were calculated "pro rata" to the lengths of each section. Table 7.1 shows the detailed costs for each of the six sections in the "With Project" case. Tables E.1 and F.1 in Appendices E and F show the cost streams for the two strategies.

Table 7.1 CONSTRUCTION COSTS BY SECTION AND TOTAL

Item	Section 1A	Section 1B	Section 2A	Section 2B	Section 3A	Section 3B	Total
Length (m)	1,900	7,962	14,480	49,148	14,277	54,760	142,527
General	39,992	167,589	304,784	1,034,499	300,511	1,152,624	3,000,000
40 mm Overlay	225,399		1,106,806		1,170,222		2,502,426
75 mm Overlay	0		422,207		423,240		845,447
120 mm Overlay	0		0		106,812		106,812
Reconstruction		2,189,526		15,323,538		17,226,790	34,739,855
New Road		618,590		270,401		0	888,991
Drainage	433	1,813	3,297	11,191	3,251	12,469	32,453
Signalisation	4,425	18,541	33,720	114,452	33,247	127,521	331,906
Dayworks	4,239	17,762	32,302	109,640	31,849	122,160	317,953
Provisional Sum	2,933	12,290	22,351	75,863	22,038	84,526	220,000
Sub Total	277,420	3,026,111	1,925,467	16,939,585	2,091,170	18,726,089	42,985,842
Contingencies 5%	13,871	151,306	96,273	846,979	104,558	936,304	2,149,292
Total (ex taxes)	291,290	3,177,417	2,021,741	17,786,564	2,195,728	19,662,393	45,135,134

Source: Consultants

It was assumed that the reconstruction and overlays would be carried out over a two year period - 1998/99. It was also assumed that with the "do minimum" case, reconstruction would be required in 2007. The economic costs for other maintenance activities such as patching and resealing were based on estimates of the costs currently incurred by Turkmenautoellari and are shown in Table 7.2. The cost streams for the two strategies are shown in Tables E.2 and F.2 in Appendices E and F.

Table 7.2 MAINTENANCE COSTS

Item	Unit	Rate (US $)
Patching	square metre	23.00
Resealing	square metre	1.25
Routine annual	kilometre	1,100

Source: Consultants

7.3 VEHICLE OPERATING COSTS

The data for the calculation of vehicle operating costs, VOC, were taken from the work prepared by Carl Bro International, CBI, for the section Ashgabat to Tedjen to allow a consistent economic evaluation to be made between the two lengths of road. The input data used is shown in Appendix D which covers all the input data for the HDM model. A summary description of the representative vehicle in each category is shown in Table 7.3. The resulting streams of vehicle operating costs are shown in Tables E.3 and F.3 in Appendices E and F for the two strategies.

Table 7.3 REPRESENTATIVE VEHICLES FOR ECONOMIC ANALYSIS

Type	Make and Model	Passenger Capacity	Average Passenger Carried	Payload Capacity tonnes	Axles	Wheels	Cost US $
Small Car	Lada 2107	5	3	-	2	4	7,000
Utility	Raf 2203	11	5	-	2	4	10,000
Large Bus	Ikarus 256	41	32	-	2	6	46,500
Medium Truck	Zil 130-80	-	-	6	2	6	20,000
Heavy Truck	Kamaz 5320	-	-	8	3	10	42,000
Articulated Truck	Mercedes 16335	-	-	20	5	18	90,000

Source: Carl Bro International

7.4 OTHER BENEFITS

7.4.1 Travel Time Costs

It is readily accepted that travel time cost savings will result from improvements to the quality of the road surface because of higher vehicle speeds. Although it is relatively easy to predict the increases in vehicle speeds and hence the amount of time that would be saved, it is often difficult to quantify the value of this time. In the CBI study of the road from Ashgabat to Tedjen, a value of US $0.18 per hour was used and this value was adopted for this study for the sake of consistency. The resulting streams of travel time costs are shown in Tables E.4 and F.4 in Appendices E and F for the two strategies being compared.

7.4.2 Accident Savings

There are no specific data available for accident statistics on the road making it difficult to estimate the likely impact from the project. Alignments are generally very good and will not be affected by the project. Improvements to the camber and roughness would have a positive effect but this could be off set by higher speeds. It was assumed therefore, that the impact of the road project on road safety would be neutral.

7.5 ECONOMIC ANALYSIS

The two sets of cost streams shown in Appendices E and F were compared to produce a stream of benefits resulting from the project case. Table 7.4 shows the separate benefit streams for capital costs, recurrent maintenance costs, VOC and travel time costs. From the total net benefit stream, the Net Present Value, NPV, at a discount rate of 15 per cent and the Economic Internal Rate of Return, EIRR, have been calculated. These show that the project achieves an EIRR of 19.4 per cent, making it a viable project on the basis of the base case assumptions.

Table 7.4 TIME STREAMS OF ECONOMIC BENEFITS

Year	Net Benefits (millions US $)				
	Capital Costs	Maintenance Costs	Vehicle Operating Costs	Travel Time Costs	Total
1998	-22.568	0.000	0.000	0.000	-22.568
1999	-22.568	0.000	0.000	0.000	-22.568
2000	0.000	0.004	5.128	0.095	5.227
2001	0.000	0.011	6.294	0.128	6.433
2002	0.000	0.017	7.826	0.177	8.020
2003	0.000	0.023	9.803	0.238	10.064
2004	0.000	0.028	12.320	0.323	12.671
2005	0.000	0.034	14.669	0.403	15.106
2006	0.000	0.038	16.220	0.453	16.711
2007	52.154	0.000	17.317	0.487	69.958
2008	0.000	0.000	-0.932	-0.009	-0.941
2009	0.000	0.000	-0.976	-0.010	-0.986
2010	0.000	0.000	-1.111	-0.012	-1.123
2011	-0.552	-0.008	-1.316	-0.014	-1.890
2012	-0.617	0.000	-1.660	-0.016	-2.293
2013	-0.090	-0.001	-2.024	-0.019	-2.134
2014	0.000	0.000	-2.379	-0.023	-2.402
				NPV @ 15% (millions US $)	8.94
				IRR	19.4%

Source: Consultants

7.6 SENSITIVITY ANALYSIS

Because the economic evaluation is potentially susceptible to the initial assumptions made, sensitivity tests were carried out assuming plus and minus twenty percent on construction and maintenance costs and plus and minus twenty percent on traffic VOC and travel time savings. The results of these on the NPV at 15 percent and the EIRR are shown in Table 7.5. From this it can be seen that the anticipated range of value for the EIRR would be between 16.2 and 23.1 percent.

Table 7.5 SENSITIVITY TESTS OF EIRR AND NPV AT 15 PERCENT

Case	Economic Internal Rate of Return	Net Present Value at 15 % (millions US $)
Base	19.4%	8.94
Costs + 20%	16.7%	4.16
Costs - 20%	23.1%	13.72
Traffic + 20%	22.4%	15.51
Traffic - 20%	16.2%	2.37

Source: Consultants

8 CONCLUSIONS

The traffic studies have shown that the existing level of traffic is lower than had been previously supposed. However, the estimated ADT of between 1550 and 3000 vehicles per day on the three sections are broadly in line with those estimated by Carl Bro International for the sections between Ashgabat and Tedjen. At these levels of traffic and assuming realistic growth rates, there would be no capacity problems before the design year, 2014.

The axle load surveys would seem to indicate fairly low average values of ESA per vehicle and it was assumed that these could increase with time. A range of growth rates and increases to average ESA values were considered resulting in a proposed one way cumulative total ESA of approximately 6 million which was used for the pavement design.

The economic evaluation was carried out using HDM Manager and showed that a mixture of overlay and reconstruction, costing an estimated total of US $ 45,135,134 at economic costs, would be viable with an EIRR of 19.4 percent. Sensitivity tests showed that the EIRR could vary between 16.2 and 23.1 percent.

APPENDIX A

1997 CLASSIFIED TRAFFIC COUNTS

Table A.1 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 11,12/02/1997 LOCATION Mary Km7 DIRECTION Mary to Tedjen

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00	0	7	0	0	1	2	0	0	0	0	3	7	10
01:00 to 02:00	0	6	1	0	3	1	0	3	0	0	7	7	14
02:00 to 03:00	0	2	0	0	2	1	1	1	0	0	5	2	7
03:00 to 04:00	1	5	0	0	0	1	0	0	0	0	1	6	7
04:00 to 05:00	0	11	0	0	3	3	0	0	0	0	6	11	17
05:00 to 06:00	0	18	1	0	0	0	0	0	0	0	0	19	19
06:00 to 07:00	1	12	1	0	7	1	0	0	0	0	8	14	22
07:00 to 08:00	2	28	7	0	5	0	1	2	0	0	8	37	45
08:00 to 09:00*	3	24	5	2	6	4	0	4	0	0	14	34	48
09:00 to 10:00	10	57	6	0	17	5	0	11	0	1	33	74	107
10:00 to 11:00	11	42	4	0	27	5	0	8	0	0	40	57	97
11:00 to 12:00	6	30	2	0	14	2	0	9	0	0	25	38	63
12:00 to 13:00	5	26	2	1	6	5	1	4	0	3	16	37	53
13:00 to 14:00	4	24	4	0	5	1	1	2	0	1	9	33	42
14:00 to 15:00	3	23	1	0	10	0	0	4	0	1	14	28	42
15:00 to 16:00	1	27	3	0	6	6	0	2	0	0	14	31	45
16:00 to 17:00	0	29	6	0	6	7	0	1	0	0	14	35	49
17:00 to 18:00	4	30	2	1	4	7	2	1	0	0	14	37	51
18:00 to 19:00	0	52	5	0	5	2	5	5	0	1	17	58	75
19:00 to 20:00	3	49	3	5	8	2	1	2	0	2	13	62	75
20:00 to 21:00	1	32	2	2	10	4	0	4	0	0	18	37	55
21:00 to 22:00	1	20	3	0	1	3	0	3	0	0	7	24	31
22:00 to 23:00	0	18	1	1	2	2	0	3	0	1	7	21	28
23:00 to 00:00	0	9	1	0	2	1	0	1	0	0	4	10	14
08:00 to 18:00	47	312	35	4	101	42	4	46	0	6	193	404	597
12:00 to 18:00	17	159	18	2	37	26	4	14	0	5	81	201	282
18:00 to 08:00	9	269	25	8	49	23	8	24	0	4	104	315	419
TOTAL 24 hr*	57	589	62	13	152	66	12	71	0	10	302	730	1032

* Total adjusted as count started at 08.15

Table A.2 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 11,12/02/1997 LOCATION Mary Km7 DIRECTION Tedjen to Mary

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00	0	12	0	1	1	2	0	2	0	0	5	13	18
01:00 to 02:00	2	5	2	0	2	1	1	0	0	0	4	9	13
02:00 to 03:00	0	6	3	0	2	1	1	2	0	0	6	9	15
03:00 to 04:00	2	3	0	0	3	0	0	2	0	0	5	5	10
04:00 to 05:00	3	1	0	0	0	0	0	0	0	0	0	4	4
05:00 to 06:00	0	8	0	0	0	4	0	1	0	0	5	8	13
06:00 to 07:00	0	5	2	0	0	0	0	0	0	3	0	10	10
07:00 to 08:00	0	62	6	1	13	4	0	0	0	2	17	71	88
08:00 to 09:00*	0	9	0	1	2	1	0	3	0	0	6	10	16
09:00 to 10:00	0	18	3	1	7	1	1	1	0	0	10	22	32
10:00 to 11:00	0	28	1	2	6	1	2	2	0	1	11	32	43
11:00 to 12:00	4	25	4	0	8	0	2	8	0	0	18	33	51
12:00 to 13:00	5	25	2	0	3	1	2	0	0	1	6	33	39
13:00 to 14:00	2	20	2	1	4	0	1	0	0	0	5	25	30
14:00 to 15:00	3	21	5	2	6	2	0	2	0	0	10	31	41
15:00 to 16:00	6	31	3	1	14	1	0	1	0	1	16	42	58
16:00 to 17:00	11	32	9	1	10	6	1	0	0	0	17	53	70
17:00 to 18:00	4	44	2	4	8	5	3	5	0	0	21	54	75
18:00 to 19:00	5	47	0	8	12	1	6	4	0	1	23	61	84
19:00 to 20:00	5	72	3	4	10	4	2	6	0	1	22	85	107
20:00 to 21:00	3	33	3	3	8	11	0	1	0	0	20	42	62
21:00 to 22:00	2	29	4	0	5	2	0	2	0	0	9	35	44
22:00 to 23:00	1	12	0	0	6	1	2	1	0	0	10	13	23
23:00 to 00:00	0	16	1	0	2	0	0	1	0	0	3	17	20
08:00 to 18:00	35	253	31	13	68	18	12	22	0	3	120	335	455
12:00 to 18:00	31	173	23	9	45	15	7	8	0	2	75	238	313
18:00 to 08:00	23	311	24	17	64	31	12	22	0	7	129	382	511
TOTAL 24 hr*	58	567	55	30	133	49	24	45	0	10	251	720	971

* Total adjusted as count started at 08.15

Table A.3 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 11,12/02/1997 LOCATION Mary Km7 DIRECTION Two way total

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00	0	19	0	1	2	4	0	2	0	0	8	20	28
01:00 to 02:00	2	11	3	0	5	2	1	3	0	0	11	16	27
02:00 to 03:00	0	8	3	0	4	2	2	3	0	0	11	11	22
03:00 to 04:00	3	8	0	0	3	1	0	2	0	0	6	11	17
04:00 to 05:00	3	12	0	0	3	3	0	0	0	0	6	15	21
05:00 to 06:00	0	26	1	0	0	4	0	1	0	0	5	27	32
06:00 to 07:00	1	17	3	0	7	1	0	0	0	3	8	24	32
07:00 to 08:00	2	90	13	1	18	4	1	2	0	2	25	108	133
08:00 to 09:00*	3	43	6	3	9	6	0	9	0	0	24	55	79
09:00 to 10:00	10	75	9	1	24	6	1	12	0	1	43	96	139
10:00 to 11:00	11	70	5	2	33	6	2	10	0	1	51	89	140
11:00 to 12:00	10	55	6	0	22	2	2	17	0	0	43	71	114
12:00 to 13:00	10	51	4	1	9	6	3	4	0	4	22	70	92
13:00 to 14:00	6	44	6	1	9	1	2	2	0	1	14	58	72
14:00 to 15:00	6	44	6	2	16	2	0	6	0	1	24	59	83
15:00 to 16:00	7	58	6	1	20	7	0	3	0	1	30	73	103
16:00 to 17:00	11	61	15	1	16	13	1	1	0	0	31	88	119
17:00 to 18:00	8	74	4	5	12	12	5	6	0	0	35	91	126
18:00 to 19:00	5	99	5	8	17	3	11	9	0	2	40	119	159
19:00 to 20:00	8	121	6	9	18	6	3	8	0	3	35	147	182
20:00 to 21:00	4	65	5	5	18	15	0	5	0	0	38	79	117
21:00 to 22:00	3	49	7	0	6	5	0	5	0	0	16	59	75
22:00 to 23:00	1	30	1	1	8	3	2	4	0	1	17	34	51
23:00 to 00:00	0	25	2	0	4	1	0	2	0	0	7	27	34
08:00 to 18:00	82	575	67	17	170	61	16	70	0	9	317	750	1067
12:00 to 18:00	48	332	41	11	82	41	11	22	0	7	156	439	595
18:00 to 08:00	32	580	49	25	113	54	20	46	0	11	233	697	930
TOTAL 24 hr*	114	1155	116	42	283	115	36	116	0	20	550	1447	1997

* Total adjusted as count started at 08.15

Table A.4 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 12/02/97 LOCATION Mary Km7 DIRECTION Mary to Tedjen

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00	5	33	3	1	3	4	1	8	0	1	16	43	59
09:00 to 10:00	11	44	7	1	8	4	0	4	0	1	16	64	80
10:00 to 11:00	12	39	6	0	18	6	1	2	0	1	27	58	85
11:00 to 12:00	6	29	3	0	12	3	0	5	0	2	20	40	60
12:00 to 13:00	4	23	1	1	7	4	1	9	0	1	21	30	51
13:00 to 14:00	2	27	3	0	7	1	0	0	0	2	8	34	42
14:00 to 15:00	4	35	3	1	9	0	0	5	0	0	14	43	57
15:00 to 16:00	5	26	2	1	8	3	1	2	0	1	14	35	49
16:00 to 17:00	3	27	4	2	5	3	4	6	0	2	18	38	56
17:00 to 18:00	0	24	0	0	1	3	1	2	0	0	7	24	31
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00	52	307	32	7	78	31	9	43	0	11	161	409	570
11:00 to 17:00	18	162	13	5	37	14	7	24	0	6	82	204	286
18:00 to 08:00 est.	11	272	24	15	39	18	18	24	0	7	99	330	429
TOTAL 24 hr est.	63	579	56	22	117	49	27	67	0	18	260	739	999

Table A.5 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 12/02/97 LOCATION Mary Km7 DIRECTION Tedjen to Mary

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00	1	12	0	0	1	3	0	2	0	0	6	13	19
09:00 to 10:00	1	17	2	0	0	3	0	0	0	0	3	20	23
10:00 to 11:00	4	30	2	1	5	2	2	0	0	0	9	37	46
11:00 to 12:00	0	28	3	2	5	2	0	3	0	1	10	34	44
12:00 to 13:00	6	13	2	0	6	1	0	0	0	1	7	22	29
13:00 to 14:00	1	24	5	0	4	4	1	2	0	0	11	30	41
14:00 to 15:00	1	19	3	1	4	2	0	3	0	0	9	24	33
15:00 to 16:00	1	24	6	1	13	0	1	2	0	1	16	33	49
16:00 to 17:00	5	47	7	2	12	3	3	2	0	2	20	63	83
17:00 to 18:00	10	48	4	2	15	8	0	10	0	2	33	66	99
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00	30	262	34	9	65	28	7	24	0	7	124	342	466
11:00 to 17:00	24	175	27	6	54	18	5	19	0	6	96	238	334
18:00 to 08:00 est.	20	325	26	12	62	49	7	25	0	16	143	400	542
TOTAL 24 hr est.	50	587	60	21	127	77	14	49	0	23	267	742	1008

Table A.6 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 12/02/97 LOCATION Mary Km7 DIRECTION Two way total

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00	7	59	3	1	4	9	1	13	0	1	27	71	98
09:00 to 10:00	12	61	9	1	8	7	0	4	0	1	19	84	103
10:00 to 11:00	16	69	8	1	23	8	3	2	0	1	36	95	131
11:00 to 12:00	6	57	6	2	17	5	0	8	0	3	30	74	104
12:00 to 13:00	10	36	3	1	13	5	1	9	0	2	28	52	80
13:00 to 14:00	3	51	8	0	11	5	1	2	0	2	19	64	83
14:00 to 15:00	5	54	6	2	13	2	0	8	0	0	23	67	90
15:00 to 16:00	6	50	8	2	21	3	2	4	0	2	30	68	98
16:00 to 17:00	8	74	11	4	17	6	7	8	0	4	38	101	139
17:00 to 18:00	10	72	4	2	16	11	1	12	0	2	40	90	130
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00	82	569	66	16	143	59	16	67	0	18	285	751	1036
11:00 to 17:00	42	337	40	11	91	32	12	43	0	12	178	442	620
18:00 to 08:00 est.	31	598	51	27	101	67	25	49	0	24	242	730	972
TOTAL 24 hr est.	113	1167	117	43	244	126	41	116	0	42	527	1481	2008

Table A.7 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 11/02/97 LOCATION Tedjen/Saraks DIRECTION Mary, two way total

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00													
09:00 to 10:00													
10:00 to 11:00													
11:00 to 12:00													
12:00 to 13:00	3	47	3	1	11	2	0	2	0	0	15	54	69
13:00 to 14:00	4	36	3	0	12	4	0	3	0	1	19	44	63
14:00 to 15:00	4	39	4	0	10	6	3	5	0	0	24	47	71
15:00 to 16:00	2	50	1	1	20	5	4	2	0	0	31	54	85
16:00 to 17:00	1	45	1	0	13	3	2	9	0	1	27	48	75
17:00 to 18:00	5	56	4	0	12	13	1	6	0	1	32	66	98
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00													
12:00 to 18:00	19	273	16	2	78	33	10	27	0	3	148	313	461
18:00 to 08:00													
TOTAL 24 hr est.	45	950	45	8	266	103	26	78	0	9	473	1056	1529

Table A.8 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 11/02/97 LOCATION Tedjen/Saraks DIRECTION Tedjen, two way total

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00													
09:00 to 10:00													
10:00 to 11:00													
11:00 to 12:00													
12:00 to 13:00	2	90	6	3	27	4	1	2	0	1	34	102	136
13:00 to 14:00	6	76	5	0	31	11	1	3	0	3	46	90	136
14:00 to 15:00	8	78	7	0	28	8	6	5	0	0	47	93	140
15:00 to 16:00	0	92	6	1	25	8	4	2	0	0	39	99	138
16:00 to 17:00	6	87	3	1	22	7	4	9	0	1	42	98	140
17:00 to 18:00	10	98	6	0	25	13	2	6	0	2	46	116	162
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00													
12:00 to 18:00	32	521	33	5	158	51	18	27	0	7	254	598	852
18:00 to 08:00													
TOTAL 24 hr est.	76	1813	93	19	503	159	46	78	0	20	786	2021	2807

Table A.9 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 11/02/97 LOCATION Tedjen/Saraks DIRECTION Saraks, two way total

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00													
09:00 to 10:00													
10:00 to 11:00													
11:00 to 12:00													
12:00 to 13:00	3	57	3	2	20	2	1	0	0	1	23	66	89
13:00 to 14:00	8	44	2	0	19	7	1	0	0	2	27	56	83
14:00 to 15:00	8	43	3	0	24	2	3	0	0	0	29	54	83
15:00 to 16:00	2	48	5	0	15	3	0	0	0	0	18	55	73
16:00 to 17:00	5	52	2	1	15	4	2	0	0	0	21	60	81
17:00 to 18:00	9	58	2	0	13	0	1	0	0	1	14	70	84
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00													
12:00 to 18:00	35	302	17	3	106	18	8	0	0	4	132	361	493
18:00 to 08:00													
TOTAL 24 hr est.	83	1051	48	11	321	56	21	0	0	11	398	1205	1603

