The European Union's Tacis TRACECA programme
for Armenia, Azerbaijan, Bulgaria, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Romania, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan

Review of Railway Rehabilitation in Central Asia

for Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan

Module B - Feasibility Study of the rehabilitation measures for the Beyneu - Uzbek Border railway section (Kazakhstan)

March 2005

This project is funded by the European Union

ITALFERR
A project implemented by Italferr S.p.A.

Report cover page

Project Title:	**Review of Railway Rehabilitation in Central Asia**		
Project Number:	**65290 – EuropeAid/116151/C/SV/Multi**		
Countries:	**Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan**		

	Local operators		EC Consultant
Name:	Republican State Enterprise "KAZAKHSTAN TEMIR ZHOLY" Mr. Talaspekov K.S.	Kyrgyz Railways Mr. Omurkulov I.Sh.	ITALFERR S.p.A.
Address:	98, Pobeda av., 473000, Astana, Kazakhstan	83, L. Tolstoy str., 720009, Bishkek, Kyrgyz Republic	via Marsala, 53/67 – 00185 Rome – Italy Akhunbabaeva ul, 15 – 700047 Tashkent – Uzbekistan
Tel:	(3172)935002	(998312) 657068	+39.06.49752721 +998.71.1321237
Fax:	(3172) 935836	(996312) 651441	+39.06.49752209 +998.71.1321286
Name:	Tajik Railways Mr. Khukumov A.	State Joint Stock Railway Company "UZBEKISTON TEMIR YULLARI" Mr. Ramatov A. J.	E-mail: a.veralli@italferr.it italferr@litel.uz
Address:	35, Nazarshoev str., 734012 Dushanbe, Tajikistan	7, T.Shevchenko str., 700060 Tashkent, Uzbekistan	
Tel:	(992372) 216059	(99871) 1388414	
Fax:	(992372) 218334	(99871) 1320552	

Contact Person:	Project Director Alessandro Veralli	Team Leader Paul Pezant
Signature:	[signature]	[signature]

Date of report: 31 March 2005

Authors of report: Project Team

EC M & E team	[name]	[signature]	[date]
NCU Uzbekistan	[name]	[signature]	[date]
TACIS Bureau [task manager]	[name]	[signature]	[date]

ABBREVIATIONS

ABLS	Automatic Block Line System
ADB	Asian Development Bank
ALC	Automatic Level Crossing
BC	Border crossing
CAR	Central Asian Republic
COTIF	Convention concerning the International Transport of Goods by Rail
CIS	Commonwealth of Independent States
CTC	Central Traffic Control
CWR	Continuous Welded Rail
EAEC	Euro Asian Economic Community
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECE	UN Economic Commission for Europe
ECO	Economic Cooperation Organisation
ECMT	European Council of Ministers of Transport
EDD	Unified Transit Tariff
EIRR	Economic Internal Rate of Return
ERII	Electric Relay Interlocking Installation
EU	European Union
FSU	Former Soviet Union
GDP	Gross Domestic Product
IGC	Intergovermental Commission TRACECA
IMF	International Monetary Fund
IRU	International Road Transport Union
IsDB	Islamic Development Bank
JBIC	Japanese Bank for International Cooperation
KAZ	Kazakhstan
KGZ	Kyrgyz Republic
KTZ	Kazakhstan Temir Zholy (Kazakhstan national railways)
MLA	Multilateral Agreement on International Transport for Development of TRACECA
KZT	Kazakhstan Tenge
LC	Level Crossing
MKDII	Mechanic Key dependent Interlocking Installation
MOTC	Ministry of Transport and Communications
MTT	International Railway Tariff
OECD	Organisation of Economic Co-operation and Development
OSJD	Organisation for the Cooperation in Railways (based in Varshaw)
PRC	People's Republic of China
PW	Permanent Way (rails, sleepers, fastenings, ballast)
SIS	Static Interlocking System
SMGS	Agreement on International Railway Freight Transport
SPECA	Special Programme for the Economies in Central Asia
TA	Technical Assistance
TACIS	Technical Assistance for the Commonwealth of Independent States
TAJ	Tajikistan
TAR	Trans-Asian Railway
TEU	Twenty Foot Equivalent Unit
TIR	Transport International Routier
TOR	Terms of Reference
TRACECA	Transport Corridor Europe Caucasus Asia
UIC	Union International des Chemins of Fer (based in Paris)
UN	United Nations

UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
USAID	United States Agency for International Development
USD	United States Dollar
UTY	Uzbek Temir Yullari (Uzbekistan national railways)
UZB	Uzbekistan
WTO	World Trade Organisation

TABLE OF CONTENTS

Executive summary i

0. Project synopsis 1

1. Introduction 4

2. Socio-economic background 6

2.1 General Features 6
2.2 Economic Profile 6
2.2.1 Economy 6
2.2.2 Foreign Trade 7
2.3 The Transport Sector 7
2.3.1 General Features. 7
2.3.2 Traffic Modal Distribution 8
2.3.3 The Railway Sub-sector 8

3. Traffic forecasts 12

3.1 Recent Trends in Railway Traffic 12
3.2 Traffic Distribution by Commodity 12
3.3 Traffic on the Kungrad-Beyneu Line 13
3.3.1 Freight Traffic 13
3.3.2 Passenger Traffic 15
3.4 Role of the Kungrad – Beyneu railway line section 15
3.5 Traffic Forecasts for the Railway Line Beyneu – Uzbek Border 17
3.5.1 Freight Traffic 17
3.5.2 Passenger Traffic. 20

4. Characteristics of existing lines and stations 21

4.1 Infrastructure 22
4.1.1 Permanent Way and earthworks 22
4.1.2 Stations 30
4.1.3 Level Crossings 34
4.1.4 Structures and Drainages 35
4.1.5 Geological and Geotechnical analysis 37
4.2 Safety devices (signalling, block devices, and CTC) 39
4.2.1 Safety and signaling systems ages 42
4.2.2 Overview of the stations and the sidings 42
4.3 Telecommunications 44
4.3.1 Description of the present telecommunication situation of the line 44
4.4 Power supply system 47
4.4.1 Description 47
4.4.2 Defects 48

4.5 Operation, speeds and running times 51

5. Rehabilitation options 54

5.1 General 54
5.2 Objectives of the rehabilitation 55
5.3 Works Typologies 60
5.3.1 Infrastructure and power supply system 61
5.3.2 Telecommunications 64
5.3.3 Safety devices 66
5.4 OPTION "BASIC WORKS" 67
5.4.1 General description 67
5.4.2 Works 68
5.4.3 Performances improvements 69
5.5 OPTION "TELECOM WORKS" 71
5.5.1 General description 71
5.5.2 Works 71
5.5.3 Performances improvements 77
5.6 OPTION "DOUBLING" 77

6. Rehabilitation options costs estimates 78

6.1 Unit costs for infrastructure works 78
6.1.1 Unit costs for materials 79
6.1.2 Unit costs for machines 80
6.1.3 Unit costs for local manpower 81
6.1.4 Cost calculation flow 82
6.2 Option "Basic Works" costs 84
6.2.1 Infrastructure and Power supply costs 84
6.2.2 Safety devices costs 85
6.3 Option "Telecom Works" costs 86
6.3.1 Telecommunications costs 86
6.4 Option "Doubling" costs 87
6.5 Cost summary 88

7. Environmental Impact Issues 89

7.1 Introduction 89
7.2 Laws and regulations frame - Environment issues and policy 89
7.3 Description of the environment 90
7.3.1 Geography and natural ecological environment 90
7.3.2 Environmental strategies, programs and projects 92
7.3.3 Analysis of environmental status along the line (sensitive areas) 93
7.4 Environment Impact Forecast 94
7.4.1 Environment impact/effects during rehabilitation period 95
7.4.2 Environment impact/effects forecast for operation period 108
7.5 Recommendation and Mitigations measures 110

7.5.1 Environmental protection measures plan during construction period ... 110
7.5.2 Environmental protection measures plan during operation period ... 116
7.6 Environmental management Plan ... 120
7.6.1 Environmental Management ... 121
7.7 Monitoring Program ... 127
7.7.1 Monitoring in construction period ... 127
7.7.2 Monitoring Plan Physical and Biological Environment ... 129
7.7.3 Monitoring Indicators ... 130

8. Preliminary implementation schedule ... 137

9. Benefits Assessment of the Project ... 140

9.1 Option "Basic Works" ... 140
9.1.1 Benefits from Infrastructure and power supply works ... 140
9.1.2 Benefits from Safety devices works ... 142
9.2 Option "Telecom Works" ... 146
9.2.1 Benefits from Telecommunication system ... 147

10. Economic / Financial Evaluation of the Investments ... 152

10.1 Introduction ... 152
10.2 Economic evaluation ... 152
10.3 Financial analysis ... 156
10.4 Sensitivity and risk analysis for the economic analysis ... 156

11. Conclusions ... 161

ANNEXES

Annex I Cost estimates and BoQ of the Options

Annex II Details of maintenance costs

Annex III Safety Devices tables

Annex IV Options schemes

Annex T Typical drawings (alignment, permanent way, structures)

Executive summary

The executive summary presents herein the contents of the Feasibility Study of the rehabilitation measures for the Beyneu - Uzbek Border railway section (in Kazakhstan), which is part of the Module B of the Project.

In fact one of the output of Module B is the "technical and economic feasibility study of the railway line sections previously identified in Kazakhstan, Kyrgyzstan and Uzbekistan".

Module B is composed by the following main activities for Kazakhstan, Kyrgyzstan and Uzbekistan:

- B.1 - Traffic Analysis
- B.2 - Technical Feasibility
- B.3 - Environmental Impact
- B.4 - Economic Viability
- B.5 - Detailed Design
- B.6 - Rehabilitation/construction implementation schedule
- B.7 - Draft tender documents preparation

The Feasibility Study fully accomplished the first four activities listed above (B.1 to B.4).

In the following stage the Consultant will be, in accordance with the contract with the European Commission, developing a detailed design and tender documents for the most advantageous option generated by the present feasibility study.

Historically the section under study belongs to the line Kungrad - Beyneu (407 km) as it is shown in Fig. A of next page.

After the collapse of the former Soviet Union, the line has been split into two sections because of the introduction of the national border between Kazakhstan and Uzbekistan: the Kungrad – Border (327 km) and the Beyneu – Border (80 km).

Besides this fact, improvements along the main line have to be financed and managed by two different Railway Administrations. Consequently the study has to consider two different Feasibility Studies for rehabilitation measures concerning sections of the same line.

The conditions of the two sections are different because of the different maintenance measures adopted during the last years. The section in Uzbekistan needs intervention especially for permanent way and some structure but also for safety devices, while, for the Kazakh side, interventions in those field are marginal. On the contrary telecommunications is an issue in both sections.

The Kazakh section of the Kungrad-Beyneu railway line is to be considered in acceptable conditions because the PW has been recently renewed and welded and the traffic speed near to the line limit. The Kazakh Beneficiary pointed out the priority of the rehabilitation of the telecom system. In accordance with the condition of the line and the Beneficiary's indication, only some minor infrastructure works have been suggested in this report, mainly to bring the whole line from

Kungrad to Beyneu to the same standard and condition, while a full feasibility study has been developed only for the telecom works.

Fig A- The Kungrad – Beyneu railway line

The contents of each Chapter of the present report is shortly described hereafter to facilitate the reading of the entire document.

Chapter 0 is the project synopsis while Chapter 1 is the introduction to the Feasibility Study Report.

In Chapter 2 the socio-economic background of the country is provided. Chapter 2 also deals with the general features of the transport sector in Kazakhstan and with the traffic modal distribution. Some considerations on the main aspects of the railway sub-sector are also included (institutional structure, infrastructure, development plans).

Traffic forecast is tackled in Chapter 3. Recent trends in railway traffic, traffic distribution by commodity and present traffic along the Kungrad-Beyneu line are reported. Traffic forecasts have been evaluated for passenger and for freight, considering both the Kazakh and Uzbek sources.

In the following table the total freight traffic forecasts at the Kazakhstan – Uzbekistan border are summarized:

	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
Kazakhstan Bound							
Total (million ton)	0.71	1,00	1,00	1,11	1,31	1,54	1,79
No Trains per day (*)	*1.14*	*1.61*	*1,61*	*1,79*	*2.11*	*2,48*	*2,88*

Uzbekistan Bound							
TOTAL (million ton)	2,45	2.78	2,50	2.43	3.75	3.84	4.48
No Trains per day *(*)*	*3.95*	*4,48*	*4,03*	*3,92*	*6,05*	*6,18*	*7,22*
Both directions							
TOTAL (million ton)	3.16	3.78	3.50	3.54	5,06	5,38	6,27
No Trains per day *(*)*	*5.09*	*6.09*	*5.64*	*5.71*	*8.16*	*8.66*	*10,10*
(*) On the basis of trains carrying 1,700 tons							

In the following table total passenger traffic forecasts are summarized:

Train Type	All	Conservative			Optimistic		
	2003	**2010**	**2015**	**2025**	**2010**	**2015**	**2025**
International Traffic	1.00	1.43	2.00	2.43	2.00	2.43	3.00
Local Trains	1.00	1.00	1.00	1.00	2.00	2.00	2.00

In Chapter 4 the description of the present situation of the line and the results of the analysis of its technical characteristics are provided. The following components have been duly investigated:

- Infrastructure (permanent way, structures, drainages, stations, level crossings, etc)
- Safety devices
- Telecommunication system
- Power supply system
- Operation.

Chapter 5 describes the measures and works which have been envisaged for the railway section. Three options have been conceived but in accordance with the condition of the line and the Beneficiary indication a complete feasibility study has been developed only for the option which includes the rehabilitation of the telecom system.

For each option a description of the works to be performed and of the related improvements in terms of performances of the line are presented.

Option "Basic Works" consists mainly in the realignment (tamping and levelling) of the existing railway line between the border and Beyneu, including the rehabilitation of the stations (sleepers replacement in Akjigit station only, ballast cleaning for all the station main tracks, construction of drainage ditches, buildings and passenger services), construction of a new double three-phase 10 kV overhead line. Works for 3 bridges rehabilitation and for safety devices have been also included. Such option will be not considered within the economic analysis because of the extent of interventions considered and since it is expected that Kazakh Railways will be carrying out such minor works in the general frame of the maintenance of the line.

Option "Telecom Works" is the installation of a new telecommunication system based on digital technology and on the adoption of optic fibre cable together with PCM (Pulse Code Modulation) technology transmission systems. The adoption of the following system is proposed: STM1 (155 Mbps) + E1 (2 Mbps) - using a SDH (Synchronous Digital Hierarchy) based system for the primary backbone complemented by PDH (Plesyocronous Digital Hierarchy) based system for the secondary backbone.

Option "Doubling" consists in line doubling and line electrification, besides the minor PW works and new safety plants and telecom system, object of the above described Option Basic Works and Option Telecom Works. This Option has been developed by this Consultant only in order to comply with the Terms of Reference of the Project. Anyway, it is firmly underlined that this Option is not applicable to the current situation of the line under study. The cost analysis has been detailed in order to reach a reliable figure of investment, as requested by ToR, but the economic and financial study of this Option has not been carried out because the investment costs, the line capacity that would be reached and electrification are not corresponding to the targets individuated for this line and to the forecast of railway traffic in the next years.

The rehabilitation works have been aggregated in three main components:

- Infrastructure and power supply
- Telecommunications
- Safety devices.

For each option and for each of these main components, the rehabilitation costs have been estimated (Chapter 6).

Chapter 7 tackles the issue of the Environmental Impact of the rehabilitation project. After an examination of the legislative Kazakh frame and of the natural environment along the line, the environmental impacts and effects during the rehabilitation period and during the operation period have been forecasted. Recommendations and mitigation measures, as well as a monitoring program, have also been proposed.

A preliminary implementation schedule of the rehabilitation Option "Telecom Works" is included in Chapter 8.

The results of the assessment of the benefits following the project implementation are presented in Chapter 9. In accordance with the costs estimates, benefits have been associated to each work component (infrastructure, telecommunications and safety devices).

The economic and financial evaluation of the investment for the Option "Telecom Works" is included in Chapter 10. Following the standard practice, the economic and financial justification of the project has been mapped by way of comparison of the discounted cost and benefit streams associated with the "base case" (without project) scenario and the "project case" (with project) scenario.

The results of the economic assessment of the considered project option are summarized in the following table, where Internal Rate of Return, Net Present Value (at a discount rate of 12%) and Benefit/Cost Ratio are compared.

	Option Telecom Works
IRR	24,7%
NPV (12% - ml US$)	3.841,9
BCR	2,92

The economic indicators resulted by the evaluation of the studied Option demonstrated the high economic viability of the project.

Additionally to that the comparison of the investment with the financial performance of the Kazakh Railways brings to the conclusion that such investment is affordable and that no specific financing mechanism has to be studied. Consequently it is logical and worth advising the Beneficiary that internal fund should be used instead to start discussion with external financial entities.

0. Project synopsis

Project Title:	Review of Railway Rehabilitation in Central Asia
Project Number:	65290 – EuropeAid/116151/C/SV/Multi
Country:	Kazakhstan, Kyrgyz Republic, Tajikistan, Uzbekistan

Wider project objectives: The development of viable, secure, safe and competitive transport routes linking the countries of Central Asia with Europe and other neighbouring countries. Strengthened border management capacity facilitating economic development, the movement of people and goods and the prevention of organised crime.

The object of the project is to carry out:

Module A / Analysis of the relevant national railway transport plans and any regional railway transport planning provisions.

Module B / Preparation of Technical and Economic Justifications to support and to attract the investments for the rehabilitation of railway lines in the Kyrgyz Republic, Kazakhstan and Uzbekistan for the purpose of increasing transportation capacities of these areas. Preparation of Feasibility study of measures for the maintenance, rehabilitation and renewal of the freight wagon fleet of the Tajik Railways.

Specific project objectives:

The project will carry out:

Module A /

- Overview of relevant traffic flows and forecasts, with special attention on freight transport from Central Asia towards Europe especially through TRACECA corridor;
- Identification of weaknesses and bottlenecks;
- Investigation on the cross-border elements, including co-operation in exchange of data and in customs (also with Afghanistan);
- Evaluation of multi-modal dimensions and possibilities for inter-operability;
- Harmonisation of standards and of operating procedures, with particular attention to compatibility with EU standards, in particular with regard to safety and security standards for the transportation of dangerous goods and oil products.

Module B /

Technical and Economic Feasibility Studies for the rehabilitation and construction of new railways lines. Pursuant to the Technical and Economic Justification data there will be prepared the loan applications to the lending banks for the allocation of investments to implement the projects.

Feasibility Study of measures for the maintenance, rehabilitation and renewal of the freight wagon fleet of the Tajik Railways.

Planned outputs:

Module A /

- Recommendations concerning multimodal transport
- Recommendations on harmonisation of standards and operating procedures and interoperability.
- Recommendations on improvements of border-crossing procedures.
- Traffic forecasts.
- Tentative prioritisation of recommended actions.

Module B /

- Technical and economic feasibility study of the railway line sections previously identified in Kazakhstan, Kyrgyzstan and Uzbekistan.
- Draft tender document for the same sections.
- Definition of a policy for the maintenance, rehabilitation and renewal of wagons in Tajikistan.
- Feasibility study and preparation of tender documents for rehabilitation and renewal of the existing workshops and maintenance plants in Tajikistan.

Project activities:

Module A /

A.1 – Collection and review of transport and economic studies. Data collection

A.2 – Overview of traffic flows

A.3 – Identification and review of physical, geopolitical, social and environmental issues

A.4 – Analysis of national railway transport plans and regional railway transport planning provisions.

A.5 – Traffic forecasts – Identification of capacity bottlenecks

A.6 – Investigation of border-crossing issues – Recommendations for improvement at borders

A.7 –Review of multimodal transport – Identification of development bottlenecks – Recommendations for improved services

A.8 – Harmonisation of standards and of operating procedures – Recommendations on standards adaptation and improved inter-operability

A.9 – Selection of railway section to be submitted to feasibility study under Module B

A.10 – Discussion with the Project Partners representatives

A.11 – Refining output of Module A

Module B /

Activities to be developed in Kazakhstan, Kyrgyzstan and Uzbekistan:

B.1 - Traffic Analysis

B.2 - Technical Feasibility

B.3 - Environmental Impact

B.4 - Economic Viability

B.5 - Detailed Design

B.6 - Rehabilitation/construction implementation schedule

B.7 - Draft tender documents preparation

Activities to be carried out in Tajikistan:

B.8 - Feasibility Study of measures for maintenance, rehabilitation and renewal of the freight wagon fleet of the Tajik Railways

Project starting date: 1 March 2004

Project duration: 18 months

1. Introduction

The present document is to report the conclusions of the feasibility study of the rehabilitation measures for the Beyneu – Kazakh border railway section in Kazakhstan.

Historically the section under study belongs to the line Kungrad - Beyneu (407 km) as it is shown in the following Fig. 1 – 1.

Fig 1 – 1- The Kungrad – Beyneu railway line

After the collapse of the former Soviet Union, the line has been split into two sections because of the introduction of the national border between Uzbekistan and Kazakhstan: the Kungrad – border (326,6 km) and the Beyneu – Border (81 km).

The administrative change could not change so much the situation since the two sections are still working in conjunction. This is why the report is making continuous reference to the whole line.

Besides this fact, improvements along the main line have to be financed and managed by two different Railway Administrations. Consequently the study has to consider two different Feasibility Studies for rehabilitation measures concerning sections of the same line.

In this respect, it is worth mentioning that conditions of the two sections are different because of the different maintenance measures adopted during the last years.

As matter of sample, the section in Uzbekistan needs intervention especially for permanent way and some structure but also for safety devices, while, for the Kazakh side, intervention in those field are very marginal and limited to punctual problems. On the contrary telecommunications is an issue in both sections.

The meeting held in Astana on January 31st, 2005 by Consultant representatives and high representatives of the Kazakhstan Temir Zholy has confirmed the above. As a consequence of the meeting Mr. Talaspekov has suggested to concentrate efforts on the telecommunication system. The Consultant agrees on the priority of the telecom issue and has developed a full feasibility study for such aspect. Notwithstanding that some minor infrastructure works are suggested in this report mainly to bring the whole line from Kungrad to Beyneu to the same standard and condition.

It is worth mentioning that according to the ToRs, also the possibility of doubling the line should be examined. Such solution is merely theoretical since the actual line capacity is adequate to support the traffic development.

2. Socio-economic background

2.1 General Features

With an area of 2,735 thousand square kilometers Kazakhstan is by far the largest country of Central Asia. 68 square kilometers are under water two thirds being part of the Aral Sea. The country stretches on 1,700 km between north and south and 3,000 km between east and west. It has borders of 6,467 km with the Russian Federation, 2,300 km with Uzbekistan, 1,460 km with China, 980 km with the Kyrgyz Republic and 380 km with Turkmenistan. Moreover its coastal area on the Caspian Sea extends on 600 km. The country is crossed by several large rivers including the Irtich on 1700 km, the Esil on 1400 km and the Syrdarya on 1400 km. Most of the territory is made of steppes but the south-east fringe is occupied by the Tien-Shan mountain range with summits reaching nearly 7,000 meters at the Khan-Tengri Peak. The climate is continental with long hot and dry summers.

With an estimated population of nearly 15 million Kazakhstan has a very low population density of only 5.5 people per square kilometers vs. for instance 60 in Uzbekistan. After independence the population decreased due to large outflows but since 2003 it started growing. Urban population represents 57% of the total. As of 1 January 2004 57.2 % of the population was Kazakh, 27.2 Russian, 3.1 % Ukrainian, 2.7 % Uzbek but there were also significant minorities of Germans, Tatars, Uigurs, Koreans and Turks.

Almaty the largest city has a population of about 1.2 million. The population of the new capital Astana is growing fast and is expected to reach a million soon. Karaganda in the center and Chimkent in the south count about half-million people each.

Kazakhstan is well endowed with many natural resources. Nearly all kind of minerals can be found. Mining of coal or metal ores is mostly located in the center and the north-east of the country. It sustains a powerful metallurgical industry. Rich deposits of oil and gas are found in the western part of the country including a giant oil field off-shore on the Caspian Sea. Stock breeding can be found all over the country. High quality grain is produced in the northern plains. Fruits and vegetables as well as cotton are grown in the south.

2.2 Economic Profile

2.2.1 Economy

Kazakhstan has a well developed industry but keeps an important agricultural sector.

The main productions were as follows between 1986 and 2003 according to ADB calculations:

(in thousand tons)	1986	1991	1995	1999	2000	2001	2002	2003
Agriculture								
Wheat	16743	6889	6490	11242	9073	12707	12700	11537
Barley	7095	3085	2208	2265	1664	2244	2209	2154
Potatoes	2137	2143	1720	1695	1693	2185	2269	2308
Mining								
Coal	137237	126463	83355	76831	72647	69773	58378	74872
Crude oil	21581	22036	18123	26736	30648	36060	42068	44523
Iron Ore	23630	21993	14902	9617	16157	15886	17675	19365

Manufacturing								
Steel	6496	6355	3027	4105	4799	4691	4866	5067
Rolled steel	4600	4700	2153	3186	3894	3888	4018	4119
Sugar	342	307	113	229	280	347	391	481
Production Indexes								
Agriculture, *1989-91=100*	...		63.6	67.5	63.8	73.9	74.0	71.6
Mining, *1980 = 100*	114.7	119.2	62.2	74.6	90.3	102.9	119.3	129.8
Manufacturing, *1980=100*	126.5	138.8	62.5	57.9	67.9	78.1	84.5	92.0

Source: ADB Key Indicators 2004

According to the same source the share of agriculture in the GDP dropped from 16 in 1993 to only 7% in 2003. Whereas the share of industry remained nearly stable around 36% the share of services rose from 46% to 57%.

According to World Bank calculations the annual growth in GDP rose from 3% in 1999 to 14% in 2001 before stabilising to 10% in 2002 and 9% in 2003. This was largely due to the increase in oil exports that passed from 25 million ton to 44 million during the period. During the same period the Gross National Income per capita calculated according to the Atlas method was increasing from US$ 1290 to US$ 1780.

2.2.2 Foreign Trade

According to the Agency for Statistics of Kazakhstan in 2003 exports amounted to US$ 12,900 million corresponding to an increase of 46% in relation to 2000. During the same period imports rose of 65% to US$ 8,327. In 2003 crude oil and gas represented 55.2 % of exports vs. 48.2% in 2000. Other main exports were rolled steel (7.2%), copper (4.8%), wheat (4.1%), ferroalloy (3.5%), coal (1.9%), alumina (1.5%), ore (1.4%), zinc (1.1%) and cotton fiber (1.1%). The main imports are machinery and equipment (25.8% in 2003), chemicals (15.1%) and transport equipment (14.4%).

In 2003 the main destinations of exports were Russia (16.5%), Bermuda (16.5%) and China (11.2%). Western Europe received about 20%. The main sources of imports were Russia (34.9% in 2003), China (18.7%) and Germany (8.9%).

2.3 The Transport Sector

2.3.1 General Features.

In 2003 the transport and communication sector represented 8.5% of the GDP. It employed about 236 thousand people that is 5.6% of the working population.

There were 88 thousand kilometers of public roads in 2003. Among the 21.2 thousand km of railway lines 14.6 thousand were of common use. Inland waterway transport operated on 4 thousand km.

2.3.2 Traffic Modal Distribution

The distribution of traffic volume between at the break-up of the Soviet Union and in 2003 was as follows.

Table 2.3.2 – 1 Distribution of freight traffic by mode (million ton)

Mode	1991		2003	
	M.ton	%	M.ton	%
Railway	328.2	13.1%	202.7	12.0%
Road	2153.6	85.7%	1313.0	78.0%
Pipeline	20.4	0.8%	166.6	9.9%
Others	11.2	0.4%	0.8	0.1%
Total	2513.5	100.0%	1682.9	100.0%

Table 2.3.2 - 2 - Distribution of freight turnover by mode (billion ton-km)

Mode	1991		2003	
	B.ton-km	%	B.ton-km	%
Railway	374.2	85.6%	147.7	57.2%
Road	44.3	10.1%	40.0	15.5%
Pipeline	15.3	3.5%	70.3	27.2%
Others	3.5	0.8%	0.2	0.1%
Total	437.2	100.0%	258.2	100.0%

The share of the railway in the freight turnover fell from 85.6% in 1991 to 57.2% in 2003. This was mostly due to the considerable development of the pipeline network.

In 2003 the railways transported 17.7 million passengers out of a total of 1114 million that is a share of 1.6 %. However in terms of passenger-km the share of railway transport was of 40%.

2.3.3 The Railway Sub-sector

General Features

In Kazakhstan the responsibility for defining the railway transport policy belongs to the Ministry of Transport and Communications. The former Department of Railway Transport has recently been transformed in a Railway Transport Committee that is a juridical entity entitled to intervene in restructuring through for instance temporary ownership of assets. The main actor is the Kazakhstan Railways State JS Company called Kazakhstan Temir Zholi (KTZ) that inherited Soviet assets but whose role is progressively focused on the management of the railway infrastructure.

The Kazak railway network is by far the largest in Central Asia with 14,605 km of main line, including 4,713 km of double-track line, 3,825 km of which being electrified as of 2003. At that date KTZ had 1,848 locomotives including 567 electric locomotives. There were some 77,000 wagons and 2,100 passenger coaches. About 56% of the electric locomotives were over 20 years old, 89 % of the diesel locomotives, 70% of the wagons and 66% of the coaches.

Institutional Structure

Kazakhstan has been the most active in the region in promoting reform. At the time of independence it found itself with three railway companies covering different regions of the country. A major step in the reform process was to merge the three companies in a single organisation that took the form of a state joint-stock company. This was achieved in 1997. Later the company was restructured to give maximal efficiency in the functioning of the railway system in a market economy.

After having considered several possible models, vertical division, vertical integration, open access to infrastructure, Kazakhstan finally opted for radical changes to be carried out in three stages.

The activities of the national company Kazakhstan Temir Zholy (KTZ) were divided into three groups:

- Core activities: management of infrastructure, rolling stock and operations;
- Ancillary activities: maintenance and repair of infrastructure and rolling stock;
- Social activities such as health and educational institutions.

The first stage (January 2001 - June 2002) was intended as a preparatory one for the restructuring of core activity and the introduction of competition in ancillary activity. It included also a major step in the form of divestiture of most social activities and release of non-essential property.

The second stage – expected to be completed by 1 January 2005 has far-reaching goals. It is intended

- to separate infrastructure from operations with the long term view that various operators could have access to the infrastructure, including with their own locomotives;
- to encourage the creation of private operators that could compete with KTZ with their own rolling stock.

What will be done in the third stage will depend on the results of the two first stages.

Kazakhstan already went far into the reallocation of assets. KTZ is basically left with the infrastructure that it should manage and make available to operators either state-owned or private. Even for infrastructure maintenance large use will be made of out-sourcing such as for instance from the "Railwaterheatsupply" subsidiary. Over 13,000 persons belonging to 80 companies work for KTZ.

Infrastructure

New lines have been constructed. The 184 km Aksu-Degelen section was opened in December 2000 allowing a direct connection between Pavlodar and Semei. After its opening in late 2004 the 398 km Altynsarino-Khromtau line. It will shorten the transport of grain or metal section from northern oblasts to the Caspian Sea by up to 2,000 km. It will also provide a direct link between the Pavlodar refinery and the oil fields in the west.

Electrification has been proceeding apace since 1991. By 1994 the electrification of the 567 km Aris-Shu section had been completed. The south line is now electrified up to Almaty. Electrification is undertaken on the Ekibastuz – Pavlodar line.

The Dostyk-Aktogai and the transhipment facilities at the Chinese border were upgraded making use of a Japanese loan. The bottleneck is now said to be on the Chinese side.

Extensive rehabilitation has been undertaken on sub-standard lines including Astana-Kokshetau, Aktogai – Sayak – Mointi and Beyneu – Mangyshlak. Major upgrading is under way in automatisation, power supply, signalling and telecommunications. For instance an optical fiber cable is being installed along the Almaty – Astana line

National Plans

Medium-term plans will largely be the continuation of the actions listed above. Reforms will proceed apace. Large amount of expenses are earmarked for rehabilitation of main lines, reconstruction of workshops and upgrading of equipment.

Nearly 90% of the diesel locomotive fleet is over 29 years. In order to renew it Kazakhstan will import new locomotives from China. Most of them will be assembled at the Chu plant after its full modernisation.

The third stage of reform is expected to last from 2005 to 2008. It should finalise the formation of a market-based system for railway transport. The objectives and tasks of that third stage can be described as:

- Ensure free access to the trunk lines by private traction means;
- Restructure the "Passenger Transport" company towards more autonomy;
- Start the provision of private services in passenger transport;
- Make decision on the transfer of the state shares in state JSCs, particularly "Locomotiv", "Rolling Stock" and "Freight Transport"
- Finalise the legal and juridical base and the standards as a framework for market-based services.

Infrastructure

On what is considered as a TRACECA route linking China with Aktau port it is planned to electrify the line between Aktogai and Almaty and to increase its capacity. The construction of a second track is envisaged on the Almaty – Chu section where a centralised dispatching system if the "Neman" type would be installed.

In the western part of the country line capacity will be increased particularly to satisfy the needs of the oil industry. This has already started with the construction of additional passing loops and the modernisation of signalling on the Aktau – Beyneu – Kulsary line. The upgrading will be later extended from Kulsary to Makat and Kandagach.

KTZ is to proceed with the construction of lines with increased impetus. Among new lines under consideration are Charskaya-Oskemen by-passing Russia in the North-East and a link between Mangyshlak station and the Bautino port along the Caspian Sea.

But those are relatively minor undertakings compared with the initiative that has been taken of building a Transkazakhstan line at standard gauge. It is estimated that the Dostyk-Aktau line could be built in five years. The first step would be the construction of a standard-gauge track along the existing line. Transhipment operations would be relocated from Dostyk at the border to Aktogai that is conveniently on a main north-south line with branching to the west. Work has already started and is expected to be completed by the end of 2005.

Further west the new line would either follow existing line such as on the Aktogai-Mointi, Kyzylzhar-Zhazkazgan and Beyneu-Aktau or being built along a new alignment. From Aktau port wagons could move by ferry to the Iranian port of Bandar Turkman. But the normal route would cross Turkmenistan to link with the Iranian rail network. The possibility of an alternative route through Russia and possibly Ukraine is also envisaged.

The proponents of the project take heart from the improvement under way on the Turkish railway with the construction of a rail tunnel under the Bosporus and the replacement of the Van Lake ferry by an on-shore line.

3. Traffic forecasts

3.1 Recent Trends in Railway Traffic

After the break-up of the Soviet Union there was a sharp fall in traffic as shown in the following table.

Traffic Type	1991	1995	1998	1999	2000	2001	2002	2003
Freight Traffic								
Volume (million ton)	328.2	161.1	170.0	133.6	171.8	183.8	178.7	202.7
Turnover (billion ton-km)	374.2	124.5	103.0	91.7	125.0	135.7	133.1	147.7
Passenger Traffic								
Volume (million pax)	40.0	37.4	21.6	18.8	21.3	21.6	20.7	17.7
Turnover (billion pax-km)	19.4	13.2	10.7	8.9	10.2	10.4	10.4	10.7

In the late nineties freight traffic volumes were only 40% of what they were in 1991 in terms of tons and even only 25% in terms of ton-km. For passenger the decline was less pronounced at slightly less than previous levels.

For freight a strong recovery is taking place since 2000 and accelerated in 2003. For passenger transport where the competition of road transport is more intense turnover seems to have stabilised at around 10 billion passenger-km per year.

3.2 Traffic Distribution by Commodity

In 2003 the freight carried by the Kazak Railways were distributed by commodity as follows:

Table 3.2-1 Traffic by commodity on the Kazakh Railways in 2002 and 2003 (thousand ton)

Commodity Group	2002		2003	
	Volume '000ton	Share %	Volume '000ton	Share %
TOTAL	**178,661**	*100.0%*	**202,737**	*100.0%*
Coal	72,976	*40.8%*	83,151	*41.0%*
Coke	1,009	*0.6%*	1,225	*0.6%*
Oil	21,046	*11.8%*	21,676	*10.7%*
Iron and manganese ores	20,850	*11.7%*	22,714	*11.2%*
Non-ferrous ores	11,256	*6.3%*	12,589	*6.2%*
Irons	6,352	*3.6%*	7,310	*3.6%*
Scrap iron	2,211	*1.2%*	2,347	*1.2%*
Flux	5,007	*2.8%*	5,002	*2.5%*
Chemical - Fertilizer	2,253	*1.3%*	2,373	*1.2%*
Construction materials	10,992	*6.2%*	14,805	*7.3%*
Cement	1,998	*1.1%*	2,586	*1.3%*
Timber	1,359	*0.8%*	1,686	*0.8%*
Cereal	7,317	*4.1%*	8,748	*4.3%*
Frozen goods	657	*0.4%*	643	*0.3%*
Others	13,378	*7.5%*	15,882	*7.8%*
Incl.containers ('000 TEU)	*118*		*107*	

The distribution between commodities did not change significantly from 2002 to 2003 although remarkably the number of containers transported decreased. Coal, oil and ores represented 70% of the total volumes carried.

3.3 Traffic on the Kungrad-Beyneu Line

3.3.1 Freight Traffic

Both Kazakh Railways and Uzbek Railways keep track on traffic moving across the common border. Statistics are available from both sides. In addition to volumes crossing the border information is available on origin and destination within the country.

Kazakh statistics were available for 2000, 2001 and 2003. They show the following trend.

Table 3.3.1-1 – Border Crossing Flows at Oasis (Akjigit) according to Kazakh sources (million ton)

Commodity Group	Border Crossing Uzbekistan - Kazakhstan at Oasis										
	Kazakhstan – bound					Uzbekistan – bound					Total
	Kazakh Import	Transit to			Total	Kazakh Export	Transit from			Total	
		Aktau	Astrakhan	Other Russian			Aktau	Astrakhan	Other Russian		
Year 2000											
Coal & Coke					0.00					0.00	0.00
Ores					0.00			0.10		0.10	0.10
Oil products					0.00			0.10		0.10	0.10
Grain					0.00					0.00	0.00
Chemicals					0.00				0.10	0.10	0.10
Construction mat.					0.00					0.00	0.00
Metal					0.00			0.20		0.20	0.20
Wooden goods					0.00					0.00	0.00
Other			0.60		0.60			0.50		0.50	1.10
TOTAL	**0.00**	**0.00**	**0.60**	**0.00**	**0.60**	**0.00**	**0.00**	**0.90**	**0.10**	**1.00**	**1.60**
Year 2001											
Coal & Coke			0.04		0.04					0.00	0.00
Ores			0.15		0.15					0.00	0.00
Oil products			0.06	0.01	0.07	0.04		0.02		0.06	0.13
Grain		0.09	0.09		0.18					0.00	0.18
Chemicals				0.08	0.08					0.00	0.08
Construction mat.			0.02	0.01	0.03	0.01				0.01	0.04
Metal			0.18	0.01	0.19					0.00	0.19
Wooden goods				0.01	0.01					0.00	0.01
Other	0.01	0.01	0.29	0.01	0.32	0.01		0.59	0.01	0.61	0.93
TOTAL	**0.01**	**0.10**	**0.83**	**0.13**	**1.07**	**0.06**	**0.00**	**0.61**	**0.01**	**0.68**	**1.75**

	Year 2003										
Coal & Coke	0.00	0.00	0.00	0.00				0.03		0.03	0.03
Ores	0.00	0.00	0.00	0.00				0.20		0.20	0.20
Oil products			0.13		0.13	0.04		0.10		0.14	0.27
Grain					0.00			0.04		0.04	0.04
Chemicals									0.01	0.01	0.01
Construction mat.					0.00			0.03	0.01	0.04	0.04
Metal	0.00	0.00	0.00	0.00	0.00	0.02		0.04	0.01	0.07	0.07
Wooden goods					0.00			0.02	0.02	0.04	0.04
Other		0.01	0.09	0.17	0.27	0.01	0.02	0.32	1.53	1.88	2.15
TOTAL	**0.00**	**0.01**	**0.22**	**0.17**	**0.40**	**0.07**	**0.02**	**0.78**	**1.58**	**2.45**	**2.85**

The comparison of traffic between the various years illustrates that there was a major change on the line during the period. Since the mid-nineties the Uzbek Railways had been building a new line connecting Navoi and Uchkuduk with Nukus and Kungrad in order to avoid passing by Turkmenistan. The new bypass line was open in 2001. It has been the Uzbek policy to channel as much as possible of the north-south traffic through that line in order to maximize the use of the national network.

It is therefore not surprising that the total traffic crossing the border increased from 2.2 million ton in 2000 to 2.82 in 2001 and 3.25 in 2003. But the change in the network does not explain why the steep fall in the north-bound traffic between 2001 and 2003 recorded by the Kazakh statistics. Nor why if in 2000 as in 2003 there was more traffic from Kazakhstan to Uzbekistan than in the opposite direction on the contrary in 2001 the dominant traffic was from south to north

An expectation of the new line bypassing Turkmenistan was that it would be possible to channel Uzbek goods using the TRACECA corridor through Aktau port. Apparently not much use is made from this opportunity since traffic coming from Uzbekistan and passing by Atkau was of 0,1 million ton in 2001 and had fallen to 0.01 million in 2003 what is not compensated by the 0.02 million coming from Aktau.

It is also worth noting that the share of the traffic crossing the Russian border at Aksaraiskaya / Astrakhan fell from 82% to 35% what is well in line with the policy of directing as much as possible of the north-south traffic through Nukus.

The Uzbek statistics shown below make it possible to have a complementary view of the traffic across the border.

