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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 Balykchi – Kazakh Border railway section (Kyrgyzstan)

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ABBREVIATIONS

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

UIC	Union International des Chemins of Fer (based in Paris)
UN	United Nations
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
USAID	United States Agency for International Development
USD	United States Dollar
UTY	Uzbek Temir Yullari (Uzbekistan national railways)
UZB	Uzbekistan
WTO	World Trade Organisation

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ANNEXES

Executive Summary

The executive summary presents herein the contents of the Feasibility Study of the rehabilitation measures for the Kazakh Border – Bishkek - Balykchi railway section (in Kyrgyzstan), 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 the Consultant will be, in accordance with the contract with the European Commission, developing a detailed design and tender documents for the most advantageous option generated by the present feasibility study.

Historically the section under study belongs to the line 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 Kyrgyzstan and Kazakhstan: 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.

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 but maintenance/services are operated by the Kyrgyz Railways. Consequently the issue of the competence has required to consider two different Feasibility Studies for rehabilitation measures concerning sections of the same line.

Since it is the only railway connection in the north of Kyrgyzstan and the more important in the whole country, the line is of strategic national importance. As a matter of fact the conditions of the line are poorer and poorer and this could impair the national trade of the country also in the short term, consequently improvements are strongly and urgently required.

Fig A- The Lugovaya – Bishkek – Balykchi railway 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.

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

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 have been evaluated both for passenger and for freight and two kinds of traffic have been distinguished:

- International traffic
- Domestic traffic within Kyrgyzstan.

Also traffic related with the construction of a new Balykchi – Kara-Keche line has been considered.

In the following table the total freight traffic forecasts by link, in million ton, are summarized:

Link	All	Conservative (million ton)			Optimistic (million ton)		
	2003	2010	2015	2025	2010	2015	2025
Chaldovar - Bishkek	2.80	3.78	4.28	5.05	4.79	6.28	9.47
Bishkek - Chaldovar	1.04	1.65	2.06	3.27	1.82	2.47	3.35

Bishkek - Tokmak	2.24	3.29	3.99	5.20	4.10	5.66	8.53
Tokmak - Bishkek	0.84	1.33	1.93	2.89	1.72	2.19	3.38
Tokmak - Balykshi	0.53	1.24	1.68	2.47	1.50	2.25	3.40
Balykshi - Tokmak	0.32	1.08	1.63	2.46	1.44	1.83	2.79

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

Link	All	Medium Scenario			High Scenario		
	2003	2010	2015	2025	2010	2015	2025
Chaldovar - Bishkek	3.8	5.2	5.9	6.9	6.6	8.6	13.0
Bishkek - Tokmak	3.1	4.5	5.5	7.1	5.6	7.8	11.7
Tokmak - Balykshi	1.0	2.3	3.1	4.5	2.7	4.1	6.2

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 (Chaldovar - Bishkek)	1.0	1.0	1.0	1.0	1.3	1.7	2.0
Domestic (Chaldovar - Balykshi)	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. Three 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 represents the proposed low cost option, mainly consisting in provision of PW materials, machines and plants that would permit to face the most urgent necessities of the line, as well as in building the indispensable structures to guarantee the line protection from land-slides. It would allow the acceleration of the capital maintenance of the remaining network putting at disposal recovered rails and machines to implement works with Kyrgyz railways personnel.

Option 2 only regards border-Bishkek line section. On this section Option 2 foresees the replacement of wooden sleeper with concrete ones, the installation of P65 cwr on the main line, included the stations, new layers of ballast and subballast, tg1/11P65 turnouts on the main lines of stations from the border to Bishkek 2. Option 2 also includes provision of machines and sleeper plant as well as the building of the indispensable structures that guarantee the line protection from land-slides.

Option 3 represents the most impacting solution to upgrade the entire Kazak border - Balykchi section. Besides all the interventions included in Option 2, Option 3 considers the demolition of the existing PW, cutting and reconstruction of sub-ballast and ballast layers, installation of concrete sleepers and P65 rails, included the main lines of stations, replacement of the existing turnouts with P65tg1/11 type switches on all the Bishkek 2 – Balykchi station main lines, construction of 2,000 m of wall for line protection in Boomsk gorge stretch. Machines and sleeper plant are not included in Option 3.

Option 3 also foresees two different alternative measures for safety devices.

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 Kyrgyz 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***	***Option 3***
IRR	14.1%	11.8%	6.5%
NPV (12% ml US$)	2.97	-0.4	-25.7
BCR	1.16	0.98	0.64

The options present 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 seems to be the most advantageous one in economic terms, it is recommended for the implementation. The option is the cheapest one and also this financial aspect is important due to the lack of fund of the Kyrgyz Railways.

Nevertheless, considering the strategic importance of the railway for the whole country and for its economy, improvements are required to avoid that the line acts as a bottleneck for the economic activities, to give access to the international markets and to connect Bishkek with the regional market.

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

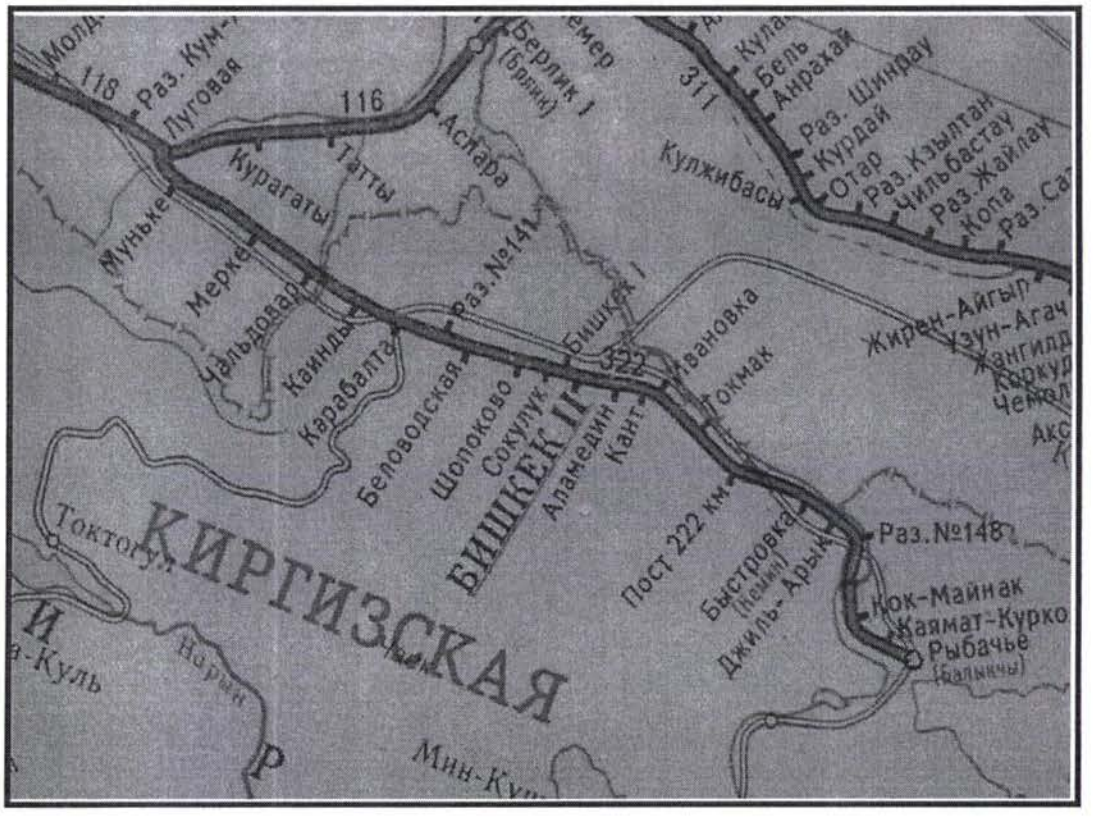
Project duration: 18 months

1. Introduction

The present document is to report the conclusions of the feasibility study of the rehabilitation measures for the Kazakh Border – Bishkek - Balykchi railway section in Kyrgyzstan.

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 but maintenance/services are operated by the Kyrgyz Railways. Consequently the issue of the competence has required to consider two different Feasibility Studies for rehabilitation measures concerning sections of the same line.

Since it is the only railway connection in the north of the country and the more important in the whole country, the line is of strategic importance for Kyrgyzstan and for its economy.

Additional to that, Kyrgyzstan has not a railway linking northern cities (i.e. Bishkek) with the southern ones (i.e. Osh, Jal Alabad) and actually transport demand uses either road or the railway Balykchi – Bishkek - Lugovaya and then up to the south crossing Kazakhstan, Uzbekistan and also Tajikistan.

Improvements are consequently required for the line not to act as a bottleneck for the economic activities, to give access to the international markets and to connect Bishkek with the regional market.

2. Socio-economic background

2.1 General Features

The Kyrgyz Republic covers nearly 200,000 square kilometers. It is a mountainous country with almost 90% of the land laying at over 1500 meter on the sea level. A large part of the country lies in the Tien-Shan Mountain. Flatter areas are found in the Chui Valley in the north and on the fringe of the Ferghana Valley in the south. It has borders with Kazakhstan, Uzbekistan, Tajikistan and China. The climate is continental. Heavy snow fall during the winter may hinder transport between the various parts of the country.

The population of the country was of 5.12 million in 2004, growing at a rate of about 1 % per year. The Kyrgyz represented about two third of the total with their share growing. There are important minorities of Uzbeks (14.2% in 2004) and of Russians (10.3%) with also a representation of many other ethnic groups such as Dungans, Uigurs, Tajiks, Kazaks, Tatars or Ukrainians.

Kyrgyzstan has been fairly progressive in carrying out market reforms, such as an improved regulatory system and land reform. It was the first CIS country to be accepted into the World Trade Organization. Much of the government's stock in enterprises has been sold

2.2 Economic Profile

2.2.1 The Economy

The Kyrgyz Republic has a predominantly agricultural economy. Cotton, tobacco, wool, and meat are the main agricultural products, although only tobacco and cotton are exported in any quantity. Industrial exports include gold, mercury, uranium, and natural gas and electricity. Inflation has been lowered from over 30% in 1999 to an estimated 2.1% in 2002, 3.1% in 2003 and 2.8% in 2004.

Drops in production had been severe after the break-up of the Soviet Union in 1991, but by mid-1995 production began to recover and exports started to increase. The drop in output at the Kumtor gold mine sparked a 0.5% decline in GDP in 2002, but GDP growth bounced back to 6% in 2003 to USD 1909.4 million and further rose to USD 2204.8 million in 2004. The government has made steady strides in controlling its substantial fiscal deficit and aims to reduce the deficit to 4.4 percent of GDP in 2004.

Fluctuations in production levels since soviet times are shown in the following table:

Table 2.2.1 - 1 Main Production of the main commodities during the 1986-2004 period

(thousand tons)	**1986**	**1991**	**1995**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Agriculture, crop year									
1. Wheat	555	434	625	1109	1039	1190	1163	1014	
2. Barley	559	557	159	180	150	140	149	198	
3. Potatoes	329	326	432	957	1046	1168	1244	1308	
4. Maize	430	365	116	308	338	443	374	399	
5. Vegetables	512	399	318	719	747	815	456	678	
6. Meat	193	230	180	196	196	197	200	201	
7. Milk	909	1131	864	1064	1105	1142	1173	1192	
Energy									
1. Coal	4000	3473	463	417	425	475	459	411	456
2. Electricity (Bn kwh)	11.4	14.2	12.3	13.2	14.9	13.7	11.9	14.0	15.1
Manufacturing									
1. Cement				386	453	469	533	758	870
2. Construction materials				1962	857	815	435	284	553
3. Sugar				70	58	31	51	76	88
Production Indexes									
Agriculture, 1985|1989-91=100	109	91	85	112	117	121	119	121	
Industry, 1985 I 1995 = 100	104	118	100	146	155	163	146	170	

Source: ADB Key Indicators 2004 and National Committee for Statistics of KR

In 2003 the output of the agricultural sector was 3.8% higher than in the previous year although the production of grain declined by 4.7%. The production of meat remained nearly unchanged. But there was a steep increase in the production of sugar beet (55.8%), vegetables (50%) and tobacco (41.2%). In 2004 the output of the sector represented nearly USD 700 million.

Industrial production continued to expand with a growth for the year of 17%. This means that the volume produced was nearly three times higher than in 1998. 411,300 tons of coal and lignite were produced, 27.1 million cubic metres of natural gas and 68,500 tons of crude oil. Manufacturing was valued at the equivalent of about 1 billion USD representing 80% of the output of the whole sector. The above table shows that by 2004 the production of cement had more than doubled compared with 1999. Moreover there was a steep increase in the volume exported to representing 39% of the production with the resulting rise in railway traffic.

2.2.2 Foreign Trade

In 2003 the value of foreign trade amounted to USD 1299 mn. i.e. 21.1% more than in 2002. Export increased by 19.8% and import by 22.2%. The trade balance showed a deficit of USD135.3 mn one third more than in 2002. The trade balance was positive with countries such as Central and Eastern Europe, the Near and Middle East and Switzerland whereas it was negative with EU, USA,

China and CIS countries. For the first eleven months of 2004 exports were at USD 660.6 mn and imports at USD 845.2 mn what meant an aggravation of the trade deficit.

According to the National Statistical Committee 49% of exports went in 2003 to Asian countries half of it being to United Arab Emirates. Other major destination for export included Kazakhstan (20%), China (8.2%), Uzbekistan (5.7%) and Tajikistan (6.6%). In ADB Keys Indicators Switzerland and Russia are listed as the largest receiving countries for export with respectively 21.3% and 16.5%.

There were some notable changes in the structure of exports by comparison with 2002. The share of precious metals increased from 33.9% to 45.1%. On the other hand there was a decline from 6.2% to 4.4% for foodstuff, from 5% to 2% for leather goods and from 5.2% to 1.7% for chemicals.

The largest shares of imports were coming from CIS countries (57.3%) and EU countries (11.1%). The main import partners were Russia (24.6%), Kazakhstan (23.8%), China (10.8%), Germany (5.3%), Uzbekistan (5.5%) and Turkey (3.3%).

No significant changes were observed in the structure of imports. The dominant commodities were still mineral products (27.3%), chemicals (12.8%), machines and equipment (12.4%), foodstuff (8.3%) and textile (6.6%).

It is worth noting that there was a strong increase in the volume of those commodities that are generally carried by railway. Export of cement increased from 245 thousand tons in 2003 to 339.4 in the first 11 months of 2004, export of sugar from 23.2 to 54.5 and export of construction materials from 283.9 to 547.6.

2.3 The Northern Kyrgyz Region

The hinterland of the railway line Lugovaya – Bishkek – Balykshi is essentially made of the Chui and Issyk-kul regions and of Bishkek the capital city. The following table shows the position of the Northern Region in the national economy.

Table 2.3 - 1 Position of the Northern Region in the National Economy in 2003

Item	Unit	Bishkek City	Chui Oblast	Isyk-Kul Oblast	Area Total	Whole Country	% Northern Region
Population	Thousand p.	803.8	753.6	425.7	1983.1	5065.0	39.2%
Urban population	Thousand p.	799.3	155.6	123.7	1078.6	1792.8	60.2%
Rural population	Thousand p.	4.5	598.0	302.0	904.5	3272.2	27.6%
PNB	Million USD	559.5	377.2	192.1	1128.8	1909.4	59.1%
Volume Investment	Million USD	80.0	3.8	11.2	95.0	204.9	46.4%
Export (2002)	Million USD	312.9	46.0	5.9	364.8	485.5	75.1%
Import (2002)	Million USD	363.9	55.7	63.6	483.2	586.7	82.4%
Production							
Total agriculture	Thousand ton		2221.8		2221.8	6001.6	37.0%
Total industry	Thousand ton	240.6	1212.6		1453.2	2618.5	55.5%
Sugar beet	Thousand ton		812.2		812.2	812.2	100.0%
Sugar	Thousand ton		75.5		75.5	75.5	100.0%

Cement	Thousand ton		754.0		754.0	757.5	99.5%
Export							
Sugar	Thousand ton	0.6	19.1		19.7	23.2	84.9%
Cement	Thousand ton		240.9		240.9	245.0	98.3%
Construction mat.	Thousand ton		146.8		146.8	283.9	51.7%
Oil products	Thousand ton	136.7			136.7	136.7	100.0%
Import							
Coal	Thousand ton	1003.1	55.7	1.8	1060.6	1063.9	99.7%
Oil products	Thousand ton	335.3	33.2	51.2	419.7	513.8	81.7%
Grain	Thousand ton	66.7	17.0	2.4	86.1	92.4	93.2%

Source: National Statistical Committee of the Kyrgyz Republic

From the above figure it is obvious that the northern region plays a dominant role in the economy particularly for those industries that are the best client of the railway. The region receives nearly all the coal and the grain and 82% of the oil products imported by the country. It sent all the cement and most of the sugar exported. In value its exports and imports represent more than the three fourth of the national total. More than half of the industrial production is generated in the region. Its share of the GDP is of 60% with half of it being accounted for by the capital city Bishkek.

The situation of the region shows at the same time that it has the potential to support a railway line and why a railway is so vital for its economic development.

2.4 The Transport Sector

2.4.1 General Features.

In Kyrgyz Republic there are about 19,000 km of public roads, 40% of them being sealed and 50 % being gravel roads. Inland waterway transport is limited to short rides on the Issyk-Kul Lake. There are two international airports and 14 other landing facilities.

The railway network consists of separate single-track spurs and has a total length of 423.9 km. To travel between the northern and the southern sub-networks as many as seven borders have to be crossed.

2.4.2 Traffic Modal Distribution

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

Table 2.4.2 - 1 Distribution of freight traffic by mode (million ton)

Mode	1991		2003	
	M.ton	%	M.ton	%
Railway	6.5	1.8%	1.1	3.7%
Road	359.1	98.1%	28.0	93.8%
Pipeline	0.0	0.0%	0.7	2.3%
Others	0.6	0.2%	0.1	0.2%
Total	366.2	100.0%	29.9	100.0%

Table 2.4.2 - 2 Distribution of freight traffic by mode (billion ton-km)

Mode	1991		2003	
	B.ton-km	%	B.ton-km	%
Railway	2.4	27.4%	0.4	23.0%
Road	5.9	67.3%	0.9	51.0%
Pipeline	0.0	0.0%	0.3	19.9%
Others	0.5	5.2%	0.1	6.2%
Total	8.8	100.0%	1.7	100.0%

The share of the freight volume carried by the railways was only of 3.7 % in 2003. However in term of ton-km the share was of 23% not much less that it was at the time of independence.

In 2003 the railways transported only 0.4 million passengers out of a total of 440 million that is a share of under 0.1 %. In terms of passenger-km the share of railway transport was of nearly 1%.

2.4.3 The Railway Sub-sector

The Kyrgyz Republic had to form its national railway company from two components from different administrations. The northern line was part of the Almaty Railways whereas the southern lines were under the Central-Asian Railways. There are two directorates dealing with railways under the Ministry of Transport and Communication. The Kyrgyz Railways (Kyrgyz Temir Iolary) manages the existing network. The Directorate on New Railway Lines Designing and Construction "Kyrgyzjeldorstroi" was given the task of integrating the railway network of the Kyrgyz Republic with international transport corridors and linking the northern and southern networks

According to figures provided by the Kyrgyz Railways the total length was of 423.9 km distributed as follows:

- 322.7 km are in the north including 60.3 km in Kazakh territory and 262.4 km in the north between the Kazakh border and Balykshi.
- 101.2 km in the south.

About 5000 persons work with the Kyrgyz Railways. It was reported that in 2001 there were 47 locomotives, 2352 wagons and 421 passenger coaches. More recent figures were not made available.

It is reported that the Kyrgyz Railway makes a profit even although international operations have to cross-subsidise both passenger traffic and domestic freight traffic.

The Kyrgyz government set as goal to link the northern and southern parts of the country across national territory with connection to China. An extension of the northern line in direction of the south could in a first stage link the coal mine of Kara-Keche with Balykshi on the existing line. This implies the construction of 181 km of new line at an estimated to cost of USD 127 million. The Kyrgyz Railways have already started the construction on their own funds.

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	2004
Freight Traffic									
Volume (million ton)	6.50	0.90	1.44	1.08	0.98	0.86	1.12	1.72	1.90
Turnover (billion tonkm)	2.41	0.40	0.47	0.35	0.34	0.33	0.39	0.56	0.72
Passenger Traffic									
Volume (million pax)	1.4	0.8	0.6	0.4	0.6	0.6	0.4	0.4	0.3
Turnover (billion paxkm)	0.200	0.087	0.059	0.031	0.044	0.050	0.043	0.050	0.045

Source: National Statistical Committee of the Kyrgyz Republic

In the late nineties freight traffic volume was only 15% of what it was in 1991 in terms of tons and even less in terms of ton-km. But since 2000 there was a remarkable recovery as freight turnover more than doubled between 2000 and 2004. In the two last years it grows at double-digit growth rate of 42% and 27%.

For passenger the turnover is less than one fourth of what it was in 1991. It is for now not clear if the recovery that started in the early 2000 is sustainable.

3.2 Traffic Distribution by Commodity

No data on traffic could be obtained from the Kyrgyz Railways. However traffic volumes by commodity group could be compiled from various sources. The following table shows the distribution by commodity in 2003. The figures are not specific to the northern line.

Table 3.2 - 1 – Railway freight traffic in the Kyrgyz Republic in 2003 (thousand ton)

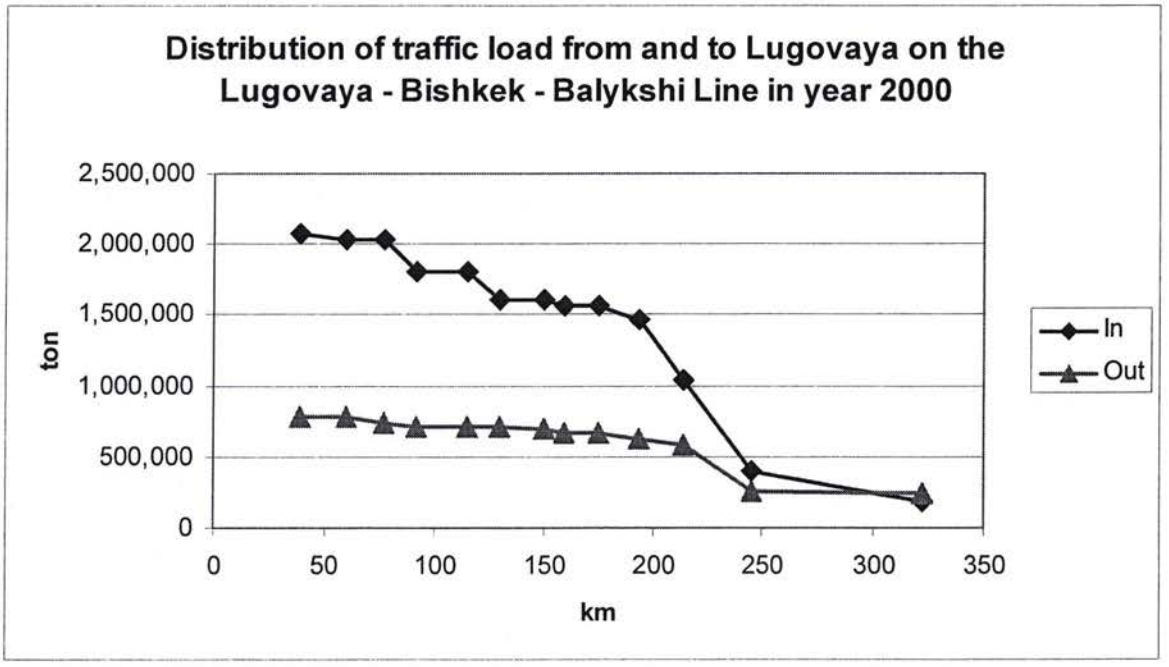
Commodity	Sent	Received	Total	Share (%)
Total	**1583.0**	**2986.8**	**4569.8**	*100.0%*
Coal +coke	33.5	870.6	904.1	*19.8%*
Ores	0.2	6.0	6.2	*0.1%*
Oil products	42.4	528.4	570.8	*12.5%*
Grain	16.5	74.1	90.5	*2.0%*
Chemicals	7.4	43.0	50.4	*1.1%*

Slags	0.0	122.1	122.1	*2.7%*
Fertilizers	0.7	35.1	35.8	*0.8%*
Construction materials	432.3	261.4	693.6	*15.2%*
Cement	299.1	56.1	355.2	*7.8%*
Industrial raw materials	0.5	213.3	213.8	*4.7%*
Metal	5.4	52.2	57.6	*1.3%*
Scrap metal	158.4	4.3	162.7	*3.6%*
Wooden goods	1.2	59.4	60.6	*1.3%*
Sugar beets	316.5	382.1	698.6	*15.3%*
Sugar	96.4	118.9	215.3	*4.7%*
Other foodstuff	48.1	80.6	128.7	*2.8%*
Consumer goods	78.6	21.2	99.8	*2.2%*
Other	45.9	58.1	104.0	*2.3%*

A few commodity groups account for over 75% of the traffic i.e. coal, oil products, construction materials including cement, sugar beets and sugar. A majority of the traffic crosses the border with Kazakhstan. However there are some large domestic movements such as for sugar beets that are no more imported.

3.3 Traffic distribution on the Lugovaya – Bishkek - Balykshi 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 International Traffic

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

It should be noted that if the above figures are consistent with the data commodity given in Paragraph 3.2 they don't tally with the figures mentioned in Paragraph 3.1.

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.

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.

3.4.2 Domestic Traffic

With the data available to the consultant it is difficult to estimate local traffic. The largest volumes relate to construction materials and sugar beets.

The cement factory in Kant ships large volumes of cargo. According to information obtained from the factory management the plant capacity is of 4 million tons per year. In 2003 it produced 754,000 ton of cement and 500,000 tons of plates or pipes. 70% of the total was shipped by railway. 80% of the production was exported to destinations in Kazakhstan such as Astana, Almaty, Uralsk or to Russian cities. That data seems to show that no much of the production makes its way to the domestic market by train.

The production of sugar is a major economic activity in northern Kyrgyzstan. There are several sugar factories in the Chui Oblast. Only two of them are presently in activity both between Bishkek and the Kazakh border. One is in Kanida with a production capacity of 100 thousand ton of sugar and the other one in the Sokuluks District with a capacity of 50 thousand ton. The plants in Kant and Kara-Balta are presently idle. No raw material is imported any more. The plants process domestically grown sugar beets. 812.2 thousand ton of beets were produced in 2003 and 642.4 in 2004. Three fifths of the production was processed in Sokuluks and two fifths in Kanada. According to the data available over 300 thousand ton of beets were transported by railway as well as about 100 thousand tons of sugar. The latter should include a majority of the 23.2 thousand tons exported in 2003. In 2004 exports raised to over 55 thousand tons.

Concerning passenger transport there is a daily train from Bishkek in both directions.

3.5 Traffic Forecasts along the line

3.5.1 Freight Traffic Forecasts

International Freight Traffic

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 based on Kazakh statistics (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	0.72
Cement	0.25	0.52	0.70	1.25	0.59	0.86	1.10
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	0.09
Other	0.04	0.06	0.07	0.10	0.06	0.08	0.10
TOTAL	**0.64**	**1.14**	**1.46**	**2.42**	**1.26**	**1.75**	**2.18**
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**

Most of the traffic crossing the border goes up to Bishkek and a substantial part goes up to Tokmak. The forecasts take into consideration the reduction of the import of coal that could result from the construction of a new line in direction of the coal mine of Kara-Keche.

Traffic related with the construction of a new Balykchi – Kara-Keche line

As above mentioned the Kyrgyz Republic has the long-term goal of connecting the northern and southern networks and of extending the connection to China. A first step would be to extend the northern line from Balykshi first to Kochkor at 64 km and later up to 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 of the new line from Balykshi to Kara-Keche was recently studied by a Check consultancy. The proposed development plan is to extend the line in four stages. 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.

Forecasts of traffic on the first section to be completed i.e. Balykshi – Kochkor are as follows:

Link	Type	2010-2014	2014-2017	2017-2019	2019-2024
Balykshi - Kochkor	*All*	0.7 / 0.7	0.7/1.2	1.2 / 1.5	1.4 / 1.8
Kochkor - Balykshi	*Coal*	0.5 / 1.1	1.1/1.45	1.45 / 1.8	1.8 / 2.2
	Others	0.1 / 0.2	0.2 / 0.2	0.2 / 0.2	0.2 / 0.3

It can be assumed that most of the traffic on the Balykshi – Kochkor section would generate similar traffic on the Balykshi – Bishkek section the largest flow consisting of coal would go the power station located near Bishkek.

Therefore the traffic generated by the construction of the new line would be as follows:

Table 3.5.1 - 2 Traffic generated by the construction of a Balykshi – Kara-Keche line (million ton)

Link	All	Low Scenario			Medium Scenario			High Scenario		
	2003	2010	2015	2025	2010	2015	2025	2010	2015	2025
Bishkek - Balykshi	0	0.50	0.70	1.40	0.60	0.95	1.60	0.70	1.20	1.80
Balykshi - Bishkek	0	0.60	1.30	2.00	0.95	1.48	2.25	1.30	1.65	2.50
of which Coal	*0*	*0.50*	*1.10*	*1.80*	*0.80*	*2.43*	*2.00*	*1.10*	*1.45*	*2.20*

Other Local Traffic

The traditional traffic would largely continue to be linked to the production of sugar and construction materials. It is likely that it will continue to grow at rate no higher than GDP. Growth

rates of 2% were assumed for the low scenario, 3.5% for the medium scenario and 5% for the high scenario.

Traffic by Link

Total traffic by link was obtained by adding international traffic, generated traffic and other local traffic. International traffic was assumed to be distributed along the line as shown by the diagram in Paragraph 3.3.

Table 3.5.1 – 3 Freight traffic forecasts by link (million ton)

Link	All	Conservative			Optimistic		
	2003	2010	2015	2025	2010	2015	2025
Chaldovar - Bishkek	2.80	3.78	4.28	5.05	4.79	6.28	9.47
Bishkek - Chaldovar	1.04	1.65	2.06	3.27	1.82	2.47	3.35
Bishkek - Tokmak	2.24	3.29	3.99	5.20	4.10	5.66	8.53
Tokmak - Bishkek	0.84	1.33	1.93	2.89	1.72	2.19	3.38
Tokmak - Balykshi	0.53	1.24	1.68	2.47	1.50	2.25	3.40
Balykshi - Tokmak	0.32	1.08	1.63	2.46	1.44	1.83	2.79

This would give the following number of trains in the most loaded direction assuming train net weight of 2000 tons in the flatter section and 1500 ton in mountainous terrain.

Link	All	Medium Scenario			High Scenario		
	2003	2010	2015	2025	2010	2015	2025
Chaldovar - Bishkek	3.8	5.2	5.9	6.9	6.6	8.6	13.0
Bishkek - Tokmak	3.1	4.5	5.5	7.1	5.6	7.8	11.7
Tokmak - Balykshi	1.0	2.3	3.1	4.5	2.7	4.1	6.2

For the purposes of the economic and financial evaluation the average traffic between "conservative" and "optimistic" scenarios 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 (Chaldovar - Bishkek)	1.0	1.0	1.0	1.0	1.3	1.7	2.0
Domestic (Chaldovar - Balykshi)	1.0	2.0	2.0	2.0	2.0	2.0	2.0

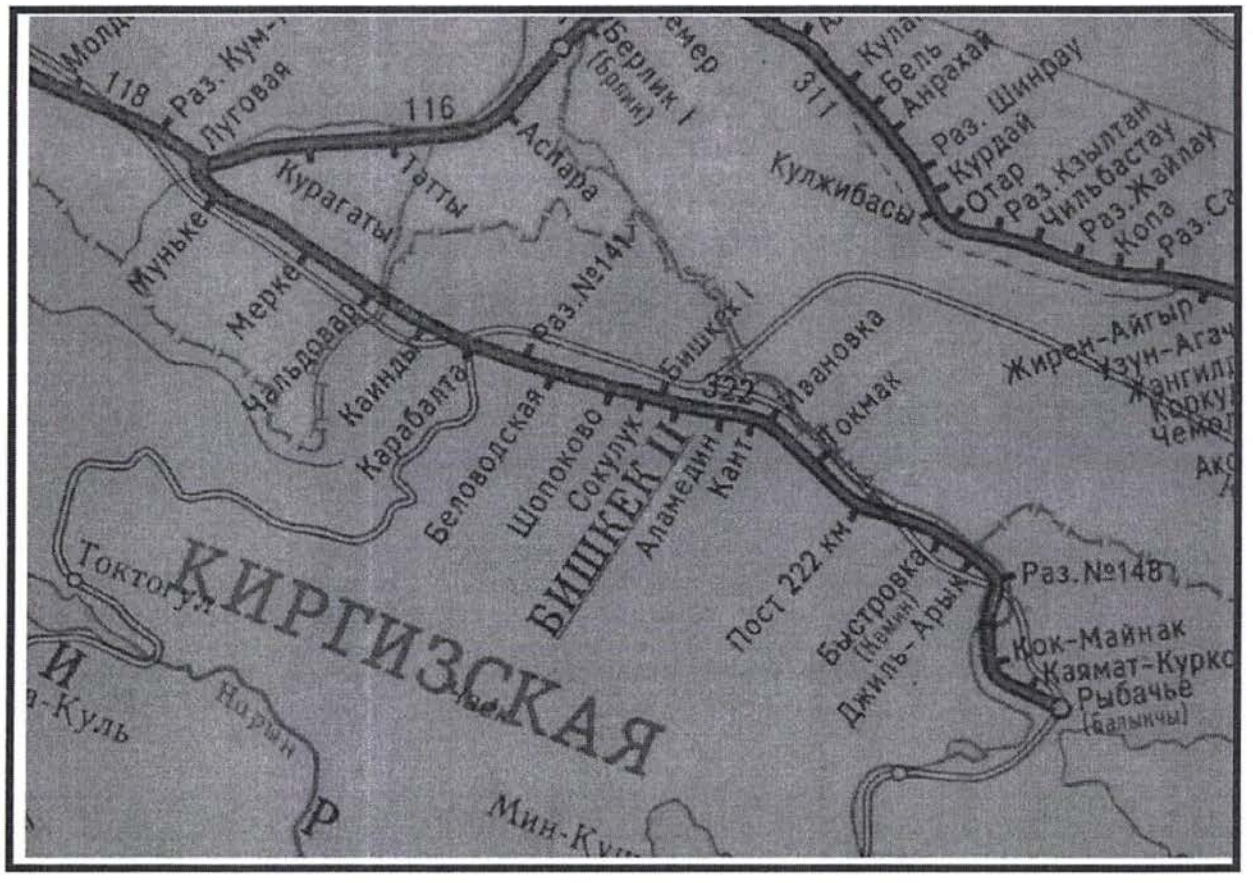
For the purposes of the economic and financial evaluation the average traffic between "conservative" and "optimistic" scenarios has been assumed.

4. Characteristics of existing line and stations

The line under study is the Kazakh border – Bishkek - Balykchi line section (261,403 km), belonging to the line Lugovoya - 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 Kazakh border-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

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.

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

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

The description of the existing Kazakh border-Balykchi line section can be done in the frame of the definitions established in line with the former Soviet railway rules (which for instance has been substantially absorbed by Uzbek Railways by the order 70"H" dated 09.11.95), concerning types and elements of permanent way, track works, maintenance and periodicity of their execution. In fact, even if the line under study for geographic and administrative reasons is located in Kyrgystan, it has been assumed by this Consultant that such rationale could be applied in terms of line classification and therefore of simulation of the future needs for line maintenance, according to the classification that will be recovered after the rehabilitation works.

From the following tables 4.1.1 – 1 and 4.1.1 - 2 the line classification in **categories**, by their technical characteristics, and in **groups,** by density of freight traffic, is possible.

Table 4.1.1 – 1 - Track classification.

Track group	Density of freight traffic, mln. tkm gross weight km/per year	Track category						
		1	2	3	4	5	6	7
		Speed: passenger trains is numerator; freight trains is denominator, km/h						Station, branch and other tracks
		121-140 / > 80	101-120 / > 70	81-100 / > 60	61-80 / > 50	41-60 / > 40	40 and less / main reception/departure tracks	
		Main tracks						
A	> 80	1	1	1	2	2	3	5 class
B	50-80	1	1	2	2	3	3	
C	25-50	1	2	2	3	3	4	
D	10-25	1	2	3	3	4	4	
E	10 and less	2	2	3	3	4	4	

Considering that the section under study had in the last years a freight traffic of $1,0 \div 1,5 * 10^6$/year gross tons, and that, on almost all the section, the speed is for the time being 70-50 km/h and that old wooden sleepers and worn out P50 rails are installed on the major part of the section, it is possible to conclude that this line is currently classified as an **E4** line.

This classification will be used in the next Chapters and paragraphs.

Table 4.1.1 - 2 Technical terms and conditions for track laying and maintenance according to its class

Track class				
1	**2**	**3**	**4**	**5**
1. Superstructure constructions **Continuous welded rail (CWR) tracks on reinforced concrete sleepers or link track on timber sleepers**				
2. Types and characteristics of superstructure				
New temperature –resistant R65 rails, 1 group, 1 class; new fastenings; new sleepers (impregnated timber, 1 group). Sleepers profile: on direct lines and curves R>1200 m - 1840 pcs/km; on curves with R<1200 m and less - 2000 pcs/km. Ballast: gravel or asbestos with the layer depth of 35 cm under timber sleepers ; 40 cm – under reinforced concrete sleepers;	New R65 rails or used ones in accordance with the Table 2.3. New or repaired used fastenings and sleepers – in accordance with Technical Conditions for the usage of used superstructure materials. Profile and the group of rails are the same as on the 1st and 2nd class tracks. Gravel or asbestos ballast, with layer depth of 25 cm under timber rails and 30 cm under reinforced concrete sleepers.	Used R65 rails – in accordance with the Technical Conditions for the usage of used superstructure rails. Used fastenings and sleepers, as a rule repaired ones. Sleeper profile is the same as on the 1 - 3 class rails. The laying of new sleepers of 2nd group is allowed. Ballast: gravel, asbestos, gravel and sand with layer depth of 20 cm under timber sleepers and 25 cm under reinforced concrete ones.	Rails, fastenings and sleepers are all used ones of all types, including the ones unusable in track laying of the 3rd and 4th class but not lighter than R 43. Interlacing of used reinforced concrete sleepers with timber ones is allowed. Sleepers profile: 1440 pcs/km on direct lines; 1600 pcs/km on curves with R< 650 m. Ballast depth underneath the sleeper not less than 15 cm.

Alignment and gradients

The total length of Kazak border – Balykchi section is 261,403 km.

The alignment is shown in Fig. 4.1.1 -1: mostly on straight from Kazak border up to Bishkek 1 (5,2 km of curves out of 90 km in length), from Bishkek 1 to Balykchi the number of curves greatly increases as well as the slopes especially in the last part of the section up to a total of 44,4 km out

of 172 km in length. Every circular curve is provided with parabolic transition curves at the beginning and at the end.

- The minimum curve radius is 260 m.
- The maximum cantilever is 150 mm.
- The maximum gradient is 20 %o, at chainage km 3892 between Djil Aryk and P 148.
- The maximum allowed load is 23 t/axle

The Tab. 4.1.1 – 3, shown in the following pages, 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 turnouts blades.

