Tacis

Rail Maintenance Central Asia:
Infrastructure Maintenance 2

Draft Final Report

July 1997

Module A

DRAFT FINAL REPORT

Project Title :	TRACECA Rail Maintenance Central Asia: Infrastructure Maintenance 2	
Project Number:	TNREG 9310	
Country:	Kazakhstan, Turkmenistan, Kyrgyzstan, Tadjikistan, Uzbekistan	
	Local operator	EC Consultant
Name:	KAZGIPROZHELDORTRANS	DE-Consult in association with ARE and SYSTRA
Address:	ul. Pushkina 2 480016 Almaty Kazakhstan	Mittelstraße 5/5a D-12529 Schönefeld bei Berlin, Germany
Tel. number :	(+7 3272) 30 44 87, 60 47 28	(+49 30 6343 1108)
Fax number:	(+7 3272) 30 44 87	(+49 30 6343 1055)
Telex number:	none	none
Contact person:	Valeri I. Kasyanov	Project Director: Peter Kulke Team Leader: Norman D. Griffiths Project Manager: Frank Prescha
Signatures:		

Date of report : July 1997

Reporting period : July 1996 - July 1997

Authors of report : N. D. Griffiths, Team Leader
F. Prescha, Project Manager

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

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia.

Module A

Feasibility Study for Upgrading the Aktau-Bejneu Line in Kazakstan

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table of Contents

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Executive Summary

Having completed both technical and economic evaluations of the Aktau-Bejneu route, the following points summarise the Consultant's principal findings.

Future Regional Economic Activity and Future Traffic Levels

The scenario prognoses postulate an increase — roundly — from a present level of 2 million tonnes of freight to between 8.1 million tonnes and 14.2 million tonnes by the year 2005, depending on the actual level of economic activity. At the same time, the demand for passenger traffic will grow from the present two train pairs per day to a future three pairs.

Risks and Assumptions

The expected level of future economic activity in the region clearly has a major impact on the expected level of traffic on the route. However, the majority of plans for investment to secure such future activity are **projected by Government** rather than private industrial investors and this aspect must therefore be considered to have a high degree of risk associated with it. This is particularly the case for those projected investments which date from the time prior to the break-up of the USSR.

The Consultant wishes to draw attention to the uncertainty of attempting to project future economic activity in an environment such as that in Kazakstan, where there is little experience of market economic processes.

Physical Condition of the Rail Route

The surveys undertaken by the Consultant show that:

infrastructure: there is a serious backlog of maintenance which results in the imposition of many temporary speed restrictions; investment is required to restore the line to good condition thereby eliminating these restrictions. This elimination in itself will lead to an increase in line capacity

signalling: the signalling system is generally in good condition and functions satisfactorily. However, the poor availability of suitable spare parts is a cause for concern and dictates that replacement by a new system using standard components will be required in the medium term.

telecommunications: as with the signalling system, the telecommunications network is generally in good condition, but suffers from obsolescence, and will need to be replaced by a modernised system in the medium term. This will also affect installations outside the strict confines of the rail route, since there is extensive communication with headquarters in Atyrau and Aktyubinsk.

traction and rolling stock: the locomotive fleet is obsolescent and, though generally in good condition, a programme to re-engine the units is proposed. Passenger rolling stock is generally in good condition but suffers from inadequate maintenance facilities. In the case of both locomotives and carriages, there is a shortage of suitable spare parts and tools which needs to be addressed. Freight rolling stock is 'common user', is not maintained on the route and is exchanged on a constant basis.

Route Capacity in Relation to Traffic Forecasts

The route is technically capable of accommodating all traffic levels up to and including the most optimistic scenario (19 train pairs per day), without any further investment. However, this statement does not take into account the steady deterioration in the technical condition of the route, particularly its infrastructure, and this deterioration can be expected to accelerate over the next few years. Nevertheless, assuming that the remedial measures for infrastructure are implemented, the other measures required are in anticipation of future problems rather than in response to existing difficulties.

There is, therefore, **no requirement** to invest in such measures as **electrification**, **track doubling** or **new construction** in order to meet future traffic demand up to 2005.

Organisation:

A major obstacle to the smooth operation of freight and passenger trains between the Port of Aktau and the junction station of Bejneu is the fact that the first 18 km of route, from Aktau to Mangyshlak, are not owned by the state railways of Kazakstan (in this case the West Kazakstan Railway — WKR), but by an industrial organisation known as KASKOR. This effectively precludes through operation of freight trains from origin to destination by one haulier, and prevents WKR passenger trains reaching their natural traffic objective at Aktau.

The Consultant therefore **strongly recommends** that the trunk route of the Aktau-Mangyshlak railway be transferred — by purchase if necessary — to the WKR. Failing this, **running powers** for WKR trains should be granted by KASKOR for the Mangyshlak-Aktau section.

Financial Analysis:

From figures provided by the West Kazakstan Railway for 1995 and part of 1996, it is estimated that the Aktau - Bejneu line presently is running at an operating loss of USD 3.6millions per year. Figures from the same source however show that the Atyrau District during the same period was operating at a profit of approximately the same figure, which indicates that the line is being cross-subsidised by the Railway's other operations in the district.

The problem in analysing this financial information however, is the lack of detailed cost information inherent in the accounting systems used in the former Soviet Union, and which are still in force in the independent states formed following the dissolution. Clearly a future priority must be the establishment of modern management accounting techniques, with computer applications, to enable the Railway to control its financial operations.
Based on the assessments of the technical experts, the required investment costs for the technical measures recommended have been estimated, which show that a total of approximately USD 257 million will be required up to the year 2007 to modernise the line.

This figure includes USD 155 million up to 2003 for the permanent way, USD 8 million up to the end of 1999 for telecommunications and USD 94 million for signalling up to the end of 2007.

A general problem with railways in the former Soviet Union is the overall lack of maintenance of the equipment. In this respect the West Kazakstan Railway is no exception. Nonetheless, if the recommended investments are implemented the required maintenance programmes must be followed to maintain the equipment at the required standard. Accordingly the maintenance costs were also calculated based on the recommended investments. These showed that for the permanent way the recommended measures would in fact reduce maintenance costs from USD 3.6 million in 1998 to USD 2.15 million by 2003. For telecommunications the annual costs when installed would amount to USD 593.7 thousand and for signalling eventually reach a level of USD 750 thousand.

From the forecast for future traffic on the line and taking into account the above-mentioned maintenance costs as well as depreciation, the results of operations under a number of scenarios have been calculated. These are presented in detail in the body of the text and the annexes. The overall result of this exercise shows however that, given the recommended investment measures are carried out as suggested, the line could in the best case be covering its costs by the year 2000. The most pessimistic scenario indicates that this level will not be reached until beyond 2006.

Economic Evaluation:

The calculations obtained from this exercise have been extrapolated over a period of 25 years to compute the Internal Rate of Return (IRR) for the various scenarios. The result shows that under the most pessimistic scenario, in which industrial production is increased without new construction taking place, oil is exported by rail and there is a growth in seaport activities, a negative IRR is obtained, whereas for the most optimistic; (a new refinery, new factory for fertilisers, opening of the North-South Corridor), an IRR of 9.6% can be achieved over the lifetime of the investments.

Therefore, in summary; of the scenario forecasts developed during the study, in comparison with the levels of investment required, **only the most optimistic** forecast traffic levels are likely to approach justifying the investment from an economic point of view.

Abbreviations and Conventions used in this Report

Conventions:

All costs and prices are expressed in US Dollars (USD) or Kazakstan Tenge (KZT) at the exchange rates shown in *Annex A: Currencies Used in Cost Calculations:*.

All units of measurement are in the Metric System unless otherwise shown.

Place names are transliterated from Cyrillic into Latin characters according to English language conventions (other than for locomotive classes and other technical abbreviations where this would prove confusing). Current (post-independence) names are used throughout, with previous names given in brackets where appropriate.

The railways of Kazakstan were, at the time of the research, organised into three companies: Almatinskaya, based in Almaty; Tsellinaya, based in Akmola; and West Kazakstan (WKR), based in Aktyubinsk. The rail route forming the subject of this Report falls entirely within the area of the West Kazakstan Railway.

Abbreviations:

ARE	Austria Rail Engineering
ATS	Austrian Schilling
C&W	Carriage and Wagon
CIS	Commonwealth of Independent States
d.c.	direct current
DEM	Deutsche Mark
DWA	Deutsche Waggonbau AG
EBRD	European Bank for Reconstruction and Development
GDP	Gross Domestic Product
ICB	International Competitive Bidding
ISDN	Integrated Services Digital Network
km	kilometres
kWh	kilowatt hour
KZT	Kazakstan Tenge
Mbit	megabit, or 1,024,000 bits
PABX	Private Automatic Branch Exchange
tkm	tonne kilometres
TRACECA	Transport Corridor Europe Caucasus Asia
USD	United States Dollars
USSR	Union of Soviet Socialist Republics
V	Volt(s)
WKR	West Kazakstan Railway
XP	Crossing Point

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

1 Introduction

1.1 About this Report

This Report summarises the research and recommendations made by the consulting group consisting of the following companies:

Deutsche Eisenbahn-Consulting GmbH (DE-Consult), Germany
Austria Rail Engineering (ARE), Austria

in association with Systra, France

and with the following local partners:

Kazgiprozheldortrans, Almaty, Kazakstan
Turkmentransmost, Ashgabat, Turkmenistan
Turkmenzheldorproject, Ashgabat, Turkmenistan
Lebapskoye Road Operation Authority, Chardzhev, Turkmenistan
Turkmendorproject, Chardzhev, Turkmenistan
Techvneshtrans, Tashkent, Uzbekistan
Kyrgyzdortranstechnika, Bishkek, Kyrgyzstan

This consulting group is referred to in the following Report collectively as 'the Consultant'.

The following Report is produced in accordance with the contract issued by the European Union's Tacis Programme for the TRACECA States, Project Number TNREG 9310, 'Rail Maintenance Central Asia, Infrastructure Maintenance 2 Project'. This Project was broken down into three primary modules:

Module A: Feasibility Study for upgrading the Aktau-Bejneu line in Kazakstan

Module B: Proposals and training to improve freight and passenger traffic on the TRACECA route

Module C: Feasibility Study for the Chardzhev Bridge (Turkmenistan)

This Report is concerned entirely with **Module A** as above described.

1.2 Selection of the Route for the Feasibility Study

As described in the Consultant's Inception Report and Progress Report, the original Terms of Reference for the Project called for Module A to consist of a 'Feasibility Study for Upgrading of the Sayak-Balkhash-Mointy line in Kazakstan'. Subsequent to the Consultant's submission of its Technical Proposal for all three modules, a request was received, and later confirmed by exchange of letters, for the feasibility study to refer to the Aktau-Bejneu line rather than Sayak-Balkhash-Mointy.

It is understood by the Consultant that this substitution was made at the request of the Government of Kazakstan.

1.3 Consultant's Personnel and Timescale of Study

The initial research and field work for the Project was carried out by the Consultant's local partner (Kazgiprozheldortrans of Almaty) in Almaty and at the Aktyubinsk headquarters of the West Kazakstan Railway (WKR) from May 1996 onwards. No other local partner was involved in this module of the Project.

The Consultant's European experts worked in Almaty and on site on the Aktau-Bejneu route, all within Kazakstan, together with the local partner from late August to November 1996.

The European experts engaged in this module of the Project were:

Mr Frank Prescha, Project Manager
Mr Norman Griffiths, Team Leader
Dr Jutta Völker, Transport Economist
Mr Michael Wogowitsch, Infrastructure Specialist
Mr Peter Wegenstein, Railway Signalling Specialist
Mr Alfred Grassl, Telecom Specialist
Mr Bernard Draper, Cost and Tariff Specialist
Mr Hans-Joachim Freitag, Specialist for Rolling Stock and Workshops
Mr Günter Fleischmann, Infrastructure Planner
Mr Frédéric Davanture, Investment Planner

The final on-site input to the Project was completed by the Investment Planner in April-May 1997.

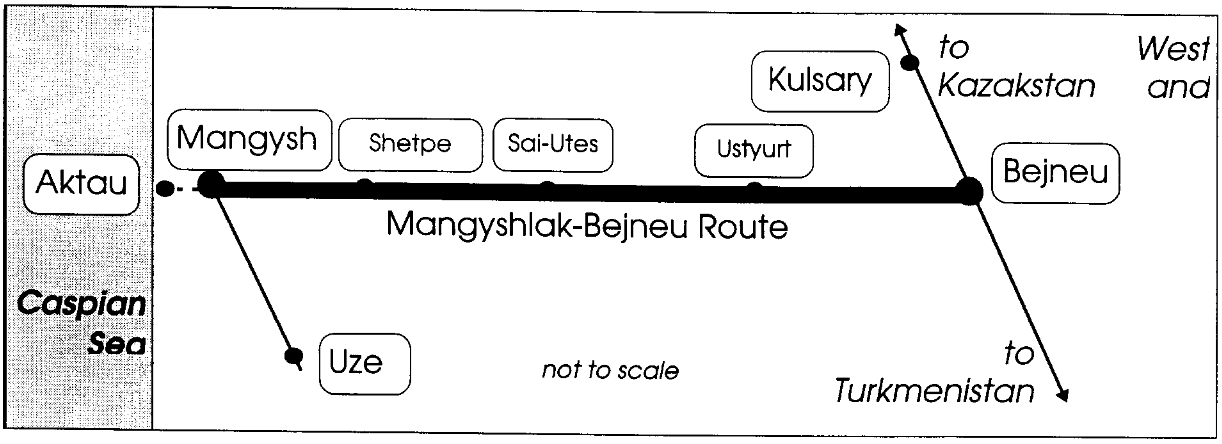
The Consultant was impressed with the professionalism and experience of the discussion partners. This was true for the Consultant's partners at the Institute as well as the Railway Organisation's staff. The only problem was that on occasions it took some time to get accurate records

1.4 Short Description of the Catchment Area of the Route

The route Aktau-Mangyshlak-Bejneu is situated in the administrative District of Mangistau (Mangistau Oblast) in south-west Kazakstan. This Oblast covers the peninsula of Mangistau, with a total area of 166,000 km^2. Approximately 335,200 inhabitants lived in the Mangistau Oblast in 1996 (324,400 in 1995). The population density is very low at 2.0 per square km.

Approximately 80% of the population is urbanised[1].

Figure 1-1: Diagrammatic Plan of the Mangyshlak—Bejneu Route



The administrative centre of the Mangistau Oblast is Aktau, which was founded in 1963 and has 157,600 inhabitants (46.8% of the total oblast population). The distance between Aktau and the capital Almaty is 3,267 km.

Further important communities (over 10,000 inhabitants) in the Mangistau Oblast are Shanaosen (pop. 46,800), Mangyshlak (pop. 14,800), Bejneu (pop. 12,800) and Shetpe (pop. 10,800).

The Mangistau Oblast is an important industrial centre in Kazakstan. The industrial structure in the catchment area of the Aktau-Bejneu line is characterised by extensive extractive and chemical industries.

In the Mangistau Oblast there is a network of public rail routes totalling 776 km, among which is the subject of the present Study, the 403 km. route from Mangyshlak to Bejneu. This line is owned by the West Kazakstan Railway (WKR) and connects the Mangistau Oblast and the industrial area of Aktau/Mangyshlak with other regions within Kazakstan and neighbouring countries. The direct rail link between Mangyshlak, 18 km from the coast, and the Port of Aktau is in fact not owned by WKR but by an industrial consortium known as KASKOR. The implications of this divided ownership are considerable and are considered further in following chapters.

The route is also important for the connection of the West Kazakstan region to the port of Aktau. Following the independence of Kazakstan, the importance of this Caspian Sea port

[1] Sources:
Regional Statistics of Kazakstan 1991 - 1994, Goskomstat Almaty 1996
Kazakstan Economic Trends
The Government of the Republic of Kazakstan, Centre for Economic Reforms, Issue of Second Quarter 1996
Population Statistics of the Republic of Kazakstan on the 1st of January 1996, Goskomstat Almaty 1996
Short Statistical Yearbook of Kazakstan 1995, Goskomstat Almaty 1996
Statistical Bulletin , Goskomstat Almaty 1996

has declined in line with a general decline in economic activity in the country.

The port of Aktau is one of two Kazakstan ports on the Caspian Sea and is important for Kazakstan's external trade, via the Caspian Sea ports in Azerbaijan and Iran, with other countries such as the Transcaucasian states, Turkey, Europe, United Arab Emirates, South and South East Asian countries. The second port at Atyrau (former Guryev) is situated in the north east part of the Caspian Sea in Atyrau Oblast, but its capacity and freight turnover are very low.

The road network in the Mangistau Oblast totals 2,600 km, of which 2,300 km are roads with a firm (metalled) surface. The density of these roads is very low at 13.9 km/1000 km^2.

A road runs parallel to the rail route. Between Shetpe and Bejneu the road is classified as a 'republic road', and between Mangyshlak and Shetpe the classification of the road is lower.

2 Economic Development and Traffic Evaluation

2.1 Traffic Flows

2.1.1 Current Economic Situation in the Mangistau Oblast and the Mangyshlak-Bejneu Route

Industrial production in 1994 in the Mangistau Oblast amounted to 5.7% of the Kazakstan total and 2.0% of the GDP in 1993. The level of industrial production per inhabitant was higher than the average in Kazakstan in 1994 (KZT 57,000 in Mangistau, KZT 20,700 in Kazakstan as a whole).

About half of the semi-finished products for the Kazak chemical industry, crude oil, natural gas and fertilisers are either extracted or produced in Mangistau Oblast (see Table 2-1).

Table 2-1: Production Volumes of the Major Commodities in the Mangistau Oblast in 1994*

Commodity	**Volume of production in Mangistau Oblast**	**Share of Mangistau Oblast (%)**
Semi-finished products for the chemical industry (styrol, polystyrene)	31,175 tonnes	58.1
Crude oil and gas condensate	9.5 million tonnes	46.9
Natural gas	2,050 million m^3	45.7
Mineral fertiliser	57,600 tonnes	45.5
Sulphuric acid and caustic soda	60,500 tonnes	8.8
Construction materials (concrete building components)	91,300 tonnes	8.4
Electro energy	3.5 billion kWh	5.2

* Data on economic output for 1995 was not available.
Source: Regional Statistical Yearbook of Kazakstan 1991 - 1994, Goskomstat Almaty 1996

Industry in the Mangistau Oblast suffers from the same problems as the economy of Kazakstan in general. The industrial output of most factories has declined in the last few years. This decline has been accompanied by a corresponding decrease in demand for transport.

The current development of the economy in the Mangistau Oblast shows a different picture. The next table shows the economic situation comparing two periods in 1996 and 1995.

Table 2-2: Development of major product output from January to March 1995 in Mangistau Oblast

Commodity	Level in 1996 compared to 1995 (%)
Semi-finished products for the chemical industry (styrol, polystyrene)	40.9
Crude oil and gas condensate	104.9
Natural gas	102.3

Source: *Statistical press-bulletin No. 2*
Goskomstat Almaty 1996

The economic situation is characterised by a continuing decline in the chemical industry affecting the production of semi-finished products. In comparison, the production of crude oil and gas is growing, albeit slowly.

The oil and chemical industry, which accounts for the greater part of the industrial activity, is concentrated in the area of Mangyshlak-Aktau-Uzen.

The next table gives an overview of the most important factories in the catchment area of the railway route from (Aktau-) Mangyshlak to Bejneu

Table 2-3: Characteristics of the Major Companies in the Catchment Area of the Route (Aktau-) Mangyshlak-Bejneu

Railway station	Company	Characteristics of production	Volume of production in 1995
Section	***Mangyshlak-Bejneu***		
Mangyshlak	PO Mangistaumunaigas	Extraction of crude oil and gas, production of oil products and gas condensate	4.6 million tonnes
	AO Karashanbasmunai	Extraction of crude oil and gas, production of oil products and gas condensate	0.7 million tonnes
	MAEK Energy company of Mangistau (Mangistauskiy energitsheskiy kombinat)	Production of electric energy	3146 million kWh
		Production of mineral fertilisers	77,900 tonnes
	AK KASKOR	Production of technical equipment and replacement parts Exploitation of the private railway network between Aktau and	KZT 271.5 million

	AK AKPO	Mangyshlak railway station, transport services for other companies Production of semi-finished products for the chemical industry (polystyrene and styrol)	45,200 tonnes
	Port of Aktau	Shipping and harbour services (incl. crude oil)	0.4 million tonnes
Shetpe	Ksyl-Turan Quarry (Ksyl-Turanskiy Karer)	Production of construction materials (bricks)	4,300 tonnes
Section	***Mangyshlak-Uzen***		
Uzen	PO Uzenmunaigas	Extraction of crude oil and gas	3.0 million tonnes
		Production of liquid gas	42,300 tonnes
Yeralivo	TOO Ultas	Production of prefabricated construction materials	15.5 million units

Sources: - *Interviews with rail customers*
- *Port of Aktau: Transport Statistics of Kazakstan, Goskomstat Almaty 1996*

The agricultural production in the Mangistau Oblast is not important, the natural conditions are not suitable for extensive agriculture. The share of Mangistau Oblast in the total Kazak agricultural production amounted to only 0.4% in 1994.

The share of Mangistau Oblast in the Kazak external trade is very low at present:

Exports 0.4% in 1993 and 0.04% in 1994
Imports 0.7% in 1993 and 1.8% in 1994

2.1.2 Freight Traffic on the Mangyshlak-Bejneu Line

2.1.2.1 Railway Stations Forwarding and Receiving Freight Traffic

The following five railway stations forward and receive traffic:

- Mangyshlak
- Shetpe
- Say-Utes
- Ustyurt
- Bejneu.

In addition to the above, there are three further stations on the southern section between Mangyshlak and Uzen (Yeralivo, Shetibay and Uzen).

The port of Aktau is not directly connected with the public railway network of the WKR: forwarding and receiving takes place via the railway station of Mangyshlak. Between Aktau Port and Mangyshlak the 18 km railway connection is run by a private company named KASKOR[2].

Traffic arising at Bejneu is of no direct importance for the freight traffic on the route being studied. The next marshalling yards are situated in Makat (300 km, north) and Kungrad (470 km, south).

The stations have tracks giving an average length of approximately 850 m. This capacity is suitable for freight trains with an average 57 wagons.

2.1.2.2 Volume and Structure of Freight Traffic in 1995

Volume

The national and international importance of the route is in fact very low. Of the total freight traffic in Kazakstan, the line accounted for only 1.3% in 1995.

The freight traffic volume using the route in 1995 amounted to 2.0 million tonnes, of which

- 0.6 million tonnes forwarded
- 1.4 million tonnes received (see table 2-4).

This volume additionally includes freight forwarded and received on the Mangyshlak-Uzen section, which must also be considered when evaluating the main Mangyshlak-Bejneu route.

The volume of freight traffic has been decreasing since 1990. The volume amounted to 10 million tonnes in 1990, with current levels at approximately 20% of that amount (see Annex S). The reasons for this decline can be linked directly to the economic changes in Kazakstan overall and the current economic situation of most factories both along the route and in the Mangistau Oblast, resulting from the changes following the break-up of the USSR and the movement towards a market economy.

[2] The whole railway network between Aktau and Mangyshlak, run by the KASKOR company, amounts to 287 km. Of this length 18 km is the trunk route between Mangyshlak and Aktau. The other lines are feeder lines from/to factories and distribution companies in the industrial complex between Mangyshlak and Aktau as well as within Aktau port itself.

Table 2-4: Freight Traffic Volume by Station in 1995

Railway Station/ Section	**Freight traffic volume in 1995 ('000 tonnes)**			**Share (%)**
	Forwarded	Received	Total	
Mangyshlak (incl. Port of Aktau)	466.8	1133.4	1600.2	80.4
Shetpe	38.0	25.1	63.1	3.2
Say-Utes	0.6	26.5	27.1	1.4
Ustyurt	1.5	0.3	1.8	0
Section Mangyshlak-Bejneu total	**506.9**	**1185.3**	**1692.2**	**85.0**
Section Mangyshlak-Uzen *	*121.0*	*176.5*	*297.5*	*15.0*
Total	***627.9***	***1361.8***	***1989.7***	***100.0***

* This volume does not include local traffic within the Mangyshlak-Uzen section.