Table 3.3.1-2 – Border Crossing Flows at Akjigit (Oasis) according to Uzbek sources (thousand ton)

Commodity Group	Border Crossing Uzbekistan – Kazakhstan at Akjigit								
	Kazakhstan – bound				Uzbekistan – bound				Total
	Uzbekistan Export	Transit from		Total	Uzbekistan Import	Transit to		Total	
		Turkmenistan	Tajikistan			Turkmenistan	Tajikistan		
Coal							2.0	2.0	2.0
Coke					3.1		32.4	35.5	35.5
Ores					0.1		190.6	190.7	190.7
Oil products	5.5	120.7		126.2	2.9		129.9	132.8	259.0

Grain	0.6			0.6	6.1		38.0	44.1	44.7
Chemicals					0.9	17.2		18.1	18.1
Construction mat.	1.8		1.1	2.9	4.3	16.3		20.6	23.5
Metal	0.2		167.3	167.5	79.8	128.3		208.1	375.6
Wooden goods			0.1	0.1	3.7	27.4		31.1	31.2
Other	254.5		156.5	411.0	395.2		297.6	692.8	1103.8
TOTAL	**262.6**	**120.7**	**325.0**	**708.3**	**496.1**	**189.2**	**690.5**	**1375.8**	**2084.1**

It should be noted first that Uzbek statistics are consistent with Kazakh statistics for most commodity groups except "metal" and "others". Thorough investigation would be needed to fully explain the discrepancy between the two sources.

What can be said is that for "metal" the north bound traffic indicated by Uzbek statistics that corresponds to an export Tajikistan is remarkably consistent with the production by that country of huge quantities of aluminum that reached over 300,000 ton in 2002 more than half of it being sent to Europe.

For the "others" group the 0.7 million ton of south-bound traffic recorded by the UTY statistics represents only one third of the Kazakh figure. This may be due to the fact that the figures published in Uzbekistan do not include some kinds of traffic of a not strictly commercial type.

The Uzbek data show that Uzbek exports accounted for only just over one third of the goods leaving Uzbekistan. In the same way Uzbek imports accounted for only just over one third of the goods crossing the border at Akjigit. Almost two third of the freight leaving or entering Uzbekistan was transit cargo coming from or going to Tajikistan (49%) or Turkmenistan (15%). Actually the figures for Tajikistan include 29.7 thousand ton going to Afghanistan and 0.2 thousand originating in that country.

3.3.2 Passenger Traffic

Present passenger traffic consists of both local and international traffic.

- Local traffic – There is a daily service between Kungrad and Beyneu in each direction. Trains leave in the morning and reach destinations in the evening. The trip takes about 11 hours.

- Through traffic – At the time of writing the report there were seven trains a week, an Uzbek train running between Tashkent and Saratov and six Tajik trains running between Tajikistan (Dushanbe, Kuliab or Khudjand / Leninabad) and Russia (Saratov in the latter case, Astrakhan in all others). A majority of the Tajik trains carry Tajik people working in Russia and their families.

3.4 Role of the Kungrad – Beyneu railway line section

In Soviet times Uzbekistan could be seen as at the heart of Central Asia. It acted as a link not only between the various countries of the region but also between various parts of countries such as Kyrgyzstan and Tajikistan. Since the break-up of the Soviet Union interdependence between the formerly soviet countries has been steadily decreasing. It was at first as the result of the civil war in Tajikistan. As the relations between Uzbekistan and Turkmenistan changed what was the main east-west transport corridor in soviet times - that is between Ferghana Valley and the port of

Krasnovodsk that became Turkmenbashi – lost of its importance. The opening of a new link with Iran was looked at positively by Uzbekistan at first but now the pressure is mounting to by-pass it through Afghanistan.

The new policy could be seen as symbolized by the construction of the Transnational Highway linking the Ferghana valley in the east to the Karakalpakstan Republic in the north-west through Tashkent and the major cities of Samarkand, Bukhara and Nukus. The construction of an all-Uzbek railway link with the same goal is also under way. A major step was the opening of a new line connecting the trunk network with the Khoresm Region and Karakalpakstan Republic through Uchkuduk. It will see its completion with a direct connection of Tashkent with the Ferghana Valley by the construction of a new Angren – Pap railway link cutting through mountainous areas.

With a normalization of the situation in Afghanistan this country has now given a new orientation to the development of the railway network. The new Guzar – Boisun – Kumkurgan railway line presently under construction will connect the center of the country with the northern region of Afghanistan with an important Uzbek minority and beyond it possibly with Iranian and Pakistanis ports.

The final railway network resulting of the implementation of the present plans will look like a five-pronged fork with a common trunk between Tashkent and Samarkand / Marokand.

- Two lines looking north in direction of Kazakhstan and Russia i.e. the line north of Tashkent and the one north of Kungrad that is the object of the feasibility study.
- In the east is the one presently linking with Kyrgyzstan with an extension to China that could be expected in a not too distant future.
- In the west the line linking with Turkmenistan that may lose much of its importance if relations with Turkmenistan do not warm up.
- In the south the new connection with Afghanistan the role of which may depend on the evolution of the relations with Turkmenistan.

It should be noted that the described pattern does not fit well with the development of a China – Europe corridor. In the highly competitive environment in which it must develop minimizing transport cost will be imperative. This gives a clear advantage to a link between the Ferghana Valley and central Uzbekistan through northern Tajikistan along the Syrdarya River.

In all cases the Kungrad – Beyneu link will remain a strategically important one for Uzbekistan.

- For linking the country with Russia and through it with Europe it presents the advantage on the line north of Tashkent of having a much longer distance on Uzbek territory and of providing revenues to UTY, economic activity along the areas it crosses and savings of foreign currency that is still scarce.
- For using the TRACECA corridor passing by Aktau port instead of Turkmenbashi that may otherwise abuse of its monopoly situation.

It is worth noting that the Kungrad – Beyneu railway line is also a vital one for Turkmenistan at least for now. It links this country to Kazakhstan and the Russian Federation. For the time being the alternatives are to use either un-sealed road links with Kazakhstan or ferry links with Makhachkala, Astrakhan or Baku. The on-going construction of a direct railway line between Ashgabat and Dashoguz not passing by Urgench should not involve much change in traffic level for the Kungrad – Beyneu link. However in longer term it is likely that Turkmens will implement their plans of building a new line between Turkmenbashi and Kazakhstan east of the Caspian Sea. If the project goes ahead the Turkmen traffic (which today is of around 15% only of the global freight traffic) along the Kungrad – Beyneu could be diverted to another line. This will of course not have any impact on the role of that line for Uzbekistan and probably only a marginal impact on the Tajik and Kyrgyz traffic. Afghanistan may as well try to take advantage of the existence of competing routes.

3.5 Traffic Forecasts for the Railway Line Beyneu – Uzbek Border

3.5.1 Freight Traffic

Since the potential for local traffic on the short Beyneu – Oasis line section appears to be limited the forecasting focused on international traffic crossing the border.

For international traffic the discrepancies between Uzbek and Kazakh statistics had to be taken into consideration. Traffic volumes are better explained by linking them to economic activities in separate countries such as Uzbekistan, Tajikistan and Turkmenistan. Since Uzbek statistics allow to identify origin and destination in those countries the Uzbek data was used as primary basis for the forecasts. However the traffic component apparently missing in Uzbek statistics was dealt with separately.

Forecast based on Uzbek Statistics

Forecasting is done according to the following approach:

- Base data as provided for 2003 by Uzbek statistics.
- Four target years as 2010, 2015, 2020 and 2025.
- Two scenarios: "conservative" and "optimistic"
- Ten commodities as defined in the traffic statistics

Change in traffic from a target year to the next one depends on four parameters. Two of them are not dependent on the commodity group.

- GDP growth rate for each of the three countries under consideration.
- Percentage of the flows taking the considered railway line.

The other two have different values for each commodity group.

- Elasticity trade change / GDP change
- Indicator of trade orientation to a geographical area.

GDP growth rates start from slightly higher values than those recently recorded 5% in Uzbekistan, 9% in Tajikistan and 10% in Turkmenistan. They get lower with time with higher values in the high scenario and lower for the low scenario.

The percentage of flows taking the line is made dependent on the opening or improvement of lines. When a new north – south link opens in Turkmenistan the share of the Turkmen traffic routed through Kungrad will obviously decrease up to possibly reaching very low levels.

The indicator of trade orientation is intended to take into consideration the fact that the relative importance of markets is changing with time as it has been for instance clearly the case for cotton. It is likely that the dominance of Russia and other European CIS countries in the trade of Central Asian countries will progressively be reduced. There is already statistical evidence of such a trend in recent years. The trade exchanges of Uzbekistan with Europe decreased steadily. This evolution will tend to lower the traffic on the Kungrad-Beyneu line.

The following table displays the result of the calculation by commodity type for two scenarios called "conservative" and "optimistic".

Table 3.5.1 - 1 International traffic forecasts based on Uzbek statistics (thousand ton)

Commodity Group	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
Kazakhstan Bound							
Coal	0	0	0	0	0	0	0
Coke	0	0	0	0	0	0	0
Ores	0	0	0	0	0	0	0
Oil products	126	267	149	11	330	254	34
Grain	1	1	1	1	1	1	1
Chemicals	0	0	0	0	0	0	0
Construction mat.	3	3	4	5	5	6	8
Metal	168	225	274	382	318	441	650
Wooden goods	0	0	0	0	0	0	0
Other	411	500	568	711	653	833	1096
TOTAL	*708*	*996*	*995*	*1110*	*1307*	*1536*	*1790*
Uzbekistan Bound							
Coal	2	3	3	2	3	4	4
Coke	36	53	65	60	60	79	121
Ores	191	286	356	319	327	437	673
Oil products	133	241	312	300	292	412	684
Grain	44	62	77	67	70	92	129
Chemicals	18	30	17	4	35	27	4
Construction mat.	21	36	23	10	42	36	11
Metal	208	344	249	162	404	353	195
Wooden goods	31	53	32	11	62	50	13
Other	693	977	1178	1184	1112	1431	1895
TOTAL	*1376*	*2085*	*2314*	*2120*	*2407*	*2922*	*3728*

There is a large difference between traffic volumes for the various scenarios. This is not surprising since there is significant uncertainty on the factors determining the growth in traffic such as GDP growth rate in the various countries, interrelation between GDP variations and change in foreign trade patterns, redistribution of trade flows between geographical areas, construction of new lines notably in Turkmenistan that may lead to route diversion.

To the above considered traffic should be added:

- The traffic shown in Kazak statistics and not reflected in Uzbek figures.
- The potential traffic that could be attracted from other routes. An obvious possibility corresponds to the freight presently moving between the Tashkent area and either Aktau or Aksaraiskaya/Astrakhan.

Table 3.5.1 - 2 Forecast traffic at the Kazakhstan – Uzbekistan border (million ton)

	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
Kazakhstan Bound							
Total (million ton)	0.71	1,00	1,00	1,11	1,31	1,54	1,79
No Trains per day (*)	*1.14*	*1.61*	*1,61*	*1,79*	*2.11*	*2,48*	*2,88*
Uzbekistan Bound							
Uzbek data based	1,38	2,09	2,31	2,12	2,41	2,92	3,73
Adjustment	1.07	0,54	0,00	0,00	1,07	0,54	0,00
Attracted traffic	0.00	0,15	0,19	0,31	0,27	0,38	0,75
TOTAL (million ton)	2,45	2.78	2,50	2.43	3.75	3.84	4.48
No Trains per day (*)	*3.95*	*4,48*	*4,03*	*3,92*	*6,05*	*6,18*	*7,22*
Both directions							
TOTAL (million ton)	3.16	3.78	3.50	3.54	5,06	5,38	6,27
No Trains per day (*)	*5.09*	*6.09*	*5.64*	*5.71*	*8.16*	*8.66*	*10,10*
(*) On the basis of trains carrying 1,700 tons							

The "adjustment" item corresponds to the difference between Kazakh and Uzbek statistics. It is assumed that it will progressively disappear.

The "attracted traffic" item refers to the possibility of diverting traffic presently going from Aktau and Astrakhan to Uzbekistan by Makat and Chengeldy – Keles. It happens that the route through Kungrad is significantly shorter in both cases. Improving the line may make the shorter route more attractive. The 2003 statistics show flows of 0.09 million tons from Aktau and 0.08 from Astrakhan. In the "conservative" scenario it was assumed that 50 % of the traffic from Aktau and 20% of that from Astrakhan could be diverted

The above figures don't take into consideration certain flows that may appear in the future such as those linked with the construction of a direct railway link between Uzbekistan and Afghanistan. However the above forecasts already include flows related with Afghanistan based on present figures. If west Afghanistan is linked by rail to Iran a larger proportion of the exchanges with Europe could take that route rather than passing by Uzbekistan.

The "conservative" scenario shows the impact of rerouting the Turkmen component of the traffic. In this scenario it has been assumed that by 2015 a new north-south line linking Turkmenistan and Kazakhstan east of the Caspian Sea was already operating. The new link has already been planned and the alignment agreed between concerned parties. It would by-pass Uzbekistan and so will be in competition with the line under study.

It is intended that the forecasting methodology will be detailed in a separate working paper.

3.5.2 Passenger Traffic.

As above noted there is presently a local daily train in each direction between Kungrad and Beyneu. There are also seven international through trains per week in each direction, six of them being Tajik and the other Uzbek.

The following development is envisaged.

Table 3.5.2 - 1 Traffic forecasts for passenger trains (number of pairs of trains)

Train Type	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
International Traffic	1.00	1.43	2.00	2.43	2.00	2.43	3.00
Local Trains	1.00	1.00	1.00	1.00	2.00	2.00	2.00

For local traffic the most likely is that the frequency will be kept at one train per day in each direction. Two trains per day could only make sense if the speed is significantly increased. On the other hand the on-going construction of a modern highway between Kazakhstan and Uzbekistan will tend to divert traffic from the railway.

Concerning international traffic it appears that there is presently a pent-up demand in Tajikistan that cannot be met. The Tajik Railways seem to be willing to satisfy that demand by introducing new trains. However in the long term when incomes increase substantially it is likely that a larger proportion of travelers will fly.

4. Characteristics of existing lines and stations

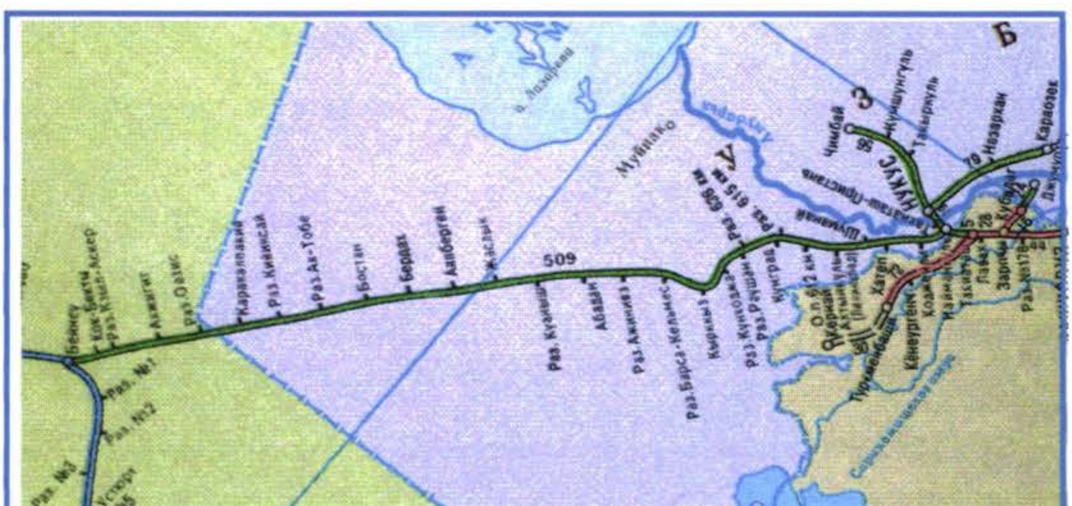
The line under study is the Uzbekistan border - Beyneu line section (81 km), belonging to the line Kungrad-Beyneu (407 km) which is part in Uzbekistan and part in Kazakhstan.

The following Fig. 4-1 shows the area interested by the line.

Fig 4 – 1- The Kungrad – Beyneu railway line

Details of the line are shown in the next Fig. 4-2

Fig 4 – 2 Details of Kungrad-Beyneu railway line



In the following part of the document description is made of the main technical aspects of the line:

- Infrastructure (including PW, earthworks and structures, stations and LC),
- Safety devices,
- Telecommunications,
- Power supply.

4.1 Infrastructure

4.1.1 Permanent Way and earthworks

Alignment

The section length is 81 km, mostly on straight. Every circular curve is provided with parabolic transition curves at the beginning and at the end.

The maximum allowed load is 23 t/axle.

Line formation

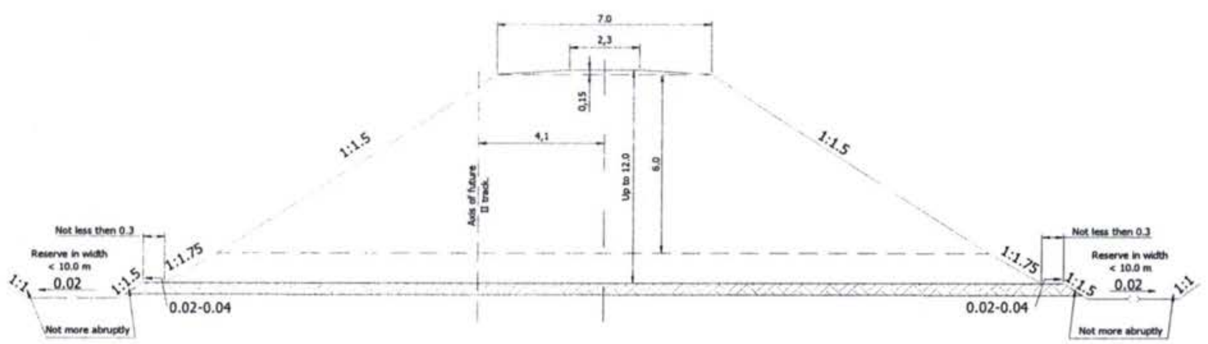
Along the Uzbek border - Beyneu line section the track formation is represented mainly by embankments 1÷3 m high. The top surface of the embankment width varies from 6,0 m to 7,1 m.

The embankment is built with local soil represented by clayey and sandy materials.

On this track section no problem related to geology, instability of soil, seismology has been detected.

The typical cross section of embankments is shown in fig. 4.1.1 – 1; can be observed the slope of about 6% towards both sides, starting from a central strip 2,3 m wide.

Fig. 4.1.1 – 1 Typical cross section of embankments



Typical cross structure of embankment in height up to 12 m from clay soils, fine and powdery sand and it is easy weathered rock.
The note: At erection of embankments from dry sand with a corner of a natural slope less than 340 their slopes are arranged more gentle slope .

Superstructure

The typical superstructure cross-sections on straight track and on curve are shown in fig.4.1.1 – 2. On the top surface of the embankment is laid down a sandy gravel layer 0,2÷0,3 m thick, and a ballast layer 0,20÷0,35 m thick under sleepers.

Along the main line of the track section the study is taking into consideration,

- the sandy gravel layer and the ballast layer are, respectively, 0,2 and 0,3 m thick,
- concrete sleepers are installed (see fig. 4.1.1 – 3), with the exception of the main line of ; they are laid down at a distance of 0,55 m / 0,50 m between their axels on straight / on curves of radius less than 1200 m (1840 / 2000 sleepers per km),
  P65 type of rails are laid down (see fig. 4.1.1 – 4),
- fastenings rail-wooden sleepers and rail-reinforced concrete sleepers are shown in fig. 4.1.1 - 5

Fig. 4.1.1 – 2 *Typical superstructure cross-sections on straight track and on curve*

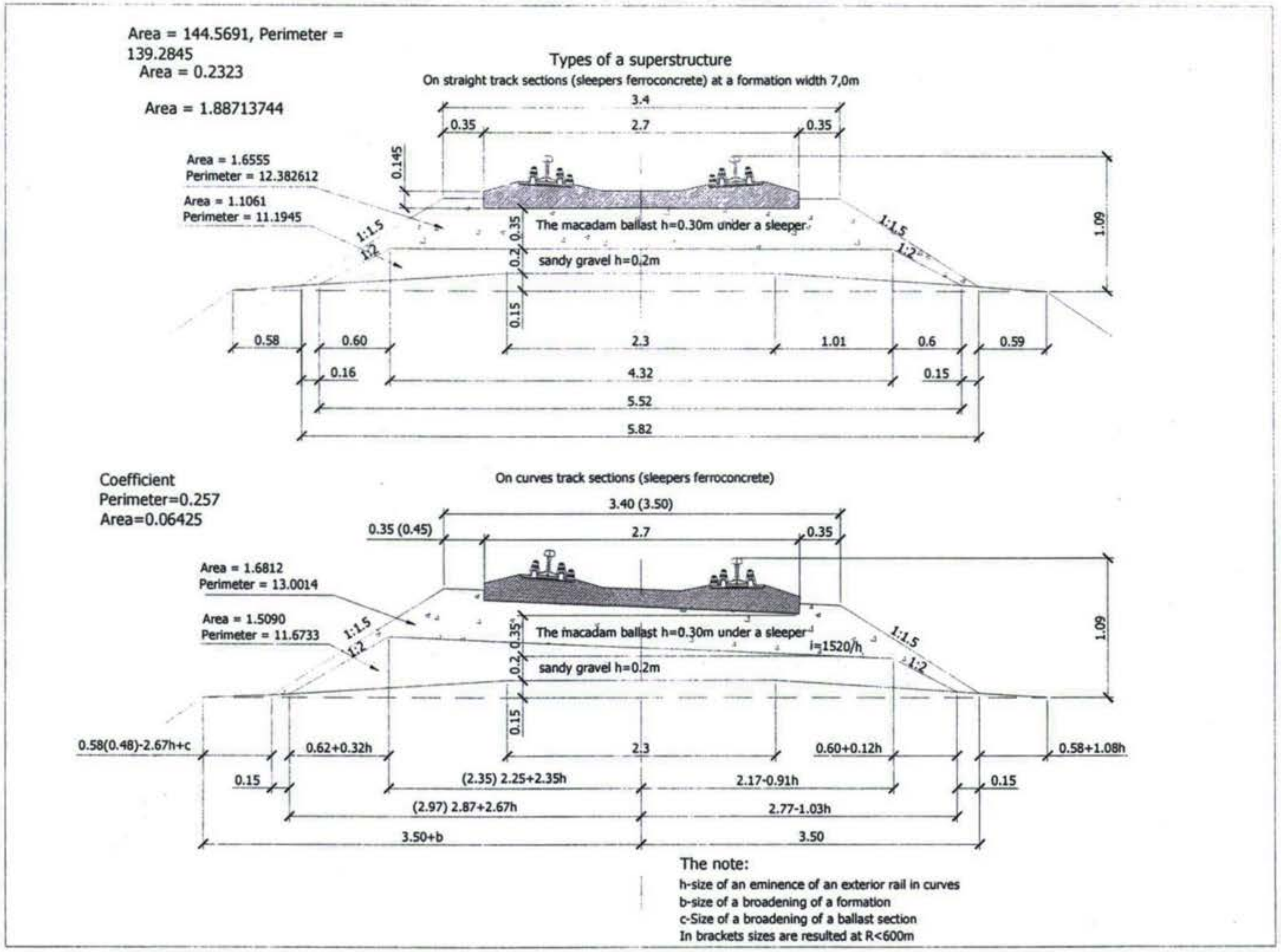
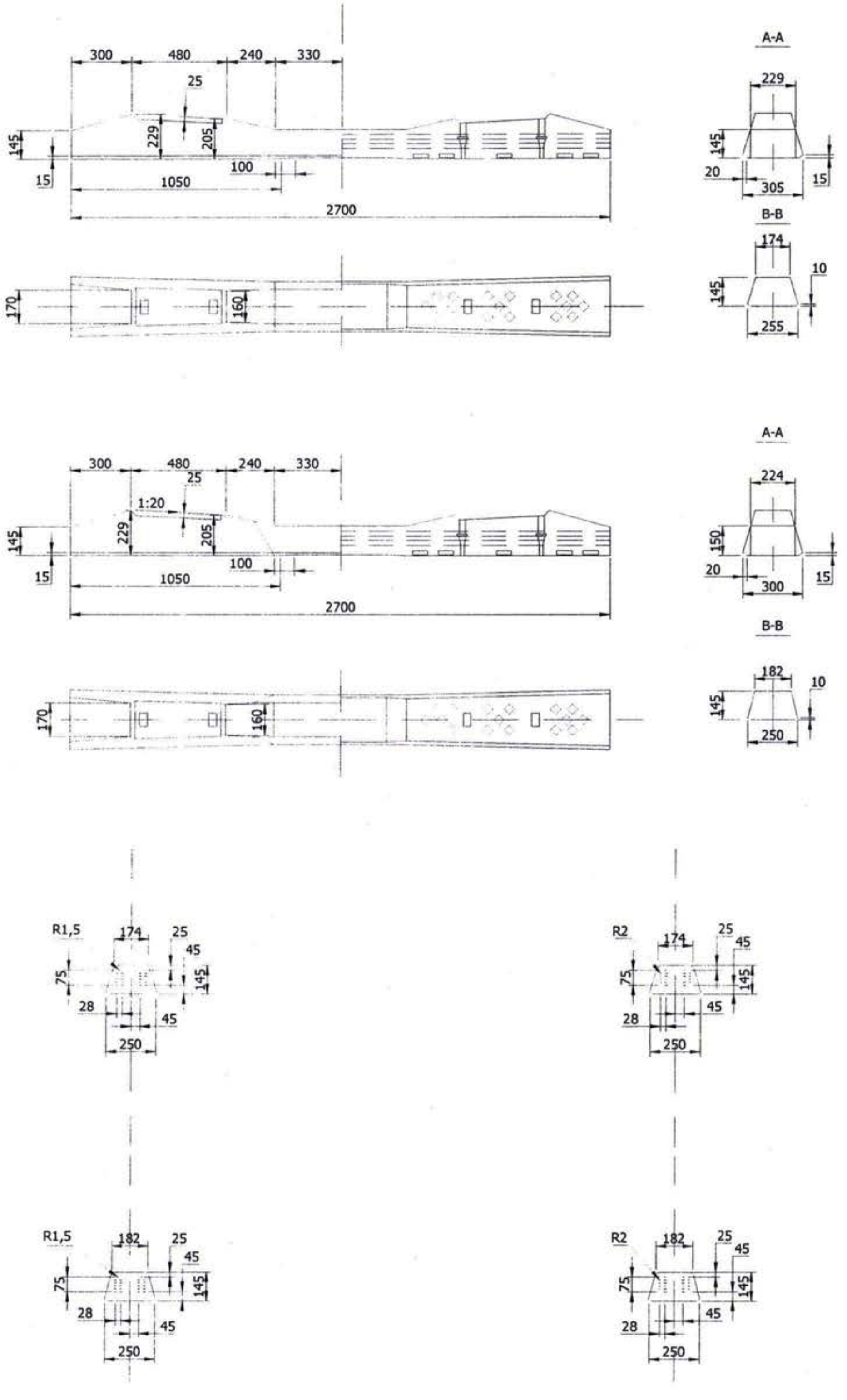
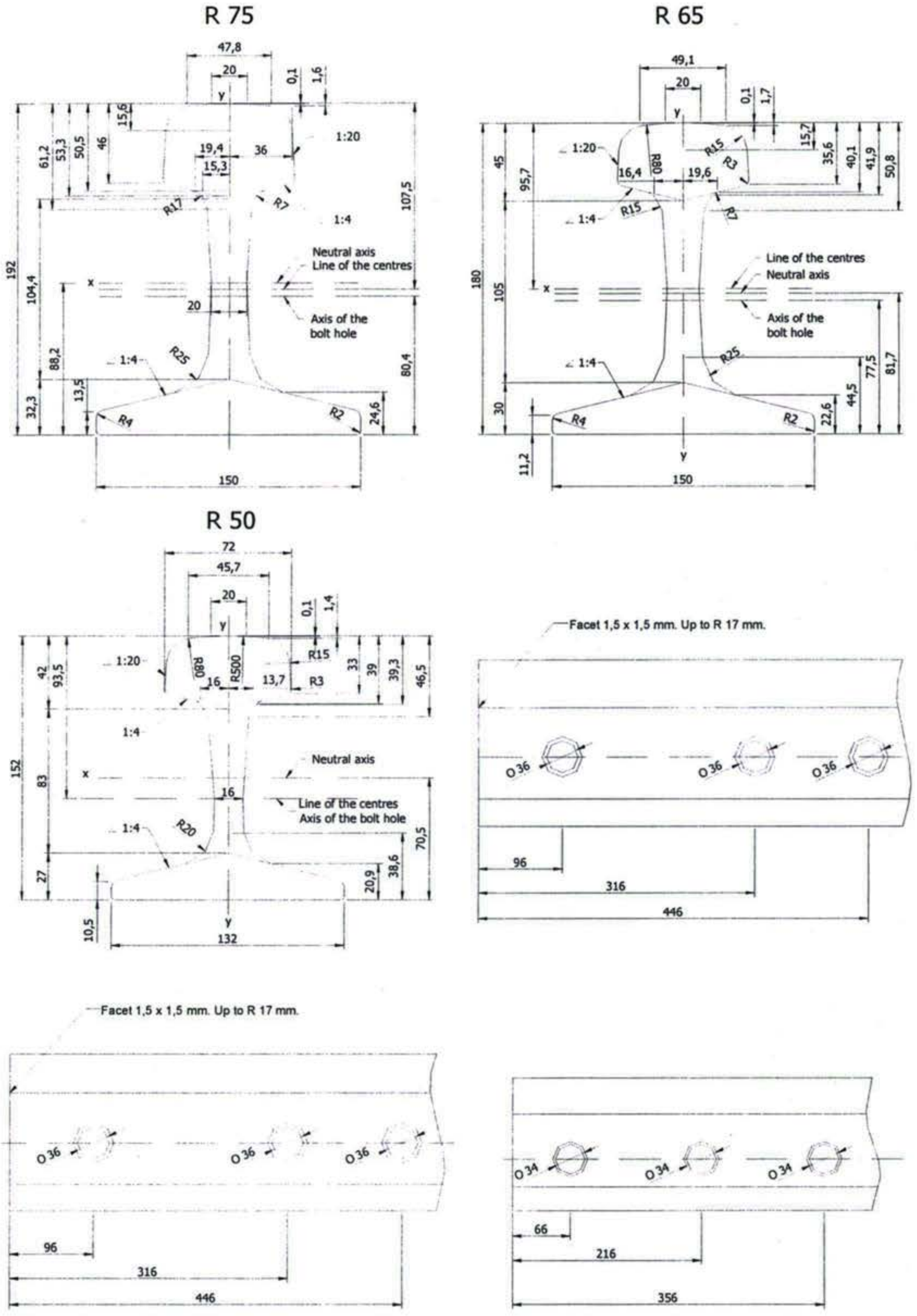


Fig. 4.1.1 – 3 Concrete sleepers
(mm)



Design of ferroconcrete sleepers
a - such as C-73-1; b - such as C-73-2; c - cross sections and reinforcing of sleepers C-73-1; d - cross sections and reinforcing of sleepers such as C-73-2.

Fig. 4.1.1 – 4 Cross profiles of standard rails (R 75, R65, R 50)



Cross profiles of standard rails (R75 R65 R50)

Fig. 4.1.1 – 5 Fastenings rail-wooden sleepers and rail-reinforced concrete sleepers

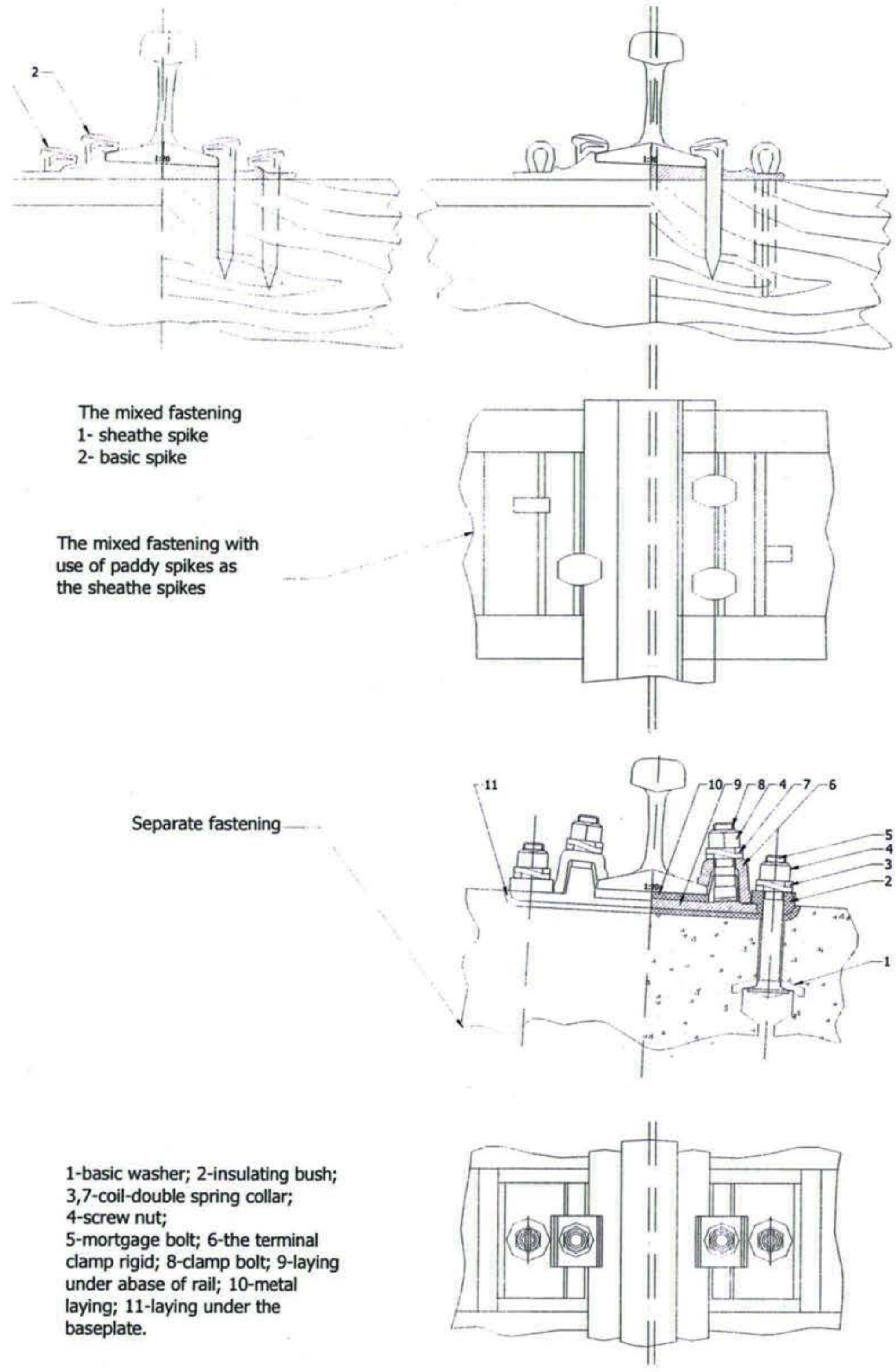


Table 4.1.1 – 2 PW characteristics along the Kungrad-Border line

PW type Kazakhstan (81 km) (turnouts excluded)		
	Line	**Stations** main track
W+P50	-	-
W+P65		1.166
C+P65	70.674	8.525

Turnouts on main line into stations have been excluded from the distances shown in the table 4.1.1-2 (each turnout tg1:11 type has a total length of about 33.5m).

Visit of the line

The line was visited by the Consultant experts on 12th of November 2004 who were allowed to investigate in detail each technical matter and to take contact with people directly involved.

Consideration about PW conditions

According to the data collected on field and to the meetings held with Kazakh Railways Representatives in Astana (meeting held on 30 January 2005) and on the line, the infrastructure results to be currently in good conditions, both for Permanent Way and formation, with the exception of erosion phenomenon in some stretches.

It is worth to mention that during the same meeting in Astana the Kazakh railways were remarking that this line is not in their priorities of interventions, because the line capacity is largely over the current traffic level (15 – 25 train pairs per day capacity against a traffic of 4-5 pairs of trains per day).

Anyway, according to Consultant experts site survey and data collection, in some short sections the following defects of PW were noticed:

- in Akjigit station, rails type P65 are installed on wooden sleepers and therefore not continuous welded,
- in the same station fastening devices, in particular those equipped on wooden sleepers, are old, and their fastening action is reduced,
- end rails in junctions present permanent deformations and are broken and worn out due to the hammering effect at the passage of trains,
- in the overall line section (81 km) the alignment and the profile geometry has to be recovered,
- in parts of the line the lateral paths of 0,59 cm on both sides of the top embankment surface was eroded for the action of raining waters and blowing wind,
- in many cases the shoulders of ballast on the sides of sleepers, that in normal conditions are 0,35÷0,45 m wide, disappeared,
- in some sections, ballast is partly polluted with clayey soil and sand, particularly on main lines of stations,
- service roads on the side of formation need interventions to be safely used by railway maintenance cars.

Because of the nature and the extent of the above defects for the PW, they have a limited effect on the performance of the line and anyway they could be duly eliminated during almost a standard maintenance routine. For that reason the improvement measures are suggested, but they have not been taken into consideration in the economic analysis.

Maintenance

According to the collected information, the following table 4.1.1-3 resumes the average quantities of replaced p.w. materials per each maintenance cycle.

Table 4.1.1 –3 Maintenance cycles materials

Rehabilitation works for Kungrad - Beyneu Line (Border - Beyneu section)			
	Type of Maintenance		
	Lifting	Medium	Capital
Ballast	30%	60%	100%
Sleepers and fastenings	20%	40%	100%
Rails	10%	30%	100%
Per km of line			
Ballast (m3)	**540**	**1,080**	**1,800**
Sleepers and fastenings (n)	368	736	1,840
Rails (t)	13	39	130

Table 4.1.1-4 resumes the average cost for 1 km maintenance of the railway line infrastructure including permanent way, turnouts, civil works, earth-works, drainages, structures, tamping, aligning, levelling. These costs have been calculated taking into account local railway manpower, materials and machines.

For the detailed table of maintenance costs, refer to Annex II to this study.

Table 4.1.1 – 4 Average cost for 1 km maintenance of the railway line infrastructure

Rehabilitation works for Kungrad - Beyneu Line (Border-Beyneu section)			
	Cost per km of type of maintenance		
	Lifting	Medium	Capital
$/km	82,320.82	206,428.12	494,305.77

4.1.2 Stations

General

The line section Border - Beyneu is provided with 5 stations with distance varying from a minimum of 10 km to a maximum of 24 km. Their main functions are:

- operation (train crossing and overtaking),
- train parking,
- rolling stock (for service, for shunting or for maintenance) parking,
- passenger service,
- link for branches.

The following table 4.1.2-1 resumes the stations position and distances on the entire Kungrad-Beyneu line.

Table 4.1.2 – 1 Stations position and distances on Kungrad - Beyneu line

Stations of the Kungrad-Beyneu line					
Station name	Chainage km	Distance km	Station name	Chainage km	Distance km
Kungrad	626.917		Berdakh	846.503	
		19.651			24.497
Raushan	646.568		Bostan	871.000	
		25.034			21.788
Kunhodja	671.602		Ak-Tobe	892.788	
		16.582			20.797
Kirk-Kyz	688.184		Kiyiksay	913.585	
		24.298			19.583
Barsa-Kelmes	712.482		Karakalpakia	933.168	
		21.610			20.332
Ajinijaz	734.092		BORDER	953.500	
		23.050			1.470
Abadan	757.142		Oazis	954.970	
		21.540			24.551
Kuanysh	778.682		Akjigit	979.521	
		18.698			24.117
Jaslyk	797.380		Kzyl-Asker	1003.638	
		24.700			19.523
Ayapbergen	822.080		Kok-Bekty	1023.161	
		24.423			10.418
			Beyneu	1033.579	

The following table resumes the station typologies and their number on the entire railway line.

Table 4.1.2 – 2

Stations type			
	Uzbekistan	**Kazakhstan**	**Tot**
Terminal	1	1	2
Small crossing stations	9	3	12
Medium crossing stations	3	1	4
Large stations	2	0	2,0
	15	***5***	***20***

As shown in the previous table 4.1.2-2, stations along the line are of different type, according to their specific function:

1. Terminal stations of the line are Kungrad and Beyneu, whose schematic lay-out is represented in the following figures 4.1.2-1 and 4.1.2-2. These stations have the functions of regulating traffic flow on the line, parking freight trains, small maintenance for rolling stock and departing and arriving trains check, forming trains, passenger trains service.
2. Small crossing stations are typical operation stations, for allowing trains crossing and overtaking. Generally composed by two tracks (one main track and one siding) connected in the middle by a single cross-over. When passenger service is operated by the station, the main track is generally provided with one platform. The siding track is provided with a refuge siding for operation safety and shunting loco recovery. Finally, this station typology is generally provided with a level crossing at one end of the track set. Its scheme is represented in the following figure 4.1.2-3.

3. Medium crossing stations are the typical operation stations, for allowing trains crossing and overtaking. Generally composed by three shorter parallel tracks (one main track and two sidings) they have 3 independent receiving and departure tracks. When passenger service is operated by the station, the first siding is generally provided with one platform. The mostly used siding (where the platform is located) is provided with refuge sidings on one or both station ends, for operation safety and shunting loco recovery. Finally, this station typology is generally provided with a level crossing at one end of the track set. Its scheme is represented in the following figure 4.1.2-4.
4. Large stations are of different types, generally linked to a branch.

