Tacis

TRACECA - Project

Trade and Transport Sectors

Implementation of Pavement Management Systems

Turkmenistan Tedjen - Mary Road Improvement Engineering Report

November 1997

Volume I

Engineering and Implementation Proposals

KOCKS CONSULT GMBH
Consulting Engineers
Koblenz / Germany

in association with

TECNECON, Economic and Transport Consultants
London / U. K.

PHØNIX
Pavement Consultants
Vejen / Denmark

KOCKS CONSULT GMBH **KOCKS** INGENIEURE

European Bank for Reconstruction
and Development - EBRD
Attn. Mr. Christopher Ousey
One Exchange Square
London EC2A 2EH

UNITED KINGDOM

243/Wei-vs/956 Koblenz, 01.12.1997

Dear Mr. Ousey,

TRACECA Project: Implementation of Pavement Management Systems
Project Number: TELREG9305
Turkmenistan
Tedjen - Mary Road Improvement
Final Report, November 97

We take pleasure in submitting to you the Final Report consisting of

- ENGINEERING REPORT, in
  - VOLUME I,
    Engineering and Implementation Proposals
  - VOLUME II,
    Drawings
  - VOLUME III,
    Traffic and Economic Evaluation Report
    Environmental Assessment
  - VOLUME IV, -
    Dynamic Penetration Test Results
    Falling Weight Deflectometer

- TENDER DOCUMENTS; in
  - VOLUME I, The Tender
  - VOLUME II, The Contract
  - VOLUME III, The Works

Европейский банк Реконструкции и
Развития - ЕБРР
One Exchange Square
Г-же Лин О' Греди
Лондон EC2A 2EH

Объединённое Королевство

243/ Wei -vs/956 Кобленц, 01.12.1997

Уважаемый г -н Оузи ,

Проект ТРАСЕКА : Создание системы управоления дорожным покрытием
Номер проекта TELREG9305
Туркменистан
Реконструкция автодороги Теджен - Мары
Окончательный отчёт, Ноябрь 97

Мы посылаем Вам Окончательный Отчёт состоящий из

- ИНЖЕНЕРНЫЙ ОТЧЁТ,
  - ТОМ I,
    Инженерные предложения и предложения по внедрению
  - ТОМ II,
    Чертежи
  - ТОМ III,
    Экономическая оценка и оценка транспортного потока
    Исследование вопросов охраны окружающей среды
  - ТОМ IV,
    Результаты проведения динамических пенетрационных испытаний
    Результаты и оценка испытаний дефлектометром падающего груза

- ТЕНДЕРНЫЕ ДОКУМЕНТЫ
  - ТОМ I, Тендер
  - ТОМ II, Контракт
  - ТОМ III, Работы

The Report has been prepared considering comments from Turkmenautoellari. Five copies of the Report in Russian language are forwarded to H. E. Nurmurad Kulmuradov, Minister, Turkmenautoellari.

Отчёт подготовлен с учётом замечаний Туркменавтоеллари. Отчёт на русском языке в количестве пяти экземпляров направляется министру, Туркменавтоеллари г -ну Н. Кульмурадову.

We are available for consultation and further assistance in the project implementation.

Мы всегда готовы оказать услуги и в дальнейшем помочь в проекте внедрения.

Yours faithfully

Искренне Ваш,

KOCKS CONSULT GMBH
Consulting Engineers

KOCKS CONSULT GMBH
Консультирующие инженеры

Werner P. Weiler

Вернер П. Вайлер

Encl. Final Report in 3 copies

Содерж. 3 копии Окончательного отчёта

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KOCKS
INGENIEURE

COVER PAGE
FINAL REPORT (TM - TM)

REPORT COVER PAGE

Project Title	:	Traceca Project - Implementation of Pavement Management Systems Addendum No. 1, Component 2: **Preparation of a Road Improvement Project Ashgabat to Mary Road (Section Tedjen - Mary)**
Project Number	:	TELREG 9305
Country	:	Republic of Turkmenistan

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Date of report : 15.11.1997

Reporting period : 01.07.1997 - 15.11.1997

Author of report: Ulrich Willems, Project Co-ordinator (Kocks Consult GmbH)

EC M & E Team	(name)	(signature)	(date)
EC Delegation	(name)	(signature)	(date)
TACIS Bureau (Task Manager)	(name)	(signature)	(date)

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PROJECT LOCATION MAP

1. INTRODUCTION

1.1 Tedjen - Mary Road Section

The Tedjen - Mary road is a section of the M 37 (Magistrale), Turkmenistan's most important artery for long distance domestic and international traffic. The more than 1,200 km long M 37 in Turkmenistan is linking Turkmenbashy (formerly Krasnovodsk) at the Caspian Sea with Ashgabat and via Tedjen - Mary the Uzbekistan border, and ultimately, Buchara and Samarkand.

The Government of Turkmenistan intends to apply to the European Bank for Reconstruction and Development (EBRD) for a loan which will cover pavement strengthening along the principal M 37 road from Ashgabat, the capital, to Mary, an industrial centre about 350 km to the east.

This road improvement project from Ashgabat to Mary is subdivided into three sections:

(i) Ashgabat - Kahka (130 km)
(ii) Kahka - Tedjen (80 km)
(iii) Tedjen - Mary (143 km)

Details for the improvement of the third section, Tedjen - Mary, are described in this report. The first two sections are being designed under a different contract by another consulting firm.

The engineering surveys and designs of the current project for the improvement of the Tedjen - Mary road section are part of the European Union - TACIS sponsored TRACECA Project (Transport Corridor Europe - Caucasus - Asia).

1.2 Project Objectives

The objective of this project component is to assist Turkmenautoellari to maintain and improve the road system in Turkmenistan, with a specific focus on the M 37 corridor road between Ashgabat and Mary. This objective will be achieved principally by

- preparation of engineering designs and tender documents
- assistance to Turkmenautoellari with tendering, including bid evaluation
- study of design, capacity and safety issues where the M 37 passes through urban areas, and
- assistance to Turkmenautoellari with strengthening road maintenance capability so that the roads remain in good condition once the immediate rehabilitation works are completed.

In general this report covers the details for the first item with the engineering surveys and designs including the environmental assessment as well as the tender documents.

1.3 Existing Situation

After independence and due to the opening of the borders to the neighbouring countries in the South heavy load traffic has substantially increased. The existing pavement has not been designed for the present loads. As a result of insufficient pavement construction, lack of equipment and quality control together with deficiencies in road maintenance the condition of the country's road system is deteriorating.

The engineering investigations of the project road showed that most parts of the road are in a poor or poor to bad condition, very often the road surface shows severe deformations (rutting, corrugations) which together with the resulting failure of road surface drainage form considerable danger to road users especially for passenger cars. Immediate action is necessary to keep the M 37 passable.

A comprehensive inspection of the bridges of the project road was carried out and their present condition investigated. Two of the bridges are in very bad condition and immediate action was advised in the Consultant's Inception Report of January 1997:

- single lane traffic (at least for trucks)
- speed limit of 30 km/h

These bridges are bridge no. 19 at km 138.50 and bridge no. 17 at km 133.50.

1.4 Mobilisation, Start of Project

Project activities in Turkmenistan commenced with the arrival of the Consultant's staff in Ashgabat on 12.11.1996.

The first activities included the arrangement of the logistics for the Project (accommodation, office, transportation etc.). Commencement meetings concerning co-operation with the local counterpart, Concern Turkmenautoellari, were held and a contract was concluded with the Institute Turkmendorproyekt as the institution for technical co-operation.

On 16 and 17 November 1996 a joint site/road inspection by staff of the Consultant and of Turkmendorproyekt was carried out for preparation of the field works and to detail the Consultant's work programme. The logistical basis for the field works was established in Mary together with Turkmendorproyekt's Mary branch.

End of November 1996, after the preparation phase, the activities for the field works including topographical survey, geotechnical investigations, Falling Weight Deflectometer survey, environmental investigations, road surface/pavement and bridge condition survey.

1.5 Acknowledgements

The Consultant wishes to express his appreciation for the co-operation of Turkmenautoellari and the Institute Turkmendorproyekt as well as of the assistance received from many institutions and individuals in Turkmenistan, especially the Tacis Co-ordinating Unit.

Our particular thanks are due to Mr. Nurmurad Kulmuradov, President of Turkmenautoellari, and Mrs. Olga Brozda, Director of Turkmendorproyekt and their staff without whose advice and assistance the successful implementation of the Project would not have been possible.

2. ENGINEERING SURVEYS AND ASSESSMENT OF ROAD AND BRIDGE CONDITIONS

2.1 General

The road M 37 connects Ashgabat via Tedjen and Mary to Chardzou It forms an important link from the east of the Caspian Sea to Uzbekistan and further east. Traffic from Iran and neighbouring countries use the road. The project road is located in the South-East Karakum region. The topography is generally flat. The land along the project road is irrigated and used for agriculture.

Climate

The project road is located in the South-Eastern Karakum region and has a distinct continental climate with wide fluctuations of temperature during the day and the year. The temperature is often higher than 35°C during summertime and the maximum temperature in Tedjen - Mary dessert region reaches 46°C in the shade.

By contrast, in winter the temperature in Tedjen drops to below 0°C. Humidity is very low and rainfall sparse. The following tables are giving average temperature and rainfall for Tedjen.

Table 2.1: Average Temperature and Rainfall (Tedjen)

month	1	2	3	4	5	6	7	8	9	10	11	12	year
rainfall (mm)	21	16	32	27	12	2	0	0	1	5	11	10	137
temperature °C	1	4	11	17	23	27	30	28	23	16	9	4	16
max. temperature °C	26	30	34	38	44	44	46	46	42	39	36	28	46

Hydrogeological Conditions

Hydrogeological conditions of this area have been changed with irrigation and reclaiming works. Government improves the agriculture in this region. Predominantly there are cotton and wheat fields in this area. The improvement of the mono-culture and irrational use of water during a long period resulted in higher ground water levels.

Tedjen - Mary road crosses two rivers Tedjen and Murgab), large irrigation canals (Kara Kum, Haus-Khan) and drainage water collector (Kara Kel), as well as a lot of small drainage and irrigation canals. The hydrogeological conditions between Tedjen and Mary are varying.

Geological Overview

The area between Tedjen and Mary is situated in the western part of Murgab depression and crosses Elan region and Northern Badhyz geological structure. The sands, fine sands and clays of quaternary and neogen period are widespread.

In origin the deposits of this area are modern riverbeds of Tedjen and Murgab River, which determine the structure of soil and geotechnical conditions. In tectonic aspect the area in regard is stable and not seismic active.

2.2 Preparation

After the initial introduction of testing equipment and the relevant working method for

- road condition survey
- bridge condition survey
- soils and materials sampling
- geotechnical field and laboratory testing
- traffic survey
- topographical survey
- environmental assessment

all activities of the field investigations, evaluation of data etc. were carried out by the Consultant's staff together with specialists of Turkmendorproyekt as on-the-job training and transfer of technology.

In order to have reference points for all activities of the fieldworks the road chainage was marked on the road where no km-posts were existing. The start of project and the km 0 of the marking respectively was set at the roundabout in the eastern part of the Tedjen townpassage. End of the project was marked at the roundabout in the western entrance of Mary shortly before the railway crossing with chainage km 142+340.

2.3 Road Condition Survey

Equipment

For the detailed data collection of the present condition of the Tedjen - Mary road section the set of equipment provided for the Tacis TRACECA Project in 1996 was used, including:

- Falling Weight Deflectometer (FWD)
- Bump Integrator System

- MERLIN
- longitudinal sensor
- various small measuring devices and office equipment

Road Roughness Measurement

For measurement of the road roughness (road unevenness) a bump integrator developed by the UK Transport Research Laboratory (TRL) was used. The bump integrator system comprises tow main units:

- the **B**ump **I**ntegrator **U**nit (BIU)
- the **C**ounter **U**nit (CU)

and was installed in a locally available vehicle. The bump integrator system measures the road roughness by recording the cumulative displacement of the vehicle axle relative to its body. The operating speed of 32 km/h (20 mph) and the measured distances were monitored by the longitudinal sensor unit.

Before starting and after completion of the measurements the bump integrator was calibrated. For calibration a road section with an about homogenous roughness was determined. This section was measured with a TRL MERLIN (**M**achine for **E**valuating **R**oughness using **L**ow-cost **In**strumentation). This device furnished directly the road roughness value. Along the same section of road several runs with the vehicle mounted bump integrator system were carried out and the calibration factor was determined.

For the project road section between Tedjen and Mary a total of four roughness measurements were done, two in each direction and each lane respectively.

The values measured with the bump integrator in units of BI (mm/km) were converted to International Roughness Index (IRI) values using the following conversion equation:

$IRI = 0.0032\ (BI)^{0.89}$
where BI is expressed in mm/km and IRI in m/km.

The records of the measurements and the resulting mean road roughness for each direction/lane is attached in Annex 1.1.

The table for (visual) condition rating is attached in Annex 1.2. Note that the roughness for the Tedjen - Mary Road was measured.

The road roughness measurement and the distress survey are shown combined in Annex 1.3, together with the road condition class. The road length by condition class is summarised below, the respective locations are listed in Annex 1.4.

Table 2.2: Road Length by Condition Class

Road Condition Class	Road Condition Category	Measured Length
1 B	good	2000
1 B - 2 B	good - fair	3000
2 B	fair	31000
2 B - 3	fair - poor	45000
3	poor	50340
3 - 4	poor - bad	7000
4	bad	4000
Total		142340

Road Distress Survey

The distress survey was carried out in January 1997 registering:

- cracks m^2
- alligator cracks m^2
- potholes m^2
- settlement m^2
- rutting 0 - 10 mm m^2
- rutting > 10 mm m^2
- patching m^2

The results are stated in the Road Straight Line Summary per km of roads. Refer to Annex 1.3.

Particular observations are:

Rutting-Deformations, unevenness in the transverse profile, are caused by plastic deformations, either because of

- compaction under traffic with volumetric decrease or
- displacement of material without volumetric decrease or
- wrong choice of material and/or
- wrong composition of material and/or
- insufficient compaction

In particular, deformation of up to 180 mm are found, and several sections of the road are severely deformed. This is partly due to soft bitumen which is laid as cold mix, and also to insufficient stability of the base course and subbases, with insufficient grading and insufficient CBR values. Also, the bituminous mix is not well graded, but consists of river gravel with large and small size fractions only.

The road in areas of rutting/deformation in excess of 40 m is considered as structurally instable, requiring reconstruction.

Water splashes (rare), unevenness in the longitudinal profile, are caused in bituminous layers by deformations due to horizontal stress-applications.

Cracks are caused either by

- unsuitable material or under dimensioned gravel layers below the asphalt or
- because of deformations due to under dimensioned pavement structure or
- because of wrong choice of bitumen or
- because of material fatigue

Potholes are resulting from

- wrong granulometric graduation
- wrong and/or overdose of bitumen

Due to the suction effect of the tires, first bitumen and subsequently the aggregates are pulled out of the road surface.

Loss of surface roughness or polishing effect due to subside of surface grains in the bituminous mortar as a result of

- wrong choice of bitumen
- overdose of bitumen

Rainfall, loss of surface aggregates and rutting may render the road impassable at sections.

Falling Weight Deflectometer (FWD) Measurement

FWD measurements were carried out and completed on the road section between Tedjen and Mary in December 1996. The measurements were done in both direction and for each lane respectively with a spacing of 200 m resulting in one point per 100 m of road.

The FWD used was a Phønix MLY 10000 equipped with 6 deflection sensors spaced at radical distances between 0 cm and 180 cm. The loading plate used was a 300 mm diameter plate above which was mounted a load cell to measure the load transferred to the road during the measurement.

The results from each point measured are:

Contact pressure on the loading plate i Deflection (1) in the centre of the loaded area.
Deflection (2) outside the loaded area (normally 210 mm from the centre of loading)
Deflection (3) outside the loaded area (normally 330 mm from the centre of loading)
Deflection (4) outside the loaded area (normally 510 mm from the centre of loading)
Deflection (5) outside the loaded area (normally 810 mm from the centre of loading)
Deflection (6) outside the loaded area (normally 1270 mm from the centre of loading)
Temperature of the asphalt in a depth of 4 cm
Description of the position where the measurement was taken

The results from each point are stored in a datafile on the computer attached to the FWD.

All the data from the measurements have then been put onto a computer together with information about the traffic prognosis for the next 15 years, and information about the existing road construction. These information were collected as information from specified points along the road and sections with average uniform thicknesses were taken.

From the measured deflections and the thicknesses given, the programme calculates the E-moduli of the layers in the measured point. The E-moduli and the traffic prognosis then build the basis for calculation of the necessary overlayer needed in each measured point for the design period.

Based on FWD measurements and calculation, sections with recommended uniform overlay thicknesses are compiled. The calculation also states the residual service life of the road and the proposed service life (15 years). In the case of the project road the residual pavement life is very low, in many sections less than 2 - 3 years.

The low residual life and poor bearing capacity requires thick overlays in many sections, as shown in the table in Annex 1.5: Reinforcement Need for Part Sections. Note please that the FWD results are not decisive by themselves in dimensioning on overlay or in deciding on reconstruction. Additional parameters need to be considered as described in the section engineering design.

Road Alignment

The road passes through a generally flat area in the South-Eastern Karakum region. The road passes through irrigated areas. Larger canals cross the road or flow parallel, and several fixed points from irrigation and pipelines exist. The horizontal alignment consists of long straights, frequently followed by narrow curves. A shorter section of the road has problems with windblown sand. The horizontal alignment is generally flat, with many depressions and/or deformations on the surface.

2.4 Geotechnical Investigations

Soils and Materials Testing Laboratory

The existing testing equipment in the laboratory of Turkmendorproyekt was inspected by the Materials Engineer of Kocks Consult and representatives of Turkmendorproyekt to check available equipment for function and suitability and to prepare a list of required additional equipment, which is listed below. The list includes international testing equipment such as for testing the CBR value, which was not used in the Former Soviet Union (FSU).

Table 2.3: Geotechnical Field- and Laboratory Testing Equipment

Pos.	Type	Quantity
1	sieve-set	1
2	base pan	1
3	sieving-machine	1
6	el. weighbridge, 2100 g	1
8	Proctor-mould, 100 mm	1
9	rammer	1
10	plate	1
11	Proctor-mould, 150 mm	1
12	rammer	1
13	plate	1
14	CBR-mould	3
15	base-plate, solid	3
16	plate	3
17	swell-plate, solid	3
18	tripod	3
19	gauge	3
20	surcharge-plate, perforated	3
21	surcharge-plate, slotted	3
22	filter-paper, pack	3
23	filter-sieve	3
24	cutting-ring	3
25	CBR-press hydraulic pressure measurement electric driven penetration	1
26	Casagrande apparatus, el.	1
27	grooving-spatuls	1
28	grooving-form	1
29	speedy moisture-tester	1
30	dynamic cone penetrometer (DPL)	1

Pos.	Type	Quantity
31	generator	1
33	rod, 22 m	15
35	adapter, 22 mm	1
36	one-way-cone, 10 cm²	20
37	one-way-cone, 5 cm²	20
40	sampling-rod 22 mm	2
41	extraction apparatus	1
42	ball-clamp, 22 - 25 mm	1
46	tools, SW 27	2
47	tools, SW 19	2
48	small items, laboratory	
49	small items, field	
50 51	Airometer for Sedimentation Analysis Water Destillation Apparatus	2
52	Thermometer 0°C - 50°C	2
53	Electrical Thermometer	1
54	Glas-Cylinder for Airometer Test	4
55	Sampling apparatus for Up Probes	1
56	Cylinder (diam. 10 cm) for sampling extraction	20
57	Pycnometer for determination of the	
	specific weight	4
58	Spare sieve sreens for the sieve set	1
59	Plastic bag for samples (1 litre)	1000
60	Plastic bag for samples (5 litres)	100

This list was forwarded to the European Commission, DG IA, in Brussels for approval. Five European firms were invited to submit a quotation. The most advantageous offer was recommended and approved by EC/Brussels. The order for the purchase of new laboratory equipment was issued and the first consignment arrived in Ashgabat on the 24 January 1997.

On 24 February 1997 the installation of the new laboratory equipment in the premises of Turkmendorproyekt's laboratory building was completed and testing of the first soils samples from the project road section started. The Consultant's Soils and Materials Specialist carried out an intensive training for the laboratory staff of the Institute.

Ground Water Table

Ground water table data for chainage 0+000 to chainage 72+000 of Tedjen - Mary road were collected from the annual report by the Ministry of Water Management of Turkmenistan. Data about the ground water table from chainage 73+000 to chainage 142+300 of the project road were provided from the annual report of the Bayram-Ali Hydrogeological Expedition of Concern TURKMENGEOLOGY. Ground water data are summarised in Annex 1.6. The ground water table is in general sufficiently low below the pavement or the embankment, respectively. Observation of actual ground water is described below in this report.

Geological structure of the surface, depth and geotechnical features

The thickness of earliest and medium quaternary alluvial deposits is quite varying. In the southern part of this area it is about 200 m, and it reduces towards the northern part to 12 m. The deposits consist of hard clays and fine sands. In the southern part of Tedjen depression alluvial deposits consist of gravely sands with stones, conglomerates and gravel with carbonatic inclusions. The thickness is about 5 - 15 m. In some parts of Tedjen riverbed the gravel deposits are without any overburden and easily accessible, thickness is about 70 - 80 m.

The earliest and medium quaternary subaeral deposits are consisting of gravel-pebbles, sands, fine sands, clayish silts and clays in the upper courses of the rivers. The fragment material is mostly consisting of small and medium parts of magmatic, metamorphical and sedimental materials. The thickness of those deposits is about 70 - 80 m.

Modern subaeral deposits are situated in the upper and medium courses of rivers. Normally these are clayish fine sands. The thickness is sometimes up to 30 m in the medium course of Tedjen and Murgab rivers, reduces to western and eastern parts of the riverbeds.

Eolian deposits are widespread between Tedjen and Murgab depressions and consist of crumbly fine sands.

Latest quaternary alluvial deposits are widespread mostly in the middle courses of the riverbeds, and consist of fine sands and gravel. Thickness is about 15 - 20 m.
Modern alluvial deposits are close to Tedjen and Murgab river. In the lower courses they are changing to modern subaeral deposits. The soil section consists of fine sands, clays and clayish silts. the thickness is about 8 - 10 m.

Latest quaternary subaeral deposits consist of clays, clayish silts and fine sands. The layers have rather various structure. The thickness is about 20 - 30 m in lower courses of Tedjen and Murgab rivers, and about 3 - 5 m in their upper courses.

Sampling and Field Testing

In early December 1996 the fieldworks started and in general the testing included:

- site investigations
- surface distresses
- materials in the existing road
    - fill material
    - road base/subbase material
    - bituminous material
- material for improvement works
    - fill material
    - subbase material
    - crushed stone road base
    - crushed aggregates
    - cement
    - bitumen
    - water

Between the 09.12.1996 and the 05.03.1997 an extensive investigation programme was carried out on site, to collect data on the pavement foundation and the stability of existing earth structure, consisting of:

⇒ 144 Nos. of drop penetration tests up to 6 m depth, to determine the compactness and the consistency of the soil

⇒ 136 Nos. of drill-soundings up to 6 m depth, to determine the type of soil and the moisture content in different layers

⇒ 56 Nos. of trial pits to determine the type of soil and the structure of existing embankment and to take samples for laboratory testing

⇒ 4 Nos. of additional pavement structure checks

The location, type of test, date of sampling and depth of penetration tests are listed in Annex 1.7.

The pavement consists of 20 mm to 150 mm bituminous pavement thickness on a road base of gravel sandy material between 90 to 400 mm approximately, both with a wide range of variation in quality and thickness. Below the road base is a layer of 'fine sand, silty' or 'silt, fine sandy' material according to the laboratory testing.

Being in the area of extensive irrigation, the existence of water in the embankment was checked.

Where the embankment was less than one meter height and close to the irrigation system of Kara Khum canal, a survey was carried out including

- the location
- the height of the embankment
- the groundwater table
- existence of water in the dam
- visible sulphate

- conspicuous surface distress
- observation

In general the survey concluded that there is no visible groundwater in the embankment. For details see Annex 1.8.

Laboratory test programme

The samples taken from the trial pits were brought to the Client's laboratory in Ashgabat and tested as follows:

⇒ 464 Nos. of moisture content tests, oven dried

⇒ 28 Nos. of wet sieve analysis to determine the relative proportions of each size range according to DIN 18123

⇒ 6 Nos. of liquid limits - Casagrande Method (LL) to determine the moisture content at which soil passes from the plastic to the liquid state, according to DIN 18122

⇒ 6 Nos. of plastic limits (PL) to determine the moisture content at which a soil passes from the plastic state to the solid state, according to DIN 18123

⇒ 128 Nos. of compaction tests according to DIN 18127 to determine:
  a) the moisture content (OMC) of the soil at which a specified amount of compaction will produce the maximum dry density
  b) the maximum dry density (MDD) obtained using a specified amount of compaction at the optimum moisture content

⇒ 24 Nos. of unsoaked and 24 Nos. of soaked California Bearing Ratio Tests (CBR) to determine the ratio of the force required to penetrate a piston into soil in a special mould, compared to that required for similar penetration into a standard sample of compacted crushed rock (100 % CBR)

⇒ 24 Nos. of sulphate content tests according to SIS (Soviet Industrial Standards) to determine the content of total sulphates in soil

The natural moisture content test results are summarised in Annex 1.9.

The soil test results are stated in Annex 1.10. The structure of pavement (trial pit diagrams) is shown in Annex 1.11, a summary is given below.

TEDJEN - MARY ROAD IMPROVEMENT
Structure of Existing Pavement, Summary

Chainage		Thickness (mm)			CBR (%)		Dam < 1.0 m		Proposed Subbase
from km	to km	Bit. Layer	Roadbase	Total	Roadbase dry / soaked	Fill dry / soaked	from km	to km	CBR > 30 % soaked
0	4.50	120	350	470	52.1 / 47.1	25.5 / 9.1	0.00	3.50	yes
4.50	7.50	50	250	300			5.50	7.50	yes
7.50	10.50	90	200	290			7.50	10.50	no
10.50	13.50	60	600	660	26.9 / 12.1	9.3 / 3.4			
13.50	16.50	60	130	190					
16.50	19.50	40	270	310					
19.50	22.50	50	450	500			20.50	21.50	yes
22.50	25.50	70	490	560	58.9 / 51.1	18.4 / 2.3	22.50	24.50	yes
		150	190	340					
25.50	28.50	50	440	490					
28.50	31.50	40	290	330					
31.50	34.00	90	90	180	26.5 / 12.1	23.4 / 1.1	31.50	34.00	no
34.00	36.50	30	100	130			34.00	36.50	no
36.50	39.50	50	650	700			36.50	39.50	no
39.50	42.50	70	190	260			39.50	40.50	no
42.50	45.50	50	350	400			44.50	45.50	no
45.50	48.50	40	350	390					
48.50	51.00	50	150	200					
51.00	53.50	50	370	420	24.0 / 24.0	4.2 / 3.0			
53.50	56.50	80	320	400			54.50	55.50	no
56.50	59.00	80	130	210			56.50	57.50	no
59.00	62.00	150	250	400			61.50	62.00	no
					44.1 / 23.5	2.2 / 2.5			
62.00	65.50	40	130	170			62.00	62.50	no
65.50	68.50	70	120	190					
68.50	71.50	30	500	530					
71.50	74.50	40	330	370					
					71.1 / 57.1	0.0 / 0.0			
74.50	77.50	60	130	190			74.50	75.50	yes
77.50	79.50	20	220	240					
79.50	81.00	90	210	300					
81.00	82.50	20	100	120			81.50	82.50	yes
82.50	84.00	40	300	340			82.50	83.50	yes
84.00	86.50	40	290	330			85.50	86.50	yes
					58.1 / 40.6	9.8 / 3.0			
86.50	89.50	20	230	250			86.50	87.50	yes
89.50	92.50	30	310	340					
92.50	94.50	50	240	290			93.50	94.50	yes
94.50	96.00	50	130	180			94.50	96.00	yes
96.00	97.50	70	230	300			96.00	97.50	yes
97.50	99.00	90	140	230			97.50	99.00	yes
99.00	101.00	30	110	140			99.00	99.50	yes
					83.2 / 63.6	13.6 / 8.5	100.50	101.00	yes
101.00	102.50	90	150	240			101.00	102.50	yes
102.50	104.00	50	170	220			102.50	104.00	yes
104.00	106.50	20	100	120			104.00	106.50	yes
106.50	109.00	110	180	290			106.50	109.00	yes
109.00	110.50	130	160	290			109.00	110.50	yes
110.50	112.50	60	190	250			110.50	112.50	yes

Chainage from km	Chainage to km	Thickness (mm) Bit. Layer	Thickness (mm) Roadbase	Thickness (mm) Total	CBR (%) Roadbase dry / soaked	CBR (%) Fill dry / soaked
112.50	115.00	130	270	400	48.1 / 31.1	6.3 / 3.0
115.00	117.00	30	140	170		
117.00	118.50	20	140	160		
118.50	120.50	100	150	250		
120.50	123.00	80	190	270		
123.00	125.50	40	230	270		
125.50	128.50	30	360	390		
		50	210	260		
128.50	131.00	70	350	420		
131.00	133.00	30	250	280	31.6 / 19.5	9.0 / 6.8
133.00	135.00	80	200	280		
135.00	137.00	80	150	230		
137.00	140.00	90	310	400		
140.00	142.85	270	310	580	51.1 / 23.0	17.5 / 3.5

Dam < 1.0 m from km	Dam < 1.0 m to km	Proposed Subbase CBR > 30 % soaked
112.50	113.50	yes
119.50	120.50	yes
120.50	123.00	yes
123.00	123.50	no
124.50	125.50	no
125.50	128.50	no
128.50	131.00	no
131.00	133.00	no
133.00	135.00	no
135.00	137.00	no
137.00	139.50	no
140.50	142.85	no

Fill Material

Obviously the embankments were constructed with the in-situ soil adjacent to the road. The material found in the embankment consists mainly of clayish, fine sandy silts of low and moderate plasticity and is partly not suitable as subgrade. the plasticity index varies from 4.0 % to 16.3 %. In particular the materials loosing bearing capacity under the influence of water.

Subgrade CBR-results are as follows:	unsoaked %	soaked %
Tedjen - House Khan:	25.9 - 2.2	9.1 - 2.3
House Khan - Mary:	17.5 - 0.0	8.5 - 0.0

Because of the low bearing capacity and the sensitivity of the influence of water, it is recommended to replace or to reinforce this material particularly in reconstruction sections where the elevation of the road is close to the existing ground surface, by selected fill-material of minimum CBR of 15 % for a minimum thickness of 0.4 m.

In-situ moisture contents measured in the earth embankment, specially in the upper layers, are far below the optimum moisture content. Below the embankment soils are mostly around or above the OMC and with increasing depth the consistency of soils is changing, due to increasing moisture content, from semi-stiff to soft.

In no case water was found in the dam structure. Supplementary soundings and investigations in dam areas below 1 m height, close to irrigation systems of Kara Khum Canal, did clearly show that the influence of ground water in the existing dam structures is very limited.

Performed DPL tests were resulting often in the upper part of the embankment in high to medium resistance 10 - 40 blows/10 cm = firm to semi stiff consistency in cohesive soils, dense in non cohesive soils. Soft consistency, i. e. 3 - 10 blows/10 cm, in the embankment was found:

In the section **Tedjen - House Khan** between ch. 4+000 - 6+000, 11+000 - 20+000, 22+000, 25+000 - 38+000, 43+000 - 44+000, 47+000 - 66+000, 69+000 - 74+000.

In the section **House Khan - Mary** from ch. 75+000 - 77+000, 82+000 - 88+000, 95+000, 111+000, 117+000, 119+000.

Below the embankment soft consistency has been found in the whole project road, very often in the transition area between subsoil and dam. This indicates that the natural soil has not been treated, i. e. properly cleared, and compacted at its optimum moisture content up to the maximum density. But due to traffic and time the consolidation of the embankments can be assumed to be completed, further settlements are not expected.

Road base material/sub-base

The gravel layer under the asphalt does not correspond with the technical specifications for road base as main load-spreading layer of the pavement. It should normally consist of crushed stone or gravel, the material should have a certain particle size distribution and particle shape which provide high mechanical stability. The soaked CBR result should reach 80 %.

Neither the particle size distribution nor the CBR results fulfil the requirements. Moreover, due to the high plastic fines content the gravel is very sensitive to water and cannot be evaluated as separating or filter layer.

The CBR values are as follows:	unsoaked %	soaked %
Tedjen - House Khan:	58.9 - 24.0	51.1 - 12.1
Haus Khan - Mary:	83.2 - 31.6	63.6 - 19.5

This material can be partly classified as ordinary sub-base, partly as fill-material only. Since the thickness of this gravel layer in some sections is not as designed a levelling and reinforcing layer has to be previewed in reconstruction sections.

Since neither an internal nor an external drainage was found the layers below the asphalt are confined between impermeable fill and shoulder material. The evacuation of penetrated water is not possible.

Due to the unsealed shoulders and the cracked asphalt, both sections are previous, saturation of the sub-base and subgrade is likely and is one of the causes for surface distresses. According to the CBR-results this silty gravel is loosing, like the fill-material, bearing capacity under influence of water. Further laboratory tests have shown that the stability of this material is degrading rapidly when the optimum moisture content is exceeded. For that reason the composition of the new overlay has to be dense to prevent water to penetrate into the road structure.

The composition of the existing pavement differs strongly and it is not possible to subdivide the road in homogenous sections. Mostly the pavement consists of one bituminous layer placed on a natural untreated granular base of low bearing capacity. In large areas this bituminous material consists of an old layer and of several newer thin overlays. The total thickness of the bituminous layer varies between 2 - 27 cm.

Around chainage 9+000, 15+000, 60+000 and 142+000 a second bitumen stabilised gravel was found below the upper gravel layer, the thickness is about 3 - 13 cm.

In large parts of the road surface, the bleeding of bitumen and polished aggregates is conspicuous. The bitumen content is obviously too high between 6 and 10 %, the bitumen too soft and the aggregates are not crushed and not well graded. Segregation specially in the centreline area, deformations and rutting, as well as other surface damages are the consequences.

Fill material for embankment will not be necessary in a large quantity, but for sections of new alignment, and will be provided from borrow pits adjacent to the road. Almost all types of soils can be used. Selected fill for subgrade has to be treated in a similar way as the sub-base before placing, i. e. sandy gravel shall be added to the in-situ soil, to assure the stability.

Subbase material for a secondary load spreading layer underlaying the road-base, consists normally of a lower quality than that used in the roadbase, such as unprocessed natural gravel. Different quarries have been visited by the Consultant. No natural occurring suitable sub-base was found. All the materials have to be processed. The following quarries were inspected by the Consultant:

- Bezmein, near Ashgabat, 220 km from Tedjen
- Kaushut, on the road from Ashgabat to Tedjen, 108 km from Tedjen plus 10 km access road
- Dushak, on road from Ashgabat to Tedjen, 49 km from Tedjen plus 10 km access road
- Seraks Hor Hor and Seraks, the road is turning off at chainage 73+500 from M 37 to the quarries. The distance from M 37 to Seraks comes to 110 km.

Each of the quarries has its own railway connection and loading and unloading facilities. Since roads are generally in bad condition, specially the road from M 37 to Seraks is narrow and the asphalt pavement is very poor, the transport by train should be taken into consideration.

Four unloading points along the project road are already existing, those are:

1 Tedjen
2 Parakhat
3 Karabata
4 Mary

The raw material from Bezmein is the best among all the quarries and is used also in other parts of the country for construction works, but has to be screened over a 35 mm sieve before placing.

The materials from the quarries Dushak, Kawshut and Serax are non cohesive and have to be screened and mixed with silty fine sands to assure the compactability and the stability.

Subbase material is required in smaller quantities for improvement of the existing layers, and in short sections of realignment of the road. Natural sub-base deposits are also important for shoulder construction works. Test results are summarised in Annex 1.12.

Crushed aggregates for premixed bituminous material and concrete, in two quarries, Dushak and Kawshut, crushed material can be produced. During the visits of the Consultant only Dushak was operating. The material passes only once through a rod-mill crusher, bar diameter is 40 - 120 mm, so the particle shape is rather flaky to elongated than cubical. The crushing procedure has to be improved by adding a cone crusher, to achieve aggregates with a cubical shape.

Two types of crushed aggregates have been on stock. According to the test results the gravel can be classified as 8 - 16 mm with 20 % oversize and as 2 - 8 mm with 24 % undersize. For grading analysis results refer to Annex 1.12.

The crushed material was dirty and the grains were partly coated with dust and have to be washed before use.

The raw material itself was inspected visually and found to be hard and durable with a dense surface without any soft, porous organic impurities, iron pyrites or oxides.

Properties have been estimated as follows:

- Water absorption < 1 %
- Aggregate crushing value < 15 %
- Los Angeles Abrasion < 20 %

Cement, two different types of Portland cements M 400 are locally made in a cement mill near Ashgabat and can be obtained in bulk, rarely bagged. According to the technical Director of the cement mill the total output per year is running up to 500,000 tons. Since sulphate resisting cement might be needed, it has to be imported from Uzbekistan. The results are presented in Annex 1.13.

Bitumen is locally produced in the refinery in Turkmenbashi. It was planned to produce quality road pavement bitumen. Test results of recently sampled and tested bitumen show a penetration grade of more than B 200, whereas a bitumen 65 is required, they are presented in Annex 1.14. Early information provided by Turkmenautoellari suggested that quality bitumen would not be available from Turkmenbashi in the near future, mainly because the crude oil is fed from three largely different sources. Latest discussions and efforts focus on the production of suitable grade bitumen, the outcome is not clear to the Consultant at the time of writing the report. If the non-availability is confirmed, bitumen may have to be imported from neighbouring countries. Previous experience suggests that constant production supervision and product testing by own or independent sources is required in any case to safeguard the quality.

Water for dam construction works can be obtained from the Tedjen River, House Khan Channel and from the Kara-Khum Channel.

Existing asphalt plants

Only one obviously functional plant was found. This plant near Seraks was installed in 1994 according to the Technical Manager and has never worked. The capacity has been indicated with 50 t/h. If this plant is really in functional conditions could not be proved. The distance to the project road is about 80 km.

Geotechnical Assessment and Recommendations

According to the obtained test results, several visual inspections and site investigations the bearing capacity of the upper layers of the road structure is predominantly already insufficient for the present traffic load. Traffic study identifies for the planning horizon of 15 years distinct increase of traffic.

In the most parts of the road, measures have to be taken to strengthen the pavement including the roadbase and the sub-base, to assure the load sharing between the different layers and to avoid further surface distresses. In those sections a simple asphalt overlay is not recommended.

The existing material under the bituminous mixture (gravel/sand/silt/mixture) could be used as sub-base, provided that a CBR value of min. 30 % is reached and the designed thickness has been obtained. But due to high fines-content this material is very sensitive to water and cannot be evaluated as separating or filter layer. Should the material fail to reach 30 % soaked CBR, substitution of material is necessary. In this case the existing bituminous mix should be used as reinforcement after milling and re-mixing.

2.5 Road Maintenance and Rehabilitation Practices and Standards

Standard

Road maintenance and rehabilitation is based on the 'Technical Standard for Road Maintenance and Rehabilitation' of the Former Soviet Union including:

- Routine Maintenance:
  - cleaning of carriageway and shoulders
  - vegetation control
  - cleaning of ditches, drains and culverts
  - minor repairs for bridges, culverts and road furniture
  - repair of cracks
  - pothole patching
  - patching/grading of shoulders
- Periodic Maintenance: Resurfacing (either resealing or asphaltic overlay)
- Reconstruction of new pavement: Reconstruction of the pavement (subbase, base course, asphaltic road surface)

- Upgrading/Improvements: Improving the technical design standard of the road such as by widening or realignments

Practices

However, the present activities for road maintenance and reconstruction are carried out on a low level only.

A minimum of routine maintenance is carried out with little activities for repair of cracks and patching of potholes. Where periodic maintenance or reconstruction is carried out cold mix asphalt is the prevailing method:

- scarification of the existing asphaltic surface and addition of 30 - 50 % new asphalt for relaying, and

- in a few cases a 50 to 60 mm asphalt overlay

The reason for the low level road maintenance and reconstruction activities is the lack of equipment, of appropriate equipment and spare parts. There was only one single equipment available for resealing. Modern type of equipment like an asphalt paver is not available and the actual practice of using graders for spreading new asphalt layers results in a relative high initial road roughness.

Further problems occur from the use of materials which do not comply with the requirements of the relevant specification:

(i) the required material is not available in Turkmenistan to the specified quality (e. g. bitumen) or cannot be produced (e. g. aggregates from crushing/screening) or other material (e. g. for subbase/base course) is used due to enormous haulage distances.

(ii) the use of cold mix asphalt instead of hot mix asphalt as specified

In summary the existing/present road maintenance and rehabilitation practices are not sufficient for the preservation of the road network and in addition further problems result from the use of sub-standard material. This results in a considerable reduction of the service life of the roads of 6 to 10 years only (depending on traffic load).

2.6 Traffic Survey

The traffic survey and report covers the review of traffic data, further traffic surveys carried out in the course of the study and forecasts of future traffic and loadings for the design process. The traffic report is issued with the economic feasibility in a separate volume of the Draft Final Engineering Report. A summary is given below.

Prior to the commencement of the field works existing reports on traffic studies as well as other traffic data and information were reviewed:

- Identification and Preparation of a Road Rehabilitation Project in Turkmenistan, Y. Atlan, 1994
- Road Improvement Project, Kocks Consult GmbH & TecnEcon Ltd., 1995
- Study on Land Transport Corridors between Central Asia and Europe, 1995/96
- Turkmenistan Highway Master Plan, Feasibility Study for Ashgabat to Mary, TICA, 1996
- Turkmenautoellari Traffic Data
- Ashgabat - Tedjen Road Improvement Project, Carl Bro, Traffic Surveys 1996/97

First review of existing data including the background of the data collection method carried out showed that most of the data are incomplete and that in principal the Consultant will have to base his traffic forecasts on own surveys (classified traffic counts and axle load surveys).

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 R 7 near to Tedjen.

At the site near to Mary, the count was carried out for a continuous period 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
- 3 axle truck > 5 tonnes
- 3 axle truck
- 4 axle truck
- 5 axle truck
- 6 axle truck, and
- other, which would mainly cover motorcycles

The results are shown in table 2.4 of the Traffic Report, copy attached.

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 8.30 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 attached.

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 2.5.

Table 2.4: Summary of Classified Traffic Counts

Location and Time Period	Agri Tractor	Car	Bus	Utility <2t	Truck >2t 2 - axle	Truck >2t 3 - axle	Truck >2t 4 - axle	Truck >2t 5 - axle	Truck >2t 6 - axle	Other	Total Trucks	Total Light Vehicles	Total
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

Table 2.5: 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

The forecast scenarios are described in the Traffic Report. The Forecast Growth Rate Scenarios are shown in Table 5.1 of the Traffic Report, see copy below.

Table 2.6: Forecast Growth Rate Scenarios

	Annual Growth rates, percent per annum					
Scenario	**Cars and Light Vehicles**	**Buses**	**Trucks >2t**			
			2 - axle	**3 - axle**	**4 - axle**	**5 - axle**
Low Growth						
1997 to 2002	4.0%	4.0%	4.0%	5.0%	5.0%	5.0%
2002 to 2012	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 2012	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 2012	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%

Source: Consultants

The forecast cumulative equivalent standard axle loads are shown attached separately for the road sections

- Mary to Haus Khan
- Haus Khan to Junction to Seraks near Tedjen
- Junction to Seraks near Tedjen to Tedjen

Figure 5.1 FORECAST CUMULATIVE EQUIVALENT STANDARD AXLE LOADS
MARY TO HAUS KHAN

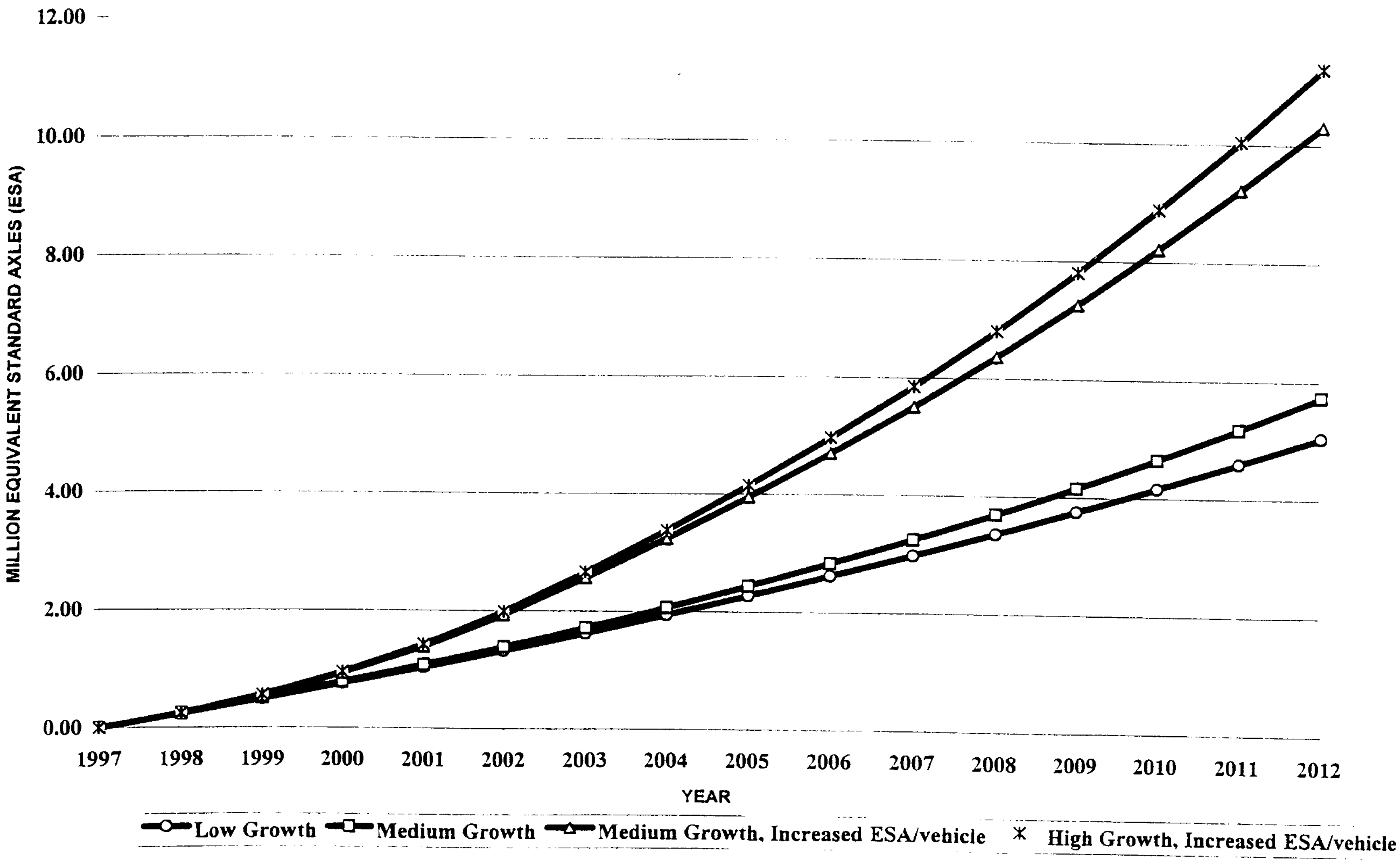


Figure 5.2 FORECAST CUMULATIVE EQUIVALENT STANDARD AXLE LOADS
HAUS KHAN TO JUNCTION TO SERAKS NEAR TEDJEN

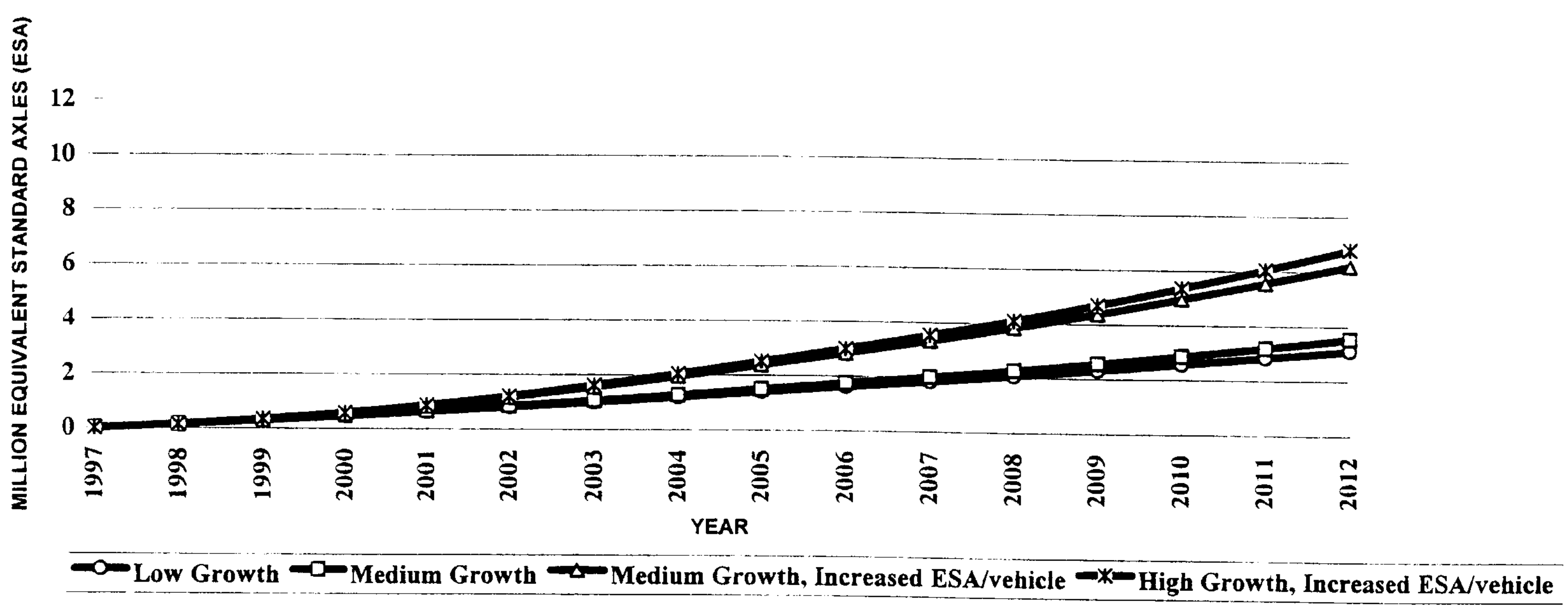
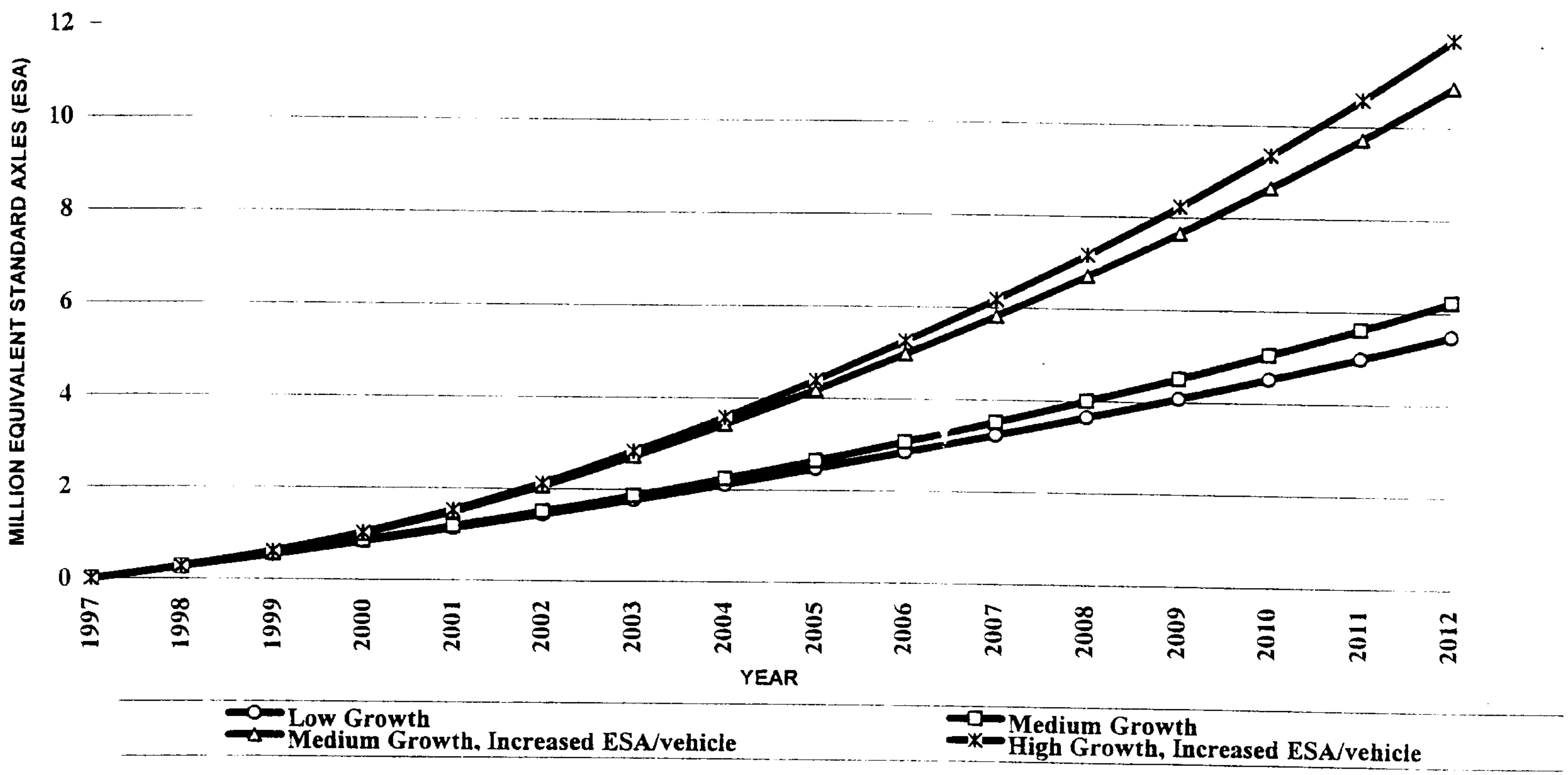


Figure 5.3 FORECAST CUMULATIVE EQUIVALENT STANDARD AXLE LOADS
JUNCTION TO SERAKS NEAR TEDJEN TO TEDJEN



Conclusions

This review of previous traffic studies and data together with the additional traffic surveys that have been carried out as part of this current study show that the existing levels of traffic are lower than had previously been assumed.

The traffic surveys show that there is a decrease in traffic volumes between Mary and Haus Khan and from there to the junction to Seraks near Tedjen, particularly in heavy trucks that turn off at Haus Khan to take the road to Seraks and the border with Iran. Between the junction to Seraks near Tedjen and Tedjen however, there is an increase in traffic, mainly because of the influence of nearby villages that are linked to Tedjen.

Overall, there is little difference in pavement loadings for the two end sections but the cumulative ESA for the section between Haus Khan and the junction to Seraks near Tedjen are nearly half that on the other two sections. However, it would not be prudent to design this middle section on the lower values of cumulative ESA because these are based on the transit traffic and more importantly, on the assumption that this traffic can continue to use the road between Seraks and Haus Khan which is understood to be in poorer shape than the road that comes to the junction near Tedjen.

As there is little difference 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 1998 to 2012.

2.7 Bridge Condition Survey

In December 1996 a comprehensive inspection of the bridges of the project road was carried out and a total number of 23 bridges was encountered. The aim of the inspection was to collect all data and information on the present condition of the bridges including

- damages on the structural components
- cracks on the structural components
- bearings
- joints
- waterproofing/sealing
- erosion/sour protection at abutments and piers
- road surface/carriageway including its drainage
- walkways, if any
- railings and other safety features
- bridge approaches

The Consultant used his own measurement/testing equipment for the inspection of bridges including

- concrete test hammer
- reinforcement bar locator
- laser distance meter
- crack measuring lens.

The present bridge condition was investigated in line with the requirement of the Bridge Management System (BMS) recently installed at Turkmenautoellari. The deficiencies/damages and their respective degree of severity were recorded for each individual bridge and the respective mark of condition was determined according to the table for BRIDGE CONDITION RATING developed by the Consultant with the introduction of the BMS and which is attached in Annex 1.17.

The structures are listed in Annex 1.18 showing

- number
- stationing
- above/below
- statical system
- cross section
- length
- width
- spans
- width of carriageway
- width of walkway

The assessment of the bridge condition and remedial works are summarised in Annex 1.19, Bridge Assessment. An overview of the recommended repair and replacements is given in section Bridge Design of the report. Note that the detail design of improvement of bridges is not part of the Consultant's tasks.

2.8 Drainage Sturctures

The road section Tedjen - Mary is located in an area with very low precipitation of 137 mm annually. Only 41 drainage structures other than bridges exist. Drainage structures include pipe culverts (reinforced concrete, metal, asbestos concrete) and box culverts (reinforced concrete). Many culverts were blocked with sand or mud, and many were partly or completely under water. Several culverts on the inventory list could not be located in the field, either because of wrong chainage, or of eolian sands, or because of earth movements along the embankment. The drainage survey was carried out during the 'rainy' season in February/March. Although there was much rain in 1997, no flooding of the embankment nor any drainage problem was encountered, nor were any drainage problems reported by the maintenance personnel. The structures and roadside drains require intense cleaning, maintenance and repair. The requirements are listed in the drainage structure list in annex 1.16.

2.9 Topographical Survey

Equipment

The Consultant's equipment for the topographical survey of the project road section included

- 1 total station Leica/Wild (as component of the Consultant's electronic data processing and CAD system)

- 2 precision levelling instruments, Zeiss
- 1 Notebook computer with surveying software
- Ancillary survey equipment like tripods, reflectors, levelling staff etc.

Surveying

In preparation of the survey works the Consultant's Surveyor formed survey groups of staff provided by the Institute and trained the local staff in the use of the survey instruments, especially the electronic theodolite (total station).

The training included also an introduction of European/German survey standards and in particular the requirements on the allowable tolerances.

According to the Terms of Reference the topographical survey shall cover the paved areas and adjacent verges. A tacheometric survey of the entire road section between Tedjen and Mary was carried out accordingly. Due to logistical reasons the fieldworks started from Mary. For the location survey a local coordinate system was established. Prior to the survey of topographical details a polygonal traverse was established between Mary and Tedjen. A total of 324 traverse points were installed and surveyed. In addition to the tacheometric survey all traverse points were levelled and connected to the national elevation system. The existing road centreline and cross sections to the pavement edges and edges of shoulders were surveyed in 50 m intervals, which were reduced to 25 m or less when required by site constraints (e. g. at junctions, built-up areas). The survey also included topographical details like existing roads, tracks, drainage structures, buildings etc.

In total 46,800 points were recorded, corresponding to 3,000 cross sections approximately. Simultaneously to the topographic survey, the second crew levelled all traverse points for controlling. The bench marks elevations are referred to the official levels.

The topographic field works were hampered by the weather conditions absolutely unusual for the season. Especially during March 1997 heavy snow- and rainfalls with high windspeed occurred. Furthermore the request of the Institute to extend the cross section survey to a corridor of 60 m on the left and on the right hand side of the existing road required additional time. As a result of this the topographic field works were completed in June 1997, about 2.0 months later than originally scheduled.

Preparation and coding of data was done parallel to the field survey. The coordinates and elevations were calculated, controlled and converted to the CAD CARD requirements.

2.10 Environmental Investigations

The corridor of the existing road was inspected as well as the proposed construction materials sources at Dushak and Serakhs in order to identify potential environmental impacts resulting from the proposed construction works for the improvement of the Tedjen - Mary road section. Existing landscaping locations were inspected to acquire further information on the performance of the implemented measures (e. g. tree planting).

The national and local environmental, health and safety regulatory requirements defined in the Turkmenistan laws, norms/standards and regulations were studied.

Details of the environmental investigations, findings, assessments and recommendations are attached as Appendix 3, ENVIRONMENTAL ASSESSMENT.

3. ENGINEERING DESIGN

3.1 Road and Pavement Rehabilitation Design

The road and pavement design is prepared in consideration of

- the existing design standard
- the survey and assessment of the existing road
- present and forecast traffic
- planned design life
- repair and/or rehabilitation requirements to restore the road condition to safe and economical conditions by the users

Mapping

The preparation of the detailed designs started with installation of the Consultant's Computer Aided Design (CAD) facilities and the mapping of the topographical survey data. The survey data were downloaded from the recording unit of the total station into the notebook computer. Consequently co-ordinates and elevation of the points surveyed were calculated and the topographical details included. In summary 46,800 points were surveyed, representing about 3,000 cross sections. The resulting survey plans were then transferred into the **C**omputer **A**ided **R**oad **D**esign (CARD) system as basis for the road design.

Drawings

A sample for the layout of the design drawings was prepared and presented to Turkmenautoellari and Turkmendorproyekt respectively. The drawing is of A 1 size, the horizontal alignment is shown at the scale of 1 : 2,000 and the vertical alignment at a scale of 1 : 2,000/200 (horizontal/vertical). Comments on the presented sample were incorporated and a copy of the agreed layout was included in Progress Report No. 1 (January 1997) as an A 3 size reduced from the original A 1 size.

The road rehabilitation is described in the following chapter under Road Design Standards.

Typical Improvement Measures
The pavement rehabilitation design would consist in general of the following:

Patching
This includes mainly surface patching and repair of surfacing distress. Included are skin patches of binder and stone or slurry seal on cracked or ravelled areas, the replacement of the surfacing in small severely-cracked areas, and the filling of potholes.

Resealing
It comprises two thin resurfacing operations which repair surface distress but cause little change to the roughness or structural strength of the pavement; these operations are surface treatment (i. e, chip seal) and slurry seal. Resealing usually implies also preparatory patching.

Overlay
It consists of bituminous overlays placed by mechanical paver-finisher in a single-layer or double-layer.

Reconstruction
It consists of all works that require re-specification of the surfacing and base types, and pavement thicknesses and strength parameters. It included scarification, stripping, base repair, recompaction and resurfacing.

Paved Routine Maintenance
This includes drainage maintenance, vegetation control, shoulder maintenance, safety installations, and other items which are not modelled as affecting the ride quality of the pavement.

3.1.1 Road Design Standards

Geometrical Design Standards

The standard used for the geometrical design of roads in Turkmenistan

- design speed
- horizontal alignment
- vertical alignment (gradient)
- number of lanes
- road width

is in general the standard of the former Soviet Union (FSU). The Soviet Union Standard SNIP 2.05.02 - 85 is still in use. Based on the traffic volume, respectively the traffic forecast the roads are classified into 6 categories: 1 a, 1 b, II, III, IV and V. Details of this standard and the respective categories are shown in tables below.

Table 3.1: Road Categories

Road category	Traffic volume (ADT) PCU	vehicles	Economic and administrative value of roads
I-a	14,000	7000	Highways of state value (including for international connection)
I-b II	> 14,000 > 6,000 - 14,000	> 7000 > 3,000 - 7,000	Highways of state (not referred to I-a cat.), republican and oblast value
III	> 2,000 - 2,000	> 100 - 1,000	Roads of state, republican, oblast (region) value (not referred to I-b and II cat.) roads of local importance
IV	> 200 - 2,000	> 100 - 1,000	Roads of republican, oblast (region) and local value
V	> 2,000	> 100	Roads of local value

Table 3.2: Geometrical Design Standard

Category	Traffic volume (ADT)		Design speed (km/h)			No. of Lanes	Lane Width	Carriageway	Width of Shoulder		Width of Median		Total Road Width
	PCU	Vehicle	normal	winding terrain	difficult terrain				total	paved	total	paved	
I-a	> 14000	> 7000	150	120	80	4, 6 or 8	3.75 m	2 x 7.50 m or 2 x 11.25 m or 2 x 15.00 m	3.75 m	0.75 m	6.00 m	1.00 m	28.50 m or 36.00 m or 43.50 m
I-b	> 14000	> 7000	120	100	60	4, 6 or 8	3.75 m	2 x 7.50 m or 2 x 11.25 m or 2 x 15.00 m	3.75 m	0.75 m	5.00 m	1.00 m	27.50 m or 35.00 m or 42.50 m
II	> 6000 - 14000	>3000 - 7000	120	100	60	2	3.75 m	7.50m	3.75 m	0.75 m	-	-	15.00 m
III	> 2000 - 6000	>1000 - 3000	100	80	50	2	3.50 m	7.00m	2.50 m	0.50 m	-	-	12.00 m
IV	> 200 - 2000	>100 - 1000	80	60	40	2	3.00 m	6.00m	2.00 m	0.50 m	-	-	10.00 m
V	< 200	< 100	60	40	30	1	-	4.50m	1.75 m	-	-	-	8.00 m

Source: Road Standard 2.05.02-85, 1986 Soviet Union

The Tedjen - Mary road falls within the definition of a category II.

Accordingly the road category II the main design parameters are:

-	design speed	120 km/h
-	min. radius	800 m
-	max. gradient	4 %
-	min. crest curve	15,000 m
-	min. sag curve	5,000 m
-	min. crossfall	1.5 %

The Consultant has reviewed the Former Soviet Union road standards for the road/highway design and compared with European/Western standards. This has also been discussed in the attached REVIEW OF ROAD DESIGN STANDARDS (Appendix 2).