Source: WKR

Mangyshlak has the biggest share of the freight traffic, corresponding to the concentration of industry in the Mangyshlak-Aktau region. Its share amounted to 80% in 1995, 74% of forwarded tonnage and 82% of received. Mangyshlak station (including Aktau traffic) is thus the main origin and destination point for freight traffic on the route.

Of the freight traffic using the route, 85% originates or terminates on the Mangyshlak-Bejneu section and the remaining 15% originates or terminates on the Uzen branch.

It should also be noted that, of the total traffic on the route, approximately two-thirds is 'received' and one-third 'forwarded'. There is no transit traffic since the line terminates at Uzen, some 180 km beyond Mangyshlak.

Breakdown by Commodity

The industrial structure of the Mangistau Oblast is reflected in the main composition of the freight traffic by commodity.

Over 80% of the loaded freight volume is oil products, construction materials and fertilisers. These main commodities have a share of about 70% of the total received freight on the route.

The transport of consumer goods by rail is very low.

The total freight volume of 2.0 million tonnes in 1995 consisted of:

- 0.36 million tonnes (18.2%) oil products
- 0.44 million tonnes (21.9%) fertilisers

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

- 0.41 million tonnes (20.4%) construction materials
- 0.26 million tonnes (13.3%) metals
- 0.43 million tonnes (21.6%) other commodities (general cargo, chemicals, grain, timber, coal etc.)

Table 2-5 and shows the detailed breakdown for 1995.

Table 2-5: Main Structure of the Freight Traffic Volume by Commodity in 1995

Section	Forwarded/Received	Total ('000 tonnes)	Major Commodities:			
			Oil products	**Fertiliser**	**Construction materials**	**Metals**
Mangyshlak-Bejneu	Total	1692.2	215.9	435.3	354.5	237.4
	Forwarded	*506.9*	*62.2*	*144.5*	*195.0*	*9.2*
	Received	*1185.3*	*153.7*	*290.8*	*159.5*	*228.2*
of which Mangyshlak and Aktau	Total	1600.2	210.7	435.2	286.1	234.0
	Forwarded	*466.8*	*62.2*	*144.5*	*157.5*	*8.5*
	Received	*1133.4*	*148.5*	*290.7*	*128.6*	*225.5*
Mangyshlak-Uzen (excluding local traffic within the section)	Forwarded and received	297.5	146.2	0	52.1	25.9
Total	**Total**	**1989.7**	**362.1**	**435.1**	**406.6**	**263.3**
	Forwarded	***627.9***	***159.9***	***144.5***	***206.3***	***10.5***
	Received	***1361.8***	***202.2***	***290.9***	***200.3***	***252.8***

Source: WKR.

Regional Structure

Freight traffic flows on a regional basis in 1995 can be sub-divided as follows (see also table 2-6):

- Local traffic within the Mangistau Oblast (construction materials, gravel): about 17% of forwarded and 8% of received freight
- Forwarded to other regions:
  - to the neighbouring oblasts Atyrau (oil products from Tengiz) and Aktyubinsk (several commodities): 33%

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

- to the Southern region of Kazakstan (oil products):17%
- to other countries: 33% (Russia: construction materials; China: fertilisers)

◆ Received from other regions:
- from Atyrau Oblast (oil products from Tengiz):15%
- from other Kazak Districts (raw material of fertilisers): 46%
- from other countries: 31% (Russia. Ukraine)

50% of the forwarded and 77% of the received traffic volume is carried over long distances (more than 2000 km).

Table 2-6: Main Freight Traffic Flows on the Mangyshlak-Bejneu Route

Destination Area	**Distance (km)**	**Freight volume (million tonnes)**	***Area of origin***	***Distance (km)***	***Freight volume (million tonnes)***
Atyrau Oblast	800	0.1	*Atyrau Oblast*	*800*	*0.2*
Aktyubinsk Oblast		0.1	*Mangistau Oblast*	*200*	*0.1*
Mangistau Oblast	200	0.1	*Karaganda Oblast*	*> 3000*	*0.1*
South Kazakstan	> 2000	0.1	*Dzhambyl Oblast*	*>2000*	*0.2*
South Kazakstan	> 2000	0.1	*Shezkazgan Oblast as well as East and South Kazakstan*	*>2000*	*0.2*
China /via Druzhba	> 2000	0.1	*North and East Kazakstan*	*> 2000*	*0.1*
Russia/via Aksaraiskaya	> 2000	0.1	*Russia (Eastern part), Ukraine*	*> 2000*	*0.4*

Source: WKR

Annex T gives a detailed overview of the main traffic flows by regions and commodities.

Number of Freight Trains

The above volume was transported by an average of two freight train pairs per day during 1995, with a peak requirement of 2.6 pairs to cope with seasonal variations. Table 2-7 shows the detail in 1995.

The maximum capacity of the route itself is between 16 and 18 train pairs per day, including passenger trains, and therefore the 1995 average equates to about 15% capacity utilisation. The service in 1990 — the last year before the break-up of the USSR — amounted to an average of eight train pairs per day.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table 2-7: ***Number and Tonnage of Freight Trains in 1995***

	Section			
	Mangyshlak-Shetpe *	**Shetpe-Say Utes ***	**Say Utes -Bejneu ***	**Mangyshlak-Uzen §**
Number of trains daily on average	2.0 / 2.2	2.0 / 2.1	1.8 / 2.0	1.1/ 1.0
of which:				
Wagonload trains	1.0 / 1.0	1.0 / 1.0	1.0 / 1.0	1.1/ 1.0
Block trains	1.0 / 1.2	1.0 / 1.2	0.8 / 1.0	
Number of trains per month:				
on average	60.8 / 66.9	60.8 / 63.9	54.8 / 60.8	
maximum	74.4 / 77.5	74.4 / 74.4	69.0 / 74.4	
Fluctuation between maximum and average (%)	+22.3/ +15.8	+22.3/ +16.4	+25.9/ +22.3	
Tonnage of trains ('000 tonnes):				
gross tonnes	2228/ 2696	2241/ 2582	2163/ 2771	1226/ 856
net tonnes	891/ 1685	862/ 1614	832/ 1630	613/ 276

* first figure: direction Mangyshlak-Bejneu; second figure: direction Bejneu-Mangyshlak
§ first figure: direction Mangyshlak-Uzen; second figure: direction Uzen-Mangyshlak

Source: *WKR*

One freight train per day operates between Mangyshlak and Uzen on average.

The average tonnage of freight trains along the Mangyshlak-Bejneu line differs according to section and direction.

Because Mangyshlak receives more loaded traffic than it forwards, there is an imbalance in the movement of both loaded and empty wagons.

Because of the physical configuration of the line[3], the permitted maximum gross trailing tonnage in each direction for freight trains is 3200 tonnes from Mangyshlak to Bejneu and 2200 tonnes in the other direction.

2.1.3 Freight Traffic Volumes by Other Transport Systems and Competitive Situation in the Mangistau Oblast

The predominant means of freight transport within the Mangistau Oblast is the conveyance of extracted crude oil and gas using the pipeline from Atyrau to Kalamgaz via Kulsary, Bejneu, Say Utes and Aktau. The system consists of two parallel pipes, of which one is

[3] See Chapter 3 of this Report.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

currently out of use.

Road freight traffic is mainly engaged in local and regional distribution (see Table 2-8). The available fleet of road freight vehicles is very low and totalled only 900 vehicles in 1994. The average distance travelled is generally less than 50km. Because of the inadequate road network, road traffic to and from the neighbouring oblasts (Atyrau. Aktyubinsk etc.) is at present unimportant.

The freight volume through the port of Aktau is also very low. Transport to and from the port is carried out exclusively by rail or pipeline.

Table 2-8: Freight Traffic Volume in the Mangistau Oblast in 1995

Type of transport	**Transport volume in 1995 (million tonnes)**
Pipeline (crude oil)	13.2
Pipeline (gas) *million m³*	20.8
Road freight traffic	1.1
Sea transport (turnover at Aktau port)	0.4
of which: dry cargo (by rail) oil (by pipeline)	0.258 0.142
Rail	2.0

Sources: *Projection of Indicators of the Socio-Economic Development in the Mangistau Oblast in 1997. Administration of Mangistau Oblast in 1996; WKR*

There is no direct competition between railway and road traffic. Rail concentrates on long distance traffic, whereas road traffic carries out mainly local and regional distribution. This situation is demonstrated by the sample of transport prices in the Mangistau region (see Table 2-9). Transport over longer distances by rail is cheaper than by road.

Table 2-9: Prices of freight traffic by rail and road

Mode	**Distance**	**Commodity**	**Price in USD per 10 tkm**
Rail	200-400 km	Oil products	0.10—0.08
		Construction materials	0.07—0.05
	1000-3000 km (domestic transport)	Oil products	0.06—0.05
		Construction materials	0.04—0.03
Road	Regional traffic	Average prices (general cargo)	0.66
	25 km	oil products in tanks	2.74

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Sources: Railway Tariff No. 10-01 (1989). issued of the Goskomitet of the Republic of prices and tariff policy
Road Survey of the five largest road transport companies in the Mangistau Oblast

2.1.4 Rail Passenger Traffic

Ticket Sales

The number of tickets sold (which equates to the number of passengers joining trains along the route)[4] totalled 400,000 between Mangyshlak and Bejneu in 1995 (see Table 2-10) as well as 71,000 between Mangyshlak and Uzen.

The volume of tickets sold in the whole of Kazakstan was 37.4 million in 1995 and therefore the proportion in Mangistau Oblast was 1.24%.[5]

Table 2-10: Tickets sold by Stations between Mangyshlak and Bejneu in 1992 and 1995 ('000 tickets/year)

	Mangyshlak - Bejneu Total	Mangyshlak	Shetpe	Say-Utes	Ustyurt	Bejneu	*Passing points 6-15*
Sold tickets 1992	614.2	324.2	47.7	92.3	40.0	91.9	3.7
Sold tickets 1995	399.7	201.4	32.2	4.7	2.3	156.7	2.4

Source: WKR (statistics of sold tickets)

The volume of tickets sold and thus the number of rail travellers has decreased by one third since 1992 and was influenced by the following:

- Decline of population in Mangistau Oblast due to the emigration of ethnic Russians to Russia between 1992 and 1995 (by approximately 20,000)
- Decline of the standard of living, particularly of salaries and household income since 1992
- Increase of railway passenger tariffs in the same period in real terms
- Basic changes in the structure of travel purpose and destination due to the independence

[4] WKR keeps records of the number of sold tickets only. Statistics concerning the number of passengers and their individual destinations are not kept. Therefore these figures had to be estimated on the basis of the distance structure inherent in the fares calculation, which is entirely distance-based.

[5] Source: Statistical Yearbook of Transport of Republic of Kazakstan, Goskomstat Almaty 1996

of Kazakstan from the USSR

Seasonal Variations of Passenger Rail Traffic

There is a strong seasonal fluctuation of passenger flows over the course of a year. Compared with the average monthly passenger traffic (100%) the fluctuation rates by station in 1995 were:

Mangyshlak	minimum	61%	maximum	142%
Shetpe	minimum	30%	maximum	251%
Say Utes	minimum	38%	maximum	210%
Ustyurt	minimum	0%	maximum	368%
Bejneu	minimum	57%	maximum	162%

Average monthly traffic = 100%

Journey Characteristics

The analysis of ticket sales[6] reveals the following general journey characteristics:

- around 25% of passengers joining trains between Mangyshlak and Bejneu, and between Mangyshlak and Uzen, are passengers whose journey both starts and finishes along the route Uzen-Mangyshlak-Bejneu (so-called "local traffic").

These passengers purchase their tickets for their journey from origin to destination and return at the railway stations between Uzen, Mangyshlak and Bejneu.

- the majority of passengers travel to or from areas outside the route being evaluated:

65% of passengers joining the trains are travelling to destinations between 800 and 2,000 km away. Thus the destinations are situated in general in the area of the WKR, particularly Aktyubinsk. Atyrau. Uralsk. Pavlodar etc.

10% of the travellers travel to destinations beyond West Kazakstan, in other regions of Kazakstan and abroad (Russia, other CIS countries, China etc.).

Based on the structure of distance and the number of tickets sold along the route, the number of passengers (one return journey = two passengers) was calculated and totalled 810,600 passengers in 1995.

[6] It should be noted that tickets are sold for a specific distance (in kilometres) rather than to a specific destination, hence the need to 'estimate' the precise destination station.

Table 2-11: ***Number of Passengers in 1995***

Section	**Number of Passengers in 1995 ***			
	Local traffic	***Traffic to and from West Kazakstan***	***Traffic to and from other Kazak regions and abroad***	**Total**
Mangyshlak-Bejneu	100,000	520,000	80,000	
Mangyshlak-Uzen	4,500[7]	92,000	14,100	
Total	**104,500**	**612,000**	**94,100**	**810,600**
Average passengers per day	286	1,677	258	2,221

* One trip is a journey from origin A to destination B (one way). The return trip is a second journey in these statistics. One journey from A to B and return is therefore two trips.

Source: *Calculation based on tickets sold in 1995*

In the opinion of local authorities and railway administration there are also some passengers travelling without purchasing tickets. The extent is unknown but is not thought to be significant.

The main traffic objectives for passengers are Mangyshlak (for Aktau) and Bejneu. In 1995 approximately 90% of all passengers joined trains at these stations, 50% in Mangyshlak and 40% in Bejneu.

Rail passenger traffic is undertaken mainly by residents of Mangistau Oblast. In contrast, very few passengers from outside the Oblast choose to travel into it.

Mobility by Rail

The average number of journeys made by residents of Mangistau Oblast along the Mangyshlak-Bejneu route can be summarised as:

2.50 trips per inhabitant and year (in 1995) of which

0.39 trips in local traffic (along the route, between 100 and 400 km per trip)
1.89 trips to/from West Kazakstan (800 to 2000 km per trip)
0.29 trips to/from other Kazak regions and abroad (over 2000 km per trip)

The use of rail transport along the route is higher than the average rail mobility in Kazakstan as a whole.

One reason for this situation is the location of the Mangistau Oblast in the fringe of

[7] It is estimated that about 75% of all local passengers in this section travel to stations between Uzen and Mangyshlak, particularly Mangyshlak itself, the railhead for Aktau, the Oblast centre. This local traffic is not significant for the Mangyshlak-Bejneu route.

Kazakstan and the low road density, and thus lack of competition, in the Mangistau peninsula. A further reason is the above-average relationship of the Mangistau residents to other regions in Kazakstan and other CIS countries (particularly Russia and Ukraine); the industrialisation of the Mangistau peninsula began in the 1960s and the capital of Mangistau Oblast (Aktau) was founded only in 1963, hence the majority of residents are not local to the region.

Another factor is that the average wage in the Mangistau Oblast is about twice as high as the average wage in other parts of Kazakstan.

Table 2-12: Mobility by Rail of the Population in the Mangistau Oblast and in Kazakstan

Year	Trips per inhabitant and year	
	Mangistau Oblast (Mangyshlak-Bejneu route)	**Whole Kazakstan**
1992	3.5	2.5
1995	2.5	2.2

Sources: Transport Statistics of Republic of Kazakstan, Goskomstat Almaty 1996.

Number and Routing of Passenger Trains

The full passenger service is as follows (see also Table 2-13):

- two daily train pairs from Mangyshlak to Bejneu and West Kazakstan (one each to Atyrau and Aktyubinsk)
- the Aktyubinsk trains convey through coaches for Moscow and Almaty
- the trains consist of passenger coaches with seating and sleeping accommodation (compartments with two and four berths), plus one or two luggage vans. This luggage service is very important for passengers in view of the high volume of 'private trading' carried out in distant markets particularly in Russia. The possibility of transporting large quantities of 'luggage' gives the railway a significant advantage compared with road and air travel
- the travel time between Mangyshlak and Bejneu varies from 10.3 to 11.8 hours
- the average travel speed between Mangyshlak and Bejneu is between 34 and 39 km/h
- the train capacity offers 1,133 places daily and 847,530 places annually in all categories; this is sufficient to satisfy the average demand (810,600), though inadequate to meet peak demand
- Bejneu offers the facility to change trains: there are two departures weekly to Volgograd in Russia, and one weekly train each to Nukus and Urgench in Uzbekistan

Table 2-13: Passenger Trains between Mangyshlak and Bejneu

Train No.	Route	Number of coaches* and places** per train	Travel time (hours)	Average speed (km/h)
201/ 202	Mangyshlak-Atyrau and return	11 coaches 568 places	11.3 - 11.8	35.7 - 34.2
203/ 204	Mangyshlak-Aktyubinsk and return incl. through coaches to/from Moscow and to/from Almaty	12 coaches 585 places including -54 places to/from Moscow -90 places to/from Almaty	10.3 - 11.4	39.1 - 35.3

* excluding mail and luggage vehicles
** these figures include seats in various classes and sleeping places in compartments.

Source: WKR Timetable 1996

2.1.5 Other Passenger Transport Services in the Mangistau Oblast

The remaining passenger transport facilities in the Oblast can be summarised as follows[8]:

Air Traffic

There are nine flights per week (average 1.3 per day) from Aktau to Almaty and return, including two connections via Dzhambyl to Almaty. but no connection to other airports in Kazakstan or abroad. There are small private air companies which fly if required from/to other destinations.

Air traffic from Aktau to all destinations conveyed 130,000 passengers in 1995. This volume has been declining since 1991, a peak of 488,000 passengers being achieved in 1990.

The air company Kazakstan Airlines still uses aircraft of the Soviet types Yak(ÄK)-42 and Tu(TU)-134/154 between Aktau and Almaty.

The possibilities for transportation of quantities of luggage are very limited.

Bus Traffic

The bus service in the region is in two categories:

- Local traffic between Mangyshlak and Aktau and within the city of Aktau generally operates on a 15-minute service interval

8 Source: Statistical Yearbook of Transport of Republic of Kazakstan, Goskomstat Almaty 1996

- Connection of the communities in the Mangistau Oblast with Aktau, the centre of population, administration, trade and services

These bus services are characterised by the following facts:

- Four routes run parallel to the existing rail line from Aktau to Uzen, Kuryk and Shetibay (parallel to the Mangyshlak-Uzen section) and to Shetpe (parallel to the Mangyshlak-Bejneu section).

- The other bus routes run outside the rail route, i.e. from Aktau to Fort Shevchenko, Tuchekudyk and Turkmenbashi (Krasnovodsk) in Turkmenistan.

The fleet of buses in the Mangistau Oblast was about 608 vehicles in 1995, of which 323 were in private ownership.

The quality of services and the comfort of these buses is low; most are Hungarian-built Ikarus vehicles, though there is also a limited number of imported second-hand buses from western Europe which offer more comfort.

The number of bus passenger journeys (local and regional) totalled 108.8 million in 1995, an average of 335 trips per person per annum, or almost one every day.

The number of passengers using buses declined between 1992 and 1994 but has picked up somewhat in 1995.

Traffic by Private Cars

Private cars are used in local and regional traffic over short and medium distances but generally not for long-distance traffic. Between Aktau and Bejneu and beyond to West Kazakstan, private car usage is very low because the road between Ustyurt and Bejneu is not tarred.

The stock of private cars is very small in the Mangistau Oblast in comparison with other Kazak regions.

Table 2-14: Motorisation Rate

	Motorisation rate (cars per 1000 inhabitants)			
	1990	**1993**	**1994**	**1995**
Republic of Kazakstan (average)	47	54	58	61
Mangistau Oblast	44	39	37	40

Source: *Statistical Yearbook of Transport of Republic of Kazakstan Goskomstat Almaty 1996*

Whereas car ownership grew by 30% in the whole of Kazakstan between 1990 and 1995, the rate in the Mangistau Oblast remained more or less constant.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Assessment of the Present Competitive Situation Between the Different Regional Transport Systems

There is still a clear distinction of function between the various modes of transport in the Mangistau Oblast which is characterised by the following:

- The railway meets the passenger demand for medium- and long-distance journeys (mainly to West Kazakstan).

- Bus services are used in local traffic within Aktau, between Mangyshlak and Aktau, as well as linking smaller non rail-connected communities in the Mangistau region with Aktau, the administrative centre of the Oblast.

A developing competitive situation between rail and bus can be observed where four bus routes run parallel to a section of the rail route. Competition is not yet important, but it exists.

Table 2-15: Comparison of Travel Times and Prices on Competitive Routes Rail/Bus

Route	**Travel time (hours per journey)**		**Price (USD per journey)**	
	By rail *	By bus direct	By rail *	By bus direct
Aktau-Uzen	4.8	3.3	1.923	2.601
Aktau-Kuryk	3.0	1.8	1.506	1.300
Aktau-Shetibay (Munayshi)	3.4	2.3	1.581	1.760
Aktau-Shetpe	3.3	4.0	1.142	2.310

* including by bus to the railway station

- A journey by bus is more expensive than a railway journey in general (except Aktau-Kuryk). The main advantages by bus are the generally shorter travel time, the higher frequency (departures by bus 4-6 times per day, by rail twice per day) and direct connection without change of mode.

- Air traffic meets the demand for longer distance services to and from Almaty and Dzhambyl with the shortest travel times. In this respect there is clearly no alternative.

The price of a journey by air is about four times higher than for an equivalent rail journey, as the next table shows. Therefore, many passengers travel by rail because it is more economic.

Table 2-16: Comparison of Travel Times and Prices Between Long-Distance Carriers

Route	**By air**		**By rail***	
	Travel time (hours)	Price (USD)	Travel time (hours)	Price (USD)
Aktau-Almaty	3.0	122.0	> 24	29.4

* Sleeping car

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

- Traffic by private car has not developed to the extent that it poses a threat to other modes, since car ownership is relatively low and the road network is unsatisfactory.

2.2 Development of Relevant Factors Influencing Future Traffic Flows

2.2.1 Relevant Economic Prospects

The existing economic conditions form an unsound basis for the assessment of future economic activity in the area and thus for the projection of future traffic volumes along the Mangyshlak-Bejneu route.

Therefore, in order to make an assessment of the potential economic and socio-economic development along the route's catchment area, it has been necessary to consult the following organisations:

- the Kazakstan Ministry of Economy and Ministry of Transport and Communication
- the Regional Administration of Mangistau Oblast

Additionally, empirical research was undertaken with important companies in the region (e.g. AKPO; KASKOR; MAEK) and in the Commercial Port of Aktau. Discussions were also held with the West Kazakstan and Turkmenistan Railway administrations regarding the potential influence of a future North-South railway corridor

The validation of potential developments has been concentrated on the years up to 2005, projecting beyond that date wherever relevant. Since most of the development projected to take place in the region is a function of Government rather than of private industry (and thus the market), such development depends to a large extent on foreign financing, often by bi- and multilateral aid. Any delay in the provision of such foreign support will naturally have a marked effect on the timing of any industrial development and thus ultimately on the future level of demand for transport, making precise projections for such demand hazardous.

2.2.2 General Development Trends

As a result of the political and economic changes in the countries of the former USSR the Kazakstan economy is undergoing considerable change.

Industrial production is declining in most sectors and additionally the regional structure of the market has changed. The process of privatisation of the companies in the region has begun but is not yet finished. In the Mangistau Oblast the proportion of companies in state ownership was 86% in 1994. This share is decreasing and amounted to only 23% in 1996. The proportion of companies in foreign ownership is very low at present.

The Kazakstan Government has forecast a growth of GDP by 10-12% by 2000. In general, this figure is also considered valid for the Mangistau Oblast.

This estimate is confirmed by a short-term forecast of the World Bank and the real development in the first half-year in 1996.

