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Review of Railway Rehabilitation in Central Asia

for Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan

Module B - Feasibility Study of the rehabilitation measures for the Lugovaya – Kyrgyz Border railway section (Kazakhstan)

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	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	Intergovernmental 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

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ANNEXES

Executive Summary

The executive summary presents herein the contents of the Feasibility Study of the rehabilitation measures for the Lugovaya – Kyrgyz border railway section (in Kazakhstan), which is part of the Module B of the Project.

In fact one of the outputs 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 in accordance with the contract with the European Commission, the Consultant will be 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 Lugovaya – Bishkek – Balykchi as it is shown in Fig. A in the 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 Kyrgyzstan: the Lugovaya - border (61 km) and the border – Bishkek – Balykchi (322 km).

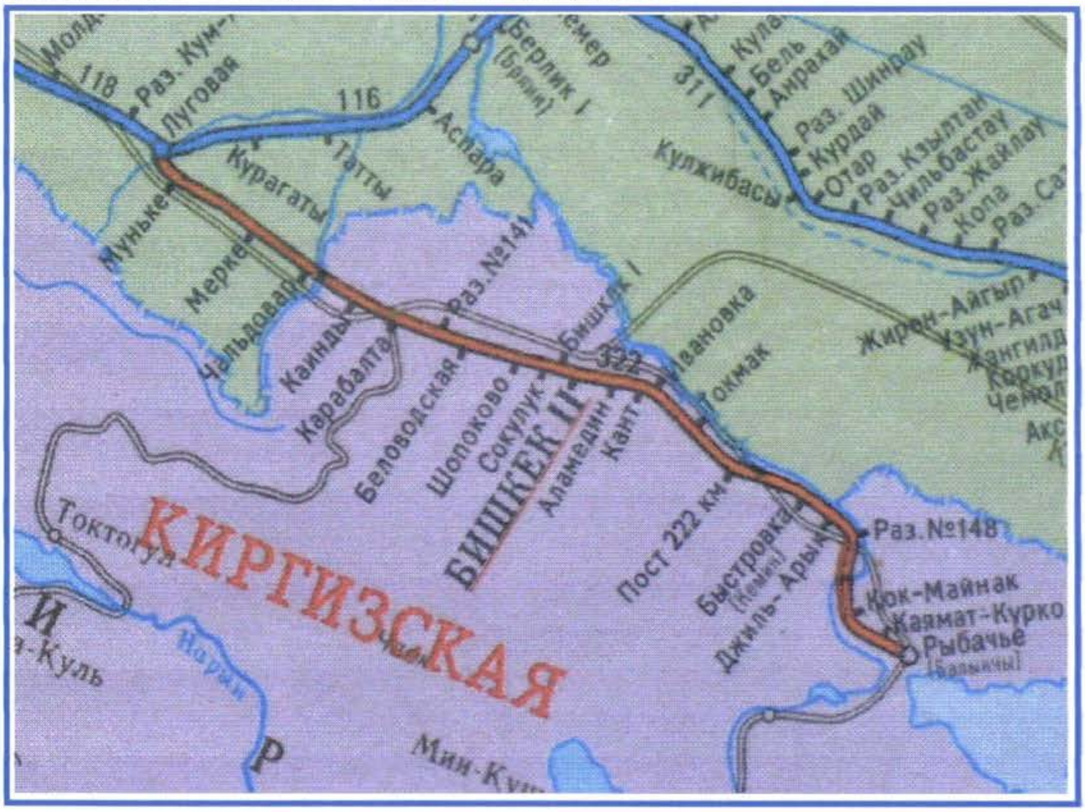
The administrative modification could not change so much the situation since the two sections are still working in conjunction. Furthermore services along the line are operated up to Lugovaya by the Kyrgyz Railways and so they will be up to 2007 at least.

After that year, improvements along the section from Balykchi to the border should be certainly managed by the Kyrgyz Railway Administration while the section up to Lugovaya belongs to the Kazakhstan Railways and it is not clear or maybe not yet decided who will be operating services and maintenance in the future. Consequently the issue of the competence has required to consider two different Feasibility Studies for rehabilitation measures concerning sections of the same line.

The contents of each Chapter of the present report are 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.

Fig A- The Lugovaya – Bishkek – Balykchi railway line



In Chapter 2 the socio-economic background of the country is provided with specific focus on the trade between Kazakhstan and the Kyrgyz Republic. 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 and present traffic distribution along the Lugovaya – Bishkek – Balykchi line are reported. Traffic forecasts for the Lugovaya – Kyrgyz border section have been evaluated both for passenger and for freight.

In the following table the total traffic forecasts on the Lugovaya – Kyrgyz border line, in million ton, are summarized:

Commodity Group	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
KAZAKHSTAN BOUND							
TOTAL	0.64	1.14	1.46	2.42	1.26	1.75	2.75
KYRGYZSTAN BOUND							
TOTAL	2.75	3.27	3.67	4.20	4.22	5.56	8.30

The consequent minimum number of loaded trains is given in the following table:

Direction	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
Lugovaya – Kyrgyz border	3.8	4.5	5.0	5.8	5.8	7.6	11.4
Kyrgyz border – Lugovaya	0.9	1.6	2.0	3.3	1.7	2.4	3.8

In the following table passenger traffic forecasts are summarized:

Type	All	Conservative (pair of train per day)			Optimistic (pair of train per day)		
	2003	2010	2015	2025	2010	2015	2025
International	1.0	1.0	1.0	1.0	1.3	1.7	2.0
Local	1.0	2.0	2.0	2.0	2.0	2.0	2.0

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
- Power supply system
- Operation.

Chapter 5 describes the measures and works which have been envisaged for the rehabilitation of the railway section. Two different rehabilitation options have been studied and 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 1 for Lugovaya – Kyrgyz border section is the natural complement of the measures envisaged in Option 1 and 2 for Kazakh border – Bishkek 2 section, as it foresees the demolition of the existing permanent way of the line, included the running tracks of the stations, the excavation of a layer of about 0.6 m of the existing material, the formation of 2 new layers of sandy gravel material 0,2 m thick and of ballast 0,3 m thick, the laying down of new concrete sleepers, the installation of new or recovered P65 rails, the formation of continuous welded rails, the replacement of the existing P50 switches with P65tg1/11 type ones on running tracks.

Option 2 considers the safety plants replacement in addition to the PW interventions foreseen in Option 1. Safety plants include 2 sub-options (Safety plants Alternative 2 and Alternative 3) including respectively:

- Alt. 2: renewal of all the stations interlockings and line block system
- Alt. 3: renewal of all the stations interlockings and line block system and moreover remote command and control from the central post.

The rehabilitation works have been aggregated in two main components:

- Infrastructure
- 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 options 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 and safety devices).

The economic and financial evaluations of the investments for the rehabilitation options are 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 options are summarized in the following table, where Internal Rate of Return, Net Present Value (at a discount rate of 12%) and Benefit/Cost Ratio for Option 1 and Option 2 are compared.

	Option 1	***Option 2***
IRR	13,5%	10,8%
NPV (12% ml US$)	926,0	-1.023,9
BCR	1,07	0,89

The options present evident economic differences. Option 1 is the only one recording a positive output from the analysis. This option is also preferable form the financial point of view.

As Option 1 is to be the most advantageous one in economic terms, it is recommended for the implementation and for the further step of the project.

Since it is likely that investment will be faced by the Kazakh railways, the comparison of the investment with the financial performance of such organization brings to the conclusion that such investment is affordable and that no specific financing mechanism has to be studied. Additionally to that the nature of the interventions could fall into a measure of extraordinary maintenance. Consequently it is logical and worth advising the Beneficiary that internal fund could 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 Lugovaya – Kyrgyz border railway section in Kazakhstan.

Historically the section under study belongs to the line Lugovaya – Bishkek – Balykchi as it is shown in the following Fig. 1 – 1.

Fig 1 – 1- The Lugovaya – Bishkek – Balykchi 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 Kyrgyzstan and Kazakhstan: the Lugovaya - border (61 km) and the border – Bishkek – Balykchi (322 km).

The administrative change could not change so much the situation since the two sections are still working in conjunction. Furthermore services along the line are operated up to Lugovaya by the Kyrgyz Railways and so they will be up to 2007 at least. This is why the report is making continuous reference to the whole line.

Besides this fact, improvements along the section from Balykchi to the border should be certainly managed by the Kyrgyz Railway Administration while the section up to Lugovaya belongs to the Kazakhstan Railways and it is likely that after 2007 improvement will be managed by such organisation. Consequently the issue of the competence has required to consider two different Feasibility Studies for rehabilitation measures concerning sections of the same line.

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 kilometres 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%).

2.2.3 Trade between Kazakhstan and the Kyrgyz Republic

Kazakhstan and Kyrgyzstan are very close trade partners. The relation is made asymmetrical by the fact that Kazakhstan is much better endowed in mineral resources.

The trends of trade relations in recent years are shown in the following table.

Table 2.2.3 - 1 Foreign trade of Kazakhstan and the Kyrgyz Republic (million USD)

	Export				Import			
	2000	**2001**	**2002**	**2003**	**2000**	**2001**	**2002**	**2003**
Kazakhstan								
Total	8,812.2	8,639.1	9,670.3	12,900.4	5,040.0	6,446.0	6,584.0	8,326.9
CIS countries	2,336.7	2,644.6	2,194.4	2,954.2	2,731.7	3,309.5	3,043.2	3,919.8
Kyrgyzstan	58.3	87.0	108.6		30.1	33.5	31.8	
% Kyrgyzstan/Total	*0.7%*	*1.0%*	*1.1%*		*0.6%*	*0.5%*	*0.5%*	
% Kyrgyzstan/CIS	*2.5%*	*3.3%*	*4.9%*		*1.1%*	*1.0%*	*1.0%*	

Kyrgyzstan								
Total	504.5	476.2	485.5	581.7	554.1	467.2	586.8	717.0
CIS countries	207.4	168.5	168.7	201.4	298.5	257.0	322.5	410.5
Kazakhstan	33.4	39.0	36.8		57.4	81.8	123.9	
% Kazakhstan/Total	6.6%	8.2%	7.6%		10.4%	17.5%	21.1%	
% Kazakhstan/CIS	16.1%	23.2%	21.8%		19.2%	31.8%	38.4%	

The above figures show that Kazakhstan is a major trade partner for the Kyrgyz Republic since in 2002 it received 21.8% of the Kyrgyz exports and sent 38.4% of the imports. The importance of Kyrgyzstan for Kazakhstan is necessarily much less. Still in 2002 nearly 5% of the Kazakh exports were going to Kyrgyzstan.

In terms of volume the relative importance of each country for the other is still greater. In 2003 Kyrgyzstan sent 527 thousand tons to Kazakhstan out of a total of 1,841 thousand tons i.e. 28% of exports. And it received 3,040 thousand tons representing 78% of export.

The trade between the two countries consists of a few commodities as shown in the table below that displays the share of the trade with Kyrgyzstan in the total volume for a commodity.

Table 2.2.3 - 2 Foreign trade of Kazkhstan with the Kyrgyz Republic by commodity group

Commodity Group	**Export to Kyrgyzstan**		**Import from Kyrgyzstan**	
	Volume (ton)	*Share (%)*	Volume (ton)	*Share (%)*
Coal	530,260	*2.2*		*0.0*
Oil Products (not including crude)	226,193	*20.3*	2	*0.0*
Grain-Cereals	172,049	*3.7*	73	*0.1*
Cement	1,086	*1.3*	64,848	*23.0*
Construction materials	517,020	*85.5*	56,882	*6.5*
Metal	15,230	*0.3*	1,938	*0.2*
Foodstuff	22,240	*7.8*	51,311	*14.4*
Other goods	237,038		13,782	
Total	**1,721,115**	***1.7***	**188,835**	***0.9***

Four commodity groups i.e. coal, oil products, grains and construction materials represent 85% of exports and three commodity groups i.e. cement, construction materials and food stuff represent 92% of export.

The mutual dependence is not fully taken into consideration in the trade figure. An important fact is that Kyrgyzstan is a major source of water for Central Asia. One of Kazakhstan largest rivers the Syr-Darya starts in the Kyrgyz Tien-Shan as the Naryn river.

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 Kazakh 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 Kazakh Railways were distributed by commodity as follows:

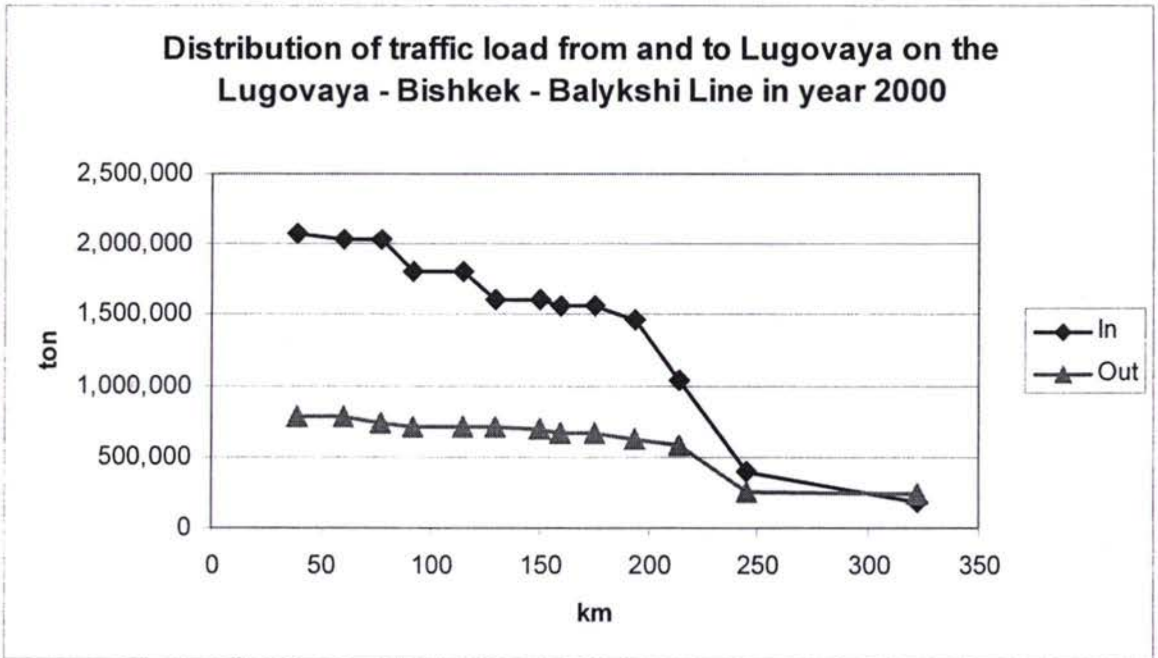
Table 3.2-1 Traffic by commodity on the Kazakh Railways in 2002 and 2003 (thousand ton)

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 distribution on the Lugovaya – Bishkek - Balykchi Line

Data collected for year 2000 by the TRACECA Project Traffic and Feasibility Studies make it possible to have the profile of the traffic that originates and ends in Lugovaya.



The diagram shows that only little traffic goes east much beyond Bishkek (Km 153). However the graphic does not show domestic flows, particularly the movements of sugar beets that are within the Chui region.

3.4 Traffic in Recent Years

3.4.1 Freight Traffic

No data on traffic was made available by the Kyrgyz Railways. But Kazakh statistics provide a good picture of the freight crossing the border between Kyrgyzstan and Kazakhstan. The following table gives the Kazakh figures for 2001 and 2003:

Table 3.4.1 - 1 – Railway freight traffic across the Kyrgyzstan – Kazakhstan border according to Kazakh statistics (million ton)

Commodity Group	Kazakhstan – bound					Kyrgyzstan – bound					Total
	Export to Kazakhstan	Transit to			Total	Import from Kazakhstan	Transit from			Total	
		Russia	Chengeldi	Dostyk			Russia	Chengeldi	Dostyk +Aktau		
Year 2001											
Coal			0.03		0.03	0.68				0.68	0.71
Coke					0.00					0.00	0.00
Ores					0.00					0.00	0.00
Oil products		0.02	0.09		0.11	0.15				0.15	0.26
Grain					0.00	0.05				0.05	0.05
Chemicals		0.01			0.01	0.01				0.01	0.02
Construction mat.	0.09	0.02			0.11	0.13		0.07		0.20	0.31
Metal		0.02			0.02	0.01				0.01	0.03
Wooden goods		0.01			0.01	0.01				0.01	0.02
Other (*)	0.02	0.11	0.02	0.01	0.16	0.05	0.02	0.01	0.05	0.13	0.29
TOTAL	0.11	0.19	0.14	0.01	0.45	1.09	0.02	0.08	0.05	1.24	1.69
Year 2003											
Coal					0.00	0.86				0.86	0.86
Coke					0.00	0.01	0.01			0.02	0.02
Ores					0.00	0.01				0.01	0.01
Oil products					0.00	0.33	0.16	0.01		0.50	0.50
Grain			0.01		0.01	0.05				0.05	0.06
Chemicals					0.00		0.03			0.03	0.03
Construction mat.	0.31		0.11		0.42	0.31	0.02			0.33	0.75
Metal (**)				0.15	0.15	0.01	0.02		0.01	0.04	0.19
Wooden goods					0.00	0.01	0.06			0.07	0.07
Other (***)	0.06				0.06	0.16	0.61		0.07	0.84	0.90
TOTAL	0.37	0.00	0.12	0.15	0.64	1.75	0.91	0.01	0.08	2.75	3.39

(**) 0.15 m.ton metal to Dostyk – 0.01 m.ton from Dostyk (***) 0.02 m.ton from Dostyk - 0.05 m. ton from Aktau (*) 0.01 m. ton to Dostyk - 0.05 m. ton from Dostyk

The data shows an increasing unbalance between export and import. In 2001 the traffic volume entering the Kyrgyz Republic was 2.7 times higher than the volume leaving the country. By 2003 that ration had risen to 4.2. The volume of freight sent was larger than in 2003 by 42 % and the volume received by three times as much. The total both directions doubled during the period.

A change in trade pattern between 2001 and 2003 is apparent. A larger share of the exports consisting of increasing volumes of construction materials particularly cement was sent to Kazakhstan instead of reaching Russia. On the contrary imports were increasingly coming from beyond Kazakh borders.

A significant share of the traffic passing by Chengeldi and crossing the Kazakh – Uzbek border probably corresponds to movements between north and south Kyrgyzstan.

There was significant exchange with China through the Dostyk border station particularly of metal. In 2003 50,000 tons are recorded as originating in the Aktau port on the northern branch of the TRACECA corridor.

3.4.2 Passenger Traffic

There are international passenger trains between Bishkek and three destinations in the Russian Federation: Moscow, Ekaterinburg in the Urals and Novo-Kuznetsk in Central Siberia. The two latter are used by traders to carry to Russia either knitwear made in Kyrgyzstan or more frequently consumer goods imported from China through one of the two road border posts Torugart and Irkeshtan. There is an average of one train per day.

3.5 Traffic Forecasts along the line

3.5.1 Freight Traffic Forecasts

Forecasts were made on the basis of the Kazakh statistics refined by separating goods such as cement and sugar for which particular information was available. Two scenarios were considered, "conservative" and "optimistic".

Assumptions were made on GDP growth in the future. Import growth rates were linked to GDP growth rates through an elasticity for each commodity group. Direct assumptions were made for export growth rate. For the largest ones, cement, construction materials and sugar the forecasts of local specialists was taken into consideration. 2004 data was also integrated. The result is given in the following table.