Tab. 4.1.1 - 3

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Element	Start (km)	End (km)	Station centre (km)	Cant (cm)	Deviation angle (degree)	-60	Radius (m)	Curve length (m)	Transition length (m)
Kazakh border	3685.746	3686.816	3686.324						
L.C.	3686.956								
Curve	3688.654	3689.036		7	20	8	800	381	100
Curve	3689.161	3689.522		6	18	42	800	361	100
L.C.	3690.142								
L.C.	3691.960								
Curve	3692.371	3692.712		5	11	44	1000	341	40
Curve	3693.075	3693.485		6	25	3	800	409	60
Curve	3693.799	3694.066		6	13	20	900	269	60
Curve	3697.569	3697.606		4	1	40	2000	146	20
	3697.606	3697.792		2	0	37	3600	96	20
L.C.	3698.967								
L.C.	3702.417								
Kaindi	3702.578	3703.838	3703.322						
Curve	3705.268	3705.467		11	8	51	900	159	40
L.C.	3705.425								
Curve	3705.803	3706.038		4	4	56	2500	236	20
L.C.	3712.066								
Curve	3715.164	3715.555		0	9	42	2200	391	20
L.C.	3715.900								
Curve	3716.133	3716.354		3	5	10	2000	220	40
L.C.	3717.088								
Curve	3717.420	3717.662		4	6	23	2000	242	20
Kara-Balta	3717.960	3719.116	3718.242						
L.C.	3720.169								
L.C.	3722.456								
L.C.	3724.100								
L.C.	3726.617								
R-141	3730.419	3731.506	3730.908						
Curve	3733.122	3733.401		5	12	24	1100	278	40
L.C.	3733.964								
L.C.	3737.029								
Curve	3738.638	3739.063		10	32	41	640	425	60
Belovodskaja	3739.682	3741.042	3740.092						
L.C.	3739.861								
L.C.	3741.943								
Curve	3742.393	3742.588		5	5	0	2000	194	20
Curve	3745.184	3745.463		5	13	55	900	278	60
L.C.	3747.418								
Curve	3753.382	3753.527		5	4	24	1500	145	30
Shopokovo	3754.716	3755.787	3755.435						
L.C.	3756.079								
L.C.	3761.310								
Soklukh	3764.750	3765.850	3765.212						
L.C.	3769.560								
L.C.	3771.950								
Bishkek - I	3773.267	3776.248	3775.591						

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Element	Start (km)	End (km)	Station centre (km)	Cant (cm)	Deviation angle (degree)	-60	Radius (m)	Curve length (m)	Transition length (m)
Curve	3775.124	3775.183		0	1	35	500	66	40
Curve	3775.183	3775.341		2	4	28	1200	49	20
L.C.	3777.041								
Curve	3777.260	3777.490		0	16	4	600	228	60
L.C.	3778.094								
Curve	3779.022	3779.326		6	10	42	1200	303	80
L.C.	3779.461								
Bishkek - II	3779.558	3780.635	3780.062						
Curve	3780.784	3781.226		5	20	45	1000	442	20
Curve	3781.873	3782.184		5	10	3	1200	250	40
Curve	3783.057	3783.341		5	7	31	1100	244	100
Alamedin	3783.550	3784.654	3783.915						
Curve	3784.856	3785.032		3	3	43	1900	186	60
L.C.	3787.064								
Curve	3788.722	3788.938		3	5	36	1000	215	20
Curve	3790.738	3791.195		5	19	55	1200	458	40
L.C.	3791.261								
Curve	3792.716	3793.086		5	16	54	1000	370	40
Curve	3793.477	3793.693		5	11	9	800	236	60
Curve	3798.208	3798.809		3	15	29	2150	601	20
L.C.	3799.215								
Kant	3799.945	3801.114	3800.569						
L.C.	3801.224								
Curve	3803.003	3803.597		4	21	10	1500	594	40
L.C.	3804.717								
Curve	3804.720	3804.958		3	5	40	2000	238	40
Curve	3805.479	3805.872		7	32	15	600	393	60
Curve	3805.872	3806.260		9	24	4	600	372	120
Curve	3806.444	3806.602		2	3	43	1500	157	60
Curve	3806.623	3806.740		3	3	58	1400	117	20
Curve	3806.878	3806.986		1	3	38	1400	109	20
Curve	3807.022	3807.162		4	3	38	1900	140	20
L.C.	3807.295								
L.C.	3812.417								
Curve	3816.950	3817.221		4	7	10	2000	270	20
Ivanovka	3818.528	3819.435	3819.090						
L.C.	3819.522								
Curve	3819.512	3819.693		9	13	14	700	182	40
Curve	3819.693	3819.793		9	9	10	500	99	40
Curve	3819.819	3820.230		11	29	34	600	411	100
Curve	3820.426	3821.003		10	49	20	600	577	60
Curve	3821.118	3821.904		10	53	18	600	786	80
Curve	3821.924	3822.462		9	43	47	600	538	80
Curve	3823.115	3823.774		7	43	15	750	659	40
Curve	3823.788	3824.114		9	21	32	600	325	100
L.C.	3826.695								
Curve	3830.631	3831.298		3	18	17	2030	667	120

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Element	Start (km)	End (km)	Station centre (km)	Cant (cm)	Deviation angle (degree)	-60	Radius (m)	Curve length (m)	Transition length (m)
L.C.	3832.903								
Curve	3834.580	3834.963		6	8	60	1800	382	100
Curve	3835.838	3836.140		5	7	53	1900	301	40
L.C.	3836.792								
L.C.	3838.447								
Tokmak	3839.124	3840.326	3839.568						
Curve	3840.875	3841.731		4	21	40	2000	856	100
L.C.	3841.151								
L.C.	3844.947								
L.C.	3848.263								
L.C.	3852.476								
Curve	3856.257	3856.666		9	27	29	600	408	120
L.C.	3857.771								
Curve	3857.907	3858.279		8	24	15	600	372	120
L.C.	3864.543								
L.C.	3868.028								
Curve	3870.010	3870.685		9	58	37	600	674	60
Bystrovka	3870.789	3871.960	3871.521						
L.C.	3872.189								
Curve	3872.065	3873.272		8	103	48	600	1207	120
Curve	3873.307	3873.649		9	23	3	600	341	100
Curve	3876.122	3876.447		10	25	30	640	325	40
L.C.	3876.830								
Curve	3878.332	3878.510		3	4	58	1600	178	40
Curve	3880.460	3880.787		4	8	40	1900	327	40
Djil-Aryk	3883.592	3884.624	3884.336						
L.C.	3884.634								
Curve	3884.637	3884.934		10	48	55	300	296	40
Curve	3885.284	3885.573		6	26	14	500	288	60
Curve	3885.694	3885.870		8	22	21	400	166	40
Curve	3885.870	3886.004		8	5	27	1200	134	40
Curve	3887.913	3888.565		6	39	25	1000	652	80
L.C.	3888.891								
Curve	3890.620	3891.013		8	27	57	600	392	100
Curve	3891.152	3891.381		8	21	21	400	229	80
Curve	3891.432	3891.571		5	9	0	600	139	60
Curve	3891.657	3891.869		6	23	55	330	212	80
Curve	3891.872	3892.156		8	38	4	320	293	80
Curve	3892.203	3892.306		1	6	0	500	103	40
Curve	3892.441	3892.576		4	14	64	400	134	40
Curve	3892.576	3892.699		4	8	26	700	123	40
L.C.	3892.621								
Curve	3892.836	3893.219		8	33	48	800	383	100

Element	Start (km)	End (km)	Station centre (km)	Cant (cm)	Deviation angle (degree)	-60	Radius (m)	Curve length (m)	Transition length (m)
Curve	3893.276	3893.507		9	26	51	300	270	90
Curve	3893.513	3893.716		6	13	2	500	204	90
Curve	3893.717	3893.916		8	24	58	320	199	60
Curve	3894.001	3894.224		9	26	20	900	223	90
Curve	3894.224	3894.695		9	80	22	300	471	50
Curve	3894.751	3895.065		9	37	35	309	314	120
Curve	3895.146	3895.734		6	90	27	500	588	60
Curve	3895.649	3895.829		9	20	59	300	180	70
Curve	3895.858	3896.047		5	10	26	600	189	80
Curve	3896.109	3896.344		8	34	10	300	235	80
Curve	3896.370	3896.776		10	56	8	300	406	50
Curve	3896.809	3897.138		10	45	44	300	329	90
Curve	3897.353	3897.447		1	1	56	2200	94	20
Curve	3897.638	3898.138		4	10	1	500	500	20
Curve	3897.776	3898.037		9	44	17	300	261	30
Curve	3898.046	3898.322		6	22	35	300	276	60
Curve	3898.274	3898.428		2	7	6	1000	154	30
Curve	3898.696	3898.851		1	13	22	450	155	60
L.C.	3898.928								
Curve	3899.031	3899.114		2	6	59	800	83	20
R-148	3899.160	3900.129	3899.660						
Curve	3899.582	3899.920		4	22	42	600	338	100
Curve	3900.150	3900.268		2	3	52	1600	118	20
Curve	3900.267	3900.339		1	2	44	1300	72	20
Curve	3900.339	3900.522		2	14	53	500	180	100
Curve	3900.522	3900.712		2	7	81	1400	190	20
Curve	3900.767	3900.882		2	12	12	400	115	30
Curve	3900.907	3901.191		10	40	56	300	284	70
Curve	3901.280	3901.613		2	22	8	500	333	140
Curve	3901.787	3901.957		6	15	50	400	170	50
Curve	3902.240	3902.555		5	22	4	610	315	80
Curve	3902.715	3902.945		8	22	52	400	230	70
Curve	3902.950	3903.178		10	32	45	400	228	70
Curve	3903.478	3903.692		4	15	21	500	214	80
Curve	3903.723	3903.933		6	14	58	500	210	80
Curve	3903.939	3904.166		8	24	0	400	227	60
Curve	3904.170	3904.391		5	20	10	400	221	80
Curve	3904.417	3904.546		6	9	82	500	129	50
Curve	3904.765	3905.009		8	33	13	300	244	70
Curve	3905.027	3905.255		8	32	5	300	228	60
Curve	3905.255	3905.434		7	19	32	350	179	50
Curve	3905.574	3905.662		2	4	1	1050	88	30
Curve	3905.683	3905.741		0	4	35	600	58	21

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Element	Start (km)	End (km)	Station centre (km)	Cant (cm)	Deviation angle (degree)	-60	Radius (m)	Curve length (m)	Transition length (m)
Curve	3905.741	3905.870		8	18	15	310	129	60
Curve	3905.891	3906.165		10	45	57	300	274	60
Curve	3906.224	3906.540		10	48	55	300	316	40
Curve	3906.600	3906.841		9	34	42	300	241	60
Curve	3906.867	3907.037		6	21	6	300	170	60
Curve	3907.067	3907.227		4	19	12	300	160	60
Curve	3907.351	3907.573		7	27	10	300	222	80
Curve	3907.606	3907.791		8	20	4	300	185	80
Curve	3907.798	3908.012		6	25	39	300	214	80
Curve	3908.148	3908.446		7	42	3	300	298	60
Curve	3908.806	3909.006		7	22	51	300	200	80
Curve	3909.030	3909.174		3	12	53	400	144	80
Curve	3909.288	3909.421		2	13	21	400	133	40
Curve	3909.425	3909.537		3	10	24	400	112	40
Curve	3909.662	3909.786		3	12	6	400	124	40
Curve	3910.125	3910.258		7	17	53	300	133	40
Curve	3910.259	3910.374		6	11	2	390	115	40
Curve	3910.400	3910.519		7	12	36	360	119	40
Curve	3910.926	3911.265		3	51	28	800	339	120
Curve	3912.200	3912.398		4	15	56	500	198	50
Curve	3912.402	3912.580		9	13	9	600	178	40
Curve	3912.628	3913.135		7	53	24	400	507	120
Curve	3913.365	3913.715		8	35	51	400	350	100
Curve	3913.737	3914.041		8	32	8	400	304	80
Curve	3915.453	3915.610		1	3	22	2000	157	40
Curve	3917.020	3917.412		7	23	49	530	392	130
Curve	3917.715	3918.265		9	11	28	450	550	80
Curve	3917.865	3917.999		10	17	42	300	134	80
Curve	3918.018	3918.219		7	20	57	330	201	80
Curve	3918.404	3918.605		7	11	10	830	201	40
Curve	3918.693	3919.021		9	45	28	360	328	80
Curve	3919.201	3919.363		8	17	33	300	162	70
Curve	3919.640	3920.025		6	25	24	600	385	120
Curve	3920.140	3920.520		10	57	29	290	380	90
Curve	3920.520	3920.821		10	43	6	320	301	60
Curve	3920.898	3921.066		6	15	27	400	168	60
Curve	3921.151	3921.350		11	23	9	370	199	100
Curve	3921.350	3921.552		9	16	56	480	202	100
Curve	3921.686	3922.043		7	24	26	650	357	80
Curve	3922.200	3922.371		1	40	19	2000	171	20
Curve	3922.497	3922.667		6	13	57	450	170	60
Curve	3922.734	3923.257		7	58	14	460	523	40
L.C.	3925.116								

Element	Start (km)	End (km)	Station centre (km)	Cant (cm)	Deviation angle (degree)	-60	Radius (m)	Curve length (m)	Transition length (m)
Curve	3926.302	3926.536		3	15	52	700	234	40
Curve	3926.678	3926.889		6	18	44	400	211	80
Curve	3926.916	3927.282		8	58	30	250	366	90
Curve	3927.484	3927.600		4	3	52	1300	116	30
Curve	3927.600	3927.738		6	8	59	500	138	60
Curve	3928.916	3929.305		6	28	35	620	389	80
Curve	3929.759	3930.351		7	58	40	500	592	60
Curve	3930.806	3931.089		17	34	58	300	283	100
Curve	3931.136	3931.337		3	9	14	1000	204	40
Curve	3931.464	3931.839		11	54	28	300	375	80
Curve	3932.243	3932.469		6	23	50	400	226	60
Curve	3932.716	3932.968		4	10	58	900	252	80
Curve	3933.902	3934.217		8	26	35	550	315	60
Curve	3934.583	3934.787		9	25	4	260	204	90
Curve	3934.789	3934.900		3	12	20	290	112	50
Curve	3934.900	3935.068		5	10	18	600	168	60
Curve	3935.331	3935.853		4	26	29	1000	522	60
Curve	3936.126	3936.411		5	19	35	600	285	80
Kojamat-Kurkol	3936.746	3937.509	3936.941						
L.C.	3938.255								
Curve	3938.272	3938.583		2	8	50	1500	311	80
Curve	3941.959	3942.399		3	12	2	2000	440	20
L.C.	3946.590								
Curve	3946.662	3947.137		5	36	48	600	475	90
Balykchi	3947.175	3948.683	3947.757						
End point	3954.300								

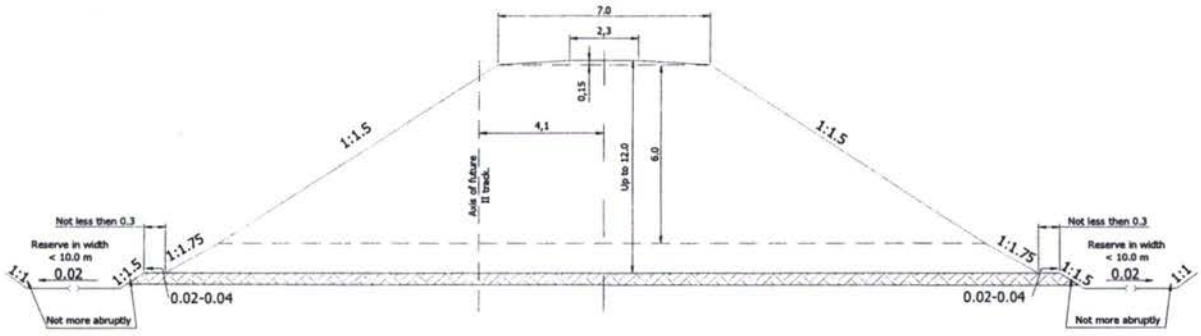
Line formation

The line formation from Kazak border to Bishkek 1 and from Bishkek 1 up to the station of Djil Arik is constituted by embankments 1÷3 m height. From Djil Arik, situated at 800 m above sea level, the line climbs tortuously with a formation mainly in cut or semi cut along the Boomy canyon up to Balykchi, the last station, situated on the shore of the Issyk Kul lake at 1600 m above sea level.

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

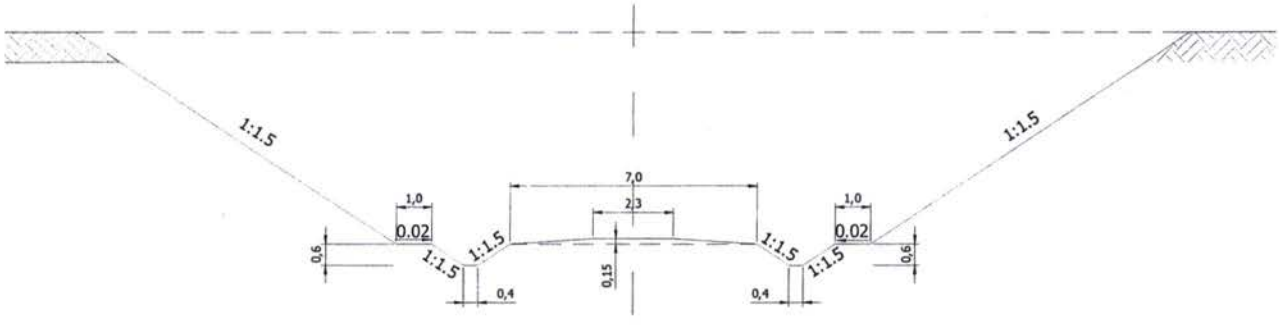
The top surface of the embankment width varies from 6,0 m to 7,1 m.

Fig. 4.1.1 – 1



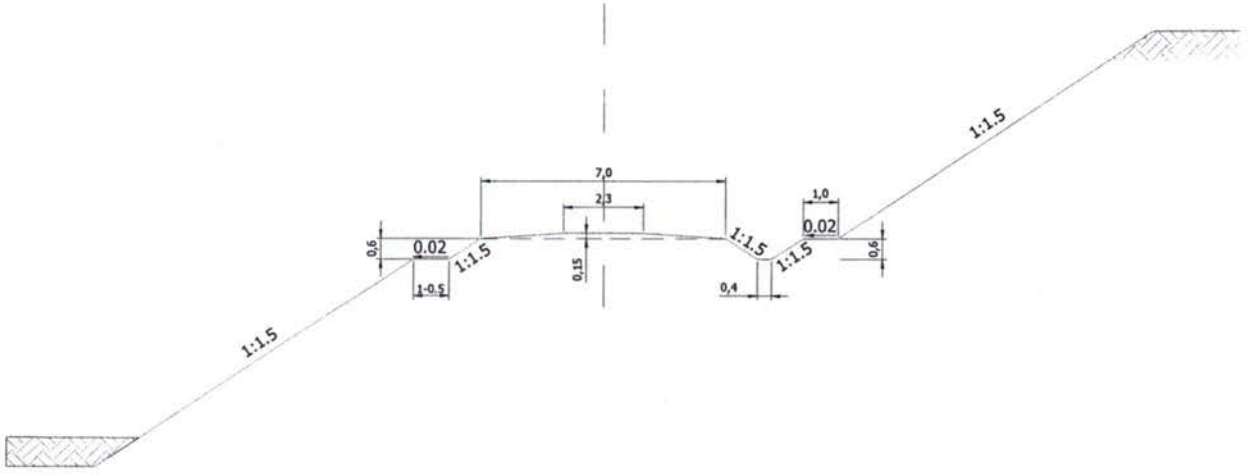
Typical cross structure of embankment in height up to 12 m from clay soils, fine and powdery sand and it is easy weathered rock.
The note: At erection of embankments from dry sand with a corner of a natural slope less than 340 their slopes are arranged more gentle slope .

Fig. 4.1.1 – 2



Typical cross a profile of a ditch depth up to 12 m in loess-like soils and a loess, silty loams, fine and powdery sands, semi-rocky breeds and loams.
The note: At height of a slope up to 2 m out of ditch's shelfs are not arranged.

Fig. 4.1.1 – 3



Typical cross section of a wide-cut formation

Superstructure

The typical superstructure cross-sections on straight track and on curve are shown in fig.4.1.1 – 4. 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,
- both wooden and concrete sleepers are installed (see fig. 4.1.1 – 5 and 4.1.1 – 6); 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),
- P50 and P65 type of rails are laid down (see fig. 4.1.1 – 7).
- fastenings rail-wooden sleepers and rail-reinforced concrete sleepers are shown in fig. 4.1.1 – 8.

Fig. 4.1.1 – 4

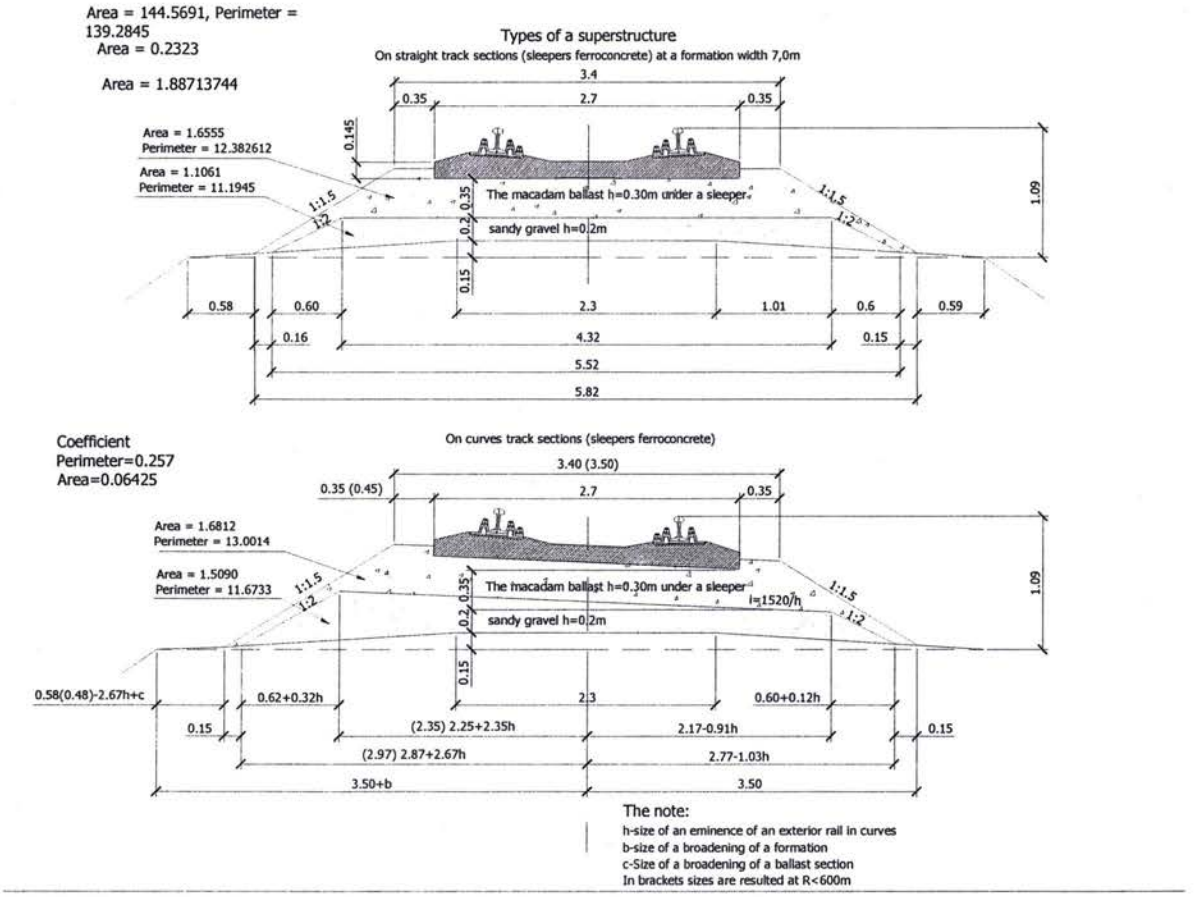
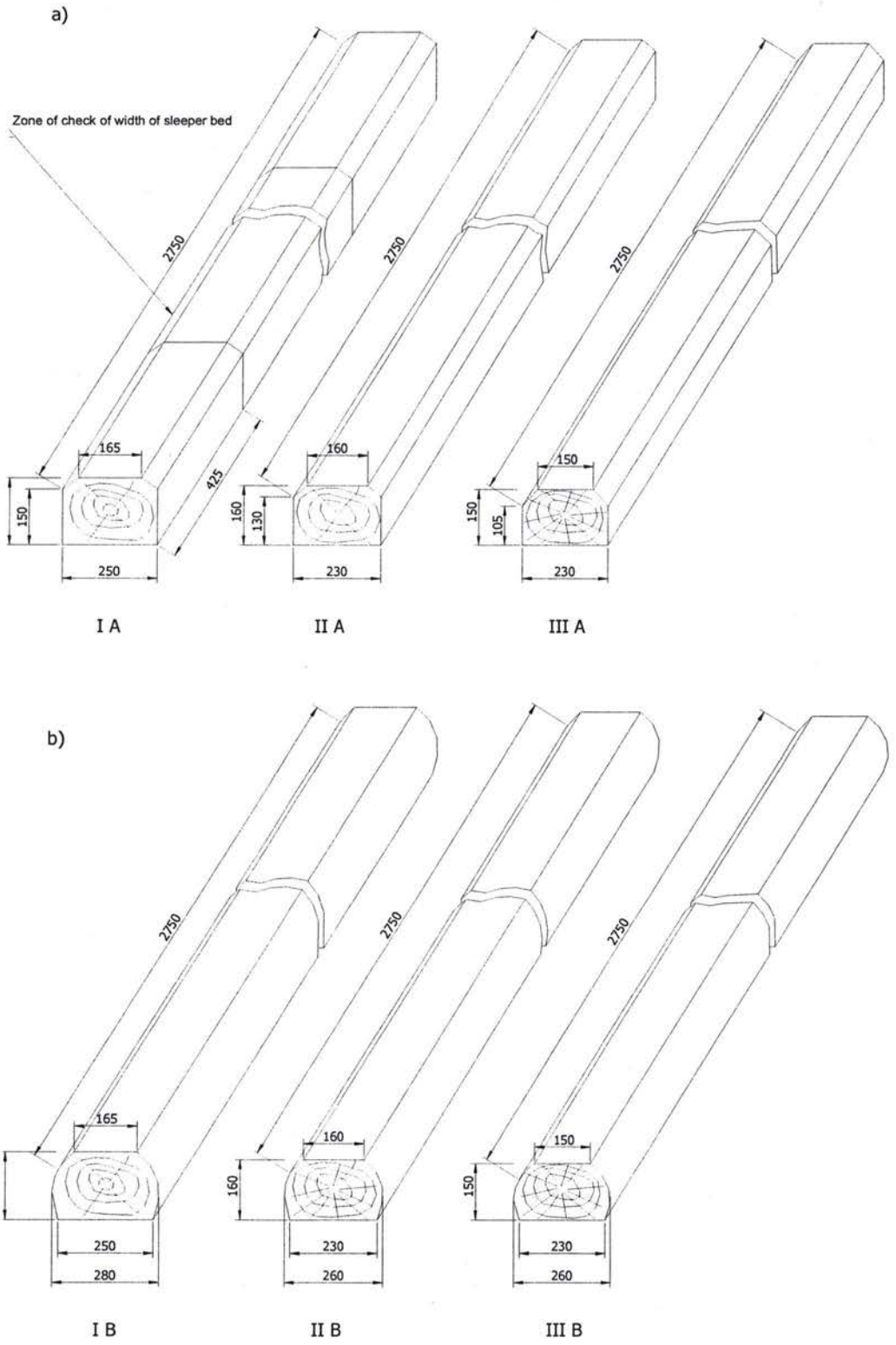
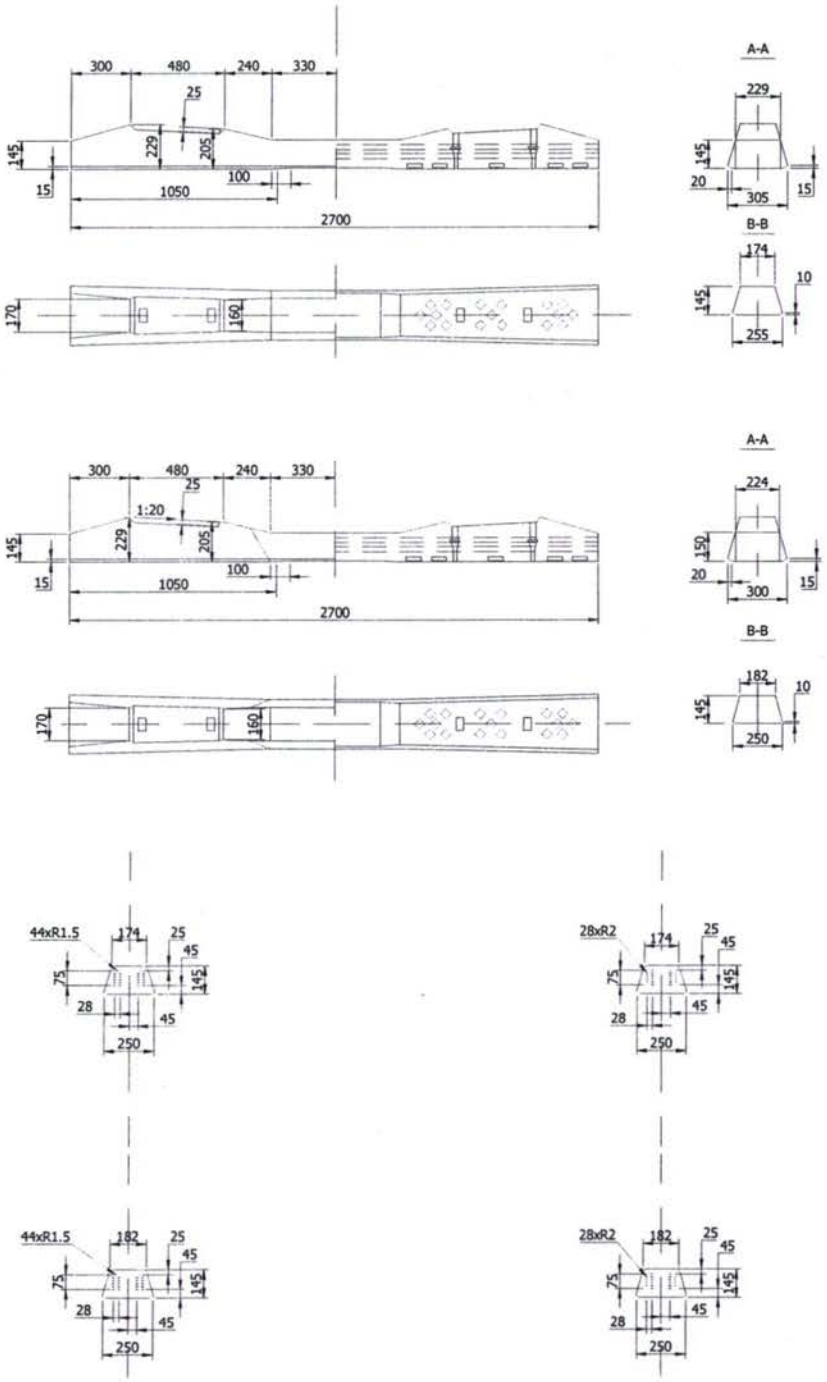

Area = 144.5691, Perimeter = 139.2845
Area = 0.2323
Area = 1.88713744
Types of a superstructure
On straight track sections (sleepers ferroconcrete) at a formation width 7,0m
3.4
0.35
2.7
0.35
0.145
Area = 1.6555
Perimeter = 12.382612
Area = 1.1061
Perimeter = 11.1945
1:1.5
1:2
0.35
0.2
The macadam ballast h=0.30m under a sleeper
sandy gravel h=0.2m
1.09
0.15
0.58
0.60
2.3
1.01
0.6
0.59
0.16
4.32
0.15
5.52
5.82
Coefficient
Perimeter=0.257
Area=0.06425
On curves track sections (sleepers ferroconcrete)
3.40 (3.50)
0.35 (0.45)
2.7
0.35
Area = 1.6812
Perimeter = 13.0014
Area = 1.5090
Perimeter = 11.6733
The macadam ballast h=0.30m under a sleeper
i=1520/h
sandy gravel h=0.2m
0.58(0.48)-2.67h+c
0.62+0.32h
2.3
0.60+0.12h
0.15
(2.35) 2.25+2.35h
2.17-0.91h
0.15
(2.97) 2.87+2.67h
2.77-1.03h
3.50+b
3.50
The note:
h-size of an eminence of an exterior rail in curves
b-size of a broadening of a formation
c-Size of a broadening of a ballast section
In brackets sizes are resulted at R<600m

Fig. 4.1.1 –5



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

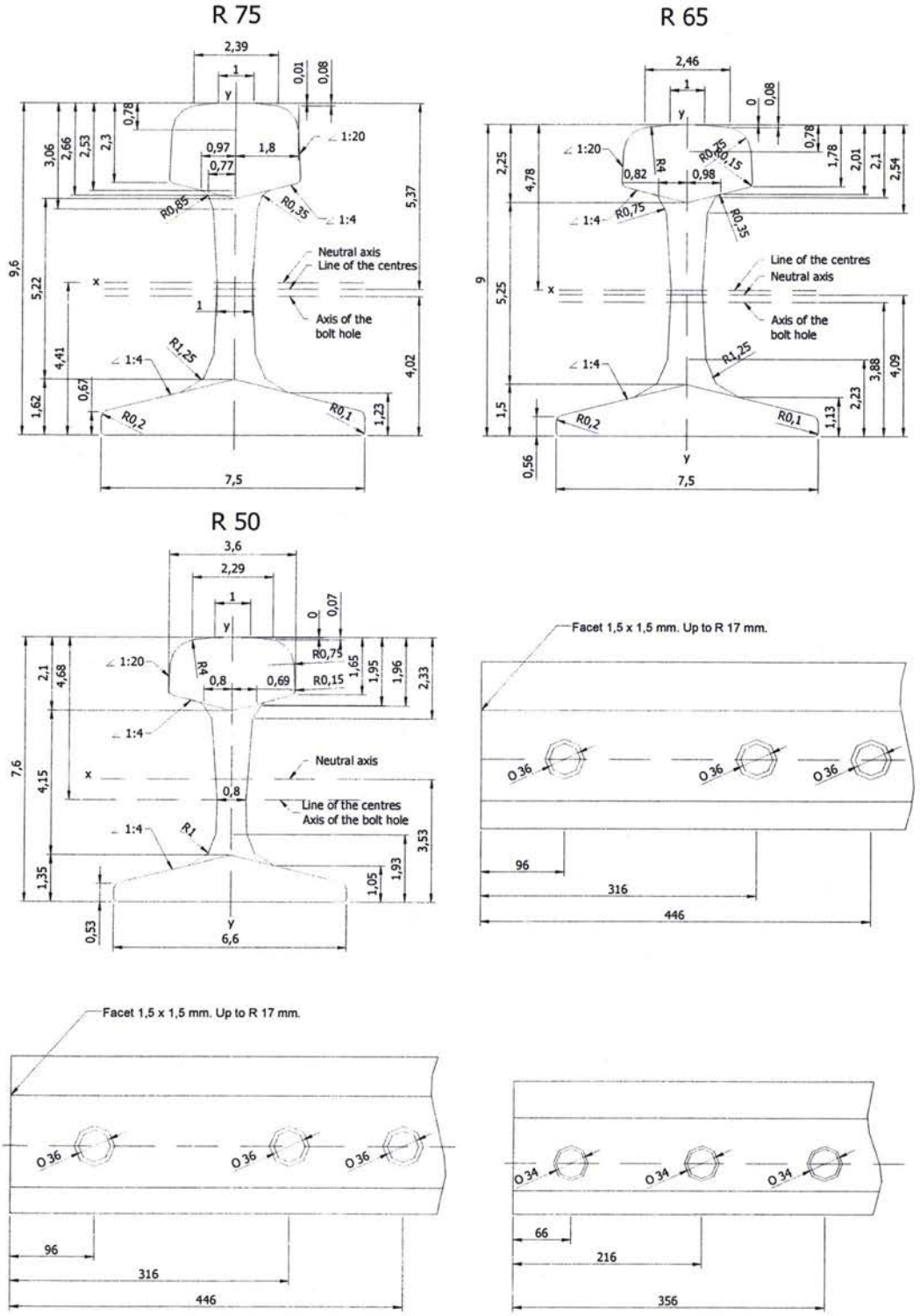
Fig. 4.1.1 - 6



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.

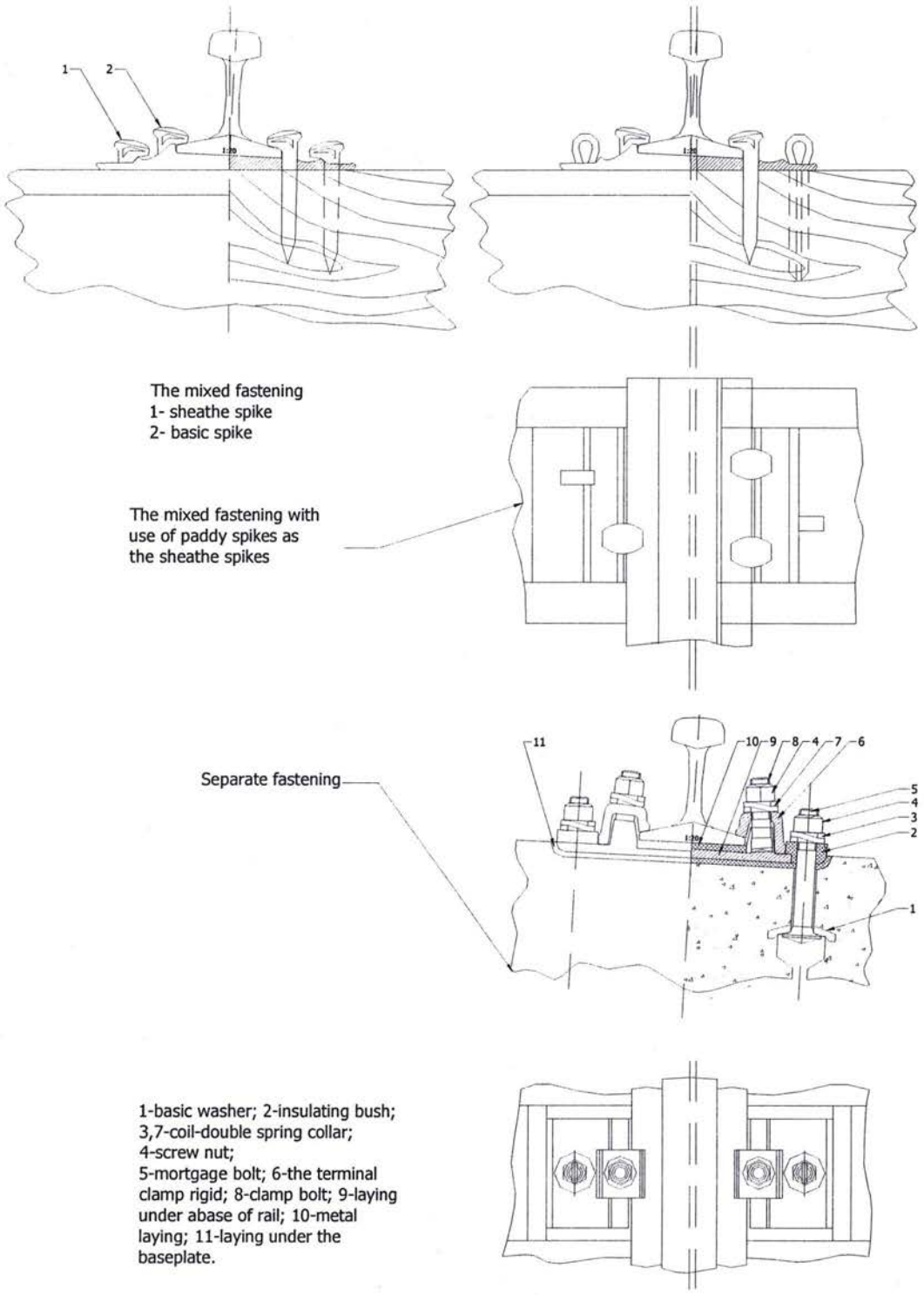
The appendix 8-4

Fig. 4.1.1 – 7



Cross profiles of standard rails (R75 R65 R50)

Fig. 4.1.1 – 8


1
2
The mixed fastening
1- sheathe spike
2- basic spike
The mixed fastening with use of paddy spikes as the sheathe spikes
Separate fastening
11
10
9
8
4
7
6
5
4
3
2
1
1-basic washer; 2-insulating bush;
3,7-coil-double spring collar;
4-screw nut;
5-mortgage bolt; 6-the terminal clamp rigid; 8-clamp bolt; 9-laying under abase of rail; 10-metal laying; 11-laying under the baseplate.