Table 2-17: Projected Development of GDP

			1994	1995	1996	1997
World Bank Scenario (1)	GDP total	Percentage change on previous year	-7.5	-2.2	+0.3	+3.9
	of which industry		-12.0	-6.0	-1.0	+5.0
Actual development (2)	GDP total	in million KZT (adjusted for inflation, at constant prices)	449,917	409,777	1st and 2nd quarter: 169,077	
		Percentage change on previous year	-25.0	-8.9	1st quarter: +1.0 2nd quarter: +0.8	

Sources: *(1) Kazakstan Economic Report. World Bank Report No. 12856-KZ. July 1994*
(2) Kazakstan Economic Trends Second Quarter 1996. Government of the Republic of Kazakstan. Centre for Economic Reforms

Although the trends and projections provide little basis for concrete prognosis, a moderate acceleration of the economic growth and especially of industrial growth in the next few years would appear to be realistic in the absence of any alternative negative indicators.

The projections indicate an increase of industrial production in the catchment area of the route. This will also mean a growth of transport demand due to increasing input of raw materials and output of final products.

The basis of this assessment is a Medium-Term Programme of the Government of Kazakstan, which projects continuing economic reforms and investment in the most important industrial sectors[9]. The growth of industrial production requires comprehensive investment. This programme includes numerous projects for industrial development throughout the country as well as in the catchment area of the route being analysed.

However, it will clearly be necessary to obtain extensive financing in order to implement this major programme of investments. In the Consultant's opinion, there is a considerable risk factor implicit in the projections for future investment, industrial production and therefore potential transport volumes. The risks can be anticipated as applying to both the extent and timescale of any investment projected. It is therefore very difficult to define precisely the

[9] Source: *Kasachstan beschließt Investitionsprogramm* in: Nachrichten für Außenhandel No. 196/1996

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

probability of implementation and the time horizon for the completion of the planned projects, or indeed whether they will be implemented at all.

A key factor in the future industrial development within the Mangistau Oblast is the privatisation of existing enterprises. This process is already very advanced, and indeed the share of privatised enterprises currently amounts to 76.5%. These enterprises depend very strongly on the participation of foreign capital and investment for their future industrial development, but there must also be a serious doubt — in some cases — about the long-term future of some of them.

The sources for the future traffic demand for freight transport using the route are particularly:

- Growth of production volume (input and output) of existing factories in the catchment area
- Implementation of planned investment projects in the oil industry and in the chemical industry
- Development of domestic and external trade
- Implementation of planned infrastructure projects

2.2.3 Projects Potentially Impacting on Future Freight Traffic Flows

2.2.3.1 Potential Investment Schemes

There are at present a number of planned investment projects for the region around Aktau which, if implemented, will have a significant impact on the freight traffic carryings of the Mangyshlak-Bejneu rail line.

Known projects in the industrial zone of Mangyshlak/Aktau/Uzen and in the Atyrau Oblast which potentially have an impact on future freight traffic volume for the route Aktau-Bejneu are described below.

It should be noted that a detailed consideration of the traffic forecast, with the various scenarios described, follows in Chapter 2.3.1. At this stage, the alternative scenarios **pessimistic** and **optimistic** have been used as broad indicators of potential future traffic levels.

2.2.3.2 Growth of Polystyrene Production and other Oil-based Products

The **pessimistic** forecast includes a growth from 40,000 tonnes in 1995 to 70,000 tonnes production output and transport volume per year by 2005. The **optimistic** variant forecasts an increase of output to 300,000 tonnes per year.

In order to achieve the **optimistic** tonnage output, it will be necessary to modernise the existing factory and to extend its production capacity. This project is part of the government investment programme.

It is estimated that about 70% of output of the **optimistic** variant would be exported via the Aktau Seaport. The rest of this volume would be transported to other areas of Kazakstan and to other countries by rail.

2.2.3.3 Growth of Production of Phosphate Fertilisers

An increase of output of fertilisers to 200,000-300,000 tonnes per annum is expected in the future.

The raw material will be transported from Dzhambyl District to Mangyshlak by rail. The volume of raw materials is expected to be between 450,000 and 700,000 tonnes per year. It is planned to export the biggest share of the production output overland by rail to Russia and China.

The Consultant considers that this proposal has a low probability, in view of the very long distances which both the raw materials and finished products will require to be transported. Dzhambyl lies in the south of Kazakstan, on the Kyrgyzstan border, some 2,000 km east of Aktau in a direct line. The Chinese border is a further 1,000 km beyond. It can hardly make economic sense for raw materials and products to be conveyed over such distances, when there are surely more local sources of supplies.

2.2.3.4 Construction of a new Factory for Production of Nitrate Fertilisers

It is planned to build a new factory by Japanese financing for production of nitrate fertilisers on the basis of using local raw materials transported by road. The planned annual output capacity of this factory will be 250,000-300,000 tonnes. It is planned to transport the finished product by rail. According to the Ministry of Economy, the factory will be completed by 2002.

2.2.3.5 Construction of a new Oil Refinery in Mangyshlak

There are plans to construct a new refinery in the Mangistau Oblast 40km to the north of Aktau/Mangyshlak.

It is planned to construct this refinery in three stages:

Stage 1: a processing capacity of 1.5 million tonnes.
Stage 2: 3 million tonnes
Stage 3: 6 million tonnes per year.

Since there are no investment funds available for this project at present, projected start and completion dates cannot be given.

The Ministry of Economy estimates that approximately 5-6 years will be required for the completion of the first stage.

The implementation of this investment includes a very high degree of uncertainty; opinions within Kazakstan concerning the real need for the refinery vary considerably[10]

- The Ministry of Economy is considering this project in the context of the planning of industrial development in Kazakstan.
- The Ministry of Oil and Gas Industry is of the opinion that the existing processing capacity of crude oil is sufficient in Kazakstan and it is not necessary to construct a new refinery in the Mangistau Oblast.
- The company of Munaigas has a similar opinion.
- The administration of the Mangistau Oblast would prefer the refinery for the industrial stabilisation of the region, but financing of this project is not available at present.

The output of the refinery is likely to be 90% of the processing capacity. Transport of raw materials between oilfield and refinery will be by pipeline.

The above mentioned organisations also have different views and opinions on the potential and regional structure of distribution and consumption of the oil products.

Therefore the **traffic forecast** for the rail route takes into consideration a **low** and a **high** variant on the basis of the second stage (output 2.7 million tonnes per year) for dispatching of different oil products by rail, which should, however, be regarded as "possible" rather than "probable":

low variant	1.35 million tonnes per year
high variant	1.5 million tonnes per year

Both variants include local consumption of oil production of about 0.4-0.5 million tonnes, which would be transported by road.

The **low variant** takes into consideration the following estimate of future rail transport volume:

0.25 million tonnes export to Russia by rail

1.1 million tonnes consumption by other regions in Kazakstan and transport by rail

The rest will be carried by road or pipeline.

[10] As determined during discussions held in October/November 1996 in Kazakstan.

The **high variant** assumes the following structure of distribution:

0.4 million tonnes local consumption and transport by road

1.6 million tonnes transport to a storage point in Uzen (transport by branch line from the refinery to Mangyshlak and then via the Mangyshlak-Uzen route); this transport to the storage point is not important for the route under consideration).

The further distribution from the store is expected to be 50% by rail using the route being analysed and 50% by road (each 0.8 million tonnes).

The remaining 0.7 million tonnes could be forwarded to other regions in Kazakstan directly by rail.

N. B. should the new refinery be constructed, it will clearly be necessary to build a new connecting line for the 40 km distance from Aktau/Mangyshlak to the refinery itself.

2.2.3.6 Growth in Demand for Production and Consumption in other Factories in the Industrial Zone of Mangyshlak-Aktau-Uzen

Different surveys show an expected growth of the future freight traffic demand of 1.2-1.5 million tonnes per year, shared equally between forwarded and received traffic.

2.2.3.7 Increase of Crude Oil Extraction in the Tengiz Oilfield, situated in the District of Atyrau near Kulsary Station

Kazakstan has an agreement with Iran to export between 1.5 and 3.0 million tonnes of crude oil from the Tengiz Oilfield via Aktau Seaport to north Iran by ship. The export should begin in 1997 with a volume of 1.5 million tonnes. In the next few years it is expected that there will be a further agreement to export up to 3 million tonnes.

This volume will be transported by rail from Tengiz Oilfield to Aktau Seaport.

2.2.4 Projected Socio-Economic Development in the Mangistau Oblast

2.2.4.1 Population

The number of inhabitants in the Mangistau Oblast has been decreasing since 1993 and stood at 324,400 in 1995. This situation was caused largely by the emigration of ethnic Russians (18,000 in 1994).

In 1996 the population increased over the previous year to 335,200, following the return of around 10,000 Russians.

The birth rate is decreasing and the mortality rate is growing in the Mangistau Oblast, largely because the migration involved mainly younger Russians. However, the birth rate is higher than the mortality rate (births: 21 per 1000 inhabitants, deaths 7 per 1000 inhabitants in 1996).

The Administration of the Mangistau Oblast and the Ministry of Economy estimate a population of about 340,000 in 2000[11]. This means that the decrease of birth rate will continue and the rates of migration and mortality will increase up to 2000.

An official population forecast beyond the year 2000 does not exist at present. Therefore the Consultant estimates that, assuming the level stabilises after 2000 and the decline in population can be stopped in the Mangistau Oblast, the population will be around 352,000-355,000 inhabitants after 2000.

2.2.4.2 Salaries and Incomes

The monthly earnings of employees changed during 1996 as follows:

Table 2-18: Changes in Monthly Salaries, 1996

Period	Monthly wages in KZT (in USD *)	
	Mangistau Oblast	**Kazakstan average**
January - June 1996	13826 (215)	6298 (97)
July 1996	18500 (285)	7083 (110)

* 1 USD = 65 KZT (Summer 1996)

Source: *Socio-economic analysis of Republic of Kazakstan in the period January - August 1996. page 119. Goskomstat Almaty 1996*

The average wage in the Mangistau Oblast is twice as high as the Kazakstan average, reflecting the difficult working and living conditions on the coast of the Caspian Sea.

The average yearly income of an employee totalled approximately USD 3000 in the Mangistau Oblast in 1996.

The proportion of salaries in the GDP was 30-36% in 1996. This proportion is projected to increase to 40-44% in 2000.

GDP in Kazakstan is forecast to increase by 10-12% from 1996 to 2000. For the period after 2000 there are no existing forecasts.

In view of these basic economic projections, a real growth of salaries by 30-50% per employee is expected in the Mangistau Oblast from 1996 to 2005.

[11] Source: Economic Strategy of Republic of Kazakstan in 1996-2000, Ministry of Economy 1995 (unpublished)

Household income will also rise, but more quickly, because the employment rate is expected to increase again should the various investments in industry take place.

2.2.4.3 Vehicle Ownership

Vehicle ownership is very low in the Mangistau Oblast at present at 43 cars per 1000 inhabitants. There is a stock of about 14,400 private cars.

New passenger cars are expensive, and therefore many buy second-hand. Although the prices for foreign types are similar to those in Western Europe, Russian products are significantly cheaper.

On the basis of the expected growth of wages, an increase of the number of private cars in the Mangistau Oblast can be expected.

Because of the low incomes and the high prices for passenger cars it is expected that the number of private passenger cars will only increase at a slow rate.

The Consultant therefore projects that the existing passenger car stock in the Mangistau Oblast will almost double by 2005.

2.2.5 Infrastructure Projects and the Development of Regional Transport Systems

2.2.5.1 Infrastructure Projects

There are two important infrastructure improvement projects planned which may influence the future of the route.

The first project is the ***reconstruction and modernisation of Aktau Seaport***.

This project with a total cost of USD 74 million was started in October 1996 and is financed by EBRD and the Kazakstan Government. The reconstruction works concentrate on that part of the port handling bulk and general cargo. The reconstruction will be finished within three or four years.

There are different forecasts concerning the expected freight handling volume in the port.

A 1994 prognosis[12] forecast handling of 7.9 million tonnes in 2005, of which 4.5 million tonnes would be crude oil and 2.7 million tonnes other cargo (general cargo, bulk goods).

On the basis of current data from the Ministry of Transport and Communications, a volume

[12] Source: Business Plan of Aktau Seaport, 1994

of 2.7-3.2 million tonnes (without crude oil)[13] is forecast. The planned volume of export of crude oil via the Aktau Seaport from Tengiz amounts to 1.5-3 million tonnes per year beginning within the next few years; this is bound for Iran as described above.

The second project involves the construction of a *railway corridor between Russia and Turkmenistan/Iran via Kazakstan* known as the ***North-South Corridor***[14].

The planned corridor will run via the following routes:

Russia		**(European Russia)-Astrakhan** ↓	
Kazakstan		**Makat-Bejneu-Yeralievo** ↓	
Turkmenistan		**Bekdash-Turkmenbashy (Krasnovodsk)-Gazandshyk** ↙ ↘	
	Kysyl Etrek-Gudriolum ↓		**Ashgabat- Mary- Tedshen-Serakhs** ↓
Iran	**Gorgan/ Bandar Torkaman**		**Meshed- Persian Gulf Ports**

This new route would be important for future traffic, mainly between European Russia, Kazakstan and Iran via Turkmenistan. Its further importance for other European countries will depend on the future development of external trade between these countries and Iran, India and Pakistan and the ability of the route to compete with established shipping routes.

It is assumed that this new link could replace the existing, currently interrupted, connections via the Transcaucasian region.

The new corridor would shorten the rail distance between western Kazakstan and Turkmenistan by 1,085 km.

There is an existing agreement between the Russian and the Turkmenistan Governments concerning this new railway corridor in which the Bejneu-Mangyshlak section forms an integral part.

[13] Source: Official data for the future capacity of Aktau Seaport after reconstruction, given by Ministry of Transport and Communication of Republic of Kazakstan in November 1996

[14] Sources: Kolyshkina/Artamkina: *Neue Wege in den Iran*, in: Rail International No. 8-9/1996; Feasibility Study of the railway connection Astrakhan-Bekdash-Turkmenbashy-Gazandshik-Kysyl Etrek-Tedshen-Serakhs, Report Part II: Traffic Volume; GIPROTRANSTEI Moskva 1995 (in Russian)

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

The development of this corridor requires the construction of new railway connections between Yeralievo and Turkmenbashy and between Gazandshyk and Gorgan/Bandar Torkaman.

The GIPROTRANSTEI Study estimates a traffic volume of 2.1 million tonnes via this North-South corridor, including 1.5 million tonnes transit in the direction from Bejneu to Mangyshlak and 0.6 million tonnes transit in the other direction.

The traffic volume takes into account transit traffic between Russia/other countries and Iran, and ports on the Persian Gulf, and does not include domestic traffic originating and arriving along the Mangyshlak-Bejneu route or export/import movements via Aktau Seaport.

A **high variant** of the traffic forecast for the North-South corridor includes a volume of 2.4 million tonnes crude oil which could be exported from Mangyshlak Oilfield via Mangyshlak station to north Iran. This volume is not important for the route between Mangyshlak and Bejneu, because this crude oil will be forwarded from Mangyshlak station and transported southwards and not towards Bejneu.

According to Kazakstan Government authorities, **the financing of this infrastructure project has not been secured** and therefore there is no precise information about the expected construction period.

Other problems facing this project relate to the competitive routes from Russia and China via Kazakstan, Uzbekistan and Turkmenistan to Iran and the plans for their upgrading (the so-called "New Silk Road"). This line already exists and a strong growth of freight traffic via this route is expected. It is therefore very difficult to judge whether the planned North-South corridor project will ever become reality.

This project will be considered as a **high level scenario** for the traffic forecast as far as the Mangyshlak-Bejneu route is concerned.

2.2.5.2 Development of Regional Transport Systems

The development of regional transport systems requires investment. It is very difficult to estimate their potential scale of development because the economic situation of the regional transport companies, the development of road infrastructure and the construction of new pipelines is uncertain and lacks financial support.

Freight traffic

In general, road freight traffic is expected to increase its market share at the expense of railway transport. However, because of the poor condition of the existing trunk road infrastructure it is estimated that road haulage will only be important for local distribution traffic. Increasing competition between rail and road freight traffic is not expected.

The construction of new pipelines may cause strong competition between rail and pipeline. There are some plans to build new pipelines, but the implementation of these plans will depend mainly on procurement of adequate funds.

According to the Kazakstan Ministry of Economy, the following plans exist:

- Construction of a pipeline for transportation of crude oil from West Kazakstan (Bejneu or Tengiz) to the central regions of Kazakstan (Kumkol)

This pipeline might connect the West Kazakstan region with the existing system of pipelines in Central Kazakstan. especially to the existing refinery in Pavlodar (North Kazakstan).

- Construction of a pipeline for transportation of oil products from Aktau to Bejneu (3 million tonnes per year)

- Construction of pipelines for transportation of ethane (0.2 million tonnes) and oil products (0.5 million tonnes) between Tengiz and Aktau

The Munaigas Company has suggested that the Chevron Oil Company may plan a pipeline from Tengiz to the Aktau Seaport if the volume of crude oil export to Iran were to grow to more than 3 million tonnes per year. However, such construction would not take place until after 2005.

Passenger Traffic

It can be expected that:

- the regional bus companies will extend their working area in future. This particularly means the development of medium-distance and interurban bus routes to West Kazakstan and to Turkmenistan

- the network of air routes between Aktau Airport and other regions in Kazakstan and abroad will extend in the next few years

This indicates that part of the expected growth in passenger demand will not be met by rail, but by aircraft and by bus. On the other hand, due to the higher fare scales, air traffic is not expected to be a real alternative to long-distance travel by rail.
This will give the rail operator two alternative courses of action:

- to continue to offer the same type of service as at present, at approximately the same fares, and see market share (though not absolute passenger journeys) reduce as passengers become more affluent

  or

- to react aggressively to the expected changes in the market by offering:

- a premium service at a higher price, with value-added facilities
- more attractive transit times
- improved accommodation
- a through service from Bejneu to Aktau

2.3 Future Traffic Flows

2.3.1 Freight Traffic

2.3.1.1 Scenarios

The potential development of the economy and infrastructure in the Mangistau Oblast is very difficult to forecast, since there are many different influences and dependencies.

The speed of development has a strong influence on the financing of the planned investments, especially those involving foreign capital.

The future rail freight traffic demand is therefore a function of:

- the future production output of industry
- the development of domestic and external trade
- the implementation of the planned infrastructure measures in the region
- the ability of the railway to compete in the market place against pipeline, road transport and alternative industrial locations

In order to consider these different development possibilities it is useful to describe several **scenarios** for the future freight demand along the route being surveyed.

These scenarios take into account the probability of the implementation of planned investment and have the following contents and key points:

Scenario A

- Growth of industrial production in existing enterprises in the Mangistau Oblast on the basis of the results of the Consultant's survey of the regional enterprises
- Increased capacity of Aktau Seaport after reconstruction
- Export of crude oil from Tengiz Oilfield to north Iran via Aktau Seaport

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Scenario B

Scenario A and in addition the expected traffic volume of the planned investment in industry in Mangistau Oblast, specifically:

- the new refinery in Mangyshlak
- construction of a new factory for nitrate fertilisers
- optimistic variant for growth of polystyrene production

Scenario C

Scenario C includes Scenario B as well as the potential traffic volume of the future North-South corridor.

As far as possible, a **low** and **high level** will be considered within the scenarios.

2.3.1.2 Future Freight Traffic Flows

Traffic Volume

The projected future freight traffic will have the following volumes, considering the expected economic development of the existing companies in the Mangistau Oblast and the implementation of planned industrial investment of the infrastructure projects already described.

The traffic forecast is based on the expected economic development in the Mangistau Oblast (see 2.2.1 above) and takes into account the results of the Consultant's surveys of the relevant companies, administrations and authorities.

As Table 2-18 shows, freight traffic demand by rail can be expected to grow significantly in comparison with the present situation.

Even in the most pessimistic growth variant (Scenario A_{LOW}), traffic will increase, from 2 million tonnes in 1995 to 8.1 million tonnes in 2005. In the optimistic variant, Scenario A_{HIGH}, a growth to 9.7 million tonnes in 2005 can be expected. This volume is almost at the level of freight traffic in 1990 (10.3 million tonnes). The other scenarios include higher freight volumes reflecting increases in the estimated production output and industrial consumption as well as the building-up of the North-South corridor.

The expected volumes of Scenario B_{LOW} (26.4%) and B_{HIGH} (25.2%) are higher than the comparable cases in Scenario A.

Table 2-19: Expected Freight Traffic Volume Mangyshlak-Bejneu in 2005

Sources of rail freight traffic	Freight traffic volume ('000 tonnes)						
	1995 **Base**	***2005***					
		Scenario A		**Scenario B**		**Scenario C**	
		low	high	low	high	low	high
Production input and output of existing companies in the catchment area received/forwarded*	1,990 630/1360	2,420 1070/1350	3,480 1470/2010	2,610 1160/1450	3,720 1560/2160	2,610 1160/1450	3,720 1560/2160
Export of Tengiz Oil (transport by rail) received/forwarded		3,000 3000/0	3,000 3000/0	3,000 3000/0	3,000 3000/0	3,000 3000/0	3,000 3000/0
Growth of turnover in Aktau Seaport received/forwarded	200	2,680 770/1910	3,190 860/2330	2,680 770/1910	3,190 860/2330	2,680 770/1910	3,190 860/2330
New industrial investment received/forwarded	-	-	-	1,950 1650/300	2,200 1900/300	1,950 1650/300	2,200 1900/300
North-South railway corridor received/forwarded	-	-	-	-	-	2,100 1500/600	2,100 1500/600
Total received/forwarded	**1,990** 630/1360	**8,100** 1840/6260	**9,670** 2330/7340	**10,240** 3580/6660	**12,110** 4320/7790	**12,340** 4180/8160	**14,210** 4920/9290

* received = direction from Bejneu to Mangyshlak; forwarded = direction from Mangyshlak to Bejneu

Sources: Research with companies concerned
Information provided by Ministry of Economy. Ministry of Transport and Communication. Ministry of Oil and Gas Industry as well as Munaigas Company and Administration of Mangistau Oblast
Feasibility Study North-South Corridor, Part II. GIPROTRANSTEI

As previously stated, it is very difficult to realistically validate any of the above forecasts. In particular, the projected developments which underlie the growth in production for Scenarios B and C depend on investment from Government agencies and/or foreign sources. It is noteworthy that none of the projected investment schemes are related to *private* investment by Kazak companies, which would obviously need to be based on market conditions.

The Consultant is particularly concerned that some of the projected developments continue to reflect the philosophy of a planned rather than a market economy, particularly where this concerns locating industry in areas physically remote from markets and/or raw material sources. In normal circumstances, the only way in which such investments can be made viable is by artificially depressing freight haulage prices so that they do not unduly affect the

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

final cost of the product in the market. The Consultant is not totally convinced that this fact is appreciated fully in Kazakstan.

Breakdown of Freight Traffic by Commodity

The breakdown of projected rail traffic by commodity in Scenarios A and B will clearly be determined by the industrial structure in the catchment area of the route (see Table 2-19).

In Scenario A it is expected that the share of crude oil and oil products will amount to approximately 43-37%, and in Scenario B to about 47-42%.

These commodities will have a considerable effect on the freight traffic structure in the future. Further important commodities will be chemicals and fertilisers, whose share is expected to be approximately 13-15% in both scenarios. This means that about the half of the future freight traffic by rail will comprise crude oil/oil products and chemicals/fertilisers.

Table 2-20: Projected Freight Traffic Volume Mangyshlak-Bejneu by Commodity in 2005

Commodity	**Freight volume ('000 tonnes)**						
	1995	**2005**					
		Scenario A		**Scenario B**		**Scenario C**	
		low	*high*	*low*	*high*	*low*	*high*
Chemicals/Fertilisers	440	1,010	1,260	1,300	1,650	1,300	1,750
Crude oil	-	3,000	3,000	3,000	3,000	3,000	3,000
Oil products	360	500	550	1,850	2,050	1,850	2,050
Construction materials	410	490	800	690	1000	690	1,000
Metals, ores	260	460	620	460	620	660	820
Timber	20	120	150	120	150	120	150
Grain	50	1,120	1,500	1,120	1,500	1,320	1,700
Other	450	1,400	1,790	1,700	2,140	3,300	3,740
Total	**1,990**	**8,100**	**9,670**	**10,240**	**12,110**	**12,240**	**14,210**

Sources: *Discussion with major customers*
Ministry of Economy and Ministry of Transport and Communication

Annex V shows the structure of freight volume by commodity as well as the breakdown between forwarded and received.