Table 3.5.1 - 1 – International traffic forecasts on the Lugovaya – Kyrgyz border line (million ton)

Commodity Group	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
KAZAKHSTAN BOUND							
Coal + Coke	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ores	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil products	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grain	0.01	0.01	0.02	0.02	0.01	0.01	0.01
Chemicals	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction mat.	0.17	0.34	0.45	0.81	0.39	0.57	0.93
Cement	0.25	0.52	0.70	1.25	0.59	0.86	1.42
Metal	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Wooden goods	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sugar	0.02	0.06	0.07	0.08	0.06	0.08	0.10
Other	0.04	0.06	0.07	0.10	0.06	0.08	0.13
TOTAL	**0.64**	**1.14**	**1.46**	**2.42**	**1.26**	**1.75**	**2.75**

KYRGYZSTAN BOUND							
Coal + Coke	0.88	0.76	0.56	0.00	1.27	1.61	2.15
Ores	0.01	0.01	0.02	0.03	0.02	0.02	0.03
Oil products	0.50	0.70	0.90	1.27	0.85	1.16	1.89
Grain	0.05	0.07	0.08	0.11	0.08	0.10	0.14
Chemicals	0.03	0.04	0.05	0.07	0.05	0.06	0.09
Construction mat.	0.33	0.46	0.59	0.84	0.54	0.74	1.20
Cement	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Metal	0.04	0.06	0.07	0.10	0.07	0.09	0.15
Wooden goods	0.07	0.10	0.13	0.18	0.11	0.14	0.22
Sugar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	0.84	1.07	1.27	1.62	1.26	1.64	2.44
TOTAL	**2.75**	**3.27**	**3.67**	**4.20**	**4.22**	**5.56**	**8.30**

The decrease in the flows of coal in the "conservative scenario" is due to the assumption the railway line would be progressively extended beyond Balykchi. A first step would be to reach Kochkor at 64 km and later Kara-Keche that is 117 km further. The coal deposit located in that place could be tapped to send coal to the Bishkek area in substitution of the coal presently imported from Kazakhstan. The effect would be of much increasing the volume carried between Balykshi and Bishkek but also reducing the amount carried from Kazakhstan.

The construction schedule assumed was the one proposed in a study recently carried out by a Czech consultantcy. Kochkor would be reached in 2009, Kyzart in 2013, Bazar-Turuk in 2017 and Kara-Keche in 2019. As long as the whole line is not operational coal would be transported by truck on part of the distance. The volume of coal would grow as line construction progresses.

Number of Trains

The above forecast would correspond to the following number of trains assuming train net weight of 2000 tons.

Direction	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
Lugovaya – Kyrgyz border (*)	3.8	4.5	5.0	5.8	5.8	7.6	11.4
Kyrgyz border – Lugovaya (*)	0.9	1.6	2.0	3.3	1.7	2.4	3.8

(*) The number of trains is to the minimum number of <u>loaded</u> trains needed to transport the freight volume. For the Lugovaya-Kyrgyz border section, which is part of the death end line Lugovaya-Balykchi, it can be assumed that the total number of train pairs is equivalent to the most loaded direction number of trains, as the useful length of the station siding does not allow to compose longer empty trains.

For the purposes of the economic and financial evaluation the average traffic between "conservative" and "optimistic" scenario" has been assumed.

3.5.2 Passenger Traffic Forecasts

It is difficult to forecast the evolution of international passenger traffic because as above explained it is much linked to a trade pattern that may drastically change in the future. It is also linked to income per capita. As income rise modes with lower travel times will be an increasingly attractive alternative to trains taking two or three days to reach destination. It could of course take the form of air transport for the richest customers. But also the form of faster trains with a wider choice of destinations. This may mean trains on the trunk lines of Kazakhstan. In this case the Kyrgyz railways may find profitable to operate light trains ensuring a connection with international trains passing by Lugovaya.

In any case local service will certainly not be less than one train per day. The best minimum frequency is of two trains one in the morning and one in the evening allowing people to reach a destination on the line and come back the same day.

The above consideration leads to the following forecasts.

Table 3.5.2 -1 Passenger traffic forecasts by link (pairs of train per day)

Type	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
International	1.0	1.0	1.0	1.0	1.3	1.7	2.0
Local	1.0	2.0	2.0	2.0	2.0	2.0	2.0

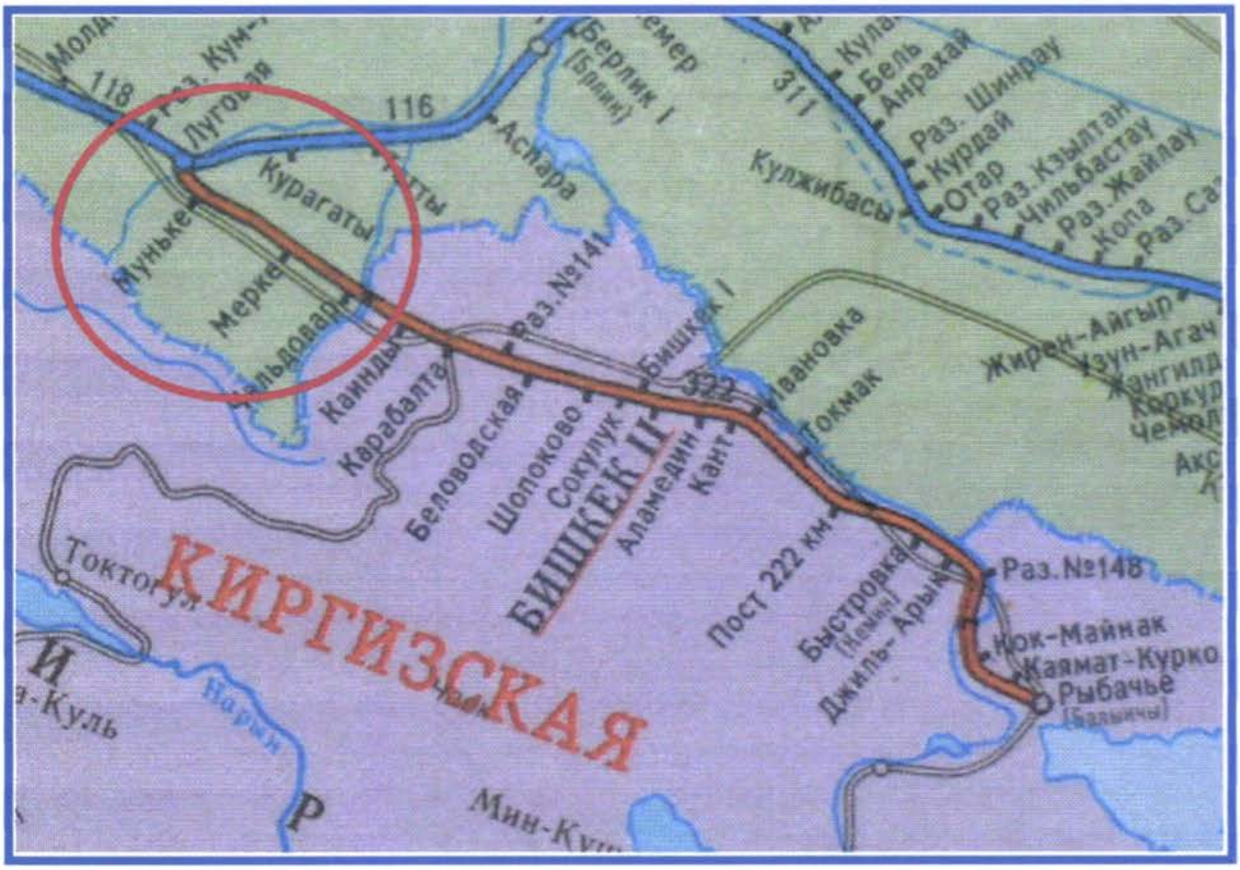
For the purposes of the economic and financial evaluation the average traffic between "conservative" and "optimistic" scenarios has been assumed.

4. Characteristics of existing lines and stations

The line under study is the Lugovaya-Kyrgyz border (Chaldovar) line section (60.9 km), belonging to the line Lugovaya-Bishkek-Balykchi (322.354 km) which is located part in Kazakhstan and part in Kyrgyzstan.

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

Fig 4 – 1 - The Lugovaya-Bishkek-Balykchi 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.

4.1 Infrastructure

The Lugovaya - Kyrgyz border section is part of the rail connection between Kyrgyz Capital, Bishkek, and the international railway network of the Central Asian Countries. In particular, due to the former Soviet Union network design and to the following divisions of the CIS Countries, Kyrgyzstan lines were mainly cut in small sections, while the largest part of the railway connections fell into the neighbouring Countries. That is the case of the line under study, that is currently assuring the main connections between Bishkek and the Kazakh railway network.

The line is single track, mainly straight, not electrified, with 5 stations (Lugovaya included) between 8 and 19 km distant.

4.1.1 Permanent Way and earthworks

In the mid XIX when the only type of transport between Central Asia and Kazakh steppes were horses and camels, caravan and mail roads were in condition of full decline. This circumstances and as well as the issues of strengthening military-political and economic influence of Russia in Central Asia, the possibility of wide use of rich sources of row materials and sales market in the South-East of Russian empire, striving for direct exit from these regions to Siberia, stimulated the emergence in 1878 of the project on connection of Central Asia and Syberia.

The Turksib (Turkestan – Siberia) railway line was at last implemented during 1913-1931, creating conditions for wider development of cotton-growing in Central Asia Republics and providing them with grain from Siberia.

Construction and development of railways in Kyrgyz Republic was implemented by stages. Lugovaya – Pispek (Bishkek 1) was put into operation in 1924, according to the project of construction of Turksib line. Due to some unclear reasons, the project was then changed and the construction of railways was carried on according to the economic possibilities, necessities and needs: Pishpek – Frunze (Bishkek 2) in 1929, Frunze – Kant in 1932 to connect a sugar refinery, Kant – Tokmak in 1941, Tokmak – Bystrovka in 1942, Bystrovka – Ribachye (Balykchi) in 1950. The station of Merke was built in 1924 along with the line Almata-Pispek. With the development of various enterprises of the region, the station was later expanding for traffic increase. Munke station was built in 1932.

After the collapse of former Soviet Union (1991), the Lugovaya – Kyrgyz border section, in spite of being in Kazakh republic territory, continue up till now to be maintained and operated by Kyrgyz railways. Meetings were held recently between Kazakh and Kyrgyz governments to agree the passage of this section to the operation and maintenance of Kazakh railways.

As the Consultant collected information about a probable passage of this line to Kazakh railways within the 2007, Lugovaya – Kyrgyz border and Kazakh border – Bishkek – Balykchi were considered separately.

Alignment and gradients

The total length of Lugovaya - Kyrgyz border section is 60.95 km.

The alignment is shown in Fig. 4-1: mostly on straight (1.27 km of curves out of 60.95 km in length). Every circular curve is provided with parabolic transition curves at the beginning and at the end.

- The minimum curve radius is 1.000 m.
- The maximum cantilever is 80 mm.
- The maximum allowed load is 23 t/axle

The Tab. 4.1.1 – 1, shown in the following page, contains all the relevant data about the line:

- curves and their characteristics (length, deviation angle, radius, cant),
- level crossings location,
- stations with start, end and centre (building) chainage. The chainage is referred to the first and last turnout blades.

Table 4.1.1 – 1 Relevant data on Lugovaya-Kyrgyz border section

Element	Start	End	Station centre	Cant	Deviation angle		Radius	Curve	Transition
	(km)	*(km)*	*(km)*	*(cm)*	*(degree)*	*-60*	*(m)*	length *(m)*	length *(m)*
Lugovaya	3626.329	3627.497	3626.329						
L.C.	3627.514								
Curve	3627.893	3627.934		0	1	18	1800	40	0
Curve	3628.076	3628.117		0	1	18	1800	40	0
L.C.	3634.355								
L.C.	3637.318								
R-3639	3637.725	3638.964	3637.726						
Curve	3643.587	3643.757		3	4	36	2250	200	20
L.C.	3646.386								
Munke	3647.563	3648.624	3648.109						
L.C.	3656.903								
Curve	3660.877	3661.066		8	8	30	1000	188	40
Curve	3651.239	3651.430		5	8	37	1000	191	40
Curve	3651.675	3651.815		4	3	55	1300	140	40
Curve	3662.372	3662.509		4	4	17	1300	137	40
Curve	3664.885	3665.194		4	3	55	2800	209	40
L.C.	3665.427								
Merke	3665.470	3666.683	3666.012						
L.C.	3666.976								
L.C.	3677.868								
L.C.	3681.525								
Curve	3684.024	3684.157		0	0	25	18500	133	0
Chaldovar	3685.746	3686.816	3686.324						
L.C.	3686.956								

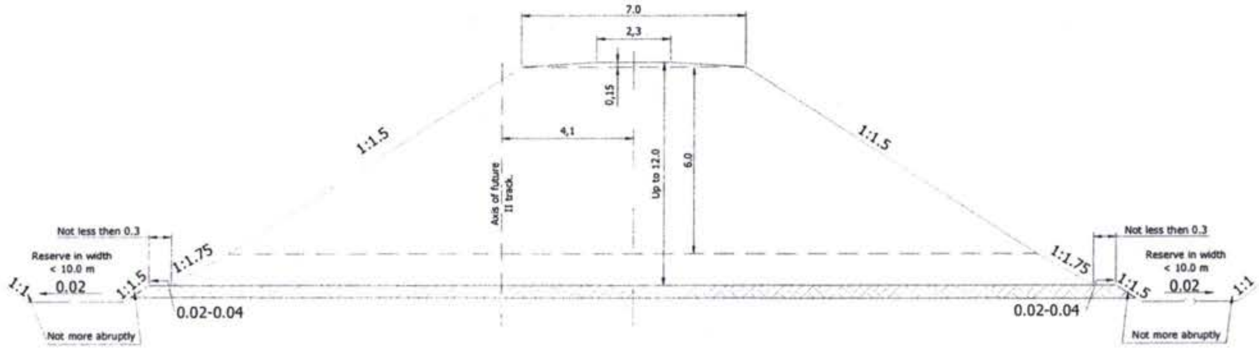
Line formation

The line formation from Lugovaya to Kyrgyz border is constituted by embankments 1÷3 m height.

The standard cross section of the formation is reported on Fig. 4.1.1 – 1 in which a slope of about 6% towards both sides, starting from a central strip 2,3 m wide, can be observed.

The top surface of the embankment width varies from 6,0 m to 7,1 m.

Fig. 4.1.1 – 1 Standard cross section of formation



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 these are the technical characteristics:

- the sandy gravel layer and the ballast layer are, respectively, 0,2 and 0,3 m thick,
- mixed wooden and concrete sleepers are installed (see fig. 4.1.1 – 3); they are laid down at a distance of 0,54 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*

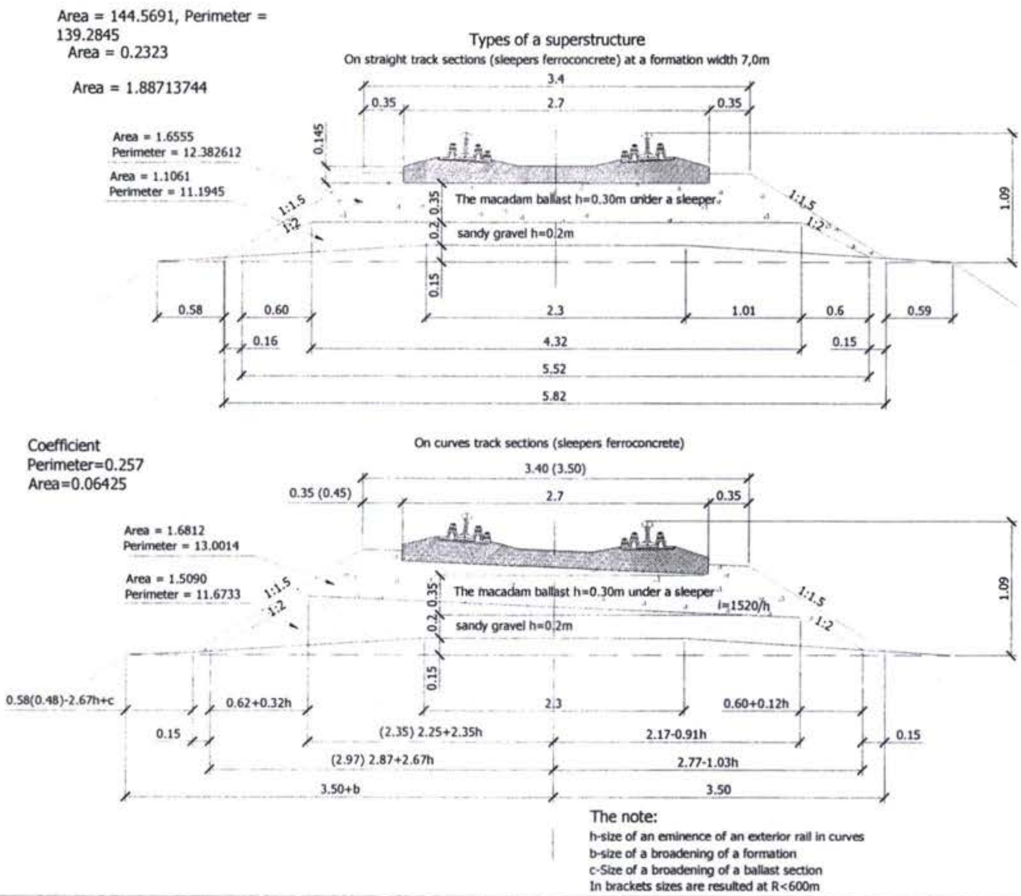
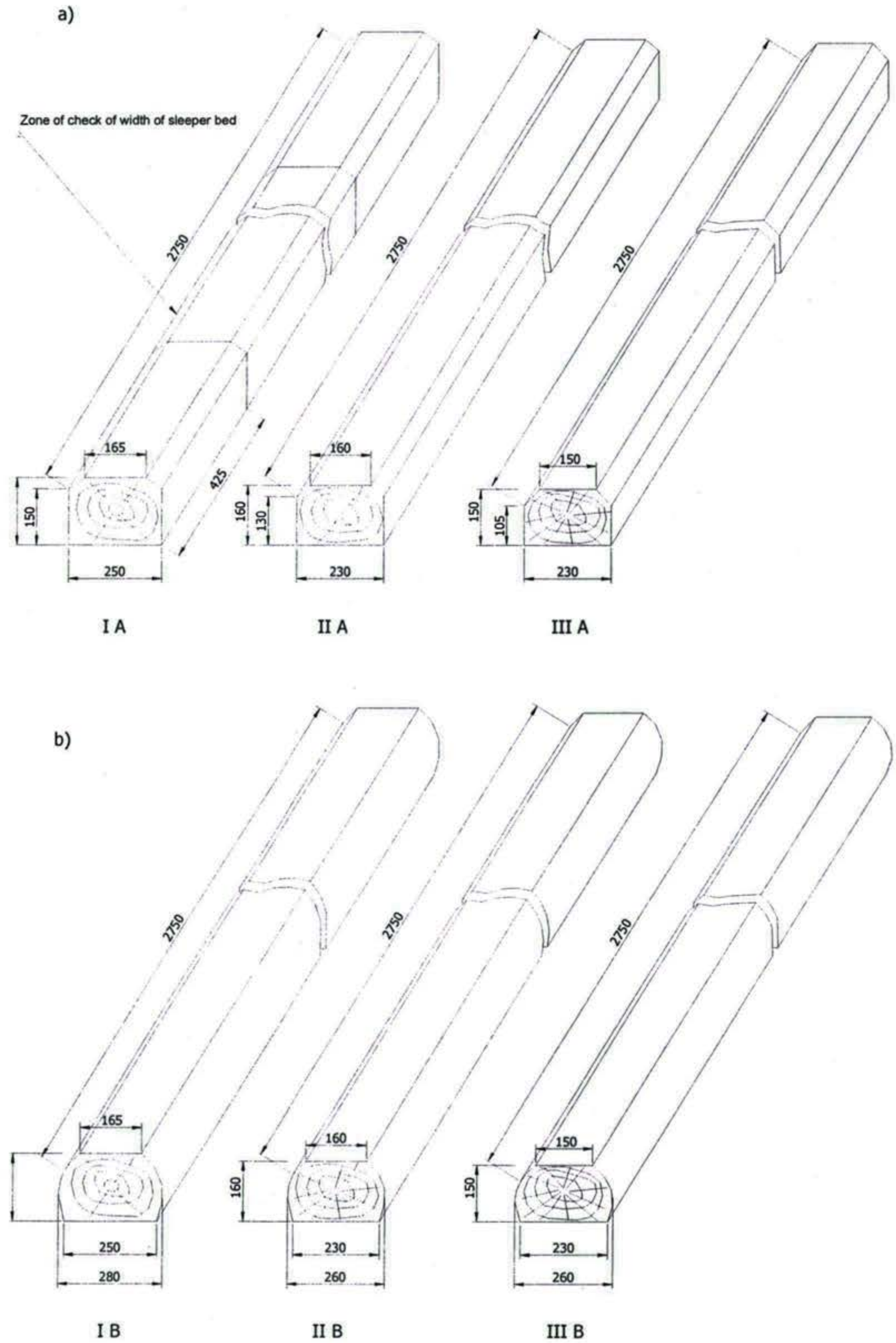
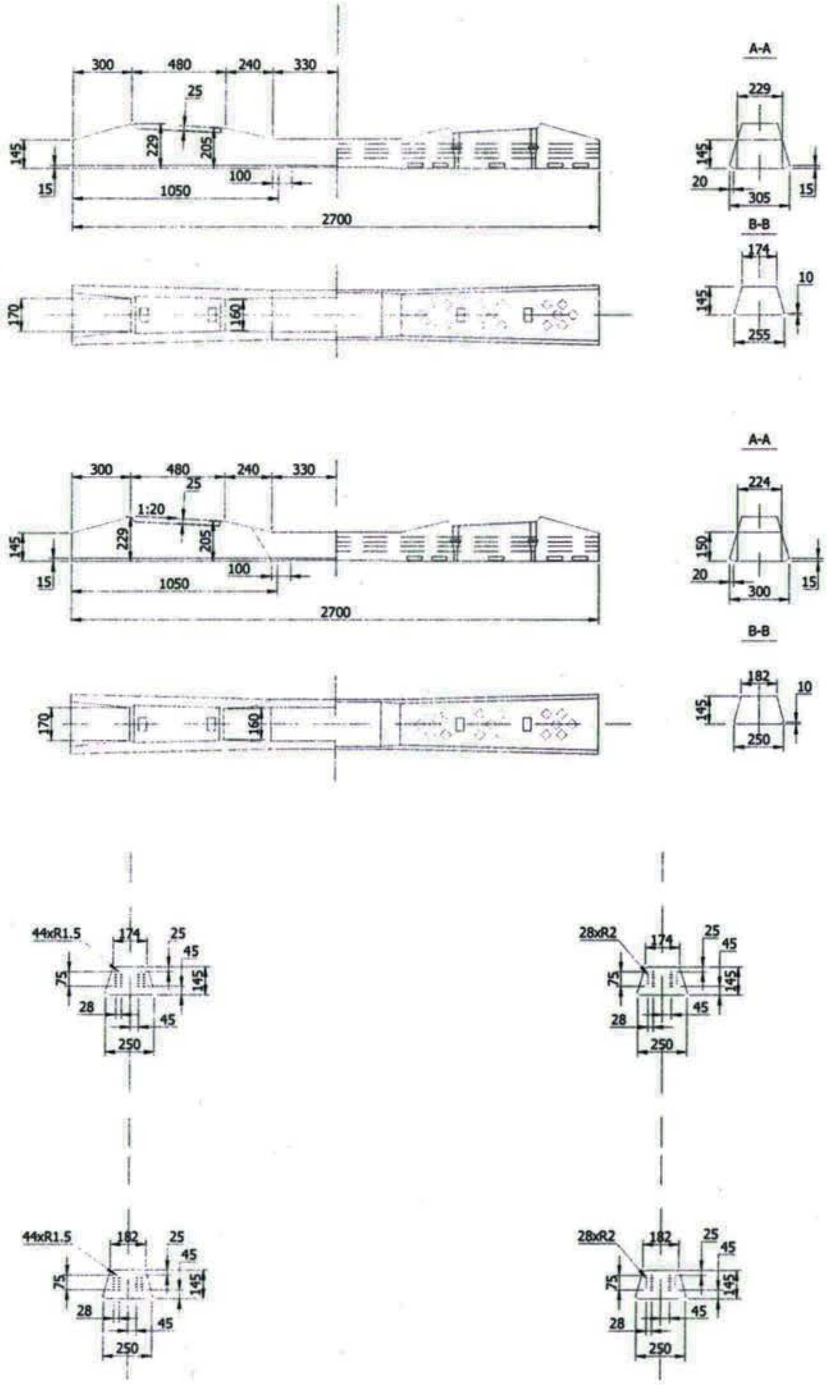