Table A.10 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 11/02/97 LOCATION Haus Khan/Saraks DIRECTION Mary, two way total

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00													
09:00 to 10:00													
10:00 to 11:00													
11:00 to 12:00	6	43	6	1	17	11	1	5	0	0	34	56	90
12:00 to 13:00	4	39	6	1	22	5	0	8	0	0	35	50	85
13:00 to 14:00	9	37	2	1	12	3	0	12	0	0	28	49	77
14:00 to 15:00	2	43	7	2	9	7	1	4	0	1	21	55	76
15:00 to 16:00	7	47	5	1	22	5	3	7	0	0	37	60	97
16:00 to 17:00	8	51	4	2	26	10	2	10	0	0	48	65	113
17:00 to 18:00													
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00													
11:00 to 17:00	36	260	30	8	108	41	7	47	0	1	203	335	538
18:00 to 08:00													
TOTAL 24 hr est.	97	900	88	31	343	161	24	127	0	3	655	1119	1774

Table A.11 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 12/02/97 LOCATION Haus Khan/Saraks DIRECTION Tedjen, two way total

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00													
09:00 to 10:00													
10:00 to 11:00													
11:00 to 12:00	4	36	3	1	9	5	1	2	0	1	17	45	62
12:00 to 13:00	5	34	6	1	7	3	0	3	0	0	13	46	59
13:00 to 14:00	8	31	1	0	8	2	0	0	0	0	10	40	50
14:00 to 15:00	2	34	3	1	5	1	1	3	0	1	10	41	51
15:00 to 16:00	4	41	6	1	17	2	3	3	0	1	25	53	78
16:00 to 17:00	9	43	4	2	18	5	2	3	0	0	28	58	86
17:00 to 18:00													
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00													
11:00 to 17:00	32	219	23	6	64	18	7	14	0	3	103	283	386
18:00 to 08:00													
TOTAL 24 hr est.	86	758	67	24	207	71	24	38	0	10	339	945	1284

Table A.12 TEDJEN TO MARY ROAD - CLASSIFIED TRAFFIC COUNT

DATE 11/02/97 LOCATION Tedjen/Saraks DIRECTION Saraks, two way total

TIME PERIOD	AGRI TRACTOR	CAR	BUS	UTILITY <2t	TRUCK >2t					OTHER	TOTAL TRUCKS	TOTAL LIGHT VEHICLES	TOTAL
					2 - axle	3 - axle	4 - axle	5 - axle	6 - axle				
00:00 to 01:00													
01:00 to 02:00													
02:00 to 03:00													
03:00 to 04:00													
04:00 to 05:00													
05:00 to 06:00													
06:00 to 07:00													
07:00 to 08:00													
08:00 to 09:00													
09:00 to 10:00													
10:00 to 11:00													
11:00 to 12:00	4	11	3	0	8	6	0	3	0	1	17	19	36
12:00 to 13:00	1	5	0	0	15	2	0	5	0	0	22	6	28
13:00 to 14:00	1	8	1	1	6	1	0	13	0	0	20	11	31
14:00 to 15:00	0	9	4	1	4	6	0	1	0	0	11	14	25
15:00 to 16:00	5	10	1	0	7	5	0	4	0	1	16	17	33
16:00 to 17:00	3	10	0	0	8	5	0	7	0	0	20	13	33
17:00 to 18:00													
18:00 to 19:00													
19:00 to 20:00													
20:00 to 21:00													
21:00 to 22:00													
22:00 to 23:00													
23:00 to 00:00													
08:00 to 18:00													
11:00 to 17:00	14	53	9	2	48	25	0	33	0	2	106	80	186
18:00 to 08:00													
TOTAL 24 hr est.	38	183	26	8	152	98	0	89	0	7	339	262	601

APPENDIX B

FORECAST ADT AND ONE WAY CUMULATIVE ESA

Table B.1.1 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - LOW GROWTH SCENARIO

SECTION: MARY TO HAUS KHAN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	1133	175	112	334	155	168	656	1421	2077	0
2000	1275	197	126	386	179	194	759	1598	2358	0.14
2001	1326	205	131	406	188	204	797	1662	2459	0.28
2002	1379	213	136	426	198	214	837	1728	2566	0.43
2003	1434	222	142	447	207	225	879	1798	2677	0.58
2004	1492	230	148	470	218	236	923	1870	2793	0.75
2005	1551	240	153	493	229	248	969	1944	2914	0.92
2006	1613	249	160	518	240	260	1018	2022	3040	1.10
2007	1678	259	166	544	252	273	1069	2103	3172	1.29
2008	1745	270	173	571	265	287	1122	2187	3309	1.49
2009	1815	280	180	599	278	301	1178	2275	3453	1.70
2010	1887	292	187	629	292	316	1237	2366	3603	1.91
2011	1963	303	194	661	306	332	1299	2460	3759	2.14
2012	2041	315	202	694	322	349	1364	2559	3922	2.38
2013	2123	328	210	728	338	366	1432	2661	4093	2.63
2014	2208	341	218	765	355	384	1504	2767	4271	2.90

Source: Consultants

Table B.1.2 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - LOW GROWTH SCENARIO

SECTION HAUS KHAN TO JUNCTION TO SERAKS, NEAR TEDJEN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	939	100	62	260	95	91	447	1101	1548	0
2000	1057	112	70	301	110	105	517	1238	1755	0.08
2001	1099	117	72	317	116	111	543	1288	1831	0.17
2002	1143	121	75	332	122	116	570	1339	1910	0.26
2003	1189	126	78	349	128	122	599	1393	1992	0.36
2004	1236	131	81	366	134	128	629	1449	2077	0.46
2005	1286	136	85	385	141	135	660	1507	2167	0.57
2006	1337	142	88	404	148	141	693	1567	2260	0.68
2007	1390	148	91	424	155	148	728	1629	2357	0.79
2008	1446	153	95	445	163	156	764	1695	2459	0.91
2009	1504	160	99	468	171	164	802	1762	2565	1.04
2010	1564	166	103	491	180	172	842	1833	2675	1.18
2011	1627	173	107	516	189	180	885	1906	2791	1.32
2012	1692	179	111	541	198	189	929	1982	2911	1.46
2013	1759	187	116	568	208	199	975	2062	3037	1.62
2014	1830	194	120	597	218	209	1024	2144	3168	1.78

Source: Consultants

Table B.1.3 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - LOW GROWTH SCENARIO

SECTION JUNCTION TO SERAKS NEAR TEDJEN TO TEDJEN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	1994	127	103	553	174	137	865	2223	3088	0
2000	2243	142	116	640	202	159	1001	2501	3501	0.15
2001	2332	148	120	672	212	167	1051	2601	3652	0.30
2002	2426	154	125	706	223	175	1103	2705	3808	0.46
2003	2523	160	130	741	234	184	1159	2813	3971	0.63
2004	2624	167	135	778	245	193	1216	2925	4142	0.81
2005	2729	173	141	817	258	202	1277	3042	4320	0.99
2006	2838	180	146	858	270	213	1341	3164	4505	1.19
2007	2951	187	152	901	284	223	1408	3291	4699	1.39
2008	3069	195	158	946	298	234	1479	3422	4901	1.61
2009	3192	203	164	993	313	246	1553	3559	5112	1.83
2010	3320	211	171	1043	329	258	1630	3702	5332	2.07
2011	3453	219	178	1095	345	271	1712	3850	5561	2.32
2012	3591	228	185	1150	362	285	1797	4004	5801	2.58
2013	3734	237	192	1207	381	299	1887	4164	6051	2.85
2014	3884	247	200	1268	400	314	1982	4330	6312	3.13

Source: Consultants

Table B.2.1 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - MEDIUM GROWTH SCENARIO

SECTION: MARY TO HAUS KHAN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	1133	175	112	334	155	168	656	1421	2077	0
2000	1312	203	130	409	190	205	804	1645	2448	0.14
2001	1378	213	136	437	203	220	860	1727	2587	0.30
2002	1447	223	143	468	217	235	920	1813	2733	0.46
2003	1533	237	152	496	230	249	975	1922	2897	0.63
2004	1625	251	161	526	244	264	1034	2037	3071	0.81
2005	1723	266	170	557	259	280	1096	2160	3255	1.01
2006	1826	282	181	591	274	297	1162	2289	3451	1.21
2007	1936	299	192	626	290	315	1231	2426	3658	1.43
2008	2052	317	203	664	308	334	1305	2572	3877	1.66
2009	2175	336	215	704	326	354	1384	2726	4110	1.91
2010	2306	356	228	746	346	375	1467	2890	4357	2.17
2011	2444	377	242	791	367	397	1555	3063	4618	2.44
2012	2591	400	256	838	389	421	1648	3247	4895	2.73
2013	2746	424	272	888	412	446	1747	3442	5189	3.04
2014	2911	450	288	942	437	473	1852	3648	5500	3.37

Source: Consultants

Table B.2.2 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - MEDIUM GROWTH SCENARIO

SECTION HAUS KHAN TO JUNCTION TO SERAKS, NEAR TEDJEN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	939	100	62	260	95	91	447	1101	1548	0
2000	1087	115	72	319	117	112	547	1274	1822	0.09
2001	1142	121	75	341	125	119	586	1338	1924	0.18
2002	1199	127	79	365	134	128	627	1405	2032	0.28
2003	1271	135	84	387	142	135	664	1489	2153	0.39
2004	1347	143	89	410	150	144	704	1579	2283	0.50
2005	1428	151	94	435	159	152	746	1673	2420	0.62
2006	1514	161	100	461	169	161	791	1774	2565	0.75
2007	1604	170	106	489	179	171	839	1880	2719	0.88
2008	1701	180	112	518	190	181	889	1993	2882	1.02
2009	1803	191	119	549	201	192	942	2112	3055	1.17
2010	1911	203	126	582	213	204	999	2239	3238	1.33
2011	2025	215	133	617	226	216	1059	2374	3432	1.50
2012	2147	228	141	654	239	229	1122	2516	3638	1.68
2013	2276	241	150	693	254	243	1190	2667	3857	1.87
2014	2412	256	159	735	269	257	1261	2827	4088	2.07

Source: Consultants

Table B.2.3 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - MEDIUM GROWTH SCENARIO

SECTION JUNCTION TO SERAKS NEAR TEDJEN TO TEDJEN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	1994	127	103	553	174	137	865	2223	3088	0
2000	2308	147	119	678	214	168	1059	2573	3633	0.15
2001	2423	154	125	725	229	180	1133	2702	3835	0.32
2002	2545	162	131	776	245	192	1213	2837	4050	0.50
2003	2697	171	139	822	259	204	1285	3007	4293	0.68
2004	2859	182	147	872	275	216	1362	3188	4550	0.88
2005	3031	192	156	924	291	229	1444	3379	4823	1.09
2006	3213	204	165	979	309	243	1531	3582	5113	1.31
2007	3405	216	175	1038	327	257	1623	3797	5420	1.55
2008	3610	229	186	1100	347	273	1720	4025	5745	1.80
2009	3826	243	197	1167	368	289	1823	4266	6089	2.06
2010	4056	258	209	1237	390	306	1933	4522	6455	2.34
2011	4299	273	221	1311	413	325	2049	4793	6842	2.64
2012	4557	289	235	1389	438	344	2172	5081	7253	2.96
2013	4830	307	249	1473	464	365	2302	5386	7688	3.29
2014	5120	325	264	1561	492	387	2440	5709	8149	3.65

Source: Consultants

Table B.3.1 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - MEDIUM GROWTH SCENARIO; INCREASED ESA PER VEHICLE

SECTION: MARY TO HAUS KHAN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	1133	175	112	334	155	168	656	1421	2077	0
2000	1312	203	130	409	190	205	804	1645	2448	0.21
2001	1378	213	136	437	203	220	860	1727	2587	0.46
2002	1447	223	143	468	217	235	920	1813	2733	0.76
2003	1533	237	152	496	230	249	975	1922	2897	1.07
2004	1625	251	161	526	244	264	1034	2037	3071	1.40
2005	1723	266	170	557	259	280	1096	2160	3255	1.75
2006	1826	282	181	591	274	297	1162	2289	3451	2.12
2007	1936	299	192	626	290	315	1231	2426	3658	2.51
2008	2052	317	203	664	308	334	1305	2572	3877	2.93
2009	2175	336	215	704	326	354	1384	2726	4110	3.37
2010	2306	356	228	746	346	375	1467	2890	4357	3.84
2011	2444	377	242	791	367	397	1555	3063	4618	4.33
2012	2591	400	256	838	389	421	1648	3247	4895	4.86
2013	2746	424	272	888	412	446	1747	3442	5189	5.42
2014	2911	450	288	942	437	473	1852	3648	5500	6.01

Source: Consultants

Table B.3.2 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - MEDIUM GROWTH SCENARIO; INCREASED ESA PER VEHICLE

SECTION HAUS KHAN TO JUNCTION TO SERAKS, NEAR TEDJEN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	939	100	62	260	95	91	447	1101	1548	0
2000	1087	115	72	319	117	112	547	1274	1822	0.13
2001	1142	121	75	341	125	119	586	1338	1924	0.29
2002	1199	127	79	365	134	128	627	1405	2032	0.47
2003	1271	135	84	387	142	135	664	1489	2153	0.67
2004	1347	143	89	410	150	144	704	1579	2283	0.88
2005	1428	151	94	435	159	152	746	1673	2420	1.10
2006	1514	161	100	461	169	161	791	1774	2565	1.33
2007	1604	170	106	489	179	171	839	1880	2719	1.58
2008	1701	180	112	518	190	181	889	1993	2882	1.84
2009	1803	191	119	549	201	192	942	2112	3055	2.12
2010	1911	203	126	582	213	204	999	2239	3238	2.42
2011	2025	215	133	617	226	216	1059	2374	3432	2.73
2012	2147	228	141	654	239	229	1122	2516	3638	3.06
2013	2276	241	150	693	254	243	1190	2667	3857	3.41
2014	2412	256	159	735	269	257	1261	2827	4088	3.78

Source: Consultants

Table B.3.3 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - MEDIUM GROWTH SCENARIO; INCREASED ESA PER VEHICLE

SECTION JUNCTION TO SERAKS NEAR TEDJEN TO TEDJEN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	1994	127	103	553	174	137	865	2223	3088	0
2000	2308	147	119	678	214	168	1059	2573	3633	0.24
2001	2423	154	125	725	229	180	1133	2702	3835	0.52
2002	2545	162	131	776	245	192	1213	2837	4050	0.86
2003	2697	171	139	822	259	204	1285	3007	4293	1.21
2004	2859	182	147	872	275	216	1362	3188	4550	1.59
2005	3031	192	156	924	291	229	1444	3379	4823	1.99
2006	3213	204	165	979	309	243	1531	3582	5113	2.41
2007	3405	216	175	1038	327	257	1623	3797	5420	2.86
2008	3610	229	186	1100	347	273	1720	4025	5745	3.34
2009	3826	243	197	1167	368	289	1823	4266	6089	3.84
2010	4056	258	209	1237	390	306	1933	4522	6455	4.37
2011	4299	273	221	1311	413	325	2049	4793	6842	4.94
2012	4557	289	235	1389	438	344	2172	5081	7253	5.54
2013	4830	307	249	1473	464	365	2302	5386	7688	6.18
2014	5120	325	264	1561	492	387	2440	5709	8149	6.85

Source: Consultants

Table B.4.1 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - HIGH GROWTH SCENARIO; INCREASED ESA PER VEHICLE

SECTION: MARY TO HAUS KHAN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	1133	175	112	334	155	168	656	1421	2077	0
2000	1350	209	134	409	190	205	804	1692	2496	0.21
2001	1431	221	142	437	203	220	860	1794	2654	0.46
2002	1517	234	150	468	217	235	920	1901	2821	0.76
2003	1623	251	161	501	232	252	985	2034	3019	1.07
2004	1737	268	172	536	249	269	1054	2177	3230	1.41
2005	1858	287	184	573	266	288	1127	2329	3456	1.77
2006	1988	307	197	613	285	308	1206	2492	3698	2.16
2007	2127	329	210	656	304	330	1291	2667	3957	2.57
2008	2276	352	225	702	326	353	1381	2853	4234	3.01
2009	2436	376	241	751	349	378	1478	3053	4530	3.49
2010	2606	403	258	804	373	404	1581	3267	4848	3.99
2011	2789	431	276	860	399	432	1692	3495	5187	4.53
2012	2984	461	295	921	427	463	1810	3740	5550	5.11
2013	3193	493	316	985	457	495	1937	4002	5939	5.73
2014	3416	528	338	1054	489	530	2072	4282	6354	6.40

Source: Consultants

Table B.4.2 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - HIGH GROWTH SCENARIO;INCREASED ESA PER VEHICLE

SECTION HAUS KHAN TO JUNCTION TO SERAKS, NEAR TEDJEN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	939	100	62	260	95	91	447	1101	1548	0
2000	1119	119	74	319	117	112	547	1311	1858	0.13
2001	1186	126	78	341	125	119	586	1390	1975	0.29
2002	1257	133	83	365	134	128	627	1473	2100	0.48
2003	1345	143	88	391	143	137	671	1576	2247	0.67
2004	1439	153	95	418	153	146	717	1687	2404	0.89
2005	1540	163	101	447	164	157	768	1805	2572	1.11
2006	1648	175	108	479	175	167	821	1931	2752	1.36
2007	1763	187	116	512	187	179	879	2066	2945	1.62
2008	1886	200	124	548	201	192	940	2211	3151	1.90
2009	2019	214	133	586	215	205	1006	2365	3372	2.19
2010	2160	229	142	628	230	220	1077	2531	3608	2.51
2011	2311	245	152	671	246	235	1152	2708	3860	2.85
2012	2473	262	163	718	263	251	1233	2898	4131	3.22
2013	2646	281	174	769	281	269	1319	3101	4420	3.61
2014	2831	300	186	823	301	288	1411	3318	4729	4.03

Source: Consultants

Table B.4.3 FORECAST ADT AND ONE WAY CUMULATIVE AXLE LOADS - HIGH GROWTH SCENARIO; INCREASED ESA/VEHICLE

SECTION JUNCTION TO SERAKS NEAR TEDJEN TO TEDJEN

Year	Cars	Utility etc.	Buses	Trucks >2t			Total Trucks	Total Light Vehcles	Total Traffic ADT	Cumulative ESA Millions
				Medium	Heavy	Articulated				
1997	1994	127	103	553	174	137	865	2223	3088	0
2000	2375	151	122	678	214	168	1059	2648	3707	0.24
2001	2517	160	130	725	229	180	1133	2807	3940	0.52
2002	2668	169	137	776	245	192	1213	2975	4188	0.86
2003	2855	181	147	830	262	206	1297	3183	4481	1.22
2004	3055	194	157	888	280	220	1388	3406	4794	1.60
2005	3269	208	168	950	300	235	1485	3644	5130	2.02
2006	3497	222	180	1017	321	252	1589	3900	5489	2.46
2007	3742	238	193	1088	343	270	1701	4173	5873	2.93
2008	4004	254	206	1164	367	288	1820	4465	6284	3.43
2009	4284	272	221	1246	393	309	1947	4777	6724	3.97
2010	4584	291	236	1333	420	330	2083	5112	7195	4.55
2011	4905	311	253	1426	450	353	2229	5469	7699	5.17
2012	5249	333	270	1526	481	378	2385	5852	8238	5.83
2013	5616	357	289	1633	515	405	2552	6262	8814	6.54
2014	6009	382	310	1747	551	433	2731	6700	9431	7.29

Source: Consultants

APPENDIX C

EXISTING ROAD ROUGHNESS MODIFIED STRUCTURAL NUMBER AND REHABILITATION OPTIONS

Table C.1 EXISTING ROUGHNESS AND STRUCTURAL NUMBERS AND REHABILITATION OPTIONS

Section				Overlay Sections							Reconstruction/New				Overlay		Reconstruction	
From	To	Length	Width	40 mm		75 mm		120 mm		Total	Recon.		New		Average	Modified	Average	Modified
				length	area	length	area	length	area	length	length	area	length	area	Rough	Structural	Rough	Structural
		m	m	m	m^2	m	m^2	m	m^2	m	m	m^2	m	m^2	IRI/km	Number	IRI/km	Number
0	1000	1000	9.00		0		0		0	0	1000	9000		0			9.5	4.56
1000	2000	1000	9.00		0		0		0	0	1000	9000		0			6.3	4.56
2000	3000	1000	9.00		0		0		0	0	1000	9000		0			8	4.56
3000	3600	600	9.00		0		0		0	0	600	5400		0			5.7	4.56
3600	3800	200	9.00		0		0		0	0			200	1800			5.7	4.56
3800	3900	100	12.40		0		0		0	0			100	1240			5.7	4.56
3900	4000	100	9.00		0		0		0	0			100	900			5.7	4.56
4000	4200	200	9.00		0		0		0	0			200	1800			4.8	4.56
4200	4550	350	9.00		0		0		0	0	350	3150		0			4.8	4.56
4550	4950	400	8.80	400	3520		0		0	400	0	0		0	4.8	3.03		
4950	5650	700	9.00		0		0		0	0	700	6300		0			7.1	3.03
5650	6000	350	9.00		0		0		0	0	350	3150		0			7.1	3.03
6000	6650	650	9.00		0		0		0	0	650	5850		0			3.9	3.03
6650	7000	350	9.20	350	3220		0		0	350	0	0		0	3.9	3.03		
7000	7500	500	11.90	500	5950		0		0	500	0	0		0	4.3	3.03		
7500	8000	500	11.90	500	5950		0		0	500	0	0		0	4.3	2.48		
8000	8150	150	8.90	150	1335		0		0	150	0	0		0	4	2.48		
8150	9000	850	9.00		0		0		0	0	850	7650		0			4	2.48
9000	9460	460	9.00		0		0		0	0	460	4140		0			5.2	2.48
9460	9750	290	9.00		0		0		0	0			290	2610			5.2	2.48
9750	9862	112	12.25		0		0		0	0			112	1372			5.2	2.48
Total Section 1		9862		1900	19975	0	0	0	0	1900	6960	62640	1002	9722				