The additional expected transport demand on the route being surveyed arising as a result of the construction of the North-South corridor will include a high proportion of "other goods", which in this context includes manufactured industrial products such as machinery, industrial equipment, vehicles, paper products etc. This proportion is estimated to be approximately 70%.

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Number of Wagons

On the basis of the projected future freight traffic volume, its breakdown by commodity and the average tonnage by wagon and commodity[15], the projected number of loaded wagons between Bejneu and Mangyshlak (including from/to Aktau Seaport) has been broadly calculated.

Table 2-21: Number of Loaded Wagons

	Number of loaded wagons					
	Scenario A		Scenario B		Scenario C	
	low	high	low	high	low	high
Forwarded	38,918	48,322	67,481	80,818	82,866	96,202
Received	106,651	127,019	115,354	137,000	149,140	170,786
of which transport of Tengiz oil	*46,875*	*46,875*	*46,875*	*46,875*	*46,875*	*46,875*

The breakdown of loaded wagons by type for Scenarios A and B is described in Annex 2-5.

The calculation was carried out on the basis of suitable types of wagons for each of the commodities.

Number of Freight Trains

The number of freight trains has been calculated by considering the following facts:

i ***Gross tonnage for each type of commodity group***

The calculation was carried out on the basis of:

Commodity	***Factor Gross tonnage : net tonnage***
Chemicals	1.64
Fertiliser	1.42
Crude oil/ Oil products	1.36
Ores	1.32
Construction materials	1.38
Metals	1.36
Timber	1.49
Grain	1.41
Other	1.64

[15] According to WKR, the average load by commodity and average type of wagon (in tonnes/wagon) is: chemicals 52, ores 68, fertilisers 63, crude oil/oil products 64, metals 61, timber 44 ,construction materials 56, grain 61, other goods 39

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Source: WKR

ii *Maximum value of fluctuation*

A value for the fluctuation of number of trains in a defined time unit between the average and maximum needed to be calculated.

For the calculation of the maximum number of trains per day via the route Mangyshlak-Bejneu, the fluctuation value ψ is used.

The maximum value of ψ *(peak)* amounted to 1.16 and 1.26 (average value = 1) in an average month in 1995. The general trend for development of this value is that the maximum value decreases, if the number of trains increases.

Therefore a maximum value $\psi = 1.2$ for the fluctuation of number of trains per day has been estimated.

iii *Maximum train length*

The existing size of passing loops on the line effectively restricts train length to 850 metres, or 57 normal wagons plus locomotive. However, it is to be expected that these loops would be capable of extension should longer trains be required.

iv *Maximum gross tonnage per freight train*

In order to forecast the number of trains, the existing maximum gross tonnage between Mangyshlak and Bejneu was used:

direction Mangyshlak-Bejneu	2200 tonnes per train
direction Bejneu-Mangyshlak	3200 tonnes per train

These tonnages are governed by the permitted trailing load for one locomotive unit (two single-ended locomotives coupled back-to-back) of class 2TQ10L.

It should be noted that the maximum gross weight of a normal four-axle wagon is 90 tonnes (22.5 tonne axleweight); the line has a permitted maximum axleweight of 23 tonnes (see also Chapter 3.1.2.2).

The Feasibility Study for construction of the North-South corridor includes a higher gross tonnage for the section Mangyshlak-Bejneu of 3600 tonnes per train in both directions, presumably using a more modern and thus more powerful locomotive type.

Therefore the calculation of the number of trains was made using both values.

v Categories of freight trains

Block trains:

It is expected that the rail transport of crude oil from the Tengiz Oilfield (Kulsary station, about 200 km north of Bejneu on the main line to the north) to Aktau Seaport will be in block trains, from Kulsary to Aktau with loaded wagons and return from Aktau to Kulsary with empty wagons

Wagonload trains:

It is assumed that the transport of all other commodities will be carried out in wagonload (mixed freight) trains.

vi Re-loading of freight wagons

The projected freight volume developed for the scenarios shows that the received freight volume is higher than the forwarded volume. Therefore a check was made to determine the extent to which the received wagons by number and type are suitable for re-loading or not.

It was also considered that the freight volume for dispatching of oil products in Scenario B requires a higher number of empty wagons.

Taking into account all facts, the future number of freight trains implied in the different scenarios will be as follows:

Table 2-22: Number of freight trains between Mangyshlak and Bejneu in 2005

Type of train and **direction**		**Number of freight trains per day in 2005**					
		Scenario A		**Scenario B**		**Scenario C**	
		low	**high**	**low**	**high**	**low**	**high**
Variant 1: Current gross train tonnage: Bejneu-Mangyshlak 2200 tonnes. Mangyshlak-Bejneu 3200 tonnes							
Wagonload trains:							
Direction Bejneu-Mangyshlak	trains/	5	7	6	8	10	11
Direction Mangyshlak-Bejneu	day	5	7	9	11	11	12
Block trains							
Direction Bejneu-Mangyshlak	trains/	4	4	4	4	4	4
Direction Mangyshlak-Bejneu	day	4	4	4	4	4	4
Number of freight trains in total:	trains/						
Direction Bejneu-Mangyshlak	day	9	11	10	12	14	15
Direction Mangyshlak-Bejneu		9	11	13	15	15	16
Variant 2: Gross train tonnage: both directions 3600 tonnes (option with North-South Corridor)							
Pick-up trains:							

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Direction Bejneu-Mangyshlak Direction Mangyshlak-Bejneu	trains/ day	5 3	6 4	6 6	7 7	8 7	9 8
Block trains Direction Bejneu-Mangyshlak Direction Mangyshlak-Bejneu	trains/ day	4 4	4 4	4 4	4 4	4 4	4 4
Number of freight trains in total: Direction Bejneu-Mangyshlak Direction Mangyshlak-Bejneu	trains/ day	9 7	10 8	10 10	11 11	12 11	13 12

2.3.2 Passenger Traffic

The future demand for passenger rail traffic is governed by the following projections (see Chapter 2.2.2):

- The population in the Mangistau Oblast will increase to 352,000-355,000 inhabitants.
- The disposable income of the population will increase.
- The number of cars will increase by 100% approximately.
- The local bus companies in the Mangistau Oblast will extend their services into regional and medium-distance traffic.

It is very difficult to estimate future passenger traffic demand by rail given the potentially wide variations in socio-economic development. It is therefore necessary to consider the future demand for rail passenger transport in the context of mobility in the Mangistau Oblast as a whole.

For regional and medium-distance traffic, mobility of inhabitants can be expected to increase significantly, but this growth will be primarily met by new services of the bus companies and by an increase in private car ownership. It is estimated that the growth of mobility by rail will be lower than the overall growth in mobility in medium-distance traffic. Therefore, an increase of rail passenger traffic of no more than 10% is projected.

Long-distance traffic will experience a higher growth of mobility. It is estimated that long-distance rail traffic will grow by between 10 and 20% by 2005. There will be further growth in air traffic.

Table 2-23: Estimated Development of Mobility and Number of Trips by Rail in Mangistau Oblast in 2005

	Mobility by rail (trips/inhabitant/year)			Trips of all inhabitants in 2005* ('000)	
	1995	2005		per year	per day
		Expected growth (%)	trips per inhabitant per year		
Local and regional traffic	0.39	+/- 0	0.39		
Medium-distance traffic	1.89	+10	2.08		
Long-distance traffic	0.29	+10 → 20	0.32-0.35		
Total	2.50	+11.5 → 12.7	2.79-2.82	981-1,000	2.7

* Forecast of population in 2005: 352-355,000 inhabitants in the Mangistau Oblast

The future passenger traffic demand by rail will amount to 2,700 passengers per day on average, equating to **3 train pairs** per day.

This dictates that

- the accommodation in each passenger train will be about 550-600 seats plus sleeping berths of different classes and
- the number of daily departures will be increased by 2005

2.3.3 Number of Freight and Passenger Trains in total in 2005 between Mangyshlak and Bejneu

Using the forecasts for traffic levels developed in the preceding chapters, the projected number of freight and passenger trains between Mangyshlak and Bejneu is shown in the next table:

Table 2-24: Number of Trains on the route Mangyshlak-Bejneu in 2005

Type of train and **direction**		**Number of trains per day in 2005**					
		Scenario A		**Scenario B**		**Scenario C**	
		low	**high**	**low**	**high**	**low**	**high**
Variant 1: Current gross train tonnage: Bejneu-Mangyshlak 2200 tonnes. Mangyshlak-Bejneu 3200 tonnes							
Total freight trains: Bejneu->Mangyshlak Mangyshlak->Beineu	trains/ day	9 9	11 11	10 13	12 15	14 15	15 16
Passenger trains: Bejneu->Mangyshlak Mangyshlak->Beineu	trains/ day	3 3	3 3	3 3	3 3	3 3	3 3
Total number of trains: **Bejneu->Mangyshlak** **Mangyshlak->Beineu**	**trains / day**	**12** **12**	**14** **14**	**13** **16**	**15** **18**	**17** **18**	**18** **19**
Variant 2: Gross train tonnage : both directions 3600 tonnes (option with North-South Corridor)							
Total freight trains: Bejneu->Mangyshlak Mangyshlak->Beineu	trains/ day	9 7	10 8	10 10	11 11	12 11	13 12
Passenger trains: Bejneu->Mangyshlak Mangyshlak->Beineu	trains/ day	3 3	3 3	3 3	3 3	3 3	3 3
Total number of trains: **Bejneu->Mangyshlak** **Mangyshlak->Beineu**	**trains / day**	**12** **10**	**13** **11**	**13** **13**	**14** **14**	**15** **14**	**16** **15**

The relationship between the above demand for trains and the available capacity on the route will be explored further in Chapter 6.2.3.

3 Technical Feasibility

3.1 Survey of Existing Line Condition

3.1.1 General Introduction

The objective of this component of the Study was to examine the existing route of the WKR between Bejneu, km 0+0 and Mangyshlak, km 404+3, and to recommend future strategies for development of the route

It became apparent during the early stages of the Study that the connecting link between Mangyshlak and the port of Aktau, some 18 km, was not the property of the WKR but was instead owned by a consortium of local industrial enterprises and operated under the name KASKOR. This link clearly plays a strategic role in the whole of the traffic development of the subject of the Study, and yet, because of its separate ownership, it could not be investigated in detail under the Terms of Reference of the Consultant. Indeed, a copy of a map showing the routing and layout of the Mangyshlak-Aktau link was actually denied to the Consultant on the grounds of secrecy.

Therefore, in examining the technical condition and potential strategies for development of the whole route, only a superficial survey of the Aktau link line could be made, and this Study concentrates — as far as the technical rehabilitation aspects are concerned — on the main line from Bejneu to Mangyshlak.

3.1.2 Permanent Way

3.1.2.1 Methodology of the Study, Visits and Discussions

First Visit from 3rd September to 4th October, 1996

The initial discussions were held between the Consultant's experts and the local partner from 4th to 8th September in Almaty.

The local partner provided maps and information about the Aktau - Bejneu line. It was agreed that it would not be necessary for the team to visit the Headquarters of the WKR in Aktyubinsk.

The next meeting took place in the Ministry of Transport and Telecommunications on 5th September with Mr. Panov, Vice Minister.

The purpose of the meeting was to organise the field visit, and to receive preliminary advice about some of the problems affecting the line.

The field mission to Aktau and Mangyshlak followed immediately after. During this field mission, the following were met and interviewed:

Mr. Tabyldy Amirov	Chief of the railway line Bejneu - Mangyshlak
Mr. Chalbek	Chief of permanent way district between Bejneu (km 0) and km 203
Mr. Kozhachmet	Chief of permanent way district between km 203 and Mangyshlak
Mrs. Sayrangul	Engineer of permanent way district between km 203 and Mangyshlak

The field trip included the following:

9th September:	rail journey Mangyshlak-Bejneu (10 hours)
10th September	Bejneu-Mangyshlak by inspection coach with stops en route to examine specific locations
11th-17th September	discussions and site visits at Mangyshlak

Between 18th and 26th September, discussions were held and preparatory work was done with the staff of the local partner.

At the same time, a meeting was held with Mrs Shivareva from the Kazakstan Scientific-Research Institute of Environmental Monitoring and Climate (KazNIIMOSK) regarding the Caspian Sea level.

A visit to a concrete sleeper factory near Almaty followed, and discussions with Mr. Serbayev, Track Department Chief of the Almatinskaya Railway Organisation, were held concerning the local costs of track machines.

Second Visit from 12th to 22nd November, 1996

During the second visit meetings were held with the local partner discussing existing development plans.

From 14th to 19th November, a second field mission took place, including visits to bridges near Mangyshlak as well as a presentation of new track-fastenings and discussions on long-welded track.

3.1.2.2 Technical Characteristics of the Line

The line is situated in the Kazakhstan desert district of Mangistau Oblast.

The line is grouped within the third category, which is one of the lowest categories of the USSR railway line classification. It was opened in 1966, the line being constructed according to:

- SN 129-60 (Standards and technical conditions of projecting of railway lines with a gauge of 1520 mm on the entire network of the USSR)

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

- BSN 56-61 (Technical indications for projecting stations and junctions on railway lines on the entire network of the USSR)
- SN 41-58 (Rules and standards of planning and construction for buildings, cities and villages), and
- other technical standards used at the end of the 1950s. Today, these standards are no longer used.

The Aktau -Bejneu line is a single-track line operated with diesel traction, with a length of 403.07 km from Bejneu to Mangyshlak station. The private line between Mangyshlak and Aktau Port is 16 km, and to Aktau Town 18 km. The kilometre count begins in Bejneu at km 0 and ends in Mangyshlak at km 403.07.

There are three intermediate stations between Bejneu and Mangyshlak: Ustyurt, Say-Utes and Shetpe, and 15 passing loops within a maximum distance of about 29 km.

The only town near the line is Aktau having 165,000 inhabitants. It did not exist before 1963. People travelling by train have to take a bus from Aktau to Mangyshlak station. Several hundred people live in Ustyurt, Say-Utes and Shetpe.

As described in Chapter 2, there are large factories between Aktau and Mangyshlak, and also a small factory in Shetpe.

Houses for rail workers have been built in the vicinity of the passing loops.

The following physical characteristics were also observed:

- The subgrade has a width of 5.8 m.
- The track length on embankments is 368 km.
- The track length in cuttings is 34 km.
- The line has 61 bridges with a maximum length of 100 m.

There are 206 pipe culverts through the embankment, 23 level crossings, but no tunnels or retaining walls.

3.1.2.3 The Topography of the Line

The line passes through two geologic zones of West Kazakhstan. The boundary between these two zones is also of interest.

Between Bejneu and Say-Utes, the line passes through the Ustyurt plateau, which is a stony desert with hardly any elevation.

After the Say-Utes station (km 180), the Ustyurt plateau ends with a steep slope. Between km 180 and km 199, the height of the track falls from 220 m to 0 m above mean sea level. This zone is cut by ravines. At the borderline between the two geological zones — between km 199 and km 226 — lies the edge of the Kaidak marshland, which has recently become a gulf of the Caspian Sea.

The Caspian Sea itself lies in a depression area which is 26.5 m below sea level.

The second geologic zone is the Mangyshlak peninsula, having mountains of up to 556 m. The railway line reaches a height of 230 m. The mountains are fractured by several canyons. The line always runs in the valley bottom of the canyons, between a couple of metres and several hundred metres away from the side of the valley.

Table 3-1: Climatic Characteristics

Climate:	**air**	**rail**
Minimum temperature	- 25 °C	- 25 °C
Maximum temperature	45 °C	70 °C
Frost line	1.4 m	
Rainfall:	less than 100 mm per year, sometimes there is no rain at all when it rains, it rains very heavily	
Wind:	When there is bad weather, it is cloudy and windy.	

3.1.2.4 Maximum Speed and Speed Restrictions

Every year speed restrictions on a long-term basis are issued to locomotive drivers. It was not possible to obtain information about the former (USSR era) maximum permissible speed. These long-term speed restrictions form the basis for the calculation of the travel time of trains, which presently totals 10 hours between Bejneu and Mangyshlak.

There are two categories of trains to which speed restrictions apply:

- passenger trains
- freight trains

Speed restrictions for passenger trains: 199.6 km with 60 km/h (50% of the line)
148.1 km with 50 km/h (37% of the line)
51.3 km with 40 km/h (13% of the line)

Speed restrictions for freight trains: 188.1 km with 60 km/h (47% of the line)
11.5 km with 50 km/h (3% of the line)
199.4 km with 40 km/h (50% of the line)
The secondary tracks in stations and passing loops are mostly restricted to 25 km/h.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

3.1.2.5 Axle Load and Train Length

The maximum permitted axle load between Aktau and Bejneu is 23 tonnes.

The maximum train weight is 3200 tonnes between Bejneu and Aktau (so-called even direction); in the reverse, direction, the following limits apply:

2200 tonnes between Mangyshlak and Say-Utes
3000 tonnes between Say-Utes and Bejneu

The usable length of passing tracks is 850 m.

3.1.2.6 Organisational Structure of Line Staff

There are two permanent way districts, one in Bejneu, the other in Mangyshlak.

Bejneu Permanent Way District

Bejneu permanent way district has a staff of 250, controlling about 281 km of line. They are responsible from Bejneu (km 0) to km 203, some 72% of the whole permanent way district area.

Table 3-2: Bejneu Permanent Way District Staff Organisation

Total staff		**Staff responsible from km 0 to km 203**
central staff (district inspector, assistants, secretariat etc.):	15	10
mechanical workers and drivers:	35	25
workers for bridges:	5	4
9 sections incl. Bejneu Station	9 section foremen	9
18 gang foreman districts	18 gang foremen	18
rail workers	122	122
Total staff for the area Bejneu to km 203		**188**

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Mangyshlak Permanent Way District

Mangyshlak permanent way district has a staff of 330, controlling about 370 km of line. They are responsible from km 203 to Mangyshlak, which is 54% of the whole permanent way district area.

Table 3-3: Mangyshlak Permanent Way District Staff Organisation

Total staff		**Staff responsible from km 203 to Mangyshlak**
central staff (district inspector, assistants, secretariat etc.):	18	10
mechanical workers and drivers:	20	11
workers for bridges:	6	3
8 sections incl. Bejneu Station	7 section foremen	7
19 gang foreman districts	13 gang foremen	13
rail workers	170	170
Total staff for the area km 203 to Mangyshlak		**214**

Thus, on the Bejneu - Mangyshlak line, 402 people are engaged solely on permanent way maintenance.

The district office controlling this line is situated in Atyrau, which is one of three district offices of the WKR.

The WKR general directorate is in Aktyubinsk, where five service trains (mobile permanent way gang) are located, each having a staff about 130 people. These gangs are available for major repair works.

The responsible ministry is the Ministry of Transport and Telecommunications in Almaty.

3.1.2.7 Geometry — Curves and Superelevation

The geometry of the track between the main sections on the line can be broken down into five categories:

straight

curved, Radius R in metres:
R>= 1000

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

R< 1000 to R>= 800
R< 800 to R>= 500
R< 500

In the following, the numbers of the curves per section and category are summarised.

Table 3-4: Number of Curves per Section and Category

section of line	total km	straight km	Radius R metres			
			R>1000	1000-800	800-500	R<500
Bejneu (km 0) to Say Utes (km 178)	178	173.4	4.6 km 9 curves			
Say Utes (km 178) to passing N° 8 (197)	19	5.0	4.6 km 7 curves	1.0 km 4 curves	2.5 km 7 curves	5.9 km 12 curves
passing N° 8 (km 197) to Shetpe (km 312)	115	76.8	11.9 km 25 curves	10.2 km 20 curves	14.5 km 27 curves	1.6 km 3 curves
Shetpe (km 312) to Mangyshlak (403,07)	91.07	75.0	10.37 km 22 curves	3.3 km 6 curves	2.4 km 3 curves	
total	**403.07**	**330.2**	**31.47 km 63 curves**	**14.5 km 30 curves**	**19.4 km 37 curves**	**7.5 km 15 curves**

The minimum radius on the line is 398 m.

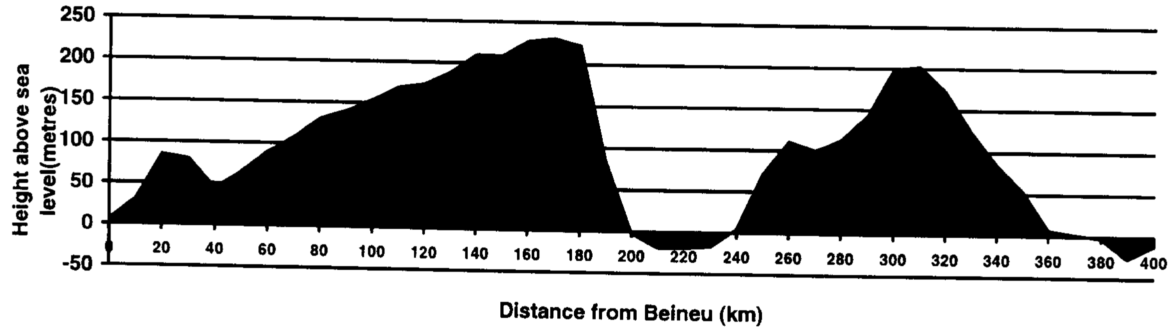
The superelevation is calculated in such a way that there is almost no cant deficiency.

3.1.2.8 Line Geometry — Gradient

Over long distances, the gradient adapts to the topographical surface. In this case, there are long distances with rising and falling gradients of up to 8‰.

Between the end of the Ustyurt plateau and the Caspian Sea, the line shows a steep falling gradient in the direction towards Mangyshlak. In this section, the gradient amounts to 15.6‰.

Figure 3-1: Longitudinal Gradient Profile



Scale: distance:1:2,500,000; height 1:10,000

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

3.1.2.9 Level of the Line— Sea Level

The line runs between 28 m below and 232 m above mean sea level. The Caspian Sea is 26.5 m below mean sea level.

In the following table, the track lengths are listed according to sea level.

Table 3-5: Distance of each section relative to height above sea level

Height above mean sea level	Total length
lower than -27 m	1.7 km
-27 m to -26 m	0.5 km
-26 m to -25 m	0.3 km
-25 m to -24 m	0.7 km
-24 m to -23 m	0.4 km
-23 m to -22 m	0.7 km
-22 m to -21 m	0.7 km
-21 m to -20 m	1.6 km
-20 m to -15 m	32.4 km
-15 m to -10 m	10.6 km
-10 m to 0 m	24.4 km
0 m to 50 m	57 km
50 m to 100 m	72 km
100 m to 150 m	81 km
150 m to 200 m	64 km
above 200 m	56 km

The lowest areas of the line are in the following mileage points:

Table 3-6: Location of lowest points on the line

Height above mean sea level	Location and length
lower than -27 m	388.0 - 389,8=1.8 km
lower than -25 m	387.6 - 390.1=2.5 km
lower than -23 m	386.8 - 390.4=3.6 km
lower than -20 m	204.9 - 205.9= 1.0 km 385.3 - 390.9=5.6 km
lower than -15 m	203.7 - 231.4= 27.7 km 383.4 - 391.6= 8.2 km 396.5 - 399.6=3.1 km

3.1.2.10 Standard and Condition of Civil Engineering Structures

Bridges and Pipe Culverts

There are 206 pipe culverts on the line. Of these, 181 are round concrete pipes with a diameter between 1 and 2 m. 30 of them have more than one tube beside them (up to 9 tubes). 25 pipe culverts are rectangular concrete pipes with a width between 2 and 3 m.