Fig. 4.1.1 –3 Types of timber sleepers



Types of timber sleepers:
a) Edging; б) not edging.

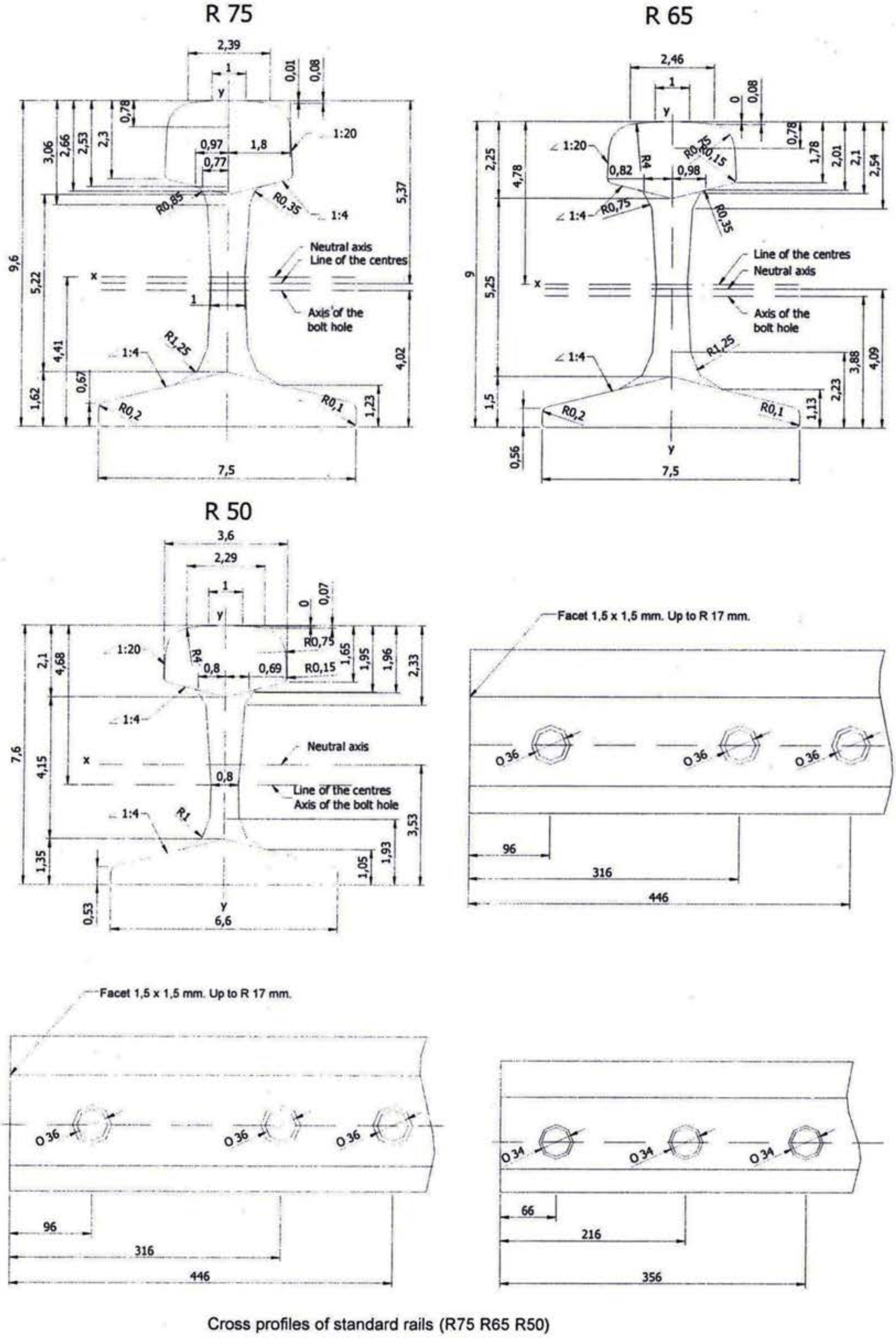
Fig. 4.1.1 – 4 Design of ferroconcrete sleepers



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.

The appendix 8-4

Fig. 4.1.1 – 5 *Cross profiles of standard rails (R 75, R 65, R 50)*



Cross profiles of standard rails (R75 R65 R50)

Normally rails are provided in 25 m bars; so, when they are laid down, a joint has to be done every 25 m. To reduce the hammering at the passage of trains, the joints on one rail are displaced 3 cm from the relevant ones on the other rail along the track

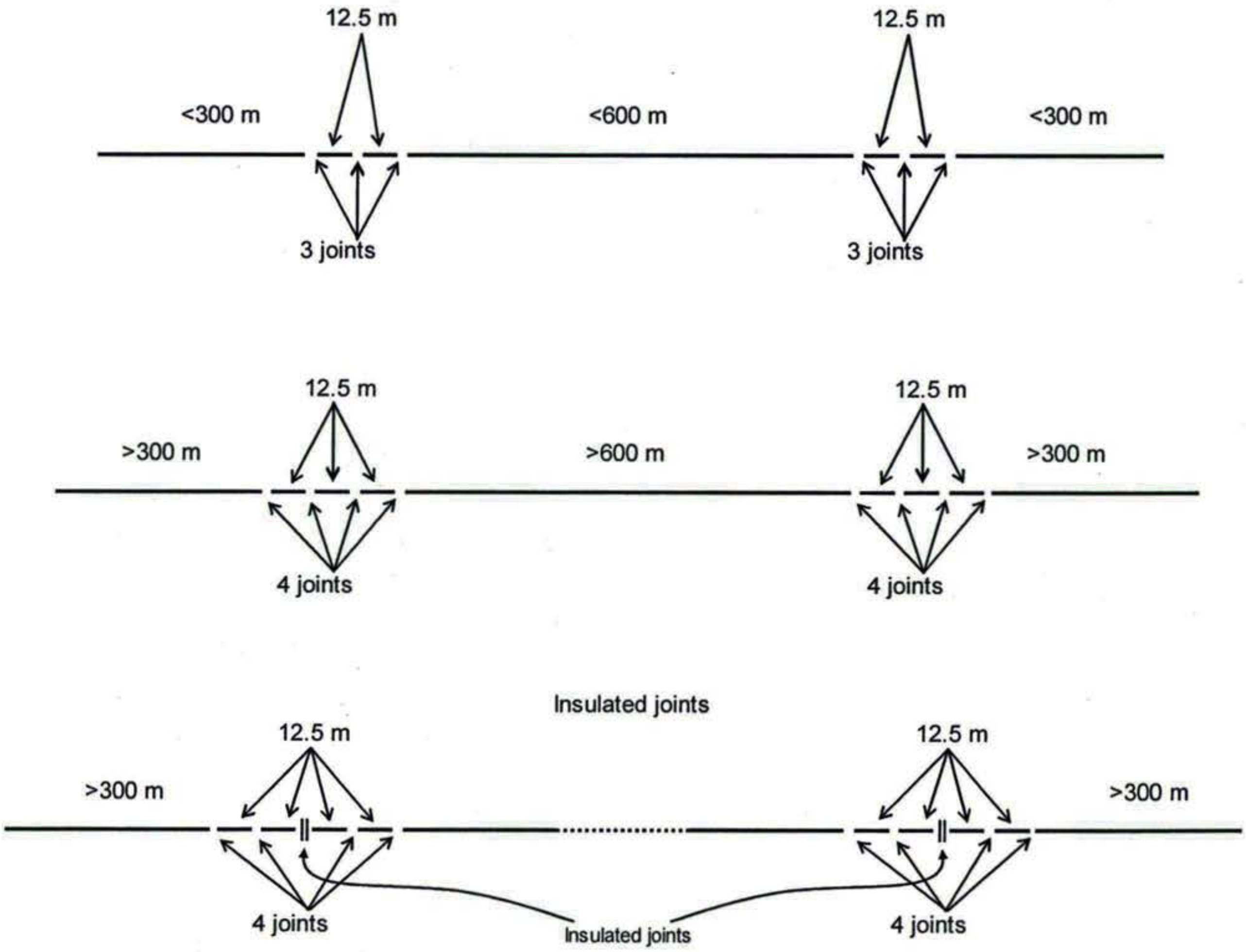
On lines equipped with concrete sleepers, a great reduction of hammering effect can be obtained by welding rails in long bars (continuous welded rails, cwr).

The great advantages of this technique, which will be described in the next paragraphs, are the increase in comfort for passengers and considerable reductions in noise, in wearing out of rails and rolling stocks, in costs of maintenance.

According to Russian standards the maximum length of welded rail bars in Central Asia countries is 900÷1000 m. At the beginning and at the end of the long welded bars a sequence of joints and short bars 12,5 m long has to be laid down to allow a limited "expansion" of the long bar at the highest levels of temperature. The schemes to be implemented are reported on fig. 4.1.1 – 6:

Fig. 4.1.1. - 6

(measures in m)



The situation of the existing permanent way on line and into stations on the studied section can be summarised as it follows (see Table 4.1.1 – 2).

Table 4.1.1 – 2 Existing permanent way on line and stations

Rehabilitation works for Lugovaya-Balykchi Line - Lugovaya-Kyrgyz border section Permanent way and turnouts type								
Stations				PW type				
Name				Line and station main lines			Stations turnouts on main track	
		start km	end km	Rail type	Sleepers	Length	P65 1/11	P50 1/11
N.						(m)	(N.)	(N.)
1	Lugovaya	3626.329	3627.497	**P65**	W/C	***1168***		
		3627.497	3637.725	**P65**	W/C	**10228**		
2	R-3639	3637.725	3638.964	**P65**	W/C	***1106***	4	
		3638.964	3647.563	**P65**	W/C	**8599**		
3	Munke	3647.563	3648.624	**P65**	W/C	***928***	4	
		3648.624	3665.470	**P65**	W/C	**16846**		
4	Merke	3665.470	3666.683	***P50***	W/C	***1080***	3	*1*
		3666.683	3685.746	**P65**	W/C	**19063**		
5	Chaldovar	3685.746	3686.816	**P65**	W/C	***1003***	2	
		3686.816	3687.280	**P65**	W/C	**464**		
	border		***3687.280***					
							13	**1**

The following table resumes the permanent way type in stations (main track) and line.

Table 4.1.1 – 3 Permanent way type in Kazakhstan

PW type Kazakhstan		
	Line	**Stations** main track
W/C+P65	55,200	4,204
W/C+P50		1,080

From the table could be observed that

- All the line (55,2 km) is equipped with P65 rails on mixed wooden/concrete sleepers,
- All the stations are equipped with P65 rails on mixed wooden/concrete sleepers with the exception of Merke station which is equipped with P50 rails (1,08 km out of 5,28 km).

No continuous welded rails are implemented along the section.

The existing turnouts are P65 tg 1/11 type on the station main lines from Lugovaya up to Kyrgyz border, with the exception of one turnout P50 tg 1/11 type installed in Merke station.

In total, on station main track the following turnouts are currently installed:

- 13 P65 tangent 1:11,
- 1 P50 tangent 1:11.

Visit of the line

The line was visited by Consultant's experts on 28th of January 2005 from Kyrgyz border to Lugovaya by car. They were allowed to have a complete and detailed survey inside the stations and on the line. In spite of the impossibility to obtain a number of "classified" documents, the railway officials were very collaborative and gave essential information that were needed for the present study. The CTC of Taraz, which controls the Southern part of Kazakh network, was also inspected during the visit by Consultant's experts.

PW defects of the line

The considered section is in quite good condition, nevertheless in the opinion of the Consultant an upgrade of the same level proposed for the Kyrgyz section of the line has to be foreseen.

On the existing state of PW the Consultant stresses that:

- the general condition of PW leads to current speed restrictions;
- 50% of wooden sleepers are to be changed, their bad condition does not permit the use of machine for tamping;
- fastening devices on wooden sleepers are old and their fastening action reduced;
- rail junctions are old and worn out; the hammering effect at the passage of trains leaded to permanent deformation and damages of the rail bars ends;
- original conditions of the alignment and profile are to be recovered;
- in parts of the line the lateral paths of 0,59 cm on both sides of the top embankment surface disappeared for the action of raining waters and blowing wind; consequently quantities of ballast fell down and were wasted;
- in many cases the shoulders of ballast on the sides of sleepers, that in normal conditions are 0,35÷0,45 m wide, are non-existent;
- most of the ballast is extremely polluted with clayey soil and sand, particularly in stations;
- generally there are not drainage ditches.

Maximum speeds along the section

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

- the head of rails is worn out up to the admissible values,
- the ballast layer is highly polluted,
- 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 cross section is greatly reduced by wind or rain water erosion,
- profile and alignment are far from the original designed ones,
- bridges and culverts needs interventions.

In the case of this section reductions of maximum speeds were imposed along all its length.

From the original 100/120 km/h speed for passenger trains and 90 km/h speed for freight trains, the maximum allowed speed, on all the considered section, is now 70 km/h.

For the original speed of the line, the Consultant has operated a detailed analysis based on the existing line geometrical value, aimed at calculating, per each curve and therefore per each section, the maximum admissible speed.

The following table 4.1.1-4 shows the existing line geometrical maximum speeds, and the theoretical maximum speeds reached with the upgrading of some indicated curve cants (superelevation). Calculations have been carried out by taking into consideration the following values:

- maximum admissible value for "a_{nc}" (not compensated acceleration on curve)=0.55 m/sec2

- maximum admissible "a_{nc}" variation on the transition curves=0.20/0.15 m/sec3

These maximum speeds will be recovered with the proposed rehabilitation options.

Table 4.1.1 – 4 Existing and future curves parameters. Future speeds.

Rehabilitation works for Lugovaya-Balykchi Line - Lugovaya-Kyrgyz border section Existing and future line speed limits - curves modifications										
Existing situation						"with project" situation				
Curves			*Existing cant*	Existing R	Max alignment speed	Min length of transition curve	Operation Max speed	Cant to be increased	Future cant value
			(cm)	*(m)*	*(km/h)*	*(m)*	*(km/h)*		*(cm)*
Curve	3627,893	3627,934	0	1800	110	105,66	110		
Curve	3628,076	3628,117	0	1800	110	105,66	110		
Curve	3643,587	3643,757	3	2250	140	126,27	110		
Curve	3660,877	3661,066	8	1000	115	112,19	110		
Curve	3651,239	3651,430	5	1000	105	105,42	110	yes	6
Curve	3651,675	3651,815	4	1300	115	114,60	110		
Curve	3662,372	3662,509	4	1300	115	114,60	110		
Curve	3664,885	3665,194	4	2800	155	119,19	110		
Curve	3684,024	3684,157	0	18500	160	31,64	110		

Theoretical maximum speeds allowed by the mentioned curves, are shown in the following table 4.1.1 – 5.

Table 4.1.1 – 5 Theoretical maximum speeds.