The field investigations carried out showed that the existing road does not fully comply with the requirements of road category II. In consequence some compromises are necessary for the present project being a pavement rehabilitation project. Those compromises as well as improvements oı the existing alignment are described in the following paragraphs.

Horizontal Alignment

The horizontal alignment generally follows the existing road. The existing horizontal alignment is not optimal everywhere. After long straight sections there are small radii for curves. Long straights lead the drivers to higher speed, and bring about monotony in driving. During darkness, headlights of oncoming cars can be a problem. Small radii do not conform with the design parameters of SNIP, where the minimum radius is 800 m. After detailed discussion with the Design Institute it was agreed to upgrade smaller radii to the minimum radius of 800 m according to SNIP. This is possible where no structures nor bridges exist. In other sections the minimum radius is kept to 600 m. This confirms to SNIP for hilly terrain with transverse slope 6 %. For details of the horizontal alignment improvement see the tables below. The transversal slope at radius 600 m should be kept at 6 %.

For the horizontal improvement it is necessary to widen by benching the existing embankment. In some sections a new embankment is needed. In those curves with small radius traffic warning signs should be installed for speed reduction. Marker posts should be installed in addition.

Table 3.3: Improvement of the horizontal alignment

Location	Existing Radius	Proposed Radius	Observation
Stat. 2+400	R = 650 m	no upgrading	directly after junction
Stat. 3+618	R = 475 m	upgraded R = 800 m	580 m new embankment
Stat. 5+510	R = 400 m	R = 800 m	benching required
Stat. 9+835	R = - 100 m R = - 150 m	R = 600 m	Junction area
Stat. 14+900	R = 630 m	no changes	
Stat. 21+880	R = 560 m	800 m upgraded	benching required
Stat. 41+800	R = - 340 m R = - 670 m	no changes	Bridge, Junctions
Stat. 63+215	R = 400 m	in straight line	benching L = 3755 m required
Stat. 74+050	R = - 570 m R = - 250 m R = - 440 m	R = 800 m	Junction Serakhs, Bridge
Stat. 75+400	R = 420 m	R = 800 m	Relocate steel masts; 173 m new embankment
Stat. 78+880	R = 610 m	no changes	Junction area
Stat. 81+320	R = - 350 m	R = 800 m	120 m new embankment
Stat. 94+185	R = 350 m	R = 800 m	benching, concrete masts, culvert
Stat. 123+660	R = - 330 m	R = 800 m	
Stat. 141+065	R = 435 m	no change	Bridge

For the horizontal alignment the recommended sequence of radii for horizontal curves was taken into consideration as well as the appropriate radius for a curve after or before a straight section of road.

For the sequence of radii for horizontal alignment and for length of straight road section and minimum radius of curve after straight road section see Review of Road Design Standards.

Transitional Curves

It was agreed to use transitional curves for horizontal curves with radii < 2000 m conforming to SNIP. SNIP shows for transitional curves the length of transitional curves according to the radii min R/3 max R = A.

Comparing to German standards the parameter for transitional curves could differ between $A = 1/3 \cdot R$ and the radius. Both standards show transitional curves for small radii. For long radii small transitional curves are used. SNIP allows only one length of transitional curves for one radii.

For the design the transitional curves conforming to SNIP are used. Where this was not possible, transitional curves parameters complying to Germany standards are used, for an optimal driving dynamic.

Road Cross Section

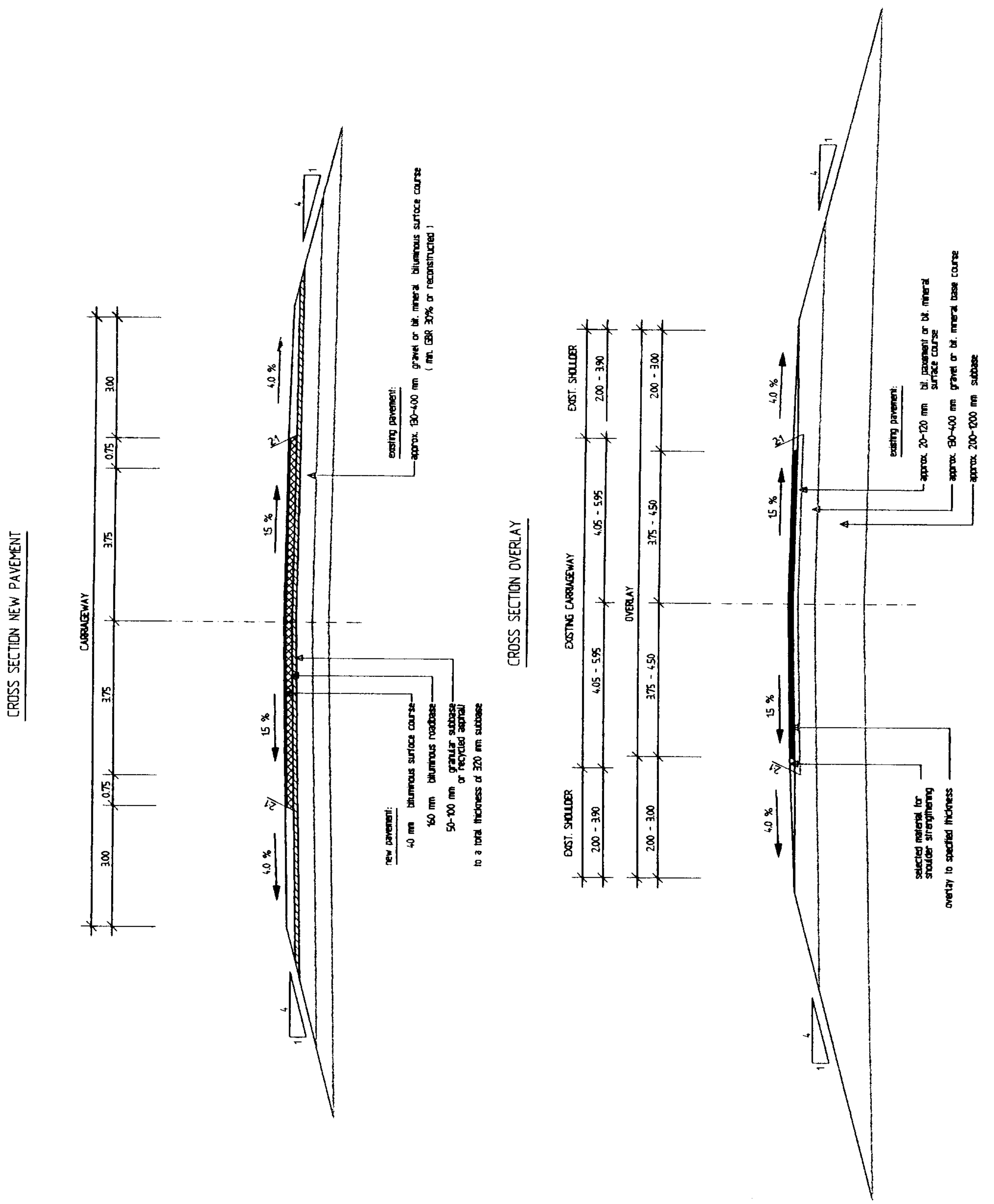
As mentioned above the SNIP requires for road category II a 2 x 3.75 m = 7.50 m wide carriageway with shoulders 0.75 m (paved) + 3.00 m = 3.75 m each. The total road width is 15.00 m. The width of the existing road varies between 14.20 and 16.60 m with a width of pavement between 7.70 and 9.20 m and shoulder width of 2.50 to 4.00 m. Under consideration of technical as well as economical constraints a compromise for the road cross-section was discussed and agreed with Turkmenautoellari and Turkmendorproyekt respectively which includes:

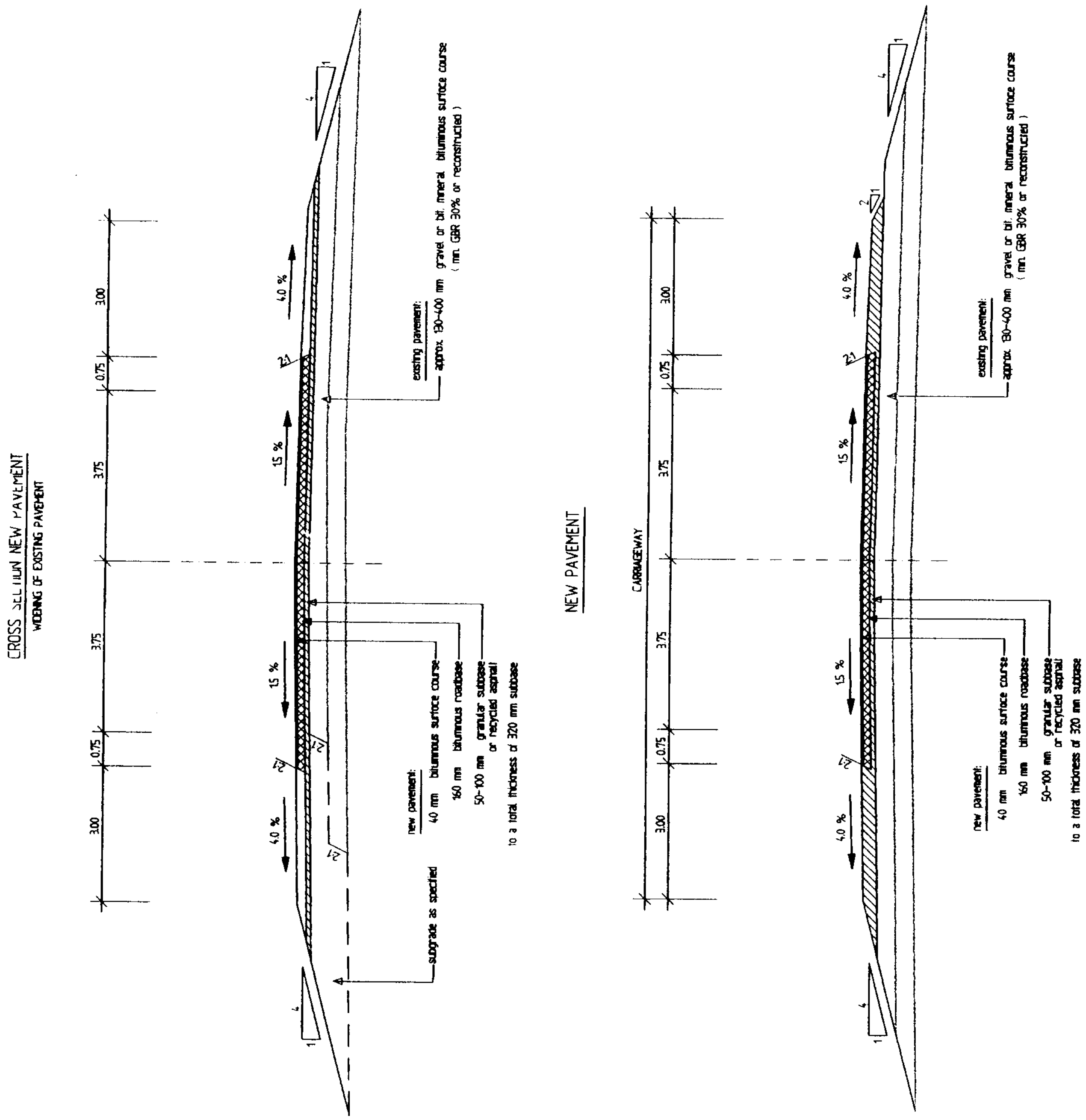
(i) full width of carriageway with 2 x 3.75 m = 7.50 m and asphalt concrete surface

(ii) according to existing road width the shoulders shall be

- in sections where the pavement is rehabilitated (overlay or new pavement)
  - 2.50 m with 0.75 m paved
    or
  - 4.00 m totally unpaved
- in sections where the road alignment is improved (e. g. R = 800 m)
  - 3.75 m each with 0.75 m paved

Typical cross sections are shown attached.


CROSS SECTION NEW PAVEMENT
CARRIAGEWAY
3.00
0.75
3.75
3.75
0.75
3.00
4.0 %
15 %
15 %
4.0 %
2:1
2:1
4
1
4
1
existing pavement:
approx. 130-400 mm gravel or bit. mineral bituminous surface course
(min. CBR 30% or reconstructed)
new pavement:
40 mm bituminous surface course
160 mm bituminous roadbase
50-100 mm granular subbase or recycled asphalt
to a total thickness of 320 mm subbase
CROSS SECTION OVERLAY
EXIST. SHOULDER
2.00 - 3.90
EXISTING CARRIAGEWAY
4.05 - 5.95
4.05 - 5.95
EXIST. SHOULDER
2.00 - 3.90
OVERLAY
2.00 - 3.00
3.75 - 4.50
3.75 - 4.50
2.00 - 3.00
4.0 %
15 %
15 %
4.0 %
existing pavement:
approx. 20-120 mm bit. pavement or bit. mineral surface course
approx. 130-400 mm gravel or bit. mineral base course
approx. 200-1200 mm subbase
selected material for shoulder strengthening
overlay to specified thickness


CROSS SECTION NEW PAVEMENT
WIDENING OF EXISTING PAVEMENT
3.00
0.75
3.75
3.75
0.75
3.00
4.0 %
1.5 %
1.5 %
4.0 %
2:1
1:4
existing pavement:
approx. 130-400 mm gravel or bit. mineral bituminous surface course
(min. CBR 30% or reconstructed)
new pavement:
40 mm bituminous surface course
160 mm bituminous roadbase
50-100 mm granular subbase
or recycled asphalt
to a total thickness of 320 mm subbase
subgrade as specified
NEW PAVEMENT
CARRIAGEWAY
3.00
0.75
3.75
3.75
0.75
3.00
4.0 %
1.5 %
1.5 %
4.0 %
2:1
1:4
existing pavement:
approx. 130-400 mm gravel or bit. mineral bituminous surface course
(min. CBR 30% or reconstructed)
new pavement:
40 mm bituminous surface course
160 mm bituminous roadbase
50-100 mm granular subbase
or recycled asphalt
to a total thickness of 320 mm subbase

3.1.2 Pavement Design Standard

The standard for the pavement design used in Turkmenistan is also a standard of the former Soviet Union. For the determination of the appropriate pavement type and thickness of layers a standard axle of 10 and 6 tons is considered:

Table 3.4:

Road Category	Traffic Volume (ADT)		Axle Load
	PCU	Vehicle	[tons]
I - III	> 2000	> 1000	10
IV	> 200 - 2000	> 100 - 1000	6 or 10
V	< 200	< 200	6

Source: Road Standard 2.05 - 02-85, 1986 Soviet Union

The standard axle of 10 tons has been introduced in 1986 only and roads which were constructed earlier have a pavement designed for a 6 ton standard axle.

The road section Tedjen - Mary was constructed before 1986, and it is suggested that the pavement was designed for a 6 ton axle.

The pavement (layer) design according to SNIP proposes:

Table 3.5:

Road Category II	Road Category III	Road Category IV
5 cm Asphalt concrete	5 cm Asphalt concrete	8 cm crushed stone with bitumen
8 cm Asphalt concrete	5 cm Asphalt concrete	
15 cm crushed stone with bitumen	8 cm crushed stone with bitumen	18 cm crushed stone-sand
19 cm crushed stone	16 cm crushed stone - sand	

The geotechnical investigations show that the existing surfacing, road base and subbase do not comply with the existing standard. The existing pavement does also not comply with pavements designed to lower categories.

For the design of road sections for reconstruction, we refer to the findings and recommendations of 'Review of Road Design Standards' see Appendix 2. In an example a pavement designed to FSU standards was recalculated and compared with international design methods. The FSU design provides a service life of the pavement of 15 years. Less than 6 years service life is the result of the recalculation to international standards using the empirical method of AASHTO. The Review of Road Design Standards recommends the use of impirically based methods.

Pavement Design

For sections where reconstruction is necessary, the pavement has been dimensioned in accordance with three methods:

Case 1	in accordance with Road Note 29, British Design
Case 2	in accordance with Road Note 21, TRL Overseas Road Note
Case 3	in accordance with RSTO, German Pavement Design Standard

The designs are shown in Annex 2.1, and are summarised thus:

Case 1:	40 mm	bituminous surface course
	160 mm	rolled asphalt road base
	320 mm	subbase
	520 mm	total thickness
Case 2:	100 mm	bituminous surface course
	200 mm	granular roadbase
	225 mm	granular subbase
	200 mm	selected subgrade fill
	725 mm	total thickness
Case 2: Alternative	50 mm	bituminous surface course
	150 mm	bituminous roadbase
	225 mm	granular subbase
	200 mm	selected subgrade fill
	625 mm	total thickness
Case 3:	40 mm	bituminous surface course
	80 mm	bituminous roadbase
	100 mm	bituminous wearing course
	380 mm	gravel or crushed rock
	600 mm	total thickness

Case 3 would assume a strong increase in traffic volume, which is not necessarily to be expected on the study road within the near future; and requires a substantial initial investment. The existing pavement layers do not correspond to the design case, and would need to be substituted.

Case 2 (both alternatives) relies on 225 mm granular subbase and 200 mm selected subgrade fill. The existing pavement may consist of a layer of 225 mm granular subbase in so far as this is the base course material downgraded to subbase, but there would be no layer of selected subgrade fill 200 mm thick. Consequently the existing base course would be deemed as selected fill, and 425 mm new crushed stone plus 100 mm asphalt would be needed for the base course, and 225 mm crushed stones plus 200 mm bituminous base and surface for the alternative.

Case 1 considers the existing base course as subbase, which will be strengthened by recycled asphalt from the pavement and/or subbase material to provide a total thickness of 320 mm subbase.

A total of 200 mm bituminous material is needed for 160 mm road base and 40 mm bituminous surface course. Tack coat shall be applied between the layers. The existing base course is downgraded to subbase. This design considers the re-use of the existing pavement layers optimal. It is preferred also because of a 200 mm strong bituminous layer of base and surface course, which can be expected to make up certain shortcomings in the quality and workmanship of the existing layers and of the embankment fill. A cost comparison is enclosed in Annex 2.4 showing that Case 1 is also the lowest price case.

Quality Requirements

Subgrade
- CBR soaked 3.5 % (for new embankments only)

Subbase
- CBR dry > 30 % (fc. arid areas), soaked > 30 % in areas where the embankment height is less than 1.0 m. A capping layer of subbase with soaked CBR > 30 % shall be laid where the existing CBR value is smaller than 30 % soaked.

Bituminous Roadbase and Surfacing: According to TRL Overseas Road Note 31

3.1.3 Pavement Rehabilitation Design

Many sections of the road Tedjen - Mary have reached the end of their useful service life (defined herein as 0 - 2 years remaining life now) or are near the end of the service life (defined as 3 - 4 years, considering that improvement works will require 2 - 3 years from now). A medium remaining life span could be defined as 5 - 8 years, and a long remaining life as 9 - 15 years. On this basis of the FWD evaluation, road length as defined above are summarised:

Table 3.6: Road Section by remaining Life Span, Summary

Total Length of Section	**Remaining Life Span in Years**			
	0 - 2	**3 - 4**	**5 - 8**	**9 - 15**
74600	X			
21100		X		
23850			X	
22450				X

However, the FWD evaluation shows the bearing capacity and strengthening need, but the quality, characterisation, composition and condition of the existing pavement must be taken into consideration for the improvement design.

Typical improvement measures are normally defined on the basis of homogenous sections. Homogenous sections would comprise a certain homogeneity of

- climatic zone

- average embankment height
- road age
- average pavement composition and thickness
- average material quality, characteristics and behaviour
- traffic condition
- road condition class.

Normally, the materials quality is specified, and where the specifications on quality and workmanship are observed and controlled, the behaviour of materials can be predicted in its performance. Unfortunately, due to various reasons and conditions, the quality and workmanship in the given road section show a wide variety, and the material does not correspond to given specifications. It is therefore most difficult to assign the road in homogenous sections for specific improvement measures. In particular, the insufficient quality of the existing bituminous pavement (bitumen is very soft, no grading of aggregates, uncrushed oversizes and mixing fractions result in very low stability) gives reason for concern of any strengthening by overlay. The surfacing was laid in cold mix. Cold mixes can be used normally in roads with low traffic volume, in the surfacing only. Cold mixes are laid with a high void content, and need traffic for compaction. where a specified gradation of aggregates and of bitumen is complied with, the stability can be achieved after the flux components of the bitumen are evaporated and the traffic has compacted the layer. The surfacing shows severe deformations in extended sections, and tests prove that the material does not correspond to the specifications. Similarly, the base and subbase material fail the specified quality, in stability (CBR values) grading, moisture sensitivity, thickness and compaction, to a very high degree. The severe surface deformation, cracking, rutting and potholes are the result of inadequate surfacing and of inadequate pavement layers.

Where the pavement stability is very low (requiring more than 100 - 120 mm bituminous overlay for strengthening), and where severe surface failures are noted, reconstruction should be considered. Reconstruction will provide material to conforming to the specification, resulting in good pavement performance and low maintenance requirements. The performance can be predicted. Reconstruction is substantially more expensive than improvement by repair.

Where strengthening is required, overlays should be considered only provided that there is no severe surface or pavement distress, and no severe deformations and rutting (< 15 mm) nor extensive cracking. Local failures shall be repaired before overlaying. Overlays 120 mm or thinner cannot prevent reflective cracking. Cracking shall receive surface crack sealing under maintenance activities. Risks in connection with overlays are:

- deformations of the overlay where the existing cold paved layers deform under traffic and hot temperatures

- cracking where the deformations are substantial

- reflective cracking due to cracks in old pavement

- rutting due to insufficient stability of the cold paved layers under increasing traffic.

The risks of failures in an overlay cannot be eliminated because the existing pavement does not correspond to specified stability requirements, and varies widely in quality and workmanship even within short road section.

Reconstruction eliminates the risks by removing substandard quality layers, by improving the sub quality layers concerned and by reconstruction to specified standards.

3.1.4 Identification of Typical Rehabilitation Cases

Typical rehabilitation cases have been identified, ranging from pavement repair and surface sealing to overlay and to complete reconstruction.

Measures are proposed to:

- arrest ongoing deterioration
- repair existing damages
- provide sufficient strengthening for the design period
- restore acceptable driving comfort
- reduce vehicle operation costs

Homogenous sections of the road will be identified for one of the following measures:

Repair and Surface Sealing

In sections of sufficient residual pavement bearing capacity, spot repairs will be carried out to the surface, and a sealing shall prevent ingress of water into base course/subbase layers. Spot repairs comprise filling of potholes by bituminous mix, crack repairs, milling and re-filling of deformations/ruttings, followed by a double surface seal. Double sealing provides a much closer sealing than single application, which is important to protect the ultra moisture sensitive base course (see geotechnical assessment).

Sealing maintains the useful service life of the road and sustains the residual bearing capacity. Sealing improves the general surface by appearance and riding comfort.

Overlay, thickness 40 mm

It is a precondition to overlaying that the base course and subbase conform to the specifications and have shown satisfactory performance until now in case where tolerable duration to the specification were determined.

The evaluation of the FWD measurements determines an overlay thickness to extend the residual pavement life to the planning horizon under a given traffic volume. In addition the overlay seals the surface against ingress of water and resulting damages in the base course and subbase layers. Before overlaying, existing spot damages must be repaired, deformations and ruttings must be milled and refilled by bituminous mixes. Local settlements or undulations must be level-filled prior to overlaying. The existing surfaces are irregular and not to proposed lines and levels. A relatively thin overlay

may either be laid carpetlike with undulations reoccurring at the surface, or a certain quantity of levelling material needs to be filled to restore line and levels before surfacing. For the levelling some 20 mm thickness in average are added for repair of localised damages and to restore the road to acceptable driving comfort.

Overlay thickness 80 mm, 120 mm

As before, but preferably with a levelling binder course to fill to line and levels, followed by a 40 mm surface course. Tack coat shall be sprayed on the existing surface and to the binder before laying the surface course.

Reconstruction

When the pavement has failed, and where the base course and for the subbase deviate substantially in quality or compaction from the specifications and have contributed to pavement failures or severe ruttings/deformations, and when the useful service life has come to its end, reconstruction is necessary. This may also apply to sections when the costs of the theoretical overlay thickness exceeds costs of pavement reconstruction. Reconstruction is also necessary where severe deformations have occurred, which extend down into the base course. The existing bitumen is often very soft, and overlaying of soft bitumen may lead to damages in an overlay. Reconstruction will re-use the existing bituminous material after milling and sieving. Missing mineral gradations must be added before re-use as subbase/base material.

3.1.5 Stage Construction

The road improvement is planned for a 15 years useful service life. Two scenarios have been assessed:

Alternative 1

Where the surface and pavement is in severe distress, reconstruction for a 15 years design life is proposed.

Where the surface requires repair and where overlays not exceeding 120 mm are required to strengthen the pavement for a 15 years service life, repair by overlay in nominal thickness 40, 75, 120 mm is proposed, on a levelling layer of 20 mm average thickness.

Reconstruction eliminates the risk of deformation of the overlay over soft pavement laid as cold mix. Overlays or reconstructions were proposed after a thorough inspection of the pavement (in April 1997) with particular emphasis on surface distress deformations and ruttings, under consideration of the FWD evaluation.

Table 3.7: Alternative 1, Summary of Improvement Measures

Overlay 40 mm	Overlay 75 mm	Overlay 120 mm	Reconstruction	New Alignment	Widening of Road
25,007	5,550	450	110,080	1,440	850

The road sections requiring reconstruction are shown in layout and longitudinal section drawings. The locations of overlay, reconstruction, new alignment and widening are listed in Annex 2.2 attached.

Alternative 2

This alternative is developed from the FWD assessment. Surface and/or pavement distress are proposed to be treated by localised repairs. Providing overlays on distressed pavements can extend the existing pavement service life, but does not improve the existing pavement materials to the standards. From observation in Turkmenistan pavements from cold bituminous have a service life of 6 - 10 years, and it is estimated that surface repairs and structural overlays would provide a similar service life, after which reconstruction must be envisaged. Note please that overlays on soft bituminous mixes must be expected to deform under summer temperatures and traffic. Overlays do not prevent reflective cracking. Maintenance costs would be high.

Table 3.8: Alternative 2, Summary of Improvement Measure

Overlay			Reconstruction	New Alignment	Widening of Road
40 mm	75 mm	100 mm			
33,607	22,830	18,250	66,000	1,440	850

The locations of the measures are listed in Annex No. 2.3 attached.

3.1.6 Recommendation for Road Improvement

Two different scenarios with six improvement cases are discussed in the foregoing chapters. Alternative 1 provides reconstruction to 76 % of the road length, and Alternative 2 provides 46 % of reconstruction to the road length.

Alternative 1 requires a higher initial investment into the road, but is structurally sound.

Alternative 2 requires a lower initial but a higher total investment, and a substantially higher maintenance requirement. Any lack of maintenance could lead to substantial loss of investment when reflective cracks are not immediately sealed and ingress of water plastices the moisture sensitive road base. In Turkmenistan, most of the rainfall occurs right after the cold season in February/March. there is a high risk of water ingress because cracks could not be immediately sealed right after they occur.

Wide variations of the quality and workmanship of the existing road are evident, and are a high risk to the success of the road improvement where overlays are constructed. Reconstruction provides quality and workmanship to international standards, and it is therefore that Alternative 1 is recommended for implementation.

3.2 Bridge Improvement

The 23 bridges inspected in the course of the Tedjen - Mary road section were constructed of pre-cast units. Depending on the respective requirement of the bridge location and determined span(s) different types of pre-cast elements were used.

Based on the data collected during the field investigations, the respective mark of condition was determined.

The summary of the condition rating is shown in the table below:

Mark of Condition	Bridges
1 (good)	none = 0 %
2 (fair)	7 = 30 %
3 (poor)	13 = 57 %
4 (bad)	3 = 13 %
Total	**23 = 100 %**

Based on the above described nature and severity of deficiency/damage the structural stability and the necessary remedial works were assessed.

Details of the condition survey, the encountered damages and the assessed remedial works are summarised in the table in Annex 1.19.

Two of the bridges, namely nos. 17 and 19 (at chainage km 133.50 and km 138.50), are in very bad condition, their structural stability is questionable and prior to a future replacement immediate action is necessary:

- single lane traffic (at least for trucks)
- speed limit of 30 km/h

This problem was discussed with Turkmenautoellari. As first measure the recommended speed limit of 30 km/h was introduced at bridge no. 17 in March 1997.

Implementation of Bridge Improvement

The Bridge Assessment attached in Annex 1.19 lists all necessary replacement or repair works. The design of bridges replacement or repair works is not part of the present assignment. It is recommended to either

- extend of the present contract by addendum to include the design works, or

- enter a provisional sum in the bidding documents for replacement and repair of bridges, and to assign the design to the Consultant's supervision of works.

3.3 Cost Estimates for Road Improvement

The cost estimates for road improvements are based on the prices of locally available material, on plant and equipment purchase on the international market or local market as applicable and local labour.

It is envisaged that an international contractor providing modern technologies would be coupled with locally available resources, through international competitive bidding with encouraged local participation in Joint Ventures or associations. The unit rates are based on prices from Turkmenautoellari and relate to prices from other international projects in the region (Turkmenistan, Armenia, Uzbekistan, Azerbaidjan).

The unit costs are calculated in Annex 2.4. This Annex also contains unit costs for comparison of costs for different parameters. Note please that the cost estimate contains the unit rate for local bitumen.

Annex 2.5 contains the quantity and cost estimates for the road improvements for various bills of quantities for Alternative 1.

Annex 2.6 contains the quantity and cost estimate for the road improvements for various bills of quantities for Alternative 2. The costs summaries are shown on the following pages.

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Confidential Cost Estimate
Summary

Bill No.	Description	Total length (m)	Unit cost per m road	Total US $
1	General Item			3,000,000.00
2	Repair and 40 mm overlay	25,007	100.07	2,502,426.80
3	Repair and 75 mm overlay	5,200	162.59	845,446.90
4	Repair and 120 mm overlay	450	237.36	106,812.05
5	Pavement reconstruction	110,430	314.59	34,739,854.60
6	New Road	1,440	617.35	888,991.10
7	Drainage			330,652.53
8	Signalisation and miscellaneous roadworks			360,270.84
9	Dayworks			317,952.50
10	Miscellaneous			310,139.50
	Cost of Improvements			43,402,546.82
	Contingencies 5 %			2,170,127.34
	Total Estimate (exclusive of taxes and duties)			45,572,674.16

Note: Unit costs per linear meter road differ between Alternatives 1 and 2 because of differences in existing road widths.

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Confidential Cost Estimate
Summary

Bill No.	Description	Total length (m)	Unit cost per m road	Total US $
1	General Item			3,000,000.00
2	Repair and 40 mm overlay	37,957	107.83	4,092,747.00
3	Repair and 75 mm overlay	22,830	155.70	3,554,738.68
4	Repair and 100 mm overlay	18,250	189.34	3,455,489.00
5	Pavement reconstruction	61,650	302.72	18,662,934.50
6	New Road	1,440	617.35	888,991.10
7	Drainage			330,652.53
8	Signalisation and miscellaneous roadworks			360,270.84
9	Dayworks			317,952.50
10	Miscellaneous			310,139.50
	Cost of Improvements			34,973,915.65
	Contingencies 5 %			1,748,695.78
	Total Estimate (exclusive of taxes and duties)			36,722,611.43

Note: Unit costs per linear meter road differ between Alternatives 1 and 2 because of differences in existing road widths.

4. IMPLEMENTATION PROPOSALS

4.1 Resources and International Competitive Tendering

The nature of work requires international equipment and machinery for milling distresses parts, for the production of bituminous mixes and laying of the mixture, including compaction. It is suggested to use locally available resources like materials, personnel, and transport (by rail) to the extend possible. Regional experience has shown that international firms should associate with local entities for full integration of locally available sources. Local entities need the international firm for transfer of the latest state of the art, and for contractual reasons (bonds, guarantees, currencies, insurances, international tender and contract conditions, and international specifications). The formation of associations between foreign and local entities shall be encouraged in the notices to the public and in the prequalification documents.

4.2 Time Schedule

Many sections of the road have reached the end of the useful service life, 74.6 km have 0 - 2 years remaining life span, and 21.1 km have 3 - 4 years remaining life span. Deformations and rutting are enormous, defined areas of up to 180 mm depth were measured, which very seriously restricts the road use by passenger vehicles, and which is a severe safety concern. Two bridges need urgent reconstruction. To keep the road serviceable, the improvements are urgently required. It is thus recommended to proceed with the procurement by international competitive bidding. A told performance period for the improvement works is estimated at 30 months.

4.3 Procurement of Works

Procurement of Works should be through competitive international bidding, using procedures recognised by international financing institutions (IFI). For financing by a particular IFI, the respective procurement guidelines should be used for:

- selecting the components of the procurement, such as open tendering or prequalification

- selecting the standard tendering and contract conditions, such as World Bank or EBRD or other IFI sample tender and contract documents

For the open tendering or prequalification and tender process, assistance by a consulting engineering firm experienced in the region on similar works is recommended, in particular for the preparation of tender documents, evaluation of prequalification applications, tendering services such as issue of tender documents, pre-tender meeting, for the issue of clarifications or amendments, and evaluation of tenders and recommendation for award of contract.

4.4 Project Management and Supervision of Construction

The conditions of the contract assign rights, duties and responsibilities to the contracting partners, to the Road Administration and to the Contractor. For correct administration and to assure that the works in quality and quantity are constructed as specified, and paid for as contained in the contract, the Project Manager and Supervising Engineer is appointed. Prior to commencement of the works, he checks and advises on performance bonds and advance payment guarantees, as well as insurance of works, equipment, plant etc.

The Project Manager and Supervising Engineer carries out the following duties:

1. Undertakes the day-to-day administration of the project.
2. Ensures that the right safety practices have been put in place by the Contractor.
3. Checks the setting out of the Works to ascertain that the right - alignment, levels and dimensions of the various parts of the Works have been attained.
4. Ensures that the vertical and horizontal alignments of the completed Works are within the tolerances specified in Technical Specifications.
5. Tests and examines any materials to be incorporated into the permanent works to ensure compliance with the Technical Specifications and the Design Standards.
6. Ensures that quality control measures specified in the Technical Specifications are strictly complied with by the Contractor.
7. Checks and advises on the workmanship and work methods being employed by the Contractor.
8. Checks the Contractor's Work Programme and advises on any modifications required.
9. Monitors the use by the Contractor of all categories of staff and constructional plant and equipment.
10. Conducts regular site meetings and distributors minutes of such meetings to all parties and offices.
11. Checks and advises on the authenticity of Manufacture's Test Certificates.
12. Keeps the Supervisor informed of significant occurrences and events at the site.
13. Checks and verifies the Contractor's invoices and recommends payment.
14. Prepares and certifies Interim Payment Certificates on the Project.
15. Prepare Monthly and Quarterly Progress Reports.
16. Keeps a daily diary of activities and events at the site.

17. Issues Site Instructions to the Contractor.

18. Monitors the use of resources by the Contractor for Works specified and agreed to be executed by Day Works.

19. Controls access at the works site to minimise interference with the Constructional Works.

20. Advises on claims from the Contractor.

21. Prepares the Final Account for the project.

22. Advise the Employer on the Contractor's rate proposals for work items not covered in the contract.

23. Ensures that any completed portion of the Project meets the minimum thresholds of the various properties specified in the Technical Specification and the Design Standards.

24. Ensures that the as-built-drawings are prepared.

25. Assesses requests for extension of time by the Contractor.

5. BIDDING DOCUMENTS

According to the Terms of Reference the bidding documents will be prepared for International Competitive Bidding (ICB). Beginning of July 1997 it has been discussed and agreed with the European Bank for Reconstruction and Development (EBRD) to base the bidding document will be based on FIDIC general conditions of contract (fourth edition 1987, reprinted in 1992) with form of bid and form of agreement. Conditions of particular application will be prepared using the relevant clauses of the EBRD as well as the World Bank (WB) standard documents and other clauses to be prepared to particular technical and environmental project requirements.
The bidding document will consist of the following volumes:

Volume I	Invitation to Tenders	
	I.i -	Instructions to Tenderers
	I.ii -	Tender Data
	I.iii -	Tender Form
		- Attachment to Tender
	I.v -	Tender Security Form
Volume II	II.i -	Standard Form: Agreement
	II.ii -	General Conditions of Contract
	II.iii -	Special Conditions of Contract
	II.iv -	Performance Security Form
	II.v -	Advance Payment Security Form
Volume III	III.i -	Schedule of Works, Bill of Quantities
	III.ii -	Technical Specifications
	III.iii -	Drawings and Other Documentation

Information for Bidders

This volume will not become part of the contract, but is to assist contractors during bidding and in the subsequent use of materials sources during construction. It will mainly include information on soils and materials, laboratory testing results and other conditions in the project area.

6. STUDY OF DESIGN, CAPACITY AND SAFETY ISSUES

Studies of design, capacity and safety issues were carried out under the TRACECA PMS Project, Review of Road Design Standards. The review includes capacity and safety issues, and is quoted below as applicable.

6.1 Road Safety and Road Design Aspects

6.1.1 Preliminary Remarks

Road and traffic safety is based on the three 'E' which can be described as:

Engineering	(e. g. standards for road design and traffic engineering, control of quality in implementation, supervision of works for and maintenance of a good/safe road condition)
Education	(e. g. education of pedestrians and motorists, training, public promotion)
Enforcement	(e. g. laws and regulations, police, justice)

and is a complex process where dynamic, visual, geometrical, drainage and psychological requirements need to be optimised.

In the following those aspects concerning road safety and related road design details are described which were presented and discussed in the seminars held in the recipient states.

6.1.2 Technical Aspects of Road Safety and Road Design

- **Sequence of Radii for horizontal Alignment**

  The relation of the radii of horizontal curves in the road alignment is specified in both standards, the SUS as well as the E/GS. The aim is to achieve a relative constant travelling speed resulting in safety for the road users (avoidance of unexpected narrow curves). In cases where constraints do not allow to follow the requirements of the standard(s) extensive signalisation is necessary.

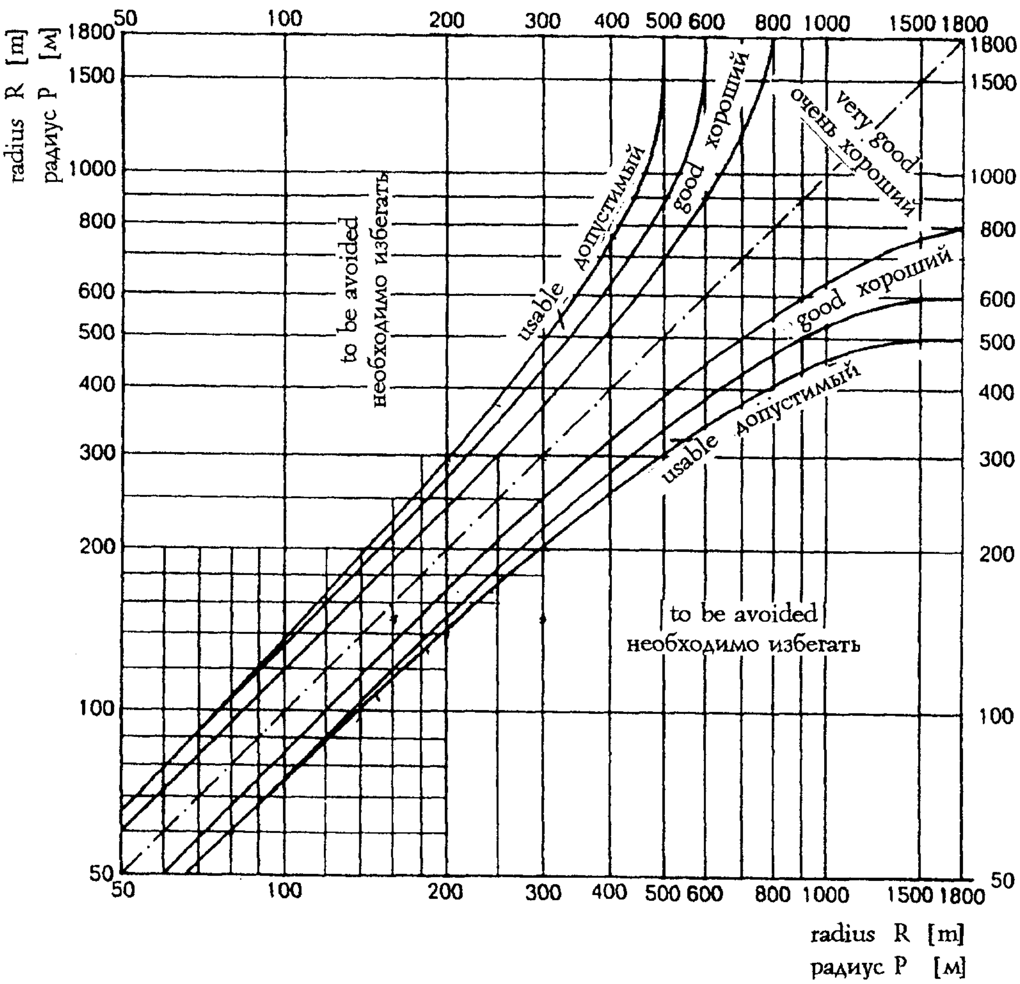
  In sub-chapter 4.3.3 of the SUS (SNIP 2.05.02 - 85) the relation of radii is specified as

  $$R_1 : R_2 = 1 : (\text{maximum } 1.3)$$

  which is considered as to rigid and not reflecting the requirements of moving vehicle dynamics.

The suitability of the sequence of radii in the E/GS (RAS-L-1, 1984) is determined according to the diagram below and improvement of the SUS is recommended.

Sequence of Radii for Horizontal Curves, RAS-L-1, 1984



- **Length of straight Road Section and minimum Radius of Curve after straight Road Section**

  At long straight road section it is rather difficult for drivers to assess distance and speed of approaching vehicles. Furthermore for the safety of road users it is important to decide on an appropriate radius after a straight section of road, where vehicles may build up speed. The SUS (SNIP) specifies maximum 5 km length of straight and should be complemented by the requirements of the E/GS for the radius after a straight road section as summarised in table 3.7 below.

Table 6.1: German Standard RAS-L-1, 1984

ROAD CATEGORY	LENGTH OF STRAIGHT	MINIMUM RADIUS
A I, A II	L ≥ 600 m	min R > 600 m
	L < 600 m	min R > L
A III, A IV, B II	L ≥ 500 m	min R > 500 m
	L < 500 m	min R > L

- **Junctions incl. Approaches and Slowing Down/Acceleration Lanes**

For Junctions and intersections one of the main design requirement is safety for the road users which can be achieved when the junction/intersection system

- provides adequate visibility
- is easy to understand
- is designed for appropriate speed
- is furnished with adequate horizontal and vertical signalisation (road markings and traffic signs)

Those requirements are of high importance especially for non-local drivers, who also need information signs for orientation and decision which direction to take well ahead of the junction.

The priority in the SUS for junctions at grade is to achieve a relative high speed for vehicles entering and moving in the junction. The resulting relative big radii used in those junctions lead to large islands and a large area for the entire junction itself with the consequence of a reduced visibility.

In comparison the E/GS has relative small radii in the junction with small islands resulting in a good visibility. To achieve a speed of entering vehicles with little difference to the through traffic acceleration lanes are provided.

In summary the E/GS with constructional measures reducing the speed in the junction approach and providing good visibility which both make the 'system' of the junction clearly understandable has advantage in traffic safety and therefore the SUS should be improved accordingly.

The SUS for grade separated junctions/intersections including clover leaves is very similar to the E/GS. During field visits in the course of the seminars several cases were observed where the SUS has been modified and shorter slowing down/acceleration lanes were constructed. This modification was explained with budget constraints and the relative low traffic volume at the time of the implementation. The theory is to provide the necessary slowing down/acceleration lanes when the traffic volume has reached a certain level and the full standard is required.

- **Signalisation**

The SUS for road and traffic signs is in line with western European/international standards and modification is considered not to be necessary. In many cases the information signs were encountered with description in Latin letters in addition to the Cyrillic, which is appreciated by foreign road users and which should be shown on all informative signs along the international, the TRACECA roads. However, the quality of materials should be improved, especially the brightness of reflective material and/or the workmanship should be better controlled.

The same applies for road marking. The SUS is appropriate and the materials/quality should be improved. Some modification/additions should be considered to increase traffic safety as for example on two lane roads arrows in the centreline ahead of a continuous centreline marking (non overtaking). In general road marking has been neglected in the TRACECA states for some time by various reasons - budget constraints for maintenance, broken down equipment, supply of paint abandoned etc.

In the TRACECA states marker posts are used at junctions, bridge approaches, railway crossings and at culvert locations only. According to the SUS the posts are white with a black stripe, reflective material or reflectors are not used. The existing standard is considered as not appropriate and should be improved: size of post and use of reflectors. Marker posts are a very important component of road safety, especially in the darkness they provide together with an appropriate road marking the best possible guidance for road users. It is understood that the provision of marker post for the entire road network in the TRACECA states would be rather costive, but it is recommended that marker posts with an appropriate spacing (say 50 to 75 m) along the international, the TRACECA roads are successively installed when road sections are improved/rehabilitated.

- **Safety for Town Passages with high Traffic Volume**

The magistrale, the TRACECA roads inspected often run through towns and villages which is inconvenient for both the road users as well as the inhabitants. For the latter besides environmental inconvenience (exhaust gases, noise) the traffic on the magistrale form a danger for crossing vehicles and pedestrians. Low speed in the town passages resulting in longer travelling time (economic losses) is the inconvenience for drivers together with the potential high danger of an accident.

A by-pass for those towns and villages would be the best solution for the above problems. As in Europe also in the TRACECA states it takes several years up to decades to prepare such a by-pass project - feasibility, financing, land acquisition etc. - and until the implementation. Therefore it is necessary to implement measures for immediate improvement of the traffic safety and if possible for mitigation of the other inconveniences.

In the meetings and seminars held in the recipient it carried out that the local engineers/specialists are familiar with and aware of the required safety improvements but financing is not available possibly because other projects have a higher priority. The following measures were discussed and include also low-cost solutions which can produce considerable improvement:

(i) Where sufficient space can be made available private accesses to the magistrale should be abandoned and collected with a parallel minor road which then enters into the magistrale with a proper junction (= reduction of danger points).

(ii) Provision of safe pedestrian crossings
- subways or bridges (= very expensive)
- traffic lights (= expensive)
- prefabricated islands bolted on the road surface as safety waiting zone after crossing of one lane and before crossing the other (= low cost and quickly implemented)

(iii) Adequate road marking and traffic signs (= minimum requirement)

(iv) Sensibly determined/useful speed limits which will be understood and accepted by drivers:

- when the houses/village is situated on one side of the road only there is hardly any crossing traffic (vehicles and pedestrians) and the village name signboards which require a speed of 50 or 60 km/h should be removed and a speed of 70 or 80 km/h should be allowed by traffic signs (= improvement of traffic flow, reduction of travelling time)

- village name signboards which very often are placed several hundred meters before the first houses appear (leads to disregarding of the 50/60 km/h limit) should be relocated close to the real village entrance, where necessary the approach can be provided with a first speed limit of 70 or 80 km/h (= improvement of traffic flow, reduction of travelling time).

- **Emergency Escape Lanes at extended Descends**

The SNIP does not include such a standard. Due to the nature of the terrain and the necessity local standards were developed in for example Kazakhstan and Kyrgyzstan which are appropriate.

- **Winter Maintenance**

  In those TRACECA states where winter conditions are experienced the aim and the requirements of winter maintenance are well known by the engineers/specialists of the institutes and departments in the recipient states. Presently the problem is that a reduced scope of winter maintenance can be carried out only due to budget constraints and equipment at the end of service life. In most cases application of salt or grit is done by throwing the material by shovel from a moving truck.
  In meetings and seminars (and during the Study Tour to Europe in November 1996) European methods and technologies were presented and possible development/improvements discussed which can be summarised as

  - updating/upgrading of winter maintenance management plans

  - introduction of modern/economically working equipment for removal of snow and for application of grit/salt (including the benefit for the environment)

6.1.3 Non Technical Aspects of Road Safety

- **Public Promotion/Information Programmes**

  The above sub-chapters present and discuss a number of technical safety measures which are the one part of road and traffic safety. The other part which is assumed to be the more difficult one is the so-called human factor, which includes all participants in the public traffic from vehicle drivers to pedestrians. Technical safety measures may not provide the planned results when the human factor fails. It has been experienced for example when a bad road was rehabilitated and had received a smooth surface, all necessary signalisation and safety measures (road marking, marker posts etc.) the number of accidents increased because drivers tended to overspeed.

  Risky behaviour may in many cases result from lack of discipline but also from not understanding or accepting measures and regulations. Therefore public promotion/information programmes are of high importance to provide the necessary background information for understanding and acceptance to increase safety. But also to enhance the understanding of one another like pedestrians and drivers as for example:

  - pedestrians must understand that a car with a speed of, say, 50 km/h cannot come to a full stop within 10 metres.

  - drivers have to control/keep the allowable maximum speed, if necessary reduce it, to give pedestrians a chance to cross safely the road

  - etc.

Before independence of the TRACECA states public promotion/information programmes existed (e. g. on TV, radio) but only a few are left like the education/training of primary school pupils. It is therefore recommended to re-activate or initiate those programmes - on TV and radio, with brochures, advertisement etc. - which in Europe are running since decades and always have to continue.

- **Enforcement of Regulations**

During the seminars in the recipient institutes the decreasing discipline and the increase of violation of traffic regulations was put into discussion as another problem of road safety aspects. Besides the above mentioned public promotion/information programmes for education possibilities to control and discipline road users repeatedly violating regulations were discussed. As an example the system in force in Germany was presented as described below.

- **Point System for Violation of Traffic Regulations (Germany)**

In addition to fines a central register has been installed for supervising repeated violations. Registration is done for all fines above 55 US$. Samples of the point system are shown in the table below.

VIOLATION	POINTS	NOTE
Exceeding of speed limit in towns		
21 - 25 km/h	●	
26 - 30 km/h	●●●	
31 - 40 km/h	●●●	
41 - 50 km/h	●●●●●	i
51 - 60 km/h	●●●●●	i
> 60 km/h	●●●●●●	ii
Driving under the influence of alcohol		
0.8 - 1.1 °/oo	●●●●	
> 1.1 °/oo	●●●●●●●	
Exceeding technical vehicle check > 8 months	●●	
Driving without valid driving licence	●●●●●●	
Driving without valid third party insurance	●●●●●●	
Misuse of number plate	●●●●●●	
Bad signalisation of broken down vehicle	●●	
Worn out tyres (< 1.6 mm)	●●●●	
Disappearance of accident site	●●●●●●●	
Dangerous overtaking	●●	
Disregarding NO OVERTAKING sign	●●●●	
Disregarding STOP sign	●●●	
Disregarding RED traffic light	●●●	
Insufficient space to vehicle in front	●●●●	
Aggressive closing up and use of flashing light	●●●●●●●	
Driving without light in fog or heavy rain	●●●	
Turning or reversing on a motorway	●●●●	
Right-hand side overtaking outside towns	●●●	

<u>NOTES</u>: (i) One month confiscation of driving licence in addition

(ii) Two months confiscation of driving licence in addition

Action is taken by the central register department at a

SUM OF 9 POINTS:	A warning letter is issued and advise is given to attend a training course, which attendance results in the deletion/reduction of 4 points.
SUM OF 14 POINTS:	The theoretical and in some cases the practical examination test for the driving licence has to be repeated.
SUM OF 18 POINTS:	A medical - psychological examination is required. Non-appearance is equal to not being qualified for a driving licence, which will then be confiscated.

- **Violation of Load Regulations (Germany)**

For vehicles with a gross weight of >7.5 tons the following fines apply when the maximum gross weight or the allowable maximum axle load is exceeded.

EXCESS	> 5 %	FINE	70 US$
	> 10 %		80 US$
	> 15 %		90 US$
	> 20 %		140 US$
	> 25 %		200 US$
	> 30 %		270 US$

In cases with an excess of >30 % unloading might be required.

- **Legislation**

In the meetings and seminars further questions and problems concerning road/traffic safety were discussed which can only be controlled by appropriate legislation as demonstrated in the above paragraphs with possibilities for enforcement of regulations.

Two highlighted problems are given below:

After independence in some of the recipient states it became somehow rather easy to get a driving license. The training is not any more comprehensive enough and many drivers drive vehicles (e. g. trucks) which class they have not acquired with their driving license.

Another growing problem is the import of right-hand steering vehicles. Since the driver has a considerably reduced sight, overtaking other vehicles becomes dangerous. Also right-hand steering vans and mini buses have the doors for passengers on the left side, the road side respectively resulting in a danger for leaving/entering passengers especially children.

7. CONCLUSION AND RECOMMENDATION

7.1 Bituminous Bound Material

The low standard and the low quality of road construction respectively encountered in most of the eight recipient states is mainly caused by:

- an inadequate pavement design methodology
- use of sub-standard materials
- poor workmanship
- inadequate equipment

A modification/improvement of the pavement design is recommended in order to base the design on empirical data which are results of practical experience. Together with a longer service life of the pavement a more economical construction and maintenance can be expected.

However, an improved design methodology will not automatically improve the quality of the roads. Two of the above reasons for the present low quality of the roads can be summarised as the problem of quality and quality control. In the former Soviet Union the supervision of works was not functioning and although the testing procedures for materials differ only little to European/western test standards sub-standard/low quality materials have been used for construction. Even when good quality materials were available the specified standards were not achieved due to poor workmanship. A quality control/assurance system should be introduced which is essential for the durability of all road components (pavement, earthworks, bridges, etc.) and should include the testing of materials as well as the supervision of construction works. Furthermore training of all levels of staff involved in road construction and road maintenance works is necessary.

On the equipment side the situation deteriorated during the past years mainly due to lack of spare parts (may be funds as well) and associated maintenance. In some states modern European/western equipment was already introduced to improve the situation. Appropriate training in the use of this equipment is recommended. In this context special seminars and training for the new recycling technology is recommended which should range from testing of existing pavement material, pavement design for re-used materials to the operation of equipment.

7.2 Road Design and Road Safety

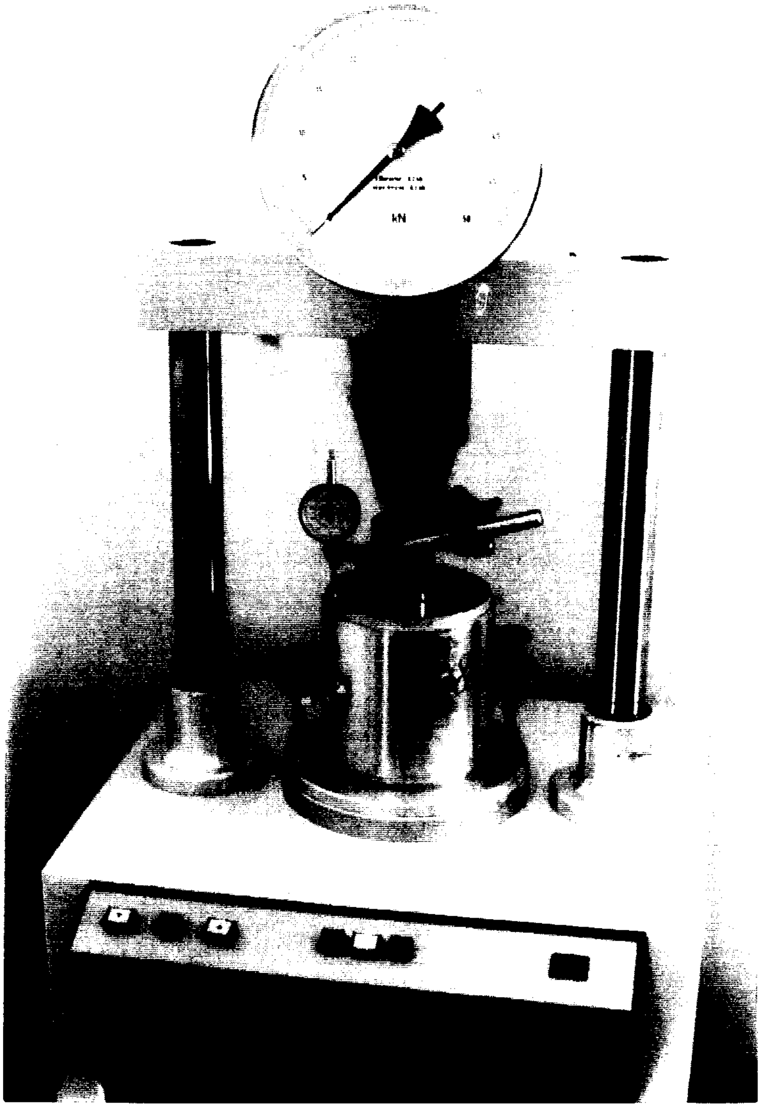
The road design standard presently used in the TRACECA states, the Soviet Union road standard (SNIP), is as far as reviewed in the course of the Project in most aspects adequate. Under consideration of economical and safety aspects some modifications are recommended which should be introduced in the current standard or in the national standards under preparation:

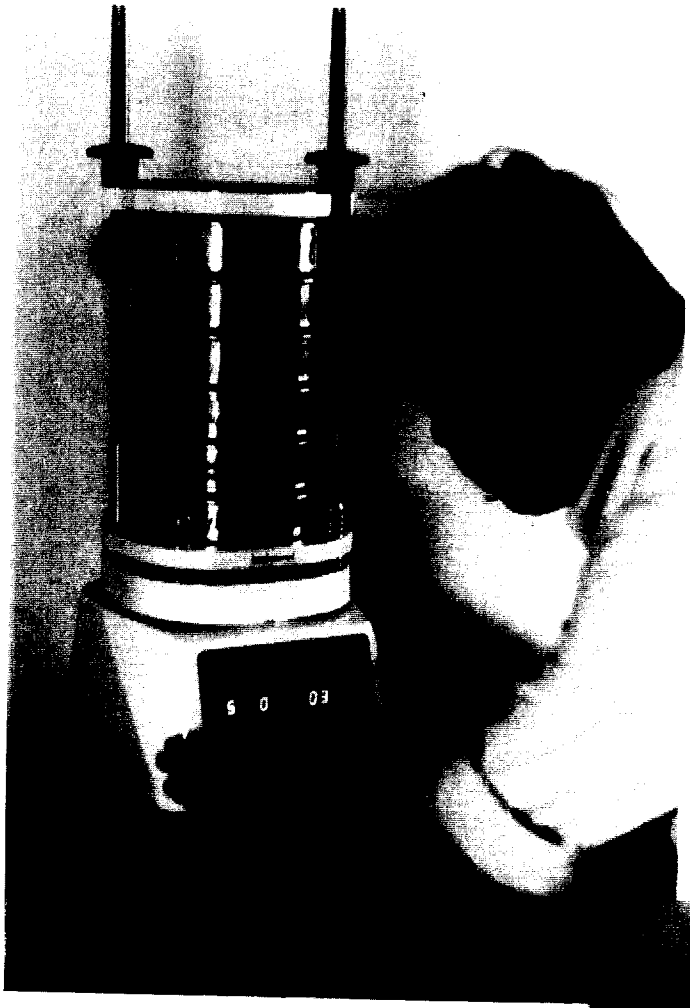
- deletion of the design speed of 150 km/h and its related design parameters

- introduction of a road cross section with three lanes (2+1 alternating) for a traffic volume of 14,000 to 27,000 vehicles per day
- improvement of road design standards for junctions and horizontal alignment
- improvement of signalisation
- improvement of safety in town passages
- reactivation/implementation of public promotion/information programmes for road/traffic safety
- amendments/additions of legislation if and where necessary

ПОДГОТОВКА ОБОРУДОВАНИЯ ДЛЯ ПРОВЕДЕНИЯ ПРОВЕРОК CBR

CBR TEST EQUIPMENT READY FOR TEST





ДЕФЕКТЫ АСФАЛЬТОВОГО ПОКРЫТИЯ

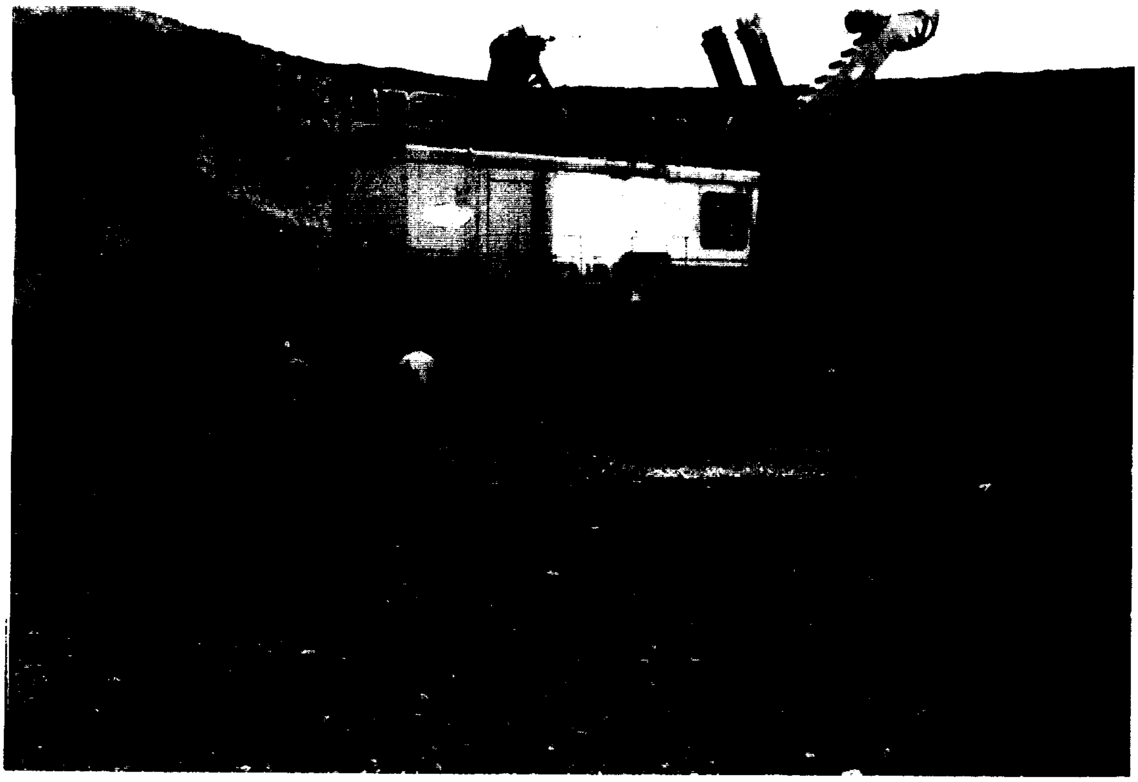
DEFECTIVE BITUMINOUS SURFACE

ТИПИЧНАЯ ДЕФОРМАЦИЯ ПОКРЫТИЯ

TYPICAL SURFACE DEFORMATIONS

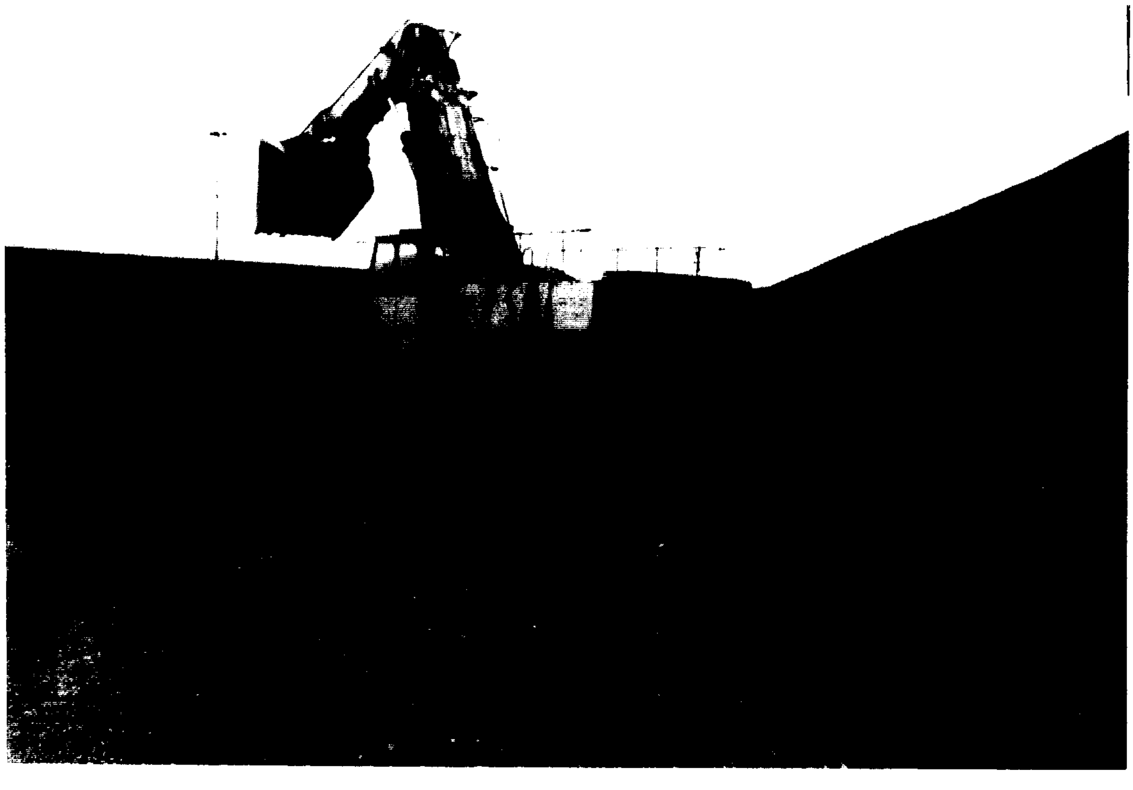
СЕРАХС ХОР ХОР. ОТКРЫТАЯ ВЫРАБОТКА
BORROW - PIT SERAKS KHOR KHOR