There are also 61 bridges. 60 bridges are made of concrete and have a maximum length of 56.1 m. One bridge is made of steel (in km 339.4) with a length of 100 m. This bridge was built in 1993, after the old one was destroyed by heavy rainfall.

Embankments and Cuttings

The width of the subgrade is 5.8 m.

The highest embankments and cuttings are between Say-Utes and km 199, where the railway line runs in an area cut by ravines.

There is a total track length on embankments of 368 km, with a maximum height of 20m. The embankments are made up of different kinds of sand, clay and marls.

The track length in cuttings is 34 km, with a maximum depth of 14 m. Cuttings are constructed in areas of marls, limestone and clay.

Drains

Mostly the drains are open catch water drains with natural soil. In some parts, where the falling gradient is too steep, the soil is supported by means of concrete plates.

Level Crossings

There are 23 level crossings on the line. Only four of them have more than 50 cars per day crossing the line. The busiest crossing is near Mangyshlak station (1800 cars per day). The level crossings mainly consist of concrete plates, though some are asphalted.

3.1.2.11 Standard and Condition of Track

Rails with Joints and Welding

The line was constructed with rails of 43 kg/m. During the past few years, some rails have been replaced by rails weighing 50 kg/m or 65 kg/m.

Presently, there are the following rails:

Table 3-7: Status of existing rails

from km	to km	weight of rail	year
0	34	65 kg/m	1990s
34	179	43 kg/m	1966
179	180	50 kg/m	1966
180	187	65 kg/m	1990s
187	197	50 kg/m	1966
197	208	65 kg/m	1987
208	278	43 kg/m	1966
278	279	50 kg/m	1966
279	297	65 kg/m	1989-91
297	298	50 kg/m	1966
298	312	65 kg/m	1988-90
312	313	43 kg/m	1966
313	342	65 kg/m	1991-96
342	403	43 kg/m	1962

The rails weigh	43 kg/m	277 km	69%
50 kg/m	13 km	3%	
65 kg/m	113 km	28%	

Each rail has a length of 25 m and fishplated joints, with six holes per joint. On the whole line, the joints are suspended rail joints. There is no welded track at all on the route.

Sleepers

Concrete sleepers were installed last year from km 17 to km 34, and these are the only ones on the route. They were bought second hand from Russia and are about 20 years old.

The rest of the line is equipped with impregnated wooden sleepers, all having been inserted in 1966, the year in which the line was opened. Very few sleepers have been replaced by new ones which means that 386 km of the line is still equipped with wooden sleepers.

The new wooden sleepers are:	length	2.70	m
width	23		cm
height	16		cm

Fastenings

There are ribbed base plates on the 17 km of old Russian concrete sleepers. Every ribbed base plate is fixed to the sleeper by two sleeper bolts. The rail is fixed by T-bolts and rail clips.

On the 386 km with wooden sleepers, there are base plates. Every base plate is fixed by 4

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

spikes (two inside the rail, two outside). The two spikes at the inside of the rail also fasten the rail. Of the two spikes outside of the rail, only one is fixing rail and plate, the other fixes only the plate. The sleepers are equipped with rail anchor devices.

The new bottom plates are for 65 kg/m rails: 36/17 cm
for 43 kg/m rails: 28/16 cm

There is no elastic material between rail and bottom plate. On the new wooden sleepers, there is approximately 8 mm elastic material inserted between sleeper and bottom plate.

Ballast

For the construction of the line in 1966, ballast, mainly sand, from a quarry near Bejneu was used. More recently, stone ballast was supplied from Aktyubinsk.

Stone ballast is only used in the following sections:

Table 3-8: Use of stone ballast

from km	to km	length
2	7	5 km
17	34	17 km
198	202	4 km

There is thus only 26 km with a stone ballast bed, the rest of the line (377 km) having sand ballast, though there is also a 10 km section with an asbestos ballast bed.

3.1.2.12 Stations and Loading Points

All stations are equipped to handle freight and passenger traffic. In this context, the expression 'siding' means dead-end roads rather than connections to customer premises.

Bejneu station (km 0) lies at the junction with the main Makat—Uzbekistan line. The station has 12 through lines and several sidings plus about 60 turnouts. A small town is located here.

Near passing loop N° 4 (km 80), there is a village named Ustyurt. The passing loop has 3 tracks and 8 turnouts.

Say-Utes (km 178) is a village. In this station the locomotives of freight trains are changed. The station has 4 through tracks and some sidings as well as 19 turnouts.

Shetpe (km 312) is a village with small factories. The station has 8 through tracks and several sidings as well as 33 turnouts.

Mangyshlak (km 403) is also a village with factories and repair shops; the station is the nearest to the town Aktau. The station has 18 through tracks and several sidings as well as about 80 turnouts.

All passing loops have between 2 and 4 tracks, most of them also have one siding and between 3 and 9 turnouts. The maximum distance between the passing loops is 29 km.

Usable Length of the Station Tracks

The two main tracks of the passing loops and stations mostly have a usable track length of about 850 m and 1100 m.

Two passing loops (N° 5 and N° 11) have a usable length of 824 m and 840 m respectively.

Standard and Condition of Turnouts

Most of the turnouts consist of 50 kg/m rails. Only single turnouts are used, and they have an arc of 300 m and a crossing angle of 1:9 or 1:11. The tongue construction is a rigid point, and switch diamonds are monobloc.

The sleepers are always made of wood. The slide chairs and the switch diamond are fixed to the sleepers with sleeper screws. The other parts of the rails are fixed by means of spikes to the sleepers.

Standard and Condition of Platforms

Each station where passenger trains stop has platforms about 15 cm above the top of the rail.

Standard and Condition of Buildings

Most of the buildings in the stations are about 100 m^2 and at the passing loops about 50 m^2. These buildings house the operator, the signal box and sometimes telecommunications equipment.

3.1.2.13 Inspection of the Line

The main line between Mangyshlak and Bejneu is inspected according to the following cycle:

- **twice monthly**: gang foreman makes inspection round
- **once monthly**: track inspection coach used
- **twice yearly**: chief permanent way engineer makes an inspection round.

3.1.2.14 Maintenance Works

Floating Repair Works or day-to-day Repair Works

The following works are included in this category:

- repair of defects in the track
- repair of defects in turnouts
- repair of defects in track geometry
- repair of defects in turnout geometry
- repair of loose fastenings (spikes)
- maintenance of joints
- maintenance of isolation joints
- repair of broken sleepers
- renewal of broken bottom plates
- renewal of cracked rails
- replacement of missing ballast
- grinding of small parts of the rail
- occasional weed killing
- maintenance of level crossings
- maintenance of buildings
- maintenance of catch water drains
- etc.

These works have to be undertaken by local staff without any track maintenance machines.

Intermediate Repair Works or Scheduled Track Maintenance

These works take place annually on a defined part of the line. It is planned to work between 30 and 80 km per year. The actual distance is determined by the money available for purchase of track material.

These works include principally:

- renewal of bad rails (about 3x25 m per km)
- renewal of bad sleepers (about 300 sleepers per km)
- renewal of broken bottom plates (about 500 plates per km)
- replacement of missing ballast (about 300 m^3 per km)
- straightening and tamping of track
- renewal of broken equipment in turnouts

Sometimes this work is done by two gangs together. In general, no track maintenance machines are available.

3.1.2.15 Major Repair and Renewal Works

Rail Renewal

In the past 10 years, 113 km of track were renewed manually, mostly by local staff. Only in some sections they were supported by the staff of the service trains from Aktyubinsk. Most of the work is done during a 4-hour closure of the line. During such periods, up to 1000 m are replaced by 50 - 60 workers.

The standard calculation is based on 0.3 man/hours/metre but in practise the number is higher.

Track Renewal

There has been practically no track renewal on this line, other than the section from km 17 to km 34 which was renewed during the last year. The equipment used was a Platov crane to replace 25 m long track panels, and an excavator for taking out the old ballast bed. Ballasting was done by means of a ballast wagon, other machines used were a track lining machine and a tamping machine. These machines can be 'ordered' for such work. The main work was done every Thursday during a closure of the line lasting for 5-6 hours. During such a closure, about 1200 m were completed.

The standard calculation is based on 0.5 man/hours/metre but in practise the number is higher.

3.1.2.16 Mechanised Track Maintenance

There are no heavy track maintenance machines for maintenance work. Only small machines are available in the permanent way district

Existing Machinery and Equipment

The following heavy machines are available at Aktyubinsk and can be ordered for use on this line for major maintenance works only:

Platov crane
SHOM ballast cleaning machine
Rail grinding machine
VPO-3000 lifting, levelling and lining machine
Tamping machine

Equipment available at the permanent way departments:

3 large track cars (for about 30 workers)
10 small track cars (for about 15 workers)
3 track cars with crane (max. lifting weight about 1 to)

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

6 ultrasonic testing machines
rail drilling machines with motor
hand-tamping machines with electric-motor
hand rail grinding machine
hand rail lifting cranes

Various annexes to this report show:

- Photo documentation (Annex X)
- Length Profile of the line 1:200,000/2000 (Annex I)

3.1.3 Telecommunications

3.1.3.1 Existing Types of Communication on the Line

The existing communication equipment was planned and constructed according to the telecommunications demand on the line (railway stations and crossings) and between this line and the control offices (central dispatcher in Atyrau, operating control in Aktyubinsk and the Ministry in Almaty).

Before describing the existing telecommunications equipment in detail, an explanation regarding the existing communication types between the above-mentioned offices and the WKR is required.

Communication within the Operating Department

In line with the existing type of operation, today the central dispatching and control of the running of trains on the Bejneu—Mangyshlak line is done by the central dispatcher in Atyrau. This involves remotely controlling the whole of the line, with the exception of the two terminal stations, where the preparation for despatch along the route is done by the local station inspectors. Along the whole line, shunting operations and the operation of connecting railways are done by local personnel. Should the remote control fail, the central dispatcher submits his commands by telephone, which then are executed by the local personnel.

The operation involves the following types of communication:

- central dispatcher to local station inspectors (dispatcher line)
- station inspectors along the railway line with each other (dispatcher line)
- selected staff members along the line without central dispatcher (additional dispatcher line), however with communication possibilities to controlling offices (up to Almaty)
- central dispatcher to locomotive drivers (radio communication with trains)
- station inspectors to locomotive drivers (radio communication with trains)
- locomotive drivers to each other (radio communication with trains)
- shunting personnel to locomotive drivers and station inspectors (radio used for directing

shunting operations)
- maintenance staff for signalling and telecommunications installations along the line with each other (own party line)
- maintenance staff for permanent way with each other (own party line)

Administrative communication

To cope with the commercial requirements of the staff on the route, there are connections between the railway stations along the line and Mangyshlak as well as from Mangyshlak directly to Atyrau, Aktyubinsk and Almaty. For this purpose, the general telephone channels of the existing carrier systems are used.

3.1.3.2 Overhead Line and Cable

An overhead line along the railway line forms the basis for all communication between local installations and to the controlling offices in Atyrau and Aktyubinsk. There is an overhead line telegraph pole equipped with three cross arms at 50 metre intervals. In general, these poles are constructed of concrete. At the transition point between the overhead line and the earthing cable, there is a wooden scaffolding, at which the overhead line is braced by means of an anchor pole.

Connection of the overhead lines to the technical telecommunications rooms is via earthing cables of the type T3B or TZB with 7 * 4 * 1.2.

The number of telecommunication circuits is adapted to demand. Starting with km 126, in addition to the telecommunication circuits required for the railway, there are also circuits for the public telephone network and Ministry of the Interior, which means that the number of connections along the line varies.

The railway's equipment consists of eight lines having the following parameters:

- 5 steel lines (10 wires) having a diameter of 5 mm: serve for the connections between the railway stations.
- 3 bimetallic lines (6 wires) (copper sheathed steel) having a diameter of 4 mm are used for the carrier systems.

The wiring of these eight lines existing on the whole line is as follows:

- dispatcher line from Bejneu to Mangyshlak including all local station inspectors as well as the central dispatcher in Atyrau,
- special dispatcher line for station inspectors along the line excluding the central dispatcher in Atyrau, but having access to controlling offices,
- party lines for permanent way maintenance staff,
- party lines for maintenance staff for communication facilities and signalling installations,
- communication between the signal boxes regarding remote control,
- local lines between two railway stations: these include also the telephones at the signals

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

and turnouts at the entry and exit area. There are no telephones between railway stations. In the event of works on the line, communication with the neighbouring railway stations uses these lines, by connecting a telephone set to the nearest telephone line by means of a connection device. This line exists only from km 124.

- carrier links (two for the railway, the public network and the Ministry of the Interior)

The following lines exist along the whole railway line:

- 8 lines (16 wires) from km 1 (Bejneu) up to km 124
- 9 lines (18 wires) from km 124 up to km 313
- 19 lines (19 wires) from km 313 up to km 372
- 11 lines (22 wires) from km 372 up to Mangyshlak

This information was supplied in response to the Consultant's written questionnaire.

The plans indicate the connections according to type. The carrier links are marked by a unique 4-digit numerical code which is also listed in the communication chart of carrier links of the WKR. The code corresponding to the systems being directly used by the railway always starts with 16, e.g. 1635 or 1617. The communication chart of carrier links only shows the carrier systems belonging to the railway, not the additional ones for the public network and the Ministry of the Interior, which however are included in the communication chart of the communication systems. The code for the additional systems always starts with 13, e.g. 1307 or 1313. However, the communication chart does not show where the individual terminal stations of these additional carrier systems are located.

3.1.3.3 Transmission Technology

For long-range communications, two different carrier systems are used:

- two-wire/twelve-channel system within a frequency range of 36 - 143 kHz, designated B-12-3
- two-wire/three-channel system within a frequency range of 4 - 31 kHz, designated B-3-3

The first figure always states the number of channels, the second the generation of the respective device, with 3 meaning the third generation. This generation is already equipped with transistors. As may be seen in the communication chart for carrier-frequency equipment, also devices of the second generation — conduit devices (e.g. all amplifiers on the line Bejneu - Mangyshlak and also of some terminal stations) are still used.

In the case of both systems, direction separation is achieved by means of grouped-frequency operation. Since both systems function in different frequency ranges, both can be switched by means of a corresponding frequency separating filter to a common two-wire circuit. In addition, a low-frequency link (LF-link) is switched to this two-wire circuit. The transmission capacity for the railway (only 16xx systems, not the 13yy for the public network) on this line is:

- 3 channels Mangyshlak - Shetpe
- 3 channels Mangyshlak - Say-Utes
- 3 channels Shetpe - Say-Utes
- 2*3 channels Say-Utes - Bejneu
- 1 LF communication Mangyshlak - Shetpe
- 1 LF communication Shetpe - Say-Utes
- 1 LF communication Mangyshlak - Say-Utes
- 2 LF communications Say-Utes - Bejneu
- 2*12 channels Mangyshlak - Bejneu

Moreover, Mangyshlak and Bejneu possess the following systems for the connection of the lines beginning or ending in these railway stations:

- Mangyshlak: 3 channels towards Uzen having terminal stations in the two intermediate stations
- Bejneu: 2 * 3 and 2 * 12 channels towards Makat and 1 * 3 and 1 * 12 channels towards Uzbekistan
- it is possible at any time to add to the three-channel systems an LF channel

As the wiring scheme for these channels shows, nearly all of the existing channels are used. Thus, there is little free capacity available.

As an example for wiring a large terminal station, in the following the outgoing and incoming connections of Mangyshlak are listed:

- first 12-channel system:
- channel 1: central dispatcher line
- channel 2: operator-switched telephone connection to Aktyubinsk
- channel 3: operator-switched telephone connection to Atyrau
- channel 4: operator-switched telephone connection to Kasalinsk
- channel 5: dedicated line for conference circuit
- channel 6: operator-switched telephone connection to Atyrau
- channel 7: dedicated line Atyrau - Mangyshlak as voice-frequency bearer circuit
- channel 8: operator-switched telephone connection to Bejneu
- channel 9: dedicated line for the party line to Shetpe for permanent way maintenance staff
- channel 10: operator-switched telephone connection to Shetpe
- channel 11: operator-switched telephone connection to Shetpe
- channel 12: dedicated line for conference circuit
- first 3-channel system including respective LF channel:
- channel 1: dedicated line for data transmission to Say-Utes
- channel 2: special dispatcher line
- channel 3: dedicated line for party line to Shetpe for maintenance staff for communication facilities and signalling installations
- LF communication: no indications
- second 12-channel system:

- channel 1: dedicated line for conference circuit (district level)
- channel 2: dedicated line for operating department
- channel 3: automatic telephone connection to Atyrau
- channel 4: reserve
- channel 5: reserve
- channel 6: automatic telephone connection to Atyrau
- channel 7: operator-switched telephone connection to Aktyubinsk
- channel 8: operator-switched telephone connection to Makat
- channel 9: dedicated line of the data pack-unpack device in Mangyshlak to Aktyubinsk
- channel 10: operator-switched telephone connection to Bejneu
- channel 11: reserve
- channel 12: reserve
- second 3-channel system including respective LF channel:
- channel 1: automatic telephone connection to Atyrau
- channel 2: indications could not be read
- channel 3: indications could not be read
- LF communication: no indications

3.1.3.4 Telephone Connections Along the Line

As already described above, the following telecommunication circuits exist along the entire railway line, which are also accessible in every railway station or passing point:

- dispatcher line from the central dispatcher in Atyrau to all local station inspectors
- party lines for local station inspectors excluding the central dispatcher in Atyrau, but having access to important offices in the whole Kazakstan railway network (Aktyubinsk, Almaty)
- party lines for the permanent way maintenance staff
- party lines for maintenance staff for communication facilities and signalling installations
- local line

The first four connections have central battery working and voice-frequency signalling. In the case of long distances, the lines are conducted via carrier frequency systems. Only the local connection of extensions uses the metal wires of the overhead line. Because of the voice-frequency signalling, individual calls as well as multi-party calls are possible.

The last line (local line) functions with local battery and hand generator for signalling (ringing current generation).

Central dispatcher line

The central dispatcher for the Bejneu—Mangyshlak line is situated in Atyrau. The central dispatcher line is routed from Atyrau via a voice-frequency channel as a dedicated line without inclusion of any subscriber up to Bejneu, and from there it is again routed via a voice-frequency channel up to Mangyshlak, including the railway stations Say-Utes and

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Shetpe. The railway station Ustyurt, being situated between Bejneu and Say-Utes, is only included in the form of a passing point (N° 4) and does not have a terminal station of the 3-channel system as do all other railway stations.

In the railway stations Bejneu, Say-Utes, Shetpe and Mangyshlak, the connection of the end-to-end voce-frequency line is executed by means of the local terminal stations as well as by means of the two-wire connection, which is necessary for the supply of the neighbouring passing places. The following passing places are connected to the individual railway stations:

- Bejneu towards Say-Utes: passing places 1 - 4 (4 corresponds to Ustyurt Station)
- Say-Utes towards Bejneu: passing places 5 - 7
- Say-Utes towards Shetpe: passing places 8 - 10
- Shetpe towards Say-Utes: passing points 11 -13
- Shetpe towards Mangyshlak: passing points 14 -15
- Mangyshlak towards Shetpe: passing point 16
- Mangyshlak towards Uzen: Uzen Station and three intermediate stations

Party line for maintenance staff for communication facilities and signalling installations

This connection is constructed similarly to the central dispatcher line. Yet, its reach is restricted to the area from Bejneu via Mangyshlak to Uzen and there is no central office. The allocation of the individual passing points to the railway stations is nearly identical to that of the central dispatcher line, only the passing points 14 and 15 being connected to Mangyshlak instead of Shetpe. The technology is identical to that of the central dispatcher line.

Party line for permanent way maintenance staff

This connection only starts in Say-Utes, and from there up to Uzen it is analogue to that of telecommunication service and signalling.

3.1.3.5 Operational Telephone Systems

In all passing places and railway stations, attendant consoles of the type DSP have been installed for telecommunications along the railway line. These are used in three different sizes (number of lines that can be connected: 6, 8 or 19), in general at least two links being not connected. The following lines are always connected:

- dispatcher line from the central dispatcher in Atyrau to all local station inspectors,
- party lines for the local station inspectors without inclusion of the central dispatcher in Atyrau, but having access to all important offices in the entire Kazak railway network,
- party lines for the permanent way maintenance staff, and
- party lines for the maintenance staff for communication facilities and signalling

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

installations.

Since these connections are party lines, it makes four connections. Starting with km 124, there is the local line being a point-to-point connection to the left and the right neighbouring railway station. This means that starting from the passing point, in each railway station at least 2 connections are added. In some railway stations also specific local telephone stations are included in the operational telephone system.

3.1.3.6 Radio Installations

Radio communication with trains

The line is equipped for radio communication with trains, which was standard in the former Soviet Union and still is standard in today's CIS. It works with a frequency of 2.1 MHz. Because of the large range, the advantage of using this frequency is that only a few fixed radio stations are required. The aerials of the fixed installations are stretched between the anchor poles of the overhead line (at the transition to an earthing cable for conducting the telecommunication circuit into the building housing the technical equipment) and these buildings; they are about 20 to 30 m long.

There is no self-contained modulation line for feeding the fixed radio installations. These installations are connected to the central dispatcher line. The central dispatcher can see in the centre where the individual trains are and sends a call via the central dispatcher line to the corresponding track section. Also the local station inspector can intrude into the radio communication via his own telephone set.

The technical equipment for the fixed radio installation is in a locked wall-mounting cabinet, to which only authorised staff members of the telecommunication service have access. All other telecommunications equipment is in unlocked wall-mounting cabinets to which all railway staff members have access.

Each passing point and each railway station possesses a fixed radio station. There are no further intermediate fixed radio stations. In total, on the Bejneu—Mangyshlak line 34 locomotives are equipped with mobile radio sets.

Radio used for directing shunting operations and radio installations for other services

Mangyshlak, Shetpe and Bejneu stations and passing point N° 1 are equipped with radio installations used for shunting operations. These work within the frequency range 152 - 154 kHz.

Similar radio sets are installed in snow-plough, breakdown trains and fire extinguishing trains. The technical department in Mangyshlak is also equipped with such devices.

Staff members responsible for recording the classification of wagons in Bejneu are also equipped with portable radio sets.

In total, there are 7 fixed, 8 mobile and 106 portable radio sets.

3.1.3.7 Telephone Network

The large railway stations have automatic switchboards with the following access capabilities:

- Bejneu: 400
- Ustyurt: 100 (10 wired)
- Say-Utes: 100 (68 wired, plus 2 parallel sets, total 70 extensions)
- Shetpe: 100 (80 wired)
- Mangyshlak: 800

With the exception of the telephone centre in Mangyshlak which is 'state of the art', all other centres have a manual exchange rather than automatic trunk connection. Only Mangyshlak is capable of automatic trunk connection with the following railway stations:

- Yeralivo
- Shetibay
- Uzen
- Ustyurt
- Bejneu
- Atyrau
- Say-Utes

However, there exists an automatic service between Ustyurt and Say-Utes.

As regards the communication with the public telephone network, switching equipment of the type M-60 is used. Such equipment is installed in the following railway stations:

- Bejneu: 18 lines, 14 occupied
- Ustyurt: 6 lines, 2 occupied
- Say-Utes: 6 lines, 5 occupied
- Shetpe: 6 lines, 6 occupied
- Mangyshlak: 30 lines, 22 occupied

As with other railway organisations, the residences of some railway staff are also equipped with a telephone connection to the railway telephone system. This applies to all railway stations and the passing points N° 10, 13 and 15.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

3.1.3.8 Telegraph and Data Transmission Network

As regards telex and data transmission, the railway stations are equipped as follows:

- Bejneu: 8 terminals
- Say-Utes: 2 terminals
- Shetpe: 2 terminals
- Mangyshlak: 4 terminals

The terminals in Say-Utes and Shetpe are connected to Mangyshlak via voice-frequency telegraph equipment. Two types of terminals are used: old mechanical terminals and modern ones based on Personal Computers (PCs) and having storage media for telegrams. As regards the intermediate stations, there is always one terminal in the telegraph office and one in the data processing office.