Source: Consultants

Table C.1 EXISTING ROUGHNESS AND STRUCTURAL NUMBERS AND REHABILITATION OPTIONS

Section				Overlay Sections							Reconstruction/New				Overlay		Reconstruction	
From	To	Length	Width	40 mm		75 mm		120 mm		Total	Recon.		New		Average Rough	Modified Structural	Average Rough	Modified Structural
				length	area	length	area	length	area	length	length	area	length	area	IRI/km	Number	IRI/km	Number
		m	m	m	m^2	m	m^2	m	m^2	m	m	m^2	m	m^2				
9862	9970	108	12.25		0		0		0	0			108	1323			5.2	2.48
9970	10300	330	9.00		0		0		0	0			330	2970			4.4	2.48
10300	11000	700	9.00		0		0		0	0	700	6300					4.4	3.74
11000	12000	1000	9.00		0		0		0	0	1000	9000					4.3	3.74
12000	13000	1000	9.00		0		0		0	0	1000	9000					5	3.74
13000	13350	350	9.00		0		0		0	0	350	3150		0			6.4	1.7
13350	14000	650	9.00		0		0		0	0	650	5850		0			6.4	1.7
14000	15000	1000	9.00		0		0		0	0	1000	9000		0			6.4	1.7
15000	16000	1000	9.00		0		0		0	0	1000	9000		0			5.4	1.7
16000	16550	550	9.00		0		0		0	0	550	4950		0			6.5	1.7
16550	17000	450	9.00		0		0		0	0	450	4050		0			6.5	2
17000	17450	450	9.00		0		0		0	0	450	4050		0			6.6	2
17450	18050	600	9.00		0		0		0	0	600	5400		0			6.6	2
18050	19000	950	8.50	950	8075		0		0	950	0	0		0	5.7	2		
19000	19880	880	8.70	880	7656		0		0	880	0	0		0	5.7	2.74		
19880	20000	120	9.00		0		0		0	0	120	1080		0			5.7	2.47
20000	21000	1000	9.00		0		0		0	0	1000	9000		0			6.5	2.47
21000	22000	1000	9.00		0		0		0	0	1000	9000		0			5.8	2.47
22000	23000	1000	9.00		0		0		0	0	1000	9000		0			6.1	2.47
23000	24000	1000	9.00		0		0		0	0	1000	9000		0			7	2.96
24000	24950	950	9.00		0		0		0	0	950	8550		0			9.1	2.96
24950	25000	50	8.70	50	435		0		0	50	0	0		0	4.8	3.23		
25000	26000	1000	8.50	1000	8500		0		0	1000	0	0		0	4.8	2.69		
26000	27000	1000	8.20	1000	8200		0		0	1000	0	0		0	4.2	2.69		
27000	27150	150	8.50	150	1275		0		0	150	0	0		0	4.2	2.42		
27150	28000	850	9.00		0		0		0	0	850	7650		0			6.6	2.42
28000	28350	350	9.00		0		0		0	0	350	3150		0			4.8	2.42

Table C.1 EXISTING ROUGHNESS AND STRUCTURAL NUMBERS AND REHABILITATION OPTIONS

Section				Overlay Sections							Reconstruction/New				Overlay		Reconstruction	
From	To	Length	Width	40 mm		75 mm		120 mm		Total	Recon.		New		Average Rough	Modified Structural	Average Rough	Modified Structural
				length	area	length	area	length	area	length	length	area	length	area	IRI/km	Number	IRI/km	Number
		m	m	m	m^2	m	m^2	m	m^2	m	m	m^2	m	m^2				
28350	29550	1200	9.00		0		0		0	0	1200	10800		0			4.8	0.6
29550	29950	400	9.00		0		0		0	0	400	3600		0			4.1	0.6
29950	30000	50	8.70	50	435		0		0	50	0	0		0	4.1	1.89		
30000	31000	1000	8.00	1000	8000		0		0	1000	0	0		0	4.2	1.89		
31000	32000	1000	8.30	1000	8300		0		0	1000	0	0		0	4.3	1.81		
32000	33000	1000	8.10	1000	8100		0		0	1000	0	0		0	3.4	1.81		
33000	34015	1015	9.00		0		0		0	0	1015	9135		0			4	0.52
34015	34550	535	9.00		0		0		0	0	535	4815		0			5.4	-0.38
34550	35024	474	9.00		0		0		0	0	474	4266		0			6.3	-0.38
35024	35750	726	9.00		0		0		0	0	726	6534		0			6.3	-0.38
35750	36000	250	8.10		0	250	2025		0	250	0	0		0	4.9	0.91		
36000	37000	1000	8.20		0	1000	8200		0	1000	0	0		0	4.9	2.26		
37000	37550	550	8.10		0	550	4455		0	550	0	0		0	4.5	3.61		
37550	37950	400	8.10	400	3240		0		0	400	0	0		0	4.5	3.61		
37950	38350	400	9.00		0		0		0	0	400	3600		0			4.5	2.32
38350	38750	400	9.00		0		0		0	0	400	3600		0			4.5	2.32
38750	39020	270	9.00		0		0		0	0	270	2430		0			4.5	2.32
39020	40150	1130	9.00		0		0		0	0	1130	10170		0			5	1.48
40150	41020	870	9.00		0		0		0	0	870	7830		0			5	0.64
41020	41850	830	9.00		0		0		0	0	830	7470		0			8.1	0.64
41850	42064	214	9.00		0		0		0	0	214	1926		0			8.1	0.64
42064	42350	286	9.00		0		0		0	0	286	2574		0			7.7	0.64
42350	43000	650	8.30	650	5395		0		0	650	0	0		0	7.7	2.36		
43000	43350	350	8.60	350	3010		0		0	350	0	0		0	4.1	2.36		
43350	44000	650	8.60		0	650	5590		0	650	0	0		0	4.1	2.36		
44000	44250	250	8.90		0	250	2225		0	250	0	0		0	4.8	2.36		
44250	44650	400	9.00		0		0		0	0	400	3600		0			4.8	2.36

Table C.1 EXISTING ROUGHNESS AND STRUCTURAL NUMBERS AND REHABILITATION OPTIONS

Section				Overlay Sections							Reconstruction/New				Overlay		Reconstruction	
From	To	Length	Width	40 mm		75 mm		120 mm		Total	Recon.		New		Average	Modified	Average	Modified
				length	area	length	area	length	area	length	length	area	length	area	Rough	Structural	Rough	Structural
		m	m	m	m^2	m	m^2	m	m^2	m	m	m^2	m	m^2	IRI/km	Number	IRI/km	Number
44650	45065	415	9.00		0		0		0	0	415	3735		0			4.8	2.36
45065	46065	1000	9.00		0		0		0	0	1000	9000		0			5.1	2.28
46065	47065	1000	9.00		0		0		0	0	1000	9000		0			4.9	2.2
47065	48065	1000	9.00		0		0		0	0	1000	9000		0			4.4	2.2
48065	49070	1005	9.00		0		0		0	0	1005	9045		0			4.3	1.85
49070	49650	580	9.00		0		0		0	0	580	5220		0			3.3	1.49
49650	50000	350	8.30	350	2905		0		0	350	0	0		0	3.3	1.49		
50000	51000	1000	7.70	1000	7700		0		0	1000	0	0		0	4.3	1.49		
51000	52000	1000	8.50	1000	8500		0		0	1000	0	0		0	5	2.44		
52000	52950	950	8.80	950	8360		0		0	950	0	0		0	7.8	2.44		
52950	55070	2120	9.00		0		0		0	0	2120	19080		0			6.7	2.7
55070	55650	580	9.00		0		0		0	0	580	5220		0			4.4	2.7
55650	56070	420	9.00		0		0		0	0	420	3780		0			4.4	2.7
56070	56550	480	9.00		0		0		0	0	480	4320		0			3.6	2.7
56550	57070	520	9.00		0		0		0	0	520	4680		0			3.6	1.88
57070	58070	1000	9.00		0		0		0	0	1000	9000		0			4.4	1.88
58070	59077	1007	9.00		0		0		0	0	1007	9063		0			5.6	1.88
59077	59250	173	9.00		0		0		0	0	173	1557		0			5.8	3.28
59250	60000	750	9.00		0		0		0	0	750	6750		0			5.8	3.28
60000	61096	1096	9.00		0		0		0	0	1096	9864		0			4.6	3.28
61096	62132	1036	9.00		0		0		0	0	1036	9324		0			6.5	3.28
62132	63179	1047	9.00		0		0		0	0	1047	9423		0			5.5	1.03
63179	63400	221	9.00		0		0		0	0	221	1989		0			5	1.03
63400	64276	876	9.00		0		0		0	0	876	7884		0			5	1.03
64276	65366	1090	9.00		0		0		0	0	1090	9810		0			4.9	1.03
65366	66470	1104	9.00		0		0		0	0	1104	9936		0			6.7	1.46
66470	67674	1204	9.00		0		0		0	0	1204	10836		0			5.5	1.46

Table C.1 EXISTING ROUGHNESS AND STRUCTURAL NUMBERS AND REHABILITATION OPTIONS

Section				Overlay Sections							Reconstruction/New				Overlay		Reconstruction	
From	To	Length	Width	40 mm		75 mm		120 mm		Total	Recon.		New		Average Rough	Modified Structural	Average Rough	Modified Structural
				length	area	length	area	length	area	length	length	area	length	area	IRI/km	Number	IRI/km	Number
		m	m	m	m^2	m	m^2	m	m^2	m	m	m^2	m	m^2				
67674	68674	1000	9.00		0		0		0	0	1000	9000		0			4.4	1.46
68674	69674	1000	9.00		0		0		0	0	1000	9000		0			3.5	2.47
69674	70674	1000	9.00		0		0		0	0	1000	9000		0			3.7	2.47
70674	71674	1000	9.00		0		0		0	0	1000	9000		0			3.9	2.47
71674	72674	1000	9.00		0		0		0	0	1000	9000		0			3.7	0.63
72674	73490	816	9.00		0		0		0	0	816	7344		0			4.9	0.63
Total Section 2		63628		11780	98086	2700	22495	0	0	14480	48710	438390	438	4293				

Source: Consultants

Table C.1 EXISTING ROUGHNESS AND STRUCTURAL NUMBERS AND REHABILITATION OPTIONS

Section				Overlay Sections							Reconstruction/New				Overlay		Reconstruction	
From	To	Length	Width	40 mm		75 mm		120 mm		Total	Recon.		New		Average Rough	Modified Structural	Average Rough	Modified Structural
				length	area	length	area	length	area	length	length	area	length	area	IRI/km	Number	IRI/km	Number
		m	m	m	m^2	m	m^2	m	m^2	m	m	m^2	m	m^2				
73490	74650	1160	9.00		0		0		0	0	1160	10440		0			5.3	0.63
74650	75050	400	9.00		0		0		0	0	400	3600		0			10.5	0.08
75050	75250	200	9.00		0		0		0	0	200	1800		0			10.5	0.08
75250	75674	424	9.00		0		0		0	0	424	3816		0			10.5	0.08
75674	76674	1000	9.00		0		0		0	0	1000	9000		0			8.7	0.08
76674	77674	1000	9.00		0		0		0	0	1000	9000		0			9.8	0.08
77674	77774	100	9.00		0		0		0	0	100	900		0			9.7	-0.16
77774	77934	160	9.00		0		0		0	0	160	1440		0			15	-0.16
77934	78674	740	9.00		0		0		0	0	740	6660		0			8.6	-0.16
78674	79674	1000	9.00		0		0		0	0	1000	9000		0			9.6	-0.16
79674	80000	326	9.00		0		0		0	0	326	2934		0			6.7	0.9
80000	80674	674	9.10		0	674	6133		0	674	0	0		0	6.7	2.33		
80674	81000	326	9.10		0	326	2967		0	326	0	0		0	6.9	2.33		
81000	81674	674	8.90	674	5999				0	674	0	0		0	6.9	0.8		
81674	82000	326	8.90	326	2901				0	326	0	0		0	7.1	0.8		
82000	82350	350	8.80	350	3080		0		0	350	0	0		0	7.1	0.8		
82350	82674	324	8.80	324	2851		0		0	324	0	0		0	7.1	1.98		
82674	83000	326	8.80	326	2869		0		0	326	0	0		0	6	1.98		
83000	83400	400	9.00	400	3600		0		0	400	0	0		0	6	1.98		
83400	83674	274	9.00		0		0		0	0	274	2466		0			6	1.98
83674	84674	1000	9.00		0		0		0	0	1000	9000		0			6.2	1.94
84674	85674	1000	9.00		0		0		0	0	1000	9000		0			6.5	1.94
85674	86674	1000	9.00		0		0		0	0	1000	9000		0			6.6	1.94
86674	87674	1000	9.00		0		0		0	0	1000	9000		0			5.7	1.36
87674	88674	1000	9.00		0		0		0	0	1000	9000		0			6	1.36
88674	89100	426	9.00		0		0		0	0	426	3834		0			3.9	1.36
89100	89674	574	9.10	574	5223		0		0	574	0	0		0	3.9	1.36		

Table C.1 EXISTING ROUGHNESS AND STRUCTURAL NUMBERS AND REHABILITATION OPTIONS

Section				Overlay Sections							Reconstruction/New				Overlay		Reconstruction	
From	To	Length	Width	40 mm		75 mm		120 mm		Total	Recon.		New		Average	Modified	Average	Modified
				length	area	length	area	length	area	length	length	area	length	area	Rough	Structural	Rough	Structural
		m	m	m	m^2	m	m^2	m	m^2	m	m	m^2	m	m^2	IRI/km	Number	IRI/km	Number
89674	90000	326	9.10	326	2967		0		0	326	0	0		0	4.7	1.87		
90000	90674	674	9.00	674	6066		0		0	674	0	0		0	4.7	1.87		
90674	91000	326	9.00	326	2934		0		0	326	0	0		0	5.3	1.87		
91000	91674	674	8.60	674	5796		0		0	674	0	0		0	5.3	1.87		
91674	92000	326	8.60	326	2804		0		0	326	0	0		0	4.8	1.87		
92000	92674	674	9.00		0		0		0	0	674	6066		0			4.8	1.87
92674	94674	2000	9.00		0		0		0	0	2000	18000		0			5.65	1.88
94674	95674	1000	9.00		0		0		0	0	1000	9000		0			8.8	2.45
95674	97674	2000	9.00		0		0		0	0	2000	18000		0			9.4	3.2
97674	98674	1000	9.00		0		0		0	0	1000	9000		0			12.1	3.12
98674	99674	1000	9.00		0		0		0	0	1000	9000		0			6.6	2.05
99674	100674	1000	9.00		0		0		0	0	1000	9000		0			7.7	2.05
100674	113750	13076	9.00		0		0		0	0	13076	117684		0			6.7846	2.688
113750	114000	250	8.70	250	2175		0		0	250	0	0		0	5.9	3.27		
114000	114674	674	9.10	674	6133		0		0	674	0	0		0	5.9	3.27		
114674	115000	326	9.10	326	2967		0		0	326	0	0		0	6.3	3.27		
115000	115674	674	8.80	674	5931		0		0	674	0	0		0	6.3	1.13		
115674	116000	326	8.80	326	2869		0		0	326	0	0		0	6.6	1.13		
116000	116674	674	8.90	674	5999		0		0	674	0	0		0	6.6	1.13		
116674	117000	326	8.90	326	2901		0		0	326	0	0		0	6.9	1.13		
117000	117250	250	9.50	250	2375		0		0	250	0	0		0	6.9	0.97		
117250	117674	424	9.00		0		0		0	0	424	3816		0			6.9	0.97
117674	120674	3000	9.00		0		0		0	0	3000	27000		0			6.3333	1.91
120674	121674	1000	9.00		0		0		0	0	1000	9000		0			4.6	2.14
121674	122674	1000	9.00		0		0		0	0	1000	9000		0			5.8	2.14
122674	123674	1000	9.00		0		0		0	0	1000	9000		0			6	2.33
123674	124674	1000	9.00		0		0		0	0	1000	9000		0			5	2.53

Table C.1 EXISTING ROUGHNESS AND STRUCTURAL NUMBERS AND REHABILITATION OPTIONS

Section				Overlay Sections							Reconstruction/New				Overlay		Reconstruction	
From	To	Length	Width	40 mm		75 mm		120 mm		Total	Recon.		New		Average	Modified	Average	Modified
				length	area	length	area	length	area	length	length	area	length	area	Rough	Structural	Rough	Structural
		m	m	m	m^2	m	m^2	m	m^2	m	m	m^2	m	m^2	IRI/km	Number	IRI/km	Number
124674	125050	376	9.00		0		0		0	0	376	3384		0			5.2	2.53
125050	125674	624	9.00		0		0		0	0	624	5616		0			5.2	2.53
125674	126550	876	9.00		0		0		0	0	876	7884		0			4.9	2.94
126550	127000	450	9.10		0		0	450	4095	450	0	0		0	4.95	2.94		
127000	127350	350	9.00	350	3150		0		0	350	0	0		0	5	2.94		
127350	128674	1324	9.00		0		0		0	0	1324	11916		0			4.2	2.94
128674	130674	2000	9.00		0		0		0	0	2000	18000		0			5.7	3.52
130674	130750	76	9.00		0		0		0	0	76	684		0			6.1	3.52
130750	131550	800	9.00		0		0		0	0	800	7200		0			6.9	2.86
131550	132000	450	9.00		0	450	4050		0	450	0	0		0	7.2	2.46		
132000	132674	674	9.00		0	674	6066		0	674	0	0		0	7.2	2.46		
132674	133000	326	9.00		0	326	2934		0	326	0	0		0	4.3	2.46		
133000	133050	50	8.00		0	50	400		0	50	0	0		0	4.3	3.03		
133050	134674	1624	9.00		0		0		0	0	1624	14616		0			6.7	3.03
134674	139674	5000	9.00		0		0		0	0	5000	45000		0			7.72	2.81
139674	140350	676	9.00		0		0		0	0	676	6084		0			10.7	2.81
140350	140674	324	8.10	324	2624		0		0	324	0	0		0	10.7	5.83		
140674	141000	326	8.10	326	2641		0		0	326	0	0		0	8	5.83		
141000	141674	674	10.00	674	6740		0		0	674	0	0		0	8	5.83		
141674	142000	326	10.00	326	3260		0		0	326	0	0		0	8.4	5.83		
142000	142527	527	13.00	527	6851		0		0	527	0	0		0	13.6	5.83		
Total Section 3		69037		11327	103706	2500	22550	450	4095	14277	54760	492840	0	0				
Overall Totals		142527		25007	221767	5200	45045	450	4095	30657	110430	993870	1440	14015				

Source: Consultants

APPENDIX D

HDM INPUT DATA

ANALYSIS CONTROL
==========

Description	Rehabilitation - Tedjen to Mary		
Run Date	Day 14	Month 08	Year 97
Discount Rate (%)	15.0		
Analysis Period (years)	20		
Calendar Year of Initial Year	1998		
Input Currency Name	Dollars		
Output Currency Name	Dollars		
Output Currency Conversion Multiplier	1.0000000		

ROAD CHARACTERISTICS

Description T-M Section 1A overlay 1.900 km

Road Class (Paved/Unpaved) P

GEOMETRY

Road Length (km)	1.9	Road Width (m)	10.5
One Shoulder Width (m)	3.0	Effective Number of Lanes	2.0
Rise & Fall (m/km)	1.6	Curvature (deg/km)	24.3
Superelevation (%)	0.0		

ENVIRONMENT

Altitude (m)	190	Rainfall (m/month)	0.0110

SURFACE Surface Type 7
Thickness: New Surfacing Layers (mm) 50 Old Surfacing Layers (mm) 180

BASE/SUBGRADE Base Type 1 Subgrade CBR (%) 9
If Cement Stabilized Base: Thickness of Base Layers (mm) 0
Resilient Modulus of Soil Cement (GPa) 0

STRENGTH Structural Number 2.84 Benkelman Beam Deflection (mm) .

CONDITION Roughness (IRI) 4.3 Construction Fault Code 1
Area All Cracks (%) 1.3 Wide Cracks (%) 0.0 Potholes (%) 0.000
Ravelled (%) 0.0 Rut Depth (mm) 25 Rut Depth St. Deviation (mm) 10

HISTORY Surfacing Age (y) 7 Construction Age (y) 20
For Old Surfacing Layers, Previous Area of Wide Cracks (%) 20

DETERIORATION FACTORS

Cracking Initiation	1.00	Roughness-age Term	0.70
Ravelling Initiation	1.00	Cracking Progression	1.00
Pothole Progression	1.00	Rut Depth Progression	1.50
		Roughness Progression	1.50

TRAFFIC

	Car	Pickup	Bus	Light Truck	Medium Truck	Heavy Truck	Articulated Truck
Average Daily Traffic	1994	127	103	0	553	174	137
Traffic Growth (%)	5.7	5.7	5.7	0.0	6.3	6.3	6.3

Change Traffic Growth in Year
New Traffic Growth (%) . . . . . .

CONGESTION

Include Congestion Effects (Y/N)	N
Road Type	Two Lane
Road Use	Seasonal
Roadside Friction	1.00

ROAD CHARACTERISTICS

Description T-M Section 1B recon. 7.962 km

Road Class (Paved/Unpaved) P

GEOMETRY

Road Length (km)	8.0	Road Width (m)	9.0
One Shoulder Width (m)	3.0	Effective Number of Lanes	2.0
Rise & Fall (m/km)	1.6	Curvature (deg/km)	24.3
Superelevation (%)	0.0		

ENVIRONMENT

Altitude (m)	190	Rainfall (m/month)	0.0110

SURFACE Surface Type 7
Thickness: New Surfacing Layers (mm) 50 Old Surfacing Layers (mm) 180

BASE/SUBGRADE Base Type 1 Subgrade CBR(%) 9
If Cement Stabilized Base: Thickness of Base Layers (mm) 0
Resilient Modulus of Soil Cement (GPa) 0

STRENGTH Structural Number 3.79 Benkelman Beam Deflection (mm) .

CONDITION Roughness (IRI) 6.3 Construction Fault Code 1
Area All Cracks (%) 1.3 Wide Cracks (%) 0.0 Potholes (%) 0.000
Ravelled (%) 0.0 Rut Depth (mm) 25 Rut Depth St. Deviation (mm) 10

HISTORY Surfacing Age (y) 7 Construction Age (y) 20
For Old Surfacing Layers, Previous Area of Wide Cracks (%) 20

DETERIORATION FACTORS

Cracking Initiation	1.00	Roughness-age Term	0.70
Ravelling Initiation	1.00	Cracking Progression	1.00
Pothole Progression	1.00	Rut Depth Progression	1.50
		Roughness Progression	1.50

TRAFFIC

	Car	Pickup	Bus	Light Truck	Medium Truck	Heavy Truck	Articulated Truck
Average Daily Traffic	1994	127	103	0	553	174	137
Traffic Growth (%)	5.7	5.7	5.7	0.0	6.3	6.3	6.3

Change Traffic Growth in Year
New Traffic Growth (%) . . . . . .