Figure 4.1.2 – 1 Kungrad station main tracks lay-out

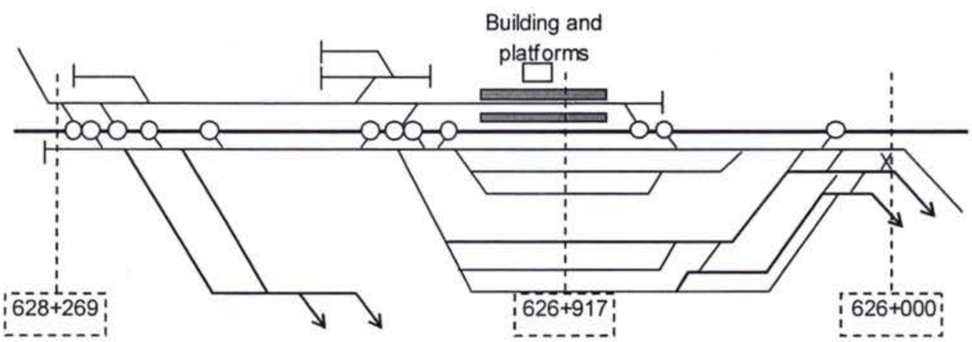


Figure 4.1.2 – 2 Beyneu station main tracks lay-out

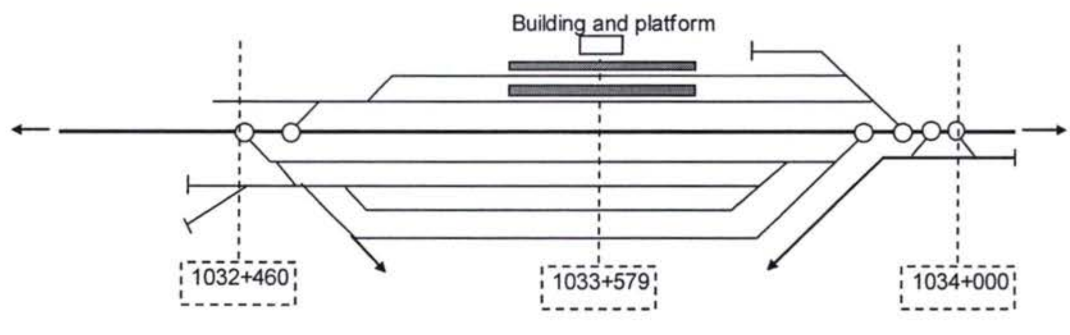


Figure 4.1.2 – 3 Typical small crossing station

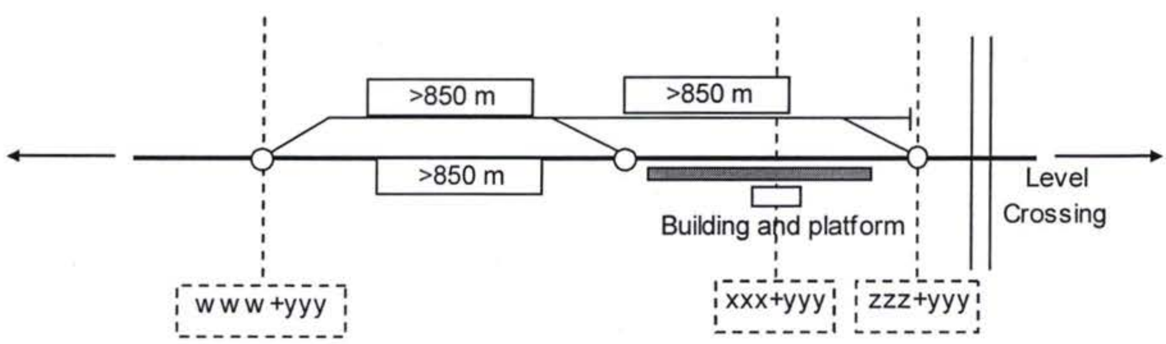
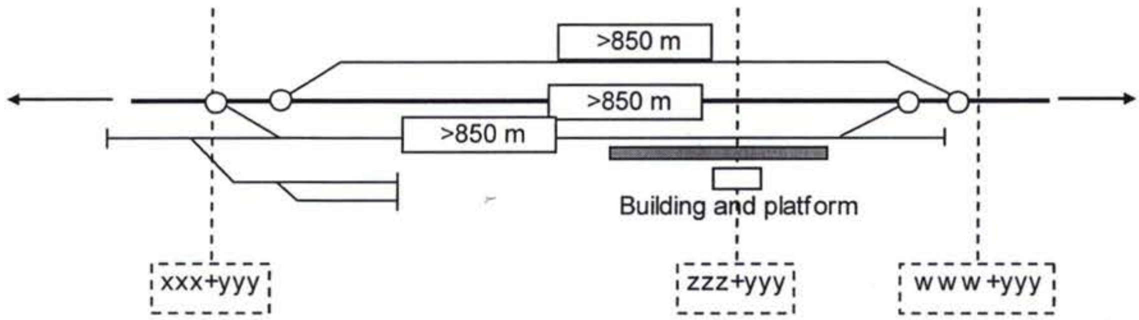


Figure 4.1.2 – 4 Typical medium crossing station



Permanent Way in stations

As shown on Table 4.1.1-1, station main lines are generally provided with P65 rails on concrete sleepers, with the exception of Akjigit (P50 on wooden sleepers). The existing turnouts are generally P65 tg 1/11 type, however 2 P50 tg 1/11 type turnouts in Akjigit are installed.

General conditions of stations PW are good, with the exception of ballast that is generally very dirty and polluted for insufficiency or absence of water collection devices.

Stations buildings and platforms

Station buildings can be divided in:

- passenger buildings,
- personnel building,
- technological buildings.

The Consultant's main interest was focused on the station buildings related to passenger and technological installation in the frame of passenger welcoming capacity increase and technological installation replacement.

The state of maintenance of the buildings is acceptable, apart for some cases, indicated in the Options of the work. Nevertheless they would ask for a general restructuring, because of the age and of the adverse meteorological conditions of the zone. Particularly the finishes of the buildings, the coverage and the frames (doors and windows) should be replaced, while for some station buildings (those interested by greater passenger traffic) a deeper restructuring would be requested.

The worse situation concerns toilettes for the public, that – where existing- should be upgraded to be suitable to the current hygienic norms, at least for the larger stations.

In particular, it is necessary to adjust the passenger buildings as the waiting rooms, and to equip them with proper heating and ventilation systems.

Electric, water distribution and sanitary plants have to be set to norms.

As it regards the external areas for passengers, as the platforms, these are generally in bad conditions and their dimensions are not matching with passenger trains average size.

Generally, every station is provided with only one platform on the proximity to the passenger building, and the platform itself has a length absolutely undersized for the average length of passenger trains. Besides, the state of maintenance of the platforms is low, putting in some cases to risk passenger safety while waiting and boarding the train. It seems necessary to restyle or rebuild the platforms, according to the current norms.

For station building and platforms upgrading, see Option Basic Works.

The following table 4.1.2-3 resumes the platforms to be extended or restyled.

Table 4.1.2 – 3

Station platforms		
	Uzbekistan	**Kazakhstan**
to be extended	9	4
to be restyled	5	1

Also in this case the Consultant considers not crucial the interventions in the stations along the line. Anyway the improvement of the station facilities should be certainly considered in the light of maintaining the whole network up to a satisfactory standard. For that reason the improvement measures are suggested, but they are not included in the economic analysis.

4.1.3 Level Crossings

Along the Oazis-Beyneu railway section a total of 7 level crossings is present.

A level crossing is situated in a range of 100 – 1000 m of distance from the limit of all the stations, namely:

- Oazis,
- Akjigit,
- Kzyl-Asker,
- Kok-Bekty,
- Beyneu.

Other two additional level crossing are located one in the Oazis – Akjigit section (chainage Km 966+316) and another in the section between Kzyl-Asker and Kok-Bekty (chainage Km 1011+787).

The level crossing protection system is only assured by crossing warning signals (traffic lights and Saint Andrew crosses) without barriers.

The warning signalling system is automatic: track circuits detect trains and activate warning indications at level crossings.

Usually level crossings allow unpaved roads or trails to cross the railway line. The pavement is made of concrete blocks or rarely of wooden sleepers.

From general experience, the level of safety afforded by these devices on their own is insufficient. In the specific case of the Oazis-Beyneu railway line this protection system could be justified by the low intensity of rail traffic and by the trifling volume of road traffic.

4.1.4 Structures and Drainages

The line object of this study is mainly running in a flat territory, mostly dry and without particular interferences with human settlements or natural constraints.

The area is mainly dry for most part of the year and this influences the nature of the river courses, almost absent. The few water courses are not permanent and therefore dry for the most part of the year. But this doesn't mean that the drainage system of the railway strip is not necessary; there are in fact some periods of the year in which the rainfalls are consistent and the natural depressions becomes rivers with a valuable water flow.

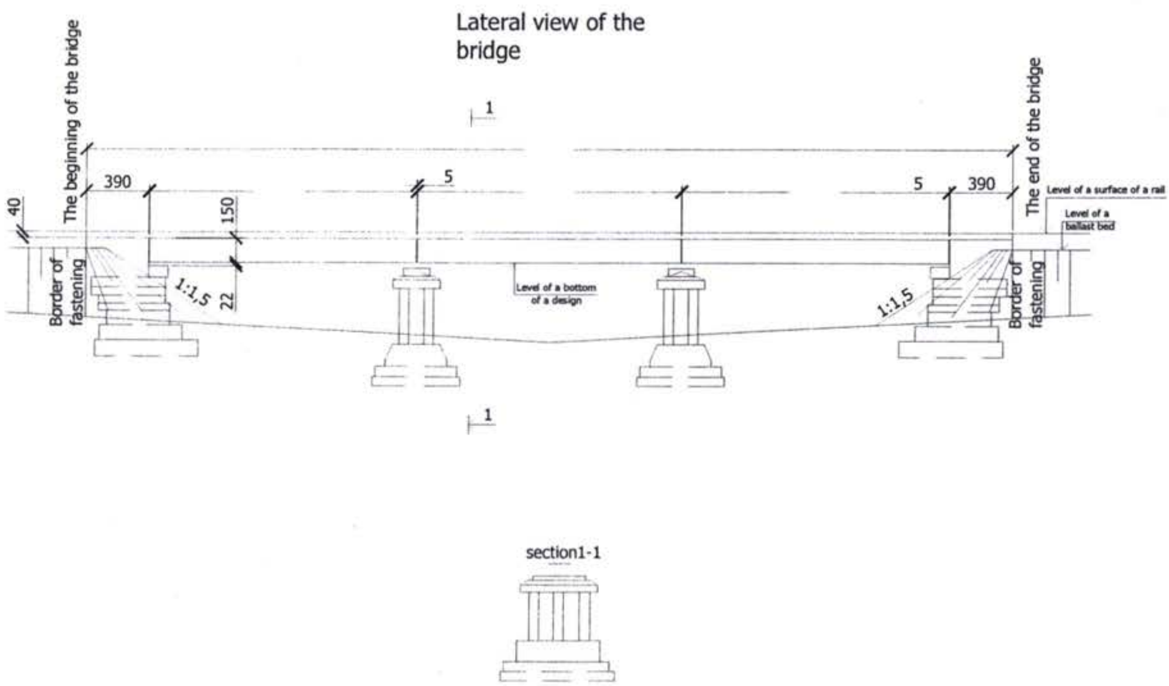
With the aim of collecting and taking away these sudden waters, the line has been designed with many pipe culverts and small bridges, mainly composed by single or double span 6m long with simply leaned structures.

Drainage main structures

Along the section Kazak border - Beyneu 4 more spans bridges and 43 pipe culverts were built to overtake depressions, channels and little rivers. Their length does not exceed 18 m and their maintenance conditions are said to be good, and Consultant's experts site survey confirmed it, with the exception of three bridges described in the next paragraph.

They are formed by door pillars and piers supporting reinforced concrete beams, generally of standard length. On fig. 4.1.4 – 1 is shown a typical view of a railway bridge.

Fig. 4.1.4 – 1 Typical view of railway bridge



Maintenance status

The main defects presented by reinforced concrete structures are:

- cracks in concrete,
- corrosion of armature,
- lixiviation of concrete,

- protective layer breaking off,
- waterproofing collars damages.

In particular, the following three structures need their beams to be replaced and their abutments and piers to be heavily maintained:

- 1022 km pc 7+90 (main line), 2x5,5 m, 1966,
- 1022 km pc 7+90 (lateral), 2x5,5 m, 1996,
- 1026 km pc 0+25 (main line), 3x5,5 m, 1972.

In fact they show the following defects:

1. The destroyed blanket of concrete with the bared rusted armature (more than 20 % of the area), chips of the concrete on a bottom of pile support,
2. Washout of the underbridge channels, with undermining pile support,
3. Destruction of concrete in sidewalk consoles with denudation the rusted working armature and collars,
4. In the middle a crack disclosing up to 1 mm,
5. Lixiviation of the cement mortar on a bottom.

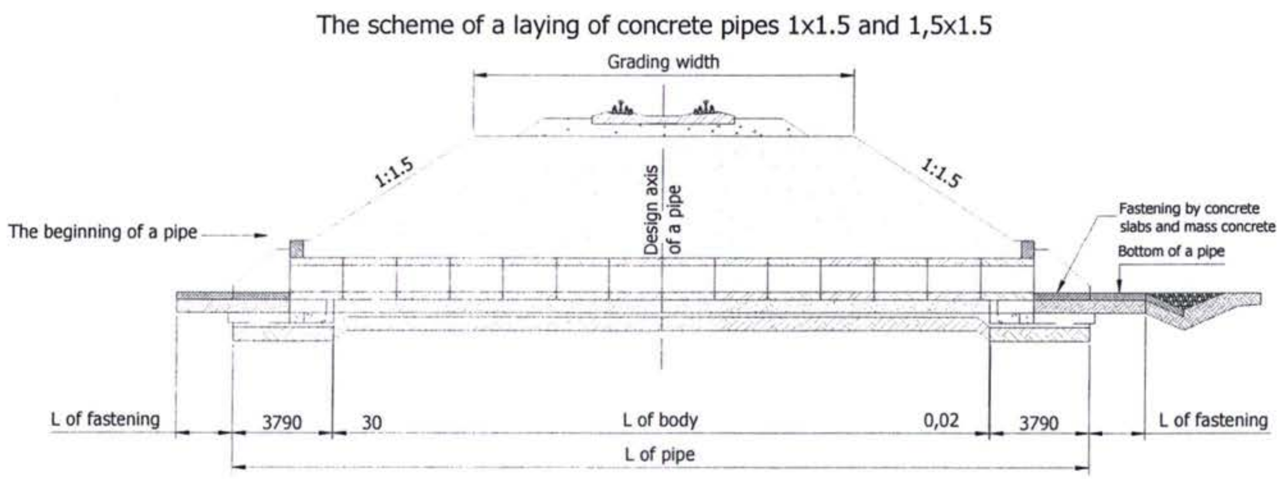
Drainage small structures

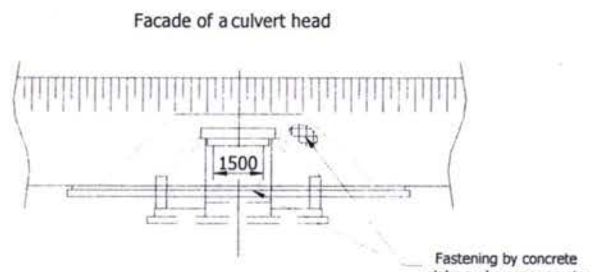
Besides the above mentioned bridges, the border-Beyneu section is provided with 43 concrete/metal pipe culverts and prefabricated concrete elements (box) culverts.

A typical section is shown in fig. 4.1.4 -2.

This Consultant's study does not envisage any work on small structures for drainages.

Fig. 4.1.4 - 2





Ditches

According to the theoretical section of the embankment (see fig. 4.1.1 – 1), ditches have to collect rain waters all along the line. During the site investigation it was noted that ditches are present only in some sections. Anyway the rare atmospheric precipitation on the Karakalpakia desert justifies plainly the poor attention to this aspect of maintenance.

In the stations, on the contrary, ditches are totally missing and the damages are evident, due to the rain water stagnation and the "pumping effect" at the passage of trains that lifts fine materials from underneath.

4.1.5 Geological and Geotechnical analysis

General geological – geomorphological and hydrogeological setting

The Kungrad – Kelmes portion of the Kungrad – Beyneu railway line, crosses the western margin of Quaternary alluvial (deltaic) plains formed by the depositional activity of the Amudaria river. The plains surface is generally very flat with only slight unevenness no more than one to few meters high.

The alluvial deposits forming the plains are prevailingly composed of sand, clay and loam layers.

Beyond Kelmes the line, from the above alluvial plains, enters, through a smooth transition, into the Ustyurt plateau and runs on the flat to gently undulated plateau surfaces up to Beyneu, in Kazakhstan.

These flat surfaces are sometime bordered by sharp cliffs few ten meters high, where the bedrock of the plateau is well exposed.

As a whole the bedrock of the plateau is composed of layered Tertiary rocks including limestones, marls, sandstones and claystones, all of them being more or less rich of gypsum and other soluble salts.

The overburden that almost continuously covers the bedrock is generally composed of fine soil with inclusions of rock debris and alluvial gravels. The rock debris increase approaching the above mentioned cliffs and often form the talus of their rocky slopes.

Abundant gypsum and other salts accumulations are generally found between the overburden and the bedrock.

On the deltaic plains the ground water regime is correlated to the regime of the Amudaria river, especially in the vicinities of the water course. In distant areas only seasonal fluctuations of the ground water, of limited amplitude, are recorded. During winter time the river is fed basically by the ground water.

The hydrogeology of the plateau is characterised by localised groundwater basins, locally fed. The ground water is generally found at the depth of 30 – 60 meter.

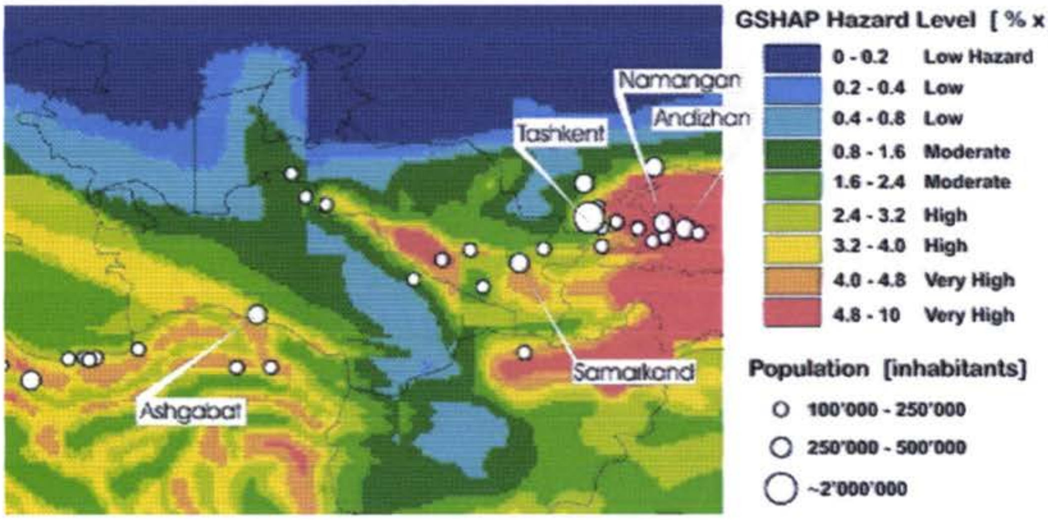
General seismology

The northern boundary of the Turan tectonic plate, characterised by the occurrence of large scale earthquakes, coincides with the latitude of Bukara – Gazli towns.

The Gazli earthquake sequence of April and May 1976 had magnitude M = 7.0 and M = 7.3. Tashkent also was badly hit in 1968 by an earthquake of M = 6.6.

On the contrary no significant seismic events are recorded in the area of the project. According to the seismic hazard map of "Global Seismic Hazard Programme" 1999, (see Fig.4.1.5 - 1) this area is almost completely characterised by low seismic hazard (moderate hazard only for a limited southern portion of the project).

Fig. 4.1.5 - 1- Peak ground acceleration with a 10% chance of exceedance in 50 years.



(Derived from the Map of the Global Seismic Hazard Programme - Giardini et al., 1999)

Engineering geological and geotechnical conditions of the line

The railway develops on flat, stable areas where no evidences of geological, geomorphological, hydrological conditions possibly critical for the stability and safety of the line are apparent. The stream beds that cross the railway are almost permanently dry.

Due to the above and to the typology of the proposed rehabilitation works, limited to the refurbishment and upgrading of the existing line, no specific geotechnical investigations, as may be required for the study of any new railway route, have been considered in this phase of the project.

However the aspects of the suggested rehabilitation works having engineering geological and geotechnical significance are mainly related to the selection of the source areas and possible quarries of the materials (ballast and sub-ballast) required for the restoration of the embankment cross section.

Further geotechnical investigations

Based on the above considerations concerning the engineering geological and geotechnical conditions of the line, it is suggested that further investigations, to be performed if necessary before undertaking suggested rehabilitation works, but in a later stage by the Kazakh Railways themselves, may include the following activities:

- detailed visual survey of the area for a final assessment of the engineering geological situation of the line, with regard also to the potential scouring conditions of the foundations of the major bridges;
- testing of any existing sources of ballast and sub ballast materials, to verify their technical properties and to confirm the availability of the required quantities;
- locating, exploring and testing of new potential source areas of said materials, if necessary.

4.2 Safety devices (signalling, block devices, and CTC)

In terms of safety and signalling devices, the line includes the following types and a brief description of which it is re ported below:

- Stations with electric relay devices;
- Sections with Automatic Block Line Systems;
- Automatic Level Crossings without half-barriers;
- Centralised dispatching control system.

Electric Relay Interlocking Installations(ERII)

These installations establish the entrance and exit routes by selecting and locking the points in the corresponding position for the required route, locking the route, permanent checking through the track circuits if the insulated sections of the route are free or occupied and by giving the free signal for the route.

These systems allow station personnel to operate points and signals via electrical devices from a single central post that contains a command and control desk and where the movement inspector operates.

Basically, the equipment is controlled from this control desk, made of mosaics representing individual outdoor elements, such as signals, points, shunting signals, track circuits etc.

These devices can be also remotely controlled and supervised from a central place (CTC) and can be unmanned.

The train route is set by simultaneously pressing the signal button and the destination button which is usually located on the track to which an entry route, for instance, is to be set.

The device automatically checks the condition of track circuits and operates points to appropriate positions by electrical points mechanisms which work with 220Vdc,250 W motors.

It also ensures flank protection, i.e. prevents crossing from the side, and a protective route in the length of 100 m behind the exit signal in case the driver could not stop the train at the prescribed distance.

At the end of this process the train route is “blocked” and the respective signal is set to clear.

All signals display two or more meaningful signal aspects which means that the signal indicates the aspect of the next signal.

The occupancy control of tracks and points, as mentioned, is carried out by track circuits.

The bridging of rails by a wagon or a locomotive is indicated as the occupancy of the section or point respectively.

The equipment operates according to following principles. The device first finds the train route defined by pressing the start and destination buttons. Then it closes this route, checks the condition of track circuits and sets the points in appropriate positions.

In the next phase it ensures flank protection: for this train runs and protects crossing routes. When checks and points setting are completed, the train route is blocked which means that other settings that could endanger the train route, are prevented.

Following this, the states of the signals are checked and the signal set to clear. The signal aspect is determined with respect to the position of points and the program foreseen.

Since signals display two or more meaning aspects, the signal aspect can be changed either by setting the next signal to clear (exit route from station) or by the situation in automatic block sections.

From the point of view of functional and constructive characteristics, all the interlocking installations are designed and used with components installed in the relay room (relay racks and boxes, control panel, cables distributor and outdoor (signals, point machines, track circuits etc.) and are connected with automatic line block installations existing on the open line.

Special suppliers ensure uninterrupted power utilizing two network and boosting batteries.

In the main stations are as well present diesel generator sets of different sizes.

Automatic Block Line Systems (ABLS) and Cab signaling

ABLS divides the line in block sections which are controlled by track circuits and protected by side light signals, displaying the reading code for speed to the driver.

By means of permissible indications displayed, the train is authorized to advance and occupy the block section protected by respective signal.

This system permits the between stations-spacing of several trains travelling in the same direction.

From the point of view of functional and constructive characteristics, ABLS is conceived with components (signals, track circuits, cabinet for equipment, cables, etc) distributed along the line and interconnected with ERII of the neighbouring stations and with ALC and LSC

Automatic blocking is supplied with continuous type devices of automatic signaling cab whose signals start to be sent in the track circuit before the light signal at the train approaching.

When code automatic blocking is applied on the electrified sites, its track circuits are fed by alternating current.

The line is not electrified and track circuits are fed by a current with frequency of 25Hz.

The current is sent into track circuits as a combination of pulses which contain the information about signal light aspects that the driver is going to see.

The automatic cab signalling can be integrated by a self- braking device with an equipment for checking the vigilance of the driver and for controlling the train speed. The checking of the driver's vigilance is made at the approaching of the train to the closed light signal; the automatic vigilance starts from the instant the engineman's indicator changes from green to yellow signal to the instant the driver gives the confirmation by pressing an acknowledging contact.

Furthermore, in the case of running with yellow signal (in excess of a fixed speed), and also with yellow/red signal or red signal on the engineman's indicator, periodic check of vigilance each 30-40 sec comes into effect.

In all cases if the acknowledging contact will not be pressed in the due time, the train automatically stops by means of a self- braking device before reaching the next closed light signal.

The train automatically stops in the following signalling aspects:

- When approaching a red signal at a speed exceeding 20km/h
- When approaching a yellow/red signal at a speed exceeding 60-70km/h.

Automatic Level Crossings (ALC) without barriers

These installations achieve the interdiction of the road traffic at the approaching of the train with a suitable time before the train arrives at the level crossing.

After the train passes, the interdicting signalization is automatically cancelled and the level crossing is again opened for road traffic.

The track circuits of the relay interlocking system (ERI I) and ABLS installations achieve the control of the train approaching to the level crossing depending on the level crossing position.

ALC installation are operated depending on ERI I installations which restrict the railway traffic in case the first installations are out of order or are not available.

ALC installations could be operated without any local agent; their operating conditions can be remotely signalled on the train dispatcher command and control panel of the ERI I in station.

On Kungrad- Beyneu line the main protection systems for level crossing are protection only by road side Saint Andrew crosses and ALC without barriers.

In the case the level crossing is located along the line the automated system is fully independent of station signals. Road side, crossing is protected by traffic lights. The station only receives alarm signals from the system .

If any level crossing is located within stations the protection system may be activated by the local interlocking through the control of an itinerary and is automatically deactivated once the train has passed and the relevant track circuit is cleared. The operation of the system is connected with station signals. Both home and departure signals indicate clear if the system efficient, meaning the road signals are on and the control system is normally operating.

A summary of the actual level crossing location is given in Table 0 of Annex III.

Local operators referred to this Consultant that level crossing protected with Saint Andrew cross present irrelevant road traffic.

Centralised dispatching control system.

The line is equipped with a centralised dispatching control system "Neva" type.

The central place for Uzbek section is located in Tashkent and is a Dialogue system; the central place of the Kazakh section is located in Atyrau. The stations of Kungrad, Jaslyk, Karakalpakija and Beyneu have only local method of operations that means the local movement operator has the responsibility of all it happens between home signals; the central dispatcher send only an electric signal of agreement in order to clear the departure signals. Central dispatcher can see from the central place the state of occupancy of the stabling track circuits and the signals aspects of the station but cannot operate on them.

The other stations of the line have two method of operation: local (that means central dispatcher excluded from operations) or fully controlled from the Center (local operator excluded from operations): the change from one method to the other is determined by turning a key on the local panel.

4.2.1 Safety and signaling systems ages

In the Section Uzbek border-Beyneu (from km 953+500 to km 1033+579) the signalling and safety systems were installed or transformed as follow:

Year 1972: interlockings systems of

- Oazis,
- Akjigit,
- Kzyl-Asker,
- Kok-Bekty,
- Beyneu.

During the **years 1996 and 1997** the activation of a CTC system from Tashkent, with the Dialog system in the central place, took place.

In 2002 the area controlled from Tashkent was limited to the last Uzbek station before the border (Karakalpakia) and the Oasis-Beyneu section went under the control of the central place of Aktyrau (Kazakhstan).

As supplement to the above data follows an overview of the stations and service points with regard to safety devices.

4.2.2 Overview of the stations and the sidings

The section Kazakh border (km 953+500) to Beyneu (1033+579) is characterized by the presence of:

- all relay interlocking systems in the stations,
- automatic block system in line,
- Centralized Traffic control from Atyrau.

The stations and the relevant distances are the following.

Oazis (km 954+970)

The station has 4 centralised tracks.

It is equipped with an Electric Relay Interlocking which control 5 points.

The system interfaces with Oazis- Akjigit ABLS section which has 12 block sections in Beyneu direction.

The interlocking is fed by an uninterruptible power system without diesel generator.

Akjigit (km 979+521)

The station has 4 centralised tracks.

It is equipped with an Electric Relay Interlocking which control 5 points.

The system interfaces with Akjigit- Kzyl-Asker ABLS section which has 11 block sections in Beyneu direction.

The interlocking is fed by an uninterruptible power system without diesel generator

Kzyl-Asker (km 1003+638)

The station has 4 centralised tracks.

It is equipped with an Electric Relay Interlocking which control 5 points.

The system interfaces with Kzyl-Asker - Kok-Bekty ABLS section which has 10 block sections in Beyneu direction.

The interlocking is fed by an uninterruptible power system without diesel generator.

Kok-Bekty (km 1023+161)

The station has 4 centralised tracks.

It is equipped with an Electric Relay Interlocking which control 5 points.

The system interfaces with Kok-Bekty - Beyneu ABLS section which has 10 block sections in Beyneu direction.

The interlocking is fed by an uninterruptible power system without diesel generator.

Beyneu (km 1033+579)

The station has 13 centralised tracks.

It is equipped with an Electric Relay Interlocking which control more than 50 points.

Beyneu is connected north side with a line to Makat and west side with a line to Aktau.

Both lines are equipped by automatic block system.

The interlocking of the station is fed by an continuity power group with 10kva diesel generator.

Finally it is possible to summarise the present main characteristics of the signalling and safety devices with the Table A of Annex III referred to stations and with Table B of Annex III concerning line systems.

4.3 Telecommunications

4.3.1 Description of the present telecommunication situation of the line

In the following a synthetic description of the telecommunications equipment of the line Uzbek border - Beyneu is provided. A graphic description of the present telecommunication situation of the line is presented in Figure 4.3.1-1.

The analogue transmission system along the railway line use aerial links.

The steel/bimetal aerial link is of the following technical type: V-12-3 and V-3-3.

All the stations are equipped with manual commutation of stations and line sections telephone service, for operation and maintenance activities. The following types of commutators are installed: KASS – 6 and KASS – DU.

Telecom switch (analogue PABX) is installed only in the station of Beyneu and it has the following technical characteristic:

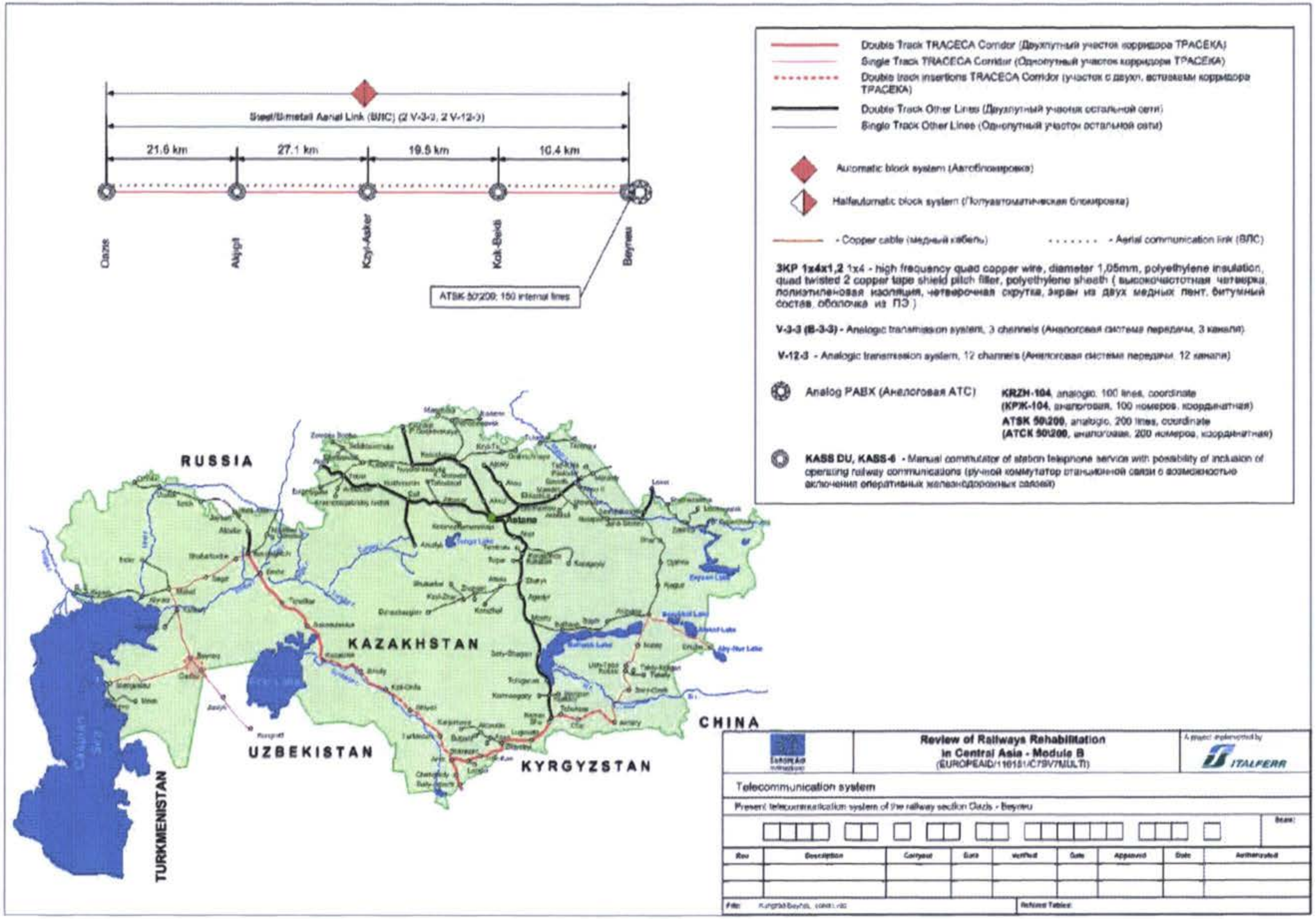
- ATSK-5000; 150 internal lines.

The following equipment for loud speaking communication is present: TU – 50, TU – 100, TU – 600, RUS.

The equipment for train to station radio communication presently installed is IZ RTS, 71 RTS.

Most of the equipment is very old, aged about 30 years, since it dates from the firs years of 70s when the line was built.

Figure 4.3.1-1 - Present telecommunication system of the railway section Oazis - Beyneu



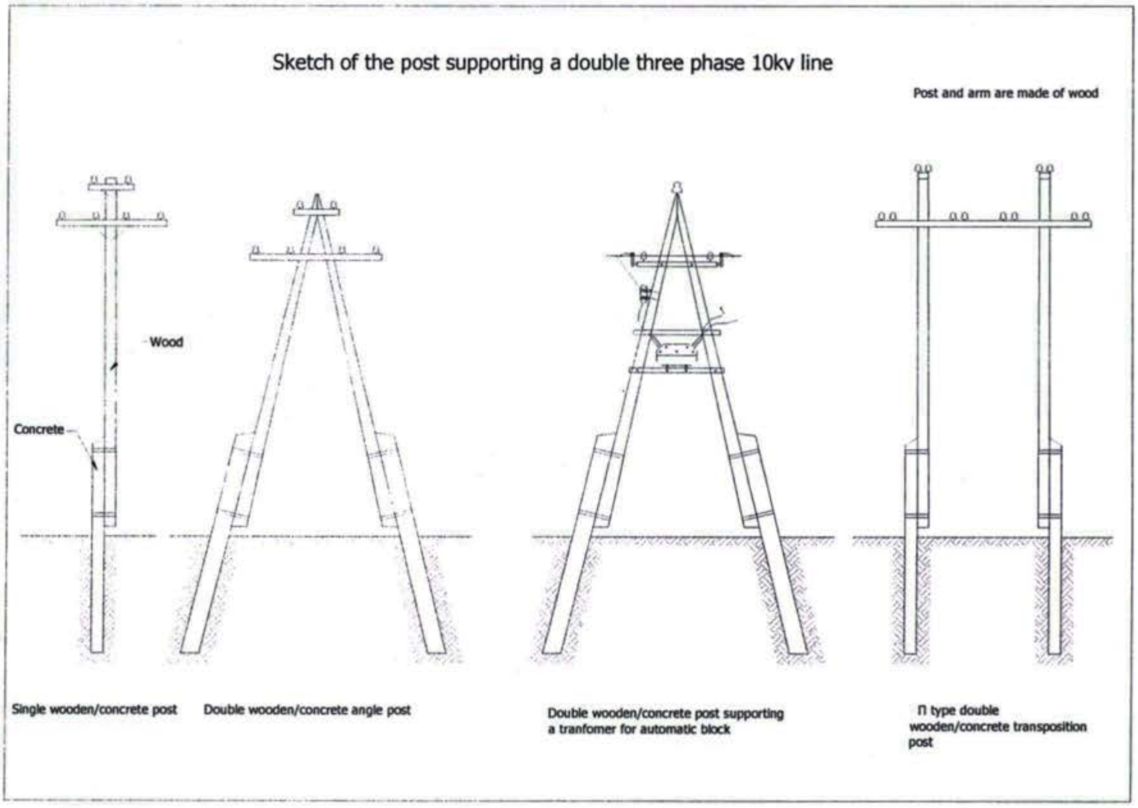
4.4 Power supply system

4.4.1 Description

The electric power supply system of border-Beyneu section is basically carried out by means of two medium voltage lines installed on the same wooden posts from the border to Beyneu; they operate at 6/10 kV and the first feeds exclusively the Automatic Block boxes along the section, while the second one feeds all the station facilities and plants (safety plants, lighting, pumps etc.).

The double line is old and obsolete. Typical posts are drawn in Fig. 4.4.1 – 1.

Fig. 4.4.1 – 1 Typical posts



The described 10 kV / 6kV system is disconnected at the border and fed by the high voltage national system in Beyneu through single three phase overhead lines at a voltage of 10 kV. Moreover the lines are sectioned in Akijit. The protection is implemented with VMG 50 circuit breakers, controlled by PP 67 relays.

The scheme of connections is indicated in Fig. 4.4.1 – 2 and Fig. 4.4.1 – 3.

The total load supplied to users by the system is about 100 kW for A.B., 100 kW for the lighting of stations, plus the power for buildings and houses, residential areas.

In all the stations there is one diesel generator for reserving an electric power supply

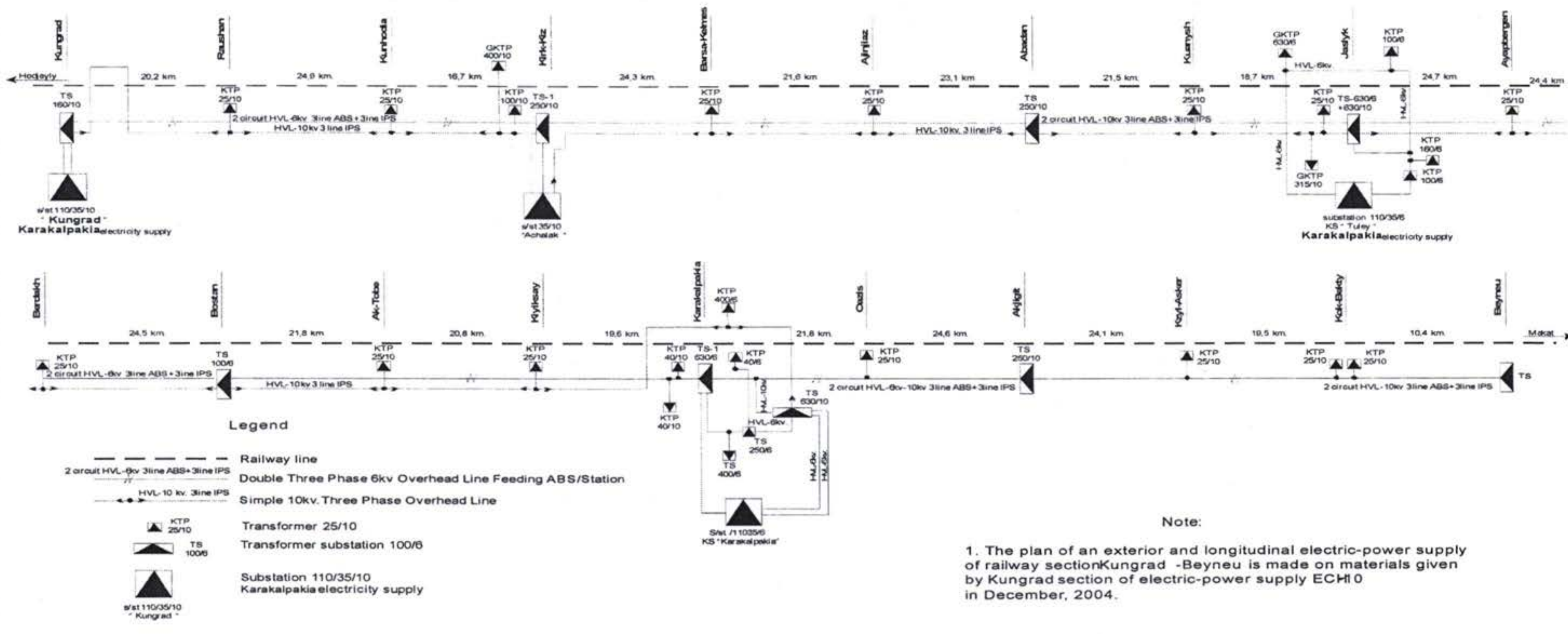
4.4.2 Defects

As above said, lines are obsolete. The area is windy and the soil polluted with salt.

Both cause frequent short circuits and interruption of the power supply continuity.

The operational voltage of the three phase line feeding the A.B. was lowered to 6 kV as provisional measure to reduce the failures, but the coexistence of 10 kV and 6 kV systems does not seem to be the best solution.