In Mangyshlak, there is a telegraph switching centre with 20 lines, 16 of which are occupied. This centre has 6 outlets which are connected to the voice-frequency telegraph system having in total 48 channels (2 * 24). In addition to the 6 outlets of the telegraph switching centre, two dedicated lines to Bejneu are occupied.

As regards data transmission, there is a data pack-unpack device to which five terminals (four in Mangyshlak and one in Say-Utes) are connected. This device is directly connected to Aktyubinsk via a voice-frequency telegraph system channel.

This data transmission network enables operation of the on-line passenger ticket sales system, using PC and ticket printing machines.

3.1.3.9 Other Technical Telecommunication Installations

Loudspeaker equipment

Bejneu, Say-Utes, Shetpe and Mangyshlak railway stations are equipped with loud-speaker equipment. In general, each station has only one amplifier (Mangyshlak: 3), one microphone (Mangyshlak 4 and Bejneu 2) and 8 to 12 loud-speakers (Mangyshlak and Bejneu 36 each). The indoor loudspeakers have a power of 2 W and those outdoors are 5 to 10 W.

Clock installations

The railway stations at Say-Utes, Shetpe and Mangyshlak are equipped with clock installations, the large station of Bejneu, however, is not. These installations consist of one master clock (Mangyshlak 2 master clocks) and 3 - 4 secondary clocks (Mangyshlak 31). The clocks are used indoors as well as outdoors.

Fire-alarm systems

The technical rooms at Bejneu station, in the buildings of the passing points (starting from N°

7) as well as in the railway stations up to Mangyshlak are equipped with a fire-alarm system.

Hot-box detectors

Hot-box detectors are installed at Ustyurt and Shetpe railway stations and in the passing points N° 6, 12 and 15.

Ticket issuing machines

Bejneu, Say-Utes, Shetpe and Mangyshlak railway stations have ticket issuing machines of the "Ekspres-2" type. These are based on a PC with on-line connection and a ticket printing machine producing tickets having a European standard format.

Power supply

The technical installations within the telecommunications area are supplied with 24 or 60 V DC. At individual locations, the necessary rectifiers and batteries are available being operated by means of a buffer-battery system.

The railway stations at Say-Utes, Shetpe and Mangyshlak plus passing places N° 1, 3, 5, 7, 9, 11, 14 and 16, have an emergency power supply system in the form of a diesel motor with connected generator.

3.1.3.10 Measuring Devices

The following measuring devices are available in the telecommunications workshop in Mangyshlak (without indication of number):

- cable test set
- cable measuring bridge
- cable fault locator
- cable insulation testing instrument
- level-measuring set
- frequency counter
- attenuation-measuring set
- universal measuring instrument (Volt, Ampere, resistance)
- generator for transistor testing and
- diode testing device

3.1.4 Signalling

At present, the Bejneu—Mangyshlak railway line is equipped with high-quality signalling installations with relay technology.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

The two railheads Bejneu and Mangyshlak each have electric signal boxes. The 18 passing loops or intermediate stations have electric signal boxes that are remotely controlled from Atyrau. A total of 100 automatic block posts divide the line into block sections of between 0.9 km and 9.2 km. 21 of the 22 level crossings are equipped with train-operated automatic light signals and one with a manually switched barrier.

The entire railway line has a track-release installation with track circuits. Automatic train-running control data is sent to the locomotives via these track circuits.

Voltage supply and transmission of signalling information takes place via a separate overhead line at the right side of the railway line (starting from 362¾ at the left side of the line) with 2 systems 3x10kV three-phase current and a number of weak-current lines according to demand.

A relay technology with gravity relay is used.

3.1.5 Operation

Co-ordination and permission of journeys

In principle, all journeys on the line, at the stations and passing loops are co-ordinated and permitted by the central dispatcher office in Atyrau.

The train and shunting routes (turnouts and signals) are controlled by the local dispatcher (operator) of the station.

The stations Bejneu, Say-Utes, Shetpe and Mangyshlak are exempted from this rule. In these railway stations, the shunting movements are co-ordinated and controlled by the dispatcher of the station who also authorises the journeys.

Passenger trains

At present, 2 pairs of passenger trains operate on this line. The passenger trains take 8h 20m from Bejneu to Mangyshlak, stopping in Ustyurt, Say-Utes and Shetpe (see Annex N).

Freight trains

At present, 5 pairs of freight trains operate between Bejneu and Say-Utes and 7 pairs of freight trains between Say-Utes and Mangyshlak. Block trains need about 12 hours from Bejneu to Mangyshlak (see Annex N).

Signalling, automatic train running control, radio communication with trains

All railway stations are equipped with locally operated signal boxes with push button geographical circuitry. There is a continuous track-release installation.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

The automatic train running control transmits the aspects of the fixed signals to the drivers' cabs.

On the whole line radio communication with trains is possible. All tractive units and trolleys can be reached by the central dispatcher and the dispatchers of the railway stations via radio communication. Also the tractive units have radio communication with each other.

Running speeds, load hauled, capacity

Annex C lists the existing permissible running speeds according to type of train and state of conservation of the track layout, the maximum load hauled per tractive unit, the possible number of trains based on the existing sequence of trains and the existing passing loops (capacities).

Wagon technical inspection

The inspection of running qualities of goods wagons is done at the originating station. For the inspection of one wagon axle, 2 minutes are planned. The inspection of a train having 50 wagons normally needs 200 to 400 minutes.

After a journey of 200 to 300 km, another C&W inspection is done (e.g.: between Bejneu - Mangyshlak, an inspection is done in Say-Utes).

Number of tractive units

In principle, the trains have two tractive units (tandem). Block trains are also driven by 3 tractive units. Locomotives are normally changed at Say-Utes, so that locomotives return to their home depot by taking over a train in the opposite direction.

Hot box detector

There are hot box detectors in the railway stations Ustyurt and Shetpe as well as in the passing loops XP 6, XP 12, XP 15.

3.2 Analysis of Previous Development Plans

3.2.1 Permanent Way

3.2.1.1 Reconstruction Plans for the Line

Reconstruction of the line was planned in the years 1979 and 1991. It was planned both for separate sections and for the whole line.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

In 1979, a reconstruction project for the Say-Utes to Mangyshlak section was initiated by Novosibirsk Giprotransputi. The Consultant has been unable to discover any information about this project.

In 1991, the Kazpromtransproject Institute developed a project to increase the capacity of the railway line between Bejneu and Mangyshlak. The reason for this project was the plan of a Dutch oil company to construct a factory with a capacity of 6 million tonnes per year. Yet this plan of the Dutch company was stopped, and the Consultant was informed that the company now plans to build a factory with a capacity between 1.5 and 3 million tonnes per year. Thus, the planned works to increase the capacity of the line were not completed. Clearly, the other reason for not executing the project was lack of finance. As a result of this project, the Consultant was able to obtain very good longitudinal maps, maps of the stations and cost estimates.

Table 3-9: Projected Reconstruction Costs, 1991/96 (Previous Project)

Works	**Costs in KZT (1991)**	**Costs in KZT (1996)**	**Costs in USD (1996)**
1) embankments and cuttings	59 million	5,310 million	77 million
2) bridges and pipe culverts	41 million	3,690 million	54 million
3) track	108 million	9,720 million	142 million
4) signal and communication	10 million	900 million	13 million
5) rolling stock	15 million	1,350 million	20 million
6) equipment and maintenance	7 million	630 million	9 million
total	**240 million**	**21,600 million**	**315 million**

3.2.1.2 Project to Protect the Line from the Rising Caspian Sea

Because the level of the Caspian Sea has been steadily rising, a project to protect the line from the high spring tide was prepared. The project was started some years ago, and a dam was built between km 216 and km 221. Subsequent forecasts predicted that the level of the Caspian Sea will stop rising in future, and thus the project was stopped. If the sea level should rise again, the project to lengthen and heighten the dam will need to be continued.

3.2.1.3 Passenger Line between Aktau and Mangyshlak

According to the head of the railway in Mangyshlak, a proposal had been made to the ministry to buy the industrial railway line between Mangyshlak and Aktau. The Consultant was shown a 1:50,000 scale map of this line including all tracks, but a copy was refused on the grounds of secrecy. Furthermore, it was unfortunately not possible to obtain cost calculations regarding the project.

The Consultant was also informed that the industrial railway organisation (KASKOR) of Aktau would like to buy the railway line between Bejneu and Mangyshlak.

3.2.1.4 Mechanised Maintenance Gang

Because staffing levels have been reduced by about 25% during recent years, the chief of the permanent way district plans to create a mechanised maintenance gang. This gang would be responsible for the whole permanent way district. The equipment would comprise a track car with crane, a Ural-car (domestic transport truck) for the workers, an excavator, a tamping machine and modern mobile machines.

3.2.2 Telecommunications

As regards the railway line Bejneu - Mangyshlak, the Planning Institute of the WKR possess a study on the reconstruction of this line. However, the measures proposed in this study have not been implemented. The English translation of the Russian original text is included as *Fehler! Verweisquelle konnte nicht gefunden werden.*.

3.2.3 Signalling

It was originally planned to construct another station with a direct connection towards Bejneu and Mangyshlak at about halfway between XP 16 and Mangyshlak. It was further planned to construct, starting from this station, a new line with a length of about 50 km and two intermediate stations towards a petrochemical plant. Construction work was started at the factory, but ceased several years ago.

As stated above in Chapter 3.1.3, the Bejneu-Mangyshlak line is equipped with high-quality signalling installations. In analysing previous development plans for signalling, only the above-mentioned projects are relevant. Because of the standard of the installations, no further development plans exist for the system on this line.

3.3 Identification of Bottlenecks and Definition of Upgrading Strategies

3.3.1 Permanent Way

3.3.1.1 Assessment of the Existing Situation

Assessment of the Technical Characteristics of the Line

For the existing traffic volume, the standard of the alignment (single-track line with diesel traction and passing loops with a maximum intermediate distance of 29 km) is sufficient.

Even for the highest forecast, Scenario C_{HIGH}, the standard of the line is adequate, though not its condition.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Assessment of Maximum Speed

Because of the speed restrictions of 40 km/h to 60 km/h on the whole line, the travel time for passenger trains between Bejneu and Mangyshlak is 10 hours. The advantageous profile of the line would however allow much higher maximum speeds, the only reason for the speed restrictions being the condition of the track.

Assessment of Axle Load and Length of Trains

The maximum axle load on the line is 23 tonnes, which is also the standard axle load in Kazakhstan. The line is adequate for the maximum train length (850 m) and weight (3000-3300 t).

Assessment of the Organisational Structure

Several years ago, the permanent way district in Mangyshlak was responsible for the whole line between Bejneu and Mangyshlak. Subsequently, a new permanent way district was formed in Bejneu, so that each is responsible for nearly 200 km of line. This is a good solution, since today the maximum travel time is about 5 hours for one direction in every district.

On the line, the personnel was reduced by about 25% during the past 3 years. In total, there are 0.99 people per kilometre for permanent way maintenance: 0.83 of them are workers, 0.16 administrative staff (gang foremen, section foremen, central staff in the permanent way district office). Because nearly all works have to be done by hand, this number is acceptable.

Assessment of the Line Geometry

Between Bejneu (km 0) and Say Utes (km 178), the layout of the line is very good. There are practically no curves and those that do exist have a minimum radius of more than 1000m. The maximum rising gradient is 8 ‰.

Between Say Utes (km 178) and passing loop N° 8 (km 197), there is a falling gradient of up to 15.6 ‰, and many curves down to a minimum radius of 398 m. It is not necessary to upgrade the geometry, because the distance is only 19 km over complex topography.

Between passing loop N° 8 (km 197) and Mangyshlak (km 403), the line has a good profile. The maximum rising gradient is about 8‰, and there are only 3 curves with a radius of less than 500 m.

Assessment of the Caspian Sea Level

The Consultant was advised that the level of the Caspian Sea has risen in recent times. In order to validate this and to make a future prognosis, research was undertaken with the Kazak Scientific-Research Institute of Environmental Monitoring and Climate (KazNIIMOSK).

Since precise data regarding the Caspian Sea level in 1900 exists, it can be seen that the sea level fell from about -25 m in 1900 to -29 m in 1977. The reason for this was the construction of hydro-electric power stations on the Volga river, which needed large artificial lakes. During this period, less water came from the Volga into the Caspian Sea. In 1977, the lakes and the ground around the lakes were saturated, but the Volga brought as much water as before 1900. Since the surface of the Caspian Sea had become smaller, the water could not evaporate. This was the reason that since 1977 the level of the Caspian Sea has steadily been rising. Today, the level of the Caspian Sea is -26.6 m.

In 1993, the Institute predicted that the sea level would not rise in future, because, the surface of the Caspian Sea being large enough, all the water brought by the rivers will evaporate. Last year's readings, however, show that this is not quite true, since the Caspian Sea is still slowly rising. The Consultant expects that the level will continue to rise, though slowly, during the next few years.

There are two depression areas on the line where the level of the track is near the Caspian Sea level. The first is between km 203 and km 230, where the Caspian Sea is nearest to the line (about 200 m). A new dam was constructed to protect the existing embankment between km 216 and km 221. The project to enlarge the dam, should the Caspian Sea rise further, still exists.

The second depression area is between km 384 and km 399. This section is protected by a natural dam between the Caspian Sea and the railway line.

Assessment of Bridges and Pipe Culverts

There are occasional heavy rainfalls in this area. Because the natural ground is very dry, and the water cannot run off, all the water remains on the surface. This water develops considerable power which can cause river-bed erosion. Where the bridges or pipe culverts are too small, water filters through the embankment or destroys the entrance or outlet of the pipe culverts. In 1993, heavy rainfall destroyed the bridge at km 339.5 and several hundred metres of the embankment in this section, mainly because the old bridge was too small.

The Consultant was shown a study of 1991 listing the bridges and pipe culverts showing such problems. During the field mission, a visit was made to some of the listed bridges near Mangyshlak, but the technical solutions proposed by the study seemed, in the Consultant's opinion, to be overdimensioned. **It is therefore recommended that a new study should be developed.**

The existing bridges are in an acceptable structural condition.

Assessment of Embankments and Cuttings

According to the rules in force, the 5.8 m width of the subgrade is too small. However, there are no problems as regards the ballast bed, only the track bench being too small. The cuttings and embankments are in good condition, except for the sections where pipe culverts or bridges are too small.

Assessment of Drains

The existing catch water drains are in good condition, however in some sections additional ones will have to be built.

Assessment of Level Crossings

The level crossings are often in poor condition. However, given the general lack of road traffic, this is not a major problem.

Assessment of Rails and Joints

The 65 kg/m rails are in good condition; the 50 kg/m rails are in normal condition. Since the total life cycle load of the 43 kg/m rails has been exceeded, they should no longer be in use. The permissible maximum life cycle load is 350 million tonnes, but in this case the actual load amounts to about 370 million tonnes.

The joints are in generally normal condition, except where different rail profiles come together. Where this occurs, the joints are in very bad condition.

The track layout is in surprisingly good condition given the fact that there is a sandy ballast bed.

Assessment of Sleepers

The main problem is that nearly all sleepers (about 90%) are 30-years old wooden sleepers which are nearing the end of their life. The statistics of permanent way district inspectors show that about 30% of them are in 'bad condition' (bad condition means that the sleepers are absolutely rotten), and also 'most' (unquantified) of the other sleepers are also in bad condition. The rules of the railway organisation state that, if 50% of the sleepers are in bad condition, the line has to be closed.

The concrete sleepers between km 17 and km 34 (nearly 4%) are in normal condition taking into account their age of about 20 years. The rest of the sleepers (about 6%) were replaced by wooden sleepers during the past few years, however only by spot resleepering and not continuously. The new sleepers are in good condition.

Assessment of Fastenings

The wooden sleepers have only spikes. On the 30-year old wooden sleepers, the bottom plates are broken, so the spikes cannot fasten the rail tightly. Today, spikes make a very poor fastening and therefore fastening should be by bolts and screws. It would therefore otherwise not be necessary to use rail anchors at every sleeper. The existing rail anchors are often situated between two sleepers, and thus are non-effective.

The fastenings on the concrete sleepers are in normal condition.

Assessment of Ballast

94% of the line is filled with used sand ballast. This sand ballast makes it impossible to apply modern maintenance methods (cleaning and tamping). Therefore, should the track be renewed, the sand ballast should be completely replaced. Additionally, the 10 km asbestos ballast must also be replaced.

Assessment of Stations and Passing Loops

The number of stations, the passing loops and their number of tracks as well as the track lengths are sufficient.

Assessment of Turnouts

The rails, tongues and diamonds of most of the turnouts are in good condition and well maintained. The permanent way district staff are aware that turnouts constitute the most important part of a line, and so they have permanently changed defective turnouts or parts of them. There is, however, the same problem as on the track: the sleepers have never been replaced, and screws and bolts are used only at tongues and diamonds; in the other parts of the turnouts the rail is fixed to the sleeper by means of spikes.

Assessment of Platforms and Buildings

The existing buildings and platforms may not be of western European standard, but they are in acceptable condition.

Assessment of Working Methods

Nearly all works have to be done by hand. Generally, only parts of the track or turnouts have been replaced, not the whole track or turnout. It was therefore impossible to use track renewal machines. Because there is sand ballast on the greater part of the line, it is impossible to use ballast cleaning machines and it is also not customary to use tamping machines. Since there is not enough money for replacing whole lengths of the track, the usual working method is to change only a small number of bad sleepers. Clearly, with this working method, it will never be possible to raise the maximum speed.

3.3.1.2 Availability of Track Material

It is possible to obtain all types of necessary track material, if there is enough money to buy it. The wooden sleepers are bought in Russia, because Kazakstan is not well-wooded. Mostly, used larch wooden sleepers have been inserted.

There are three concrete sleeper factories in Kazakstan, each of them having a relatively small output of about 50,000 sleepers per year. One factory is situated near Aktyubinsk. The concrete sleepers do not have the same high quality as western European prestressed concrete sleepers. The rails, turnouts and other steel materials are bought in Russia.

Stone ballast from Aktyubinsk is used at present.

3.3.1.3 Identification of Bottlenecks

Connection to Aktau

There is only one major city near the line — Aktau — having 157,600 inhabitants. The passenger trains terminate at Mangyshlak, which is 18 km inland from Aktau. Thus, all passengers have to travel by bus from Aktau to Mangyshlak.

Maximum Speed (Condition of the Track)

The current maximum speed is 60 km/h, governed by the condition of the track. Because the geometry of the line has a good profile, there will be no problems when increasing the speed following track renewal. The suggested new maxima are shown in Annex O.

Working Methods

The usual method is to undertake only spot resleepering. With this method, the overall condition of the track will never be good, and it will not be possible to raise the speed. For modern track maintenance methods, a stone ballast bed must be used.

Track Fastenings

The spikes in use may be cheap, but it is uneconomic to use them as fastenings. Screws and bolts would be better and more economical, because the service life of the sleepers would be then longer.

Dimension of Bridges and Pipe Culverts

Some pipe culverts and bridges are too small, leading to water destroying pipe culverts, bridges and embankments during heavy rainfall. Also sometimes there is erosion in the river-bed near the line, which could be dangerous for bridges and pipe culverts.

Caspian Sea Level

Should the Caspian Sea level continue to rise, it would be necessary to enlarge the existing dam on the section km 215 and km 225. However, if the level of the Caspian were to stabilise at or below -26 m, as predicted by the observatory, no further work on the dam will be necessary.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

3.3.1.4 Definition of Upgrading Strategies

Aktau to Mangyshlak

For passenger trains, the operation between Bejneu and Mangyshlak should be extended to Aktau over the KASKOR line. The track is in similar condition to that on the Bejneu - Mangyshlak section. It is not important who actually owns the line, since it must also be possible to operate passenger trains on a private line[16] and pay for the usage. At the existing Aktau passenger station, a station building needs to be constructed.

Renewal of Track and Turnouts

Because most of the rails and sleepers are in bad condition, whole track sections should be renewed by means of a Platov crane. Also the existing sand ballast must be replaced. Existing 65 kg/m rails in good condition could be re-used in the same track panels on other track sections. The same applies to the recently-laid wooden sleepers which could be re-used in secondary tracks in stations. All new sleepers, either wooden or concrete, must have bolts to fix the bottom plate to the sleeper and the rail to the bottom plate. Also the Pandrol fastening system would be a good solution for this line.

When rehabilitating the track, long welded track without joints should be constructed up to a minimum radius of 700 m with wooden sleepers and up to 300 m with concrete sleepers. If, in some sections, it is not possible to lay long-welded tracks, the joints have to be on twin sleepers.

The quality of locally-available rails and sleepers, with fastenings, needs to be investigated, since the price quoted for such material is almost the same as in Europe.

In general, concrete sleepers should be used. In sections where sand-storms are frequent, wooden sleepers (about 20%) should be used.

In all existing turnouts, the sleepers have to be replaced. In the parts of the turnout with spikes, screws and bolts should be used to fasten the rail to the sleepers. The steel parts of the turnouts should be replaced to the same extent as that already achieved during the past 10 years.

After track renewal and renewal of the turnout sleepers, maintenance works could be reduced and undertaken by means of maintenance machines.

The speeds possible after having renewed the track are shown in Annex O.

The resulting travel time for passenger trains between Bejneu and Mangyshlak would be reduced to almost half of that of today, namely about 5 hours.

[16] It should be noted that KASKOR already operates a passenger train service over its lines, primarily for commuter traffic. The route is therefore already 'approved' for passenger trains.

Maintenance and Renewal of Bridges and Pipe Culverts

Where the existing pipe culverts or bridges are too small, new or additional larger ones have to be constructed.

If the entry or outlet of pipe culverts are destroyed, the pipe culvert has to be rehabilitated. Where there is erosion in the river-bed, a protection has to be constructed, so that the erosion cannot destroy the bridge or pipe culvert.

Protection Dam for the Caspian Sea

There was in the past a second project to build a larger dam than the existing one to protect the line from the Caspian Sea. This project was stopped, as it was predicted that the Caspian Sea level would stop rising. This decision seems to be correct; however, if the Caspian Sea rises again, a new project will be required.

3.3.1.5 Time Estimates

Aktau - Mangyshlak

The opening of the line between Aktau and Mangyshlak to passenger traffic does not constitute a technical problem, but rather an economic decision. Track renewal and construction of a station building in Aktau will last for several months.

Renewal of Track and Turnouts

Because about 90% wooden sleepers are older than 30 years and are in bad condition, the track is nearing the end of its life. The existing working method has to be changed as soon as possible. The large number of wooden sleepers being replaced individually is not economical over a longer period. Therefore, every year about 60 km will have to be replaced, which will take 6-7 years. This renewal must start as soon as possible. The best sections of the track have a maximum life of about 7 years, so the works have to be carried out between 1998 and 2003.

The same schedule is valid regarding the replacing of the sleepers in turnouts.

Bridges and Pipe Culverts

The incidence of heavy rainfall is extremely irregular, and therefore the next occurrence cannot be predicted. Therefore, the required bridges and pipe culverts have to be constructed as soon as possible. It would be appropriate to do this at the same time as track renewal.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

3.3.2 Telecommunications

The existing communication systems and installations were dimensioned for the demand that could be foreseen at the time of the construction of the railway line. They still are sufficient and in good condition.

Nevertheless, there are the following problems:

- in most cases, the name and address of the producers are not known,
- procurement of spare parts is not possible,
- obsolete technology is used which needs a high level of maintenance
- no possibility to enlarge the system, not even by system components of Western companies, since the systems do not correspond to international standards.

In order to maintain the operability of the installations, according to the method of cannibalisation — "make one out of two" — components (transistors, diodes, condensers, etc.) are unsoldered out of less important installations and are inserted into those systems which are urgently needed. Therefore, it is foreseeable that at a specific future point in time the system will no longer be operable.