CONGESTION

Include Congestion Effects (Y/N)	N
Road Type	Two Lane
Road Use	Seasonal
Roadside Friction	1.00

ROAD CHARACTERISTICS
==========

Description T-M Section 2A overlay 14.480 km

Road Class (Paved/Unpaved) P

GEOMETRY

Road Length (km)	14.5	Road Width (m)	8.3
One Shoulder Width (m)	3.0	Effective Number of Lanes	2.0
Rise & Fall (m/km)	1.8	Curvature (deg/km)	4.1
Superelevation (%)	0.0		

ENVIRONMENT

Altitude (m)	202	Rainfall (m/month)	0.0110

SURFACE Surface Type 7
Thickness: New Surfacing Layers (mm) 50 Old Surfacing Layers (mm) 180

BASE/SUBGRADE Base Type 1 Subgrade CBR(%) 2
If Cement Stabilized Base: Thickness of Base Layers (mm) 0
Resilient Modulus of Soil Cement (GPa) 0

STRENGTH Structural Number 2.28 Benkelman Beam Deflection (mm) .

CONDITION Roughness (IRI) 4.9 Construction Fault Code 1
Area All Cracks (%) 11.9 Wide Cracks (%) 0.7 Potholes (%) 0.400
Ravelled (%) 0.0 Rut Depth (mm) 30 Rut Depth St. Deviation (mm) 20

HISTORY Surfacing Age (y) 7 Construction Age (y) 20
For Old Surfacing Layers, Previous Area of Wide Cracks (%) 20

DETERIORATION FACTORS

Cracking Initiation	1.00	Roughness-age Term	0.70
Ravelling Initiation	1.00	Cracking Progression	1.00
Pothole Progression	1.00	Rut Depth Progression	1.50
		Roughness Progression	1.50

TRAFFIC

	Car	Pickup	Bus	Light Truck	Medium Truck	Heavy Truck	Articulated Truck
Average Daily Traffic	939	100	62	0	260	95	91
Traffic Growth (%)	5.7	5.7	5.7	0.0	6.3	6.3	6.3

Change Traffic Growth in Year
New Traffic Growth (%) . . . . . .

CONGESTION

Include Congestion Effects (Y/N)	N
Road Type	Two Lane
Road Use	Seasonal
Roadside Friction	1.00

ROAD CHARACTERISTICS

Description T-M Section 2B recon 49.148 km

Road Class (Paved/Unpaved) P

GEOMETRY

Road Length (km)	49.1	Road Width (m)	9.0
One Shoulder Width (m)	3.0	Effective Number of Lanes	2.0
Rise & Fall (m/km)	1.8	Curvature (deg/km)	4.1
Superelevation (%)	0.0		

ENVIRONMENT

Altitude (m)	202	Rainfall (m/month)	0.0110

SURFACE Surface Type 7
Thickness: New Surfacing Layers (mm) 50 Old Surfacing Layers (mm) 180

BASE/SUBGRADE Base Type 1 Subgrade CBR (%) 2
If Cement Stabilized Base: Thickness of Base Layers (mm) 0
Resilient Modulus of Soil Cement (GPa) 0

STRENGTH Structural Number 1.94 Benkelman Beam Deflection (mm) .

CONDITION Roughness (IRI) 5.4 Construction Fault Code 1
Area All Cracks (%) 11.9 Wide Cracks (%) 0.7 Potholes (%) 0.400
Ravelled (%) 0.0 Rut Depth (mm) 30 Rut Depth St. Deviation (mm) 20

HISTORY Surfacing Age (y) 7 Construction Age (y) 20
For Old Surfacing Layers, Previous Area of Wide Cracks (%) 20

DETERIORATION FACTORS

Cracking Initiation	1.00	Roughness-age Term	0.70
Ravelling Initiation	1.00	Cracking Progression	1.00
Pothole Progression	1.00	Rut Depth Progression	1.50
		Roughness Progression	1.50

TRAFFIC

	Car	Pickup	Bus	Light Truck	Medium Truck	Heavy Truck	Articulated Truck
Average Daily Traffic	939	100	62	0	260	95	91
Traffic Growth (%)	5.7	5.7	5.7	0.0	6.3	6.3	6.3

Change Traffic Growth in Year
New Traffic Growth (%) . . . . . .

CONGESTION

Include Congestion Effects (Y/N)	N
Road Type	Two Lane
Road Use	Seasonal
Roadside Friction	1.00

ROAD CHARACTERISTICS

Description T-M Section 3A overlay 14.277 km

Road Class (Paved/Unpaved) P

GEOMETRY

Road Length (km)	14.3	Road Width (m)	9.1
One Shoulder Width (m)	3.0	Effective Number of Lanes	2.0
Rise & Fall (m/km)	1.8	Curvature (deg/km)	7.7
Superelevation (%)	0.0		

ENVIRONMENT

Altitude (m)	202	Rainfall (m/month)	0.0110

SURFACE Surface Type 7
Thickness: New Surfacing Layers (mm) 50 Old Surfacing Layers (mm) 180

BASE/SUBGRADE Base Type 1 Subgrade CBR(%) 4
If Cement Stabilized Base: Thickness of Base Layers (mm) 0
Resilient Modulus of Soil Cement (GPa) 0

STRENGTH Structural Number 2.52 Benkelman Beam Deflection (mm) .

CONDITION Roughness (IRI) 6.6 Construction Fault Code 1
Area All Cracks (%) 14.2 Wide Cracks (%) 1.4 Potholes (%) 1.200
Ravelled (%) 0.0 Rut Depth (mm) 32 Rut Depth St. Deviation (mm) 16

HISTORY Surfacing Age (y) 7 Construction Age (y) 20
For Old Surfacing Layers, Previous Area of Wide Cracks (%) 20

DETERIORATION FACTORS

Cracking Initiation	1.00	Roughness-age Term	0.70
Ravelling Initiation	1.00	Cracking Progression	1.00
Pothole Progression	1.00	Rut Depth Progression	1.50
		Roughness Progression	1.50

TRAFFIC

	Car	Pickup	Bus	Light Truck	Medium Truck	Heavy Truck	Articulated Truck
Average Daily Traffic	1133	175	112	0	334	155	168
Traffic Growth (%)	5.7	5.7	5.7	0.0	6.3	6.3	6.3

Change Traffic Growth in Year
New Traffic Growth (%) . . . . . .

CONGESTION

Include Congestion Effects (Y/N)	N
Road Type	Two Lane
Road Use	Seasonal
Roadside Friction	1.00

ROAD CHARACTERISTICS

Description T-M Section 3B recon 54.760 km

Road Class (Paved/Unpaved) P

GEOMETRY

Road Length (km)	54.8	Road Width (m)	9.0
One Shoulder Width (m)	3.0	Effective Number of Lanes	2.0
Rise & Fall (m/km)	1.8	Curvature (deg/km)	7.7
Superelevation (%)	0.0		

ENVIRONMENT

Altitude (m)	202	Rainfall (m/month)	0.0110

SURFACE Surface Type 7
Thickness: New Surfacing Layers (mm) 50 Old Surfacing Layers (mm) 180

BASE/SUBGRADE Base Type 1 Subgrade CBR(%) 4
If Cement Stabilized Base: Thickness of Base Layers (mm) 0
Resilient Modulus of Soil Cement (GPa) 0

STRENGTH Structural Number 2.22 Benkelman Beam Deflection (mm) .

CONDITION Roughness (IRI) 7.0 Construction Fault Code 1
Area All Cracks (%) 14.2 Wide Cracks (%) 1.4 Potholes (%) 1.200
Ravelled (%) 0.0 Rut Depth (mm) 32 Rut Depth St. Deviation (mm) 16

HISTORY Surfacing Age (y) 7 Construction Age (y) 20
For Old Surfacing Layers, Previous Area of Wide Cracks (%) 20

DETERIORATION FACTORS

Cracking Initiation	1.00	Roughness-age Term	0.70
Ravelling Initiation	1.00	Cracking Progression	1.00
Pothole Progression	1.00	Rut Depth Progression	1.50
		Roughness Progression	1.50

TRAFFIC

	Car	Pickup	Bus	Light Truck	Medium Truck	Heavy Truck	Articulated Truck
Average Daily Traffic	1133	175	112	0	334	155	168
Traffic Growth (%)	5.7	5.7	5.7	0.0	6.3	6.3	6.3

Change Traffic Growth in Year
New Traffic Growth (%) . . . . . .

CONGESTION

Include Congestion Effects (Y/N)	N
Road Type	Two Lane
Road Use	Seasonal
Roadside Friction	1.00

REQUIRED VEHICLE CHARACTERISTICS
==========

Description Required Data for Turkmenistan

BASIC CHARACTERISTCS	Car	Pickup	Bus	Light Truck	Medium Truck	Heavy Truck	Artic. Truck
Gross Vehicle Weight (t)	1.450	2.500	15.000	5.600	10.000	17.000	32.400
ESAl Factor per Veh.(E4)	0.000	0.000	0.800	0.100	0.960	1.830	2.920
Number of Axles	2	2	2	2	2	3	5
Number of Tires	4	4	6	6	6	10	18
Number of Passengers	3.00	5.00	32.00	0.00	0.00	0.00	0.00
VEHICLE UTILIZATION DATA							
Service Life (yr)	15.0	12.0	10.0	8.0	15.0	10.0	10.0
Hours Driven per Year	350	750	1250	1300	1250	1500	1750
Km Driven per Year	17500	37500	62500	0	50000	60000	80000
Depreciation Code	2	2	2	2	2	2	2
Utilization Code	1	3	3	3	3	3	3
Annual Interest Rate (%)	15.00	15.00	15.00	15.00	15.00	15.00	15.00
ECONOMIC UNIT COSTS							
New Vehicle Price (C)	7000	10000	46500	20000	20000	42000	90000
New Tire Price (C)	40.0	50.0	180.0	275.0	180.0	180.0	250.0
Maintenance Labor (C/hr)	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Crew Cost (C/crew-hr)	0.00	0.49	0.74	3.00	0.74	0.74	0.98
Passenger Time (C/pa-hr)	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Cargo Time (C/veh-hr)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Gas/Petrol Price (C/lt)	0.25
Diesel Price (C/lt)	0.22
Lubricants Price (C/lt)	1.20

Note: C is the input currency defined in the Analysis Control Data

OPTIONAL VEHICLE CHARACTERISTICS
==========

Description Optional Data for Turkmenistan

VEHICLE PARAMETERS	Car	Pickup	Bus	Light Truck	Medium Truck	Heavy Truck	Artic. Truck
Payload (Tons)	0.35	0.60	3.50	2.80	2.00	2.50	11.00
Aerodynamic Drag Coeff.	0.450	0.460	0.650	.	0.850	0.850	0.630
Projected Frontal Area	1.800	2.700	6.300	.	5.200	5.200	5.800
Driving Power (Metric HP)	41.0	40.0	138.0	.	67.0	147.0	245.0
Braking Power (Metric HP)	20.0	32.0	208.0	.	147.0	217.0	467.0
Paved Desired Spd (km/h)	98.30	94.90	93.40	81.60	88.80	88.80	84.10
Unpaved Desired Sp (km/h)	82.20	76.30	69.40	71.90	72.10	72.10	49.60
Energy Efficiency Factor	0.95	0.90	1.00	0.95	1.00	1.00	1.00
Hourly Utilization Ratio	0.40	0.50	0.65	.	0.50	0.60	0.65
Calibrated Eng Spd (rpm)	3500.0	3300.0	2300.0	.	1800.0	1800.0	1700.0
Weibull Shape Parameter	.	.	.	.	.	.	.
Max Avg Rect Vel (mm/s)	.	.	.	.	.	.	.
Width Parameter for Spd	.	.	.	.	.	.	.
Fuel Adjustment Factor	1.160	1.160	1.150	.	1.150	1.150	1.150
FRATIO0 (Paved)	.	.	.	.	.	.	.
FRATIO0 (Unpaved)	.	.	.	.	.	.	.
FRATIO1 (Paved)	.	.	.	.	.	.	.
FRATIO1 (Unpaved)	.	.	.	.	.	.	.
Recap Cost Ratio (%)	.	.	30.0	.	30.0	30.0	30.0
Tire Rubber Vol (cu dm)	.	.	7.600	.	7.600	7.300	8.390
Base Number of Retreads	.	.	1.000	.	1.000	1.000	1.000
Tread Wear, C0TC	.	.	0.164	.	0.164	0.164	0.164
Tread Wear, CTCTE	.	.	12.780	.	12.780	12.780	12.780
Spare Parts, C0SP	.	.	.	.	.	.	.
Spare Parts, CSPQI	.	.	.	.	.	.	.
Spare Parts, QI0SP	.	.	.	.	.	.	.
Labor Hours, C0LH	.	.	.	.	.	.	.
Labor Hours, CLHPC	.	.	.	.	.	.	.
Labor Hours, CLHQI	.	.	.	.	.	.	.

OPERATIONS UNIT COSTS
==========

Description Tedjen to Mary Rehabilitation

Operation	Financial Unit Cost	Economic Unit Cost
Grading (Currency per km of road graded)	0.0	0.0
Spot Regraveling (Currency per cu m)	0.00	0.00
Gravel Resurfacing (Currency per cu m)	0.00	0.00
Unpaved Routine Maintenance (Currency per km per yr)	0	0
Patching (Currency per sq m)	27.06	23.00
Resealing (Currency per sq m)	1.47	1.25
Overlay (Currency per sq m)	17.16	14.58
Reconstruction (Currency per sq m)	51.66	43.91
Paved Routine Maintenance (Currency per km per yr)	1294	1100
Construction (Thousands currency per km)	0.0	0.0

Note: The input currency is defined in the Analysis Control Data

DEFINITION OF STRATEGIES
==========

Description T-M Reconstruction sections

STRATEGY 1:	Do Minimum		
Start in Year:	1998 Policy:	T-M Do Minimum - initial	(Pav:TMS1IN)
	2007	T-M Do Minimum - future	(Pav:TMS1FU)
			( )
			( )
STRATEGY 2:	Reconstruction 1998/99		
Start in Year:	1998 Policy:	T-M Initial reconstruction	(Pav:TMS2R)
	1999	T-M Reconstruction - future	(Pav:TMS3R)
			( )
			( )
STRATEGY 3:	Not Used		
Start in Year:	1998 Policy:	Reseal (12mm,20%), Patching	(Pav:STS_20)
			( )
			( )
			( )
STRATEGY 4:	Not used		
Start in Year:	1998 Policy:	Reseal (12mm,20%), Patching	(Pav:STS_20)
			( )
			( )
			( )
STRATEGY 5:	Not Used		
Start in Year:	1998 Policy:	Reseal (12mm,20%), Patching	(Pav:STS_20)
			( )
			( )
			( )

DEFINITION OF STRATEGIES
==========

Description T-M Overlay sections

STRATEGY 1:	Do Minimum		
Start in Year:	1998 Policy:	T-M Do Minimum - initial	(Pav:TMS1IN)
	2007	T-M Do Minimum - future	(Pav:TMS1FU)
			( )
			( )
STRATEGY 2:	Overlay in 1998/99		
Start in Year:	1998 Policy:	T-M Initial Overlay	(Pav:TMS2O)
	1999	T-M Overlay - future	(Pav:TMS3O)
			( )
			( )
STRATEGY 3:	Not Used		
Start in Year:	1998 Policy:	Reseal (12mm,20%), Patching	(Pav:STS_20)
			( )
			( )
			( )
STRATEGY 4:	Not used		
Start in Year:	1998 Policy:	Reseal (12mm,20%), Patching	(Pav:STS_20)
			( )
			( )
			( )
STRATEGY 5:	Not Used		
Start in Year:	1998 Policy:	Reseal (12mm,20%), Patching	(Pav:STS_20)
			( )
			( )
			( )

PAVED MAINTENANCE POLICY
==========

Description T-M Do Minimum

Yes/No				
Y	ROUTINE MAINTENANCE			
	Features:	Cost factor	1.00	
Y	PATCHING	(Scheduled or Responsive)	R	
	Scheduled:	Area to be patched (m2/km/y)		0.0
	Responsive:	Percent of pothole area to be patched		100.0
		Maximum applicable area (m2/km/y)		.
	Features:	Cost factor		1.00
		Last applicable year		
		Maximum applicable roughness (IRI)		.
N	RESEALING	(Scheduled or Responsive)	R	
	Scheduled:	Resealing interval (y)		0
	Responsive:	Maximum allowable total damaged area (%)		30.0
		Minimum applicable resealing interval (y)		
		Maximum applicable resealing interval (y)		
	Features:	Cost factor		1.00
		Resealing type		3
		Resealing strength coefficient		0.25
		Resealing thickness (mm)		15.0
		Last applicable year		
		Maximum applicable roughness (IRI)		.
N	OVERLAY	(Scheduled or Responsive)	R	
	Scheduled:	Overlay interval (y)		0
	Responsive:	Maximum allowable roughness (IRI)		11.0
		Minimum applicable overlay interval (y)		
		Maximum applicable overlay interval (y)		
	Features:	Cost factor		1.00
		Overlay type		2
		Overlay strength coefficient		0.10
		Overlay thickness (mm)		50.0
		Last applicable year		
		Roughness after overlay (IRI)		.
Y	RECONSTRUCTION	(Scheduled or Responsive)	S	
	Scheduled:	Reconstruction Interval (IRI)		9
	Responsive:	Maximum allowable roughness (IRI)		9.0
		Minimum applicable reconst. interval (y)		
		Maximum applicable reconst. interval (y)		
	Features:	Cost factor		1.00
		New structural number		6.00
		Surface type		2
		Total new surfacing layer thickness (mm)		75.0
		Base type		1
		If cement stabilized base:		
		Base layer thickness (mm)		0.0
		Resilient modulus of soil cement (GPA)		0
		Construction fault code		0
		Last applicable year		
		Roughness after reconstruction (IRI)		.

PAVED MAINTENANCE POLICY
==========

Description T-M Do Minimum - initial

Yes/No			
Y	ROUTINE MAINTENANCE		
	Features:	Cost factor	1.00
Y	PATCHING	(Scheduled or Responsive) R	
	Scheduled:	Area to be patched (m2/km/y)	0.0
	Responsive:	Percent of pothole area to be patched	100.0
		Maximum applicable area (m2/km/y)	.
	Features:	Cost factor	1.00
		Last applicable year	
		Maximum applicable roughness (IRI)	.
N	RESEALING	(Scheduled or Responsive) R	
	Scheduled:	Resealing interval (y)	0
	Responsive:	Maximum allowable total damaged area (%)	30.0
		Minimum applicable resealing interval (y)	
		Maximum applicable resealing interval (y)	
	Features:	Cost factor	1.00
		Resealing type	3
		Resealing strength coefficient	0.25
		Resealing thickness (mm)	15.0
		Last applicable year	
		Maximum applicable roughness (IRI)	.
N	OVERLAY	(Scheduled or Responsive) R	
	Scheduled:	Overlay interval (y)	0
	Responsive:	Maximum allowable roughness (IRI)	11.0
		Minimum applicable overlay interval (y)	
		Maximum applicable overlay interval (y)	
	Features:	Cost factor	1.00
		Overlay type	2
		Overlay strength coefficient	0.10
		Overlay thickness (mm)	50.0
		Last applicable year	
		Roughness after overlay (IRI)	.
N	RECONSTRUCTION	(Scheduled or Responsive) R	
	Scheduled:	Reconstruction Interval (IRI)	9
	Responsive:	Maximum allowable roughness (IRI)	11.0
		Minimum applicable reconst. interval (y)	
		Maximum applicable reconst. interval (y)	
	Features:	Cost factor	1.00
		New structural number	6.00
		Surface type	2
		Total new surfacing layer thickness (mm)	75.0
		Base type	1
		If cement stabilized base:	
		Base layer thickness (mm)	0.0
		Resilient modulus of soil cement (GPA)	0
		Construction fault code	0
		Last applicable year	
		Roughness after reconstruction (IRI)	.

PAVED MAINTENANCE POLICY
==========

Description T-M Do Minimum - future

Yes/No				
Y	ROUTINE MAINTENANCE			
	Features:	Cost factor		1.00
Y	PATCHING	(Scheduled or Responsive)	R	
	Scheduled:	Area to be patched (m2/km/y)		0.0
	Responsive:	Percent of pothole area to be patched		100.0
		Maximum applicable area (m2/km/y)		.
	Features:	Cost factor		1.00
		Last applicable year		
		Maximum applicable roughness (IRI)		.
N	RESEALING	(Scheduled or Responsive)	R	
	Scheduled:	Resealing interval (y)		0
	Responsive:	Maximum allowable total damaged area (%)		30.0
		Minimum applicable resealing interval (y)		
		Maximum applicable resealing interval (y)		
	Features:	Cost factor		1.00
		Resealing type		3
		Resealing strength coefficient		0.25
		Resealing thickness (mm)		15.0
		Last applicable year		
		Maximum applicable roughness (IRI)		.
N	OVERLAY	(Scheduled or Responsive)	R	
	Scheduled:	Overlay interval (y)		0
	Responsive:	Maximum allowable roughness (IRI)		11.0
		Minimum applicable overlay interval (y)		
		Maximum applicable overlay interval (y)		
	Features:	Cost factor		1.00
		Overlay type		2
		Overlay strength coefficient		0.10
		Overlay thickness (mm)		50.0
		Last applicable year		
		Roughness after overlay (IRI)		.
Y	RECONSTRUCTION	(Scheduled or Responsive)	S	
	Scheduled:	Reconstruction Interval (IRI)		8
	Responsive:	Maximum allowable roughness (IRI)		11.0
		Minimum applicable reconst. interval (y)		
		Maximum applicable reconst. interval (y)		
	Features:	Cost factor		1.00
		New structural number		6.00
		Surface type		2
		Total new surfacing layer thickness (mm)		75.0
		Base type		1
		If cement stabilized base:		
		Base layer thickness (mm)		0.0
		Resilient modulus of soil cement (GPA)		0
		Construction fault code		0
		Last applicable year		
		Roughness after reconstruction (IRI)		.