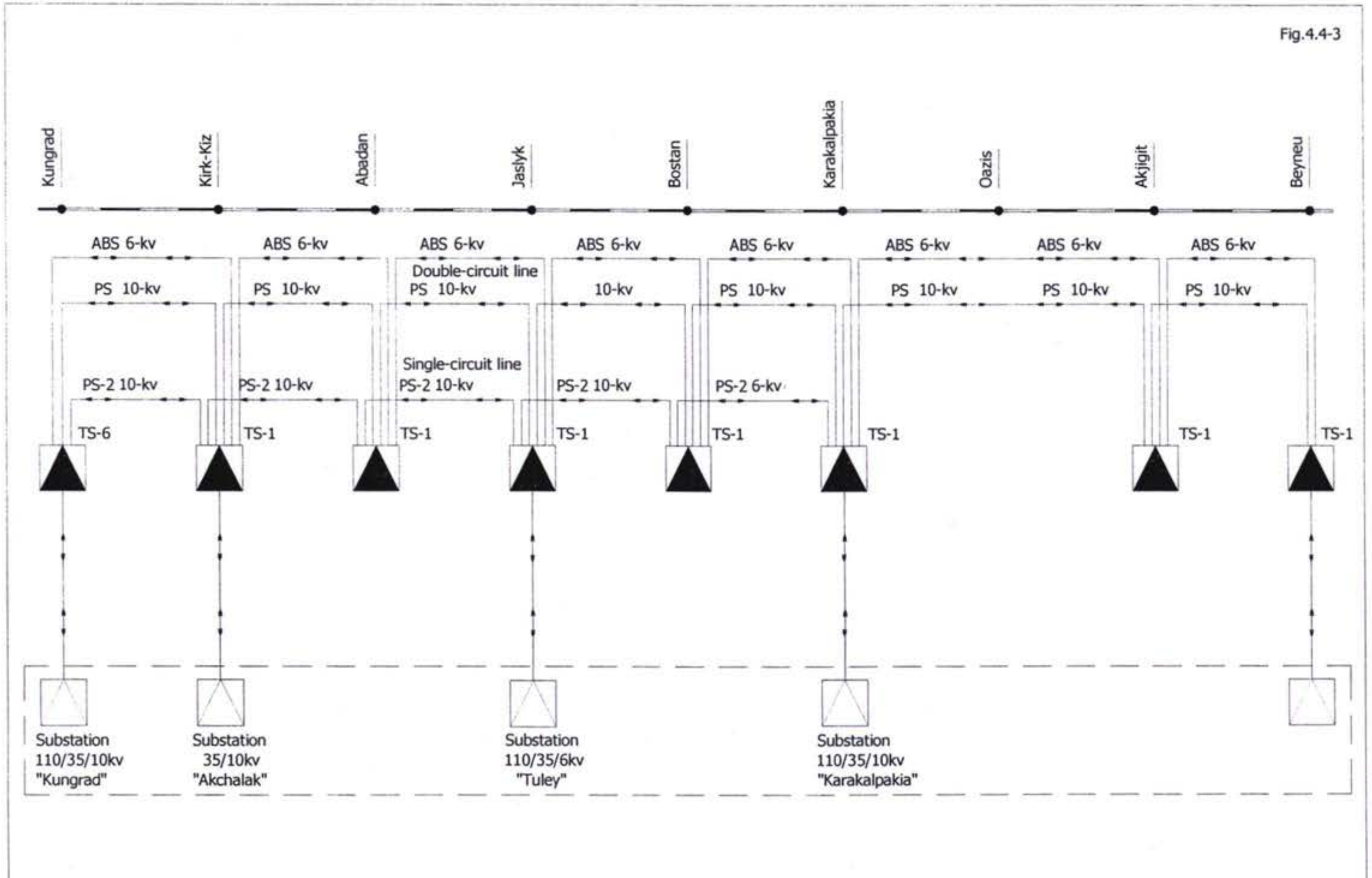
Fig. 4.4.1 - 2 Kungrad –Beyneu line. Power Supply Scheme – 10kv/6kv System



Summary of installed equipment (transformers of model OM)					
On the section Beyneu - border (Oazis)					
HVL-6kv.ABS	HVL-10kv.IPS	HVL-6kv.ABS	HVL-10kv.IPS	HVL-6kv.ABS	HVL-10kv.IPS
OM-0,66	OM-0,66	OM-1,25	OM-1,25	KTPO-4/6	KTPO-4/10
137	150	83	124	6	11
Section border (Oazis)-Beyneu					
41	3	11	3		5

Kungrad - Karakalpakia (Uzbekistan) Line
Power Supply Scheme - 10kv/6kv System

Fig. 4.4.1 – 3 Power line 6/10 kv of auto block system and power utility. Scheme of feeding



Power line 6/10kv of auto block system and power utility. Schem of feeding

4.5 Operation, speeds and running times

The line is currently operated both with freight and passenger trains.

Current number of trains on the line is largely inferior to line capacity, because of the mentioned situation about traffic (see traffic chapter).

Line capacity

Line capacity in terms of number of trains per day has been estimated in the current infrastructure conditions by this Consultant, by applying the international formula of Fiche UIC 405.

According to this formula, line capacity is strictly depending on the following factors:

- Number of tracks (in this case one);
- Longest section length (longest section in terms of running time, generally the worst mix of length and acclivity); in this case the existing section between the stations of Akjigit and Kzyl Asker being 24,1 km long;
- Trains speed on this section (in this case 80 km/h as maximum speed);
- Distance between two following main signals (such as, for example, the distance between the starting signal and the home signal of the following station in case the section of line is composed only by a single block section) [D]; in this case this distance has been assumed as 1,7 km;
- Train length [te], in this case 700 m;
- headway between two trains (both for crossing trains and following trains, including the time for setting the routes within the station) [tm]; the headway must be assumed as the necessary lost time between two consecutive trains operated in the same station (for example, the minimum time between the departure of one train and the arrival of a second train in case of following trains). Headway is mainly depending on the signalling and communication system used in the station and along the line for train distance, in this calculation analysis 1min has been assumed, according to the modern system of signalisation adopted by the rail line;
- distance between distant and main signal [d]; in this case 1,7 km (three aspects signals);
- visibility distance of the distant signal [l];

Line capacity has been calculated with the following formula:

$$P = \frac{T}{t_{fm} + t_r + t_{zu}}$$

Where:

- "T" is the total operating time per day (20 hours for this line),
- "tr" is 0.67 * tfm,
- "tzu" is 0.25 * number of sections,
- "tfm" is calculated with the following formula,

$$t_{fm} = \frac{D}{V} + \frac{l+d+te}{V} + t_m$$

Where:

- "D" is the distance between two following main signals,
- "V" is the average speed of the section calculated according to the running simulations of the typical freight,
- "l" is the visibility distance of the signal,
- "d" is the distance between distant and main signal,
- "te" is the train length,
- "tm" is the lost operating time between two consecutive trains into the same station

Results of the mentioned calculation show that current capacity of the line is very high in case of traffic homogeneous direction, being the line equipped with short bi-directional block sections, while the line capacity heavily decreases for traffic made by all crossing trains (one train upward, one downward):

C (100% crossing trains) = 33 trains/day

C (80% crossing trains) = 57 trains/day.

Line speed restrictions

Conditions of permanent way elements and bridges cause the necessity to reduce the maximum allowed speed on the lines. Generally this measure is taken when:

- profile and alignment are far from the original designed ones, thus implying high vibrations increasing with the speed,
- the ballast layer is highly polluted (stations main tracks),
- the sleepers are no more in reliable condition for mechanical wear, decay and cracking,
- turnouts are obsolete and their elements worn out (in particular blades and crossings),
- existing embankment section is greatly reduced by wind or rain water erosion,
- structures do not assure the necessary bearing capacity.

In the case of the Border-Beyneu line section, slight reductions of maximum speeds were imposed along all its length with the result that today the line is operated at less than its possibilities in terms of line operations, speeds and transportation capacity (trains by day).

From the original 100-120 km/h speed for passenger trains and 80 km/h speed for freight trains, the maximum allowed speeds are, for the time being, the following (see Table 4.1.1 – 4):

Table 4.5 - 1

Current speed on the Border-Beyneu line		
Stretches between stations	**Length** (km)	**Maximum speed allowed** (km/h)
Oasis - Akjigit	21.55	70
Akjigit-Kzyl Asker	27.12	80
Kzyl Asker-Kok Bekty	19.52	80
Kok Bekty – Beyneu	10.42	70

In the section Kok Bekty – Beyneu, line speed is reduced because of the three mentioned bridges conditions.

Existing and future line speed profile is shown in Annex IV "Options Schemes".

Current running times

These speeds restrictions lead to the following running times on the line from Beyneu to the Border:

- *Passenger train with few stops: 1h 15"*
- *Freight trains with few stops: 1h 40"*

Time savings due to basic works will be calculated in the following chapters.

5. Rehabilitation options

5.1 General

The existing situation of the considered section has to be examined in the frame of a general crisis that involves the railway system. The freight railway national traffic decreased of about two third in 90s, as it was widely commented in the Module A - Final Report, while is slowly increasing again in the last years. The reasons can be found in the economical situation as well as in the competition of other modalities of transport.

The lines that are object of this study are to be considered in this frame, and they are as well as the other ones involved in the perverse cycle that links strictly reduction of traffic, reduction of revenues, reduction of expenses, reduction of maintenance, degrade of the system.

In particular, the line section under study (Border-Beyneu) belongs to the Karakalpakia railway line going from Kungrad to Beyneu and must be analysed in this general context. Compared with the current situation of the section in Uzbekistan, the Kazakh section is to be considered in acceptable conditions for being the PW recently renewed and welded and the traffic speed near to the line limit.

The rehabilitation study carried out for this line section has therefore envisaged largely minor basic works (if compared with the Kungrad-Border section), works limited to the re-alignment and levelling of the existing PW, cleaning of the ballast section in particular into stations (where it is highly polluted), replacing the permanent way in one station only (together with 2 turnouts) and replacing the existing safety systems and the power supply line for automatic block and for stations. Moreover, the feasibility study analyses from both technical and economical points of view the construction of a telecom net, as done for the Uzbek section.

The objective of the interventions suggested in the Option Basic Works is not only to recover the original characteristics, but also to obtain higher levels of safety, speed and reliability of the infrastructure, that must be considered as a present and future transportation axis for all the area.

Such option will be not considered within the economic analysis because of the extent of interventions considered and since it is expected that Kazakh Railways will be carrying out such minor works in the general frame of the maintenance of the line. This is also in line with what has been requested by the Beneficiary.

Notwithstanding that, the Consultant has carried out an estimation of the costs necessary for the interventions and the related benefits. As far as costs are concerned, the Consultant has developed the analysis as the rehabilitation would be performed by a Contractor: this could be not the case if interventions of part of them will be carried out by personnel internal to the railways.

On the contrary the feasibility study was considering the Option Telecom Works for both technical and economical aspects including the calculation of the indicators of economic and financial performance.

The interventions envisaged for the improvement of the Border-Beyneu line have been studied and selected in order this line section to be set at homogeneous technical characteristics with the Uzbek section.

Specific technical aims of the improvement are:

- increasing traffic speed both for passenger and freight trains,

- increasing traffic safety in terms of accident (or their probability) reduction,
- increasing general service level offered by the infrastructure to the running trains, in terms of travel quality, speed, vibration and noise,
- increasing line capacity in terms of trains per day (depending on the traffic flow directions, on signalling and telecommunication devices, on stations maximum distance).

In terms of costs, the proposed interventions have been focused on the following targets:

- reducing maintenance costs (for rolling stock and infrastructure),
- reducing operation costs (rolling stock and operation personnel) consequent to travel time reduction and new safety devices installation,
- reducing accidents (or their probability) costs, in particular by the adoption of the new safety systems,
- recycling residual material of the replaced permanent way, by using them on secondary lines of the network or on sidings and branches with low traffic.

Construction cost for the proposed option have been estimated, as well as maintenance cost reduction.

Under the point of view of Safety Devices, based on the results of the investigations of the technical installations and on several interviews of officials and technicians of Kazakh Railways, Italferr experts did not foresee any type works to be carried out in order to restore operations safety at levels which cannot be renounced. Of course equipment which will be out of order because of the age should be replaced and in a perspective of relevant traffic increase the needs of this section consist in the renewal of existing safety devices located in line and in the stations and specifically:

- the renewal of the Relay Interlocking Installations (all more than 30 years aged) by the activation of other devices relay operated but of last generation;

- the activation of renewed Automatic Block Line Systems (ABLS) and Cab signalling;

- the insertion of the new devices into existing Central Post (P.C.) of Atyrau which already controls present old equipment

In general, the intervention suggested have been developed with the aim of producing the best effects with the minor investment on the infrastructure.

The general proposed works can be seen as a speed up of the capital maintenance, carried out on those parts of the line currently suffering for long and continuous lack of adequate maintenance.

5.2 Objectives of the rehabilitation

The Investment Component involves performing what is essentially a speeded-up capital repair of the entire Kungrad-Beyneu line, split into two sections:

- Kungrad-border (in Uzbekistan) – 326,6 km long and 15 stations.
- border-Beyneu (in Kazakhstan) – 81,0 km long and 5 stations.

The whole line has been studied as a unique transport corridor and with homogeneous technical parameters, as it is correct under an interoperable point of view, that is one of the major tasks of this study. Anyway, since the line belongs to two different Countries and railway Authorities and the two sections had different levels of maintenance, in order to assess costs and benefits for the two different sections, two separated studies have been carried out.

The main objectives of the proposed rehabilitation works, common to both the line sections and to both Countries, can be resumed as follows:

- Increasing train speed both for freight and for passenger trains. Higher speed along the entire line or some sections will reflect in total travel time reductions (time savings), reflecting in travel cost savings in terms of rolling stock cost and in terms of operation and personnel cost. In fact, not only the time saving will reflect in passenger time cost reduction (extremely low in this area), but it will reflect in rolling stock cost saving, due to the possibility of reducing the train cycle along the whole network to which this line belongs. Hourly costs for the typical passenger and freight trains are calculated, their value is multiplied by the total amount of time saving per travel, by the total number of trains per year, and this will allow to estimate the total yearly cost saving due to travel time reduction. It is clear that, in order to take advantage of the benefits so created, the line operation must be modified in order to take into consideration the major speeds and therefore line timetable will be modified after the completion of the proposed rehabilitation works.

- Reducing infrastructure maintenance needs along the rehabilitated sections of the line, for "lifting", "medium" and "capital" maintenance. In particular, due to the rules currently applied by the Railway Administration, "capital" maintenance will result highly reduced, this sensitively allowing to reduce maintenance costs. For each Option, infrastructure maintenance cost savings have been estimated, taking into consideration "materials", "machines" and "man-work" costs.

- Increasing travel safety along the line and into the stations, in terms of accident reduction. Anyway, this item is almost insensitive because implicitly hidden into the first mentioned benefit (travel speed increase). In fact, it is possible to say that since safety is the most important aspect for each railway administration, this parameter is practically constant, slightly depending on the maintenance status of the railway infrastructure. In fact, maintenance lacks are generally reflecting into speed restrictions, imposed by the administration for keeping a constant and acceptable safety status on the line.

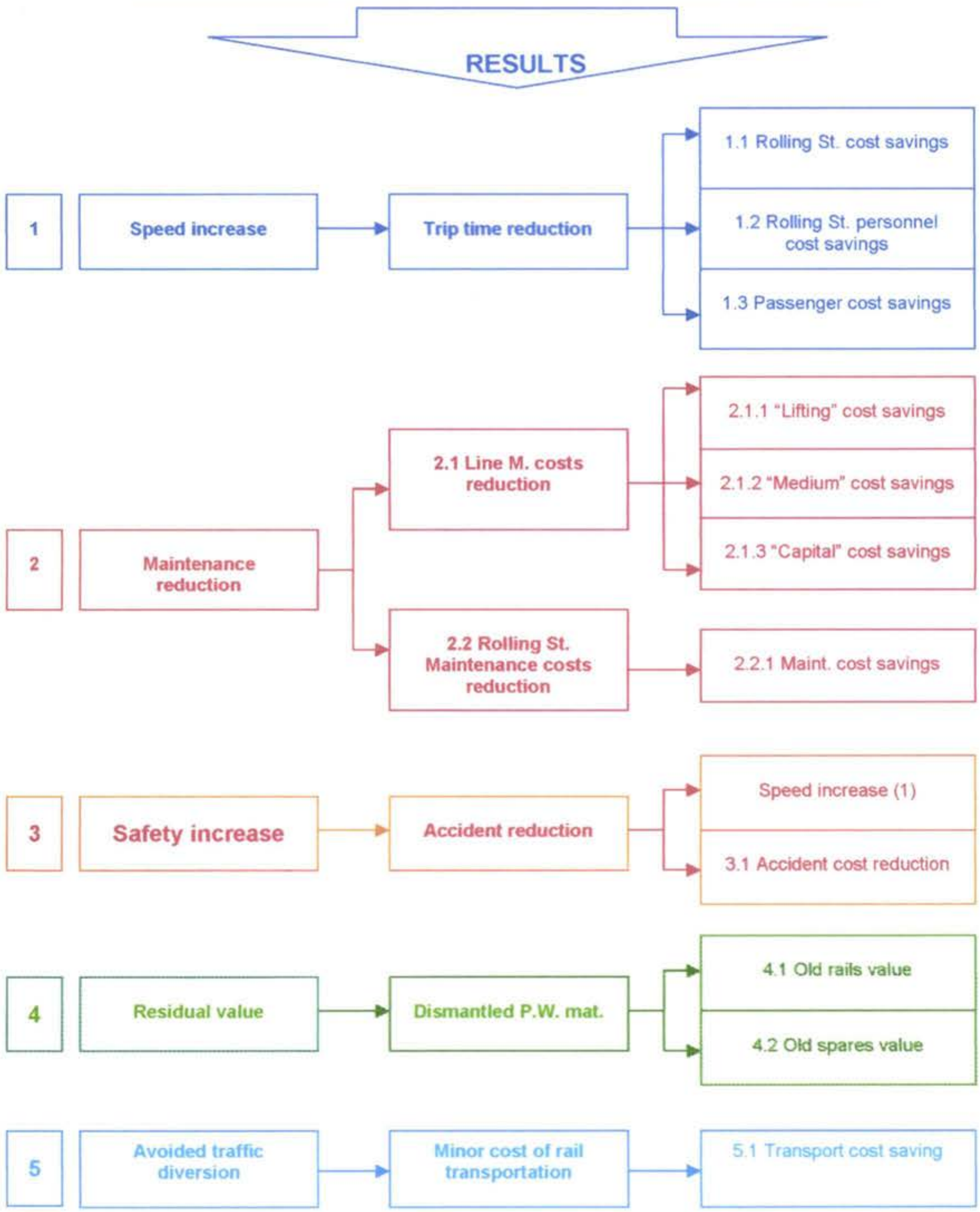
- Residual value of the replaced dismantled permanent way. Old permanent way, constituted by P50 type rails on mixed wooden/concrete sleepers, will be dismantled and possibly re-used or directly sold, at the residual value which is depending on the average age and preservation status of this material. In particular rails, iron parts as bolts, fastening devices, will be taken into consideration, while for sleepers, only those made of concrete can be considered for their residual value. Residual value of ballast, sub-ballast where existing and earths will not be considered because their re-use has been already taken into consideration within the works to be carried out on the considered sections.

- Avoided traffic diversion. In this case, for the short term period, traffic diversion on the road is impossible, because the road is currently not existing. In the future, when the road will be completed, traffic diversion from the railway will be a sure effect. Dimensions of this effect will depend on the current status of the road and of the railway, on their service level and on transportation cost. It is possible to assume that rehabilitation works on the railway will help to reduce traffic diversion in the near future when the road construction will be completed. Comparison will be made between the two scenarios "with project" and "without project".

Resuming the positive effects of the rehabilitation (benefits):

Rehabilitation works:

- permanent way replacement earthworks
- drainage devices works
- signalling and telecommunication systems replacement or improvement
- level crossing works
- stations works
- re-alignment works

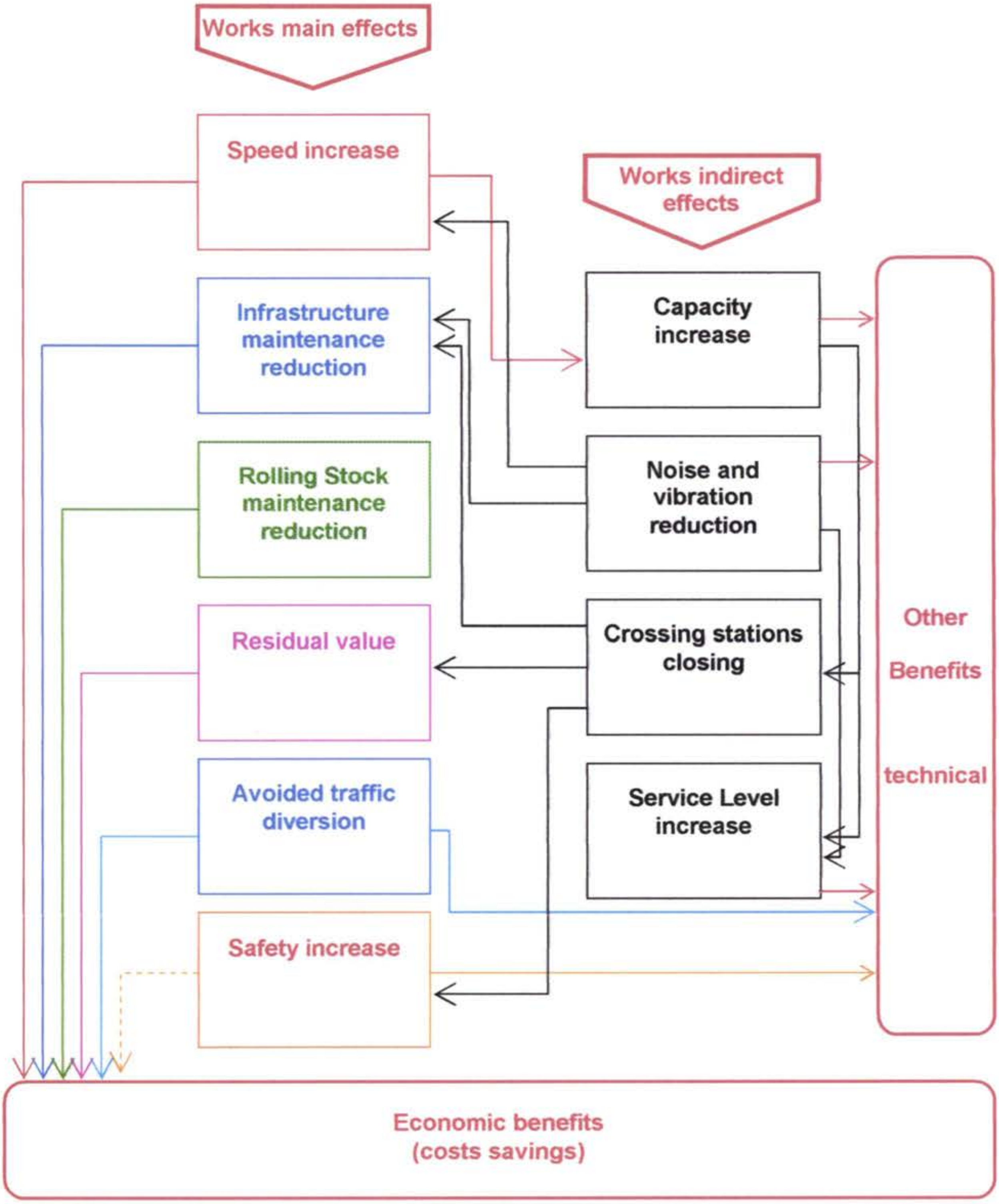


Moreover, in addition to the before mentioned aspects, there are some other potential results to be taken into consideration in this analysis. In fact, following the rehabilitation works, the line will offer an increased Service Level (S.L.), both to the users and to the surrounding areas:

- Line capacity increase. See the above paragraph 4.5 " *Line Capacity*" for the existing capacity of the line. In the case of line rehabilitation, capacity itself will be positively influenced by the speed increase generated by the envisaged works. A further contribution to line capacity increase will be also given by the adoption of new updated signalling system for both line and stations. The detailed analysis of line capacity will be carried out in the chapter *"Performance improvements"*.

- Station number reduction. Present and forecast traffic on this line does not seem to require a huge line capacity increase, therefore it is possible to assume that capacity increase can be compensated by the closure of non necessary crossing stations, by keeping the line capacity at constant value. In order to clarify this item, it is obvious to show that the same capacity can be offered by a single track line section with D=15,0 km ("D" is the distance between two consecutive stations) and a single track line section with double D (30 km), corresponding to the closure of the intermediate station, if the line speed is increased from 45 km/h to 80 km/h. In the case of the line under study, the presence of more block sections between two stations (on average 1,7 km long) allows to increase line capacity only in case of homogeneous traffic direction in different periods of the day. Moreover, the presence of more block sections, further increases the effects of the speed increase, in terms of capacity. In fact, with 70% of homogeneous direction traffic, with the presence of 1,7 km long block sections, the line capacity increases to 62 trains/day (for average speed 45 km/h and D=15km). The same capacity value, can be offered with the closure of the intermediate station (D=30km/h) in case of V= 75 km/h.

  Pointless to say that in case of station number reduction, positive effects would reflect on operation and maintenance cost. Moreover, rehabilitation works will be less costly, for the elimination of sidings, station technologies and switches.


Works main effects
Speed increase
Infrastructure maintenance reduction
Rolling Stock maintenance reduction
Residual value
Avoided traffic diversion
Safety increase
Works indirect effects
Capacity increase
Noise and vibration reduction
Crossing stations closing
Service Level increase
Other Benefits
technical
Economic benefits (costs savings)

For the solutions proposed for the Signalling System, the suggestion aimed at improving equipment availability and reducing the cost of traffic control and maintenance of the safety devices.

The general policy of the Kazakh Railways is to adopt computer aided interlocking technology but the suggestion is to consider that the adoption of such devices should be limited in the peripherals places every time there is the presence of extreme environmental condition (simultaneous presence of very high temperature excursions, presence of salt, sand, high difficulty to reach the equipments, absence of near villages etc), because of the present inadequate knowledge of their behaviour in such conditions.

Additionally to that the utilisation of other types of automatic block systems is not recommended by this Consultant even if they have been taken into consideration and evaluated.

In fact a different type of automatic block as axels counter automatic block is cheaper and suitable for present and middle term traffic but its adoption would mean a worsening:

- in the safety (no cab signal and no self-braking devices),
- in the capacity of the lines,
- possibly rail disconnections would not be detected and
- in all probability also RAM conditions (Reliability, Availability and Maintenance) of the whole trains spacing system will suffer a worsening.

On the contrary the coded circuits automatic block system has been widely checked as regards reliability, availability and maintenance also in the extreme environmental conditions present in these lines.

Furthermore several block sections, if coupled with a planned circulation in a single direction for certain period of the day, will allow to ensure present line capacity for future needs.

The adoption of the envisaged measures and the consequent increase of the RAM conditions of the interlockings and the block system will allow the unmanning of the smaller stations (that have no need of shunting).

5.3 Works Typologies

The envisaged works for line and station improvement have been thought in order to answer to the mentioned targets in a progressive way and with increasing investment costs.

In particular the categories in which the whole rehabilitation works can be divided are:

1. Infrastructure:
    a. Civil works concerning earthworks and drainages;
    b. Permanent way replacing works (only for one station, there including replacement of turnouts and replacement of blades and crosses for those to be re-used on siding tracks);
    c. Existing permanent way rail welding and tension regulation (the largest part of the PW is already welded, only a short section of 3,3 km is missing);
    d. Re-alignment, levelling and ballast cleaning on the existing sections;
    e. Civil works concerning bridges beams replacement;
    f. Civil works concerning bridges abutments and piers restructuring;
    g. Civil works concerning station buildings and station platforms;

   h. Civil works concerning re-pavement of some level crossings (L.C.). In terms of L.C. their elimination has not been envisaged for the low traffic both on the railway line and on the interfered roads (mainly unpaved roads).
2. Power supply systems: new double three-phase overhead 10kV line for supporting electrical needs of signaling and ancillary services of stations and line.
3. Safety devices:
   a. Renewal of station interlocking systems;
   b. Renewal of line traffic control and train spacing systems (signaling, block devices, etc.);
   c. Remote commanding and controlling of the line and stations (CTC).
4. Telecommunications.

All the works above described, with the only exception of the 1.e), f) ones, are not urgent and could be coordinated with the execution of the similar activities on the Uzbek section, that is within three or four years. Most of them could be implemented with the existing maintenance personnel, while, in the meantime, some provisional inexpensive measures can be taken into consideration.

5.3.1 Infrastructure and power supply system

In details the following Table 5.3.1-1 contains the description of the works typologies identified by the Consultant for points 1. and 2. Infrastructure and Power Supply system, as they have been considered in the Bill of Quantities.

Table 5.3.1 – 1 Description of works typologies for infrastructure and power supply systems

INFRASTRUCTURE AND POWER SUPPLY WORKS FOR LINE AND STATIONS REHABILITATION		
	A. WORKS	DESCRIPTION
1A	Topographic survey of the line and corrections of the existing alignment and profile.	Topographic survey to be carried out along the line, for a strip of 50+50m around the existing railway axis, production of the current status cartografy, and detailed correction of the alignment and profile of the line. New plan profile in scale 1:1,000 and current cross sections of the line in scale 1:200-1:100 step 50 m will be produced, indicating the existing and future geometrical parameters of the line.
2A	Demolition of line.	It consists in dismantling the existing worn out permanent way (rails, junctions, sleepers and fastenings), transportation of the materials to the deposit sites, dividing them into old and re-usable materials (residual value). This operation will be presumably carried out according to the methodology developed in this area: after having manually eliminated the fish-plated junctions of the rails, the dismantling train will pass over the free track panels, and its tail equipped with a dismantling crane will dismantle the track panels and automatically transport them into the front platform wagons.

3A	Excavation.	After having dismantled the permanent way, escavation of about 50-60 cm of topping material of the embankment by means of machine (buldozer with front showel). Generally, during this process, old polluted ballast and old polluted sub-ballast (sandy gravel) are discharged on embankment side for their future re-use. In case this work takes place into stations, the removed top material will be transported to dump. This item also include the further compaction of the top layer of the embankment for increasing hits bearing capacity and for re-shaping the embankment roof.
4A	Partial lateral rebuilding embankment section, placing and compacting the removed top material for widening the top surface of about 1,0 m.	This item will be applied only on those sections where the existing embankment is found to be eroded and not copliant with the typical cross section. In many cases in fact, ballast is falling on the embankment side for the embankment is reduced in transversal dimensions due to the water and wind erosion of hits slopes, not protected by means of grassing. For this item, material will be taken from the side material demolished in Item 3A for those sections where 3A took place, while for the other sections material will be transported or taken from the surrounding environment after tests. In order to widen the embankment side, the existing eroded side will be shaped in steps, and the additional earth will be added in layers of max 20-30cm in order to compact it by means of manual vibro-compacting machine.
5A	Implementation of a layer of sandy gravel material, 0,2 m thick under sleepers (sub-ballast).	After the item 4A, on the compacted top layer of the embankment the new layer of sandy gravel (sub-ballast) will be laid and compacted in the correct shape, according to typical cross section.
6A	Construction of line.	After the item 5A, the new track will be built (sleepers, fastenings and rails), by laying it on the sub-ballast layer. This procedure will be presumably carried out with the system used in this area, described in detail in the Figure on the next page. This system is based on the use of construction train, similar to the dismantling train, with opposed operations. Tail locomotive of this train will push the front laying crane against the section to be built, and the crane will lay track panels, casted outside of the field, on the sub-ballast layer. Provisional junctions will be installed and the construction train will run on the just installed panels. Construction of the line can also be carried out with other methods, as for example that envisaging the use of long welded rail to be laid on the two sides of the existing permanent way and the transportation of the sleepers only on the construction train. This second method allows to avoid the big number of weldings to be done on field and allows to transport on field sleepers and long rails separately. The first train transporting long rails would also run during line operation, laying the new rails on the two sides, the second train would dismantle the existing permanent way, cleaning and re-laying the sub-ballast, laying the sleepers (tranported by hits wagons) at the correct distance and it would finally install the lateral new rails on the sleepers, with fastenings. In the next pages the two envisaged construction methodologies will be described with schematic drawings. The item 6A also includes first layers ballast spreading, tamping and lifting of rails up to 3 cm to final level.
7A	Flash-butt or thermic weld of P65 rail.	Welding of the panels by means of flash-butt or thermic system. Welding of the rails will have to be done according to strict technical specifications, that will be detailed in the next phase of the study.

8A	Regulation of mechanical tension of long welded rails (l.w.r.).	After the rail welding, mechanical tensions will be regulated, according to strict technical specifications, that will be detailed in the next phase of the study.
9A	Final tamping and leveling of new line.	The permanent way, so welded and regulated, will be in this phase taken to hits final level and alignment by means of final tamping and leveling.
10A	Ballast cleaning on the other existing sections.	On some of the sections where existing permanent way is preserved, ballast cleaning will be carried out. Ballast cleaning concerns the existing section ballast cleaning and re-shaping, with some addition of new ballast where necessary. It can be carried out by means of automatic machines or by handwork.
11A	Tamping, leveling and aligning the other existing sections with l.w.r.	All over the sections where existing permanent way is preserved, tamping, leveling and aligning will be carried out for reaching the final alignment.
12A	Substitution of culverts concrete pipes.	For some culverts, the worn out pipes will be dismantled and repalced with new ones. The operation needs line interruption, permanent way dismantling, embankment cutting, structural works and embankment and permanent way reconstruction. On average, each culvert is 12m long (embankment between 1 and 2m high).
13A	Excavation of ditches.	Hydraulic drainages must be cleaned and embankment side ditches must be excavated when absent, in order to protect the embankment side from water infiltration and foot erosion. In general, no concrete cover is requested for the ditches. Trapezoid ditch 0.5-0.5-0.5 has a volume of 0,5m3/m.
14A	Pavement of level crossings.	This item concerns the reconstruction of the pavement of the level crossings for the area of railway crossing only. It has been estimated that each level crossing envisages an area of about 50m by 10m.
15A	Passenger stations: platforms new.	Dismantling and reconstruction of passenger platforms into stations. During the reconstruction of the platform, also drainage works for the running track will be carried out.
16A	Passenger stations: platforms restyling.	Existing platforms restyling.
17A	Passenger stations: building restyling.	Station building restyling.
18A	Replacing switch crossings.	For the preserved turnouts or for the turnouts to be re-used on siding tracks, where the existing conditions of crossings are not acceptable (consumed), the crossings will be replaced with new ones.
19A	Replacing switch blades.	For the preserved turnouts or for the turnouts to be re-used on siding tracks, where the existing conditions of blades are not acceptable (consumed), the blades will be replaced with new ones.
20A	Replacing (or installation) of switch small tg(complete).	It includes dismantling of existing old turnouts and construction of new turnouts.
21A	Construction of new double threephase overhead 10kV line.	It includes foundation works for the new reinforced concrete posts (50m distance), posts installation, posts equipments, cables laying and their tensioning. Finally it includes electrical connections to the sources and clients.

Points 2A, 6A and 9A correspond to general Capital Maintenance carried out by the Railway Administration. They in fact include dismantling of the P.W., compacting the sub-layers, laying the new P.W. panels, and adding the necessary quantity of ballast for tamping and leveling till the final requested level.

5.3.2 Telecommunications

The Consultant has been explicitly requested by the Kazakh Railways to carry out a complete feasibility study only for aspects concerning telecommunication along the line.

The Consultant has recently developed for the European Commission the TACIS/TRACECA project Central Asia Railways Telecommunications (2002-2003). Outputs of that project were the Central Asia Railways Telecommunications and Signalling Master Plan and 8 Feasibility Studies for the modernisation of railways telecommunication systems. The present telecommunication project is consequently in accordance with the indications and recommendations of the mentioned Master Plan and the adopted methodology and the proposed technical solutions are derived by the Central Asia Railways Telecommunications Project.

Particularly, two Feasibility Studies were developed for Kazakhstan in the Central Asia Railways Telecommunications Project and one of them is for the railway line Kandagach – Makat – Beyneu – Aktau. The present Oazis – Beyneu section has been therefore studied as a branch of the mentioned main line and a compatible technology has been proposed.

Services to be guarantee

The telecommunication services to be guaranteed in the strictly railway context can be grouped into the following categories:

- *Signalling telecommunications* (train spacing and protection). The role of this type of telecommunications is to transmit information regarding the status of the signalling field elements such as: signal condition, track circuit clear, points setting, etc. This information serves to space and protect trains in circulation; therefore they must be securely transmitted. In and around stations, the flow of information from track to signal boxes and vice versa utilises a local cable network. For full line section information can travel from track to station as well as from station to station.

- *Operating telecommunications* (traffic and energy command and control). The term "Railway operating telecommunications" covers all telecommunications directly connected with train circulation other than signalling information, like for example: railway operations and electric line control; control over various line elements (for example, level crossings); dedicated station to station lines; lines dedicated to maintenance; shunting radio; ground to train radio; etc.

- *Applications telecommunications* (management information system, invoicing, ticketing, etc.). In terms of global development of computer applications, the railway sector has also experienced a significant increase of requirements for high-speed data transmission systems, and an equally significant increase in the demand for high quality and secure connections. The network to design must therefore respond to these needs by guaranteeing adequate transmission capacity.

The role of these services affects the choice of the type of telecommunications system to adopt, with particular reference to the type of cabling.

Naturally, other functions have to be considered as well, such as: short and long distance automatic telephone services; data transmission; radio communications; public services.

Definition of needs of the telecommunication system

The increase in the demand for ever higher volumes of information and transmission speed has been such an incentive for technological development as to lead, especially in the case of telecommunications, to the replacement of perfectly functioning systems with others of the latest generation with lower investment and maintenance costs. This type of replacement intervention had never been before part of the railway logic. Now it has, however, become a standard of new trends in the sector. Multi-service networks, for services companies, are coming to the fore as a strategic medium: all the various types of communication (data, voice and video) being channelled along the same transmission medium.

The multi-service networks that have to meet these requirements have, also, to respond to the following major criteria:

- use of a multi-hierarchical level architecture, based on the most recent technology adopted in Western Europe;
- secure transmission;
- open and flexible structure to facilitate extension and upgrading;
- management systems compatible with local and long distance operability;
- the capacity to interface with all types of terminals;
- an adequate number of spare channels to implement advanced level services, considering also the future expansion of the demand in communications;
- and the possibility of marketing residual capacity.

To meet these basic requisites it is essential to consider the adoption of digital technology as an inevitable fact, because it permits cost reductions for both constructors and users, as well as increased performance.

Among the many existing transmission technologies, the most respondent ones to the explained needs could be based on the utilisation of copper cable or optic fibre cable.

For the same transmission capacity the sheer dimensions of copper cables compared to optic fibre is a point in favour of fibre optics cable, because it allows smaller ducting as well as junctions and terminals. Also, the adoption of optic fibre cable, together with PCM (Pulse Code Modulation) technology transmission systems, allows a great number of channels with high quality transmission characteristics, because the system, using optic fibre transported light impulses, is practically immune to the electromagnetic interference normally induced in copper cables and even more so in aerial lines. Moreover, optic fibre is a dielectric component and therefore not subject to breakdown due to lightning strikes or other sources of overload by contact with overhead traction power lines (if present). There are no drawbacks in using fibre optics for railway operating and telecommunications applications. Local copper cable networks are only necessary for certain signalling telecommunication services and for short distance and limited bandwidth communications.

The technical/economic comparison between aerial and buried cable leads to the conclusion that the recommended solution for railway applications should be that of a cable buried in a High Density Polyethylene (HDPE) conduit for the high degree of protection this offers, coupled with advantages in terms of functional reliability, operational costs, ease of maintenance and cable life span.

Network availability and flexibility

Availability is one of the indicators that measures quality of service and refers to the probability that a certain system, operating in a given environment, is available at a certain time.

Redundancy is used to increase network availability. Fundamentally, redundancy for SDH networks can be obtained with a ring-shaped structure achieved by connecting the extremities of the transmission system together, which permits access to the apparatus from two different directions.

The flexibility of the network refers to its attitude toward low cost modification to respond to the requirements of changing demand.

For this purpose, modular structure is required, especially for transmission equipment, and, if necessary, for increased transmission capacity simply by adding other modules.

Importance of standard protocol

It has to be stressed the importance of using systems based on standard protocols. Although a solution based on proprietary protocol can be valid from the technical point of view and can be competitive from the financial side, it will have strong implications for the future steps too.

Telecommunications works as a system; which means that to talk about railways telecommunications generally doesn't mean to talk about a single railway line you are considering, but of the telecommunications system needed for the operation of that line. Consequently during the technical evaluation of the possible solution also the following aspects have to be considered in discarding "proprietary protocols based-solutions":

- there will be no fair competition in the tenders once a proprietary protocol will be starting colonising the area;
- additional costs will be born for allowing different part of the network (with different protocols) to talk each other, providing that this is possible;
- maintenance and future provisions of spare parts can't take the advantage of economy scale (with different systems in place) but mainly will be in the hands of the protocol owner with uncontrollable consequences on the costs.

5.3.3 Safety devices

The Option Basic Works envisages the following works typologies:

1. renewal of the Relay Interlocking Installations by the activation of other devices relay operated but more moderns;
2. activation of renewed Automatic Block Line Systems (ABLS) and Cab signalling;
3. insertion of the new devices into existing Central Posts (P.C.) of Atyrau.

The locations of works are:

1. Renewal relay interlockings systems in:
    - Oazis,
    - Akjigit,
    - Kzyl-Asker,
    - Kok-Bekty.

2. Renewal of Automatic Block Line Systems (ABLS) and Cab signalling in the following sections:
   - Karakalpakia- Oazis,
   - Oazis- Akjigit,
   - Akjigit- Kzyl-Asker,
   - Kzyl-Asker - Kok-Bekty,
   - Kok-Bekty – Beyneu.