Thus, the only solution that can be offered is to completely renew virtually all communication systems, which is **urgently recommended.** The measures are described in detail in Chapter 3.4.2.

3.3.3 Signalling

All signalling installations are properly maintained and thus in good condition and fit for operation. With the exception of the 8 passing loops which were built 14 years ago, the installations stem from the time of the construction of the railway line, which means today they are 30 years old. Also the overhead line is in good condition, except for the area near the Caspian Sea, which is endangered by floods.

Apart from the rehabilitation of the 30-year-old installations, no direct improvement measures are necessary.

As regards maintenance of the signalling installations along this line as well as the branch to Uzen, there is an office including a workshop in Mangyshlak. Here, maintenance work and working up of the relays are done. 76 workers are planned for these works.

At present, there are no indigenous suppliers of signalling equipment. All spare parts have to be imported from Russia.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

3.3.4 Vehicle Fleet and Maintenance, Identification of Constraints and Determination of Improvement Strategies

3.3.4.1 Introduction

This document describes the vehicle stock and the existing maintenance system. Starting from the stock of vehicles found, the constraints are identified and ways of improving the situation are described.

3.3.4.2 Vehicle Fleet

Locomotive Fleet

A total of 47 main-line diesel locomotives and 10 shunting locomotives are available for train haulage and shunting in the Bejneu - Aktau railway region.

Of this total stock, 23 main-line diesel locomotives and 7 shunting locomotives are based in Mangyshlak, the only adequate locomotive depot in the region. Twenty-four main-line diesel locomotives and three shunting locomotives are located at Bejneu locomotive service point, which belongs to Makat depot

.

Class 2TQ10L, 2TQ10M and 2TQ10U locomotives are used for main-line operation and class TQM2 for shunting. The age structure of the locomotive fleet is shown in the following table.

Table 3-10: Age structure of locomotives

class/age	*> 21*	*21 - 16*	*15 - 11*	*10 - 6*	*5 - 0*	*total*
2TQ10L	4	19				23
2TQ10M			15	3		18
2TQ10U					6	6
Total	4	19	15	3	6	47
%	8.5	40.4	31.9	6.4	12.8	100

The existing age structure shows a slow shift of the majority of locomotives into the age bracket above 16 years (48.9%).

The main-line locomotives are all close-coupled twin locomotives, each with 3-axle bogies. The class 2TQ10L has an axle load of approximately 21 tonnes, whereas the 2TQ10M and 2TQ10U have axle loads of approximately 23 tonnes. All locomotives have diesel-electric transmission with d.c. traction motors.

Stock of passenger coaches

A total of 48 passenger coaches are available for passenger transport in the Bejneu-Aktau railway region. Twenty five centre-corridor coaches, known as "open coaches", and 23 compartment coaches, known as "coupé coaches", are based at the Mangyshlak carriage depot. The open coaches have 54 seats and were manufactured in the coachbuilding works in Tver in the Russian Federation. The open coaches are only equipped with hot water heating for winter operation.

The compartment coaches have 4 couchettes per compartment in the night position and thus a total of 36 couchettes. They were manufactured by Waggonbau Ammendorf in Germany, which now belongs to the Deutsche Waggonbau Aktiengesellschaft (DWA) group of companies.

These coaches have an adequate air conditioning system based on a 28 kW or 32 kW generator. The generator is mounted centrally below the longitudinal axis of the body and is driven by a bogie axle via a gear and propeller shaft with a torsion coupling.

The age structure of the coaches is shown in the following table.

Table 3-11: Age structure of coaches

type/age	21 - 25	16 - 20	11 - 15	6 - 10	1 - 5	1996	total
centre corridor (open)	1	2	7	15			25
compartment coach			4	14		5	23
total	1	2	11	29		5	48
%	2.1	4.2	22.9	60.4		10.4	100

The existing age structure can be assessed as 'healthy'.

Fleet of freight wagons

The WKR, to which the Bejneu - Aktau region belongs, has 28,131 wagons available at the time of collecting this data. The wagons conform to the standards and technical regulations laid down for railway operation in the networks of all broad-gauge railways in the CIS countries to ensure smooth international freight transport.

The breakdown of the freight wagon stock into types of wagon and their age structure is shown in the following table.

Table 3-12: Structure and age of freight wagon fleet

wagon type/ age	*total*	*> 25*	*16 - 25*	*11 - 15*	*6 - 10*	*1 - 5*	*1996*	*%*
covered	6,781	1,802	3,401	856	637	85	0	24.1
open	6,678	689	2,658	1,524	1,606	201	0	23.7
flat wagon	4,887	1,116	2,266	728	707	70	0	17.4
refrigerated wagon	814	52	288	210	260	4	0	2.9
tank wagon	3,950	1,455	1,461	525	482	27	0	14.0
cement wagon	636	112	284	113	116	11	0	2.3
container wagon	979	457	233	112	154	23	0	3.5
remaining wagons	3,406	289	711	1,154	1,227	25	0	12.1
total	28,131	5,972	11,302	5,222	5,189	446	0	100
%	100	21.2	40.2	18.6	18.4	1.6	0	100

The table shows that 61.4% of freight wagons are 16 years or older; 21.2% are even older than 25 years. However, the main cause for concern is that the procurement of replacement wagons has dropped drastically in the last 5 years and was practically nil in 1996.

This fact is however somewhat insignificant in the present period of heavily reduced freight traffic.

A conspicuous feature of the structure of the freight wagon fleet is the relatively small proportion of special wagons.

3.3.4.3 Fleet Maintenance System

Locomotive maintenance, workshops and locomotive condition

Diesel locomotive maintenance is organised into a system of servicing tasks (TO), medium inspection tasks (TP) and main inspections/repair tasks (KP). The need for the relevant maintenance category depends on locomotive performance, in terms of kilometres run; the distances travelled equate to certain average periods of time as shown in the following table.

Table 3-13: Locomotive Maintenance System

type	*running kilometres*	*approximate time*	*name of maintenance activity*
TO-1	-	daily	daily service, preparing for operation
TO-2	-	weekly - 2-weekly	weekly inspection
TO-3	7,200 km	17 days to 1 month	monthly inspection
TO-4		as necessary	wheelset repair
TP-1	29,000 km	after 2.3 months	first overhaul
TP-2	115,000 km	after 9.2 months	second overhaul
TP-3	210,000 km	after 1.5 years	overhaul with lifting
KP-1	680,000 km	after 4.5 years	main repair
KP-2	1,360,000 km	after 9 years	general repair

The servicing tasks (TO) and the TP-1 are carried out at Mangyshlak depot, whereas only the TO-1 is carried out at Bejneu locomotive operation point. The following external facilities must be used for the necessary higher (i.e. more complex) maintenance levels.

- TO-4 and TP-2 Makat depot of WKR
- TP-3 Kasalinsk depot of WKR
- KP Dnepropetrovsk locomotive repair works of Ukrainian Railways (abroad).

A total of 2,493.5[17] locomotives were maintained at Mangyshlak depot in 1995, compared with 1,202 locomotives in the first half-year of 1996. The individual maintenance categories are shown in the following table.

Table 3-14: Locomotive maintenance services

type	*1995*	*1st half-year 1996*	*remarks*
TO-2	2,290	1,092	(second figure is the number of main-line locos of class 2TQ10L)
TO-3	174.5 / 140.5	91 / 78	
TP-1	29 / 28	19 / 18	

Of the 23 main-line locomotives, an average of 10 are in daily service, 9 as operational reserves and 4 under repair. In spite of their relatively old age (all locomotives in Mangyshlak depot are 16 years or older), they are in good condition due to the low use.

Coach maintenance, workshops and condition of coaches

Coach maintenance is organised in a system of servicing tasks and running repairs (TO and TP), annual depot inspections (DP) and main repairs (KP).

[17] The decimal value indicates half units of the close-coupled main-line locomotives.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table 3-15: Coach Maintenance System

type	***description of maintenance activity***
TO-1	daily inspection in trains
TO-2	inspection before winter or summer period
TO-3	standard technical inspection of main components, 6 months after DP or KP
TR-1	repair uncoupled from the train
DP	yearly repair in depots after 1 year
KR-1	main repair in workshops after 5 years
KR-2	main repair in workshops after 20 years
KVR	general reconstruction

The servicing tasks (TO) and the TP-1 are carried out in the Mangyshlak depot with its various repair support points (PTO). The following external facilities must be used for the other necessary maintenance levels.

- DR Aktyubinsk carriage depot of WKR
- KR-1 Ksyl-Orda coach depot of WKR
- KR-2, KVR Almaty coach repair works

Of the 48 coaches, an average of 37 are in daily service, 3 as operational reserve and 8 under repair. Approximately 60% of the coaches are 10 years old or less. A particular problem in coach maintenance is the supply of spare parts for the German-made coaches due to lack of foreign exchange. At present, three compartment coaches in need of main repair are stored for this reason.

The Mangyshlak carriage depot and its PTOs repaired 16,015 coaches in the first half-year of 1996 as shown below.

Table 3-16: Coach Maintenance Services

	PTO Mangyshlak	***PTO Bejneu***
number of wagons (TO and TP-1)	5,028	10,987
average per working day	42	92

Freight wagon maintenance, workshops and condition of freight wagons

Freight wagon maintenance is organised in a system of daily inspections and running repairs (TP), annual depot inspections (DP) and main repairs (KP). The various types of freight wagon maintenance are carried out according to time intervals as shown in the following table.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table 3-17: Freight wagon maintenance system

type	*name of maintenance activity*
TO	daily inspection in trains
TR-1	repair of wagons uncoupled from trains before loading
TR-2	repair of wagons uncoupled from trains with load
DP	yearly repair in depots after 1 or 2 years
KR	main repair in workshops after 4, 8, 10, 12, 13 or 17 years[18]

A special maintenance system applies to refrigerated wagons.

A depot is available for freight wagons in Mangyshlak and is responsible for the following:

- units for technical handling of freight wagons (PTO) in Mangyshlak and Bejneu, points for technical preparation for train operation (PPW) in Mangyshlak and Bejneu,

- units for technical inspection of freight wagons (PKTO) in Say-Utes, Shetpe and Uzen and

- checkpoints (PK) in Ustyurt, Shetibay, Opornaya and at km 10, 12, 15 and 462, with the units from Opornaya onwards being equipped with the Ponab electronic hot-air locator.

These units carry out servicing tasks and technical inspections (TO), repairs to empty wagons in preparation for loading and the necessary and possible occasional repairs (TP) of loaded wagons with or without uncoupling from the train. The following external facilities must be used for the necessary higher (i.e. more complex) maintenance levels (occasional repairs):

- DR Ksyl-Orda, Kasalinsk and Uralsk freight wagon depots of the WKR

- KR Martuskoye AO Remontnik freight wagon depot and Aralskoye Morye wagon repair workshop.

Of the 28,131 freight wagons, an average of 17,900 are in daily service, with approximately 9,000 of these outside the country at any one time, 4,500 in the operative reserve and 5,500 stored because of damage. Approximately 60% of the freight wagons are older than 16 years, which explains the high proportion (20%) of damaged wagons stored.

Mangyshlak wagon depot, its PTOs and all its external points repaired a total of 100,236 freight wagons in the first half-year of 1996 as shown in the following table.

[18] Varies according to type of wagon.

Table 3-18: Freight Wagon Maintenance Services

	PTO Mangy-shlak	PPW Mangy-shlak	PTO Bejneu	PPW Bejneu	PKTO Say-Utes	PKTO Shetpe	PKTO Uzen
number of wagons (TO and TP-1)	21,117	5,028	71,690	652	19	702	1,028
average per working day	176	42	597	5		6	9

3.4 Definition of Volume of Repair and Reconstruction Works and Description of Proposed Programme of Works

3.4.1 Permanent Way

3.4.1.1 Report on the Consultant's Demonstration of European Track Fastening Systems on the Mangyshlak-Bejneu Section

Mission period: *November 14-19, 1996*
Date of Demonstration: *November 15, 1996*

Location: about 3 km out of Mangyshlak on the track of the harbour railway

Demonstration:

On a new wooden sleeper that was made available and inserted by the WKR, two ribbed bottom plates were mounted by means of 4 sleeper screws and spring washers. One stretch of rails was mounted to the ribbed bottom plate by means of the common fastening by using T-head bolt, sleeper clip, spring washer and nut. The second rail was mounted to the ribbed bottom plate by means of T-head bolt, Vossloh clip and nut.

Background:

During the first visit to the line Aktau - Bejneu in September 1996, the two district inspectors being responsible for the line were very interested in the method used in western Europe for permanent way fastening. In the following, the Vossloh clip used for concrete sleepers as well as the Pandrol clip were explained and for wooden sleepers, the method using ribbed bottom plates with clip fastening was explained. The Kazak experts stated that out of the fastening methods used in western Europe, in Kazakstan only the ribbed bottom-plate fastening to concrete sleepers is used.

It was observed during the visit to the line that all wooden sleepers, also those having been inserted during the past years, are spiked. Since this spike fastening of permanent way in no

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

way represents a modern standard and is not economical in the long run, the demonstration was organised.

Preparation:

The necessary fastening material is composed of standard types for UIC-60 permanent way used by the Austrian Federal Railways. Since the flange of rail of the UIC-60 rail is the same as that of the Kazak R-65 rail, this type of permanent way could be used. The fastening material had a weight of 28 kg and was sent by airfreight to Almaty.

The Demonstration:

The demonstration was executed in the presence of the District Track Foreman. With the help of maintenance staff, the Foreman arranged the insertion of a new wooden sleeper in one of the existing R-65 tracks. For the site, a section of private harbour railway was selected, since this was the nearest track available that had the necessary type of permanent way. During the insertion, the advantages of a spring washer fastening as well as the necessary high creeping resistance were pointed out as regards the realisation of long-welded tracks. These advantages can especially be seen in case of the demonstrated fastening by Vossloh clip, since the clamping force is kept more constant due to the higher spring tension.

On the one hand, the Kazak representatives stated their concerns regarding the durability of the Vossloh clip and on the other hand the idea of a long-welded track were discussed intensively.

Summary:

Because in Kazakstan mainly wooden sleepers with spiked permanent way fastenings are in use, and because also in sections with concrete sleepers and ribbed bottom plates such prerequisites as, for example, ballast quality and ballast shoulder are not at all fulfilled, the existing line practically never fulfils the prerequisites for a long-welded track. Moreover, the theory of long-welded track is not known.

Since this method is advantageous for a modern permanent way as regards the quality of operation as well as the economic efficiency, prior to realising long-welded tracks in Kazakstan, it will be necessary to arrange detailed training courses on this subject.

3.4.1.2 Description and Volume of Renewal Works

Track and Turnouts

Other than the section from km 17 to km 34, all sleepers need to be replaced, which means they have to be replaced on a length of 386 km. All rails weighing 43kg/m or 50 kg/m have to be changed, a total of 290 km.

It will therefore be necessary to renew:

96km sleepers only
290km track including sleepers

In general, 65 kg/m rails and concrete sleepers should be used. Only wooden sleepers should be used in sections with sandstorms and sand in the ballast bed, in order to avoid breaking of sleepers. These areas constitute about 20% of the line. The ballast bed must also be replaced in all sections, using a Platov crane.

In recent years, 15 turnouts per year have been replaced, except for the sleepers. Thus the replaced parts of the turnouts are in normal condition. It is recommended to continue to replace 15 turnouts on a yearly basis, but to include sleeper replacement, and to insert new bolts instead of spike fastenings.

Therefore, it is necessary to renew during the next 6 years

100 complete turnouts
100 sleepers of turnouts with new fastenings

The 100 new turnouts should be used only on the main track. The old turnouts of the main track could be used with new sleepers for secondary tracks in stations.

Pipe Culverts and Bridges

The study of 1991 showed a number of problems at bridges and pipe culverts. Some of the solutions presented in the study seem to be overdimensioned. This situation therefore requires a more precise study to calculate the length of new bridges. The precise work and locations are described in detail in *Fehler! Verweisquelle konnte nicht gefunden werden.*

3.4.1.3 Necessary Equipment

The machines required for renewal of track and turnouts (Platov crane and excavator) are available. But there are no modern tamping and ballasting machines, which will be necessary for the rehabilitation works, and later on for maintenance work. Since the capacity of the machine will only be about 50% utilised, it can also be used on other lines.

For the track renewal machine (Platov crane), it will be necessary to construct two assembly sites for the production of track panels, with roof, a crane, staff accommodation etc.

Based on the proposal made by the chief of the permanent way district to create a mobile mechanised gang, which the Consultant fully supports, the following equipment will be necessary:

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

- a track car with crane,
- a Ural car for staff,
- an excavator
- several mobile track machines such as mobile motor screw drivers, mobile motor drilling machines, generator sets, rail drilling machines, etc.

3.4.1.4 Options for Upgrading Standards

All prices for the required work are calculated on the basis that only the existing track will be renewed, which means that all work will have to be carried out during a line closure period of only about six hours per day.

The alternative would be to make a wider subgrade of about 4 metres and to construct a new line alongside the existing one. Thus, the works could be done in less than half the time. The local price for the construction of a new embankment or cutting is about USD3.60/m^3. For each running metre of line, about 10m^3 of civil works will be required, giving a cost of USD36 per running metre. The local manpower costs for the renewal of 1 metre of track amount to about USD3.00.

In the study of 1991, a cost calculation was made to enlarge the subgrade. During the track renewal, the old ballast bed (sand) will have to be taken out of the track and put alongside the existing embankment, which will enlarge the subgrade by about half a metre. This should be sufficient as regards the future traffic volume and maximum speed.

Another option would be to use second-hand track material (rails and sleepers). This would be cheaper, though not more economical, because the service life would be reduced.

3.4.1.5 Volume of Present Maintenance Works

The strategy of the proposed maintenance works will ensure that it is possible to use the line well into the future, when there will be no immediate need for investment in track renewal. Based on the present maintenance procedures, about 20,000 wooden sleepers, rails on about 6,500 m track, broken base plates, joints and the rails of about 15 turnouts will be replaced annually. The costs of track material make up about 80% of the maintenance costs, that of staff about 20%.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

3.4.1.6 Schedules of Maintenance and Repair during the next 20 Years

The future level of maintenance works will depend very much on the volume of track renewal during the next few years. If bad sleepers and rails are replaced during the coming years, they will not require replacement again for a further 20 years. The standard of the line would therefore be better, allowing higher operating speeds, and at the same time the costs for maintenance will be lower than today.

However, if there is no track renewal, the costs of track maintenance will steadily increase, because it will be necessary to progressively replace more sleepers and rails per year than is done at present.

3.4.1.7 Increase in Line Speed

In order to consider options for an increase in traffic levels, the feasibility of increasing the average speed for different train categories from 40 km/h to 80 km/h for freight trains and 100 km/h for passenger trains was examined.

As a result of the examination of the route, it can be concluded that approximately 80% of the existing line, after rehabilitation, would enable rail traffic to operate at the required speeds.

The remaining 20% of the route is characterised by somewhat mountainous terrain and this precludes an increase in operating speed to the required levels without major investment in realignment. However, partial replacement of the existing infrastructure, with necessary repairs on a few short sections, would enable a general increase in average speed to 80 km/h.

3.4.1.8 Protection against Sea Inundation

For approximately 30 km, the line runs along the Caspian Sea, as shown in the length profile *Fehler! Verweisquelle konnte nicht gefunden werden.* between km 203 to 232. As described in Chapter 3.3.1.1, the level of the Caspian **is expected to rise by approximately two metres over the next ten years. In July 1996, the Caspian Sea level was measured at -26.6 m.**

The existing level of the Caspian Sea is about -27 m and is expected to rise to about -25 m in the near future. The existing track level is between -19.0 to -20.1 m. When this rise has taken place, the present line will be in danger of damage at times of flooding. It is therefore suggested that the construction of the "sea wall" should be continued along the whole length of the section adjacent to the Caspian Sea.

Additionally it is recommended that a new drainage system be designed and constructed on the 'inland' side of the Caspian Sea section of the route, so as to retain the water from the hills at times of flooding. *A hydrological study will also be required to determine the basic information.*

The present freshwater drainage system operates at almost the current level of the Caspian Sea. Consequently, during times of flooding, water will flow back from the sea into the drainage system and destroy the track unless a new drainage system is installed which is designed to prevent this back-flow.

The new level of the new drainage system needs to be several metres higher than the existing one. The track will keep its existing level.

3.4.1.9 Railway Stations

It is recommended that the existing railway stations should be retained as they are adequate for future projected traffic levels, but some reconstruction work is required.

3.4.1.10 The Mangyshlak - Aktau Connection

The single track line from the WKR at Mangyshlak running to the Port of Aktau is owned by a private company, KASKOR. Additionally, there is a branch line from km 12.0 which reaches the centre of Aktau, where a terminal passenger station has been laid out. KASKOR operates both freight and passenger services, the latter geared to the needs of employees of the companies within the line's reach. Long-distance passenger transport starts in Mangyshlak, some 18 km from the centre of population, Aktau.

The existing public passenger connection from Aktau to Mangyshlak is provided by buses and taxis.

The terminal station in Aktau is laid out with all rail facilities, but lacks any form of building or covered waiting accommodation. Between the nearest track and the existing road network is space enough (approximately 40m) to build a station and parking for taxis and buses. The three existing platforms can be retained for local passenger traffic.

3.4.1.11 Priorities of the Different Components

Based on the analysis of the present situation and the definition of the volume of repair and reconstruction work, the following activities are recommended without any order of priority.

The programme of track renewal described above is the only technical solution to improve the quality of the line.

The programme of pipe culvert repair and construction of longer bridges is important for protecting the line from breakdown in the event of heavy rainfall.

Summary of Civil Engineering Work

1. Renovate existing track and superstructure, apart from a few sections which are in acceptable condition.
2. Renovate the existing drainage system over the whole line.
3. Design and construct a new drainage system several metres higher from km 203 to 232 on the inland side of the railway line.
4. Continue construction of the sea wall along the Caspian Sea side section from km 203 to 232.
5. Retain the existing stations with renovation as required.
6. Negotiate a contract between WKR and KASKOR to enable the through operation of passenger services from Aktau via Mangyshlak to Bejneu.
7. Renovate the existing line Aktau - Mangyshlak
8. Construct a station building and the other necessary facilities such as car parking etc.
9. Renovate the line to the Port of Aktau, in conjunction with the ongoing Port Project.

Expected results:

1. Increase of the average speed for freight trains to 80 km/h over the whole 400 km line.
2. Increase of the speed for passenger trains to a speed of at least 100 km/h, for about 80% of the total length of the line and up to 85 km/h for the remaining sections.

The use of the line between Aktau and Mangyshlak for through passenger traffic, is a political and economic question; from the technical point of view there are no problems.

3.4.2 Telecommunications

3.4.2.1 General

As has already been described in Chapter 3.3.2, nearly all telecommunications systems on the Bejneu - Mangyshlak line need to be renewed. The fact that this line constitutes only part of the WKR network is important for the planning of new systems and their integration into the existing network. This integration is not only necessary at the two railheads of this line, but also at other places in Kazakstan, since there is also direct communication between the line's stations and Atyrau, Aktyubinsk and Almaty. Thus, it will also be necessary to invest in telecommunication in locations of the WKR that are not situated along the line.