PAVED MAINTENANCE POLICY
==========

Description T-M Initial Overlay

Yes/No				
Y	ROUTINE MAINTENANCE			
	Features:	Cost factor		1.00
Y	PATCHING	(Scheduled or Responsive)	R	
	Scheduled:	Area to be patched (m2/km/y)		0.0
	Responsive:	Percent of pothole area to be patched		100.0
		Maximum applicable area (m2/km/y)		.
	Features:	Cost factor		1.00
		Last applicable year		
		Maximum applicable roughness (IRI)		.
Y	RESEALING	(Scheduled or Responsive)	R	
	Scheduled:	Resealing interval (y)		12
	Responsive:	Maximum allowable total damaged area (%)		30.0
		Minimum applicable resealing interval (y)		
		Maximum applicable resealing interval (y)		
	Features:	Cost factor		1.00
		Resealing type		3
		Resealing strength coefficient		0.25
		Resealing thickness (mm)		15.0
		Last applicable year		
		Maximum applicable roughness (IRI)		.
Y	OVERLAY	(Scheduled or Responsive)	S	
	Scheduled:	Overlay interval (y)		1
	Responsive:	Maximum allowable roughness (IRI)		6.0
		Minimum applicable overlay interval (y)		
		Maximum applicable overlay interval (y)		
	Features:	Cost factor		1.00
		Overlay type		2
		Overlay strength coefficient		0.40
		Overlay thickness (mm)		40.0
		Last applicable year		
		Roughness after overlay (IRI)		.
N	RECONSTRUCTION	(Scheduled or Responsive)	R	
	Scheduled:	Reconstruction Interval (IRI)		0
	Responsive:	Maximum allowable roughness (IRI)		7.0
		Minimum applicable reconst. interval (y)		10
		Maximum applicable reconst. interval (y)		
	Features:	Cost factor		1.00
		New structural number		5.00
		Surface type		2
		Total new surfacing layer thickness (mm)		200.0
		Base type		1
		If cement stabilized base:		
		Base layer thickness (mm)		0.0
		Resilient modulus of soil cement (GPA)		0
		Construction fault code		0
		Last applicable year		
		Roughness after reconstruction (IRI)		.

PAVED MAINTENANCE POLICY
==========

Description T-M Overlay - future

Yes/No				
Y	ROUTINE MAINTENANCE			
	Features:	Cost factor	1.00	
Y	PATCHING	(Scheduled or Responsive)	R	
	Scheduled:	Area to be patched (m2/km/y)		0.0
	Responsive:	Percent of pothole area to be patched		100.0
		Maximum applicable area (m2/km/y)		.
	Features:	Cost factor		1.00
		Last applicable year		
		Maximum applicable roughness (IRI)		.
Y	RESEALING	(Scheduled or Responsive)	R	
	Scheduled:	Resealing interval (y)		12
	Responsive:	Maximum allowable total damaged area (%)		30.0
		Minimum applicable resealing interval (y)		
		Maximum applicable resealing interval (y)		
	Features:	Cost factor		1.00
		Resealing type		3
		Resealing strength coefficient		0.25
		Resealing thickness (mm)		15.0
		Last applicable year		
		Maximum applicable roughness (IRI)		.
Y	OVERLAY	(Scheduled or Responsive)	S	
	Scheduled:	Overlay interval (y)		9
	Responsive:	Maximum allowable roughness (IRI)		5.0
		Minimum applicable overlay interval (y)		
		Maximum applicable overlay interval (y)		
	Features:	Cost factor		1.00
		Overlay type		2
		Overlay strength coefficient		0.40
		Overlay thickness (mm)		40.0
		Last applicable year		
		Roughness after overlay (IRI)		.
N	RECONSTRUCTION	(Scheduled or Responsive)	R	
	Scheduled:	Reconstruction Interval (IRI)		0
	Responsive:	Maximum allowable roughness (IRI)		0.0
		Minimum applicable reconst. interval (y)		
		Maximum applicable reconst. interval (y)		
	Features:	Cost factor		1.00
		New structural number		0.00
		Surface type		0
		Total new surfacing layer thickness (mm)		0.0
		Base type		0
		If cement stabilized base:		
		Base layer thickness (mm)		0.0
		Resilient modulus of soil cement (GPA)		0
		Construction fault code		0
		Last applicable year		
		Roughness after reconstruction (IRI)		.

PAVED MAINTENANCE POLICY
==========

Description T-M Initial reconstruction

Yes/No				
Y	ROUTINE MAINTENANCE			
	Features:	Cost factor		1.00
Y	PATCHING	(Scheduled or Responsive)	R	
	Scheduled:	Area to be patched (m2/km/y)		0.0
	Responsive:	Percent of pothole area to be patched		100.0
		Maximum applicable area (m2/km/y)		.
	Features:	Cost factor		1.00
		Last applicable year		
		Maximum applicable roughness (IRI)		.
Y	RESEALING	(Scheduled or Responsive)	R	
	Scheduled:	Resealing interval (y)		12
	Responsive:	Maximum allowable total damaged area (%)		30.0
		Minimum applicable resealing interval (y)		
		Maximum applicable resealing interval (y)		
	Features:	Cost factor		1.00
		Resealing type		3
		Resealing strength coefficient		0.25
		Resealing thickness (mm)		15.0
		Last applicable year		
		Maximum applicable roughness (IRI)		.
Y	OVERLAY	(Scheduled or Responsive)	R	
	Scheduled:	Overlay interval (y)		1
	Responsive:	Maximum allowable roughness (IRI)		5.0
		Minimum applicable overlay interval (y)		
		Maximum applicable overlay interval (y)		
	Features:	Cost factor		1.00
		Overlay type		2
		Overlay strength coefficient		0.40
		Overlay thickness (mm)		40.0
		Last applicable year		
		Roughness after overlay (IRI)		.
Y	RECONSTRUCTION	(Scheduled or Responsive)	S	
	Scheduled:	Reconstruction Interval (IRI)		1
	Responsive:	Maximum allowable roughness (IRI)		6.0
		Minimum applicable reconst. interval (y)		20
		Maximum applicable reconst. interval (y)		
	Features:	Cost factor		1.00
		New structural number		6.00
		Surface type		2
		Total new surfacing layer thickness (mm)		200.0
		Base type		1
		If cement stabilized base:		
		Base layer thickness (mm)		0.0
		Resilient modulus of soil cement (GPA)		0
		Construction fault code		0
		Last applicable year		
		Roughness after reconstruction (IRI)		.

PAVED MAINTENANCE POLICY
==========

Description T-M Reconstruction - future

Yes/No				
Y	ROUTINE MAINTENANCE			
	Features:	Cost factor	1.00	
Y	PATCHING	(Scheduled or Responsive)	R	
	Scheduled:	Area to be patched (m2/km/y)		0.0
	Responsive:	Percent of pothole area to be patched		100.0
		Maximum applicable area (m2/km/y)		.
	Features:	Cost factor		1.00
		Last applicable year		
		Maximum applicable roughness (IRI)		.
Y	RESEALING	(Scheduled or Responsive)	R	
	Scheduled:	Resealing interval (y)		12
	Responsive:	Maximum allowable total damaged area (%)		30.0
		Minimum applicable resealing interval (y)		
		Maximum applicable resealing interval (y)		
	Features:	Cost factor		1.00
		Resealing type		3
		Resealing strength coefficient		0.25
		Resealing thickness (mm)		15.0
		Last applicable year		
		Maximum applicable roughness (IRI)		.
Y	OVERLAY	(Scheduled or Responsive)	R	
	Scheduled:	Overlay interval (y)		9
	Responsive:	Maximum allowable roughness (IRI)		5.0
		Minimum applicable overlay interval (y)		
		Maximum applicable overlay interval (y)		
	Features:	Cost factor		1.00
		Overlay type		2
		Overlay strength coefficient		0.40
		Overlay thickness (mm)		40.0
		Last applicable year		
		Roughness after overlay (IRI)		.
N	RECONSTRUCTION	(Scheduled or Responsive)	R	
	Scheduled:	Reconstruction Interval (IRI)		0
	Responsive:	Maximum allowable roughness (IRI)		0.0
		Minimum applicable reconst. interval (y)		
		Maximum applicable reconst. interval (y)		
	Features:	Cost factor		1.00
		New structural number		0.00
		Surface type		0
		Total new surfacing layer thickness (mm)		0.0
		Base type		0
		If cement stabilized base:		
		Base layer thickness (mm)		0.0
		Resilient modulus of soil cement (GPA)		0
		Construction fault code		0
		Last applicable year		
		Roughness after reconstruction (IRI)		.

APPENDIX E

STRATEGY 1 - DO MINIMUM
HDM OUTPUT COST DATA

Table E.1 COSTS OF CAPITAL INVESTMENT - DO MINIMUM

Year	Capital Costs (millions US $)						
	Section						
	1A	1B	2A	2B	3A	3B	Total
1998	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2007	0.876	3.162	5.285	19.404	5.714	21.656	56.097
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2012	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2013	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2014	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: Consultants

Table E.2 COSTS OF RECURRENT MAINTENANCE - DO MINIMUM

Year	Recurrent Costs (millions US $)						
	Section						
	1A	1B	2A	2B	3A	3B	Total
1998	0.002	0.009	0.027	0.096	0.053	0.200	0.387
1999	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2000	0.002	0.009	0.017	0.057	0.016	0.060	0.161
2001	0.002	0.009	0.017	0.059	0.017	0.064	0.168
2002	0.002	0.009	0.018	0.062	0.017	0.066	0.174
2003	0.002	0.009	0.018	0.064	0.018	0.069	0.180
2004	0.002	0.009	0.019	0.066	0.018	0.071	0.185
2005	0.002	0.010	0.019	0.068	0.019	0.073	0.191
2006	0.002	0.010	0.020	0.070	0.019	0.074	0.195
2007	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2008	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2009	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2010	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2011	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2012	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2013	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2014	0.002	0.009	0.016	0.054	0.016	0.060	0.157

Source: Consultants

Table E.3 VEHICLE OPERATING COSTS - DO MINIMUM

Year	Vehicle Operating Costs (millions US $)						
	Section						
	1A	1B	2A	2B	3A	3B	Total
1998	0.532	2.417	2.233	7.730	3.543	13.801	30.256
1999	0.568	2.580	2.400	8.368	3.744	14.610	32.270
2000	0.606	2.755	2.604	9.149	4.035	15.784	34.933
2001	0.648	2.947	2.844	10.059	4.364	17.133	37.995
2002	0.693	3.158	3.128	11.112	4.738	18.712	41.541
2003	0.744	3.392	3.450	12.307	5.165	20.602	45.660
2004	0.800	3.652	3.818	13.648	5.658	22.881	50.457
2005	0.861	3.936	4.234	14.896	6.226	25.085	55.238
2006	0.926	4.239	4.644	15.896	6.866	26.818	59.389
2007	0.996	4.563	4.980	16.860	7.425	28.451	63.275
2008	0.896	3.773	3.653	12.370	5.460	20.925	47.077
2009	0.953	4.011	3.885	13.157	5.808	22.258	50.072
2010	1.011	4.259	4.127	13.974	6.170	23.644	53.185
2011	1.074	4.522	4.383	14.840	6.554	25.114	56.487
2012	1.140	4.801	4.654	15.760	6.961	26.675	59.991
2013	1.211	5.098	4.943	16.737	7.393	28.333	63.715
2014	1.286	5.413	5.249	17.774	7.853	30.093	67.668

Source: Consultants

Table E.4 TRAVEL TIME COSTS - DO MINIMUM

Year	Travel Time Costs (millions US $)						
	Section						
	1A	1B	2A	2B	3A	3B	Total
1998	0.015	0.067	0.063	0.216	0.098	0.382	0.841
1999	0.016	0.071	0.067	0.232	0.103	0.403	0.892
2000	0.017	0.075	0.072	0.253	0.111	0.435	0.963
2001	0.018	0.080	0.078	0.278	0.120	0.473	1.047
2002	0.019	0.086	0.086	0.309	0.130	0.518	1.148
2003	0.020	0.092	0.095	0.345	0.142	0.573	1.267
2004	0.022	0.099	0.106	0.386	0.156	0.643	1.412
2005	0.023	0.107	0.119	0.423	0.173	0.710	1.555
2006	0.025	0.115	0.131	0.451	0.193	0.759	1.674
2007	0.027	0.123	0.141	0.477	0.209	0.802	1.779
2008	0.026	0.108	0.105	0.356	0.155	0.596	1.346
2009	0.027	0.114	0.111	0.376	0.164	0.630	1.422
2010	0.029	0.120	0.117	0.398	0.174	0.666	1.504
2011	0.030	0.127	0.124	0.421	0.184	0.705	1.591
2012	0.032	0.135	0.131	0.445	0.194	0.745	1.682
2013	0.034	0.142	0.139	0.470	0.206	0.788	1.779
2014	0.036	0.151	0.147	0.497	0.217	0.833	1.881

Source: Consultants

APPENDIX F

STRATEGY 2 - OVERLAY AND RECONSTRUCTION
HDM - OUTPUT COST DATA

Table F.1 COSTS OF CAPITAL INVESTMENT - WITH PROJECT

Year	Capital Costs (millions US $)						
	Section						
	1A	1B	2A	2B	3A	3B	Total
1998	0.291	3.177	2.022	17.787	2.196	19.662	45.135
1999	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2007	0.291	0.000	1.755	0.000	1.897	0.000	3.943
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	0.000	0.000	0.000	0.552	0.000	0.000	0.552
2012	0.000	0.000	0.000	0.000	0.000	0.617	0.617
2013	0.000	0.090	0.000	0.000	0.000	0.000	0.090
2014	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: Consultants

Table F.2 COSTS OF RECURRENT MAINTENANCE - WITH PROJECT

Year	Recurrent Costs (millions US $)						
	Section						
	1A	1B	2A	2B	3A	3B	Total
1998	0.002	0.009	0.016	0.054	0.016	0.060	0.157
1999	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2000	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2001	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2002	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2003	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2004	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2005	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2006	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2007	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2008	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2009	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2010	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2011	0.002	0.009	0.016	0.062	0.016	0.060	0.165
2012	0.002	0.009	0.016	0.054	0.016	0.060	0.157
2013	0.002	0.010	0.016	0.054	0.016	0.060	0.158
2014	0.002	0.009	0.016	0.054	0.016	0.060	0.157

Source: Consultants

Table F.3 VEHICLE OPERATING COSTS - WITH PROJECT

Year	Vehicle Operating Costs (millions US $)						
	Section						
	1A	1B	2A	2B	3A	3B	Total
1998	0.532	2.417	2.233	7.730	3.543	13.801	30.256
1999	0.533	2.218	2.226	7.268	3.466	12.276	27.987
2000	0.566	2.358	2.389	7.729	3.707	13.056	29.805
2001	0.602	2.504	2.559	8.208	3.961	13.867	31.701
2002	0.641	2.658	2.741	8.716	4.231	14.728	33.715
2003	0.683	2.822	2.935	9.255	4.520	15.642	35.857
2004	0.727	2.996	3.145	9.828	4.829	16.612	38.137
2005	0.775	3.181	3.373	10.435	5.163	17.642	40.569
2006	0.826	3.377	3.624	11.080	5.526	18.736	43.169
2007	0.880	3.585	3.903	11.767	5.925	19.898	45.958
2008	0.901	3.806	3.854	12.497	5.816	21.135	48.009
2009	0.956	4.041	4.118	13.278	6.203	22.452	51.048
2010	1.016	4.292	4.399	14.113	6.616	23.860	54.296
2011	1.078	4.559	4.700	15.043	7.056	25.367	57.803
2012	1.145	4.845	5.025	16.042	7.529	27.065	61.651
2013	1.216	5.167	5.379	17.069	8.040	28.868	65.739
2014	1.291	5.509	5.766	18.164	8.596	30.721	70.047

Table F.4 TRAVEL TIME COSTS - WITH PROJECT

Year	Travel Time Costs (millions US $)						
	Section						
	1A	1B	2A	2B	3A	3B	Total
1998	0.015	0.067	0.063	0.216	0.098	0.382	0.841
1999	0.016	0.065	0.064	0.216	0.097	0.362	0.820
2000	0.017	0.069	0.068	0.228	0.103	0.383	0.868
2001	0.017	0.073	0.073	0.242	0.109	0.405	0.919
2002	0.018	0.077	0.077	0.255	0.116	0.428	0.971
2003	0.020	0.082	0.082	0.270	0.123	0.452	1.029
2004	0.021	0.086	0.087	0.286	0.131	0.478	1.089
2005	0.022	0.091	0.092	0.302	0.139	0.506	1.152
2006	0.023	0.097	0.099	0.319	0.148	0.535	1.221
2007	0.024	0.102	0.105	0.338	0.158	0.565	1.292
2008	0.026	0.108	0.107	0.357	0.159	0.598	1.355
2009	0.027	0.114	0.113	0.378	0.168	0.632	1.432
2010	0.029	0.121	0.120	0.399	0.178	0.669	1.516
2011	0.030	0.128	0.127	0.423	0.189	0.708	1.605
2012	0.032	0.135	0.135	0.447	0.200	0.749	1.698
2013	0.034	0.143	0.143	0.473	0.212	0.793	1.798
2014	0.036	0.151	0.153	0.501	0.225	0.838	1.904

Source: Consultants

ENVIRONMENTAL ASSESSMENT

CONTENTS

Page

1 Introduction

1.1 Project background and terms of reference

The planning for the 143 km of existing paved road between Tedjen and Mary (M 37) aims at the improvement of the road surface itself, whereas the layout (alignment, width and gradient) shall mainly remain unchanged. Exceptions to this could be in the two cases where the structural stability of the existing bridges is questionable. Replacements will probably be necessary in the immediate future and they could be constructed either on or off line[1]. Given the project frame and the actual state of the road environment (see point 1.2) it can be presumed that within the construction corridor itself there will be *no significant* disturbance of the natural environment such as large scale soil erosion, changes to streams, underground water or interference with animal or plant life. However, according to the national legal and regulatory requirements and also according to EBRD-standards, this in fact does not exclude the need to plan for a number of measures, that would help to avoid construction-related impacts or to keep them to a minimum.

Additionally, adverse environmental impacts may result from the extraction of construction material so that these factors will also have to be included in the environmental considerations.

Thus, the environmental assessment will address the following:

- Identification of the most important (potential) consequences of project implementation with respect to
  - environmental pollution
  - human health and safety
  - secondary impacts resulting from the exploitation of borrow pits
- Review of Turkmen environmental laws and regulations relevant to the project
- Development of mitigation measures for both, direct and secondary impacts
- Development of proposals for additional environmental enhancement
- Development of recommendations for the inclusion in the tender documents

[1] When this report was prepared, no decision had been taken with regard to the question whether rehabilitation of these bridges would be included in the project or not.

1.2 Description of the project environment

The project area is located in the south-eastern part of the Kara Kum desert. The terrain is generally flat and gently undulating in only a few sections. The ground level lies between 180 and 210 m on average. The road environment between Tedjen and Mary is mainly composed of two types of landscape:

- ❒ Irrigated, cultivated land in the oases (Tedjen and Mary)
- ❒ desertic to semi-desertic steppe between road km 75 to 116 with sections bearing a more or less dense cover of *Saxaul* (*Haloxylon parsicum*)

The road crosses a total of 23 water courses, of which only the river Tedjen is a natural one. Almost all of the land in the oases has been (or still is) subject to extensive human interference and uses such as the construction of the gas-pipeline, the electricity and telecommunication lines, the construction and maintenance of irrigation and drainage facilities, agriculture, grazing, urban development and last but not least the construction of the road itself. Further, the planning area suffers to a great extent from severe salination of soils, so that significant natural habitats do not remain. Apart of the rows of trees that have been planted or are currently being planted in the immediate vicinity of a number of road sections, the overall impression of the project area is that of a very monotone, deserted landscape.

The *immediate* road environment can be characterized as follows: Beginning at the junction Tedjen / Serakhs a deep and severely eroded drainage channel runs parallel to the southern side of the road, in rather close distances of 10 to 30 m. This channel follows the road on the right side over more than 70 km up to Hauz Khan. For extended length excavated material from this channel has been heaped up to heights of 2 to 3 m alongside the road. In March 1997, during the course of the field investigations many of these heaps, as well as a 20 to 30 m wide strip north to the road, were levelled in preparation for tree planting. These activities are mainly based on a Presidential Decree, that calls for the planting of trees along all of the M 37 between Turkmenbashi and Mary (see also point 3.1).

The initiative for the implementation of these plantations lies with the Etraps Tedjen, Murgab, Niasov and Mary as well as the road maintenance departments (LEO) of Tedjen and Mary.

For most of the 70 km section between Hauz Khan and Mary the former M 37 runs as a narrow paved road at variable distances from the actual M 37, crossing it at several locations.

The height of embankments of the M 37 project road section varies between 1 and 1.5 m with a rather steep slope of 1:1 or 1:1.5 (horizontal : vertical). Vegetation is scarce, but there is actually no evidence of erosion.