3. Insertion of new devices into the existing Central Post of CTC in Atyrau.

5.4 OPTION "BASIC WORKS"

5.4.1 General description

The Option "Basic Works" consists in a list of suggested interventions to be performed during maintenance operation by the Kazakh Railways for which costs and benefits have been separately assessed. Such Option will be not considered within the economic/financial analysis and consequently is not a real option of the feasibility study.

Option Basic Works consists mainly in the realignment (tamping and levelling) of the existing railway line between the border and Beyneu, including the rehabilitation of the stations (sleepers replacement in Akjigit station only, ballast cleaning for all the station main tracks, construction of drainage ditches, buildings and passenger services), construction of a new double three-phase 10 kV overhead line. Works for 3 bridges rehabilitation and for safety devices have been also included.

Option Basic Works includes in detail:

- replacement of 14 beams (5.5 m span) and rehabilitation of 10 elevations (abutments and piers),
- construction of a new 10 kV power supply line for station services and signalling system all along the line,
- new Station Interlocking System (S.I.S.), renewal of Automatic Line Block System (A.L.B.S.) and CTC control.

As above said in paragraph 5.3 all these works are not urgent and could be coordinated with the execution of the similar activities on the Uzbek section, that is, within three or four years. Most of them could be implemented with the existing maintenance personnel, while, in the meantime, some provisional inexpensive measures can be taken into consideration.

In the following paragraph the description of the works can be found.

A scheme of the works to be performed along the line is attached in Annex IV "Options schemes".

5.4.2 Works

Infrastructure

With the implementation of Option Basic Works, every line section (stations included) currently equipped with P65 welded rails (all) will be re-aligned and re-levelled. Akjigit station main line, will be equipped with concrete sleepers, continuous welded rails (cwr). Line sections without c.w.r. will be welded in long bars and drainage ditches will be built along stations main tracks. On stations main tracks, ballast cleaning, ballast addition and tamping will be carried out. In some line sections, where the embankment lost its original shape, earthworks are envisaged for reshaping it.

Other works have been foreseen for station buildings and platforms restyling.

- renewal of 4 platforms: length 100m, width 3m,
- restyling of 1 platform: length 200m, width 3m,
- restyling of 2 stations 120 m^2 each, plus Beyneu (300 m^2),
- replacing 2 P50 turnouts

Earthworks

- Partial lateral rebuilding embankment section for 20 km, placing and compacting the removed top material for widening the top surface of about 1,0 m.

Drainages and structures

- Excavation of drainage ditches in line for about 15 km,
- Excavation of drainages and laying of drainage pipes along the stations main track for about 10 km,
- replacement of 14 beams of 3 bridges (5.5 m span),
- rehabilitation of 10 elevations of the same 3 bridges (abutments and piers).

Safety devices

1. Renewal of the Relay Interlocking Installations by the activation of other devices relay operated but more moderns;
2. activation of renewed Automatic Block Line Systems (ABLS) and Cab signalling;
3. insertion of the new devices into existing Central Posts (P.C.) of Atyrau.

For locations of works, see paragraph 5.3.2 "Safety Devices".

Power supply system

In the Consultant opinion the power supply system needs a new double three-phase 10 kV overhead line, or, better but more expensive, two single three-phase 10 kV line, conveniently protected and sectionable.

5.4.3 Performances improvements

Option Basic Works has been thought in order to recover original line parameters and in some cases to upgrade them. For example in terms of stability of the earthworks, of protection of railway body from water and other erosion factors, of increasing bearing capacity of the line structures and for assuring long life to the elements composing the infrastructure. In particular, drainages works into the stations will preserve main track PW from flooding and ballast pollution in the future, assuring a better bearing capacity to the running track. Moreover the adoption of a new power supply overhead 10 kV line for electrical feedings and the safety devices proposed by Option Basic Works will allow to improve technological service of the line, in strict connection with what has been proposed for the neighbouring section in Uzbekistan.

Option Basic Works takes to the following performances improvements:

1. Line speed is recovered to its original values:
    a. Max speed into stations 110 km/h for passenger trains, 80 for freight trains.
    b. Max speed on line sections 110 km/h for passenger trains, 80 for freight trains.
2. Line capacity in terms of trains per day will be increased from the current minimum value of 33 trains per day, to the minimum value of **38 trains per day** (increasing with the percentage of homogeneous direction traffic).
3. Line maintenance costs will be largely reduced for the following main reasons:
    a. Capital maintenance (the most expensive) in the years following the rehabilitation will be absent.
    b. Medium maintenance in the years following the rehabilitation will be largely reduced.
    c. Lifting maintenance will be reduced.
    d. Number of spare parts to be used for each maintenance cycle will be reduced.
    e. The last wooden sleepers in Akjigit station will be replaced by concrete ones, having much longer life and assuring a better loads transfer to the ballast, there helping to reduce ballast friction and pollution.
4. Elimination or sensitive reduction of rail joints (C.W.R. will be adopted also on the remaining 3.3 km) will contribute to reduce maintenance.
5. CWR implementation limits traffic vibrations, dynamic forces at minimum values, reflects more comfortable travel conditions for passengers, reduces impact on the environment, fuel consumption and maintenance needs both for line and for rolling stock.

In addition, the recommended investments for Safety Devices are aimed at improving equipment availability and reducing the cost of traffic control and maintenance of the safety devices.

The adoption of the envisaged measures and the consequent increase of the RAM conditions of the interlocking and the block system will allow the unmanning of the smaller stations (that have no need of shunting movements). Benefits from the adoption of the new safety devices are shown in the next chapter.

For maintenance needs and costs reduction, see chapter "Benefits assessment".

For residual value of the replaced materials, see chapter "Benefits assessment".

One of the main effects of the rehabilitation works will be traffic safety increase, but this parameter, as previously stated, is strictly correlated with line speed. Therefore this Consultant assumed no benefits will be assessed for traffic safety, while the majority of the benefits will be derived from time savings due to speed increase.

For the calculation of the time savings occurring with the rehabilitation works, passenger and freight typical trains have been simulated on the existing line and on the renewed line, according to the following simulation inputs:

Table 5.4.3 – 1 Speeds for passenger trains "with" and "without project"

Rehabilitation of the line Kungrad - Beyneu Speeds for passenger trains with and without the project - Kazakh section			
Passenger Speeds	**section**	**speed**	
Vmax line without project	all except the following	70	km/h
Vmax line without project	976,9-1021,9	80	km/h
Vmax line with project	all	110	km/h
Vmax station without project	Akjigit	50	km/h
Vmax stations without project	all	70	
Vmax station with project	all	110	km/h

Table 5.4.3 – 2 Speeds for freight trains "with" and "without project"

Rehabilitation of the line Kungrad - Beyneu Speeds for freight trains with and without the project - Kazakh section			
Freight Speeds	**section**	**speed**	
Vmax line without project	all except the following	70	km/h
Vmax line without project	976,9-1021,9	80	km/h
Vmax line with project	all	80	km/h
Vmax station without project	Akjigit	50	km/h
Vmax station without project	all	70	km/h
Vmax station with project	all	80	km/h

The results are shown on Table 5.4.3-3.

Table 5.4.3 – 3 Calculation of time savings for passenger and freight trains

Rehabilitation of the line Kungrad - Beyneu Trip time and time savings - Kazakh section					
Scenarios		**Passenger trains**		**Freight trains**	
		existing time (h)	BASIC WORKS option time (h)	existing time (h)	BASIC WORKS optio time (h)
Tot time no stop	(h)	**1.08**	**0.73**	**1.08**	**1.00**
	(min)	64.72	43.81	64.72	60.24
Time savings without stops	(h)		**0.35**		**0.07**
	(min)		20.91		4.48
Additional time for each stop	(min)	2.53	3.17	15.96	16.35
Total travel time with 2 stops	(h)	**1.16**	**0.84**	**1.61**	**1.55**
	(min)	69.78	50.14	96.65	92.94
Time savings with 2 stops	**(h)**		**0.33**		**0.06**
in Kazakhstan section	**(min)**		**19.64**		**3.71**

Time savings are very small for freight trains - in case of 2 stops along the journey, just less than 4 minutes, while they are sensitive for passenger trains: about 20 minutes.

5.5 OPTION "TELECOM WORKS"

5.5.1 General description

The present option has been explicitly requested by the Kazakh Railways to be of their interest. It has been consequently treated separately from the rest. According to what has been explained in the previous chapter, this is the only option considered within the economic/financial analysis.

Option Telecom Works is the installation of a new telecommunication system based on digital technology and on the adoption of optic fibre cable together with PCM (Pulse Code Modulation) technology transmission systems.

The adoption of the following system is proposed:

- *STM1 (155 Mbps) + E1 (2 Mbps) - using a SDH (Synchronous Digital Hierarchy) based system for the primary backbone complemented by PDH (Plesyocronous Digital Hierarchy) based system for the secondary backbone.*

A scheme of the works to be performed along the line is attached in Annex IV "Options schemes".

5.5.2 Works

The Consultant has developed a parallel Feasibility Study for the railway section Kungrad – Kazakh border in Uzbekistan for the rehabilitation of the entire line Kungrad – Beyneu. The technical solution studied for the Oazis – Beyneu section is therefore the very same solution designed for the section in Uzbekistan and they can be seen as two parts of the same project.

The following telecommunication system, suitable for low traffic lines, is proposed and has been evaluated for the Oazis - Beyneu line:

- STM1 (155 Mbps) + E1 (2 Mbps) - using a SDH (Synchronous Digital Hierarchy) based system for the primary backbone complemented by PDH (Plesyocronous Digital Hierarchy) based system for the secondary backbone.

The system is based on two level network solution, with a first level of backbone assured by SDH 155.52 Mbps technology and a secondary provided by PDH technology with multiplexer of 2 Mbps capacity.

The highest backbone of the system is a ring structure using STM1 (155 Mbps) for the transport between the Add/Drop Multiplexers (ADM1) at the higher order station (Beyneu,) which is equipped also with PABX.

The secondary backbone uses PDH technology, adopts E1 (2Mbps) for transport and uses PRMs (Primary Rate Multiplexer) for the transmission and for interfacing with higher level.

A scheme of the system proposed for the line Oazis – Beyneu is represented in Figure 5.5.2-1.

The system uses:

- 2 fibres of the optic cable for the functionality of the primary connection
- 2 fibres of the optic cable for the functionality of the secondary connection
- 2 fibres of the optic cable for redundancy reason (closure of the line).

Fibres for the primary and secondary connections are normally in the same cable while fibres for redundancy should be physically located in another cable and in another place.

Since the second cable is needed to ensure the redundancy of the system in case of problems with the first one (a cut of the cable, a card out of order or not functioning properly and consequent need of substitution), this measure allows for safety conditions of trains running along the line. In order to do that, it is "necessary" to maintain the two cables physically separated so to prevent the simultaneous cut of both.

Every cable is supposed to be of the current international standard: <u>at least 32 fibres</u>. Thus the cable's capacity is redundant in respect to the real use for the railways purpose (4 fibres in one cable and 2 fibres in the other one). Because of that and to reduce costs, the two-cable solutions are adopted only when there are no other possibilities, so to reduce costs.

Therefore for the Oazis - Beyneu line, as far as the redundancy is concerned, it has been considered the following two possibilities:

- implement a second cable for the redundancy, or
- renting of channels or a fibre pair from third party.

A preliminary screening of the just mentioned possibilities has excluded the first-one, namely the adoption of a second cable, for costs reasons: major cost vis-à-vis an oversized system composed by two optical fibres cables (the "two-cable solution" is - in so far the total cost of the solution - at least 40 percent to 60 percent more expensive than the alternatives with the "one-cable solution").

Therefore, as a transitory measure, the closure of the ring will be by external link and the suggestion is to use the existing facilities of public Telecom along the railway line. For the closure of the ring 5 links at 2 Mbps are needed.

It has to be remarked that the use of a link external to the railway network could be seen as a transitory measure in the time being up to when long distance transmission will be in operating on the primary railway network (in this case, involving also the Uzbek network, Kandagach – Makat – Beyneu – Miskent – Samarkand – Tashkent – Arys – Kandagach) and consequently the closure of the ring can be actuated directly by the railways.

Taking into consideration optical signals attenuation and distances between higher order stations, additional regenerators of optical signals have been introduced in correspondence of stations every time distances appears to be critical for the efficiency of the transmission.

The suggested solution covers also copper cable transmission for service telephones (those in open line in correspondence to the signals for neighbouring track circuits, additional future needs like remote signals control, interlocking station systems, central control of power supply for the line contact, remote level crossing control).

The adopted standards will simplify the technical arrangement necessary to operate trans-border train services in the border stations of Karakalpakia and Oazis with Uzbek Railways.

As already explained, the whole architecture would require 6 fibres. The cable to be implemented (a 32 optic fibre cable) will be supplying 4 fibres while the other links will be taken externally as explained previously.

Both the primary backbone and the secondary backbone are protected by a ring configuration, thus the system is able to guarantee the proper functioning in consequence of a single failure and allows point-to-point link.

Point-to-multipoint links, the use bandwidth on demand and the automatic re-routing are not allowed by this system, but some of these just mentioned weak points can be later exceeded because the system has the capability of growing with a minimum of changes (adding other devices, such as IP Router in the main station).

The old telecom exchange in Beyneu will be replaced with latest generation automatic electronic exchanges (PABX) of adequate potential, that will include the interfaces with the digital junction lines (conforming to ITU-T standard G.703) in output and a fully automatic system for calls, with the adoption of a new national numbering plan that makes calls between different exchanges possible by forming certain telephone number prefixes.

For each connected number it will be possible to allow or deny national and international calls and automatic connection to the public network. It will also be possible to provide each customer, with adequate apparatus, DTMF or digital telephones and all the services of a modern public telephone system (call notice during a conversation, call back in case of number engaged, call transfer, etc.).

The new exchange will also allow for easy expansion of capacity, foreseeing spaces in the cabinets for inserting user cards without having to add or replace control and switching gear, which must already be adequate at maximum capacity of the exchange model and redundant for greater reliability.

This transmission system is highly suited to replace the service currently provided by telex, now rarely used and with high maintenance costs, especially for the dedicated telegraph exchanges and telex machines themselves.

All stations are also equipped with UPS and PABX is provided with special electric power supply station, sized on the effective needs of the system, and able to be further expanded by incorporating modules. A storage battery will assure the proper functionality of the PABX for at least 8 hours – in case of blackout of power supply. The battery will also assure the functionality of accessory devices (i.e. service terminals) in the case the system is not equipped with devices for memorising failure signals during blackout.

A system for management, supervision, and maintenance of all PCM equipment of the country has to be implemented. Generally, for a country network railways configuration, such a system is organised on two levels: the first level is formed by Element Manager (EM) spread along the lines supervised by the system, while the second one by a Network Manager (NM), consisting of one only equipment. By this system, the possible alarm will be recorded by both the competent EM and the NM. The costs for the PCM management system have not been included in this study, since they were already considered in the Feasibility Study of the railway line Kandagach – Makat – Beyneu – Aktau (Package 2 of the Central Asia Railways Telecommunications Project) and the Oazis – Beyneu section can be considered as a branch of that main line.

The PABX Management System consists in a Domain Management System that allows centralized management of all the PABX of the line by high-level user interfaces. All the functions are realised on the same HW and SW platforms and use the same database to achieve a global management system with a single access point. The system is implemented on PC and will interface with global network management systems (telecom and data), in accordance with the standard SMNP (Simple Network Management Protocol). Again the costs for the PABX Management System have not been included in this study, since they were already estimated and charged in the Feasibility Study of the railway line Kandagach – Makat – Beyneu – Aktau. In accordance with that study, the PABX Management System is based in Makat and from there also the Oazis – Beyneu section can be managed.

The Synchronisation System allows every apparatus to receive the synchronisation signal from both sides. At the ends of every section and every 30-35 apparatus, a SASE (Stand Alone Synchronisation Equipment) has to be installed. The SASE produces a high-quality clock that is used for synchronisation of all the apparatus. With this system, every apparatus will use the Ck coming from one side as prime priority signal and the Ck from the other side as signal with second level of priority. SASE installed in Beyneu, and already planned in the Feasibility Study of the railway line Kandagach – Makat – Beyneu – Aktau will also managed the Oazis – Beyneu section.

Technical specifications for the equipment will be provided separately with the Detailed Design and the Tender Dossier to be presented later in the project.

The Consultant strongly recommends to continue the technical co-operation with Uzbek Railway because of the possible future synergies able to reduce costs form both sides.

Co-operation with public telecom has also to be carried out. The limited resources to be devoted to the renewing of the existing telecom infrastructure suggest a close collaboration between different possible actors in the sector aiming at optimising the resources utilisation.

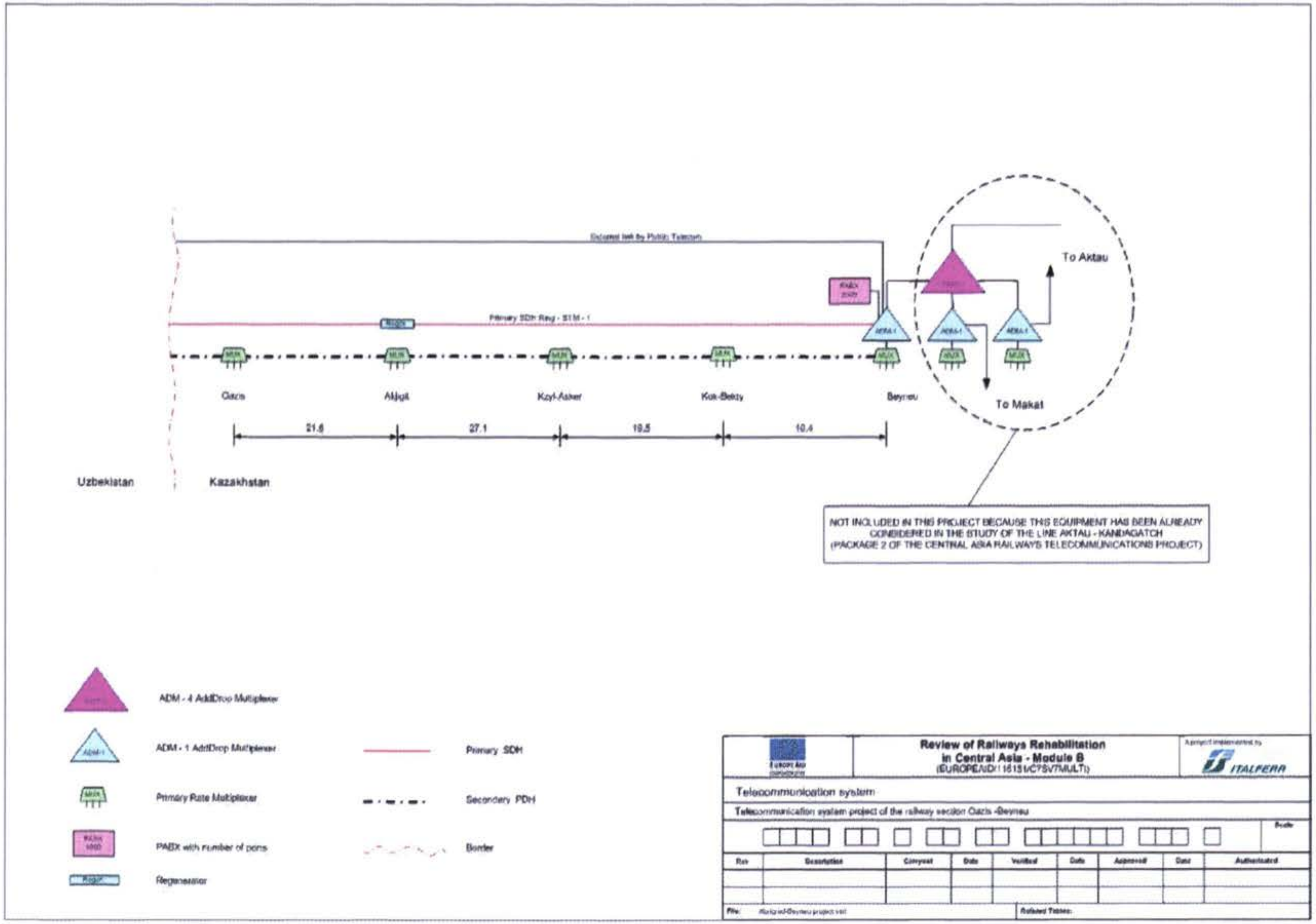
Finally it has to be remarked that the proposed system uses standard protocols, as previously recommended in the basic criteria described in paragraph 5.3.1.

The following table details the number of every specific equipment to be implemented and the quantity of civil works to be performed for allowing the implementation of the system.

Table 5.5.2-1 Telecommunication work items

Feasibility Study Beyneu-Uzbek boredr - Bill of Quantities			
Item	**Q-ty**	**Unit**	**Note**
ADM 4 with installation	0	unit	
ADM 1 with installation	1	unit	
MUX D/I with installation	5	unit	
Regenerators	1	unit	
UPS with installation	5	unit	
PABX 500 with installation	0	unit	
PABX 800 with installation	0	unit	
PABX 1000 with installation	0	unit	
PABX 1500 with installation	0	unit	
PABX 2000 with installation	1	unit	
PABX 2500 with installation	0	unit	
Various item for equipment (frames, cards, etc.)	10%	percentage	percentage of the equipment costs
Stock	10%	percentage	percentage of the equipment costs
PCM management system	0	unit	
PABX management system	0	unit	
Syncronisation system	0	unit	
Fiber Optical Cable	86,46	km	
Other costs for OF cable (junctions, cable ends, tubes, shafts, etc.)	15%	percentage	percentage of the OF Cable costs
Laying of the OF cable	78,6	km	
Copper Cable	86,46	km	
Other costs for Copper cable (junctions, cable ends, tubes, shafts, etc.)	15%	percentage	percentage of Copper Cable costs
Laying of the Copper cable	78,6	km	
Preparation of rooms, big stations	1	unit	
Preparation of rooms, medium stations	0	unit	
Preparation of rooms, small stations	4	unit	

Figure 5.5.2-1 – Telecommunication system project of the railway section Beyneu – Uzbek border



5.5.3 Performances improvements

The adoption of a new functional telecommunication system, will assure:

1. direct benefits deriving from performance improvements in the following domains:
   - telecommunication maintenance and operation cost,
   - traffic management and train delays,
   - revenues from leasing excess capacity to third parties,
   - train operational improvement,
   - energy costs,
   - enterprise management,
   - installation of powerful communications links between railways in the region.
2. indirect benefits are difficult to be quantified and have not been considered in the analytic calculation; anyway they are important and contribute to the evaluation of an economic investment:
   - installation of further set of equipment using standard technologies,
   - creation of the infrastructure required for the installation of more advanced traffic control, operation, maintenance systems,
   - creation of the infrastructure necessary to fit real-time freight tracking systems requested by customers.

5.6 OPTION "DOUBLING"

This Option consists in line doubling and line electrification, besides the minor PW works and new safety plants and telecom system, object of the above described Option Basic Works and Option Telecom Works.

Option "Doubling", has been developed by this Consultant only in order to comply with the Terms of Reference of the Project. Anyway, it is firmly underlined that this Option is not applicable to the current situation of the line under study because of the existing capacity which is in line with existing traffic and its forecasts.

The cost analysis has been detailed in order to reach a reliable figure of investment, as requested by ToR, but the economic and financial study of this Option has not been carried out because the investment costs, the line capacity that would be reached, and electrification are not corresponding to the targets individuated for this line and to the forecast of railway traffic in the next years.

A scheme of the works to be performed along the line is attached in Annex IV "Options schemes".

6. Rehabilitation options costs estimates

6.1 Unit costs for infrastructure works

For the rehabilitation of the Uzbek border – Beyneu line, a detailed cost analysis has been carried out by this Consultant, with the valuable support of the local Sub-Consultant. Costs have been derived from those developed for the Uzbek section, by adapting local manpower costs at the average salary in Kazakhstan (much higher than in Uzbekistan).

The analysis was aimed at detailing all the cost items, including foreign and national expenditures for materials, foreign and national cost for man-power, cost of the machines and expenditures for taxes, duties and Contractor and Client general expenditures.

For the Infrastructure and Power supply, the construction cost is subdivided into the following types of work and expenditures in accordance with the structure of capital investments and the planned schedule of activities of constructing-and-mounting companies (Contractors):

- Materials;
- Construction works;
- Works on mounting of equipment (mounting works);
- Expenditures on equipment, furniture and inventory;
- Miscellaneous expenditures of a contractor;
- Miscellaneous expenditures of a customer.

A Contractor includes in the above cost both direct and concomitant expenditures (factor costs, miscellaneous expenditures, profit, and also funds for payment of taxes, duties and other obligatory payments).

Direct expenditures (including miscellaneous ones) are the expenditures of a contractor to construct a requested object that is labour and material resources, etc.

When calculating a construction cost, the following types of work and expenditures are considered:

1. Materials cost – cost of the necessary building materials, divided in national and foreign costs, according to the production Country;
2. Manpower Construction works – works on construction of buildings, different types of structures, finishing works, installation of external and internal engineering networks, installation of foundation and supporting structures for equipment, preparation a site for construction, etc.;
3. Manpower Mounting works - assembly and installation of devices at the place of their permanent operation (including inspection and individual testing of all kinds of equipment, electric installations, devices, computer engineering, connection of the equipment to engineering networks and other works);
4. Cost of equipment, furniture, inventory – the cost of manufacturing, purchasing and delivery to the warehouse of all sets of equipment, controlling equipment, instruments, punches, spare parts included in the basic funds of production capacity, cost of materials necessary for mounting of equipment, cost of equipment mounting, etc.;
5. Miscellaneous expenditures are the rest of expenditures not included in the factor costs for construction-and-mounting works, including:

- Other industrial expenditures defined for a construction project (a contractor's expenditures);
- For organization of construction works (overhead expenses);
- For construction of temporary buildings;
- For performing works in winter time;

- For long service bonus;
- For additional leave of workers;
- Travelling expenses;
- For transportation of workers up to the building object;
- For relocation of construction-and-mounting organizations;
- For a mobile method of work performance;
- Insurance of construction risks;
- Obligatory payments (taxes), duties in conformity with the local legislation;
- Unforeseen costs and other expenditures for construction of objects.

Besides, the construction cost includes other expenditures of a customer during the construction:

- Allotment of a piece of land for construction of an object and external engineering structures;
- Fixing of points and signs;
- Demolition of structures;
- Bonus for timely and prescheduled commissioning of objects;
- Insurance of building risks;
- For banking services;
- Loan interests;
- Maintenance of a customer's facilities;
- Training of operational staff;
- Design and survey works;
- Survey works;
- Expertise of the design documentation;
- Profit necessary to cover the expenditures of a customer;
- Unforeseen costs.

The cost of the above mentioned expenditures is defined through calculations or through actual expenses of a customer and a contractor.

In the conditions of the market economy being developed in Kazakhstan, the prioritized importance is attached to the method of calculating a construction cost based on the cost of resources. This method of defining a construction cost is a method of calculating expenditures in current prices or forecast prices and tariffs to be incurred during a project implementation.

A construction cost in current prices is defined on the basis of resource estimates developed through the above mentioned resource method with the use of information on actual prices for resources.

The factor cost is determined based on the allocated resources in current prices by types of expenditures:

a) wages including charges on social insurance;
b) maintenance cost of machines and mechanisms;
c) cost of building materials, items and structures including their transportation.

6.1.1 Unit costs for materials

The following table resumes the main unit costs for materials, according to detailed investigation carried out over the Uzbek and Kazakh market, split into "foreign" or "national production.

Costs for materials have been considered the same of Uzbekistan, because the border-Beyneu line section belongs to the main line Kungrad-Beyneu line, and it is believable that materials costs will not be different in the area.

Table 6.1.1 – 1 Main unit costs for materials

Rehabilitation works for Kungrad - Beyneu Line "Main unit costs for materials"				
Material	Unit	Rate ($)	Variation	
Rails	tonne	580.00	+/-20 $	Foreign
Concrete sleepers	each	25.00	+/-4 $	National
Indirect fastenings	couple	25.00	+/-3 $	Foreign
Ballast	m3	5.50	+/-1 $	National
Sub-ballast	m3	2.00	+/-1 $	National
New double three-phase overhead 10kV line	km	12,000.00	+/-10 %	60% For/ 40% Nat
Bridge beams in reinforced concrete (6m span)	each	7,750.00	+/-10 %	National
Total turnout large tangent with concrete sleepers	each	43,000.00	+/-10 %	Foreign
Total turnout small tangent with concrete sleepers	each	52,000.00	+/-10 %	Foreign
Turnout crossing	each	4,000.00	+/-15 %	Foreign
Turnout blades	pair	15,600.00	+/-15 %	Foreign
Rail joint	each	25.00	+/-4 $	Foreign
Insulated joint	each	34.00	+/-4 $	Foreign

Sources: Boshtransloyiha, Consultant's estimate.

6.1.2 Unit costs for machines

The following table resumes the main unit costs for machines averagely used for similar rehabilitation works for railways.

Table 6.1.2 – 1 Main unit costs for machines

Rehabilitation works for Kungrad - Beyneu Line "Main unit costs for machines"			
	Machine	*Unit*	*$*
1.	MOTORGRADERSE (MAINTAINERS) OF MEAN (AVERAGE) TYPE 99 [135] KWT [Л.С]	MACH/HOUR	8.27
2.	BULLDOZER AT WORK ON OTHER TYPES OF CONSTRUCTION: 79 [108] KWT [Л.С]	MACH/HOUR	11.63
3.	BULLDOZER AT WRK ON OTHER TYPES OF CONSRUCTION: 96 [130] KWT [Л.С]	MACH/HOUR	11.63
4.	TROLLEY OF WIDE GAUGE WITH CRANE 3,5 T	MACH/HOUR	17.69
5.	GANTRIES OVERHANGING FOR WORKS ON ASSEMBLAGE BASES, 10 T	MACH/HOUR	2.02
6.	CRANES ON RAILWAY MOTION 16 T	MACH/HOUR	8.27
7.	STACKING (LAYING) CRANES FOR RAIL UNITS 25 M ON WOODEN SLEEPERS	MACH/HOUR	67.71
8.	STACKING CRANES FOR RAIL UNITS 25 M ON CONCRETE SLEEPERS	MACH/HOUR	67.71

9.	MACHINES FOR BALLASTING OF RAILWAY TRAIL ON CONCRETE SLEEPERS	MACH/HOUR	37.24
10.	MACHINES FOR TAMPING WITH PNEUMATIC TAMPING PICK (CUTTING)	MACH/HOUR	12.16
11.	LINERS	MACH/HOUR	3.11
12.	MOTOR PLATFORMS FOR TRACKLAYER	MACH/HOUR	37.58
13.	PLATFORM OF WIDE GAUGE WITH ROLLER CONVEYER	MACH/HOUR	2.41
14.	PLATFORMS OF WIDE GAUGE 71 T	MACH/HOUR	2.41
15.	SELF-PROPELLED TRACK LIFT	MACH/HOUR	6.11
16.	DIESEL LOCOMOTIVES OF WIDE GAUGE SHUNTING 883 [1200] Kwt [Л.С]	MACH/HOUR	59.47
17.	DIESEL LOCOMOTIVES OF WIDE GAUGE 294 [400] KWT [Л.С]	MACH/HOUR	59.47
18.	SINGLE BUCKET DIESEL EXCAVATOR ON CATERPILLAR AT WORK ON OTHER TYPES OF CONSTRUCTION: 0,4 M3	MACH/HOUR	14.06

These figures are referred to Railway Administration (R.A.) owned machines. It is therefore assumed that the Contactor will make use of these machines, by renting them from the R.A. or will use its own machines at similar current costs.

Anyway, for the work typology considered in the frame of the line rehabilitation, this Consultant estimates that the cost of machines is between 6 and 10% of the materials cost.

6.1.3 Unit costs for local manpower

It is assumed by this Consultant that the works to be carried out for the line rehabilitation will be carried out by local manpower with the exception of field engineers and works coordinators, whose costs will be considered apart.

It is estimated therefore that the Contractor will make use of local workers and the average salaries and wages have been derived from those of railway employees in the country to which the line belongs (Kazakhstan).

The following table 6.1.3-2 resumes the main unit costs for local manpower, per work item, according to the bill of quantities adopted for Options evaluation and based on average worker cost data, shown in table 6.1.3-1

Table 6.1.3 – 1 Average worker cost data

Rehabilitation works for Kungrad - Beyneu Line - border-Beyneu section *"Average worker cost data"*		
Average annual salary of builders in the region counting on 1 month, defined from statistical data for previous 12 months	253.8	$/ month
Average monthly fund of working time in hours as of data of the Ministry of Labor and Social Protection of population of the Republic of Kazakhstan	168	hour
Coefficient of account of the amount of deduction for social insurance (Kcc)	1.48	coeff.
Net local manpower cost per hour	1.511	$/hour
Total local manpower cost per hour	2.236	$/hour

Table 6.1.3 – 2 Main unit costs for local manpower

Rehabilitation works for Kungrad - Beyneu Line Border-Beyneu section *"Main unit costs for local manpower"*			
	Work Items	Unit	US$
2A	Demolition of line	km	975.61
3A	Excavation	m^3	0.37
4A	Partial lateral rebuilding embankment section placing and compacting the removed top material for widening the top surface of about 1,0 m	m^3	0.49
5A	Implementation of a layer of sandy gravel material, 0,2 m thick under sleepers (sub-ballast)	m^3	0.07
6A	Construction of line	m	2.15
7A	Flash-butt or thermic weld of P65 rail	unit	4.00
8A	Regulation of mechanical tension of long welded rails (l.w.r.)	km	300.00
9A	Final tamping and leveling of line	km	316.41
10A	Ballast cleaning on the other existing sections	km	116.62
11A	Tamping, leveling and aligning the existing sections with l.w.r.	km	316.41
12A	Substitution of concrete pipes of 20 culverts	n	200.00
13A	Excavation of ditches	m	2.00
14A	Pavement of level crossings	unit	400.00
15A	Passenger stations: platforms new	m2	24.00
16A	Passenger stations: platforms restyling	m2	16.00
17A	Passenger stations: building restyling	m2	120.00
18A	Replacing switch crossings	unit	166.88
19A	Replacing switch blades	unit	166.88
20A	Replacing of switch small tg (complete)	unit	333.76
21A	Construction of new pipe culverts (extension of the existing) for line doubling	each	520.00
22A	Construction of new bridges for line doubling (6m span)	each	6,000.00

6.1.4 Cost calculation flow

The following Table 6.1.4-1 resumes the main factors for calculation of the total cost amounts.

Table 6.1.4 – 1 Main factors for cost amounts calculation

Rehabilitation works for Kungrad - Beyneu Line "Main factors for cost amounts calculation"		
Expenses for operation of machines and mechanisms (Сэм)	5-10%	of materials cost
Transport expenditures for materials	6	%
Transport expenditures for constructions	6	%
Risk coefficient	1.15	coeff.
Other expenses and cost of contractor	20	%
Other expenses and costs of the client	9	%
Expenses for insurance of construction objects	0.4	%

Other expenses and costs of the contractor include:

- profit;
- administrative costs of the company;
- fix costs for the company;
- other general expenses.

The value of 20% has been recovered among average values of similar works in Kazakhstan.

Other expenses and costs of the client include:

- tendering costs;
- administrative costs of the company;
- fix costs for the company;
- other general expenses.

The value of 9% has been recovered among average values of similar works in Kazakhstan.

The following table resumes the cost calculation flow.

Table 6.1.4 - 2 Project cost calculation flow

Rehabilitation works for Kungrad - Beyneu Line "Project cost calculation flow"		
Item	**Article of expenses**	**Calculation method**
1	Expenses for construction materials (including 6% for transport)	from the construction materials list
	including: imported materials produced in Kazakhstan	
2	Expenses for salary with account of social insurance charges (including 6% for movements)	from the work list with addition of social insurance
3	Expenses for operation of machines	from the operation machines cost
A	**Total net cost of construction**	**A=1+2+3**
4	Other expenses and costs of the contractor	4=20%A
5	Other expenses and cost of the client	5=9%A
B	**Total cost of construction and contractor and client expenses**	**B=A+4+5**
6	tax 25%	D=25%B
C	**Total cost of construction and contractor and client expenses with taxes**	**C=B+6**
7	Expenses for insurance of construction objects	7=0,4%C
8	Risk coefficient defined on basis of forecasted index of construction price growth for the following year	8=15%(C+7)
D	**Total cost of construction in current prices**	**D=C+7+8**

6.2 Option "Basic Works" costs

6.2.1 Infrastructure and Power supply costs

The following table 6.2.1-1 resumes the result of cost analysis for Option 1 for Infrastructure and Power supply (10kV line).

The table has been developed according to the detailed bill of quantities that is annexed to this report (*Annex I*) and it includes also international manpower cost (Contractor consulting team) for works supervision and co-ordination.

25% taxes and risk coefficient are not applied to international manpower.

Table 6.2.1 – 1 BASIC WORKS Option cost

Rehabilitation works for Kungrad - Beyneu Line (Border-Beyneu section) "Option Basic Works cost for Infrastructure and Power supply "		
Item number	**Article of expenses**	**Cost ($)**
1	Expenses for construction materials (including 6% for transport)	1,909,796.75
	including: imported materials	724,423.35
	materials produced in Kazakhstan	1,185,373.41
2	Expenses for local workers salary with account of social insurance charges (including 6% for movements)	440,559.02
3	Expenses for operation of machines and mechanisms	171,881.71
A	**Total net cost of construction**	**2,522,237.48**
4	Other expenses and costs of the contractor	504,447.50
5	Other expenses and cost of the client	227,001.37
B	**Total cost of construction and contractor and client expenses**	**3,253,686.35**
6	tax 25%	813,421.59
C	**Total cost of construction and contractor and client expenses with taxes**	**4,067,107.94**
7	Expenses for insurance of construction objects	16,268.43
8	Risk coefficient defined on basis of forecasted index of construction price growth for the following year	612,506.46
D	**Sub-Total cost of construction in current prices**	**4,695,882.83**
E	**International consulting cost**	**598,725.00**
F	**Total cost of construction in current prices**	**5,294,607.83**

*The estimation of investments costs for Option "Basic Works" Infrastructure and Power supply add to about **5,294,607 $***

Accuracy of this amount is estimated +/-15%.

6.2.2 Safety devices costs

Investment values have been estimated by average and current prices of materials and labour. The basic investments are shown on Table C of Annex III.

Investments costs include the following items:

- construction design;
- supply and material transportation;
- factory tests;
- site preparation(worksites setting up);
- installation;
- field tests,
- commissioning;
- quality assurance;
- warranty for first year after plants delivery to Client;
- project management and procurement;
- risks and contingencies strictly related to the scope of the work.

The sharing out of the costs adopted is shown on following table:

Table 6.2.2 – 1 Capital costs for safety devices

Rehabilitation works for Kungrad - Beyneu Line (Border-Beyneu section) Option Basic Works "Safety devices"				
	supply quote %	works quote %	national quote %	foreign quote %
Signal System				
Relay Interlockings	80%	20%	20%	80%
Indoor power supplies	80%	20%	20%	80%
Level crossings	70%	30%	30%	70%
Block systems	75%	25%	20%	80%
Centralised Traffic Control				
Peripheral Places	75%	25%	10%	90%

As a consequence (*see Annex III, table C*), we have:

Total cost of the option "Basic Works" Safety Devices: **3,537,040 $** of which:

Supply quote:	2,723,982 $ (77%)
Works quote:	813,058 $ (23%) with
National quote:	711,808 $ (20%)
Foreign quote:	2,825,232 $ (80%).

6.3 Option "Telecom Works" costs

6.3.1 Telecommunications costs

The capital cost has been estimated starting from the bill of quantities of the proposed telecommunication system which details the number of every specific equipment to be implemented and the quantity of civil works to be performed for allowing the implementation of the system (*see table 5.5.2-1*).

In the subsequent stage, these quantities have been associated to the correspondent unit rate in order to produce the final estimation of the global capital costs. The unit rates reflect market prices and conditions prevailing at the end of 2004 and also include costs for installation/set up of the equipment, hypothesis for the discount rates used during tender stage and taxation effects.

As far as costs for installation/set up of equipment are concerned, they have been estimated as percentage of the purchase costs. The percentage to be used has been carefully assessed taking into account the large experience of the Consultant in installing railways telecom equipment in Europe and abroad together with factors like difficulty and possibility to use local expert under supervision of expatriate experts. The percentage ranges from 2% to 10%.

As far as the discount rates during tender stage are concerned, the Consultant has deducted the reduction usually applied by suppliers. The reduction has been evaluated from the Consultant experience in evaluating tenders for the Italian State Railways but with a very cautious approach in order not to underestimate capital costs. Consequently, although deduction is sometime higher, the applied discount rates are ranging form 10% to 20%.

Finally, as the equipment is normally exempt form taxes and duties on imported goods especially vis-à-vis funds from IFIs, all taxes have been omitted in the study.

A provision for contingency has been introduced on the basis of the aggregate investment, as commonly happens for preliminary studies. The suggested percentage is 10%, in accordance with the Consultant experience.

Following the above mentioned assumption, estimates for the capital costs related to the renewing of the telecommunication system are summarised in the following table:

Table 6.3.1 – 1 Capital costs for telecommunication system

Rehabilitation works for Kungrad - Beyneu Line (Border-Beyneu section) *Option Telecom Works "Telecom system"*	
Description	**Amount (US$)**
Equipment	314.000
Fibre optical and copper cables (with junctions, cable ends and conduits)	1.123.000
Laying of fibre optical and copper cables	377.000
Civil works	3.000
Contingencies (10 %)	182.000
Total	**1.999.000**

As already explained in the technical analysis, the proposed technical solution needs the closure of the ring for redundancy reason. This necessity would be turning into running costs for renting channels or fibres from third parties.

It is suggested for the first period to rent channels from public Telecom for assuring redundancy (5 links at 2 Mbps are needed for the closure of the ring). In this way the cost of renting can not be suffered because of the mutual advantage of the parts. In a second period, as it was explained, redundancy can be assured by rings internal to the railways.

6.4 Option "Doubling" costs

The following table 6.4-1 resumes the result of cost analysis of this Option for Infrastructure and line Electrification.