Rehabilitation works for Lugovaya-Balykchi Line - Lugovaya-Kyrgyz border section Theoretical maximum speeds		
Radius	Cant	Speed
(m)	(mm)	(km/h)
1000	80	110
1300	40	115
1800	0	110
2250	0	130
2800	40	170

Maintenance of PW

According to the collected information, the following table 4.1.1-6 resumes the average quantities of replaced p.w. materials per each maintenance cycle.

Table 4.1.1 – 6 Maintenance cycles materials

Rehabilitation works for Lugovaya-Balykchi Line (Lugovaya – Kyrgyz border section) Maintenance replaced quantities			
	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 4.1.1-7 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 IV to this study.

Table 4.1.1 – 7 Cost per km of type of maintenance

Rehabilitation works for Lugovaya – Balykchi Line (Lugovaya – Kyrgyz border 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 Lugovaya - Kyrgyz border is provided with 5 stations with a distance between 20,3 km (longest section) and 10,4 km. Their main functions are:

- operation (train crossings and overtaking);
- train parking;
- rolling stock parking (for service, for shunting or for maintenance);
- passenger service.

The following table 4.1.2-1 resumes the stations position and distances on the Lugovaya - Kyrgyz border section.

Table 4.1.2 – 1 Stations on the Lugovaya - Kyrgyz border section

Rehabilitation works for Lugovaya-Balykchi Line - Lugovaya-Kyrgyz border section Stations					
	Station name	Dimension (number of tracks)	kind of station	centre building chainage	Distance (km)
1	Lugovaya		large plant	3626,329	
					11,397
2	R-3639	3	small	3637,726	
					10,383
3	Munke	3	small	3648,109	
					17,903
4	Merke	4	medium	3666,012	
					20,312
5	Chaldovar	2	small	3686,324	
					0,956
	Kazakh border			3687,280	

4.1.3 Level Crossings

Along the Lugovaya – Kyrgyz border railway section a total of 10 level crossings is present.

The level crossing protection system is assured by crossing warning signals (traffic lights and Saint Andrew crosses) without barriers in 8 cases, with barriers protected by block signals in one case, with barriers protected by station signals in the last case.

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

The pavement of the level crossing area is typically made of concrete blocks or rarely of wooden sleepers.

Hereafter is listed the position of each level crossing:

Table 4.1.3-1 Position for each level crossing

Lugovaya – Kyrgyz border section Level Crossings		
1	L.C.	3627,514
2	L.C.	3634,355
3	L.C.	3637,318
4	L.C.	3646,386
5	L.C.	3656,903
6	L.C.	3665,427
7	L.C.	3666,976
8	L.C.	3677,868
9	L.C.	3681,525
10	L.C.	3686,956

4.1.4 Structures and Drainages

Along the entire Lugovaya – Kyrgyz border there are 25 concrete bridges, 44 pipe culverts, 6 box culverts and 31 arch culverts. According to the Kyrgyz railway experts, only a few of them are to be rehabilitated.

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

In terms of safety and signalling devices, the line includes the following typologies which are described below:

- Stations with electric relay devices
- Sections with Automatic Block Line Systems
- Automatic Level Crossings with or without half-barriers.

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 relevant 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.

On this line these installations permit electrical detection of the state of occupation of station tracks by electric track circuits.

In stations, one rail is usually insulated while the other rail will serve for the traction return current, when the catenary will possibly be present.

The points are usually hand operated by levers.

Shuntings movements use two aspects (white and blue) light.

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 start 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 throws 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 engine driver cannot 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.).

These devices are connected with automatic line block installations existing on the open line.

Special suppliers ensure uninterrupted power utilizing two network and storage batteries. In the main stations are as well present diesel generator sets of different sizes.

Automatic Block Line Systems (ABLS) and Cab signalling

ABLS divides the line in block sections controlled by track circuits and protected by side light signals and displays 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 Level Crossing control systems.

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

Track circuits are fed by alternating current which 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 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) with or without half-barriers (stations)

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 (ERII) 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 ERII 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 are remotely signalled on the train dispatcher command and control panel of the ERII in station.

On Lugovaya-Balykchi line the main protection systems for level crossing are:

a) Protection only by road side Saint Andrew crosses;
b) If the level crossing is located within stations the system is 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 barriers are lowered and the system efficient, meaning the road signals are on and the control system is normally operating.
c) If 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 or traffic lights plus half barriers. The station only receives alarm signals from the system.

A summary of the actual level crossing situation is given in Table C of Annex II.

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

4.2.1 Safety and signalling systems ages

In the years from 1983 to 1985 were installed the present devices from Lugovaya to Bishkek, and with regard to the considered section:

- Post 3639,
- Munke,
- Merke,
- Chaldovar.

In the same years was installed the Neva CTC systems from Lugovaya to Bishkek1 with Central Place in Bishkek1.

Lugovaya interlocking system was renewed during these last years owing to the damages suffered by the interlocking building from the earthquake of the end of nineties.

Before 1985 also for the section from Lugovaya to Bishkek1 traffic was controlled by local Movements Inspectors who operated, under their own responsibility, safety devices.

With the activation of the Central Command Post in Bishkek, a command and control panel became available to the Central Train Dispatcher (TD) displaying all the information necessary for direct control of traffic over the section previously entrusted to the Movement Inspectors.

The TD had the task of drawing the train graph as well.

4.2.2 Overview of the stations and the sidings

The section from Lugovaya (Km 3626) to Kyrgyz border (Km 3689) is characterized by the presence of:

- all relay interlocking systems in the stations,
- automatic block system in line,
- Centralised Traffic Control from Bishkek.

Lugovaya (Km 3626)

This is an intermediate station of the Tashkent-Arys-Almaty line which branches off the line for Bishkek and Balykchi.

It is equipped with an Electric Relay Interlocking, BMRC Type just renewed, which covers all main lines, secondary lines and points with related signals for trains and shunting.

The station has 23 (plus 12 in the freight yards) centralised tracks and it has to be noted that out of these, the third and the fifth (from the passengers terminal) are the main lines of the Tashkent-Arys-Almaty while the second one is the through line to Bishkek.

Points electrically operated sum to 97.

The system interfaces, side Bishkek, with the Lugovaya-Post 3639 ABLS section which has 6 block sections in such direction.

The interlocking is fed by an uninterruptible power system with a new diesel generator (power 65 kVA).

The implementation of the relevant control panel is on progress.

Post 3639 (Km 3639)

The station has 3 centralised tracks, out of which the second is the through line to Bishkek.

It is equipped with an Electric Relay Interlocking which controls 4 points.

The distance between the home signal is 2175 metres.

The system interfaces with the Post 3639-Munke ABLS section which has 6 block sections in such direction.

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

Munke (Km 3648+100)

The station has 3 centralised tracks and the second is the through line to Bishkek.

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

The distance between the home signal is 1205 metres.

The system interfaces with Munke-Merke ABLS section which has 9 block sections in such direction.

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

Merke (Km 3666+012)

The station has 4 centralised tracks, out of which the second is the through line to Bishkek.

It is equipped with an Electric Relay Interlocking which control 16 points.

The distance between the home signal is 3572 metres.

The system interfaces with Merke- Chaldovar ABLS section which has 10 block sections in such direction.

The interlocking is fed by an uninterruptible power system with diesel generator (power 24 Kva).

Chaldovar (Km3686+325)

The station has 5 centralised tracks, out of which the first is the through line to Bishkek.

It is equipped with an Electric Relay Interlocking which control 7 points.

The distance between the home signal is 1096 metres.

The system interfaces with Chaldovar-Kaindy ABLS section which has 11 block sections in such direction.

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

Finally the present main characteristics of the signalling and safety devices are summarised in Table A of Annex II referred to the stations and in Table B concerning line systems.

4.2.3 Equipment maintenance and needs for the safety devices

The organisation of routine and major maintenance of the existing safety devices was discussed with some officials of the Kazakh Railways.

Current maintenance is organised in terms of cyclic preventive maintenance and takes the form of periodic checks, adjustment and replacement of individual worn parts.

Major maintenance instead involves replacement works on elements (relays, point mechanisms, level crossing barriers mechanisms, etc.) which are worn or which present malfunction that are no longer reparable through routine maintenance.

Corrective maintenance (following failures) during service hours is based on interventions by maintenance personnel; outside normal service hours, emergency intervention is organised by on call units.

The maintenance operations require the utilisation of skilled engineers both for supervising and for monitoring the state of the equipment, with consequent impact on maintenance costs.

In the section Lugovaya - Kyrgyz border the age of the equipment results of about 20 years.

Therefore it will be increasingly hard to find spare parts, since most of them are, or are going, out of production and for this reason are made available in small batches at high costs.

Furthermore an increasing level of unreliability has serious consequences especially in unmanned areas.

Indeed, the reliability of peripheral devices has to be considered as essential in a remote controlled system since a failure of a equipment or device causes:

- constant problems to traffic circulation (slow-down, train prescriptions or other problems);
- often maintenance intervention on site to repair damaged equipment, with consequent need of manned operations of traffic management;
- in same cases the need to exclude the element from the system with consequent direct control by local operators and increased incidence of human factors on safety levels.

4.3 Power supply system

The Kyrgyz railway experts did not stress any particular problems concerning presently the power supply system along this section.

4.4 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 Merke and Chaldovar being 20,3 km long;
- trains speed on this section (in this case 70 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 2.2 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 crossing 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 2.2 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) = 56 trains/day.

Line speed restrictions

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

- the head of rails is worn out up to the admissible values;
- the ballast layer is highly polluted;
- 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;
- profile and alignment are far from the original designed ones, thus implying high vibrations increasing with the speed;
- bridges and culverts needs interventions.

But first of all, speed restrictions have been imposed according to the PW age on the line, in terms of gross million tons operated on the line sections after the last Capital Maintenance.

In the case of the Lugovaya – Kyrgyz border line section, reductions of maximum speeds were imposed along all its length, at last resulting in limitation of its possibilities in terms of line operations and transportation capacity (trains by day).

From the original 100-120 km/h speed for passenger trains, the maximum allowed speeds are, for the time being, 70 km/h.

Existing and future line speed profile is shown in Annex III "Options schematic plans".

Current running times

Train running simulations have been carried out along the existing line, and they show that the mentioned speeds restrictions lead to the following running times on the line from Lugovaya to Kyrgyz border:

- *Passenger train with three stops: 1h 04' (3' per each stop),*
- *Freight trains with three stops: 1h 43' (5' per each stop).*

Time savings due to rehabilitation works, will be shown in the following chapters, as benefit of the proposed options, against the "without project" scenario.

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 railway national traffic decreased of two third in twelve years, as it was widely commented in the Module A – Final Report. 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 this context this Consultant has focused the considerations on the infrastructural problems, starting from the evidences at the Consultant's disposal.

One of the most evident consequence of the existence of this problems is the reduction of the maximum allowed speed along all the section. From the original 80-100 km/h a reduction to 70 km/h has actually to be faced along the section. The reasons can be found mainly in the conditions of rails, of the sleepers, of the polluted ballast, on the bridges, on the modification of the original profile and alignment.

The effectiveness and the strict necessity of upgrading the infrastructural system are out of doubt.

Option 1 and 2 have been studied and selected with the specific technical aims of:

- increasing traffic speed both for passenger and freight trains,
- increasing line capacity in terms of trains per day (depending on the traffic flow directions, on signalling and telecommunication devices, on stations maximum distance),
- 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,
- reducing environmental impact of the railway system, consequent to emissions reduction, and noise and vibration reduction.

In terms of costs, the proposed options 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,
- reducing accidents,
- recycling residual materials 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 each option has been estimated and for each option different rates of maintenance cost reduction have been evaluated (in particular due to the adoption of the long welded rails).

In general, the proposed options 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 speed up capital maintenance, carried out on those parts of the line currently suffering for long and continuous lack of adequate maintenance.

Option 1 considers only permanent works, while interventions about safety plants along the section are not envisaged, because they guarantee presently safety conditions for the train operation, in spite of their long working life. In fact, for the signalling devices, based on the results of the investigations of the technical installations and on several interview of officials and technicians of Kyrgyz and Kazakh Railways, this consultant verified that there is not need of works to be carry out in any case in order to restore operations safety at levels which cannot be renounced

Option 2 includes, besides the Option1 interventions, the complete replacement of the safety plants, with computer aided interlocking ones. These will be aimed at increasing equipment availability and reducing the cost of maintenance of the safety devices.

Furthermore 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). Moreover, in the possible perspective of traffic control by Kazakh Railways, the transfer of the remote traffic control from Bishkek 1 to the nearest existing Kazakh Central Post with an improvement of traffic coordination on the southern line of Kazakh network has been considered (Table D of Annex II: Kazakhstan CTC Southern Lines).

5.2 Objectives of the rehabilitation

The feasibility study considers measures that consist essentially in a speeded-up capital repair of the entire Lugovaya – Bishkek – Balykchi line, split into two sections:

- Lugovaya – Kyrgyz border (in Kazakhstan) – 60.9 km long and 4 stations.
- Kazakh border-Bishkek-Balykchi (in Kyrgystan) – 261,4 km long and 16 stations.

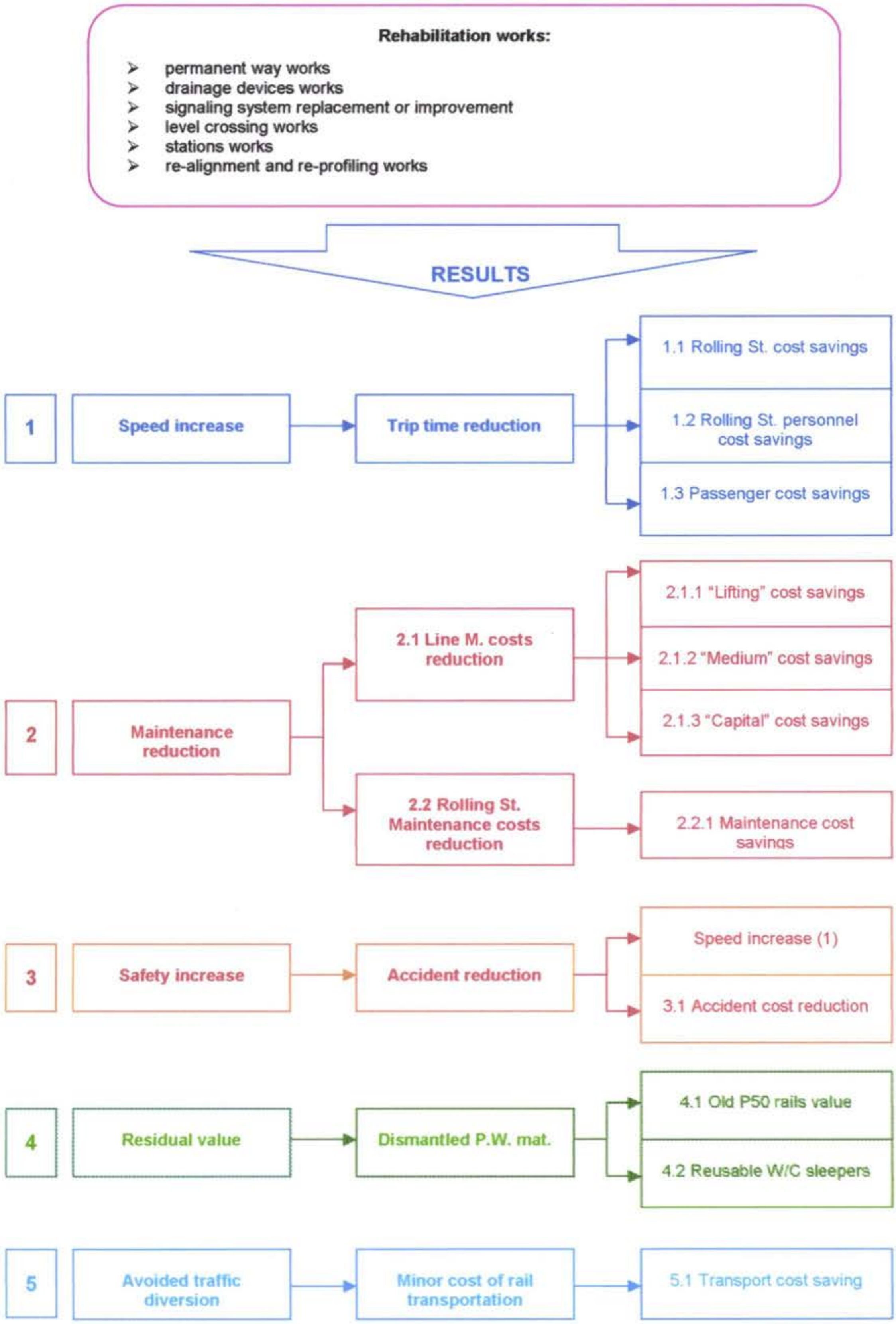
The whole line has been studied as a unique transport corridor and with homogeneous technical parameters, as it is correct under an interoperable point of view, that is one of the major tasks of this study. For the time being, the line is entirely operated and maintained by the Kyrgyz railways. Anyway, as it belongs to two different Countries, 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 two both Countries, can be resumed as follows:

- <u>Increasing train speed both for freight and for passenger trains</u>. 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.
- <u>Reducing infrastructure maintenance needs along the rehabilitated sections</u> of the line, for "lifting", "medium" and "capital" maintenance. In particular, due to the rules currently applied, "capital" maintenance will result highly reduced, this sensitively allowing the reduction of total maintenance costs. For each Option, infrastructure maintenance cost savings have been estimated, taking into consideration "materials", "machines" and "man-work" costs.