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

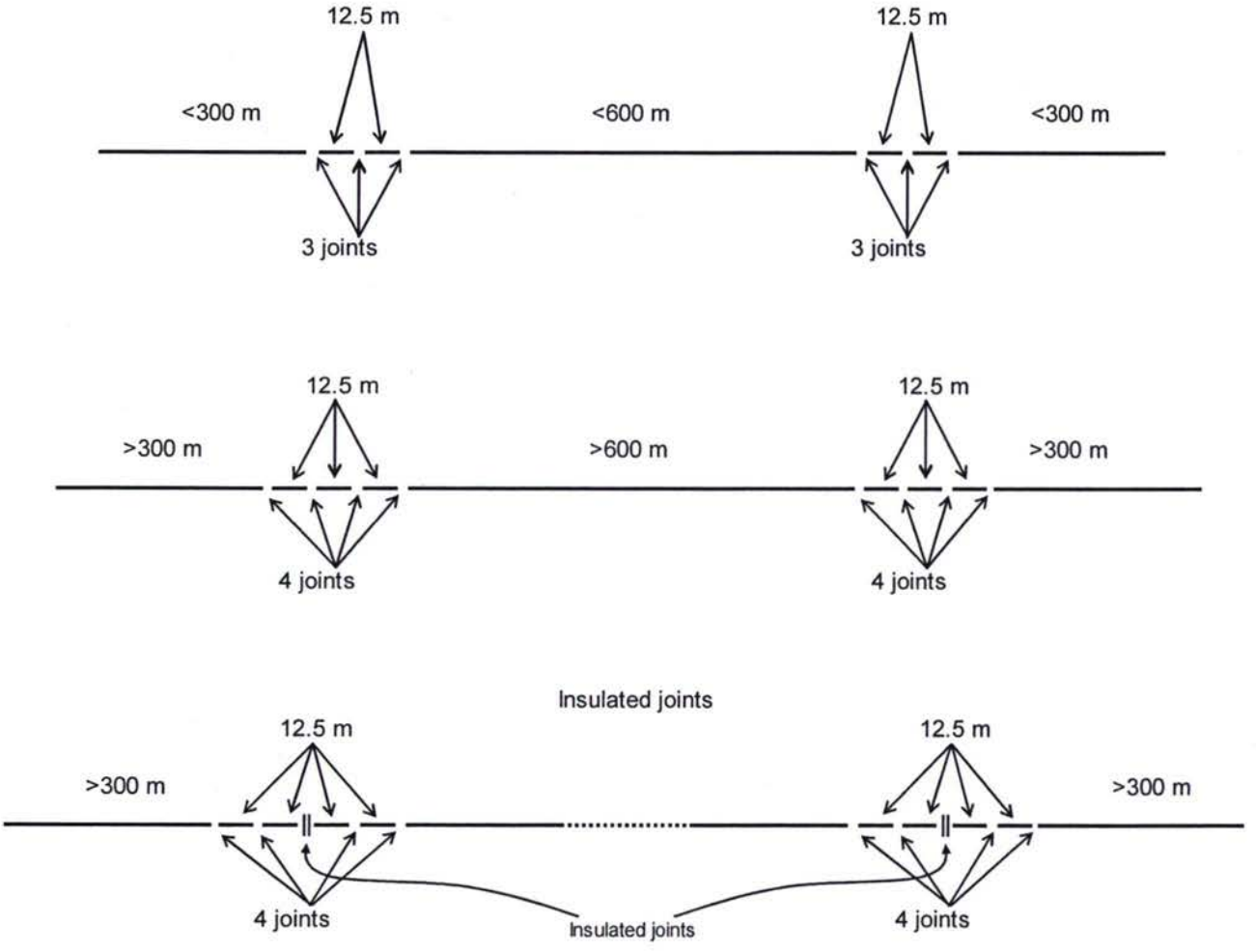
On lines equipped with concrete sleepers, a great reduction of hammering effect can be obtained by welding rails in long bars (continuous welded rails, cwr).

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 – 9:

Fig. 4.1.1. - 9

(measures in m)



The situation of the existing rails, sleepers, implementation of cwr on the section under study can be summarized as it follows (see Table 4.1.1 – 4)

Table 4.1.1 - 4

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section
Permanent way and turnouts type

Stations				PW type						
Name				Line and station main lines			Stations turnouts			
		start km	end km				on main track			
				Rail type	Sleepers	Length	P65 1/11	P50 1/11		
N.						(m)	(N.)	(N.)		
	border	0.000	***3687.280***							
		3687.280	3698.100	P65	W/C	**10820**			OPTION 2	OPTION 3
		3698.100	3702.578	**P65**	C	**4478**				
1	*Kaindi*	3702.578	3703.838	P65	W/C	***1093***	5			
		3703.838	3717.960	**P65**	C	**14122**				
2	*Kara-Balta*	3717.960	3719.116	P65	W/C	***989***	5			
		3719.116	3729.28	**P65**	W/C	**10164**				
		3729.280	3730.419	***P50***	W/C	***1139***				
3	*R-141*	3730.419	3731.506	***P50***	W/C	***954***	4			
		3731.506	3739.682	***P50***	W/C	***8176***				
4	Belovodskaja	3739.682	3741.042	**P65**	W/C	***1193***	5			
		3741.042	3754.716	***P50***	W/C	***13674***				
5	Shopokovo	3754.716	3755.787	**P65**	W/C	***904***	5			
		3755.787	3764.750	***P50***	W/C	***8963***				
6	Soklukh	3764.750	3765.850	***P50***	W/C	***967***	4			
		3765.850	3773.267	***P50***	W/C	***7417***				
7	Bishkek - I	3773.267	3776.248	***P50***	W/C	***2447***	16			
		3776.248	3779.558	***P50***	W/C	***3310***				
8	Bishkek - II	3779.558	3780.635	***P50***	W/C	***910***	2	3		
		3780.635	3783.550	***P50***	W/C	***2915***				
9	Alamedin	3783.550	3784.654	***P50***	W/C	***904***		6		
		3784.654	3799.945	***P50***	W/C	***15291***				
10	Kant	3799.945	3801.114	***P50***	W/C	***1002***		5		
		3801.114	3818.528	***P50***	W/C	***17414***				
11	Ivanovka	3818.528	3819.435	***P50***	W/C	***774***		4		
		3819.435	3839.124	***P50***	W/C	***19689***				
12	Tokmak	3839.124	3840.326	***P50***	W/C	***1035***		5		
		3840.326	3870.789	***P50***	W/C	***30463***				
13	Bystrovka	3870.789	3871.960	***P50***	W/C	***1004***		5		
		3871.960	3883.592	***P50***	W/C	***11632***				
14	Djil-Aryk	3883.592	3884.624	***P50***	W/C	***832***		6		
		3884.624	3899.160	***P50***	W/C	***14536***				
15	R-148	3899.160	3900.129	***P50***	W/C	***869***		3		
		3900.129	3922.080	***P50***	W/C	***21951***				
		3922.080	3936.746	***P43***	W/C	14666				
16	Kojamat-Kurkol	3936.746	3937.509	***P43***	W/C	*696*		2		
		3937.509	3947.175	***P43***	W/C	9666				
17	Balykchi	3947.175	3948.683	***P43***	W/C	*1341*		5		
							46	**44**		

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

Table 4.1.1 - 5

PW type Kyrgyzstan		
	Line	**Stations**
		main track
W/C+P65	20,984	4,180
W+P43	24,332	2,037
W/C+P50	176,570	11,697
C+P65	18,600	

From the table could be observed that

- 43,764 km of track - between the border and few km after Kara-Balta station, and in Belovodskaja and Shopokovo stations - are equipped with P65 rails, out of them 18,6 km are on reinforced concrete sleepers and in continuous welded rails (cwr), the remaining part is formed by jointed 25 m bars on mixed wooden/concrete sleepers,
- 188,267 km are equipped with P50 rails on mixed wooden/concrete sleepers,
- 26,369 km are equipped with P43 rails on mixed wooden/concrete sleepers.

All these measures do not consider turnouts length.

Stations PW

The station main lines are generally provided with P50 rails, with the exception of:

- Kaindi,
- Kara – Balta,
- Belovodskaja,
- Shopokovo.

The existing turnouts are P65 tg 1/11 type on the station main lines from the Kazak border up to Bishkek 2, with the exception of this last station in which two P65 tg 1/11 and three P50 tg1/11 type turnouts are installed. From Alamedin to Balykchi the station main lines are all equipped with P50tg1/11 turnouts.

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

- 44 P65 tangent 1:11,
- 46 P50 tangent 1:11.

Visit of the line

The line was visited by Consultant's experts from 7th to 13th of October 2004 from Kazak border to Balykchi by trolley put at their disposal.

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.

PW defects of the line

During the site visit of the line the experts could check the present condition of the line and they could directly verify some information provided by the railway representatives. In detail, it has been noticed that:

- PW is old and worn out in many sections, rails type P50 and wooden sleepers are at their life limit, and their use leads to current heavy speed restrictions and to the sensitive risk of derailment for heavy trains (where the dynamic factor on the permanent way is higher);
- fastening devices, in particular those equipped on wooden sleepers, are old, and their fastening force is almost absent. Bolts and their parts are often worn out. Part of them is not properly working because of the conditions of the sleepers; old wooden sleepers are damaged and their retaining force on bolts and screw is low,
- rail junctions (every 25m for the sections not interested by the C.W.R.) are old and worn out, many bolts are missing for vibration and hammering,
- in correspondence with rail junction, hammering on the rails leaded to a rail consumption over the limits, in particular for those junction where the opening is larger than the maximum admitted,
- general conditions of the alignment geometry have been lost and their preservation is very difficult because of the deformation of the track panels and the bearing capacity of the formation level;
- 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 km/h speed for passenger trains and 90 km/h speed for freight trains, the maximum allowed speeds are, for the time being, the following:

Table 4.1.1 - 6

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "without project" speed		
Chainage	**Section length**	**Speed**
(km)	***(km)***	***(km/h)***
3626	61	70
3687	83	70
3770	178	50
3948		

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 4.1.1-7 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 – 7 Existing and future curves parameters. Future speeds.

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section 1/4 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	Theoretical Max speed	Cant to be increased	Future cant value
			(cm)	*(m)*	*(km/h)*	*(m)*	*(km/h)*		*(cm)*
Curve	3688.654	3689.036	7	800	100	98.62	100		
Curve	3689.161	3689.522	6	800	95	88.01	100	yes	7
Curve	3692.371	3692.712	5	1000	105	105.42	100		
Curve	3693.075	3693.485	6	800	95	88.01	100	yes	7
Curve	3693.799	3694.066	6	900	100	90.21	100		
Curve	3697.569	3697.606	4	2000	140	132.05	110		
Curve	3697.606	3697.792	2	3600	160	126.01	110		
Curve	3705.268	3705.467	11	900	115	96.92	110		
Curve	3705.803	3706.038	4	2500	150	124.34	110		
Curve	3715.164	3715.555	0	2200	125	126.86	110		
Curve	3716.133	3716.354	3	2000	135	129.50	110		
Curve	3717.420	3717.662	4	2000	140	132.05	110		
Curve	3733.122	3733.401	5	1100	110	110.05	110		
Curve	3738.638	3739.063	10	640	95	82.87	110	yes	14
Curve	3742.393	3742.588	5	2000	140	116.06	110		
Curve	3745.184	3745.463	5	900	100	101.63	110	yes	10
Curve	3753.382	3753.527	5	1500	125	114.64	110		
Curve	3775.124	3775.183	0	500	60	61.73	90	yes	12
Curve	3775.183	3775.341	2	1200	100	96.22	90		
Curve	3777.260	3777.490	0	600	65	65.40	90	yes	10
Curve	3779.022	3779.326	6	1200	115	102.25	90		
Bishkek - II	3779.558	3780.635					90		
Curve	3780.784	3781.226	5	1000	105	105.42	90		
Curve	3781.873	3782.184	5	1200	115	115.39	90		
Curve	3783.057	3783.341	5	1100	110	110.05	90		
Curve	3784.856	3785.032	3	1900	130	120.66	110		
Curve	3788.722	3788.938	3	1000	95	89.94	110	yes	7
Curve	3790.738	3791.195	5	1200	115	115.39	110		
Curve	3792.716	3793.086	5	1000	105	105.42	110	yes	7
Curve	3793.477	3793.693	5	800	90	78.79	110	yes	10
Curve	3798.208	3798.809	3	2150	135	117.24	110		
Curve	3803.003	3803.597	4	1500	120	109.76	90		
Curve	3804.720	3804.958	3	2000	135	129.50	90		
Curve	3805.479	3805.872	7	600	85	78.26	90	yes	10
Curve	3805.872	3806.260	9	600	90	81.05	90		
Curve	3806.444	3806.602	2	1500	110	101.65	90		

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section 2/4 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	Theoretical Max speed	Cant to be increased	Future cant value
			(cm)	*(m)*	*(km/h)*	*(m)*	*(km/h)*		*(cm)*
Curve	3806.623	3806.740	3	1400	115	115.80	110		
Curve	3806.878	3806.986	1	1400	105	106.15	110	yes	2
Curve	3807.022	3807.162	4	1900	135	123.33	110		
Curve	3816.950	3817.221	4	2000	140	132.05	110		
Curve	3819.512	3819.693	9	700	100	101.29	90		
Curve	3819.693	3819.793	9	500	90	64.05	90		
Curve	3819.819	3820.230	11	600	95	84.77	90		
Curve	3820.426	3821.003	10	600	95	95.63	90		
Curve	3821.118	3821.904	10	600	95	95.63	90		
Curve	3821.924	3822.462	9	600	90	81.05	90		
Curve	3823.115	3823.774	7	750	95	87.36	90		
Curve	3823.788	3824.114	9	600	90	81.05	90		
Curve	3830.631	3831.298	3	2030	135	126.91	110		
Curve	3834.580	3834.963	6	1800	140	121.84	110		
Curve	3835.838	3836.140	5	1900	140	126.38	110		
Curve	3840.875	3841.731	4	2000	140	132.05	110		
Curve	3856.257	3856.666	9	600	90	81.05	90		
Curve	3857.907	3858.279	8	600	90	91.34	90		
Curve	3870.010	3870.685	9	600	90	81.05	90		
Curve	3872.065	3873.272	8	600	90	91.34	90		
Curve	3873.307	3873.649	9	600	90	81.05	90		
Curve	3876.122	3876.447	10	640	95	82.87	90		
Curve	3878.332	3878.510	3	1600	120	113.18	90		
Curve	3880.460	3880.787	4	1900	135	123.33	90		
Curve	3884.637	3884.934	10	300	65	56.53	60		
Curve	3885.284	3885.573	6	500	75	69.14	60		
Curve	3885.694	3885.870	8	400	70	58.54	60		
Curve	3885.870	3886.004	8	1200	125	118.30	60		
Curve	3887.913	3888.565	6	1000	105	93.42	60		
Curve	3890.620	3891.013	8	600	90	91.34	60		
Curve	3891.152	3891.381	8	400	70	58.54	60		
Curve	3891.432	3891.571	5	600	80	76.23	60		
Curve	3891.657	3891.869	6	330	60	52.39	60		
Curve	3891.872	3892.156	8	320	70		60		
Curve	3892.203	3892.306	1	500	60	54.87	60		
Curve	3892.441	3892.576	4	400	60	49.74	60		
Curve	3892.576	3892.699	4	700	85	86.51	60		
Curve	3892.836	3893.219	8	800	100	87.20	60		
Curve	3893.276	3893.507	9	300	65	63.96	60		
Curve	3893.513	3893.716	6	500	75	69.14	60		
Curve	3893.717	3893.916	8	320	70		60		
Curve	3894.001	3894.224	9	900	110	98.19	60		
Curve	3894.224	3894.695	9	300	65	63.96	60		
Curve	3894.751	3895.065	9	309	65	60.15	60		
Curve	3895.146	3895.734	6	500	75	69.14	60		
Curve	3895.649	3895.829	9	300	65	63.96	60		
Curve	3895.858	3896.047	5	600	80	76.23	60		

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section 3/4 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	Theoretical Max speed	Cant to be increased	Future cant value
			(cm)	*(m)*	*(km/h)*	*(m)*	*(km/h)*		*(cm)*
Curve	3896.109	3896.344	8	300	60	48.03	60		
Curve	3896.370	3896.776	10	300	65	56.53	60		
Curve	3896.809	3897.138	10	300	65	56.53	60		
Curve	3897.353	3897.447	1	2200	130	127.84	60		
Curve	3897.638	3898.138	4	500	70	66.03	60		
Curve	3897.776	3898.037	9	300	65	63.96	60		
Curve	3898.046	3898.322	6	300	55	41.54	60	yes	7
Curve	3898.274	3898.428	2	1000	90	83.60	60		
Curve	3898.696	3898.851	1	450	55	46.54	60	yes	2
Curve	3899.031	3899.114	2	800	80	73.17	60		
Curve	3899.582	3899.920	4	600	75	66.19	60		
Curve	3900.150	3900.268	2	1600	115	109.54	60		
Curve	3900.267	3900.339	1	1300	100	98.49	60		
Curve	3900.339	3900.522	2	500	65	63.63	60		
Curve	3900.522	3900.712	2	1400	110	110.71	60		
Curve	3900.767	3900.882	2	400	55	46.86	60	yes	3
Curve	3900.907	3901.191	10	300	65	56.53	60		
Curve	3901.280	3901.613	2	500	65	63.63	60		
Curve	3901.787	3901.957	6	400	65	53.54	60		
Curve	3902.240	3902.555	5	610	80	74.23	60		
Curve	3902.715	3902.945	8	400	70	58.54	60		
Curve	3902.950	3903.178	10	400	75	65.00	60		
Curve	3903.478	3903.692	4	500	70	66.03	60		
Curve	3903.723	3903.933	6	500	75	69.14	60		
Curve	3903.939	3904.166	8	400	70	58.54	60		
Curve	3904.170	3904.391	5	400	65	60.97	60		
Curve	3904.417	3904.546	6	500	75	69.14	60		
Curve	3904.765	3905.009	8	300	60	48.03	60		
Curve	3905.027	3905.255	8	300	60	48.03	60		
Curve	3905.255	3905.434	7	350	65	60.13	60		
Curve	3905.574	3905.662	2	1050	95	94.97	60		
Curve	3905.683	3905.741	0	600	65	65.40	60		
Curve	3905.741	3905.870	8	310	60	44.71	60		
Curve	3905.891	3906.165	10	300	65	56.53	60		
Curve	3906.224	3906.540	10	300	65	56.53	60		
Curve	3906.600	3906.841	9	300	65	63.96	60		
Curve	3906.867	3907.037	6	300	55	41.54	60	yes	7
Curve	3907.067	3907.227	4	300	55	54.11	60	yes	7
Curve	3907.351	3907.573	7	300	60	54.89	60		
Curve	3907.606	3907.791	8	300	60	48.03	60		
Curve	3907.798	3908.012	6	300	55	41.54	60	yes	7
Curve	3908.148	3908.446	7	300	60	54.89	60		
Curve	3908.806	3909.006	7	300	60	54.89	60		
Curve	3909.030	3909.174	3	400	60	56.59	60		
Curve	3909.288	3909.421	2	400	55	46.86	60	yes	3
Curve	3909.425	3909.537	3	400	60	56.59	60		
Curve	3909.662	3909.786	3	400	60	56.59	60		

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section 4/4 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	Theoretical Max speed	Cant to be increased	Future cant value
			(cm)	*(m)*	*(km/h)*	*(m)*	*(km/h)*		*(cm)*
Curve	3910.125	3910.258	7	300	60	54.89	60		
Curve	3910.259	3910.374	6	390	65	56.05	60		
Curve	3910.400	3910.519	7	360	65	57.01	60		
Curve	3910.926	3911.265	3	800	85	80.55	70		
Curve	3912.200	3912.398	4	500	70	66.03	70		
Curve	3912.402	3912.580	9	600	90	81.05	70		
Curve	3912.628	3913.135	7	400	70	66.54	70		
Curve	3913.365	3913.715	8	400	70	58.54	70		
Curve	3913.737	3914.041	8	400	70	58.54	70		
Curve	3915.453	3915.610	1	2000	125	125.26	70		
Curve	3917.020	3917.412	7	530	80	74.05	70		
Curve	3917.715	3918.265	9	450	80	80.30	70		
Curve	3917.865	3917.999	10	300	65	56.53	60		
Curve	3918.018	3918.219	7	330	60	45.54	60		
Curve	3918.404	3918.605	7	830	100	92.17	60		
Curve	3918.693	3919.021	9	360	70	64.15	60		
Curve	3919.201	3919.363	8	300	60	48.03	60		
Curve	3919.640	3920.025	6	600	80	67.08	60		
Curve	3920.140	3920.520	10	290	65	61.04	60		
Curve	3920.520	3920.821	10	320			60	yes	
Curve	3920.898	3921.066	6	400	65	53.54	60		
Curve	3921.151	3921.350	11	370	75	68.65	60		
Curve	3921.350	3921.552	9	480	80	70.14	60		
Curve	3921.686	3922.043	7	650	90	88.27	60		
Curve	3922.200	3922.371	1	2000	125	125.26	60		
Curve	3922.497	3922.667	6	450	70	60.92	60		
Curve	3922.734	3923.257	7	460	75	71.06	60		
Curve	3926.302	3926.536	3	700	80	77.09	60		
Curve	3926.678	3926.889	6	400	65	53.54	60		
Curve	3926.916	3927.282	8	250	55	44.82	60	yes	9
Curve	3927.484	3927.600	4	1300	115	114.60	70		
Curve	3927.600	3927.738	6	500	75	69.14	70		
Curve	3928.916	3929.305	6	620	85	83.26	70		
Curve	3929.759	3930.351	7	500	75	60.57	70		
Curve	3930.806	3931.089	17	300	75	55.25	70		
Curve	3931.136	3931.337	3	1000	95	89.94	70		
Curve	3931.464	3931.839	11	300	65	49.10	70	yes	12
Curve	3932.243	3932.469	6	400	65	53.54	70	yes	7
Curve	3932.716	3932.968	4	900	95	92.70	60		
Curve	3933.902	3934.217	8	550	85	81.85	60		
Curve	3934.583	3934.787	9	260	60	57.00	60		
Curve	3934.789	3934.900	3	290	50	44.45	60	yes	5
Curve	3934.900	3935.068	5	600	80	76.23	60		
Curve	3935.331	3935.853	4	1000	100	97.18	60		
Curve	3936.126	3936.411	5	600	80	76.23	60		
Curve	3938.272	3938.583	2	1500	110	101.65	60		
Curve	3941.959	3942.399	3	2000	135	129.50	60		
Curve	3946.662	3947.137	5	600	80	76.23	60		
Balykchi	**3947.175**	**3948.683**							

PW maintenance

Constant operability of tracks, long service of its elements, uninterrupted and safe train transportation with established speeds are ensured by the system of planned-preventive maintenance which includes supervision over permanent way, track formation, its drainage and strengthening devices, structures, their maintenance and different types of repairs.

As mentioned in the previous chapter, for the line under study, even if its geographic and administrative location is in Kyrgyzstan, it has been assumed by this Consultant that the rationale taken from the former Soviet railways rules could be applied with satisfactory approximation.

It has to be pointed out that the line in current status is in category E4 of track, corresponding to the track class 3, while after renewal of permanent way it will be in category E2-E3 of track, corresponding to the same track class 3 but, being the pw replaced with concrete sleepers, the maintenance cycles will pass from a periodicity of 15 years to one of 25 years, therefore reducing maintenance needs.

Table 4.1.1 – 8 Norms of intervals in renovation and major repair works of the track for establishing the necessity of track works in perspective planning
(in brackets – for junction points)

Track class	Combination of group and category of the track	Intervals in track renovation and major repair works, ml tkm/km per year		Diagram of track works in the period between renovations (major repair works) of the track	
		continuous welded rail track with reinforced concrete sleepers	Linked train with timber rails	continuous welded rail track with reinforced concrete sleepers	Linked train with timber rails
1	2	3	4	5	6
1 and 2	A1; A2; A3	1400	1200	ОВПВ (РС)ВПВО {ОВРВ(РС)ВРВО}	ОВПВ (РС)ВПВО {ОВРВ(РС)ВРВО}
	A4	1500	1300	same	same
	A5	1600	1400	same	same
	B1; B2; B3	1400	600	ОВСВ (РС)ВСВО {ОВРВ(РС)ВРВО}	ОВСО {ОВ(РС)РВО}
	B4	1500	650	same	same
	B5	1600[1])	700	same	same
	C1; C2; C3	1400[1])	600[2])	ОВСВ (РС)ВСВО {ОВРВ(РС)ВРВО}	ОВВСВВО {ОВ(РС)РВО}
	D1; D2; E1	Once in 25 years	Once in 15 years	ОВВСВВО {ОВВ(РС)РВВО}	ОВСВО same
3	A6	1200	1000	КВLВ (РС)ВLВК {ОВРВ(РС)ВРВО}	КВLВ (РС)ВLВК {ОВРВ(РС)ВРВО}
	B5; B6	1200	500		
	C4; C5	700[3])	500[2])	КВВ (РС)ВLК {ОВРВ(РС)ВРВО}	КВСLК {ОВ(РС)ВО}
	D3; D4; **E2; E4**	**Once in 25 years**	**Once in 15 years**	**КВВСВLК** {ОВРВ(РС)ВРВО}	КВСLК {ОВ(РС)ВО}
4 including reception and departure	C6	1200[3])	Once in 15 years	КВLВ (РС)ВLВК {ОВРВ(РС)ВРВО}	КВСLК {ОВ(РС)ВО}
	D5; D6; E5; E6	Once in 25 years	Once in 15 years	КВВСВLК {КВВ(РС)ВLК}	КВСLК {КВСLК}
5	A7; B7; C7; D7;E7	Once in 30 years		КВВСВLК {КLРLК}	КLСLК {КLРLК}

Note:

O – superstructure renovation; (PC) – complete rail replacement (metal elements of junction points): in the period between track renovations – with new ones; in the period between major repair works – with used ones), accompanied by medium track repairs (on sections with asbestos ballast instead of medium may be carried out a lifting repair work or systematic warning track level adjustment); K – major track repair works; C – medium track repair; L – lifting track repair; B - systematic warning track level adjustment using the set of machines; medium repair in accordance with the project documentation may be replaced with the reconstruction of ballast prism, which is, as well as medium repair, can be carried out as a separate work.

It is therefore possible to define normative necessity by class of tracks, types and volume of track-works, the amount of new and used materials of permanent way, machines, labour and other resources.

Operations on technical maintenance of track and switches are subdivided into the following maintenance cycles:

1. renewal of a track ("*Capital Maintenance*");
2. thorough repair of a track;
3. reconstruction of a ballast section;
4. mid-life repair of a track ("*Medium Maintenance*");
5. complete replacement of rails and metal parts of switches for new of used ones;
6. lifting track maintenance ("*Lifting Maintenance*");
7. grinding of rails;
8. planned- preventive track alignment with the use of a complex of machines.

Renewal of a track. It is intended for periodic full renewal of rail-sleeper panels.

Renewal of a track and switches should be accompanied by rehabilitation of a ballast section or its purification according to Technical specifications for indicated works, or accompanied by substitution of low-purity ballast of other types.

At the renewal of a track conducted with rehabilitation of a ballast section, it is necessary to carry out packing of railbed slope with liquidation or hardening of ballast stub lines and providing of a steepness of slopes 1:1.5 in conformity with standard typical cross profiles of a track formation.

At renewal of a track the following works are performed: substitution of rail-sleeper grid, repair of drainages, liquidation of heaving places in track formation and increase of bearing capacity of its main platform in places of deformation, adjustment and wadding of track with its placement on a design reference mark in the profile, adjustment of curves in the layout with restoring of design radiuses, standardization of the length of spiral curves and direct insertion curves between curves in conformity with the top speeds of movement established in the section, planning of ballast section, reduction (ct) of edge of track formation planning and purification of ditches, repair of level crossings, cleaning of river-beds and planning of cones of small structures and other works stipulated by the project.

Thorough repair of tracks. It is intended for substitution of permanent way on tracks of class 3-5 (switches –class 4, 5) for more powerful or less worn out ones which is mounted form either completely old materials or from combination of old with new materials including laying of old rails on tracks of class 3at speeds of t passenger trains traffic up to 100 km/h.

Thorough repair of a track is executed in a complex - with full substitution of a track skeleton, and in a separate way - with substitution of rails and fastenings, metal parts of switches, sleepers, skids with clearing or reconstruction of a ballast section.

At thorough repair of a track the same operations are to be performed as at renewal of a track.

Reconstruction of a ballast section. The reconstruction is carried out on the sections where the ballast section exceeded admissible sizes due to over-track raising of a track, and does not ensure availability of roadsides (edges) of width not less than 40 sm, or if further track raising is restricted by limited dimensional distances to structures as well as if change of ballast is necessary due to its insufficient carrying capacity or a heightening of stability of the main basic platform of track formation.

At reconstruction of ballast section clearing of detritus is made into such depth that will enable to mark the profile of the track to the designed one and restore normal sized of a section (prism). The broken stone ballast of weak rock is substituted to the ballast of hard rock. Works can be conducted together with restoration of sand cushion and laying of special coatings on the main platform of track formation. Flattening of slopes of embankment to steepness of 1:1.5, liquidation or hardening of ballast stub lines on them are carried out as well.

Other ancillary works executed under reconstruction of ballast section include: substitution of unsuitable sleepers, bars and fastenings, removal of heavy cards (at timber sleepers), alignment of circular and transition curves in the profile and payout according to the design, repair of level crossings, drainage and supporting structures, clearing of river-bed and medium structures and other ancillary works. If necessary, grinding and welding of rails, entire substitution of metal parts of switches can be carried out.

Medium repair of a track. Improvement of a ballast section by means of entire clearing broken stone ballast on the depth specified or by renewal of a low-purity ballast of other type on sections where it is not required to downgrade the mark of a track.

At medium repair of a track the same ancillary work are carried out as at reconstruction of ballast section.

Lifting track maintenance. It intended to decrease the extent of unbalance of permanent way and non-equal elasticity of under-sleeper basis by substituting worn out elements of permanent way, and partial restoration of draining properties of ballast, entire alignment and wadding of a track.

At lifting track maintenance the following works are carried out: substitution of a low-purity ballast, regulation of clearances in junctions, removal of heavy cards or adjusting shims, substitution of unsuitable sleepers, transferable bars, fastenings, anticreepers, entire lubrication and fixing of bolts, clearing of drainage structures and other works the necessity in which imply from the actual condition of a track.

Grinding of rails. Two types of grinding of rails are carried out: profile at which the head of a rail is grinded along all perimeter; and grinding intended for elimination of a undulating wear and short irregularities of other types on the surface of rails rolling with the purpose of decrease of vibration effects of a rolling stock on a track.

Besides the listed works, other works on track repair, structures as well as repair of industrial plants related with track operation are performed at the expense of repair fund of the railways.

The following works are referred to such operations: complete substitution of bars on switching points; fixing of switches on broken stone ballast or asbestos ballast; welding of rails, scissors crossings, other elements of switches; repair of rails, fastenings, sleepers, transferable and bridge bars; the device of a protection of track and switches from a snow (snow fences, boards, the equipment on blasting and heating of switches, etc.), repair of fixed fences erected along the track for the warning of cattle; thorough repair of level crossings and the equipping them with automation; thorough repair of track formation and its drainage and strengthening devices; structures, structure of industrial bases which carry out mechanization and preparatory works for

renewal and thorough repair of a track; erection of temporary structures related to repair of track, track formation and structures; operations on winter warehousing of detritus and other materials; redeployment of tracks machine stations, re-equipment of coaches for inhabited and cultural-welfare during their thorough repair; the device of soil roads along the track formation transfer of equipment from one to other place of operations.

Inspections for determining the present condition of a track. Includes inspection over the condition of a track and it is carried out continuously during the year including the sections where repair works are being conducted.

Operations are divided into urgent and primary, related with the elimination of dangerous inaccuracies of the track in places of their detection, and planned-preventive works, carried out with application of a complex of machines and mechanisms with the purpose of prevention of the emersion of faultinesses in a track.

According to the collected information, the following table 4.1.1-9 resumes the average quantities of replaced p.w. materials per each maintenance cycle.

Table 4.1.1 – 9 Maintenance cycles materials

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi 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 4.1.1-10 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 in case of "with" and "without the project".

In the second case, maintenance manpower is double than in case of "with project" because the project options 1 and 2 envisage the purchase of machines for maintenance. Costs of maintenance machines has not been considered in the "with project" options because their purchase cost has been already taken into consideration in the Options costs, and their consume and spare parts costs for the first operating years are assumed marginal.

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

Table 4.1.1 – 10 Average cost for 1 km maintenance of the railway line

Rehabilitation works for Lugovaya-Balykchi Line (Border-Balykchi section)			
Cost per km of type of maintenance ($/km)			
	Lifting	Medium	Capital
without project	50,062	122,498	312,846
with project Option 1-2 (*)	45,562	112,498	282,846
with project Option 1 with all materials purchased by Option			45,072
with project Option 1 with only sleepers purchased by Option			148,912

(*) in option 1-2 maintenance is carried out with purchased machines, therefore the manpower (in hours) is 50%

In case of Option 1, as shown in the following chapter, capital maintenance in the first years will be carried out with materials purchased with the Option 1 finance plan, therefore the cost is lower (*see details of maintenance costs in Annex II).*

According to the information collected from Kyrgyz Railways, currently line maintenance is carried out by means of 125 employees for the section from Lugovaya to Bishkek 1 (the Kazakh section is still operated and maintained by Kyrgyz Railways). These employees are so divided:

- 8 sections, each one composed by:
  - 1 master,
  - 2 inspectors (brigadiers),
  - 12/13 workers.

For the section from Bishkek 1 to Balykchi, maintenance workers are 102, so divided:

- 6 sections, each one composed by:
  - 1 master,
  - 2 inspectors (brigadiers),
  - 14 workers.

Consultant has estimated that this personnel can develop about 423,000 hours per year.

This figure has been compared with the estimated manpower hours for each maintenance cycle per km:

- Capital maintenance: 25,000 h/km (12,500 in case of machines),
- Medium maintenance: 10,000 h/km (5,000 in case of machines),
- Lifting maintenance: 5,000 h/km (2,500 in case of machines).

Therefore, the maximum productivity per year can be 17km of Capital, 42km of Medium, 84km of Lifting, or a mix of them.

Anyway, due to the spare parts lack, in the last years only few sections have been maintained, leading to the current poor conditions of the infrastructure and to the mentioned speed restrictions.

4.1.2 Stations

General

The line Bishkek-Balykchi is provided with 17 stations with a distance between 37 (longest section) and 4 km. Their main functions are:

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

The following table 4.1.2-1 resumes the stations position and distances on the Bishkek-Balykchi line.

Table 4.1.2 – 1 Stations on the Kazakh border-Bishkek-Balykchi line

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section Stations					
	Station name	Dimension (number of tracks)	kind of station	centre building chainage	Distance (km)
	Kazak border			3687.280	
					16.042
1	Kaindi	5	medium	3703.322	
					14.920
2	Kara-Balta	7	large plant	3718.242	
					12.666
3	R-141	4	small/petroleum	3730.908	
					9.184
4	Belovodskaja	6	large plant	3740.092	
					15.343
5	Shopokovo	5	medium	3755.435	
					9.777
6	Soklukh	3	small	3765.212	
					10.379
7	Bishkek - I		large plant	3775.591	
					4.471
8	Bishkek - II	5	medium	3780.062	
					3.853
9	Alamedin	7	large plant	3783.915	
					16.654
10	Kant	6	large plant	3800.569	
					18.521
11	Ivanovka	5	medium	3819.090	
					20.478
12	Tokmak	11	large plant	3839.568	
					31.953
13	Bystrovka	5	medium	3871.521	
					12.815
14	Djil-Aryk	6	medium	3884.336	
					15.324
15	R-148	2	small	3899.660	
					37.281
16	Kojamat-Kurkol	3	small	3936.941	
					10.816
17	Balykchi	11	large plant	3947.757	
	end of station			3948.683	0.926

4.1.3 Level Crossings

Along the Kazakh border-Biskek-Balykchi railway section a total of 52 level crossings is present.

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

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

Usually in correspondence of the level crossings there are unpaved tracks and not proper roads. The pavement of the level crossing area is typically made of concrete blocks or rarely of wooden beams.

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

Hereafter is listed the position of each level crossing:

Table 4.1.3-1

Kazakh border-Balykchi line Level Crossings		
1	L.C.	3690.142
2	L.C.	3691.960
3	L.C.	3698.967
4	L.C.	3702.417
5	L.C.	3705.425
6	L.C.	3712.066
7	L.C.	3715.900
8	L.C.	3717.088
9	L.C.	3720.169
10	L.C.	3722.456
11	L.C.	3724.100
12	L.C.	3726.617
13	L.C.	3733.964
14	L.C.	3737.029
15	L.C.	3739.861
16	L.C.	3741.943
17	L.C.	3747.418
18	L.C.	3756.079
19	L.C.	3761.310
20	L.C.	3769.560
21	L.C.	3771.950
22	L.C.	3777.041
23	L.C.	3778.094
24	L.C.	3779.461
25	L.C.	3787.064
26	L.C.	3791.261
27	L.C.	3799.215
28	L.C.	3801.224
29	L.C.	3804.717
30	L.C.	3807.295
31	L.C.	3812.417
32	L.C.	3819.522
33	L.C.	3826.695
34	L.C.	3832.903
35	L.C.	3836.792
36	L.C.	3838.447
37	L.C.	3841.151
38	L.C.	3844.947
39	L.C.	3848.263
40	L.C.	3852.476
41	L.C.	3857.771

42	L.C.	3864.543
43	L.C.	3868.028
44	L.C.	3872.189
45	L.C.	3876.830
46	L.C.	3884.634
47	L.C.	3888.891
48	L.C.	3892.621
49	L.C.	3898.928
50	L.C.	3925.116
51	L.C.	3938.255
52	L.C.	3946.590

4.1.4 Structures and Drainages

Along the entire Lugovaya-Balykchi line there are 3 steel bridges, the longest one between Djil Aryk station and R148 (see Table 4.1.4 – 1 and the photographic record) and 132 concrete bridges (see Table 4.1.4 – 2)

Table 4.1.4 – 1 Steel bridges

Steel bridges		
Span	Length	number
(n)	*(m)*	*(n)*
1	26	1
1	64	1
1	9,8	1

Table 4.1.4 – 2 Concrete bridges

Concrete bridges		
Span	Length	number
(n)	*(m)*	*(n)*
1	2,13	28
2	2,13	1
1	4,27	20
2	4,27	13
1	6,40	8
2	6,40	8
3	4,22	3
3	6,40	1
2	8,53	3
4	4,27	1
3	2,53	1
1	8,53	2
4	2,60	1
1	0,50	2
3	8,53	1
5	6,40	2
1	15,80	1
3	7,90	1
2	9,90	2

1	10,00	1
1	11,00	2
3	15,30	1
2	12,50	1
3	10,00	1
2	10,00	1
2	14,00	1
1	3,00	2
2	5,00	1
1	1,00	4
3	7,30	1
1	2,00	6
1	4,00	6
1	6,00	1
1	7,90	2
1	5,00	1
2	7,90	1
		132

The number of pipe culverts, box culverts and arch culverts is indicated in Table 4.1.4 – 3.

Table 4.1.4 – 3 Culverts

Pipe culverts	
Pipes	number
(n)	*(n)*
1	204
2	28
3	2
>3	2(*)

(*) 5 and 8 pipes

Box culverts	
Boxes	number
(n)	*(n)*
1	24
2	11

Arch culverts	
	number
	(n)
	164

The necessity of rebuilding no more than 30 pipe culverts has been stressed by Kyrgiz officials about all these structures.

4.1.5 Geological and Geotechnical analysis

General geological – geomorphological and hydrogeological setting

The main portion of the railway line, from Lugovaya, in Kazakhstan, to approximately Djil Arik in Kyrgyzstan, corresponding to appoximately the 80 % of the line length, is basically situated on flat areas presenting, however, a general, regional inclination to the north, towards the Chu river.

These areas, extending between the Kyrgyz range, at south and the Chu river, at north, are part of the vast southern extension of the catchment area of this river, tributary of the large Issyk – Kul interior basin.

Geologically said areas are mainly composed of Neogene molasse and Quaternary alluvial fans and alluvial sediments deposited by the numerous mountains rivers discharging from the Kyrgyz range to the north, as tributaries of the Chu river.

The groundwater and acquifers of these Quaternary sediments are recharged both by atmospheric precipitations and by river water infiltration.

Past Djil Arik the railway enters into mountainous areas, following the Chu river valley up to reach Balikchy, at the western edge of the Issik Kul lake.

The valley sides generally present rather steep, rocky slopes mainly formed by the outcropping geological formations of the North Tien Shan mountains. These formations include both sedimentary (sandstones, conglomerates, carbonates) and igneous (effusive and intrusive) pre – Mesozoic rocks. Among the igneous formations rock like basalt, andesite, porphyry, granite, granodiorite and other effusive and intrusive formations are present. Metamorphic rocks are also included in the North Tien Shan pre-Mesozoic series.

Open jointing type ground water systems, mainly fed by atmospheric precipitations, are developed in these rock formations.

Entering into the mountainous area the railway is first located on the right (southern) side of the river, either cut along or at the toe of the valley rocky slopes. The river is then crossed some 35 Km before reaching Balykchi.

The valley bottom, becoming rather large and flat expecially beyond the river crossing, is composed of recent alluvial and slope rock debris sediments.

Issik Kul lake correspons to a large interior basin, located at 1574 m above sea level, with no outlet; basically the water inflows are balanced by evaporation and water uses.

General seismology

Kyrgystan is situated in one of the most seismically active regions of the world.