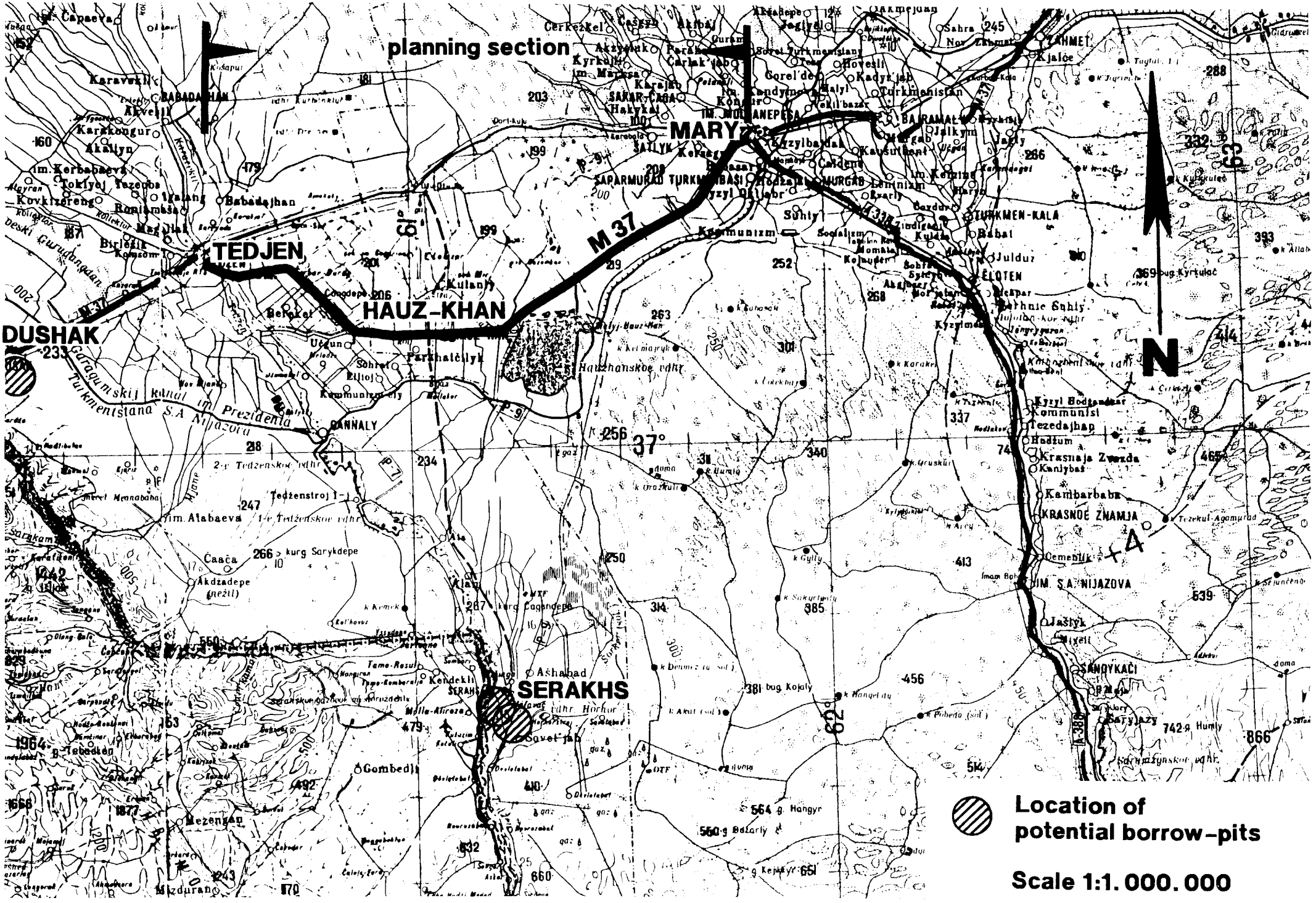
1.3 Proposed borrow pits

With reference to the geotechnical investigations three potential sources for construction *materials* have been identified. While the existing borrow pit at Dushak lies at a distance of about 7.5 km from the M 37 and some 50 km south-west of Tedjen, the borrow pits at Serakhs are located at a distance of about 120 km south-west of Mary (see map 1). The present situation at these sites can roughly be described as follows:

Dushak

The first mining operations at Dushak date back to the late 60s. Today this borrow pit is a one of the main sources of materials for industrial and construction uses in the country (coarse gravel with a high sand fraction). Data on the actual area of this mining site are not available. Excavations reach down to 8 m below the surrounding surface but groundwater is not met at this level. As can be seen on pictures 5 and 6 (appendix 3) mining is carried out by electro-powered machines.

The existing crushing and sieving plant is directly connected to the main railway line Ashgabad - Mary. Moreover, a narrow paved road exists, which links the borrow site to the M 37. This road is in rather bad condition and partly lined by settlements at distances of about 30 to 50 m on average.


planning section
MARY
TEDJEN
HAUZ-KHAN
DUSHAK
M 37
SERAKHS
TURKMEN-KALA
BAJRAMALY
ASHHABAD
KRASNOE ZNAMJA
IM. S.A. NIJAZOVA
TAŠLYK
SANDYKAČI
KANNALY
TEDŽENSTROJ
Location of potential borrow-pits
Scale 1:1.000.000

Recultivation of exploited parts is actually not being done at this borrow pit. Topsoil is removed and stored some 500 m away from the present borrow site. However, natural regrowth has produced some sparse herbaceous and grass vegetation in the eldest parts of the borrow pit.

Serakhs

At Serakhs two borrow pits are used by the maintenance department of Turkmenautoellari (LEU) for various construction and maintenance activities:

One borrow pit called '**Khor-Khor**' is located about 13 km south-east of Serakhs which is about the same distance from the new railway line. The first mining activities at Khor-Khor date back to the mid 1950s, but more intensive excavations began in 1978. Data on the actual extension of this borrow pit are not available. The material which is encountered below a depth of 1.5 to 1.8 m at Khor-Khor is coarse gravel with a high proportion of sand and sandy loam.

At this site material extraction reaches to 10 to 15 m below ground surface. Small patches of reed at the bottom of the borrow pit indicate moisture, but it is unlikely that groundwater would be met at this level already (see picture 7, Appendix 3). According to the head of the local road construction administration, groundwater level may be expected 15 m below surface level. It is highly likely that actual occasional water influx to the borrow pit would originate from irrigation in the surrounding agricultural lands.

The older, rather shallow parts of the borrow pit are characterized by (uncontrolled) waste dumping (see picture 8). Since no alternative official dump site or organized waste management exist, this situation seems to be officially accepted.

A recultivation plan exists for Khor-Khor, but actually no steps have ever been taken in this regard. The first reason for this is that no suitable machines are locally available for these works. Secondly, most of the top soil is used for the local fabrication of loam-bricks, so that hardly any material remains for recultivation.

In the case of Khor-Khor the only official road that connects the site to the M 37 in direction of Hauz-Khan leads directly through the village of Serahks.

The **second borrow pit at Serakhs** forms part of the higher terrace of the river Tedjen which represents the national border line between Turkmenistan and Iran. Accordingly the site is located within a guarded and fenced border strip where access is restricted.

At this site the first exploitation dates back to 1990. According to information from local staff inundation of the vast floodplain of the river Tedjen between March and May regularly includes the area of the present borrow site. During this period the area of the floodplain is subject to considerable shifts so that the material that is extracted from here consists of very new deposits of gravel with admixtures of sand and loam. Given the natural dynamics within this site there is only very little or no evidence of vegetation.

For this borrow pit no license exists. LEU-staff favour mining at this site since the material is looser and easier to extract than at Khor-Khor.

The distance to the new single line railway which leads south is less than 1 km but there is no provision for material transfer from rail to road. This railway crosses the M 37 west of Hauz Khan at about km 60. According to LEU-staff road traffic in the direction of Hauz-Khan would again have to pass through the village of Serakhs. In the Tedjen direction only a few single houses exist along the paved road on one side at distances of about 30 to 50 m.

2 Legal and administrative framework

The compilation of the relevant legal and administrative framework aims at

- the identification of the national requirements for impact mitigation or other environmental protection measures in road rehabilitation and borrow pit operations
- the provision of a list of key permits and regulatory requirements that are relevant to the present project and the measures that have been proposed.

2.1 Laws and regulations

The Consultant has reviewed the current Environmental laws of Turkmenistan which are compiled in a booklet entitled: 'Environmental Protection and Public Health for The People of Turkmenistan, Collection of Laws for the period 1989 to 1995'. In order to obtain first hand information, representatives of 'Ministerstwo Prirodopolsowanja Ohrana Okruschajuschej Sredi' ('Ministry of Nature Exploitation and Environmental Protection', referred to as 'Ministry of Environment' in the following) were visited. In summary the following laws and regulations will have to be considered:

The **'Turkmen Law for Nature Protection'** (12 November 1991) represents a general framework for all National objectives in the area of environmental protection. With regard to the current project 2 sections of this law are relevant. Under section 16 the law determines that for any project with a potential for adverse environmental impacts measures for environmental protection or mitigation measures have to be considered. Section 20 relates to pollution issues in general. It requires effective measures for the protection of groundwater and drinking-water from pollution which may arise from the disposal, storage and processing of waste. Since the law does not give any definition of 'waste' in this context, it is assumed that it includes those waste materials, that commonly result from operations within the contractor's yard and spoil materials from construction activities.

According to article 3 of the **'Turkmen Law On State Ecological Expertise'**, (June 1995) 'State Ecological Expertise' is compulsory for projects which are expected to be associated with a 'transformation of the natural human

environment'. A supplement to this law was published on 13 November 1996. This paper defines the type of projects which need compulsory 'State Ecological Expertise' as well as the procedures. It also gives a rough concept of the methodology to be applied. Accordingly a project would be appraised from the point of view of the ecological impact on the environment. Based on this appraisal, the Ministry of Environment would approve or reject the project or make approval subject to conditions. However, according to the supplement to the law, the present project of road improvement does not fall under the requirements of the law.

Decree on the Development of Nurseries and Green Spaces in Turkmenistan, November 9th 1992

This Presidential Decree determines, among other things, that within a period of 2 years after publication fruit trees and other decorative trees shall be planted along the M 37 between Turkmenbashi, Ashgabad and Mary. The responsibility for the enforcement of these plantations lie with the Velayats Ahal (Ashgabad) and Mary (Mary), while the Ministry of Environment and the Academy of Agriculture (today Ministry of Agriculture) are in charge of the procurement of planting material.

SNIP-Regulations (= Russian construction norms and rules) and GOST standards (= state standards)

Various lists and publications of the existing official standards that could be relevant in the present study were also reviewed, but many of these documents could not be made available. It can be presumed, however, that these documents (which are all between 15 and 20 years old) would be rather general and broad in their statements, so that no valuable additional findings are expected here.

With respect to environmental issues, the following official regulations would have to be considered when roads are newly built or rehabilitated:

SNIP-Regulations 2.05.02-85

This paper is a former Soviet Union (FSU) **Regulation on Road Construction**. Actually, these FSU-regulations will be applied until the recently drafted Turkmen SNIP-regulations for the road construction sector will be officially approved[2].

[2] According to the Director of the Turkmendorproyekt, the date of official approval of the National Regulations is not yet determined. However, major changes that would affect regulations of environmental concern are not expected.

Environmental issues are dealt with under point 3 of this document (3.1 - 3.18). Most of the statements under this section are very general and do mainly apply to impact avoidance or mitigation on new road projects. Section 3.4 deals with topsoil protection. It specifies the removal and reuse of fertile topsoil from any land that is to be occupied by a new road or temporarily used for construction. Section 3.5 is more specific to that regard and contains detailed information on topsoil protection and qualities that would require special handling / precautions during construction with the intention to preserve fertile soils (namely top-soils with granulometric compositions from clayey to sandy and densities not exceeding 1.4 g/cm^3). Point 3.7 makes provisions on the minimization of dust-development in cotton-producing areas. This could be relevant for the road section between Tedjen and Hauz Khan and the time between May and October. Point 3.16 finally states that in unstable locations or in locations of highly sensitive ecological systems, the Project shall develop suitable mitigation measures aimed at the minimization of adverse environmental impacts.

The document does not give any specifications about the handling or storage of harmful substances or any other preventive measures for the protection of groundwater, surface water or soils from pollution during construction / within the contractor's yard, nor does it make reference to other relevant regulations.

Also, standard procedures for the preservation or the protection of trees growing adjacent to a road or the construction site are not specified.

Construction Norms of Turkmenistan CNT 3.02.011-94

These regulations are only *indirectly* linked to the present project, since they mainly refer to the construction of towns and the planning and construction of/in cities, villages and settlements. Under point No. 9 (Environmental Protection) reference is given to the protection and rational use of natural resources (9.1 - 9.4), the protection of atmosphere, water units and soil against pollution (9.5 - 9.7), the protection against noise, vibration, electric and magnetic fields and radiation (9.9 - 9.11) in general terms. Point 9.8 refers to the protection of soils in general and also to the general obligation to preserve top soil and to restore or recultivate borrow pits. The regulation of the microclimate is addressed under point 9.12, where the positive effects of green plants on the human environment are pointed out.

As the aforementioned SNIP-Regulations all statements given in this paper are again non-specific.

BCH 8-89: Regulation on Environmental Protection in Construction, Rehabilitation and Maintenance of Roads

This document includes comprehensive regulations on environmental protection in road construction, rehabilitation or maintenance activities (among others: use of soils, protection of water resources, protection of forests, flora and fauna, use, preparation and storage of road construction machinery and materials, provisional structures, provisional roads, fire protection, borrow pits and material transport, avoidance of dust, protection of soils from pollution, prevention of soil erosion etc.).

The appendices to this document also include standards for:

- the maximum permitted concentrations of toxic substances
- noise control measures
- soil pollution through losses of oil and fuel from construction equipment
- quality standards for surface waters

SNIP III 4-80: Norms for Construction Safety

This document refers to construction activities in general and comprises, among others, detailed regulations on worker's health and safety. With regard to the present project the chapters 2 and 5 may be of relevance (organization of the construction site, the work sites and transport works). It also determines the maximum permissable concentration of toxic substances in the air, which could be relevant, among others, for road marking operations (Appendix 9).

Safety Regulations for Construction, Rehabilitation and Maintenance of Roads 1978 (corresponds to SNIP III A-11-70)

This document is a comprehensive compilation of safety rules for almost all aspects and stages of road construction, e.g. requirements for the technical safety for work with road construction equipment, the construction of dams, the rehabilitation and maintenance of bridges and culverts, loading and unloading operations, operation and maintenance of asphalt plants, work with toxic substances, work in quarries and borrow pits, work with compressors, mobile power plants, operation and maintenance of road construction equipment etc.

GOST 13508-74

This document deals with road marking and describes the requirements and standards of white lining for the various road categories, which is an important aspect of road safety.

Mining licenses

Regularly renewable licences regulate the extension and direction of the progressing mining activities at the borrow pits. These licenses may be issued to different contractors at the same time and would in general allow for the extraction of a fixed volume of material within a certain time frame. Licenses are issued by the respective Hekimlik (Dept. for Construction) and would normally include the obligation for site restoration (without however specifying how such restoration is to be carried out).

2.2 Current planning practise

Actually, the general practice in road planning is such, that Turkmendorproyekt would only inform other official bodies (Ministries, Velayats, Hekimliks, energy and water suppliers, etc.) about the project *on completion* of the design documents. Approval is granted or may be subject to conditions that are, if necessary, incorporated into the final design.

With respect to environmental issues a project would proceed more or less automatically through the permitting agency channels without further suggestions or comments. This statement does also apply to the previous and actual cooperation between Turkmendorproyekt and those bodies that are officially in charge with environmental matters. The process in fact is mainly a formal and not a consultative one.

One example for the current practise is a recent road construction project (45 km of *new* road from Ashgabad-Gaudan to Bandjiran on the Iranian border). The final design documents were handed out to the Ministry of the Environment at the very end of the proceedings. In these documents environmental issues are discussed in one short paragraph with only a few very general statements on the design features of the planned road and the intention to plant trees. Based on this, approval was granted by the Ministry of Environment without any comments within one week.

Conclusions

The existing legislation and regulations do in fact include a general conception of avoiding or minimizing construction-related impacts and also health and safety regulations seem to be adequate. From this point of view and also considering (the relatively few) requirements for the project under consideration it is

assumed, that there are in general sufficient provisions to ensure environmentally sound planning and construction practices which would also meet EBRD-standards for similar road rehabilitation projects. Yet no bodies / institutions or mechanisms have been established, that would pursue the consistent implementation of the full range of existing laws and regulations.

The next project stages will have to specify mechanisms which will ensure the consistent implementation of the steps to take and measures to be carried out.

The following chapter summarizes the legally required environmental protection and safety measures and also contains additional measures for environmental improvement and enhancement, which do largely follow World Bank recommendations for similar road rehabilitation projects.[3].

A tabular summary of these measures is given in Appendix 2.

[3] The World Bank 1994: 'Roads and Environment: A Handbook'

3 Environmental impacts, avoidance and mitigation measures

The Consultant undertook two visits to the project road section between Tedjen and Mary and one to the proposed borrow areas at Dushak and Serakhs. Project features were discussed with representatives of Turkmendorproyekt, representatives of the Ministry of Environment, the Ashgabad Ecology Club. The conclusions are as follows:

Environmental impacts

As the project is limited to the repair of the pavement on an existing road *no significant* impacts are to be expected. Possible adverse impacts would be those that are caused by the purely *construction related activities*, the *temporary use of land* for the contractor's yard(s) as well as the extraction of construction material from *existing borrow pits.*

Human Health

As the project will improve the surface and the 'furniture' of an existing road, potential negative impacts on human health would be restricted to the construction period where workers may be exposed to exhaust fumes, noise, dust or deal with potentially harmful substances and materials. Further noise impacts are not considered to be an issue in the present case because outside Tedjen and Mary no settlements exist along the road.

Human Safety

With regard to road users travelling safety will be improved through a smoother road surface and a better road furniture (guard rails, road marking, traffic signs etc.). During construction however, safety could be affected by construction traffic, activities within the contractor's yard and works in borrow pits.

Measures

The measures to be specified as the planning proceeds will thus have to focus on the activities within the contractor's yard(s) and the management of construction works. The concept will have to address aspects like ground and surface water protection, dust control, waste management, materials handling and storage areas, worker's health and safety as well as road safety.

Project-related impacts as well as a *general concept* of suitable mitigation and additional environmental enhancement measures is discussed in some broader terms below (see 3.1 - 3.4). Based on this a set of safeguards will be compiled that need to be built in into the tender documents in order to prepare the implementation of these measures and to ensure, that contractors will follow environmentally sound construction practises (see point 4). Where norms and regulations exist, these will be stated (see tabular summary, Appendix 2).

3.1 Establishment, setup and operation of the work site

Impacts

The location of work facilities is a key environmental issue during the establishment of the construction site. Depending on the site that is chosen, the installation of equipment and storage of materials may cause traffic disruption, noise and dust affecting road users and neighbouring residential areas (the latter could refer to the peripheries of Tedjen or Mary, if a construction camp was installed there). During harvest seasons temporary detours or road closures could create additional problems. Pollution of soils, surface and ground waters could result from equipment cleaning and materials storage and handling. Finally, site establishment could cause the destruction of valuable vegetation.

Mitigation measures

Reasonable siting of the contractor's yard would not exclusively take technical or economical aspects into account but would also consider environmental requirements. Without anticipating further decisions to this regard the following is proposed: The contractor's yard(s) should only be established beyond a minimum distance as defined by existing regulations from the river Tedjen or any irrigation channels, which are important sources of drinking water and fish for the local population. Also, the potential existence of fresh-water wells in the possible area of influence should be considered (see point 4 for further detail). Site selection and preparation shall avoid, as far as possible, the removal of trees or bushes and also the areas with natural growth of Sakxaul (chainage km 75 - 116). Where trees are growing in the immediate vicinity or within the selected site, they should be protected against damage by suitable measures. Also, site preparation should include removal and storage of topsoil.

Depending on the number of workers and the mode of accommodation (i.e. construction camp with containers or other accommodation facilities), provisions will also have to be established for the proper treatment of sewerage and waste.

If not handled properly, storage and handling of hazardous substances such as detergents, bitumen, lubricants, oil, fuels, paint etc. can be considerable sources of groundwater pollution and the pollution of surface water or soil. In order to prevent these impacts a set of binding safety provisions needs to be established. The proper implementation of these regulations shall be ensured by clearly defined responsibilities and compliance to be monitored by an inspector or the construction supervision team.

Also, it must be assumed, that the awareness about the adverse impacts potentially arising from operations within the contractor's yard (and also construction activities in general) will probably be very low among the workers. It is therefore recommended that the construction supervision shall provide some on site training or briefing for the workshop personnel as well as for those operating and maintaining machines and equipment. Alternatively the contractor shall provide a method statement of his proposals.

Another important aspect of contractor responsibility is the restoration of work areas, work depots and material storage sites. As has been mentioned before (see point 2.1), site restoration is compulsory according to local regulations, so that land that has been temporarily used shall be restored to the initial state. This would also include respreading of top soil, removal of all scrap or waste material from the work site. The contractor shall submit a method statement for the establishment, maintenance and restoration of site compounds.

3.2 Activities within the construction corridor

Impacts

While this report was being prepared, the design of technical improvement requirements of the various road sections was still ongoing. Consequently, only very general presumptions can be made with regard to the impacts that could be related to the construction phase, the temporary diversion of traffic or traffic management during construction. Safety of road workers and other road users can be put at risk by inadequate traffic management and work zone controls.

Also, attention should be paid to the existing stands of trees. In some sections planted trees / natural tree vegetation grow very close to the roadside in double or more rows. If suitable protection measures are not provided, destruction of roadside trees is very likely. In the sections between km 75 and 116 the destruction of the natural vegetation could trigger sand drift from the adjacent dunes.

The road has a total of 23 bridges. Most of these will have to be repaired in the medium term, while for 2 urgent replacement has been recommended because of structural instability (see Inception Report, January 1997). The construction of new bridges is expected to require some major earthworks on the sensitive embankments of the streams and, if no further precautions are taken, soil erosion and water pollution could be caused.

Depending on the local soil properties soil compaction may be caused by construction equipment moving around the construction site which may harm the soil's potential for future agricultural use or planting measures.

Finally, abandoned machinery (scrap) and waste materials could disfigure the landscape.

Mitigation measures

With regard to traffic and worker's safety, potential risks and disturbances for local residents can be avoided or mitigated through a well designed traffic management plan. Within settlements, where material transport may disturb local residents, minimization of dust development can be achieved by periodically watering the transport roads and using covered trucks.

As already mentioned, an old paved road runs parallel close to the M 37 in the sections between Hauz Khan and Mary (total length: ≈ 70 km). If, for any reason, single lane traffic should not be possible or efficient during construction, the use of the old road should be considered instead of building an additional road for the temporary diversion of traffic. This would minimize the need for land acquisition during construction and restoration of the site after completion of works. As determined by the existing legal requirements and regulations all top soil shall be removed and stored properly before the beginning of any activity outside the road itself.

The actual planning practices in the country do not consider the protection of road side trees in any standardized or systematic manner, so that special precautions should be taken during construction for that purpose. In the sections km 75 to 116 natural growth of *Haloxylon parsicum* (Sakxaoul) does often reach immediately to the shoulders of the road so that construction operations in these sections should be carried out with special precautionary measures.

In order to promote more considered construction operations it is therefore suggested to place the responsibility for the effective protection of roadside-trees with the contractor (i.e. in the contract documentation). The contractor, possibly in cooperation with an inspector (see point 4.7), would instruct all workers on this issue.

In the case that bridges are replaced, the material (reinforced concrete) shall be removed and disposed of properly in suitable locations. Also, careful work procedures are necessary in order to avoid or minimize the risks of erosion or pollution and additional siltation of watercourses.