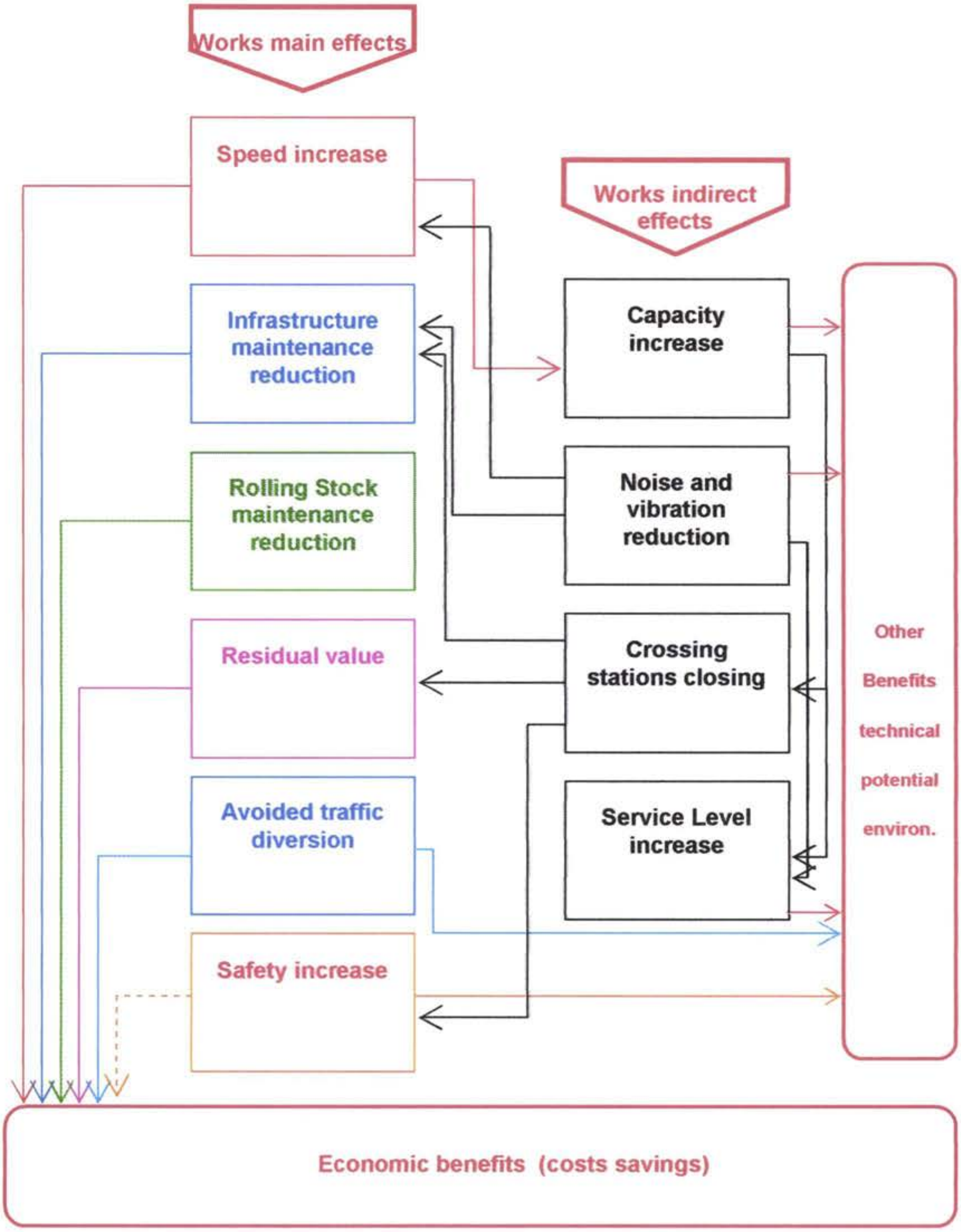
- Reducing rolling stock maintenance cost consequent to the better geometric and maintenance conditions of the line. In fact in the proposed options, not only re-alignment and permanent way replacement is envisaged, but also rail welding is considered, this further reducing wheels and suspension devices fatigue in the long term scenarios. Vibration reduction along the line is needed therefore not only for allowing speed increase, that will give the major benefits, but also for increasing passenger comfort and reducing rolling stock wearing out and infrastructure maintenance in correspondence of the existing rail joints.
- 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 (railway transport "is" safe), 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. For this reason, when rehabilitation works occur, speed restrictions are cancelled, and operation speed of the line increases.
- Residual value of the replaced dismantled permanent way. Old permanent way will be dismantled and P65 rails as well as the other reusable materials will be recovered to be successively reinstalled or considered for their residual value. Scrap materials could be sold and their residual value considered. Residual value of ballast, sub-ballast, where existing, and earth will not be considered because their re-use has been already taken into consideration within the works of widening section.
- Avoided traffic diversion. 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, for the improved railway services. Comparison will be made between the two scenarios "with project" and "without project".

The positive effects of the rehabilitation (benefits) are resumed in the following scheme:


Rehabilitation works:
permanent way works
drainage devices works
signaling system replacement or improvement
level crossing works
stations works
re-alignment and re-profiling works
RESULTS
1
Speed increase
Trip time reduction
1.1 Rolling St. cost savings
1.2 Rolling St. personnel cost savings
1.3 Passenger cost savings
2
Maintenance reduction
2.1 Line M. costs reduction
2.1.1 "Lifting" cost savings
2.1.2 "Medium" cost savings
2.1.3 "Capital" cost savings
2.2 Rolling St. Maintenance costs reduction
2.2.1 Maintenance cost savings
3
Safety increase
Accident reduction
Speed increase (1)
3.1 Accident cost reduction
4
Residual value
Dismantled P.W. mat.
4.1 Old P50 rails value
4.2 Reusable W/C sleepers
5
Avoided traffic diversion
Minor cost of rail transportation
5.1 Transport cost saving

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, both to the users and to the surrounding areas:

- Line capacity increase. Line capacity is intended as the maximum number of trains per day served by the line and it can vary from about 30 to 70 trains per day per single track, according to different conditions of the sensitive parameters (line speed, traffic flow homogeneity, percentage of fast trains, signalling systems, distance between stations, etc.). In this case of line rehabilitation, depending the capacity on the occupation time of the block sections by the trains, 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 next chapter (5.4.3 "Performance improvements").
- Traffic noise and vibration reduction. The rehabilitation works envisage the elimination of the most part of rail junctions currently present along the track (every 25m), by means of the adoption of continuous welded rail (C.W.R.). Moreover the proposed works include the re-alignment of plan and vertical geometric conditions of the line, by contributing to reduce noise and vibration during train operation. Their impact on service level (passenger comfort) will be considerable. Anyway, large part of the benefits of these improved infrastructure conditions will be exploited in terms of increased train speed.


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
potential
environ.
Economic benefits (costs savings)

5.3 Works Typologies

The envisaged works for line and station rehabilitation 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 (for line and stations, there including replacement of 1 turnout);
   c. rail welding and mechanical tension regulation;
   d. re-aligning, re-levelling and ballasting;
   e. civil works concerning re-pavement of some level crossings (L.C.). No elimination of level crossing by substitution with bridges has been envisaged for the low traffic both on the railway line and on the interfered roads.
2. Safety devices:
   a. replacement of station interlocking systems;
   b. replacement of automatic block system
   c. modification of commanding and controlling plant of the line and stations (CTC).

5.3.1 Infrastructure

In details the following Table 5.3-1 contains the description of the works to be carried out for infrastructure, as they have been considered in the Bill of Quantities for each option.

Table 5.3 – 1

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 20+20m around the existing railway axis, production of the current status cartography, 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 permanent way (rails, junctions, sleepers and fastenings). This operation could be carried out according to the methodology developed in this area: after having removed the fish-plated junctions of the rails, the track panels are lift by a dismantling crane and loaded on wagons and transported to the deposit sites, to be divided into scratch and re-usable materials (residual value).

3A	Excavation.	After having dismantled the permanent way, excavation of about 50-60 cm of topping material of the embankment by means of machine (bulldozer 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 includes the further compaction of the top layer of the embankment for increasing its bearing capacity and for re-shaping the embankment top surface.
4A	Partial lateral rebuilding embankment section, placing and compacting the removed top material for widening the top surface of about 1,0 m on both sides.	This item will be applied only on those sections where the existing embankment is eroded and not compliant with the typical cross section. In many cases in fact, ballast is falling down the embankment that is reduced in transversal dimensions due to the water and wind erosion of slopes, particularly where the grass is missing. 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. 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, assembled 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 welds to be done along the line 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 (transported by its wagons) at the correct distance and it would finally install the lateral new rails on the sleepers, with fastenings. 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	After the rail welding, mechanical tensions will be regulated, according to strict technical specifications that will be detailed in the

	(l.w.r.).	next phase of the study.
9A	Final tamping and levelling of new line.	The permanent way, so welded and regulated, will be in this phase taken to its final level and alignment by means of final tamping and levelling.
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, levelling and aligning the other existing sections with l.w.r.	All over the sections where existing permanent way is preserved, tamping, levelling 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 replaced 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.	Drainages must be cleaned and embankment side ditches must be excavated when missing, 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 (worn out), 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.

5.3.2 Safety devices

The proposed alternative envisages the following works typologies:

- modernisation of the Electric Relay Interlocking Installations by the activation of electronic systems (indoor devices),
- activation of renewed Automatic Block Line Systems (ABLS) and Cab signalling.

The new electronic Interlockings will essentially be capable of:

- guaranteeing safety through redundancy of their own microprocessor systems and comparison of data processing performed with at least two independent systems (2 from 3 or two times 2 from 2 principle);
- being remotely controlled from the central post and equipped with adequate self diagnosis systems;
- possible managing the existing field elements.

The utilisation of automatic block systems different from *ABLS* 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 axles counter automatic block is cheaper and suitable for present and middle term traffic but its adoption would mean a decline:

- in the safety (no cab signal and no self-braking devices);
- in the capacity of the lines;
- possibly rail disconnections would not be detected;
- 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 extreme environmental conditions.

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

Above measures don't deal with the investments to carry on supply and telecom lines. Anyway, about the connection of the telecom and the safety we have to underline following evaluation.

In the Kazakh Southern lines (see Table G of Annex II) 7 central places of Centralised Traffic Control are working, located in:

- Djambyl,
- Tchimkent,
- Almaty,
- Kzil-Orda,
- Atyrau,
- Aktyubinsk,
- Uralsk.

Many times in the same post are present equipment of very different ages and technology.

According the point of view of this Consultant the renewal of the oldest ones could be usefully done in a view of concentration of control equipment in one same building, for instance of the capital or of another town which can offer a more strategic location. The benefits of these solutions are surely well known and consist in scale cost-cutting measure with a better coordination of traffic and maintenance.

Of course this plan can be afforded when an efficient telecom net will be available and each peripheral place will be in any condition connected with the Central Place of the System.

As a first small step of this final solution we propose:

- The insertion of the Lugovaya - Chaldovar section into an existing section of the Central Post (C.P.) located in Taraz. This implementation has to be done only in the case a possible agreement between Kazakh and Kyrgyz Governments should statue (at the end of present agreement – i. e. year 2007) that the train control of the line should be by Kazakh instead of Kyrgyz Railways.
- The section under feasibility study could be added to the existing Newman system which is a computer aided system activated in recent times (1999) in Taraz.
- The area of the dispatcher of the Newman system (presently Chu-Otar of 156 Km) could be extended to the Chu-Lugovaya-Chaldovar without any increase of operational costs and a better coordination of traffic on southern Kazakh lines.
- The dispatcher operating in the C.P. will provide for all traffic operations relative to unmanned peripheral posts (command/control of itineraries, routing and individual field elements).
- The C.P. will guarantee a display of traffic and plant situations for the controlled lines.
- The same C. P. with existing equipment will ensure the co-ordination of preventive and corrective maintenance intervention on the basis of traffic situation and with the help of diagnostics systems.
- Lugovaya will remain still locally controlled with regard to the special needs of shunting and manning of this station.

5.4 OPTION 1

5.4.1 General description

Option 1 for Lugovaya – Kyrgyz border section is the natural complement of the measures envisaged in Option 1 and 2 for Kazakh border – Bishkek 2 section, as it foresees the demolition of the existing permanent way of the line, included the running tracks of the stations, the excavation of a layer of about 0.6 m of the existing material, the formation of 2 new layers of sandy gravel material 0,2 m thick and of ballast 0,35 m thick, the laying down of new concrete sleepers, the installation of new or recovered P65 rails, the formation of continuous welded rails, the replacement of the existing P50 switches with P65tg1/11 type ones on running tracks.

5.4.2 Works

Infrastructure

The interventions can be summarized as it follows:

- Topographic survey of the Lugovaya - Kyrgyz border (km 61),

- from chainage km 3626,329 to km 3665,47 (km 39,1 - P65 rails w/c sleepers),
- from chainage km 3665,470 to km 3666,683 (km 1,08 – P50 rails w/c sleepers),
- from chainage km 3666,683 to km 3687,280 (km 20,5 – P65 rails w/c sleepers),

- demolition of existing P65/P50 rails and wooden/concrete sleepers (60,5 km),
- recover of P65 rail bars (118.400 m) and reusable concrete sleepers,
- excavation of a layer 0,6 m thick of material (172.691 m^3),
- widening, if needed, the top surface of formation of 1.0m on both sides (15 km have been estimated, corresponding to 81,450 m3 of earth),
- laying down a layer 0,2 m thick of sandy gravel material (65.485 m^3),
- installation of reinforced concrete sleepers (115.300 pieces),
- installation of P65 rails on the main lines, stations included (121.000 m, corresponding to 7,100 t, out of which 1,430 t new purchased for replacing the old P65 in bad conditions),
- laying down a layer 0,35 m thick of ballast (107.206 m^3),
- regulation of mechanical tensions of continuous welded bars (121,0 km),
- formation of continuous welded rails (about 4,330 welds, 440 normal joints, 110 insulated joints),
- replacement of one P50tg1/11switche with a P65tg1/11 one in Merke station,
- demolition of 10 level crossing pavements,
- rebuilding of 10 definitive level crossing pavements (the pavement is generally formed by 24 reinforced concrete blocks),
- final tamping, levelling, aligning, addition of ballast, if needed (61,0 km).

It is also assumed that the machines will be put at the Contractor disposal by the Railways for all the period of works and then will be handed over back to the railways in good conditions and with the original quantities of spare parts. Therefore in contractor costs, rental cost for machine has been included. In the case the works would be directly implemented by the Railways the same cost for use of machine should be considered.

Safety devices

Option 1 does not envisage safety devices investments.

5.4.3 Performances improvements

Option 1 has been thought in order to recover the original line parameters along the section taking in account the most urgent necessities at the lowest cost and in shorter time. After the works are completed, the following performance improvements will be reached:

1. Traffic vibrations and dynamic forces limited at minimum values reflected on a more comfortable train travel, on a reduced impact on the environment, on a reduction of fuel consumption and on a reduction of maintenance needs both for line and for rolling stock.
2. Line speed recovered to its original values,
   Line speed after the works will be recovered to the following values:

Table 5.4.3-1 Option 1 speeds

Rehabilitation works for Lugovaya-Kyrgyz border section "with project" Option 1 speed		
Chainage *(km)*	**Section length** *(km)*	**Speed** *(km/h)*
3626		
	61	110
3687		
	7	100
3694		
	78	110
3772		
	8	90
3780		
	168	50
3948		

3. Line capacity increased from a minimum of 33 to 48 train per day.
4. Line maintenance costs largely reduced.

For maintenance needs and costs reduction, see chapter 9.1 "Benefits assessment".

For residual value of the replaced materials, see chapter 9.1 "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 "without project" and "with project" speed limits shown respectively in Chapter 4, Section "Maximum speeds along the section" (existing maximum speed 70 km/h, future speed for passenger trains 110 km/h, for freight trains 80 km/h).

The results are shown on Table 5.4.3-2.

Table 5.4.3 – 2 Option 1 Time savings

Rehabilitation of the line Lugovaya-Balykchi - Section Lugovaya-Kyrgyz border					
Scenarios		**Passenger trains**		**Freight trains**	
		existing time (h)	option 1 time (h)	existing time (h)	option 1 time (h)
Tot time no stop	*(h)*	0.87	0.55	0.87	0.76
	(min)	52.24	33.25	52.24	45.71
Time savings without stops	*(h)*		0.32		0.11
	(min)		19.00		6.53
Additional time for each stop (3 stops) (*)	*(min)*	4.02	4.17	6.35	6.53
Total travel time	*(h)*	1.07	0.76	1.72	1.63
	(min)	64.29	45.75	103.04	97.98
Time savings with stops	*(h)*		**0.31**		**0.08**
	(min)		**19**		**5**
(*) net stop time 3 minutes passenger trains, 5 minutes freight trains.					

5.5 OPTION 2

5.5.1 General description

Option 2 considers the safety plants replacement in addition to the PW interventions foreseen in Option 1. Safety plants include 2 sub-options (Safety plants Alternative 2 and Alternative 3) including respectively:

Alt. 2: renewal of all the stations interlockings and line block system;

Alt. 3: renewal of all the stations interlockings and line block system and moreover remote command and control from the central post.

5.5.2 Works

Infrastructure

See Option 1. Option 2 envisages the same works of Option 1 for infrastructure.

Safety devices

Safety devices Alternative 2 envisages:

1) new computer aided interlockings in:

- Post 3639,
- Munke,
- Merke,
- Chaldovar.

Outdoor field devices (signals, point machines, track circuits etc) are included.

2) Renewal of Automatic Block Line Systems (ABLS) and Cab signalling in the following sections:

- Lugovaya-Post 3639,
- Post 3639-Munke,
- Munke-Merke,
- Merke- Chaldovar.

In order to ensure cab signalling and to conform the technology to that one of the other sections it is foreseen Automatic Block Line Systems (ABLS) which divides the line in block sections (on average of 2,200 metres) which are controlled by track circuits and protected by side light signals.

Safety devices Alternative 2 envisages all the works of Alternative 1 and moreover:

1) Insertion of the section Lugovaya - Chaldovar into the Central Post of Taraz (included peripheral and central devices for remote control).

5.5.3 Performances improvements

Option 2 has been thought in order to recover original line parameters along the Kazakh section and to replace the existing old safety plants.

After the works completion, all the performances improvements mentioned and calculated within Option 1 will be reached, and in addition the following improvements due to the adoption of new safety devices will be achieved:

- Traffic safety increase,
- Traffic management procedures speed increase,
- Reduction of maintenance costs,
- Personnel reduction in stations (traffic operators). This personnel could be employed in other necessary railway related works in the framework of the general railway re-arrangement.

It is well known that the introduction of modern technologies has impacts on a wider area of technical and business system functioning.

When defining the benefits brought about by modern technologies, it must be established, that in the majority of cases these are multiplicative effects which are difficult to be quantified in advance, valued in money and contributed to only one factor.

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 can exert impacts, commonly, on:

- Rationalization of system operation;
- Rationalization of equipment maintenance;
- Increase in line capacity;
- Improvement of transport service quality.

As the Consultant did not obtain reliable data of service quality (i.d. news about failures, accidents, delays etc), in the prosecution of the study, only the first three above benefits have been analysed (see Chapter 9).

6. Rehabilitation options costs estimates

6.1 Unit costs

For the rehabilitation of the Lugovaya – Kyrgyz border section, a detailed cost analysis has been carried out.

In order to achieve reliable figures for manpower and materials costs, Italferr carried out a cost analysis both in Kazakhstan and in Kyrgyzstan, for comparing and grouping in the best way the unit costs. But, taking into consideration that the works have been assumed to be carried out by the Kazakh Railways Administration, according to the information for which this railway section will be operated and maintained by Kazakhstan after 2007, Italferr decided to adopt the very same figures developed for the other Kazakh section being part of this Study, the Beyneu-Uzbek border section.

For not available figures, Italferr carried out its own investigations and reached reliable figures for the purpose of the project.

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 (purchase costs) and expenditures for taxes, duties and Contractor and Client general expenditures.

For the Infrastructure, 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;
- 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. 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 Kazakh and international market, split into "foreign" or "national production.

Table 6.1.1 – 1 Main unit costs for materials

Rehabilitation works for Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border section "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
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
Rail joint	each	25.00	+/-4$	Foreign
Isulated joint	each	34.00	+/-4$	Foreign

6.1.2 Unit costs for machines

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

Table 6.1.2 – 1 Main unit costs for machines

Rehabilitation works for Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border section "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 Contractor 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 Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border 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	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 cost for local manpower

Rehabilitation works for Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border 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

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 Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border section *"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 for all Contractor works and purchases.

Table 6.1.4 – 2 Project cost calculation flow

Rehabilitation works for Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border section *"Project cost calculation flow"*		
Item	**Article of expenses**	**Calculation method**
1	Expenses for construction materials (including 6% for transport) including: imported materials produced in Kazakhstan	from the construction materials list
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 1 costs

6.2.1 Infrastructure costs

The following table 6.2.1-1 resumes the result of cost analysis for Option 1 for Infrastructure.

The table has been developed according to the detailed bill of quantities that is annexed to this report (*Annex I*).

Table 6.2.1 – 1 Cost analysis for Option 1 for Infrastructure

Rehabilitation works for Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border section "Option 1 cost for Infrastructure"		
Item number	**Article of expenses**	**Cost ($)**
1	Expenses for construction materials (including 6% for transport)	7,887,718.00
	including: imported materials	3,997,408.40
	materials produced in Kazakhstan	3,890,309.60
2	Expenses for local workers salary with account of social insurance charges (including 6% for movements)	602,742.39
3	Expenses for operation of machines and mechanisms	709,894.62
A	**Total net cost of construction**	**9,200,355.01**
4	Other expenses and costs of the contractor	1,840,071.00
5	Other expenses and cost of the client	828,031.95
B	**Total cost of construction and contractor and client expenses**	**11,868,457.97**
6	tax 25%	2,967,114.49
C	**Total cost of construction and contractor and client expenses with taxes**	**14,835,572.46**
7	Expenses for insurance of construction objects	59,342.29
8	Risk coefficient defined on basis of forecasted index of construction price growth for the following year	2,234,237.21
D	**Sub-Total cost of construction in current prices**	**17,129,151.96**
E	**International consulting cost (including 35% of profit)**	**936,225.00**
F	**Total cost of construction in current prices**	**18,065,376.96**

The estimation of investments costs for Option 1 Infrastructure add to ***18,065,377 $***

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

6.2.2 Safety devices costs

Not applicable. Option 1 does not envisage safety devices investments.