ДУШАК. ОТКРЫТАЯ ВЫРАБОТКА
BORROW - PIT DUSHAK



ДУШАКСКИЙ ГРАВИЙНЫЙ ЗАВОД.
DUSHAK GRAVEL PROCESSING PLANT

Conveyer belt system Замкнутая конвейерная система



Stock pile Гравийная масса

Annex 1.1: Road Roughness

Road Roughness

Callibrationfactor C= 5.36 5.36

M 37, Tedjen - Mary (km 0 - km 142.34)

Location km-Post etc.	Measured Length [m]	Bump Integ. [impuls] T-M (1)	Bump Integ. [impuls] T-M (2)	Bump Integ. [impuls] M-T (1)	Bump Integ. [impuls] M-T (2)	Bump Integ. [impuls] AVERAGE	Road Roug. BI [mm/km]	Road Chainage from [km]	Road Chainage to [km]	IRI [m/km]	Section Length [km]
0											
1	1000		192	104		148	7933	0.000	1.000	9.5	1.000
2	1000		97	92		95	5065	1.000	2.000	6.3	1.000
3	1000		146	100		123	6593	2.000	3.000	8.0	1.000
4	1000		91	78		85	4529	3.000	4.000	5.7	1.000
5	1000		78	59		69	3672	4.000	5.000	4.8	1.000
6	1000		115	98		107	5708	5.000	6.000	7.1	1.000
7	1000		61	48		55	2921	6.000	7.000	3.9	1.000
8	1000		60	61		61	3243	7.000	8.000	4.3	1.000
9	1000		59	53		56	3002	8.000	9.000	4.0	1.000
10	1000		75	76		76	4047	9.000	10.000	5.2	1.000
11	1000		67	57		62	3323	10.000	11.000	4.4	1.000
12	1000		58	65		62	3296	11.000	12.000	4.3	1.000
13	1000		73	73		73	3913	12.000	13.000	5.0	1.000
14	1000		100	90		95	5092	13.000	14.000	6.4	1.000
15	1000		103	88		96	5119	14.000	15.000	6.4	1.000
16	1000		67	90		79	4208	15.000	16.000	5.4	1.000
17	1000		99	96		98	5226	16.000	17.000	6.5	1.000
18	1000		111	87		99	5306	17.000	18.000	6.6	1.000
19	1000		92	75		84	4476	18.000	19.000	5.7	1.000
20	1000		90	76		83	4449	19.000	20.000	5.7	1.000
21	1000		99	95		97	5199	20.000	21.000	6.5	1.000
22	1000		82	88		85	4556	21.000	22.000	5.8	1.000
23	1000		87	93		90	4824	22.000	23.000	6.1	1.000
24	1000		113	97		105	5628	23.000	24.000	7.0	1.000
25	1000		138	145		142	7584	24.000	25.000	9.1	1.000
26	1000		79	58		69	3672	25.000	26.000	4.8	1.000
27	1000		66	53		60	3189	26.000	27.000	4.2	1.000
28	1000		93	105		99	5306	27.000	28.000	6.6	1.000
29	1000		76	62		69	3698	28.000	29.000	4.8	1.000
30	1000		62	55		59	3136	29.000	30.000	4.1	1.000
31	1010		68	53		61	3211	30.000	31.010	4.2	1.010
32	1005		53	70		62	3280	31.010	32.015	4.3	1.005
33	1000		51	44		48	2546	32.015	33.015	3.4	1.000
34	1000		57	56		57	3028	33.015	34.015	4.0	1.000
35	1009		75	85		80	4250	34.015	35.024	5.4	1.009
36	1000		92	97		95	5065	35.024	36.024	6.3	1.000
37	1000		81	59		70	3752	36.024	37.024	4.9	1.000
38	1000		67	62		65	3457	37.024	38.024	4.5	1.000
39	996		66	63		65	3471	38.024	39.020	4.5	0.996
40	1000		69	75		72	3859	39.020	40.020	5.0	1.000
41	1000		65	80		73	3886	40.020	41.020	5.0	1.000
42	1044		145	116		131	6700	41.020	42.064	8.1	1.044
43	1006		125	111		118	6287	42.064	43.070	7.7	1.006
44	1015		63	55		59	3116	43.070	44.085	4.1	1.015
45	980		66	68		67	3664	44.085	45.065	4.8	0.980
46	1000		90	57		74	3940	45.065	46.065	5.1	1.000
47	1000		76	65		71	3779	46.065	47.065	4.9	1.000
48	1005		68	58		63	3360	47.065	48.070	4.4	1.005
49	1000		62	59		61	3243	48.070	49.070	4.3	1.000
50	1000		46	46		46	2466	49.070	50.070	3.3	1.000
51	1000		70	52		61	3270	50.070	51.070	4.3	1.000
52	1000		75	70		73	3886	51.070	52.070	5.0	1.000
53	1000		156	82		119	6378	52.070	53.070	7.8	1.000
54	1000		102	98		100	5360	53.070	54.070	6.7	1.000
55	1000		96	103		100	5333	54.070	55.070	6.6	1.000

Location km-Post etc.	Measured Length [m]	Bump Integ. [impuls]	Bump Integ. [impuls]	Bump Integ. [impuls]	Bump Integ. [impuls]	Bump Integ. [impuls]	Road Roug. BI [mm/km]	Road Chainage from	Road Chainage to	IRI [m/km]	Section Length [km]
56	1000		51	75		63	3377	55.070	56.070	4.4	1.000
57	1000		55	45		50	2680	56.070	57.070	3.6	1.000
58	1000		70	56		63	3377	57.070	58.070	4.4	1.000
59	1007		100	65		83	4391	58.070	59.077	5.6	1.007
60	1006		70	102		86	4582	59.077	60.083	5.8	1.006
61	1013		73	60		67	3519	60.083	61.096	4.6	1.013
62	1036		81	120		101	5200	61.096	62.132	6.5	1.036
63	1047		90	80		85	4351	62.132	63.179	5.5	1.047
64	1097		82	76		79	3860	63.179	64.276	5.0	1.097
65	1090		74	79		77	3762	64.276	65.366	4.9	1.090
66	1104		98	125		112	5413	65.366	66.470	6.7	1.104
67	1204		109	84		97	4296	66.470	67.674	5.5	1.204
68	1000		61	63		62	3323	67.674	68.674	4.4	1.000
69	1000		52	45		49	2600	68.674	69.674	3.5	1.000
70	1000		54	48		51	2734	69.674	70.674	3.7	1.000
71	1000		58	51		55	2921	70.674	71.674	3.9	1.000
72	1000		45	59		52	2787	71.674	72.674	3.7	1.000
73	1000		63	79		71	3806	72.674	73.674	4.9	1.000
74	1000		62	94		78	4181	73.674	74.674	5.3	1.000
75	1000	135	131	196	204	167	8924	74.674	75.674	10.5	1.000
76	1000	137	132	120	148	134	7196	75.674	76.674	8.7	1.000
77	1000	161	139	161	152	153	8214	76.674	77.674	9.8	1.000
77.1	100	15	17	15	14	15	8174	77.674	77.774	9.7	0.100
*77.26	160	151	150	139	152	[illegible]	49580	77.774	77.934	> 15	0.160
78	740	104	100	92	99	99	7153	77.934	78.674	8.6	0.740
79	1000	158	155	140	150	151	8080	78.674	79.674	9.6	1.000
80	1000	115	106	87	91	100	5347	79.674	80.674	6.7	1.000
81	1000	121	108	90	98	104	5588	80.674	81.674	6.9	1.000
82	1000	117	99	108	107	108	5775	81.674	82.674	7.1	1.000
83	1000	97	84	83	91	89	4757	82.674	83.674	6.0	1.000
84	1000	96	88	87	96	92	4918	83.674	84.674	6.2	1.000
85	1000	108	98	86	97	97	5213	84.674	85.674	6.5	1.000
86	1000	101	115	85	95	99	5306	85.674	86.674	6.6	1.000
87	1000	85	79	83	87	84	4476	86.674	87.674	5.7	1.000
88	1000	82	72	100	102	89	4770	87.674	88.674	6.0	1.000
89	1000	64	59	47	52	56	2975	88.674	89.674	3.9	1.000
90	1000	74	71	56	71	68	3645	89.674	90.674	4.7	1.000
91	1000	84	78	70	74	77	4100	90.674	91.674	5.3	1.000
92	1000	77	65	63	73	70	3725	91.674	92.674	4.8	1.000
93	1000	85	80	82	81	82	4395	92.674	93.674	5.6	1.000
94	1000	89	88	74	82	83	4462	93.674	94.674	5.7	1.000
95	1000	136	132	129	151	137	7343	94.674	95.674	8.8	1.000
96	1000	153	143	153	165	154	8228	95.674	96.674	9.8	1.000
97	1000	139	123	130	170	141	7531	96.674	97.674	9.0	1.000
98	1000	213	196	175	195	195	10439	97.674	98.674	12.1	1.000
99	1000	105	86	95	107	98	5266	98.674	99.674	6.6	1.000
100	1000	151	122	90	104	117	6258	99.674	100.674	7.7	1.000
101	1000	163	130	107	124	131	7022	100.674	101.674	8.5	1.000
102	1000	105	85	102	118	103	5494	101.674	102.674	6.8	1.000
103	1000	108	88	101	107	101	5414	102.674	103.674	6.7	1.000
104	1000	122	97	124	127	118	6298	103.674	104.674	7.7	1.000
105	1000	112	91	98	113	104	5548	104.674	105.674	6.9	1.000
106	1000	126	107	100	115	112	6003	105.674	106.674	7.4	1.000
107	1000	124	105	90	102	105	5641	106.674	107.674	7.0	1.000
108	1000	104	86	88	102	95	5092	107.674	108.674	6.4	1.000
109	1000	136	113	115	140	126	6754	108.674	109.674	8.2	1.000
110	1000	109	83	83	82	89	4784	109.674	110.674	6.0	1.000
111	1000	104	86	86	94	93	4958	110.674	111.674	6.2	1.000
112	1000	98	74	74	86	83	4449	111.674	112.674	5.7	1.000
113	1000	75	68	61	67	68	3631	112.674	113.674	4.7	1.000
114	1000	105	105	64	74	87	4663	113.674	114.674	5.9	1.000
115	1000	88	78	100	108	94	5012	114.674	115.674	6.3	1.000
116	1000	112	88	92	103	99	5293	115.674	116.674	6.6	1.000

Location km-Post etc.	Measured Length [m]	Bump Integ. [impuls]	Bump Integ. [impuls]	Bump Integ. [impuls]	Bump Integ. [impuls]	Bump Integ. [impuls]	Road Roug. BI [mm/km]	Road Chainage from	Road Chainage to	IRI [m/km]	Section Length [km]
117	1000	126	101	90	99	104	5574	116.674	117.674	6.9	1.000
118	1000	141	107	107	125	120	6432	117.674	118.674	7.8	1.000
119	1000	102	88	89	95	94	5012	118.674	119.674	6.3	1.000
120	1000	99	88	78	79	86	4610	119.674	120.674	5.8	1.000
121	1000	78	66	57	64	66	3551	120.674	121.674	4.6	1.000
122	1000	91	79	83	90	86	4596	121.674	122.674	5.8	1.000
123	1000	114	85	73	82	89	4744	122.674	123.674	6.0	1.000
124	1000	85	68	65	70	72	3859	123.674	124.674	5.0	1.000
125	1000	90	76	66	70	76	4047	124.674	125.674	5.2	1.000
126	1000	85	63	62	76	72	3832	125.674	126.674	4.9	1.000
127	1000	86	70	66	65	72	3846	126.674	127.674	5.0	1.000
128	1000	70	57	51	59	59	3176	127.674	128.674	4.2	1.000
129	1000	81	66	84	77	77	4127	128.674	129.674	5.3	1.000
130	1000	107	85	93	79	91	4878	129.674	130.674	6.1	1.000
131	1000	105	83	114	115	104	5588	130.674	131.674	6.9	1.000
132	1000	123	102	105	106	109	5842	131.674	132.674	7.2	1.000
133	1000	69	58	60	56	61	3256	132.674	133.674	4.3	1.000
134	1000	147	123	117	119	127	6780	133.674	134.674	8.2	1.000
135	1000	94	74	86	84	85	4529	134.674	135.674	5.7	1.000
136	1000	129	106	117	132	121	6486	135.674	136.674	7.9	1.000
137	1000	137	118	140	144	135	7223	136.674	137.674	8.7	1.000
138	1000	154	135	124	122	134	7169	137.674	138.674	8.6	1.000
139	1000	113	103	123	130	117	6285	138.674	139.674	7.7	1.000
140	1000	188	155	172	167	171	9139	139.674	140.674	10.7	1.000
141	1000	130	117	120	125	123	6593	140.674	141.674	8.0	1.000
142	1000	126	105	144	145	130	6968	141.674	142.674	8.4	1.000
142.34	340	54	43	103	103	76	11942	142.674	143.014	13.6	0.340

Annex 1.2: Road Roughness Condition Category and Road Condition Class

TRACECA - IMPLEMENTATION OF PAVEMENT MANAGEMENT SYSTEMS

ROAD ROUGHNESS CONDITION CATEGORY AND ROAD CONDITION CLASS

Description	**IRI [m/km]**	**Road Condition Category**	**Road Condition Class**
Ride comfortable at 100 km/h or above. Road unevenness barely perceptible at 80 km/h. No depressions, rutting, potholes, cracks or corrugations noticeable. Typical high quality asphalt concrete or high quality bituminous surface treatment.	4.0 <	very good	0
Ride comfortable up to 100 km/h. At 80 km/h moderately perceptible movements or large undulations may be felt. Very few defects of the road surface for class 1A: - occasional depressions or large undulations - moderate corrugations - moderate rutting - shallow potholes (e.g. 5-15mm/3m or 10-20mm/5m or 10-20mm/5m with frequency 1-2 per 50m) - good quality patches (e.g. 1-2 per 50m) and in addition for class 1B: - occasional longitudinal cracks - occasional transverse cracks <u>NOTE:</u> Road sections measured and/or classified in terms of roughness values as 'GOOD', but with severe rutting or pavement deformation should be downgraded to category 'FAIR'.	> 4.0 - 6.0	good	1A 1B
Ride comfortable up to 70 - 90 km/h, but with strongly perceptible movements and swaying. Usually associated with road surface defects for class 2A: - frequent moderate and uneven depressions - pronounced undulations - pronounced corrugations - pronounced rutting - occasional potholes (e.g. 15-20mm/3m or 20-40mm per 5m with frequency 5-3 per 50m) - poor quality patches (e.g. 1-3 per 50m) and in addition for class 2B: - many longitudinal and/or transverse cracks - alligator cracking <u>NOTE:</u> Road sections measured and/or classified in terms of roughness values as 'FAIR', but with severe rutting or pavement deformation should be downgraded to category 'POOR'.	> 6.0 - 8.5	fair	2A 2B

Description	**IRI [m/km]**	**Road Condition Category**	**Road Condition Class**
Ride quite comfortable up to 50 - 60 km/h, except the worst, not possible to avoid driving across the defects of the road resulting in frequent sharp movements or swaying. Severe defects in the road surface: - frequent deep and uneven depressions - severe undulations - severe corrugations - deep rutting - frequent potholes (e.g. >30mm/3m or >60mm/5m with frequency 4-6 per 50m) - very poor quality patches (e.g. 5-3 per 50m) - severe cracking	> 8.5 - 10.5	poor	3
Necessary to reduce speed to 50 km/h or below, higher speeds would cause extreme discomfort. Disintegration of the road surface associated with many deep depressions or potholes, extreme corrugations or rutting, bad quality patches.	> 10.5 - 12.0	bad	4
Severely disintegrated road pavement allowing a speed of 30 km/h or below, higher speeds would possibly cause damage to the vehicle: - destroyed / failed road pavement - destroyed / failed road pavement repaired e.g. by bad quality patching resulting in an extreme uneven road surface causing wheel bounce - unpaved (gravel or earth) road with high roughness progression.	> 12.0	very bad	5

Source: Consultants estimates based on TRL (Transport Research Laboratory, U.K.) Road Note 5 and on estimates of previous studies.

Annex 1.3: Road Straight Line Summary

Implementation of Pavement Management Systems (Project No TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

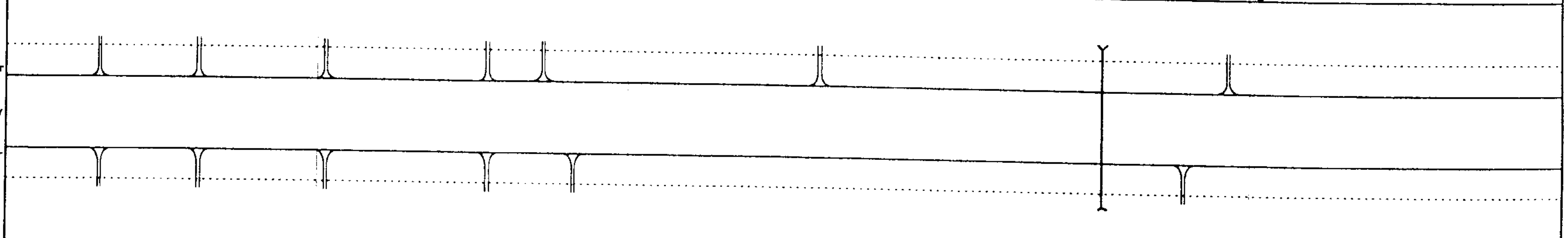
Section: M 37; km 0+000 to km 5+000

KOCKS
INGENIEURE

Station (km + m)	0+000	0+200	0+400	0+600	0+800	1+000	1+200	1+400	1+600	1+800	2+000	2+200	2+400	2+600	2+800	3+000	3+200	3+400	3+600	3+800	4+000	4+200	4+400	4+600	4+800
Location		Junctions km 0,295		Junctions km 0,615		Junctions km 1,035		Junctions km 1,550	Junction km 1,723	Junction km 1,820				Junction km 2,610					Culvert km 3,537	Junction km 3,790	Junction km 3,940				
Width of Carriageway m	15.00					14.00					12.00					9.40					8.80				
Width of Shoulders Left m																3.80					2.70				
Right m																3.50					3.50				

Layout

Shoulder
Carriageway
Shoulder



Station (km + m)	0+000	0+200	0+400	0+600	0+800	1+000	1+200	1+400	1+600	1+800	2+000	2+200	2+400	2+600	2+800	3+000	3+200	3+400	3+600	3+800	4+000	4+200	4+400	4+600	4+800
Road Condition Survey: January '97 Cracks m²													10					5					20		
Alligator Cracks m²													40										10		
Potholes m²																									
Settlement m²			30																				15		
Rutting 0-10 mm m²			2,700					100					800					1,640					1,600		
Rutting >10 mm m²			1,200					280					40					1,920					800		
Patching m²			20					45					70					75					20		
Roughness (IRI): < 4.0 m/km																									
> 4.0 - 6.0 m/km																									
> 6.0 - 8.5 m/km																									
> 8.5 - 10.5 m/km																									
> 10.5 - 12.0 m/km																									
> 12.0 m/km																									
Road Condition Class			3-4					3					3					3					2B-3		
Pavement Structure Existing mm																		120 Bituminous pavement 470 Gravel, sandy Silt, fine sandy							
DPL: 0 - 1.5 m (min. blows/10 cm) 0.1 - 0.5 No	13					17					13					15					10				
0.5 - 1.0 No	6					3					4					4					6				
1.0 - 1.5 No	6					2					4					3					3				
CBR: Basecourse CBRo/CBRw																52.1/47.1									
Fill CBRo/CBRw																25.5/9.0									

FWD Results:

from Stat. to Stat.	Overlay needed for 15 Year mm	Remaining Lifetime Years
0 – 350	120	4
350 – 950	145	0
950 – 1850	120	3
1850 – 2450	60	1
2450 – 2950	95	1
2950 – 3750	80	1
3750 – 4550	50	2
4550 – 4950	5	10

Final Visual Inspection: April '97

Cracks
Big Cracks
Cracks + Grass
Alligator Cracks
Big Alligator Cracks
Potholes in W/C
Deformations <4 cm
Deformations >4 cm
Rutting <4 cm
Rutting >4 cm
Failures
Surf. open text./small potholes
Miscellaneous

Since this section was foreseen in the first draft to be reconstructed, no further inspection has been carried out
Refer to above mentioned distresses

3 some 3 8

Measures:
"O" - Overlay
"R" - Reconstruction
"N. A." - New Alignment
"W" - Widening of Road

From	To	Measure
0	1850	"R"
1850	2450	"O" 75mm
2450	3600	"O" 100 mm
3600	4200	"N. A."
4200	4550	"O" 75
4550	4950	"O" 40 mm

partly level differences between older and newer asphalt layer up to 4 cm (edge)

KOCKS
INGENIEURE

Section: M 37; km 5+000 to km 10+000

Item		Unit	km 5+000 – 6+000	km 6+000 – 7+000	km 7+000 – 8+000	km 8+000 – 9+000	km 9+000 – 10+000
Location			Bridge km 5,873	Bridge km 6,538	Junction km 7,060; Junction km 7,658		Junction km 9,862
Station		km + m	5+000, 5+200, 5+400, 5+600, 5+800	6+000, 6+200, 6+400, 6+600, 6+800	7+000, 7+200, 7+400, 7+600, 7+800	8+000, 8+200, 8+400, 8+600, 8+800	9+000, 9+200, 9+400, 9+600, 9+800
Width of Carriageway		m	10.00	9.20	11.90	8.90	9.30
Width of Shoulders	Left	m	3.50	3.00	3.70	3.00	3.00
	Right	m	4.00	3.00	3.50	3.00	3.00
Layout	Shoulder / Carriageway / Shoulder						
Road Condition Survey: January '97	Cracks	m²		5			
	Alligator Cracks	m²		600	480		
	Potholes	m²					
	Settlement	m²	500		30		
	Rutting 0-10 mm	m²	2,200	1,200	1,600	1,000	
	Rutting >10 mm	m²	880	600		400	
	Patching	m²		15	10		50
Roughness (IRI):	< 4.0	m/km					
	> 4.0 - 6.0	m/km					
	> 6.0 - 8.5	m/km					
	> 8.5 - 10.5	m/km					
	> 10.5 - 12.0	m/km					
	> 12.0	m/km					
Road Condition Class			3	1B-2B	2B	2B	1B-2B
Pavement Structure	Existing	mm		50 Bituminous pavement 300 Gravel, sandy Silt, fine sandy			90 Bituminous pavement 290 Gravel, sandy 350 Bituminous pavement 580 Gravel, sandy Silt, fine sandy
DPL: 0 - 1.5 m (min. blows/10 cm)	0.1 - 0.5	No	6	11	17	30	22
	0.5 - 1.0	No	3	10	9	14	5
	1.0 - 1.5	No	2	5	4	9	4
CBR:	Basecourse CBRo/CBRw						
	Fill CBRo/CBRw						

FWD Results:

from Stat. to Stat.	5000 – 5650	5650 – 6650	6650 – 8150	8150 – 9150	9150 – 9850
Overlay needed for 15 Year (mm)	55	100	5	25	145
Remaining Lifetime (Years)	3	5	8	5	1

Final Visual Inspection: April '97

Item	Unit	Observations
Cracks		
Big Cracks		
Cracks + Grass		
Alligator Cracks		16; 60; 80; 54 92 136
Big Alligator Cracks		
Potholes in W/C		
Deformations	<4 cm	4; 3 3 4 3-4 3 3
Deformations	>4 cm	7; 7; 6; 5 6
Rutting	<4 cm	some 3; 2-3 1-3 1-2 3 2 2 2; 2 1-2 1.5 1-2 1.5 1-3 1-4 1-2 1-2.5 1-3; 2-3 2.5-4
Rutting	>4 cm	
Failures		
Surf. open text./small potholes		
Miscellaneous		partly level differences between older and newer asphalt layer up to 4 cm (edge)

Measures: "O" - Overlay; "R" - Reconstruction; "N. A." - New Alignment; "W" - Widening of Road

5000 – 5650	5650 – 6650	6650 – 9150	9150 – 9460	9460 – 10000
"O" 75 mm	"O" 100 mm	"O" 40 mm pipeline crossing repair and backfill	"R"	"NA"

Implementation of Pavement Management Systems (Project No. TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

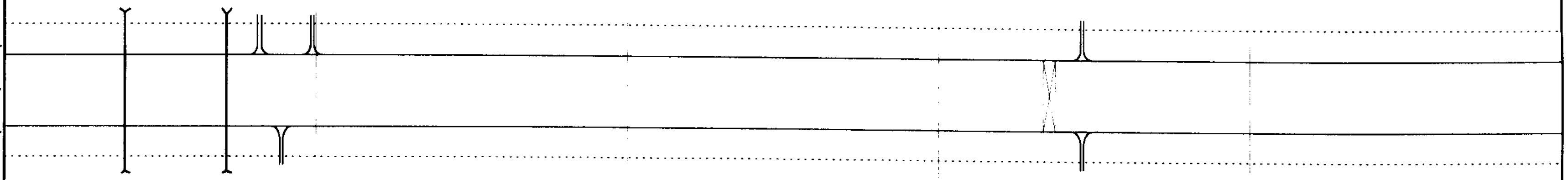
KOCKS
INGENIEURE

Section: M 37; km 10+000 to km 15+000

Item	Unit	10+000	10+200	10+400	10+600	10+800	11+000	11+200	11+400	11+600	11+800	12+000	12+200	12+400	12+600	12+800	13+000	13+200	13+400	13+600	13+800	14+000	14+200	14+400	14+600	14+800
Location				Culver km 10,396	Culvert km 10,717	Junction km 10,985 Junction km 10,890 Junction km 10,810													Bridge km 13,357 Junctions km 13,440							
Station	km + m	10 +000	10 +200	10 +400	10 +600	10 +800	11 +000	11 +200	11 +400	11 +600	11 +800	12 +000	12 +200	12 +400	12 +600	12 +800	13 +000	13 +200	13 +400	13 +600	13 +800	14 +000	14 +200	14 +400	14 +600	14 +800
Width of Carriageway	m	9.00					9.40					8.50					8.30					8.70				
Width of Shoulders Left	m	3.00					3.00					3.10					2.40					2.80				
Right	m	3.00					3.00					3.70					3.20					2.80				

Layout

Shoulder
Carriageway
Shoulder



Item	Unit	10+000	10+200	10+400	10+600	10+800	11+000	11+200	11+400	11+600	11+800	12+000	12+200	12+400	12+600	12+800	13+000	13+200	13+400	13+600	13+800	14+000	14+200	14+400	14+600	14+800
Road Condition Survey: January '97 Cracks	m²																									
Alligator Cracks	m²								20					500					1,400							
Potholes	m²													25					50							
Settlement	m²								30										40					240		
Rutting 0-10 mm	m²				1,600														1,600							
Rutting >10 mm	m²								480					1,000					1,000					3,000		
Patching	m²								60					60												
Roughness (IRI): <4.0	m/km																									
>4.0 - 6.0	m/km																									
>6.0 - 8.5	m/km																									
>8.5 - 10.5	m/km																									
>10.5 - 12.0	m/km																									
>12.0	m/km																									
Road Condition Class					2B				1B-2B					2B					3					3		
Pavement Structure Existing	mm												60 Bituminous pavement 310 Gravel, sandy Fine sand, silty													
DPL: 0 - 1.5 m (min. blows/10 cm) 0.1 - 0.5	No	6					33					19					10					20				
0.5 - 1.0	No	6					4					10					3					4				
1.0 - 1.5	No	7					3					6					2					3				
CBR: Basecourse	CBRo/CBRw											29.6/12.1														
Fill	CBRo/CBRw											9.3/3.3														

FWD Results: from Stat. to Stat.	Overlay needed for 15 Year (mm)	Remaining Lifetime (Years)
– 10950	145	1
10950 – 11550	60	1
11550 – 12250	145	3
12250 – 12950	85	1
12950 – 13350	100	1
13350 – 14150	50	2
14150 – 14750	75	1

Final Visual Inspection: April '97

Since this section was foreseen in the first draft to be reconstructed, no further inspection has been carried out. Refer to above mentioned distresses.

Item	Unit	13+400	13+600	14+200	14+400	14+800
Cracks						
Big Cracks						
Cracks + Grass						
Alligator Cracks						
Big Alligator Cracks			40			
Potholes in W/C	m²		10			
Deformations	<4 cm		3.5			
Deformations	>4 cm			6	7	5
Rutting	<4 cm					5
Rutting	>4 cm					
Failures						
Surf. open text./small potholes						
Miscellaneous						

Measures:
"O" - Overlay
"R" - Reconstruction
"N. A." - New Alignment
"W" - Widening of Road

From	To	Measure
10+000	10300	"N.A."
10300	13350	"R"
13350		"O" 75mm

KOCKS
INGENIEURE

Section: M 37; km 15+000 to km 20+000

Location: Junction km 15,825; Bridge km 18,034

Station (km + m): 15+000, 15+200, 15+400, 15+600, 15+800, 16+000, 16+200, 16+400, 16+600, 16+800, 17+000, 17+200, 17+400, 17+600, 17+800, 18+000, 18+200, 18+400, 18+600, 18+800, 19+000, 19+200, 19+400, 19+600, 19+800

Station	15+000	16+000	17+000	18+000	19+000
Width of Carriageway (m)	8.60	8.50	8.00	8.50	8.70
Width of Shoulders, Left (m)	3.00	3.00	3.30	2.80	3.10
Width of Shoulders, Right (m)	2.90	3.40	3.30	2.00	3.10

Layout: Shoulder / Carriageway / Shoulder

Road Condition Survey: January '97

Item	Unit	km 15–16	km 16–17	km 17–18	km 18–19	km 19–20
Cracks	m²				45	
Alligator Cracks	m²	280	320	3,600	230	
Potholes	m²		30	20	15	660
Settlement	m²				15	15
Rutting 0-10 mm	m²	1,800			15	
Rutting >10 mm	m²	1,400	2,200		2,100	1,000
Patching	m²			30		2,400

Roughness (IRI): < 4.0 m/km; > 4.0 - 6.0 m/km; > 6.0 - 8.5 m/km; > 8.5 - 10.5 m/km; > 10.5 - 12.0 m/km; > 12.0 m/km

Road Condition Class: 2B-3 (km 15–16); 3 (km 16–17); 2B (km 17–18); 2B (km 18–19); 2B-3 (km 19–20)

Pavement Structure – Existing (mm)

At km 15+000:
60 Bituminous pavement
190 Gravel, sandy
220 Bituminous pavement
510 Gravel, sandy
Silt, fine sandy

At km 18+000:
40 Bituminous pavement
310 Gravel, sandy
Silt, fine sandy

DPL: 0 - 1.5 m (min. blows/10 cm)

	Unit	15+000	16+000	17+000	18+000	19+000
0.1 - 0.5	No	18	12	16	12	12
0.5 - 1.0	No	6	9	3	5	13
1.0 - 1.5	No	3	5	2	2	9

CBR: Basecourse CBRo/CBRw; Fill CBRo/CBRw

FWD Results

from Stat. to Stat.	Overlay needed for 15 Year (mm)	Remaining Lifetime (Years)
15000 – 16150	60	5
16150 – 16550	75	1
16550 – 17450	25	6
17450 – 18050	100	1
18050 – 18650	30	4
18650 – 19150	5	11
19150 – 19550	35	4
19550 – 20000	25	8

Final Visual Inspection: April '97

Cracks; Big Cracks; Cracks + Grass; Alligator Cracks; Big Alligator Cracks; Potholes in W/C (m²): 40; Deformations <4 cm: 3, 3, 10; Deformations >4 cm: 6, 6-9, 7, 6-7, 5, 4, 4, 3-4; Rutting <4 cm: 3, 1-2, 1-2, 1-2, 2.5, 2-2.4, 2-3, 1-2, 1-2, 1.3-2, 1-2.5, 6-12; Rutting >4 cm: 6, 6-9, 7, 6-7, 5, 1-2, 1.5, 1, 1.5-4, 1.5-3, 1.5-2, 1.5-3, 1.5-2, 1.5-3, 1-2.5, 2-3.5, 2-3, 1.5-3, 2-3.5, 2-4, 1.5-3, 1.5-3; Failures: 5, 1.5-4.5; Surf. open text./small potholes; Miscellaneous: cracks and small holes in whole section; cracks and small potholes

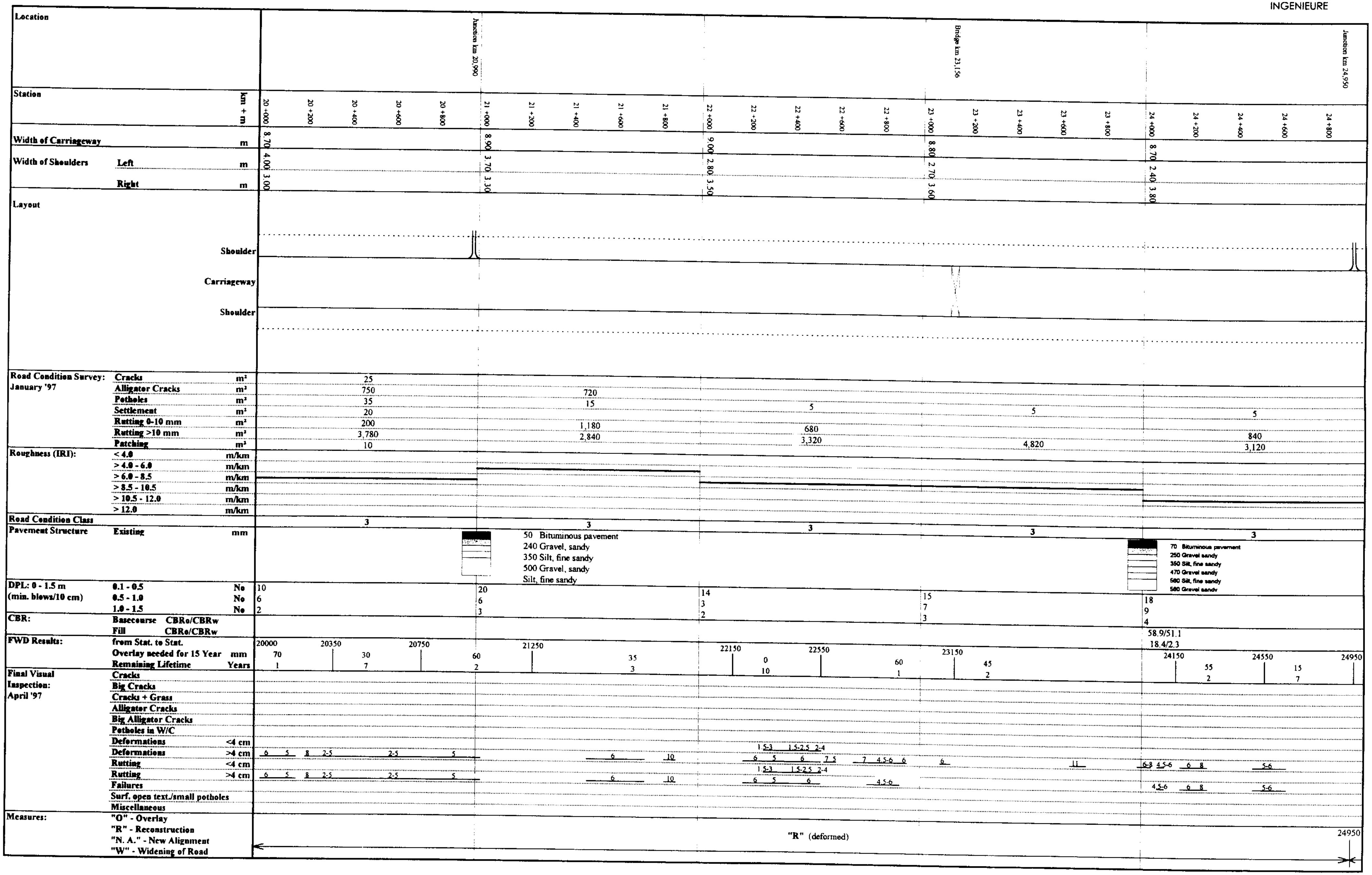
Measures: "O" - Overlay; "R" - Reconstruction; "N. A." - New Alignment; "W" - Widening of Road

From	To	Measure
15000	16550	"O" 75 mm
16550	17450	"O" 40 mm
17450	18050	"O" 100 mm
18050	19880	"O" 40 mm
19880		"R"

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

KOCKS
INGENIEURE

Section: M 37; km 20+000 to km 25+000



Implementation of Pavement Management Systems (Project No: TELREG 9305)

TEDJEN - MARY ROAD IMPROVEMENT

Section: M 37; km 25+000 to km 30+000

KOCKS
INGENIEURE

Location			Bridge km 27,815	Junction km 28,560	
Station (km + m)	25 +000	26 +000	27 +000	28 +000	29 +000
Width of Carriageway (m)	8.50	8.20	8.50	8.20	8.70
Width of Shoulders Left (m)	2.40	3.00	2.70	3.00	3.60
Width of Shoulders Right (m)	3.50	3.70	2.80	3.20	3.00

Stations: 25 +000, 25 +200, 25 +400, 25 +600, 25 +800, 26 +000, 26 +200, 26 +400, 26 +600, 26 +800, 27 +000, 27 +200, 27 +400, 27 +600, 27 +800, 28 +000, 28 +200, 28 +400, 28 +600, 28 +800, 29 +000, 29 +200, 29 +400, 29 +600, 29 +800

Layout: Shoulder / Carriageway / Shoulder

Road Condition Survey: January '97	Unit	km 25–26	km 26–27	km 27–28	km 28–29	km 29–30
Cracks	m²	1,380		120		
Alligator Cracks	m²	690	3,540	1,120		
Potholes	m²			20		15
Settlement	m²					
Rutting 0-10 mm	m²	500	1,800		1,200	860
Rutting >10 mm	m²	2,000	320	8,500	880	1,280
Patching	m²					

Roughness (IRI): < 4.0 m/km; > 4.0 - 6.0 m/km; > 6.0 - 8.5 m/km; > 8.5 - 10.5 m/km; > 10.5 - 12.0 m/km; > 12.0 m/km

Road Condition Class	2B-3	2B	3	2B	2B-3

Pavement Structure Existing (mm), at km 27+000:

50 Bituminous pavement
280 Gravel, sandy
370 Fine sand, silty
490 Gravel, sandy
Fine sand, silty

DPL: 0 - 1.5 m (min. blows/10 cm)	Unit	25 +000	26 +000	27 +000	28 +000	29 +000
0.1 - 0.5	No	21	19	15	15	18
0.5 - 1.0	No	11	17	5	5	13
1.0 - 1.5	No	5	5	8	5	9

CBR: Basecourse CBRo/CBRw; Fill CBRo/CBRw

FWD Results: from Stat. to Stat.	– 27150	27150 – 27750	27750 – 28350	28350 – 28950	28950 – 29550	29550 – 29950
Overlay needed for 15 Year (mm)	0	90	90	15	35	80
Remaining Lifetime (Years)	9	1	3	9	3	1

Final Visual Inspection: April '97

Item	Unit	Values along section
Cracks		
Big Cracks		
Cracks + Grass		
Alligator Cracks		
Big Alligator Cracks		
Potholes in W/C	m²	
Deformations	<4 cm	2-3
Deformations	>4 cm	5; 2-8 4-10 2-8 3-8 4 12-18; 4.5
Rutting	<4 cm	1.5-2 3 1-2.5 1.5-2 1.5-2.5; 3 4 1-2 1-1.5 1.5-3 1 1-2 1.5-3 1.5 1.5 1.5 1.5 1-2 1-2.5 1-1.5; 2.5-4 1.5-2.5 1.5-3.5; 1.5 2-3 1-2 1-2 1.5-2 1.5-2
Rutting	>4 cm	6 5-6; 5; 2-8 4-10 2-8 3-8 4 12-18; 4.5; 1.5-5; 5 4
Failures		
Surf. open text./small potholes		
Miscellaneous		Small to medium cracks and small potholes

Measures: "O" - Overlay; "R" - Reconstruction; "N. A." - New Alignment; "W" - Widening of Road

From – To	25000 – 27150	27150 – 28350	28350 – 29550	29550 – 29950
Measure	"O" 40 mm milling of rutting	"R" (deformed)	"O" 40 mm	"O" 100 mm

KOCKS
INGENIEURE

Section: M 37; km 30+000 to km 35+000

Location: Junction km 31,850; Bridge km 34,710

Station (km + m): 30+000, 30+200, 30+400, 30+600, 30+800, 31+000, 31+200, 31+400, 31+600, 31+800, 32+000, 32+200, 32+400, 32+600, 32+800, 33+000, 33+200, 33+400, 33+600, 33+800, 34+000, 34+200, 34+400, 34+600, 34+800

Item	Unit	30+000	31+000	32+000	33+000	34+000
Width of Carriageway	m	8.00	8.30	8.10	8.00	7.80
Width of Shoulders – Left	m	3.60	3.30	2.80	2.90	2.90
Width of Shoulders – Right	m	3.00	3.50	3.00	3.10	3.00

Layout: Shoulder / Carriageway / Shoulder

Road Condition Survey: January '97

Item	Unit	km 30–31	km 31–32	km 32–33	km 33–34	km 34–35
Cracks	m²	80	10	50	80	10
Alligator Cracks	m²	930	2,100	880	1,010	1,050
Potholes	m²	15			20	15
Settlement	m²	150		20	140	
Rutting 0-10 mm	m²	680	1,680	2,520		
Rutting >10 mm	m²		1,400			780
Patching	m²			10	25	

Roughness (IRI): < 4.0 m/km; > 4.0 - 6.0 m/km; > 6.0 - 8.5 m/km; > 8.5 - 10.5 m/km; > 10.5 - 12.0 m/km; > 12.0 m/km

Item	km 30–31	km 31–32	km 32–33	km 33–34	km 34–35
Road Condition Class	2B	2B-3	2B	2B	2B-3

Pavement Structure – Existing (mm)

At km 30+000: 40 Bituminous pavement; 140 Gravel, sandy; 230 Silt, fine sandy; 330 Gravel, sandy; Silt, fine sandy

At km 33+000: 90 Bituminous pavement; 180 Gravel, sandy; Silt, fine sandy

DPL: 0 - 1.5 m (min. blows/10 cm)

Depth	Unit	30+000	31+000	32+000	33+000	34+000
0.1 - 0.5	No	6	15	10	9	10
0.5 - 1.0	No	2	2	5	4	4
1.0 - 1.5	No	2	2	4	3	2

CBR: Basecourse CBRo/CBRw: 26.5/12.1 (33+000), 26.5/12.1 (33+400); Fill CBRo/CBRw: 23.4/1.1 (33+000)

FWD Results:

from Stat. to Stat.	Overlay needed for 15 Year (mm)	Remaining Lifetime (Years)
30000 – 30350	30	8
30350 – 30950	35	3
30950 – 31550	5	14
31550 – 33450	40	5
33450 – 34150	15	12
34150 – 34550	25	5
34550 – 35000	80	1

Final Visual Inspection: April '97

Cracks; Big Cracks (1-2); Cracks + Grass; Alligator Cracks; Big Alligator Cracks; Potholes in W/C; Deformations <4 cm (1.5-3, 3; 3, 3); Deformations >4 cm (7); Rutting <4 cm (1.5-3; 1-2, 1-2, 1.5-3.5; 1.5-2, 1.5, 1.5, 2, 1.5, 1.5, 1.5, 1.5, 2.5, 2, 2); Rutting >4 cm (4); Failures; Surf. open text./small potholes; Miscellaneous (cracks and small potholes)

Measures: "O" - Overlay; "R" - Reconstruction; "N. A." - New Alignment; "W" - Widening of Road

30+000 – 34550: "O" 40 mm; 34550 – 35000: "O" 100 mm

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

KOCKS
INGENIEURE

Section: M 37; km 35+000 to km 40+000

Item		Unit	km 35+000	km 36+000	km 37+000	km 38+000	km 39+000
Location							
Station		km + m	35+000, 35+200, 35+400, 35+600, 35+800	36+000, 36+200, 36+400, 36+600, 36+800	37+000, 37+200, 37+400, 37+600, 37+800	38+000, 38+200, 38+400, 38+600, 38+800	39+000, 39+200, 39+400, 39+600, 39+800
Width of Carriageway		m	8.10	8.20	8.10	8.30	8.60
Width of Shoulders	Left	m	2.90	3.00	3.60	4.00	3.40
	Right	m	2.60	3.20	3.10	4.00	4.20
Layout	Shoulder						
	Carriageway						
	Shoulder						
Road Condition Survey: January '97	Cracks	m²	130	70	230	280	200
	Alligator Cracks	m²	550	1,110	3,320	1,900	4,600
	Potholes	m²	150	60	5	30	
	Settlement	m²					
	Rutting 0-10 mm	m²	330				
	Rutting >10 mm	m²	340		400		800
	Patching	m²	140				
Roughness (IRI):	< 4.0	m/km					
	> 4.0 - 6.0	m/km					
	> 6.0 - 8.5	m/km					
	> 8.5 - 10.5	m/km					
	> 10.5 - 12.0	m/km					
	> 12.0	m/km					
Road Condition Class			3	2B	2B-3	2B	2B-3
Pavement Structure	Existing	mm	30 Bituminous pavement 130 Gravel, sandy Fine sand, silty			50 Bituminous pavement 700 Gravel, sandy Fine sand, silty	
DPL: 0 - 1.5 m (min. blows/10 cm)	0.1 - 0.5	No	15	6	16	15	15
	0.5 - 1.0	No	12	5	14	7	10
	1.0 - 1.5	No	8	7	14	10	8
CBR:	Basecourse CBRo/CBRw						
	Fill CBRo/CBRw						
Final Visual Inspection: April '97	Cracks						
	Big Cracks						
	Cracks + Grass						
	Alligator Cracks						
	Big Alligator Cracks						
	Potholes in W/C						
	Deformations	<4 cm					
	Deformations	>4 cm					
	Rutting	<4 cm					
	Rutting	>4 cm					
	Failures						
	Surf. open text./small potholes						
	Miscellaneous		+ grass				

FWD Results:

from Stat. to Stat.	35+000–35750	35750–36450	36450–37550	37550–37950	37950–38350	38350–38750	38750–39250	39250–40+000
Overlay needed for 15 Year (mm)	80	50	65	0	75	20	90	90
Remaining Lifetime (Years)	1	5	3	-	0	6	0	1

Measures:
"O" - Overlay
"R" - Reconstruction
"N. A." - New Alignment
"W" - Widening of Road

35+000–35750	35750–37550	37550–37950	37950–38350	38350–38750	38750–40+000
"O" 100 mm	"O" 75 mm	"O" 40 mm	"O" 75 mm	"O" 40 mm	"O" 100 mm

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

KOCKS
INGENIEURE

Section: M 37; km 40+000 to km 45+000

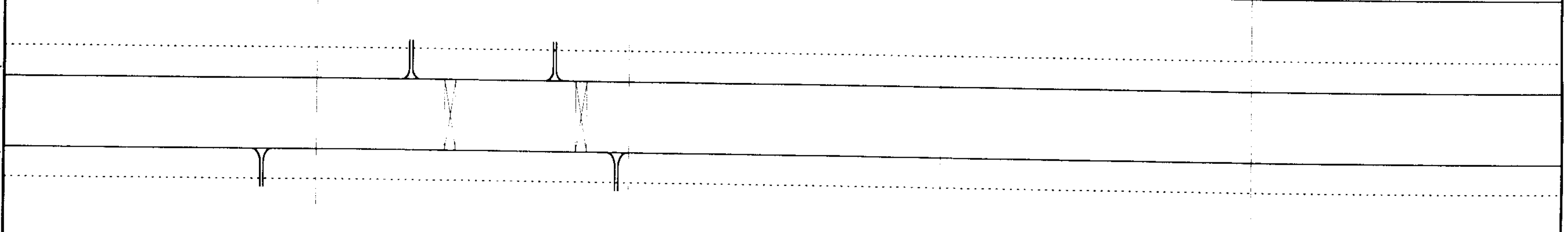
Location

- Junction km 40,820
- Junction km 41,310
- Bridge km 41,424
- Junction km 41,770
- Bridge 41,839
- Junction km 41,970

Station (km + m)	40+000	40+200	40+400	40+600	40+800	41+000	41+200	41+400	41+600	41+800	42+000	42+200	42+400	42+600	42+800	43+000	43+200	43+400	43+600	43+800	44+000	44+200	44+400	44+600	44+800
Width of Carriageway (m)	8.10					8.40					8.30					8.60					8.90				
Width of Shoulders, Left (m)	3.00					4.30					2.70					3.80					2.80				
Width of Shoulders, Right (m)	4.20					4.00					3.60					3.90					3.30				

Layout

Shoulder
Carriageway
Shoulder



Item	Unit	km 40+000 – 41+000	km 41+000 – 42+000	km 42+000 – 43+000	km 43+000 – 44+000	km 44+000 – 45+000
Road Condition Survey: January '97 – Cracks	m²	20		400	40	20
Alligator Cracks	m²	7,600	2,640	1,820	2,740	1,600
Potholes	m²	15				20
Settlement	m²					
Rutting 0-10 mm	m²				20	
Rutting >10 mm	m²					
Patching	m²			2,280		
Roughness (IRI): < 4.0	m/km					
> 4.0 - 6.0	m/km	—			—	—
> 6.0 - 8.5	m/km			—		
> 8.5 - 10.5	m/km		—			
> 10.5 - 12.0	m/km					
> 12.0	m/km					
Road Condition Class		2B-3	3	3	2B	2B

Pavement Structure – Existing (mm)

At km 41+000:
70 Bituminous pavement
260 Gravel, sandy
Silt, fine sandy

At km 44+000:
50 Bituminous pavement
400 Gravel, sandy
Silt, fine sandy

DPL: 0 - 1.5 m (min. blows/10 cm)	Unit	40+000	41+000	42+000	43+000	44+000
0.1 - 0.5	No	17	18	10	18	16
0.5 - 1.0	No	8	7	3	14	6
1.0 - 1.5	No	6	7	4	5	3

CBR: Basecourse CBRo/CBRw; Fill CBRo/CBRw

FWD Results:

from Stat. to Stat.	40150 – 41850		41850 – 42350	42350 – 43350		43350 – 44250		44250 – 44650	44650 –
Overlay needed for 15 Year (mm)	90	115	65	35		50		90	45
Remaining Lifetime (Years)	1	0	1	8		2		1	4

Final Visual Inspection: April '97

Cracks
Big Cracks
Cracks + Grass
Alligator Cracks: 300 (at km 41+000)
Big Alligator Cracks
Potholes in W/C
Deformations <4 cm: 4 (at km 42+350 – 42+450)
Deformations >4 cm
Rutting <4 cm: 3.5 1.5 1.0 1.5 1.5 1.5 1.5 2-2.5 1-1.5 1-1.5 1-2
Rutting >4 cm
Failures
Surf. open text./small potholes
Miscellaneous: cracks in the whole section, partly surface open structure between 42+355 - 42+450 = 100 m²

Measures:
"O" - Overlay
"R" - Reconstruction
"N. A." - New Alignment
"W" - Widening of Road

40150		41850	42350	43350	44250	44650
"O" 100 mm	"R"	"O" 75 mm	"O" 40 mm	"O" 75 mm	"O" 100 mm	"O" 40 mm

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

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Section: M 37; km 45+000 to km 50+000

		Unit	km 45+000 – 46+000	km 46+000 – 47+000	km 47+000 – 48+000	km 48+000 – 49+000	km 49+000 – 50+000
Location			Junction km 45,460			Junction km 48,185; Junction km 48,260	Junction km 49,840
Station		km + m	45 +000, 45 +200, 45 +400, 45 +600, 45 +800	46 +000, 46 +200, 46 +400, 46 +600, 46 +800	47 +000, 47 +200, 47 +400, 47 +600, 47 +800	48 +000, 48 +200, 48 +400, 48 +600, 48 +800	49 +000, 49 +200, 49 +400, 49 +600, 49 +800
Width of Carriageway		m	9.10	8.60	8.80	9.00	8.30
Width of Shoulders	Left	m	3.30	2.40	4.20	3.90	3.40
	Right	m	3.00	3.20	4.20	3.50	3.10
Layout	Shoulder / Carriageway / Shoulder						
Road Condition Survey: January '97	Cracks	m²	30	40	15	20	
	Alligator Cracks	m²	1,040	960	1,180	1,820	
	Potholes	m²	5	20	10		
	Settlement	m²	20	70	5		
	Rutting 0-10 mm	m²					
	Rutting >10 mm	m²			80		
	Patching	m²					
Roughness (IRI):	< 4.0	m/km					
	> 4.0 - 6.0	m/km					
	> 6.0 - 8.5	m/km					
	> 8.5 - 10.5	m/km					
	> 10.5 - 12.0	m/km					
	> 12.0	m/km					
Road Condition Class			2B	2B	2B-3	2B	1B
Pavement Structure	Existing	mm			40 Bituminous pavement 390 Gravel, sandy Silt, fine sandy		
DPL: 0 - 1.5 m (min. blows/10 cm)	0.1 - 0.5	No	16	10	20	12	10
	0.5 - 1.0	No	16	3	3	4	5
	1.0 - 1.5	No	12	3	3	4	3
CBR:	Basecourse CBRo/CBRw						
	Fill CBRo/CBRw						

FWD Results: from Stat. to Stat.	Overlay needed for 15 Year (mm)	Remaining Lifetime (Years)
45000 – 45550	45	4
45550 – 47750	80	2
47750 – 48450	110	0
48450 – 49650	85	3
49650 – 50000	10	8

Final Visual Inspection: April '97

Item	Unit	Entries
Cracks		
Big Cracks		
Cracks + Grass		
Alligator Cracks		
Big Alligator Cracks		80 48 small (from 49650)
Potholes in W/C		
Deformations	<4 cm	
Deformations	>4 cm	
Rutting	<4 cm	
Rutting	>4 cm	1-1.5 1-1.5 1.5-2.5 (from 49650)
Failures		
Surf. open text./small potholes		
Miscellaneous		

Measures:
"O" - Overlay
"R" - Reconstruction
"N. A." - New Alignment
"W" - Widening of Road

From	To	Measure
45000	45550	"O" 40 mm
45550	47750	"O" 75 mm
47750	48450	"R"
48450	49650	"O" 100 mm
49650	50000	"O" 40 mm

Implementation of Pavement Management Systems (Project No: TELREG 9305)
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Section: M 37; km 50+000 to km 55+000

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Station (km + m)	50+000	50+200	50+400	50+600	50+800	51+000	51+200	51+400	51+600	51+800	52+000	52+200	52+400	52+600	52+800	53+000	53+200	53+400	53+600	53+800	54+000	54+200	54+400	54+600	54+800
Location			Culvert km 50,373 Culvert km 50,300		Culvert km 51,780 Junction km 50,900									Culvert km 52,535 Junction km 52,640			Junction km 53,310								
Width of Carriageway (m)	7.70					8.50					8.80					9.00					8.80				
Width of Shoulders Left (m)	3.40					3.80					2.90					2.90					3.60				
Width of Shoulders Right (m)	3.10					3.60					3.40					3.60					3.80				
Layout: Shoulder / Carriageway / Shoulder																									
Road Condition Survey: January '97 Cracks (m²)																									
Alligator Cracks (m²)																		20					80		
Potholes (m²)													950					2,140					10		
Settlement (m²)																		10					20		
Rutting 0-10 mm (m²)								800																	
Rutting >10 mm (m²)								940															720		
Patching (m²)																		60					1,007		
Roughness (IRI): < 4.0 (m/km)																		25							
> 4.0 - 6.0 (m/km)																									
> 6.0 - 8.5 (m/km)																									
> 8.5 - 10.5 (m/km)																									
> 10.5 - 12.0 (m/km)																									
> 12.0 (m/km)																									
Road Condition Class			1B					2B-3					2B					2B-3					3		
Pavement Structure Existing (mm)	50 Bituminous pavement 200 Gravel, sandy Silt, fine sandy										50 Bituminous pavement 420 Gravel, sandy Fine sand, silty														
DPL: 0 - 1.5 m (min. blows/10 cm) 0.1 - 0.5 (No)	41					9					20					13					17				
0.5 - 1.0 (No)	3					5					4					7					9				
1.0 - 1.5 (No)	4					4					3					5					4				
CBR: Basecourse CBRo/CBRw											24.4/24.0														
Fill CBRo/CBRw											4.2/3.0														
FWD Results: from Stat. to Stat.	50000															52950					54050				54850
Overlay needed for 15 Year (mm)									40									145					150		
Remaining Lifetime (Years)									6									0					0		
Final Visual Inspection: April '97 Cracks																									
Big Cracks				2																					
Cracks + Grass																									
Alligator Cracks																									
Big Alligator Cracks														small											
Potholes in W/C (m²)																									
Deformations (<4 cm)																									
Deformations (>4 cm)																									
Rutting (<4 cm)	1-2 1-1.5	1-1.5 1-1.5	1-1.5 1-2	1-1.5 1-2	1-2 1-2	1-2		2-3.5 1-3	1-4 1-3	2-4 2	1-2.5 1.5-4	1.5-2.5 1.5	1.5 1.5-2	1.5 1.5	4-1 1-2	1.5-3									
Rutting (>4 cm)					4	4																			
Failures																									
Surf. open text/small potholes																									
Miscellaneous																									
Measures:	"O" 40 mm (50+000 – 52950)															52950					"R" (52950 – 55+000)				

Since this section was foreseen in the first draft to be reconstructed, no further inspection has been carried out. Refer to above mentioned distresses.

Measures:
"O" - Overlay
"R" - Reconstruction
"N. A." - New Alignment
"W" - Widening of Road

Implementation of Pavement Management Systems (Project No: TELREG 9305)
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Section: M 37; km 55+000 to km 60+000

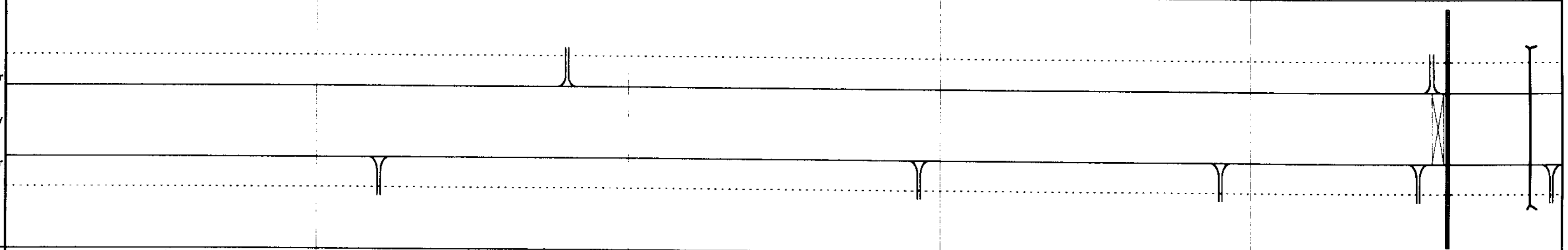
Location: Junction km 56,200; Junction km 56,800; Junction km 57,930; Junction km 58,890; Junction km 59,560; Junction km 59,590; Bridge km 59,559; Railway km 59,630; Culvert km 59,991; Junction km 59,990

Station (km + m): 55+000, 55+200, 55+400, 55+600, 55+800, 56+000, 56+200, 56+400, 56+600, 56+800, 57+000, 57+200, 57+400, 57+600, 57+800, 58+000, 58+200, 58+400, 58+600, 58+800, 59+000, 59+200, 59+400, 59+600, 59+800

Item	Unit	55+000	56+000	57+000	58+000	59+000
Width of Carriageway	m	7.60	8.60	8.10	8.60	8.80
Width of Shoulders – Left	m	3.50	3.10	3.10	3.20	4.00
Width of Shoulders – Right	m	4.10	3.70	4.30	4.80	3.50

Layout

Shoulder
Carriageway
Shoulder



Road Condition Survey: January '97	Unit	km 55	km 56	km 57	km 58	km 59
Cracks	m²	45	20	210	130	40
Alligator Cracks	m²	30	25	660	3,600	1,200
Potholes	m²	40	15	40	60	20
Settlement	m²					
Rutting 0-10 mm	m²	720	720	2,000	1,000	2,400
Rutting >10 mm	m²	1,007	1,007	1,000	600	60
Patching	m²					

Roughness (IRI): < 4.0 m/km; > 4.0 - 6.0 m/km; > 6.0 - 8.5 m/km; > 8.5 - 10.5 m/km; > 10.5 - 12.0 m/km; > 12.0 m/km

Road Condition Class	km 55	km 56	km 57	km 58	km 59
	2B-3	2B	2B-3	3	3

Pavement Structure – Existing (mm)

km 55+000:
80 Bituminous pavement
190 Gravel, sandy
270 Fine sand, silty
400 Gravel, sandy
Fine sand, silty

km 58+000:
80 Bituminous pavement
210 Gravel, sandy
Silt, fine sandy

DPL: 0 - 1.5 m (min. blows/10 cm)	Unit	55+000	56+000	57+000	58+000	59+000
0.1 - 0.5	No	12	5	12	9	15
0.5 - 1.0	No	6	3	5	2	6
1.0 - 1.5	No	3	3	2	4	5

CBR: Basecourse CBRo/CBRw; Fill CBRo/CBRw

FWD Results: from Stat. to Stat.	Overlay needed for 15 Year (mm)	Remaining Lifetime (Years)
55+000 – 55650	115	2
55650 – 56150	70	3
56150 – 56550	60	2
56550 – 57350	95	2
57350 – 59250	100	1
59250 – 60+000	75	2

Final Visual Inspection: April '97

Cracks; Big Cracks; Cracks + Grass; Alligator Cracks; Big Alligator Cracks; Potholes in W/C; Deformations <4 cm; Deformations >4 cm; Rutting <4 cm; Rutting >4 cm; Failures; Surf. open text./small potholes; Miscellaneous

more
less
7

Since this section was foreseen in the first draft to be reconstructed, no further inspection has been carried out. Refer to above mentioned distresses.

Since this section was foreseen in the first draft to be overlayed with 120 mm bit. mix, no further inspection has been carried out. Refer to above mentioned distresses.

Measures: "O" - Overlay; "R" - Reconstruction; "N. A." - New Alignment; "W" - Widening of Road

From	To	Measure
55+000	55650	"R"
55650	56550	"O" 75 mm
56550	59250	"O" 100 mm
59250	60+000	"O" 75 mm

Implementation of Pavement Management Systems (Project No: TELREG 9305)
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Section: M 37; km 60+000 to km 65+000

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Station (km + m)	60 +000	60 +200	60 +400	60 +600	60 +800	61 +000	61 +200	61 +400	61 +600	61 +800	62 +000	62 +200	62 +400	62 +600	62 +800	63 +000	63 +200	63 +400	63 +600	63 +800	64 +000	64 +200	64 +400	64 +600	64 +800
Location									Culvert km 61,617	Junction km 61,785			Junctions km 62,440		Culvert km 62,772										Junctions km 64,790
Width of Carriageway (m)	8.50					8.30					8.20					8.90					8.90				
Width of Shoulders Left (m)	3.10					3.60					2.60					3.40					3.60				
Right (m)	2.80					3.50					3.10					3.40					3.40				
Layout Shoulder																									
Carriageway																									
Shoulder																									
Road Condition Survey: January '97 Cracks (m²)			40					10					100												
Alligator Cracks (m²)			1,280					90					530					800					220		
Potholes (m²)													60										340		
Settlement (m²)			300										20												
Rutting 0-10 mm (m²)			1,210					1,800					1,200					1,600					1,600		
Rutting >10 mm (m²)			1,280					600					600					2,400					400		
Patching (m²)													40												
Roughness (IRI): < 4.0 (m/km)																									
> 4.0 - 6.0 (m/km)																									
> 6.0 - 8.5 (m/km)																									
> 8.5 - 10.5 (m/km)																									
> 10.5 - 12.0 (m/km)																									
> 12.0 (m/km)																									
Road Condition Class			2B-3					3					2B-3					2B-3					2B-3		
Pavement Structure Existing (mm)																					40 Bituminous pavement 170 Gravel, sandy Silt, fine sandy				
DPL: 0 - 1.5 m (min. blows/10 cm) 0.1 - 0.5 (No)	9					7					12					9					10				
0.5 - 1.0 (No)	3					3					4					3					3				
1.0 - 1.5 (No)	3					2					3					2					2				
CBR: Basecourse CBRo/CBRw											44.1/23.5														
Fill CBRo/CBRw											2.2/2.4														
FWD Results: from Stat. to Stat.											61950					63150				63850					
Overlay needed for 15 Year (mm)						65							140					125					85		
Remaining Lifetime (Years)						3							0					0					5		
Final Visual Inspection: April '97 Cracks																									
Big Cracks																									
Cracks + Grass																									
Alligator Cracks																									
Big Alligator Cracks																									
Potholes in W/C (m²)																									
Deformations <4 cm	3-4																								
Deformations >4 cm				3-8	13	3-8	8		3-10																
Rutting <4 cm																									
Rutting >4 cm																									
Failures																									
Surf. open text./small potholes																									
Miscellaneous																									

Since this section was foreseen in the first draft to be reconstructed,
no further inspection has been carried out.
Refer to above mentioned distresses.