The table has been developed according to the detailed bill of quantities that is annexed to this report and it includes also international manpower cost (Contractor consulting team) for works supervision and co-ordination.

25% taxes and risk coefficient are not applied to international manpower.

Table 6.4 – 1 Cost analysis for Infrastructure and line Electrification

Rehabilitation works for Kungrad - Beyneu Line (Border-Beyneu section) "Option Doubling cost for Infrastructure and Electrification " (*)		
Item number	**Article of expenses**	**Cost ($)**
1	Expenses for construction materials (including 6% for transport)	44,380,898.24
	including: imported materials	36,988,106.40
	materials produced in Kazakhstan	7,392,791.84
2	Expenses for local workers salary with account of social insurance charges (including 6% for movements)	2,953,466.13
3	Expenses for machines and tools	3,994,280.84
A	**Total net cost of construction**	**51,328,645.21**
4	Other expenses and costs of the contractor	10,265,729.04
5	Other expenses and cost of the client	4,619,578.07
B	**Total cost of construction and contractor and client expenses**	**66,213,952.32**
6	tax 25%	16,553,488.08
C	**Total cost of construction and contractor and client expenses with taxes**	**82,767,440.40**
7	Expenses for insurance of construction objects	331,069.76
8	Risk coefficient defined on basis of forecasted index of construction price growth for the following year	12,464,776.52
D	**Sub-Total cost of construction in current prices**	**95,563,286.69**
E	**International consulting cost**	**2,162,700.00**
F	**Total cost of construction in current prices**	**97,725,986.69**

(*) Option Basic Works costs must be added

*The total estimation of investments costs for this option should also include Infrastructure and Power Supply costs of Option Basic Works (rehabilitation of the existing track) and the costs of Option Telecom Works. The total estimation amounts to about **105,019,594 $.***

Accuracy of this amount is estimated +/-20%.

6.5 Cost summary

Option Basic Works

- Line rehabilitation stations included,
- Power supply new 10 kV line,
- Signalling devices for all the line and stations.

8,831,647 $ +/- 15%

Option Telecom Works

- Telecom.

1,999,000 $ +/- 15%

Option Doubling

- Line rehabilitation stations included,
- Power supply new 10 kV line,
- Telecom,
- Line doubling,
- Electrification.

105,019,594 $ +/-20%.

7. Environmental Impact Issues

7.1 Introduction

The focus of the Environmental Impact Assessment is to:

- identify and analyse the potential impacts on affected area;
- identify and analyse the "Critical Areas" for each line under study;
- propose the mitigation measures in order to reduce the potential impacts on affected area.

7.2 Laws and regulations frame - Environment issues and policy

Kazakhstan is at present boosting its ecological policy. In the field of the environment protection new conceptual and program documents are being developed.

The ecologization the legislation, economy and whole society is becoming the basic priority direction of environment protection measures. That is the introduction of strict ecological requirements in all legal acts, all sectors of the economy and people's minds as well.

With the aim to implement the decisions of the World Summits on sustainable development held in Rio de Janeiro and Johannesburg, it has been decided to create a National Commission on sustainable development and work out the Program on sustainable development. It is planned to create necessary financial institutions under the commission, which will accumulate grants, donor and other non-budgetary contributions.

Today one of the most important issues is the improvement of nature protection legislation with orientation to the European Union standards which is the most important foreign trade and investment partner.

First of all, Kazakhstan plans to lift the status of ecological requirements up to the level of laws. They should go in a package as an appendix to legal acts as practiced in the developed countries of the world. The implementation of international quality standards ISO-9000 and the environment protection ISO-14000 has started.

Kazakhstan in simplifying the procedures of obtaining necessary permits, simultaneously toughening the ecological requirements, harmonizing them with the requirements adopted in the European countries.

The obligatory environment impact evaluation is already being introduced at the time of drafting any programme aimed at the development of the industry and agriculture as well as schemes on allocation industrial capacities, construction of urban areas and other large-scale programs.

Kazakhstan will reform economic tools of environment protection, increasing the size of ecologic payments to the levels of actual inflicted damage, and all the accumulated funds will be forwarded to the restoration of the environment.

Beginning from 2003 Kazakhstan is going to introduce obligatory ecological insurance and ecological audit of environmentally harmful types of activities. The relevant laws are being developed.

In the field of the international cooperation the work on preparation of Ecologic strategy of the countries of the Eastern Europe, Caucasus and Central Asia will go on. The draft programme has been submitted for the consideration of the all-European conference of ministers of environment protection in Kiev in May 2003.

Kazakhstan will continue to actively participate in the international and regional programs of environment protection and, first of all, in the Program the Environment for Europe, which it joined in 1995.

Kazakhstan will strengthen regional cooperation in the Central Asia. These countries have a common ecosystem, and are united by the interdependence on water resources, tragedy of the Aral Sea and other issues.

Kazakhstan has ratified 19 international conventions, including those of a climate change, destruction of ozone layer, desertification and preservation of a biodiversity, 4 transnational conventions of the European Commission and Aarhus Convention on ensuring the access of the population to the information on ecology, decision making and law maintenance in the field of environment protection.

Kazakhstan actively cooperates with around 300 non-governmental organizations (NGOs) on the issues of environment protection and involves them in realization of the state programs and assists in setting aside the state grants for projects having significance for the society.

7.3 Description of the environment

7.3.1 Geography and natural ecological environment

Kazakhstan is situated in Central Asia, deep in the Eurasian continent.

Its territory is as large as 2,735,000 sq km (i.e. 1,049,150 sq miles). In terms of the area it is the second largest among the CIS states. In fact the territory of Kazakhstan exceeds that occupied by twelve countries of the European Union.

Kazakhstan borders upon the following states: China- 1.460 km - long border; Kyrgyzstan - 980 km; Turkmenistan - 380 km; Uzbekistan - 2.300 km; the Russian Federation - 6.467 km. Total length of borders amounts to 12.187 km.

The territory of the Republic stretches on from the low reaches of the Volga in the West to the foothills of the Altai mountains in the East - for some 3,000 km (a distance that spans two time zones), from West Siberian lowland in the North to the desert of Kyzylkum and the mountain range of Tien Shan in the South for some 2,000 km.

The northernmost point in Kazakhstan - 55'26" NL - corresponds to the southern latitude of the central part of the East-European plain and to the southern part of the British Isles (the latitude of Moscow). As to the southernmost point - 40'56" NL - it corresponds to latitudes of Transcaucasis and Mediterranean countries of Southern Europe (the latitude of Madrid, Istanbul and Baku).

Yet remoteness of the country from oceans and vastness of its territory determine climatic conditions.

The climate of the country is sharply continental. Average temperature in January varies within - 19° - - 4° C while average July temperature fluctuates within + 19° - + 26° C. The lowest temperature in winter may go down to - 45° C with the highest one in summer + 30° C.

The population numbers some 14,841,900 people (01.01.2001). Population density is as high as 5,5 people per 1 sq km.

The capital is the city of Astana (since December 10, 1997) whose population is as large as 319,000 people.

Administratively Kazakhstan is comprised of 14 regions (as of 5.05.97) with cities of Almaty and Leninsk enjoying a special status), 85 cities of which 40 refer to those of Republican and regional subordination, 160 districts, 10 municipal districts, 195 settlements, 2,150 aul (rural) counties.

In terms of the number of the population cities of Kazakhstan may be subdivided into several categories:

- those having 300-400 thou. residents (Karagandy, Shymkent, Pavlodar, Taraz, Ust-Kamenogorsk);
- those with 200-280 thou. residents (Uralsk, Temirtau, Kostanay, Aktobe, Petropavlovsk, Semipalatinsk);
- those with 110-160 thousand residents (Zhezkazgan, Yekibastuz, Kyzylorda, Aktau, Kokshetau, Atyrau).

There are 8,500 big and small rivers in Kazakhstan. The length of seven largest rivers exceeds 1000 km. The largest ones are the Ural and the Emba flowing into the Caspian Sea, the Syrdaria falling into the Aral Sea while the Irtysh, the Ishim and the Tobol run all across the Republic to eventually reach the Arctic Ocean.

There are 48,000 big and small lakes in Kazakhstan. The largest among them are the Aral Sea, Balkhash, Zaisan, Alakol, Tenghiz and Seletenghiz. Besides Kazakhstan shares the larger portion of the nothern and half of the eastern littoral of the Caspian Sea - the largest ever sea on the planet. The length of the coast line of the Caspian Sea (its Kazakhstani portion) is 2,340 km.

Steppes occupy some 26% of the territory of Kazakhstan. 167,000,000 ha account for deserts (44%) and semi-deserts (14%) with forests occupying 21,000,000 ha.

When speaking about the flora and fauna of the Republic, we have to mention 155 species of mammals, 480 and 150 species of birds and fish respectively and about 250 species of medicinal herbs. Worth noting is that such exceedingly rare plant as santonica wormwood grows nowhere else but in the South of Kazakhstan.

Kazakhstan is rich with commercial minerals. In terms of chromium, vanadium, bismuth and fluorine reserves Kazakhstan knows no second in the world while in resources of iron, chromite, lead, zink, tungsten, molybdenum, phosphorite, copper, potassium and cadmium the country holds one of the leading places.

On the territory of the country they have discovered nearly 160 deposits of oil and gas. Their reserves - known to this day - are approximately equal to present day resources of the whole of the Western Europe. These oil and gas fields contain about 20,000,000,000 barrels of oil and 700,000,000 ton of gas condensate. Sum total of the cost thereof is estimated in the region of USD 4 bln. The Tenghiz field only ranks as one of the largest deposits of the world.

Coal reserves in Kazakhstan reach 160,000,000,000 ton. The Republic numbers 10 coal fields of bituminous and brown coal, 155 deposits all in all.

Iron ore resources (containing 50-60% of pure iron) in the Republic surpass those of many a country in the world.

Kazakhstan is the second richest country in the world (after Russia) with regard to phosphorite reserves while phosphorite deposits of Zhanatas and Karatau in terms of thickness and quality are second to none in the world.

Kazakhstan holds one of the first places in the world as to the production of aluminium.

The Republic harbours uncommonly superb resources of copper ore. Zhezkazgan ore deposits are second largest in the world as to their potential.

The territory of Kazakhstan affords infinite resources of salt and construction materials.

The already prospected deposits serve a fine basis for the development of mining, coal-mining, metallurgy, oil-and-gas and chemical industries.

Kazakhstan's share in world output of commercial minerals and products of procession thereof (according to estimates of the Union Bank of Switzerland) in the days of the late USSR amounted to the following: *Beryllium - 24%, Zink - 7%, Tantalum - 33%, Titanium - 26%, Chromite - 27%, Copper - 3%, Barite - 7%, Molybdenum - 3%, Lead - 7%, Bauxites - 1%, Uranium -14%, Manganese - 5%, Silver - 6%, Iron ore - 2%, Tungsten - 12%, Gold - 1%.*

7.3.2 Environmental strategies, programs and projects

Following a brief description of ecological projects executing in Kazakhstan, Kyrgyzstan and Uzbekistan is shown. Also activities of the different governmental, non-governmental and international organizations in field of the environment protection on national and regional levels are described – INTAS, COPERNICUS, USAID, UNDP, Global Environmental Facility (GEF), UNEP, WB, UNESCO, and other.

Joint projects on trans-boundary and regional environmental problems	**Kazakhstan**	**Kyrgyzstan**	**Uzbekistan**
National Environmental Action Plan	yes		yes
Participation in international environmental conventions	9	3	8
Creation of regional environmental database	yes		yes
Regional Environmental Action Plan	yes	yes	yes
Environmental projects			
Region of the Semipalatinsk nuclear testing area	yes		
Foothills of the Tyan-Shan	yes	yes	yes
Region of the Caspian Sea	yes		
Aral Sea Project			
Aral Sea VISION	yes	yes	yes
International Fund for the Saving Aral Sea	yes		yes
Aral Sea Basin Capacity Development Project	yes		yes
National strategies and Reports			
Biodiversity			
Water			
Climate Change			
Ozone layer			
Desertification			

The environmental strategy for Kazakhstan, Kyrgyzstan and Uzbekistan comprises:

- National Environmental Action Plan
- Harmonisation of environmental legislation
- Co-operation of national strategies related to international environmental conventions
- Creation of regional environmental database - started
- Preparation of joint projects on trans-boundary and regional environmental problems

7.3.3 Analysis of environmental status along the line (sensitive areas)

As result of the environmental investigation relatively to the territory examined, the environmental related to the territorial areas interested by the railway lines can be summarised in the following types:

Kungrad – Beyneu line	• urban areas • areas far from borrow pits (ballast)

KUNGRAD - BEYNEU

CRITICAL AREAS

Sections (Km)	Actual land use	Environment items	Environmental receptors
626-627	Urban area (Kungrad)	Urban ecology	Residential build-up area
645-646	Urban area (Raushan)	Urban ecology	Residential build-up area
671-672	Urban area (Kunhodja)	Urban ecology	Residential build-up area
689-690	Urban area (Kirk-Kyz)	Urban ecology	Residential build-up area
710-711	Urban area (Barsa-Kelmes)	Urban ecology	Residential build-up area
731-732	Urban area (Ajinijaz)	Urban ecology	Residential build-up area
760-761	Urban area (Abadan)	Urban ecology	Residential build-up area
779-780	Urban area (Kuanysh)	Urban ecology	Residential build-up area
796-797	Urban area (Jaslik)	Urban ecology	Residential build-up area
820-821	Urban area (Ayapbergen)	Urban ecology	Residential build-up area
845-846	Urban area (Berdakh)	Urban ecology	Residential build-up area
870-871	Urban area (Bostan)	Urban ecology	Residential build-up area
893-894	Urban area (Ak-Tobe)	Urban ecology	Residential build-up area
910-911	Urban area (Kiyiksay)	Urban ecology	Residential build-up area
933-934	Urban area (Karakalpakia)	Urban ecology	Residential build-up area
955-956	Urban area (Oasis)	Urban ecology	Residential build-up area
977-978	Urban area (Akjigit)	Urban ecology	Residential build-up area
1005-1006	Urban area (Kzyl-Asker)	Urban ecology	Residential build-up area
1025-1026	Urban area (Kok-Bekty)	Urban ecology	Residential build-up area
1033-1034	Urban area (Beyneu)	Urban ecology	Residential build-up area

7.4 Environment Impact Forecast

The issue described below is based on the observation by the consultant, the review of the available and relevant literature and statistics on the area and the characteristics of the infrastructure.

The impacts of the construction period will be described for defining the recommendations and measures to prevent the environmental interferences and to retain and mitigate the potential pollutions.

The foresees rehabilitation works groups are:

- railway line works (rehabilitation of the embankments, construction of the embankments, dismantling and remounting, the rails and the sleepers; building, upgrading or capital repairing of culverts, technological rehabilitation works);
- works carried out outside the railway line (guard ditches, drainage, etc.)
- environmental protections works.

7.4.1 Environment impact/effects during rehabilitation period

Obviously the realisation of a new transport infrastructure provokes major impacts on the surrounding environment then the rehabilitation works proposed by this project, but, in general, there are some guidelines to be always followed.

The interferences and the criticisms linked to the construction period are connected with two aspects. The more general come from the analysis of the total area involved by the infrastructure implementation, in order to identify the most compatible areas to realize the rehabilitations, namely the overall vulnerability of the concerned environmental context.

The second aspect, more linked to the technical and operative management of the construction site, is connected to the proposed works peculiarities, that is the whole activities and logistics structures provided for each site, that in a different way could produce insertion problems.

The basic principles connected to construction site location are:

- the construction site should be placed close by the working area in order to reach easily the assembly place, in order to reduce as far as possible the trouble brought about means of transport traffic;
- the construction site space should have surface area wide enough to permit the planned activities carrying out, but on the same time these areas should be limited as much as possible to reduce the (temporary) occupation of land;
- fixing the construction site position should be necessary to consider the right possibility of easy connection with the present services network (electricity, piping system for white or black drain water);
- the possibility to assure a smooth approach road or a material transports on the railroad;
- it will be necessary to verify the materials supplying and waste management, that is the right conditions of the road system (small transport distances for supplied materials);
- the construction site should be realized so that to reduce at the lowest terms the insertion of the potential environmental interferences with the neighborhood (local people life and activity).

Likewise the impacts and effects of the involved environmental components will be essentials to parameter, during the construction period, the interference's insertion brought by the construction site peculiarities, their dimensions and the characteristic of the pertinent territorial context.

With reference to the environmental components it is possible to synthesize a list of the principals potentials problems induced by the construction period:

Environmental components	Potential effects
Atmosphere	Alterations of air quality conditions Dust production
Water environment	Fluvial regime modification Alterations of water quality conditions
Land and subsoil	Morphological modifications
Vegetation, flora and fauna	Vegetation damages due to powder production Departure / Damages to the fauna
Noise – Vibration	Disturb due to means of transport traffic and work processing

It is possible to foresee that the majority of the construction materials will be brought to the work site through the existing railway. The material supply will be realized accordingly with the necessity of the project and it will be organized by a specific time/ quality schedule. The schedule must avoid the overloading of materials in the construction site, as well as the too long permanence of stocked materials in the site itself.

The traffic trucks have strong variation in time, in relationship with the nature of the terrain operations. The highest intensity of the traffic is estimated for the embankment working (ballast transportation) a medium intensity for the concrete plants and the lowest intensity for the operations of leveling and ground excavations, when the traffic takes place from the embankment to the borrow pit and back.

As mentioned above, the construction work of the project will potentially generate a series of environmental impacts on the area of the construction site and along the line. Analysis is detailed as follow.

Impacts on physical environment

Impacts on soil and water resources

a. Soil and subsoil environment

From Kungrad to approximately Kelmes the project area extends on the Quaternary deltaic plains formed by the depositional activity of the Amudaria river. The alluvial sediments forming the plains are mainly composed of sands, clay and loam layers.

The plains surface is generally fairly regular, presenting only slight unevennesses no more than few m high.

The ground water of these plains is generally correlated with the regime of the Amudaria river.

Past Kelmes the project area extends onto Ustyurt plateau up to Beyneu.

The flat to gently undulated surfaces of the plateau are sometime bordered by sharp cliffs composed of layered Tertiary rocks including limestones, marls, sandstones and claystones, more or less rich of gypsum and other soluble salts. These rock formations form the bedrock of the plateau, generally covered by overburden materials composed of fine soils with inclusions of rock debris and alluvial gravels.

Gypsum and other salts generally accumulate between the overburden and the bedrock.

The hydrogeology of the plateau is characterised by localised ground water basins generally found at the depth of 30 – 60 m .

The area of the project appears interested only by low to moderate seismic activity.

The forecasted potential impact forms on the soil environment that could be identified in:

- the removal of the vegetal soil bed and the construction of an artificial profile through the works of embankments executed on the road territory;
- the deterioration of the soil profile of parcels were there will be settled site organizations and working points for the destructions of soil profiles (by leveling);
- the apparition of erosion;
- the loss of natural characteristics of the fertile soil bed through inadequate storage in the soil dumps resulted from uncovers;
- the removal/degradation of the fertile soil bed in the areas where new technological roads or detours of the current access routes will be realized;
- the isolation of some soil surfaces from the natural ecologic circuits through their concreting;
- accidental spills of some substances/compounds (used oils, lubricants, fuel) directly on the soil;
- the uncontrolled storage of waste, construction materials or technological waste;
- potential leaks in the sewage/used water collection systems;
- quality modifications of the soil under the influence of air pollutants (qualitative and quantitative of the local geochemical circuits);
- Interruption of subsoil and overland drainage patterns.

The materials that are to be used during the construction works do not present a strong risk of pollution for the soil. The most important aspect is represented, however, by the ground mass which will be processed.

On one side, we are referring to the filling materials that will be delivered both from quarries (clay, broken stone and aggregates) and borrowing pits. This will generate a transfer of possible disturbance from the research area of the present study to the sources of materials (the accentuation of phenomena like erosion, the modification of the local levels of underwater).

On the other hand the waste materials resulted by excavation shall be, on their turn, deposited.

The soil erosion and damages generated by soil borrow and spoil regard the following two aspects:

- a large scale borrow will result in heavy damages and disturbance to the earth surface of the borrow pits and their surroundings, leading to damages and extinction of the vegetation, soil exposition, declining of mountain body stability and soil anti erosion capacity, and along the line, under the scouring of rich rainfall, the surface rocks are liable to be broken and weathering, forming soil and water erosion;

- large amount of broken rocks and various impurities are contained in the construction spoil, which is low both in stability and anti erosion capacity. If piled improperly, under strong scouring if rainfall in rain season, it is easily denuded and collapsed, forming mud – rock flow and dirty muddy water, damaging nearby soil and farm lands, and also bringing about pollution and damages to irrigation canals and ditches, rivers and pounds.

b. Impacts on water environment

Particular regard should be posed in the selection of the place for the construction site location.

First of all must subdivide the arguments in two principals group of problems, from one side there is the construction site impact and then this consequences on the water environment (impact factor) connected to vulnerability of the environment.

On the other side there are the risk on which the installation could be subject for natural reasons (natural risk factors) underestimate or not exactly evaluate.

The first group of problems is related to:

- all the waters pollution risks, either superficial or deep, due to the pollutant substances spilling on the construction site services area (oils, petrol, unloading, etc.) and along the routes of the mechanics means;
- the insertion of cloudy waters, for the presence on the water-rivers of powders and sediments coming from washing waters of concreting stations, with consequent damage to existing life around them;
- the unloading of white or black water generate from the high concentration of construction site authorized person;

Obviously the spilling of pollutants substances or unloading, even fortuitous, involves heavy problems also on the underground water. On this sense oneself advise the opportunity to provide all the construction site of suitable system to deal the water before of their insertion in the superficial water network.

To the second group of problems are then ascribed to the cases of construction site wrong location, ad as an example the alluvial or active riverside areas or terraces reaching when there are exceptional floods. The works site will be selected by a preliminary investigation of the areas subjects to periodic river flows, in order to reduce to the highest the probability of the same sites inundation.

In succession are carried over in a systematic form, the list of potential effects of construction site on the examined system:

- Alteration of hydrographical superficial network

The effect it is conductible to the obstructions and barriers introduction intercepting the hydrographical superficial network. The potential receptors are composed from the bigger and the smaller watercourse and from the superficial stream activity.

- Alteration of physical/chemicals characteristics of superficial waters

Generally speaking the effect is as consequence of the pollutant spilling substances or to mud or grounds introduction on the watercourses involved by the work fulfillment. The phenomenon is to be considered temporary to the construction site phase, and it is interesting particularly the building phase, the excavations, the impermeabilizations, the machinery utilization, etc.;

- Alteration of physical/chemicals characteristics of underground waters

Almost all the project actions can theoretically alter the underground waters characteristics, chemicals and physicals. This effect can rise essentially from the building phase following, as an example, the fortuitous spilling to soil of pollutant substances penetrating deeply and pollute the water bed.

The project actions that potentially can alter the quality of the underground waters are the excavations and the clearing, tests and assays, structures (as example the foundations), the processing inside the construction site, the impermeabilizations, the wastes stocks and clearances.

These actions are referring to the construction site, and therefore the coming effects are of temporary impact. The receptors of which it is possible will be involved by this effect are principally, the high and medium permeability soils, and subordinately, these identified with medium and low permeability;

- Engaging on of erosion phenomena

Generally this effect is caused by means of all actions of the project connected with the removal of the vegetal covering and/or the superficial part of the soil. When the soil is subject to the erosion, take place also the transport of the solid in the direction of the flowing waters, with consequent increase of the turbidity of superficial water corps (secondary effects).

The project actions that can determine the engaging of erosion phenomena are: the physical areas occupation, the evacuation, the clearing, the building, the impermeabilization, the placements and the secondary works;

- Alteration of the water underground flow

Generally speaking this effect can be determined by all the project actions, relatives above all to the construction phase, interesting in a certain way the subsoil. The receptors potentially involved by this effect are the water-bed and the picking up works of the same water-bed.

c. Soil and water environment impacts interaction

Impacts induced by the construction site activities

With reference to the soil permeability it is possible to say that during the works it is foreseen to spill into the soil and the subsoil substances generating pollution.

These substances are:

- suspended solids – are the suspended sediments that carried by the waters percolate into the subsoil polluting both the unsaturated soils sector and the water-bed below. This kind of pollutant will inevitably generate the increase of water turbidity especially in the reinforcing and piles foundation or slopes protection.

The activities generating this pollution are:

- Excavations and spoil works in the riverbeds and in their close vicinity as in the case of bridges and culverts works;

- surfaces washing of the construction site service areas;

- washing of the motor vehicles wheels;

- washing out by the rain waters of the powders and the mud placed on the road system engaged by the construction site means;

- construction works near water-course (rivers and channels);

- oils and hydrocarbons – to these categories can add the fuels, the lubricants fluids for the hydraulic system normally used on the construction site. The reasons of he pollution brought by these fluids are principally linked to:

- leaks from the fuel tanks valves or tubes;

- fuel tanks corrosion;

- damages induced by frost to the fuel tanks;

- supplying activity of the construction site means and of the same tanks;

- oils leaks from pomp and generator;

- used oils abandonment;

- accidents (accidentals leaks during the refueling activities, mechanics breakage of hydraulic tubes, insufficient capacity of the holding basins).

- concrete and his derived products utilization - the cement and his derived products utilisation in the construction site, present contamination risks for the water environmental due to the water use for processing them. Particularly during the "on site" production of concrete are used big quantity of water especially for washing the equipment. In the case of outside purchase of concrete by means truck mixer, the pollution could rise from the washing of the same into the construction site area, necessary to reduce the impacts on the atmosphere of routing construction site-quarry-dump;

- heavy metals – The heavy metal pollution normally are referring to mercury, cadmium, lead and aluminum, they are the bigger responsible of the environmental damages. The heavy metals pollution it is strictly linked to the industrial and combustion activities that are causing the movement of them at the surrounding level. The heavy metal is polluting either the soil than the subsoil, the vegetation and the waterbeds.

- liquid sewage

- pesticides

- herbicide

- others pollutant and dangerous substances as: rubbish; solvents; detergents; paints; sealing products; adhesive; drilling fluids; others chemicals substances.

Impacts induced by the processing

About what are specifically concerning the soil and subsoil components, the construction site activities can provoke the physical impacts temporary or permanent because of:

- reduction of the functional soil qualities (either productive or protective) due to the temporary surface area covering (even if soon after reclaimed), presence of gravel, sands or waste-materials inactive, and also due to incidental organic horizon loss or to happen of long anaerobic conditions;

- soil compactness from the construction site means;

- trouble of the network lay out for irrigation and drain in the agricultural context;

- chemicals pollution coming from the heavy metal and the organic substances included on construction site means exhaust pipe, the loss of oils and hydrocarbons and the mechanics parts wear from the some machinery.

The areas where these impacts could happen are principally those destined to the main construction site, to the motor vehicles transit roads and the temporary occupations areas to stocking soil and/or materials. Heavy traffic, specific to the construction site, determines various emissions of polluting substances into the atmosphere (NO_x, CO, SO_x – characteristic to diesel fuel -, particles in suspension etc). There will also be particles resulted from friction and attrition (the rolling way, the tires). The atmosphere is also washed by rain, thus the pollutants present in the air are transferred to the other environmental factors (surface and ground water, soil, etc).

<u>Excavations and soil movements</u>

The excavations can be pollutant activities center if realized with presence of mud or substances like that, and if first of all are interfering directly with the waterbed or water-course.

The pollution of waterbed and soils could be realized on the case of soaking into the subsoil, washing away, water flow and delivery to existing pits.

<u>Fuelling and maintenance stations</u>

The fuelling and maintenance stations for the gear and transportation means are potential pollution sources for soil and surface and ground waters. These stations must be approved of in their project phase and must be checked periodically during their functioning period, from the environmental protection point of view. It is to be expected that the contractor does not build new stations for refueling motor vehicles and other gear at work, the endowments of the enterprise being used for this task. Anyway, the fuel distribution toward the gear at work will be done directly at the work point. During the execution of these operations the necessary precautionary and protective measures will have to be taken in order to prevent the discharge of fuels in the open environment. Simple means of intervention in the case of fuel spills will be made available: metal platters placed under the fuelling hoses, sand crates for the absorption of the discharged fuel, etc.

<u>Works filling on the back</u>

On this case the risk exist if the soil utilized for refilling is polluted from substances that, by filtration, could reach the waterbed or the water superficial body.

<u>Finishing and maintenance works</u>

The operations of finishing and maintenance of crossing works of culverts for the superficial waters manhole cover could create pollution for the waters firstly superficial and than underground, due to the washing away or the direct fall of small parcel of metal, paint and detergents.

As to what concerns the site organizational facilities, their place has not been established yet. But in the cases in which the works are carried out in the proximity of the intersected watercourses, all of these could produce the direct pollution of the water. Also, water coming from precipitation, which washes the surface of the site, may mobilize the sediments and thus, indirectly, these end up in the watercourses.

At the current phase in the elaboration of the project, the technologies that will be used by the builders are not yet known. They will request authorizations for the functioning of their production bases, the employed technologies, from the Regional Agencies for Environmental Protection.

It is considered that the emissions of pollutant substances (resulted from road traffic characteristic to the construction site, from manipulation to execution of materials), which might reach directly, or indirectly into the surface or ground waters are not in important quantities and they do not modify the framing in water quality categories.

The pollutant quantities that will usually reach the watercourses during the execution period will not affect the aquatic ecosystems or the water facilities. Only by accidental spilling of large amounts of fuel, oils or construction materials, the aquatic environment could be damaged.

As to what concerns the possibility of polluting the phreatic bed, it is considered that it will also be relatively reduced. The storage of fuel in hermetically sealed reservoirs will be imposed; the maintenance of the gear (washing, repairing, part and oil changes, refueling) will be done only in specially designed places (concrete platforms, with decanters to retain the losses).

Impacts on biological environment (flora and fauna)

<u>Flora and vegetation</u>

In the case of the construction site areas will be placed in an natural valence context, it is necessary to underline that at the end of works this areas must be object of recovery activity to previous situation. Besides, a lot of dust caused by construction and transportation activities covers the stems and leaves of the roadside crops and vegetation, which will affect there.

During the works, where are observing alteration phenomena (affect the photosynthesis and production decrease of the agricultural products and vegetation withering) on the existing vegetal community in a strip of 1 km adjacent to the railway, it will necessary take all the expedient suitable to reduce such interferences.

One of the most important phenomenon correspond to the dust presence on leaves surfaces of the arboreal and shrub species and on the grass present alongside the edge of the lines and the areas of the works site.

It is possible to take under control this phenomenon by means recurrent forecasted bathing to carry out in order to cut down the dust production. In case of works are interfering with individual arboreal and shrub but where is not necessary to cut, could be adopt as protection net or mobile barrier.

The description of the natural environmental situation let to identify all the present receptors and to forecast the possible interferences on the potential identified receptors due to rehabilitation activities, presence and operations of considered construction site including the pertinent accessory works.

In succession are put in evidence the receptors subject to alterations and the list with description of potential impacts determined of construction site implementation.

The main identified receptors are:

- natural vegetation

- hedges and/or shrub rows and/or lonely trees (autochthonous or not native)

Potential impacts identified:

- removal of natural vegetation, including naturalistic value elements;

- removal of arboreal elements of human origin;

- alteration of vegetal populations due to pollution ;

- removal of vegetal soil.

The removal impacts of natural vegetation, including the naturalistic value elements, and those of arboreal elements of human origin, are determined by the project actions carried out during the construction phase as: excavations, clearings and works of art achievements.

The removal of vegetal soil is of diffused characteristic because this is generating by all the project actions forecasted for the construction site fulfilment.

All the vegetal formations and the lonely trees close to the construction site areas are potentially subjects of alteration because of pollution aroused by the powders lifted from the mechanical means utilized during work phase. The impacts during the construction site phase appear in any case of short significance, because this provokes temporary alterations to the physiological functionality at the involved vegetation.

The impact on the vegetation and fauna of the pollutants existing in the work perimeter are due at:

- <u>Particles.</u>

- <u>Sulfur Dioxide.</u>

- <u>Nitrogen oxides.</u>

- <u>Heavy metals.</u>

Inside every kind of impact the gravity is variable in the role of involved receptor sensibility, and also by the level of involvement of it. The receptor sensibility comes from a number of parameters like: to be natural, resistant, rare and endemic, with particular geographic distribution.

The involvement degree is the measure on which the receptors are subjected to the removal both: the quantitative point (amount of individuals removed, removed area on the total) and the qualitative point (modality of receptors involvement, such as partial, marginal, etc.).

<u>Fauna</u>

About with fauna interference, this aspect it is not considered significant since these presence are too limited and restricted to micro fauna.

In addition it necessary to put in evidence that the construction sites setting up activities – make level and or soil surface re-shape – are not operations provoking the direct fauna destruction, because the territorial context of reference don't result to be passing road.

Nevertheless the problem of the construction site placed close to watercourses, it could involve the water variation of some physical-chemicals characteristics of these and consequently it could cause damage to fishing fauna development. This problem it is faced with the control of working areas waters insertion points.

The works of rehabilitating and modernizing the already existing railway can lead to the amplification of the stress affecting the natural ecosystems, as a result of both the direct works and the collateral effects (the increment of traffic), leading to unwanted phenomena of loosing the ecological diversity, the simplification of functional structures and shortening of trophic chains, increasing the sensitivity of the ecosystems.

This is why after the concluding of the necessary works on the infrastructures, it is necessary to apply a proper nature protecting management in these perimeters by involving all the responsible institutions.

Impacts on atmospheric environment

Pollutant emissions during railway rehabilitation and laying works relate mainly to earth movement, handling other materials and the actual building of specific facilities.

Dust emissions vary from day to day, depending on weather conditions, activities, specific operations and vehicle traffic.

Railway rehabilitation works consist of a series of different operations, each of them generating its own dust quantity for a certain period of time. In other words, the beginning and end of dust emission within a construction site may be very well defined, but they vary quite a lot depending on the different phases of the rehabilitation process. This characteristic makes dust emissions different from other uncontrolled dust sources, which either have a relatively fixed cycle or an annual cycle easy to highlight.

As with dust emissions, the condition of these pollutants depends on the different activities and specific operations, thus varying from day to day, from one process phase to the other.

The main activities that represent dust emission sources are:

- Excavations that including earth scarification; excavation and gathering earth and ballast in piles, charging the earth and the ballast in wagons and in tracks.
- Filling including material discharging from the wagons on the railway bed, compacting, layers scarifying, line tamping, slopes finishing, final leveling of the railway formation layer.
- Material transport.
- Wind erosion, it is a phenomenon the appears due to uncovered ground surfaces that are exposed to the wind action.

The main problems brought about the works realization phase, on the component atmosphere are concerning:

- the powder production;

- the gas emissions and the dust.

The powder emission, induced by the activities carrying out constitutes the main atmospheric pollution for a railway construction site. However both of the problems can be verified along the line system involved from the heavy means movement, and around the areas on which take place the works.

The rehabilitation involve a series of various operations, each having its duration and dust generating potential. In other words, when realizing the construction, the emissions have well define periods of existence (the rehabilitation time), but they can substantially vary from one construction phase to another. Exactly these particularities differentiate then from other uncontrolled sources of dust, which have stationary emissions or follow an undetectable annual cycle.

Atmosphere pollution represents one of the major elements that effect the population' life conditions in the large and small town areas. The discomfort produced by smoke and smells, the visibility reducing, the negative effect on the human health and the vegetation due to harmful powders and gasses, the damages to the buildings due to the dust and corrosive gases, all these belong to the major environment issues of the urban areas. The atmosphere is the largest pollution spreading vector, the evacuated noxious affecting as much directly as indirectly the human element and then others components of the natural and artificial (built) environment.

It is to be noticed that the spatial distribution of the concentration fields due to the emissions resulted from the activities developed along the railway line placement do present some particularities, characteristic to the line sources:

- atmospheric pollutants are distributed mostly along the railway line;
- the highest pollutant concentrations appear in the railway placement, along it;
- the pollutant concentrations are quickly diminishing with the distance on a direction perpendicular on the railway axis;
- the highest pollutant concentrations in the line proximity areas appear when the wind blows perpendicular on the railway axis.

In conclusion the significant area of impact extends along the railway line on its both sides, on strips of 80 - 100 m width at the most (transversally on the line) which led to an effective width of 40 – 50 m because the works for every track are not simultaneous.

The emission of a pollutant in the air (irrespective of time or quality) may produce a perturbation of all the environmental factors implied in the impact area of the emission. The emission effect depends both on its concentration and on its duration, on how sensitive the receptor is and on the meteorological conditions while the emission is realized. The proper effect of the emission may be observed in relation to the impact upon the environmental factors and upon the population.

In succession there are indicated some indications usually applied during works of railway intervention fulfillment.

<u>The powders</u> - The powder production coming from the means movement and from the works, could be controlled carrying out expedients as listed in succession.

In particular in order to contain the problem linked to the powder raising induced from the traffic of the construction site means must be carry out recurrent wettings of the construction site surfaces.

This action will made with reference to the seasonal period, with an increase of wettings during the summer time. The efficacy of the powders control with water it depend essentially from the frequency on which the system is applied.

Furthermore to reduce the powder production it will be possible to provide the chemical stabilization of the construction site tracks.

With reference to the urban road systems distances (for the built-up area involved along the connections between railway and quarry sites) and the extra urban one, engaged from the transits of the construction site means entrusted with the purchasing materials transport, it is necessary to put in evidence that, to reduce the interferences of construction site means on the road system, must:

- to clean with water the tyres of the coming out vehicles from each construction site through washing systems placed near the entry;
- to cover the means boxes with sheets to reduce eventual powder dispersions during the materials transport.

Gas emissions and the dust

An other issue is concerning the problem of the nitrogen oxide, the dust and the powder from the construction site means. To face at this problem the construction site means must correspond to the emission limits in compliance with regulations. Therefore the construction site means must be equipped of dust reduction systems of which it will be necessary to plan a suitable and frequent maintenance and to verify the efficiency also through the measurement of fumes opacity.

Finally for the construction site means and the fixed installations must foresee to utilize equipment with electric engine linked to the existing network.

Wind erosion represents an additional dust source. Wind erosion occurs due to the presence of uncovered areas, which are exposed to wind action for a certain period of time. The dust produced by material handling and wind erosion usually has natural origins (soil particles, mineral dust).

Apart from these dust sources, there are also pollution emission sources specific for internal combustion engines, is the engines of the equipment used in different works on site. Another pollutant source specific for internal combustion engines is the vehicle traffic (vehicle carrying materials and products used in the construction works). The works within the site, especially the ones carried out for earthwork reinforcement, represent the pollution sources with the highest atmospheric pollution potential.

Regardless of their type, equipment and vehicles run on Diesel engines and the exhaust gases, discharged into the air, contain the entire range of pollutants specific for internal combustion engines: nitrogen oxides (NO_x), non-methane volatile organic compounds (COV_{nm}), methane (CH_4), carbon oxides (CO, CO_2), hydrogen nitride (NH_3), heavy metal particles (Cd, CU, Cr, Ni, Se, Zn), polynuclear hydrocarbons (HAP), sulphur dioxide (SO_2).

The range of organic and inorganic pollutants discharged into the air through vehicle exhaust gases contains substances with different toxicity levels. Thus, apart from the ordinary pollutants (NO_x, SO_2, CO, particles), there are certain potentially dangerous substances, whose cancerous nature has been discovered through different epidemiological studies prepared under the care of the World Health Organisation. The substances are: cadmium, nickel, chromium and polynuclear aromatic hydrocarbons (HAP).

There are also nitrogen protoxide (N_2O), which is known to destroy the stratosphere ozone layer, and methane, which, in combination with CO, has a global impact on the environment, since these are greenhouse effect generating gases.

Obviously, pollutant emissions decrease as the engine performance is higher; the world trend in this respect is to manufacture engines with less fuel consumption per power unit and with restrictive emission control.

Atmospheric pollutant emission sources specific for the area under review are the following: soil sources, nearby soil sources (emission heights of up to 4 m from the soil level), open sources (earth handling) and mobile sources. The source characteristics and the area geometry place the site in the linear pollutant source category.

Impacts on human environment

The exposure to the pollutant substances during this period is acute (of high intensity and for a period of 1-7 days) or sub-acute (of average intensity and for a period of 3-6 months).

The exposure to pollutants in this period of time is generated by the following sources:

- equipment provided with diesel engines (particles, irritant pollutants),
- soil processing (suspended particles);
- multiple noise sources.

Impacts generated by construction noise and vibration

The noise represents an environment factor omnipresent for which is difficult to establish the tolerance limit between the necessary level and the noxious one, depending on a multitude of physical factors (physical of the noise, personal of the receiver or other external variables).

The noise influence on the human body depends on a factor series:

- factors related to noise: intensity, frequency, action times, noise feature (continuous or intermittent);
- factors related to the human body: age, activity, physical state, individual sensitivity;
- factors related to the place of the action: space dimension, field configuration, architectural structure, etc.

Generally, the noise effects depend on the characteristics and complexity of the activity to be carried out. The simple, repetitive and monotonous activities are less affected by noise.

In order to limit the possible impact of the sound pollution on population health, there are recommended the following measures:

- equipment operating within the limits of the functional parameters;
- monitoring the noise levels in order to adopt the correction measures of the excessive sound pollution.

The construction site will generate problems linked to the noise emissions and vibrations connected either the working activities or the materials movement.

In order to accurately present the different aspects regarding the noise produced by various devices, three levels of observation are been considered:

- sources noises;
- proximity noises;
- distance noises

In the case of source noises each equipment have to be Each of the three levels of observance presents its own characteristics.

Impacts of construction solid waste on environmental

The solid waste from the construction activities and its environmental impacts can be summarized into two categories:

- living refuse by construction workers. This kind of refuse can be collected and disposed by environmental sanitation departments in urban areas, while in rural areas, it may cause harms to soil, vegetation and water environment.
- various kinds of construction refuses will be generated by rehabilitation and upgrade works.