6.3 Option 2 costs

6.3.1 Infrastructure costs

As per Option 1, the estimation of investments costs for Option 2 Infrastructure add to ***18,065,377$.***

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

6.3.2 Safety devices costs

Investment values have been estimated by average and current prices of materials and labor and are especially referred to EU prices for innovative electronic equipment. Russian market could offer in this field interesting technical and economical solutions and this Consultant could deepen this analysis in case Option 2 is selected.

The following investments have been taken into account (*see Annex II, Tables F.1 and F.2*):

- Basic investments for Safety Devices Alternative 2 (Table F.1, Annex II).
- Basic investments for Safety Devices Alternative 3 (Table F.2, Annex II).

Investments for Safety Devices Alternative 2 add to about **4.373.030 $.**

Investments for Safety Devices Alternative 3 add to about **4.453.030 $.**

Investments costs for both Alternatives 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 cost of basic investments, as described before includes the following items:

- Uninterruptible Power Supply (UPS)for electronics interlockings of the stations;
- Electronic interlocking of the stations (indoor safety devices);
- Outdoor safety devices (signals, points machines, track circuits, level crossing systems etc.).

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

Table 6.3.2 – 1 Safety devices cost sharing

Lugovaya-Bishkek-Balykchi section	*supply quote %*	*works quote %*	*national quote %*	*foreign quote%*
Signal System				
Computer based Interlocking	80%	20%	10%	90%
Indoor power supplies	80%	20%	20%	80%
Block systems	75%	25%	20%	80%
Level crossings	70%	30%	30%	70%
Centralised Traffic Control				
Central Post	95%	5%	5%	95%
Peripheral Places	75%	25%	10%	90%

As a consequence (*see Annex II tables F.1 and F.2*)

Safety Devices Alternative 2:

Total cost 4.373.030 $ of which:
Supply quote: 3.420.674 $ (78%)
Works quote: 952.356 $ (22%) with
National quote: 599.406 $ (14%)
Foreign quote: 3.773.624 $ (86%)

Safety Devices Alternative 3:

Total cost 4.453.030 $ of which:
Supply quote : 3.480.674 $ (78%)
Works quote : 972.356 $ (22%) with
National quote : 607.406 $ (14%)
Foreign quote : 3.845.624 $ (86%)

6.4 Cost summary

Option 1

- Infrastructure rehabilitation,
- No signalling devices.

18,065,377 $ +/- 15%

Option 2 (S.D. Alt. 2)

- Infrastructure rehabilitation,
- Line block system and stations interlocking systems renewal.

22,438,407 $ +/- 15%

Option 2 (S.D. Alt. 3)

- Infrastructure rehabilitation,
- Line block system and stations interlocking systems renewal,
- CTC.

22,518,407 $ +/- 15%

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 2,724,900 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:

Lugovaya – Bishkek – Balykchi	• urban areas • areas far from borrow pits (ballast) • areas prone to erosion soil • area with possibility of flooding

Critical areas

Sections (Km)	Actual land use	Environment items	Environmental receptors
3645-3646	Urban area (Munke)	Urban ecology	Residential build-up area
3666-3667	Urban area (Merke)	Urban ecology	Residential build-up area
3684-3685	Urban area (Chaldovar)	Urban ecology	Residential build-up area
3701-3702	Urban area (Kaindi)	Urban ecology	Residential build-up area
3716-3717	Urban area (Kara-Balta)	Urban ecology	Residential build-up area
3725-3735	Cultivation area, shrubland/grassland	Agriculture environment	Cultivation area
3741-3742	Urban area (Belovod.)	Urban ecology	Residential build-up area
3755-3756	Urban area (Shopokovo)	Urban ecology	Residential build-up area
3764-3765	Urban area (Soklukh)	Urban ecology	Residential build-up area
3775-3776	Urban area (Bishkek 1)	Urban ecology	Residential build-up area
3781-3782	Urban area (Bishkek 2)	Urban ecology	Residential build-up area
3782-3783	Urban area (Alamedin)	Urban ecology	Residential build-up area
3800-3801	Urban area (Kant)	Urban ecology	Residential build-up area
3821-3822	Urban area (Ivanovka)	Urban ecology	Residential build-up area
3825-3835	Cultivation area, shrubland/grassland	Agriculture environment	Cultivation area
3840-3841	Urban area (Tokmak)	Urban ecology	Residential build-up area
3861-3862	Urban area (Bystrovka)	Urban ecology	Residential build-up area
3885-3886	Urban area (Djil-Aryk)	Urban ecology	Residential build-up area
3886-3900	Riverside, road infrastructure	Water environment	Landscape, soil (prone to erosion soil), water
3901-3913	Riverside, road infrastructure	Water environment	Landscape, soil (prone to erosion soil), water
3913-3934	Wetland	Water environment	Landscape, soil (prone to erosion soil), water
3935-3936	Urban area (Kojamat-Kurkol)	Urban ecology	Residential build-up area
3945-3946	Urban area (Balykchi)	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 neighbourhood (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 levelling 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*

The area extending from Lugovaya (Kazakhstan) to approximately Djil Arik (Kyrgyzstan) is geologically formed by Neogene molasse and Quaternary alluvial sediments of the numerous rivers coming down from the Kyrgyz range, at south. The atmospheric precipitations and rivers waters feed the aquifers of these sediments.

Morphologically the area, part of the southern extension of the Chou river catchment basin, is basically flat, presenting however a general inclination northwards, i.e. towards the said river.

Beyond Djil Arik up to Balykchi the area is mountainous and is geologically composed of the pre-Mesozoic formations of the North Tien Shan mountains, that include both sedimentary (sandstones, conglomerates, carbonates) and igneous (effusive and intrusive) rocks. The groundwater systems developed in these rocks are mainly of the open jointing type and fed by atmospheric precipitations. The area is subject to high seismic activity.

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

- the deterioration of the soil profile of parcels were there will be settled site organizations and working points for the destructions of soil profiles;
- 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 fulfilment. 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

<u>Impact induced by the construction site activities</u>

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:

- <u>suspended solids</u> – 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 refuelling 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).

Excavations and soil movements

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.

Fuelling and maintenance stations

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.

Works filling on the back

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.

Finishing and maintenance works

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, refuelling) will be done only in specially designed places (concrete platforms, with decanters to retain the losses).

Impacts on biological environment (flora and fauna)

Flora and vegetation

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 levelling 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's 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 fulfilment.

The powders

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
Replacement of the safety systems of the stations	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

The area extending from Lugovaya (Kazakhstan) to approximately Djil Arik (Kyrgyzstan) is geologically formed by Neogene molasse and Quaternary alluvial sediments of the numerous rivers coming down from the Kyrgyz range, at south. Morphologically the area, part of the southern extension of the Chou river catchment basin, is basically flat, presenting however a general inclination northwards, i.e. towards the said river.

Beyond Djil Arik up to Balykchi the area is mountainous and is geologically composed of the pre-Mesozoic formations of the North Tien Shan mountains, that include both sedimentary (sandstones, conglomerates, carbonates) and igneous (effusive and intrusive) rocks. The groundwater systems developed in these rocks are mainly of the open jointing type and fed by atmospheric precipitations.

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 unfavourable 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.

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
Water quality	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
Waste				
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, particularly on the Lugovaya – Balykchi line.

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 prevented 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, (Lugovaya – Balykchi, from Km. 3885 to Km. 3900) the proposed mitigation measures will be in addition special retain structures (gabion retaining 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 Environment	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.

Overflowing areas

The analysis of the work status before the rehabilitation works underlines some aspects, interested by the layout project, influenced by potential overflowing (Lugovaya – Balykchi line: from km. 3900 to km. 3913).

In these aspects the stretches in the surveys should be dimensioned without interfering with the superficial discharge characteristics. Besides the presence of the culverts that guarantees the maintenance of the superficial water network allows to avoid the effect of dams in compare to the superficial discharge.

The river discharge in the areas have a condition of extreme variability, so it is absolutely requested a detailed hidrogeological study to evaluate the highest level of the river Chou and of his main side-streams in the most raining periods of the year. It would be then requested to evaluate the return timing from the condition of the flooding and from the water levels that may change the structure of the railway line.

Actually is possible to conjecture the whole valley as an overflow area, this by simply observing the valley's morphology particularly flat, the absolute absence of obstacles to prevent the outflow of the waters and also the light incision of the fluvial basin.

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 "Reccomandetion 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
water quality	▪ Increased use of natural resources due to influx of construction workers: ○ Ensure drainage systems do not pollute water sources through appropriate alignment or through filtration as appropriate ○ Ensure other sources of pollution are not allowed to enter the water courses ○ Ensure that local people's needs take precedent over construction and construction workers ○ Ensure that access points/paths to water sources for people are not disrupted during construction and post-construction ○ Contractors are required to make arrangements for water supply that do not affect supply to other users ○ To ensure that access points to water sources are not blocked during construction ○ To provide adequate washing facilities for construction workers ○ 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 Local Railway Company (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, (O_2 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, SO_x, 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	X	X	
	In order to reduce dust in the villages, also a particular gravel is recommended	Monitor implementation	X	X	
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	X	X	
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	X		
	Restore vegetation immediately after the end of works	Monitor implementation			X

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	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 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	Monitor implementation			
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			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	Restore vegetation immediately after the end of works	Monitor implementation			
	Forbid project staff to kill, injure or poach wild animals	Monitor implementation			
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			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	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 and Table 8 - 2 show a preliminary implementation plan for both Option 1 and Option 2.

The Option 1 considers only PW works, mainly consisting in the demolition and reconstruction of the PW, recover and reinstallation of P65 rails, laying down new sandy gravel and ballast layers, replacement of wooden sleepers with reinforced concrete ones, formation of continuous welded rails. Only one contract is foreseen.

The scheduled activities will be completed in 26 months.

Option 2 includes all the activities of Option 1, with the addition of the replacement of the existing safety plants. Therefore two different contracts have to be considered: one for the infrastructural works and another one for the safety plants works.

The scheduled activities will be completed in 26 months.

Table 8.1 Implementation programme for Option 1

	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	25	26
1	*Approval of financement*	*																									
2	*Final tender document preparation*	■	■																								
3	*Tendering and signing contract*			■	■	■	■																				
4	*Mobilization*							■	■																		
5	*Topographic survey, final profile*								■	■	■	■															
6	*Provision of materials*										■	■	■	■	■												
7	*Welding P65 rails in 100m bars*													■	■	■	■										
8	*Laying down 100 m rail bars along the line*															■											
9	*Demolition, excavation, laying down new subballast, ballast, concrete sleepers, P 65 rails*																■	■	■	■	■	■	■				
10	*Dismantling, recovering P65 rails and other materials*																■	■	■	■	■	■	■	■			
11	*First ballasting, first tamping*																■	■	■	■	■	■	■	■			
12	*Second ballasting, second tamping*																	■	■	■	■	■	■	■			
13	*Welding rails in 1000m bars along the line*																	■	■	■	■	■	■	■	■		
14	*Regulation of rail mechanical tension and welding in long bars.*																		■	■	■	■	■	■	■		
15	*Final tamping, leveling, aligning*																			■	■	■	■	■	■	■	
16	*Tests and taking over of rehabilitated line*																										■

Table 8.2 Implementation programme for Option 2

	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	25	26
1	*Approval of financement*	*																									
2	*Final tender document preparation*	■	■																								
3	*Tendering and signing contract*			■	■	■	■																				
4	*Mobilisation*							■	■																		
5	*Topographic survey, final profile*								■	■	■	■															
6	*Provision of materials*										■	■	■	■	■												
7	*Welding P65 rails in 100m bars*													■	■	■	■										
8	*Laying down 100 m rail bars along the line*															■											
9	*Demolition, excavation, laying down new subballast, ballast, concrete sleepers, P 65 rails*																■	■	■	■	■	■	■				
10	*Dismantling, recovering P65 rails and other materials*																■	■	■	■	■	■	■	■			
11	*First ballasting, first tamping*																■	■	■	■	■	■	■	■			
12	*Second ballasting, second tamping*																	■	■	■	■	■	■	■			
13	*Welding rails in 1000m bars along the line*																	■	■	■	■	■	■	■	■		
14	*Regulation of rail mechanical tension and welding in long bars.*																		■	■	■	■	■	■	■		
15	*Final tamping, leveling, aligning*																			■	■	■	■	■	■	■	
16	*Tests and taking over of rehabilitated line*																										■
	SAFETY PLANTS																										
17	*Final tender document preparation*	■																									
18	*Tendering and signing contract*		■	■	■																						
19	*Production of efecutive design, detailed specification, examination and approval of managership*					■	■	■	■	■	■																
20	*Construction on factory and delivery*								■	■	■	■	■	■													
21	*Site installations*											■	■	■	■	■	■	■	■	■							
22	*Tests on site out of operation*																		■	■	■	■	■	■	■	■	■
23	*Commissioning*																										■

9. Benefits Assessment of the Project

9.1 Option 1

Option 1 benefits derive from the mentioned rehabilitation works related to infrastructure only.

9.1.1 Benefits from infrastructure works

Running time savings

As calculated in chapter 5.4.3, the following time savings have been considered should Option 1 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 KTZ priority schedule for the whole network.

Table 9.1.1 – 1 Option 1 Time savings

Rehabilitation of the line Lugovaya-Balykchi - (Lugovaya – Kyrgyz border section)		
Scenario	*Passenger trains (minutes)*	*Freight trains (minutes)*
future	*19*	*5*

Benefits related to time savings

As a consequence of the time savings a number of benefits derives, but not all of them have been considered in the calculation, in accordance with a conservative approach.

Value of the time saved by passenger using the railways have been calculated starting form the passenger train traffic along the line and its projection in the future.

As the railway section is mainly utilised by traffic to/from Kyrgyzstan, the value of the time has been calculated taking into consideration the following Kyrgyz data/assumption:

GDP at national level (year 2002): 1603 ml US$

Total population (year 2002): 4,97 million residents

Employed people: 30%.

It is worth mentioning that adoption of the corresponding Kazakh figures will bring to an higher value of the time. Consequently it has to be remarked that in the present case using Kyrgyz data for calculating the value of the time is a conservative assumption.

Assuming that 220 is the average number of working day in one year and 8 hours is the normal working time per day, the hourly add value per resident employed has been estimated in 0,46 US$ / hour.

The same indicator for not-employed people has been estimated as one-third of the previous one. For the estimation of the add value (or value of time) for a generic passenger, it has been assumed that 1/3 of the trips are for business and 2/3 for other purposes. Consequently the added value of one hour of travelling is given by the related weighted figure and it has been estimated to be equal to 0.265 US$ per hour per passenger.

Value of time has been finally estimated by using savings in time and assuming 756 passenger per train.

Value of time saved by freight has been assumed to be related to the value of time impacts on the income of final user (i.e. importer, exporter and trader). This is based on the fact that the time the transaction takes place plays a key role in buying or selling a good.

In buying a material good, usually, there is a time gap between buyer's disbursement and acquiring the merchandise. This time gap is mainly due to travel time. The buyer, then, needs to finance the operation during the time between disbursement and selling again the merchandise. The trader operates with a bank, which finances the trade operation receiving an interest that in the present situation can be valued around 12% per year. Knowing the value of the merchandise traded is then possible to assign a value to travel time for freight. The freight time value of one hour can be calculated multiplying the value of the good by the interest rate and dividing by 8,760, which are the hours contained in one year.

Information available in the base year suggests the use of foreign trade which allows to establish an average unit price of the traded freights (i.e. US$ per ton).

The analysis has been carried out on figures concerning foreign trade with Europe in the year 1999 (Source OECD) but excluding, mineral fuel, crude materials, lubricants and not-classified commodities. Dividing value of import and exports by the related quantity the average unit price of total merchandise traded is 6.080 US$/ton. Consequently adopting 12% interest rate, the freight time is 0,00347 US$ per ton per hour.

Value of time has been finally estimated by using savings in time and tonnes transported.

Locomotive and rolling savings effect are also a close consequence of the time savings along the line because of the shortest cycle of utilisation. The reduced transport time results in a reduction of the overall locomotive and rolling stock requirement.

Although most of the regional railways fleet is very old, and its financial book correspondingly low, the value in economic terms of the service it provides is that of the imported resources it replaces. Train hourly costs (working and standby) have therefore been calculated analytically, on the bases of the current world price for locomotives, freight cars and passenger coaches and according to the standards train configuration.

As far as the calculation for locomotive is concerned it has been assumed the cost for a 4000 HP diesel-electric equivalent to 3000 HP locomotive widely used in term of average train's overall power.

The following Table 9.1.1-2 and Table 9.1.1-3 show results of the calculation which have been used crossed with time savings.

Table 9.1.1-2 Locomotive hourly cost calculation

Description		Value	Unit
BASIC DATA			
Locomotive:			
Diesel Locomotive cost		2.300.000	US$
Installed Horsepower		4.000	HP
Economic Life:			
Life		18	years
Utilisation		1.820	hours/year
Total life		32.760	hours
Financial Charges:			
Interest rate		12%	
Maintenance:			
Parts & Labour Factor		120%	of depreciation
Power:			
Diesel fuel cost		0,13	US$/liter
Specific consumption		0,15	liter/HP/hour
Hourly consumption		600	liter/hour
Ownership cost:			
Depreciation		70,21	US$/hour
Interest		80,04	US$/hour
	TOTAL	150,25	US$/hour
Operating cost			
Maintenance		84,25	US$/hour
Power		78,00	US$/hour
Lubricants		19,50	25% Fuel
	TOTAL	181,75	US$/hour
TOTAL HOURLY OPERATING COSTS			
Working		332,0	US$/hour
Standby		80,04	US$/hour

The above calculation is very conservative since it considers diesel fuel costs according to the information available for Kyrgyzstan. According to Kazakh sources diesel costs is nowadays 0,25 US$/liter. This brings to a bigger difference between working hourly cost (422 US$) and standby hourly costs (80.04 US$) which can result into bigger benefits. Despite the fact that the line section belongs to the Kazakh, it is not known what will be the proportion of the services operated by the two railways companies after 2007. Consequently, the Consultant has assumed the more conservative figure for the purposes of the calculation.

Table 9.1.1-3 Rolling stock hourly cost calculation

Description	Freight Wagons						Passenger Coach	Unit
<u>BASIC DATA</u>	Boxcar	Flat car	Gondola	Tank car	Grain carrier	Cement carrier		
Wagon:								
Wagon cost	30.000	25.000	30.000	35.000	35.000	35.000	1.320.000	US$
Specifications:								
Number of axles	4	4	4	4	4	4	4	
Tare	22,88	20,90	22,00	25,30	22,00	28,50	20,00	tonnes
Payload	68,00	70,00	69,00	62,00	64,00	67,00	70,00	tonnes
Max Gross weight	90,88	90,90	91,00	87,30	86,00	95,50	90,00	tonnes
Economic life:								
Life	32	32	22	32	30	26	25	years
Utilisation	4.040	5.880	3.570	7.580	4.500	6.000	4.000	hour/year
Total life	129.280	188.160	78.540	242.560	135.000	156.000	100.000	hour
Financial charges:								
Interest rate	12%	12%	12%	12%	12%	12%	12%	
Maintenance:								
Parts & Labour Factor	100%	100%	100%	100%	100%	100%	100%	of depreciation
<u>Ownership cost:</u>								
Depreciation	0,23	0,13	0,38	0,14	0,26	0,22	13,20	US$/hour
Interest	0,46	0,26	0,53	0,29	0,48	0,36	20,59	US$/hour
TOTAL	0,69	0,39	0,91	0,43	0,74	0,58	33,79	US$/hour
<u>Operating cost</u>								
Maintenance	0,23	0,13	0,38	0,14	0,26	0,22	13,20	US$/hour
TOTAL	0,23	0,13	0,38	0,14	0,26	0,22	13,20	US$/hour
	<u>TOTAL HOURLY OPERATING COSTS</u>							
Working	0,92	0,53	1,29	0,58	1,00	0,81	46,99	US$/hour
Standby	0,46	0,26	0,53	0,29	0,48	0,36	20,59	US$/hour

It is intended that benefits generated by locomotive and rolling stock optimisation will be shared between Kazakh and Kyrgyz Railways to which the fleet using the line will belong. For the purposes of the calculation a conservative assumption has been taken: it has been assumed that only a 30% of that benefit will be accruing to the Kazakh Railways.