Measures:
"O" - Overlay
"R" - Reconstruction
"N. A." - New Alignment
"W" - Widening of Road

km 60+000 – 63000	63000 – 63400	63400 – 63850	63850 – km 65+000
"R" (deformed)	"R" "W"	"R" (deformed)	"O" 100 mm

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

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INGENIEURE

Section: M 37; km 65+000 to km 70+000

			km 65	km 66	km 67	km 68	km 69
Location			Junction km 65,210; Junction km 65,505; Culvert km 65,602	Junction km 66,170; Bridge km 66,673	Junction km 67,505		Junction km 69,200; Junction km 69,730
Station		km + m	65 +000, 65 +200, 65 +400, 65 +600, 65 +800	66 +000, 66 +200, 66 +400, 66 +600, 66 +800	67 +000, 67 +200, 67 +400, 67 +600, 67 +800	68 +000, 68 +200, 68 +400, 68 +600, 68 +800	69 +000, 69 +200, 69 +400, 69 +600, 69 +800
Width of Carriageway		m	8.10	9.20	8.00	8.80	9.00
Width of Shoulders	Left	m	3.60	3.30	3.50	4.10	3.80
	Right	m	3.50	3.40	4.80	3.90	3.20
Layout	Shoulder / Carriageway / Shoulder						
Road Condition Survey: January '97	Cracks	m²		10	8	10	
	Alligator Cracks	m²	240	220	360	10	60
	Potholes	m²	80	15	135	445	5
	Settlement	m²		25	50	40	80
	Rutting 0-10 mm	m²	1,200		1,000	2,100	1,920
	Rutting >10 mm	m²	1,800	3,880	1,650		300
	Patching	m²	30			30	
Roughness (IRI):	<4.0	m/km					
	>4.0 - 6.0	m/km	65366	66470		68670	
	>6.0 - 8.5	m/km					
	>8.5 - 10.5	m/km					
	>10.5 - 12.0	m/km					
	>12.0	m/km					
Road Condition Class			3	3	2B-3	2B-3	2B-3
Pavement Structure	Existing	mm			70 Bituminous pavement 190 Gravel, sandy Silt, fine sandy		
DPL: 0 - 1.5 m (min. blows/10 cm)	0.1 - 0.5	No	5	11	20	10	8
	0.5 - 1.0	No	3	5	5	2	3
	1.0 - 1.5	No	3	4	3	3	4
CBR:	Basecourse	CBRo/CBRw					
	Fill	CBRo/CBRw					
FWD Results:	from Stat. to Stat.			66150		68550	69350
	Overlay needed for 15 Year	mm	85			65	105; 60
	Remaining Lifetime	Years	5			-	1; 4
Final Visual Inspection: April '97	Cracks						
	Big Cracks						
	Cracks + Grass						
	Alligator Cracks						
	Big Alligator Cracks						
	Potholes in W/C	m²					
	Deformations	<4 cm					
	Deformations	>4 cm	6; 6 8	6; 8; 5			
	Rutting	<4 cm					
	Rutting	>4 cm					
	Failures						
	Surf. open text./small potholes						
	Miscellaneous						
Measures:	"O" - Overlay "R" - Reconstruction "N. A." - New Alignment "W" - Widening of Road		"O" 100 mm; 65370; "R" (deformed)	66470	"O" 75 mm	68550; "O" 100 mm	69350; "O" 75 mm

Since this section was foreseen in the first draft to be overlayed with 120 mm bit. mix, no further inspection has been carried out. Refer to above mentioned distresses.

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

Section: M 37; km 70+000 to km 75+000

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		km 70	km 71	km 72	km 73	km 74
Location		Junction km 70,015; Junction km 70,648			Junction km 73,490	Junctions km 74,225; Bridge km 74,748
Station	km + m	70 +000, 70 +200, 70 +400, 70 +600, 70 +800	71 +000, 71 +200, 71 +400, 71 +600, 71 +800	72 +000, 72 +200, 72 +400, 72 +600, 72 +800	73 +000, 73 +200, 73 +400, 73 +600, 73 +800	74 +000, 74 +200, 74 +400, 74 +600, 74 +800
Width of Carriageway	m	8.80	9.00	9.10	8.60	9.00
Width of Shoulders Left	m	3.00	3.20	3.50	4.00	3.80
Right	m	3.30	3.40	3.20	3.80	3.30
Layout (Shoulder / Carriageway / Shoulder)						
Road Condition Survey: January '97 Cracks	m²	30	45	55	160	30
Alligator Cracks	m²	10	210	1,280	220	140
Potholes	m²	15	20	20		
Settlement	m²	110	110	110		
Rutting 0-10 mm	m²	1,400	800	400		
Rutting >10 mm	m²	420	120	100		
Patching	m²				640	540
Roughness (IRI): < 4.0	m/km					
> 4.0 - 6.0	m/km				73670	
> 6.0 - 8.5	m/km					
> 8.5 - 10.5	m/km					74670
> 10.5 - 12.0	m/km					
> 12.0	m/km					
Road Condition Class		2B-3	2B-3	2B-3	2B-3	4
Pavement Structure Existing	mm	30 Bituminous pavement; 60 Gravel, sandy; 360 Silt, fine sandy; 530 Gravel, sandy; Silt, fine sandy			40 Bituminous pavement; 150 Gravel, sandy; 250 Silt, fine sandy; 370 Gravel, sandy; Fine sand, silty	
DPL: 0 - 1.5 m (min. blows/10 cm) 0.1 - 0.5	No	10	16	9	8	12; 14
0.5 - 1.0	No	5	2	5	4	7; 16
1.0 - 1.5	No	3	2	4	2	6; 6
CBR: Basecourse	CBRo/CBRw					
Fill	CBRo/CBRw					
FWD Results: from Stat. to Stat.		70350; 70950			72850; 73650	74650
Overlay needed for 15 Year	mm	60; 85	75		100	70; 0
Remaining Lifetime	Years	1; 1	2		2	3; 15
Final Visual Inspection: April '97 Cracks						centerline area
Big Cracks						
Cracks + Grass						
Alligator Cracks						
Big Alligator Cracks						
Potholes in W/C	m²					
Deformations	<4 cm					
Deformations	>4 cm	5	5			
Rutting	<4 cm				9	12; 6
Rutting	>4 cm					
Failures						12
Surf. open text./small potholes						
Miscellaneous						
Measures: "O" - Overlay; "R" - Reconstruction; "N. A." - New Alignment; "W" - Widening of Road		"O" 75 mm; 70350; "O" 100 mm; 70950	"O" 75 mm		72850; "R" (deformed)	74650

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

Section: M 37; km 75+000 to km 80+000

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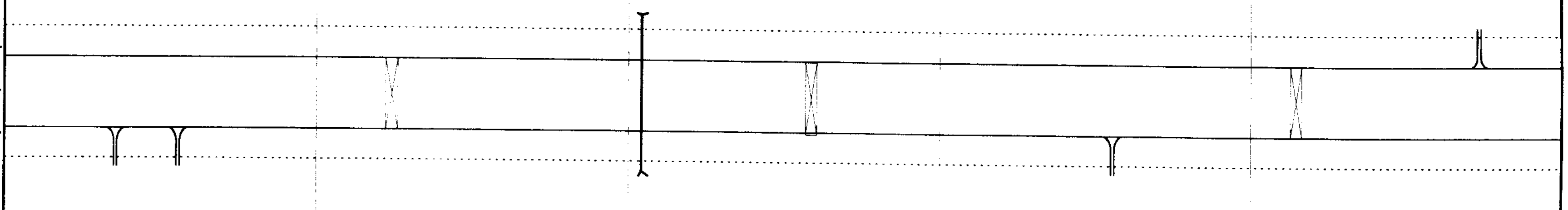
Location: Junction km 75,350; Junction km 75,540; Bridge km 76,244; Culvert km 77,030; Bridge km 77,594; Junction km 78,545; Bridge km 79,155; Junction km 79,740

Station (km + m): 75 +000; 75 +200; 75 +400; 75 +600; 75 +800; 76 +000; 76 +200; 76 +400; 76 +600; 76 +800; 77 +000; 77 +200; 77 +400; 77 +600; 77 +800; 78 +000; 78 +200; 78 +400; 78 +600; 78 +800; 79 +000; 79 +200; 79 +400; 79 +600; 79 +800

Station	Width of Carriageway (m)	Width of Shoulders Left (m)	Width of Shoulders Right (m)
75 +000	8.80	2.90	3.40
76 +000	7.90	2.80	3.00
77 +000	7.60	2.30	2.90
78 +000	7.80	3.00	3.30
79 +000	9.20	2.80	3.00

Width of Carriageway remarks: Partly new pavement (76+000 – 77+000); Partly new pavement (77+000 – 78+000)

Layout



Road Condition Survey: January '97

Distress	Unit	75+000–76+000	76000-76490	76490-76860	76860-77100	77100-77260	77260-78000	78+000–79+000	79+000–80+000
Cracks	m²							35	15
Alligator Cracks	m²	2,550	2,040		620		2,720	1,287	1,287
Potholes	m²	5				30	10	117	117
Settlement	m²	15	10				920	138	138
Rutting 0-10 mm	m²	240		200	120			1,733	1,733
Rutting >10 mm	m²	460	400	100	180			1,283	1,283
Patching	m²						1,`80		

Roughness (IRI): < 4.0 m/km; > 4.0 - 6.0 m/km; > 6.0 - 8.5 m/km; > 8.5 - 10.5 m/km; > 10.5 - 12.0 m/km; > 12.0 m/km
Marks: 76670; 77930; Site; 79670

Road Condition Class: 4 (75+000–76+000); 3-4; 3-4; 3-4; 3; 3-4; 3

Pavement Structure – Existing (mm):
- At 76+000: 60 Bituminous pavement; 190 Gravel, sandy; Fine sand, silty
- At 79+000: 20 Bituminous pavement; 240 Gravel, sandy; Fine sand, silty

DPL: 0 - 1.5 m (min. blows/10 cm)

Station	0.1 - 0.5 (No)	0.5 - 1.0 (No)	1.0 - 1.5 (No)
75 +000	17	5	3
76 +000	5	3	3
77 +000	16	6	5
78 +000	14	11	7
79 +000	9	8	5

CBR: Basecourse CBRo/CBRw: 71.1/57.1; Fill CBRo/CBRw: 0/0

FWD Results:

from Stat. to Stat.	Overlay needed for 15 Year (mm)	Remaining Lifetime (Years)
75050 – 76350	70	3
76350 – 80000	145	0

Final Visual Inspection: April '97
Cracks; Big Cracks; Cracks + Grass; Alligator Cracks; Big Alligator Cracks; Potholes in W/C (m²); Deformations (<4 cm); Deformations (>4 cm); Rutting (<4 cm); Rutting (>4 cm); Failures; Surf. open text./small potholes; Miscellaneous

- Cracks: totally cracked surface
- Deformations >4 cm: 4
- Miscellaneous: totally cracked surface

Since this section was foreseen in the first draft to be reconstructed, no further inspection has been carried out. Refer to above mentioned distresses.

Measures: "O" - Overlay; "R" - Reconstruction; "W" - Widening of Road; "W" - Wideing of Road

From	To	Measure
75050	75250	"R"
75250	75550	"R" "W"
75550	80000	"R" (cracked)

Implementation of Pavement Management Systems (Project No: TELREG 9305)

TEDJEN - MARY ROAD IMPROVEMENT

KOCKS INGENIEURE

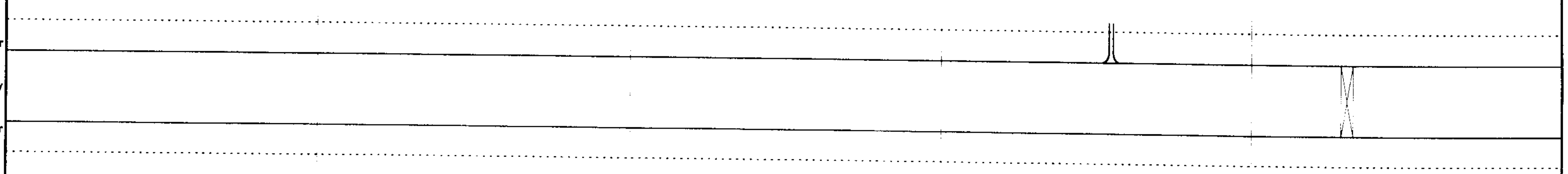
Section: M 37; km 80+000 to km 85+000

Location: Junction km 83,550; Bridge km 84,306

Station (km + m): 80+000, 80+200, 80+400, 80+600, 80+800, 81+000, 81+200, 81+400, 81+600, 81+800, 82+000, 82+200, 82+400, 82+600, 82+800, 83+000, 83+200, 83+400, 83+600, 83+800, 84+000, 84+200, 84+400, 84+600, 84+800

Station	80+000	81+000	82+000	83+000	84+000
Width of Carriageway (m)	9.10	8.90	8.80	9.00	8.80
Width of Shoulders, Left (m)	2.70	3.90	3.60	3.40	2.90
Width of Shoulders, Right (m)	3.40	3.70	3.60	3.20	3.10

Layout: Shoulder / Carriageway / Shoulder



Road Condition Survey: January '97	Unit	km 80	km 81	km 82	km 83	km 84
Cracks	m²	30	50	130	135	40
Alligator Cracks	m²	1,287	620	830	1,980	4,380
Potholes	m²	117	120	145	820	750
Settlement	m²	138	25	42		20
Rutting 0-10 mm	m²	1,733	340	340	340	320
Rutting >10 mm	m²	1,283				313
Patching	m²					

Roughness (IRI): < 4.0 m/km; > 4.0 - 6.0 m/km; > 6.0 - 8.5 m/km; > 8.5 - 10.5 m/km; > 10.5 - 12.0 m/km; > 12.0 m/km — change points 82670, 83670

	km 80	km 81	km 82	km 83	km 84
Road Condition Class	3	2B-3	2B-3	3	3
Pavement Structure, Existing (mm)	90 Bituminous pavement; 300 Gravel, sandy; Fine sand, silty		20 Bituminous pavement; 120 Gravel, sandy; Fine sand, silty	40 Bituminous pavement; 340 Gravel, sandy; Fine sand, silty	

DPL: 0 - 1.5 m (min. blows/10 cm)	Unit	80+000	81+000	82+000	83+000	84+000
0.1 - 0.5	No	15	15	9	13	25
0.5 - 1.0	No	10	6	7	9	20
1.0 - 1.5	No	7	5	10	6	10

CBR: Basecourse CBRo/CBRw; Fill CBRo/CBRw

FWD Results: from Stat. to Stat.	Overlay needed for 15 Year (mm)	Remaining Lifetime (Years)
80000 – 80950	70	4
80950 – 81850	45	8
81850 – 82750	25	5
82750 – 83350	15	7
83350 – 83950	50	3
83950 – 84550	30	10
84550 –	90	1

Final Visual Inspection: April '97

Rows: Cracks; Big Cracks; Cracks + Grass; Alligator Cracks; Big Alligator Cracks; Potholes in W/C (m²); Deformations <4 cm; Deformations >4 cm; Rutting <4 cm; Rutting >4 cm; Failures; Surf. open text./small potholes; Miscellaneous

- Big Cracks: surface cracked (km 84+600 – 84+800)
- Deformations <4 cm: 3 (km 80+600); 2-3 2-3 2 3-3.5 3 (km 81+000 – 81+400); 60; d=20 cm
- Deformations >4 cm: 2-5 6
- Rutting <4 cm: 5; 6
- Rutting >4 cm: 1-2.5 1-2 2-2.5 1-2 1-1.5 1.5-2.5 1.5-2.5 1-2 1-2.5 1-3.5 1.5-3 1.5-2.5 1.0 2-4 2-4 3-3.5 1.5-3.5 1.5-2.5 3 3 1-5-2
- Failures: 4
- Surf. open text./small potholes: small potholes
- Miscellaneous: surface completely cracked

Measures: "O" - Overlay; "R" - Reconstruction; "N. A." - New Alignment; "W" - Widening of Road

From	To	Measure
80000	81000	"O" 75 mm
81000	81200	"O" 40
81200	81350	"O" 40, "W"
81350	83400	"O" 40 mm
83400		"R"

KOCKS
INGENIEURE

Section: M 37; km 85+000 to km 90+000

			85+000 – 85+800	86+000 – 86+800	87+000 – 87+800	88+000 – 88+800	89+000 – 89+800
Location			Culvert km 85,719	Junction km 86,560			
Station		km + m	85+000, 85+200, 85+400, 85+600, 85+800	86+000, 86+200, 86+400, 86+600, 86+800	87+000, 87+200, 87+400, 87+600, 87+800	88+000, 88+200, 88+400, 88+600, 88+800	89+000, 89+200, 89+400, 89+600, 89+800
Width of Carriageway		m	9.00	8.80	8.60	8.90	9.10
Width of Shoulders	Left	m	3.20	3.20	2.50	3.50	2.90
	Right	m	3.30	3.20	3.40	3.00	3.10
Layout	Shoulder / Carriageway / Shoulder						
Road Condition Survey: January '97	Cracks	m²	115	150	5		6
	Alligator Cracks	m²	570	860	20		
	Potholes	m²	140	120	20	5	4
	Settlement	m²	40		10	130	80
	Rutting 0-10 mm	m²	320	320	1,450		1,000
	Rutting >10 mm	m²	313	313	390	1,644	480
	Patching	m²					
Roughness (IRI):	< 4.0	m/km					
	> 4.0 - 6.0	m/km		86670			
	> 6.0 - 8.5	m/km					
	> 8.5 - 10.5	m/km					
	> 10.5 - 12.0	m/km					
	> 12.0	m/km					
Road Condition Class			3	2B	3	2B	2B
Pavement Structure	Existing	mm	40 Bituminous pavement 330 Gravel, sandy Fine sand, silty			20 Bituminous pavement 250 Gravel, sandy Fine sand, silty	
DPL: 0 - 1.5 m (min. blows/10 cm)	0.1 - 0.5	No	15	26	13	27	12
	0.5 - 1.0	No	6	4	9	10	5
	1.0 - 1.5	No	5	2	5	5	5
CBR:	Basecourse CBRo/CBRw				83.2/63.6		
	Fill CBRo/CBRw				9.8/3.0		
FWD Results:	from Stat. to Stat.		85050, 85650				95000
	Overlay needed for 15 Year	mm	75		10		
	Remaining Lifetime	Years	2		14		
Final Visual Inspection: April '97	Cracks						
	Big Cracks						
	Cracks + Grass						
	Alligator Cracks			192	small		
	Big Alligator Cracks						
	Potholes in W/C	m²					
	Deformations	<4 cm					
	Deformations	>4 cm	5	8	6, 5	5, 5-6	
	Rutting	<4 cm	2-3	1-3.5, 1.5-2.5, 2.5-3.5, 1.5-3, 1-1.5, 2-3, 2-3, 1.5, 2.5	1.5, 1.5-2, 1.5-2, 1.5, 1.5-3	1-2, 2-3, 1.5, 1-2, 1.5-2.5, 1.5-2	1.5-3.5, 1.5, 1.5-2, 2-3, 1.5, 1-2, 1-1.5, 1.5-2
	Rutting	>4 cm	3-5, 2.5-5.5			1.5-4, 3-5, 1.5-4.5, 2.5-5	2.6
	Failures						
	Surf. open text./small potholes						
	Miscellaneous						
Measures:	"O" - Overlay "R" - Reconstruction "N. A." - New Alignment "W" - Widening of Road		85050 – 85650 "O 75" mm	"O" 40 mm			

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

KOCKS
INGENIEURE

Section: M 37; km 90+000 to km 95+000

Location												Junction km 91,775						Junction km 93,035 Pipeline km 92,975 Junction km 92,935					Pipeline km 94,110	Culvert km 94,305			
Station		km + m	90 +000	90 +200	90 +400	90 +600	90 +800	91 +000	91 +200	91 +400	91 +600	91 +800	92 +000	92 +200	92 +400	92 +600	92 +800	93 +000	93 +200	93 +400	93 +600	93 +800	94 +000	94 +200	94 +400	94 +600	94 +800
Width of Carriageway		m	9.00					8.60					11.10					8.50					8.40				
Width of Shoulders	Left	m	3.30					3.20					2.80					3.00					3.00				
	Right	m	3.30					3.20					3.30					3.50					3.00				
Layout	Shoulder																										
	Carriageway																										
	Shoulder																										
Road Condition Survey: January '97	**Cracks**	m²																									
	Alligator Cracks	m²																									
	Potholes	m²																							161		
	Settlement	m²			20										8										79		
	Rutting 0-10 mm	m²			1,200					1,200					1,200					1,200					30		
	Rutting >10 mm	m²			2,040					2,040					2,040					2,040					1,340		
	Patching	m²																							540		
Roughness (IRI):	**< 4.0**	m/km																									
	> 4.0 - 6.0	m/km																									
	> 6.0 - 8.5	m/km														92670											
	> 8.5 - 10.5	m/km																								94670	
	> 10.5 - 12.0	m/km																									
	> 12.0	m/km																									
Road Condition Class					2B-3					2B-3					3					3					3		
Pavement Structure	**Existing**	mm							30 Bituminous pavement 340 Gravel, sandy Fine sand, silty															50 Bituminous pavement 290 Gravel, sandy Fine sand, silty			
DPL: 0 - 1.5 m (min. blows/10 cm)	**0.1 - 0.5**	No	18					8					35					8					18				
	0.5 - 1.0	No	9					16					13					10					13				
	1.0 - 1.5	No	10					16					9					6					5				
CBR:	**Basecourse** CBRo/CBRw																										
	Fill CBRo/CBRw																										
FWD Results:	from Stat. to Stat.																										95000
	Overlay needed for 15 Year	mm													10												
	Remaining Lifetime	Years													14												
Final Visual Inspection: April '97	**Cracks**																										
	Big Cracks																										
	Cracks + Grass																										
	Alligator Cracks																										
	Big Alligator Cracks																										
	Potholes in W/C	m²																									
	Deformations	<4 cm																									
	Deformations	>4 cm																									
	Rutting	<4 cm	1.5	1.5 1.5-2	1.5-2.5 2.5-3	1.5-2.5 2-4.5	2-3	2 2-3	1.5-2.5 2.5 1.5	1-4 1.5-2	1.5	1.5			2.5-3.5	2-5 3-4 2.5-3.5	2.5-3	1.5-3 1-1.5	1-2 1.5-3	1-2.5 1.5	1.0 1.5-2		1.5-2.5 2 2-3		2.5	2.5 1.5	
	Rutting	>4 cm															1.5-7.5					3-6		3-9 4-7			
	Failures																										
	Surf. open text./small potholes																										
	Miscellaneous																									smaller potholes and patching	
Measures:	**"O" - Overlay** **"R" - Reconstruction** **"N. A." - New Alignment** **"W" - Widening of Road**								**"O" 40 mm**							92670				**"R" (deformed)**						94670 **"O" 40 mm**	

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

Section: M 37; km 95+000 to km 100+000

KOCKS
INGENIEURE

		Unit	km 95	km 96	km 97	km 98	km 99
Location			Culvert km 95,575		Culvert km 97,098	Junction km 98,025	Junction km 99,440
Station		km + m	95 +000, 95 +200, 95 +400, 95 +600, 95 +800	96 +000, 96 +200, 96 +400, 96 +600, 96 +800	97 +000, 97 +200, 97 +400, 97 +600, 97 +800	98 +000, 98 +200, 98 +400, 98 +600, 98 +800	99 +000, 99 +200, 99 +400, 99 +600, 99 +800
Width of Carriageway		m	7.80	8.20	8.10	8.60	9.50
Width of Shoulders	Left	m	2.60	2.90	2.60	2.70	3.40
	Right	m	2.60	3.00	3.00	2.70	3.10
Layout	Shoulder / Carriageway / Shoulder						
Road Condition Survey: January '97				96000-96774	96774-97140 New pavement		
	Cracks	m²					
	Alligator Cracks	m²	110	135	30	950	690
	Potholes	m²	150	21		75	195
	Settlement	m²	2,499	35	580	15	5
	Rutting 0-10 mm	m²	1,340		1,169	1,376	687
	Rutting >10 mm	m²	540	1,040	2,164	2,543	193
	Patching	m²					
Roughness (IRI):	< 4.0	m/km					
	> 4.0 - 6.0	m/km					
	> 6.0 - 8.5	m/km					
	> 8.5 - 10.5	m/km					
	> 10.5 - 12.0	m/km			97670	98670	
	> 12.0	m/km					
Road Condition Class			3-4	3-4	4	3	3
Pavement Structure	Existing	mm	50 Bituminous pavement 180 Gravel, sandy Fine sand, silty			90 Bituminous pavement 230 Gravel, sandy Fine sand, silty	
DPL: 0 - 1.5 m (min. blows/10 cm)	0.1 - 0.5	No	8	10	3	19	12
	0.5 - 1.0	No	6	11	15	9	15
	1.0 - 1.5	No	10	16	9	3	6
CBR:	Basecourse	CBRo/CBRw					
	Fill	CBRo/CBRw					
FWD Results:	from Stat. to Stat.		95000 – 95950				99250
	Overlay needed for 15 Year	mm	35		145		60
	Remaining Lifetime	Years	12		0		8
Final Visual Inspection: April '97	Cracks						
	Big Cracks						
	Cracks + Grass						
	Alligator Cracks						
	Big Alligator Cracks						
	Potholes in W/C	m²					
	Deformations	<4 cm					
	Deformations	>4 cm					
	Rutting	<4 cm	1.5-2 1.5-2 1.5-3 2-3 1-1.5				
	Rutting	>4 cm					1.5-2.5 1.5-2.5 1-2 2-3 2 2-3 1-2
	Failures						
	Surf. open text./small potholes						
	Miscellaneous		Patching+cracks+deform.				
Measures:	"O" - Overlay "R" - Reconstruction "W" - Widening of Road "W" - Wideing of Road		"O" 40 mm (95000 – 95950)	"R" (95950 – 99250)			"O" 75 mm (from 99250)

Implementation of Pavement Management Systems (Project No. TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

KOCKS INGENIEURE

Section: M 37; km 100+000 to km 105+000

Location																											
Station		km + m	100 +000	100 +200	100 +400	100 +600	100 +800	101 +000	101 +200	101 +400	101 +600	101 +800	102 +000	102 +200	102 +400	102 +600	102 +800	103 +000	103 +200	103 +400	103 +600	103 +800	104 +000	104 +200	104 +400	104 +600	104 +800
Width of Carriageway		m	9.20					8.40					8.20					8.00					8.70				
Width of Shoulders	**Left**	m	2.60					2.80					3.50					3.30					3.00				
	Right	m	3.40					3.10					2.70					3.20					3.30				
Layout	**Shoulder**																										
	Carriageway																										
	Shoulder																										
Road Condition Survey: January '97	**Cracks**	m²			160										12					10					2		
	Alligator Cracks	m²			2,024					2,085					4,200					3,000					3,200		
	Potholes	m²			89										4					40					65		
	Settlement	m²			175					166					28					6							
	Rutting 0-10 mm	m²			687					687																	
	Rutting >10 mm	m²			193					193					480					160							
	Patching	m²																									
Roughness (IRI):	**< 4.0**	m/km																									
	> 4.0 - 6.0	m/km																									
	> 6.0 - 8.5	m/km																									
	> 8.5 - 10.5	m/km																									
	> 10.5 - 12.0	m/km																									
	> 12.0	m/km																									
Road Condition Class					3					3					3					3					2B		
Pavement Structure	**Existing**	mm	300 Bituminous pavement 140 Gravel, sandy Fine sand, silty															50 Bituminous pavement 220 Gravel, sandy Fine sand, silty									
DPL: 0 - 1.5 m (min. blows/10 cm)	**0.1 - 0.5**	No	7					21					13					18					22				
	0.5 - 1.0	No	10					17					5					5					7				
	1.0 - 1.5	No	6					17					5					4					7				
CBR:	**Basecourse CBRo/CBRw**							83.2/63.6																			
	Fill CBRo/CBRw							13.6/8.5																			
FWD Results:	**from Stat. to Stat.**			100350								101950					102850			103450					104350		104850
	Overlay needed for 15 Year	mm	60					125						145		130		145				145				105	145
	Remaining Lifetime	Years	8					0						0		0		0				0				1	1
Final Visual Inspection: April '97	**Cracks**																										
	Big Cracks																										
	Cracks + Grass																										
	Alligator Cracks																										
	Big Alligator Cracks																										
	Potholes in W/C	m²													Since this section was foreseen in the first draft to be reconstructed,												
	Deformations	<4 cm													no further inspection has been carried out.												
	Deformations	>4 cm													Refer to above mentioned distresses.												
	Rutting	<4 cm	1-3	1-3 1-3																							
	Rutting	>4 cm																									
	Failures																										
	Surf. open text./small potholes																										
	Miscellaneous																										
Measures:	**"O" - Overlay**			100350																							
	"R" - Reconstruction		"O" 75 mm												"R"												
	"N. A." - New Alignment																										
	"W" - Widening of Road																										

Implementation of Pavement Management Systems (Project No. TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

KOCKS
INGENIEURE

Section: M 37; km 105+000 to km 110+000

		Unit	km 105	km 106	km 107	km 108	km 109
Location				Junction km 106,560; Junction km 106,730	Junction km 107,427		
Station		km + m	105 +000, 105 +200, 105 +400, 105 +600, 105 +800	106 +000, 106 +200, 106 +400, 106 +600, 106 +800	107 +000, 107 +200, 107 +400, 107 +600, 107 +800	108 +000, 108 +200, 108 +400, 108 +600, 108 +800	109 +000, 109 +200, 109 +400, 109 +600, 109 +800
Width of Carriageway		m	8.60	8.60	8.20	8.80	8.60
Width of Shoulders	**Left**	m	3.00	3.30	3.60	3.20	3.10
	Right	m	3.40	3.10	3.10	3.30	3.50
Layout	Shoulder / Carriageway / Shoulder						
Road Condition Survey: January '97	Cracks	m²			107000-107900	10790-108870	108870-109870
	Alligator Cracks	m²	4,700	3,200	15	5	2
	Potholes	m²	50	5	1,330	5,840	200
	Settlement	m²	10		80	30	100
	Rutting 0-10 mm	m²			230	80	80
	Rutting >10 mm	m²			160		400
	Patching	m²			440	40	100
Roughness (IRI):	**< 4.0**	m/km					10
	> 4.0 - 6.0	m/km					
	> 6.0 - 8.5	m/km					109670
	> 8.5 - 10.5	m/km					
	> 10.5 - 12.0	m/km					
	> 12.0	m/km					
Road Condition Class			2B	2B	3	3	2B-3
Pavement Structure	**Existing**	mm	20 Bituminous pavement; 120 Gravel, sandy; Fine sand, silty			110 Bituminous pavement; 290 Gravel, sandy; Fine sand, silty	
DPL: 0 - 1.5 m (min. blows/10 cm)	**0.1 - 0.5**	No	7	11	13	10	20
	0.5 - 1.0	No	11	8	4	9	10
	1.0 - 1.5	No	4	5	5	9	7
CBR:	**Basecourse**	CBRo/CBRw					
	Fill	CBRo/CBRw					
FWD Results:	**from Stat. to Stat.**					108250 - 108750	108750 - 109550; 109550 - 110000
	Overlay needed for 15 Year	mm		145		110	70; 145
	Remaining Lifetime	Years		0		2	2; 1
Final Visual Inspection: April '97	**Cracks**						
	Big Cracks					larger cracks allover, pot holes up to 50 cm, depth = 3 cm (W/C layer)	
	Cracks + Grass						
	Alligator Cracks						Since this section was foreseen in the first draft to be reconstructed, no further inspection has been carried out. Refer to above mentioned distresses.
	Big Alligator Cracks						
	Potholes in W/C	m²					
	Deformations	<4 cm					
	Deformations	>4 cm					
	Rutting	<4 cm				2-5	5
	Rutting	>4 cm					
	Failures						
	Surf. open text./small potholes						
	Miscellaneous						
Measures:	**"O" - Overlay**; **"R" - Reconstruction**; **"W" - Widening of Road**; **"W" - Widening of Road**		"R" (deformed)				

Section: M 37; km 110+000 to km 115+000

KOCKS
INGENIEURE

Location

Junction km 110,280
Junction km 110,390
Junction km 110,440
Junction km 112,000

Station (km + m)

110 +000, 110 +200, 110 +400, 110 +600, 110 +800, 111 +000, 111 +200, 111 +400, 111 +600, 111 +800, 112 +000, 112 +200, 112 +400, 112 +600, 112 +800, 113 +000, 113 +200, 113 +400, 113 +600, 113 +800, 114 +000, 114 +200, 114 +400, 114 +600, 114 +800

Station	Width of Carriageway (m)	Width of Shoulders Left (m)	Width of Shoulders Right (m)
110 +000	8.50	3.40	3.50
111 +000	9.30	4.00	3.90
112 +000	9.10	2.90	3.30
113 +000	8.70	3.30	3.10
114 +000	9.10	2.70	2.80

Layout

Shoulder
Carriageway
Shoulder

Road Condition Survey: January '97

	Unit	109870-110850	110850-111850	111850-112850	112850-113830	113830-114830
Cracks	m²	2	20	30	35	
Alligator Cracks	m²	80	250			
Potholes	m²	20	330	35	190	
Settlement	m²	90	10			100
Rutting 0-10 mm	m²	160				110
Rutting >10 mm	m²	20	95			
Patching	m²	10		1,260	2,360	320
				5	10	

Roughness (IRI):

< 4.0 m/km
> 4.0 - 6.0 m/km: 110000-110670
> 6.0 - 8.5 m/km: 110670-111670; 111670-114670
> 8.5 - 10.5 m/km
> 10.5 - 12.0 m/km: 114670-
> 12.0 m/km

Road Condition Class: 2B-3 (from 110+000); 2B (from 111+000); 3 (from 112+000); 3 (from 113+000); 2B-3 (from 114+000)

Pavement Structure – Existing (mm)

- 110+000: 130 Bituminous pavement, 290 Gravel, sandy, Fine sand, silty
- 111+000: 100 Bituminous pavement, 250 Gravel, sandy, Fine sand, silty
- 114+000: 130 Bituminous pavement, 270 Gravel, sandy, Fine sand, silty

DPL: 0 - 1.5 m (min. blows/10 cm)

	Unit	110+000	111+000	112+000	113+000	114+000
0.1 - 0.5	No	16	11	14	16	20
0.5 - 1.0	No	9	7	6	9	18
1.0 - 1.5	No	6	5	5	15	14

CBR:

Basecourse CBRo/CBRw: 48.1/31.1 (114+000)
Fill CBRo/CBRw: 6.3/3.0 (114+000)

FWD Results:

from Stat. to Stat.	Overlay needed for 15 Year (mm)	Remaining Lifetime (Years)
110000-110750	110	0
110750-111450	65	2
111450-111950	110	0
111950-112650	20	5
112650-113050	105	2
113050-113750	65	2
113750-	15	10

Final Visual Inspection: April '97

Cracks: smaller cracks; larger cr.; in centerline area
Big Cracks
Cracks + Grass
Alligator Cracks
Big Alligator Cracks
Potholes in W/C (m²): smaller potholes; bigger potholes
Deformations <4 cm
Deformations >4 cm: 5; 5; 5; 6.5; 8; 6; 8; 5; 3
Rutting <4 cm: 2.5-5; 2-4; 2-3.5; 2.5-3.5; 2.5-3; 2-3; 1-3; 1-2; 1-3; 1-2; 1-3; 1.5-2.5; 1-2
Rutting >4 cm: 2.5-6.5; 2.5-5; 3-5; 1-5
Failures
Surf. open text./small potholes: centerline area partly surf. open and cracked; partly surface open structure
Miscellaneous

Measures:

"O" - Overlay
"R" - Reconstruction
"W" - Widening of Road
"W" - Wideing of Road

"R" (110+000 to 113750)
113750
"O" 40 mm (113750 to 115+000)

KOCKS INGENIEURE

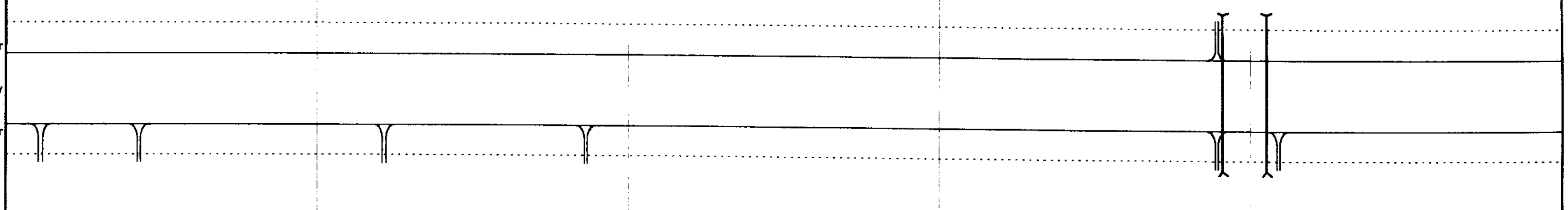
Section: M 37; km 115+000 to km 120+000

Location: Junction km 115,110; Junction km 115,420; Junction km 116,210; Junction km 116,860; Culvert km 118,905; Junctions km 118,900; Culvert km 119,058; Junction km 119,080

Station (km + m): 115 +000, 115 +200, 115 +400, 115 +600, 115 +800, 116 +000, 116 +200, 116 +400, 116 +600, 116 +800, 117 +000, 117 +200, 117 +400, 117 +600, 117 +800, 118 +000, 118 +200, 118 +400, 118 +600, 118 +800, 119 +000, 119 +200, 119 +400, 119 +600, 119 +800

	115 +000	116 +000	117 +000	118 +000	119 +000
Width of Carriageway (m)	8.80	8.90	9.50	8.90	8.80
Width of Shoulders Left (m)	2.90	3.20	3.90	2.60	3.40
Width of Shoulders Right (m)	2.90	3.50	3.20	2.70	3.50

Layout



Road Condition Survey: January '97		114830-115720	115720-116970	116970-117800	117800-118790	118790-119780
Cracks	m²			10	65	10
Alligator Cracks	m²		9,000	720	3,900	70
Potholes	m²			150	34	67
Settlement	m²	100				30
Rutting 0-10 mm	m²	80				1,220
Rutting >10 mm	m²					150
Patching	m²					

Roughness (IRI): < 4.0 m/km; > 4.0 - 6.0 m/km; > 6.0 - 8.5 m/km; > 8.5 - 10.5 m/km; > 10.5 - 12.0 m/km; > 12.0 m/km — 119670

Road Condition Class	2B	2B	2B-3	3	2B-3

Pavement Structure – Existing (mm):

- at 116+000: 30 Bituminous pavement; 170 Gravel, sandy; Fine sand, silty
- at 118+000: 20 - 100 Bituminous pavement; 160 - 250 Gravel, sandy; Fine sand, silty

DPL: 0 - 1.5 m (min. blows/10 cm)		115 +000	116 +000	117 +000	118 +000	119 +000
0.1 - 0.5	No	13	15	13	8	22
0.5 - 1.0	No	8	7	5	5	9
1.0 - 1.5	No	10	6	3	5	3

CBR: Basecourse CBRo/CBRw; Fill CBRo/CBRw

FWD Results: from Stat. to Stat.	– 116450	116450 – 117250	117250 – 118350	118350 – 119150	119150 – 119850
Overlay needed for 15 Year (mm)	15	25	125	65	115
Remaining Lifetime (Years)	10	5	2	2	1

Final Visual Inspection: April '97

Cracks; Big Cracks; Cracks + Grass; Alligator Cracks; Big Alligator Cracks; Potholes in W/C (m²); Deformations <4 cm; Deformations >4 cm; Rutting <4 cm; Rutting >4 cm; Failures; Surf. open text./small potholes; Miscellaneous

- Big Cracks: centerline area; biggercracks on whole surface; centerline area
- Potholes in W/C: d=0.5 m; centerline area; d=1 m
- Deformations <4 cm: 3
- Rutting <4 cm: 1-2, 1-2, 1-2, 2-3, 2, 2-2.5, 2, 2-3, 1-2, 1-2.5, 1-2, 1-2, 2-3, 2-3; 5, 6-7
- Rutting >4 cm: 5, 6-7
- Miscellaneous: centerline area

Measures: "O" - Overlay; "R" - Reconstruction; "W" - Widening of Road; "W" - Wideing of Road

- "O" 40 mm (115+000 to 117250)
- "R" (117250 to 120+000)

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

Section: M 37; km 120+000 to km 125+000

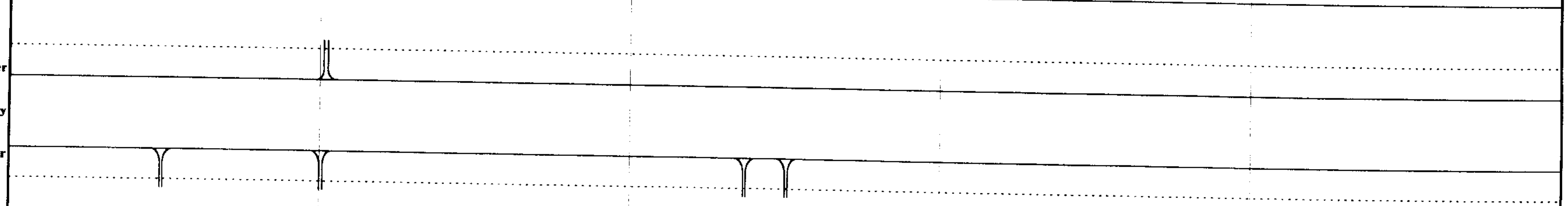
KOCKS
INGENIEURE

Location: Junction km 120,480; Junction km 121,000; Junction km 121,010; Junction km 122,380; Junction km 122,510

Station (km + m): 120 +000, 120 +200, 120 +400, 120 +600, 120 +800, 121 +000, 121 +200, 121 +400, 121 +600, 121 +800, 122 +000, 122 +200, 122 +400, 122 +600, 122 +800, 123 +000, 123 +200, 123 +400, 123 +600, 123 +800, 124 +000, 124 +200, 124 +400, 124 +600, 124 +800

		120 +000	121 +000	122 +000	123 +000
Width of Carriageway	m	9.00	12.50	8.80	9.10
Width of Shoulders, Left	m	3.30	3.80	3.20	3.00
Width of Shoulders, Right	m	3.30	3.80	3.40	3.20

Layout: Shoulder / Carriageway / Shoulder



Road Condition Survey: January '97

	Unit	119780-120780	120780-121780	212780-122560	122560-123000	123+000 – 124+000	124+000 – 125+000
Cracks	m²	60	22	28	450	900	900
Alligator Cracks	m²	1,590	550	320	978	1,956	1,956
Potholes	m²	53	135	20	10	20	20
Settlement	m²		220	80	600	1,200	1,200
Rutting 0-10 mm	m²		580		230	460	460
Rutting >10 mm	m²			80			
Patching	m²						

Roughness (IRI):

	Unit	122560-123000	123+000 – 124+000	124+000 – 125+000
< 4.0	m/km	56	112	112
> 4.0 - 6.0	m/km			
> 6.0 - 8.5	m/km			
> 8.5 - 10.5	m/km			
> 10.5 - 12.0	m/km			
> 12.0	m/km			

Road Condition Class: 2B-3 (120+000 – 121+000); 3 (121+000 – 122+000); 3 (122+000 – 122+560); 2B-3 (122+560 – 123+000); 2B-3 (123+000 – 124+000); 2B (124+000 – 125+000)

Pavement Structure, Existing (mm):

- at 122+000: 80 Bituminous pavement; 270 Gravel, sandy; Fine sand, silty
- at 124+000: 40 Bituminous pavement; 270 Gravel, sandy; Fine sand, silty

DPL: 0 - 1.5 m (min. blows/10 cm)

	Unit	120 +000	121 +000	122 +000	123 +000	124 +000
0.1 - 0.5	No	11	17	15	29	16
0.5 - 1.0	No	8	9	12	19	5
1.0 - 1.5	No	6	6	6	17	4

CBR: Basecourse CBRo/CBRw; Fill CBRo/CBRw

FWD Results:

from Stat. to Stat.	120000-120450	120450-121550	121550-122000	122000-123550	123550-124450	124450-
Overlay needed for 15 Year (mm)	55	100	110	115	65	10
Remaining Lifetime (Years)	1	2	1	0	4	11

Final Visual Inspection: April '97

Cracks; Big Cracks; Cracks + Grass; Alligator Cracks; Big Alligator Cracks; Potholes in W/C (m²); Deformations (<4 cm); Deformations (>4 cm); Rutting (<4 cm); Rutting (>4 cm); Failures; Surf. open text./small potholes; Miscellaneous

- 121+600 – 122+000: Rutting <4 cm: 6; Failures: 6
- 124+000 – 124+200: Deformations >4 cm: 240
- 124+400 – 124+800: Failures: 2-4, 2-3, 2.5-3, 2-3, 2.5-4; centerline area

Since this section was foreseen in the first draft to be overlayed with 120 mm bit. mix, no further inspection has been carried out. Refer to above mentioned distresses.

Measures: "O" - Overlay; "R" - Reconstruction; "W" - Widening of Road; "W" - Wideing of Road

120000 – 120450	120450 – 121550	121550 – 123550	123550 – 124450	124450 – 125000
"O" 75 mm	"O" 100 mm	"R"	"O" 75 mm	"O" 40 mm

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

KOCKS
INGENIEURE

Section: M 37; km 125+000 to km 130+000

Item	Sub-item	Unit	Entries along chainage (km 125+000 → 129+800)
Location			Pipeline km 126,610
Station		km + m	125 +000; 125 +200; 125 +400; 125 +600; 125 +800; 126 +000; 126 +200; 126 +400; 126 +600; 126 +800; 127 +000; 127 +200; 127 +400; 127 +600; 127 +800; 128 +000; 128 +200; 128 +400; 128 +600; 128 +800; 129 +000; 129 +200; 129 +400; 129 +600; 129 +800
Width of Carriageway		m	9.00 (at 127+000)
Width of Shoulders	Left	m	3.00 (at 127+000)
	Right	m	3.00 (at 127+000)
Layout	Shoulder		
	Carriageway		
	Shoulder		
Road Condition Survey: January '97	Cracks	m^2	
	Alligator Cracks	m^2	
	Potholes	m^2	1,488
	Settlement	m^2	1,040
	Rutting 0-10 mm	m^2	440
	Rutting >10 mm	m^2	1,960; 1,960; 1,960; 1,960
	Patching	m^2	800
Roughness (IRI):	< 4.0	m/km	48
	> 4.0 - 6.0	m/km	
	> 6.0 - 8.5	m/km	129670
	> 8.5 - 10.5	m/km	
	> 10.5 - 12.0	m/km	
	> 12.0	m/km	
Road Condition Class			2B-3; 2B-3; 2B-3; 2B-3; 2B-3
Pavement Structure	Existing	mm	50/30 Bituminous pavement; 210 - 390 Gravel, sandy; Silt, fine sandy
DPL: 0 - 1.5 m (min. blows/10 cm)	0.1 - 0.5	No	33; 9; 17; 18; 10
	0.5 - 1.0	No	16; 8; 14; 25; 8
	1.0 - 1.5	No	7; 11; 8; –; 16
CBR:	Basecourse	CBRo/CBRw	
	Fill	CBRo/CBRw	
FWD Results:	from Stat. to Stat.		125050; 125450; 126550; 127350; 128050; 128850; 129450
	Overlay needed for 15 Year	mm	145; 90; 35; 140; 80; 30; 100
	Remaining Lifetime	Years	0; 2; 14; 0; 1; 6; 6
Final Visual Inspection: April '97	Cracks		
	Big Cracks		centerline area and LHS; map cracking
	Cracks + Grass		
	Alligator Cracks		
	Big Alligator Cracks		1857
	Potholes in W/C	m^2	
	Deformations	<4 cm	2-3.5; 1-3.5; 3-4
	Deformations	>4 cm	7; 7
	Rutting	<4 cm	9; 11
	Rutting	>4 cm	2.5; 2-3.5; 1.5-3; 1-2
	Failures		
	Surf. open text./small potholes		
	Miscellaneous		
Measures:	"O" - Overlay; "R" - Reconstruction; "N. A." - New Alignment; "W" - Widening of Road		R 40; 125050 – 125450 "R"; "O" 100 mm; 127000 – 127350 "O" 40; "R" (deformed); 128520; "O" 100 mm

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

KOCKS
INGENIEURE

Section: M 37; km 130+000 to km 135+000

Location: Bridge km 134,076; Junctions km 134,600; Junction km 134,800

Station (km + m): 130 +000, 130 +200, 130 +400, 130 +600, 130 +800, 131 +000, 131 +200, 131 +400, 131 +600, 131 +800, 132 +000, 132 +200, 132 +400, 132 +600, 132 +800, 133 +000, 133 +200, 133 +400, 133 +600, 133 +800, 134 +000, 134 +200, 134 +400, 134 +600, 134 +800

Width of Carriageway (m): 8,00 (at 133 +000)

Width of Shoulders: Left (m) 2,00; Right (m) 2,00 (at 133 +000)

Layout: Shoulder / Carriageway / Shoulder

		130+000 – 131+000	131000-131500	131500-132000	132+000 – 133+000	133+000 – 134+000	134+000 – 135+000
Road Condition Survey: January '97							
Cracks	m²			433	867		
Alligator Cracks	m²	1.488	744	483	967	110	110
Potholes	m²	1.040	520			2 140	2.140
Settlement	m²	440	220				
Rutting 0-10 mm	m²			593	1.187	1.120	1.120
Rutting >10 mm	m²	800	400	77	153	75	75
Patching	m²	48	24	43	87	100	100
Roughness (IRI):							
< 4.0	m/km						
> 4.0 - 6.0	m/km						
> 6.0 - 8.5	m/km				132670		
> 8.5 - 10.5	m/km					133670	134670
> 10.5 - 12.0	m/km						
> 12.0	m/km						
Road Condition Class		2B-3	2B-3	3	2B	3	2B-3
Pavement Structure Existing	mm	70 Bituminous pavement 420 Gravel, sandy Fine sand, silty			30 Bituminous pavement 280 Gravel, sandy Fine sand, silty		80 Bituminous pavement 280 Gravel, sandy Fine sand, silty

DPL: 0 - 1.5 m (min. blows/10 cm)		130 +000	131 +000	132 +000	133 +000	134 +000
0.1 - 0.5	No	11	27	18	10	18
0.5 - 1.0	No	8	7	20	8	10
1.0 - 1.5	No	4	6	7	7	6
CBR: Basecourse	CBRo/CBRw			31.6/19.5		
Fill	CBRo/CBRw			9.0/6.8		

FWD Results: from Stat. to Stat.	130000-130350	130350-130750	130750-131550	131550-132250	132250-133050	133050-134050	134050-134450	134450-135000
Overlay needed for 15 Year mm	100	145	85	70	60	40	145	135
Remaining Lifetime Years	6	0	3	4	2	1	0	0

Final Visual Inspection: April '97

Cracks		map cracking
Big Cracks		
Cracks + Grass		
Alligator Cracks		
Big Alligator Cracks		
Potholes in W/C	m²	
Deformations	<4 cm	
Deformations	>4 cm	
Rutting	<4 cm	
Rutting	>4 cm	
Failures		
Surf. open text./small potholes		
Miscellaneous		

Measures:
"O" - Overlay
"R" - Reconstruction
"W" - Widening of Road
"W" - Wideing of Road

130000-130350	130350-130750	130750-131550	131550-133050	133050-134050	134050-135000
"O" 100 mm	"R"	"O" 100 mm	"O" 75 mm	"O" 40 mm	"R"

Implementation of Pavement Management Systems (Project No: TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

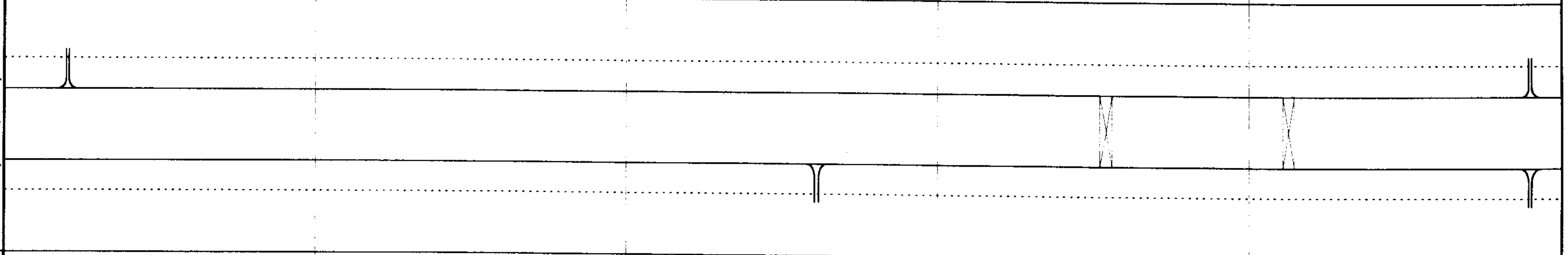
Section: M 37; km 135+000 to km 140+000

KOCKS
INGENIEURE

Item		Unit	km 135+000 – 136+000	km 136+000 – 137+000	km 137+000 – 138+000	km 138+000 – 139+000	km 139+000 – 140+000
Location			Junction km 135,200		Junction km 137,600	Bridge km 138,552	Bridge km 139,133; Junctions km 139,900
Station		km + m	135 +000, 135 +200, 135 +400, 135 +600, 135 +800	136 +000, 136 +200, 136 +400, 136 +600, 136 +800	137 +000, 137 +200, 137 +400, 137 +600, 137 +800	138 +000, 138 +200, 138 +400, 138 +600, 138 +800	139 +000, 139 +200, 139 +400, 139 +600, 139 +800
Width of Carriageway		m			7.00		
Width of Shoulders	**Left**	m			2.00		
	Right	m			2.00		

Layout

Shoulder
Carriageway
Shoulder



Item		Unit	km 135+000 – 136+000	km 136+000 – 137+000	km 137+000 – 138+000		km 138+000 – 139+000	km 139+000 – 140+000
Road Condition Survey: January '97					137000-137500	137500-138000		
	Cracks	m²	50	50	25	108	216	216
	Alligator Cracks	m²	344	344	172	449	898	898
	Potholes	m²	36	36	18	2	3	3
	Settlement	m²	1,680	1,680	840	110	220	220
	Rutting 0-10 mm	m²	216	216	108	136	272	272
	Rutting >10 mm	m²						
	Patching	m²						
Roughness (IRI):	**< 4.0**	m/km						
	> 4.0 - 6.0	m/km						
	> 6.0 - 8.5	m/km		136670				
	> 8.5 - 10.5	m/km					138670	
	> 10.5 - 12.0	m/km						139670
	> 12.0	m/km						
Road Condition Class			3	3-4	3	3	3	4
Pavement Structure	**Existing**	mm		80 Bituminous pavement 230 Gravel, sandy Silt, fine sandy			90 Bituminous pavement 400 Gravel, sandy Silt, fine sandy	
DPL: 0 - 1.5 m (min. blows/10 cm)	**0.1 - 0.5**	No	10	13	12		16	11
	0.5 - 1.0	No	1	9	8		9	5
	1.0 - 1.5	No	12	8	18		14	7
CBR:	**Basecourse**	CBRo/CBRw						
	Fill	CBRo/CBRw						
FWD Results:	**from Stat. to Stat.**		135050 – 135750; 135750 – 136150	136150 – 139850				139850
	Overlay needed for 15 Year	mm	115; 40				145	
	Remaining Lifetime	Years	0; 6				0	
Final Visual Inspection: April '97	**Cracks**							
	Big Cracks							
	Cracks + Grass							
	Alligator Cracks							
	Big Alligator Cracks							
	Potholes in W/C	m²						
	Deformations	<4 cm						
	Deformations	>4 cm						
	Rutting	<4 cm	1.5-2; 1-2; 2					
	Rutting	>4 cm		2-6				
	Failures							
	Surf. open text./small potholes							
	Miscellaneous							
Measures:	**"O" - Overlay** **"R" - Reconstruction** **"W" - Widening of Road** **"W" - Wideing of Road**		"R" (deformed)					

Since this section was foreseen in the first draft to be reconstructed, no further inspection has been carried out. Refer to above mentioned distresses.