The categories of works will produce:

Work	***Wastes***
Embankment works	Solid waste, pulverulent
Contact line replacement	Copper wastes, ceramics insulators and other metallic materials
Replacement of the safety systems of the stations for the power supply	Liquid waste, acid electrolytic solutions, plastic boxes/ tanks, lead electrode
Current repairs of the equipment	Used oils, worn – out tyres, metallic wastes
Site organizations	Domestic waste, paper, packing

The toxic and dangerous wastes as fuel (gasoline), lubrificants and brimstone acid, required for a good functioning of equipment. Equipment fuel supply will be done with a cistern car, when necessary. The equipment will be brought to site in good functioning, will al technical revisions carried out fuel changes. Fuel change will be done after each working season in authorized workshops, where also the hydraulic and transmission oils will be changed.

7.4.2 Environment impact/effects forecast for operation period

Impacts on water and soil environment

From Kungrad to approximately Kelmes the project area extends on the Quaternary deltaic plains formed by the depositional activity of the Amudaria river.

The ground water of these plains is generally correlated with the regime of the Amudaria river.

Past Kelmes the project area extends onto Ustyurt plateau up to Beyneu.

The hydrogeology of the plateau is characterised by localised ground water basins generally found at the depth of 30 – 60 m .

Environmental impact

Considering that the proposed railway rehabilitation works do not require any re routing of the existing line, no significant impacts on the geological environment are expected in relation with this project; the only project action of some potential impact on the soil and subsoil refers, in fact, to the possible quarrying of the materials required for the re construction of the top of the railway embankment.

An important danger of the underground water is related to the qualitative changes of the water produced through the pollution with impure substances altering the water's physical, chemical and biological qualities. The more significant contamination may appear in case of accidents or failures in the freight transport, special the liquid products transport. In fact the potential polluting substances, if not disposed of properly and evacuated directly into the watercourses, will modify their quality class.

Impacts on biological environment (flora and fauna)

The proposed railway projects are an existing railways requiring upgrading and do not involve in any fresh encroachment into previously inaccessible areas. Therefore destruction of valuable wildlife habitants and impediments to wildlife movements is not expected during the operation period.

Impacts on atmospheric environment

When the rehabilitation project is completed the discharge amount of air pollutants will be decrease considerably.

Impacts on noise and vibration environment

Quite part of the lines lies on the outskirt of the cities or countryside where there are less residents and rarely located sensitive areas; in those stretches the railway noise has a minor impact.

Impacts of solid waste during the operation period

After the project completion the passenger flow increase generating unfavorable impact to the railway and train sanitary conditions. The stations mainly handle the train refuse and domestic refuse from railway stations. All the refuse are required to have a classified treatment in for categories (including paper, wood, fruit shell and fruit foodstuffs); plastic and glass and metal with refuse box provided respectively the trains and stations.

During the operating period specific domestic waste will be resulted from the railway traffic and also waste resulting for an improper actions of the railway traffic participants such as throwing away of bags during traffic.

Matrix of identification and screening of Environmental Impacts during the construction and operation period

The following matrix summarizing:

- Type of impact (positive or negative)
- The timing (construction, operation)

- Nature of impact (direct, indirect, cumulative)
- The magnitude of impact (low, medium, high)

Impact Issue	Timing	Type of Impact	Nature	Magnitude
Soil pollution and erosion				
Erosion	Construction-operation	Negative	Direct	Medium
Alteration of overland and soil drainage	Construction-operation	Negative	Direct	Medium
Air quality	Construction	Negative	Direct	Medium
Nuisance noise	Construction	Negative	Direct	Medium
Vibration	Construction	Negative	Direct	Medium
Natural ecosystem				
Alteration or damage of wildlife habitats, biological resources or ecosystem	Construction	Negative	Direct-indirect	Low
Solid waste management	Construction-operation	Negative	Direct-indirect	Medium
Social – economic environment				
Employment opportunities related to rehabilitation works	Construction	Positive	Direct	Medium
Human health				
Water borne diseases	Construction	Negative	Indirect	Medium
Increasing water demand/waste water	Construction	Negative	Direct	Medium
Construction camp	Construction	Negative	Direct	Medium

7.5 Recommendation and Mitigations measures

7.5.1 Environmental protection measures plan during construction period

The recommended mitigation measures, both for construction and operation period, are discussed in this chapter, following the same categories for potential impacts. Such measures consist essentially on prescriptions for the construction period or rather project solutions or technical-realizations with the purpose of foreseeing the possible rising up of impacts in the territory.

Therefore, both in the construction and operation period, it should try:

- to contain the impact on the settlement keeping the layout of the project as further as possible from the houses/residential area and, where this is not possible, adopting technical solutions.
- to reduce the interruption of the agricultural continuum restoring the accessibility conditions of the local connections network.
- to maintain the continuity of the water network

It has been underlined two categories of the project:

- the one of mitigation measures
- the one of optimisation of the project on the contents at the outline

The mitigation measures are finalized to pursue the elimination/ control of the potential interferences gathered during the environmental analysis that had taken into consideration all the elements involved.

The second category of activities carries out a double function: integrate the project infrastructure and the interventions of mitigation defined among the operation context. In the definition of these works, the landscape planning covers an extreme important role. In order to define the type of operation of environmental setting it was taken into deep consideration the components Vegetation and Landscape.

Measures of environmental prevention and protection during construction period

At this phase of the project the number and location of the construction site cannot be identified exactly.

Obviously the realisation of a new transport infrastructure provokes major impacts on the surrounding environment then the rehabilitation works proposed by this project, but, in general, there are some guidelines to be always followed.

The places where these organizations will be built must be so set as they don't bring any harm to the natural or human environment (through affecting the vegetation, by imposing land clearings, by affecting the soil structure, atmospheric emissions, by the production of accidents caused by the traffic within the site, or in manoeuvring the materials, by the accidental unloading of cars which transport materials in the surface water courses, by the production of noise etc). Also, it is recommended that they occupies terrain surfaces as reduced as possible, so they don't take out of the actual circuit too large areas of land.

To ensure that constructions camps, temporary works and lifestyle of construction workers do not negatively effect to the adjacent communities, workers should be prevent from using resources held in common by local population. Construction camps should provide services which otherwise would overburden the local public facilities/ utilities.

However, to limit or even to eliminate the impact, several special works are foreseen: installations for cleansing used waters (septic tank) coming from the site organization, decanter for the sludge from the concrete station, impermeable work platforms, etc.

For these objectives to work and for the installations, which serve them, notices and accords must be solicited and obtained by the proper authorities. Usually any measure of good management of construction works, good practice will insure, implicitly, the protection of the environment.

Water and soil environment

In the interested area, one of the most important impact is that on the water environment, strictly connected at the soil environment.

Recommendations and mitigations for prevention water and soil pollution

Concerning the prevention from the pollutions it will need to pursue the following measures. The contamination of the soil, of the under-soil and water structures, superficial and underground, could be done only inside the construction site areas and during the single artwork.

Main items for the prevention measures of the water and soil pollution inside the construction areas that have to be analysed are:

1. prevention of contamination of water structures or of soil by chemical substances used at the construction site;

2. prevention of contamination from stocking of waste produce by the temporally waste depots;

3. recommendations for activities related the delivery of fuel to the deposit and to the refuelling operations;

4. water drainage and waste water treatment devices;

5. maintenance of the construction site machineries.

Even if it is impossible at this stage of the project to localize the areas of the construction site, it is possible to describe the general organisation principles.

It is recommended that the platforms for the production bases have concrete or broken stone surfaces in order to stop or reduce infiltrations by pollutant substances; the provisioning with drains to direct eventual spills, which go over the top in impermeable slots out of which the contaminated liquids can be collected operatively.

Also, for the production bases, the gear maintenance and washing platforms must be executed with a slope so that they insure the collection of residual water (resulted from the wash), oils, fuel, and then introducing them into a decanter, that is periodically cleaned, and the deposits are transported to the nearest cleaning station.

Inside the site organizations the flow of meteoric water must be insured as it washes a large area, on which various substances from eventual losses, so that no they are not forming puddles which, in time, might infiltrate into the underground polluting the soil and the pyretic bed. Their evacuation can be done at the closes emissary or even on the surrounding terrain after they pass through a decanter basin.

The wastewaters that come from the site organization must be introduced into a septic tank, which will be periodically cleaned and evacuated at a cleaning station nearby with which a service contract has been signed previously.

For the execution period the constructor has the obligation to realize all the measures for environmental protection for the polluting or potentially polluting objectives (production bases, material storage facilities, site organizations, earth quarries).

For the foreseen activities along the line the general organisation principles are mainly related to the presence of potential receptors of the impacts, as the watercourses. This kind of activities could in fact generate an increase of the water turbidity.

If the excavation escarpment are stable enough and there is the necessary space, this material can also be used for erecting a temporary embankment around the dig, in order to avoid the flooding and also problems of water contamination that could derive from it.

In general the activity in the bed of the watercourses should take place into circumscribed areas, dry and separated from the running flow trough provisional works and performed in order to limiting problems on the existing bed and on the bank upstream and downstream in the intervention area.

Where possible all the equipments and the plants used for the works should be kept outside the overflowing area during the hours and periods in which the works have been interrupted. It is necessary to avoid the stocking of big quantities of iron close to the work areas: the oxidation of iron materials could in fact determine pollution phenomenon in the waters and soils.

The platform of the organization must be designed so that the meteoric water is also collected through a system of ditches or drains, where sedimentation can take place before the discharge, or they can be outfitted with draining holes from where the water can be introduced into the modulated cleansing station outfitted for sewage waters. For the collecting and the cleaning of the wastewaters during the constructions execution it be referred to the following basic operations:

Installing of septic tanks at the construction site;

Drainage of the rain water towards the sedimentation chambers (which must reduce the suspension by 90%);

Before discharging to the emissaries, the collected rain water will be passed through oil separators (which must reduce the oil content by 90%).

Therefore the mitigations measures that shall be foreseen for prevention water and soil pollution are:

-Appropriate waste management control;

-Disposal management of unused oil, fuels and their containers;

-Ensure drainage systems do not polluted water sources through appropriate alignment or through filtration;

-Ensure other sources of pollution are not allowed to enter the waters course;

-Prevent water pollution and turbidity;

- Scheduling construction activities near waterways for seasonably dry periods, wherever possible.

Recommendations and mitigations for prevention soil erosion and slope stability

Owing to the favourable nature of the topography, no special mitigation measures for stabilizing, cut and fill slopes are considered necessary, for the most part. In case of the area, normal good engineering practice and drainage system will be adequate.

In case of areas prone to erosion soil, the proposed mitigation measures will be in addition special retain structures and bio – engineering medium control techniques.

This kind of mitigation measures should be incorporated during major works. Bio – engineering, as well as other slope protection measures are very site specific and can be selected at engineering design stage and finally during the construction.

The mitigations measures shall be foreseen for prevention of soil erosion and slope stability are:

- scheduling construction activities near waterways for seasonably dry periods, wherever possible;
- re – vegetation of barren earth surface such borrow pits and storage yards, where appropriate, with final treatment to involve landscaping aesthetics, as well as measures for erosion control;
- protection of drainage from flowing waters, trough bafflers in the cannels, rocks aprons at the end of the culverts and other points or rapid water flows, surface stones and/or gabions (wire baskets filled with stones) by embankments or abutments at stream crossings;
- Construct the base of the railway from porous material in order to allow water to continue draining.

Most of the part used/occupied by the construction site, once demolished, will be given back to the public service, through the realization of projects following the plans of the town Council, or to private previous use.

In particular at the end of the construction phase and in order to avoid after the closing of the construction site, impacts on the water and soil, it will be important to provide the following recovery activities:

1 -Elimination of residues, of constructive works and of debris.

2 -Restoring of the original morphology

3 -Restoring of the superficial hydrography.

4 -Restoring the current soil uses.

Biological environment (flora and fauna)

In order to protect the actual vegetation and farm crops from destruction, maximum care should be taken in selection of foreseen detours and access routes to the construction sites and to the borrow pits and quarries. Design and construction of the required detours at several locations along the projects should choose that will cause minimal damage to the natural vegetation.

Land clearing with the destruction of shrubs or other vegetative cover may lead to soil erosion, modification in biodiversity, loss of indigenous vegetation.

A new right of way of permanent road alternatives or of temporary detours during construction, will result in consumption of natural space, destruction of flora and severance effects on fauna.

The stability of ecosystem, which was already altered by human interventions, is reduced and its vulnerability to new disturbance factors is significant.

The use of chemicals, herbicides, etc., to clear vegetation shall be forbidden due to the heavy pollution they cause to the soils, ground and surface water and they are toxic to humans and animals.

Then the mitigation measures foreseen for this component are:

- Prevention of neighbouring surface deterioration in order to not lose and/or affect the floristic and faunistic habitats from working and conterminous areas and detours and, in addition, access road to the construction sites and to the borrow pits and quarries
- Control of dust levels;
- Control of fuel and other volatile matters discharge near sewerage;
- Prevention of drainage systems alteration;
- Prevention of soil compaction in areas designed for materials and equipment storage;
- Restore vegetation immediately after the end of works.

Atmospheric environment

It is recommended that during the works to be used only equipment and means of transport that have Diesel engines that produce very little carbon monoxide and no Pb emissions. Construction machinery must be well maintained to minimize excessive gaseous emission.

Traffic speed should be restricted and application of water or other dust suppressants should be applied to the road at regular intervals (in the urban areas the use of bumps is recommended). The pavement of the roads has direct positive impact on people's health and decreasing risk of accidents in order to reduce dust in the urban areas, particular gravel is recommended.

Trucks carrying fine materials that are easily wind blown should be covered with appropriate covers.

To control the powders inside the construction site areas, in the presence of receptors, could be adopted in addition continuous panels of h = 2.00/2.50 m.

Noise and vibrations environment

The following recommendations may be added:

- The itinerary of the transport track must be carefully studied in order to avoid as much as possible noise and vibration disturbances and than strictly respected;
- In particular the dumpers must be operating as far as possible from the existing human settlement;
- For the working activities be developed at distances from populated areas lower than 200 m, the works should be undertaken only during the day or screened by anti – noise screens;
- The arranging of the activities in the construction site should be studied in the way that noisy activities would be protected;
- The stocking of materials in the construction site should be located in such a way to act as a noise barrier toward the settlements;
- The noise absorption system provided for the machinery should be regularly maintained.

Solid wastes

The construction period recommendations about the management of the solid wastes come from the working activities are:

- the waste stores from the rehabilitation of the embankments must be reused after a screening;
- the waste remaining will be transported in the existing landfills where fertilizing works are to be provided and reclaim such areas for production. In alternative the waste could be use as cover material in municipal urban waste stores for reduce the emissions to the atmosphere and prevent animals and human access;
- the metal waste should be reused, as possible;
- The used electrolyte solutions will be first neutralized then disposed of the closest municipal waste facilities;

7.5.2 Environmental protection measures plan during operation period

The objective of the present study is that to mitigate the foreseen impacts from the rehabilitation works for the proposal and existing alignment. At the same time the mitigations measures have the aim, in the operation phase, both for the new and for the actual stretches with the objective to the global environmental rehabilitation of the interested areas.

With reference to what before developed concerning the analysis of the interferences derived from the work during the operative phase, follows the description of the mitigation measures foreseen. The environmental components, the parameters involved and the related effects are summarized in the table below.

ENVIRONMENTAL COMPONENT	ENVIRONMENTAL PARAMETER	EFFECT
Water environment	water network	crossing of the main and secondary hydric network
	areas of overflowing	crossing of the areas influenced by periodical overflowing.
	hydrogeological vulnerability	crossing of areas with high vulnerability
Noise-Vibration Enviroment	Acoustic limits	receptors in which it is possible to see the overcoming of the acoustic limits

With reference to the potential effects noticed during the environmental analysis , below the description of the mitigation measures adopted.

Water environment

The mitigation measures required for the component will be planned in the project preparation and carried out in the construction phase.

Water network

The problems of the alteration of the continuity of the superficial and underground hydric network belong to the aspects taken into consideration during the projecting of the works. The project should guarantee the maintenance of the superficial hydric network continuity either the principal nor the secondary one through the adoption of the appropriate works.

Hydro-geological vulnerability

The analysis carried out for the definition of the hydrogeological vulnerability areas directly affected by the project layout underlined the problem of protection from a possible contamination connected with the infiltration of contaminated waters in the water tables under conditions of high level of vulnerability.

In fact it is emerged that in the inspected area the level of vulnerability is really high depending on the depth of the water table. In this case, such an elevate level of vulnerability imposes the necessity to avoid the dispersion of the waters in the soil and of taking away them to areas of low level. The separation will be provided using a canalisation network properly sized and their content will determine the realization of appropriate catchment's areas, waterproof at the bottom, that will allow to perform the pre-treatment of the fluids before being give back to the superficial hydric network.

Noise and vibration environment

The estimated analysis of the infrastructural railway insertion, has underlined the necessity of providing mitigation measures along the railway in order to minimize acoustic environmental impact.

The leading criteria will be:

- to maximum protection likely to be achieved by using plane dimensional anti – noise screening in high sensitive areas (school, hospital, etc.) and in the high populated residential areas;

- to take the noise level lower or equal to 70 dB(A) in all residential areas.

The acoustic protection measures suggested could be divided into two categories:

- sound absorbent barriers in which, in function with the distance and of the quality of the receptors involved nor the intervention context .

- insertion, when is possible, of arbores/shrubbery screens functioning as a filter for the acoustic contaminations; these green screens provide also a function of integration of the infrastructure in the landscape. Forestation may be made along the line in a planned way if possible, especially at the newly constructed railway and it may be set up with evergreen arbores, shrubs and lawns combining together.

Matrix of environmental recommendations and measures of mitigation

Project stage	Project preparation	Construction period	Operation period
1. Planning activities			
- Selection of construction camp sites and ensure availability of resources (water, fuel, etc.) for potential future settlements			
- Selection of less vulnerable sites (distant from urban areas, cultural heritage sites, protected areas)			
- Consultations with local officials before locating and building the camp			
- Consider the location of special environmental areas during route selection for detour roads			
- Traffic management: plan location of sign/ traffic management measures (bumps) to be posted/ constructed			
2. Activities during preparatory phase and construction works			
- Identification of critical areas and construction of speed bumps/ passing points			
- Post traffic sign and warnings at construction sites in advance			
3. Construction activities related to erosion and slope stability			
- Re - vegetation of barren earth surface such as borrow pits and storage			
- Avoid any under cutting of such slopes			
- Avoid using land slide susceptible slopes for the extraction of construction material			
- In unstable areas use gabion retaining structure			
- Use of bio - engineering techniques			
4. Other preventive measures			
- Reused of the waste stores from the rehabilitation, as much is possible			

- Adoption of regulation that prohibit livestock grazing on railway shoulder, embankments and row			
- Rehabilitation of detours after construction			
- Maximum care should be taken in selection of detours and access routes to borrow pits and quarries: design and construction should choose routes that will cause minimal damage to the natural vegetation			
5. Construction activities related to water and air quality and noise			
- Scheduling construction activities near waterways for seasonably dry period			
- Protection drainage from flowing waters			
- Prevent water pollution and turbidity			
- Construction waste, waste oil and other liquids must be disposed in a proper manner			
- Reduction of the traffic speed especially in the urban areas			
- Application of water on construction roads and sites pavements as appropriate to prevent high dust emissions			
- All trucks carrying fine material should be covered			
- Construction machinery must be well maintained to minimize excessive gaseous emissions			
- Areas with activities producing excessive dust or for material stock should be screened			
- Activities producing excessive noise levels should be restricted to the day time and equipment producing high levels should be suppressed or screened			
6 . Activities related to construction camps			
- Restore vegetation immediately after the end of the works			
- The storage of the hazardous materials by the construction camps and their use in construction must be appropriate			

- After the use of these materials their disposal system must be proper			
7. Activities related to borrow pits and quarries			
- Working plan giving an outline of the direction , phasing and depth of working			
- Reclamation/ restoration n plan giving details of final grading, drainage and sediment control, resoling and re - vegetation measures and design after use			
8. Operation activities related at the noise level control			
- Protection the critical surrounding areas with noise barriers			

7.6 Environmental management Plan

The potential negative impacts have been identified and discussed "Environmental impact forecast" and the recommended mitigation measures that should be adopted to avoid or minimise potential adverse impacts are discussed in "Recommendations and mitigation measures". Some of the measures involve good engineering practices while others are viewed from human and social angle. The table at the end of this Chapter provides a summary of mitigation plan and the organisation responsible for their implementation.

The management will cover two periods. It will cover the period during the construction phase of the project and operation phase of the railway line programme.

The following stakeholders will perform different roles in the management programme:

- interested Ministries and the Environmental protection agencies;
- extension personnel and community participation. To ensure that Environmental management measures succeed, the extension personnel in the relevant/line departments will carry out the work of community mobilisation continuously. This is a two way process in that the affected communities are involved right from the start so that mutually beneficial agreements are reached to between all the agencies;
- the Contractor is the key player during the pre-and construction phase. He is to ensure that all guidelines as agreed on in the contract documents regarding the Environment are implemented.

Environmental management and protection program

A principal project goal is environmental protection of the project. It is achieved through avoidance or mitigation of anticipated drawbacks associated with the project, and enhancement of the project benefits. Towards this goal, the Consultant recommends an environmental management and protection program.

7.6.1 Environmental Management

The environmental management program has the following objectives: protection of the environment from potentially detrimental line and related activities, and vice versa; enhancement of line attributes, especially in regard to integrated local development; governmental institutional strengthening in conducting environmental protections and monitoring. These objectives can be achieved by the following elements of the environmental program: a small environmental team, as guided by an advisory group; resources to assist the highway-related units; a diverse array of impact mitigation and enhancement measures; contractor requirements for environmental protection to be implemented during the rehabilitation of the lines.

Environmental Team

The Consultant proposes a small team of the Local Railway Companies (LRC) to operate an environmental management program for this project. This group would coordinate and administer all aspects of the program. Through training and experience with this project, this team would develop further an environmental oversight capability within LRC on future projects, and programs. Specific duties of the team for the project road will include the following: promote cooperation among government officials, contractors, engineers, construction crews; organize training workshops; facilitate environmental monitoring and evaluation of the biophysical and socio-cultural concerns pertaining to the line; help administer resources designated for assistance at the local level; conduct studies, and perform other project-related tasks.

A two-person team, a coordinator and an assistant, should be sufficient to implement the environmental management program. The team will require additional LRC support (e.g., secretarial and vehicle driving) assistance, upon occasion.

Resources

Resources for implementing the environmental management program are of two types, personnel and finances. The recommended personnel include the environmental management team, an advisory group to the project, and an array of persons from construction staff to government officials at all levels. Further recommended are bringing the latter together at workshops.

The advisory group is an organization that should issue candid advice on program, liaison, and practical matters concerning environmental aspects of the project. This group should represent the array of parties involved in activities of the road project (e.g., transport operators, local financiers), and persons with living and/or professional experience with the areas of the project. The Environmental Coordinator will ultimately decide upon the composition, size, policies, and procedures (e.g., conditions and timing of group gatherings) of the advisory group.

The workshops are of three types. One will facilitate coordination and communication among parties involved in small, local development projects. Another workshop will provide practical training for construction and LRC personnel on implementation of mitigation measures appropriate to Project. A third is a series of duplicated workshops that will focus upon arrangements its and techniques for maintenance at the local level.

Project and Local Development

Impacts of railway projects are usually viewed as potentially deleterious effects to be avoided or mitigated. Another category of effects, beneficial ones often accrue to railway projects both during and after construction is completed, and/or may be indirectly induced by changed transport.

Project benefits occur during construction or rehabilitation of lines. Employment and purchases of local supplies are not the sole potential positive benefits during construction. Others are development related, but often are unrealised where the projects address a sole aim (i.e., implementation) without consideration of other community needs.

People at the local level are relatively uniformed about the project, activities and procedures. Many communication problems can be avoided if publicity begins soon after tender documents are issued. Informing people about the projects, planned construction schedule, employment, procurement procedures and other concerns in the form of press releases, memoranda to relevant parties, and other means that will facilitate liaison.

Requirements of Contractors

Frequently, there is displeasure over barren areas, rubble pipes, scattered wastes sprawling borrow pits, damaged archaeological artefacts and other problems that are easily preventable through careful construction practices.

Adherence of construction workers to environmental requirements is a major aspect of environmental protection in road projects. This adherence is best achieved through training and contract stipulations, as outlined in tender documents. Monitoring and enforcement of the requirements are necessary aspects of the process that will be part of the duties of the environmental team.

Environmental Management Plan

Impact Issue	***Measure Required***	***Timing (start up of measures)***	***Duration of Measures***	***Responsibility***	***Monitoring***
Physical Environment					
-Erosion	▪ Re-vegetation of barren earth surface such as borrow pits and storage	Project preparation	Operation phase	LRC-Contractor	Monitor implementation
	▪ Special retaining structures	Project preparation and construction phase	Construction and operation phase	LRC-Contractor	Monitor implementation
-Slope stability	▪ Avoid using land slide susceptible slopes for the extraction of construction material	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
	▪ In unstable areas use gabion retaining structures	Project preparation	Construction phase	LRC-Contractor	Monitor implementation / construction
	▪ Bio-engineering techniques.	Project preparation and construction phase	Construction and operation phase	LRC-Contractor	Monitor implementation
Hydrological conditions and water quality					
-Water resources and	▪ Waste oil and other liquids must be disposed in a proper manner	Construction phase	Construction phase	LRC-Contractor	Monitor implementation

Impact Issue	Measure Required	Timing (start up of measures)	Duration of Measures	Responsibility	Monitoring
	▪ Increased use of natural resources due to influx of construction workers: o Ensure drainage systems do not pollute water sources through appropriate alignment or through filtration as appropriate o Ensure other sources of pollution are not allowed to enter the water courses o Ensure that local people's needs take precedent over construction and construction workers o Ensure that access points/paths to water sources for people are not disrupted during construction and post-construction o Contractors are required to make arrangements for water supply that do not affect supply to other users o To ensure that access points to water sources are not blocked during construction o To provide adequate washing facilities for construction workers o Prevent pollution of water courses	Construction phase	Construction phase	LRC-Contractor	Monitor implementation

Impact Issue	*Measure Required*	*Timing (start up of measures)*	*Duration of Measures*	*Responsibility*	*Monitoring*
Air quality	▪ Traffic speed should be reduced (bumps) and regular application of water on road pavements may be required as appropriate to prevent high dust emission	Project preparation	Construction phase and operation	LRC-Contractor-Local authorities	Monitor implementation / construction
	▪ All trucks carrying fine material should be covered	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
	▪ Construction machinery must be well maintained to minimise excessive gaseous emission	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
	▪ In order to reduce dust in the villages, also a particular gravel is recommended	Project preparation	Construction phase	LRC-Contractor	Monitor implementation
Nuisance noise	▪ Activities producing excessive noise levels (work in borrow pits and quarries) should be restricted to the day time and equipment normally producing high levels should be suppressed or screened when working within a distance of 200 m. from any settlement or religious building	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
Construction camp	▪ Consultations with local officials before locating and building the camps, including discussions on appropriate sites, resources, dispute resolution procedures and rights and responsibilities of various parties	Project preparation	Construction phase	LRC-Contractor	Monitor implementation

Impact Issue	*Measure Required*	*Timing (start up of measures)*	*Duration of Measures*	*Responsibility*	*Monitoring*
	▪ Restore vegetation immediately after the end of works	Construction phase	Construction phase/end of work	LRC-Contractor	Monitor implementation
	▪ The storage of the hazardous materials by the construction camps and their use in construction (vehicles, asphalt plants etc.) must be such as not to let chemicals to leak to the soil or water system. After the use of these materials their disposal system must be proper as not to harm environment	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
Biological Environment					
Natural vegetation	▪ Maximum care should be taken in selection of detours and access routes to borrow pits and quarries	Project preparation	Construction phase	LRC-Contractor	Monitor implementation
	▪ Design and construction of the required detours at several locations along the project line should choose routes that will cause minimal damage to the natural vegetation	Project preparation	Construction phase	LRC-Contractor	Monitor implementation
	▪ Minimise destruction of trees and vegetation	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
	▪ Restore vegetation immediately after the end of works	Construction phase	Construction phase	LRC-Contractor	Monitor implementation

7.7 Monitoring Program

7.7.1 Monitoring in construction period

Monitoring is carried out to assess any disturbance to the environment and to protect both LRC and the affected parties from false charge. An environmental inspector could be proposed to this project by LRC. The inspector should have a number of short-term inputs from the commencement of the construction through to its completion and until cleanup has been finalised.

During construction, monitoring of the following indicators is recommended. Although LRC will retain administrative directive and management, certain part of this programme, as described below, will be performed by other agencies under contract to LRC.

Monitoring plan and implementation program

Monitoring a project or a program and its surrounding is a tool for decision-making, not an end product. The monitoring will be conducted by the environmental team and Environmental protection agencies. The monitoring will involve maximum use of information collected in existing regular channels for reasons of resources efficiency and to avoid adding to the workload of the organisation compiling data. The information will be used in three types of monitoring: construction activities; effects of the project upon the surrounding environment and vice versa; internal progress of the environmental management group.

Environmental implementation measures

Monitoring the environmental protection measures during construction mainly concern the progress of impact mitigation and enhancement and the construction activities that are required of the contractors. The latter include rehabilitation or protection of borrow pits, re-vegetation of barren areas, bush clearance with minimal ancillary damage to the landscape, proper waste management and other obligations. An aim is for the environmental team to help the contractors maintain sensitivity towards environmental concerns, meet their contractual responsibilities and have flexibility in response to environment-related issue.

The effects of the project road upon surrounding environment has both short-range and long-term dimension. The short-range effects mainly involve construction-related activities.

Monitoring these events require attention to the following:

- Appropriate data collected by government agencies;
- Suitable institutional arrangements and communications;
- Necessary staff to get tasks done;
- Adequate financial and technical resources;
- Capacities to compile, process and analyse information in a timely fashion.

The kinds of effects to be monitored:

- Population displacement;

- Resettlements and compensation;
- Construction-related pollution;
- Land and water uses;
- City infrastructure.

In addition to construction-related concerns, the environmental management team will establish systems to monitor long-range, mainly development-related effects.

It will be necessary to assess the capacities of organisations to collect the required data and perform appropriate analyses.

Environmental management team

The aim of a group that monitors its own program is to determine the adequacy of past and present tasks, so as to plan for the future. On the project road these evaluations will address the subjects of staff, finance, support, resources, progress of program activities and change to work plans.

The monitoring will include quarterly work-plans that are update as necessary and quarterly meetings or as necessary, to anticipate problems, suggest solutions and help implement the work program.

Work program

The environmental protection work program has the following goals:

- The implementation of environmental protection measures both during the construction of the project and afterwards;
- The addressing of environmental issues by appropriate organisations and officials, within the context of long-term planning and management of the project;
- The organisational strengthening of LRC.

Work activities

Work activities for environmental protection associated with the project are in four areas:

- Establishment of liaison, communications and working arrangements;
- Implementation of measures for avoiding or mitigating problems and enhancing benefits and opportunities associated with the roads project;
- Monitoring activities;
- LRC staff training.

Much of the work involves monitoring contractor activities and coordination of the impact mitigation and enhancement measures. The Environmental Coordinator will arrange specific work activities and organizations responsible for their implementation.

Schedule

Early activities of the environmental team include the following:

- Preparation of the training materials for the workshops, followed by the start of the training itself;

- Dissemination of information about the project;

Many of the activities involve coordination, encouragement, and impetus provided by the environmental staff, rather than their extensive participation.

Some tasks will begin with the construction of the line. These include the following activities:

- Establishing working relationships and monitoring arrangements with the contractors;

- Facilitation of planning for lay-byes and service centres;

- Feedback from the advisory group on organisation, initial efforts and future program priorities.

7.7.2 Monitoring Plan Physical and Biological Environment

Soil and Erosion

Monitoring during construction shall be done by LRC (Environmental Inspector) as per the mitigation measures recommended in Chapter E. During operation the district maintenance office should conduct the surveillance of erosion.

Terrestrial Vegetation

The purpose of this programme is to monitor effects of the project during the construction and after the completion of the project. The monitoring of components associated with terrestrial vegetation will be contracted to the interested Ministry and the Environmental protection agencies, they will determine which species stands should be planted and implement as recommended by mitigation plan and periodically report the progress to LRC.

Agricultural Land

The LRC (Env. Ins.) should ensure that topsoil stripping and separate stockpiling occur during construction on agricultural land. Topsoil shall be removed to its actual depth. After completion of the work all stored topsoil shall be returned to its original area.

Nuisance Noise and Dust

It will be the responsibility of LRC (Env. Ins.) or Site Engineer to ensure that appropriate control measures are taken.

Clean up

Following the completion of the road project, it will be necessary to cleanup and rehabilitate the construction site.

This monitoring will be maintained for only a short duration during the cleanup of the construction site to ensure that environmental precautions are implemented.

7.7.3 Monitoring Indicators

Objectively verifiable monitoring should include (It is a suggestion):

Item	Indicator (Ex.)
Soil	Hectare of land by use, tons/hectare/year of loss of terrain
Water	COD, BOD, (O2 mg/l), other (following the legislation of Kazakhstan, Uzbekistan, Kyrgyzstan)
Biota, vegetation	Hectares and type of green areas, hectares and type of critical areas, tons and type of harvest products, n° of animal-vehicle traffic accident
Safety	Accident/injury records, traffic counts, safety inventory
Atmosphere	Traffic counts, traffic projections, vehicle test records, meteorological records, emissions in atmosphere (NO, CO, SOx, PM10)
Noise pollution	Noise levels: dB(A)
Line maintenance records	Drain maintenance reports, supplies inventory records, rehabilitation

Environmental Monitoring Plan

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
		Physical Environment			
-Erosion	Mulch used in establishing vegetation propagated by seeds as appropriate	Monitor implementation			
	Adoption of regulations that prohibit livestock grazing on road shoulder, embankments, and right of way, as necessary.	Monitor implementation			
	Special retaining structures	Monitor implementation / construction			
-Slope stability	Re-vegetation of the land, since tree roots can hold soil together	Monitor implementation			
	Up slope cultivation in such zones	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	In unstable areas use gabion retaining structures	Monitor implementation / construction			
	Bio-engineering techniques	Monitor implementation / construction			
Hydrological conditions and water quality					
-water resources and water quality	Waste oil and other liquids must be disposed in a proper manner	Monitor implementation			
Air quality	Traffic speed should be reduced (in the villages the use of bumps is recommended) and regular application of water on road pavements may be required as appropriate to prevent high dust emission	Monitor implementation / construction			
	All trucks carrying fine material should be covered	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	Construction machinery must be well maintained to minimise excessive gaseous emission	Monitor implementation			
	In order to reduce dust in the villages, also a particular gravel is recommended	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
Nuisance noise	Activities producing excessive noise levels (work in borrow pits and quarries) should be restricted to the day time and equipment normally producing high levels should be suppressed or screened when working within a distance of 200 m. from any settlement or religious building	Monitor implementation			
Construction camp	Consultations with local officials before locating and building the camps, including discussions on appropriate sites, resources, dispute resolution procedures and rights and responsibilities of various parties	Monitor implementation			
	Restore vegetation immediately after the end of works	Monitor implementation			
	Assess vector ecology in work areas and avoid creation of undesirable habitats (e.g. stagnant water)	Monitor implementation			
	The storage of the hazardous materials by the construction camps and their use in construction (vehicles, asphalt plants etc.) must	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	such as not to let chemicals to leak to the soil or water system. After the use of these materials their disposal system must be proper as not to harm environment				
Biological Environment					
Natural vegetation	Maximum care should be taken in selection of detours and access routes to borrow pits and quarries	Monitor implementation	■		
	Design and construction of the required detours at several locations along the project road should choose routes that will cause minimal damage to the natural vegetation	Monitor implementation	■	■	
	Minimise destruction of vegetation	Monitor implementation	■	■	
	Restore vegetation immediately after the end of works	Monitor implementation		■	■
	Forbid project staff to kill, injure or poach wild animals	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
Borrow pits and quarries	Pit or quarry location and area	Monitor implementation			
	Access arrangements	Monitor implementation			
	A working plan giving an outline of the direction, phasing and depth of working	Monitor implementation			
	A reclamation/restoration plan giving details of final grading, drainage and sediment control, resoling and re-vegetation measures and design after use	Monitor implementation			

8. Preliminary implementation schedule

The following Table 8 - 1 shows a preliminary implementation plan for Option "Telecom Works".

The Option Telecom Works considers that all the activities will be up to Contractors. One Contract is envisaged for providing and installing both optic fibre cable and accessories.

The scheduled activities will be completed in 13 months.

As far as Option "Basic Works" regards, as already explained, the main part of the suggested works could be performed during maintenance operation directly by the Kazakh Railways, therefore a preliminary implementation schedule for this option has not been developed. In fact all these works are not urgent and could be coordinated with the execution of the similar activities on the Uzbek section.

As far as Option "Doubling" is concerned, the option is theoretical and it will not be implemented, so the implementation schedule is not needed.

Table 8 – 1 Implementation programme for Option Telecom Works

OPTION TELECOM WORKS

BEYNEU - UZBEK BORDER
WORK PROGRAM

	ACTIVITY/months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	CABLES AND ACCESSORIES (KAZAKH RAILWAYS)																								
1	*Approval and financing work*																								
	CABLE AND ACCESSORIES																								
2	*Final tender document preparation*	■																							
3	*Tendering and signing contract*		■	■																					
4	*Ordering materials*				■																				
5	*Production and handing over material*					■	■	■	■																
6	*Installation of cable and accessories*								■	■	■	■	■												
7	*Commissioning*													■											

9. Benefits Assessment of the Project

9.1 Option "Basic Works"

Option Basic Works benefits are divided in:

1. benefits deriving from the upgrading works related to infrastructure (included stations) and power supply,
2. benefits deriving from works for signalling and safety devices replacement,

These two groups of benefits, as the investment costs, have been treated separately.

9.1.1 Benefits from Infrastructure and power supply works

Running time savings

As calculated in chapter 5.4.3, the following time savings have been considered should Option Basic Works be carried out.

Time savings have been assumed in comparison with "do nothing" scenario, where "do nothing" means that the line will not be upgraded in the terms of this study, but will in any case be taken in operation with the on going maintenance cycles, according to current KTZ finance flows and priority schedule for the whole network.

Time savings from 2007:

- 20 minutes for passenger trains,
- 4 minutes for freight trains.

Replaced materials residual value

Not applicable.

Infrastructure maintenance costs savings

According to current line maintenance procedures, to line maintenance costs per km per cycle and typology (see chapter 4.1.1) and according to the evaluation of maintenance needs after the works have been completed, Consultant estimated the following maintenance costs related to Option Basic Works.

Table 9.1.1 – 1 Maintenance costs "with project" Option Basic Works

Rehabilitation works for Kungrad - Beyneu Line (Border-Beyneu section) Line maintenance costs for OPTION Basic Works							
Year	Required Maintenance (km)			Maintenance Costs (US$)			
	Lifting	Medium	Capital	Lifting	Medium	Capital	Total
2007	0	0	0	-	-	-	-
2008	0	0	0	-	-	-	-
2009	0	0	0	-	-	-	-
2010	0	0	0	-	-	-	-
2011	0	0	0	-	-	-	-
2012	0	0	0	-	-	-	-
2013	0	0	0	-	-	-	-
2014	2	0	0	164,642	-	-	164,642
2015	2	0	0	164,642	-	-	164,642
2016	2	3	0	164,642	619,284	-	783,926
2017	2	3	0	164,642	619,284	-	783,926
2018	2	3	0	164,642	619,284	-	783,926
2019	2	3	0	164,642	619,284	-	783,926
2020	2	3	0	164,642	619,284	-	783,926
2021	2	3	0	164,642	619,284	-	783,926
2022	2	3	0	164,642	619,284	-	783,926
2023	2	3	5	164,642	619,284	2,471,529	3,255,455
2024	2	3	5	164,642	619,284	2,471,529	3,255,455
2025	2	5	5	164,642	1,032,141	2,471,529	3,668,311
2026	2	5	5	164,642	1,032,141	2,471,529	3,668,311
2027	4	5	5	329,283	1,032,141	2,471,529	3,832,953
2028	4	5	5	329,283	1,032,141	2,471,529	3,832,953
2029	4	5	5	329,283	1,032,141	2,471,529	3,832,953
2030	4	5	5	329,283	1,032,141	2,471,529	3,832,953
2031	6	5	5	493,925	1,032,141	2,471,529	3,997,594
2032	6	5	5	493,925	1,032,141	2,471,529	3,997,594

The hypothesis that has been followed in estimating the number of km per year for each maintenance type is that, according to the existing rules for line maintenance, the Railway Administration should make a complete maintenance cycle per each type, every 25 years after the completion of rehabilitation works on the rehabilitated sections. Also in case of "without project", line maintenance cycles for Capital, Medium and Lifting will occur every 25 years.

In the case of "without project" scenario, maintenance needs have been quantified and their cost have been assessed in the following table 9.1.1-2.

Also for maintenance in case of "without project", the estimation of the number of km per year has been based on the existing rules. Anyway, in case of "without project", the estimation has been made following a prudential analysis: according to this analysis, the maintenance needs envisaged cannot be much higher than the real maintenance carried out in the last years by KTZ. In fact KTZ, for a priority policy of resources allocation, in the last years concentrated its investments on other lines, thought to be more strategic for the KTZ network, and this will be presumably done also in the future. Anyway, the proposed "without project" scenario for maintenance forecast is assumed to be the minimum, in order to maintain the line in good technical conditions for operation (as it is currently).