Historical eartquakes mainly concentrate in the northern Tien Shan, along a narrow belt in the southern Tien Shan, and along the Talas – Fergana strike slip zone.

From 1885 to 1992, up to 25 large erthquakes (magnitude greater than 6) affected Kyrgyzstan and adjoining areas. Twelve of them had magnitudes equal or larger than 7. The last big erthquake occurred in 1992 (Rochnor – Ata, M=6.2). In 1885 a strong eartquake occurred near Bishkek; several landslides were initiated by this earthquake.

In the area of Lake Issyk Kul, almost all the epicentres of strong earthquakes are located to the north of the basin, within a narrow zone extending east-west between the latitudes 75 and 79 North.

According to a map of seismic hazard prepared by the Monitoring and Forecasting Department of the Ministry of Emergency and Civil Defense of Kyrgyzstan, in collaboration with other insitutes and financial assistance from UNDP, shown in fig.4.1.5-1, the project area appears to extend mainly in territories considered of I and II degree of seismic hazard (magnitude M of the Richter scale respectively M□9 and M□8).

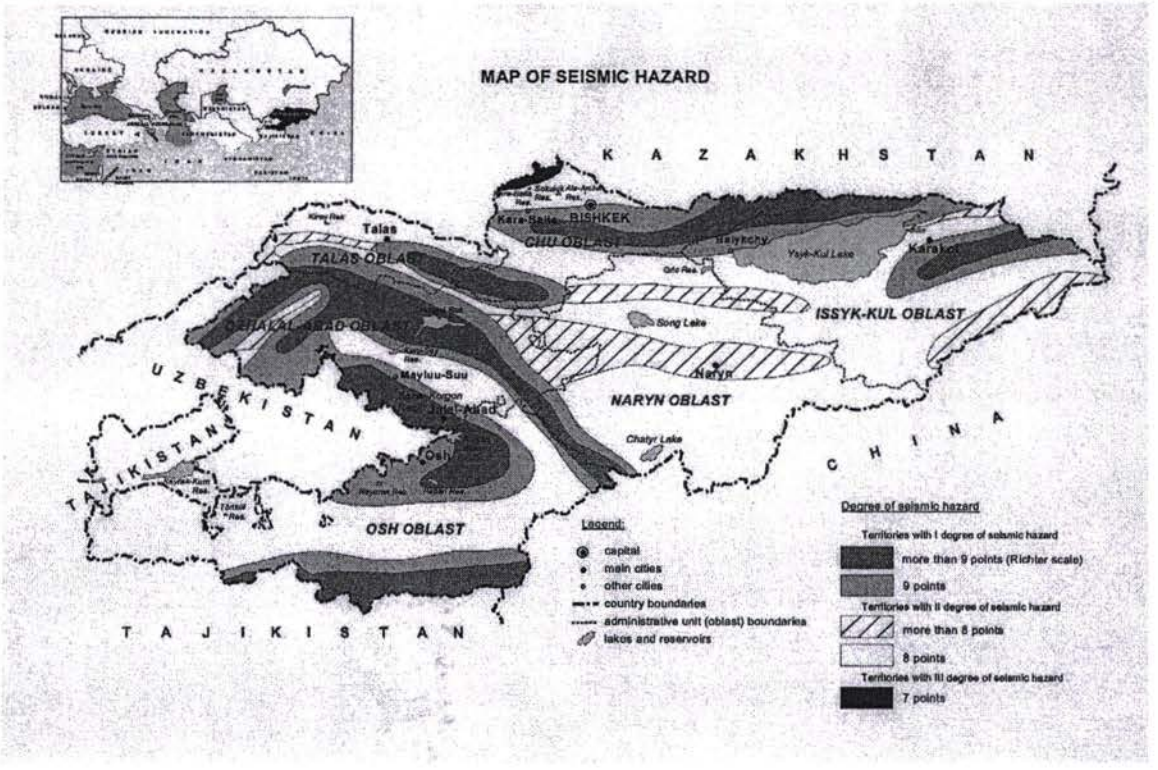


Fig. 4.1.5 -1 Abstract from the Map of the Seismic Hazard of UNECE Enviromental Performance Reviews

Engineering geological and geotechnical conditions of the line

It is noted that the rehabilitation of the railway under consideration does not include any route variation; therefore the engineering geological and geotechnical activity performed during this phase of the study has been limited to a visual inspection of the existing line.

The results of this inspection are summarised here below referring to line sections of general homogeneous conditions.

- Lugovaya – Djil/Arik railway section

  No critical engineering geological conditions for the existing railway have been observed along this portion of the line. However some concern may be related to the effects of potential erosional and scouring activity of the water courses that cross the railway on the stability of the existing bridges foundations. Floods potential of these water courses may also be of concern.

  If required, it is expected that potential source areas for embankment and ballast materials may be found in the Quaternary sediments of the crossed plains.

- Djil/Arik – Kojamat/Kurkol railway section

  East of Djil/Arik the line enters into the mountainous area following the narrow Chu river valley.

  The valley has steep slopes, prevailingly composed of highly jointed and fractured basaltic and other igneous rocks, into which the line cuts often its way.

The dense jointing and fracturing weaken significantly the solidity of the rock mass and, consequently, the stability of the rock cuts; these conditions have , therefore, required the frequent construction of large retaining walls along the existing line.

Considering the above situation it is apparent that the principal engineering geological concern of this part of the line is the high danger of rock falls and rock slides, being this danger even more acute due to the high seismicity of the region. In this area artificial, reinforced concrete tunnels have been built for protection of the existing railway against rock falls.

The river is crossed, as mentioned above, some 35 km before reaching Balykchi, with one span steel bridge supported by concrete piers, founded on rocks outcropping on both river banks.

Past the river the railway remains parallel to the water course, while approaching Kojamat/Kurkol the valley bottom starts widening.

Possible sources of any ballast and embankment materials in this mountainous part of the line may be found exploring either the possibility of rock quarries or the use of the unconsolidated alluvial and colluvial deposits of the valley bottom.

❖ Kojamat/Kurkol – Balykchi line section

The river valley widens considerably before reaching Kojamat/Kurkol up to form a plain past this station.

The flat valley bottom and the plain are composed of Quaternary-Recent river alluvium and colluvium deposits (apparently more or less coarse, poorly rounded gravels are prevailing).

The railway extends on these flat areas parallel and, sometime, very close to the river, probably in the reach of potential floods.

The alluvium and colluvium sediments that form the valley bottom and the plain may provide the source of embankment materials.

Further geotechnical investigations

- During the detailed design phase of the railway rehabilitation project the following further investigations should be carried out : detailed visual survey of the sites for a final assessment of the overall engineering geological situation of the existing line;
- analysis of the geomorphological and hydrological conditions of the water courses crossing the railway to asses the bridges foundationsscouring hazard. The hydrological study of the water courses should also include the prediction of floods possibly dangerous for the line;
- detailed geological and structural survey of the mountain slopes standing above the railway and analysis of their stability conditions, to asses the rocks falls and rocks slides hazard;
- testing of any existing sources of ballast and embankment materials to verify the technical properties of the same materials and to confirm the availability of the required quantities;
- locating, exploring and testing of new potential source areas of said materials, if necessary.

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

In terms of safety and signaling devices, the line includes the following types and a brief description of which we repeat below:

- Stations with the oldest devices (Mechanical Key Dependence Interlocking Installations),
- Stations with electric relay devices,
- Sections with Half Automatic Block Line Systems,
- Sections with Automatic Block Line Systems,
- Automatic Level Crossings with or without half-barriers.

Mechanical Key Dependence Interlocking Installations (MKDI I)

These systems allow station personnel to operate points and signals trough electromechanical devices and are based on a central lock where the keys, collected from points, are imprisoned in order to secure points in the required positions.

Only in such situation the signals can be set to clear. These systems perform a secure connection between signals and points so that itineraries remain interlocked until the train has cleared the section.

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 signal.

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.

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 220 Vdc, 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 storages batteries.

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

Half Automatic Block Line Systems (HABLS)

It is a connection between corresponding stations based upon equipment ability to detect the occupancy of the section between stations equipped with electro-mechanical or electric - relay signaling and safety devices.

The signals can be set to clear only if the section is not occupied.

From a station to the corresponding one only one train at a time can run on a single track line.

Automatic Block Line Systems (ABLS) and Cab signaling

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 traveling 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 neighboring stations and with Level Crossing control systems.

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

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

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

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

The train automatically stops in the following signaling 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

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 signaled on the train dispatcher command and control panel of the ERII in station.

On Kazakh border-Balykchi line the main protection systems for level crossing are both the protection only by road side Saint Andrew crosses and ALC with or without half-barriers.

In the case 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.

In the case the level crossing is located along the line the automated system is fully independent of station signals, as opposed to previous case. 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 Annex IV, Table D.

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

The signalling and safety systems of the line were installed or transformed between 1975 and 1988 and exactly:

Between 1975 and 1984 were gradually installed the devices of:

- Bishkek1,
- Bishkek2,
- Alamedin,
- Kant,
- Post 3848,
- Bistrovka,
- R148,
- Kayamat/Kurkol,
- Balykchi.

In the years from 1983 to 1985 were installed the present devices from Lugovaya to Bishkek, that is the interlockings of:

- Post 3639
- Munke
- Merke
- Kazakh border
- Kaindy
- Karabalta
- R.141
- Belovodskaya
- Shopokovo
- R.3766

and the Neva CTC systems from Lugovaya to Bishkek1 with Central Place in Bishkek1

Finally were installed the devices of:

- Tokmak (1986)
- Djil-Aryk (1988)

The safety system of Lugovaya was renewed in these last years and located in a new building owing to the damages of the previous building for the earthquake of the end of ninety years.

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 has the task of drawing the train graph as well.

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

4.2.2 Overview of the stations and the sidings

Section from Kazakh border (Km 3689) to Bishkek1 (Km 3774+708)

This section is characterized by the presence of:

- all relay interlocking systems in the stations,
- automatic block system in line,
- Centralized Traffic Control from Bishkek 1.

Kaindy (Km 3703+322)

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

It is equipped with an Electric Relay Interlocking which control 12 points.

The distance between the home signal is 1542 meters.

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

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

Karabalta (Km 3718+242)

The station has 8 centralised tracks, of which the second is the through line to Bishkek.

It is equipped with an Electric Relay Interlocking which control 38 points.

The distance between the home signal is 1550 meters.

The system interfaces with Karabalta-R.141 ABLS section which has 6 block sections in such direction.

The interlocking is fed by an uninterruptible power system with diesel generator (power 48 kva).

R.141 (Km 3730+908)

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

It is equipped with an Electric Relay Interlocking which control 8 points.

The distance between the home signal is 1310meters.

The system interfaces with R.141- Belovodskaja ABLS section which has 6 block sections in such direction.

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

Belovodskaja (Km 3740+092)

The station has 6 centralised tracks,of which the second is the through line to Bishkek.

It is equipped with an Electric Relay Interlocking which control 20 points.

The distance between the home signal is 1711 meters.

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

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

Shopokovo (Km 3755+435)

The station has 5 centralised tracks,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 1585 meters.

The system interfaces with Shopokovo-R.3766 ABLS section which has 5 block sections in such direction.

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

R.3766 (Soklukh) (Km 3765+212)

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

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

The distance between the home signal is 1240 meters.

The system interfaces with R.3766 –Bishkek1 ABLS section which has 5 block sections in such direction.

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

Bishkek 1 (Km 3774+708)

The station has about 25 centralised tracks and it is equipped with the bigger Electric Relay Interlocking of the line which controls about 120 point switches.

The distance between the home signal is 3450 meters.

The system interfaces with 2 block section towards Bishkek 2.

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

Section from Bishkek 2 (Km3780+062) to Balykchi (Km3947+226)

This section is characterized by:

- Several key dependent interlockings systems in the stations,
- Half automatic block system in line,
- Absence of CTC.

Bishkek 2 (Km 3780+062)

The station has 5 centralized tracks,of which the second is the through line to Balykchi It is equipped with an Electric Relay Interlocking which control 25 points.

The distance between the home signal is 1911 meters.

The system is connected with Alamedin through one Half Automatic Block section.

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

Alamedin (Km 3783+915)

The station has 16 switch points hand operated and 5 tracks of which the second is the through line to Balykchi.

It is equipped with a Mechanical Key Dependence Interlocking (MKDI).

The distance of the extreme tip of switches is 1104 meters.

The distance between the home signal is 1826 meters.

The system is connected with Kant through one Half Automatic Block section.

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

Kant (Km 3800+569)

The station has 17 switch points hand operated and 6 tracks of which the second is the through line to Balykchi.

It is equipped with a Mechanical Key Dependence Interlocking (MKDI).

The distance of the extreme tip of switches is 1344 meters.

The distance between the home signal is 1725 meters.

The system is connected with Kant through one Half Automatic Block section.

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

Ivanovka (Km 3819+090)

The station has 5 centralised tracks,of which the second is the through line to Balykchi.

It is equipped with an Electric Relay Interlocking which control 10 points.

The distance of the extreme tip of switches is 1014 meters.

The distance between the home signal is 1363 meters.

The system is connected with Tokmak through one Half Automatic Block section.

The interlocking is fed by an uninterruptible power system with diesel generator (power 16 Kva).

Tokmak (Km 3839+568)

The station has 19 switch points hand operated and 4 tracks of which the second is the through line to Balykchi.

It is equipped with a Mechanical Key Dependence Interlocking (MKDI).

The distance of the extreme tip of switches is 755 meters.

The distance between the home signal is 1353 meters.

The system is connected with Bystrovka (or with Post 3848 in the periods on which this post is manned) through one Half Automatic Block section.

The interlocking is fed by an uninterruptible power system with diesel generator (16Kva).

Post 3848 (Km 3848)

It is composed of a switch point in full line which connects with a branch line to a ballast quarry.

Such point is electrically operated by a small interlocking equipment which can't operate crossings.

The system, when manned is connected with Bistrovka through one Half Automatic Block section.

Bystrovka (Km 3871+521)

The station has 5 centralised tracks of which the third is the through line to Balykchi.

It is equipped with an Electric Relay Interlocking which control 14 points.

The distance of the extreme tip of switches is 1167 meters.

The distance between the home signal is 1432 meters.

The system is connected with Djil-Aryk through one Half Automatic Block section.

The interlocking is fed by an uninterruptible power system with diesel generator (power 16 Kva).

Djil-Aryk (Km 3884+336)

The station has 5 centralised tracks of which the third is the through line to Balykchi.

It is equipped with an Electric Relay Interlocking which control 17 points.

The distance of the extreme tip of switches is 1200 meters.

The distance between the home signal is 1574 meters.

The system is connected with R. 148 Post through one Half Automatic Block section.

The interlocking is fed by an uninterruptible power system with diesel generator (power 16 Kva).

R. 148 Post (Km 3899+660)

The station has 2 centralised tracks of which the first is the through line to Balykchi

It is equipped with an Electric Relay Interlocking which control 3 points.

The distance of the extreme tip of switches is 968 meters.

The distance between the home signal is 1196 meters.

The system is connected with Kayamat-Kurkol through one Half Automatic Block section.

The interlocking is fed by an uninterruptible power system with diesel generator (power 16 Kva).

Koyamat-Kurkol (Km 3936+941)

The station has 3 centralised tracks, of which the first is the through line to Balykchi.

It is equipped with an Electric Relay Interlocking which control 3 points.

The distance of the extreme tip of switches is 775meters

The distance between the home signal is 884meters.

The system is connected with Balykchi through one Half Automatic Block section.

The interlocking is fed by an uninterruptible power system with diesel generator (power 16 Kva).

Balykchi (Km 3947+226)

The yard of the station presents a wide terminal.

The station has 23 switch points hand operated and 5 tracks of which the first is the through line from Bishkek.

It is equipped with a Mechanical Key Dependence Interlocking (MKDI).

The distance from the axis of the building of the extreme tip of switches side Bishkek is 288 meters and that of the home signal side Bishkek is 707 meters.

The interlocking is fed by an uninterruptible power system with diesel generator (power of 16 Kva).

A level crossing locally operated is located down from the home signal.

Finally the present main characteristics of the signalling and safety devices are summarised in the Table A of Annex IV referred to the stations and in Table B concerning the 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 Kyrgyz Railways.

Current maintenance is organised in terms of cyclic preventive maintenance and take 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.

The age of the equipment results of more 20 years in the section Lugovaya-Bishkek while the devices of Bishkek-Balykchi section are, on average, more than 25 years old.

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.

In addition, some type of equipment are not suitable for integration with a remote Central Control System able to manage the line in terms of traffic and maintenance.

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.

Finally we have to take on account the increasing difficulty to implement the maintenance of the old key dependent interlocking due to the vanishing of the required skills in the young generations.

4.3 Power supply system

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

4.4 Telecommunications

4.4.1 Description of the present telecommunication situation of the line

The Consultant has recently developed for the European Commission the TACIS/TRACECA project Central Asia Railways Telecommunications (2002-2003). Outputs of that project were the Central Asia Railways Telecommunications and Signalling Master Plan and 8 Feasibility Studies for the modernisation of railways telecommunication systems.

One of these Feasibility Studies (Package 3) was exactly for the railway line Lugovaya - Bishkek - Balikchy. Therefore the rehabilitation of the telecom system of the line, already studied in that previous project, will be not included and assessed in the present study.

In this paragraph only a synthetic description of the present situation of the telecom system is provided, while for more details and for information on the system designed for the line Lugovaya - Bishkek - Balikchy in the framework of the Central Asia Railways Telecommunications Project it has to refer to the mentioned project.

4.4.1.1Description of Line Telecommunication Equipment

The analogue transmission system along the railway line use both buried copper cable and aerial links.

The copper cable is installed on the Lugovaja – Bishkek section and it has the following technical specification:

МКПАБ 7x4x1,05+5x2x0,9 - Magistral Cable with polyethylene cord-sleeve insulation of wires, aluminium sheath, armoured, quad twisted (7 quads), 1,05mm diameter, 5 pairs with 0,9mm diameter.

The steel/bimetal aerial link is present on the section Bishkek - Balykchi and it is of the following technical type: V-12 and V-3.

Line Section	Length (km)	Transmission media *	Type of transmission system	No of channels	Max No of channels
Lugovaya - Bishkek	154	1 x CC	Analogue K-12+12	24	48
Bishkek - Balykchi	168	Aerial link	Analogue V-12, V-3	15	15

,* 1 x CC – One buried Copper Cable

4.4.1.2Description of Station Telecommunication Equipment

All the stations are equipped with manual commutator of stations and line sections telephone service, for operation and maintenance activities.

Telecom switches (analogue PABX) are installed on the following stations:

- Bishkek – ATS-54, analogic, 1200 internal lines, 1972;
- Pishpek – KRZH-204, analogic, 100 internal lines, 1983;

- Tokmak – KRZH-104, analogic, 50 internal lines, 1984;
- Balikchy - KRZH-204, analogic, 100 internal lines, 1983;
- Karabalty - KRZH-204, analogic, 100 internal lines, 1982;
- Belovodskaya - KRZH-104, analogic, 50 internal lines, 1983.

4.5 Operation, speeds and running times

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

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

Line capacity

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

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

- Number of tracks (in this case one);
- Longest section length (longest section in terms of running time, generally the worst mix of length and acclivity); in this case the existing section between the stations of R148 and Kojamat-Kurkol being 37,2 km long;
- Trains speed on this section (in this case 50 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) = 14 trains/day

C (80% crossing trains) = 32 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 Remonta (maintenance).

Consultant permanent way experts, correlated, during a previous study in Uzbekistan (1999 – Rehabilitation of the line Samarkan-Bukhara-Kodjadavlet), the data concerning the rail age per section, with the speed restrictions imposed by UTY on these sections.

The results of this correlation is reported in the following table and shows that, on average, when the rail age is around 700-800 million gross tons, every further 50-60 million gross tons, the line is interested by a further speed restriction of 10 km/h.

Table 4.4 – 1 Speed restriction and rail age correlation

Speed restrictions correlation with rail age		
Rail Age ('000 gross tonnes)	Speed Restriction Class (kph, passengers-freight)	Remarks
466.607	10-0	interpolated
660.870	10-20	"
774.470	30-20	"
855.070	40-30	"
917.590	50-40	"
968.670	60-50	"
1.011.860	70-60	extrapolated
1.049.270	80-70	"

Sources: Consultant's estimates.

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

From the original 100-120 km/h speed for passenger trains and 80 km/h speed for freight trains, the maximum allowed speeds are, for the time being, those shown in Table 4.1.1-6.

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 the Border to Balykchi:

- *Passenger train with few stops: 4h 40' (8 stops with 3' per each stop),*
- *Freight trains with few stops: 5h (8 stops with 5' per each stop).*

These running times have been estimated to increase in 15 years because the additional lack of maintenance over about 250 km of line will imply the additional speed restriction of at least 10 km/h.

Time savings due to rehabilitation works, calculated for different scenarios and time periods 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 50-70 km/h has actually to be faced along all 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 is out of doubt.

The objective of the interventions considered in Options 1, 2 and 3 is not only to improve the original characteristics, but also to obtain higher levels of safety, speed and reliability of the infrastructure, that must be considered as a future transportation axis for all the area.

The options envisaged for the rehabilitation of the Kazak border - Balykchi line are to be considered separately. The Option 1 has been studied to take in due account the economical situation of Kyrgyzstan and of their railways that allows only loan of low amount. After the collapse of the Soviet Union in 1991, the Kyrgyz railways were left without sufficient resources for the maintenance of their network in terms of materials and machinery. The result is a slow degradation of the Kyrgyz railway network. Option 1 attempts to stop this trend and speed up the capital maintenance of their lines, giving the Kyrgyz railways, **at the lowest possible costs**, a minimum of materials, machines and plants, to be purchased directly by themselves, envisaging the execution of works directly with their personnel. A similar solution has been conceived also for the other options, to reduce as much as possible the costs, leaving nevertheless to a Contractor the execution of works.

Moreover 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 costs for each option have been estimated and for each option different rate of maintenance cost reduction have been evaluated (in particular due to the adoption of the long welded rails).

Main envisaged works concern the rehabilitation and replacement of the Permanent Way elements (rails, fastenings, sleepers and ballast), and increasing the bearing capacity of the existing formation and upper part of embankments. **Option 3,** moreover, envisages the replacement of the existing station safety plants with modern, electronic, computer assisted plants, the automatic block from Bishkek 2 to Balykchi, a new CTC.

Other minor works have been envisaged concerning the drainage system, ditches and some replacements of minor structures (culverts), and the protection of embankment from land slides and rock falls (avalanche shed).

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.

5.2 Objectives of the rehabilitation

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

- Lugovaya – Uzbek border (in Kazakhstan) – 60.9 km long and 4 stations.
- Kazak 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:

- Increasing train speed both for freight and for passenger trains. Higher speed along the entire line or some sections will reflect in total travel time reductions (time savings), reflecting in travel cost savings in terms of rolling stock cost and in terms of operation and personnel cost. In fact, not only the time saving will reflect in passenger time cost reduction (extremely low in this area), but it will reflect in rolling stock cost saving, due to the possibility of reducing the train cycle along the whole network to which this line belongs. Hourly costs for the typical passenger and freight trains are calculated, their value is multiplied by the total amount of time saving per travel, by the total number of trains per year, and this will allow to estimate the total yearly cost saving due to travel time reduction.

It is clear that, in order to take advantage of the benefits so created, the line operation must be modified in order to take into consideration the major speeds and therefore line timetable will be modified after the completion of the proposed rehabilitation works.

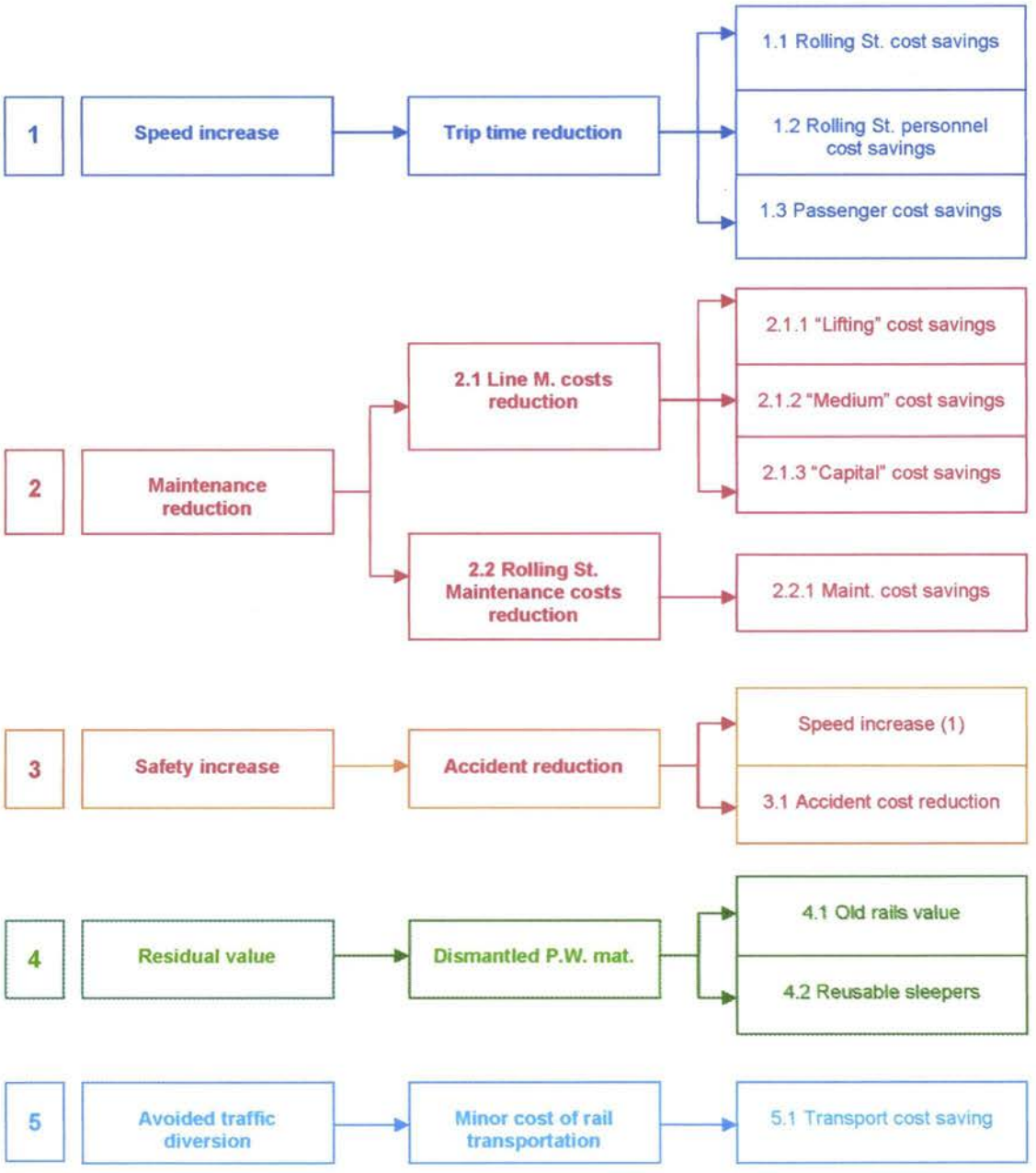
- Reducing infrastructure maintenance needs along the rehabilitated sections of the line, for "lifting", "medium" and "capital" maintenance. In particular, due to the rules currently applied, "capital" maintenance will result highly reduced, this sensitively allowing the reduction of total maintenance 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 most of 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, generally of P50 type, will be dismantled and possibly re-used or directly sold, at the residual value which is depending on the average age and preservation status of this material. In particular rails, iron parts as bolts, fastening devices, will be taken into consideration, while for sleepers, only the reusable ones can be considered for their residual value. Residual value of ballast, sub-ballast where existing and earths will not be considered because their re-use has been already taken into consideration within the works to be carried out on the considered sections.
- Avoided traffic diversion.. Dimensions of this effect will depend on the current status of the road and of the railway, on their service level and on transportation cost. It is possible to assume that rehabilitation works on the railway will help to reduce traffic diversion in the near future when the road construction is completed. Comparison will be made between the two scenarios "with project" and "without project".

Resuming the positive effects of the rehabilitation (benefits):

Rehabilitation works:

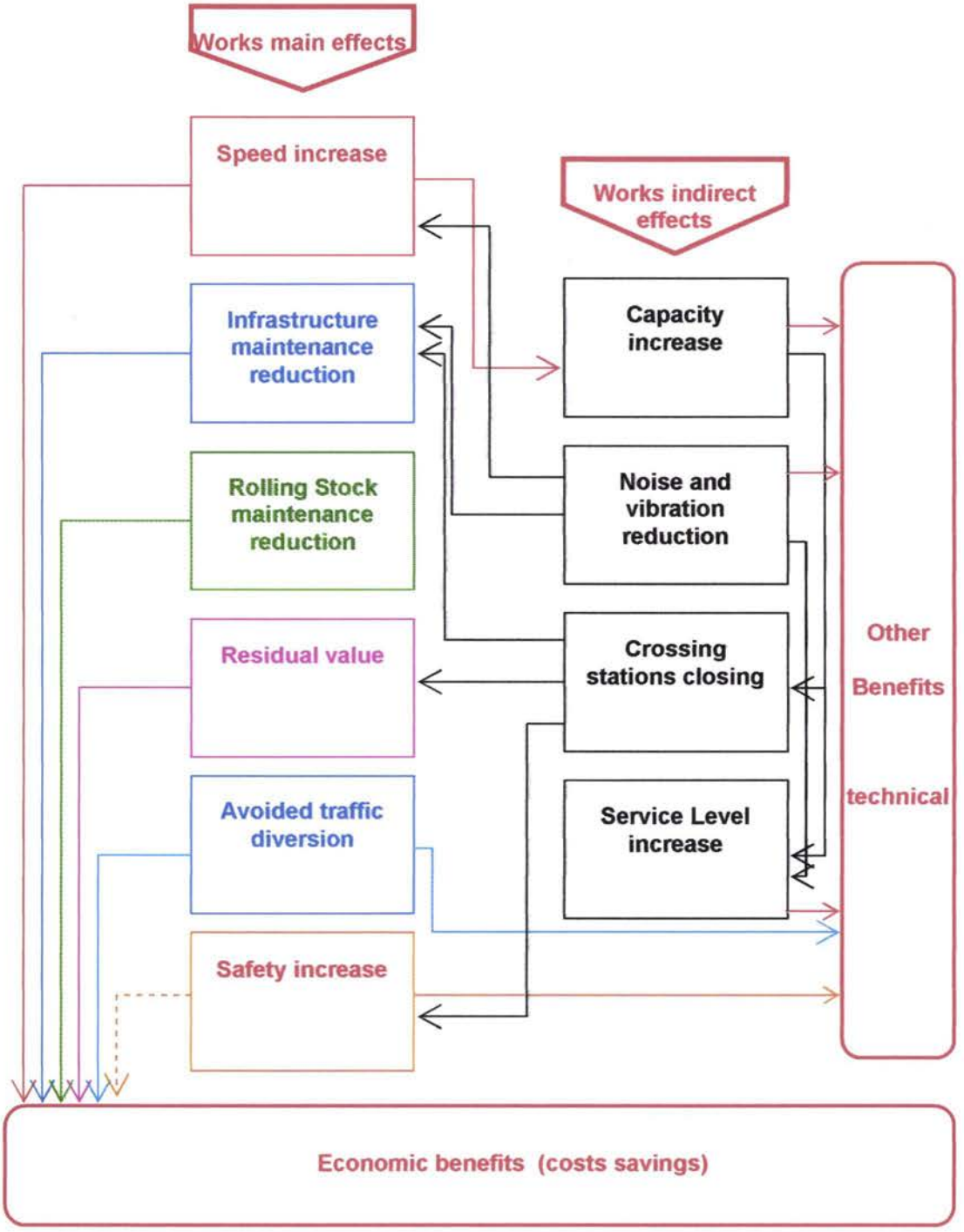
- permanent way replacement earthworks
- drainage devices works
- signaling and telecommunication systems replacement or improvement
- level crossing works
- stations works
- re-alignment works

RESULTS



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

- Line capacity increase. Line capacity is intended as the maximum number of trains per day served by the line and it can vary from about 30 to 90 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 (5.4.2 "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. If these factors can be considered as non sensitive factors in a mainly desert area for their impact on surrounding environment, 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
Economic benefits (costs savings)

Based on the results of the investigations of the technical installations and on several interview of officials and technicians of Kyrgyz Railways, the Consultant verified no need of works to carry out in order to restore operations safety at levels which cannot be renounced (Option 1 and Option 2).

While the **Option 3** aims at

- reducing the cost of traffic control and maintenance of the safety devices presently hand operated i.e. Mechanical Key Dependence Interlocking Installations (MKDI I) and at improving equipment availability.
- extending the traffic control costs reduction to the whole section Bishkek 2 – Balykchi plus an increase of traffic capacity on the base of following considerations:
  - *Kazakh border-Bishkek 1 section is already equipped with Relay Interlocking Installations, Automatic Block and CTC;*
  - *these equipments already allow to save operational costs in such section;*
  - *most of the installations of this section, even if not of new types, were installed in more recent years than those operating on Bishkek2-Balykchi section.*

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 turnouts and replacement of blades and crosses for those to be re-used on siding tracks);
   c. Existing permanent way rail welding and mechanical tension regulation;
   d. Realigning, levelling and ballasting on the existing sections;
   e. Civil works concerning structures (replacement of pipe culverts, construction of avalanche shed);
   f. Civil works concerning re-pavement of some level crossings (L.C.). In terms of level crossings no eliminations has been envisaged for the low traffic both on the railway line and on the interfered roads (mainly unpaved roads).
2. Safety devices:
   a. Renewal of some station interlocking systems;
   b. Renewal of line traffic control and train spacing systems (automatic block on Bishkek 2 Balykchi section);
   c. Remote commanding and controlling 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 – 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 cartografy, and detailed correction of the alignment and profile of the line. New plan profile in scale 1:1,000 and current cross sections of the line in scale 1:200-1:100 step 50 m will be produced, indicating the existing and future geometrical parameters of the line.
2A	Demolition of line.	It consists in dismantling the existing worn out permanent way (rails, junctions, sleepers and fastenings), transportation of the materials to the deposit sites, dividing them into scratch and re-usable materials (residual value). 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.
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 include the further compaction of the top layer of the embankment for increasing hits 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.	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.

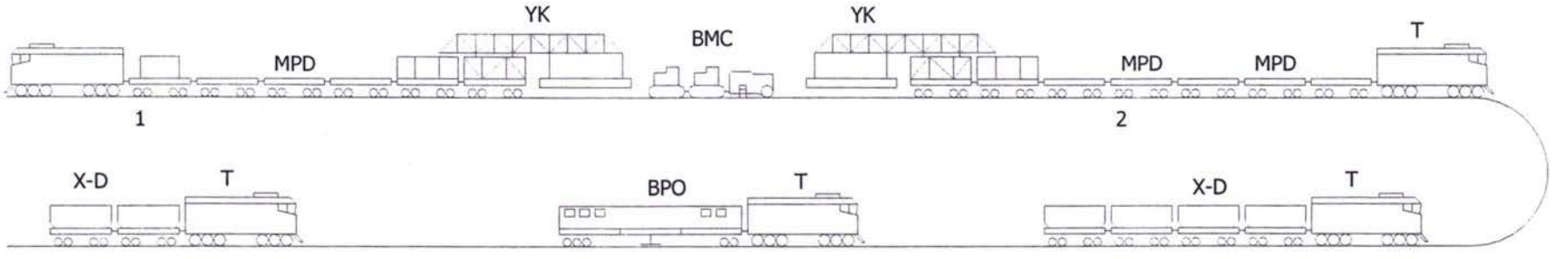
6A	Construction of line.	After the item 5A, the new track will be built (sleepers, fastenings and rails), by laying it on the sub-ballast layer. This procedure will be presumably carried out with the system used in this area, described in detail in the Figure on the next page. This system is based on the use of construction train, similar to the dismantling train, with opposed operations. Tail locomotive of this train will push the front laying crane against the section to be built, and the crane will lay track panels, casted outside of the field, on the sub-ballast layer. Provisional junctions will be installed and the construction train will run on the just installed panels. Construction of the line can also be carried out with other methods, as for example that envisaging the use of long welded rail to be laid on the two sides of the existing permanent way and the transportation of the sleepers only on the construction train. This second method allows to avoid the big number of 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. In the next pages the two envisaged construction methodologies will be described with schematic drawings. The item 6A also includes first layers ballast spreading, tamping and lifting of rails up to 3 cm to final level.
7A	Flash-butt or thermic weld of P65 rail.	Welding of the panels by means of flash-butt or thermic system. Welding of the rails will have to be done according to strict technical specifications, that will be detailed in the next phase of the study.
8A	Regulation of mechanical tension of long welded rails (l.w.r.).	After the rail welding, mechanical tensions will be regulated, according to strict technical specifications, that will be detailed in the next phase of the study.
9A	Final tamping and levelling of new line.	The permanent way, so welded and regulated, will be in this phase taken to hits final level and alignment by means of final tamping and 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.

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

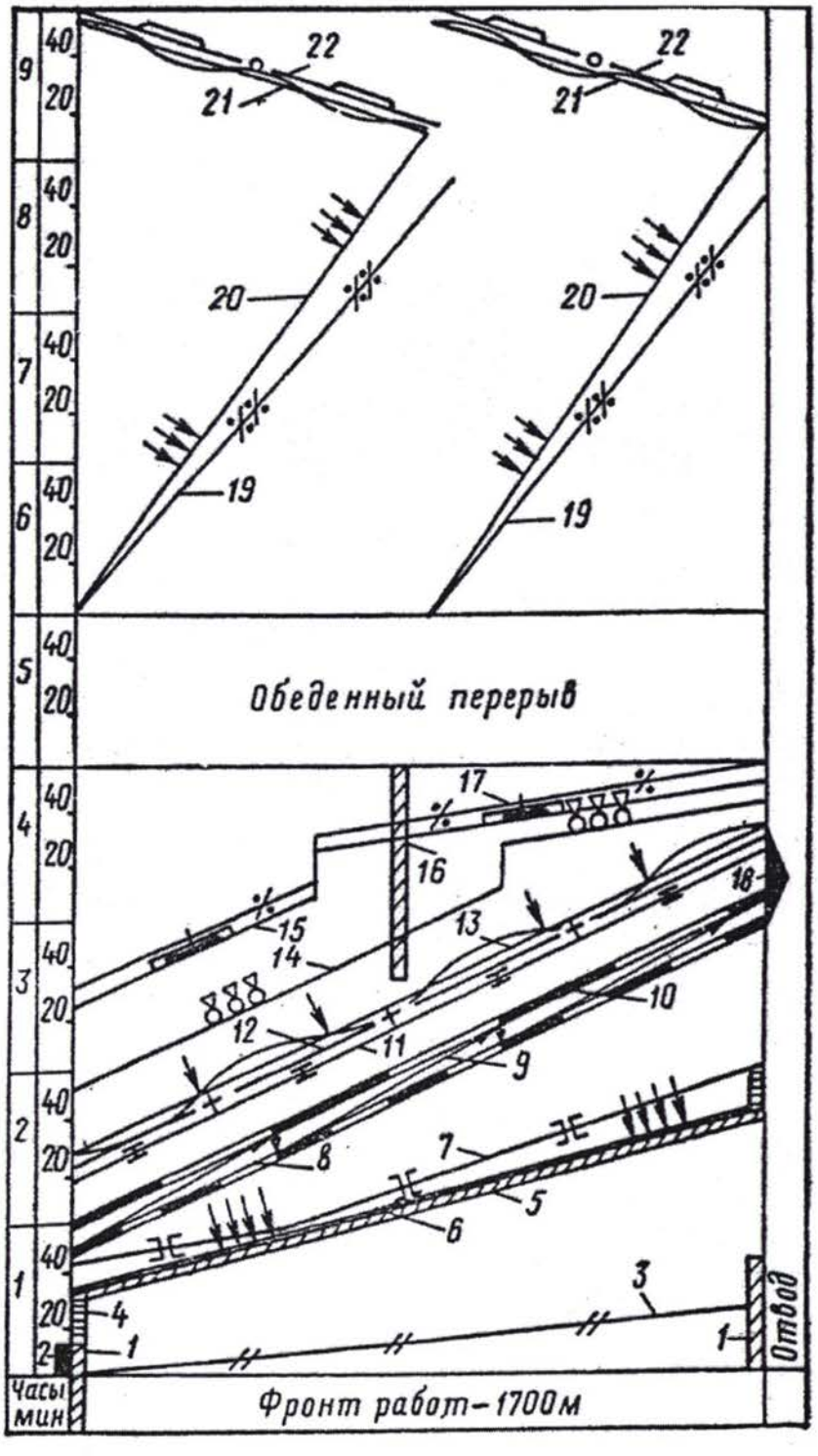
These actions and working times are strictly connected with the methodology adopted by the Railway Administration and are well described by the following time scheme.