Implementation of Pavement Management Systems (Project No TELREG 9305)
TEDJEN - MARY ROAD IMPROVEMENT

Section: M 37; km 140+000 to km 142+300

KOCKS
INGENIEURE

Item	Sub-item	Unit	Values
Location			Bridge km 140,254; Bridge km 140,393; Bridge km 141,192; Bridge km 142,340
Station		km + m	140 +000; 140 +200; 140 +400; 140 +600; 140 +800; 141 +000; 141 +200; 141 +400; 141 +600; 141 +800; 142 +000; 142 +200; 142 +400; 142 +600
Width of Carriageway		m	8.10; 10.00; 13.00; 15.00
Width of Shoulders	Left	m	3.60
	Right	m	3.50
Layout	Shoulder		
	Carriageway		
	Shoulder		
Road Condition Survey: January '97			141000-142300
	Cracks	m²	109; 141
	Alligator Cracks	m²	235; 305
	Potholes	m²	
	Settlement	m²	87; 113
	Rutting 0-10 mm	m²	391; 509
	Rutting >10 mm	m²	
	Patching	m²	
Roughness (IRI):	< 4.0	m/km	
	> 4.0 - 6.0	m/km	
	> 6.0 - 8.5	m/km	
	> 8.5 - 10.5	m/km	140670; 142670
	> 10.5 - 12.0	m/km	
	> 12.0	m/km	
Road Condition Class			3; 3
Pavement Structure	Existing	mm	
DPL: 0 - 1.5 m (min. blows/10 cm)	0.1 - 0.5	No	16; 15; 19
	0.5 - 1.0	No	9; 11; 6
	1.0 - 1.5	No	7; 10; 6
CBR:	Basecourse CBRo/CBRw		51.1/23.0
	Fill CBRo/CBRw		17.5/3.5
FWD Results:	from Stat. to Stat.		140350; 142000
	Overlay needed for 15 Year	mm	120; 40
	Remaining Lifetime	Years	3; 13
Final Visual Inspection: April '97	Cracks		map cracking; some
	Big Cracks		
	Cracks + Grass		
	Alligator Cracks		
	Big Alligator Cracks		
	Potholes in W/C	m²	some
	Deformations	<4 cm	
	Deformations	>4 cm	6
	Rutting	<4 cm	1.5-2.5; 1-2.5; 1-1.5; 2-5; 2; 1.5; 2-4; 1-3
	Rutting	>4 cm	
	Failures		
	Surf. open text./small potholes		
	Miscellaneous		in front of roundabout 800 m² to be repaired
Measures:	"O" - Overlay		140350; 142527
	"R" - Reconstruction		"R"; "O" 40 mm
	"W" - Widening of Road		
	"W" - Wideing of Road		

Annex 1.4: Summary of Road Condition Category and Road Condition Class

SUMMARY OF ROAD CONDITION CATEGORY AND ROAD CONDITION CLASS

Road Condition Class	Road Condition Category	Road Chainge from	to	Measured Length (m)
1 B	good			
		49+000	51+000	2000
Sub-total 1B				**2000**
1B - 2B	good, fair	6+000	7+000	1000
		9+000	10+000	1000
		11+000	12+000	1000
Sub-total 1B - 2B				**3000**
2B	fair			
		7+000	9+000	2000
		10+000	11+000	1000
		12+000	13+000	1000
		17+000	19+000	2000
		26+000	27+000	1000
		28+000	29+000	1000
		30+000	31+000	1000
		32+000	34+000	2000
		36+000	37+000	1000
		38+000	39+000	1000
		43+000	47+000	4000
		48+000	49+000	1000
		52+000	53+000	1000
		56+000	57+000	1000
		86+000	87+000	1000
		88+000	90+000	2000
		104+000	107+000	3000
		111+000	112+000	1000
		115+000	117+000	2000
		124+000	125+000	1000
		132+000	133+000	1000
Sub-total 2B				**31000**
2B - 3	fair, poor	4+000	5+000	1000
		15+000	16+000	1000
		19+000	20+000	1000
		25+000	26+000	1000
		29+000	30+000	1000
		31+000	32+000	1000
		34+000	35+000	1000
		37+000	38+000	1000
		39+000	41+000	2000
		47+000	48+000	1000
		51+000	52+000	1000
		53+000	54+000	1000
		55+000	56+000	1000
		57+000	58+000	1000
		60+000	61+000	1000
		62+000	65+000	3000
		67+000	74+000	7000
		81+000	83+000	2000
		90+000	92+000	2000
		109+000	111+000	2000
		114+000	115+000	1000

SUMMARY OF ROAD CONDITION CATEGORY AND ROAD CONDITION CLASS

Road Condition Class	Road Condition Category	Road Chainge from	Road Chainge to	Measured Length (m)
		117+000	118+000	1000
		119+000	121+000	2000
		123+000	124+000	1000
		125+000	132+000	7000
		134+000	135+000	1000
Sub-total 2B - 3				**45000**
3	poor			
		1+000	4+000	3000
		5+000	6+000	1000
		13+000	15+000	2000
		16+000	17+000	1000
		20+000	25+000	5000
		27+000	28+000	1000
		35+000	36+000	1000
		41+000	43+000	2000
		54+000	55+000	1000
		58+000	60+000	2000
		61+000	62+000	1000
		65+000	67+000	2000
		79+000	81+000	2000
		83+000	86+000	3000
		87+000	88+000	1000
		92+000	95+000	3000
		98+000	104+000	6000
		107+000	109+000	2000
		112+000	114+000	2000
		118+000	119+000	1000
		121+000	123+000	2000
		133+000	134+000	1000
		135+000	136+000	1000
		137+000	139+000	2000
		140+000	142+340	2340
Sub-total 3				**50340**
3 - 4	poor, bad			
		0+000	1+000	1000
		76+000	79+000	3000
		95+000	97+000	2000
		136+000	137+000	1000
Sub-total 3 - 4				**7000**
4	bad			
		74+000	76+000	2000
		97+000	98+000	1000
		139+000	140+000	1000
Sub-total 4				**4000**
TOTAL				**142340**

Annex 1.5: Reinforcement Need for Part Sections

Tedjen to Mary (6 million ESA)

From Chainage	To Chainage	Overlay need for 15 Years design	Remaining life now	Remaining life after overlay	Additional tons for local repair
0	350	120	4	15	90
350	950	145	0	15	329
950	1850	120	3	15	177
1850	2450	60	1	15	0
2450	2950	95	1	15	35
2950	3750	80	1	15	101
3750	4550	50	2	15	25
4550	4950	5	10	15	35
4950	5650	55	3	15	61
5650	6650	100	5	15	233
6650	8150	5	8	15	30
8150	9150	25	5	15	66
9150	9850	145	1	15	501
9850	10950	145	1	15	430
10950	11550	60	1	15	466
11550	12250	145	3	15	111
12250	12950	85	1	15	339
12950	13350	100			
13350	14150	50	2	15	0
14150	14750	75	1	15	0
14750	16150	60	5	15	132
16150	16550	75	1	15	0

16550	17450	25	6	15	46
17450	18050	100	1	15	81
18050	18650	30	4	15	30
18650	19150	5	11	15	0
19150	19550	35	4	15	0
19550	20000	25	8	15	38
20000	20350	70	1	15	41
20350	20750	30	7	15	51
20750	21250	60	2	15	0
21250	22150	35	3	15	30
22150	22550	0	10	15	0
22550	23150	60	1	15	0
23150	24150	45	2	15	0
24150	24550	55	2	15	0
24550	24950	15	7	15	30
24950	27150	0	9	15	30
27150	27750	90	1	15	116
27750	28350	90	3	15	41
28350	28950	15	9	15	51
28950	29550	35	3	15	0
29550	29950	80	1	15	0
29950	30350	30	8	15	56
30350	30950	35	3	15	0
30950	31550	5	14	15	25
31550	33450	40	5	15	218
33450	34150	15	12	15	56
34150	34550	25	5	15	30

34550	35750	80	1	15	0
35750	36450	50	5	15	30
36450	37550	65	3	15	132
37550	37950	0			
37950	38350	75	0	15	0
38350	38750	20	6	15	0
38750	39250	90	0	15	0
39250	40150	90	1	15	56
40150	41850	115	0	15	258
41850	42350	65	1	15	0
42350	43350	35	8	15	137
43350	44250	50	2	15	35
44250	44650	90	1	15	41
44650	45550	45	4	15	122
45550	47750	80	2	15	147
47750	48450	110	0	15	106
48450	49650	85	3	15	258
49650	50000	10	8	15	10
50000	52950	40	6	15	354
52950	54050	145	0	15	187
54050	54850	150	0	15	0
54850	55650	115	2	15	137
55650	56150	70	3	15	81
56150	56550	60	2	15	51
56550	57350	95	2	15	172
57350	59250	100	1	15	370

59250	60050	75	2	15	56
60050	61950	65	3	15	329
61950	63150	140	0	15	203
63150	63850	125	0	15	81
63850	66150	85	5	15	96
66150	68550	65	4	15	177
68550	69350	105	1	15	76
69350	70350	60	1	15	0
70350	70950	85	1	15	0
70950	72850	75	2	15	167
72850	73650	100	2	15	157
73650	74650	70	3	15	233
74650	75050	0			
75050	76350	70			
76350	76950	145	0	15	284
76950	77550	145	0	15	739
77550	78550	145	0	15	496
78550	79050	145	0	15	385
79050	79450	145	0	15	197
79450	80000	145	0	15	668
80000	80950	70	4	15	152
80950	81850	45	8	15	41
81850	82750	25	2	15	66
82750	83350	15	7	15	35
83350	83950	50	3	15	41
83950	84550	30	10	15	86
84550	85050	90	1	15	71

85050	85650	75	2	15	71
85650	95950	10	14	15	344
95000	95950	35	12	15	142
95950	99250	145	0	15	742
99250	100350	60	8	15	223
100350	101950	125	0	15	243
101950	102850	145	0	15	122
102850	103450	130	0	15	81
103450	104350	145	0	15	405
104350	104850	105	1	15	35
104850	108250	145	0	15	476
108250	108750	110	2	15	71
108750	109550	70	2	15	41
109550	110000	145	1	15	152
110000	110750	110	0	15	172
110750	111450	65	2	15	0
111450	111950	110	0	15	35
111950	112650	20	5	15	41
112650	113050	105	2	15	56
113050	113750	65	2	15	71
113750	116450	15	10	15	35
116450	117250	25	5	15	25
117250	118350	125	2	15	223
118350	119150	65	2	15	35
119150	119850	115	1	15	96
119850	120450	55	1	15	0

120450	121550	100	2	15	243
121550	122000	110	1	15	0
122000	123550	115	0	15	0
123550	124450	65	4	15	127
124450	125050	10	11	15	51
125050	125450	145	0	15	101
125450	126550	90	2	15	218
126550	127350	35	14	15	20
127350	128050	140	0	15	142
128050	128850	80	1	15	46
128850	129450	30	6	15	61
129450	130350	100	6	15	248
130350	130750	145	0	15	122
130750	131550	85	3	15	137
131550	132250	70	4	15	106
132250	133050	60	2	15	0
133050	134050	40	1	15	177
134050	134450	145	0	15	299
134450	135050	135	0	15	116
135050	135750	115	0	15	106
135750	136150	40	6	15	61
136150	137350	145	0	15	623
137350	138950	145	1	15	623
138950	139350	145	0	15	390
139350	139850	145	2	15	91
139850	140350	120	3	15	162
140350	142000	40	13	15	35

Annex 1.6: Groundwater Table

GROUND WATER TABLE

NN	Chainage km	Number of borehole	Side of road distance (m)	Water level below existing surface in cm			
				High	Month	Low	Month
1	5,0	2603	L 1800	160	IV	278	III
2	6,0	2608	L 1750	136	IV	250	III
3	13,0	2629	R 750	60	III	359	II
4	14,0	2609	L2200	120	XI	250	III
5	14,0	2630	R 2630	241	VII	284	II
6	17,0	2634	R 600	241	III	379	II
7	17,0	2631	L 300	90	III	278	II
8	20,0	2615	R 900	173	III	285	II
9	24,0	2618	R 400	161	III	291	II
10	25,0	2616	R 3100	167	III	294	II
11	26,0	7005	L 1600	204	IV	253	XII
12	28,0	7040	L 2000	191	VI	328	II
13	30,0	7048	L 800	190	X	267	XI
14	33,0	7049	L 750	144	III-IV	258	XI
15	45,0	7431	L 1900	19[illegible]	VI	262	XII
16	46,4	7438	L 850	213	VII	261	VI
17	43,8	7506	R 1000	223	IV	294	XI
18	47,5	7515	R 875	278	IV	332	X
19	47,25	7443	L 850	224	VIII	294	II
20	48,9	7520	R 1000	124	IV	262	III
21	48,8	7445	L 600	217	VI	277	XII
22	49,7	7521	R 1000	147	IV	263	I
23	50,3	7456	L 1200	194	IV	272	XII
24	51,5	7525	R 950	208	V	284	XII
25	52,25	7466	L 500	186	VI	287	X
26	53,8	7534	R 650	225	VI	262	XII
27	53,3	7467	L 550	160	VII	288	I
28	54,6	7535	R 620	211	VII	254	XI
29	55,1	7474	L 1050	197	II	315	I
30	55,3	7538	R 600	213	VII	261	VI
31	55,85	7475	L 600	212	VIII	307	I
32	56,1	7539	R 550	228	VII	267	XI
33	57,0	7486	L 950	211	III	284	X
34	62,75	7600	R 500	196	II	301	XI
35	62,6	7506	L 750	223	IV	294	XI
36	65,0	7618	R 500	207	VI	293	XII
37	68,3	7628	R 650	220	VII	261	XI
38	70,0	279	R5500	208	IV	276	X
39	75,8	621	L100	38	IV	164	X
40	81,2	630	R700	223	III	292	IX
41	82,0	634	L1400	103	VII	255	I

TEDJEN- MARY ROAD IMPROVEMENT

NN	Chainage km	Number of borehole	Side of road distance (m)	Water level below existing surface in cm			
				high	Month	low	Month
42	83,0	631	R 700	99	III	167	VIII
43	83,2	600	L3000	196	IV	265	I
44	83,9	616	L1400	75	IV	164	XI
45	88,3	617	L100	559	VII	549	X
46	91,6	420	L3000	117	V	241	X
47	93,4	710	R400	20	IV	153	VIII
48	110,3	719	R100	730	V	767	XII
49	118,7	299	R2300	436	VII	502	XII
50	119,2	296	R100	312	II	366	XII
51	132,9	83	R100	225	V	322	XII
52	141,2	43	R6000	247	IV	305	II
53	141,4	421	R200	75	IV	155	IX

Anenx 1.7: Geotechnical Investigation Programme

TEDJEN- MARY Road Improvement
Geotechnical Investigation Programm

Point No.	Chainage km	Road side Right/Left	Date of testing and sampling	Trial Pit	DPL Depth in (m)	BS Depth in (m)
0	000 + 000	L	05.03.97		5.00	5.00
1	001 + 000	R	04.03.97		4.70	4.70
2	002 + 000	L	04.03.97		5.00	5.00
3	003 + 000	R	04.03.97	X	5.00	5.00
4	004 + 000	L	03.03.97		4.50	4.70
5	005 + 000	R	03.03.97		5.00	5.00
6	006 + 000	L	03.03.97	X	5.00	5.00
7	007 + 000	R	27.02.97		4.50	5.00
8	008 + 000	L	27.02.97		4.00	4.00
9	009 + 000	R	27.02.97	X	5.00	5.00
10	010 + 000	L	26.02.97		5.00	5.00
11	011 + 000	R	26.02.97		5.00	5.00
12	012 + 000	L	26.02.97	X	5.00	5.00
13	013 + 000	R	25.02.97		5.00	5.00
14	014 + 000	L	25.02.97		5.00	5.00
15	015 + 000	R	25.02.97	X	5.00	5.00
16	016 + 000	L	24.02.97		5.00	5.00
17	017 + 000	R	24.02.97		5.00	5.00
18	018 + 000	L	24.02.97	X	5.00	4.90
19	019 + 000	R	23.02.97		5.00	5.00
20	020 + 000	L	23.02.97		4.50	4.60
21	021 + 000	R	22.02.97	X	5.00	5.00
22	022 + 000	R	22.02.97		5.00	5.00
23	023 + 000	L	21.02.97		5.00	5.00
24	024 + 000	L	21.02.97	X	5.00	5.00
25	025 + 000	R	20.02.97		5.00	5.00
26	026 + 000	R	20.02.97		5.00	5.00
27	027 + 000	L	19.02.97	X	5.00	5.00
28	028 + 000	L	19.02.97		5.00	5.00
29	029 + 000	R	18.02.97		5.00	5.00
30	030 + 000	R	18.02.97	X	5.00	5.00
31	031 + 000	L	17.02.97		5.00	5.00
32	032 + 000	L	17.02.97		5.00	5.00
33	033 + 000	R	14.02.97	X	4.00	4.00
34	034 + 000	L	14.02.97		4.60	4.60
35	035 + 000	L	13.02.97	X	4.10	4.40
36	036 + 000	R	13.02.97		4.60	4.60
37	037 + 000	R	12.02.97		4.00	4.00
38	038 + 000	L	12.02.97	X	3.70	4.00
39	039 + 000	L	12.02.97		3.90	4.00
40	040 + 000	R	06.02.97		3.90	3.90
41	041 + 000	L	06.02.97	X	4.30	4.20
42	042 + 000	R	05.02.97		5.00	5.00
43	043 + 000	L	05.02.97		5.00	5.00
44	044 + 000	R	05.02.97	X	5.00	5.00
45	045 + 000	L	04.02.97		4.70	4.70
46	046 + 000	R	04.02.97		5.00	5.00
47	047 + 000	L	04.02.97	X	5.00	5.00
48	048 + 300	R	06.12.96		4.90	4.80
49	049 + 000	R	03.02.97		4.50	4.50
50	050 + 300	L	06.12.96	X	4.90	4.80
51	051 + 000	R	03.02.97		5.00	5.00
52	052 + 000	R	03.02.97	X	5.00	5.00
53	053 + 000	L	02.02.97		4.50	4.60

TEDJEN- MARY Road Improvement
Geotechnical Investigation Programm

KOCKS INGENIEURE

Point No.	Chainage km	Road side Right/Left	Date of testing and sampling	Trial Pit	DPL Depth in (m)	BS Depth in (m)
54	054 + 000	R	02.02.97		5.00	5.00
55	055 + 000	L	02.02.97	X	5.00	5.00
56	056 + 000	R	31.01.97		4.80	5.00
57	057 + 000	L	31.01.97		4.60	4.50
58	058 + 000	R	31.01.97	X	5.00	5.00
59	059 + 000	L	30.01.97		5.00	5.00
60	060 + 000	R	30.01.97		5.00	5.00
61	061 + 500	L	05.01.97	X	3.90	3.70
62	062 + 000	R	30.01.97		4.40	4.50
63	063 + 000	R	29.01.97		5.00	5.00
64	064 + 000	L	29.01.97	X	5.00	5.00
65	065 + 000	R	28.01.97		5.00	5.00
66	066 + 000	L	28.01.97		3.90	4.00
67	067 + 000	R	28.01.97	X	4.90	4.90
68	068 + 000	L	27.01.97		4.80	5.00
69	069 + 000	R	27.01.97		4.60	4.60
70	070 + 000	L	27.01.97	X	5.00	5.00
71	071 + 000	R	23.01.97		5.00	5.00
72	072 + 000	L	23.01.97		4.70	4.70
73	073 + 000	R	23.01.97	X	5.00	5.00
74a	074 + 000	L	22.01.97		5.00	5.00
74b	074 + 500	R	04.12.96	X	3.90	3.50
75	075 + 000	R	22.01.97		4.20	4.50
76	076 + 000	L	21.01.97	X	4.50	4.00
77	077 + 000	R	21.01.97		4.50	4.00
78	078 + 000	L	21.01.97		5.00	5.00
79	079 + 000	R	20.01.97	X	4.70	4.70
80	080 + 000	L	20.01.97	X	4.90	5.00
81	081 + 000	R	20.01.97		5.00	5.00
82	082 + 000	L	17.01.97	X	5.00	5.00
83	083 + 000	R	24.01.97	X	5.00	5.00
84	084 + 000	L	16.01.97		4.60	4.40
85	085 + 000	R	16.01.97	X	4.90	4.90
86	086 + 500	L	4.12.96	X	5.00	5.00
87	087 + 000	R	15.01.97		4.70	4.70
88	088 + 000	L	24.01.97	X	4.50	4.20
89	089 + 000	R	15.01.97		5.00	5.00
90	090 + 000	L	13.01.97		4.80	4.50
91	091 + 000	R	24.01.97	X	3.80	4.00
92	092 + 000	L	13.01.97		4.60	4.70
93	093 + 000	L	10.01.97		4.60	5.00
94	094 + 000	L	09.01.97	X	3.90	4.30
95	095 + 000	R	09.01.97	X	4.20	4.50
96	096 + 000	L	08.01.97		3.80	4.00
97	097 + 000	R	08.01.97	X	4.50	4.70
98	098 + 000	L	08.01.97	X	5.00	5.00
99	099 + 000	R	27.12.96		5.00	5.00
100	100 + 000	L	27.12.96	X	5.00	5.00
101	101 + 000	R	3.12.96	X	3.50	0.00
102	102 + 000	L	26.12.96		4.90	4.90
103	103 + 000	R	26.12.96	X	4.70	4.90
104	104 + 000	L	26.12.96		4.60	4.80
105	105 + 000	L	25.12.96	X	5.00	5.00
106	106 + 000	R	25.12.96		5.00	5.00

TEDJEN- MARY Road Improvement
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Point No.	Chainage km	Road side Right/Left	Date of testing and sampling	Trial Pit	DPL Depth in (m)	BS Depth in (m)
107	107 + 000	L	25.12.96		4.50	4.50
108	108 + 000	R	24.12.96	X	4.50	4.50
109	109 + 000	L	24.12.96		3.70	3.80
110	110 + 000	R	24.12.96	X	4.30	4.50
111	111 + 000	L	23.12.96	X	5.00	5.00
112	112 + 000	R	20.12.96		3.80	3.70
113	113 + 200	L	3.12.96	X	4.00	3.80
114	114 + 000	R	19.12.96	X	3.90	4.00
115	115 + 000	R	19.12.96		5.00	5.00
116	116 + 000	L	18.12.96	X	5.00	5.00
117	117 + 000	L	18.12.96		5.00	5.00
118	118 + 000	R	17.12.96	X	4.70	4.80
119	119 + 000	L	17.12.96	X	4.90	4.90
120	120 + 000	R	17.12.96		4.90	5.00
121	121 + 000	L	16.12.96		5.00	5.00
122	122 + 000	R	16.12.96	X	4.70	4.70
123	123 + 000	R	14.12.96	X	5.00	5.00
124	124 + 000	L	13.12.96	X	3.90	3.90
125	125 + 000	R	13.12.96		3.70	3.80
126	126 + 000	R	13.12.96		3.60	3.80
127	127 + 000	L	12.12.96	X	3.90	3.90
128	128 + 000		12.12.96		0.80	1.00
129	129 + 200	R	3.12.96	X	3.40	3.70
130	130 + 000	L	12.12.96		3.80	3.80
131	131 + 000	R	12.12.96		3.90	3.90
132	132 + 000	R	11.12.96	X	4.30	4.50
133	133 + 000	L	11.12.96		4.00	4.10
134	134 + 000	L	11.12.96	X	3.50	3.60
135	135 + 000	R	10.12.96		4.00	3.90
136	136 + 000	R	10.12.96	X	3.70	3.80
137	137 + 000	L	10.12.96		3.60	3.70
138	138 + 000	L	10.12.96	X	3.80	3.10
139	139 + 000	R	9.12.96		3.70	2.80
140	140 + 000	R	9.12.96	X	1.70	0.00
141	141 + 000	L	9.12.96		3.00	2.40
142	142 + 000	L	9.12.96	X	3.00	3.00

BS-Samples — Samples (small quantity) extracted by sampling rod

X — Trial Pit executed

Annex 1.8: Dam Structures below 1 m

Dam structures below 1 meter

Chainage	Height of dam (m)	Groundwater table (m)	Water in dam structure	Visible sulphate	Conspicious surface distresses	Observations
0+000	0,50	3,10	no	no	no	No irrigation system in this section
1+000	0,20	3,60	no	no	no	No irrigation system in this section
2+000	0,80	4,4	no	no	no	No irrigation system in this section
8+000	0,30	2,70	no	no	no	Irrigation canal 7m to the right of the road
9+000	0,20	3,00	no	few	no	
10+000	0,20	2,80	no	no	no	Collector 30m from the road
19+000	0,60	4.60 moist	no	no	no	1) Irrigation canal 7m to the right of the road, water level 6m below road surface
						2) Irrigation lateral next to the road, water level 2.5m below road surface
21+000	0,50	5,00	no	no	Deform. 5cm	Irrigation canal 30m to the right of the road, water level 2.5m below the road surface
23+000	0,10	2.20 moist	no	no	no	as chainage 21+000
33+000	0,20	not found	no	no	Shift. layers	as chainage 21+000
34+000	0,20	4,60	no	no	no	as chainage 21+000
35+000	0,10	2.40 wet	no	no	Cracks	as chainage 21+000
36+000	1,00	3.60 wet	no	no	Cracks	as chainage 21+000
37+000	0,10	1.90 wet	no	no	Cracks	as chainage 21+000
39+000	0,80	2.60 moist	no	no	Cracks	as chainage 21+000
40+000	0,50	1.00 moist	no	no	Cracks	as chainage 21+000
41+000	0,40	3.00 moist	no	no	All. Cracks	as chainage 21+000
63+000	0,60	3,60	no	no	no	Kara Khum canal 50m to the right of the road
65+000	0,60	4,50	no	few	no	
67+000	0,60	3,50	no	no	no	Irrigation canals 50m right and left of the road, water level 4m below road surface
73+000	0,70	4,40	no	few	no	Irrigation canal 40m to the right, water level 2m below road surface

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Chainage	Height of dam (m)	Groundwater table (m)	Water in dam structure	Visible sulphate	Conspicious surface distresses	Observations
79+000	0,70	3.50 wet	no	few	no	Small reservoir 200m to the right of the road
89+000	0,80	3.50 wet	no	no	Defo. 5-6cm	Sand dune area, irrigation canal 150m to left of the road
97+000	0,35	3.00 wet	no	no	no	Irrigation system is crossing the road at ch. 97+100
99+000	0,50	not found	no	no	no	Sand dune area, no irrigation system
101+000	0,30		no	no	no	Sand dune area, no irrigation system
102+000	0,50	4.00 wet	no	no	no	Sand dune area, no irrigation system
103+000	0,70	3.80 wet	no	no	no	Sand dune area, no irrigation system
104+000	0,40	1.20 wet	no	no	no	Sand dune area, no irrigation system
105+000	0,50	1.0 moist	no	no	no	Sand dune area, no irrigation system
106+000	0,80	not found	no	no	no	Sand dune area, no irrigation system
107+000	0,40	not found	no	no	no	Sand dune area, no irrigation system
108+000	0,30	2.30 moist	no	no	no	Sand dune area, no irrigation system
112+000	0,70	not found	no	no	no	Irrigation canal 100m to the left of the road, water level 2.5m below road surface
113+000	0,50		no	no	Defo. 6cm	as chainage 112+000
114+000	0,80	not found	no	no	Defo. 5cm	as chainage 112+000
115+000	0,50	3.90 wet	no	no	no	Irrigation canal 60m to the left of the road, water level 2m below road surface
116+000	0,90	4.10 wet	no	no	no	Irrigation canal 50m to the left of the road, water level 1.5m below road surface
118+000	0,80	4,20	no	no	no	as chainage 116+000
120+000	0,90	3,60	no	no	no	Irr. canal 200m to the left, irr. lateral 50m to the right of the road
121+000	0,60	3,90	no	no	no	as chainage 120+000
122+000	0,40	4,50	no	no	no	as chainage 120+000
124+000	0,90	3,50	no	few	no	Irrigation canal 30m to the left of the road, water level 2.0m below road surface

Chainage	Height of dam (m)	Groundwater table (m)	Water in dam structure	Visible sulphate	Conspicious surface distresses	Observations
125+000	0,30	3.40 wet	no	few	Cracks CL	Irrigation canal 30m to the left of the road, water level 2m below road surface
126+000	0,90	3,30	no	few	Cracks	Irrigation lateral 25m to the left of the road
127+000	0,80	not found	no	few	no	as chainage 127+000
128+000	0,60	not found	no	few	Cracks	Irrigation lateral 10m to the left of the road, water level 1.0m below road surface
129+000	0,60		no	no	All. Cracks, P.H.	as chainage 128+000
131+000	0,70	2.90 wet	no	few	Cracks	Irrigation canal 70m to the left of the road
132+000	0,40	2.30 wet	no	few	no	Irrigation canal 50m to the left, irrigation laterals to the left and the right, dry
135+000	0,50		no	no	no	Irrigation canal 25m to the left of the road
136+000	0,70		no	few	no	Irrigation canals 25m left (in concrete) and 50m to the right, water level 2.5m bel. r. s.
137+000	0,30		no	no	no	Irrigation canals 50m to the left and 40m to the right of the road
138+000	0,30		no	no	no	Irrigation laterals next to the road, water level 0.5m below road surface
139+000	0,20	not found	no	few	Cracks	Irrigation laterals next to the road, water level 1.0m below road surface
140+000	0,60		no	no	no	Irrigation canal 15m to the left of the road, water level 1.2m below road surface
141+000	0,20	2,40	no	no	Cracks	Irrigation laterals 10m to :he left and to the right of the road, dry
142+000	0,20	2,40	no	no	no	Built up area

Annex1.9: Natural Moisture Contents

TEDJEN-MARY Road Improvement

Natural Moisture Contents

Sample Nr.	Chainage	Depth m	Moisture content	Sample Nr.	Chainage	Depth m	Moisture content	Sample Nr.	Chainage	Depth m	Moisture content
1	000+000	0.3-0.9	4,83	53	011+000	0.5-1.9	3,12	105		4.5-5.0	16,12
2		0.9-1.3	7,87	54		1.9-3.2	8,11	106	025+000	0.7-1.0	3,21
3		1.3-4.3	22,11	55		3.2-4.6	12,42	107		1.0-3.4	10,03
4		4.3-5.0	29,35	56		4.6-5.0	18,34	108		3.4-5.0	14,18
5	001+000	0.3-0.7	5,1	57	012+000	0.6-2.7	3,38	109	026+000	0.7-2.6	4,12
6		0.7-2.4	8,78	58		2.7-3.1	7,12	110		2.6-3.3	7,21
7		2.4-3.4	20,03	59		3.1-3.4	12,18	111		3.3-4.0	10,03
8		3.4-4.7	25,63	60		3.4-5.0	21,83	112		4.0-5.0	14,85
9	002+000	0.35-1.2	6,03	61	013+000	0.4-0.7	2,12	113	027+000	0.45-2.2	2,27
10		1.2-2.3	8,17	62		0.7-1.9	4,77	114		2.2-4.0	7,18
11		2.3-4.1	24,16	63		1.9-3.4	8,21	115		4.0-4.7	13,12
12		4.1-5.0	28,36	64		3.4-4.0	17,83	116		4.7-5.0	18,07
13	003+000	0.35-0.6	4,14	65		4.0-5.0	19,37	117	028+000	0.5-0.9	3,94
14		0.6-3.8	8,83	66	014+000	0.6-1.9	3,12	118		0.9-1.9	7,21
15		3.8-5.0	22,89	67		1.9-2.4	13,06	119		1.9-3.8	10,03
16	004+000	0.4-1.7	4,33	68		2.4-5.0	21,18	120		3.8-4.6	12,13
17		1.7-2.0	10,04	69	015+000	0.45-0.8	3,11	121		4.6-5.0	17,23
18		2.0-3.1	18,02	70		0.8-2.3	7,23	122	029+000	0.25-1.5	3,33
19		3.1-4.7	29,09	71		2.3-3.2	13,14	123		1.5-2.7	7,11
20	005+000	0.25-0.4	4,07	72		3.2-5.0	19,21	124		2.7-5.0	14,15
21		0.4-1.4	7,18	73	016+000	0 7-2.9	2,37	125	030+000	0.25-1.4	3,89
22		1.4-1.8	10,4	74		2.9-3.7	8,13	126		1.4-3.6	9,13
23		1.8-3.2	13,49	75		3.7-5.0	21,28	127		3.6-4.7	14,83
24		3.2-4.4	19,14	76	017+000	0.6-3.8	2,61	128		4.7-5.0	17,32
25		4.4-5.0	24,03	77		3.8-4.5	9,29	129	031+000	0.5-2.0	4,12
26	006+000	0.3-0.9	4,08	78		4.5-5.0	17,2	130		2.0-3.6	13,01
27		0.9-2.4	7,33	79	018+000	0.4-2.4	3,09	131		3.6-5.0	18,21
28		2.4-3.0	9,17	80		2.4-2.9	7,12	132	032+000	0.4-1.4	2,12
29		3.0-4.8	11,81	81		2.9-4.1	11,83	133		1.4-2.9	4,28
30		4.8-5.0	17,09	82		4.1-4.9	20,18	134		2.9-3.4	7,12
31	007+000	0.4-0.9	4,21	83	019+000	0.5-1.9	3,13	135		3.4-4.1	14,17
32		0.9-1.6	7,13	84		1.9-2.9	9,17	136		4.1-5.0	18,39
33		1.6-2.3	11,18	85		2.9-4.6	11,49	137	033+000	0.2-1.9	4,33
34		2.3-3.5	12,32	86		4.6-5.0	16,21	138		1.9-4.0	17,86
35		3.5-3.7	20,08	87	020+000	0.3-0.5	1,28	139	034+000	0.25-2.0	2,27
36		3.7-4.1	24,11	88		0.5-1.9	4,43	140		2.0-2.8	4,32
37		4.1-5.0	28,32	89		1.9-3.4	7,12	141		2.8-3.8	7,19
38	008+000	0.7-2.1	3,18	90		3.4-4.6	11,18	142		3.8-4.6	16,31
39		2.1-3.0	12,23	91	021+000	0.4-0.8	3,12	143	035+000	0.2-0.9	3,83
40		3.0-3.5	18,41	92		0.8-4.5	7,03	144		0.9-2.0	5,22
41		3.5-4.0	24,12	93		4.5-5.0	13,23	145		2.0-2.4	9,88
42	009+000	0.5-0.8	5,31	94	022+000	0.45-0.7	2,33	146		2.4-4.4	15,21
43		0.8-1.5	7,12	95		0.7-2.4	4,98	147	036+000	0.25-1.2	3,37
44		1.5-2.8	10,18	96		2.4-4.4	8,22	148		1.2-3.6	14,15
45		2.8-4.0	20,11	97		4.4-5.0	16,21	149		3.6-4.6	22,03
46		4.0-5.0	22,18	98	023+000	0.5-1.8	3,15	150	037+000	0.3-1.2	2,43
47	010+000	0.3-0.7	2,18	99		1.8-2.2	4,35	151		1.2-1.9	9,21
48		0.7-1.5	4,3	100		2.2-3.0	8,18	152		1.9-4.0	14,17
49		1.5-2.0	8,72	101		3.0-5.0	14,32	153	038+000	0.35-2.7	3,71
50		2.0-3.1	14,27	102	024+000	0.6-1.9	3,12	154		2.7-4.0	13,39
51		3.1-4.1	19,13	103		1.9-3.1	7,21	155	039+000	0.4-1.8	2,12
52		4.1-5.0	21,87	104		3.1-4.5	11,37	156		1.8-2.6	4,89

TEDJEN-MARY Road Improvement

Natural Moisture Contents

Sample Nr.	Chainage km	Depth m	Moisture content	Sample Nr.	Chainage	Depth m	Moisture content	Sample Nr.	Chainage	Depth m	Moisture content
157	039+000	2.6-3.3	11,12	209	057+000	0.4-1.2	8,38	261	073+000	0.3-0.6	4,02
158		3.3-4.0	12,23	210		1.2-2.4	10,24	262		0.6-3.4	6,21
159	040+000	0.25-1.0	6,66	211		2.4-3.7	20,18	263		3.4-4.1	15,17
160		1.0-2.9	4,90	212		3.7-4.5	22,83	264		4.1-5.0	24,78
161		2.9-3.9	18,27	213	058+000	0.3-0.7	7,32	265	074+000	0.4-1.1	3,49
162	041+000	0.25-0.9	7,75	214		0.7-2.6	10,28	266		1.1-3.8	11,12
163		0.9-3.0	1,00	215		2.6-3.1	11,3	267		3.8-5.0	14,17
164		3.0-4.2	8,85	216		3.1-3.6	14,42	268	075+000	0.35-1.0	6,87
165	042+000	0.3-3.1	4,13	217	059+000	3.6-4.0	8,54	269		1.0-2.9	17,23
166		3.1-5.0	9,22	218		4.0-4.7	9,25	270		2.9-4.5	22,17
167	043+000	0.65-2.6	3,42	219		4.7-5.0	22,02	271	076+000	0.25-2.0	3,78
168		2.6-3.6	8,43	220	060+000	0.25-0.6	24,33	272		2.0-4.0	13,12
169		3.6-5.0	16,2	221		0.6-2.4	19,10	273	077+000	0.3-2.5	4,21
170	044+000	0.4-3.5	3,57	222		2.4-3.4	12,71	274		2.5-4.0	12,76
171		3.5-3.9	9,12	223		3.4-4.2	24,36	275	078+000	0.2-2.2	2,14
172		3.9-5.0	18,13	224		4.2-5.0	24,91	276		2.2-3.9	9,47
173	045+000	0.45-1.6	2,13	225	062+000	0.4-2.9	9,04	277		3.9-5.0	12,32
174		1.6-3.7	4,53	226		2.9-3.4	19,13	278	079+000	0.35-3.5	2,79
175		3.7-4.3	8,37	227		3.4-4.5	21,75	279		3.5-4.1	7,18
176		4.3-4.7	14,35	228	063+000	0.25-2.8	12,52	280		4.1-4.7	15,76
177	046+000	0.2-1.0	2,82	229		2.8-3.7	21,92	281	080+000	0.35-3.3	4,18
178		1.4-1.8	5,58	230		3.7-5.0	23,68	282		3.3-5.0	11,13
179		1.8-3.2	8,27	231	064+000	0.25-2.9	16,54	283	081+000	0.4-2.4	4,82
180		3.2-4.4	11,21	232		2.9-3.7	23,63	284		2.4-3.4	14,07
181		4.4-5.0	19,73	233		3.7-4.2	22,29	285		3.4-5.0	20,37
182	047+000	0.4-2.6	3,3	234		4.2-5.0	24,76	286	082+000	0.25-1.8	6,78
183		2.6-4.0	7,21	235	065+000	0.3-2.8	9,32	287		1.8-2.8	11,81
184		4.0-5.0	18,25	236		2.8-3.3	12,20	288		2.8-5.0	18,32
185	049+000	0.35-2.6	8,48	237		3.3-4.1	19,27	289	083+000	0.2-4.0	3,28
186		2.6-3.1	12,21	238		4.1-5.0	21,08	290		4.0-5.0	12,47
187		3.1-4.5	24,14	239	066+000	0.6-3.0	4,34	291	084+000	0.25-2.0	6,37
188	051+000	0.3-1.9	3,45	240		3.0-3.3	7,93	292		2.0-4.4	10,72
189		1.9-3.8	14,76	241		3.3-4.0	18,28	293	085+000	0.35-1.3	5,92
190		3.8-5.0	23,17	242	067+000	0.25-2.7	4,3	294		1.3-2.2	11,43
191	052+000	0.45-1.2	2,37	243		2.7-4.9	12,03	295		2.2-3.9	11,37
192		1.2-3.7	8,11	244	068+000	0.25-1.9	4,03	296		3.9-4.9	23,30
193		3.7-5.0	22,54	245		1.9-3.4	8,27	297	087+000	0.4-3.9	1,73
194	053+000	0.6-2.2	6,72	246		3.4-4.7	22,3	298		3.9-4.7	18,00
195		2.2-3.7	19,77	247		4.7-5.0	24,87	299	088+000	0.5-2.9	10,18
196		3.7-4.6	20,50	248	069+000	0.4-2.9	4,2	300		2.9-4.2	21,47
197	054+000	0.3-0.8	9,93	249		2.9-3.4	6,8	301	089+000	0.25-3.5	2,96
198		0.8-4.1	3,66	250		3.4-3.7	7,32	302		3.5-5.0	14,60
199		4.1-5.0	28,61	251		3.7-4.6	21,45	303	090+000	0.25-3.5	1,22
200	055+000	0.3-0.7	12,20	252	070+000	0.2-0.7	4,76	304		3.5-4.5	3,96
201		0.7-2.9	10,93	253		0.7-3.1	9,07	305	091+000	0.25-2.9	1,15
202		2.9-3.5	22,29	254		3.1-5.0	20,87	306		2.9-4.0	19,81
203		3.5-5.0	23,76	255	071+000	0.4-2.9	6,37	307	092+000	0.6-2.6	0,95
204	056+000	0.25-0.6	6,11	256		2.9-3.6	9,99	308		2.6-3.4	1,35
205		0.6-2.8	7,12	257		3.6-5.0	23,07	309		3.4-4.7	15,50
206		2.8-3.4	12,21	258	072+000	0.25-1.0	3,42	310	093+000	0.25-0.9	7,57
207		3.4-3.6	18,42	259		1.0-3.2	12,2	311		0.9-3.5	5,20
208		3.6-5.0	22,8	260		3.2-4.7	15,47	312		3.5-5.0	21,20

TEDJEN-MARY Road Improvement

Natural Moisture Contents

Sample Nr.	Chainage km	Depth m	Moisture content	Sample Nr.	Chainage km	Depth m	Moisture content	Sample Nr.	Chainage km	Depth m	Moisture content
313	094+000	0.4-1.1	0,98	365		3.9-5.0	12,25	417	128+000	0.6-1.0	2,12
314		1.1-3.0	2,64	366	116+000	0.25-1.7	1,92	418		>1.0	6,73
315		3.0-4.3	22,60	367		1.7-1.9	0,53	419	129+200	0.1-0.30	2,06
316		0.3-0.9	5,00	368		1.9-2.1	0,52	420		0.3-0.75	7,12
317	095+000	0.9-1.2	12,70	369		2.1-4.1	19,38	421	130+000	0.5-1.8	11,24
318		1.2-2.9	23,00	370		4.1-5.0	22,39	422		1.8-2.7	19,40
319		2.9-4.5	24,90	371	117+000	0.25-2.9	2,20	423		2.7-2.9	21,87
320	096+000	0.3-1.3	3,71	372		2.9-3.9	16,88	424		2.9-3.4	19,52
321		1.3-1.8	8,49	373		3.9-5.0	24,84	425		3.4-3.8	18,91
322		1.8-4.0	20,14	374	118+000	0.25-1.8	3,69	426	131+000	0.45-1.2	2,00
323	0.97+000	0.4-3.0	5,31	375		1.8-2.6	5,21	427		1.2-2.5	3,01
324		3.0-4.7	20,88	376		2.6-3.8	21,24	428		2.5-2.9	20,14
325	098+000	0.4-3.3	2,80	377		3.8-4.8	17,91	429		2.9-3.9	21,14
326		3.3-5.0	18,83	378	119+000	0.25-1.0	1,04	430	132+000	0.35-1.0	2,44
327	099+000	0.35-3.2	1,33	379		1.0-1.9	1,60	431		1.0-1.7	13,28
328		3.2-5.0	1,14	380		1.9-3.1	11,62	432		1.7-2.3	19,00
329	100+000	0.25-5.0	1,56	381		3.1-4.0	24,12	433		2.3-3.7	18,77
330		2.0-3.1	3,29	382		4.0-4.9	23,30	434		3.7-3.9	20,65
331		3.1-4.7	8,57	383	120+000	0.25-1.5	1,02	435		3.9-4.5	20,96
332	102+000	0.4-4.0	2,14	384		1.5-2.1	18,48	436	133+000	0.3-1.6	2,84
333		4.0-4.9	2,41	385		2.1-3.6	6,59	437		1.6-1.8	16,86
334	103+000	0.35-3.8	0,93	386		3.6-5.0	20,78	438		1.8-2.8	23,22
335		3.8-4.9	1,02	387	121+000	0.25-3.0	1,28	439		2.8-4.1	24,21
336	104+000	0.35-1.2	1,17	388		3.0-3.9	9,44	440	134+000	0.35-1.0	2,35
337		1.2-4.8	0,34	389		3.9-5.0	19,50	441		1.0-2.1	15,34
338	105+000	0.2-0.6	2,38	390	122+000	0.35-0.9	0,90	442		2.1-2.8	19,94
339		0.6-1.0	1,03	391		0.9-1.9	2,47	443		2.8-3.6	20,88
340		1.0-5.0	5,14	392		1.9-2.9	16,24	444	135+000	0.3-0.9	6,43
341	106+000	0.35-1.7	3,50	393		2.9-4.35	21,78	445		0.9-1.7	10,49
342		1.7-3.6	2,46	394		4.35-4.7	22,10	446		1.7-1.8	16,01
343		3.6-5.0	1,65	395	123+000	0.55-0.9	1,59	447		1.8-3.2	21,50
344	107+000	0.3-2.6	1,68	396		0.9-1.3	1,70	448		3.2-3.9	24,90
345		2.6-3.0	8,21	397		1.3-2.2	0,21	449	136+000	0.3-2.6	10,00
346		3.0-4.5	1,12	398		2.2-3.6	15,03	450		2.6-3.3	23,26
347	108+000	0.3-1.4	4,52	399		3.6-5.0	18,65	451		3.3-3.8	24,55
348		1.4-2.3	1,36	400	124+000	0.45-1.0	1,48	452	137+000	0.2-0.9	12,97
349		2.3-4.5	1,80	401		1.0-2.15	1,22	453		0.9-2.1	14,72
350	109+000	0.3-1.9	0,41	402		2.15-3.5	18,88	454		2.1-2.95	20,87
351		1.9-2.8	1,07	403		3.5-3.9	22,83	455		2.95-3.7	25,16
352		2.8-3.8	1,73	404	125+000	0.55-1.0	5,97	456	138+000	0.4-0.95	13,90
353	110+000	0.35-2.4	2,90	405		1.0-1.6	4,36	457		0.95-2.55	19,91
354		2.4-3.8	1,42	406		1.6-2.2	19,39	458		2.55-3.1	18,39
355		3.8-4.5	9,93	407		2.2-3.4	22,04	459	139+000	0.65-1.0	1,12
356	111+000	0.35-2.2	2,69	408		3.4-3.8	21,01	460		1.0-2.8	6,29
357		2.2-3.2	9,26	409	126+000	0.3-1.75	7,70	461	141+000	0.55-1.6	5,83
358		3.2-5.0	0,36	410		1.75-2.1	18,45	462		1.6-2.4	11,13
359	112+000	0.3-2.5	1,32	411		2.1-3.1	23,64	463		2.4-3.0	19,47
360		2.5-3.7	6,25	412		3.1-3.8	27,70	464	142+000	0.6-1.5	1,28
361	114+000	0.3-2.5	3,50	413	127+000	0.35-1.0	7,52	465		1.5-2.4	5,46
362		2.5-4.0	2,97	414		1.0-1.9	2,74	466		2.4-3.0	8,12
363	115+000	0.3-2.9	2,70	415		1.9-3.7	2,30	467			
364		2.9-3.9	2,11	416		3.7-3.9	7,88	468			

Annex 1.10: Soil Test Results

TEDJEN- MARY Road Improvement
Soil Test Results

KOCKS INGENIEURE

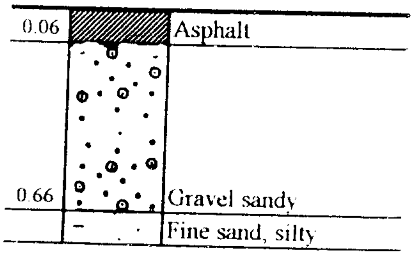
Chainage km	Side of road R / L	Depth of sampling m	Grain size distribution in % >31.5 mm	>16 mm	>8 mm	>2 mm	< 0.063 mm	Atterberg Limits PL %	LL %	PI %	Moisture density relation opt. W. %	max. DD	CBR, % dry/soaked	Sulphat %
003 + 000	R	0.12-0.47	1,8	13,2	30,7	52,5	16,4				6,0	2,29	52.1 / 47.1	0,5886
003 + 000	R	below0.47				0,0	61,1				12,0	1,88	25.5 / 9.1	0,5239
012 + 000	L	0.06-0.66	1,9	23,7	33,6	44,5	33,1				8,0	2,17	29.6 / 12.1	0,2244
012 + 000	L	below0.66				0,0	78,3				16,0	1,82	9.30 / 3.40	0,0258
024 + 000	L	0.07-0.25	1,1	15,3	33,7	53,6	23,8				7,0	2,00	58.9 / 51.1	0,7363
024 + 000	L	0.35-0.47		0,0	0,6	1,6	65,6	17,00	21,00	4,00	8,0	1,96	18.4 / 2.30	0,0067
033 + 000	L	0.09-0.18	2,1	11,3	21,9	34,4	30,4				8,0	2,12	26.5 / 12.1	0,3612
033 + 000	L	below0.18				0,0	68,9	15,85	24,70	8,85	14,0	1,85	23.4 / 1.10	0,5455
052 + 000	L	0.05-0.42	7,8	34,6	49,0	63,1	12,0				6,0	2,24	24.0 / 24.0	0,0399
052 + 000	L	below0.42				0,0	7,9				18,0	1,61	4.20 / 3.00	0,0220
061 + 500	L	0.10-0.40	2,5	12,5	30,4	51,9	17,6				6,0	1,96	44.1 / 23.5	0,1745
061 + 500	L	below0.40				0,0	58,3	17,50	22,70	5,20	10,0	1,93	2.2 / 2.5	0,3885
074 + 500	R	0.10-0.40	4,9	24,1	48,4	73,5	1,4				6,0	1,70	71.1 / 57.1	0,1741
074 + 500	R	below0.40				0,0	52,7				16,0	1,84	0.0 / 0.0	0,0328
086 + 500	L	0.10-0.35	1,25	14,7	37,3	61,3	12,7				6,0	2,29	58.1 / 40.6	0,5081
086 + 500	L	below0.35				0,0	87,2	7,70	34,00	16,30	18,0	1,79	9.8 / 3.0	0,6404
101 + 000	R	0.10-0.25	19,7	30,4	50,4	72,6	2,4				6,0	2,26	83.2 / 63.6	0,3693
101 + 000	R	below0.25				0,0	18,3	14,80	24,50	9,70	13,7	1,67	13.6 / 8.5	0,0257
113 + 200	L	below0.30				0,0	47,9				13,5	1,76		0,0183
114 + 000	L	0.13-0.27	1,6	14,5	32,1	55,1	11,0				6,0	2,21	48.1 / 31.1	0,1820
114 + 000	L	below0.27				0,0	42,6				16,0	1,76	6.3 / 3.0	0,0224
129 + 200	R	0.15-0.50	3,3	32,5	50,1	72,1	8,7				8,0	2,01		
129 + 200	R	below0.50				0,0	18,5				13,6	1,69		0,0174
132 + 000	L	0.03-0.28	9,9	24,8	38,9	52,2	18,1				8,0	2,17	31.6 / 19.5	
132 + 000	L	below0.28			0,0	0,2	12,3				12,0	1,69	9.0 / 6.8	
136 + 000	R	below0.35			0,0	0,2	43,1				14,0	1,83		
142 + 000	L	0.30-0.60	24,2	38,8	52,3	68,1	10,6				8,0	2,22	51.1 / 23.0	0,0687
142 + 000	L	below0.60		0,0	4,2	6,2	81,9	18,70	30,00	11,30	14,0	1,85	17.5 / 3.5	0,8360

Annex 1.11: **Structure of Pavement (trial pit diagrams)**
Structure of Pavement (additional checks)

STRUCTURE OF PAVEMENT (trial pit diagrams)

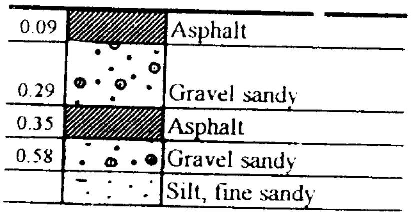
Location/Место: km12+00/L
Data/Дата: 26.02.1997
Level/Уровень: Shoulder surface

No. TP- 133



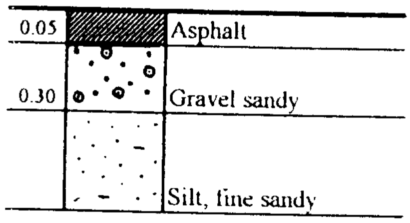
Location/Место: km 09+00/R
Data/Дата: 27.02.1997
Level/Уровень: Shoulder surface

No. TP- 136



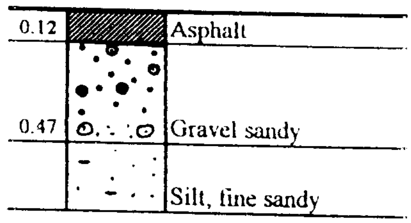
Location/Место: km06+00/L
Data/Дата: 03.03.1997
Level/Уровень: Shoulder surface

No. TP- 139



Location/Место: km 03+00/R
Data/Дата:04.03.1997
Level/Уровень: Shoulder surface

No. TP- 142



STRUCTURE OF PAVEMENT (trial pit diagrams)

Location/Место: km24+00/L — **No. TP- 121**
Data/Дата: 21.02.1997
Level/Уровень: Shoulder surface

Depth	Layer
0.07	Asphalt
0.25	Gravel sandy
0.35	Silt, fine sandy
0.47	Gravel sandy
0.56	Silt, fine sandy
0.56	Gravel sandy
	Silt, fine sandy

Location/Место: km 21+00/R — **No. TP- 124**
Data/Дата: 22.02.1997
Level/Уровень: Shoulder surface

Depth	Layer
0.05	Asphalt
0.24	Gravel sandy
0.35	Silt, fine sandy
0.50	Gravel sandy
	Silt, fine sandy

Location/Место: km18+00/L — **No. TP- 127**
Data/Дата: 24.02.1997
Level/Уровень: Shoulder surface

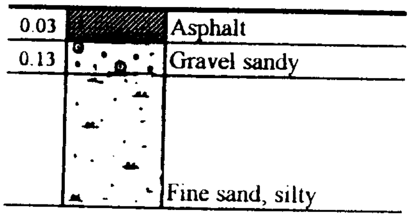
Depth	Layer
0.04	Asphalt
0.31	Gravel sandy
	Silt, fine sandy

Location/Место: km 15+00/R — **No. TP- 130**
Data/Дата:25.02.1997
Level/Уровень: Shoulder surface

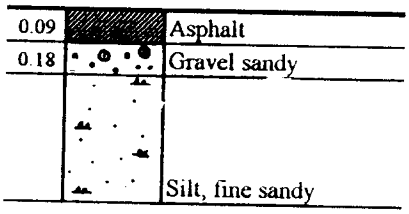
Depth	Layer
0.06	Asphalt
0.19	Gravel sandy
0.22	Asphalt
0.51	Gravel sandy
	Fine sand, silty

STRUCTURE OF PAVEMENT (trial pit diagrams)

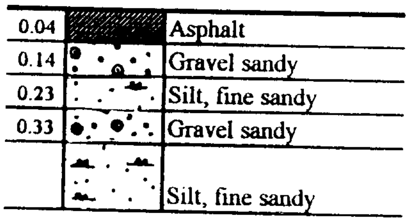
Location/Место: km35+00/L — **No. TP- 110**
Data/Дата: 13.02.1997
Level/Уровень: Shoulder surface



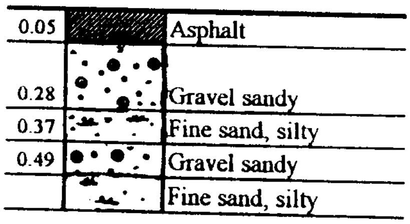
Location/Место: km 33+00/R — **No. TP- 112**
Data/Дата: 07.02.1997
Level/Уровень: Shoulder surface



Location/Место: km30+00/R — **No. TP- 115**
Data/Дата: 18.02.1997
Level/Уровень: Shoulder surface

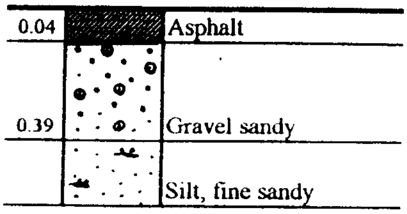


Location/Место: km 27+00/L — **No. TP- 118**
Data/Дата:19.02.1997
Level/Уровень: Shoulder surface

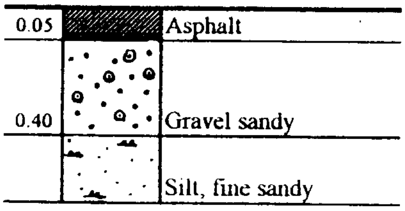


STRUCTURE OF PAVEMENT (trial pit diagrams)

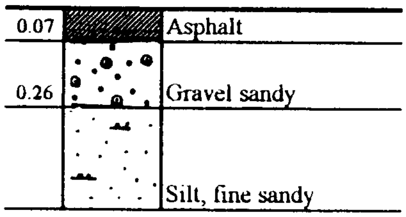
Location/Место: km47+00/L — **No. TP- 98**
Data/Дата: 04.02.1997
Level/Уровень: Shoulder surface



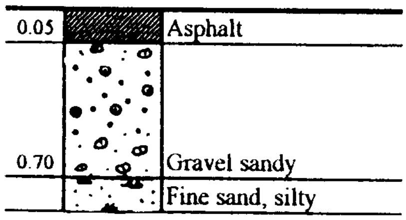
Location/Место: km 44+00/R — **No. TP- 101**
Data/Дата: 05.02.1997
Level/Уровень: Shoulder surface



Location/Место: km41+00/L — **No. TP- 104**
Data/Дата: 06.02.1997
Level/Уровень: Shoulder surface

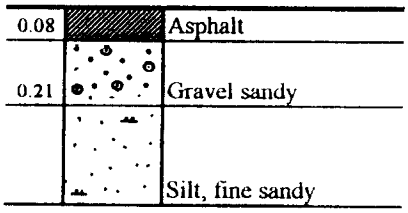


Location/Место: km 38+00/R — **No. TP- 107**
Data/Дата:18.02.1997
Level/Уровень: Shoulder surface

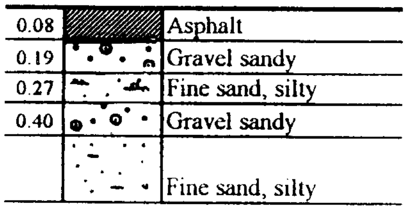


STRUCTURE OF PAVEMENT (trial pit diagrams)

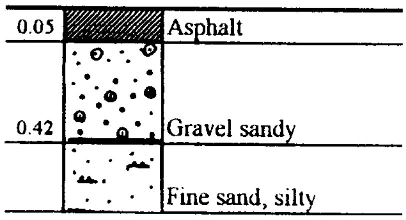
Location/Место: km58+00/R — **No. TP- 89**
Data/Дата: 31.01.1997
Level/Уровень: Shoulder surface



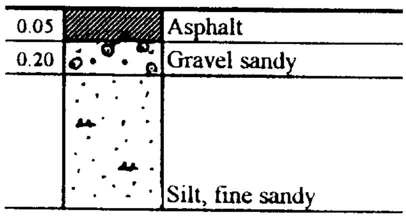
Location/Место: km 55+00/L — **No. TP- 92**
Data/Дата: 02.02.1997
Level/Уровень: Shoulder surface



Location/Место: km52+00/R — **No. TP- 95**
Data/Дата: 03.02.1997
Level/Уровень: Shoulder surface



Location/Место: km 50+00/L — **No. TP- 7**
Data/Дата: 03.02.1997
Level/Уровень: Shoulder surface



STRUCTURE OF PAVEMENT (trial pit diagrams)

Location/Место: km73+00/R — **No. TP- 73**
Data/Дата: 23.01.1997
Level/Уровень: Shoulder surface

0.04	Asphalt
0.15	Gravel sandy
0.25	Silt, fine sandy
0.37	Gravel sandy
	Fine sand, silty

Location/Место: km 70+00/L — **No. TP- 78**
Data/Дата: 27.01.1997
Level/Уровень: Shoulder surface

0.03	Asphalt
0.06	Gravel sandy
0.36	Silt, fine sandy
0.53	Gravel sandy
	Silt, fine sandy

Location/Место: km67+00/R — **No. TP- 81**
Data/Дата: 28.01.1997
Level/Уровень: Shoulder surface

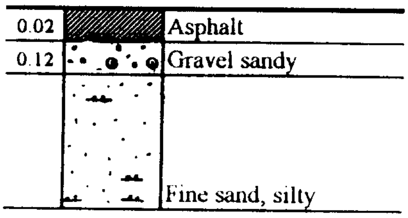
0.07	Asphalt
0.19	Gravel sandy
	Silt, fine sandy

Location/Место: km 64+00/L — **No. TP- 84**
Data/Дата: 29.01.1997
Level/Уровень: Shoulder surface

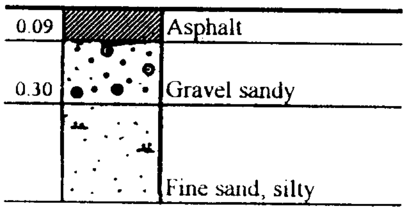
0.04	Asphalt
0.17	Gravel sandy
	Silt, fine sandy

STRUCTURE OF PAVEMENT (trial pit diagrams)

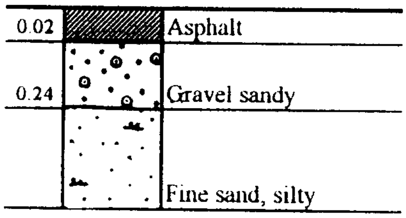
Location/Место: km82+00/L — **No. TP- 66**
Data/Дата: 24.01.1997
Level/Уровень: Shoulder surface



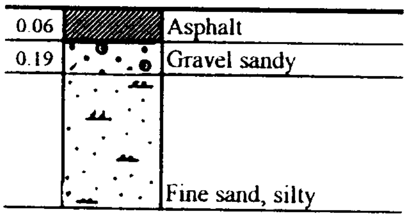
Location/Место: km 80+00/L — **No. TP- 68**
Data/Дата: 24.01.1997
Level/Уровень: Shoulder surface



Location/Место: km79+00/R — **No. TP- 69**
Data/Дата: 20.01.1997
Level/Уровень: Shoulder surface

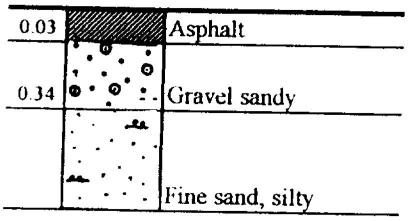


Location/Место: km 76+00/R — **No. TP- 72**
Data/Дата: 21.01.1997
Level/Уровень: Shoulder surface

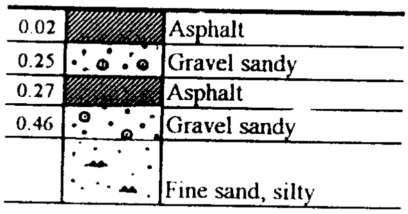


STRUCTURE OF PAVEMENT (trial pit diagrams)

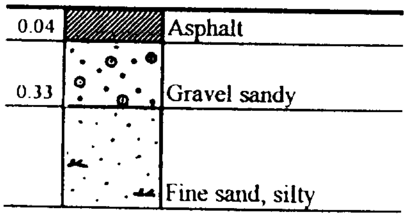
Location/Место: km 91+00/R — **No. TP- 58**
Data/Дата: 24.01.1997
Level/Уровень: Shoulder surface



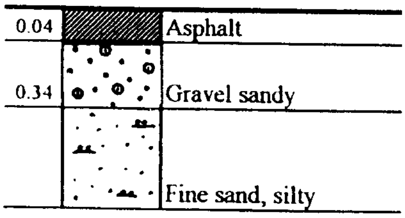
Location/Место: km 88+00/L — **No. TP- 61**
Data/Дата: 24.01.1997
Level/Уровень: Shoulder surface



Location/Место: km85+00/R — **No. TP- 63**
Data/Дата: 24.01.1997
Level/Уровень: Shoulder surface

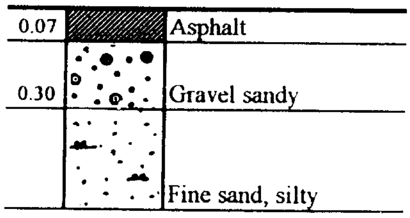


Location/Место: km 83+00/R — **No. TP- 65**
Data/Дата: 24.01.1997
Level/Уровень: Shoulder surface

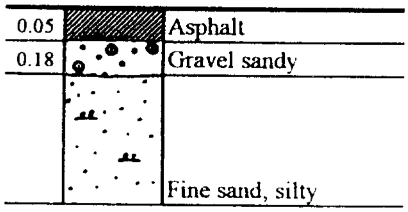


STRUCTURE OF PAVEMENT (trial pit diagrams)

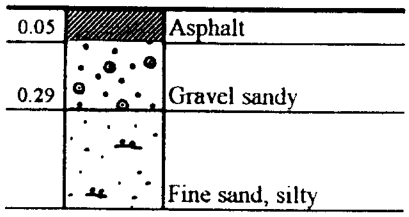
Location/Место: km 97+00/R — **No. TP- 52**
Data/Дата: 08.01.1997
Level/Уровень: Shoulder surface



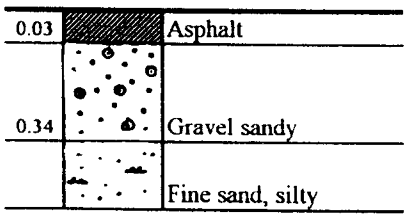
Location/Место: km 95+00/R — **No. TP- 54**
Data/Дата: 09.01.1997
Level/Уровень: Shoulder surface



Location/Место: km 94+00/L — **No. TP- 55**
Data/Дата: 09.01.1997
Level/Уровень: Shoulder surface

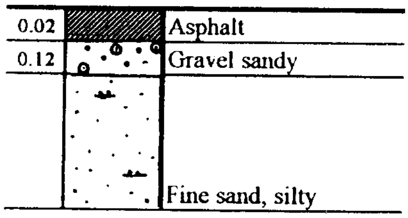


Location/Место: km 91+00/R — **No. TP- 58**
Data/Дата: 24.01.1997
Level/Уровень: Shoulder surface

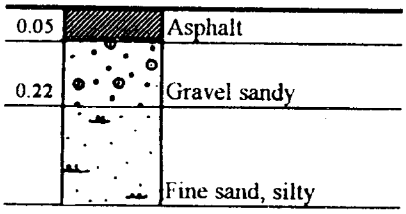


STRUCTURE OF PAVEMENT (trial pit diagrams)

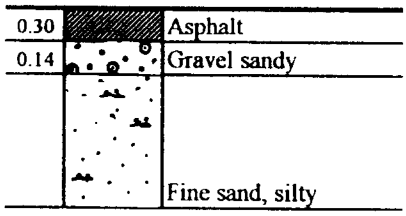
Location/Место: km 105+00/L — **No. TP- 45**
Data/Дата: 25.12.1996
Level/Уровень: Shoulder surface



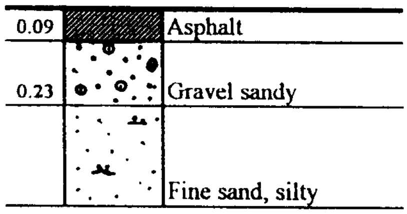
Location/Место: km 103+00/R — **No. TP- 47**
Data/Дата: 26.12.1996
Level/Уровень: Shoulder surface



Location/Место: km 100+00/L — **No. TP- 49**
Data/Дата: 27.12.1996
Level/Уровень: Shoulder surface

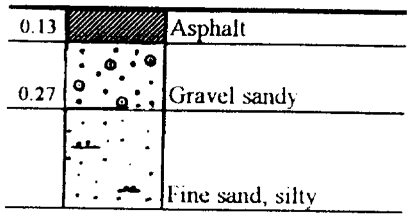


Location/Место: km 98+00/L — **No. TP- 51**
Data/Дата: 08.01.1997
Level/Уровень: Shoulder surface

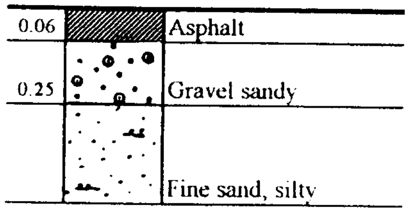


STRUCTURE OF PAVEMENT (trial pit diagrams)

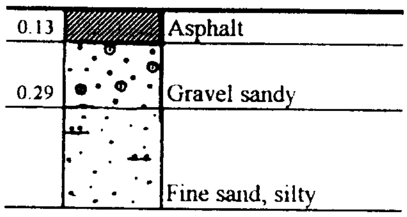
Location/Место: km 114+00/R — **No. TP- 36**
Data/Дата: 19.12.1996
Level/Уровень: Shoulder surface



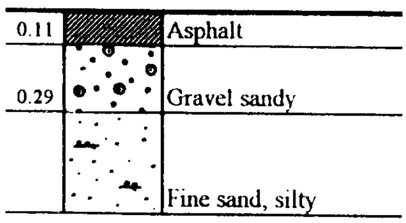
Location/Место: km 111+00/L — **No. TP- 39**
Data/Дата: 23.12.1996
Level/Уровень: Shoulder surface



Location/Место: km 110+00/R — **No. TP- 40**
Data/Дата: 24.12.1996
Level/Уровень: Shoulder surface

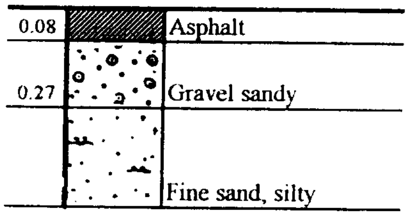


Location/Место: km 108+00/R — **No. TP- 42**
Data/Дата: 24.12.1996
Level/Уровень: Shoulder surface

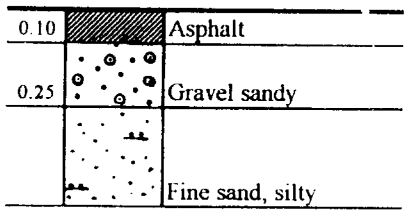


STRUCTURE OF PAVEMENT (trial pit diagrams)

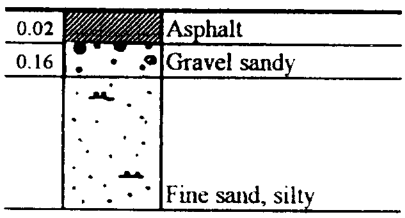
Location/Место: km 122+00/R **No. TP- 28**
Data/Дата: 16.12.1996
Level/Уровень: Shoulder surface



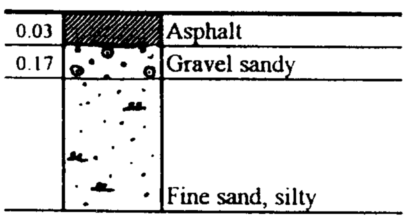
Location/Место: km 119+00/L **No. TP- 31**
Data/Дата: 17.12.1996
Level/Уровень: Shoulder surface



Location/Место: km 118+00/R **No. TP- 32**
Data/Дата: 17.12.1996
Level/Уровень: Shoulder surface

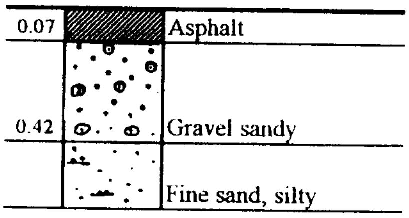


Location/Место: km 116+00/L **No. TP- 34**
Data/Дата: 18.12.1996
Level/Уровень: Shoulder surface

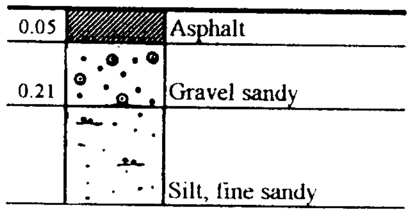


STRUCTURE OF PAVEMENT (trial pit diagrams)

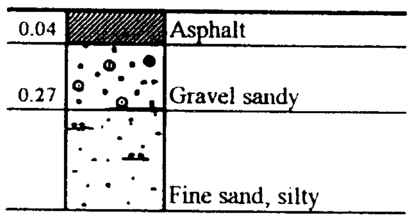
Location/Место: km 130+00/L — **No. TP- 21**
Data/Дата: 12.12.1996
Level/Уровень: Shoulder surface



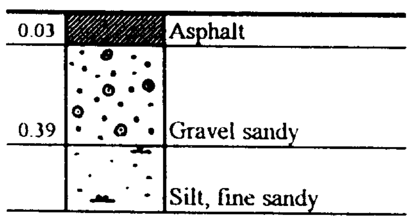
Location/Место: km 127+00/L — **No. TP- 23**
Data/Дата: 13.12.1996
Level/Уровень: Shoulder surface



Location/Место: km 124+00/L — **No. TP- 26**
Data/Дата: 13.12.1996
Level/Уровень: Shoulder surface

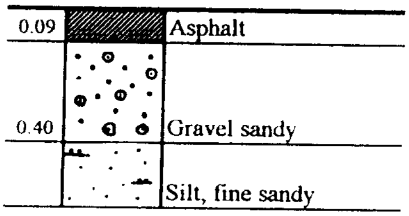


Location/Место: km 127+00/R — **No. TP- 27**
Data/Дата: 14.12.1996
Level/Уровень: Shoulder surface

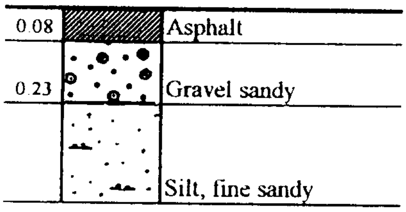


STRUCTURE OF PAVEMENT (trial pit diagrams)

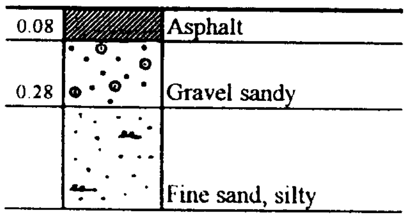
Location/Место: km 138+00/L — **No. TP- 13**
Data/Дата: 10.12.1996
Level/Уровень: Shoulder surface



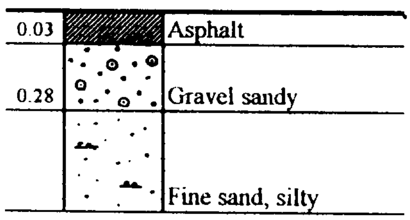
Location/Место: km 136+00/R — **No. TP- 15**
Data/Дата: 10.12.1996
Level/Уровень: Shoulder surface



Location/Место: km 134+00/L — **No. TP- 17**
Data/Дата: 11.12.1996
Level/Уровень: Shoulder surface