Table 9.1.1 – 2 Maintenance costs "without project"

Rehabilitation works for Kungrad - Beyneu Line (Border-Beyneu section) Line maintenance costs "without project"							
Year	*Required Maintenance (km)*			*Maintenance Costs (US$)*			
	Lifting	*Medium*	*Capital*	*Lifting*	*Medium*	*Capital*	*Total*
2007	5	0	1	411,604	-	494,306	905,910
2008	5	0	1	411,604	-	494,306	905,910
2009	5	0	0	411,604	-	-	411,604
2010	5	0	0	411,604	-	-	411,604
2011	5	0	0	411,604	-	-	411,604
2012	5	0	0	411,604	-	-	411,604
2013	5	0	0	411,604	-	-	411,604
2014	5	3	0	411,604	619,284	-	1,030,888
2015	5	3	0	411,604	619,284	-	1,030,888
2016	5	3	0	411,604	619,284	-	1,030,888
2017	5	3	0	411,604	619,284	-	1,030,888
2018	5	3	0	411,604	619,284	-	1,030,888
2019	5	3	0	411,604	619,284	-	1,030,888
2020	5	3	0	411,604	619,284	-	1,030,888
2021	2	3	0	164,642	619,284	-	783,926
2022	2	3	0	164,642	619,284	-	783,926
2023	2	3	5	164,642	619,284	2,471,529	3,255,455
2024	2	3	5	164,642	619,284	2,471,529	3,255,455
2025	2	5	5	164,642	1,032,141	2,471,529	3,668,311
2026	2	5	5	164,642	1,032,141	2,471,529	3,668,311
2027	4	5	5	329,283	1,032,141	2,471,529	3,832,953
2028	4	5	5	329,283	1,032,141	2,471,529	3,832,953
2029	4	5	5	329,283	1,032,141	2,471,529	3,832,953
2030	4	5	5	329,283	1,032,141	2,471,529	3,832,953
2031	6	5	5	493,925	1,032,141	2,471,529	3,997,594
2032	6	5	5	493,925	1,032,141	2,471,529	3,997,594

Differences between maintenance costs "without the project" and "with the project Option Basic Works" correspond the maintenance costs savings related to Option Basic Works.

Lighter maintenance cycles, as:

1. reconstruction of a ballast section,
2. grinding of rails,
3. inspection for analysis of present condition of a track and
4. minor ancillary works,

has not been taken into consideration in this analysis because their weight is negligible and their quantities will be approximately the same in case of "with" or "without" the project.

9.1.2 Benefits from Safety devices works

The analysis of the effectiveness of the project was focused only on the evaluation of the main measurable effects to be produced by the investments.

The modernization of the signaling and safety devices belongs to a cluster of measures which exert impacts on:

- Rationalization of system operation;
- Rationalization of equipment maintenance;
- Increase in line capacity;
- Improvement of transport service quality.

Not having obtained reliable data of service quality (i.d. news about failures, accidents, trains delays etc) this Consultant dealt with only the first three above benefits.

Workers need for signaling system maintenance

The main equipment of technological sites taken into consideration are electric interlocking installation, automatic and semiautomatic block systems, centralized dispatching control (CTC), automated and mechanized marshalling yards, automatic level crossing signaling system.

Consultant made use of instructions derived from Soviet Railway Rules, as a common meter of estimate of the needs of the Uzbek and Kazak section of the Kungrad-Beyneu where:

1. Specifications of number of workers of the signaling systems are developed on the basis of maintenance work times in view of differentiation of periodicity of manufacture of works (Table E in Annex III).
2. In specifications of number of workers, requirements of standard codes of operating rules, safety precautions regulations, statutory acts on traffic security and other statutory acts working on the railway transportation, are taken into account.
3. In specifications of number are included: time for spadework, service of the work area, regulated breaks, supervision of performance of the works connected to operation of devices, carried out by workers from other services, participation in commission surveys, performance of technical actions on increase of reliability of work of devices, carrying out of technical study.
4. On sites with constant using double-track traffic on each track, norm of service is to apply with factor 0,8.
5. The norm of service at imposing on automatic block system of coded track circuits is applied with factor 0,85.
6. At service of devices which life time has expired from 1 year till 5 years, before their modernization, norm of service are to apply with factor 0,95; after expiring of the term from 5 till 10 years and over 10 years factors are accordingly equal 0,9 and 0,35.

Determination of benefits

The Consultant did not obtain from Kazakh Railway any information about salaries and costs of operational and maintenance work force.

The only indication we had in the Headquarters of Astana was that the average salary for an operational or maintenance unit is monthly 385 $ (5005 $/year).

The cost of this unity for the Company can be stated in 6174$/year.

In Uzbek railways the equivalent cost is 2970 $/year (traffic operator level 1).

Therefore we assumed a cost of work force in Kazakh Railways about twice than Uzbek one.

The benefits of proposed investments can be shown as follow, taking into consideration that the unity costs for work force, on average, in Kazakh railway are twice the correspondents Uzbek.

Operational costs

Decrease of operational needs due to the increased availability of the new safety devices between Karakalpatia and Beyneu (full remote control from Atyrau of Oazis, Akjigit, Kzyl-Asker, Kok-Bekty).

Saving of 20 station supervisors.

The cost per unity may be evaluated, with the criterion above said, of 2590x2 = 5180 $/year.

It must be observed that above benefits correspond to the situation of the stations found on site during the visit of this Consultant and match with the report of local Sub-Consultant (*see Table G of Annex III*).

Successively we learnt that some of the unmanning measures were anticipated by Kazakh Railway. So, on this study, we take into account only the saving of 10 station supervisors (50% of the total).

Operational cost saving will be 51800 $/year.

Maintenance costs

With the investment will occur a decrease of ordinary maintenance needs.

Accordingly above Specifications, the present maintenance need for the interlockings and the automatic block system from Uzbek border to Beyneu may be evaluated in **13** men (Table F of Annex III).

As the new interlocking will be put in the place of others whose life times were expired since more than 5-10 years, we can evaluate the foreseen maintenance need equal the basic (**8** men, see Table F of Annex III).

With the investment will occur as well:

- Reduction of major maintenance,
- Decrease of materials of ordinary maintenance,
- Decrease of failures.

The overall cost saving of the above three points can be evaluated at least of about 10% of present need (about **2** men, see Table F of Annex III).

The cost saving is than the cost of **7** unities. The average cost per unity may be evaluated of 2290x2=4580 $/year.

Maintenance cost saving will be 32060 $/year.

Total costs saving for safety devices installation

The following table resumes the costs savings for new safety devices installation.

Table 9.1.2-1 Safety devices cost savings

Labour saving	Yearly costs (Thousand of USD)
Operational	**51.800**
Maintenance	**32.060**
Total	**83.860**

"With" and "without" scenarios

Following standard practice, the financial justification of the Project shall be based on a comparison of the discounted incremental costs and benefits flows associated with the "with" and the "without" Project Scenario.

The "with project" situations relates to the costs and benefits arising from the realization of the Project which foresees:

- the renewal of the old Electric Relay Interlocking Installations (ERII) of the relevant section by the activation of Electric Relay Interlocking Installations of new generation;
- the construction with renewed equipment of Automatic Block Line Systems (ABLS) and Cab signalling of the relevant line sections;
- the insertion of the new equipments into the existing Central Post (P.C.).

On the other hand, the "without" Project scenario is based on a realistic assumption of what would happen, should the Project not be implemented.

To the purpose of the economic and financial analyses, it shall be assumed that the "without project" scenario would imply:

- an increase in the provision cost of materials for carrying out safety devices maintenance, since current obsolete equipment spare parts are becoming increasingly expensive, given the incoming lack of a regular industrial production;
- extra-costs due to the need of avoiding further deterioration of the quality of service in terms of traffic regularity and safety. The extra costs will be necessary because current maintenance is expected not to be able to prevent an increase of failures on the devices.

In order to develop the economic and financial analyses these extra-costs can be quantified in 25% of the total costs of current maintenance which have, for safety devices, the structure of the table 9.1.2-2.

Table 9.1.2-2 Structure of current safety devices cost savings

Cost item	**share**
Material	15 %
Energy	1%
Maintenance services	2%
Remuneration in connection with work	4%
Wages and compensations	41%
Other costs	5%
Overhead costs	32%
Total	100%

Therefore wages and remuneration in connection with work are the 45% of the total maintenance cost for signaling. (The same evaluation we find on Norms of Technological designing of devices of automatics and telemechanics on the railway transport, Moscow, Ministry of Railways, 1985).

In the line sections involved by scenarios the labour costs can be evaluated as follow:

Uzbek Border - Beyneu: need 13 men.

The average cost per unity may be evaluated of 2290 x 2=4580$/year.

Labour costs will be 59540 $/year.

Therefore the total cost of current maintenance sum to:

Uzbek Border - Beyneu: 59540 x 100 / 45 = 132311 $/year

Finally the Uzbek Border - Beyneu extra costs are:

132311 x 0,25= 33.078 $/year.

9.2 Option "Telecom Works"

The Consultant has specified a large number of benefits to be generated by the rail telecom infrastructure improvement. The approach used for the economic impact assessment by the Consultant has been very prudent and some of these benefits, which are described below, have been excluded from the analytical calculation. The existence of additional benefits can only further improve (providing this would be necessary) the good performance of the project.

Direct benefits are expected to derive from performance improvements in the following domains:

- Telecommunication maintenance and operation cost;
- Traffic management and train delays;
- Revenues from leasing excess capacity to third parties;
- Train operational improvement;
- Energy costs;
- Enterprise management;
- Installation of powerful communications links between railways in the region.

The indirect benefits are difficult to be quantified and have not been considered in the analytic calculation, anyway they are important and contribute to the evaluation of an economic investment:

- Installation of further set of equipment using standard technologies;
- Creation of the infrastructure required for the installation of more advanced traffic control, operation, maintenance systems;
- Creation of the infrastructure necessary to fit real-time freight tracking systems requested by customers.

9.2.1 Benefits from Telecommunication system

Telecommunication maintenance and operation costs

Base Case

The costs for telecommunication maintenance and operation in KK2003 were the following:

- maintenance cost 2,465 $/km,
- operation cost 435 $/km.

These costs were estimated by the Consultant, in the framework of the Central Asia Railways Telecommunications Project, from available data taken directly from Kazakh Railways, from specific studies (Rail Maintenance Central Asia Project (1998) - Tacis/Traceca Programme) and from similar data of Central Asian railways, taking into account also specific economic indicators (GDP, average salary for technical staff, etc.).

Under the base case, because of the condition and the age of the equipment and considering the present trend, these expenses are expected to increase at a rate of at least 5% per year. There would be little or no opportunity for staff redundancies. There would inevitably be an increase in expenditures on parts and factory repairs. This leads to doubling of maintenance charges in fifteen years.

It is expected that equipment will wear out beyond possibility of repair, and that progressive abandonment and cannibalisation of components of the system would take place, as in some case is just happening.

Project Case

In a new digital system, the operations and maintenance costs are extremely low. In complete contrast to the present situation, all circuits will be automated and solid state, with no wear as such, nor staff intervention required completing a connection.

Maintenance and operations charges would then be approximately 4% of the initial cost of the equipment, and 0,20 $/m of laid fibre optic cable. This would be in line with west European practice. It is expected that operations and maintenance costs would increase at 2% per year.

The saving streams (difference between base and project case) for maintenance and operation during the evaluation period are shown in Table 9.2.1-1.

In the transition period, some training programmes for professional development of the staff have to be foreseen. The implementation of these courses is not a cost from the economic point of view because they increase the value of the personnel.

Other benefits would include reduced space requirements of the new equipment, which are much lower than that for the old one. No new buildings are foreseen, and extensive space may be liberated in existing facilities for other purposes. The fact that existing equipment should, sometime, be used transitorily for other lines, has been considered to bring negligible benefits into the railways telecommunications system.

Traffic management and train delays

Traffic management failures cause train delays and wasted hours. The existing situation is expected to become worst and worst in a very short time. This is because of the age of all the existing equipment whereby the equipment age has already exceeded the technical life. The new implemented telecommunication system would reduce the number of failures producing train cost saving and reduction of train hourly costs.

Few information on traffic failures and accidents were available. But, even if larger bases of information on traffic failures were available, they might not be representative of the real situation. In other words in some cases few traffic accidents recorded can't persuade experts that the system is properly operating. On the contrary the reduction of traffic accidents is generated by exogenous factors first (as it is for example the drastic traffic reduction after the collapse of Soviet Union) and then by the poor performance of the railways system.

The estimation performed, under this condition, aims at reconstructing a more likely situation vis-à-vis the future perspective.

Base Case

The total number of failures on the whole network for previous years has been uniformly assigned to the network to estimate the number of failures along the line; the obtained figure has been checked by comparison of the ratio failure/km recorded for lines in similar conditions in the area. The estimated number of failures along the lines during 2004 were 38. This figure is apparently high but it reflects the poor performance of the systems especially for lines where the existing equipment is very old while the technical life span for such equipment is 25 years.

Every failure generates an average delay, which has been estimated to be 195 minutes on average, being 483 $ the average train hourly cost in 2003 (average value for freight and passenger train). The average train cost has been evaluated taking into consideration a breakdown of operation costs (labour impact, average salary for technicians, energy, etc.) both for passenger and freight trains.

The base case considers that, in accordance with the present trend, the existing number of train hours wasted due to traffic management incidents will be increasing by 5% per year.

Project Case

Due to the poor condition of the existing equipment as before explained the project is expected to reduce delay troubles by at least 40% on the section concerned. Delays will then increase at a rate of 2% per year.

In Table 9.2.1-1 it is shown the saving streams derived from delay reduction.

Revenues from leasing excess capacity to third parties

Optical fibre cables and digital switching equipment allow additional or reserve telecommunications capacity at very low marginal cost. The technical recommendations specified a level of capacity superior to the foreseen needs of the railways, thus creating the option of leasing excess capacity to third parties.

Conservative assumptions have been made saying that costs of renting of telecom facilities is reflecting the cost-opportunity of the resource in the Kazakh economy. The following two paragraphs will be providing more details on how possible benefits can be derived for the Kazakh society.

There are two types of excess capacity:

- Spare channel capacity on the railways operational network
- Laid fibres not activated by the railways operational network, (dark fibres).

Spare Channel Capacity

This type of capacity could be of benefit to GSM operators, companies wishing to create IT links between different locations, internet providers.

But in the proposed technical solution, the potential client has not direct access to the system; it means that in order to use the available excess capacity further investments are needed for creating the necessary interfaces. These aspects renders obtaining of these benefits extremely unlikely. Consequently, taking into consideration also the region crossed by the railway line, the Consultant has not considered this possible benefit in the evaluation.

Dark Fibres

This type of capacity will be used by worldwide telecommunications operators who will have the means and opportunity to install the electronic technology necessary to use the optical fibres surplus to railways needs, without investing in cables.

Indicative international rates are 2-3 $/m/year per fibre pair. For the purpose of this study a more realistic rate of 1,0 $/m/year has been taken, also in anticipation of rate declines.

Taking into consideration that 10 of the 32 fibres specified in the technical recommendation, will be reserved for railways (4 to use immediately and 6 for future needs), the potential excess capacity will lie in the 22 residual fibres in 11 pairs.

For the purpose of this evaluation 11 packages (each consisting of one fibres pair) have been considered, in order to simulate the progressive utilisation of the cable capacity. The first package has been supposed to be activated after 4 years from the entering into operation of the system. Four following packages are supposed to be then activated one every year and the remaining others every two years. The four years for the activation of the first package are due to the fact that presently the Kazakh legislation doesn't allow the Railways to lease excess capacity of their network to possible customers. This four-year period of delay has been introduced to allow the fulfilment of a legislative process, strongly recommended by the Consultant, which could permit to the Railways to lease dark fibres.

Train operational improvement

Modernisation of the telecommunications systems would certainly have a positive effect on these functions:

- Communications with the dispatching centres
- Communications between operational and rolling stock maintenance units
- Management of switches, level crossings
- Station-to-station dedicated telephone lines for safety and other purposes
- Dedicated telephone lines for work crews, for track and catenary maintenance
- Ground to train radio, and other radio communications, which might pass through the fibre.

The improvement of these operations would bring better utilisation of locomotives, wagons, passenger cars, faster train formation, and more efficient terminal operations.

All the above issues will most probably turn into an optimisation of the use of the rolling stock, reducing the cycle time for both wagons and locomotives and consequently increasing their utilisation. So the comparison between "base case" (progressive deterioration of the operational asset utilisation) and "project case" (reduction of lost time for operational assets in asset utilisation at the terminals and in train formation) will be bringing benefits into the project.

Such train operational improvement depends on the telecommunications infrastructure; however not entirely on this. Consequently, the Consultant has made a conservative assumption and didn't include these benefits in the analytical evaluation.

Energy costs

After project implementation, benefits involving energy cost are expected to derive from two different improvements:

- a more efficient dispatching of energy for traction, with for example an easier possibility to identify abnormal load demands;
- a reduction of energy consumption by the new installed telecommunications equipment, respect to the present.

This benefit has not been included in the analytic evaluation as there are not useful and reliable available data for assessment these benefits.

Enterprise management

With the project implementation, reduction of cost of enterprise management (maintenance, commercial, financial, warehouse) is foreseeable.

This benefit would be determined by the real improvement of data transfer facilities and data communication system applied to the following operation:

- Accounting systems, cost controls, invoicing
- Freight and wagon tracking systems
- Locomotive, wagon, and track maintenance management systems
- Warehouse management, stock control, purchasing of consumables, and spare parts
- Border crossing communication and management (e.g. in collaboration with neighbouring state railways and customs authorities)
- Ticketing and reservation systems.

The new telecommunication system will be a primary step for the introduction of advanced solution for the above mentioned aspects, but they needs further implementation. Consequently, the implementation of a new rail telecom system will be in any case generating benefits in the management of the enterprise (for instance facilitating and speeding data transfer), but other investment will be needed for further improvement and personnel training (for instance for new ticketing and reservation system and devices) and other decision should be taken sometime for modifying the organisational structure.

Consequently, the estimation of the benefits by comparison of "base case" and "project case" is complex but also difficult because of the lack or reliable information due to continuous changes in the railway management organisation. Hence, the Consultant has made a conservative assumption and has excluded these benefits from the analytic evaluation.

Indirect benefits

The indirect benefits have not been included in the analytical calculation. Despite this fact, all these effect are really relevant to the development of the railways in the countries directly involved and they will add an incredibly positive impetus mainly to those countries interested in using the rail network in the area for freight transit (like for instance China and Europe).

Installation of further set of equipment using standard technologies

As mentioned in the basic criteria, the implementation of solutions using standards technology is probably the most important step of this study. The installation of this equipment on this railway line has to be seen as an important step for favouring the adoption of standard technology.

Creation of the infrastructure required for the installation of more advanced traffic control, operation, maintenance systems

Also in this case, the installation of new telecom system along the line is the necessary prerequisite for installing more advanced solutions in other domains (traffic control, operation, maintenance), those being the domains related to a centralised vital functions management more then local functionality. Again, the consideration of the cost for telecom to be "sunk cost" is a valid one and it is in the step of taking the decision of implementing further functions.

Creation of the infrastructure necessary to fit real-time freight tracking systems requested by customers

The new telecom system is necessary for having real-time tracking systems requested by customers. This system can make the rail system more competitive vis-à-vis other transport mode and can have influences in both financial and economic terms.

Table 9.2.1-1.– Streams of costs and benefits

Rehabilitation works for Kungrad - Beyneu Line (Border-Beyneu section)					
		COSTS	BENEFITS ($/1000)		
		($/1000)	Savings		Revenues
Year	Year	Capital cost	Maintenance & Operation	Train delays	Leasing excess capacity (dark fibres)
1	2006	1.999,4	-	-	-
2	2007	-	246,8	37,8	-
3	2008	-	260,0	40,4	-
4	2009	-	273,8	43,2	-
5	2010	-	288,4	46,2	-
6	2011	-	303,7	49,3	78,6
7	2012	-	319,8	52,6	157,2
8	2013	-	336,8	56,0	235,8
9	2014	-	354,6	59,7	314,4
10	2015	-	373,3	63,5	393,0
11	2016	-	392,9	67,6	393,0
12	2017	-	413,6	71,9	471,6
13	2018	-	435,3	76,4	471,6
14	2019	-	458,1	81,2	550,2
15	2020	-	482,1	86,2	550,2
16	2021	-	507,3	91,5	628,8
17	2022	-	533,8	97,0	628,8
18	2023	-	561,6	102,9	707,4
19	2024	-	590,9	109,1	707,4
20	2025	-	621,6	115,6	786,0
21	2026	-	653,9	122,5	786,0
22	2027	-	687,8	129,7	864,6
23	2028	-	723,5	137,3	864,6
24	2029	-	760,9	145,3	864,6
25	2030	-	800,3	153,7	864,6
26	2031	-	841,7	162,6	864,6
27	2032	-	885,1	172,0	864,6
28	2033	-	930,8	181,8	864,6
29	2034	-	978,7	192,2	864,6
30	2035	-	1.029,1	203,1	864,6

10. Economic / Financial Evaluation of the Investments

10.1 Introduction

As already explained, the Kazakh Beneficiary is especially interested in the rehabilitation of the telecom system and asked to develop a complete Feasibility Study only for this component. The Consultant agrees on the priority of the telecom issue for the Beyneu – border railway section and has performed the economic evaluation of the Option "Telecom Works".

Notwithstanding that, the suggested infrastructure works included in the described Option "Basic Works" have been evaluated both in terms of costs and related benefits in the previous chapters while Option "Doubling" has been discarded already within technical analysis because it is unfitting with the traffic.

While Option "Doubling" has been discarded already within technical analysis because.

Following the standard practice, the economic and financial justification of the project has been mapped by way of comparison of the discounted cost and benefit streams associated with the "base case" (without project) scenario and the "project case" (with project) scenario.

10.2 Economic evaluation

The calculation of the economic profitability of the projects has been performed by assessing the social value of the project which is summarised by the following indicators:

- Net Present Value (NPV)
- Benefit/Cost Ratio (BCR),
- Internal Rate of Return (IRR).

These indicators result from the calculation, year-by-year, of the net benefits generated by each proposed project against the "base case" option, duly actualised at a base-year to ensure the necessary inter-temporal comparison of monetary flows occurring in different years.

The use of the above mentioned indicators allows for a comparison between alternative projects and a consequent ranking.

In the evaluation process the following common parameters have been defined.

- discount rate
- appraisal period
- base year for price and values.

In the following table are presented some assumptions and common parameters used in the evaluation process of the different alternatives:

Currency unit	US dollar
Implementing start year	2006
Implementing period (years)	1
Base year for prices and values	2005
Operating period (years)	30
Appraisal period (constructing period + operating period)	31
Shadow discount rate	12%

Time schedule for disbursements is in accordance with the time schedule for implementation of the Option under study.

The operating period to be considered has been stated by the ToRs to be over 30 years, and the residual value of investments after that period has been considered to be negligible and consequently not included in the evaluation.

The analyses compare monetary flows of costs and benefits subsequent to the implementation of the project. Normally those flows are generated first in strictly financial terms, which later will be transformed in economic terms. In other words, any implementation involves consumption of resources whose (economic) value is represented by their opportunity cost. This cost reflects the degree to which consumption elsewhere, in the national economies, is sacrificed by diverting the resources required by the projects from other uses. It is also defined as the maximum worth of a good or input among possible alternative use.

Current market prices, established in the imperfect markets, not always represent adequately the opportunity costs of resources, therefore they require to be appropriately adjusted. The strict application of the opportunity cost principle would require to define, for each resource used in the projects, the corresponding "shadow price", which is an estimate of what the price of a good or input would be in the absence of market distortions, such as externalities or taxes. This approach, however, is not applied in the common practice because of the significant difficulties encountered in the identification of all possible distortions on existing market prices, both on goods/services and labour markets.

Hence, the economic value of each resource should be calculated starting from the relevant market prices duly adjusted by subtracting transfer payments, which do not affect the availability of real resources to the rest of the economy. As a general rule, the estimate of economic investment and operating/running costs of each proposed project has to be based on production factors valued at market prices, net of indirect taxes and subsidies.

In the specific project under evaluation, economic costs are closely reflected in market price because of the following reasons:

- all the equipment (first installation and spare parts for maintenance) is tax-exempt;
- a minor part of the implementation costs will be for covering unskilled manpower while the large majority will be for high skilled experts (including foreigners), so no adjustment factors have been introduced for the estimation of the opportunity-cost of unskilled manpower;

- high skilled persons will be operating the system and will be performing maintenance.

Also in the case of renting/leasing of channel/optical fibres form third parties, it has been made the strong assumption that market costs reflects at least the opportunity cost for the Kazakh community of the use of that resource.

The results of the economic evaluation for the project Option Telecom Works is shown in Table 10.2-1, where Internal Rate of Return, Net Present Value (at a discount rate of 12%) and Benefit/Cost Ratio it is also reported.

TABLE 10.2 -1 Economic evaluation of Option Telecom Works

		COSTS ($/1000)	BENEFITS ($/1000)			
			Savings		Revenues	
Year	Year	Capital cost	Maintenance & Operation	Train delays	Leasing excess capacity (dark fibres)	NPV (DR%) (€/1000)
1	2006	1.999,4	-	-	-	- 1.999,4
2	2007	-	246,8	37,8	-	- 1.745,3
3	2008	-	260,0	40,4	-	- 1.505,8
4	2009	-	273,8	43,2	-	- 1.280,1
5	2010	-	288,4	46,2	-	- 1.067,5
6	2011	-	303,7	49,3	78,6	- 822,5
7	2012	-	319,8	52,6	157,2	- 554,2
8	2013	-	336,8	56,0	235,8	- 269,9
9	2014	-	354,6	59,7	314,4	24,4
10	2015	-	373,3	63,5	393,0	323,6
11	2016	-	392,9	67,6	393,0	598,5
12	2017	-	413,6	71,9	471,6	873,6
13	2018	-	435,3	76,4	471,6	1.126,0
14	2019	-	458,1	81,2	550,2	1.375,7
15	2020	-	482,1	86,2	550,2	1.604,5
16	2021	-	507,3	91,5	628,8	1.828,8
17	2022	-	533,8	97,0	628,8	2.034,3
18	2023	-	561,6	102,9	707,4	2.234,1
19	2024	-	590,9	109,1	707,4	2.417,1
20	2025	-	621,6	115,6	786,0	2.594,0
21	2026	-	653,9	122,5	786,0	2.755,9
22	2027	-	687,8	129,7	864,6	2.911,6
23	2028	-	723,5	137,3	864,6	3.054,2
24	2029	-	760,9	145,3	864,6	3.184,9
25	2030	-	800,3	153,7	864,6	3.304,7
26	2031	-	841,7	162,6	864,6	3.414,6
27	2032	-	885,1	172,0	864,6	3.515,6
28	2033	-	930,8	181,8	864,6	3.608,3
29	2034	-	978,7	192,2	864,6	3.693,5
30	2035	-	1.029,1	203,1	864,6	3.771,9
31	2036	-	1.029,1	203,1	864,6	3.841,9

IRR =	**24,7%**
NPV (12%) =	**3.841,9**
BCR =	**2,92**

10.3 Financial analysis

Financial and economic analyses are in the present case close and the reasons are explained in the previous chapter.

Additionally the adoption of the reference discount rate of 6% will record a NVP (6%) of 10,9 ml US$ and the Revenue/Cost Ratio of more than 6.0. This means that the investment is highly profitable.

By comparing the investment with the financial performance of the Kazakh Railways, it is clear that such investment is affordable and that no specific financing mechanism has to be studied. Consequently it is logical and worth advising the Beneficiary that internal fund should be used instead to start discussion with external financial entities.

10.4 Sensitivity and risk analysis for the economic analysis

Since project appraisal requires forecasting, the factors entering into the calculation of costs and benefits are inevitably subject to various degrees of uncertainty.

For Option Basic Works, sensitivity and risk analyses on the inputs of the economic assessments have been developed to study and forecast the stability of the achieved results.

This kind of approach is particularly suited to take into account that the evaluations of the principal inputs for the economic assessment are relative to a preliminary design phase. In further steps of the project (detailed design and construction) the preliminary evaluation and assumption could not be totally confirmed. The sensitivity and risk analysis is able to consider this "indeterminacy in inputs determining".

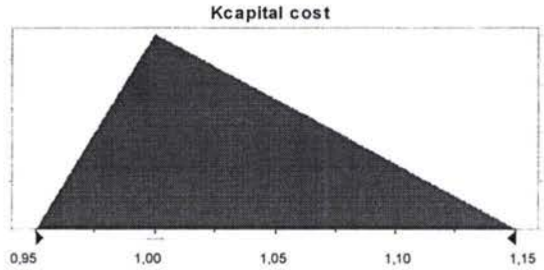
The key variables that have been subjected to the analysis are the following:

- capital cost
- benefit related to maintenance and operation costs
- benefit related to traffic management (train delays)
- leasing excess telecommunication capacity.

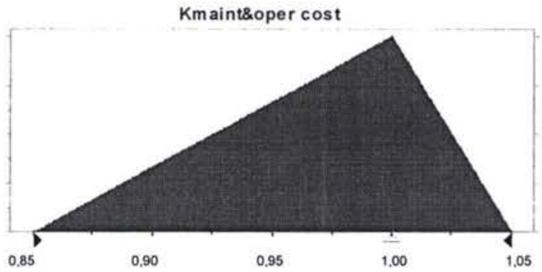
For the analysis has been used a random sampling method (also known as "Monte-Carlo methodology") on continuous probability distributions of the key variables. Usually, the considered probability distributions are not symmetrical (beta, triangular, etc.) so that the estimated value for the basic evaluation is not the average value of the distribution range, but rather the mode (likeliest value) of the distribution.

As the real probability distribution of the input (or target) variable is not known, a triangular distribution has been assumed, in accordance with the usual practice:

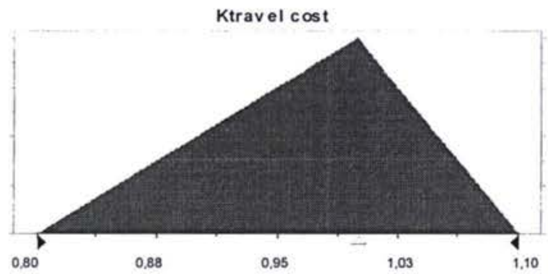
- for capital cost an asymmetric triangular distribution has been assumed with a variation between –5% and +15% from the estimated base value; this should be very conservative since 10% for contingencies has been already included in capital cost estimation;



- for benefits related to project maintenance and operation it has been used an asymmetric triangular distribution variable between –15% and +5% from the estimated base value;



- for benefits related to traffic management (train delays) an asymmetric triangular distribution has been assumed with a variation between –20% and +10% from the estimated base value.



- for the variable associated with the possibility of leasing excess telecommunications capacity to third parties, the approach undertaken for the renting of fibres is explained in the following.

The rationale of the approach is that it is unlikely that the market can request whole such big information transport capacity at least form the very beginning. Consequently the approach to calculate revenues from leasing excess capacity has been probabilistic more then deterministic.

The whole available capacity (11 fibres pairs) has been split into packages: 11 fibres pairs have been considered as packages progressively activated in order to simulate the progressive utilisation of the cable capacity (the first package to be activated after four years from the entering into operation, the following four packages one every year and the remaining packages every two years). To each fibres pair it has been assigned a different probability distribution to be activated and so bring revenue into the project.

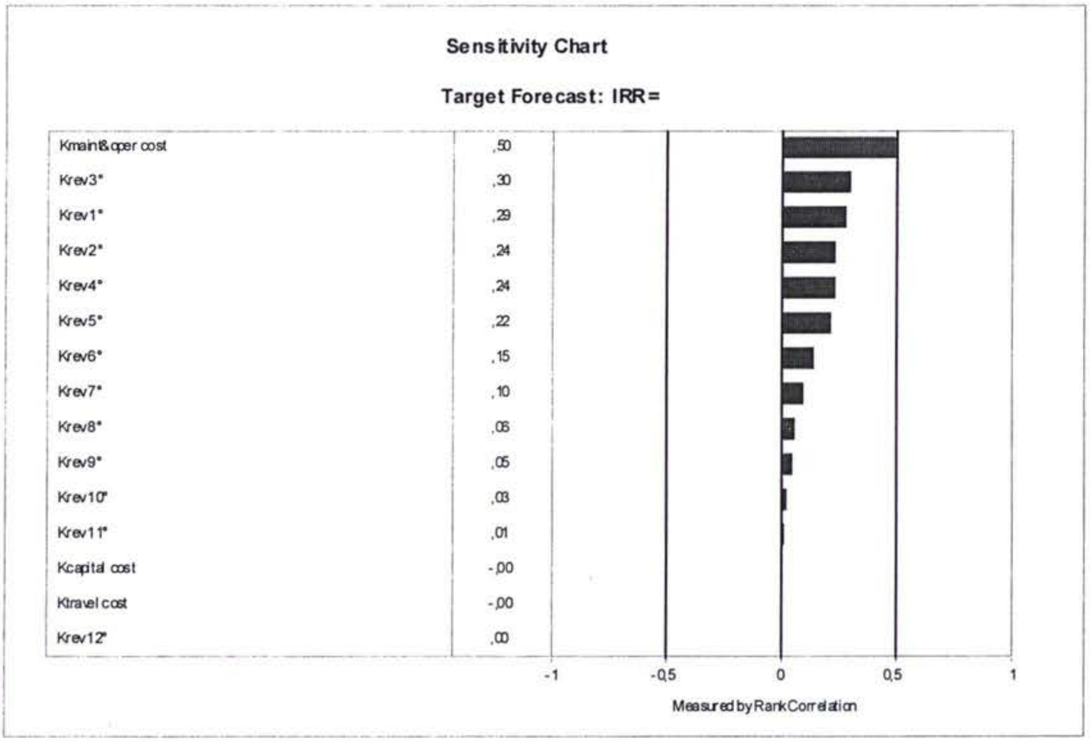
The distribution of probability of leasing a fibre pair has been assumed to be always uniform, but the distribution ends have been fixed differently to simulate the different level of certainty of the benefit. The multiplication factor has been switching from 0 (no benefits) or 1 (full benefit) after the rounding to the closer entire of the sampling result taken from a distribution:

- from 0,4 to 1,0 for 1st and 2nd fibre pairs; it corresponds to the probability 83% to lease the fibre pair;
- from 0,3 to 1,0 for 3rd and 4th fibre pair; it corresponds to the probability 71% to lease the fibre pair;
- from 0,2 to 1,0 for 5th and 6th fibre pair; it corresponds to the probability 62% to lease the fibre pair;
- from 0,0 to 1,0 for 7th to 11th fibre pair; it corresponds to the probability 50% to lease the fibre pair.

For the analysis a series of 100.000 simulations has been performed (random samplings from all the probability distributions above described).

The described analytic–probabilistic approach allows to identify the sensitivity of the result respect to the key variables and to order them in an importance scale in relation to the their effect on the result. This kind of analysis is useful to recognise the more critical inputs regard to the achievement of the result and it allows adopting precautionary measures.

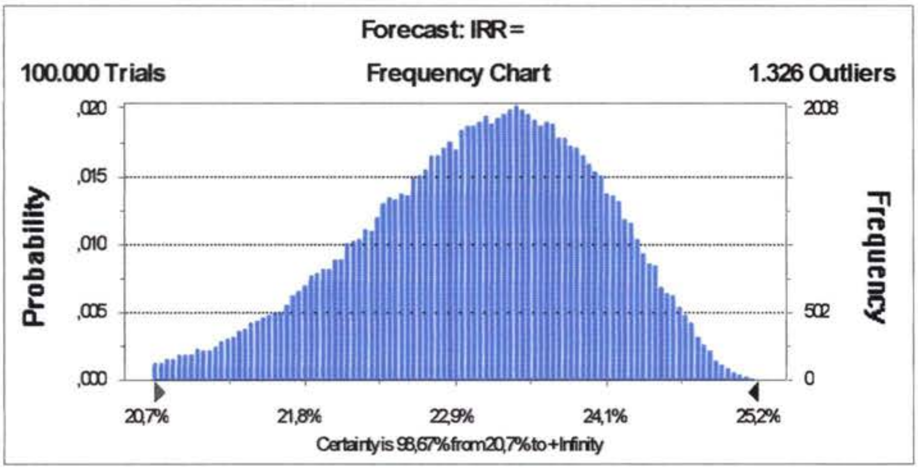
The following chart shows the sensitivity of IRR in regard to probability distributions of the key input variables.



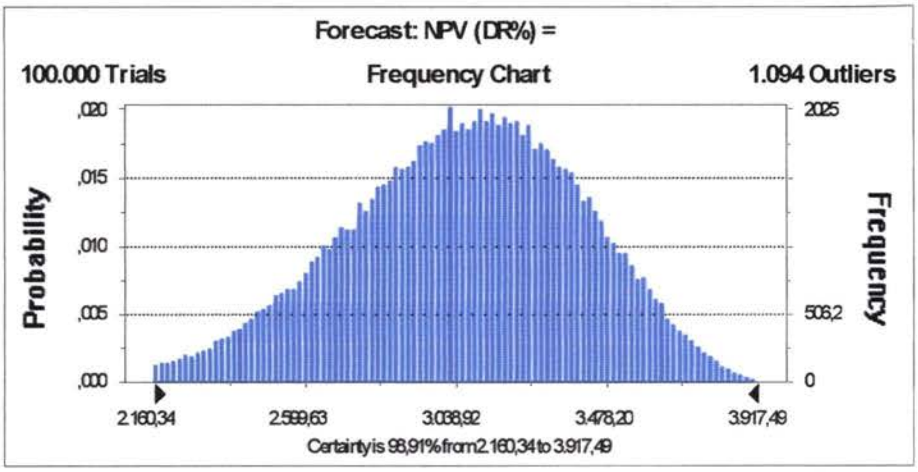
It has been calculated, without considering outliers, the combined probability that the economic indicators of the project are higher than the threshold values for the stability area; the stability are being: 12% for IRR, 0 for NPV(12%) and 1 for BCR.

The following diagrams show the distribution of the results for the three indicators.

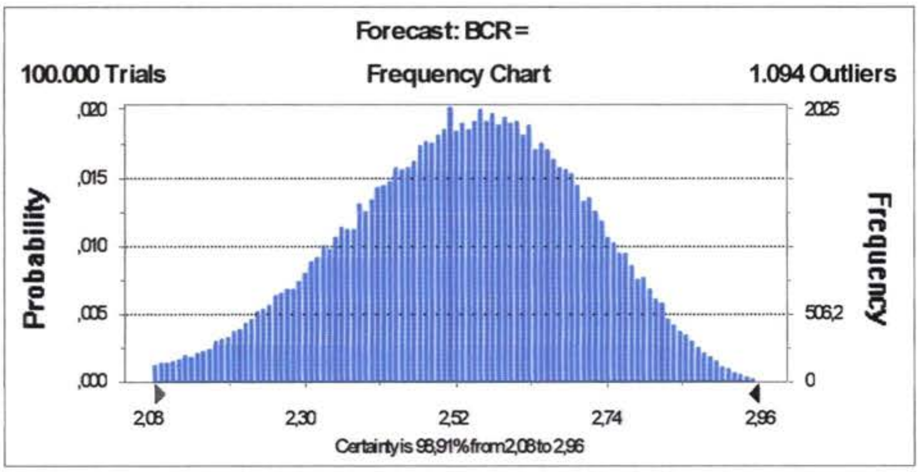
IRR ranges from 20.7% to 25.2%.



The distribution of NPV is shown in the following diagram.



BCR ranges from 2.08 to 2.96.



The following table reports the distribution of the indicators for increase per cent (5%), considering also the previously excluded outliers.

Per cent	IRR	NPV(12%) ($/1000)	BCR
0%	17,9%	1.376,31	1,69
10%	21,9%	2.587,48	2,29
25%	22,5%	2.827,89	2,41
50%	23,2%	3.082,41	2,54
75%	23,8%	3.314,71	2,66
90%	24,2%	3.502,93	2,75
100%	25,2%	3.983,70	2,99

The solution is always over the stability threshold, which means that the sensitivity analysis has shown that the result of the economic analysis is absolutely stable.

11. Conclusions

The Kazakh section of the Kungrad-Beyneu railway line is to be considered in acceptable conditions because the PW has been recently renewed and welded and the traffic speed near to the line limit. The Beneficiary pointed out the priority of the rehabilitation of the telecom system. In accordance with the condition of the line and the Beneficiary's indication, only some minor infrastructure works have been suggested in this report, mainly to bring the whole line from Kungrad to Beyneu to the same standard and condition, while a full feasibility study has been developed only for the telecom works.

Therefore, the present Feasibility Study for rehabilitation measures for the Beyneu - Uzbek Border railway section has taken into consideration the following options:

<u>Option Basic Works</u> *consists mainly in the realignment (tamping and levelling) of the existing railway line between the border and Beyneu, including the rehabilitation of the stations (sleepers replacement in Akjigit station only, ballast cleaning for all the station main tracks, construction of drainage ditches, buildings and passenger services), construction of a new double three-phase 10 kV overhead line. Works for 3 bridges rehabilitation and for safety devices have been also included.*

The main part of the suggested works could be performed during maintenance operation directly by the Kazakh Railways. Consequently, such Option has net been considered within the economic/financial analysis and consequently it is not a real option of the feasibility study.

<u>Option Telecom Works</u> *is the installation of a new telecommunication system based on digital technology and on the adoption of optic fibre cable together with PCM (Pulse Code Modulation) technology transmission systems.*

The adoption of the following system is proposed: STM1 (155 Mbps) + E1 (2 Mbps) - using a SDH (Synchronous Digital Hierarchy) based system for the primary backbone complemented by PDH (Plesyocronous Digital Hierarchy) based system for the secondary backbone.

Also a third option for doubling and electrification of the line has been examined by the technical feasibility point of view but it was discarded because not justified by the traffic interested to the line.

Consequently the economical/financial analysis has been used for evaluating the economical feasibility of the Option "Telecom Works".

The economic indicators resulted by the evaluation of the studied Option demonstrated the high economic viability of the project.

Additionally to that the comparison of the investment with the financial performance of the Kazakh Railways brings to the conclusion that such investment is affordable and that no specific financing mechanism has to be studied. Consequently it is logical and worth advising the Beneficiary that internal fund should be used instead to start discussion with external financial entities.

As far as the services to be rendered by the Consultant are concerned, only Option Telecom Works will be considered for the detailed design which will start immediately after the delivery of this report.

Published March 2005

This publication has been produced with the assistance of the European Union.
The contents of this publication is the sole responsibility of Italferr S.p.A.
and can in no way be taken to reflect the views of the European Union.