Fig. 5.3.1 – 1



1 - dismantling (distributor) train; 2 - packing (laying) train; T - disel locomotive;
MPD - motor platform; YK - laying crane; BMC - balast dearer; XD - hopper-batcher;
BPO - liner-tamper supfaser.

Fig 5.3.1 – 2 Main work schedule in the major repair works on track



1 – preparing for charging and discharging of gravel-cleaning machine; 2 – securing the closure of the route section; 3 – preparing for dismantling; 4 - preparing for charging and discharging of gravel-cleaning machine; 5 – gravel cleaning; 6 – track rectification; 7 – unbolting the rail joints; 8 - dismantling of the track; 9 – gravel ploughing; 10 – track laying; 11 - bolting the rail joints; 12 – installing inventory stop brakes; 13 – setting the track on axle; 14 – gravel unloading; 15 – track rectification with VPO-3000 machine; 16 – equipping electrically-failed joints; 17 and 19 – exit of stop brakes; 18 – exhaust unit; 20 - track rectification; 21 - lining of the track; 22 – prism alignment.

Finally, the following table contains detailed timing of each phase of the works.

Table 5.3.1 – 2 Operational main work schedule in "possession"

N.	Operation name	Planned time	
		Duration (min)	End of operation, Hours and minutes
	The passing of the last scheduled train on station		10.40
	The work of the dismantling train		
1	Arrival to the place of work	15	10.50
2	Positioning in running order	8	10.58
3	Dismantling of first packet (gravel-cleaning machine's work start)	12	11.10
4	Dismantling of second packet	12	11.22
5	Same, third etc	12	11.34
22	Dismantling of twentieth packet	12	14.58
23	Positioning in transport order	12	15.10
24	Departure of dismantling train	5	15.15
	Gravel-cleaning machine's work		
1	Arrival on track	5	11.15
2	Gravel cleaning on the first section extending over 50 m (beginning of track laying)	5	11.20
3	Finishing gravel cleaning	225	15.00
4	Derailment	5	15.05
	Laying train work starts		
1	Following to the place of work	20	11.10
2	Positioning in running order (start of laying)	10	11.20
3	First packet laying	12	11.32
4	Same, second etc	12	11.44
22	Twentieth packet laying	12	15.20
23	Exhaust unit positioning of crane in transport order	10	15.30
24	Departure for station	3	15.33
	Hoppers-dozers work		
1	Following to the place of work of welded structure from 40 hoppers-dozers (start unloading)	15	13.00
2	Ballast unloading during track laying		15.20
3	Unloading after track laying		15.35
4	Departure of welded structure from 40 hoppers-dozers for station		15.40
	The work of VPO-3000 machine		
1	Following to the place of work	15	13.35
2	Charging	5	13.40
3	Machine's work during gravel unloading		15.40
4	The finishing of the measured shovel-packing		15.55
5	Machine discharging and leaving for station	5	16.00
	Hoppers-dozers work		
1	Following to the place of work	15	14.00
2	Ballast unloading		16.15
3	Departure of welded structure from 40 hoppers-dozers for station		16.20
4	Time route section is closed	from 10. 40 until 16.40	

It must be underlined that, while the first two categories of works (Infrastructure and Power Supply) have been treated strictly together for homogeneous results of the works, Safety Devices and Telecommunications have been analyzed as separated items for their being completely independent from the other items in terms of effects on the line operation and on benefits deriving from their application.

5.3.2 Safety devices

As far as concerns safety devices the Consultant has envisaged the possibility of replacement of the existing Mechanical Key Dependence Interlocking Installations in four stations of the Bishkek-Balykchi section with computer aided remote controlled interlockings.

Furthermore, in case of higher investment measures, the Consultant envisaged the installation of new computer aided interlockings in the remaining stations of the Bishkek-Balykchi section and arrangement of the equipment for remote station control, Automatic Block Line Systems (ABLS) and Cab signalling all along Bishkek – Balykchi line section, insertion of same into a new Central Post that must provide traffic and maintenance operations (included peripheral and central devices for remote control).

5.4 OPTION 1

5.4.1 General description

Option 1 represents the proposed low cost option, mainly consisting in provision of PW materials, machines and plants that would permit to face the most urgent necessities of the line, as well as in building the indispensable structures that guarantee the line protection from land-slides. It would allow the acceleration of the capital maintenance of the remaining network putting at disposal recovered rails and machines to implement works with Kyrgyz railways personnel.

The most urgent necessities of Kyrgyz railways were focused and discussed with the top responsible officials in several meetings. They explained that the dramatic situation could be resumed in a few data: a length of 44,6 km of tracks are equipped with P50 rails worn out and to be replaced, as well as 26,6 km of tracks equipped with P43 rails, only 18,6 km are equipped continuously with concrete sleepers and they are obliged to replace the wooden ones here and there to plug a situation that would need the replacement of at least a 50% of wooden sleepers. After the collapse of Soviet Union, they were left without sufficient resources in terms of machines and materials for maintaining their network

5.4.2 Works

Infrastructure

Provision of materials, machines and plants

Taking in due consideration these statements, the Option 1 consist in the provision of the following materials, machines and plants:

- 100.000 reinforced concrete sleepers,
- 140.000 m of P65 rails (9100 T),
- 100.000 complete fastenings for concrete sleepers,
- 4.000 joints (out of them 1500 insulated),

- 40.000 m^3 of ballast to be spread along the line,
- 50 pairs of blades/stock rails and 50 crossings for P65 tg1/11 switches,
- 50 pairs of blades/stock rails and 50 crossings for P50 tg1/11 switches,
- one modern tamping machine,
- one modern profiler machine,
- two gantry cranes and accessories,
- one positioner,
- one removable plant for producing concrete sleepers,
- two excavators equipped with a 1,5 m^3 bucket capacity for the ballast quarry operation.

Note: in order to reduce purchasing costs, the Consultant assumes that all the purchases procedures of machinery, materials and plants are up to the Kyrgyz Railways.

Works

1,000 m of avalanche sheds for line protection against land slides and rock falls danger are to be built in the Boomsk canyon stretch.

Safety devices

Option 1 does not envisage safety devices investments.

5.4.3 Performances improvements

Option 1 has been thought in order to recover original line parameters along the sections with most urgent necessities at the minimum cost (works will be carried out with the purchased machines, directly by the Railway Administration).

Therefore it is estimated that, with the purchased construction materials, Kyrgyz Railways can carry out Capital maintenance over the section between the Border and Bishkek, where currently wooden sleepers and P50 are installed, or in the sections where P65 are installed over wooden sleepers (by re-using the existing P65 rails). These works related to the Capital maintenance will be carried out by means of machines and therefore the capital maintenance manpower has been estimated to be reduced of about 50% (in hours).

In the simulation of the capital maintenance works, this Consultant estimates that within 2012 – 2015 the section will be rehabilitated and therefore, after this period, all the line performances will be recovered (line speed, maintenance conditions, line safety, etc.). This estimate take into consideration the development of about 10-15 km of capital maintenance per year.

After the works are completed, the following performances improvements will be reached:

1. Traffic vibrations and dynamic forces are limited at the minimum values this reflecting 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 need both for line and for rolling stock.

2. Line speed is recovered to hits original values, on the first line section from the border to Bishkek. Line speed after the works will be recovered to the following values:

Table 5.4.3-1 Option 1 speeds after 2018-2020

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "with project" Option 1 speed after 2018-2020		
Chainage	**Section length**	**Speed**
(km)	***(km)***	***(km/h)***
3626	61	110
3687	7	100
3694	78	110
3772	8	90
3780	168	50
3948		

3. Line capacity in terms of trains per day will not be increased by the proposed option, if rehabilitation works are carried out on the border-Bishkek section, because the limiting section is on the Bishkek-Balykchi line. Anyway, for the section between the border and Bishkek, line capacity will be increased from a minimum of 46 to 68 train per day (limiting section is Belovodskaja-Shopokovo – 15.34 km long).
4. Line maintenance costs will be largely reduced for the following main reasons:

a. Capital maintenance costs (the most expensive) in the years of rehabilitation will be covered by the option costs as for the materials. In the following years it will be reduced.
b. Medium maintenance in the years following the rehabilitation will be largely reduced.
c. Lifting maintenance will be reduced.
d. Number of spare parts to be used for each maintenance cycle will be reduced.
e. The new elements composing the infrastructure will be of modern type, so to allow a sensitive reduction of failures during their lifetime.
f. Line category, according to the current norms indicated above, will be increased by the works and therefore maintenance needs will be reduced (every 25 years, instead of 15 years).
g. Wooden sleepers will be replaced by concrete ones, having much longer life and assuring a better loads transfer to the ballast, there helping to reduce ballast friction and pollution.
h. Use of machines purchased by the option, will reduce maintenance costs.

For maintenance needs and costs reduction, see chapter 8.1 "Benefits assessment".

For residual value of the replaced materials, see chapter 8.1 "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 table 4.1.1-6 and in table 5.4.3-1:

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 Kazakh border-Balykchi (*)		
Scenario	***Passenger trains (minutes)***	***Freight trains (minutes)***
2008-2012	***0***	***0***
2012-2022	***30***	***20***
After 2022 (**)	***40***	***50***

(*) For Option 1, after 2012 Capital maintenance will be carried out over 75 km of line, with the same results in terms of operation as Option 2.

(**) After 2022, in the without project scenario, over about 250 km, due to Capital maintenance lack, additional 10km/h speed restrictions will be applied.

5.5 OPTION 2

5.5.1 General description

Option 2 only regards border-Bishkek line section. On this first section the Option 2 foresees the replacement of wooden sleeper with concrete ones, the installation of P65 cwr on the main line, included the stations, new layers of ballast and subballast, tg1/11P65 turnouts on the main lines of stations from the border to Bishkek 2.

Option 2 also includes provision of machines and sleeper plant as well as in building the indispensable structures that guarantee the line protection from land-slides.

Option 2 has been thought in order to be carried out by a Contractor, but, for reducing materials costs, Railway Administration will purchase materials directly.

For the second section, Bishkek 2 – Balykchi, it could increase its importance only when and if it will be connected with China through Kashgar - Torugart new line. For the time being, the construction of this line can not be considered realistic nor in a short neither in a medium term. Another possibility of increasing traffic could be originated by the exploitation of Kara-Keche coal mine, but the investment for building the line for connecting Balykchi to the site seems not rentable. So in this last section only 1000 m of wall protections against land slides / rock falls are foreseen.

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

5.5.2 Works

Infrastructure

The interventions can be summarized as it follows:

- Topographic survey of the Kazak border – Bishkek 2 (km 94),
- From chainage km 3687,28 to km 3699,36 (km 12,08 - P65 rails w/c sleepers),
- from chainage km 3717,960 to km 3729,280 (km 11,3 - P65 rails w/c sleepers),
- from chainage km 3729,280 to km 3783,550 (km 54,27 – P50 rails w/c sleepers):

- demolition of existing P65/P50 rails and wooden/concrete sleepers,(73.1 km)
- recover of P65 rail bars (50420 m) and reusable concrete sleepers,
- excavation of a layer 0,6 m thick of material (209.943 m^3),
- widening, if needed, the top surface of formation,
- laying down a layer 0,2 m thick of sandy gravel material (79.825 m^3),
- installation of reinforced concrete sleepers (141.229),
- installation of P65 rails on the main lines, stations included (95.780 m, about 6225 t),
- laying down a layer 0,3 m thick of ballast (138.670 m^3),
- regulation of mechanical tensions of continuous welded bars (146.2 km),
- formation of continuous welded rails(about 5.080 welds, 1050 normal joints, 256 insulated joints),
- replacement of three P50tg1/11switches with P65tg1/11 ones in Bishkek 2 station,

- construction of 1000 m of avalanche sheds for line protection against land slides and rock falls in the Boomsk canyon stretch,
- demolition of 24 level crossing pavements,
- rebuilding of 24 definitive level crossing pavements (the pavement is generally formed by 24 reinforced concrete blocks),
- final tamping, levelling, aligning, addition of ballast, if needed (73.1 km + 18.6 km),
- provision of a tamping machine, a profiler machine, 2 gantry cranes, accessories and a positioner.
- provision of a plant for reinforced concrete sleepers production.

Note: for reducing the total cost, the Consultant assumes that all the purchases procedures of machinery and plants are up to the Kyrgyz Railways as well as the most expensive materials (rails, sleepers, fastenings).

It is also assumed that the machines will be put at the Contractor disposal for all the period of works and then will be handed over back to Kyrgyz Railways in good conditions and with the original quantities of spare parts. Therefore in contractor costs, machines cost has not been included.

Safety devices

Option 2 does not envisage safety devices investments.

5.5.3 Performances improvements

Option 2, as Option 1, has been thought in order to recover original line parameters along the sections with most urgent necessities at the medium cost and in shorter time (works will be carried out with the purchased machines, by a Contractor).

After the works are completed, the following performances improvements will be reached:

1. Traffic vibrations and dynamic forces are limited at the minimum values this reflecting 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 need both for line and for rolling stock.
2. Line speed is recovered to hits original values, on the first line section from the border to Bishkek. Line speed after the works will be recovered to the following values:

Table 5.5.3-1 Option 2 speeds

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "with project" Option 2 speed		
Chainage	**Section length**	**Speed**
(km)	***(km)***	***(km/h)***
3626	61	110
3687	7	100
3694	78	110
3772	8	90
3780	168	50
3948		

3. Line capacity in terms of trains per day will not be increased by the proposed option, if rehabilitation works are carried out on the border-Bishkek section, because the limiting section is on the Bishkek-Balykchi line. Anyway, for the section between the border and Bishkek, line capacity will be increased from a minimum of 46 to 68 train per day (limiting section is Belovodskaja-Shopokovo – 15.34 km long).
4. Line maintenance costs will be largely reduced for the same reasons expressed in Option 1.

For maintenance needs and costs reduction, see chapter 8.1 "Benefits assessment".

For residual value of the replaced materials, see chapter 8.1 "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 table 4.1.1-6 and in table 5.5.3-1:

The results are shown on Table 5.5.3-2.

Table 5.5.3 – 2 Option 2 Time savings

Rehabilitation of the line Lugovaya-Balykchi - section Kazakh border-Balykchi		
Scenario	***Passenger trains (minutes)***	***Freight trains (minutes)***
2008-2012	***25***	***9***
2012-2022	***30***	***20***
After 2022 (*)	***40***	***50***

(*) After 2022, in the without project scenario, over about 250 km, due to Capital maintenance lack, additional 10km/h speed restrictions will be applied.

5.6 OPTION 3

5.6.1 General description

Option 3 represents the most impacting solution to upgrade all the considered line, that is from Kazak border to Balykchi, if traffic forecast on the last section would greatly increase for some of the above mentioned reasons (see Option 2) or for other ones presently not expected. Besides all the interventions listed in Option 2, Option 3 considers moreover the demolition of the existing PW, cutting and reconstruction of sub-ballast and ballast layers, installation of concrete sleepers and P65 rails, included the main lines of stations, replacement of the existing turnouts with P65tg1/11 type switches on all the Bishkek 2 – Balykchi station main lines, construction of 2,000 m of wall for line protection in Boomsk gorge stretch.

Machines and sleeper plant are not included in Option 3. Contractor will use its own machines for the development of the works.

Option 3 foresees two different alternatives as far as concerns safety devices:,

S.D. Alternative 2: it consists on the replacement of the existing Mechanical Key Dependence Interlocking Installations in four stations of the Bishkek-Balykchi section with computer aided remote controlled interlockings.

S.D. Alternative 3: it consists on the installation of new computer aided interlockings in the remaining stations of the Bishkek-Balykchi section and arrangement of the equipment for remote station control, Automatic Block Line Systems (ABLS) and Cab signalling all along Bishkek – Balykchi line section, insertion of same into a new Central Post that must provide traffic and maintenance operations (included peripheral and central devices for remote control).

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

5.6.2 Works

Infrastructure

The interventions can be summarized as it follows:

- Topographic survey of Kazak border – Bishkek 2 – Balykchi section (km 262),
- demolition of existing P65/P50 rails and wooden/concrete sleepers on the Kazak border – Bishkek 2 – Balykchi section (239.8 km),
- recover of P65 rail bars (50,420 m) and reusable concrete sleepers (concrete sleepers will be completely replaced, while the existing ones – about the 10% of the existing – will be considered as residual value),
- excavation of a layer 0,6 m thick of material (694,039 m^3),
- widening, when needed, the top surface of formation of 1 m on both sides (230,000 m^3 of earth for 50 km),
- laying down a layer 0,2 m thick of sandy gravel material (264,761 m^3),
- installation of reinforced concrete sleepers (448,943),
- installation of P65 rails on the main lines, stations included (429,200 m, about 27,896t),
- laying down a layer 0,3 m thick of ballast (454,219 m^3),
- regulation of mechanical tensions of continuous welded bars (479.6 km),

- formation of continuous welded rails(about 17,679 welds, 2,828 normal joints, 502 insulated joints),
- replacement of 44 P50tg1/11switches with P65tg1/11 ones in Bishkek 2 station,
- construction of 2,000 m of avalanche sheds for line protection against land slides and rock falls in the Boomsk canyon stretch,
- gabions for formation protections from river water action (10,000 m^3),
- demolition of 52 level crossing pavements,
- rebuilding of 52 definitive level crossing pavements (the pavement is generally formed by 24 reinforced concrete blocks),
- final tamping, levelling, aligning, addition of ballast, if needed (239.8 km).

Note: for reducing the total cost, the Consultant assumes that all the purchase procedures of the most expensive materials (rails, sleepers, fastenings, turnouts) will be carried out by the Railway Administration itself. Machines purchase is not included because the Contractor will make use of its own machines.

Safety devices

Option 3 envisages two different alternatives for the safety devices: Alternative 2 and Alternative 3.

Alternative 2

Alternative 2 envisages new computer aided interlockings in:

- Alamedin,
- Kant,
- Tokmak,
- Balykchi.

Outdoor field devices (signals, point machines, track circuits etc) and arrangement of the equipment for remote station control are included.

Alternative 3

Alternative 3 envisages investments of Alternative 2 and in addition:

1) New computer aided interlockings in:

- Bishkek 2,
- Ivanovka,
- Post 3848км,
- Bistrovka,
- Djil-Aryk,
- R. 148,
- Kayamat – Kurkol.

Outdoor field devices (signals, point machines, track circuits etc) and arrangement of the equipment for remote station control are included.

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

- *Bishkek2-Alamedin,*
- *Alamedin-Kant,*
- *Kant-Ivanovka,*
- *Ivanovka-Tokmak,*
- *Tokmak-Post3848km,*
- *Post3848km-Bistrovka,*
- *Bistrovka-Djil/Aryk,*
- *Djil/Aryk-R.148,*
- *R.148-Kayamat/Kurkol,*
- *Kayamat/Kurkol-Balykchi.*

In order to ensure cab signalling and to conform the technology to that one of the section Lugovaya-Bishkek it is foreseen Automatic Block Line Systems (ABLS) which divides the line in block sections (on average of 2000meters) which are controlled by track circuits and protected by side light signals.

3) Insertion of the line Bishkek2-Balykchi into a new Central Post that must provide traffic and maintenance operations (included peripheral and central devices for remote control).

5.6.3 Performances improvements

Option 3 has been thought in order to recover original line parameters along the entire Kyrgyz section in shorter time (works will be carried out by a Contractor with its own machines).

After the works are completed, the following performances improvements will be reached:

1. Traffic vibrations and dynamic forces are limited at the minimum values this reflecting 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 need both for line and for rolling stock.
2. Line speed is recovered to hits original values, for all its length. Line speed after the works will be recovered to the following values:

Table 5.6.3-1 Option 3 speeds

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "with project" Option 3 speed		
Chainage	**Section length**	**Speed**
(km)	***(km)***	***(km/h)***
3626		
	61	110
3687		
	7	100
3694		
	78	110
3772		
	12	90
3784		
	17	110
3801		
	5	90
3806		
	12	110
3818		

	6	90
3824		
	24	110
3848		
	36	90
3884		
	26	60
3910		
	8	70
3918		
	9	60
3927		
	5	70
3932		
	16	60
3948		

3. Line capacity in terms of trains per day will be increased along the whole line by the proposed option. In particular, for the section from the border to Bishkek, line capacity will be increased from a minimum of 46 to 68 train per day (limiting section is Belovodskaja-Shopokovo – 15.34 km long), while for the section from Bishkek to Balykchi, line capacity will increase from a minimum of 14 to 18 trains per day.

4. Line maintenance costs will be largely reduced for the same reasons expressed in Options 1-2, for all the line.

For maintenance needs and costs reduction, see chapter 8.1 "Benefits assessment".

For residual value of the replaced materials, see chapter 8.1 "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 table 4.1.1-6 and in table 5.6.3-1:

The results are shown on Table 5.6.3-2.

Table 5.6.3 – 2 Option 3 Time savings

Rehabilitation of the line Lugovaya-Balykchi - section Kazakh border-Balykchi		
Scenario	***Passenger trains (minutes)***	***Freight trains (minutes)***
2008-2012	***90***	***64***
2012-2022	***100***	***76***
After 2022 (*)	***110***	***100***

(*) After 2022, in the without project scenario, over about 250 km, due to Capital maintenance lack, additional 10km/h speed restrictions will be applied.

Out of these time savings, related to the whole line, the following time savings are related to the two sub-sections.

Time savings Option 3 border-Bishkek		
Scenario	***Passenger trains (minutes)***	***Freight trains (minutes)***
2008-2012	***25***	***9***
2012-2022	***30***	***20***
After 2022 (*)	***40***	***50***
Time savings Option 3 Bishkek-Balykchi		
Scenario	***Passenger trains (minutes)***	***Freight trains (minutes)***
2008-2012	***65***	***55***
2012-2022	***70***	***56***
After 2022 (*)	***70***	***50***

6. Rehabilitation options costs estimates

6.1 Unit costs

For the rehabilitation of the Kazakh border-Bishkek-Balykchi line, a detailed cost analysis has been carried out by this Consultant, with the valuable support of the information received by the Kyrgyz Railways about unit costs. Kyrgyz Railways submitted to this Consultant the detail of the cost estimate for the typical rehabilitation works carried out by the Administration, divided in materials and manpower, and all the additional information about taxes and general costs. Italferr carried out an analysis of these figures aimed at checking their correspondence to the terms of this study and aimed at grouping these costs according to the items envisaged by this Consultant. 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).

In case of Option 1 no Contractor has been envisaged and related costs have not been considered.

In case of Option 2 and 3, part of the purchase materials (rails, sleepers, fastenings, machines and the sleeper factory) have been assumed to be purchased directly by the Railways Administration, in order the Contractor not to charge their costs with the typical additional general costs of a Contractor.

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;
- Traveling 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 legislation of the Republic of Uzbekistan;
- 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 Kyrgyzstan, 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.

When calculating a construction cost, the level of current prices is taken on the basis of:

- wages – average statistical wage of construction workers as per the data of the State Committee on Forecast and Statistics;
- maintenance of machines and mechanisms – as per similar objects or special calculations;
- materials, items, structures, equipment - proceeding from the price level at the local and foreign markets, on the basis of wholesale prices of manufacturing factories, prices at stock exchanges and fairs of building materials, the catalogue of current prices for building materials published by the State Architecture and Construction Committee of the Republic of Uzbekistan (Gosarhitektstroy), data of the regional price formation centers of the State Architecture and Construction Committee of the Republic of Uzbekistan.

It must be pointed out that in the frame of this work, being the machines purchased directly by the Kyrgyz Railways, their use by the Contractor will be regulated by the Contract and their use cost has not been included in the cost estimates.

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 Kyrgyz 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 - Kazakh border-Balykchi section "Main unit costs for materials"				
Material	Unit	Rate ($)	Variation	
Rails	tonne	450.00	+/-20$	Foreign
Concrete sleepers	each	30.00	+/-4$	National
Indirect fastenings	couple	20.00	+/-3$	Foreign
Ballast	m3	6.00	+/-1$	National
Sub-ballast	m3	3.00	+/-1$	National
Avalanche shed in reinforced concrete (windows on side)	m	5,000.00	+/-10%	National
Total turnout small tangent with concrete sleepers	each	52,000.00	+/-10%	Foreign
Turnout crossing	each	4,000.00	+/-15%	Foreign
Turnout blades	pair	15,600.00	+/-15%	Foreign
Rail joint	each	25.00	+/-4$	Foreign
Isulated joint	each	34.00	+/-4$	Foreign
Tamping machine	each	2,883,300.00	+/-3%	Foreign
Profiler	each	1,365,000.00	+/-3%	Foreign
Gantry cranes	couple	735,000.00	+/-3%	Foreign
Excavators equipped with a 1,5 m^3 bucket capacity for the ballast quarry operation.	each	300000.00	+/-7%	Foreign

Sources: KTZ, Italferr

Costs of machines (tamping, profiler, gantry cranes, excavators) have been received by Italferr, after investigating among the biggest international producers firms of these machines. The cost includes all the spares, the additional expenses for wide gauge but not the transportation cost, that will be added in the cost flow table (additional 6%).

6.1.2 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 (Kyrgyzstan).

The following table 6.3.1-2 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 6.1.2 – 1 Average worker cost data

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section *"General data for project cost estimation"*			
Average annual salary of builders in the region counting on 1 month, defined from statistical data for previous 12 months.		109	$/ month
Average monthly fund of working time in hours as of data of the Ministry of Labor and Social Protection of population of Kyrgystan		165	hour
Seniority (15%)		16.35	$/ month
Professional premium (40%)		43.6	$/ month
sub total		168.95	$/ month
Social insurance (25%)		42.2375	$/ month
total		211.1875	$/ month
Net local manpower cost per hour		0.66	$/hour
Total local manpower cost per hour		1.28	$/hour

Table 6.1.2 – 2 Main unit cost for local manpower

Rehabilitation works for Lugovaya - Balykchi Line Kazakh border-Balykchi 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 on both sides	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 for culverts	n	200.00
13A	Excavation of ditches	m	0.50
14A	Pavement of level crossings	unit	100.00
15A	Repainting and adjusting km posts and some hm posts	unit	1.00
16A	Replacing switch crossings	unit	41.72
17A	Replacing switch blades	unit	41.72
18A	Dismantling and installation of new turnouts	unit	283.00

6.1.3 Cost calculation flow

The following Table 6.1.3-1 resumes the main factors for calculation of the total cost amounts.

Table 6.1.3 – 1 Main factors for calculation of total cost amounts

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "General data for project cost estimation"			
Transport expenditures for materials		6	%
Transport expenditures for constructions		6	%
Risk coefficient		1.15	coeff.
Other expenses and cost of contractor		15	%
Other expenses and costs of the client		9	%

In addition 20% taxes will be added.

In case of direct purchase by the Railway Administration, no Contractor costs will be added.

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 15% has been recovered among average values of similar works in Kyrgyzstan.

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 Kyrgyzstan.

The following table resumes the cost calculation flow for all Contractor works and purchases.

Table 6.1.3 – 2 Cost calculation flow

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "Project cost calculation flow"		
Item	**Article of expenses**	**Calculation method**
1	Expenses for construction materials (including 6% for transport)	from the construction materials list
	including: imported materials produced in Kyrgystan	
2	Expenses for salary with account of social insurance charges, seniority and premium (including 6% for movements)	from the work list with addition of social insurance
A	**Total net cost of construction**	**A=1+2**
3	Other expenses and costs of the contractor (profit included)	3=15%A
4	Other expenses and cost of the client	4=9%A
B	**Total cost of construction and contractor and client expenses**	**B=A+3+4**
5	tax 20%	5=20%B
C	**Total cost of construction and contractor and client expenses with taxes**	**C=B+5**
6	Risk coefficient defined on basis of forecasted index of construction price growth for the following year	6=5%C
D	**Total cost of construction in current prices**	**D=C+6**

This cost calculation flow is valid for the case the Constructor is using machines purchased by the Railways, therefore no machines cost has been included (depending on the contract).

In the case (Option 3) the Contractor uses its own machines, the additional machines cost will be added after point 1.

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*). No Contractor expenses have been envisaged.

Table 6.2.1 – 1 Cost analysis for Option 1 for Infrastructure

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "Option 1 cost for materials purchase "		
Item	**Article of expenses**	**Cost ($)**
1	Expenses for construction materials (including 6% for transport)	26,231,608.00
	imported materials	16,437,208.00
	produced in Kyrgystan	9,794,400.00
2	Expenses for salary with account of social insurance charges, seniority and premium (including 6% for movements)	-
A	**Total net cost of purchase**	**26,231,608.000**
3	Other expenses and costs of the contractor (profit included) (15%)	0.000
4	Other expenses and cost of the client (9%)	2,360,844.720
B	**Total cost of purchase and client expenses**	**28,592,452.720**
5	tax 20%	5,718,490.544
C	**Total cost of purchase and client expenses with taxes**	**34,310,943.264**

The estimation of investments costs for Option 1 Infrastructure add to ***34,310,943 $***

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

The following table 6.3.1-1 resumes the result of cost analysis for Option 2 for Infrastructure.

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

As already stated, rails, fastenings, sleepers, turnouts, machines and sleeper factory will be purchased directly by the Railways and therefore have been treated separately (table 6.3.1-2).

20% taxes and risk coefficient are not applied to international manpower.

Table 6.3.1 – 1 Cost analysis for Option 2 for Infrastructure (Contractor)

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "Option 2 cost for infrastructure works excluded main materials purchase"		
Item	**Article of expenses**	**Cost ($)**
1	Expenses for construction materials (including 6% for transport)	7,958,307.01
	imported materials	252,443.24
	produced in Kyrgystan	7,705,863.77
2	Expenses for salary with account of social insurance charges, seniority and premium (including 6% for movements)	1,037,109.51
A	**Total net cost of construction**	**8,995,416.518**
3	Other expenses and costs of the contractor (profit included) (15%)	1,349,312.478
4	Other expenses and cost of the client (9%)	809,587.487
B	**Total cost of construction and contractor and client expenses**	**11,154,316.483**
5	tax 20%	2,230,863.297
C	**Total cost of construction and contractor and client expenses with taxes**	**13,385,179.779**
6	Risk coefficient defined on basis of forecasted index of construction price growth for the following year (5%)	669,258.989
D	**Total cost of construction in current prices**	**14,054,438.768**
E	**International consulting cost**	**1,385,000.00**
F	**Total cost of construction in current prices**	**15,439,438.77**

Table 6.3.1 – 2 Cost analysis for Option 2 for materials purchase (KTZ)

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "Option 2 cost for machines, sleeper factory and materials purchased by the Railway Administration "		
Item	**Article of expenses**	**Cost ($)**
1	Expenses for machines, materials and plant (including 6% for transport)	21,393,264.50
	imported materials	16,902,175.94
	produced in Kyrgystan	4,491,088.56
2	Expenses for salary with account of social insurance charges, seniority and premium (including 6% for movements)	-
A	**Total net cost of purchase**	**21,393,264.500**
3	Other expenses and costs of the contractor (profit included)	0.000
4	Other expenses and cost of the client risk included (7%)	1,497,528.515
B	**Total cost of purchase and client expenses**	**22,890,793.015**
5	tax 20%	4,578,158.603
C	**Total cost of purchase and client expenses with taxes**	**27,468,951.618**

*The estimation of investments costs for Option 2 Infrastructure add to **42,908,390 $***

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

6.3.2 Safety devices costs

Not applicable. Option 2 does not envisage safety devices investments.

6.4 Option 3 costs

6.4.1 Infrastructure costs

The following table 6.4-1 resumes the result of cost analysis for Option 3 for Infrastructure.

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

20% taxes and risk coefficient are not applied to international manpower.

Table 6.4.1 – 1 Cost analysis for Option 3 for Infrastructure works (Contractor)

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "Option 3 cost for infrastructure works excluded main materials purchase "		
Item	**Article of expenses**	**Cost ($)**
1	Expenses for construction materials (including 6% for transport)	20,379,913.32
	imported materials	2,920,249.12
	produced in Kyrgystan	17,459,664.20
	Machines (about 6% of materials)	3,594,354.02
2	Expenses for salary with account of social insurance charges, seniority and premium (including 6% for movements)	3,090,426.00
A	**Total net cost of construction**	**27,064,693.340**
3	Other expenses and costs of the contractor (profit included) (15%)	4,059,704.001
4	Other expenses and cost of the client (9%)	2,435,822.401
B	**Total cost of construction and contractor and client expenses**	**33,560,219.741**
5	tax 20%	6,712,043.948
C	**Total cost of construction and contractor and client expenses with taxes**	**40,272,263.689**
6	Risk coefficient defined on basis of forecasted index of construction price growth for the following year (5%)	2,013,613.184
D	**Total cost of construction in current prices**	**42,285,876.874**
E	**International consulting cost**	**3,413,000.00**
F	**Total cost of construction in current prices**	**45,698,876.87**

Table 6.4.1 – 2 Cost analysis for Option 3 for materials purchase (KTZ)

Rehabilitation works for Lugovaya-Balykchi Line - Kazakh border-Balykchi section "Option 3 cost for materials purchased by the Railway Administration (rails, sleepers, fastenings and turnouts)"		
Item	**Article of expenses**	**Cost ($)**
1	Expenses for materials (including 6% for transport)	39,525,987.02
	imported materials	25,249,598.35
	produced in Kyrgystan	14,276,388.67
2	Expenses for salary with account of social insurance charges, seniority and premium (including 6% for movements)	-
A	**Total net cost of purchase**	**39,525,987.020**
3	Other expenses and costs of the contractor (profit included)	0.000
4	Other expenses and cost of the client risk included (7%)	2,766,819.091
B	**Total cost of purchase and client expenses**	**42,292,806.111**
5	tax 20%	8,458,561.222
C	**Total cost of purchase and client expenses with taxes**	**50,751,367.334**

The estimation of investments costs for Option 2 Infrastructure add to ***96,450,244 $***

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

6.4.2 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. May be the Russian market could offer in this field interesting technical and economical solutions and this Consultant wishes reserve to deep this subject if it is be necessary.

We have taken into account the following investments (see table C1 and C2 Annex IV):

1. Basic investments for alternative 2
2. Basic investments for alternative 3

The cost estimate of basic investments for alternative 2 sums to about 4.239.000$ and that for alternative 3 sums to about 15.199.000$.

Investments costs for both solutions 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 6.4.2 – 1 Cost analysis for Option 3 for materials purchase (KTZ)

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%

Lugovaya-Bishkek-Balykchi section:sharing out of the costs

As a consequence (see annexed table C-Costs Annex IV)

A) for **Alternative 2** we have:

Total cost 4.238.746$ of which:
Supply quote: 3.390.997 $ (80%)
Works quote: 847.749 $ (20%) with
National quote: 434.549 $ (10%)
Foreign quote 3.803.397 $ (90%)

B) for **Alternative 3** we have:

Total cost 15.198.947 $ of which:
Supply quote: 11.821.158 $ (78%)
Works quote: 3.377.789 $ (22%) with
National quote: 2.248.789 $ (15%)
Foreign quote: 12.950.158 $ (85%)

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

6.5 Cost summary

Option 1

- Only material supply for line rehabilitation from the border to Bishkek,
- Sleeper factory supply,
- Machines supply,
- No signalling devices.

34,310,943 $ +/- 15%

Option 2

- Rehabilitation by Contractor of the line section from the border to Bishkek,
- Sleeper factory supply,
- Machines supply,
- No signalling devices.

42,908,390 $ +/- 15%

Option 3 (S.D. Alt. 2)

- Rehabilitation by Contractor of all the line from the border to Balykchi,
- Signalling devices: four station s computerised interlocking.

100,689,244 $ +/-15%.

Option 3 (S.D. Alt. 3)

- Rehabilitation by Contractor of all the line from the border to Balykchi,
- Signalling devices: four station s computerised interlocking.

111,649,244 $ +/-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 of Kyrgyzstan

7.2.1 Structure of management bodies

The decree of the government "On state control statement in the sphere of nature protection and natural resources use" (December, 1992) determined special authorised bodies providing state control in the sphere of environment protection.

They are:

State Committee on Environment Protection (Ministry of Environment Protection);

Ministry of Internal Affairs;

State sanitary and epidemiologic control (Ministry of Health service);

State inspection of land use under the government of the republic;

State forestry inspection under the government of the republic;

- State inspection on control for safety works in industry and mining.

7.2.2 Legislative basis of environment protection

Since 1991 Kyrgyzstan started reconstruction of legislation to provide really executive, market-oriented juridical basis for ecology improvement.

Law "On nature protection" adopted by the Supreme Soviet (April, 17, 1991) established juridical basis for nature protection and guaranteed rational use of natural resources. Legislative branch of Jogorku Kenesh of the Kyrgyz Republic considered 2 law drafts in 1998:

- "On ecological expertise"
- "On environment protection".

7.2.3 International initiatives and cooperation

The first international agreement in the sphere of environment protection, signed and ratified by the Kyrgyz Republic as a subject of international law, was the agreement on cooperation in the sphere of ecology and environment protection of the CIS (June, 1992, Moscow).

This agreement determined the main principles and cooperation sphere among the CIS countries, created International ecological Council and its executive body -Secretariat (Minsk).

The second international agreement, signed and ratified by Kyrgyzstan, was the agreement on joint actions to save the Aral Sea. Permanent executive and instructive body -Executive Committee of International Fund of the Aral Protection was established on the basis of the agreement (March, 20, 1997).

In 1995 Kyrgyzstan together with the World Bank worked out the national action plan on environment protection. To realise this plan Kyrgyzstan joined the Basel convention on transboundary transport control of dangerous wastes and their removal in February, 1996.

In 1996 the Asian Bank of Development rendered technical aid to the Ministry of Environment Protection to develop international possibilities of improving assessment procedure of impact on environment in the sum of 550 thousand US dollars. The government of Finland took a decision to allocate 1.5 million DM for the project of ecological and economic development of biosphere "Issyk-Kul".

One of the largest donor funds of Kyrgyzstan is the Soros-Kyrgyzstan Foundation, which spent 3 thousand US dollars on ecological training and 1.5 thousand US dollars to introduce a certain ecological organisation to the Internet.

7.2.4 Environmental legislation

The development of environmental legislation is characterized by the following general features and trends:

- Framework laws prevail, frequently requiring governmental regulations for their application and enforcement
- The new environmental legislation does not necessarily replace the corresponding legal instruments that had been applied during the former Soviet Union, so that new legal instruments may be added to old instruments that continue to be valid
- The new legislation is strongly influenced by the practices of the former Soviet Union republics
- Legislation develops fast, with most of the basic environmental laws adopted in 1999 often being revisions of laws that had first been adopted in the early 90s.

The laws are comprehensive and cover aspects of environmental protection concerning specific natural objects or activities, including ownership, distribution of mandates among State authorities, necessary procedural rules, and liability requirements. Their provisions are further developed in governmental regulations and ministerial acts.

The general legal framework for comprehensive environmental protection and for the use of natural resources is established by the Law on Environmental Protection. It covers a wide range of issues including environmental standard setting, the legal regime of specially protected areas, rules and procedures for natural resource use, and procedures for dealing with emergencies. Natural

resources can be used in accordance with established limits and environmental standards. Environmental standards include, inter alia, maximum allowable concentrations of pollutants in air, water, soil and subsoil, maximum allowable effluent discharges, emissions and radiation, rules for the use of chemicals in agriculture, maximum allowable concentrations of chemical and biological substances in consumer goods. The Law forbids the use of toxic chemicals that do not decompose, and the import of radioactive wastes and materials for storage, disposal or transit.

Selected environmental legislation

Law on Environmental Protection (1999)
Law on Specially Protected Areas (1994)
Law on Biosphere Territories (1999)
Law on Drinking Water (1999)
Law on the Protection of Ambient Air (1999)
Law on Waters (1994, amended in 1995)
Forest Code (1999)
Land Code (1999)
Law on the Radioactive Safety of the Population (1999)
Law on Ecological Expertise (1999)
Law on Wildlife (1999)
Law on Fisheries (1997, amended in 1998)
Law on the Subsoil (1997, amended in 1999)

7.2.5 Policy objectives and implementing institutions

Objectives

The objectives of environmental policy are stated both in legislative acts and in certain 'soft-law' political documents. In particular, the Law on Environmental Protection gives nature and its components a significant role in sustainable development. The Law on the Radioactive Safety of the Population is aimed at protecting people and the environment against the harmful effects of radiation.

The overall objectives of environmental policy are determined in the Strategy for Sustainable Human Development. The Strategy was approved by Presidential Decree in 1996. It targets a national economic growth that is accompanied by a minimum impact on the environment.