Wherever possible, processing and reuse of existing materials (pavement material or material from demolished bridges for example) should be considered. This would help to avoid or minimize the need of waste disposal and also reduce adverse impacts potentially resulting from material extraction and transport.

Finally, all land that has been temporarily used for construction or deviation of traffic will have to be restored to the initial state. This shall also include the removal of all machines and waste material from the construction site and the reuse of previously stockpiled topsoil.

3.3 Material extraction and transport

Impacts

Borrow sites in Turkmenistan which provide road building materials have had substantial adverse impacts on soils, water, the natural environment and human health in the past. Although licensing would generally include the requirement to recultivate or protect the borrow site, this doesn't happen in practice. Non-compliance however doesn't have any consequences for contractors, omission is neither pursued nor fined. According to information obtained from the Ecological Club of Ashgabad, uncontrolled waste deposition is the order of the day in many

borrow sites. As mentioned before, waste dumping does in fact take place at Khor-Khor in some older parts of the borrow pit that are located near to a former collective farm and in the direction of the village (see picture 8). Given the location of the borrow pit it is not to be expected, that further project-related mining would induce additional activities to this regard in other parts of the borrow pit

For both cases, the borrow pit at Dushak and also Khor-Khor at Serakhs, further material extraction would not create additional impacts in terms of new quality of impacts to be expected since extensive mined areas already exist. Also, project-related additional material extraction will not disfigure the landscape significantly nor will it lead to considerable losses of valuable vegetation. Provided that material extraction does not exceed the present excavation level (8 m below surface at Dushak and 10 to 15 m at Khor-Khor) no additional impairment of groundwater resources is to be expected.

In the case of the second borrow pit at Serakhs, material extraction takes place in some kind of 'no-man's-land' within the immediate border area. Adverse impacts on the landscape are assessed to be of minor importance since access to the area is severely restricted. Also in the last few years, the regularly recurring floods and the reported high velocity of the river have allowed for impact mitigation by means of natural processes to a considerable extent. In this context, mention should be made of an alleged Iranian dam project on some upper parts of the river. Such a project would surely lead to a complete change of the natural dynamics in all downstream sections of the river. However, since further details of this could not be obtained, further statements to that regard shall be avoided.

Noise and dust development related to material extraction are not expected to create problems since settlements are located in sufficient distances from the potential borrow pits in all three cases.

Noise and dust development resulting from material transport could create problems in the case of the borrow pit at Dushak, since settlements closely line the road connecting the site to the M 37. Also this road is very narrow and in poor condition. Heavily loaded trucks and two way traffic could be expected to worsen the situation and increase disturbance to the neighbouring settlements.

Depending on the direction of transport traffic (Mary or Tedjen) this issue would also have to be considered in the case of the Serakhs borrow pit. Moreover, it is assumed that the existing road network at Serakhs would not allow for the avoidance of the village itself. However, since no figures exist on the expected amount of transport traffic no other detailed statements can presently be given in respect of the nuisances that could result therefrom.

Any evaluation of the quality and dimension of potential environmental impacts that would be related to additional (yet unknown) quantities of material extraction from the proposed borrow sites can only be general in the present cases. The main reason for this is the lack of useful and reliable base-line data. According to impressions from the visual evaluation, purely project-related, additional material extraction would not create serious additional or new impacts on the natural surroundings, animal or plant life, groundwater or landscape in the cases of Dushak and Khor-Khor.

Comparing the physical surroundings and the actual state of the three proposed sites it is assumed, that the borrow site that is located in the floodplain of the river Tedjen would probably bear the highest risk of, however uncertain, adverse environmental impacts. Although no detailed information on the local situation was available, it should be considered, that the ecological sensitivity and value of river ecosystems (which include the natural floodplains) would in general exceed that of adjacent terrestrial habitats. Since figures on necessary volumes of materials are not yet available and also given the fact that the area was not accessible for evaluation, this subject cannot be explored in greater depth. One further argument which adds to this view is that no one could presently estimate the influence of the aforementioned possible dam project in Iran on this complex and sensitive ecosystem.

Measures

With regard to site selection for building material the omission of river gravel extraction from the Tedjen river would be understood as a contribution to impact mitigation. An alternative approach to this would be to carry out an environmental impact assessment or other kind of thorough investigation specifically considering the ecological potential of the possible area of influence and the consequences of further material extraction at this site.

As a first step to avoid or reduce transport-related annoyances for local residents it should be considered to what extent the existing railway transport can be integrated into the material transport plan. Especially in the case of Dushak, where all processing facilities exist in the site, this option should be considered in earnest.

If transport through the village cannot be avoided in the case of Serakhs, roads shall be periodically watered. The use of covered trucks will mitigate dust development. In both cases a well designed traffic management plan should consider traffic safety and make statements on working hours for material transport. Again a contractor's method statement on material handling and transportation should be sought for approval.

Local people should be informed of construction works to be carried out in advance of their start in order to allay fears and complaints.

3.4 Proposals for additional environmental enhancement

Sand drift control

Sand drift is not a general problem on the project road, but a typical one in the sections between km 81 - km 94 and km 99 - km 103. As can be seen on pictures 3 and 4 dunes have moved on to the shoulders of the road in several locations. According to locally obtained information sand is frequently blown onto the carriageway in these sections. This circumstance could represent a safety risk for road users, especially since the average travelling speed is expected to increase with the improvements to the road.

In order to alleviate this potential safety risk, methods to prevent sand drift should be applied locally. An example for a simple and successful local practice of sand drift control is shown in picture 4a. This method is based on the use of rushes (local term: *Kamish*) which are easily available from the nearby irrigation and drainage channels. Cuttings with a length of about 0.6 m are stuck into the sand to about half of their length in dense single rows and in pattern similar to a fence or a net.

According to LEU-staff the average life span of these arrangements is 5 to 10 years and the efficiency is well acknowledged. It is recommended to include a

plan for the local application of this method, especially in those sections, where the dunes reach to the edges of the road (i.e. km 87 - 88 and km 92 - 94).

Tree planting

As mentioned before, many sections of the M 37 are already lined by younger and mature rows of planted trees. Additionally, a large-scale tree-planting campaign is currently carried out along all of the M 37 between Tedjen and Mary.

According to a Presidential Decree (see point 2.1) further tree planting is planned for on the remaining road section in the longer terms. Given that context it is felt that the present project should take up this concept and make tree planting an integral part of the planning. Actually, the Ministry of Environment stated that the project would be deemed 'incomplete' without this element of tree planting.

Details on suitable sections of the M 37 that should be preferably selected for those measures were discussed with representatives of the Forestry Department of the above Ministry. As was mentioned before, intensive planting is presently going on in so many sections of the road, that presently an inventory of the status quo would be useless. Accordingly, it is suggested that a record of missing sections be carried out on completion of construction operations in order to identify those sections, that shall be completed within the project. At the same time this process would allow for the replacement of construction-related damage or loss of trees which could not be avoided. Moreover, this record shall make statements on the availability of water from the existing channels since regular irrigation of new plantations is a prerequisite for successful growth. The schedule for the inventory and the tree-plantations shall also consider that planting shall be carried out as soon as possible after completion of construction operations of a particular section. Planting itself would be limited to the time between December and 15 March.

The planting programme shall exclude the sections between km 75 and 116 where emphasis is put on the preservation of the existing natural vegetation that is especially adapted to the sandy underground and the given natural growing conditions.

Apart from the road-side itself, further suitable locations for tree planting would be around the 25 bus stops that are located on both sides of the road between Tedjen and Hauz-Khan (km 0.65 and 69.8) and the road-side bazar at about km 10.0 (left). This option was proposed to representatives of the Ministry of

Environment and the Chief of the Road Maintenance Department (LEU) of Turmenautoellari in Ashgabad and highly appreciated by all. As for the other tree plantations, the availability of water for irrigation shall be carefully considered at each individual site.

The actual design of the present bus stop facilities only provides some shade during a few hours of the day. Tree plantations would improve on that situation, even though it would take some years before the planted trees would become effective in that regard. Some of the bus stop facilities are in a poor technical condition and may need replacement in the near future. In this case proper timing of the two measures shall be considered.

4. Recommendations for the preparation of tender documents

Based on the findings according to point 3, the following contains elements of guidelines that should be included in the tender documents or added to construction contracts. This shall ensure that environmentally sound construction practices are followed and adverse impacts avoided or mitigated. In addition to this, all regulations that are stated in tables 1 - 4 (appendix 2) shall be applied during all stages of the project.

4.1 Establishment, setup and operation of the work site (= contractor's yard)

Site selection contractor's yard

The contractor shall submit documents for approval (short statement and site plan in appropriate scale) which indicate

- ❒ the location of the site(s)
- ❒ the surface area required (incl. access)
- ❒ the actual characteristics of the proposed site(s) with respect to soil and groundwater conditions, drinking water intakes, irrigation channels, actual land use, adjoining land uses, distance to settlements, existing vegetation (by quality and quantity)

The documents shall give evidence that environmental impacts that might be related to the site selection (see point 3.1) have been perceived and will be avoided or at least mitigated.

Site preparation

The contractor shall indicate efforts to maintain / protect vegetation within the selected site (trees or bushes) and consider the removal and storage of topsoil as well as the proposed location for topsoil storage. Also, the contractor's site installation shall be bordered by a fence or other means.

The contractor shall provide details on his site installation and indicate the number of workers to be employed, the time period of employment as well as the proposed mode of accommodation. This shall also include information on the treatment of sewerage and waste. Also, the contractor shall provide a recovery system for used motor oil. Prior to the commencement of works the site installations shall be inspected for approval.

Work site operation

Prior to the commencement of works, the work site personnel shall be instructed in site on safety rules for the handling and storage of hazardous substances (fuel, oil, lubricants, bitumen, paint etc.) and also the cleaning of equipment. In preparation of this the contractor shall establish a short list of materials to be used (by quality and quantity) and provide a rough concept explaining the training / briefing that shall be provided for the construction personnel.

Work site restoration

Upon completion of works the contractor shall execute all work necessary to restore the sites to their original state (removal and proper disposal of all materials, wastes, installations, ground surface, spreading and levelling of stored top soil). Prior to official delivery / acceptance an inspector shall prepare a report confirming that such site restoration has been completed (see sub-chapter 4.8).

4.2 Construction (= road corridor and adjacent land)

The contractor shall ensure, that clearing is limited to surfaces absolutely necessary for the road project and preserve and protect, as far as possible, trees within or in the vicinity of the construction corridor. This will be of special importance in the section chainage km 75 to 116. Here, the works shall be strictly limited to the existing road corridor in order to prevent damage or destruction of the natural vegetation (especially *Haloxylon parsicum*).

Where the use of neighbouring lands for traffic diversion or working activities cannot be avoided all top soil shall be carefully stripped and stored for re-use.

Wherever possible, recycling of material shall be considered (would apply to the reuse of asphalt or surplus material) to be built into the subbase where it is renewed.

Also, a well designed traffic management plan for both construction vehicles and (potentially) diverted traffic shall be established.

Site Restoration

All land that that has been temporarily used shall be restored to the previous state on completion of works, including reuse of stored topsoil.

4.3 Borrow pits: site preparation and material extraction

The contractor shall remove and properly store topsoil. During mining operation the exposure of groundwater shall be avoided. In order to make revegetation possible top soil shall be spread over temporarily used area.

The contractor shall prepare a recultivation plan which indicates the location to be used for material extraction and the kind of measures to be taken in that area after completion of mining operations.

4.4 Transport traffic

The contractor shall prepare a transport management plan which indicates the proposed haul routes (preferably by using a map of suitable scale) and also propose measures for road safety (temporary measures during construction, information, warnings). He shall make indications on the proposed working hours which shall consider the mitigation of disturbances for the local residents (restrict hours of operation, e.g. no night-time or weekend working). Locations that would require temporary watering of transport roads shall be indicated. Also, the use of covered trucks shall be considered in this context in order to avoid spillage of material.

In order to allay fears and complaints of local people project signboards shall be installed, to inform on construction works to be carried out in advance of their start.

4.5 Tree planting

The Turkmen standard for road-side plantations is considered to be 2 or 4 rows of trees with 3 plants every 6 metres. In order to prepare the planting measures the following steps shall be carried out on completion of construction works or as works are progressing:

- ❒ Mapping of remaining gaps for tree plantations along the M 37 (km 0 - 74 and 116 - 143) and soil conditions (especially the degree of salination since this would influence the planting scheme (see fig. 1).
- ❒ Determination of necessary earthworks for the preparation of tree planting (by quality and quantity)
- ❒ Determination of sections where existing trees were destroyed during construction
- ❒ Evaluation of 25 bus stops between Tedjen and Hauz Khan and road side bazar at km 10.0 (left) with regard to suitability for tree planting (see fig. 2)
- ❒ Evaluation of local availability of irrigation water from near-by channels
- ❒ Prepare data on the necessary measures for irrigation (e.g. amount of earthworks)
- ❒ Determination of necessary planting material (by quantity and quality)
- ❒ Preparation of a time table for implementation

Provided that watering can be assured by local irrigation facilities the following species should be considered for planting along the road, around the bus stops or at the bazar:

Ailanthus altissima	*Maclura aurantica*
Eleagnus angustifolia	*Morus alba / nigra*
Fraxinus pennsylvatica	*Ulmus pinato-racemosa.*

Where soils are sandy the most suitable species *would be the local Sakxaul* or *Haloxylon parsicum.*

Where high salt concentrations prevail soil preparation will have to include two cycles of thorough earth „rinsing" prior to planting. Planting itself shall be carried out between December and mid March. Trees would be available in sufficient numbers from the Forestry Department's own tree nurseries.

According to information from the Forestry Department maintenance requirements in the first 5 years would be watering 5 to 10 times per year and manual soil treatment twice to five times per year. In this way 80% success can be expected.

Tree planting itself is usually carried out jointly by the Ministry of Environment (Forest Dept.) and Turkmenautoellari (LEU = Maintenance Dept.). Since these two institutions actually dispose of the best practical experience in this field, they should be consulted to advise on assignments of local specialists to carry out the measures as described above.

4.6 Sand drift control

The contract shall include all necessary sand drift control measures in the road section between km 87 to 88 and 91 to 94. Preferably the method that was described before shall be applied, also including the plantation of *Haloxylon parsicum* within the Kamish-rows (see Figure 3).

The contractor shall work closely together with Turkmenautoellary's LEO from Mary or the Ministry of Environment (Forest department) who have the necessary practical experience.

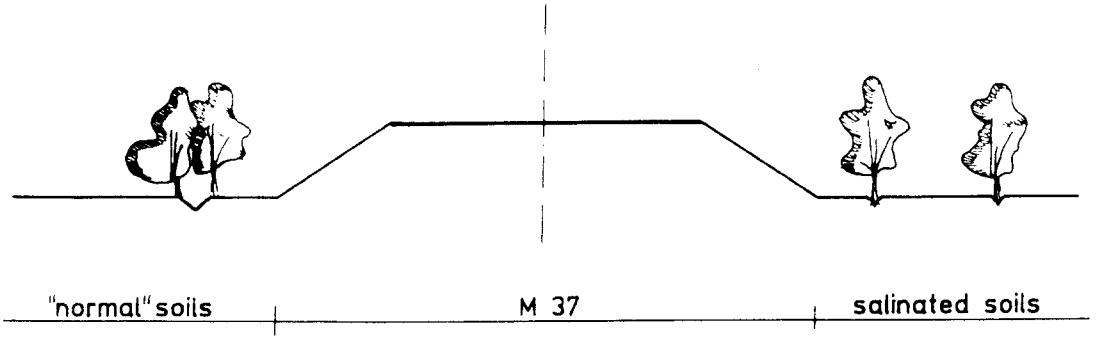


Figure 1: Comparison of recommended planting schemes according to different soil conditions

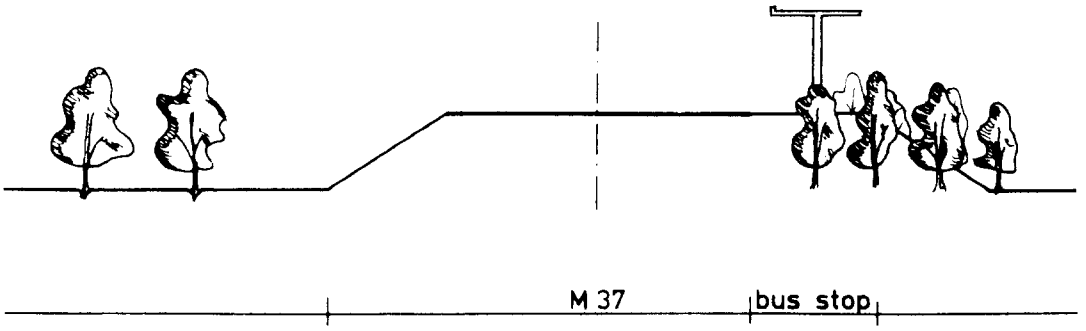


Figure 2: Tree planting at bus stop

4.7 Road safety

A smoother road surface itself will have a positive effect on road safety in general. Further improvements are expected from appropriate road marking (white lining according to GOST 13508-74, standard for road marking, preferably using detergent-free products) and guard rails where the embankments exceed 2 or 3 m height (to be determined individually). For the bridges appropriate safety equipment shall be provided (hand rails etc.).

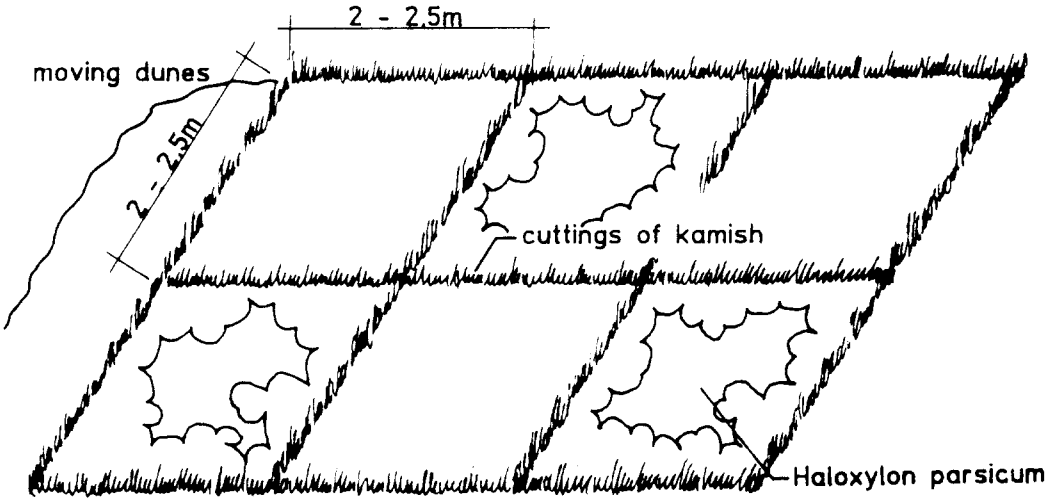


Fig. 3: Sand drift control - method as recommended by the Forest Department

4.8 Monitoring

In order to ensure the correct preparation and implementation of all remedial and mitigation measures an inspector shall be designated under the Project. This inspector shall supervise site preparation, site installation, worker's training / briefing, construction, advise on the design and the execution of measures for sand drift control, advise on and supervise site restoration (contractor's yard, construction sites, quarries). Also, tree planting shall be monitored.

A regular (monthly?) report shall be submitted by the inspector summarizing information on environmental improvements / measures during the construction period:

- steps taken by the contractor to preserve the environment
- data on quarries (safeguards, area, depth, recultivation, regular update of characteristics)
- trees planted (location, number, state of irrigation facilities etc.)

This inspector shall report to the Resident Engineer and cooperate closely with the appropriate official bodies.