Location/Место: km 132+00/R — **No. TP- 19**
Data/Дата: 11.12.1996
Level/Уровень: Shoulder surface



STRUCTURE OF PAVEMENT (additional checks)

Location/Место: km 24+00/R — No. TP- 24CCH
Data/Дата: 22.04.1997
Level/Уровень: Shoulder surface

0.04	Asphalt
0.11	Asphalt
0.34	Gravel sandy

Location/Место: km 60+00/L — No. TP- 60CCH
Data/Дата: 23.04.1997
Level/Уровень: Shoulder surface

0.15	Asphalt
0.40	Gravel sandy
0.44	Asphalt
0.59	Gravel sandy

Location/Место: km102+00/R — No. TP- 102CCH
Data/Дата: 24.04.1997
Level/Уровень: Shoulder surface

0.09	Asphalt
0.24	Gravel sandy

Location/Место: km 142+00/R — No. TP- 142CCH
Data/Дата: 25.04.1997
Level/Уровень: Shoulder surface

0.27	Asphalt
0.58	Gravel sandy
0.71	Asphalt
0.85	Gravel sandy

Annex 1.12: Gravel Test Results

GRAVEL TEST RESULTS

Quarry	Type of material	Grain size distribution in %										
		>64mm	>32mm	>16mm	>8mm	>4mm	>2mm	>1mm	>0.5mm	>0.250mm	>0.125mm	< 0.063mm
Serahs (Hor-Hor)	Raw material	0.0	5.0	14.0	30.0	46.0	57.3	64.8	71.8	84.0	90.0	6.9
Serahs (Border)	Raw material	0.0	2.2	16.6	35.3	52.2	63.5	72.3	79.5	86.8	93.2	3.8
Dushak	Raw material	0.0	24.7	60.8	83.9	91.1	93.6	94.6	95.3	95.9	96.4	2.9
Dushak	Crushed		0.0	20.0	94.3	99.3	99.5	99.7	99.7	99.7	99.7	0.0
Dushak	Crushed			0.0	0.7	43.5	75.8	90.8	97.2	98.6	98.8	0.1
Kaushut	Raw material	28	34.2	47.8	63.4	70.8	74.6	76.9	79.3	84.9	89.3	7.6
Bezmein	Raw material	0	12.6	30.9	47.1	59.7	66.1	72.1	79.3	83.7	85.9	11.5

Annex 1.13: Cement Test Results

CEMENT TEST RESULTS

Location: Buzmein cement plant (Turkmenistan)
Data: May 1997

INDEX		Units	Portlandcement M-400
Physico-mechanical tests			
Specific surface		m/kg	296,8
Normal density		%	24,5
Water-cement relation			0,4
Slump test		mm	112,5
Setting time	Starting	h., min.	1hours 40 minutes
	End	h., min.	3 hours 00 minutes
Regularity of volume change			ok
Flexure	3 days	kg/cm2/mPa	46.1 (4.5)
	28 days	kg/cm2/mPa	72.6 (7,11)
Compressing strength	3 days	kg/cm2/mPa	320 (31.3)
	28 days	kg/cm2/mPa	446 (43.7)
Admixtures		%	not
Chemical composition of clinker			
p.p.p		%	0,60
SiO_2		%	21,87
Al_2O_3		%	5,04
Fe_2O_3		%	3,73
CaO		%	65,61
MgO		%	2,11
SO_3 (in cement)		%	2,39
SO_3		%	0,41
R_2O		%	0,10
TiO_2		%	0,27
Unsoluble sediment		%	0,12
Cr^{+6}		%	0,002
CaO		%	0,6
K_n (coefficient of saturation)			0,9
n (silicat modul)			2,49
p (clayish-soil modul)			1,35
Mineralogical composition of clincer		%	
C_3S		%	58,17
C_2S		%	18,81
C_3A		%	7,02
C_4AF		%	11,34

CEMENT TEST RESULTS

Location: Buzmein cement plant (Turkmenistan)
Data: May 1997

INDEX		Units	Portlandcement M-400 with mineral adds
Physico-mechanical tests			
Specific surface		m/kg	296.8 (11.5)
Normal density		%	24.5
Water-cement relation			0.4
Slump test		mm	114
Setting time	Starting	h., min.	1hours 45 minutes
	End	h., min.	2 hours 50 minutes
Regularity of volume change			0k
Flexure	3 days	kg/cm2/mPa	45.7 (4.48)
	28 days	kg/cm2/mPa	61.8 (6,05)
Compressing strength	3 days	kg/cm2/mPa	187 (18.3)
	28 days	kg/cm2/mPa	424 (41.55)
Admixtures		%	to 10
Chemical composition of clinker			
p.p.p		%	0.65
SiO_2		%	21.94
Al_2O_3		%	5.07
Fe_2O_3		%	3.85
CaO		%	64.98
MgO		%	2.27
SO_3 (in cement)		%	2.00
SO_3		%	0.44
R_2O		%	0.15
TiO_2		%	0.29
Unsoluble sediment		%	0.18
Cr^{+6}		%	0.002
CaO		%	0.4
K_n (coefficient of saturation)			0.89
n (silicat modul)			2.46
p (clayish-soil modul)			1.32
Mineralogical composition of clincer		%	
C_3S		%	55.95
C_2S		%	20.84
C_3A		%	6.81
C_4AF		%	11.70

Annex 1.14: Bitumen Test Results

BITUMEN TEST RESULTS

Location: Turkmenbashi refinery (Turkmenistan)
Data: January 1997

NN	Index		Units	Test result	Required acc. to DIN 1995
1	External condition			Waterlogged, strong oil smell	-
2	Needle penetration DIN 52010		1/10mm	273	160...210
3	Softening point DIN 52011		C	41.5	37.0...44.0
4	Breaking point after Fraass DIN 52012		C	-23	<-15
5	Ductility at 7 C DIN 52013		cm	13	-
6	Penetration index after Pfeifer and van Doorman			2.42	-
7	Ashe DIN 52005		%	0.1	<0.5
8	Alteretion of weight after thermical treatment DIN 52016		%	1.23	<1.50
9	Increase of softening point due to thermical strain		C	4.5	<8.0
10	Reduction of needle penetration due to thermical strain DIN 52010		%	48	<50
11	Breaking point after Fraass after thermical strain		C	-18	-
12	Ductility at 7 C after thermical strain DIN 52013		cm	5	-
13	Penetration index after Pfeifer and van Doorman after thermical strain			5	-
14	Density at 25 C DIN 52004		g/cm3	0.97	<1
15	Kinematical viscosity DIN 52 007 Part 2	at 75 C	mm2	3395	
		at 100 C		632	-
		at 125 C		171	-
16	Aquviscosity temperature (EVT) DIN 52 007 Part 2	EVT 100	C	139	
		EVT 1000		93	-
17	Flame point in open tigel after Clevelend DIN ISO 2592		C	155	-
18	Content of paraffin DIN 52015		%	4.20	<2

Annex 1.15
Chainages for road site drains

Tedjen - Mary Road Improvement

Chainages for road site drains

Chainage from Stat. km	to Stat. km	Both sites m	LHS m	RHS m
0+000	1+454	1,454		
1+454	1+675		221	
1+675	2+371	696		
2+371	2+511			140
2+511	3+448	936		
5+500	5+857	375		
5+857	6+200		343	
6+200	6+582	382		
6+582	7+500			918
7+500	9+778	2,278		
9+778	10+025		247	
10+025	10+500	475		
20+500	21+294	794		
21+294	21+500			206
22+500	24+500	2,000		
31+500	40+000	9,000		
44+500	45+500	1,000		
54+500	55+500	1,000		
56+500	57+500	1,000		
61+500	62+500	1,000		
74+500	74+746		246	
74+746	74+798			52
74+798	75+252	454		
75+252	75+500			248
81+500	83+500	2,000		
85+500	87+500	2,000		
93+500	93+785		285	
93+785	94+093	308		
94+093	94+435			342
94+435	95+044		609	
95+044	99+500	4,456		
100+500	113+500	13,000		
119+500	121+157	1,657		
121+157	121+635			478
121+635	123+500	1,825		
124+500	136+413	11,913		
136+413	136+694			281
136+694	139+500	2,806		
140+500	141+084	584		
141+084	141+226			142
141+226	141+773	547		
141+773	142+977	2,204		
		66,144	1,951	2,807

Total length : 70,902 m

Annex 1.16: Drainage Structures List

TRACECA -Tedjen - Mary Road Improvement
- DRAINAGE STRUCTURES LIST -

KOCKS
INGENIEURE

No	Chainage (km)	EXISTING STRUCTURE Type	material	Length (m)	Size/Dia (mm)	EXISTING DAMAGE Silted/ Blocked	Scour	Structural Damage	MAINTENANCE ACTIVITY Cleaning	Backfill of scoured areas	Repair	Reconst.	DESIGN MEASURE	OBSERVATIONS	REMARKS measured chainage
1	003+537	P	M	20.0	1000				X					In soil, L 75% R 100% blocked	
2	005+171	B	RC	27.0	1400				X						005+205
3	007+946	P	AC	27.0	350									Under water, in soil	007+986
4	010+349	B	RC	14.0	1000				X		?	X		Poor concrete quality, reinforcement visible, under water	010+370
5	**010+712**	B	RC	16.0	1000	80%			X		?	X		Poor concrete quality, cracks	
6	050+314	B/2	RC	17.0	2x1000				X		?	X		Poor concrete quality, cracks wingwalls, under water	050+302
7	050+387	B/2	RC	16.0	2x1000				X		?			Fair concrete quality, concrete outlet (walls), under water	050+375
8	051+787	B/R	RC	18,3	1000	L B/2	R		X		?	X		Wingwalls, poor concrete quality, 3/4 under water	051+764
9	052+551	B	RC	18.0	1000	100%			X		?			Completly under mud and water	052+525
10	055+104	B	RC	15.0	1000						?	X		Under water, poor concrete quality	055+085
11	056+617	B	RC	17.0		100%			X		?	X		Completly blocked, with mud 100%, poor concrete quality	056+595
12	057+481	B	RC	17.0					X			X		100% blocked, very poor concrete quality	057+455
13	058+594	P	RC	16,5	800 ?	90%			X		?			90% blocked with mud	058+568
14	058+928	B	RC	15.0	1000	50%			X					50% blocked with mud, poor concrete quality	058+895
15	060+014	B/2	RC	14.0	?				X		?			Under water	059+975
16	061+268	B/2	RC	16.0	1000				X			X		Very poor concrete quality, cracks	061+215
17	062+854	?	?	15.0	?									100% under water,concrete surface very poor quality.	062+710
18	065+869	B/2?	RC	17.0	?						?			100% under water, concrete slab poor to fair	065+450
19	076+528													Not found	
20	**085+705**	B	RC	18.0	1000	80%					?	X		80% blocked, poor concrete quality.	
21	086+533													Not found	
22	**094+300**	P	M	17.0	1000									Completly under water	
23	094+931													Not found	
24	**095+579**	P	M		300									LHS only / waste water / rusty	
25	**097+080**	P/2	M											Outlet L in concrete, pipes in soil	
26	097+733													Not found	
27	**118+905**	B/2	RC	25.0	1000				X		?	X		Poor concrete quality	

Structure: P= PIPE CULVERT
B= BOX CULVERT
Material: RC= REINFORCED CONCRETE M= METAL AC=ASBEST

TRACECA -Tedjen - Mary Road Improvement
- DRAINAGE STRUCTURES LIST -

KOCKS
INGENIEURE

No	Chainage (km)	EXISTING STRUCTURE Type	material	Length (m)	Size/Dia (mm)	EXISTING DAMAGE Silted/ Blocked	Scour	Structural Damage	MAINTENANCE ACTIVITY Cleaning	Backfill of scoured areas	Repair	Reconst.	DESIGN MEASURE	OBSERVATIONS	REMARKS measured chainage
28	119+056	B/2?	RC	21.0	?									Wingwalls. in water (F). 100% under water	
29	119+691													Not found	
31	127+240													Not found	
32	132+500	B	RC	16.0					X		?			Poor concrete quality, under water	
33	133+141													Not found	
34	137+775	B/P	RC	30.0	900									L side under water, L= box, R= pipe	
35	138+250	B	RC	11,50	?						?			Under water,poor concrete quality	
36	138+423													Not found	
37	138+910													Not found	
38	140+454	B	C											Under water, poor concrete quality,in front of big box culvert	
39	141+176													Height of dam = 20cm, not found	
40	141+852													Height of dam = 20cm, not found	
41	142+811													Not found	

Structure: P= PIPE CULVERT
B= BOX CULVERT
Material: RC= REINFORCED CONCRETE M= METAL AC=ASBEST

Annex 1.17: Bridge Condition Rating

TRACECA - IMPLEMENTATION OF BRIDGE MANAGEMENT SYSTEM (BMS)

BRIDGE CONDITION RATING

GUIDELINES FOR THE EVALUATION OF BRIDGE DEFICIENCIES AND DETERMINATION OF BRIDGE CONDITION CLASSES (MARKS OF CONDITION)

Description of Condition	Mark of Condition	Remedial Works
The structure has no or minor, hardly visible damages only. The deficiencies restrict neither separately, nor in summary the stability and/or the traffic safety and/or the durability of the structure. Examples for typical deficiencies: • dirty facing areas not allowing visual inspection • minor unevenness/rutting of wearing surfaces (carriageway, walkways etc.) • dirty deck joints (expansion joints), bearings and areas around the bearings, joints of steel structures and walkable interiors of structures • not planned vegetation at/on structure • minor alluviated material and/or scouring • dirty/unlegible traffic signs	1	Routine maintenance
The structure has clearly visible damages which do not yet affect the stability. Traffic safety is slightly affected. The existing condition of the structure does not fulfil long term requirements on durability. Examples for typical deficiencies: • minor damages on the bridge furniture and/or it's corrosion protection (railing, guard rails, marker posts, road lights etc.) • bridge furniture in operational condition, but not in accordance with actual standard requirements (out of date) • minor damages on the invert and slope stabilisation, slope stairs, bridge drainage, deck joints (expansion joints), joint sealings • minor damages on the corrosion protection of structural steel units • medium unevenness/rutting of wearing surfaces (carriageway, walkways etc.)	2	Routine and period maintenance and/or repair

Description of Condition	Mark of Condition	Remedial Works
The structure has significant damages, which in short term **may** result separately or in summary in a reduction of stability and/or of traffic safety requiring restriction of use (load restriction, one lane traffic by sign posts/barriers etc.). The existing damages are reducing the durability of the structure. Examples for typical deficiencies: • significant damages on railings and covering plates • significant damages on the wearing surfaces of carriageway and walkways • significant unevenness/rutting in the wearing surfaces • significant damages on the corrosion protection and the coating of structural steel units • erosion and corrosion on the superstructure and the substructure with starting reduction of the cross section area of load bearing components • damages on sealings, joint sealings, drainage of bridge and sealing, erosion/scour protection, hindered bearing movement, which may cause considerable other damages • corrosion with reduction of the cross section area of the reinforcement and load bearing steel components • damages, which are the result of partial failure under load (deformation, cracking, deformed structural elements) • railing, safety furniture, wearing surfaces and other units of the bridge furniture are damaged • cable housings are visible, cable housings without grouting, corroded tendons • longitudinal cracks parallel to tendons	3	Major repairs and/or rehabilitation
The structure has severe damages , which separately and/or in summary reduce the stability and/or restrict the traffic safety. The durability of the structure is considerably reduced. An immediate restriction of use (load restriction, one lane traffic by sign posts/barriers etc.) and/or an immediate removal of the dangers for the restoration of the traffic safety is required. Examples for typical deficiencies: • failure of tendons • significant damages on main load bearing components which are the result of partial failure under load (deformation, cracking in the area of coupling joints, significant cracks parallel to tendons, deformed fastener) • railing, safety furniture, wearing surfaces and other units of the bridge furniture have damages affecting their function considerably • structural units have damages, which cause an acute danger for the traffic (e.g. reduction of the clearance, parts of the structure which may fall on the road)	4	Rehabilitation or reconstruction

Annex 1.18: Bridge Structures List

Abschnitt Tedjen - Mary

Bw.-Nr.	km	oben/ unten	statisches System	Querschnitt	Bw - Länge	Bw - Breite	Stützweiten	Breite Fahrbahn + Gehwege
1	5,95	M-37/ Kanal	3-feld, einfach gelagert	6-stegiger Plattenbalken aus Spannbetonfertigteilen	99,00 m	15.40 m	3 x 33 m	11,95 + 2 x 1,60
2	6,50	M-37/ Kollektor	1-feld, einfach gelagert	10-stegiger Plattenbalken aus Spannbetonfertigteilen	15,00 m	15,25 m	15 m	15,25 + 2 x 1,10
3	13,40	M-37/ Kollektor	3-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	18,00 m	13,65 m	3 x 6 m	12,05 + 2 x 0,65
4	18,00	M-37/ Kollektor	6-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	54,00 m	11,70 m	6 x 9 m	11,70 + 2 x 0,60
5	23,10	M-37/ Kollektor	10-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	60,00 m	10,50 m	10 x 6 m	10,50
6	27,90	M-37/ Kollektor	7-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	4[illegible],00 m	10,30 m	7 x 6 m	8,00 + 2 x 0,95
7	34,80	M-37/ Kollektor	5-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	30,00 m	10,30 m	5 x 6 m	8,00 + 2 x 0,95
8	41,50	M-37/ Kanal	5-feld, einfach gelagert	5-stegiger Plattenbalken aus Ortbeton	84,40 m	9,00 m	5 x 16,80 m	7,00 + 2 x 0,80
9	41,90	M-37/ Kollektor	7-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	63,00 m	12,80 m	7 x 9 m	10,70 + 2 x 0,70
10	59,60	M-37/ Kollektor	1-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	9,00 m	12,80 m	9,00 m	10,90 + 2 x 0,7
11	66,20	M-37/ Kollektor	7-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	42,00 m	13,65 m	7 x 6 m	11,00 + 1,10 + 0,75

Bw.-Nr.	km	oben/ unten	statisches System	Querschnitt	Bw - Länge	Bw - Breite	Stützweiten	Breite Fahrbahn + Gehwege
12	74,00	M-37/ Magistr.-Kanal	6-feld, einfach gelagert	6-stegiger Plattenbalken aus Fertigteilen	82,60 m	10,40 m	6 x 10 m	8,00 + 2 x 1,00
13	75,00	M-37/ Kollektor	1-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	9,00 m	14,35 m	9,00 m	11,95 + 2 x 1,00
14	77,00	M-37/ Kollektor	4-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	36,00 m	14,15 m	4 x 9,00 m	11,75 + 2 x 1,00
15	78,20	M-37/ Kollektor	1-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	9,00 m	13,80 m	9,00 m	???????
16	83,60	M-37/ Kollektor	3-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	27,00 m	13,80 m	3 x 9,00 m	11,40 + 2 x 0,95
17	133,50	M-37/ Kollektor	4-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	36,00 m	13,80 m	4 x 9,00 m	11,90 + 2 x 0,70
18	137,90	M-37/ Kollektor	2-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	12,00 m	10,90 m	2 x 6,00 m	9,00 + 2 x 0,65
19	138,50	M-37/ Kollektor	5-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	30,00 m	14,40 m	5 x 6,00 m	12,00 + 2 x 1,20
20	139,70	M-37/ Kollektor	5-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	30,00 m	11,40 m	5 x 6,00 m	9,00 + 2 x 1,00
21	139,80	M-37/ Kollektor	2-feld, einfach gelagert	Stahlbetonplattenbalken aus Fertigteilen	12,00 m	11,20 m	2 x 6,00 m	10,00
22	140,20	M-37/ Kollektor	2-feld, einfach gelagert	Stahlbetonplattenbalken aus Fertigteilen	12,00 m	8,80 m	2 x 6,00 m	8,00

Bw.-Nr.	km	oben/ unten	statisches System	Querschnitt	Bw - Länge	Bw - Breite	Stützweiten	Breite Fahrbahn + Gehwege
23 a	142,34	M-37/ Aryk	1-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	9,00 m	39,80 m	9,00 m	> 32,70
23 b	142,34	M-37/ Aryk	1-feld, einfach gelagert	Stahlbetonplatte aus Fertigteilen	9,00 m	27,80 m	9,00 m	> 23,07

Annex 1.19: Assessment of Bridge Condition and Remedial Works

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
1	5.95	• abutment at front - slope damaged; bored piles are visible (≈ 1,5 m), the bearing capacity of the foundation is possibly reduced	3	• reconstruction of embankment and new slope protection
2	6.50	• all pile heads of the foundation are visible • at all wingwalls (no separate foundation) the connection with the abutment (chamber wall) is broken • 4. + 5. Beam - longitudinal cracks in the web of the beams • cracks and scalings on the sidewalk elements	3	• reconstruction of embankment and new slope protection • repair of the wingwalls • repair of cracks and scalings
3	13.40	• left side without railing • right side - the first and the last 3 m without railing • longitudinal cracks in the beams as a result of corrosion of the reinforcement • sealing layer is damaged • the distance between the kerbs is greater than the width of the road carriageway - the area beside the carriageway is without pavement or sealing layer	2 (4)	• new railings • new sealing and pavement layers
4	18.00	• the collector drain is without embankment • the visible high of the driven piles is up to 8.5 m - the length in the ground is unknown • cross heads made of cast in place concrete are of poor quality - cracks and visible reinforcement • the distance between the kerbs is greater than the width of the road carriageway - the area beside the carriageway is without pavement or sealing layer • the railing is not high enough and corroded	3	• checking of the remaining length in the ground of the driven piles and the bearing capacity • reconstruction of embankment and new slope protection • new railings • new sealing and pavement layers • repair of the concrete surfaces

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
5	23.10	• the collector drain is without embankment • the visible high of the driven piles is up to 6.5 m - the length in ground is unknown • the quality of the driven piles is very poor - honeycombs, visible reinforcement - scalings, cracks and rusted reinforcement in the splash zone • cross heads made of cast in place concrete are of poor quality - cracks and visible reinforcement • damages in the sealing - specially in the area of the longitudinal joint between the side beam and the first normal beam • railing with damages - remaining sections weak and not high enough	3	• checking of the remaining length in the ground of the driven piles and the bearing capacity of the piles • reconstruction of embankment and new slope protection • new railings • new sealing and pavement layers • repair of concrete surfaces
6	27.90	• the collector drain is without embankment • the quality/workmenship of the driven piles is very poor - honeycombs, visible reinforcement - scalings, cracks and rusted reinforcement in the splash zone • cross heads made of cast in place concrete are of poor quality - cracks and visible reinforcement • quality of the precast elements is bad • cracks and moisture on the side beams • damages in the sealing layer - the whole bottom side of the superstructure is moist • cross and longitudinal joints are broken • railing with damages - remaining sections weak and not high enough	3	• reconstruction of embankment and new slope protection • new railings • new sealing and pavement layers • repair of concrete surfaces

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
7	34.80	• the collector drain is without embankment • the quality of the driven piles is very poor - honeycombs, visible reinforcement - scalings, cracks and rusted reinforcement in the splash zone • cross heads made of cast in place concrete are of poor quality - cracks and visible reinforcement • quality of the precast elements is bad • cracks and moisture on the side beams • damages in the sealing - the whole bottom side of the superstructure is moist - corrosion of the reinforcement with concrete scalings on the bottom side of the precast elements • cross and longitudinal joints are broken • railing with damages - remaining sections weak and not high enough	3	• reconstruction of embankment and new slope protection • new railings • new sealing and pavement layers • repair of concrete surfaces
8	41.50	• carriageway is narrow • superstructure with thin concrete cover - vertical cracks on every link of the webs - rusted reinforcement • sidewalkblocks in bad condition - the last block on the left hand side failed • no sealing under the sidewalkblocks - superstructure is moist • carriageway is uneven • railing in bad condition	2	• new pavement and sealing layers - including all cross joints • repair of the sidewalkblocks • new railing • concrete protection system for the superstructure • safety/warning measures at the bridge approaches due to narrow carriageway on bridge deck

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
9	41.90	• one damaged pile - pile is buckled, may be already during the erection of the bridge • cross cracks in the 2. and 3. cross head because of settlements • the collector drain is without embankment • the quality of the driven piles is bad - honeycombs, visible reinforcement - scalings, cracks and rusted reinforcement in the splash zone • cross heads made of cast in place concrete are of poor quality - cracks and visible reinforcement • quality of the precast elements is bad • damages in the sealing - specially the sealing of the joints • carriageway uneven and with pot holes - on the left hand side 2 m without pavement • railing with damages	4	• Investigation of thereasons for the cracks in the cross heads and the buckling of the driven pile • repair of this damages if possible • new sealing and pavement • reconstruction of embankment and new slope protection • repair railing • repair of concrete surfaces note: erection of a new bridge if it is more conomical solution
10	59.60	• without railing • settlements of the road in front and behind the bridge • longitudinal joint between side beam and first normal beam is broken • crosscracks in the wearing surface above the abutments	2 (4)	• new railing • sealing of the longitudinal joints • repair of settlements

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
11	66.20	• the collector drain is without embankment • the quality of the driven piles is bad - honeycombs, visible reinforcement - scalings, cracks and rusted reinforcement in the splash zone • cross heads are a combination of precast and cast in place concrete - poor quality • quality of the precast elements is bad • cracks and moisture on the side beams • on the left hand side 3 m of the carriageway without pavement and sealing • damages in the sealing - water is running through the longitudinal joints • the whole bottom side of the superstructure is moist - especially on the left hand side under the unpaved part of the carriageway • precast elements on the left with big scalings on the bottom side, the whole reinforcement is visible and rusted • railing with damages - remaining sections weak and not high enough	3	• new sealing and pavement layers • reconstruction of embankment and new slope protection • new railing • repair of concrete surfaces • replacement of damaged precast elements note: erection of a new bridge if it is the more economical solution
12	74.00	• carriageway is narrow • beams with thin concrete cover - vertical cracks in the webs over each link as a result of corrosion of the reinforcement • some sidewalkblocks are damaged - no sealing under the sidewalkblocks • joints between the sidewalkblocks over the piers are open • steel bearings are rusted • carriageway with ruttings and very uneven • railing with damages - remaining sections weak and not high enough	3	• new sealing and pavement layers • surface protection system for all concrete surfaces • new railing • repair of all cross joints • safety/warning measures at the bridge approaches due to narrow carriageway on bridge deck
13	75.00	• without railing • sidewalkblocks damaged - without anchorage on the superstructure • slope is damaged - transition slabs are visible • wearing surface of the carriageway in bad condition	2 (4)	• new sealing and pavement layers • new sidewalks and railings • repair of the slopes

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
14	77.00	• each cross head has a gap of 500 mm between two precast elements - that means there is not enough bearing area for the beams • the collector drain is without embankment • vertical cracks in the side of the side beams in the middle of the span (width 0.5 mm) • sealing is damaged - cross and longitudinal joints are moist • uneven wearing surface • on both sides 1 m carriageway without pavement • railing with damages - not high enough	3	• repair of cross heads to better the bearing conditions • new sealing and pavement • repair of sidewalks • reconstruction of embankment and new slope protection • new railing • repair of concrete surfaces and cracks
15	78.20	• without railing • some of the pile heads are damaged • sidewalkblocks damaged - without anchorage on the superstructure • slope is damaged - sliding slabs are visible • the chamber wall is made of thin concrete slab - this slab is broken • wearing surface of the carriageway in bad condition	3 (4)	• new sealing and pavement • new sidewalks and railings • repair of slopes and the chamber walls • repair of pile heads
16	83.60	• the collector drain is without embankment • scalings, cracks and rusted reinforcement in the splash zone of the driven piles • sealing is damaged - cross and longitudinal joints are moist • uneven wearing surface with cracks • railing with damages - rusted, not high enough	3	• new sealing and pavement • repair of sidewalks • reconstruction of embankment and new slope protection • new railing • repair of concrete surfaces

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
17	133.50	• all precast elements are of bad quality - many significant damages • the slope on the end of the bridge is destroyed - transition slabs nearly totally visible • quality of the longitudinal joints between the precast elements is very bad (too big, without filling) • some driven piles not vertical • the collector drain is without embankment • bad quality of the connection between the pile heads and the cross heads and of the cast in place parts of the cross heads • the upper side of some beams is broken (especially right side of the 1. Span) - holes and grooves in the wearing surface (one hole 600 mm deep) • sealing is damaged - cross and longitudinal joints are moist • railing with damages - rusted, not high enough	4	• structural stability is questionable and immediate action necessary like single lane traffic and 30 km/h speed limit • replacement by a new bridge required
18	137.90	• all concrete surfaces are damaged because of the moisture under the bridge - there are cracks because of rusted reinforcement, scalings and • the collector drain is without embankment • sealing is damaged - cross joint is leaky • wearing surface with ruts, cracks and pot holes • only a part of the railing is left on the bridge - which is also in bad condition	3	• new sealing and pavement • reconstruction of embankment and new slope protection • new railing • repair of the concrete surfaces • surface protection system for the bottom side of the superstructure and for the substructure

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
19	138,50	• bad quality/workmenship of the pile heads and of the connection between cross head and pile heads - settlement of the fourth cross head - joints between the precast elements of this cross head are broken • no railing • on the left hand side 2.30 m of the carriageway without pavement and sealing • the collector drain is without embankment damages in the sealing layer • the hold bottom side of the superstructure is moist - especially on the left hand side under the unpaved part of the carriageway • precast elements on the left with great scalings on the bottom side, the hold reinforcement is visible and rusted • the quality/workmenship of the driven piles is bad - honeycombs, visible reinforcement - scalings, cracks and rusted reinforcement in the splash zone • side beams in bad condition	4	• structural stability is questionable and <u>immediate action necessary</u> like single lane traffic and 30 km/h speed limit • replacement by a new bridge required
20	139.70	• cracks in the 1. and 2. cross head because of settlements of the piles • the quality/workmenship of the driven piles is bad - honeycombs, visible reinforcement - scalings, cracks and rusted reinforcement in the splash zone • the collector drain is without embankment • cast in place part of the cross heads and the connection between the cross heads and the piles are of bad quality • side beams with vertical cracks in the webs - moist • pavement in front and behind the bridge with severe settlements • sealing layer with damages • joints between side beams and normal beams are broken • railing with damages - rusted, not high enough	3	• investigation of the settlements • new sealing and pavement layers • reconstruction of embankment and new slope protection • new railing • repair of concrete surfaces • repair of pavement in the bridge approaches

TEDJEN - MARY ROAD IMPROVEMENT
ASSESSMENT OF BRIDGE CONDITION AND REMEDIAL WORKS

Bridge No.	Chainage [km]	Encountered Damages	Mark of Condition	Assessment of Remedial Works
21	139.80	• carriageway narrow - bridge without sidewalks • all concrete surfaces weathered - cracks, scalings, rusted reinforcement • very thick pavement layer • wearing surface with ruttings • railing with damages - rusted, not high enough	2	• new sealing and pavement layers • new railing and sidewalks • repair of concrete surfaces • surface protection system for the bottom side of the superstructure and for the substructure • safety/warning measures at the bridge approaches due to narrow carriageway on bridge deck
22	140.20	• no railing • carriageway narrow - bridge without sidewalks • all concrete surfaces weathered - cracks, scalings, rusted reinforcement • very thick pavement layer • wearing surface with ruttings • backfilling of the abutment in front with settlement	2 (4)	• new sealing and pavement layers • new railing and sidewalks • repairing of concrete surfaces • surface protection system for the bottom side of the superstructure and for the substructure • repair of backfilling • safety/warning measures at the bridge approaches due to narrow carriageway on bridge deck
23	142.34	• no railing • carriageway uneven, with ruttings • areas aside the carriageway without sealing layer - damages of the sealing are not visible • precast elements too big for the span (span: 4.00 m; length of the elements: 9.00 m)	2 (4)	• new railing • repair of pavement and sealing layers

Note: Mark of Condition in (..) for downgrading with regard to traffic safety

Annex 1.20
Capping layer due to water in dam structure

Tedjen - Mary Road Improvement

Capping layer due to water in dam structure

Chainage from Stat. km	to Stat. km	Capping layer m	Sulfate	Groundwater m
9+00	10+00	0,4	few	
40+00	41+00	0,4		1,00 moist
65+00	67+00	0,4	few	
79+00	80+00	0,4		small reservoir
105+00	106+00	0,4		1,00 moist
124+00	128+00	0,4	few	
131+00	133+00	0,4	few	
136+00	137+00	0,4	few	
138+00	139+00	0,4		channel 50m left
139+00	140+00	0,4	few	

Annex 121
Widening of curves

Tedjen - Mary Road Improvement

Widening of curves

Chainage		Widening	Radius	Length of widening
from Stat.	to Stat.	w	R	L
km	km	m	m	m
3+447.77	4+350.78	0,40	950	903,01
5+453.90	5+613.91	0,40	1000	140,00
6+581.87	7+498.52	overlay	800	
9+778.17	10+024.70	2,20	145	246,53
14+782.02	15+116.85	0,70	630	334,83
18+132.51	18+335.63	overlay	700	
21+293.81	21+527.76	0,50	850	233,95
21+703.61	22+174.97	0,70	600	471,36
22+327.83	22+602.43	0,40	970	274,60
41+683.48	41+846.02	1,10	340	123,64
41+860.34	42+164.16	0,80	500	303,62
73+981.07	74+190.73	0,70	600	209,66
74+190.73	74+548.34	1,50	250	357,61
74+548.34	74+746.67	0,40	1000	198,33
75+251.26	75+714.23	0,50	800	462,97
78+135.02	78+530.38	0,40	975	395,36
78+888.71	79+120.98	0,70	600	232,27
79+298.35	79+520.51	0,40	900	222,16
81+204.59	81+583.34	overlay	800	
94+093.26	94+391.06	0,50	800	297,80
94+653.37	95+043.61	0,50	800	390,24
123+512.85	124+018.25	0,50	800	505,40
136+413.19	136+693.53	0,70	600	280,35

Annex 2.1: Pavement Designs

PAVEMENT DESIGN

Case 1

Pavement design for reconstruction according to Road Note 29

- cumulative number of ESA in design lane 6 x 10^6 ESA
  CBR value for subgrade 3.5 % (soaked)

⇨ Sub-base thickness according to figure 6:
320 mm minimum CBR = 30 %

⇨ Roadbase thickness according to figure 7:
110 mm rolled asphalt roadbase

⇨ Surfacing thickness according to figure 7:
90 mm rolled asphalt (basecourse + wearing course min. 40 mm)

―――――

520 mm

Consultant's observation and recommendation

Substitute

⇨ Roadbase thickness

1st layer	80 mm	rolled asphalt roadbase
2nd layer	80 mm	rolled asphalt roadbase

⇨ surface thickness 40 mm asphalt concrete

Case 2

Pavement design for reconstruction according to Road Note 31

Traffic class:
cumulative ESA in 15 years 2012: 12 x 10^6 ESA both directions

⇨ 6 x 10^6 ESA per direction ⇨ T 5 - T 6

Subgrade strength class

CBR soaked for subgrade	3 - 4 %	⇨	S 2
CBR dry for subgrade	17.5 %	⇨	S 5

Alternative pavement according to Chart 5 Granular Roadbase/Structural Surface

S 2/T 6:	100 mm	Bituminous surface
	200 mm	Granular roadbase
	225 mm	Granular subbase
	200 mm	Selected subgrade fill
	725 mm	

Alternative pavement according to Chart 7

S 2/T 6:	50 mm	Bituminous surface
	150 mm	Bituminous roadbase
	225 mm	Granular subbase
	200 mm	Selected subgrade fill
	625 mm	

<u>Case 3</u>

according to RSTO (German Pavement Design Standard)

Road section with max. traffic volume (east of Tedjen)

1997:	870 trucks/24 h
Design Life:	20 years
$f_{sv} = 1.5$	increase in axle loads
$f_1 = 0.5$	lane factor for 2 lanes
$f_2 = 1.10$	lane factor for 3.25 m - 3.75 m
$f_3 = 1.00$	increase factor, max. increase in gradient ≤ 2 %

Traffic loading number VB = 1,680 x 1.5 x 0.5 x 1.1 x 1 = 1.386

⇨ construction class II, with sensitivity to frost F 2

⇨	basic thickness	500 mm	
	embankment	+ 50 mm	
	moisture content increased	+ 50 mm	
		600 mm	total thickness

According to table: bituminous base course with granular crushed rock base on subbase

40 mm	Surface course	
80 mm	Bituminous road base	
100 mm	Bituminous wearing course	
380 mm	Gravel or crushed rock	E_{V2} = 150 MN/m²
600 mm	Subgrade	E_{V2} = 45 MN/m²

Annex 2.2: Alternative 1, Improvement Measures

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 1)

Geometry											
Chainage		Pavement	Shoulder width		Length	Overlay 40 mm	Overlay 75 mm	Overlay 120 mm	Reconstruction	New	Widening
from	to	width	left	right						Alignment	of Road
m	m	m	m	m	km	km	km	km	km	km	km
0	1,000	9.00	2.00	2.00	1.000				1.000		
1,000	2,000	9.00	2.00	2.00	1.000				1.000		
2,000	3,000	9.00	2.00	2.00	1.000				1.000		
3,000	3,600	9.00	3.85	3.85	0.600				0.600		
3,600	3,800	9.00	3.00	3.00	0.200					0.200	
3,800	3,900	12.40	3.00	3.00	0.100					0.100	
3,900	4,200	9.00	3.00	3.00	0.300					0.300	
4,200	4,550	9.00	3.00	3.00	0.350		0.350				
4,550	4,950	8.80	2.70	3.50	0.400	0.400					
4,950	6,000	9.00	4.25	4.25	1.050				1.050		
6,000	6,650	9.00	3.00	3.00	0.650				0.650		
6,650	7,000	9.20	3.00	3.00	0. 50	0.350					
7,000	8,000	11.90	3.70	3.50	1.000	1.000					
8,000	8,150	8.90	3.00	3.00	0.150	0.150					
8,150	9,000	9.00	3.00	3.00	0.850				0.850		
9,000	9,460	9.00	3.15	3.15	0.460				0.460		
9,460	9,750	9.00	3.15	3.15	0.290					0.290	
9,750	9,970	12.25	3.00	3.00	0.220					0.220	
9,970	10,300	9.00	3.00	3.00	0.330					0.330	
10,300	11,000	9.00	3.00	3.00	0.700				0.700		
11,000	12,000	9.00	3.20	3.20	1.000				1.000		
12,000	13,000	9.00	3.15	3.15	1.000				1.000		
13,000	14,000	9.00	2.45	2.45	1.000				1.000		
14,000	15,000	9.00	2.65	2.65	1.000				1.000		
15,000	16,000	9.00	2.75	2.75	1.000				1.000		
16,000	17,000	9.00	2.95	2.95	1.000				1.000		
17,000	18,050	9.00	2.80	2.80	1.050				1.050		
18,050	19,000	8.50	2.80	2.00	0.950	0.950					
19,000	19,880	8.70	3.10	3.10	0.880	0.880					
19,880	20,000	9.00	2.95	2.95	0.120				0.120		
20,000	21,000	9.00	3.35	3.35	1.000				1.000		
21,000	22,000	9.00	3.45	3.45	1.000				1.000		
22,000	23,000	9.00	3.15	3.15	1.000				1.000		
23,000	24,000	9.00	3.05	3.05	1.000				1.000		
24,000	24,950	9.00	2.95	2.95	0.950				0.950		
24,950	25,000	8.70	2.40	3.80	0.050	0.050					

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 1)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 120 mm	Reconstruction	New Alignment	Widening of Road
Chainage		Pavement width	Shoulder width		Length						
from	to		left	right							
m	m	m	m	m	km	km	km	km	km	km	km
25,000	26,000	8.50	2.40	3.50	1.000	1.000					
26,000	27,000	8.20	3.00	3.70	1.000	1.000					
27,000	27,150	8.50	2.70	2.80	0.150	0.150					
27,150	28,000	9.00	2.50	2.50	0.850				0.850		
28,000	29,000	9.00	2.70	2.70	1.000				1.000		
29,000	29,950	9.00	3.15	3.15	0.950				0.950		
29,950	30,000	8.70	3.60	3.00	0.050	0.050					
30,000	31,000	8.00	3.60	3.00	1.000	1.000					
31,000	32,000	8.30	3.30	3.50	1.000	1.000					
32,000	33,000	8.10	2.80	3.00	1.000	1.000					
33,000	34,000	9.00	2.50	2.50	1.000				1.000		
34,000	35,000	9.00	2.35	2.35	1.000				1.000		
35,000	35,750	9.00	2.30	2.30	0.750				0.750		
35,750	36,000	8.10	2.90	2.60	0.250		0.250				
36,000	37,000	8.20	3.00	3.20	1.000		1.000				
37,000	37,550	8.10	3.65	3.65	0.550		0.550				
37,550	37,950	8.10	3.65	3.65	0.400	0.400					
37,950	39,000	9.00	3.60	3.10	1.050				1.050		
39,000	40,000	9.00	3.60	3.60	1.000				1.000		
40,000	41,000	9.00	3.15	3.15	1.000				1.000		
41,000	42,000	9.00	3.85	3.85	1.000				1.000		
42,000	42,350	9.00	2.80	2.80	0.350				0.350		
42,350	43,000	8.30	2.70	3.60	0.650	0.650					
43,000	43,350	8.60	3.80	3.90	0.350	0.350					
43,350	44,000	8.60	3.80	3.90	0.650		0.650				
44,000	44,250	8.90	2.80	3.30	0.250		0.250				
44,250	45,000	9.00	3.00	3.00	0.750				0.750		
45,000	46,000	9.00	3.20	3.20	1.000				1.000		
46,000	47,000	9.00	2.60	2.60	1.000				1.000		
47,000	48,000	9.00	4.10	4.10	1.000				1.000		
48,000	49,000	9.00	3.70	3.70	1.000				1.000		
49,000	49,650	9.00	2.90	2.90	0.650				0.650		
49,650	50,000	8.30	3.40	3.10	0.350	0.350					
50,000	51,000	7.70	3.40	3.10	1.000	1.000					
51,000	52,000	8.50	3.80	3.60	1.000	1.000					
52,000	52,950	8.80	2.90	3.40	0.950	0.950					

KOCKS
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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 1)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 120 mm	Reconstruction	New Alignment	Widening of Road
Chainage from	Chainage to	Pavement width	Shoulder width left	Shoulder width right	Length						
m	m	m	m	m	km	km	km	km	km	km	km
52,950	54,000	9.00	3.25	3.25	1.050				1.050		
54,000	55,000	9.00	3.6	3.6	1.000				1.000		
55,000	56,000	9.00	3.10	3.10	1.000				1.000		
56,000	57,000	9.00	3.20	3.20	1.000				1.000		
57,000	58,000	9.00	3.25	3.25	1.000				1.000		
58,000	59,000	9.00	3.80	3.80	1.000				1.000		
59,000	60,000	9.00	3.65	3.65	1.000				1.000		
60,000	61,000	9.00	2.70	2.70	1.000				1.000		
61,000	62,000	9.00	3.20	3.20	1.000				1.000		
62,000	63,000	9.00	2.45	2.45	1.000				1.000		
63,000	63,400	9.00	3.35	3.35	0.400				0.400		0.400
63,400	64,000	9.00	3.35	3.35	0.600				0.600		
64,000	65,000	9.00	3.45	3.45	1.000				1.000		
65,000	66,000	9.00	3.10	3.10	1.000				1.000		
66,000	67,000	9.00	3.45	3.45	1.000				1.000		
67,000	68,000	9.00	3.65	3.65	1.000				1.000		
68,000	69,000	9.00	3.90	3.90	1.000				1.000		
69,000	70,000	9.00	3.50	3.50	1.000				1.000		
70,000	71,000	9.00	3.05	3.05	1.000				1.000		
71,000	72,000	9.00	3.30	3.30	1.000				1.000		
72,000	73,000	9.00	3.40	3.40	1.000				1.000		
73,000	74,000	9.00	3.70	3.70	1.000				1.000		
74,000	75,000	9.00	3.55	3.55	1.000				1.000		
75,000	75,250	9.00	3.05	3.05	0.250				0.250		
75,250	75,550	9.00	3.05	3.05	0.300				0.300		0.300
75,550	76,000	9.00	3.05	3.05	0.450				0.450		
76,000	77,000	9.00	2.35	2.35	1.000				1.000		
77,000	78,000	9.00	1.90	1.90	1.000				1.000		
78,000	79,000	9.00	2.55	2.55	1.000				1.000		
79,000	80,000	9.00	3.00	3.00	1.000				1.000		
80,000	81,000	9.10	2.70	3.40	1.000		1.000				
81,000	81,200	8.90	3.90	3.70	0.200	0.200					
81,200	81,350	8.90	3.90	3.70	0.150	0.150					0.150
81,350	82,000	8.90	3.90	3.70	0.650	0.650					
82,000	82,350	8.80	3.60	3.60	0.350	0.350					
82,350	83,000	8.80	3.60	3.60	0.650	0.650					
83,000	83,400	9.00	3.40	3.20	0.400	0.400					

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 1)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 120 mm	Reconstruction	New Alignment	Widening of Road
Chainage		Pavement width	Shoulder width		Length						
from	to		left	right							
m	m	m	m	m	km	km	km	km	km	km	km
83,400	84,000	9.00	3.30	3.30	0.600				0.600		
84,000	85,000	9.00	2.90	2.90	1.000				1.000		
85,000	86,000	9.00	3.25	3.25	1.000				1.000		
86,000	87,000	9.00	3.10	3.10	1.000				1.000		
87,000	88,000	9.00	2.75	2.75	1.000				1.000		
88,000	89,100	9.00	3.20	3.20	1.100				1.100		
89,100	90,000	9.10	2.90	3.10	0.900	0.900					
90,000	91,000	9.00	3.30	3.30	1.000	1.000					
91,000	92,000	8.60	3.20	3.20	1.000	1.000					
92,000	93,000	9.00	3.00	3.00	1.000				1.000		
93,000	94,000	9.00	3.00	3.00	1.000				1.000		
94,000	95,000	9.00	2.70	2.70	1.000				1.000		
95,000	96,000	9.00	2.00	2.00	1.000				1.000		
96,000	97,000	9.00	2.55	2.55	1.000				1.000		
97,000	98,000	9.00	2.35	2.35	1.000				1.000		
98,000	99,000	9.00	2.50	2.50	1.000				1.000		
99,000	100,000	9.00	3.50	3.50	1.000				1.000		
100,000	101,000	9.00	3.10	3.10	1.000				1.000		
101,000	102,000	9.00	2.65	2.65	1.000				1.000		
102,000	103,000	9.00	2.70	2.70	1.000				1.000		
103,000	104,000	9.00	2.75	2.75	1.000				1.000		
104,000	105,000	9.00	3.00	3.00	1.000				1.000		
105,000	106,000	9.00	3.00	3.00	1.000				1.000		
106,000	107,000	9.00	3.00	3.00	1.000				1.000		
107,000	108,000	9.00	2.95	2.95	1.000				1.000		
108,000	109,000	9.00	3.15	3.15	1.000				1.000		
109,000	110,000	9.00	3.10	3.10	1.000				1.000		
110,000	111,000	9.00	3.20	3.20	1.000				1.000		
111,000	112,000	9.00	4.10	4.10	1.000				1.000		
112,000	113,000	9.00	3.15	3.15	1.000				1.000		
113,000	113,750	9.00	3.05	3.05	0.750				0.750		
113,750	114,000	8.70	3.30	3.10	0.250	0.250					
114,000	115,000	9.10	2.70	2.80	1.000	1.000					
115,000	116,000	8.80	2.90	2.90	1.000	1.000					
116,000	117,000	8.90	3.20	3.50	1.000	1.000					
117,000	117,250	9.50	3.90	3.20	0.250	0.250					
117,250	118,000	9.00	3.20	3.20	0.750				0.750		

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 1)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 120 mm	Reconstruction	New Alignment	Widening of Road
Chainage		Pavement width	Shoulder width		Length						
from	to		left	right							
m	m	m	m	m	km	km	km	km	km	km	km
118,000	119,000	9.00	2.60	2.60	1.000				1.000		
119,000	120,000	9.00	3.35	3.35	1.000				1.000		
120,000	121,000	9.00	3.30	3.30	1.000				1.000		
121,000	122,000	9.00	3.80	3.80	1.000				1.000		
122,000	123,000	9.00	3.20	3.20	1.000				1.000		
123,000	126,550	9.00	3.15	3.15	3.550				3.550		
126,550	127,000	9.10	3.00	3.20	0.450			0.450			
127,000	127,350	9.00	3.00	3.00	0.350	0.350					
127,350	131,550	9.00	3.00	3.00	4.200				4.200		
131,550	132,000	9.00	3.00	3.00	0.450		0.450				
132,000	133,000	9.00	3.00	3.00	1.000		1.000				
133,000	133,050	8.00	2.00	2.00	0.050		0.050				
133,050	134,000	9.00	2.00	2.00	0.950				0.950		
134,000	135,000	9.00	2.00	2.00	1.000				1.000		
135,000	136,000	9.00	2.00	2.00	1.000				1.000		
136,000	137,000	9.00	2.00	2.00	1.000				1.000		
137,000	138,000	9.00	2.00	2.00	1.000				1.000		
138,000	139,000	9.00	2.00	2.00	1.000				1.000		
139,000	140,000	9.00	2.00	2.00	1.000				1.000		
140,000	140,350	9.00	3.10	3.10	0.350				0.350		
140,350	141,000	8.10	3.60	3.50	0.650	0.650					
141,000	142,000	10.00	3.60	3.50	1.000	1.000					
142,000	142,527	13.00	3.60	3.50	0.527	0.527					
Total					142.527	25.007	5.550	0.450	110.080	1.440	0.850

Annex 2.3: Alternative 2, Improvement Measures

KOCKS INGENIEURE

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 100 mm	Reconstruction	New Alignment	Widening of Road
Chainage		Pavement width	Shoulder width		Length						
from	to		left	right							
m	m	m	m	m	km	km	km	km	km	km	km
0	1,000	9.00	3.00	3.00	1.000				1.000		
1,000	1,850	9.00	2.50	2.50	0.850				0.850		
1,850	2,000	14.00	0.00	0.00	0.150		0.150				
2,000	2,450	12.00	0.00	0.00	0.450		0.450				
2,450	3,000	12.00	0.00	0.00	0.550			0.550			
3,000	3,600	9.40	3.80	3.50	0.600			0.600			
3,600	3,800	9.00	3.00	3.00	0.200					0.200	
3,800	3,900	12.40	3.00	3.00	0.100					0.100	
3,900	4,200	9.00	3.00	3.00	0.300					0.300	
4,200	4,550	8.80	2.70	3.50	0.350		0.350				
4,550	4,950	8.50	2.70	3.50	0.400	0.400					
4,950	5,650	10.00	3.50	4.00	0.700		0.700				
5,650	6,650	9.20	3.00	3.00	1.000			1.000			
6,650	7,000	9.20	3.00	3.00	0.350	0.350					
7,000	8,000	11.90	3.70	3.50	1.000	1.000					
8,000	9,000	8.90	3.00	3.00	1.000	1.000					
9,000	9,150	9.30	3.00	3.00	0.150	0.150					
9,150	9,460	9.00	3.15	3.15	0.310				0.310		
9,460	9,750	9.00	3.00	3.00	0.290					0.290	
9,750	9,970	12.25	3.00	3.00	0.220					0.220	
9,970	10,300	9.00	3.00	3.00	0.330					0.330	
10,300	11,000	9.00	3.20	3.20	0.700				0.700		
11,000	12,000	9.00	3.15	3.15	1.000				1.000		
12,000	13,350	9.00	2.45	2.45	1.350				1.350		
13,350	14,000	8.30	2.40	2.20	0.650		0.650				
14,000	15,000	8.70	2.80	2.80	1.000		1.000				
15,000	16,000	8.60	3.00	2.90	1.000		1.000				
16,000	16,550	8.50	3.00	3.40	0.550		0.550				
16,550	17,000	8.50	3.00	3.40	0.450	0.450					
17,000	17,450	8.00	3.30	3.30	0.450	0.450					
17,450	18,000	8.00	3.30	3.30	0.550			0.550			
18,000	18,050	8.50	2.80	2.80	0.050			0.050			

KOCKS
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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry												
Chainage		Pavement	Shoulder width		Length	Overlay 40 mm	Overlay 75 mm	Overlay 100 mm	Reconstruction	New	Widening
from	to	width	left	right						Alignment	of Road
m	m	m	m	m	km	km	km	km	km	km	km
18,050	19,000	8.50	2.80	2.00	0.950	0.950					
19,000	19,880	8.70	3.10	3.10	0.880	0.880					
19,880	20,000	9.00	2.95	2.95	0.120				0.120		
20,000	21,000	9.00	3.35	3.35	1.000				1.000		
21,000	22,000	9.00	3.45	3.45	1.000				1.000		
22,000	23,000	9.00	3.15	3.15	1.000				1.000		
23,000	24,000	9.00	2.90	2.90	1.000				1.000		
24,000	24,950	9.00	2.95	2.95	0.950				0.950		
24,950	26,000	8.50	2.40	3.50	1.050	1.050					
26,000	27,000	8.20	3.00	3.70	1.000	1.000					
27,000	27,150	8.50	2.70	2.80	0.150	0.150					
27,150	28,000	9.00	2.50	2.50	0.850				0.850		
28,000	28,350	9.00	2.70	2.70	0.350				0.350		
28,350	29,000	8.20	3.00	3.20	0.650	0.650					
29,000	29,550	8.70	3.60	3.00	0.550	0.550					
29,550	29,950	8.70	3.60	3.00	0.400			0.400			
29,950	31,000	8.00	3.60	3.00	1.050	1.050					
31,000	32,000	8.30	3.30	3.50	1.000	1.000					
32,000	33,000	8.10	2.80	3.00	1.000	1.000					
33,000	34,000	8.00	2.90	3.00	1.000	1.000					
34,000	34,550	7.80	2.90	3.00	0.550	0.550					
34,550	35,000	7.80	2.90	3.00	0.450			0.450			
35,000	35,750	8.10	2.90	2.60	0.750			0.750			
35,750	36,000	8.10	2.90	2.60	0.250		0.250				
36,000	37,000	8.20	3.00	3.20	1.000		1.000				
37,000	37,550	8.10	3.60	3.10	0.550		0.550				
37,550	37,950	8.10	3.60	3.10	0.400	0.400					
37,950	38,350	8.30	4.00	4.00	0.400		0.400				
38,350	38,750	8.30	4.00	4.00	0.400	0.400					
38,750	39,000	8.30	4.00	4.00	0.250			0.250			
39,000	40,000	8.60	3.40	4.20	1.000			1.000			
40,000	40,150	8.10	3.00	4.20	0.150			0.150			

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 100 mm	Reconstruction	New Alignment	Widening of Road
Chainage		Pavement width	Shoulder width		Length						
from	to		left	right							
m	m	m	m	m	km	km	km	km	km	km	km
40,150	41,000	9.00	3.15	3.15	0.850				0.850		
41,000	41,850	9.00	3.85	3.85	0.850				0.850		
41,850	42,350	8.30	2.70	3.60	0.500		0.500				
42,350	43,000	8.30	2.70	3.60	0.650	0.650					
43,000	43,350	8.60	3.80	3.90	0.350	0.350					
43,350	44,000	8.60	3.80	3.90	0.650		0.650				
44,000	44,250	8.90	2.80	3.30	0.250		0.250				
44,250	44,650	8.90	2.80	3.30	0.400			0.400			
44,650	45,000	8.90	2.80	3.30	0.350	0.350					
45,000	45,550	9.10	3.30	3.00	0.550	0.550					
45,550	46,000	9.10	3.30	3.00	0.450		0.450				
46,000	47,000	8.60	2.40	3.20	1.000		1.000				
47,000	47,750	8.80	4.20	4.20	0.750		0.750				
47,750	48,450	9.00	3.70	3.70	0.700				0.700		
48,450	49,000	9.00	3.90	3.50	0.550			0.550			
49,000	49,650	8.30	3.40	3.10	0.650			0.650			
49,650	50,000	8.30	3.40	3.10	0.350	0.350					
50,000	51,000	7.70	3.40	3.10	1.000	1.000					
51,000	52,000	8.50	3.80	3.60	1.000	1.000					
52,000	52,950	8.80	2.90	3.40	0.950	0.950					
52,950	54,000	9.00	3.25	3.25	1.050				1.050		
54,000	55,000	9.00	3.70	3.70	1.000				1.000		
55,000	55,650	9.00	3.60	3.60	0.650				0.650		
55,650	56,000	7.60	3.50	4.10	0.350		0.350				
56,000	56,550	8.60	3.10	3.70	0.550		0.550				
56,550	57,000	8.60	3.10	3.70	0.450			0.450			
57,000	58,000	8.10	3.10	4.30	1.000			1.000			
58,000	59,000	8.60	3.20	4.20	1.000			1.000			
59,000	59,250	8.80	4.00	3.50	0.250			0.250			
59,250	60,000	8.80	4.00	3.50	0.750		0.750				
60,000	61,000	8.50	3.10	2.80	1.000				1.000		
61,000	62,000	8.30	3.60	3.50	1.000				1.000		

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry											
Chainage		Pavement	Shoulder width		Length	Overlay 40 mm	Overlay 75 mm	Overlay 100 mm	Reconstruction	New Alignment	Widening of Road
from	to	width	left	right							
m	m	m	m	m	km	km	km	km	km	km	km
62,000	63,000	8.20	2.60	3.10	1.000				1.000		
63,000	63,400	9.00	3.35	3.35	0.400				0.400		0.400
63,400	63,850	9.00	3.35	3.35	0.450				0.450		
63,850	64,000	8.90	3.40	3.40	0.150			0.150			
64,000	65,000	8.90	3.60	3.40	1.000			1.000			
65,000	65,370	8.10	3.60	3.50	0.370			0.370			
65,370	66,000	9.00	3.10	3.10	0.630				0.630		
66,000	66,470	9.00	3.45	3.45	0.470				0.470		
66,470	67,000	9.20	3.30	3.40	0.530		0.530				
67,000	68,000	8.00	3.50	4.80	1.000		1.000				
68,000	68,550	8.80	4.10	3.90	0.550		0.550				
68,550	69,000	8.80	4.10	3.90	0.450			0.450			
69,000	69,350	9.00	3.80	3.20	0.350			0.350			
69,350	70,000	9.00	3.80	3.20	0.650		0.650				
70,000	70,350	8.80	3.00	3.30	0.350		0.350				
70,350	70,950	8.80	3.00	3.30	0.600			0.600			
70,950	72,000	9.00	3.20	3.40	1.050		1.050				
72,000	72,850	9.10	3.50	3.20	0.850		0.850				
72,850	74,000	9.00	3.70	3.70	1.150				1.150		
74,000	74,650	9.00	3.55	3.55	0.650				0.650		
74,650	75,050	8.80	2.90	3.40	0.400						
75,050	75,250	9.00	3.05	3.05	0.200				0.200		
75,250	75,550	9.00	3.05	3.05	0.300				0.300		0.300
75,550	76,000	9.00	305.00	3.05	0.450				0.450		
76,000	77,000	9.00	2.35	2.35	1.000				1.000		
77,000	78,000	9.00	1.90	1.90	1.000				1.000		
78,000	79,000	9.00	2.55	2.55	1.000				1.000		
79,000	80,000	9.00	3.00	3.00	1.000				1.000		
80,000	81,000	9.10	2.70	3.40	1.000		1.000				
81,000	81,200	8.90	3.90	3.70	0.200	0.200					
81,200	81,350	8.90	3.90	3.70	0.150	0.150					0.150
81,350	82,000	8.90	3.90	3.70	0.650	0.650					

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 100 mm	Reconstruction	New Alignment	Widening of Road
Chainage		Pavement width	Shoulder width		Length						
from	to		left	right							
m	m	m	m	m	km	km	km	km	km	km	km
82,000	83,000	8.80	3.60	3.60	1.000	1.000					
83,000	83,400	9.00	3.40	3.20	0.400	0.400					
83,400	84,000	9.00	3.30	3.30	0.600				0.600		
84,000	85,000	9.00	2.90	2.90	1.000				1.000		
85,000	85,050	9.00	3.25	3.25	0.050				0.050		
85,050	85,650	9.00	3.20	3.30	0.600		0.600				
85,650	86,000	9.00	3.10	3.10	0.350	0.350					
86,000	87,000	9.00	2.75	2.75	1.000	1.000					
87,000	88,000	9.00	3.20	3.20	1.000	1.000					
88,000	90,000	9.00	3.05	3.05	2.000	2.000					
90,000	91,000	9.00	3.30	3.30	1.000	1.000					
91,000	92,000	8.60	3.20	3.20	1.000	1.000					
92,000	92,670	11.10	2.80	3.30	0.670	0.670					
92,670	93,000	9.00	3.00	3.00	0.330				0.330		
93,000	94,000	9.00	3.00	3.00	1.000				1.000		
94,000	94,670	9.00	2.70	2.70	0.670				0.670		
94,670	95,000	8.40	3.00	3.00	0.330	0.330					
95,000	95,950	7.80	2.60	2.60	0.950	0.950					
95,950	97,000	9.00	2.55	2.55	1.050				1.050		
97,000	98,000	9.00	2.35	2.35	1.000				1.000		
98,000	99,000	9.00	2.50	2.50	1.000				1.000		
99,000	99,250	9.00	3.50	3.50	0.250				0.250		
99,250	100,000	9.50	3.40	3.10	0.750		0.750				
100,000	100,350	9.20	2.60	3.40	0.350		0.350				
100,350	101,000	9.00	3.10	3.10	0.650				0.650		
101,000	102,000	9.00	2.70	2.70	1.000				1.000		
102,000	103,000	9.00	2.70	2.70	1.000				1.000		
103,000	104,000	9.00	2.90	2.90	1.000				1.000		
104,000	105,000	9.00	3.00	3.00	1.000				1.000		
105,000	106,000	9.00	3.00	3.00	1.000				1.000		
106,000	107,000	9.00	2.98	2.98	1.000				1.000		
107,000	108,000	9.00	3.05	3.05	1.000				1.000		

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 100 mm	Reconstruction	New Alignment	Widening of Road
Chainage		Pavement width	Shoulder width		Length						
from	to		left	right							
m	m	m	m	m	km	km	km	km	km	km	km
108,000	109,000	9.00	3.13	3.13	1.000						
109,000	110,000	9.00	3.15	3.15	1.000				1.000		
110,000	111,000	9.00	3.65	3.65	1.000				1.000		
111,000	112,000	9.00	3.65	3.65	1.000				1.000		
112,000	113,000	9.00	3.10	3.10	1.000				1.000		
113,000	113,750	9.00	2.93	2.93	0.750				1.000		
113,750	114,000	8.70	3.30	3.10	0.250				0.750		
114,000	115,000	9.10	2.70	2.80	1.000	0.250					
115,000	116,000	8.80	2.90	2.90	1.000	1.000					
116,000	117,000	8.90	3.20	3.50	1.000	1.000					
117,000	117,250	9.50	3.90	3.20	0.250	1.000					
117,250	118,000	9.00	3.20	3.20	0.750	0.250					
118,000	119,000	9.00	3.00	3.00	1.000				0.750		
119,000	120,000	9.00	3.35	3.35	1.000				1.000		
120,000	120,450	9.00	3.30	3.30	0.450				1.000		
120,450	121,000	9.00	3.30	3.30	0.550		0.450				
121,000	121,550	12.50	3.80	3.80	0.550			0.550			
121,550	122,000	9.00	4.40	4.40	0.450			0.550			
122,000	123,000	9.00	3.20	3.20	1.000				0.450		
123,000	123,550	9.00	3.15	3.15	0.550				1.000		
123,550	124,450	9.10	3.00	3.20	0.900				0.550		
124,450	125,050	9.10	3.00	3.20	0.600		0.900				
125,050	125,450	9.00	3.15	3.15	0.400	0.600					
125,450	127,000	9.10	3.00	3.20	1.550				0.400		
127,000	127,350	9.00	3.00	3.00	0.350			1.550			
127,350	128,520	9.00	3.00	3.00	1.170	0.350					
128,520	130,350	9.00	3.00	3.00	1.830				1.170		
130,350	130,750	9.00	3.00	3.00	0.400			1.830			
130,750	131,550	9.00	3.00	3.00	0.800				0.400		
131,550	133,000	9.00	3.00	3.00	1.450			0.800			
133,000	133,050	8.00	2.00	2.00	0.050		1.450				
133,050	134,050	8.00	2.00	2.00	1.000		0.050				
						1.000					

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm	Overlay 75 mm	Overlay 100 mm	Reconstruction	New Alignment	Widening of Road
Chainage		Pavement width	Shoulder width		Length						
from	to		left	right							
m	m	m	m	m	km	km	km	km	km	km	km
134,050	137,000	9.00	2.00	2.00	2.950				2.950		
137,000	140,000	9.00	2.00	2.00	3.000				3.000		
140,000	140,350	9.00	3.10	3.10	0.350				0.350		
140,350	141,000	8.10	3.60	3.50	0.650	0.650					
141,000	142,000	10.00	3.60	3.50	1.000	1.000					
142,000	142,527	13.00	3.60	3.60	0.527	0.527					
Total					142.527	37.957	22.830	18.250	61.650	1.440	0.850

Annex 2.4: Unit Costs

TRACECA, Tedjen - Mary Road Improvement

UNIT OPERATING COSTS: Mixing

Equipment costs per month:

Item	No.	Price US $	Service life years	Interest Rate %	Costs per month US $
Asphalt Plant	1	1,700,000	15	4.0	68,000
Loader	1	150,000	8	3.5	5,250
Total					**73,250**