Following the Decree, "The Ecological Safety Concept" was prepared. –It is a soft-law document by the Ministry of Environmental Protection that sees sustainable development as a prerequisite for the ecological safety of the nation. In particular, it recognizes that the depletion and pollution of natural resources lead to economic recession in the long term, that a fall in economic activity leads to poverty, and that poverty leads to still greater demands on natural resources. The State policy should therefore be aimed at breaking this vicious circle by ensuring environmental protection and the long-term rational use of natural resources during the promotion of economic activities.

The immediate objectives of environmental policy were set out in the National Environmental Action Plan (NEAP), which was adopted in 1995 for the 1995-97 period. Just how far it has been implemented has not been checked, but it remains a guiding political document, as its objectives

demonstrate a long-term perspective. According to the NEAP, Kyrgyzstan's overriding objectives are to ensure sustained economic growth and to reduce poverty. Environmental protection is viewed as both a tool and a condition for achieving the broad goals. The NEAP was prepared with a grant from the World Bank and is administered by a special office created within the structure of the Ministry of Environmental Protection.

The environmental protection objectives specified in the NEAP include an increase in the efficiency of the use of renewable and non-renewable natural resources as well as ensuring sound public health. The following main actions are planned to achieve these objectives:

- To channel investments into the water and sanitation infrastructure and to support rural natural-resource-based enterprises. These actions are taken with a view to achieving socio-economic development and conserving natural resources at the same time.
- To establish and maintain an efficient system of information about the state of the environment, the impacts of economic activities on the environment and public health, as well as the sources of these impacts.
- To raise the efficiency of administrative activities during the current economic, social and political reform.

Priorities

According to the NEAP, the Ecological Safety Concept and the Strategy for Sustainable Human Development, the following priority objectives were identified for environmental protection:

- Reducing urban air pollution
- Using water resources efficiently and economically, and improving waste-water treatment
- Protecting arable lands against degradation
- Establishing a system of sustainable use of plant resources, including forests
- Updating the Red Data Books
- Expanding the system of specially protected areas and of biosphere reserves
- Rehabilitating radioactive dumpsites and ensuring their safe operation
- Controlling the production, treatment, transport and disposal of toxic wastes
- Registering harmful substances
- Improving the environmental monitoring system.

7.2.6 Environmental impact assessment

General

For the purpose of preventing the negative impacts of economic and other activities on the environment, a two-stage procedure for decision-making is established. It applies to specified activities that in general can be expected to carry environmental risks. Such activities may be carried out only after

- conducting an environmental impact assessment (EIA), and
- obtaining a positive ecological expertise (EE) report on the project.

EIA requirements are established by the 1997 Regulation of the Ministry of Environmental Protection on Procedures of EIA and the Law on Ecological Expertise. EE is regulated on a piecemeal basis by several acts (like the Laws on Wildlife, on Waters, the Forest Code and others) and comprehensively by the Law on Ecological Expertise adopted in 1999.

EIA procedure

The list of activities and projects that are subject to EIA includes 23 types. Among them are energy facilities, including heating and hydroelectric power stations, oil and gas pipelines, oil and gas storage sites; water reservoirs; oil and gas processing facilities; building materials facilities; forestry and agriculture projects, including agricultural development projects, land allocation projects, water management projects for agricultural purposes, poultry and cattle-breeding farm and land improvement projects, afforestation and logging projects; industrial projects, including mining and quarrying, metal processing, chemical and textile factories, food-processing plant; highways and railroads, airports and ports; storage facilities for toxic, dangerous and radioactive substances, communal and industrial wastes, and some other activities.

EIA aims to determine the impacts on the environment of the project and to decide on its feasibility. EIA is to be conducted by the project developer. For the purpose of conducting EIA, experts are hired. EIA is conducted in 5 stages:

- Submission of the Declaration of Intent regarding the project to the local administration for approval
- Determination of the impacts on the environment
- Assessment of the expected impacts
- Updating of the project
- Preparation of the Statement on Impacts.

The first stage is particularly important, as at that point an interim administrative decision concerning the feasibility of the project is made by the local government concerned. The rules do not clarify whether a possible negative decision blocks the further progress of the project. It envisages only that if the proposed activity is rejected, the developer is entitled to apply to other local governments. In preparing this documentation the investor may be assisted by external, licensed experts. The Ministry of Architecture and Construction is responsible for the licensing of these experts. The documentation must include:

- A protocol of agreement signed by the investor and the mayor of the municipality where the project is to be located
- An assessment of possible impacts on the environment during construction
- A study of the possible impacts and consequences of the investment's activities on the environment.

While conducting the EIA, the project developer has to meet a number of obligations. Information concerning both the short-term and long-term impacts of the activity on the natural objects in the area is to be collected and analysed. A forecast of cumulative environmental impacts has to be provided. The social and economic impacts of the project have to be analysed, together with alternatives. Public hearings have to be organized. The public and NGOs are invited to take part in the EIA process as well as in the post-construction analysis. Their participation is governed by the Law on Ecological Expertise, which came into force in May 1999.

The Statement of Impacts should contain a summary of the results of the assessment. It should be made available to all interested persons and governmental bodies, and submitted as a package with other technical documentation for EE.

Ecological expertise

EE is the tool for preparing the final governmental decision on the authorization of the project. The Law on Ecological Expertise provides for a separate list of activities for which EE is mandatory. It is

not as specific as that for EIA, although it appears to encompass not only every activity subject to EIA, but goes further. For instance, projects for regulatory acts, social and economic programmes or plans for the social and economic development of the country and its regions, projects for international programmes and agreements, technical documentation for new technologies, materials and substances, goods and services, are all subject to EE. It covers also activities requiring governmental licences and permits.

EE has a formally different objective then EIA. EE checks whether the project complies with environmental legal requirements - whereas EIA aims to assess its impacts. However, some overlap is unavoidable, as certain assessments are needed to prepare the final decision on the project.

EE is an entirely administrative procedure. However, the administrative expenses connected with it are to be covered by the project developer. EE is arranged, conducted and administered by the Ministry of Environmental Protection. Since it has the right to adopt a report with either a negative or positive decision that overrides any previous decision, the Ministry has the power to control practically all activities in the country that are subject to EE.

Procedurally, EE is conducted after the project developer has submitted all documentation, including the impact statement resulting from EIA, to the Ministry of Environmental Protection. The Ministry convenes a group of experts on an ad hoc basis for each project. The group is responsible for preparing a final report including a draft decision. The group of experts consists of staff of the Ministry and other experts representing science and organizations competent in the area of environmental protection that is under investigation. It is not clear whether staff of other ministries with some environmental competence, but whose interests are primarily economic, can be members of the group. It is only clearly stated that the representatives of the project itself cannot be included in the group of experts.

EE is to be completed within three months after submission of all necessary project documentation. The report prepared by the experts can suggest either a positive or a negative decision. If the final decision is negative, the project cannot go ahead. Funding, lending, investing for the project can be effected only if the decision is positive. If negative, the developer may introduce changes in the project. This updated project is subject to another EE. The report enters into force after being signed by the Minister of Environmental Protection.

7.2.7 Regulatory instruments for environmental protection

Licensing and environmental impact assessment (EIA)

The Law on Environmental Protection was first adopted in April 1991. Its currently valid version follows the revision of 1999. The Law defines the procedures for ecological appraisal and contains specific articles on "licences for the use of natural resources". The following activities related to the environment are licensed: the prospecting and exploitation of mineral resources, the withdrawal of surface and groundwater for irrigation, fishing and hunting. Some activities are licensed but are reserved exclusively for special State enterprises (such as logging, which is licensed exclusively to the State forestry farms).

The Ministry of Environmental Protection is required to prepare an environmental assessment of contracts and agreements related to the use of natural resources. It also assesses the materials presented for a licence application when the licence is to be issued by a State agency (e.g. for prospecting for mineral resources, the withdrawal of water for irrigation, hunting and forestry). Licence fees are paid into the State budget.

The environmental impact assessment regulation of 1997 incorporates the environmental impact assessment principles and procedures. For almost all new investments a set of documents must be prepared and submitted by the developer when applying for a building permit. In the case of large-scale investment projects (23 main types have been identified in the law), the documentation is submitted to the Department of Ecological Expertise at the Ministry of Environmental Protection. See Chapter 1 for a brief description.

For small investments, the investor normally submits a declaration on pollution, which is subject to ecological expertise at oblast level. Post-project analysis and construction control are also carried out. They include:

- An assessment of the consequences and a comparison with the originally assumed circumstances
- Data monitoring and evaluation

Permits and related procedures

The system for issuing permits is not unified. Permits are issued separately for:

- Water abstraction and water use
- Emissions from stationary sources
- Waste generation and management
- Waste-water discharges
- Use of natural resources

The Environmental Inspectorate evaluates the request for a permit – except regarding water abstraction, which is administered by the Ministry of Agriculture and Water Resources. If a positive opinion is given, the regional departments of the Ministry of Environmental Protection issue the permit. Generally, a permit is valid for five years. All the conditions related to emissions – locations, emission thresholds and duration – are specified in each permit. The permit conditions are monitored and enforced by inspectors.

The limits on the use of natural resources are established by the competent State agency after consultation with the Ministry of Environmental Protection. For example, logging takes place in accordance with the resolution of the State Agency for Forestry. The actual volume and methods of cutting are specified in the licences granted to the State forestry farms. Limits on mining are defined by the State Agency for Geology and Mineral Resources.

Data related to emission limits for water, air and waste disposal are recorded in one single document called the "ecological passport". Violating the conditions laid down in this permit, i.e. violating the methods or the volume of use of natural resources (harvesting, fishing and hunting more, or deviating from harvesting, fishing or hunting rules), or exceeding the emission limits leads to fines.

Environmental inspection

In theory, the national environmental inspectorate inspects enterprises one to three times a year, depending on the degree of hazard associated with the inspected activity. In practice, inspections are less frequent for lack of manpower and technical resources. In general, inspections aim at controlling the conformity of the activity with the granted permit, as well as the emission or discharge information provided by the enterprise.

It is reported that companies report correctly and respect the MAEs in more than 80 per cent of the cases, errors being mostly due to misunderstanding of the methodology to be followed or its implementation. However, there is no table of correlation between the results of the inspection and the values reported by the enterprises. In case of infringement or non-compliance, penalties can be applied to the company manager, or to the company.

Trade and environment

Kyrgyzstan is a member of several international financial and economic institutions including the International Monetary Fund (IMF) (it was the first former Soviet republic to accede to IMF), the World Bank, the European Bank for Reconstruction and Development (EBRD), the Asian Development Bank (it accepted Kyrgyzstan as its 55th member in 1994) and, most notably, in December 1998, Kyrgyzstan became the first newly independent State to join the World Trade Organization (WTO).

So far, the free-trade regime has not aroused the interest of the industrial sector with regard to improving the industry's environmental efficiency or changing pollution patterns. It is hoped that trade liberalization will facilitate access to environmentally friendly technologies and improve the distribution of environmentally friendly products (e.g. by developing eco-labels, environmental management schemes or other instruments).

7.3 Description of the environment

7.3.1 Geography and natural ecological environment

The Kyrgyz Republic (Kyrgyzstan) is a continental country, located in the north-east of Central Asia. In the north Kyrgyzstan borders on Kazakhstan, in the south-east and east on China. In the south-west where the Tien-Shan joins the Pamiro-Altai mountain shaft, it borders on Tadjikistan, and in the west on Uzbekistan.

The Tien-Shan ridge predominates in Kyrgyzstan. It divides the country into two zones: the northern part, including the Talas, Chui and Issyk-Kul oblasts and Bishkek, and the southern part, including the Djalal-Abad, Naryn and Osh oblasts.

The area of Kyrgyzstan is 199,9 thousand km2 4,2% of this area is occupied by forests; 4,4% - by water; 53,5% - by cultivated lands.

The country is extremely mountainous, 94% of its territory is located 1000m above the sea level, 40% of which is over 3000 m. above the sea level with large glaciers and eternal snow.

Average altitude of the Kyrgyz territory is 2750 m. above the sea level. The highest point is Peak Pobeda (7439 m), the lowest is 350 m. above sea level (in the south-west of the republic). The area occupied by the republic is very seismic, with frequent earthquakes and sill floods.

Ecological situation

In Kyrgyzstan, the high mountain ecological systems are especially vulnerable to natural and anthropogenic influence. Of a total area of 199.9 thousand km^2 no more than 30% are suitable for constant residing, due to climatic condition. Only about 20% belongs to a zone with comfortable and rather comfortable conditions, where an absolute majority of the population lives. Practically, the whole anthropogenic load is on these territories. This circumstance has seriously worsened the ecological state of the republic. In a number of regions the indicators show that the environment is

in crisis, with a situation that is becoming irreversible. This unfavourable ecological state is aggravated by economic problems, forcing the population to inefficient use of natural resources (cutting down woods, poaching, extensive use of arable grounds, neglect by melioration and other measures). This results, by a principle of a closed circle, in much greater deterioration of the state of the ecology. At the same time, unique landscapes, clean waters and air have in certain areas been kept almost untouched by anthropogenic activity. This has an economic value along with other benefits, and represents a special good of international importance, the value of which will grow with time.

Landlocked Kyrgyzstan is slightly larger than Austria and Hungary put together. It borders Kazakstan in the north, China in the east, Tajikistan in the south and Uzbekistan in the west. Nearly 95% of the country is mountainous: almost half of it at an elevation of over 3000m (9840ft) and three-quarters of it under permanent snow and glaciers. The dominant feature is the Tian Shan range in the south-east. Its crest, the dramatic Kakshaal-Too range, forms a stunning natural border with China, culminating at Pik Pobedy (7439m/24,400ft), Kyrgyzstan's highest point. The southern border with Tajikistan lies along the Pamir Alay Range. Lake Issyk-Kul, almost 700m (2300ft) deep, lies in a vast indentation on the fringes of the Tian Shan in eastern Kyrgyzstan.

Though environmental pressures are as bad in Central Asia as anywhere, there's a reasonably good chance of seeing memorable beasts and plants, especially since *Cannabis indica* grows thick and wild by the roadsides. The mountains of Kyrgyzstan are the setting for high, grassy meadows - it's not unheard of to look out a train or bus window on the open steppe and see a rushing herd of antelope. Marmots and pikas are preyed upon by eagles and lammergeiers while the elusive snow leopard hunts the ibex amongst the crags and rocky slopes. Forests of Tian Shan spruce, larch and juniper provide cover for lynx, wolf, wild boar and brown bear. In summer, the wildflowers are a riot of colour.

The climate of this mountainous region is influenced by its distance from the sea and the sharp change of elevation from neighbouring plains. Conditions vary from permanent snow in high-altitude cold deserts to hot deserts in the lowlands. From the end of June through mid-August most afternoons reach 32°C (90°F) or higher, with an average annual maximum of 40°C (104°F). During the winter months, temperatures remain below freezing for about 40 days. The coldest month is January when winds blow in from Siberia.

Landscape

Kyrgyzstan is dominated by the dramatic mountain systems of the Tien Shan and the Pamirs. These rise up to 7439m and make up approximately 90% of the country's area. In the south, they are covered by walnut forests and in the north, by junipers.

The landscape is characterised by alpine lakes and glaciers which give rise to fast flowing rivers. These are associated with four non-draining Central Asian basins; the Aral, Tarim, Issyk-Kul and Balkhash basins. Overall, the annual flow of these rivers represents about 50,000m^3.

The borders to the north and west open out into treeless steppe which stretches over 2,000km to Eastern Europe.

Fauna and Flora

The Tien Shan Mountains is the mostly westerly area where the snow leopard still lives and hunts in the high mountains.

The white clawed bear is unique to the Tien Shan Mountains and can be seen in the late summer eating wild apples, pears and walnuts before hibernating for the winter.

Many garden plants originate from this region and over 60 different species of tulip are found in Kyrgyzstan which flower from early spring at lower altitudes to late summer in alpine meadows.

Where the landscape opens out into the steppe many different birds of prey may be observed, including vultures and kites. This has resulted in the traditional development of falconry, which includes the spectacular use of golden eagles by local hunters.

The landscape and wildlife are under threat from illegal hunting and unsustainable use of biological resources.

Environmental Problems

Kyrgyzstan has been spared many of the enormous environmental problems faced by its Central Asian neighbors, primarily because its designated roles in the Soviet system involved neither heavy industry nor large-scale cotton production. Also, the economic downturn of the early 1990s reduced some of the more serious effects of industrial and agricultural policy. Nevertheless, Kyrgyzstan has serious problems because of inefficient use and pollution of water resources, land degradation, and improper agricultural practices.

Land Resources

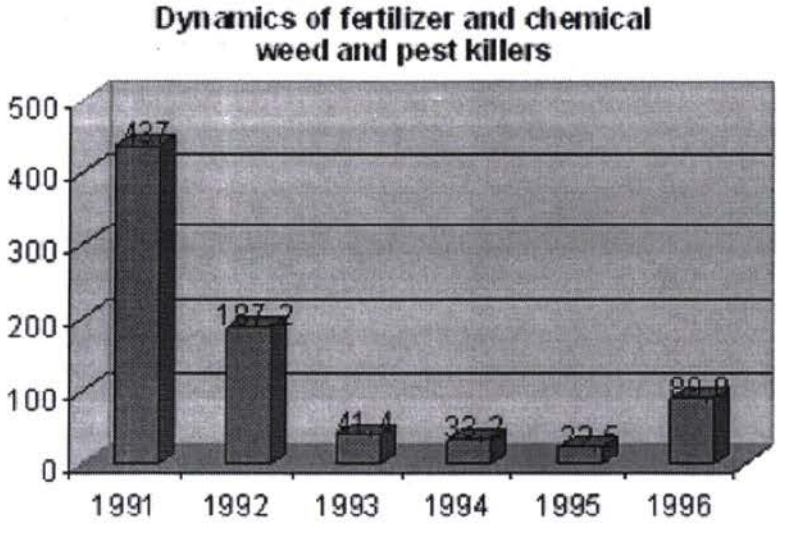
The factors of impact on soil cover are cattle grazing and agriculture. Urbanisation of territories, construction of transport systems, hydro-engineering structures and mining enterprises completely destroy a soil cover. The deterioration of a state of used land resources occurs also owing to erosion and salinisation of soil irrigated by a wrong way.

There are all kinds of soil erosions on the territory of the republic: pasture, wind, water, irrigation surface, and ravine erosion.

Decrease of the main humus fertility index is going on due to erosion removal and absence of necessary doses of organic fertilisers. Removal of humus by plants from arable horizon has made up from 20 up to 45%, and its content does not exceed 2.5%. In these conditions the productivity of agricultural plants directly depends on amount of brought mineral fertilisers.

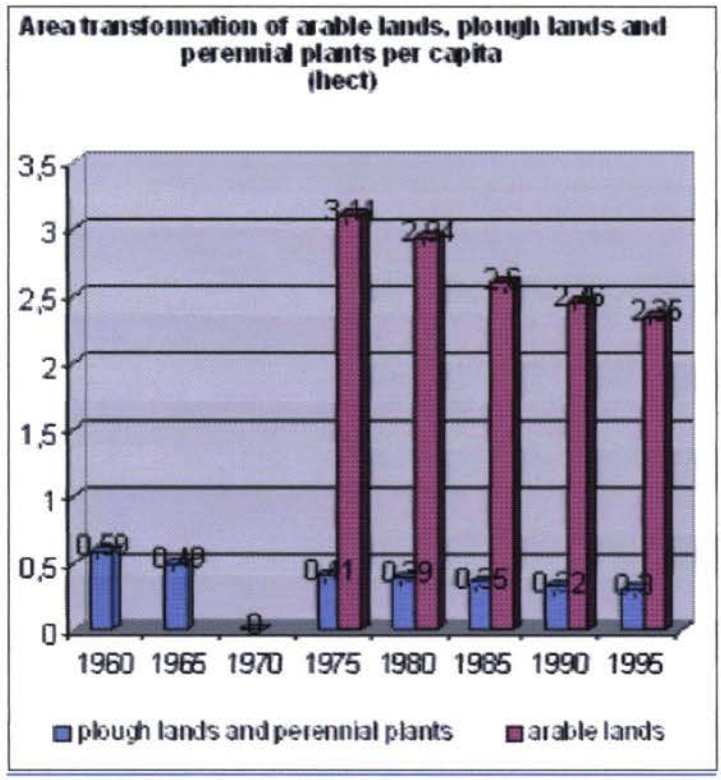
Now, 5302.1 thousand hectares of arable lands are exposed by erosion, including about 968 thousand hectares of arable lands, about 4544.8 thousand hectares of pasture, and about 87.1 thousand hectares of hay cultivation. Water erosion, resulting also in pollution of water sources, has captured 54.1 thousand hectares of arable lands. Salting of lands caused by a wrong and irrational irrigation has removed 80 thousand hectares of agricultural arable lands from turn over. Existing in the last years overload of pastures by cattle has resulted in fall of their productivity for 4 times 25-30 years on the average, in their overgrowing by weed and poisonous vegetation, in different kinds of erosion. The degree of pasture degradation may be related to a strong and very strong gradation. Increase of intensive use of lands into plough land, particularly irrigated, and also reasons stipulated by social economic factors, led to some negative phenomena. Vast arable land areas are in unsatisfactory conditions.

According to land inventory 8 thousand hectares of irrigated lands were taken away from the turnover for the last 5 years. From 1985 to 1990 areas of salinised lands increased from 28.9 to 89.2 thousand hectares, stony lands -from 239.9 to 3808.8 thousand hectares, deflation lands- from 616.2 to 5475.3 thousand hectares. A crop shortage due to various degrees of soil degradation was 20-80% for herbs and 15-20 % for cereals. Unsatisfactory quality of projecting and building of irrigation constructions and networks, over-watering of lands caused irrigative erosion on the territory of 74.2 thousand hectares of plough lands. Neglect of anti-erosion principles of territory organisation when average decrease size of one agricultural land use decreased 43 times, makes the process of land erosion endless.



At present 5302.1 thousand hectares or 51 % of arable lands are subject to erosions, including ploughed lands968 thousand hectares, pastures 4544.8 thousand hectares and hay -mowing -81.7 thousand hectares.

Urbanisation of territories, building of transport systems, hydro-technical constructions and mining enterprises completely destroy thousands of topsoil. Scantiness of arable lands, worsening of melioration conditions of arable lands combined with population increase led to as table tendency of productive area reduction per capita. With increase of population and systematic withdrawal of lands for non-agricultural needs, the area of plough lands in the republic decreased from 0.43 to 0.3 hectares including irrigated lands -from 0.27 to 0.195 hectares. By 2030 it will be 0.18 and 0.1 hectares per capita respectively Overloading pastures led to decrease of their crop capacity for 25-30 years on average 4 times, over-growing with weeds and poisonous vegetation, damage and other kinds of erosion. Anthropogenic influence on pastures is being aggravated by the same natural factors as for topsoil. As a result, the pastures of the Chui Valley, pre-mountain and plain part of the Fergana valley, Issyk-Kul and the Atbasha depressions, the upstream of the Naryn river, the valley of the Sary-Djaz are evaluated as having a very strong level of degradation. The level of degradation of considerable part of pastures (25-50 %) of the Terskei and Kungei Ala - Too, the Talas, Fergana and Chatkal ranges, Susamyr and Dzhumgal valleys is also estimated as strong. At present, due to sharp reduction of cattle on distant and remote pastures the process of natural rehabilitation has begun. However, on pastures located close to residential settlements the process of degradation is going on. Under such conditions the problem of rational use of pastures by means of pasture turnover development and national maintenance of distant cattle breeding arises urgently.



Water Resources

Although Kyrgyzstan has abundant water running through it, its water supply is determined by a post-Soviet sharing agreement among the five Central Asian republics. As in the Soviet era, Kyrgyzstan has the right to 25 percent of the water that originates in its territory, but the new agreement allows Turkmenistan and Uzbekistan unlimited use of the water that flows into them from Kyrgyzstan, with no compensation for the nation at the source. Kyrgyzstan uses the entire amount to which the agreement entitles it, but utilization is skewed heavily in favor of agricultural irrigation. In 1994 agriculture accounted for about 88 percent of total water consumption, compared with 8 percent by industry and 4 percent by municipal water distribution systems. According to World Bank (see Glossary) experts, Kyrgyzstan has an adequate supply of high-quality water for future use, provided the resource is prudently managed.

Irrigation is extremely wasteful of water because the distribution infrastructure is old and poorly maintained. In 1993 only an estimated 5 percent of required maintenance expenditures was allocated. Overall, an estimated 70 percent of the nation's water supply network is in need of repair or replacement. The quality of drinking water from this aging system is poorly monitored--the water management staff has been cut drastically because of inadequate funds. Further, there is no money to buy new water disinfection equipment when it is needed. Some aquifers near industrial and mining centers have been contaminated by heavy metals, oils, and sanitary wastes. In addition, many localities rely on surface sources, making users vulnerable to agricultural runoff and livestock waste, which seep gradually downward from the surface. The areas of lowest water quality are the heavily populated regions of the Chu Valley and Osh and Jalal-Abad provinces, and areas along the rivers flowing into Ysyk-Köl.

In towns, wastewater collection provides about 70 percent of the water supply. Although towns have biological treatment equipment, as much as 50 percent of such equipment is rated as ineffective. The major sources of toxic waste in the water supply are the mercury mining combine at Haidarkan; the antimony mine at Kadamzai; the Kadzyi Sai uranium mine, which ceased extraction in 1967 but which continues to leach toxic materials into nearby Ysyk Köl; the Kara-Balta

Uranium Recovery Plant; the Min Kush deposit of mine tailings; and the Kyrgyz Mining and Metallurgy Plant at Orlovka.

Land Management

The most important problems in land use are soil erosion and salinization in improperly irrigated farmland. An estimated 60 percent of Kyrgyzstan's land is affected by topsoil loss, and 6 percent by salinization, both problems with more serious long-term than short-term effects. In 1994 the size of livestock herds averaged twice the carrying capacity of pasturage land, continuing the serious overgrazing problem and consequent soil erosion that began when the herds were at their peak in the late 1980s (see Agriculture, this ch.). Uncertain land tenure and overall financial insecurity have caused many private farmers to concentrate their capital in the traditional form--livestock--thus subjecting new land to the overgrazing problem.

The inherent land shortage in Kyrgyzstan is exacerbated by the flooding of agricultural areas for hydroelectric projects. The creation of Toktogol Reservoir on the Naryn River, for example, involved the flooding of 13,000 hectares of fertile land. Such projects have the additional effect of constricting downstream water supply; Toktogol deprives the lower reaches of the Syrdariya in Uzbekistan and the Aral Sea Basin of substantial amounts of water. Because the Naryn Basin, where many hydroelectric projects are located, is very active seismically, flooding is also a danger should a dam be broken by an earthquake. Several plants are now in operation in zones where Richter Scale readings may reach eleven.

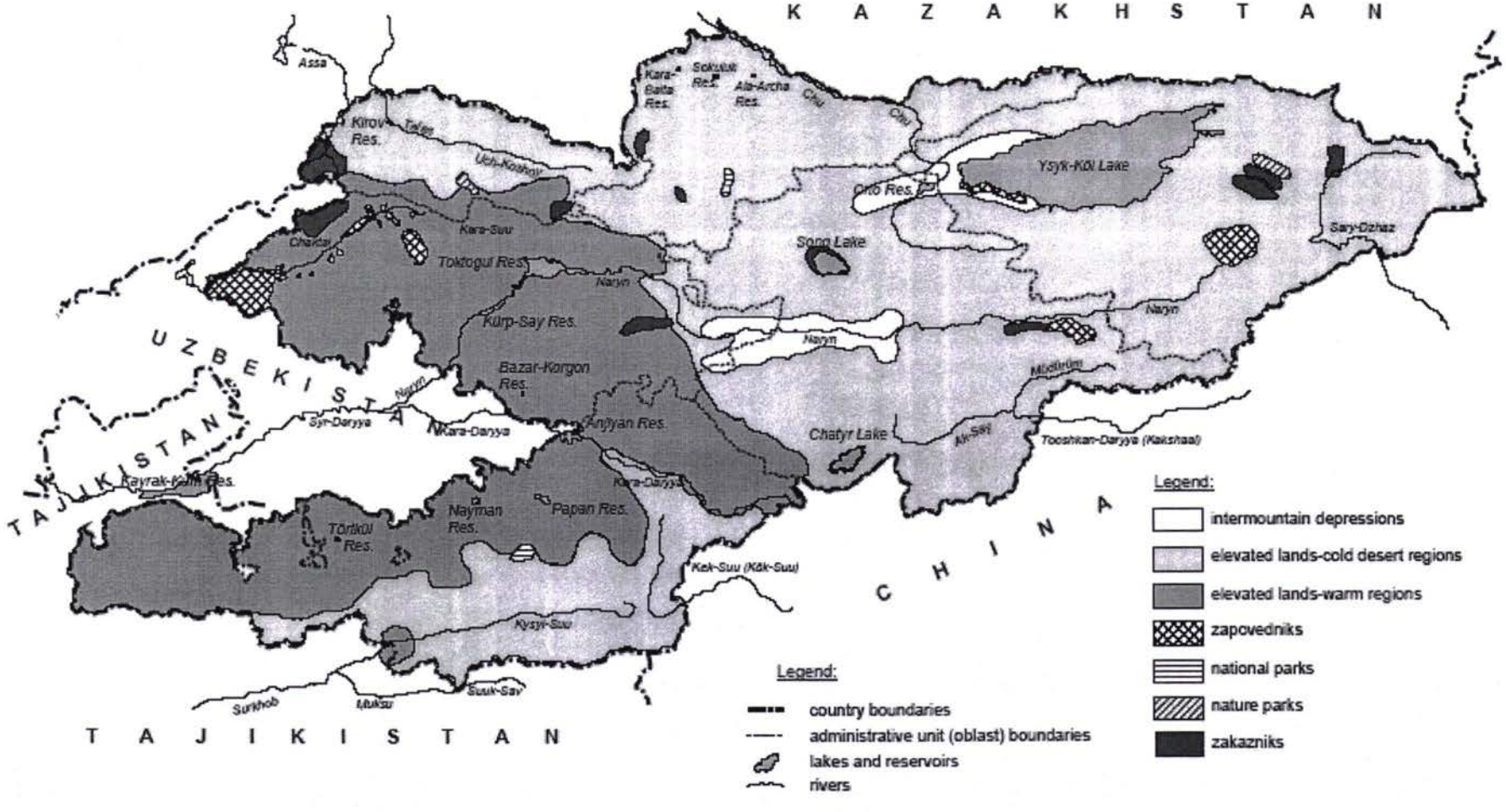
The Aral Sea

In response to the internationally recognized environmental crisis of the rapid desiccation of the Aral Sea, the five states sharing the Aral Sea Basin (Kazakstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) are developing a strategy to end the crisis. The World Bank and agencies of the United Nations (UN) have developed an Aral Sea Program, the first stage of which is funded by the five countries and external donors. That stage has seven areas of focus, one of which--land and water management in the upper watersheds--is of primary concern to Kyrgyzstan. Among the conditions detrimental to the Aral Sea's environment are erosion from deforestation and overgrazing, contamination from poorly managed irrigation systems, and uncontrolled waste from mining and municipal effluents. Kyrgyzstan's National Environmental Action Plan (NEAP) has addressed these problems as part of its first-phase priorities in cooperation with the Aral Sea Program.

Protected areas

The protected areas in Kyrgyzstan cover only 3.9 per cent of the Republic, which is short of the global average of about 6 per cent. To preserve biodiversity, six nature reserves (zapavedniki), 70 nature preserves (zakazniki) and nature memorial parks grouped into forest, botanical, hunting and complex parks, one national park and five nature parks were created. The 32 forest and botanical zakazniki, although perhaps adequately protecting individual plant clusters or localized botanical associations, are in general too small to be of importance for regional ecosystems, and certainly too small to protect many of the more widespread species of the Tien Shan fauna. There is no network of the protected areas that would take migration into consideration. More than half of the 19 vegetation zones of Kyrgyzstan are inadequately or very inadequately represented within the protected areas. Only about 15 of the zakazniki are sufficiently large (greater than 5,000 ha) to be considered as significant multi-habitat nature reserves, assuming that they are still in reasonably pristine condition after years of active use by hunters.

MAP OF MAJOR ECOSYSTEMS AND PROTECTED AREAS OF KYRGYZSTAN

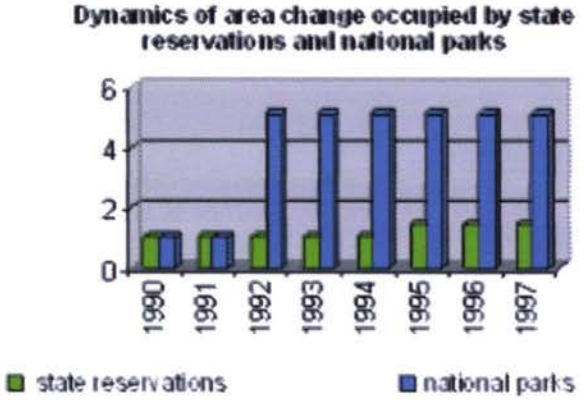


Particularly protected territories (PPT)

Kyrgyzstan inherited the national system of preservation in-situ from the former USSR.

At present, there is rather multifunctional network of territories and objects, forming particularly protected natural territories in the republic. At present, Kyrgyzstan accounts for 86 PPTs with total area of 777.3 thous. hectares that is 3.9 % of the total territory.

However, they do not cover all important ecosystems and they are not situated in all biogeographical subdivisions of the country.



As for their functional significance, particularly preserved natural territories refer to 4 categories, adopted by International nature protection union:

- Reservations. They consist of 6 reservations with total area of 250.5 thous. hectares.
- National and natural parks. There is 1 national and 5 natural parks with total area of 72.2 thous. hectares.
- Natural Monuments. There are 19 natural monuments, which were taken under protection in 1975.
- Objects of biotops and species protection: 71 preservations with total area of 319.9 thous. hectares. They occupy more than a half of the total area of particularly protected natural territories.

The reservations have definite specifications. The Sary-Chelek reservation preserves a unique landscape with a picturesque lake. The Issyk-Kul reservation keeps hibernating water fowl and the communities of the lake side and lake as well. The Naryn reservation preserves a maral population. The Besh-Aral, Kratal-Zhalyryk, Sarychat-Eratash reservations preserve high-land and mountain middle land ecosystems. 3 botanical gardens, 2 zoos, 5 nursery gardens were organized for preservations of biological variety by ex situ method. Some of them have been existing since the Soviet epoch and the others were organized comparatively not long ago.

Unique, rare and endemic species (which are in need of protection) are preserved in them. Practically all main types of forests (there are few of them) are included in particularly protected natural territories. They concentrate a considerable part of biological variety and play an important role in maintenance of ecological balance. Preserved areas include only parts (islands) of several ecosystems. Some of natural ecosystems are not included in the network of particularly protected natural territories. Their area should be enlarged for a possibility to reproduce the populations of the most important species.

Most species need larger areas and ecological passages for moving to other areas, depending on the seasons of a year.

Any economic activities are prohibited in reservations. In natural parks a limited economic utilization of their territories is allowed.

Some kinds or complex species are under protection on special territories. A considerable decrease of financing caused a staff reduction and less effective work of PPTs security service.

Financial maintenance of PPTs is carried out by means of development of economic activity at the expense of resources utilization (forest products, game, etc.).

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

7.4.1 Environment impact/effects during rehabilitation period

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

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

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

The basic principles connected to construction site location are:

- the construction site should be placed close by the working area in order to reach easily the assembly place, in order to reduce as far as possible the trouble brought about means of transport traffic;

- the construction site space should have surface area wide enough to permit the planned activities carrying out, but on the same time these areas should be limited as much as possible to reduce the (temporary) occupation of land;

- fixing the construction site position should be necessary to consider the right possibility of easy connection with the present services network (electricity, piping system for white or black drain water);

- the possibility to assure a smooth approach road or a material transports on the railroad;

- it will be necessary to verify the materials supplying and waste management, that is the right conditions of the road system (small transport distances for supplied materials);

- the construction site should be realized so that to reduce at the lowest terms the insertion of the potential environmental interferences with the neighborhood (local people life and activity).

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

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

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

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

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

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

Impacts on physical environment

Impacts on soil and water resources

a) *Soil and subsoil environment*

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

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

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

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

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

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

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

b) Impacts on water environment

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

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

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

The first group of problems is related to:

- all the waters pollution risks, either superficial or deep, due to the pollutant substances spilling on the construction site services area (oils, petrol, unloading, etc.) and along the routes of the mechanics means;

- the insertion of cloudy waters, for the presence on the water-rivers of powders and sediments coming from washing waters of concreting stations, with consequent damage to existing life around them;

- the unloading of white or black water generate from the high concentration of construction site authorized person;

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

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

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

Alteration of hydrographical superficial network

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

Alteration of physical/chemicals characteristics of superficial waters

Generally speaking the effect is as consequence of the pollutant spilling substances or to mud or grounds introduction on the watercourses involved by the work fulfillment. The phenomenon is to

be considered temporary to the construction site phase, and it is interesting particularly the building phase, the excavations, the impermeabilizations, the machinery utilization, etc.;

Alteration of physical/chemicals characteristics of underground waters

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

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

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

Engaging on of erosion phenomena

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

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

Alteration of the water underground flow

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

c) Soil and water environment impacts interaction

Impact induced by the construction site activities

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

These substances are:

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

  The activities generating this pollution are:

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

- surfaces washing of the construction site service areas;

- washing of the motor vehicles wheels;

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

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

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

  - leaks from the fuel tanks valves or tubes;

  - fuel tanks corrosion;

  - damages induced by frost to the fuel tanks;

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

  - oils leaks from pomp and generator;

  - used oils abandonment;

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

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

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

- liquid sewage

- pesticides

- herbicide

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

Impacts induced by the processing

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

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

- soil compactness from the construction site means;

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

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

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

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, refueling) 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 fulfillment.

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:

- Particles.

- Sulfur Dioxide.

- Nitrogen oxides.

- Heavy metals.

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.).

Fauna

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

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

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

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

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

Impacts on atmospheric environment

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

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

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

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

The main activities that represent dust emission sources are:

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

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

- the powder production;
- the gas emissions and the dust.

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

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

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

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

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

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

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

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

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
Contact line replacement	Copper wastes, ceramics insulators and other metallic materials
Replacement of the safety systems of the stations for the power supply	Liquid waste, acid electrolytic solutions, plastic boxes/ tanks, lead electrode
Current repairs of the equipment	Used oils, worn – out tyres, metallic wastes
Site organizations	Domestic waste, paper, packing

The toxic and dangerous wastes as fuel (gasoline), lubrificants and brimstone acid, required for a good functioning of equipment. Equipment fuel supply will be done with a cistern car, when necessary. The equipment will be brought to site in good functioning, will al technical revisions carried out fuel changes. Fuel change will be done after each working season in authorized workshops, where also the hydraulic and transmission oils will be changed.

7.4.2 Environment impact/effects forecast for operation period

Impacts on water and soil environment

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 unfavorable impact to the railway and train sanitary conditions. The stations mainly handle the train refuse and domestic refuse from railway stations. All the refuse are required to have a classified treatment in for categories (including paper, wood, fruit shell and fruit foodstuffs); plastic and glass and metal with refuse box provided respectively the trains and stations.

During the operating period specific domestic waste will be resulted from the railway traffic and also waste resulting for an improper actions of the railway traffic participants such as throwing away of bags during traffic.

Matrix of identification and screening of Environmental Impacts during the construction and operation period

The following matrix summarizing:

- Type of impact (positive or negative)
- The timing (construction, operation)
- Nature of impact (direct, indirect, cumulative)
- The magnitude of impact (low, medium, high)

Impact Issue	Timing	Type of Impact	Nature	Magnitude
Soil pollution and erosion				
Erosion	Construction-operation	Negative	Direct	Medium
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 prevent from using resources held in common by local population. Construction camps should provide services which otherwise would overburden the local public facilities/ utilities.

However, to limit or even to eliminate the impact, several special works are foreseen: installations for cleansing used waters (septic tank) coming from the site organization, decanter for the sludge from the concrete station, impermeable work platforms, etc.

For these objectives to work and for the installations, which serve them, notices and accords must be solicited and obtained by the proper authorities. Usually any measure of good management of construction works, good practice will insure, implicitly, the protection of the environment.

Water and soil environment

In the interested area, one of the most important impact is that on the water environment, strictly connected at the soil environment.

Recommendations and mitigations for prevention water and soil pollution

Concerning the prevention from the pollutions it will need to pursue the following measures. The contamination of the soil, of the under-soil and water structures, superficial and underground, could be done only inside the construction site areas and during the single artwork.

Main items for the prevention measures of the water and soil pollution inside the construction areas that have to be analysed are:

1. prevention of contamination of water structures or of soil by chemical substances used at the construction site;

2. prevention of contamination from stocking of waste produce by the temporally waste depots;

3. recommendations for activities related the delivery of fuel to the deposit and to the refuelling operations;

4. water drainage and waste water treatment devices;

5. maintenance of the construction site machineries.