5. Key permits

According to the existing planning regulations, permits / approvals would be required from the following institutions (this list is a complete one and is not restricted to purely environmental aspects):

Velayat Ahal

Etraps / Hekimliks (Dept. for Architecture)

Kahka	borrow pit license Dushak
Serakhs	borrow pit license Serakhs
Tedjen	road construction corridor, also including contractor's yard, traffic diversion: Dept. of Land Use

Velayat Mary

Etraps / Hekimliks (Dept. for Architecture)

Mary	road construction corridor, also including contractor's yard, tree planting along road and creation of irrigation facilities
Murgab	road construction corridor, also including contractor's yard, tree planting along road and creation of irrigation facilities
Niasov	road construction corridor, also including contractor's yard, tree planting along road / police post Hauz Khan and creation of irrigation facilities

Ministries:	
Railway	any change on railways
Construction Material	borrow pits Dushak and Serakhs
Economy & Finance	???
Agriculture & Food	???
Water Management & Irrigation	Borrow pit Dushak and Serakhs (on the river Tedjen); water suppliers
Velayats:	
Dept. of Oil & Gas	crossing of gas pipelines
Dept. of Energy & Industry	crossing of energy lines
Dept. of Communication	crossing of telecommunication lines
Etraps:	
Dept. for Irrigation:	crossing of water pipelines. In cases of changes on water pipelines: technical specifications
Gas stations Hauz Khan	
Manager	Tree planting on gas station

APPENDIX 1:

List of people contacted

Almuradov, Mamed	LEU Ahal, Chief of Maintenance Department
Atamuradov, Begensh	Ministry of Nature Exploitation and Environment Forestry Department
Baliyev, Sihmurat	LEU Ahal, DCU 10 Serakhs
Berkeliev, Timur	Ashgabad Ecology Club CATENA
Brozda, Olga	Turkmendorproyekt, Director
Danielowa, Ludmilla	Ministry of Environment Senior Expert for Ecological Expertises
Glasovski, Vladimir	Ministry for Nature Exploitation and Environment Head of Department for Environmental Protection
Kuliyev, Akmukhamed	Ministry of Nature Exploitation and Environment Deputy minister-chief forester
Mirgorodski, Leonid	Turkmendorproyekt, Senior Engineer

APPENDIX 2:

Tabular Summary Potential Impacts, Measures And Regulations

Table 1: Establishment, setup and operation of the work site - potential impacts, measures and regulations

Potential Impact	Measures	Regulations
Loss of or damage to roadside trees and bushes	• **preserve / protect single trees and bushes within or adjacent to the work site**	BCH 8-89 no. 2.3.4 - 2.3.7
Loss of valuable topsoil	• **remove and store topsoil**	SNIP 2.05.02-85, no. 3.4 and 3.5
Pollution of soils, surface and ground waters	• **avoid water protection zones and surface waters, restrict activities in areas near to rivers or streams / irrigation facilities**	BCH 8-89, no. 2.2.5, 2.2.9, 2.2.10;BCH 8-89 no. 2.4.11
	• **proper storage, use a. handling of hazardous materials (detergents, lubricants, fuel, oil, paint...)**	Safety Regulations for Construction, Rehabilitation and Maintenance of Roads (corresp. to SNIP III A-11-70) Chapter 11; BCH 8-89 no. 2.2.1, 2.2.4, 2.2.5; SNIP III-4-80
	• designate inspector for the supervision of all measures and activities, define clear responsibilities	
	• temporary sealing of contractor's yard (storage area of machines, filling and washing sites, workshop, storage areas for hazardous substances), installation of oil-fuel separator	-.-
	• proper treatment of sewerage and waste from worker's accomodation	(BCH 8-89 no. 2.2.1 and 2.2.4)
	• raise awareness of workers and other personnel on use and handling of hazardous materials by on-site training / briefing	-.-
	• on completion of works: restore site (work areas, work depots and material storage site) to initial state; respread top-soil	-.-
	remove machines and waste material	-.-
	• define clear responsibilities, monitor compliance by inspector or construction supervision team	-.-
Noise development	• **use machinery corresponding to existing noise regulations**	BCH 8-89 no. 2.4.2
	• work site establishment to avoid neighbourhood of settlements	-.-
Dust development	• **adopt dust control measures**	BCH 8-89 no.4.1.1 (applies to roads within settlements)
Traffic disruption and worker's safety	• develop well designed traffic management plan	
Risk for worker's health and safety	• **apply and supervize safety regulations for road works**	Safety Regulations for Construction, Rehabilitation a. Maintenance of Roads (corresp. to SNIP III A-11-70) Chapters 1, 2,11, 17; SNIP III 4-80 no. 2

Note: Measures in bold are mandatory due to existing regulations; (...) recommended measures only partly covered by existing regulations
-.- indicates additional recommended measures

Table 2: Activities within the construction corridor - potential impacts, measures and regulations

Potential Impact	Measures	Regulations
Risk for worker's health and safety	• **apply and supervize safety regulations for road works**	Safety Regulations for Construction, Rehabilitation and Maintenance of Roads (corresponds to SNIP III A-11-70) Chapters 2, 9, 11;
	• **in case of works on bridges and culverts apply and supervize specific regulations**	see above, Chapter 6
	• develop well designed traffic management plan	(SNIP III-4-80 no. 2.20)
Destruction of roadside trees	• **preserve / protect trees within or adjacent to the construction corridor**	BCH 8-89 no. 2.3.4 - 2.3.7
Surface water pollution	• **respect protection zones along streams and rivers**	BCH 8-89 no. 2.2
Noise development	• **use machinery corresponding to existing noise regulations**	BCH 8-89 Annex 2
	• limit working hours	-.-
Dust development	• **adopt dust control measures**	BCH 8-89 no. 4.1.1
Worker's health	• apply health and safety regulations for road construction equipment	BCH 8-89 no. 2.4 and Annex 2; SNIP III-4-80
Generation of waste from road rehabilitation	• reuse material whereever possible	-.-
Traffic disruption	• develop well designed traffic management plan	-.-
For better control of measures	• contractor to provide a method statement	-.-
Additional environmental enhancement measures	• tree-planting • sand drift control	-.-

Table 3: Material extraction and transport - potential impacts, measures and regulations

Potential Impact	Measures	Regulations
Disturbances of local residents through material transport (noise, dust)	• consider possibility of material transport by railway • inform local people about project (responsibilities, purpose, duration...)	-.- -.-
	• **apply measures for dust control**	(BCH 8-89 Nr. 3.4), no. 4.1.1
loss of valuable topsoil	• remove and store topsoil	SNIP 2.05.02-85 no. 3.4 and 3.5
safety risks because of material transport through settlements	• develop of well designed traffic management plan	(SNIP III-4-80), no. 2.20)
risk for worker's health and safety	• **apply and supervize safety regulations for works in quarries and borrow pits**	Safety Regulations for Construction Rehabilitation and Maintenance of Roads (corresponds to SNIP III A-11-70) Chapter 12

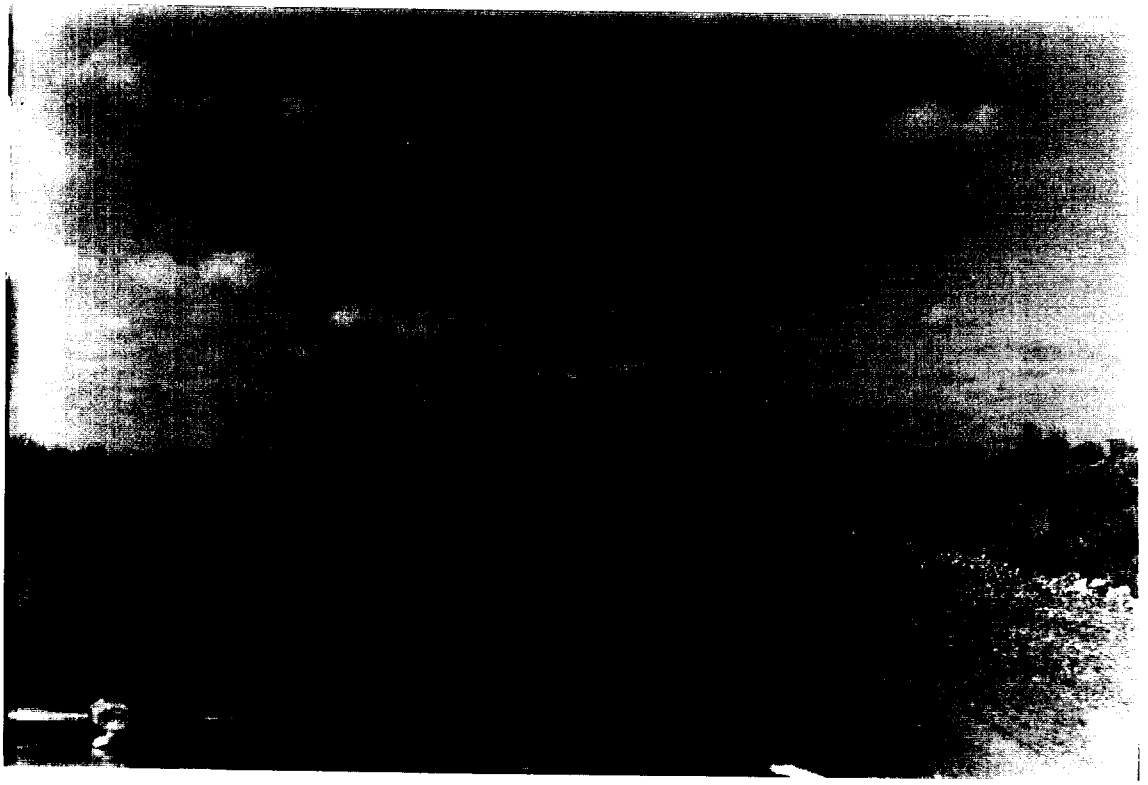
Table 4: Further opportunities for positive environmental enhancement

Aim	Measures	Regulations
Improvement of road safety	• **white linings** (preferably using environmentally friendly products) • **crash barriers in road sections with embankments > 3m height** • sand drift control	GOST 13508-74 -.- GOST
Tree-planting	• mapping of remaining gaps for tree planting • determination of necessary earth works • determination of number of trees destroyed during construction • evaluation of bus stops for suitability of tree planting • evaluation of existing irrigation conditions • prepare data on measures required for tree irrigation • determination of quantity and quality of planting material	-.-

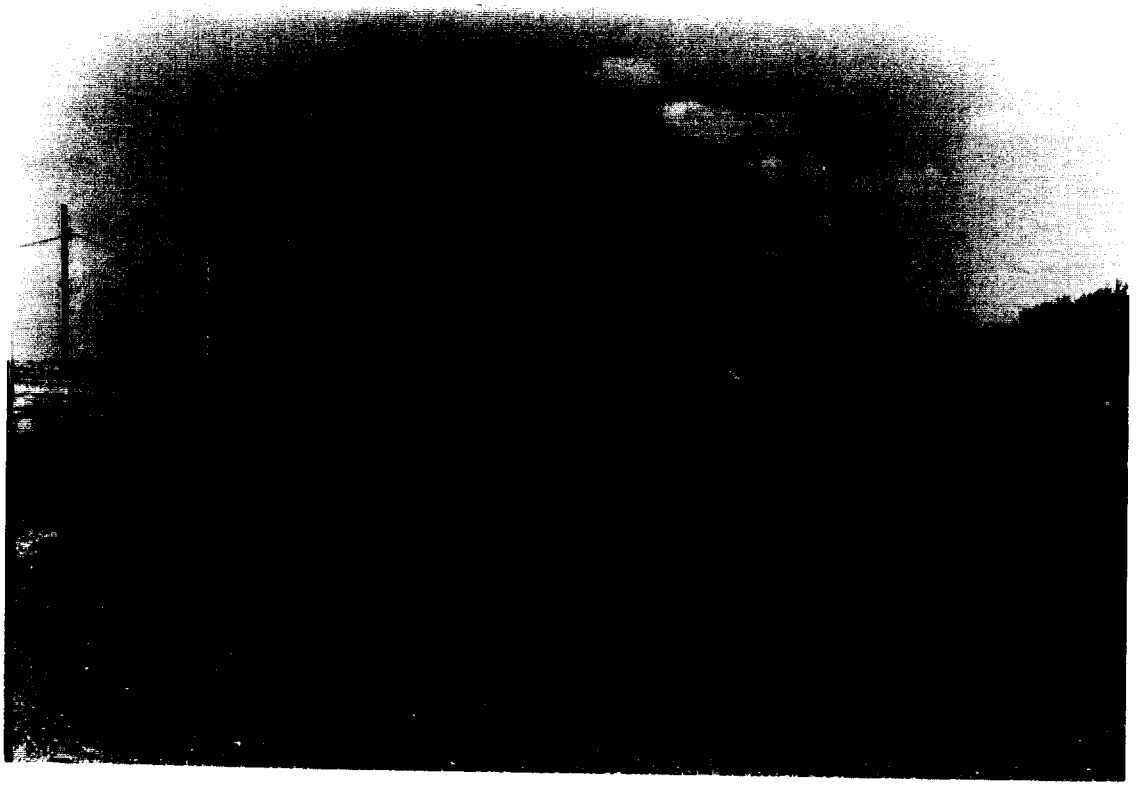
APPENDIX 3:

Photographs

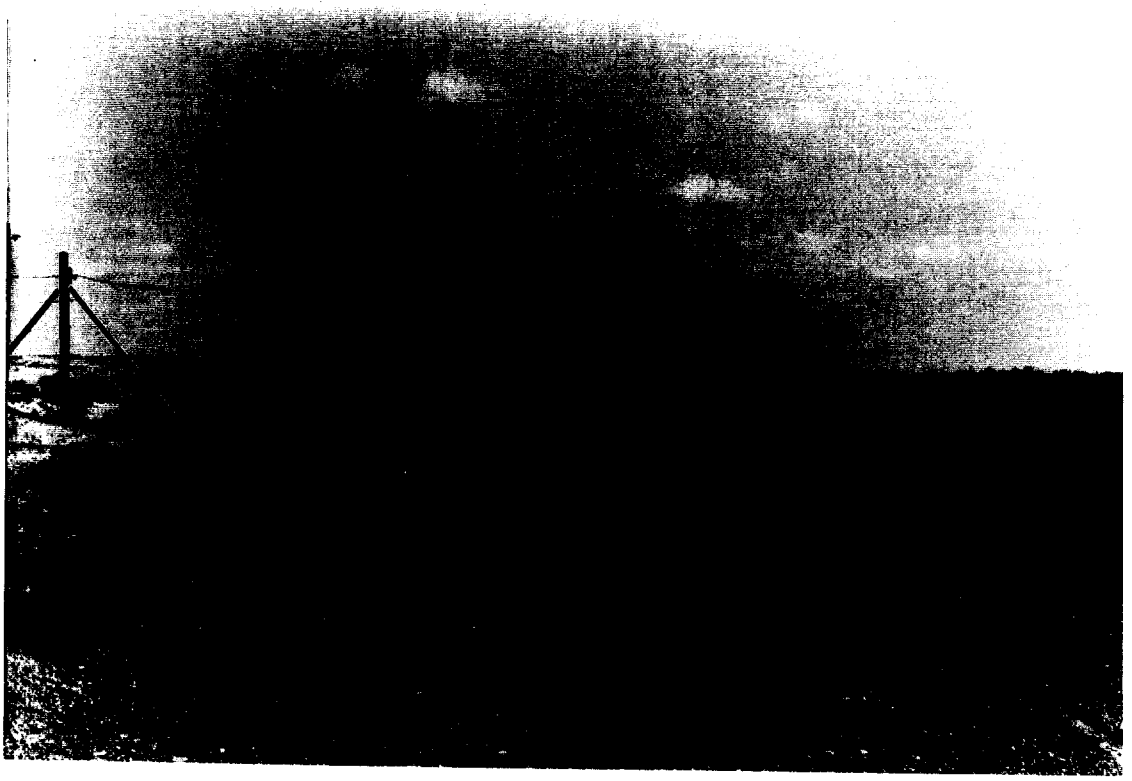
Picture 1: Road section between Tedjen and Hauz Khan (~km 33), where road sides are currently being prepared for tree planting



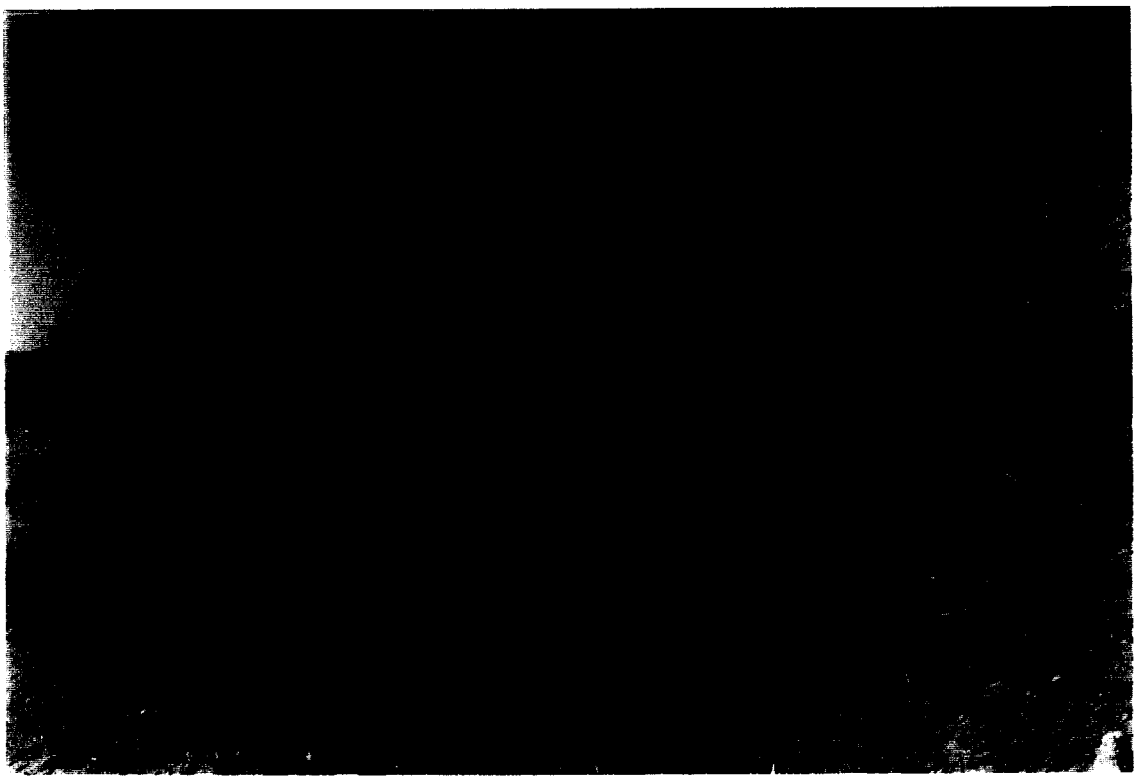
Picture 2: Typical aspect of natural vegetation between at about road km 98 where Sakxaul (*Haloxylon parsicum*) reaches up to the edges of the shoulders



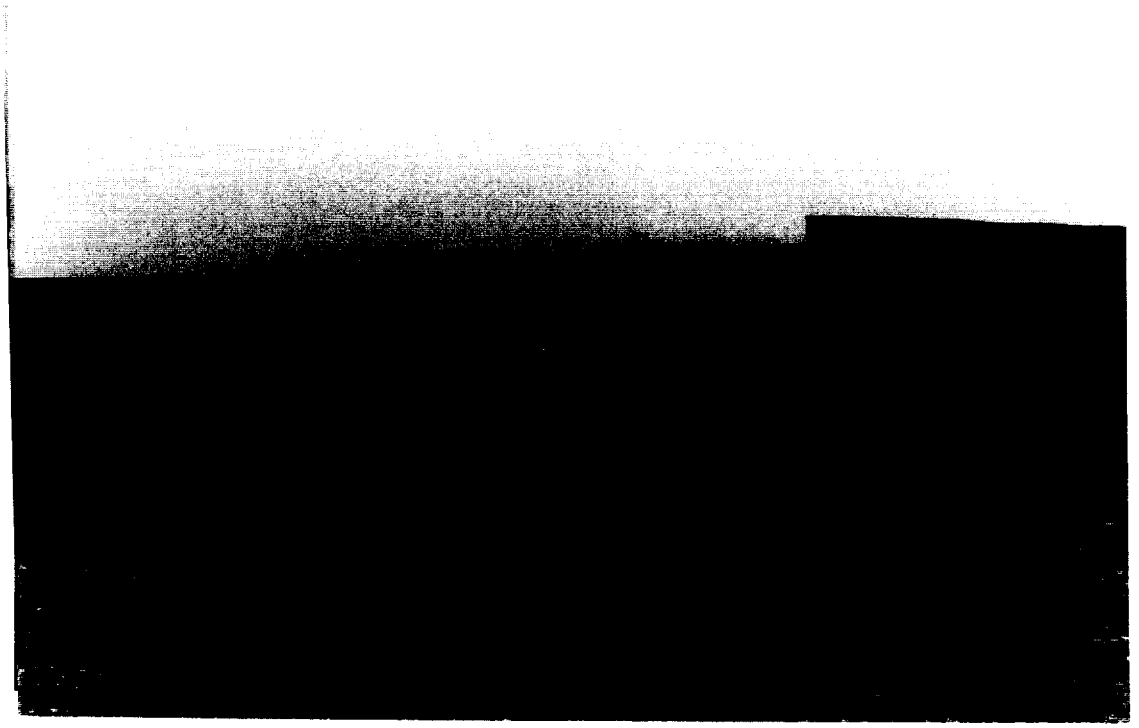
Picture 3: Moving sand dunes between road km 88 ad 91,5. In these locations measures for sand drift control are recommended



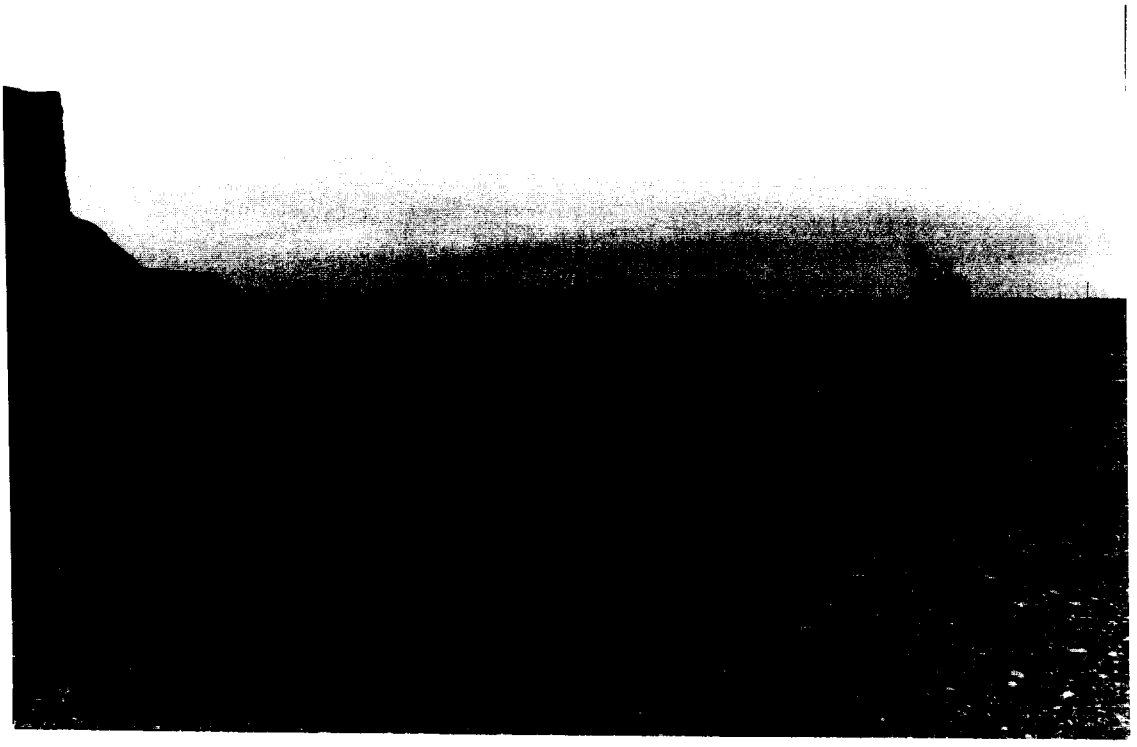
Picture 4: see above



Picture 4a: Proposed method for sand drift control with *Kamish*



Picture 5: Proposed borrow pit at Dushak, aspect of the present borrow site



Picture 6: Same borrow pit, view over some older parts of the borrow area

Picture 7: Borrow pit at Serakhs ('Khor Khor') with aspects of spontaneous growth of rushes in local depressions

Picture 8: Apect of some older parts of the same borrow pit with wide-spread waste in the background. The water at this location originates from a nearby factory for loam bricks