Operating Costs per month:

Item		Unit Price US $	Costs per month US $
Fuel	130 t / month	125	16,250
Electricity			1,000
Labor costs	10 persons	250	2,500
50 % administrative costs			1,250
			21,000

Subtotal costs per month	**94,250**
Overhead (25 %)	23,563
Equipment and Labor Costs per month	**117,813**

Unit Costs per ton:

Estimated Output per month:	11500 ton/month
Costs per ton:	**10.24**

UNIT OPERATING COSTS: Asphalt Laying

Equipment costs per month:

Item	No.	Price US $	Service life years	Interest Rate %	Costs per month US $
Paver	1	200,000	8	7.0	14,000
Rollers	3	60,000	8	7.0	12,600
Spreader	1	30,000	8	7.0	2,100
Trucks	10	30,000	8	3.5	10,500
Miscellaneous	1	20,000	8	7.0	1,400
Tools					1,500
Total					**42,100**

Operating Costs per month:

Item			Unit Price US $	Costs per month US $
Fuel	1120 l / day	21 working days	0.10	2,352
Labor costs	30 persons		250	7,500
50 % administrative costs				3,750
				13,602

Subtotal costs per month	**55,702**
Overhead (30 %)	16,711
Equipment and Labor Costs per month	**72,413**

Unit Costs per m²:

Estimated Output per month: 95,000 m²/month

Costs per m²: **0.76**

UNIT OPERATING COSTS: Base Course Laying (granular)

Equipment costs per month:

Item	No.	Price US $	Service life years	Interest Rate %	Costs per month US $
Grader	2	200,000	8	7.0	28,000
Rollers	2	60,000	8	7.0	8,400
Excavator	1	150,000	8	7.0	10,500
Trucks	8	30,000	8	3.5	8,400
Miscellaneous	1	30,000	8	7.0	2,100
Tools					1,500
Total					**58,900**

Operating Costs per month:

Item			Unit Price US $	Costs per month US $
Fuel	960 l / day	21 working days	0.10	2,016
Labor costs	40 persons		250	10,000
50 % administrative costs				5,000
				17,016

Subtotal costs per month	**75,916**
Overhead (30 %)	22,775
Equipment and Labor Costs per month	**98,691**

Unit Costs per m²:

Estimated Output per month: 16,000 m²/month (depense of the average output of reconstruction)

Costs per m²: **6.17**

UNIT OPERATING COSTS: Patching (replacing wearing and base course)

Equipment costs per month:

Item	No.	Price US $	Service life years	Interest Rate %	Costs per month US $
Trucks	2	30,000	8	3.5	2,100
Compactor	1	15,000	8	7.0	1,050
Miscellaneous	1	30,000	8	7.0	2,100
Tools					2,000
Total					**7,250**

Operating Costs per month:

Item			Unit Price US $	Costs per month US $
Fuel	160 l / day	21 working days	0.10	336
Labor costs	15 persons		250	3,750
50 % administrative costs				1,875
				5,961

Subtotal costs per month	**13,211**
Overhead (30 %)	3,963
Equipment and Labor Costs per month	**17,174**

Unit Costs per m²:

Estimated Output per month: 1,900 m²/month

Costs per m²: **9.04**

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UNIT OPERATING COSTS: Surface Dressing

Equipment costs per month:

Item	No.	Price US $	Service life years	Interest Rate %	Costs per month US $
Bitumen Distributor	1	60,000	8	7.0	4,200
Chipping Spreader	1	30,000	8	7.0	2,100
Rollers	2	60,000	8	7.0	8,400
Loader	1	150,000	8	3.5	5,250
Trucks	6	30,000	8	3.5	6,300
Miscellaneous	1	5,000		7.0	350
Tools					500
Total					**27,100**

Operating Costs per month:

Item			Unit Price US $	Costs per month US $
Fuel	640 l / month	21 working days	0.10	1344
Labor costs	25 persons		250	6250
50 % administrative costs				3125
				10719

Subtotal costs per month	**37,819**
Overhead (30 %)	11,346
Equipment and Labor Costs per month	**49,165**

Unit Costs per m²:

Estimated Output per month: 160000 m²

Costs per m² **0.31**

UNIT OPERATING COSTS: Bitumen distribution

Equipment costs per month:

Item	No.	Price US $	Service life years	Interest Rate %	Costs per month US $
Bitumen Distributor	1	60,000	8	7.0	4,200
Miscellaneous	1	500		7.0	35
Tools					50
Total					**4,285**

Operating Costs per month:

Item			Unit Price US $	Costs per month US $
Fuel	20 l / day	21 working days	0.10	42
Labor costs	3 persons		250	750
50 % administrative costs				375
				1167

Subtotal costs per month	**5,452**
Overhead (30 %)	1,636
Equipment and Labor Costs per month	**7,088**

Unit Costs per m²:

Estimated Output per month: 16,000 m² (depense of the average output of reconstruction)

Costs per m² **0.44**

Material Costs: Asphalt concrete wearing course
(local bitumen)

Composition of wearing course		Unit price	Material densities	Unit price US $/t	Transport				
Bitumen	6 %			70.00				70.00 US $/t	4.20 US $/t
Filler	7 %			25.00	100 km a	0.35 t/km =	35.00 US $/t	60.00 US $/t	4.20 US $/t
Sand	30 %	9.64 US $/m³	1.5 t/m³	6.43	20 km a	0.35 t/km =	7.00 US $/t	13.43 US $/t	4.03 US $/t
Aggregate	75 %	10.83 US $/m³	1.7 t/m³	6.37	100 km a	0.35 t/km =	35.00 US $/t	41.37 US $/t	31.03 US $/t
Material cost of asphalt concrete wearing course									**43.46 US $/t**
								=	**104.29 US $/m³**

Material Costs: Asphalt concrete road base
(local bitumen)

Composition of wearing course		Unit price	Material densities	Unit price US $/t	Transport				
Bitumen	6 %			70.00				70.00 US $/t	4.20 US $/t
Filler	5 %			25.00	100 km a	0.35 t/km =	35.00 US $/t	60.00 US $/t	3.00 US $/t
Sand	35 %	9.64 US $/m³	1.5 t/m³	6.43	20 km a	0.35 t/km =	7.00 US $/t	13.43 US $/t	4.70 US $/t
Aggregate	54 %	10.83 US $/m³	1.7 t/m³	6.37	100 km a	0.35 t/km =	35.00 US $/t	41.37 US $/t	22.34 US $/t
Material cost of asphalt concrete road base									**34.24 US $/t**
								=	**82.17 US $/m³**

Material Costs: Asphalt concrete wearing course
(imported bitumen)

Composition of wearing course		Unit price	Material densities	Unit price US $/t		Transport			
Bitumen	6 %			200.00				200.00 US $/t	12.00 US $/t
Filler	7 %			25.00	100 km a	0.35 t/km =	35.00 US $/t	60.00 US $/t	4.20 US $/t
Sand	30 %	9.64 US $/m³	1.5 t/m³	6.43	20 km a	0.35 t/km =	7.00 US $/t	13.43 US $/t	4.03 US $/t
Aggregate	75 %	10.83 US $/m³	1.7 t/m³	6.37	100 km a	0.35 t/km =	35.00 US $/t	41.37 US $/t	31.03 US $/t

Material cost of asphalt concrete wearing course **51.26 US $/t**

= **123.01 US $/m³**

Material Costs: Asphalt concrete road base
(imported bitumen)

Composition of wearing course		Unit price	Material densities	Unit price US $/t		Transport			
Bitumen	6 %			200.00				200.00 US $/t	12.00 US $/t
Filler	5 %			25.00	100 km a	0.35 t/km =	35.00 US $/t	60.00 US $/t	3.00 US $/t
Sand	35 %	9.64 US $/m³	1.5 t/m³	6.43	20 km a	0.35 t/km =	7.00 US $/t	13.43 US $/t	4.70 US $/t
Aggregate	54 %	10.83 US $/m³	1.7 t/m³	6.37	100 km a	0.35 t/km =	35.00 US $/t	41.37 US $/t	22.34 US $/t

Material cost of asphalt concrete road base **42.04 US $/t**

= **100.89 US $/m³**

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Unit Costs: Reconstruction / New Pavement
(Case: local bitumen)

Road structure Road Note 29		Material costs		Mixing costs			Laying costs	Total
40 mm	Asphalt concrete wearing course	104.29 US $/m³ =	4.17 US $/m²	10.24 US $/t =	24.59 US $/m³ =	0.98	0.76 US $/m²	**5.92 US $/m²**
160 mm	Asphalt concrete road base	82.17 US $/m³ =	13.15 US $/m²	10.24 US $/t =	24.59 US $/m³ =	3.93	0.76 US $/m²	**17.84 US $/m²**
320 mm	Granular subbase							
	(200 - 250 mm existing base + 100 mm reinforcement)							
	remove the existing asphalt layer							**1.68 US $/m²**
	re-mixing and recompact						6.17 US $/m²	**6.17 US $/m²**
	Prime coat 1.00 kg/m²	70.00 US $/t =	0.07 US $/m²				0.44 US $/m²	**0.51 US $/m²**
	Tack coat 0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**

Unit Costs for Reconstruction / New Pavement **32.62 US $/m²**

Unit Costs: Reconstruction / New Pavement
(Case: imported bitumen)

Road structure Road Note 29		Material costs		Mixing costs			Laying costs	Total
40 mm	Asphalt concrete wearing course	123.01 US $/m³ =	4.92 US $/m²	10.24 US $/t =	24.59 US $/m³ =	0.98	0.76 US $/m²	**6.67 US $/m²**
160 mm	Asphalt concrete road base	100.89 US $/m³ =	16.14 US $/m²	10.24 US $/t =	24.59 US $/m³ =	3.93	0.76 US $/m²	**20.84 US $/m²**
320 mm	Granular subbase							
	(200 - 250 mm existing base + 100 mm reinforcement)							
	remove the existing asphalt layer							**1.68 US $/m²**
	re-mixing and recompact						6.17 US $/m²	**6.17 US $/m²**
	Prime coat 1.00 kg/m²	200.00 US $/t =	0.20 US $/m²				0.44 US $/m²	**0.64 US $/m²**
	Tack coat 0.80 kg/m²	200.00 US $/t =	0.16 US $/m²				0.44 US $/m²	**0.60 US $/m²**

Unit Costs for Reconstruction / New Pavement **36.60 US $/m²**

TRACECA, Tedjen - Mary Road Improvement

Unit Costs: Reconstruction / New Pavement
(Case: local bitumen)

Road structure Road Note 31			Material costs		Mixing costs			Laying costs	Total
100 mm	Asphalt concrete wearing course		104.29 US $/m³ =	10.43 US $/m²	10.24 US $/t =	24.59 US $/m³ =	2.46	0.76 US $/m²	**13.65 US $/m²**
200 mm	Granular road base								
100 mm	crushed gravel		10.83 US $/m³ =	1.08 US $/m²				6.17 US $/m²	**7.25 US $/m²**
100 mm	remove the existing asphalt layer re-mixing and recompact as road base								**1.68 US $/m²**
225 mm	Granular subbase		10.12 US $/m³ =	2.28 US $/m²				6.17 US $/m²	**6.17 US $/m²**
200 mm	Selected subgrade fill (=200 - 250 mm existing base)							6.17 US $/m²	**8.45 US $/m²**
	Prime coat	1.00 kg/m²	70.00 US $/t =	0.07 US $/m²				0.44 US $/m²	**0.51 US $/m²**

Unit Costs for Reconstruction / New Pavement **37.71 US $/m²**

Unit Costs: Reconstruction / New Pavement
(Case: imported bitumen)

Road structure Road Note 31			Material costs		Mixing costs			Laying costs	Total
100 mm	Asphalt concrete wearing course		123.01 US $/m³ =	12.30 US $/m²	10.24 US $/t =	24.59 US $/m³ =	2.46	0.76 US $/m²	**15.52 US $/m²**
200 mm	Granular road base								
100 mm	crushed gravel		10.83 US $/m³ =	1.08 US $/m²				6.17 US $/m²	**7.25 US $/m²**
100 mm	remove the existing asphalt layer re-mixing and recompact as road base								**1.68 US $/m²**
225 mm	Granular subbase		10.12 US $/m³ =	2.28 US $/m²				6.17 US $/m²	**6.17 US $/m²**
200 mm	Selected subgrade fill (=200 - 250 mm existing base)							6.17 US $/m²	**8.45 US $/m²**
	Prime coat	1.00 kg/m²	200.00 US $/t =	0.20 US $/m²				0.44 US $/m²	**0.64 US $/m²**

Unit Costs for Reconstruction / New Pavement **39.71 US $/m²**

Unit Costs: Overlay
(Case: local bitumen)

			Material costs		Mixing costs			Laying costs	Total
40 mm Overlay									
40 mm	40 mm Overlay		104.29 US $/m³ =	4.17 US $/m²	10.24 US $/t =	24.59 US $/m³ =	0.98	0.76 US $/m²	**5.92 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
Unit Costs									**6.42 US $/m²**
40 mm Overlay + 20 mm Regulating layer									
60 mm	40 mm Overlay + 20 mm Regulating layer		104.29 US $/m³ =	6.26 US $/m²	10.24 US $/t =	24.59 US $/m³ =	1.48	0.76 US $/m²	**8.50 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
Unit Costs									**8.99 US $/m²**
75 mm Overlay									
75 mm	Overlay		104.29 US $/m³ =	7.82 US $/m²	10.24 US $/t =	24.59 US $/m³ =	1.84	0.76 US $/m²	**10.43 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
Unit Costs									**10.93 US $/m²**
75 mm Overlay + 20 mm Regulating layer									
40 mm	Wearing cource		104.29 US $/m³ =	4.17 US $/m²	10.24 US $/t =	24.59 US $/m³ =	0.98	0.76 US $/m²	**5.92 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
55 mm	Second Layer & Regulating layer		104.29 US $/m³ =	5.74 US $/m²	10.24 US $/t =	24.59 US $/m³ =	1.35	0.76 US $/m²	**7.85 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
Unit Costs									**14.77 US $/m²**
100 mm Overlay									
40 mm	Wearing cource		104.29 US $/m³ =	4.17 US $/m²	10.24 US $/t =	24.59 US $/m³ =	0.98	0.76 US $/m²	**5.92 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
60 mm	Second Layer & Regulating layer		104.29 US $/m³ =	6.26 US $/m²	10.24 US $/t =	24.59 US $/m³ =	1.48	0.76 US $/m²	**8.50 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
Unit Costs									**15.41 US $/m²**
100 mm Overlay + 20 mm Regulating layer									
40 mm	Wearing cource		104.29 US $/m³ =	4.17 US $/m²	10.24 US $/t =	24.59 US $/m³ =	0.98	0.76 US $/m²	**5.92 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
80 mm	Second Layer & Regulating layer		104.29 US $/m³ =	8.34 US $/m²	10.24 US $/t =	24.59 US $/m³ =	1.97	0.76 US $/m²	**11.07 US $/m²**
	Tack coat	0.80 kg/m²	70.00 US $/t =	0.06 US $/m²				0.44 US $/m²	**0.50 US $/m²**
Unit Costs									**17.99 US $/m²**

Unit Costs: Overlay
(Case: imported bitumen)

			Material costs		Mixing costs			Laying costs	Total
40 mm Overlay									
40 mm	40 mm Overlay		123.01 US $\$/m^3$ =	4.92 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	0.98	0.76 US $\$/m^2$	**6.67 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
Unit Costs									**7.27 US $\$/m^2$**
40 mm Overlay + 20 mm Regulating layer									
60 mm	40 mm Overlay + 20 mm Regulating layer		123.01 US $\$/m^3$ =	7.38 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	1.48	0.76 US $\$/m^2$	**9.62 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
Unit Costs									**10.22 US $\$/m^2$**
75 mm Overlay									
75 mm	Overlay		123.01 US $\$/m^3$ =	9.23 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	1.84	0.76 US $\$/m^2$	**11.83 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
Unit Costs									**12.44 US $\$/m^2$**
75 mm Overlay + 20 mm Regulating layer									
40 mm	Wearing cource		123.01 US $\$/m^3$ =	4.92 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	0.98	0.76 US $\$/m^2$	**6.67 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
55 mm	Second Layer & Regulating layer		123.01 US $\$/m^3$ =	6.77 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	1.35	0.76 US $\$/m^2$	**8.88 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
Unit Costs									**16.75 US $\$/m^2$**
100 mm Overlay									
40 mm	Wearing cource		123.01 US $\$/m^3$ =	4.92 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	0.98	0.76 US $\$/m^2$	**6.67 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
60 mm	Second Layer & Regulating layer		123.01 US $\$/m^3$ =	7.38 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	1.48	0.76 US $\$/m^2$	**9.62 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
Unit Costs									**17.49 US $\$/m^2$**
100 mm Overlay + 20 mm Regulating layer									
40 mm	Wearing cource		123.01 US $\$/m^3$ =	4.92 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	0.98	0.76 US $\$/m^2$	**6.67 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
80 mm	Second Layer & Regulating layer		123.01 US $\$/m^3$ =	9.84 US $\$/m^2$	10.24 US $\$/t$ =	24.59 US $\$/m^3$ =	1.97	0.76 US $\$/m^2$	**12.57 US $\$/m^2$**
	Tack coat	0.80 kg/m^2	200.00 US $\$/t$ =	0.16 US $\$/m^2$				0.44 US $\$/m^2$	**0.60 US $\$/m^2$**
Unit Costs									**20.44 US $\$/m^2$**

Annex 2.5: **Confidential Cost Estimate Summary, Alternative 1**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Confidential Cost Estimate
Summary

Bill No.	Description	Total length (m)	Unit cost per m road	Total US $
1	General Item			3,000,000.00
2	Repair and 40 mm overlay	25,007	100.07	2,502,426.80
3	Repair and 75 mm overlay	5,200	162.59	845,446.90
4	Repair and 120 mm overlay	450	237.36	106,812.05
5	Pavement reconstruction	110,430	314.59	34,739,854.60
6	New Road	1,440	617.35	888,991.10
7	Drainage			330,652.53
8	Signalisation and miscellaneous roadworks			360,270.84
9	Dayworks			317,952.50
10	Miscellaneous			310,139.50
	Cost of Improvements			43,402,546.82
	Contingencies 5 %			2,170,127.34
	Total Estimate (exclusive of taxes and duties)			45,572,674.16

Note: Unit costs per linear meter road differ between Alternatives 1 and 2 because of differences in existing road widths.

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Item	Description	Unit	Quantity	Rate USD	Amount USD
100	General Items				
101	performance bond/guarantee	l.s	--		
102	insurance of the works	l.s	--		
103	insurance of constructional plant	l.s.	--		
104	third party insurance	l.s.	--		
105	safety measures and precautions concerning works under traffic	l.s.	--		
106	mobilisation of contractor's machinery, equipment, tools, shelters, facilities	l.s.	--		
107	contractor's site installation and temporary works for carrying out the works	l.s.	--		
108	maintenance of site installation during the construction period	l.s.	--		
109	office and operatives for engineer	l.s.	--		
110	removal of contractor's site installation, equipment, shelters, facilities and clearing of the area used on completion	l.s.			
	Total bill no. 1 carried to summary				**3,000,000.00**

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Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
200	Repair and 40 mm overlay				
201	Cleaning of cracks, incl. removal of joint sealant, foreign matter, and treating against grass growth, filling of cracks with a sand bitumen mixture	m	4,225.00	4.00	16,900.00
202	Milling 60 mm deep to spot damages, deformations and rutting, apply tack coat and fill with bituminous material	m^2		12.20	
203	Milling of elevated parts of the asphalt 0 - 40 mm	m^2	12,100.00	2.70	32,670.00
204	Levelling by filling of depressions with bituminous surface course incl. cleaning of surface and tack coat	m^2	100.00	7.00	700.00
205	Cleaning of surface to receive tack coat	m^2	221,767.00	0.40	88,706.80
206	Tack coat 0.5 l/m^2	m^2	221,767.00	0.50	110,883.50
207	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2	rate only			
208	Bituminous surface course 40 mm nominal, thickness, laid in 60 mm average thickness for levelling of undulations	m^2	221,767.00	8.50	1,885,019.50
209	Alteration rate in adjustment in bitumen contents for each 0.1 %	rate only			
210	Scarifying existing shoulders	m^2	162,603.00	1.50	243,904.50
211	Place selected material for shoulders, spread and compact at OMC to line and levels	m^3	13,015.00	9.50	123,642.50
212	Provisional Item: Benching in Shoulders Remove material in shoulders, construct at OMC the shoulder in benchings with selected material to widen the existing road/shoulder to line and levels	-	-	-	-
	Total bill no. 2 carried to summary				**2,502,426.80**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
300	Repair and 75 mm overlay				
301	Cleaning of cracks, incl. removal of joint sealant, foreign matter, and treating against grass growth, filling of cracks with a sand bitumen mixture	m	7,000.00	4.00	28,000.00
302	Milling 60 mm deep to spot damages, deformations and rutting, apply tack coat and fill with bituminous material	m^2	700.00	12.20	8,540.00
303	Milling of elevated parts of the asphalt 0 - 40 mm	m^2	1,900.00	2.70	5,130.00
304	Levelling by filling of depressions with bituminous surface course, incl. cleaning of surface and tack coat	m^2	1,000.00	7.00	7,000.00
305	Cleaning of surface to receive tack coat	m^2	45,045.00	0.40	18,018.00
306	Tack coat 0.5 l/m^2	m^2	90,090.00	0.50	45,045.00
307	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2	rate only			
308	Bituminous binder course 0/16 40 mm nominal thickness, laid in 60 mm average thickness for levelling of undulations	m^2	45,045.00	8.50	382,882.50
309	Alteration rate in adjustment in bitumen contents for each 0.1 %	rate only			
310	Bituminous surface course 0/11 mm 40 mm thick	m^2	45,045.00	5.92	266,666.40
311	Alteration rate in adjustment in binder contents for each 0.1 %	rate only			
312	Scarifying existing shoulders	m^2	33,120.00	1.50	49,680.00
313	Place selected material for shoulders, spread and compact at OMC to line and levels	m^3	3,630.00	9.50	34,485.00
314	Provisional Item: Benching in Shoulders Remove material in shoulders, construct at OMC the shoulder in benchings with selected material to widen the existing road/shoulder to line and levels				
	Total bill no. 3 carried to summary				**845,446.90**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
400	Repair and 120 mm overlay				
401	Cleaning of cracks, incl. removal of joint sealant, foreign matter, and treating against grass growth, filling of cracks with a sand bitumen mixture	m	2,300.00	4.00	9,200.00
402	Milling 60 mm deep to spot damages, deformations and rutting, applying tack coat and fill with bituminous material	m^2	800.00	12.20	9,760.00
403	Milling of elevated parts of the asphalt 0 - 40 mm	m^2	800.00	2.70	2,160.00
404	Levelling by filling of depressions with bituminous surface course, incl. cleaning of surface and tack coat	m^2		7.00	
405	Cleaning of surface to receive tack coat	m^2	4,095.00	0.40	1,638.00
406	Tack coat 0.5 l/m^2	m^2	9,190.00	0.50	4,595.00
407	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2	rate only			
408	Bituminous binder 0/16 B65 80 mm thick	m^2	4,095.00	11.07	45,331.65
409	Alteration rate in adjustment in bitumen contents for each 0.1 %	rate only			
410	Bituminous surface course 0/11 B65 40 mm thick	m^2	4,095.00	5.92	24,242.40
411	Scarifying existing shoulders	m^2	2,790.00	1.50	4,185.00
412	Place selected material for shoulders, spread and compact at OMC to line and levels	m^3	600.00	9.50	5,700.00
413	Provisional Item: Benching in Shoulders Remove material in shoulders, construct at OMC the shoulder in benchings with selected material to widen the existing road/shoulder to line and levels				
	Total bill no. 4 carried to summary				**106,812.05**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
500	Pavement Reconstruction				
501	Remove existing shoulder material to the underside of the existing asphalt	m^2	658,721.00	3.00	1,976,163.00
502	Milling of existing asphalt, and sieving to the gradations for subbase material	m^3	114,682.00	16.75	1,920,923.50
503	Scarify existing base course material, compact to line and levels at OMC as subbase (CBR > 30)	m^2	1,652,591.00	1.20	1,983,109.20
504	Provide sub-base material (CBR > 30) fill and compact at OMC to line and levels	m^3	110,595.00	9.50	1,050,652.50
505	Subbase material from recycled asphalt by adding gradation as required and built in 100 mm thick	m^3	225,277.00	7.00	1,576,939.00
506	Prime coat RC 30 at 0.8 l/m^2	m^2	993,870.00	0.51	506,873.70
507	Alteration rate for adjustment in application rate of each 0.1 l	rate only			
508	Rolled asphalt roadbase 0/22 B 65 160 mm thick	m^2	993,870.00	17.84	17,730,640.80
509	Tack coat at 0.5 l/m^2	m^2	993,870.00	0.50	496,935.00
510	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2				
511	Bituminous surface course 0/11, B 65 - 40 mm thick	m^2	993,870.00	5.92	5,883,710.40
512	Selected material built in at OMC to line and levels to shoulders	m^3	169,885.00	9.50	1,613,907.50
	Total bill no. 5 carried to summary				**34,739,854.60**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
600	New Road				
601	Remove existing shoulder material to the underside of the existing asphalt in connection areas	m^2	1,580.00	3.30	5,214.00
602	Milling of existing asphalt and sieving to the gradations for subbase material in connection areas	m^3	240.00	16.75	4,020.00
603	Scarify existing basecourse material, compact to line and levels at OMC as subbase (CBR > 30) in connection areas	m^2	2,000.00	1.20	2,400.00
604	Provide sub-base material (CBR > 30) fill and compact at OMC to line and levels in connection areas	m^3	2,000.00	9.50	19,000.00
605	Clearing of overgrowth and stripping of top soil 0 - 150 mm thick	m^3	2,108.00	1.50	3,162.00
606	Scarify and compact at OMC commencing ground	m^2	26,350.00	3.50	92,225.00
607	Fill to embankment at OMC	m^3	17,918.00	6.50	116,467.00
608	Provide sub-base material (CBR > 30) fill and compact at OMC to line and levels	m^3	18,180.00	9.50	172,710.00
609	Prime coat RC30 at 0.8 l/m^2	m^2	18,180.00	0.51	9,271.80
610	Alteration rate for adjustment in application rate of each 0.1 l				
611	Rolled asphalt roadbase 0/22 B 65/160 mm thick	m^2	18,180.00	17.84	324,331.20
612	Tack coat at 0.5 l/m^2	m^2	18,180.00	0.50	9,090.00
613	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2				
614	Bituminous surface course 0/11 B 65 40 mm thick	m^2	18,180.00	5.92	107,625.60
615	Selected material built in at OMC to line and levels to shoulders	m^3	2,471.00	9.50	23,474.50
	Total bill no. 6 carried to summary				**888,991.10**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
700	Drainage				
701	Clean and desilt existing pipe and box culverts	no.	13	291.00	3,783.00
702	Clean/excavate outfall ditches	m^3	780.00	4.20	3,276.00
703	Provide, lay and join precast concrete pipe, incl. all necessary works - 1000 mm diameter	m	20.00	237.05	4,741.00
704	Construct apron, head and wing wall, item 703, with reinforced in-situ concrete, incl. all necessary works	m^3	5.00	125.95	629.75
705	Demolish, clear away existing concrete box culvert, incl. apron, head and wing wall - Size1000 mm	m	16	67.00	1,072.00
706	Demolish, clear away existing concrete double box culvert,incl. apron, head and wing wall - Size1000 mm	m	17	250.00	4,250.00
707	Construct box culvert, incl. all necessary works - Size1000 mm	m	16.00	271.30	4,340.80
708	Construct double box culvert, incl. all necessary works - Size1000 mm	m	17.00	516.80	8,785.60
709	Construct apron, head and wing wall, items 707and 708 with reinforced in-situ concrete, incl. all necessary work	m^3	12.50	125.95	1,574.38
710	Construct roadside drains as shown in the drawings	m	71,000.00	4.20	298,200.00
	Total bill no. 7 carried to summary				**330,652.53**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
800	Signalisation and miscellaneous roadworks				
801	Road marking				
	- Line passed through, width 0.1m	km	5.4	454.60	2,454.84
	- Line passed through, width 0.4m	km	0.5	454.60	227.30
	- Broken line, width 0.1m, ratio 3:1	km	17.0	454.60	7,728.20
	- Broken line, width 0.1m, ratio 1:3	km	140.0	454.60	63,644.00
	- Traffic islands	no.	85	70.00	5,950.00
802	Road signs				
	- Small signs	no.	450	183.00	82,350.00
	- Large signs	no.	267	229.50	61,276.50
803	Roadside marking post	no.	6,260	21.00	131,460.00
804	Km - post	no.	140	37.00	5,180.00
805	Crash barrier	m		23.00	0.00
	Total bill no. 8 carried to summary				**360,270.84**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
900	Dayworks Labour				
901	Unskilled labour	h	5,000.00	2.00	10,000.00
902	Skilled labour	h	2,000.00	2.00	4,000.00
903	Foreman	h	100.00	5.00	500.00
	Total to Dayworks Summary				**14,500.00**
	Allow for 28 per cent of subtotal for Contractor's overhead, profit				**4,060.00**
	Materials				
904	sand	m^3	100.00	5.00	500.00
905	sulphate resisting Portland cement	t	100.00	65.00	6,500.00
906	crushed sand	m^3	100.00	13.00	1,300.00
907	crushed course aggregate	m^3	100.00	6.50	650.00
908	crushed fine aggregate	m^3	100.00	6.50	650.00
909	bit. binder B 60 - 70	t	1.00	75.00	75.00
910	prime coat RC 30	m^2	100.00	2.00	200.00
	Total to Dayworks Summary				**9,875.00**
	Allow for 10 per cent of subtotal for Contractor's overhead, profit				**987.50**
	Equipment				
911	Pick-up car	h	1,000.00	24.00	24,000.00
912	Truck 10 t capacity	h	1,000.00	42.00	42,000.00
913	Hydraulic excavator bakc-hoe	h	1,000.00	93.00	93,000.00
914	grader 140 hp	h	500.00	112.00	56,000.00
915	air compressor incl. hoses, hammers, chisels 7 m^3/minute	h	100.00	25.00	2,500.00
916	rubber tyre roller	h	100.00	40.00	4,000.00
917	vibrating roller steel drum	h	100.00	64.00	6,400.00
918	crane lifting capacity 10 t	h	100.00	102.00	10,200.00
919	bitumen sprayer	h	100.00	58.00	5,800.00
920	asphalt paver/finisher	h	100.00	184.00	18,400.00
	Total to Dayworks Summary				**262,300.00**
	Allow for 10 per cent of subtotal for Contractor's overhead, profit				**26,230.00**
	Daywork Summary				
	Total for daywork labour				**18,560.00**
	Total for daywork materials				**10,862.50**
	Total for daywork equipment				**288,530.00**
	Total bill no. 9 carried to summary				**317,952.50**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 1-

Item	Description	Unit	Quantity	Rate USD	Amount USD
1000	Miscellaneous				
	Reconstruction of pavement for adjustment of final road level before and after railway crossings				
1001	Excavation and disposal of existing pavement and subgrade material to required depth	m^3	216.00	16.75	3,618.00
1002	Preparation of formation (shaping, compaction etc.)	m^2	2,700.00	1.20	3,240.00
1003	Provide sub-base material (CBR > 30) fill and compact at OMC to line and levels	m^3	864.00	9.50	8,208.00
1004	Prime coat RC 30 at 0.8 l/m^2	m^2	2,700.00	0.51	1,377.00
1005	Rolled asphalt roadbase 0/22 B 65 160 mm thick	m^2	2,700.00	17.84	48,168.00
1006	Tack coat at 0.5 l/m^2	m^2	2,700.00	0.50	1,350.00
1007	Bituminous surface course 0/11, B 65 - 40 mm thick	m^2	2,700.00	5.92	15,984.00
	Relocation of supply lines				
1008	Provisional sum allowed for the relocation of supply lines				200,000.00
	Total to Miscellaneous				**281,945.00**
	Allow for 10 per cent of subtotal for Contractor's overhead, profit				**28,194.50**
	Total bill no. 10 carried to summary				**310,139.50**

Implementation of Pavement Management System (Project No: TELREG 9305)

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures

(Alternative 1)

KOCKS INGENIEURE

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement width	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to		left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
0	1,000	9.00	2.00	2.00	1.000							9,000	4,000		
1,000	2,000	9.00	2.00	2.00	1.000							9,000	4,000		
2,000	3,000	9.00	2.00	2.00	1.000							9,000	4,000		
3,000	3,600	9.00	3.85	3.85	0.600							5,400	4,620		
3,600	3,800	9.00	3.00	3.00	0.200									1,800	1,200
3,800	3,900	12.40	3.00	3.00	0.100									1,240	600
3,900	4,200	9.00	3.00	3.00	0.300									2,700	1,800
4,200	4,550	9.00	3.00	3.00	0.350							3,150	2,100		
4,550	4,950	8.80	2.70	3.50	0.400	3,520	2,480								
4,950	5,000	9.00	4.25	4.25	0.050							450	425		
5,000	6,650	9.00	3.00	3.00	1.650							14,850	9,900		
6,650	7,000	9.20	3.00	3.00	0.350	3,220	2,100								
7,000	8,000	11.90	3.70	3.50	1.000	11,900	7,200								
8,000	8,150	8.90	3.00	3.00	0.150	1,335	900								
8,150	9,000	9.00	3.00	3.00	0.850							7,650	5,100		
9,000	9,460	9.00	3.15	3.15	0.460							4,140	2,898		
9,460	9,750	9.00	3.15	3.15	0.290									2,610	1,827
9,750	9,862	12.25	3.00	3.00	0.112									1,372	672
Subtotal					**9.862**	**19,975**	**12,680**	**0**	**0**	**0**	**0**	**62,640**	**37,043**	**9,722**	**6,099**

Implementation of Pavement Management System (Project No: TELREG 9305)

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures

(Alternative 1)

KOCKS INGENIEURE

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement width	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to		left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
9,862	9,970	12.25	3.00	3.00	0.108									1,323	648
9,970	10,300	9.00	3.00	3.00	0.330									2,970	1,980
10,300	11,000	9.00	3.00	3.00	0.700							6,300	4,200		
11,000	12,000	9.00	3.20	3.20	1.000							9,000	6,400		
12,000	13,000	9.00	3.15	3.15	1.000							9,000	6,300		
13,000	14,000	9.00	2.45	2.45	1.000							9,000	4,900		
14,000	15,000	9.00	2.65	2.65	1.000							9,000	5,300		
15,000	16,000	9.00	2.75	2.75	1.000							9,000	5,500		
16,000	17,000	9.00	2.95	2.95	1.000							9,000	5,900		
17,000	18,050	9.00	2.80	2.80	1.050							9,450	5,880		
18,050	19,000	8.50	2.80	2.00	0.950	8,075	4,560								
19,000	19,880	8.70	3.10	3.10	0.880	7,656	5,456								
19,880	20,000	9.00	2.95	2.95	0.120							1,080	708		
20,000	21,000	9.00	3.35	3.35	1.000							9,000	6,700		
21,000	22,000	9.00	3.45	3.45	1.000							9,000	6,900		
22,000	23,000	9.00	3.15	3.15	1.000							9,000	6,300		
23,000	24,000	9.00	3.05	3.05	1.000							9,000	6,100		
24,000	24,950	9.00	2.95	2.95	0.950							8,550	5,605		
24,950	25,000	8.70	2.40	3.80	0.050	435	310								
25,000	26,000	8.50	2.40	3.50	1.000	8,500	5,900								
26,000	27,000	8.20	3.00	3.70	1.000	8,200	6,700								
27,000	27,150	8.50	2.70	2.80	0.150	1,275	825								
27,150	28,000	9.00	2.50	2.50	0.850							7,650	4,250		
28,000	29,000	9.00	2.70	2.70	1.000							9,000	5,400		
29,000	29,950	9.00	3.15	3.15	0.950							8,550	5,985		
29,950	30,000	8.70	3.60	3.00	0.050	435	330								
30,000	31,000	8.00	3.60	3.00	1.000	8,000	6,600								
31,000	32,000	8.30	3.30	3.50	1.000	8,300	6,800								
32,000	33,000	8.10	2.80	3.00	1.000	8,100	5,800								
33,000	34,000	9.00	2.50	2.50	1.000							9,000	5,000		
34,000	35,000	9.00	2.35	2.35	1.000							9,000	4,700		
35,000	35,750	9.00	2.30	2.30	0.750							6,750	3,450		
35,750	36,000	8.10	2.90	2.60	0.250			2,025	1,375						
36,000	37,000	8.20	3.00	3.20	1.000			8,200	6,200						
37,000	37,550	8.10	3.65	3.65	0.550			4,455	4,015						
37,550	37,950	8.10	3.65	3.65	0.400	3,240	2,920								

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures

(Alternative 1)

KOCKS
INGENIEURE

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to	width	left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
37,950	39,000	9.00	3.60	3.10	1.050							9,450	7,035		
39,000	40,000	9.00	3.60	3.60	1.000							9,000	7,200		
40,000	41,000	9.00	3.15	3.15	1.000							9,000	6,300		
41,000	42,000	9.00	3.85	3.85	1.000							9,000	7,700		
42,000	42,350	9.00	2.80	2.80	0.350							3,150	1,960		
42,350	43,000	8.30	2.70	3.60	0.650	5,395	4,095								
43,000	43,350	8.60	3.80	3.90	0.350	3,010	2,695								
43,350	44,000	8.60	3.80	3.90	0.650			5,590	5,005						
44,000	44,250	8.90	2.80	3.30	0.250			2,225	1,525						
44,250	45,000	9.00	3.00	3.00	0.750							6,750	4,500		
45,000	46,000	9.00	3.20	3.20	1.000							9,000	6,400		
46,000	47,000	9.00	2.60	2.60	1.000							9,000	5,200		
47,000	48,000	9.00	4.10	4.10	1.000							9,000	8,200		
48,000	49,000	9.00	3.70	3.70	1.000							9,000	7,400		
49,000	49,650	9.00	2.90	2.90	0.650							5,850	3,770		
49,650	50,000	8.30	3.40	3.10	0.350	2,905	2,275								
50,000	51,000	7.70	3.40	3.10	1.000	7,700	6,500								
51,000	52,000	8.50	3.80	3.60	1.000	8,500	7,400								
52,000	52,950	8.80	2.90	3.40	0.950	8,360	5,985								
52,950	54,000	9.00	3.25	3.25	1.050							9,450	6,825		
54,000	55,000	9.00	3.60	3.60	1.000							9,000	7,200		
55,000	56,000	9.00	3.10	3.10	1.000							9,000	6,200		
56,000	57,000	9.00	3.20	3.20	1.000							9,000	6,400		
57,000	58,000	9.00	3.25	3.25	1.000							9,000	6,500		
58,000	59,000	9.00	3.80	3.80	1.000							9,000	7,600		
59,000	60,000	9.00	3.65	3.65	1.000							9,000	7,300		
60,000	61,000	9.00	2.70	2.70	1.000							9,000	5,400		
61,000	62,000	9.00	3.20	3.20	1.000							9,000	6,400		
62,000	63,000	9.00	2.45	2.45	1.000							9,000	4,900		
63,000	63,400	9.00	3.35	3.35	0.400							3,600	2,680		
63,400	64,000	9.00	3.35	3.35	0.600							5,400	4,020		
64,000	65,000	9.00	3.45	3.45	1.000							9,000	6,900		
65,000	66,000	9.00	3.10	3.10	1.000							9,000	6,200		
66,000	67,000	9.00	3.45	3.45	1.000							9,000	6,900		
67,000	68,000	9.00	3.65	3.65	1.000							9,000	7,300		
68,000	69,000	9.00	3.90	3.90	1.000							9,000	7,800		

KOCKS
INGENIEURE

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 1)

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to	width	left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
69,000	70,000	9.00	3.50	3.50	1.000							9,000	7,000		
70,000	71,000	9.00	3.05	3.05	1.000							9,000	6,100		
71,000	72,000	9.00	3.30	3.30	1.000							9,000	6,600		
72,000	73,000	9.00	3.40	3.40	1.000							9,000	6,800		
73,000	73,490	9.00	3.70	3.70	0.490							4,410	3,626		
Subtotal					**63.628**	**98,086**	**75,151**	**22,495**	**18,120**	**0**	**0**	**438,390**	**307,794**	**4,293**	**2,628**

KOCKS
INGENIEURE

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures

(Alternative 1)

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement width	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to		left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
73,490	74,000	9.00	3.70	3.70	0.510							4,590	3,774		
74,000	75,000	9.00	3.55	3.55	1.000							9,000	7,100		
75,000	75,250	9.00	3.05	3.05	0.250							2,250	1,525		
75,250	75,550	9.00	3.05	3.05	0.300							2,700	1,830		
75,550	76,000	9.00	3.05	3.05	0.450							4,050	2,745		
76,000	77,000	9.00	2.35	2.35	1.000							9,000	4,700		
77,000	78,000	9.00	1.90	1.90	1.000							9,000	3,800		
78,000	79,000	9.00	2.55	2.55	1.000							9,000	5,100		
79,000	80,000	9.00	3.00	3.00	1.000							9,000	6,000		
80,000	81,000	9.10	2.70	3.40	1.000			9,100	6,100						
81,000	81,200	8.90	3.90	3.70	0.200	1,780	1,520								
81,200	81,350	8.90	3.90	3.70	0.150	1,335	1,140								
81,350	82,000	8.90	3.90	3.70	0.650	5,785	4,940								
82,000	82,350	8.80	3.60	3.60	0.350	3,080	2,520								
82,350	83,000	8.80	3.60	3.60	0.650	5,720	4,680								
83,000	83,400	9.00	3.40	3.20	0.400	3,600	2,640								
83,400	84,000	9.00	3.30	3.30	0.600							5,400	3,960		
84,000	85,000	9.00	2.90	2.90	1.000							9,000	5,800		
85,000	86,000	9.00	3.25	3.25	1.000							9,000	6,500		
86,000	87,000	9.00	3.10	3.10	1.000							9,000	6,200		
87,000	88,000	9.00	2.75	2.75	1.000							9,000	5,500		
88,000	89,100	9.00	3.20	3.20	1.100							9,900	7,040		
89,100	90,000	9.10	2.90	3.10	0.900	8,190	5,400								
90,000	91,000	9.00	3.30	3.30	1.000	9,000	6,600								
91,000	92,000	8.60	3.20	3.20	1.000	8,600	6,400								
92,000	93,000	9.00	3.00	3.00	1.000							9,000	6,000		
93,000	94,000	9.00	3.00	3.00	1.000							9,000	6,000		
94,000	95,000	9.00	2.70	2.70	1.000							9,000	5,400		
95,000	96,000	9.00	2.00	2.00	1.000							9,000	4,000		
96,000	97,000	9.00	2.55	2.55	1.000							9,000	5,100		
97,000	98,000	9.00	2.35	2.35	1.000							9,000	4,700		
98,000	99,000	9.00	2.50	2.50	1.000							9,000	5,000		
99,000	100,000	9.00	3.50	3.50	1.000							9,000	7,000		
100,000	101,000	9.00	3.10	3.10	1.000							9,000	6,200		
101,000	102,000	9.00	2.65	2.65	1.000							9,000	5,300		
102,000	103,000	9.00	2.70	2.70	1.000							9,000	5,400		

KOCKS
INGENIEURE

TEDJEN - MARY ROAD IMPROVEMENT
Improvement Measures
(Alternative 1)

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement width	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to		left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
103,000	104,000	9.00	2.75	2.75	1.000							9,000	5,500		
104,000	105,000	9.00	3.00	3.00	1.000							9,000	6,000		
105,000	106,000	9.00	3.00	3.00	1.000							9,000	6,000		
106,000	107,000	9.00	3.00	3.00	1.000							9,000	6,000		
107,000	108,000	9.00	2.95	2.95	1.000							9,000	5,900		
108,000	109,000	9.00	3.15	3.15	1.000							9,000	6,300		
109,000	110,000	9.00	3.10	3.10	1.000							9,000	6,200		
110,000	111,000	9.00	3.20	3.20	1.000							9,000	6,400		
111,000	112,000	9.00	4.10	4.10	1.000							9,000	8,200		
112,000	113,000	9.00	3.15	3.15	1.000							9,000	6,300		
113,000	113,750	9.00	3.05	3.05	0.750							6,750	4,575		
113,750	114,000	8.70	3.30	3.10	0.250	2,175	1,600								
114,000	115,000	9.10	2.70	2.80	1.000	9,100	5,500								
115,000	116,000	8.80	2.90	2.90	1.000	8,800	5,800								
116,000	117,000	8.90	3.20	3.50	1.000	8,900	6,700								
117,000	117,250	9.50	3.90	3.20	0.250	2,375	1,775								
117,250	118,000	9.00	3.20	3.20	0.750							6,750	4,800		
118,000	119,000	9.00	2.60	2.60	1.000							9,000	5,200		
119,000	120,000	9.00	3.35	3.35	1.000							9,000	6,700		
120,000	121,000	9.00	3.30	3.30	1.000							9,000	6,600		
121,000	122,000	9.00	3.80	3.80	1.000							9,000	7,600		
122,000	123,000	9.00	3.20	3.20	1.000							9,000	6,400		
123,000	126,550	9.00	3.15	3.15	3.550							31,950	22,365		
126,550	127,000	9.10	3.00	3.20	0.450					4,095	2,790				
127,000	127,350	9.00	3.00	3.00	0.350	3,150	2,100								
127,350	131,550	9.00	3.00	3.00	4.200							37,800	25,200		
131,550	132,000	9.00	3.00	3.00	0.450			4,050	2,700						
132,000	133,000	9.00	3.00	3.00	1.000			9,000	6,000						
133,000	133,050	8.00	2.00	2.00	0.050			400	200						
133,050	134,000	9.00	2.00	2.00	0.950							8,550	3,800		
134,000	135,000	9.00	2.00	2.00	1.000							9,000	4,000		
135,000	136,000	9.00	2.00	2.00	1.000							9,000	4,000		
136,000	137,000	9.00	2.00	2.00	1.000							9,000	4,000		
137,000	138,000	9.00	2.00	2.00	1.000							9,000	4,000		
138,000	139,000	9.00	2.00	2.00	1.000							9,000	4,000		
139,000	140,000	9.00	2.00	2.00	1.000							9,000	4,000		

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TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 1)

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement width	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to		left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
140,000	140,350	9.00	3.10	3.10	0.350							3,150	2,170		
140,350	141,000	8.10	3.60	3.50	0.650	5,265	4,615								
141,000	142,000	10.00	3.60	3.50	1.000	10,000	7,100								
142,000	142,527	13.00	3.60	3.50	0.527	6,851	3,742								
Subtotal					**69.037**	**103,706**	**74,772**	**22,550**	**15,000**	**4,095**	**2,790**	**492,840**	**313,884**	**0**	**0**
Total					**142.527**	**221,767**	**162,603**	**45,045**	**33,120**	**4,095**	**2,790**	**993,870**	**658,721**	**14,015**	**8,727**

Tedjen - Mary Road Improvement

Costs for widening of curves

Chainage		Widening	Length of widening	Height of dam	Costs
from Stat.	to Stat.	w	L	H	
km	km	m	m	m	USD
3+447.77	4+350.78	0,40	903,01	1,10	10,867.94
5+453.90	5+613.91	0,40	140,00	1,00	1,914.88
6+581.87	7+498.52	overlay			
9+778.17	10+024.70	2,20	246,53	0,60	12,165.06
14+782.02	15+116.85	0,70	334,83	1,40	4,889.39
18+132.51	18+335.63	overlay			
21+293.81	21+527.76	0,50	233,95	0,85	2,619.78
21+703.61	22+174.97	0,70	471,36	1,05	4,923.28
22+327.83	22+602.43	0,40	274,60	1,80	3,857.61
41+683.48	41+846.02	1,10	123,64	2,30	5,218.34
41+860.34	42+164.16	0,80	303,62	2,30	7,551.96
73+981.07	74+190.73	0,70	209,66	1,65	5,011.13
74+190.73	74+548.34	1,50	357,61	1,65	8,072.53
74+548.34	74+746.67	0,40	198,33	1,65	2,708.74
75+251.26	75+714.23	0,50	462,97	1,25	5,527.91
78+135.02	78+530.38	0,40	395.36	1,30	3,827.56
78+888.71	79+120.98	0,70	232,27	1,40	3,280.60
79+298.35	79+520.51	0,40	222,16	1,40	1,588.94
81+204.59	81+583.34	overlay			
94+093.26	94+391.06	0,50	297.80	0,50	2,483.03
94+653.37	95+043.61	0,50	390.24	0,85	4,019.56
123+512.85	124+018.25	0,50	505,40	2,20	7,410.09
136+413.19	136+693.53	0,70	280,35	0,60	3,037.15
		Total Length :	5500,29	Total Costs :	**100,975.38**

Annex 2.6: **Confidential Cost Estimate Summary, Alternative 2**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Confidential Cost Estimate
Summary

Bill No.	Description	Total length (m)	Unit cost per m road	Total US $
1	General Item			3,000,000.00
2	Repair and 40 mm overlay	37,957	107.83	4,092,747.00
3	Repair and 75 mm overlay	22,830	155.70	3,554,738.68
4	Repair and 100 mm overlay	18,250	189.34	3,455,489.00
5	Pavement reconstruction	61,650	302.72	18,662,934.50
6	New Road	1,440	617.35	888,991.10
7	Drainage			330,652.53
8	Signalisation and miscellaneous roadworks			360,270.84
9	Dayworks			317,952.50
10	Miscellaneous			310,139.50
	Cost of Improvements			34,973,915.65
	Contingencies 5 %			1,748,695.78
	Total Estimate (exclusive of taxes and duties)			36,722,611.43

Note: Unit costs per linear meter road differ between Alternatives 1 and 2 because of differences in existing road widths.

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
100	General Items				
101	performance bond/guarantee	l.s	--		
102	insurance of the works	l.s	--		
103	insurance of constructional plant	l.s.	--		
104	third party insurance	l.s.	--		
105	safety measures and precautions concerning works under traffic	l.s.	--		
106	mobilisation of contractor's machinery, equipment, tools, shelters, facilities	l.s.	--		
107	contractor's site installation and temporary works for carrying out the works	l.s.	--		
108	maintenance of site installation during the construction period	l.s.	--		
109	office and operatives for engineer	l.s.	--		
110	removal of contractor's site installation, equipment, shelters, facilities and clearing of the area used on completion	l.s.			
	Total bill no. 1 carried to summary				**3,000,000.00**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
200	Repair and 40 mm overlay				
201	Cleaning of cracks, incl. removal of joint sealant, foreign matter, and treating against grass growth, filling of cracks with a sand bitumen mixture	m	11,865.00	4.00	47,460.00
202	Milling 60 mm deep to spot damages, deformations and rutting, apply tack coat and fill with bituminous material	m^2		12.20	
203	Milling of elevated parts of the asphalt 0 - 40 mm	m^2	36,160.00	2.70	97,632.00
204	Levelling by filling of depressions with bituminous surface course incl. cleaning of surface and tack coat	m^2	800.00	7.00	5,600.00
205	Cleaning of surface to receive tack coat	m^2	357,900.00	0.40	143,160.00
206	Tack coat 0.5 l/m^2	m^2	357,900.00	0.50	178,950.00
207	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2	rate only			
208	Bituminous surface course 40 mm nominal, thickness, laid in 60 mm average thickness for levelling of undulations	m^2	357,900.00	8.50	3,042,150.00
209	Alteration rate in adjustment in bitumen contents for each 0.1 %	rate only			
210	Scarifying existing shoulders	m^2	253,780.00	1.50	380,670.00
211	Place selected material for shoulders, spread and compact at OMC to line and levels	m^3	20,750.00	9.50	197,125.00
212	Provisional Item: Benching in Shoulders Remove material in shoulders, construct at OMC the shoulder in benchings with selected material to widen the existing road/shoulder to line and levels	-	-	-	-
	Total bill no. 2 carried to summary				**4,092,747.00**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
300	Repair and 75 mm overlay				
301	Cleaning of cracks, incl. removal of joint sealant, foreign matter, and treating against grass growth, filling of cracks with a sand bitumen mixture	m	14,000.00	4.00	56,000.00
302	Milling 60 mm deep to spot damages, deformations and rutting, apply tack coat and fill with bituminous material	m^2	3,500.00	12.20	42,700.00
303	Milling of elevated parts of the asphalt 0 - 40 mm	m^2	10,000.00	2.70	27,000.00
304	Levelling by filling of depressions with bituminous surface course, incl. cleaning of surface and tack coat	m^2	1,800.00	7.00	12,600.00
305	Cleaning of surface to receive tack coat	m^2	200,904.00	0.40	80,361.60
306	Tack coat 0.5 l/m^2	m^2	401,808.00	0.50	200,904.00
307	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2	rate only			
308	Bituminous binder course 0/16 35 mm nominal thickness, laid in 55 mm average thickness for levelling of undulations	m^2	200,904.00	7.85	1,577,096.40
309	Alteration rate in adjustment in bitumen contents for each 0.1 %	rate only			
310	Bituminous surface course 0/11 mm 40 mm thick	m^2	200,904.00	5.92	1,189,351.68
311	Alteration rate in adjustment in binder contents for each 0.1 %	rate only			
312	Scarifying existing shoulders	m^2	144,800.00	1.50	217,200.00
313	Place selected material for shoulders, spread and compact at OMC to line and levels	m^3	15,950.00	9.50	151,525.00
314	Provisional Item: Benching in Shoulders Remove material in shoulders, construct at OMC the shoulder in benchings with selected material to widen the existing road/shoulder to line and levels				
	Total bill no. 3 carried to summary				**3,554,738.68**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
400	Repair and 100 mm overlay				
401	Cleaning of cracks, incl. removal of joint sealant, foreign matter, and treating against grass growth, filling of cracks with a sand bitumen mixture	m	10,250.00	4.00	41,000.00
402	Milling 60 mm deep to spot damages, deformations and rutting, applying tack coat and fill with bituminous material	m^2	3,100.00	12.20	37,820.00
403	Milling of elevated parts of the asphalt 0 - 40 mm	m^2	7,875.00	2.70	21,262.50
404	Levelling by filling of depressions with bituminous surface course, incl. cleaning of surface and tack coat	m^2		7.00	
405	Cleaning of surface to receive tack coat	m^2	160,600.00	0.40	64,240.00
406	Tack coat 0.5 l/m^2	m^2	321,200.00	0.50	160,600.00
407	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2	rate only			
408	Bituminous binder course 0/16 60 mm nominal thickness, laid in 80 mm average thickness for levelling of undulations	m^2	160,600.00	11.07	1,777,842.00
409	Alteration rate in adjustment in bitumen contents for each 0.1 %	rate only			
410	Bituminous surface course 0/11 B65 40 mm thick	m^2	160,600.00	5.92	950,752.00
411	Scarifying existing shoulders	m^2	112,625.00	1.50	168,937.50
412	Place selected material for shoulders, spread and compact at OMC to line and levels	m^3	24,530.00	9.50	233,035.00
413	Provisional Item: Benching in Shoulders Remove material in shoulders, construct at OMC the shoulder in benchings with selected material to widen the existing road/shoulder to line and levels				
	Total bill no. 4 carried to summary				**3,455,489.00**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
500	Pavement Reconstruction				
501	Remove existing shoulder material to the underside of the existing asphalt	m^2	378,925.00	3.00	1,136,775.00
502	Milling of existing asphalt, and sieving to the gradations for subbase material	m^3	60,650.00	16.75	1,015,887.50
503	Scarify existing base course material, compact to line and levels at OMC as subbase (CBR > 30)	m^2	990,550.00	1.20	1,188,660.00
504	Provide sub-base material (CBR > 30) fill and compact at OMC to line and levels	m^3	58,212.00	9.50	553,014.00
505	Subbase material from recycled asphalt by adding gradation as required and built in 100 mm thick	m^3	118,960.00	7.00	832,720.00
506	Prime coat RC 30 at 0.8 l/m^2	m^2	525,150.00	0.51	267,826.50
507	Alteration rate for adjustment in application rate of each 0.1 l	rate only			
508	Rolled asphalt roadbase 0/22 B 65 160 mm thick	m^2	525,150.00	17.84	9,368,676.00
509	Tack coat at 0.5 l/m^2	m^2	525,150.00	0.50	262,575.00
510	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2				
511	Bituminous surface course 0/11, B 65 - 40 mm thick	m^2	525,150.00	5.92	3,108,888.00
512	Selected material built in at OMC to line and levels to shoulders	m^3	97,675.00	9.50	927,912.50
	Total bill no. 5 carried to summary				**18,662,934.50**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
600	New Road				
601	Remove existing shoulder material to the underside of the existing asphalt in connection areas	m^2	1,580.00	3.30	5,214.00
602	Milling of existing asphalt and sieving to the gradations for subbase material in connection areas	m^3	240.00	16.75	4,020.00
603	Scarify existing basecourse material, compact to line and levels at OMC as subbase (CBR > 30) in connection areas	m^2	2,000.00	1.20	2,400.00
604	Provide sub-base material (CBR > 30) fill and compact at OMC to line and levels in connection areas	m^3	2,000.00	9.50	19,000.00
605	Clearing of overgrowth and stripping of top soil 0 - 150 mm thick	m^3	2,108.00	1.50	3,162.00
606	Scarify and compact at OMC commencing ground	m^2	26,350.00	3.50	92,225.00
607	Fill to embankment at OMC	m^3	17,918.00	6.50	116,467.00
608	Provide sub-base material (CBR > 30) fill and compact at OMC to line and levels	m^3	18,180.00	9.50	172,710.00
609	Prime coat RC30 at 0.8 l/m^2	m^2	18,180.00	0.51	9,271.80
610	Alteration rate for adjustment in application rate of each 0.1 l				
611	Rolled asphalt roadbase 0/22 B 65/160 mm thick	m^2	18,180.00	17.84	324,331.20
612	Tack coat at 0.5 l/m^2	m^2	18,180.00	0.50	9,090.00
613	Alteration rate for adjustment in tack coat application for each 0.1 l/m^2				
614	Bituminous surface course 0/11 B 65 40 mm thick	m^2	18,180.00	5.92	107,625.60
615	Selected material built in at OMC to line and levels to shoulders	m^3	2,471.00	9.50	23,474.50
	Total bill no. 6 carried to summary				**888,991.10**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
700	Drainage				
701	Clean and desilt existing pipe and box culverts	no.	13	291.00	3,783.00
702	Clean/excavate outfall ditches	m^3	780.00	4.20	3,276.00
703	Provide, lay and join precast concrete pipe, incl. all necessary works - 1000 mm diameter	m	20.00	237.05	4,741.00
704	Construct apron, head and wing wall, item 703, with reinforced in-situ concrete, incl. all necessary works	m^3	5.00	125.95	629.75
705	Demolish, clear away existing concrete box culvert, incl. apron, head and wing wall - Size1000 mm	m	16	67.00	1,072.00
706	Demolish, clear away existing concrete double box culvert,incl. apron, head and wing wall - Size1000 mm	m	17	250.00	4,250.00
707	Construct box culvert, incl. all necessary works - Size1000 mm	m	16.00	271.30	4,340.80
708	Construct double box culvert, incl. all necessary works - Size1000 mm	m	17.00	516.80	8,785.60
709	Construct apron, head and wing wall, items 707and 708 with reinforced in-situ concrete, incl. all necessary work	m^3	12.50	125.95	1,574.38
710	Construct roadside drains as shown in the drawings	m	71,000.00	4.20	298,200.00
	Total bill no. 7 carried to summary				**330,652.53**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
800	Signalisation and miscellaneous roadworks				
801	Road marking				
	- Line passed through, width 0.1m	km	5.4	454.60	2,454.84
	- Line passed through, width 0.4m	km	0.5	454.60	227.30
	- Broken line, width 0.1m, ratio 3:1	km	17.0	454.60	7,728.20
	- Broken line, width 0.1m, ratio 1:3	km	140.0	454.60	63,644.00
	- Traffic islands	no.	85	70.00	5,950.00
802	Road signs				
	- Small signs	no.	450	183.00	82,350.00
	- Large signs	no.	267	229.50	61,276.50
803	Roadside marking post	no.	6,260	21.00	131,460.00
804	Km - post	no.	140	37.00	5,180.00
805	Crash barrier	m		23.00	0.00
	Total bill no. 8 carried to summary				**360,270.84**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
900	Dayworks Labour				
901	Unskilled labour	h	5,000.00	2.00	10,000.00
902	Skilled labour	h	2,000.00	2.00	4,000.00
903	Foreman	h	100.00	5.00	500.00
	Total to Dayworks Summary				**14,500.00**
	Allow for 28 per cent of subtotal for Contractor's overhead, profit				**4,060.00**
	Materials				
904	sand	m^3	100.00	5.00	500.00
905	sulphate resisting Portland cement	t	100.00	65.00	6,500.00
906	crushed sand	m^3	100.00	13.00	1,300.00
907	crushed course aggregate	m^3	100.00	6.50	650.00
908	crushed fine aggregate	m^3	100.00	6.50	650.00
909	bit. binder B 60 - 70	t	1.00	75.00	75.00
910	prime coat RC 30	m^2	100.00	2.00	200.00
	Total to Dayworks Summary				**9,875.00**
	Allow for 10 per cent of subtotal for Contractor's overhead, profit				**987.50**
	Equipment				
911	Pick-up car	h	1,000.00	24.00	24,000.00
912	Truck 10 t capacity	h	1,000.00	42.00	42,000.00
913	Hydraulic excavator bakc-hoe	h	1,000.00	93.00	93,000.00
914	grader 140 hp	h	500.00	112.00	56,000.00
915	air compressor incl. hoses, hammers, chisels 7 m^3/minute	h	100.00	25.00	2,500.00
916	rubber tyre roller	h	100.00	40.00	4,000.00
917	vibrating roller steel drum	h	100.00	64.00	6,400.00
918	crane lifting capacity 10 t	h	100.00	102.00	10,200.00
919	bitumen sprayer	h	100.00	58.00	5,800.00
920	asphalt paver/finisher	h	100.00	184.00	18,400.00
	Total to Dayworks Summary				**262,300.00**
	Allow for 10 per cent of subtotal for Contractor's overhead, profit				**26,230.00**
	Daywork Summary				
	Total for daywork labour				**18,560.00**
	Total for daywork materials				**10,862.50**
	Total for daywork equipment				**288,530.00**
	Total bill no. 9 carried to summary				**317,952.50**

Road Improvement Project
Section Tedjen - Mary of the Ashgabat - Mary Road
-Alternative 2-

Item	Description	Unit	Quantity	Rate USD	Amount USD
1000	Miscellaneous				
	Reconstruction of pavement for adjustment of final road level before and after railway crossings				
1001	Excavation and disposal of existing pavement and subgrade material to required depth	m^3	216.00	16.75	3,618.00
1002	Preparation of formation (shaping, compaction etc.)	m^2	2,700.00	1.20	3,240.00
1003	Provide sub-base material (CBR > 30) fill and compact at OMC to line and levels	m^3	864.00	9.50	8,208.00
1004	Prime coat RC 30 at 0.8 l/m^2	m^2	2,700.00	0.51	1,377.00
1005	Rolled asphalt roadbase 0/22 B 65 160 mm thick	m^2	2,700.00	17.84	48,168.00
1006	Tack coat at 0.5 l/m^2	m^2	2,700.00	0.50	1,350.00
1007	Bituminous surface course 0/11, B 65 - 40 mm thick	m^2	2,700.00	5.92	15,984.00
	Relocation of supply lines				
1008	Provisional sum allowed for the relocation of supply lines				200,000.00
	Total to Miscellaneous				**281,945.00**
	Allow for 10 per cent of subtotal for Contractor's overhead, profit				**28,194.50**
	Total bill no. 10 carried to summary				**310,139.50**

Implementation of Pavement Management System (Project No: TELREG 9305)

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures

(Alternative 2)

KOCKS INGENIEURE

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement width	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to		left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
0	1,000	9.00	3.00	3.00	1.000							9,000	6,000		
1,000	1,850	9.00	2.50	2.50	0.850							7,650	4,250		
1,850	2,000	14.00	0.00	0.00	0.150			2,100	0						
2,000	2,450	12.00	0.00	0.00	0.450			5,400	0						
2,450	3,000	12.00	0.00	0.00	0.550					6,600	0				
3,000	3,600	9.40	3.80	3.50	0.600					5,640	4,380				
3,600	3,800	9.00	3.00	3.00	0.200									1,800	1,200
3,800	3,900	12.40	3.00	3.00	0.100									1,240	600
3,900	4,200	9.00	3.00	3.00	0.300									2,700	1,800
4,200	4,550	8.80	2.70	3.50	0.350			3,080	2,170						
4,550	4,950	8.50	2.70	3.50	0.400	3,400	2,480								
4,950	5,650	10.00	3.50	4.00	0.700			7,000	5,250						
5,650	6,650	9.20	3.00	3.00	1.000					9,200	6,000				
6,650	7,000	9.20	3.00	3.00	0.350	3,220	2,100								
7,000	8,000	11.90	3.70	3.50	1.000	11,900	7,200								
8,000	9,000	8.90	3.00	3.00	1.000	8,900	6,000								
9,000	9,150	9.30	3.00	3.00	0.150	1,395	900								
9,150	9,460	9.00	3.15	3.15	0.310							2,790	1,953		
9,460	9,750	9.00	3.00	3.00	0.290									2,610	1,740
9,750	9,862	12.25	3.00	3.00	0.112									1,372	672
Subtotal					**9.862**	**28,815**	**18,680**	**17,580**	**7,420**	**21,440**	**10,380**	**19,440**	**12,203**	**9,722**	**6,012**