Even if it is impossible at this stage of the project to localize the areas of the construction site, it is possible to describe the general organisation principles.

It is recommended that the platforms for the production bases have concrete or broken stone surfaces in order to stop or reduce infiltrations by pollutant substances; the provisioning with drains to direct eventual spills, which go over the top in impermeable slots out of which the contaminated liquids can be collected operatively.

Also, for the production bases, the gear maintenance and washing platforms must be executed with a slope so that they insure the collection of residual water (resulted from the wash), oils, fuel, and then introducing them into a decanter, that is periodically cleaned, and the deposits are transported to the nearest cleaning station.

Inside the site organizations the flow of meteoric water must be insured as it washes a large area, on which various substances from eventual losses, so that no they are not forming puddles which,

in time, might infiltrate into the underground polluting the soil and the pyretic bed. Their evacuation can be done at the closes emissary or even on the surrounding terrain after they pass through a decanter basin.

The wastewaters that come from the site organization must be introduced into a septic tank, which will be periodically cleaned and evacuated at a cleaning station nearby with which a service contract has been signed previously.

For the execution period the constructor has the obligation to realize all the measures for environmental protection for the polluting or potentially polluting objectives (production bases, material storage facilities, site organizations, earth quarries).

For the foreseen activities along the line the general organisation principles are mainly related to the presence of potential receptors of the impacts, as the watercourses. This kind of activities could in fact generate an increase of the water turbidity.

If the excavation escarpment are stable enough and there is the necessary space, this material can also be used for erecting a temporary embankment around the dig, in order to avoid the flooding and also problems of water contamination that could derive from it.

In general the activity in the bed of the watercourses should take place into circumscribed areas, dry and separated from the running flow trough provisional works and performed in order to limiting problems on the existing bed and on the bank upstream and downstream in the intervention area.

Where possible all the equipments and the plants used for the works should be kept outside the overflowing area during the hours and periods in which the works have been interrupted. It is necessary to avoid the stocking of big quantities of iron close to the work areas: the oxidation of iron materials could in fact determine pollution phenomenon in the waters and soils.

The platform of the organization must be designed so that the meteoric water is also collected through a system of ditches or drains, where sedimentation can take place before the discharge, or they can be outfitted with draining holes from where the water can be introduced into the modulated cleansing station outfitted for sewage waters. For the collecting and the cleaning of the wastewaters during the constructions execution it be referred to the following basic operations:

Installing of septic tanks at the construction site;

Drainage of the rain water towards the sedimentation chambers (which must reduce the suspension by 90%);

Before discharging to the emissaries, the collected rain water will be passed through oil separators (which must reduce the oil content by 90%).

Therefore the mitigations measures that shall be foreseen for prevention water and soil pollution are:

-Appropriate waste management control;

-Disposal management of unused oil, fuels and their containers;

-Ensure drainage systems do not polluted water sources through appropriate alignment or through filtration;

-Ensure other sources of pollution are not allowed to enter the waters course;

-Prevent water pollution and turbidity;

- Scheduling construction activities near waterways for seasonably dry periods, wherever possible.

Recommendations and mitigations for prevention soil erosion and slope stability

Owing to the favourable nature of the topography, no special mitigation measures for stabilizing, cut and fill slopes are considered necessary, for the most part. In case of the area, normal good engineering practice and drainage system will be adequate.

In case of areas prone to erosion soil, (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 Enviroment	Acoustic limits	receptors in which it is possible to see the overcoming of the acoustic limits

With reference to the potential effects noticed during the environmental analysis , below the description of the mitigation measures adopted.

Water environment

The mitigation measures required for the component will be planned in the project preparation and carried out in the construction phase.

Water network

The problems of the alteration of the continuity of the superficial and underground hydric network belong to the aspects taken into consideration during the projecting of the works. The project should guarantee the maintenance of the superficial hydric network continuity either the principal nor the secondary one through the adoption of the appropriate works.

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: o Ensure drainage systems do not pollute water sources through appropriate alignment or through filtration as appropriate o Ensure other sources of pollution are not allowed to enter the water courses o Ensure that local people's needs take precedent over construction and construction workers o Ensure that access points/paths to water sources for people are not disrupted during construction and post-construction o Contractors are required to make arrangements for water supply that do not affect supply to other users o To ensure that access points to water sources are not blocked during construction o To provide adequate washing facilities for construction workers o Prevent pollution of water courses	Construction phase	Construction phase	LRC-Contractor	Monitor implementation

Impact Issue	*Measure Required*	*Timing (start up of measures)*	*Duration of Measures*	*Responsibility*	*Monitoring*
Air quality	▪ Traffic speed should be reduced (bumps) and regular application of water on road pavements may be required as appropriate to prevent high dust emission	Project preparation	Construction phase and operation	LRC-Contractor-Local authorities	Monitor implementation / construction
	▪ All trucks carrying fine material should be covered	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
	▪ Construction machinery must be well maintained to minimise excessive gaseous emission	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
	▪ In order to reduce dust in the villages, also a particular gravel is recommended	Project preparation	Construction phase	LRC-Contractor	Monitor implementation
Nuisance noise	▪ Activities producing excessive noise levels (work in borrow pits and quarries) should be restricted to the day time and equipment normally producing high levels should be suppressed or screened when working within a distance of 200 m. from any settlement or religious building	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
Construction camp	▪ Consultations with local officials before locating and building the camps, including discussions on appropriate sites, resources, dispute resolution procedures and rights and responsibilities of various parties	Project preparation	Construction phase	LRC-Contractor	Monitor implementation

Impact Issue	*Measure Required*	*Timing (start up of measures)*	*Duration of Measures*	*Responsibility*	*Monitoring*
	▪ Restore vegetation immediately after the end of works	Construction phase	Construction phase/end of work	LRC-Contractor	Monitor implementation
	▪ The storage of the hazardous materials by the construction camps and their use in construction (vehicles, asphalt plants etc.) must be such as not to let chemicals to leak to the soil or water system. After the use of these materials their disposal system must be proper as not to harm environment	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
Biological Environment					
Natural vegetation	▪ Maximum care should be taken in selection of detours and access routes to borrow pits and quarries	Project preparation	Construction phase	LRC-Contractor	Monitor implementation
	▪ Design and construction of the required detours at several locations along the project line should choose routes that will cause minimal damage to the natural vegetation	Project preparation	Construction phase	LRC-Contractor	Monitor implementation
	▪ Minimise destruction of trees and vegetation	Construction phase	Construction phase	LRC-Contractor	Monitor implementation
	▪ Restore vegetation immediately after the end of works	Construction phase	Construction phase	LRC-Contractor	Monitor implementation

7.7 Monitoring Program

7.7.1 Monitoring in construction period

Monitoring is carried out to assess any disturbance to the environment and to protect both LRC and the affected parties from false charge. An environmental inspector could be proposed to this project by LRC. The inspector should have a number of short-term inputs from the commencement of the construction through to its completion and until cleanup has been finalised.

During construction, monitoring of the following indicators is recommended. Although LRC will retain administrative directive and management, certain part of this programme, as described below, will be performed by other agencies under contract to LRC.

Monitoring plan and implementation program

Monitoring a project or a program and its surrounding is a tool for decision-making, not an end product. The monitoring will be conducted by the environmental team and Environmental protection agencies. The monitoring will involve maximum use of information collected in existing regular channels for reasons of resources efficiency and to avoid adding to the workload of the organisation compiling data. The information will be used in three types of monitoring: construction activities; effects of the project upon the surrounding environment and vice versa; internal progress of the environmental management group.

Environmental implementation measures

Monitoring the environmental protection measures during construction mainly concern the progress of impact mitigation and enhancement and the construction activities that are required of the contractors. The latter include rehabilitation or protection of borrow pits, re-vegetation of barren areas, bush clearance with minimal ancillary damage to the landscape, proper waste management and other obligations. An aim is for the environmental team to help the contractors maintain sensitivity towards environmental concerns, meet their contractual responsibilities and have flexibility in response to environment-related issue.

The effects of the project road upon surrounding environment has both short-range and long-term dimension. The short-range effects mainly involve construction-related activities.

Monitoring these events require attention to the following:

- Appropriate data collected by government agencies;
- Suitable institutional arrangements and communications;
- Necessary staff to get tasks done;
- Adequate financial and technical resources;
- Capacities to compile, process and analyse information in a timely fashion.

The kinds of effects to be monitored:

- Population displacement;

- Resettlements and compensation;
- Construction-related pollution;
- Land and water uses;
- City infrastructure.

In addition to construction-related concerns, the environmental management team will establish systems to monitor long-range, mainly development-related effects.

It will be necessary to assess the capacities of organisations to collect the required data and perform appropriate analyses.

Environmental management team

The aim of a group that monitors its own program is to determine the adequacy of past and present tasks, so as to plan for the future. On the project road these evaluations will address the subjects of staff, finance, support, resources, progress of program activities and change to work plans.

The monitoring will include quarterly work-plans that are update as necessary and quarterly meetings or as necessary, to anticipate problems, suggest solutions and help implement the work program.

Work program

The environmental protection work program has the following goals:

- The implementation of environmental protection measures both during the construction of the project and afterwards;
- The addressing of environmental issues by appropriate organisations and officials, within the context of long-term planning and management of the project;
- The organisational strengthening of LRC.

Work activities

Work activities for environmental protection associated with the project are in four areas:

- Establishment of liaison, communications and working arrangements;
- Implementation of measures for avoiding or mitigating problems and enhancing benefits and opportunities associated with the roads project;
- Monitoring activities;
- LRC staff training.

Much of the work involves monitoring contractor activities and coordination of the impact mitigation and enhancement measures. The Environmental Coordinator will arrange specific work activities and organizations responsible for their implementation.

Schedule

Early activities of the environmental team include the following:

- Preparation of the training materials for the workshops, followed by the start of the training itself;

- Dissemination of information about the project;

Many of the activities involve coordination, encouragement, and impetus provided by the environmental staff, rather than their extensive participation.

Some tasks will begin with the construction of the line. These include the following activities:

- Establishing working relationships and monitoring arrangements with the contractors;

- Facilitation of planning for lay-byes and service centres;

- Feedback from the advisory group on organisation, initial efforts and future program priorities.

7.7.2 Monitoring Plan Physical and Biological Environment

Soil and Erosion

Monitoring during construction shall be done by LRC (Environmental Inspector) as per the mitigation measures recommended in Chapter E. During operation the district maintenance office should conduct the surveillance of erosion.

Terrestrial Vegetation

The purpose of this programme is to monitor effects of the project during the construction and after the completion of the project. The monitoring of components associated with terrestrial vegetation will be contracted to the interested Ministry and the Environmental protection agencies, they will determine which species stands should be planted and implement as recommended by mitigation plan and periodically report the progress to LRC.

Agricultural Land

The LRC (Env. Ins.) should ensure that topsoil stripping and separate stockpiling occur during construction on agricultural land. Topsoil shall be removed to its actual depth. After completion of the work all stored topsoil shall be returned to its original area.

Nuisance Noise and Dust

It will be the responsibility of LRC (Env. Ins.) or Site Engineer to ensure that appropriate control measures are taken.

Clean up

Following the completion of the road project, it will be necessary to cleanup and rehabilitate the construction site.

This monitoring will be maintained for only a short duration during the cleanup of the construction site to ensure that environmental precautions are implemented.

7.7.3 Monitoring Indicators

Objectively verifiable monitoring should include (It is a suggestion):

Item	Indicator (Ex.)
Soil	Hectare of land by use, tons/hectare/year of loss of terrain
Water	COD, BOD, (O2 mg/l), other (following the legislation of Kazakhstan, Uzbekistan, Kyrgyzstan)
Biota, vegetation	Hectares and type of green areas, hectares and type of critical areas, tons and type of harvest products, n° of animal-vehicle traffic accident
Safety	Accident/injury records, traffic counts, safety inventory
Atmosphere	Traffic counts, traffic projections, vehicle test records, meteorological records, emissions in atmosphere (NO, CO, SOx, PM10)
Noise pollution	Noise levels: dB(A)
Line maintenance records	Drain maintenance reports, supplies inventory records, rehabilitation

Environmental Monitoring Plan

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
Physical Environment					
-Erosion	Mulch used in establishing vegetation propagated by seeds as appropriate	Monitor implementation			
	Adoption of regulations that prohibit livestock grazing on road shoulder, embankments, and right of way, as necessary.	Monitor implementation			
	Special retaining structures	Monitor implementation / construction			
-Slope stability	Re-vegetation of the land, since tree roots can hold soil together	Monitor implementation			
	Up slope cultivation in such zones	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	In unstable areas use gabion retaining structures	Monitor implementation / construction			
	Bio-engineering techniques	Monitor implementation / construction			
Hydrological conditions and water quality					
-water resources and water quality	Waste oil and other liquids must be disposed in a proper manner	Monitor implementation			
Air quality	Traffic speed should be reduced (in the villages the use of bumps is recommended) and regular application of water on road pavements may be required as appropriate to prevent high dust emission	Monitor implementation / construction			
	All trucks carrying fine material should be covered	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	Construction machinery must be well maintained to minimise excessive gaseous emission	Monitor implementation			
	In order to reduce dust in the villages, also a particular gravel is recommended	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
Nuisance noise	Activities producing excessive noise levels (work in borrow pits and quarries) should be restricted to the day time and equipment normally producing high levels should be suppressed or screened when working within a distance of 200 m. from any settlement or religious building	Monitor implementation			
Construction camp	Consultations with local officials before locating and building the camps, including discussions on appropriate sites, resources, dispute resolution procedures and rights and responsibilities of various parties	Monitor implementation			
	Restore vegetation immediately after the end of works	Monitor implementation			
	Assess vector ecology in work areas and avoid creation of undesirable habitats (e.g. stagnant water)	Monitor implementation			
	The storage of the hazardous materials by the construction camps and their use in construction (vehicles, asphalt plants etc.) must	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
	such as not to let chemicals to leak to the soil or water system. After the use of these materials their disposal system must be proper as not to harm environment				
Biological Environment					
Natural vegetation	Maximum care should be taken in selection of detours and access routes to borrow pits and quarries	Monitor implementation			
	Design and construction of the required detours at several locations along the project road should choose routes that will cause minimal damage to the natural vegetation	Monitor implementation			
	Minimise destruction of vegetation	Monitor implementation			
	Restore vegetation immediately after the end of works	Monitor implementation			
	Forbid project staff to kill, injure or poach wild animals	Monitor implementation			

Impact	*Measure*	*Monitoring*	*Planning / Project Preparation*	*Construction*	*Operation*
Borrow pits and quarries	Pit or quarry location and area	Monitor implementation			
	Access arrangements	Monitor implementation			
	A working plan giving an outline of the direction, phasing and depth of working	Monitor implementation			
	A reclamation/restoration plan giving details of final grading, drainage and sediment control, resoling and re-vegetation measures and design after use	Monitor implementation			

8. Preliminary implementation schedule

The following Table 8.1, Table 8.2 and Table 8.3 show a preliminary implementation plan for the Options under study.

Option 1 takes in account the indication collected during the Consultant experts visits in Kyrgyzstan, about the extremely low economical resources of the Government and railways. It was then mainly conceived as a provision of materials, machines and plants to be purchased or manufactured (reinforced concrete sleepers) directly by the railways, saving the extra costs that a Contractor would charge and in the meantime providing machinery and plant (sleeper factory), that later on will produce further savings in maintenance activities.

Consequently the implementation schedule does report the rehabilitation activities under the assumption that they will be carried on by the existing railway maintenance personnel. It considers time intervals for examining offers, ordering producing and delivering before the proper rehabilitation.

Nevertheless the construction of avalanche shed was considered to be tendered and awarded to a Contractor for its specificity and the relevant activities analyzed separately.

All the described activities will be completed in 60 months.

Option 2 considers, for the same reasons previously mentioned for Option 1, the direct purchase of the most valuable materials, machinery and plant directly managed by railways, while the rehabilitation PW works and the construction of avalanche sheds would be carried out by Contractors. The handing over of both materials and machines to Contractors is envisaged, so the rehabilitating activities have to follow the first ones; the total execution time will then suffer inevitable delays.

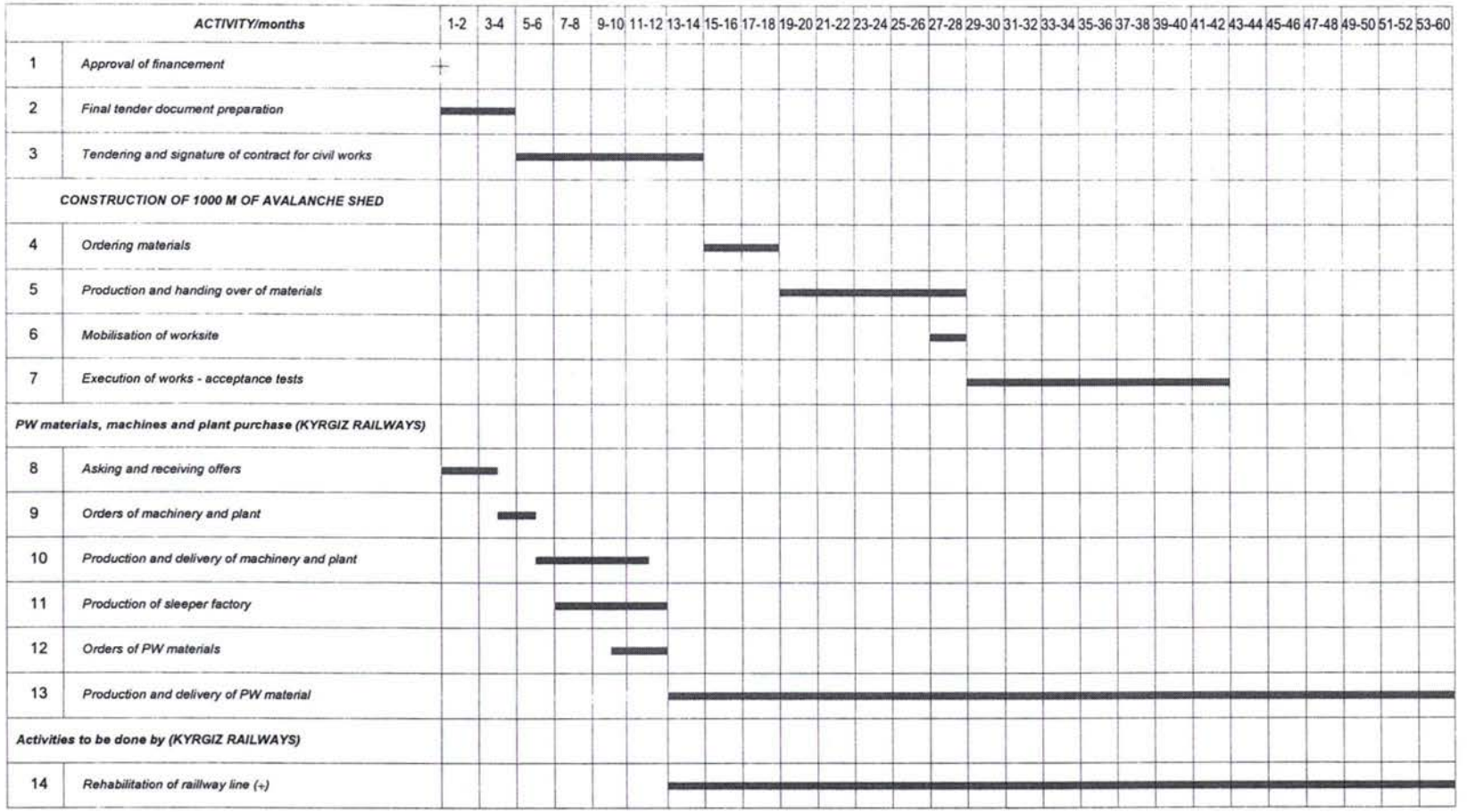
In the implementation schedule the railway and Contractors activities are considered separately.

All the described activities will be completed in 33 months.

Option 3 considers that all the activities will be up Contractors. Two Contracts, the first one for carrying out PW and civil works (avalanche sheds) as well as purchasing materials machinery and plant, the second one for executing and installing safety plants, are envisaged.

The scheduled activities will be completed in 62 months.

Table 8.1 Implementation programme for Option 1



(+) The detailed implementation programme is depending on availability of resources, but it is assumed to be completed within 48 months; the total lenght is consequently 60 months.

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	27	28	29	30	31	32	33
1	Approval of financing																																	
2	Final tender document preparation for civil works																																	
3	Tendering and signature of contract for civil works																																	
	CONSTRUCTION OF 1000 M OF AVALANCHE SHED																																	
4	Ordering materials (cement, reinforcement steel, prefabricated beams, included necessities of sleeper plant)																																	
5	Production and handing over of materials																																	
6	Mobilisation of worksite																																	
7	Execution of works - acceptance tests - taking over of structures																																	
	ACTIVITIES TO BE DONE BY KYRGYZ RAILWAYS																																	
8	Asking and receiving offers for materials, machines and plants																																	
9	Emission of orders																																	
10	Production and handing over of PW materials																																	
11	Production and handing over of tamping, profiler, positioner machines, gantry cranes																																	
12	Production, assembling, testing sleeper factory																																	
13	Civil works for sleeper factory, ordering materials for sleeper manufacturing																																	
14	Starting concrete sleeper production																																	
	ACTIVITIES TO BE DONE BY CONTRACTOR																																	
15	Final tender document preparation for PW works																																	
16	Tendering, signature of contract for PW works																																	
17	Handing over of materials and machines to contractor																																	
18	Mobilisation of worksite																																	
19	Topographic survey, final profile																																	
20	Welding P65 rails in 100m bars																																	
21	Laying down 100 m rail bars along the line																																	
22	Starting demolition, excavation, laying down new subballast, ballast, concrete sleepers, P 65 rails																																	
23	First ballasting, first tamping																																	
24	Second ballasting, second tamping																																	
25	Welding rails in 1000m bars along the line																																	
26	Regulation of rail mechanical tension and welding in long bars.																																	
27	Final tamping, leveling, aligning																																	
28	Dismantling, recovering and classificating materials																																	
29	Tests and taking over of rehabilitated line																																	

Table 8.3 Implementation programme for Option 3

	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	27 28	29 30	31 32	33 34	35 36	37 38	39 40	41 42	43 44	45 46	47 48	49 50	51 52	53 54	55 56	57 58	59 60	61 62
1	Approval of financing																															
2	Final tender preparation																															
3	Tendering and signing contract																															
	ACTIVITIES TO BE DONE BY CONTRACTOR - PW WORKS																															
4	Mobilisation																															
5	Topographic survey, final profile																															
6	Emission of orders for materials, machines, plant purchase																															
7	Production and handing over of PW materials																															
8	Production and handing over of machines																															
9	Production, assembling sleeper factory																															
10	Civil works for sleeper factory, ordering materials for sleeper manufacturing																															
11	Concrete sleeper production																															
12	Welding rails in 100m bars																															
13	Laying down 100 m rail bars along the line																															
14	Demolition, excavation, laying down new subballast, ballast, concrete sleepers, P 65 rails																															
15	First ballasting, first tamping																															
16	Second ballasting, second tamping																															
17	Welding rails in 1000m bars along the line																															
18	Regulation of rail mechanical tension and welding in long bars.																															
19	Final tamping, leveling, aligning																															
20	Dismantling, recovering and classificating materials																															
21	Tests and taking over of rehabilitated line																															
	CIVIL WORKS - AVALANCHE SHED (300m)																															
22	Ordering materials (cement, reinforcement steel, prefabricated beams, included necessities of sleeper plant)																															
23	Production and handing over of materials																															
24	Mobilisation of worksite																															
25	Execution of works																															
26	Acceptance tests - taking over of structures																															
	SAFETY PLANTS																															
27	Final tender preparation																															
28	Tendering and signing contract																															
29	Production of efecutive design, detailed specification, examination and approval of managership																															
30	Construction on factory and delivery on site																															
31	Assembling and installing																															
32	Tests on site out of operation																															
33	Commissioning																															

9. Benefits Assessment of the Project

9.1 Option 1

Option 1 benefits derive from the mentioned purchased materials and related maintenance works that will be carried out by the Railway Administration.

9.1.1 Benefits from purchased materials

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 - section Kazakh border-Balykchi (*)		
Scenario	*Passenger trains (minutes)*	*Freight trains (minutes)*
2008-2012	*0*	*0*
2012-2022	*30*	*20*
After 2022 (**)	*40*	*50*

Benefits related to time savings As a consequence of the time savings a number of benefits have been included in the calculation.

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. The value of the time has been calculated starting from the following data/assumption:

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

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

Employed people: 30%

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 result in a reduction of the in the overall locomotive and rolling stock requirement.

Although most of the regional railways fleet is very old, and it's 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 shows result 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

Table 9.1.1-3 Rolling stock hourly cost calculation

Description	Freight Wagons						Passenger Coach	Unit
BASIC DATA	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
Ownership cost:								
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$/hour
Operating cost								
Maintenance	0,23	0,13	0,38	0,14	0,26	0,22	13,20	US$/hour
TOTAL	0,23	0,13	0,38	0,14	0,26	0,22	13,20	US$/hour
TOTAL HOURLY OPERATING COSTS								
Working	0,92	0,53	1,29	0,58	1,00	0,81	46,99	US$/hour
Standby	0,46	0,26	0,53	0,29	0,48	0,36	20,59	US$/hour

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	Average	Residual Value		
Track Age ('000 Gross Tonnes)	Rail Age ('000 Gross Tonnes)	Gross (US$/tonne)	Recovered (US$/tonne)	Net Value (US$/km)
<200,000	100,000	430	410	53,300
201,000 - 400,000	300,000	380	360	46,800
401,000 - 500,000	450,000	320	290	37,700
501,000 - 700,000	600,000	200	170	22,100
701,000 - 800,000	750,000	160	140	18,233
801,000 - 1,000,000	900,000	66	56	7,293
>1,000,000	1,000,000	50	43	5,525

Sources: Consultant's estimate

SLEEPERS	Average	Residual Value		
Sleeper Type	Sleeper Age (years)	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	30	30	55,200.00
Concrete used	15	12	10	18,400.00

Sources: Consultant's estimate

FASTENINGS	Average	Residual Value		
FasteningType	Fastening Age (years)	Gross (US$/each)	Recovered (US$/each)	Net Value (US$/km)
New	0	20	20	36,800.00
Used	20	7	6	11,040.00

Sources: Consultant's estimate

According to the age of the dismantled PW elements and their quantities, the following table 8.1.1-3 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 - Border-Balykchi section Residual value for Option 1			
			Value ($)
Rails	replaced (t)	6,200.00	347,820.00
Wooden sleepers	replaced (n) 90%	90,000.00	
	20% re-usable (n)	18,000.00	126,000.00
Concrete sleepers	replaced (n) 10%	10,000.00	
	50% re-usable (n)	5,000.00	50,000.00
Fastenings	replaced (n)	100,000.00	
	20% re-usable (n)	20,000.00	120,000.00
			643,820.00

Total residual value: 643,820 $.

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, divided per option, reference is made to Table 4.1.1-10. For the detailed maintenance costs divided per materials and manpower, reference is made to Annex II "Details of maintenance costs".

Some maintenance has also been envisaged for the years in which option related works are being carried out, for maintaining the sections out of the option (stations tracks).

Table 9.1.1 – 6 Forecast of maintenance costs related to Option 1

Rehabilitation works for Kungrad - Beyneu Line (Kungrad-Border section) Line maintenance costs for OPTION 1								
Year	Required Maintenance (km)				Maintenance Costs (US$)			
	Lifting	*Medium*	*Capital*		*Lifting*	*Medium*	*Capital*	*Total*
				materials costs covered by Option 1				
2007	10	0	10	yes	455,620	-	450,722	906,342
2008	10	0	15	yes	455,620	-	676,083	1,131,703
2009	10	0	15	yes	455,620	-	676,083	1,131,703
2010	10	0	8	yes	455,620	-	360,578	816,197
2011	10	0	7	only sleepers	455,620	-	1,042,383	1,498,002
2012	5	0	7	no	227,810	-	1,979,920	2,207,730
2013	5	4	2	no	227,810	449,990	565,692	1,243,491
2014	5	4	2	no	227,810	449,990	565,692	1,243,491
2015	5	4	2	no	227,810	449,990	565,692	1,243,491
2016	5	4	2	no	227,810	449,990	565,692	1,243,491
2017	5	8	2	no	227,810	899,980	565,692	1,693,481
2018	5	8	2	no	227,810	899,980	565,692	1,693,481
2019	5	8	2	no	227,810	899,980	565,692	1,693,481
2020	5	8	3	no	227,810	899,980	848,537	1,976,327
2021	5	5	3	no	227,810	562,488	848,537	1,638,835
2022	10	5	3	no	455,620	562,488	848,537	1,866,644
2023	10	5	3	no	455,620	562,488	848,537	1,866,644
2024	10	5	3	no	455,620	562,488	848,537	1,866,644

2025	10	5	3	no	455,620	562,488	848,537	1,866,644
2026	10	5	3	no	455,620	562,488	848,537	1,866,644
2027	10	5	3	no	455,620	562,488	848,537	1,866,644
2028	10	5	3	no	455,620	562,488	848,537	1,866,644
2029	10	5	3	no	455,620	562,488	848,537	1,866,644
2030	10	5	3	no	455,620	562,488	848,537	1,866,644
2031	10	5	3	no	455,620	562,488	848,537	1,866,644
2032	10	7	3	no	455,620	787,483	848,537	2,091,639

From 2007 to 2011, capital maintenance will be carried out by using materials whose cost is covered by the option.

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. For the non rehabilitated sections, this time should be 15 years.

In the case of "without project" scenario, maintenance needs have been quantified and their cost have been assessed in the following table 9.1.1-7.

Also for maintenance in case of "without project", the estimation of the number of km per year has been based on the mentioned decree, according to which, in case of wooden sleepers and jointed rails, the maintenance cycle should be carried out every 15 years for E5 railway category (the current line category).

Anyway, in case of "without project", the estimation has been made following a prudential analysis: according to this analysis, the maintenance needs envisaged cannot be much higher than the real maintenance carried out in the last years by KTZ. In fact KTZ, for a highly affecting shortage of resources, in the last years concentrated its small investments on small sections maintenance, and this will be presumably done also in the future. Anyway, the proposed "without project" scenario for maintenance forecast is assumed to be the minimum, in order to maintain the line in 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.

Table 9.1.1 – 7 Forecast of maintenance costs "without the project"

Rehabilitation works for Lugovaya-Balykchi Line (Border-Balykchi section)							
Line maintenance costs "WITHOUT THE PROJECT"							
Year	Required Maintenance (km)			Maintenance Costs (US$)			
	Lifting	*Medium*	*Capital*	*Lifting*	*Medium*	*Capital*	*Total*
2007	15	6	5	750,930	734,985	1,564,229	3,050,143
2008	15	6	5	750,930	734,985	1,564,229	3,050,143
2009	15	6	5	750,930	734,985	1,564,229	3,050,143
2010	15	6	5	750,930	734,985	1,564,229	3,050,143
2011	15	6	5	750,930	734,985	1,564,229	3,050,143
2012	15	6	5	750,930	734,985	1,564,229	3,050,143
2013	15	6	5	750,930	734,985	1,564,229	3,050,143
2014	15	6	5	750,930	734,985	1,564,229	3,050,143
2015	15	6	5	750,930	734,985	1,564,229	3,050,143
2016	15	6	5	750,930	734,985	1,564,229	3,050,143
2017	15	6	5	750,930	734,985	1,564,229	3,050,143
2018	15	6	5	750,930	734,985	1,564,229	3,050,143
2019	15	6	5	750,930	734,985	1,564,229	3,050,143
2020	15	6	4	750,930	734,985	1,251,383	2,737,298
2021	10	6	4	500,620	734,985	1,251,383	2,486,988
2022	10	6	4	500,620	734,985	1,251,383	2,486,988
2023	10	6	4	500,620	734,985	1,251,383	2,486,988

2024	10	6	4	500,620	734,985	1,251,383	2,486,988
2025	10	6	4	500,620	734,985	1,251,383	2,486,988
2026	10	6	4	500,620	734,985	1,251,383	2,486,988
2027	10	6	4	500,620	734,985	1,251,383	2,486,988
2028	10	6	4	500,620	734,985	1,251,383	2,486,988
2029	10	6	4	500,620	734,985	1,251,383	2,486,988
2030	10	6	4	500,620	734,985	1,251,383	2,486,988
2031	10	6	4	500,620	734,985	1,251,383	2,486,988
2032	10	6	4	500,620	734,985	1,251,383	2,486,988

Differences between maintenance costs "without the project" and "with the project Option 1" correspond 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,

has not been taken into consideration in this analysis because their weight is reduced 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.

Consequently that amount has been computed as benefit in the calculation

9.1.2 Benefits from Safety devices works

Not applicable.

9.2 Option 2

Option 1 benefits derive from the upgrading works that will be carried out by the Contractor, with the materials party purchased by the Railway Administration. Moreover, additional benefits have been estimated in the "with project" maintenance, for the presence of purchased machines.

9.2.1 Benefits from Infrastructure works and machines

Running time savings

As calculated in chapter 5.5.3, the following time savings have been considered should Option 1 be carried out.

Table 9.2.1 – 1 Option 2 Time savings

Rehabilitation of the line Lugovaya-Balykchi - section Kazakh border-Balykchi		
Scenario	*Passenger trains (minutes)*	*Freight trains (minutes)*
2008-2012	*25*	*9*
2012-2022	*30*	*20*
After 2022 (*)	*40*	*50*

(*) After 2022, in the without project scenario, over about 250 km, due to Capital maintenance lack, additional 10km/h speed restrictions will be applied.

Benefits related to time savings As a consequence of the time savings a number of benefits have been included in the calculation. The methodological approach is given for Option 2.

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.

Table 9.1.1-2 estimated residual value for rails, sleepers and fastenings.

According to the age of the dismantled PW elements and their quantities, the following table 8.2.1-2 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 9.2.1 – 2 Option 2 PW residual

Rehabilitation of Border-Balykchi railway line - Border-Balykchi section Residual value for Option 2			
			Value ($)
Rails	replaced (t)	6,200.00	347,820.00
Wooden sleepers	replaced (n) 90%	127,100.00	
	20% re-usable (n)	25,420.00	177,940.00
Concrete sleepers	replaced (n) 10%	14,129.00	
	50% re-usable (n)	7,064.50	70,645.00
Fastenings	replaced (n)	141,000.00	
	20% re-usable (n)	28,200.00	169,200.00
			765,605.00

Total residual value: 765,605 $.

Infrastructure maintenance costs savings

Also for Option 2, according to the line maintenance procedures, to line maintenance costs per km per cycle and typology and according to the estimation of maintenance needs after the works have been completed, Consultant estimated the following maintenance costs.

Table 9.2.1 – 3 Maintenance costs related to Option 2

Rehabilitation works for Lugovaya-Balykchi Line (Border-Balykchi section)							
Line maintenance costs for OPTION 2							
Year	Required Maintenance (km)			Maintenance Costs (US$)			
	Lifting	*Medium*	*Capital*	*Lifting*	*Medium*	*Capital*	*Total*
2007	8	0	0	364,496	-	-	364,496
2008	8	0	0	364,496	-	-	364,496
2009	8	0	0	364,496	-	-	364,496
2010	8	0	0	364,496	-	-	364,496
2011	8	0	0	364,496	-	-	364,496
2012	8	0	0	364,496	-	-	364,496
2013	8	0	2	364,496	-	565,692	930,187
2014	8	4	2	364,496	449,990	565,692	1,380,177
2015	8	5	2	364,496	562,488	565,692	1,492,675
2016	8	5	2	364,496	562,488	565,692	1,492,675
2017	8	5	2	364,496	562,488	565,692	1,492,675
2018	8	5	2	364,496	562,488	565,692	1,492,675
2019	8	5	2	364,496	562,488	565,692	1,492,675
2020	8	5	3	364,496	562,488	848,537	1,775,521
2021	8	5	3	364,496	562,488	848,537	1,775,521
2022	8	5	3	364,496	562,488	848,537	1,775,521
2023	8	5	3	364,496	562,488	848,537	1,775,521
2024	8	5	3	364,496	562,488	848,537	1,775,521
2025	8	5	3	364,496	562,488	848,537	1,775,521
2026	8	5	3	364,496	562,488	848,537	1,775,521
2027	8	5	3	364,496	562,488	848,537	1,775,521
2028	8	5	3	364,496	562,488	848,537	1,775,521
2029	8	5	3	364,496	562,488	848,537	1,775,521
2030	8	5	3	364,496	562,488	848,537	1,775,521
2031	8	5	3	364,496	562,488	848,537	1,775,521
2032	8	7	3	364,496	787,483	848,537	2,000,516

It has been assumed that, in the years following the complete rehabilitation of line and stations, capital and medium maintenance will be suspended for about 20-25 years along the border-Bishkek section, while the minimum maintenance will be carried out for operating in safe conditions the section from Bishkek to Balykchi. Lifting and medium maintenance will be reduced at their minimum values.

In the case of "without project" scenario, maintenance needs have been quantified and their cost have been assessed in table 8.1.1-5.

Differences between maintenance costs "without the project" and "with the project Option 2" correspond the maintenance costs savings related to Option 2.

Also for Option 2 lighter maintenance cycles has not been taken into consideration in this analysis.

9.2.2 Benefits from Safety devices works

Not applicable. No safety devices envisaged by this Option.

9.3 Option 3

Option 3 benefits are divided in:

1. benefits deriving from the upgrading works related to infrastructure and power supply,
2. benefits deriving from the safety device systems.

9.3.1 Benefits from Infrastructure works

Running time savings

As calculated in chapter 5.6.3, the following time savings have been considered should Option 2 be carried out.

Table 9.3.1 – 1 Option 3 Time savings

Time savings Option 3 (border-Bishkek section)		
Scenario	*Passenger trains (minutes)*	*Freight trains (minutes)*
2008-2012	*25*	*9*
2012-2022	*30*	*20*
After 2022 (*)	*40*	*50*
Time savings Option 3 (Bishkek-Balykchi section)		
Scenario	*Passenger trains (minutes)*	*Freight trains (minutes)*
2008-2012	*65*	*55*
2012-2022	*70*	*56*
After 2022 (*)	*70*	*50*

Benefits related to time savings As a consequence of the time savings a number of benefits have been included in the calculation. The methodological approach is given for Option 2.

Replaced materials residual value

Table 9.3.1 – 2 Option 3 PW residual

Rehabilitation of Border-Balykchi railway line - Border-Balykchi section Residual value for Option 3			
			Value ($)
Rails	replaced (t)	27,896.00	1,564,965.60
Wooden sleepers	replaced (n) 90%	404,000.00	
	20% re-usable (n)	80,800.00	565,600.00
Concrete sleepers	replaced (n) 10%	45,000.00	
	50% re-usable (n)	22,500.00	225,000.00
Fastenings	replaced (n)	448,000.00	
	20% re-usable (n)	89,600.00	537,600.00
			2,893,165.60

Total residual value: 2,893,165 $.

Infrastructure maintenance costs savings

Also for Option 3, according to the line maintenance procedures, to line maintenance costs per km per cycle and typology and according to the estimation of maintenance needs after the works have been completed, Consultant estimated the following maintenance costs.

Table 9.3.1 – 3 Maintenance costs related to Option 3

Rehabilitation works for Lugovaya-Balykchi Line (Border-Balykchi section)							
Line maintenance costs for OPTION 3							
Year	Required Maintenance (km)			Maintenance Costs (US$)			
	Lifting	*Medium*	*Capital*	*Lifting*	*Medium*	*Capital*	*Total*
2007	0	0	0	-	-	-	-
2008	0	0	0	-	-	-	-
2009	0	0	0	-	-	-	-
2010	0	0	0	-	-	-	-
2011	0	0	0	-	-	-	-
2012	0	0	0	-	-	-	-
2013	0	0	0	-	-	-	-
2014	0	0	0	-	-	-	-
2015	0	0	0	-	-	-	-
2016	5	0	0	250,310	-	-	250,310
2017	5	1	0	250,310	122,498	-	372,807
2018	5	1	0	250,310	122,498	-	372,807
2019	5	1	0	250,310	122,498	-	372,807
2020	5	1	0	250,310	122,498	-	372,807
2021	5	1	0	250,310	122,498	-	372,807
2022	5	1	0	250,310	122,498	-	372,807
2023	5	1	0	250,310	122,498	-	372,807
2024	5	2	0	250,310	244,995	-	495,305
2025	5	2	0	250,310	244,995	-	495,305
2026	8	2	0	400,496	244,995	-	645,491
2027	8	2	0	400,496	244,995	-	645,491
2028	8	3	0	400,496	367,493	-	767,988
2029	8	4	0	400,496	489,990	-	890,486
2030	8	4	2	400,496	489,990	625,692	1,516,177
2031	8	5	2	400,496	612,488	625,692	1,638,675
2032	8	7	2	400,496	857,483	625,692	1,883,670

It has been assumed that, in the years following the complete rehabilitation of line and stations, capital and medium maintenance will be suspended for about 20-25 years, while lifting maintenance will be reduced at its minimum.