Despite the uncertainty on who will be operating services, this is, of course, very conservative since Kazakh benefit could derive both by the savings of Kazakh rolling stock which will use the line and by the performance improvement of the line which allows the owner of the infrastructure to proper discuss the access fee on the infrastructure itself mainly on the basis of the benefits generated to the services operator by such new improved performance.

Replaced materials residual value

Dismantled permanent way can be re-used on secondary lines or on station sidings and its residual value has been considered as a benefit of the "with project" option.

The following table 9.1.1-4 shows the Consultant's estimate for the rails, sleepers and fastenings residual value.

Table 9.1.1 – 4 PW elements residual value

RAILS Track Age ('000 Gross Tonnes)	Average Rail Age ('000 Gross Tonnes)	Residual Value Gross (US$/tonne)	 Recovered (US$/tonne)	 Net Value (US$/km)
<200,000	100,000	550	530	68,900
201,000 - 400,000	300,000	490	460	59,800
401,000 - 500,000	450,000	410	370	48,100
501,000 - 700,000	600,000	260	220	28,600
701,000 - 800,000	750,000	200	180	23,400
801,000 - 1,000,000	900,000	85	70	9,100
>1,000,000	1,000,000	60	50	6,500

Sources: Consultant's estimate

SLEEPERS Sleeper Type	Average Sleeper Age (years)	Residual Value Gross (US$/each)	 Recovered (US$/each)	 Net Value (US$/km)
Wood new	0	25	25	46,000.00
Wood used	20	10	7	12,880.00
Concrete new	0	25	25	46,000.00
Concrete used	15	10	8	14,720.00

Sources: Consultant's estimate

FASTENINGS Sleeper Type	Average Sleeper Age (years)	Residual Value Gross (US$/each)	 Recovered (US$/each)	 Net Value (US$/km)
New	0	25	25	46,000.00
Used	20	8	7	12,880.00

Sources: Consultant's estimate

According to the estimated age of the dismantled PW elements and their quantities, the following table 9.1.1-5 calculates the PW residual value. For the quantities, it has been estimated that the 90% of replaced sleepers are wooden and, out of these, only the 20% will be re-usable, while the 10% are concrete, and out of these only 50% will be reusable. For fastenings, out of 100 dismantled, 20 will be in conditions to be re-used.

Table 9.1.1 – 5 Option 1 PW residual

Rehabilitation of Border-Balykchi railway line - Lugovaya-Kyrgyz Border section Residual value for Option 1			
			Value ($)
Rails	replaced (t)	1,430.00	100,100.00
Wooden sleepers	replaced (n)	100,000.00	
	20% re-usable (n)	20,000.00	140,000.00
Concrete sleepers	replaced (n)	12,000.00	
	50% re-usable (n)	6,000.00	48,000.00
Fastenings	replaced (n)	112,000.00	
	20% re-usable (n)	22,400.00	156,800.00
			444,900.00

Total residual value: 444,900 $.

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 1.

For unit costs of maintenance, per each maintenance cycle, reference is made to Table 4.1.1-7. For the detailed maintenance costs divided per materials and manpower, reference is made to Annex IV "Details of maintenance costs".

In case of "with project", and "without the project", it is assumed that the future cycle of Capital Maintenance will start presumably on 2026 and it will only include rails replacement because their time limit is reached, while for the other PW elements there will be other 7-8 years of life. It is moreover assumed, that when replacing only the rails, also 10% of sleepers and fastenings and 20% additional ballast for refilling will be considered. For turnouts, joints and insulated joints, quantities are the same of normal Capital Maintenance. For details of capital maintenance costs in case of replacing only the rails, reference is made to Annex IV.

The following table 9.1.1 -6 resumes the unit costs of maintenance per each km of line, as shown in Table 4.1.1-7.

Table 9.1.1 – 6 Unit maintenance costs.

Rehabilitation works for Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border section					
	Cost per km of type of maintenance				
	Lifting	Medium	Capital	Capital without rails replacement	Capital only rails replacement
$/km	82,321	206,428	494,306	355,910	253,643

Table 9.1.1 – 7 Forecast of maintenance costs related to Option 1

Rehabilitation works for Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border section Line maintenance costs for OPTIONS 1 - 2							
Year	*Required Maintenance (km)*			*Maintenance Costs (US$)*			
	Lifting	*Medium*	*Capital (1)*	*Lifting*	*Medium*	*Capital (1)*	*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	0	0	164,642	-	-	164,642
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	0	164,642	619,284	-	783,926
2024	2	3	0	164,642	619,284	-	783,926
2025	2	4	0	164,642	825,712	-	990,354
2026 *(1)*	2	4	5	164,642	825,712	1,268,216	2,258,570
2027 *(1)*	4	4	10	329,283	825,712	2,536,431	3,691,427
2028 *(1)*	4	4	10	329,283	825,712	2,536,431	3,691,427
2029 *(1)*	4	4	10	329,283	825,712	2,536,431	3,691,427
2030 *(1)*	4	4	5	329,283	825,712	1,268,216	2,423,211
2031 *(1)*	6	4	5	493,925	825,712	1,268,216	2,587,853
2032 *(1)*	6	4	2	493,925	825,712	507,286	1,826,924

(1) Capital maintenance only includes rails replacement.

As shown, capital maintenance will be suspended after the works are carried out, till approximately the year 2026, when existing rails have largely reached their life limits (30-35 years) and the replaced sleepers and fastenings have been working for about 19-20 years. Capital maintenance will involve the complete replacement of rails and only part of the other pw components.

The hypothesis that has been followed in estimating the number of km per year for each maintenance type is that, according to the rules indicated in the line maintenance chapter, 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.

In the case of "without project" scenario, maintenance needs have been quantified and their cost have been assessed in the following table 9.1.1-8.

Also for maintenance in case of "without project", the estimation of the number of km per year has been based on the mentioned rule, according to which, in case of wooden sleepers and jointed rails, the maintenance cycle should be carried out every 15 years.

Anyway, in case of "without project", the estimation has been made following a conservative analysis: according to this analysis, the maintenance needs envisaged cannot be much higher than the real maintenance carried out in the last years. In fact Kyrgyz Railways, for a highly affecting shortage of resources, in the last years concentrated its small investments on small sections maintenance on other line sections, and this will be presumably done also in the future, also when the line passes to Kazakh Railways. Anyway, the proposed "without project" scenario for maintenance forecast is assumed to be the minimum, in order to maintain the line in the lowest technical conditions for operation. It is not possible to envisage a future in which the line operation, for lack of maintenance, will be suspended.

For the "without the project" scenario, it has been assumed that in the future two different cycles of Capital Maintenance will be carried out: the first, in the next years, will be done without replacing the rails, while the second, starting approximately in 2026, will only involve rails replacement and some minor quantities of sleepers, fastenings and ballast.

Table 9.1.1 – 8 Forecast of maintenance costs "without the project"

Rehabilitation works for Lugovaya - Balykchi Line - Lugovaya-Kyrgyz Border section Line maintenance costs "without project"							
Year	*Required Maintenance (km)*			*Maintenance Costs (US$)*			
	Lifting	*Medium*	*Capital*	*Lifting*	*Medium*	*Capital*	*Total*
2007 *(2)*	4	3	2	329,283	619,284	711,820	1,660,387
2008 *(2)*	4	3	2	329,283	619,284	711,820	1,660,387
2009 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2010 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2011 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2012 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2013 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2014 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2015 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2016 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2017 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2018 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2019 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2020 *(2)*	4	3	4	329,283	619,284	1,423,639	2,372,207
2021 *(2)*	2	3	4	164,642	619,284	1,423,639	2,207,565
2022 *(2)*	2	3	2	164,642	619,284	711,820	1,495,746
2023 *(2)*	2	3	2	164,642	619,284	711,820	1,495,746
2024	2	4	0	164,642	825,712	-	990,354
2025	2	4	0	164,642	825,712	-	990,354
2026 *(1)*	2	4	5	164,642	825,712	1,268,216	2,258,570
2027 *(1)*	4	4	10	329,283	825,712	2,536,431	3,691,427
2028 *(1)*	4	4	10	329,283	825,712	2,536,431	3,691,427
2029 *(1)*	4	4	10	329,283	825,712	2,536,431	3,691,427
2030 *(1)*	4	4	5	329,283	825,712	1,268,216	2,423,211
2031 *(1)*	6	4	5	493,925	825,712	1,268,216	2,587,853
2032 *(1)*	6	4	2	493,925	825,712	507,286	1,826,924

(1) Capital maintenance only includes rails replacement.

(2) Capital maintenance does not include rails replacement.

Differences between maintenance costs "without the project" and "with the project Option 1" correspond to the maintenance costs savings related to Option 1.

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,

have 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.

Rolling stock maintenance costs saving from rail welding

The benefits previously duly described accrue to the system from the reduction of the maintenance costs of the infrastructure and from the optimisation of the rolling stock utilisation.

A benefit of valuable importance is generated by the savings in rolling stock maintenance as a consequence of the adoption of the technique of the welding of the rail. The presence of a close correlation is out of doubt and the phenomenon has been studied in Russia starting form 80's. Several Russian publications mention savings of the order of 15% of the rolling stock maintenance costs as a consequence of the introduction of the long welded rail.

According to a conservative approach, this benefit has not been included in the calculation of the project assessment.

9.1.2 Benefits from Safety devices works

Not applicable.

9.2 Option 2

Option 2 benefits derive from the upgrading works involving both infrastructure and safety devices.

9.2.1 Benefits from Infrastructure works and machines

As per Option 1.

9.2.2 Benefits from Safety devices works

Safety devices Alternative 2.

Benefits with the investments of Alternative 2 (renewal of line block system and stations interlocking) can be shown as follow.

The Consultant did not obtain from Kazakh Railway any information about salaries and costs of operational and maintenance work force.

The only indication the consultant was provided with in the Headquarters of Astana was that the average salary for an operational or maintenance unit is corresponding to monthly 385 $ (5005 $/year).

For Kyrgyz Railways the equivalent salary is 1,650 $/year (traffic operator level 1). Therefore it has been assumed a cost of work force in Kazakh 3 times the Kyrgyz one.

Decrease of operational needs

- Saving of traffic operators in Post 3639, Munke, Merke, Chaldovar in consequence of the increase of the RAM conditions of the interlockings and the block system which allows the unmanning of the smaller stations:

  8 Traffic Operators.

  The cost per unity may be evaluated of 1,645 x 3= 4,935 $/year, therefore operational cost saving will be 39,480 $/year (Traffic operators).

- Saving of station masters in Post 3639, Munke, Merke, (not in Chaldovar as it is border station)

3 stations x 1 = 3

The cost per unity may be evaluated of 2,513 x 3=7,539 $/year, therefore operational cost saving will be 22,617 $/year (Station masters).

Total operational cost saving 62,097 $/year.

Decrease of maintenance needs

A. Line block systems (Annex II Table D)

A1.Automatic block

Present needs (see Tables E.1 and E.2 of Annex II):

Electromechanics: 1.88 x1,6 = 3

Electrical engineers: 1x 1,6 = 1,6

Total = 4.6

As the new interlocking will replace others whose life times were expired since more than 5-10 years, this consultant estimated that the future maintenance need is equal the basic (2,88 men):

Labour saving is than of about **2** men.

B. New interlockings

Accordingly above Specifications, the present maintenance need for the interlockings of Lugovaya (e), Post 3639, Munke, Merke may be evaluated in **5,9** men (see Annex II Tables E.1 and E.2).

As the new interlocking will replace others whose life times were expired since more than 5-10 years, the consultant estimated that the future maintenance need is equal to the basic (**3,69** men, see Tables E.1 and E.2 of Annex II).

Labour saving of about **2 men.**

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 points from 1 to 3 can be evaluated of about 10% of present basic needs shown on Tables E.1 and E.2 of Annex II (about 1 man).

The cost saving for the renewal of the ancient relay interlocking systems is therefore the cost of about **3 men.**

The total cost saving is finally the cost of 5 men:

Maintenance total cost saving 5 X 5,046= 25,230 $/year

Safety devices Alternative 3.

The benefits related to this alternative are those of alternative 2 and in addition a better coordination of the traffic, specifically of that one interested to the Lugovaya junction both in normal and in disrupted conditions.

The new Kazakh Central Post will more easily get all needed information about equipment effectiveness and trains localization necessary to optimize decisions of the Central Dispatcher relevant to service quality, rolling stock and lines best utilization.

As these last effects, although real, are very difficult to be quantified in advance and valued in money, only the benefits quantified for alternative 2 have been conservatively considered also for alternative 3.

Total cost saving

The operational and maintenance total cost saving is shown on the following table:

Table 9.2.2 – 1 "Forecast of safety devices costs savings"

Labour saving (yearly)	costs ($)
Alternative 2 / Alternative 3	
operation	62,097
maintenance	25,230
Total	**87,327**

"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 Scenarios.

The "with project" situation relates to the costs and benefits arising from the realization of both the Project alternatives. The "with project" scenarios involve for each alternative the measures above shown.

On the other hand, the "without" Project scenario is based on a realistic assumption of what would happen, should the Project not be implemented.

The Lugovaya- Bishkek- Balykchi is a vital link for the trades between Kyrgyzstan and Kazakhstan. So it looks inconceivable that the two Governments would allow it to deteriorate to the level that commercial speeds become increasingly low and that the safety devices conditions create a serious risk of failure.

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 9.2.2-2.

Table 9.2.2 – 2 "Safety devices costs structure"

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 related to work are the 45% of the total maintenance cost for signalling.

In this line section the labour costs can be evaluated in 1652x3 x 11=54516 $/year, therefore the total cost of current maintenance sum to 54.516 x 100/45 =121.147 $/year and above extra costs may be roughly estimated in 30.280 $/year.

10. Economic / Financial Evaluation of the Investments

10.1 Introduction

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 project options 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 option 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$
Implementing start year	2007
Implementing period (years)	26 month
Base year for prices and values	2006
Operating period (years)	Minimum 30
Appraisal period (constructing period + operating period)	Depending on the option
Shadow discount rate	12%

As far as the Alternatives mentioned within Option 2 are concerned, only Alternative 2 has been considered for the purposes of the present evaluation for being the cheapest one.

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.

For the purpose of the economic evaluation, market financial costs previously described have been amended of the component related to the taxes (25%) while import taxes have non been considered in that evaluation. No standard conversion factors have been used for shadow-pricing components of the costs.

Timing of implementation has been previously duly described.

The results of the economic evaluation for the project alternatives are shown in Table 10.2-1 and Table 10.2-2.

TABLE 10.2 -1 Economic evaluation of Option 1

		COSTS (US$/1000)	BENEFITS (US$/1000)						
Year	Year	Capital cost	Time savings	Residual value recovering	Maintenance	Fleet Optimisation	Fleet Maintenance	Signalling	NPV (12%) (US$/1000)
1	2006	-	-	-	-	-	-	-	-
2	2007	6.968,4	-	205,3	613,1	-	-	-	- 5.491,1
3	2008	6.968,4	20,5	205,3	1.226,1	89,9	-	-	- 9.817,1
4	2009	1.161,4	52,2	34,2	1.897,8	184,1	-	-	- 9.100,4
5	2010	-	106,1	-	1.897,8	188,5	-	-	- 7.707,2
6	2011	-	161,6	-	1.897,8	192,8	-	-	- 6.429,2
7	2012	-	218,9	-	1.897,8	197,2	-	-	- 5.256,9
8	2013	-	220,0	-	1.897,8	198,5	-	-	- 4.209,2
9	2014	-	221,1	-	1.766,1	199,7	-	-	- 3.325,9
10	2015	-	222,2	-	1.766,1	200,9	-	-	- 2.536,5
11	2016	-	223,3	-	1.766,1	202,2	-	-	- 1.830,9
12	2017	-	224,4	-	1.270,6	203,4	-	-	- 1.342,6
13	2018	-	225,4	-	1.270,6	204,7	-	-	- 906,1
14	2019	-	226,5	-	1.270,6	205,9	-	-	- 515,8
15	2020	-	227,6	-	1.270,6	207,2	-	-	- 166,8
16	2021	-	228,7	-	1.138,9	208,4	-	-	121,1
17	2022	-	229,8	-	569,5	221,6	-	-	287,7
18	2023	-	229,8	-	569,5	221,6	-	-	436,3
19	2024	-	229,8	-	165,1	221,6	-	-	516,5
20	2025	-	229,8	-	-	221,6	-	-	568,9
21	2026	-	229,8	-	-	221,6	-	-	615,7
22	2027	-	229,8	-	-	221,6	-	-	657,5
23	2028	-	229,8	-	-	221,6	-	-	694,8
24	2029	-	229,8	-	-	221,6	-	-	728,2
25	2030	-	229,8	-	-	221,6	-	-	757,9
26	2031	-	229,8	-	-	221,6	-	-	784,5
27	2032	-	229,8	-	-	221,6	-	-	808,2
28	2033	-	229,8	-	-	221,6	-	-	829,3
29	2034	-	229,8	-	-	221,6	-	-	848,2
30	2035	-	229,8	-	-	221,6	-	-	865,1
31	2036	-	229,8	-	-	221,6	-	-	880,2
32	2037	-	229,8	-	-	221,6	-	-	893,6
33	2038	-	229,8	-	-	221,6	-	-	905,6
34	2039	-	229,8	-	-	221,6	-	-	916,4
35	2040	-	229,8	-	-	221,6	-	-	926,0

IRR =	13,5%
NPV (12%) =	926,0
BCR =	1,07

TABLE 10.2-2 – Economic evaluation of Option 2

		COSTS (US$/1000)	BENEFITS (US$/1000)						
Year	**Year**	**Capital cost**	**Time savings**	**Residual value recovering**	**Maintenance**	**Fleet Optimisation**	**Fleet Maintenance**	**Signalling**	**NPV (12%) (US$/1000)**
1	**2006**	-	-	-	-	-	-	-	-
2	**2007**	8.986,8	-	205,3	613,1	-	-	-	- 7.293,2
3	**2008**	8.986,8	61,6	205,3	1.226,1	89,9	-	-	- 13.195,4
4	**2009**	1.497,8	125,3	34,2	1.897,8	184,1	-	87,3	- 12.541,8
5	**2010**	-	212,1	-	1.897,8	188,5	-	91,7	- 10.964,6
6	**2011**	-	215,5	-	1.897,8	192,8	-	96,3	- 9.546,8
7	**2012**	-	218,9	-	1.897,8	197,2	-	101,1	- 8.272,1
8	**2013**	-	220,0	-	1.897,8	199,7	-	106,1	- 7.127,8
9	**2014**	-	221,1	-	1.766,1	202,1	-	111,5	- 6.153,6
10	**2015**	-	222,2	-	1.766,1	204,5	-	117,0	- 5.278,4
11	**2016**	-	223,3	-	1.766,1	207,0	-	122,9	- 4.492,2
12	**2017**	-	224,4	-	1.270,6	209,4	-	129,0	- 3.928,0
13	**2018**	-	225,4	-	1.270,6	211,9	-	135,5	- 3.420,1
14	**2019**	-	226,5	-	1.270,6	214,3	-	142,2	- 2.962,6
15	**2020**	-	227,6	-	1.270,6	216,8	-	142,2	- 2.553,5
16	**2021**	-	228,7	-	1.138,9	219,2	-	142,2	- 2.211,6
17	**2022**	-	229,8	-	569,5	221,6	-	142,2	- 1.998,7
18	**2023**	-	229,8	-	569,5	221,6	-	142,2	- 1.808,6
19	**2024**	-	229,8	-	165,1	221,6	-	142,2	- 1.691,4
20	**2025**	-	229,8	-	-	221,6	-	142,2	- 1.605,9
21	**2026**	-	229,8	-	-	221,6	-	142,2	- 1.529,6
22	**2027**	-	229,8	-	-	221,6	-	142,2	- 1.461,5
23	**2028**	-	229,8	-	-	221,6	-	142,2	- 1.400,7
24	**2029**	-	229,8	-	-	221,6	-	142,2	- 1.346,4
25	**2030**	-	229,8	-	-	221,6	-	142,2	- 1.297,9
26	**2031**	-	229,8	-	-	221,6	-	142,2	- 1.254,6
27	**2032**	-	229,8	-	-	221,6	-	142,2	- 1.216,0
28	**2033**	-	229,8	-	-	221,6	-	142,2	- 1.181,4
29	**2034**	-	229,8	-	-	221,6	-	142,2	- 1.150,6
30	**2035**	-	229,8	-	-	221,6	-	142,2	- 1.123,1
31	**2036**	-	229,8	-	-	221,6	-	142,2	- 1.098,6
32	**2037**	-	229,8	-	-	221,6	-	142,2	- 1.076,6
33	**2038**	-	229,8	-	-	221,6	-	142,2	- 1.057,0
34	**2039**	-	229,8	-	-	221,6	-	142,2	- 1.039,6
35	**2040**	-	229,8	-	-	221,6	-	142,2	- 1.023,9

IRR =	**10,8%**
NPV (12%) =	**-1.023,9**
BCR =	**0,89**

10.3 Ranking of alternative solutions

The results of the economic assessment of the two considered project options are summarized in the following table, where Internal Rate of Return, Net Present Value (at a discount rate of 12%) and Benefit/Cost Ratio for Option 1 and Option 2 are compared.