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

KOCKS
INGENIEURE

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to	width	left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
9,862	9,970	12.25	3.00	3.00	0.108									1,323	648
9,970	10,300	9.00	3.00	3.00	0.330									2,970	1,980
10,300	11,000	9.00	3.20	3.20	0.700							6,300	4,480		
11,000	12,000	9.00	3.15	3.15	1.000							9,000	6,300		
12,000	13,350	9.00	2.45	2.45	1.350							12,150	6,615		
13,350	14,000	8.30	2.40	2.20	0.650			5,395	2,990						
14,000	15,000	8.70	2.80	2.80	1.000			8,700	5,600						
15,000	16,000	8.60	3.00	2.90	1.000			8,600	5,900						
16,000	16,550	8.50	3.00	3.40	0.550			4,675	3,520						
16,550	17,000	8.50	3.00	3.40	0.450	3,825	2,880								
17,000	17,450	8.00	3.30	3.30	0.450	3,600	2,970								
17,450	18,000	8.00	3.30	3.30	0.550					4,400	3,630				
18,000	18,050	8.50	2.80	2.80	0.050					425	280				
18,050	19,000	8.50	2.80	2.00	0.950	8,075	4,560								
19,000	19,880	8.70	3.10	3.10	0.880	7,656	5,456								
19,880	20,000	9.00	2.95	2.95	0.120							1,080	708		
20,000	21,000	9.00	3.35	3.35	1.000							9,000	6,700		
21,000	22,000	9.00	3.45	3.45	1.000							9,000	6,900		
22,000	23,000	9.00	3.15	3.15	1.000							9,000	6,300		
23,000	24,000	9.00	2.90	2.90	1.000							9,000	5,800		
24,000	24,950	9.00	2.95	2.95	0.950							8,550	5,605		
24,950	26,000	8.50	2.40	3.50	1.050	8,925	6,195								
26,000	27,000	8.20	3.00	3.70	1.000	8,200	6,700								
27,000	27,150	8.50	2.70	2.80	0.150	1,275	825								
27,150	28,000	9.00	2.50	2.50	0.850							7,650	4,250		
28,000	28,350	9.00	2.70	2.70	0.350							3,150	1,890		
28,350	29,000	8.20	3.00	3.20	0.650	5,330	4,030								
29,000	29,550	8.70	3.60	3.00	0.550	4,785	3,630								
29,550	29,950	8.70	3.60	3.00	0.400					3,480	2,640				
29,950	31,000	8.00	3.60	3.00	1.050	8,400	6,930								
31,000	32,000	8.30	3.30	3.50	1.000	8,300	6,800								
32,000	33,000	8.10	2.80	3.00	1.000	8,100	5,800								
33,000	34,000	8.00	2.90	3.00	1.000	8,000	5,900								
34,000	34,550	7.80	2.90	3.00	0.550	4,290	3,245								

Implementation of Pavement Management System (Project No: TELREG 9305)

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures

(Alternative 2)

KOCKS INGENIEURE

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage from	Chainage to	Pavement width	Shoulder width left	Shoulder width right	Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
34,550	35,000	7.80	2.90	3.00	0.450					3,510	2,655				
35,000	35,750	8.10	2.90	2.60	0.750					6,075	4,125				
35,750	36,000	8.10	2.90	2.60	0.250			2,025	1,375						
36,000	37,000	8.20	3.00	3.20	1.000			8,200	6,200						
37,000	37,550	8.10	3.60	3.10	0.550			4,455	3,685						
37,550	37,950	8.10	3.60	3.10	0.400	3,240	2,680								
37,950	38,350	8.30	4.00	4.00	0.400			3,320	3,200						
38,350	38,750	8.30	4.00	4.00	0.400	3,320	3,200								
38,750	39,000	8.30	4.00	4.00	0.250					2,075	2,000				
39,000	40,000	8.60	3.40	4.20	1.000					8,600	7,600				
40,000	40,150	8.10	3.00	4.20	0.150					1,215	1,080				
40,150	41,000	9.00	3.15	3.15	0.850							7,650	5,355		
41,000	41,850	9.00	3.85	3.85	0.850							7,650	6,545		
41,850	42,350	8.30	2.70	3.60	0.500			4,150	3,150						
42,350	43,000	8.30	2.70	3.60	0.650	5,395	4,095								
43,000	43,350	8.60	3.80	3.90	0.350	3,010	2,695								
43,350	44,000	8.60	3.80	3.90	0.650			5,590	5,005						
44,000	44,250	8.90	2.80	3.30	0.250			2,225	1,525						
44,250	44,650	8.90	2.80	3.30	0.400					3,560	2,440				
44,650	45,000	8.90	2.80	3.30	0.350	3,115	2,135								
45,000	45,550	9.10	3.30	3.00	0.550	5,005	3,465								
45,550	46,000	9.10	3.30	3.00	0.450			4,095	2,835						
46,000	47,000	8.60	2.40	3.20	1.000			8,600	5,600						
47,000	47,750	8.80	4.20	4.20	0.750			6,600	6,300						
47,750	48,450	9.00	3.70	3.70	0.700							6,300	5,180		
48,450	49,000	9.00	3.90	3.50	0.550					4,950	4,070				
49,000	49,650	8.30	3.40	3.10	0.650					5,395	4,225				
49,650	50,000	8.30	3.40	3.10	0.350	2,905	2,275								
50,000	51,000	7.70	3.40	3.10	1.000	7,700	6,500								
51,000	52,000	8.50	3.80	3.60	1.000	8,500	7,400								
52,000	52,950	8.80	2.90	3.40	0.950	8,360	5,985								
52,950	54,000	9.00	3.25	3.25	1.050							9,450	6,825		
54,000	55,000	9.00	3.70	3.70	1.000							9,000	7,400		
55,000	55,650	9.00	3.60	3.60	0.650							5,850	4,680		

KOCKS INGENIEURE

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage from	Chainage to	Pavement width	Shoulder width left	Shoulder width right	Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
55,650	56,000	7.60	3.50	4.10	0.350			2,660	2,660						
56,000	56,550	8.60	3.10	3.70	0.550			4,730	3,740						
56,550	57,000	8.60	3.10	3.70	0.450					3,870	3,060				
57,000	58,000	8.10	3.10	4.30	1.000					8,100	7,400				
58,000	59,000	8.60	3.20	4.20	1.000					8,600	7,400				
59,000	59,250	8.80	4.00	3.50	0.250					2,200	1,875				
59,250	60,000	8.80	4.00	3.50	0.750			6,600	5,625						
60,000	61,000	8.50	3.10	2.80	1.000							8,500	5,900		
61,000	62,000	8.30	3.60	3.50	1.000							8,300	7,100		
62,000	63,000	8.20	2.60	3.10	1.000							8,200	5,700		
63,000	63,400	9.00	3.35	3.35	0.400							3,600	2,680		
63,400	63,850	9.00	3.35	3.35	0.450							4,050	3,015		
63,850	64,000	8.90	3.40	3.40	0.150					1,335	1,020				
64,000	65,000	8.90	3.60	3.40	1.000					8,900	7,000				
65,000	65,370	8.10	3.60	3.50	0.370					2,997	2,627				
65,370	66,000	9.00	3.10	3.10	0.630							5,670	3,906		
66,000	66,470	9.00	3.45	3.45	0.470							4,230	3,243		
66,470	67,000	9.20	3.30	3.40	0.530			4,876	3,551						
67,000	68,000	8.00	3.50	4.80	1.000			8,000	8,300						
68,000	68,550	8.80	4.10	3.90	0.550			4,840	4,400						
68,550	69,000	8.80	4.10	3.90	0.450					3,960	3,600				
69,000	69,350	9.00	3.80	3.20	0.350					3,150	2,450				
69,350	70,000	9.00	3.80	3.20	0.650			5,850	4,550						
70,000	70,350	8.80	3.00	3.30	0.350			3,080	2,205						
70,350	70,950	8.80	3.00	3.30	0.600					5,280	3,780				
70,950	72,000	9.00	3.20	3.40	1.050			9,450	6,930						
72,000	72,850	9.10	3.50	3.20	0.850			7,735	5,695						
72,850	73,490	9.00	3.70	3.70	0.640							5,760	4,736		
Subtotal					**63.628**	**139,311**	**106,351**	**134,451**	**104,541**	**92,077**	**74,957**	**178,090**	**127,813**	**4,293**	**2,628**

KOCKS
INGENIEURE

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to	width	left	right											
m	m	m	m	m	km	m²	m²	m²	m²	m²	m²	m²	m²	m²	m²
73,490	74,000	9.00	3.70	3.70	0.510							4,590	3,774		
74,000	74,650	9.00	3.55	3.55	0.650							5,850	4,615		
74,650	75,050	8.80	2.90	3.40	0.400										
75,050	75,250	9.00	3.05	3.05	0.200							1,800	1,220		
75,250	75,550	9.00	3.05	3.05	0.300							2,700	1,830		
75,550	76,000	9.00	305.00	3.05	0.450							4,050	138,623		
76,000	77,000	9.00	2.35	2.35	1.000							9,000	4,700		
77,000	78,000	9.00	1.90	1.90	1.000							9,000	3,800		
78,000	79,000	9.00	2.55	2.55	1.000							9,000	5,100		
79,000	80,000	9.00	3.00	3.00	1.000							9,000	6,000		
80,000	81,000	9.10	2.70	3.40	1.000			9,100	6,100						
81,000	81,200	8.90	3.90	3.70	0.200	1,780	1,520								
81,200	81,350	8.90	3.90	3.70	0.150	1,335	1,140								
81,350	82,000	8.90	3.90	3.70	0.650	5,785	4,940								
82,000	83,000	8.80	3.60	3.60	1.000	8,800	7,200								
83,000	83,400	9.00	3.40	3.20	0.400	3,600	2,640								
83,400	84,000	9.00	3.30	3.30	0.600							5,400	3,960		
84,000	85,000	9.00	2.90	2.90	1.000							9,000	5,800		
85,000	85,050	9.00	3.25	3.25	0.050							450	325		
85,050	85,650	9.00	3.20	3.30	0.600			5,400	3,900						
85,650	86,000	9.00	3.10	3.10	0.350	3,150	2,170								
86,000	87,000	9.00	2.75	2.75	1.000	9,000	5,500								
87,000	88,000	9.00	3.20	3.20	1.000	9,000	6,400								
88,000	90,000	9.00	3.05	3.05	2.000	18,000	12,200								
90,000	91,000	9.00	3.30	3.30	1.000	9,000	6,600								
91,000	92,000	8.60	3.20	3.20	1.000	8,600	6,400								
92,000	92,670	11.10	2.80	3.30	0.670	7,437	4,087								
92,670	93,000	9.00	3.00	3.00	0.330							2,970	1,980		
93,000	94,000	9.00	3.00	3.00	1.000							9,000	6,000		
94,000	94,670	9.00	2.70	2.70	0.670							6,030	3,618		
94,670	95,000	8.40	3.00	3.00	0.330	2,772	1,980								
95,000	95,950	7.80	2.60	2.60	0.950	7,410	4,940								
95,950	97,000	9.00	2.55	2.55	1.050							9,450	5,355		
97,000	98,000	9.00	2.35	2.35	1.000							9,000	4,700		

KOCKS INGENIEURE

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement width	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to		left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
98,000	99,000	9.00	2.50	2.50	1.000							9,000	5,000		
99,000	99,250	9.00	3.50	3.50	0.250							2,250	1,750		
99,250	100,000	9.50	3.40	3.10	0.750			7,125	4,875						
100,000	100,350	9.20	2.60	3.40	0.350			3,220	2,100						
100,350	101,000	9.00	3.10	3.10	0.650							5,850	4,030		
101,000	102,000	9.00	2.70	2.70	1.000							9,000	5,400		
102,000	103,000	9.00	2.70	2.70	1.000							9,000	5,400		
103,000	104,000	9.00	2.90	2.90	1.000							9,000	5,800		
104,000	105,000	9.00	3.00	3.00	1.000							9,000	6,000		
105,000	106,000	9.00	3.00	3.00	1.000							9,000	6,000		
106,000	107,000	9.00	2.98	2.98	1.000							9,000	5,960		
107,000	108,000	9.00	3.05	3.05	1.000							9,000	6,100		
108,000	109,000	9.00	3.13	3.13	1.000							9,000	6,260		
109,000	110,000	9.00	3.15	3.15	1.000							9,000	6,300		
110,000	111,000	9.00	3.65	3.65	1.000							9,000	7,300		
111,000	112,000	9.00	3.65	3.65	1.000							9,000	7,300		
112,000	113,000	9.00	3.10	3.10	1.000							9,000	6,200		
113,000	113,750	9.00	2.93	2.93	0.750							6,750	4,395		
113,750	114,000	8.70	3.30	3.10	0.250	2,175	1,600								
114,000	115,000	9.10	2.70	2.80	1.000	9,100	5,500								
115,000	116,000	8.80	2.90	2.90	1.000	8,800	5,800								
116,000	117,000	8.90	3.20	3.50	1.000	8,900	6,700								
117,000	117,250	9.50	3.90	3.20	0.250	2,375	1,775								
117,250	118,000	9.00	3.20	3.20	0.750							6,750	4,800		
118,000	119,000	9.00	3.00	3.00	1.000							9,000	6,000		
119,000	120,000	9.00	3.35	3.35	1.000							9,000	6,700		
120,000	120,450	9.00	3.30	3.30	0.450			4,050	2,970						
120,450	121,000	9.00	3.30	3.30	0.550					4,950	3,630				
121,000	121,550	12.50	3.80	3.80	0.550					6,875	4,180				
121,550	122,000	9.00	4.40	4.40	0.450							4,050	3,960		
122,000	123,000	9.00	3.20	3.20	1.000							9,000	6,400		
123,000	123,550	9.00	3.15	3.15	0.550							4,950	3,465		
123,550	124,450	9.10	3.00	3.20	0.900			8,190	5,580						
124,450	125,050	9.10	3.00	3.20	0.600	5,460	3,720								

Implementation of Pavement Management System (Project No: TELREG 9305)

KOCKS
INGENIEURE

TEDJEN - MARY ROAD IMPROVEMENT

Improvement Measures
(Alternative 2)

Geometry						Overlay 40 mm		Overlay 75 mm		Overlay 120 mm		Reconstruction		New Alignment	
Chainage		Pavement	Shoulder width		Length	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder	Pavement	Shoulder
from	to	width	left	right											
m	m	m	m	m	km	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2	m^2
125,050	125,450	9.00	3.15	3.15	0.400		2,520					3,600	2,520		
125,450	127,000	9.10	3.00	3.20	1.550					14,105	9,610				
127,000	127,350	9.00	3.00	3.00	0.350	3,150	2,100								
127,350	128,520	9.00	3.00	3.00	1.170							10,530	7,020		
128,520	130,350	9.00	3.00	3.00	1.830					16,470	10,980				
130,350	130,750	9.00	3.00	3.00	0.400							3,600	2,400		
130,750	131,550	9.00	3.00	3.00	0.800					7,200	4,800				
131,550	133,000	9.00	3.00	3.00	1.450			13,050	8,700						
133,000	133,050	8.00	2.00	2.00	0.050			400	200						
133,050	134,050	8.00	2.00	2.00	1.000	8,000	4,000								
134,050	137,000	9.00	2.00	2.00	2.950							26,550	11,800		
137,000	140,000	9.00	2.00	2.00	3.000							27,000	12,000		
140,000	140,350	9.00	3.10	3.10	0.350							3,150	2,170		
140,350	141,000	8.10	3.60	3.50	0.650	5,265	4,615								
141,000	142,000	10.00	3.60	3.50	1.000	10,000	7,100								
142,000	142,527	13.00	3.60	3.60	0.527	6,851	3,794								
Subtotal					**69.037**	**165,745**	**116,941**	**50,535**	**34,425**	**49,600**	**33,200**	**355,320**	**359,830**	**0**	**0**
Total					**142.527**	**333,871**	**241,972**	**202,566**	**146,386**	**163,117**	**118,537**	**552,850**	**499,846**	**14,015**	**8,640**

Tedjen - Mary Road Improvement

Costs for widening of curves

Chainage		Widening	Length of widening	Height of dam	Costs
from Stat.	to Stat.	w	L	H	
km	km	m	m	m	USD
3+447.77	4+350.78	0,40	903,01	1,10	10,867.94
5+453.90	5+613.91	0,40	140,00	1,00	1,914.88
6+581.87	7+498.52	overlay			
9+778.17	10+024.70	2,20	246,53	0,60	12,165.06
14+782.02	15+116.85	0,70	334,83	1,40	4,889.39
18+132.51	18+335.63	overlay			
21+293.81	21+527.76	0,50	233,95	0,85	2,619.78
21+703.61	22+174.97	0,70	471,36	1,05	4,923.28
22+327.83	22+602.43	0,40	274,60	1,80	3,857.61
41+683.48	41+846.02	1,10	123,64	2,30	5,218.34
41+860.34	42+164.16	0,80	303,62	2,30	7,551.96
73+981.07	74+190.73	0,70	209,66	1,65	5,011.13
74+190.73	74+548.34	1,50	357,61	1,65	8,072.53
74+548.34	74+746.67	0,40	198,33	1,65	2,708.74
75+251.26	75+714.23	0,50	462,97	1,25	5,527.91
78+135.02	78+530.38	0,40	395.36	1,30	3,827.56
78+888.71	79+120.98	0,70	232,27	1,40	3,280.60
79+298.35	79+520.51	0,40	222,16	1,40	1,588.94
81+204.59	81+583.34	overlay			
94+093.26	94+391.06	0,50	297.80	0,50	2,483.03
94+653.37	95+043.61	0,50	390.24	0,85	4,019.56
123+512.85	124+018.25	0,50	505,40	2,20	7,410.09
136+413.19	136+693.53	0,70	280,35	0,60	3,037.15
		Total Length :	5500,29	Total Costs :	**100,975.38**

Annex 3
Review of Design Standards

TABLE OF CONTENTS

1. INTRODUCTION

This report on the Review of Road Design Standards in one of the reports being produced under the European Union - Tacis sponsored TRACECA Project for the Implementation of Pavement Management Systems. The Project covers eight states of the south of the former Soviet Union which are five states in Central Asia

- Kazakhstan
- Kyrghyzstan
- Tadjikistan
- Turkmenistan
- Uzbekistan

and another three states in the Caucasus area

- Armenia
- Azerbaijan
- Georgia.

The introduction of the Terms of Reference already describes a number of deficiencies which were also encountered during the Consultant's studies and review like

- low standard/quality of road construction (e. g. laying techniques, compaction, mix design, workmanship)
- modern Western performance criteria, technical specifications and implementation technologies are little known in the region
- high nominal standards (e. g. design speed of 150 km/h)
- road safety is inadequate

During the Consultant's activities in the project area the above listed deficiencies were further studied, detailed and discussed in a number of meetings and seminars in each of the eight recipient states with the two main headings:

BITUMINOUS BOUND MATERIALS

REVIEW OF METHODS, TECHNOLOGIES AND RELATED STANDARDS IN THE RECIPIENT STATES AND COMPARISON WITH EUROPEAN AND OTHER WESTERN METHODS, TECHNOLOGIES AND STANDARDS

ROAD DESIGN AND ROAD SAFETY

REVIEW OF RELEVANT ROAD DESIGN AND ROAD SAFETY STANDARDS FOR THE TRACECA ROADS (MAGISTRALE) IN THE RECIPIENT STATES AND COMPARISON WITH WESTERN EUROPEAN STANDARDS

In this report under the same headings the topics of the seminars are summarised and the review/analysis of the relevant standards is detailed.

2. BITUMINOUS BOUND MATERIALS

2.1. Pavement Design

2.1.1 Design Philosophies

The pavement design of a road general depends on:

- planned design life
- traffic volume (traffic forecast)
- road category

Taking into consideration the above basic design factors the main aim of the pavement design should be to achieve

- riding comfort acceptable to road users
- economy (implementation and life time)
- limited surface deflection

In the former Soviet Union Standards (SUS) the governing factor for pavement design is the so-called stiffness modulus of the pavement structure, comprising the different pavement layers (e. g. subbase, base course, asphalt concrete). With this stiffness modulus the total pavement thickness and the allowable deflection is specified. The stiffness modulus is calculated under consideration of E-moduli of the respective pavement layers. Based on researches the SUS specifies the E-moduli, which then are used without further verification for the design and on site. The criteria for determination of asphalt layer thickness is the limit on the tensile stress at the bottom of the asphalt layer.

In European/Western standards (E/WS) the pavement design is based on tolerable stresses induced in the subgrade by traffic load. The different subgrade materials and their behaviour are considered with the respective subgrade bearing capacity (e. g. CBR, plate load test) leading to the total pavement thickness. The total pavement thicknesses result from standardised pavement layer thicknesses which have been empirically determined. In addition the materials requirements are specified and have to be verified on site by regular testing to ensure the required bearing capacity of each layer. The criteria for determination of asphalt layer thickness is to provide a satisfactory service over the planned design life period of the pavement, taking into consideration the effects (climate, traffic) on the road surface.

The main differences between the SUS pavement design and E/WS pavement design are:

Requirement	SUS Design	E/WS Design
pavement deformation is limited by	stiffness modulus of the pavement structure	stress on subgrade
asphalt layer thickness is determined by	tensile stress at bottom of asphalt layers	limitation of deterioration resulting in acceptable surface condition

In summary the SUS design procedure is a method using theoretical material values. Although an adequate stiffness of a road structure is an important requirement, this does not necessarily translate into a well designed road, comfortable to use and economic in construction and maintenance.

The E/WS design procedure is based on empirical factors which are the results of practical experience with specified control of each pavement layer on site.

2.1.2 Characterisation of pavement layers

The surface course or wearing course is the top layer of an asphalt pavement and should be constructed of dense asphalt concrete. Between surface course and base course a more porous asphalt layer the so called binder course is placed. The binder course should be an asphalt mixture with a high stability and shear strength.

Below the binder the base course (road base) is the main load spreading layer of the pavement. It will normally consist of crushed stone or suitable natural gravel. For roads with high traffic load the base course can be a bituminous treated layer with high compressive strength for the total layer thickness or for the upper part combined with a lower base course layer of cement or lime treated or untreated gravel sand mixture.

The subbase is the second load spreading layer underlying the base course. It normally consists of a material of lower quality than the base course such as a natural gravel-sand mixture. This layer also serves as a separating layer preventing contamination of the base course by subgrade material during construction. Base course and subbase have to be frost-resistant.

The subgrade (existing natural ground or embankment fill) should be compacted to fulfil the requirements of a sufficient bearing capacity.

2.1.3 Assessment of existing design methods in comparisation with western design procedures

In the example below a pavement designed to SUS is recalculated and compared with an E/WS design method. The SUS design provides a service life of the pavement of 15 years. Less than 6 years service life for the same pavement is the result of the recalculation with the E/WS method, the empirical method of AASHTO (American Association of State Highway and Transport Officials).

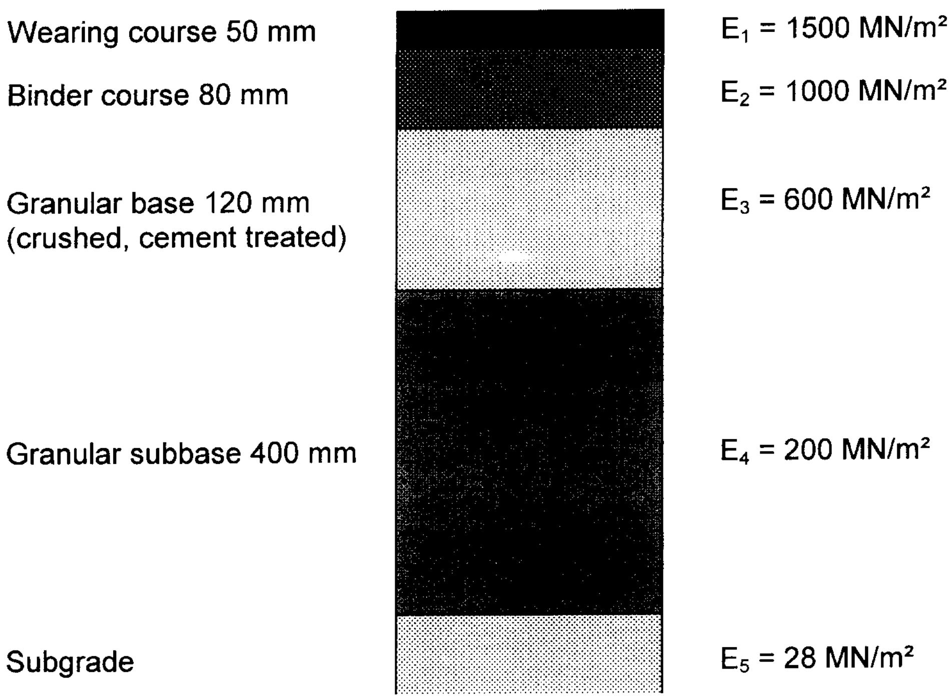
Design with SUS (VSN 46 - 83)

Design Traffic: 1342 equivalent standard vehicles per day in day in design lane

Initial traffic assuming 1.5 % growth = 1073 vpd

Accumulated $ESAL_{80}$ = 7.02 x 10^6 (15 years)

DESIGN SOLUTION
according to VSN 46 - 83



Recalculation by AASHTO Method

The relation for the number of $ESAL_{80}$ is as follows :

$$\text{Log } ESAL_{80} = Z_R\, S_o + 9{,}36 \log(SN + 1) - 0.20 + \frac{\log((\,PSI/(4.2-1.5))}{0.4 + (1094/(SN+1)^{5,15}} + 2.32 \log M_R - 8.07$$

Z_R = - 1.645 (Normal deviate for 35 % reliability level)

S_o = 0.45 (Standard deviation)

M_R = 5 10^3 for example 1 (Subgrade resilient modulus)

PSI = 4.2 - 2.5 = 1.7 (Change in the present serviceability index)

PSI = 4.2 Construction Quality common in USA

PSI = 2.5 Minimum acceptable PSI

$\text{Log ESAL}_{80} = -0.740 + 7.083 - 0.396 + 8.582 - 8.07 = 6.459$

$\text{ESAL}_{80} = 2.88 * 10^6$ (Number of passes by Equivalent Standard Axle Load)

Design Traffic : 1342 equivalent standard axle loads per day in design lane (assumption)

$= 2,88 * 10^6 / 1342 = 2146$

2146 / 365 = 5.8 years Design life according AASHTO

2.1.4 Assessment and recommendation

The SUS design is a theoretical procedure. It is recommended to use a method more based on values of experience and empirical studies as demonstrated in the above example. Specially the present practice with computation using the stiffness modulus and the tensile stress at the bottom of the asphalt layers should be discarded. If it is necessary to use still the SUS then more attention has to be paid to the bearing capacity of the subgrade (testing of CBR, moisture content, grading). For roads with a high traffic load, as the magistrale are, the upper layer of the base course (road base) should always be a bituminous layer. The thickness of all frost resistance layers should be reconsidered according to local conditions and experience.

For the asphalt concrete itself it is recommended to reduce the maximum grain size of the aggregates and to use as binder a destillation bitumen.

2.2 Materials

Asphalt concrete is a mixture of sand, aggregates and bitumen. A mineral powder is added as filler to provide a sufficient quantity of fine material, which can be also cement or crushed limestone. Between bitumen and aggregates a sufficient adhesion is required. The value of adhaesion depends on the kind of bitumen and the aggregate.

Aggregates
The maximum grain size of the aggregates is of great importance for the mechanical values of the asphalt and directly related to thickness of asphalt layers.

Bitumen
The bitumen used in Western European countries for road construction is named according the average penetration value. For example B65 means B for Bitumen, 65 for 65 1/10 mm medium penetration (max/min limits of penetration 50/75). Bitumen in Europe is produced by a two step destillation procedure (atmospheric and vaccuum destillation).

The following types of bitumen are available B15, B25, B45, B65, B80, B200, B300.

For road construction (rolled asphalt) bitumen B65 and B80 is preferably used, and Bitumen B200, B300 for road surface treatment

Natural asphalt (bitumen) is found in Azerbaijan, Turkmenistan.

Natural asphalt (bitumen) is found in Azerbaijan, Turkmenistan.

Asphalt job mix design criteria and laboratory testing
The asphalt job mix design provides the optimum values for
- density
- air voids content
- bitumen content
- stability and flow value

standard laboratory tests for bitumen carried out on construction site
- penetration
- softening point
- breaking point
- ductility

Assessment and recommendation
Existing laboratory equipment in the eight recipient states was produced in the former Soviet Union and complies with the relevant SUS.

Main laboratory testing procedures for aggregates, sand, bitumen and asphalt is done according the SUS which differ only little to European/western tests standards. The Marshall test is widely known, but not used due to lack of equipment and missing requirement for limitations.

2.3 Quality Control

The aim of quality control in production and implementation is to maintain a constant level of quality which in the long term results in a cost reduction

Regular testing of the product quality shall be done by the manufacturer before delivery to customers (testing as a measure of self controlling). Furthermore sample controlling and testing shall be carried out by an independent institution to supervise the manufactuer's testing in order to assure constantly the quality of the product/materials.

When materials are used for construction field and laboratory testing is required to assure that the materials used and the workmanship comply with the relevant standards and specifications. The usual approach on a construction site is that the contractor carries out own testing throughout the period of execution of works. The test results are to be submitted to the (independent) supervisor for verification and the supervisor will do own testing.

In the recipient states the European/western approach for quality control and the independent supervision of works is not existing and thus very often the materials and construction requirements of the existing standards and specifications are not achieved resulting in poor quality implementation and short service life with high maintenance costs. Therefore a quality control, a quality assurance system should be introduced which will support the durability of construction and encourage the countries' economy.

2.4 Asphalt Production and Pavement Placing Techniques

Asphalt products for road construction

There are generally two different types of asphalt mixtures used for road construction:

(i) rolled asphalt (with air voids)

The asphalt is placed and compacted at maximum density and there are still air voids not filled with bitumen. The specified temperature for placing hot asphalt mixtures is 120 - 180°C and compaction has to be completed before the temperature drops below 90°C.

In Europe the use of cold asphalt mixtures is restricted to special cases or locations (islands, moutainous regions, temporary repairs).

(ii) Mastic asphalt (without air viods)

In the asphalt mixture there are no air voids and therefore after placing no compaction is necessary. The specified paving temperature temperature is 220 - 240 °C.

Overheating of bitumen will result in a poor quality asphalt mixture and therefore the maximum admissible temperatures of bitumen for asphalt mixtures are specified:

Type of Bitumen	max. Temperature [°C]
B45	190
B65	180
B80	180

Lowest and highest temperatures for asphalt mixtures in °C leaving the mixer:

(i) SUS (GOST)

Type of Bitumen	Temperature of Asphalt [°C]
BND 40 / 60 BND 60 / 90 BND 90 / 130 BN 60 / 90 BN 90 / 130	140 - 160

Note: The maximum temperature may be 10 °C higher if the asphalt is placed at air temperatures below 5 °C.

(ii) E/WS (ZTV - Asphalt, German Standard)

Typ of Bitumen	Temperature of Asphalt for Binder Layer [°C]	Temperature of Asphalt for Surface Course [°C]
B45	130 - 190	140 - 190
B65	120 - 180	130 - 180
B80	120 - 180	130 - 180

Note: Surface course should not be placed at air temperatures below 3°C, Asphalt binder course not below 0 °C.

Asphalt mixing plants

A mixing plant for asphalt production shall be designed and operated so as to produce mixtures according to the Job-Mix-Formula. There are general two types of mixing plants used for asphalt production:

- Batch mixing plants
- Continuous mixing plants

Asphalt placing and compacting procedures

Placing of asphalt is done with an asphalt finisher (paver), normal working width 6 m to 8 m, which achieve a so-called precompaction of about 90% of required density. Paving speed is depending on kind, width and thickness of asphalt layers ranging from about 1.0 m/min. (surface course) to 2.5 m/min (binder course, base course).

Compacting of asphalt with tandem steel roller (vibration possible) and pneumatic roller.

Assessment and recommendation

In the recipient states the mixing equipment is of Soviet Union or east German origin. Most of the mixing plants are out of operation since a number of years by various reasons. Due to the lack of operating mixing plants and long haulage distances the use of cold mix asphalt became common for maintenance and repair works. Compacting was and is still done with static steel rollers. Pneumatic rollers and rollers with vibration possibility have not been encountered in the recipient states.

The existing mixing plants could produce a good quality asphalt, but this depends on the condition of the equipment and it is difficult to purchase spare parts. A similar problem for spare parts appears for asphalt placing equipment (pavers, rollers).

With regard to the above problems and the superiority of E/WS asphalt placing equipment some of the recipient states have started to use E/WS equipment to achieve a better quality in pavement construction. However, it is recommended to provide appropriate training for those equipment so that their possibilities are understood and can be fully utilised.

2.5 Rehabilitation of Asphalt Pavement

The deterioration of a pavement manifests itself by various signs of appearance or indicators which can be associated with the probable causes of the failure or imperfection. To determine if and to which extend rehabilitation measures are necessary as a first step an assessment of the road condition is required.

An assessment of road condition should include the following:

(i) surface condition
A visual condition survey of an asphalt pavement shall describe the types of pavement distress relating them to the likely causual factors. The visible manifestations related to pavementdistress generally fall into one of the following broad categories:

- cracking
- distortion
- disintegration
- skid resistance

(ii) bearing capacity
Special equipment is used to asses the actual bearing capacity. The Benkelman beam is widely known but the results of the measurements cannot be related to the different pavement layers. The Falling Weight Deflectometer (FWD) is a fast and most advanced method to collect relevant data from actual deflection measurements and following calculations give distinguished results for the different pavement layers.

(iii) pavement composition
Sampling and laboratory testing of the existing asphalt pavement reveals the actual condition of aggregates and bitumen as well as the used basecourse and subbase material.

(iv) pavement structure condition
After a certain time depending for example on traffic load and climatic conditions all pavements need maintenance and repairs to keep a certain level of ride comfort. If maintenance of a pavement is neglected for a longer period the deterioration of the road may accelerate. The pavement condition is quickly getting worse and is then unacceptable to road users. The high degree of deterioration of a neglected pavement results in destruction requiring an expensive reconstruction in the end. A permanent maintenance and repair of smaller deficiencies will extend the life time of a pavement and keeps the surface in good condition.

Assessment and Recommendation

During the road inspections carried out in the 8 recipient states very different quality of road maintenance/repair/rehabilitation works was observed ranging from good to very poor. Cases were observed where on the one hand cold asphalt was dropped into water filled potholes but also on the other hand proper edge cutting with preparation for receiving the asphalt and following compaction. Furthermore placing of asphalt concrete layers was carried out by pavers but without grade control or the materials was spread by graders. In only a few cases the resulting surface condition, in particular the road roughness, was satisfactory. When the above described deficiencies were discussed in the seminars with the specialists of the recipient institutes the main reason given was that maintenance is mostly done according to financial possibilities/constraints and not according to technical requirements.

In summary the existing methodology as well as the equipment is in most of the recipient states unsatisfactory. As already described in the sub-chapter above some of the states have started to purchase modern European/western equipmnet and it is recommended to carry out training for operators, foremen, site engineers etc. to achieve an advanced knowledge in the methodology and techniques for road maintenance and rehabilitation works and for an optimum utilisation of the equipment.

2.6 Recycling Techniques and Methods for Asphalt Concrete

Cold and hot recycling

Cold recycled (cut/milled and pulverised) asphalt pavement can only be used for lower layers as base course or as binder course when adding bitumen emulsion and/ or cement or cement suspension. Depending on the traffic load and to achieve the required surface properties the compacted recycled road base is subsequently covered with a bituminous surface layer. Depending on laboratory testing results of the existing asphalt concrete hot recycled asphalt pavement may be used also for surface course with or without adding new materials.

Conventional methods

Deteriorated asphalt pavement is cut or milled and transported to a mixing plant. There the material is pulverised, heated and mixed with or without adding new aggregates and bitumen. The asphalt mixture is then transported to the construction site and placed on the road. This method is used when a mixing plant is close to the site since additional transport of removed asphalt pavement to the mixing plant and of the newly mixed material back to the road construction site has to be considered.

Mix in place recycling

The mix-in-place recycling is a very promising and economical method for the reconstruction of damaged asphalt roads. With this method the material of deteriorated roads is recycled in place and immediately used for the new pavement construction.

- Objectives of this method
  - Rehabilitation of road surface
  - Improvement of load bearing capacity
  - Improvement of frost resistance

- Advantages of this method
  - Avoidance of waste road construction material
  - Saving of natural resources
  - Environmental friendly
  - Reduction of material transports resulting in avoidance of traffic load burden on other rural/public roads in the area usually used for haulage

This construction method is characterised by a recycling equipment which cuts/mills and pulverises the existing road material if necessary including the unbound road base and subsequently mixes the crushed material with cement or bituminous binder agents. At this time available recycling equipment can be used on asphalt layers with a thickness of up to 150 mm. The following methods and techniques are used:

- Reshape: Deteriorated surface course/asphalt pavement will be heated, loosened and the hot material placed without adding material.
- Repave: The loosened and hot replaced material is immediately covered with a new hot asphalt layer containing only new material.
- Remix: Deteriorated surface course/asphalt pavement will be heated, loosened and new material (asphalt mixture or only bitumen) has to be added to get a mixture according the job mix design.

Assessment and Recommendation

Modern asphalt recycling techniques are requiring special equipment and a well trained labour force. In addition in all recipient states the budget for road maintenance and road repair is very limited so that recycling of asphalt concrete, if any, as for example in Uzbekistan and Kazakstan is very rare and done by specialised European/western companies.

However, the specialists of the recipient institutes met in the seminars are very interested in this modern and economical road/pavement rehabilitation technology. When the recycling technology is introduced it should be accompanied by special seminars and training not only for the use of equipment but also for technicians and engineers who have to do the laboratory testing of the existing pavement materials as well as the job mix design for the re-use.

3. ROAD DESIGN AND ROAD SAFETY

3.1 Road Design Standards

3.1.1 General

The standard for the geometrical design of roads and highways in the TRACECA states was developed in the former Soviet Union. In some of the states researches are ongoing for modification of this standard towards the development of national standards, which may consider local requirements as well as harmonisation with western European standards. However, no new standard has been published yet and the Soviet Union road standard (SNIP) is still in use.

For comparison with an western European standard the German standard for road and highway design is used and was presented in the seminars respectively.

The TRACECA Project includes selected international road links in the eight recipient states which in most cases are the so-called magistrale with the highest standard, but also with the next lower category of standard reflecting the requirements of lower traffic volume. The details of road design standards described in the following therefore cover these categories of the TRACECA roads.

3.1.2 Road Categories and Design Speeds

For an better overview all road categories and related design speeds are listed in the tables below. The relevant parameters of the Soviet Union road standard (SUS) are given in Table 3.1 and of the European/German road standard (E/GS) in Table 3.2. Categories not applicable for the TRACECA roads are shaded.

Apparent are the relative high design speeds of the SUS and the subdivision of the group category/road category with particulars of the E/GS. During seminars in the recipient institutes the scientific/research background of the two standards was discussed and some approaches were found as different, however, to discuss and evaluate all the differences of the development of the standards would be beyond the scope of the Project.

As discussed in the seminars the SUS design speed of 150 km/h has been used in flat terrain only (e.g. steppe of Kazakhstan) or not at all (e.g. Azerbaijan, Georgia, Kyrgyzstan, Uzbekistan) since the requirements are very high and the various constraints would have made the implementation to expensive. Considering this approach in the design practice, the differences of the two standards are marginal only.

Table 3.1: Soviet Union Road Standard 2.05.02-85, 1986

CATEGORY	DESIGN SPEED [Km/h]		
	GENERAL	WINDING TERRAIN	MOUNTAIN. TERRAIN
I - a	150	120	80
I - b	120	100	60
II	120	100	60
III	100	80	50
IV	80	60	40
V	60	40	30

Table 3.2: German Standard RAS-Q, 1982/1996

CATEGORY				DESIGN SPEED [km/h]
GROUP CATEGORY		ROAD CATEGORY		
A	MAGISTRALE, outside populated areas	A I A II A III A IV	long distance/international link regional link interurban link major infrastructure link	90 - 120 80 - 120 60 - 80 (100) 60 - 80
B	HIGHWAYS, around or through towns	B II B III B IV	major highway main highway highway	(60) 70 - 80 (50) 60 - 70 50 - 60
C	MAJOR URBAN ROADS	C III C IV	major road (highway) main road	50 (- 70) (40) 50 (60)
D	URBAN MAIN ROADS	D IV D V	main road main street	40 - 50 none
E	URBAN ACCESS ROADS	E V E VI	street lane	none none

Values in (...) = Exceptions

3.1.3 Geometrical Design Elements

Based on the selected road category and the design speed respectively the geometrical elements for the road design are defined.

The main parameters for ***horizontal and vertical alignment*** are summarised in Table 3.3 for the SUS and for the E/GS in Table 3.4. When as described above the requirements of the SUS design speed 150 km/h is not taken into consideration the two standards are very similar with more particulars given in the E/GS.

Table 3.3: Soviet Union Road Standard 2.05.02-85, 1986

DESIGN SPEED	MAX. GRADI - ENT	MINIMUM VERTICAL CURVE Radius Crest Curve	Radius Sag Curve general	mountain.	MINIMUM HORIZONTAL CURVE general Radius	Crossfall	mountainous Radius	Crossfall
150 km/h	3.0 %	30000 m	8000 m	4000 m	1200 m	2 - 3 %	1000 m	2 - 3 %
120 km/h	4.0 %	15000 m	5000 m	2500 m	800 m	3 - 4 %	600 m	5 - 6 %
100 km/h	5.0 %	10000 m	3000 m	1500 m	600 m	5 - 6 %	400 m	6 %
80 km/h	6.0 %	5000 m	2000 m	1000 m	300 m	6 %	250 m	6 %
60 km/h	7.0 %	2500 m	1500 m	600 m	150 m	6 %	125 m	6 %

Table 3.4: German Standard RAS-L-1, 1984, for Road Category A

DESIGN SPEED	MAX. GRADI - ENT	MINIMUM VERTICAL CURVE Radius Crest Curve	Radius Sag Curve	MINIMUM HORIZONTAL CURVE Radius and minimum Crossfall	Radius and maximum Crossfall
120 km/h	4.0 %	20000 m	10000 m	3000 m & 2.5 %	800 m 7 % (8 %)
100 km/h	4.5 %	10000 m	5000 m	1800 m & 2.5 %	500 m 7 % (8 %)
90 km/h	5.0 %	7000 m	3500 m	1400 m & 2.5 %	380 m 7 % (8 %)
80 km/h	6.0 %	5000 m	2500 m	1100 m & 2.5 %	280 m 7 % (8 %)
70 km/h	7.0 %	3500 m	2000 m	800 m & 2.5 %	200 m 7 % (8 %)
60 km/h	8.0 %	2750 m	1500 m	500 m & 2.5 %	135 m 7 % (8 %)

Values in (...) = Exceptions

With the determined road category and the respective traffic volume both standards define the main parameters for the ***road cross section*** which are summarised in Table 3.5 for the SUS and for the E/GS in Table 3.6.

Again and as described for other parameters before the two standards for the road cross section are very similar and adequate with the exception of the decision point from two to four lanes in the SUS which requires at least four lanes for a traffic volume of above 14,000 vehicles per day. In the highest category A I of the E/GS and for up to 27,000 vehicles/day the 1982 RAS-Q standard required two lanes only which with regard to traffic flow and road safety recently has been revised (RAS-Q 1996, published on 15.08.96) to three lanes.

Table 3.5: Soviet Union Road Standard 2.05.02-85, 1986

CAT	TRAFFIC VOLUME (ADT) NORMAL + WINDING	DIFFIC. TERRAIN	LANES NO.	WIDTH	SHOULDER TOTAL (PAVED)	MEDIAN TOTAL (PAVED)	TOTAL ROAD WIDTH
I-a	> 80000	> 70000	8	3.75 m	3.75 m (0.75m)	6.00 m (1.00m)	43.50 m
	> 40000 ≤ 80000	> 34000 ≤ 70000	6	3.75 m	3.75 m (0.75m)	6.00 m (1.00m)	36.00 m
	> 14000 ≤ 40000	> 14000 ≤ 34000	4	3.75 m	3.75 m (0.75m)	6.00 m (1.00m)	28.50 m
I-b	> 80000	> 70000	8	3.75 m	3.75 m (0.75m)	5.00 m (1.00m)	42.50 m
	> 40000 ≤ 80000	> 34000 ≤ 70000	6	3.75 m	3.75 m (0.75m)	5.00 m (1.00m)	35.00 m
	> 14000 ≤ 40000	> 14000 ≤ 34000	4	3.75 m	3.75 m (0.75m)	5.00 m (1.00m)	27.50 m
II	6000 - 14000		2	3.75 m	3.75 m (0.75m)	--	15.00 m
III	2000 - 6000		2	3.50 m	2.50 m (0.75m)	--	12.00 m
IV	200 - 2000		2	3.00 m	2.00 m (0.50m)	--	10.00 m
V	< 200		1	(2.25 m)	1.75 m (--)	--	8.00 m

Table 3.6: German Standard RAS-Q, 1996

ROAD CAT.	TRAFFIC VOLUME (ADT) [veh./day]	LANES NO	WIDTH	SHOULDER TOTAL (PAVED)	MEDIAN TOTAL (PAVED)	TOTAL ROAD WIDTH	NOTE
A I	45000 - 61000	6	3.75 m 3.50 m	4.50 m (3.00 m)	5.00 m (2x0.75m)	35.50 m	i
	29000 - 39000	4	3.75 m	4.75 m (3.25 m)	5.00 m (2x0.75m)	29.50 m	
	14000 - 27000	3	3.75 m 3.50 m 3.25 m	1.75/2.75 m (0.25 m)	0.50 m (0.50 m)	15.50 m	ii
A II	54000 - 66000	6	3.50 m	4.00 m (2.50 m)	4.00 m (2x0.50m)	34.00 m	
	35000 - 42000	4	3.50 m	4.00 m (2.50 m)	4.00 m (2x0.50m)	26.00 m	
	22000 - 27000	3	3.75 m 3.50 m 3.25 m	1.75/2.75 m (0.25 m)	0.50 m (0.50 m)	15.50 m	ii
	14000 - 21000	2	3.50 m	1.75 m (0.25 m)	--	10.50m	
A III	33000 - 42000	4	3.25 m	2.00 m (0.50m)	3.00 m (2x0.50m)	20.00 m	
	11000 - 21000	2	3.00 m	1.75 m (0.25m)	--	9.50 m	
A IV	11000 - 14000	2	3.00 m	1.75 m (0.25m)	--	9.50 m	

NOTES: (i) total width of 35.50 m with width of right lane 1 x 3.75 m and left lanes 2 x 3.50 m

(ii) total width of 15.50 m:
- no. of lanes 3 (2+1 alternating)
- width of single (1) lane 1 x 3.75 m with shoulder 2.75 m (0.25m paved)
- width of double (2) lanes 1 x 3.50 m (right) + 1 x 3.25 m (left) with shoulder 1.75 m (0.25m paved)
- width of "median" 0.50 m (paved)

3.2 Road Safety and Road Design Aspects

3.2.1 Preliminary Remarks

Road and traffic safety is based on the three 'E' which can be described as:

Engineering	(e. g. standards for road design and traffic engineering, control of quality in implementation, supervision of works for and maintenance of a good/safe road condition)
Education	(e. g. education of pedestrians and motorists, training, public promotion)
Enforcement	(e. g. laws and regulations, police, justice)

and is a complex process where dynamic, visual, geometrical, drainage and psychological requirements need to be optimised.

In the following those aspects concerning road safety and related road design details are described which were presented and discussed in the seminars held in the recipient states.

3.2.2 Technical Aspects of Road Safety and Road Design

- **Sequence of Radii for horizontal Alignment**

  The relation of the radii of horizontal curves in the road alignment is specified in both standards, the SUS as well as the E/GS. The aim is to achieve a relative constant travelling speed resulting in safety for the road users (avoidance of unexpected narrow curves). In cases where constraints do not allow to follow the requirements of the standard(s) extensive signalisation is necessary.

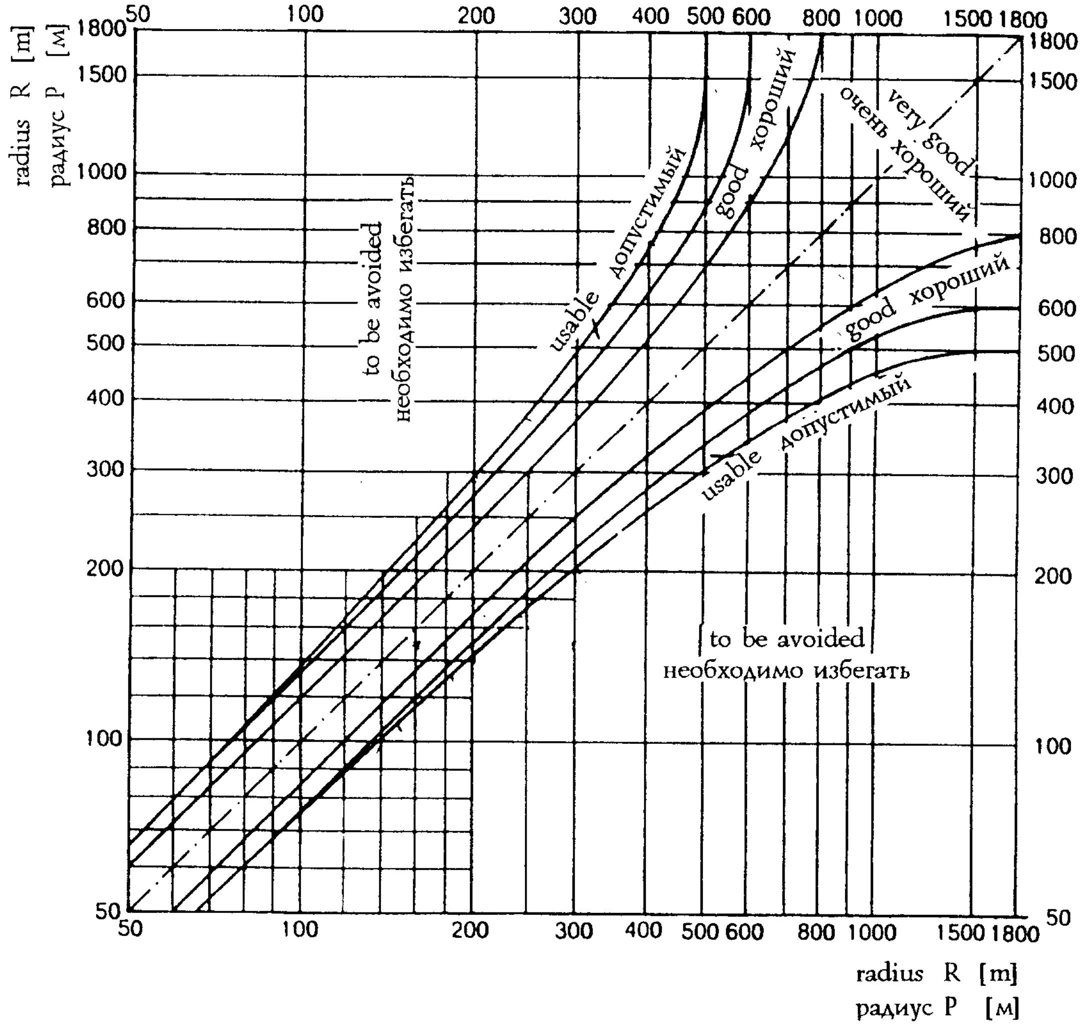
  In sub-chapter 4.3.3 of the SUS (SNIP 2.05.02 - 85) the relation of radii is specified as

  $$R_1 : R_2 = 1 : (\text{maximum } 1.3)$$

  which is considered as to rigid and not reflecting the requirements of moving vehicle dynamics.

  The suitability of the sequence of radii in the E/GS (RAS-L-1, 1984) is determined according to the diagramm below and improvement of the SUS is recommended.

Sequence of Radii for Horizontal Curves, RAS-L-1, 1984



- **Length of straight Road Section and minimum Radius of Curve after straight Road Section**

  At long straight road section it is rather difficult for drivers to assess distance and speed of approaching vehicles. Furthermore for the safety of road users it is important to decide on an appropriate radius after a straight section of road, where vehicles may build up speed. The SUS (SNIP) specifies maximum 5 km length of straight and should be complemented by the requirements of the E/GS for the radius after a straight road section as summarised in table 3.7 below.

Table 3.7: German Standard RAS-L-1, 1984

ROAD CATEGORY	LENGTH OF STRAIGHT	MINIMUM RADIUS
A I, A II	L ≥ 600 m	min R > 600 m
	L < 600 m	min R > L
A III, A IV, B II	L ≥ 500 m	min R > 500 m
	L < 500 m	min R > L

- **Junctions incl. Approaches and Slowing Down/Acceleration Lanes**

  For Junctions and intersections one of the main design requirement is safety for the road users which can be achieved when the junction/intersection system

  - provides adequate visibility
  - is easy to understand
  - is designed for appropriate speed
  - is furnished with adequate horizontal and vertical signalisation (road markings and traffic signs)

  Those requirements are of high importance especially for non-local drivers, who also need information signs for orientation and decision which direction to take well ahead of the junction.

  The priority in the SUS for junctions at grade is to achieve a relative high speed for vehicles entering and moving in the junction. The resulting relative big radii used in those junctions lead to large islands and a large area for the entire junction itself with the consequence of a reduced visibility.

  In comparison the E/GS has relative small radii in the junction with small islands resulting in a good visibility. To achieve a speed of entering vehicles with little difference to the through traffic acceleration lanes are provided.

  In summary the E/GS with constructural measures reducing the speed in the junction approach and providing good visibility which both make the 'system' of the junction clearly understandable has advantage in traffic safety and therefore the SUS should be improved accordingly.

  The SUS for grade separated junctions/intersections including clover leaves is very similar to the E/GS. During field visits in the course of the seminars several cases were observed where the SUS has been modified and shorter slowing down/acceleration lanes were constructed. This modification was explained with budget constraints and the relative low traffic volume at the time of the implementation. The theory is to provide the necessary slowing down/acceleration lanes when the traffic volume has reached a certain level and the full standard is required.

- **Signalisation**

  The SUS for road and traffic signs is in line with western European/international standards and modification is considered not to be necessary. In many cases the information signs were encountered with description in Latin letters in addition to the Cyrillic, which is appreciated by foreign road users and which should be shown on all informative signs along the international, the TRACECA roads. However, the quality of materials should be improved, especially the brightness of reflective material and/or the workmenship should be better controlled.

  The same applies for road marking. The SUS is appropriate and the materials/quality should be improved. Some modification/additions should be considered to increase traffic safety as for example on two lane roads arrows in the centreline ahead of a continous centreline marking (non overtaking). In general road marking has been neglected in the TRACECA states for some time by various reasons - budget constraints for maintenance, broken down equipment, supply of paint abandoned etc.

In the TRACECA states marker posts are used at junctions, bridge approaches, railway crossings and at culvert locations only. According to the SUS the posts are white with a black stripe, reflective material or reflectors are not used. The existing standard is considered as not appropriate and should be improved: size of post and use of reflectors. Marker posts are a very important component of road safety, especially in the darkness they provide together with an appropriate road marking the best possible guidance for road users. It is understood that the provision of marker post for the entire road network in the TRACECA states would be rather costive, but it is recommended that marker posts with an appropriate spacing (say 50 to 75 m) along the international, the TRACECA roads are successively installed when road sections are improved/rehabilitated.

- **Safety for Town Passages with high Traffic Volume**

The magistrale, the TRACECA roads inspected often run through towns and villages which is inconvenient for both the road users as well as the inhabitants. For the latter besides environmental inconvenience (exhaust gases, noise) the traffic on the magistrale form a danger for crossing vehicles and pedestrians. Low speed in the town passages resulting in longer travelling time (economic losses) is the inconvenience for drivers together with the potential high danger of an accident.

A by-pass for those towns and villages would be the best solution for the above problems. As in Europe also in the TRACECA states it takes several years up to decades to prepare such a by-pass project - feasibility, financing, land acquisition etc. - and until the implementation. Therefore it is necessary to implement measures for immediate improvement of the traffic safety and if possible for mitigation of the other inconveniences.

In the meetings and seminars held in the recipient it carried out that the local engineers/specialists are familiar with and aware of the required safety improvements but financing is not available possibly because other projects have a higher priority. The following measures were discussed and include also low-cost solutions which can produce considerable improvement:

(i) Where sufficient space can be made available private accesses to the magistrale should be abandoned and collected with a parallel minor road which then enters into the magistrale with a proper junction (= reduction of danger points).

(ii) Provision of safe pedestrian crossings
- subways or bridges (= very expensive)
- traffic lights (= expensive)
- prefabricated islands bolted on the road surface as safety waiting zone after crossing of one lane and before crossing the other (= low cost and quickly implemented)

(iii) Adequate road marking and traffic signs (= minimum requirement)

(iv) Sensibly determined/useful speed limits which will be understood and accepted by drivers:

- when the houses/village is situated on one side of the road only there is hardly any crossing traffic (vehicles and pedestrians) and the village name signboards which require a speed of 50 or 60 km/h should be removed and a speed of 70 or 80 km/h should be allowed by traffic signs (= improvement of traffic flow, reduction of travelling time)

- village name signboards which very often are placed several hundred meters before the first houses appear (leads to disregarding of the 50/60 km/h limit) should be relocated close to the real village entrance, where necessary the approach can be provided with a first speed limit of 70 or 80 km/h (= improvement of traffic flow, reduction of travelling time).

- **Emergency Escape Lanes at extended Descends**

The SNIP does not include such a standard. Due to the nature of the terrain and the necessity local standards were developed in for example Kazakhstan and Kyrgyzstan which are appropriate.

- **Winter Maintenance**

In those TRACECA states where winter conditions are experienced the aim and the requirements of winter maintenance are well known by the engineers/specialists of the institutes and departments in the recipient states. Presently the problem is that a reduced scope of winter maintenance can be carried out only due to budget constraints and equipment at the end of service life. In most cases application of salt or grit is done by throwing the material by shovel from a moving truck.

In meetings and seminars (and during the Study Tour to Europe in November 1996) European methods and technologies were presented and possible development/improvements discussed which can be summarised as

- updating/upgrading of winter maintenance management plans

- introduction of modern/economically working equipment for removal of snow and for application of grit/salt (including the benefit for the environment)

3.2.3 Non Technical Aspects of Road Safety

- **Public Promotion/Information Programmes**

The above sub-chapters present and discuss a number of technical safety measures which are the one part of road and traffic safety. The other part which is assumed to be the more difficult one is the so-called human factor, which includes all participants in the public traffic from vehicle drivers to pedestrians. Technical safety measures may not provide the planned results when the human factor fails. It has been experienced for example when a bad road was rehabilitated and had received a smooth surface, all necessary signalisation and safety measures (road marking, marker posts etc.) the number of accidents increased because drivers tended to overspeed.

Risky behaviour may in many cases result from lack of discipline but also from not understanding or accepting measures and regulations. Therefore public promotion/information programmes are of high importance to provide the necessary background information for understanding and acceptance to increase safety. But also to enhance the understanding of one another like pedestrians and drivers as for example:

- pedestrians must understand that a car with a speed of, say, 50 km/h cannot come to a full stop within 10 metres.
- drivers have to control/keep the allowable maximum speed, if necessary reduce it, to give pedestrians a chance to cross safely the road
- etc.

Before independence of the TRACECA states public promotion/information programmes existed (e. g. on TV, radio) but only a few are left like the education/training of primary school pupils. It is therefore recommended to re-activate or initiate those programmes - on TV and radio, with brochures, advertisement etc. - which in Europe are running since decades and always have to continue.

- **Enforcement of Regulations**

During the seminars in the recipient institutes the decreasing discipline and the increase of violation of traffic regulations was put into discussion as another problem of road safety aspects. Besides the above mentioned public promotion/information programmes for education possibilities to control and discipline road users repeatedly violating regulations were discussed. As an example the system in force in Germany was presented as described below.

- **Point System for Violation of Traffic Regulations (Germany)**

In addition to fines a central register has been installed for supervising repeated violations. Registration is done for all fines above 55 US$. Samples of the point system are shown in the table below.

VIOLATION	POINTS	NOTE
Exceeding of speed limit in towns		
21 - 25 km/h	●	
26 - 30 km/h	●●●	
31 - 40 km/h	●●●	
41 - 50 km/h	●●●●●	i
51 - 60 km/h	●●●●●	i
> 60 km/h	●●●●●●	ii
Driving under the influence of alcohol		
0.8 - 1.1 °/oo	●●●●	
> 1.1 °/oo	●●●●●●●	
Exceeding technical vehicle check > 8	●●	
months	●●●●●●	
Driving without valid driving licence	●●●●●●	
Driving without valid third party insurance	●●●●●●	
Misuse of number plate		
Bad signalisation of broken down vehicle	●●	
Worn out tyres (< 1.6 mm)	●●●●	
Disappearance of accident site	●●●●●●●	
Dangerous overtaking	●●	
Disregarding NO OVERTAKING sign	●●●●	
Disregarding STOP sign	●●●	
Disregarding RED traffic light	●●●	
Insufficient space to vehicle in front	●●●●	
Aggressive closing up and use of flashing	●●●●●●●	
light	●●●	
Driving without light in fog or heavy rain	●●●●	
Turning or reversing on a motorway	●●●	
Right-hand side overtaking outside towns		

<u>NOTES</u>: (i) One month confiscation of driving licence in addition
(ii) Two months confiscation of driving licence in addition

Action is taken by the central register department at a

SUM OF 9 POINTS: A warning letter is issued and advise is given to attend a training course, which attendance results in the deletion/reduction of 4 points.

SUM OF 14 POINTS: The theoretical and in some cases the practical examination test for the driving licence has to be repeated.

SUM OF 18 POINTS: A medical - psychological examination is required. Non-appearance is equal to not being qualified for a driving licence, which will then be confiscated.

- **Violation of Load Regulations (Germany)**

For vehicles with a gross weight of >7.5 tons the following fines apply when the maximum gross weight or the allowable maximum axle load is exceeded.

EXCESS	> 5 %	FINE	70 US$
	> 10 %		80 US$
	> 15 %		90 US$
	> 20 %		140 US$
	> 25 %		200 US$
	> 30 %		270 US$

In cases with an excess of >30 % unloading might be required.

- **Legislation**

In the meetings and seminars further questions and problems concerning road/traffic safety were discussed which can only be controlled by appropriate legislation as demonstrated in the above paragraphs with possibilities for enforcement of regulations.

Two highlighted problems are given below:

After independence in some of the recipient states it became somehow rather easy to get a driving license. The training is not any more comprehensive enough and many drivers drive vehicles (e. g. trucks) which class they have not acquired with their driving license.

Another growing problem is the import of right-hand steering vehicles. Since the driver has a considerably reduced sight, overtaking other vehicles becomes dangerous. Also right-hand steering vans and mini buses have the doors for passengers on the left side, the road side respectively resulting in a danger for leaving/entering passengers especially children.

4. CONCLUSION AND RECOMMENDATION

4.1 Bituminous Bound Material

The low standard and the low quality of road construction respectively encountered in most of the eight recipient states is mainly caused by:

- an inadequate pavement design methodology
- use of sub-standard materials
- poor workmanship
- inadequate equipment

A modification/improvement of the pavement design is recommended in order to base the design on empirical data which are results of practical experience. Together with a longer service life of the pavement a more economical construction and maintenance can be expected.

However, an improved design methodology will not automatically improve the quality of the roads. Two of the above reasons for the present low quality of the roads can be summarised as the problem of quality and quality control. In the former Soviet Union the supervision of works was not functioning and although the testing procedures for materials differ only little to European/western test standards substandard/low quality materials have been used for construction. Even when good quality materials were available the specified standards were not achieved due to poor workmanship. A quality control/assurance system should be introduced which is essential for the durability of all road components (pavement, earthworks, bridges, etc.) and should include the testing of materials as well as the supervision of construction works. Furthermore training of all levels of staff involved in road construction and road maintenance works is necessary.

On the equipment side the situation deteriorated during the past years mainly due to lack of spare parts (may be funds as well) and associated maintenance. In some states modern European/western equipment was already introduced to improve the situation. Appropriate training in the use of this equipment is recommended. In this context special seminars and training for the new recycling technology is recommended which should range from testing of existing pavement material, pavement design for re-used materials to the operation of equipment.

4.2 Road Design and Road Safety

The road design standard presently used in the TRACECA states, the Soviet Union road standard (SNIP), is as far as reviewed in the course of the Project in most aspects adequate. Under consideration of economical and safety aspects some modifications are recommended which should be introduced in the current standard or in the national standards under preparation:

- deletion of the design speed of 150 km/h and its related design parameters
- introduction of a road cross section with three lanes (2+1 alternating) for a traffic volume of 14,000 to 27,000 vehicles per day
- improvement of road design standards for junctions and horizontal alignment
- improvement of signalisation
- improvement of safety in town passages

- reactivation/implementation of public promotion/information programmes for road/traffic safety
- amendments/additions of legislation if and where necessary

It should be noted that the three lane (2+1 alternating) cross section was encountered in a section of one of the TRACECA roads, namely in town/village passages of the M 39 in Kyrgyzstan west of Bishkek to Kara Balta and the border with Kazakhstan. This local standard should be reviewed with regard to results and findings described above.