In the case of "without project" scenario, maintenance needs have been quantified and their cost have been assessed in table 8.1.1-5.

Differences between maintenance costs "without the project" and "with the project Option 3" correspond the maintenance costs savings related to Option 3.

Also for Option 3 lighter maintenance cycles has not been taken into consideration in this analysis.

9.3.2 Benefits from Safety devices system

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 exert impacts on:

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

As the Consultant'experts did not obtain reliable data of service quality (i.d. news about failures, accidents, delays, etc), in the continuation of this study, only the first three above benefits are treated.

Safety Devices Alternative 2

Decrease of operational needs

Alamedin, Kant, Tokmak will have no need of switchmen:

- The relative saving will be of 28 switchmen,
- The cost per unity may be evaluated of **1150 $/year,** (*see Annex IV Table C4.1:Kyrghyz cost for operational unit),*
- Operational cost saving will be **32200** $/year.

Decrease of maintenance needs

Accordingly above Specifications, the present ordinary maintenance need for the interlocking of Alamedin, Kant, Tokmak and Balykchi may be evaluated in 8 man *(Annex IV table F.1).*

As the new interlocking will be put in the place of others whose life times expired since more 5-10 years, we can evaluate the maintenance need equal the basic (5 man- *Annex IV table F.1*) with a 3 unities saving.

With the investment will occur as well:

- Reduction of major maintenance,
- Decrease of materials of ordinary maintenance,

- Decrease of failures.

The overall cost saving of the above three points can be evaluated at least of about 10% of present need. (i.e. about 1 man, *see Annex IV table F.1*)

The relative saving will be the cost of 4 unities.

The average cost per unity may be evaluated of **1682 $/year** (*see Annex IV table C.4* cost for maintenance unit).

Therefore, maintenance cost saving will be **6728** $/year.

Safety Devices Alternative 3

Benefits with the investments of Alternative 3 can be shown as follow:

Decrease of operational needs

Saving of traffic operators in Alamedin(4), Kant(4), Tokmak(3), Ivanovka(4), Bistrovka(4), Djil-Aryk(2), R. 148(2), Kayamat – Kurkol(2). Total saving: 25 unities.

The cost per unity may be evaluated of **1645 $/year**

Therefore operational cost saving will be 41125 $/year (Traffic operators)

Saving of station masters in, Ivanovka, Bistrovka, Djil-Aryk, R. 148, Kayamat – Kurkol

5 stations x 1 = 5

The cost per unity may be evaluated of **2513 $/year**

Therefore operational cost saving will be 14670$/year (Station masters).

Total operational cost saving **55795** $/year, (in addition to costs saving referred to the measures adopted in Option 2).

Decrease of maintenance needs

A. Line block systems (*Annex IV table E*)

A1.Automatic block

Foreseen needs:

- Electromechanics: 6
- Electrical engineers: 3,5

A2. Manual block:

Present needs:

- Electromechanics: 5
- Electrical engineers: 3

Therefore, major need with the new automatic block is 1,5 man.

B. New interlocking:

In accordance with the above Specifications, the present maintenance need for the interlockings of Bishkek 2, Ivanovka, Bistrovka, Djil-Aryk, R148, Kayamat-Kurkol may be evaluated in **22** man. (*see Annex IV table F.2).*

As the new interlocking will be put in the place of others whose life times were expired since more than 5-10 years, we can evaluate the future maintenance need equal the basic (**14** man, see *Annex IV table F.2*).

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 *Annex IV table F.2* (1,5 man).

The cost saving for the renewal of the ancient relay interlocking systems. is than the cost of about 9,5 man.

The total cost saving is than the cost of 9,5-1,5=8 man plus costs saving referred to the measures adopted in S.D. Alternative 2.

The average cost per unity may be evaluated of 1682 $/year

Therefore, maintenance cost saving will be **13456** $/year, (in addition to costs saving referred to the measures adopted in Alternative 2).

Total costs saving

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

Table 9.3.2 – 1 Total cost savings for safety devices

Safety devices Cost savings	
Labour saving	**costs**
	($/year)
S.D. Alternative 2	
operational	**32,200**
maintenance	**6,728**
Total Option 2	**38,928**
S.D. Alternative 3	
operational	**87,995**
maintenance	**20,184**
Total Option 3	**108,179**

"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" situations relate to the costs and benefits arising from the realization of both the Project alternatives.

The "with project" scenarios (that are referred to the section from Bishkek2 to Balykchi) involve **for both alternatives**

- the modernisation of the Mechanical Key Dependence Interlocking Installations by the activation of electronic systems.

In addition the second alternative envisages:

- the renewal of the ancient Electric Relay Interlocking Installations(ERII) of the whole section from Bishkek2 to Balykchi by the activation of electronic systems (indoor devices).;
- the activation of Automatic Block Line Systems (ABLS) and Cab signalling of the whole section
- the insertion of the section into a new Central Post (P.C.) structured such as to progressively accept the management of other sections of the Kyrgyz lines;
- the same P.C. must ensure the co-ordination of preventive and corrective maintenance intervention on the basis of traffic situation and with the help of diagnostics systems.

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 Kyrghystan and it is inconceivable that the Government 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.

Also as regard the possible implementation of the new rail link between the two parts of present national network (and Kashkar in China) a "without Project" Scenarios of the Lugovaya- Bishkek-Balykchi would impose a severe strain on the country economy.

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 shown in the following table.

Table 9.3.2-2 Structure of current safety devices maintenance costs

Cost item	share
Material	15 %
Energy	1%
Maintenance services	2%
Remuneration in connection with work	4%
Wages and compensations	41%
Other costs	5%
Overhead costs	32%
Total	100%

Therefore wages and remuneration in connection with work are the 45% of the total maintenance cost for signalling.

(The same evaluation we find on Norms of Technological designing of devices of automatics and telemechanics on the railway transport, Moscow, Ministry of Railways, 1985)

In our line section (Bishkek2-Balykchi) the labour costs can be evaluated, accordingly to Table F in Annex IV, in 30 x 1682 =50460 $/year therefore the total cost of current maintenance sum to 112.133 $/year and above extra costs may be roughly estimated in 28.000 $/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 projects has been performed by assessing the social value of the project which is summarised by the following indicators:

- Net Present Value (NPV)
- Benefit/Cost Ratio (BCR),
- Internal Rate of Return (IRR).

These indicators result from the calculation, year-by-year, of the net benefits generated by each proposed project against the "base case" option, duly actualised at a base-year to ensure the necessary inter-temporal comparison of monetary flows occurring in different years.

The use of the above mentioned indicators allows for a comparison between alternative projects and a consequent ranking.

In the evaluation process the following common parameters have been defined.

- discount rate
- appraisal period
- base year for price and values.

In the following table are presented some assumptions and common parameters used in the evaluation process of the different alternatives:

Currency unit	US$
Implementing start year	2007
Implementing period (years)	Depending on the option
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 3 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 (20%) while import taxes have non been considered in that evaluation. No standard conversion factor have been used for shadow-pricing components of the costs.

In the Option 1 and Option 2, the implementation require at the beginning of the project the purchase of the machineries necessary to executing the rehabilitation. Since in both cases such machineries are property of the Kyrgyz Railways, the related residual value has been included at the end of the implementation period and conservatively estimated to be 50% of the initial one.

Timing of implementation has been previously duly described.

The results of the economic evaluation for the project alternatives are shown in Table 9.2-1, Table 9.2-2 and Table 9.2-3.

TABLE 9.2 -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	12.000,0	-	-	1.715,0	-	-	-	- 9.183,0
3	2008	4.136,9	-	161,0	1.534,8	-	207,2	-	- 10.963,9
4	2009	4.136,9	21,0	161,0	1.534,8	109,3	211,7	-	- 12.458,1
5	2010	4.136,9	83,8	161,0	1.787,2	327,8	216,2	-	- 13.450,1
6	2011	4.136,9	188,6	161,0	1.241,7	655,6	220,6	-	- 14.397,4
7	2012	- 6.000,0	335,2	-	673,9	1.092,7	225,1	-	- 10.178,6
8	2013	-	350,3	-	1.445,3	1.150,3	226,5	-	- 8.743,6
9	2014	-	365,4	-	1.445,3	1.207,8	227,9	-	- 7.432,4
10	2015	-	380,4	-	1.445,3	1.265,3	229,3	-	- 6.235,0
11	2016	-	395,5	-	1.445,3	1.322,9	230,7	-	- 5.142,1
12	2017	-	410,5	-	1.085,3	1.380,4	232,1	-	- 4.248,6
13	2018	-	425,6	-	1.085,3	1.437,9	233,5	-	- 3.431,7
14	2019	-	440,7	-	1.085,3	1.495,4	234,9	-	- 2.685,4
15	2020	-	455,7	-	608,8	1.553,0	236,3	-	- 2.101,5
16	2021	-	470,8	-	678,5	1.610,5	237,7	-	- 1.553,9
17	2022	-	485,9	-	496,3	2.178,7	262,8	-	- 995,4
18	2023	-	485,9	-	496,3	2.178,7	262,8	-	- 496,7
19	2024	-	485,9	-	496,3	2.178,7	262,8	-	- 51,5
20	2025	-	485,9	-	496,3	2.178,7	262,8	-	346,0
21	2026	-	485,9	-	496,3	2.178,7	262,8	-	700,9
22	2027	-	485,9	-	496,3	2.178,7	262,8	-	1.017,8
23	2028	-	485,9	-	496,3	2.178,7	262,8	-	1.300,7
24	2029	-	485,9	-	496,3	2.178,7	262,8	-	1.553,3
25	2030	-	485,9	-	496,3	2.178,7	262,8	-	1.778,9
26	2031	-	485,9	-	496,3	2.178,7	262,8	-	1.980,3
27	2032	-	485,9	-	316,3	2.178,7	262,8	-	2.150,6
28	2033	-	485,9	-	316,3	2.178,7	262,8	-	2.302,7
29	2034	-	485,9	-	316,3	2.178,7	262,8	-	2.438,6
30	2035	-	485,9	-	316,3	2.178,7	262,8	-	2.559,8
31	2036	-	485,9	-	316,3	2.178,7	262,8	-	2.668,1
32	2037	-	485,9	-	316,3	2.178,7	262,8	-	2.764,7
33	2038	-	485,9	-	316,3	2.178,7	262,8	-	2.851,1
34	2039	-	485,9	-	316,3	2.178,7	262,8	-	2.928,1
35	2040	-	485,9	-	316,3	2.178,7	262,8	-	2.996,9

IRR =	14,1%
NPV (12%) =	2.996,9
BCR =	1,16

TABLE 9.2-2 – 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	20.722,8	-	278,4	1.074,3	-	-	-	- 17.294,8
3	2008	8.722,8	79,8	278,4	1.611,4	373,9	207,2	-	- 22.215,2
4	2009	6.542,1	170,0	208,8	2.148,5	625,5	211,7	-	- 24.477,0
5	2010	- 6.000,0	300,6	-	2.148,5	920,3	216,2	-	- 18.385,3
6	2011	-	317,9	-	2.148,5	1.006,5	220,6	-	- 16.289,4
7	2012	-	335,2	-	2.148,5	1.092,7	225,1	-	- 14.363,4
8	2013	-	350,3	-	1.696,0	1.201,3	228,9	-	- 12.790,8
9	2014	-	365,4	-	1.336,0	1.309,9	232,7	-	- 11.480,6
10	2015	-	380,4	-	1.246,0	1.418,5	236,4	-	- 10.297,3
11	2016	-	395,5	-	1.246,0	1.527,1	240,2	-	- 9.199,8
12	2017	-	410,5	-	1.246,0	1.635,7	244,0	-	- 8.183,2
13	2018	-	425,6	-	1.246,0	1.744,3	247,8	-	- 7.242,9
14	2019	-	440,7	-	1.246,0	1.852,9	251,5	-	- 6.374,1
15	2020	-	455,7	-	769,4	1.961,5	255,3	-	- 5.669,8
16	2021	-	470,8	-	569,2	2.070,1	259,1	-	- 5.054,2
17	2022	-	485,9	-	569,2	2.178,7	262,8	-	- 4.483,9
18	2023	-	485,9	-	569,2	2.178,7	262,8	-	- 3.974,6
19	2024	-	485,9	-	569,2	2.178,7	262,8	-	- 3.519,9
20	2025	-	485,9	-	569,2	2.178,7	262,8	-	- 3.114,0
21	2026	-	485,9	-	569,2	2.178,7	262,8	-	- 2.751,5
22	2027	-	485,9	-	569,2	2.178,7	262,8	-	- 2.427,9
23	2028	-	485,9	-	569,2	2.178,7	262,8	-	- 2.138,9
24	2029	-	485,9	-	569,2	2.178,7	262,8	-	- 1.880,9
25	2030	-	485,9	-	569,2	2.178,7	262,8	-	- 1.650,5
26	2031	-	485,9	-	569,2	2.178,7	262,8	-	- 1.444,9
27	2032	-	485,9	-	389,2	2.178,7	262,8	-	- 1.270,7
28	2033	-	485,9	-	389,2	2.178,7	262,8	-	- 1.115,1
29	2034	-	485,9	-	389,2	2.178,7	262,8	-	- 976,3
30	2035	-	485,9	-	389,2	2.178,7	262,8	-	- 852,3
31	2036	-	485,9	-	389,2	2.178,7	262,8	-	- 741,6
32	2037	-	485,9	-	389,2	2.178,7	262,8	-	- 642,8
33	2038	-	485,9	-	389,2	2.178,7	262,8	-	- 554,5
34	2039	-	485,9	-	389,2	2.178,7	262,8	-	- 475,7
35	2040	-	485,9	-	389,2	2.178,7	262,8	-	- 405,4

IRR =	11,8%
NPV (12%) =	-405,4
BCR =	0,98

TABLE 9.2-3 – Economic evaluation of Option 3

		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	19.784,4	-	560,0	944,6	-	-	-	- 16.321,3
3	2008	19.784,4	66,5	560,0	1.416,8	854,5	533,0	-	- 29.358,2
4	2009	19.784,4	204,0	560,0	1.889,1	1.363,3	544,0	-	- 40.194,4
5	2010	19.784,4	412,4	560,0	2.361,4	1.926,5	554,9	38,9	- 49.022,6
6	2011	19.784,4	691,9	560,0	2.440,1	2.543,9	565,9	40,9	- 56.342,9
7	2012	3.297,4	833,9	46,7	2.440,1	2.769,1	576,8	42,9	- 54.592,5
8	2013	-	849,3	-	2.440,1	2.894,6	585,8	45,1	- 51.489,4
9	2014	-	864,7	-	2.440,1	3.020,0	594,7	47,3	- 48.656,5
10	2015	-	880,1	-	2.440,1	3.145,5	603,6	49,7	- 46.071,4
11	2016	-	895,6	-	2.239,9	3.271,0	612,5	52,2	- 43.777,9
12	2017	-	911,0	-	2.141,9	3.396,5	621,4	54,8	- 41.713,8
13	2018	-	926,4	-	2.141,9	3.521,9	630,3	57,5	- 39.830,9
14	2019	-	941,9	-	2.141,9	3.647,4	639,2	60,4	- 38.114,1
15	2020	-	957,3	-	1.891,6	3.772,9	648,1	63,4	- 36.600,6
16	2021	-	972,7	-	1.691,3	3.898,4	657,0	66,6	- 35.257,3
17	2022	-	988,2	-	1.691,3	4.023,8	665,9	69,9	- 34.032,4
18	2023	-	988,2	-	1.691,3	4.023,8	665,9	69,9	- 32.938,7
19	2024	-	988,2	-	1.593,3	4.023,8	665,9	69,9	- 31.975,0
20	2025	-	988,2	-	1.593,3	4.023,8	665,9	69,9	- 31.114,5
21	2026	-	988,2	-	1.473,2	4.023,8	665,9	69,9	- 30.358,7
22	2027	-	988,2	-	1.473,2	4.023,8	665,9	69,9	- 29.683,8
23	2028	-	988,2	-	1.375,2	4.023,8	665,9	69,9	- 29.089,4
24	2029	-	988,2	-	1.277,2	4.023,8	665,9	69,9	- 28.565,9
25	2030	-	988,2	-	776,6	4.023,8	665,9	69,9	- 28.131,4
26	2031	-	988,2	-	678,7	4.023,8	665,9	69,9	- 27.749,3
27	2032	-	988,2	-	482,7	4.023,8	665,9	69,9	- 27.418,4
28	2033	-	988,2	-	482,7	4.023,8	665,9	69,9	- 27.122,9
29	2034	-	988,2	-	482,7	4.023,8	665,9	69,9	- 26.859,1
30	2035	-	988,2	-	482,7	4.023,8	665,9	69,9	- 26.623,6
31	2036	-	988,2	-	482,7	4.023,8	665,9	69,9	- 26.413,3
32	2037	-	988,2	-	482,7	4.023,8	665,9	69,9	- 26.225,6
33	2038	-	988,2	-	482,7	4.023,8	665,9	69,9	- 26.057,9
34	2039	-	988,2	-	482,7	4.023,8	665,9	69,9	- 25.908,2
35	2040	-	988,2	-	482,7	4.023,8	665,9	69,9	- 25.774,6

IRR =	6,5%
NPV (12%) =	-25.774,6
BCR =	0,64

10.3 Ranking of alternative solutions

The results of the economic assessment of the three 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, Option 2 and Option 3 are compared.

	Option 1	***Option 2***	***Option 3***
IRR	14.1%	11.8%	6.5%
NPV (12% ml US$)	2.97	-0.4	-25.7
BCR	1.16	0.98	0.64

Options present 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, rolling stock maintenance and signaling.

Obviously the nature of the improvement doesn't allow changes in the tariff policy, consequently financial indicators are the following:

	Option 1	***Option 2***	***Option 3***
IRR	9.2%	6.7%	6.7%
NPV (6% ml US$)	9.3	2.7	5.6
BCR	1.34	1.07	1.06

It is worth mentioning that the financial rate of return is in any case well over the reference discount rate of 6%. This means that the investment is profitable.

The three options record a positive output form the analysis but it worth mentioning that Option 1 is remarkably the best option considered in the present study.

The solution is also the cheapest one and so in line with resources available to the Kyrgyz Railways which make necessary the use of external funds for the rehabilitation.

Nevertheless a financing mechanism should be carefully studied also taking into account data concerning the financial performance of the Kyrgyz Railways in last years.

Information on the financial situation in recent years was requested from the Kyrgyz Railways but no data could be obtained so far. The Consultant was informed that such information is restricted and cannot be released for the purpose of implementing the project.

The following table presents the best data that could be found on the revenues of the Kyrgyz Railways but the figures could not be confirmed by that organization.

Traffic Type	**1999**	**2000**	**2001**	**2002**	**2003**
Freight traffic	98	117	140	162	217
Passenger traffic	16	26	29	22	24
Total	**114**	**143**	**169**	**184**	**241**
Exchange rate Som/USD	*39.02*	*47.72*	*48.44*	*46.92*	*43.69*
Equivalent million USD	2.93	2.99	3.48	3.93	5.51

According to the above figures there was a substantial increase in revenues in recent years what is well in line with the increase in traffic volume. Revenues from passenger traffic represent only a small fraction of the total. It went down from 18% in 2000 to 10% in 2003.

The KR are said to have constantly made a profit since it was formed in 1992 on the basis of a section of the former Almatinski Railways. However this profit has been small. Moreover as for other railways in the area it has been overstated by counting amortization at an artificially low value instead of basing it on renewal costs. In recent years an important part of the profit was used for the construction of a new line from Balykshi in direction of Kochkor but the works went very slow due the shortage of funds. A competing use could be the construction of a optical-fiber cable along the railway line that is under serious consideration.

It is acknowledged that passenger traffic has been a drain on railway revenue. It is cross-financed from the revenues on international freight traffic.

In any case it is clear that the railways have not the internal resources to finance major rehabilitation works. In such a case they should rely on external financing. Since they are state organization any financing arrangement should get the agreement of the Ministry of Finances.

Information on the present policy could be obtained from the Department of Investment Policy of that ministry. The present international financial situation of the Kyrgyz Public is not conducive to additional borrowing. The international debt could be as high as 2 billion dollars that is more that the GDP. Some relief is expected from the Paris Club by the way of a rescheduling of the debt reimbursement. But this could be only a short-term measure that cannot make up for the fact that the trade balance has deteriorated with a deficit reaching USD 135 mn in 2003 with a coverage of import by export of 81% only. The preliminary figures for 2004 show that the deficit should be close to USD 200 mn.

According to IMF international borrowing should not be more that 3 – 3.5% whereas it reached 12% in 2000. As a result debt servicing consumes now over 30% of the national budget. Belt tightening has therefore become inevitable.

Concerning the rehabilitation of the railways several forms of financing could be envisaged.

- Loan from IFIs. This is made more difficult than in the mid-nineties when the Kyrgyz Republic started borrowing from ADB for the rehabilitation of the Bishkek-Osh Highway. Now the loans are subject to strict limitation. Not only they should be concessional but 45%

should come in form of grant. Particular banks have anyway a ceiling such as the Islamic Bank of Development that would not finance a project of over USD 10 million in Kyrgyzstan.
- Grant from countries such as Japan. Even if the railways could get attention from a donor it would not necessary get the agreement from the Ministry of Finances. It became clear when a Japanese grant that had been considered for the renewal of the wagon fleet went in the end to the procurement of machinery for agriculture.
- Supplier credit. This could be the case for instance if the railways want to procure tamping machines. However even in this case the Ministry of Finance has a say.
- If a grant is obtained from a tied sectoral programe such as TRACECA it is unlikely that it will face obstacles. But approval is still required because privileges such as duty-free import of equipment are normally granted.

The Ministry of Transport and Communication is aware of the constraints put by the Ministry of Finance. They are however willing to support requests for financing made by the railways.

Such support seems to be rather logical since, besides financial difficulties and constraints, the strategic importance of the Balykchi – Lugovaya railway line for the Kyrgyz economy is out of discussion. That line is, as a matter of facts, the only rail connection supporting the north of the country and the eventual closure will certainly result into difficulties for the whole economy.

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:

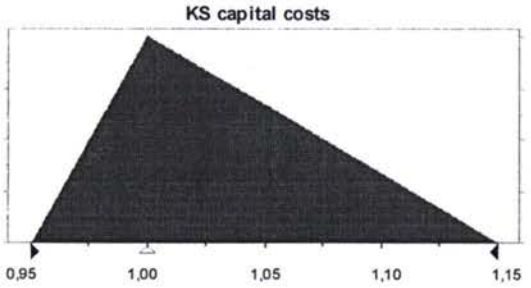
- capital cost
- benefit for users because of time savings
- benefit related to the residual value recovering
- track maintenance savings
- benefit for the operator for optimisation of the rolling stock because of the time savings
- benefits for the operators for fuel consumption because of the time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

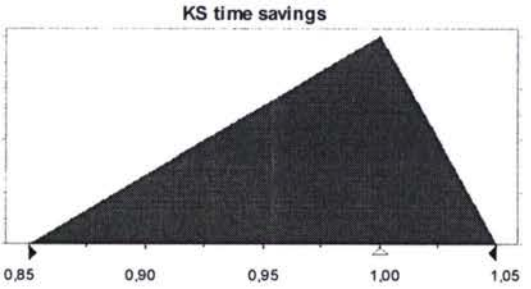
the basic evaluation is not the average value of the distribution range, but rather the mode (likeliest value) of the distribution.

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:

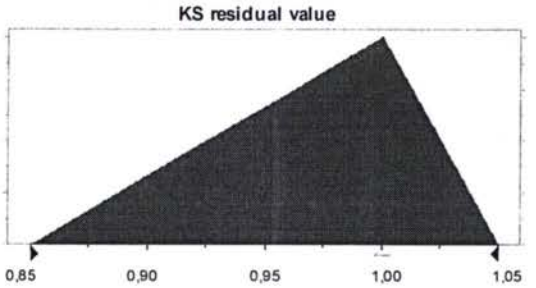
- for capital cost an asymmetric triangular distribution has been assumed with a variation between –5% and +15% from the estimated base value; this should be very conservative since 5% for contingencies has been already included in capital cost estimation;



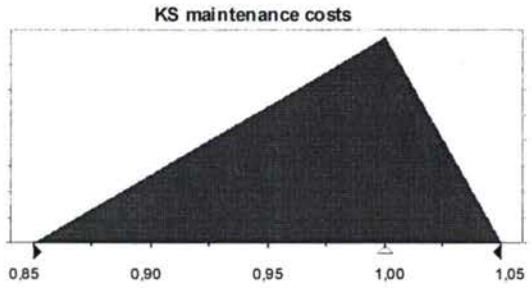
- for benefits to the user because of time savings it has been used an asymmetric triangular distribution variable between –15% and +5% from the estimated base value;



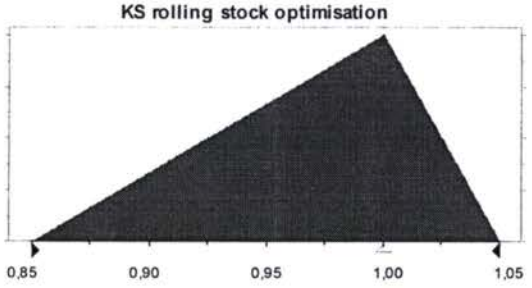
- for benefits related to residual value recovering an asymmetric triangular distribution has been assumed with a variation between –15% and +5% from the estimated base value.



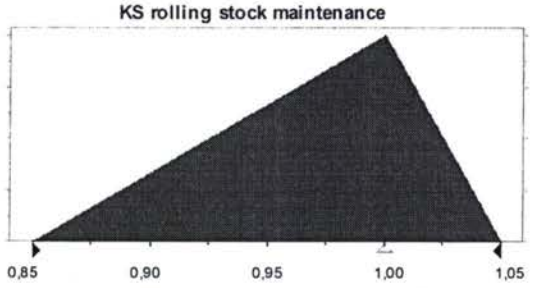
- for track maintenance savings an asymmetric triangular distribution has been assumed with a variation between -15% and +5% from the estimated base value.



- for benefits for optimisation of rolling stock use an asymmetric triangular distribution has been assumed with a variation between -15% and +5% from the estimated base value.



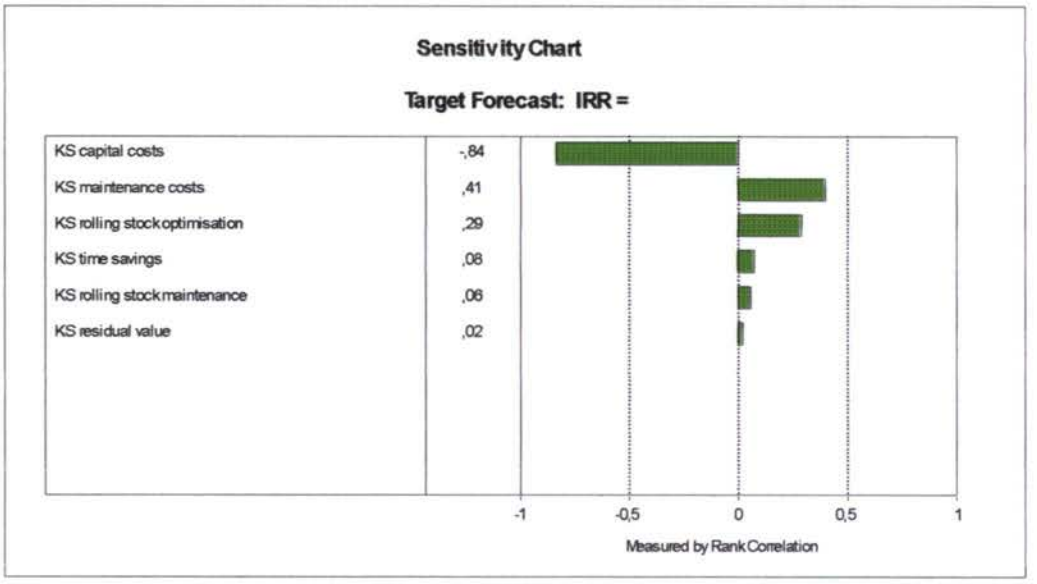
- for benefits for rolling stock maintenance due to the welding of rails an asymmetric triangular distribution has been assumed with a variation between -15% and +5% from the estimated base value.



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.

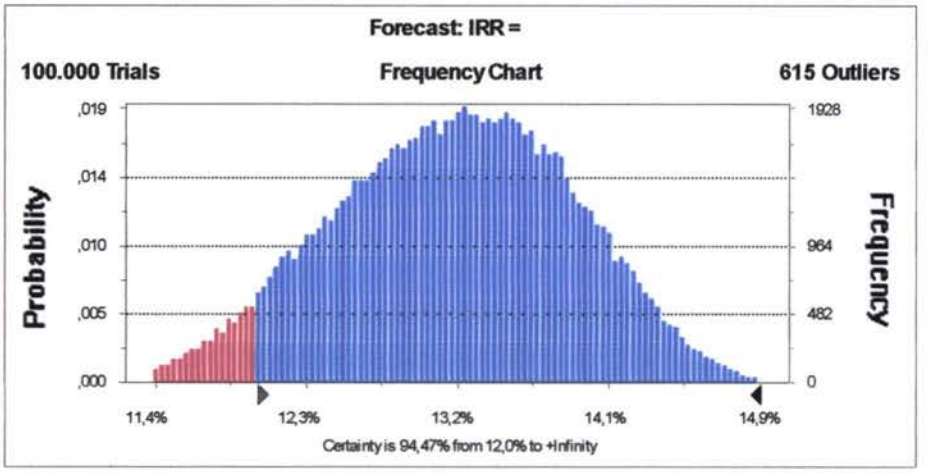
The following chart shows the sensitivity of IRR in regard to probability distributions of the key input variables.



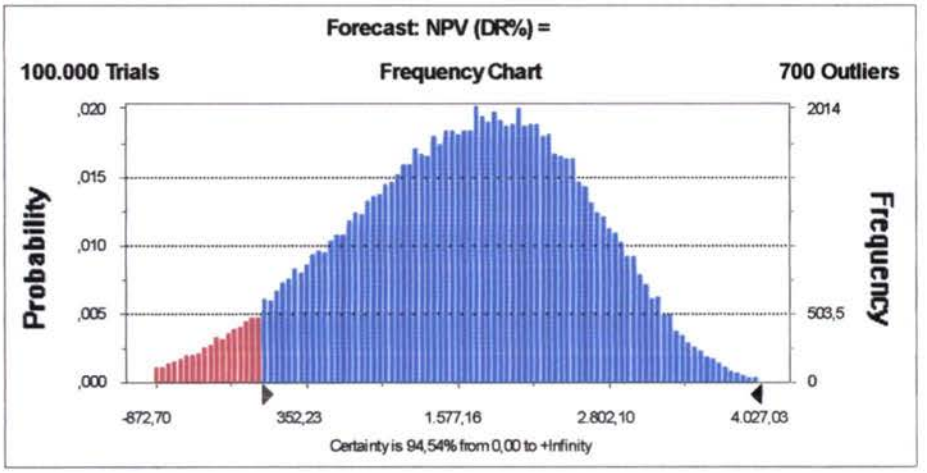
The calculations show, without considering outliers, that the combined probability that the economic indicators of the project are higher than the threshold values for the stability area; the stability are being: 12% for IRR, 0 for NPV(12%) and 1 for BCR.

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

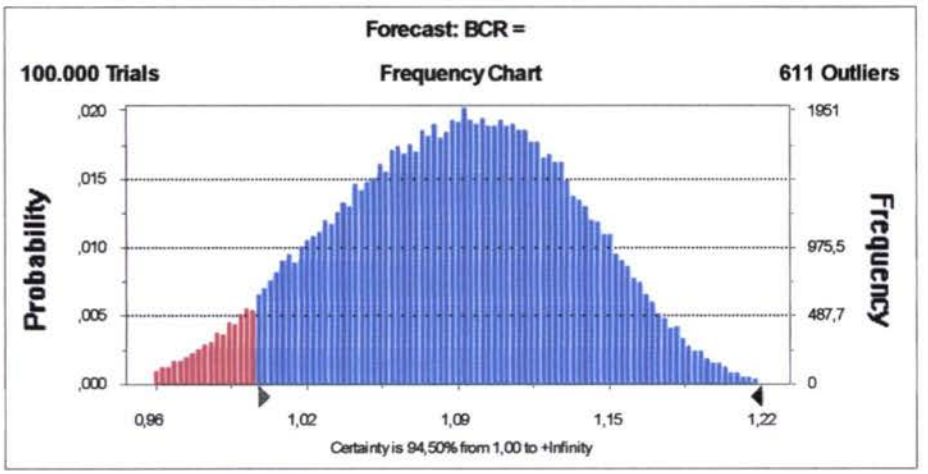
IRR is over 12% in the 94,47% of observed cases.



NPV is over 0 in the 94,54% of observed cases.



BCR is over 1 in the 94,50% 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%	10,6%	-2.152,65	0,90
10%	12,2%	312,37	1,02
25%	12,7%	979,17	1,05
50%	13,2%	1.705,27	1,09
75%	13,7%	2.348,18	1,12
90%	14,1%	2.857,28	1,15
100%	15,3%	4.425,12	1,25

The solution is over the stability threshold in more than the 94% of cases, which means that the sensitivity analysis has shown that the result of the economic analysis is absolutely 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 5% of the capital cost has been included as contingencies. This means that excluding the double counting (5% of contingencies and subsequently up to 15% in the probabilistic distribution) the solution is always over the threshold and so it is stable.

11. Conclusions

The present Feasibility Study for rehabilitation measures for the Kazakh Border – Bishkek – Balykchi railway sections has taken into consideration the following rehabilitation options:

Option 1 *represents the proposed low cost option, mainly consisting in provision of PW materials, machines and plants that would permit to face the most urgent necessities of the line, as well as in building the indispensable structures that guarantee the line protection from land-slides. It would allow the acceleration of the capital maintenance of the remaining network putting at disposal recovered rails and machines to implement works with Kyrgyz railways personnel.*

Option 2 *only regards border-Bishkek line section. On this first section the Option 2 foresees the replacement of wooden sleeper with concrete ones, the installation of P65 cwr on the main line, included the stations, new layers of ballast and subballast, tg1/11P65 turnouts on the main lines of stations from the border to Bishkek 2.*

Option 2 also includes provision of machines and sleeper plant as well as in building the indispensable structures that guarantee the line protection from land-slides.

Option 2 has been thought in order to be carried out by a Contractor, but, for reducing materials costs, Railway Administration will purchase materials directly.

Option 3 *represents the most impacting solution to upgrade all the considered line, that is from Kazak border to Balykchi, if traffic forecast on the last section would greatly increase for some of the above mentioned reasons (see Option 2) or for other ones presently not expected. Besides all the interventions listed in Option 2, Option 3 considers moreover the demolition of the existing PW, cutting and reconstruction of sub-ballast and ballast layers, installation of concrete sleepers and P65 rails, included the main lines of stations, replacement of the existing turnouts with P65tg1/11 type switches on all the Bishkek 2 – Balykchi station main lines, construction of 2,000 m of wall for line protection in Boomsk gorge stretch.*

Machines and sleeper plant are not included in Option 3. Contractor will use its own machines for the development of the works.

Option 3 foresees two different alternatives as far as concerns safety devices:,

S.D. Alternative 2: it consists on the replacement of the existing Mechanical Key Dependence Interlocking Installations in four stations of the Bishkek-Balykchi section with computer aided remote controlled interlockings. Alternative 3: it consists on the installation of new computer aided interlockings in the remaining stations of the Bishkek-Balykchi section and arrangement of the equipment for remote station control, Automatic Block Line Systems (ABLS) and Cab signalling all along Bishkek – Balykchi line section, insertion of same into a new Central Post that must provide traffic and maintenance operations (included peripheral and central devices for remote control).

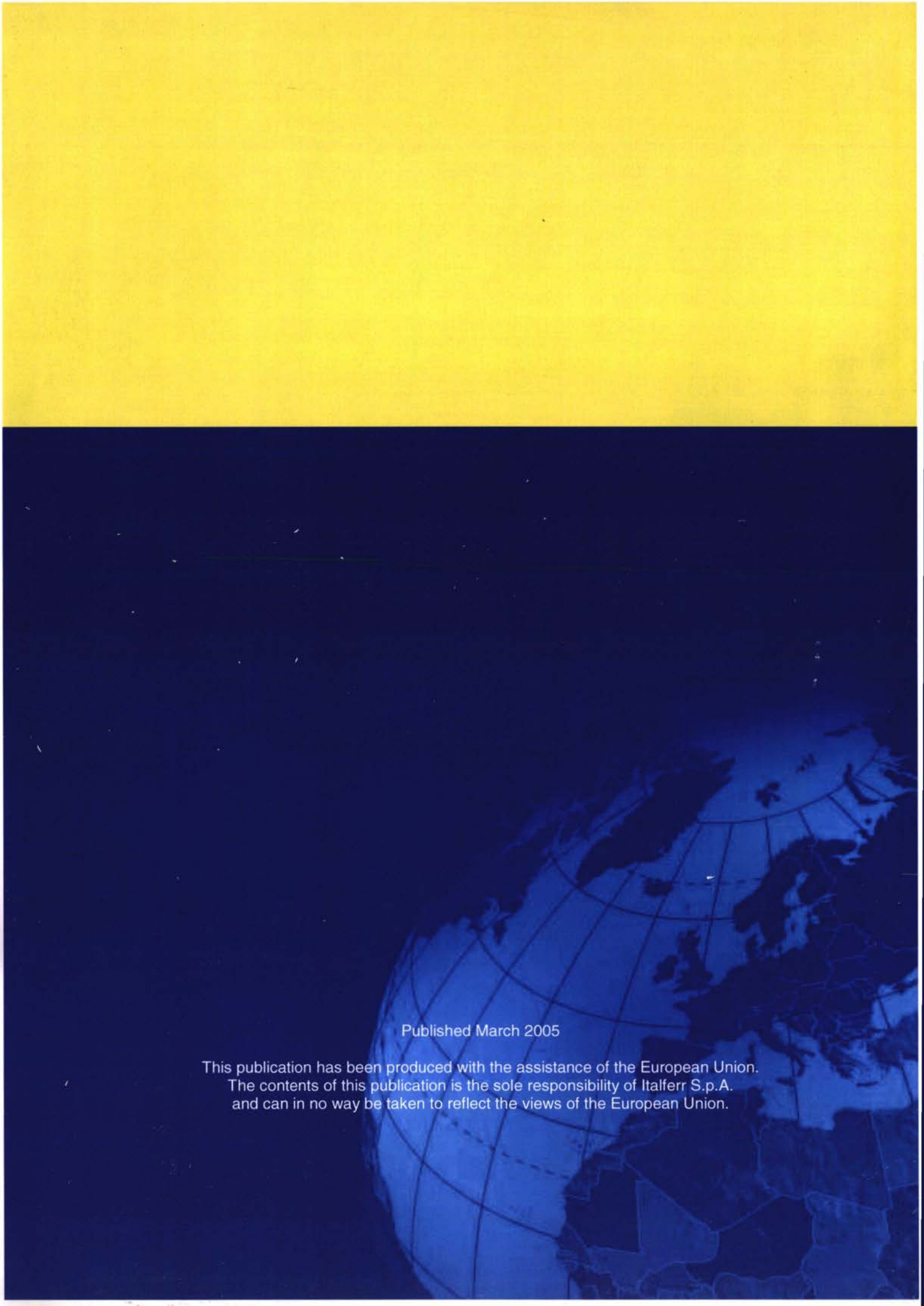
Consequently the economical analysis has been used for selecting the most convenient one between the three options.

As previously mentioned the Option 1 seems to be the most advantageous one in economic terms and so it is recommended for the implementation. The option is also the cheapest one and also this financial aspect is important due to the lack of fund of the Kyrgyz Railways.

Nevertheless the line is the only railway connection in the north of the country and the more important in the whole country. The line is of strategic importance for Kyrgyzstan and for its economy. Improvements are consequently required for the line not to act as a bottleneck for the economic activities, to give access to the international markets and to connect Bishkek with the regional market.

Additional to that, Kyrgyzstan has not a railway linking northern cities (i.e. Bishkek) with the southern ones (i.e. Osh, Jal Alabad) and actually transport demand uses either road or the railway Balykchi – Bishkek - Lugovaya and then up to the south crossing Kazakhstan, Uzbekistan and also Tajikistan.

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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