	Option 1	*Option 2*
IRR	13,5%	10,8%
NPV (12% ml US$)	926,0	-1.023,9
BCR	1,07	0,89

Options present evident economic differences. Option 1 is the only one recording a positive output form the analysis. This option is also preferable form the financial point of view in the light of the consideration given in the next chapter.

10.4 Financial analysis

The financial intern rate of return was calculated by estimating and comparing financial flows with estimating financial flows for the same period considered for the economic analysis.

For the calculation of the financial rate of return, it has been considered only the financial flows of residual value recovering, maintenance, rolling stock optimization and signaling.

Financial indicators are the following:

	Option 1	*Option 2*
IRR	7,4%	3,9%
NPV (6% ml US$)	1.699,5	-3.252,6
BCR	1,08	0,87

Also for the financial analysis Option 1 is the only option which records a financial rate of return over the reference discount rate of 6%. Option 1 is therefore preferable from the financial point of view as well.

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 the Beneficiary could uses internal founds for the implementation of the project instead to start discussion with external financial entities.

10.5 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 1, 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".

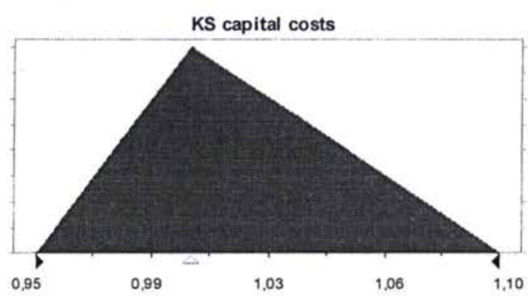
The key variables that have been subjected to the analysis are the following:

- capital cost
- benefit for users because of time savings
- benefit related to the residual value recovering
- track maintenance savings
- benefit for the operator for optimisation of the rolling stock because of the time savings
- benefits for the operators for fuel consumption because of the time savings.

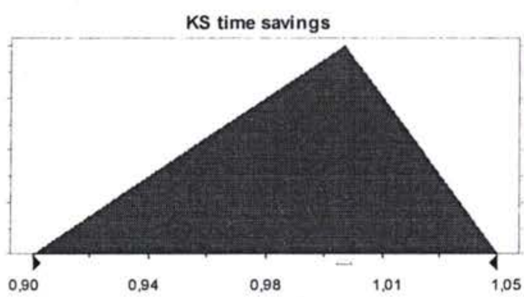
For the analysis has been used a random sampling method (also known as "Monte-Carlo methodology") on continuous probability distributions of the key variables. Usually, the considered probability distributions are not symmetrical (beta, triangular, etc.) so that the estimated value for the basic evaluation 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:

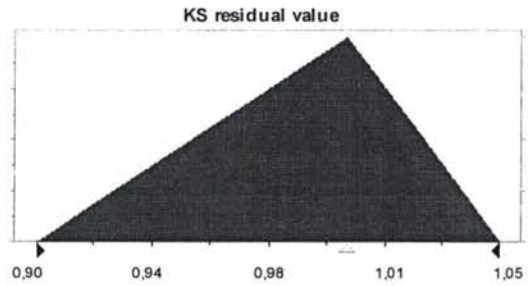
- for capital cost an asymmetric triangular distribution has been assumed with a variation between –5% and +10% from the estimated base value; this should be very conservative since 15% for contingencies has been already included in capital cost estimation;



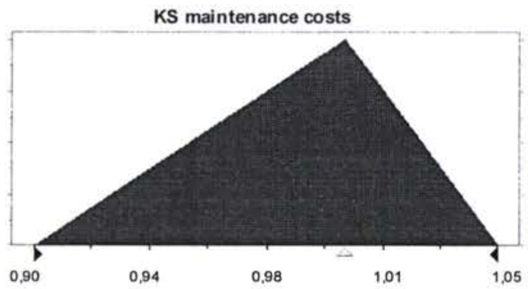
- for benefits to the user because of time savings it has been used an asymmetric triangular distribution variable between –10% and +5% from the estimated base value;



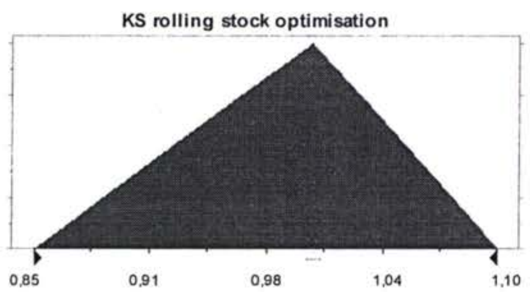
- for benefits related to residual value recovering an asymmetric triangular distribution has been assumed with a variation between –10% and +5% from the estimated base value.



- for track maintenance savings an asymmetric triangular distribution has been assumed with a variation between -10% and +5% from the estimated base value.



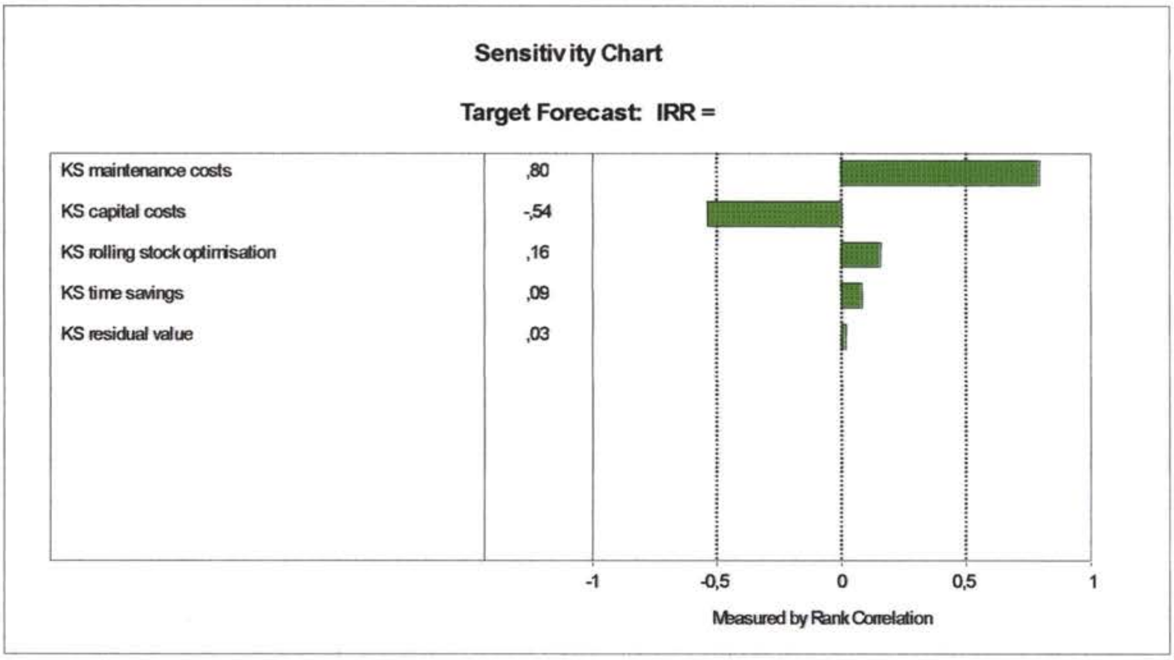
- for benefits for optimisation of rolling stock use an asymmetric triangular distribution has been assumed with a variation between -15% and +10% from the estimated base value.



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.

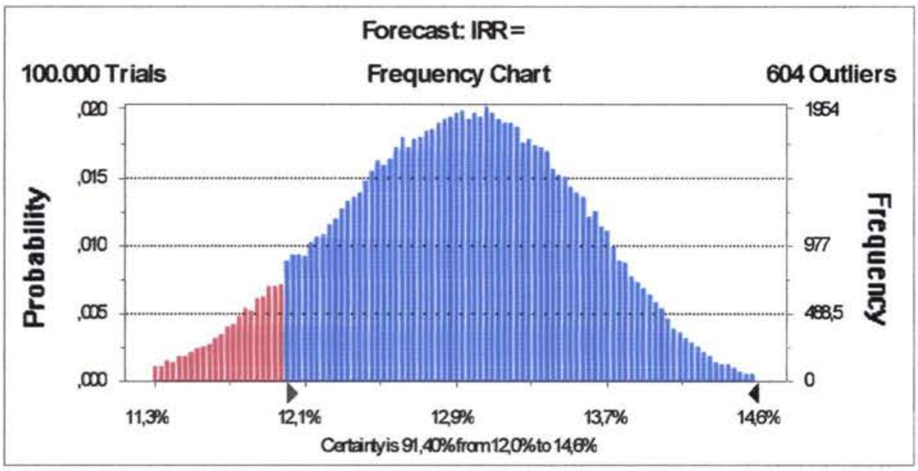
The following chart shows the sensitivity of IRR in regard to probability distributions of the key input variables.



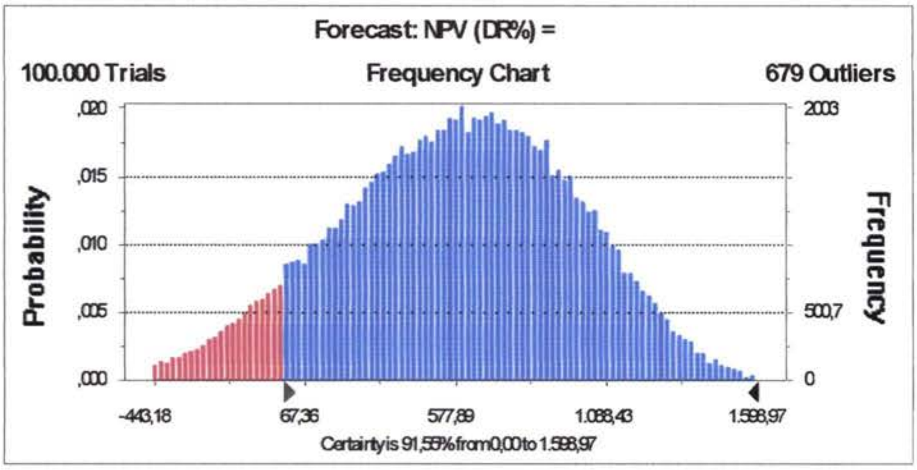
The calculations show, without considering outliers, that the combined probability that the economic indicators of the project are higher than the threshold values for the stability area; the stability are being: 12% for IRR, 0 for NPV(12%) and 1 for BCR.

The following diagrams show the distribution of the results for the three indicators.

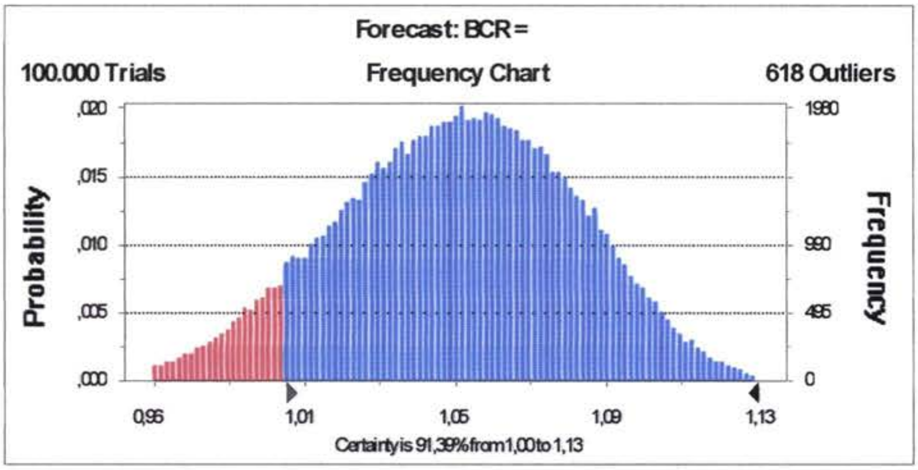
IRR is over 12% in the 91,40% of observed cases.



NPV is over 0 in the 91,55% of observed cases.



BCR is over 1 in the 91,39% of observed cases.



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%	10,7%	-852,80	0,94
10%	12,1%	39,35	1,00
25%	12,5%	308,76	1,02
50%	13,0%	604,84	1,05
75%	13,4%	878,81	1,07
90%	13,8%	1.097,54	1,09
100%	14,9%	1.776,63	1,14

The solution is over the stability threshold in more than the 91% of cases, which means that the sensitivity analysis has shown that the result of the economic analysis is stable.

Furthermore it has to be remarked that conditions for the sensitivity analysis have been severe and that for the purpose of the evaluation also 15% of the capital cost has been included as contingencies. This means that excluding the double counting (15% of contingencies and subsequently up to 10% in the probabilistic distribution) the solution is even more stable.

11. Conclusions

The present Feasibility Study for rehabilitation measures for the Lugovaya – Kyrgyz border railway sections has taken into consideration the following rehabilitation options:

Option 1 *for Lugovaya – Kyrgyz border section is the natural complement of the measures envisaged in Option 1 and 2 for Kazakh border – Bishkek 2 section, as it foresees the demolition of the existing permanent way of the line, included the running tracks of the stations, the excavation of a layer of about 0.6 m of the existing material, the formation of 2 new layers of sandy gravel material 0,2 m thick and of ballast 0,3 m thick, the laying down of new concrete sleepers, the installation of new or recovered P65 rails, the formation of continuous welded rails, the replacement of the existing P50 switches with P65tg1/11 type ones on running tracks.*

Option 2 *considers the safety plants replacement in addition to the PW interventions foreseen in Option 1. Safety plants include 2 sub-options (Safety plants Alternative 2 and Alternative 3) including respectively:*

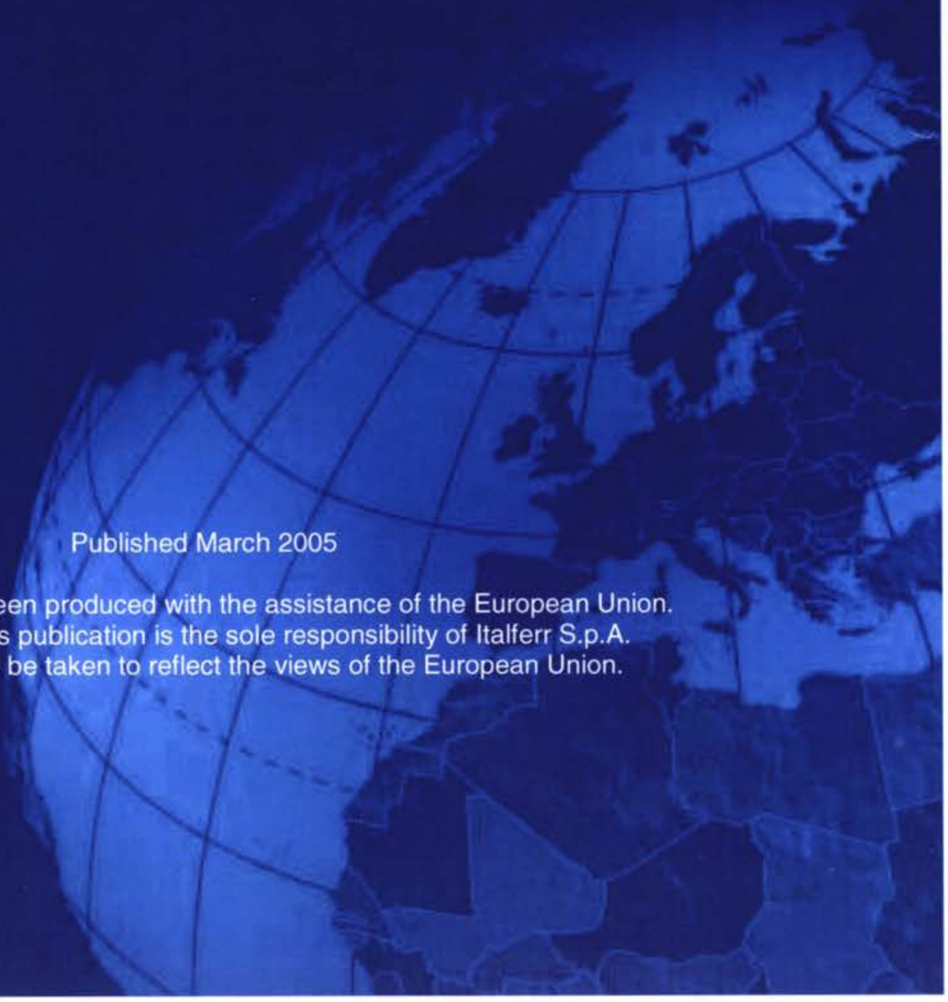
- *Alt. 2: renewal of all the stations interlockings and line block system*
- *Alt. 3: renewal of all the stations interlockings and line block system and moreover remote command and control from the central post.*

Consequently the economical analysis has been used for selecting the most convenient one between the two options.

As previously mentioned the Option 1 is to be the most advantageous one in economic terms and so it is recommended for the implementation.

In the likely case that investment will be faced by the Kazakh railways, the comparison of the investment with the financial performance of such organization brings to the conclusion that such investment is affordable and that no specific financing mechanism has to be studied. Additionally to that the nature of the interventions could fall into a measure of extraordinary maintenance. Consequently it is logical and worth advising the Beneficiary that internal fund could be used instead to start discussion with external financial entities.

As far as the services to be rendered by the Consultant are concerned, only the most advantageous Option will be considered for the detailed design which will start immediately after the delivery of this report.



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