The following list (based on the information already given in Chapter 3.1.3) comprises a summary of the proposed measures, which are subsequently described in detail:

- Overhead line and cable: replacement of the existing systems by optical cables
- Transmission technology: replacement of the analogue carrier-frequency systems by digital PDH and SDH systems,
- Telephone connections along the line: replacement of the existing terminal equipment for party lines by terminals for a party line with digital signalling

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

- Operational telephone systems: replacement of the existing installations by modern, digital systems
- Radio installations:
  Radio communication with trains: retaining the present system
  Radio communication in stations: replacement of the existing installations
- Telephone network: replacement of the existing analogue switching centres by digital telephone exchanges. The Mangyshlak Station is excepted, since it already possesses a digital system
- Telegraph and data transmission network:
  replacement of the existing telegraph switching centre in Mangyshlak by a computer-controlled system
  replacement of the existing analogue voice-frequency telegraph systems by digital transmission systems
  replacement of the old mechanical teleprinters by systems based on PCs
  retaining the existing PC-based teleprinter terminals and
  retaining the pack-unpack device in Mangyshlak
- Other technical telecommunications installations:
  lud-speaker equipment: renewal
  clock installations: renewal
  fire-alarm systems: renewal
  hot-box detectors: renewal
  ticket issuing machines: retaining
  power supply installations: renewal
- Measuring devices: the existing measuring devices partly have to be renewed and completed by those being necessary for the maintenance of digital systems

3.4.2.2 Overhead line and cable

There is an overhead line on each side of the railway line — one for telecommunications and one for signalling and power supply. Along the Caspian Sea, the overhead line route for signalling and power supply suffers from scour for a length of 40 km, and thus its stability is endangered. In order to solve this problem and at the same time reduce the maintenance effort needed for two overhead lines, in future it is recommended that there will only be one overhead line.

For this, three variants exist. Variants one and two (one overhead line for all three services) would be to shift the overhead line for the power supply to the other side of the railway line in the endangered section along the Caspian Sea. The third variant would be to construct a grounding conductor for all three applications

The suspension of the aerial cables in case of the variants 1 and 2 is always done in the same manner. The factory length of the cables is 2 km. Rolls are mounted to the poles by means of straps, and over these, the cable is stretched. Every two kilometres, the cable is anchored over anchor spirals (in the following section, these poles are called anchor poles). The sag in the sections between the poles is regulated automatically.

This method of mounting has the advantage that trees falling onto the cable route will not damage the cable, since the latter draws its length reserves from the neighbouring sections and, after removal of the obstacle, will return to the initial position undamaged. Also in case of accidents, in which a pole is knocked over, the cable will remain intact.

The existing overhead line poles are generally adequate. Only the anchoring poles would need additional protection through anchoring the pole on both sides in the direction to the overhead line route.

Variant 1: Optical aerial cable

An optical self-supporting 12-fibre aerial cable is mounted onto the standard poles of the power supply. The fibres are allocated as follows:

- 2 fibres for the local communication from station to station (telecommunication service),
- 2 fibres for the telecommunication Bejneu - Mangyshlak (telecommunication service),
- 2 fibres for the remote control of the signal boxes and block posts (signalling),
- 2 fibres for the public network,
- 2 fibres for the Ministry of the Interior, and
- 2 fibres as reserve.

The signalling pilot wires existing on these poles can be removed, since the corresponding signals will be transmitted via the optical cable.

This variant does not include a telephone link along the line as exists at present from km 124 to Mangyshlak. It is currently possible to enter this telephone link at any place of the line via a connecting device. Since the whole line is equipped with train radio communication, and also the breakdown train has a corresponding device, it would be justifiable to do without this line telephone link, particularly since there is none existing in the section from Bejneu to km 124.

As with variant 2, local telephone links (for example from a signal box to the pointsmen) could be installed along the line via local copper aerial cables or by placing buried cables in the signalling conduit for the colour light signals at the ends of the stations. Since the distances are very short, and thus also the investment costs are not high, these costs are included in the statement of costs per railway station in the form of a lump sum. The necessary excavation work is included in the schedule of costs of signalling.

In each station and passing loop, the 12 fibres are fully connected, and thus are accessible for measuring and inspection. Fibres to which no system is connected (e.g. telecommunication between Bejneu and Mangyshlak) are patched through by means of plug connections. However, at the block posts only the two fibres planned for signalling are entered.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Variant 2: Optical aerial cable supplemented by a copper aerial cable

If a line telephone link should be necessary, a copper connection will be required. Two wires of an overhead line cannot be used for this, if these are mounted on the only remaining overhead power supply line pole, since in this case the induction influence would be far too high. Thus, for such a communication link only a self-supporting copper aerial cable with 10 pairs is possible.

To be able to enter the line telephone link between the stations, at adequate distances (e.g. every 2 kilometres) telephone sets have to be mounted either in a cabinet fixed to the pole or in a tin box and to be connected to the corresponding copper wires. Unlike the optical cable, the distance between the anchor poles for the copper cable amounts to 1 km.

Variant 3: Replacement of both overhead lines by a common buried cable system for all three applications

Obviously, this variant is the most expensive investment. However, maintenance will be less and it has the advantage that the installation will be protected against damage by weather, accidents and vandalism. In a conduit having a width of 60 cm, the three following cables will be laid:

- optical buried cable with 12 fibres,
- telecommunication copper cable with 10 pairs, and
- power cable with 3 x 10 kV.

The width of the conduit results from the necessity to observe a corresponding distance between telecommunications and power cable.

As regards the conduct of the optical fibres for signalling into the block posts as well as putting telephone sets into cabinets or boxes along the line, the same applies as for variants 1 or 2.

3.4.2.3 Transmission Technology

For transmission technology, only digital systems are possible. According to the demands of communication along the line, three levels of hierarchy are necessary:

- long-range communication system (Bejneu - Mangyshlak without field equipment) being composed of one SDH node at each of the two railheads and a digital connection with 155 Mbit/s,
- local system between the railway stations by means of PDH nodes and a transmission speed of 8 Mbit/s, and
- system for low-speed data transmission with 50 baud up to 9.6 kb/s.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Long-range communication system

In both railway stations — Bejneu and Mangyshlak — one SDH node will be installed. The two nodes are directly connected — without field equipment — via two optical fibres having a transmission speed of 155 Mbit/s. At the tributary station, it is possible to connect 63 2 Mbit or four 34 Mbit links or a corresponding mix thereof.

Local system

As regards the connection between the railway stations and passing loops, a system with 8 Mbit/s is planned. In each station or passing loop one node will be necessary. In the sense of branch and re-seizure technology, these nodes make possible any access to maximum 4 x 2 Mbit or to one or more of the 64 kb-channels existing per 2 Mbit system.

Each node is a flexible multiplexer which can collect 64 kb-channels to one 2Mbit signal and also 4 x 2 Mbit to one 8 Mbit signal in a very flexible way.

The 2 Mbit channels are used for the connection of the telephone exchanges, while the 64 kb-channels serve for the other telephone connections between the individual places (e.g. party lines, data circuits or hot standby for voice-frequency telegraph systems, etc.).

System for low-speed data transmission

Along railway lines, a multitude of communications links operating with a speed lower than 64 kb/s is necessary. These include low-speed data connections, telegraph connections and connections for remote control systems, etc.

For these connections, a 64 kb sub-multiplexer is used. This sub-multiplexer summarises asynchronous and synchronous connections with a transmission speed of 50 baud up to 9.6 kb/s in one 64 kb signal, which is transmitted via the local system to the next node. Within the 64 kb bandwidth, the low-speed data transmissions can be combined and summarised in any form. Special compressing procedures enable also voice transmission including signalling in one channel of 9.6 kb.

Also on this sub-multiplexer level, the individual connection can be branched and re-occupied in the nodes in any form. These sub-multiplexers can also be directly connected to optical fibres by means of suitable converters.

Such a sub-multiplexer is planned for each railway station and each passing loop, which, because of its capability regarding branching and re-seizure, can work in both directions (incoming and outgoing).

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

3.4.2.4 Telephone Links along the Line

The following telephone connections exist along the whole line:

- dispatcher lines from the local dispatcher in Atyrau to all local station inspectors,
- party lines for local station inspectors without inclusion of the central dispatcher in Atyrau, but having access to important offices in the whole Kazak railway network / Aktyubinsk, Almaty),
- party lines for the permanent way maintenance staff, and
- party lines for maintenance staff for communication facilities and signalling installations.

Not every railway station or passing loop possesses telephone stations for all party lines. We propose uniform equipment for the new system.

A modern control line system shall be used, for which 2-wire or 4-wire connections are enough along the line, whereby all stations are interconnected in a party line. Multi-address calls and group calls as well as intrusion to a busy line in case of an accident are possible. Signalling is done in the voice band by seizing a 150 Hz frequency band in which signalling is done via FSK modulation. 64 kb-channels of the 8 Mbit system are used as transmission paths between stations and/or passing loops. Since this is a four-wire circuit, the individual railway stations need their own installations for the branch line to local installations. In the following, this is called a 'branch device'. Moreover, for the conversion of signalling on the line to a common telephone set, another device — local device — is needed.

Each railway station and each passing loop needs one branch device per party line and one local device per station. Any common telephone with dial or push-button dialling can be used as telephone set.

Since not only positions on the line Bejneu - Mangyshlak are connected to these party lines, investment will also be necessary at locations that can be reached via these links. The control line can also be prolonged via carrier-frequency systems to remote locations, and there it can be connected to a telephone station. For this, at each location and party line a branch device and at each station a local device with standard telephone set are necessary.

According to the present project, the following locations are affected

- Atyrau,
- Aktyubinsk,
- Almaty, and
- the railway stations on the line Mangyshlak - Uzen:
  Yeralivo and
  Shetibay.

It seems to be adequate and necessary to equip these two railway stations with installations of the new control line, since otherwise the new control lines and the old party lines would have to be interconnected in Mangyshlak. This would necessitate the development of additional interfaces, which will result in high costs and low operational reliability. The extension of the control lines to locations outside of the Bejneu - Mangyshlak line can be made via existing analogue TF-channels.

3.4.2.5 Operational telephone systems

An operational telephone system serves as central communication equipment in each railway station and each passing loop. All have to be renewed, however, using only digital systems. It has to be possible to connect to these systems:

- party lines,
- local telephone links with local battery working,
- public network extensions,
- radio communication with trains,
- radio communication in railway stations,
- two-way intercom systems,
- loud-speaker installations and
- clocks needed for synchronisation.

A modular expansion of the system has to be possible, in order to be able to connect the number of lines necessary according to the size of the railway station. Thus, the statement of costs lists installations of different sizes for the individual railway stations and passing loops (differing number of lines that can be connected planned).

3.4.2.6 Radio installations

Radio communication with trains

In the former Soviet Union, uniform radio communication with trains was developed and constructed in the 2 MHz range, being a uniform standard within the whole CIS. Thus, it makes no sense to renew it on this section, which — compared to the whole network of the Kazakstan railways — is relatively short. Moreover in case of a new system, the locomotives would have to be equipped with a second radio for use along this line only, assuming that the locos actually operate beyond the confines of the line. As soon as these locomotives were assigned to other lines or other locomotives were sent here from workshops, locomotives would circulate on the line which do not have the corresponding radio equipment. This problem can only be solved by means of an overall plan being applied to the whole country.

The fixed stations for radio communication with trains in the stations and passing loops are currently connected to the dispatcher line. Since these installations have to be renewed in any case, at each fixed station for radio communication with trains - which means in each railway station and passing loop - an interface between the new dispatcher line and the old radio communication with trains will be necessary.

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Radio communication in railway stations

The radio equipment for shunting operation and technical services must be renewed. A 20% increase in equipment is suggested. If, however, the number of locomotives used should increase, additional mobile radio equipment would be necessary.

The renewal could be done in the same frequency range (2 metre band). Due to a better transmission quality, a shift to the 70 cm band should be considered. This, however, requires a new frequency assignment by the authority.

3.4.2.7 Telephone Network

The existing telephone exchanges in the following stations have to be renewed:

- Bejneu (400 subscribers),
- Ustyurt (10 subscribers),
- Say-Utes (70 subscribers) and
- Shetpe (80 subscribers)

Only the installation in Mangyshlak corresponds to the 'state of the art'. We propose digital ISDN PABXs. A 20% increase in subscribers has to be expected. Since there are currently only 10 subscribers connected in Ustyurt, no system is planned for this station. The subscribers will be connected to the next installation in Say-Utes via the existing 8 Mbit system, which also includes user-network interfaces.

Individual neighbouring installations will be interconnected by means of a 2 Mbit-connection of the 8 Mbit system. Bejneu has several direct 2 Mbit connections of the 155 Mbit system to Mangyshlak.

3.4.2.8 Telegraph and Data Transmission Network

The teleprinter exchange in Mangyshlak (20 extensions) has to be replaced by a computer-aided system. A slight increase in the number of subscribers has to be expected.

The existing voice-frequency telegraph connections will be replaced by digital connections of the sub-multiplexer network (see chapter 3.4.2.3). As regards the number, this can be done one-to-one. Because of the modular design of the sub-multiplexer and the fact that there is sufficient transmission capacity, it will be possible to increase the number at any time at low cost.

The old mechanical teleprinters (at present 6) have to be replaced by devices equipped with PCs. The PC-based systems that exist already as well as the pack-unpack device installed in Mangyshlak can be further used.

In this context, the question arises of whether it is really sensible to renew teleprinter installations or rather install an X 400 system. The same applies to the data network. Why keep this network? Would it not be better to plan a modern X25 network or Frame Relay System?

As regards these questions, the same holds true as for radio communication with trains. Teletype and data transmission networks can only be considered for the whole country. It is only useful to introduce new technologies in an overall plan for all of the Kazakstan railways.

3.4.2.9 Other Technical Telecommunication Installations

Loudspeaker equipment

At present, the following systems exist:

Table 3-19: Loudspeaker Equipment

railway station	amplifier	loud-speaker	stations
Bejneu	1	36	2
Say-Utes	1	10	1
Shetpe	1	10	1
Mangyshlak	3	36	4

The systems must be renewed in line with modern technology. Systems should be planned which not only fulfil the functions of a loudspeaker installation, but also that of a two-way intercom system. Thus, the number of stations will increase and the number of loudspeakers should be increased accordingly.

Clock installations

At present, the following systems exist:

Table 3-20: Railway clocks

railway station	master clocks	secondary clocks
Say-Utes	1	4
Shetpe	1	4
Mangyshlak	2	26

The systems should be renewed, planning electronic quartz clocks as master clocks. The number of secondary clocks may slightly increase. Moreover, in Bejneu a clock installation of the same size of that in Mangyshlak should be constructed.

Fire-alarm systems

At present, there are 21 systems with 3 detectors each. The installations need to be renewed.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Hot-box detectors

The five existing detectors have to be renewed in accordance with modern technology. Moreover, supplementing these installations by detectors locating blocking brakes should be considered.

Ticket issuing machines

The existing ticket issuing machines correspond to the state of the art. Thus, at present no renewal is necessary. A renewal would only be useful in a country-wide project, similar to radio communication with trains and telegraph and data transmission networks.

Power supply

Because of their age, the existing 21 power supply installations (rectifiers and batteries) for 24V need to be renewed. The existing 60V installations are no longer needed, since modern communication systems use 48V. Thus, for all locations where modern systems are to be installed, a 48V installation should be planned.

3.4.2.10 Measuring Devices

The number of existing measuring devices is sufficient for the technology used. However, the measuring devices to be generally used, as for example universal measuring devices, do not correspond to the state of the art. Thus the acquisition of a number of measuring devices that corresponds to the number of personnel is proposed.

It is difficult to produce a concrete proposal for the individual systems, since many communication systems include special test and measuring devices. The statement of costs is therefore presented as a lump sum.

Tools and measuring devices for optical cable and transmission equipment are excepted from this procedure, since there are international standards for measuring systems.

3.4.3 Signalling

The present signalling system on the line Bejneu - Mangyshlak is appropriate for the current level of train service. Because of the high standard of the equipment, it would be possible to handle much more traffic than is currently the case with the present installations.

The disadvantage of this high-grade equipment being over-dimensioned in relation to the present traffic level lies in the high maintenance effort required. In general, no additional construction is required in order to cope with the forecast increase in the number of trains. However, the age of part of the existing installation necessitates signalling renewal.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

When renewing the signalling, the national signalling system has to be taken into consideration. Nevertheless, for all new signalling installations, the interface signalling installation / track-release installation and signalling installation / train-running control system has to be made in such a way that it will later be possible to convert to other, more easily-maintained, systems.

When renewing the automatic block posts, longer block sections and thus a smaller number of block posts should be implemented. Despite the planned increase in running speed, this will not lead to a reduction of the line capacity; it will, however, reduce considerably the number of installations to be installed.

For the renewal of the installations it has to be considered that there are 2 parallel overhead lines. By digitisation and employing fibre cables, a common transmission and communication line shall be created. Thereby, the present transmission line can be adapted accordingly. However, in the Caspian Sea area, this common line has to be positioned at the side of the railway line that is at the remote side of the sea. This aspect is described in more detail in chapter 3.4.2.2 above.

The following installations need to be rehabilitated:

Table 3-21: Required Rehabilitation Work (Signalling Installations)

Location	Work Required
Atyrau:	Remote control part Bejneu - Mangyshlak
Bejneu - XP 1:	5 automatic block posts, to be reduced to 2
XP 1:	* signal box (4 tracks, 9 turnouts)
XP 1 - XP 2:	5 automatic block posts, to be reduced to 2
XP 2:	signal box (2 tracks, 3 turnouts)
XP 2 - XP 3:	5 automatic block posts, to be reduced to 3
XP 3:	* signal box (3 tracks, 5 turnouts)
XP 3 - Ustyurt:	6 automatic block posts, to be reduced to 3
Ustyurt:	signal box (3 tracks, 8 turnouts)
Ustyurt - XP 5:	5 automatic block posts, to be reduced to 3
XP 5:	* signal box (3 tracks, 5 turnouts)
XP 5 - XP 6:	5 automatic block posts, to be reduced to 3
XP 6:	signal box (2 tracks, 3 turnouts)
XP 6 - XP 7:	5 automatic block posts, to be reduced to 3
XP 7:	* signal box (3 tracks, 5 turnouts)
XP 7: - Say-U:	6 automatic block posts, to be reduced to 4
Say-Utes:	signal box (4/6 tracks, 18 turnouts)
Say-U - XP 8:	5 automatic block posts, to be reduced to 3
XP 8:	signal box (2 tracks, 4 turnouts)
XP 8: - XP 9:	3 automatic block posts, to be reduced to 1
XP 9:	* signal box (3 tracks, 5 turnouts)
XP 9 - XP 10:	7 automatic block posts, to be reduced to 5
XP 10:	signal box (2 tracks, 6 turnouts)

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Location	Work Required
XP 10: - XP 11:	4 automatic block posts, to be reduced to 2
XP 11:	* signal box (3 tracks, 5 turnouts)
XP 11 - XP 12:	5 automatic block posts, to be reduced to 3
XP 12:	signal box (2 tracks, 3 turnouts)
XP 12 - XP 13:	5 automatic block posts, to be reduced to 3
XP 13:	* signal box (3 tracks, 5 turnouts)
XP 13 - Shetpe:	4 automatic block posts, to be reduced to 3
Shetpe:	signal box (8/10 tracks, 34 turnouts)
Shetpe - XP 14:	4 automatic block posts, to be reduced to 2
XP 14:	* signal box (3 tracks, 5 turnouts)
XP 14 - XP 15:	5 automatic block posts, to be reduced to 3
XP 15:	signal box (2 tracks, 3 turnouts)
XP 15 - XP 16:	6 automatic block posts, to be reduced to 4
XP 16:	* signal box (3 tracks, 7 turnouts)
XP 16 - Mangyshlak:	10 automatic block posts, to be reduced to 4

(installations marked by * are only 14 years old)

The new signalling installations should be constructed in such a way that the maintenance requirement will be relatively low. For this, computer technology has to be used. The connection of the installations with each other as well as with the central train control system is accomplished via digital transmission channels. Thus, two optical fibres for signalling are planned in the new telecommunications cable. The required terminals are seen as part of the signalling installation. Moreover, it is important that the digital connection between Bejneu and Atyrau is installed using the existing copper links of the telecommunications installations in this section.

From the technical point of view it would be appropriate to execute the rehabilitation of the entire signalling system during one construction phase (no adaptation of existing installations necessary, common design of all installations). From the economic point of view, an extension in two stages of construction seems to be suitable. During the first, the installations dating from the time of the construction of the railway should be renewed. Only after the completion of this stage, the remaining installations should be renewed in a second stage. The renewal of the block installations can be done by sections between the two large stages of construction.

It is not necessary to renew the signalling installations on whole sections. This should be done station by station over a longer period. The following procedure should be observed:

- The first step will be to create a remote-control system in the central train control system in Atyrau for the whole railway line as well as digital transmission paths from Atyrau up to XP 3. Then, the remote-control system of XP 1 and XP 3 as well as the intermediate signal box including remote control part of XP 2 will have to be completed. As regards these installations, a longer dummy run for the training of the operational and maintenance staff has to be planned, with the light signals being covered. The automatic block posts should remain the same for the time being.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

- During the next step, the digital transmission path up to XP 5 has to be enlarged. In Ustyurt, the intermediate signal box including the remote control part and the remote-control system of XP 5 have to be completed and put into operation including the corresponding part in the central train control system in Atyrau.

These steps have to be repeated until the last installation in XP 15 including the remote-control system in XP 16 have been renewed.

The renewal of the level-crossing remote control has to be done at the same time as the corresponding railway stations and automatic block posts.

This procedure has the benefit that the oldest installations are renewed first; there will, however, be some provisional installations during the construction and transition time (adaptation of the computer-technology remote control to the existing, 14-year-old installations). This allows the remote control of all signalling installations from the central train control system in Atyrau during the entire transition time.

The renewal of the block installations that are only supervised in the central train control system is done independently of the other renewal works.

For the new signalling installations, computer technology has to be used, and there has to be a digital connection to the central train control system disposing also of computer technology. Because of the high-quality training level of the maintenance staff being presently employed, also when using the most modern computer technology, there should be no problems after having trained the staff accordingly.

3.4.4 Vehicle Fleet and Maintenance: Determination of Repair and Reconstruction Tasks and Description of Proposed Work Programme

3.4.4.1 Estimation of Current Capacity of Fleet

The current capacity of the existing vehicle fleet is determined by its size and condition. Performance parameters specified elsewhere for future periods of time are used to derive the necessary measures for the vehicle park and its maintenance with the aim of improving capacity.

Locomotives

The availability of locomotives at the time of collecting this data was.

- 36 of 47 main-line locomotives (approximately 77%)
- 6 of 10 shunting locomotives (60%).

Five main-line locomotives and 3 shunting locomotives from the unused vehicles were not in the available fleet for technical reasons. A general overview is given in the following table.

Table 3-22: Overview of Locomotive Availability

Total		Working	Not Working	Operational Reserve	Technical Reserve		
					Occasional Repair	Waiting for Repair	Factory Repair
Main-line locos:							
Mangyshlak	23	10	13	9	2	-	2
Bejneu	24	5	19	18	1	-	-
Total	**47**	**15**	**32**	**27**	**3**	**-**	**2**
Shunting locos:							
Mangyshlak	7	4	3	-	1	-	2
Bejneu	3	2	1	1		-	-
Total	**10**	**6**	**4**	**1**	**1**	**-**	**2**

The large stock of main-line locomotives in the operational reserve is attributed to the continuous fall in transport demand since 1989[19]. Due to the poor condition of the permanent way of the Mangyshlak - Bejneu line, the heavy main-line locomotives (21 tonne or 23 tonne axle load) can only run at reduced line speed (see Chapter 3.1.2.10), which results in longer turn-round times.

The 10% of main-line locomotives in the technical reserve can be assessed as quite normal. The locomotives currently available in the operational reserve could be used to run an additional 6 freight trains in the section each day under the same operating conditions. This would easily enable the freight train volume of 1989 to be achieved again, if demand warrants it.

Further reserve capacity would be available if the existing reduced operating speed (caused by the permanent way condition, as already mentioned) were to be eliminated. This would have the effect of improving operational efficiency to the extent that the locomotives would be able to operate more trips per day, and therefore fewer locomotives would be required.

As long as the existing track condition is not improved (the 'Do Nothing' scenario), the critical number of train pairs (one train in each direction) is 10. Exceeding this limit requires the provision of 2 locomotives per extra train pair under the same haulage conditions. An additional requirement of 4 locomotives is thus needed for 2005 according to the scenarios shown in Chapter 2, in the event that there is no infrastructure improvement.

[19] The number of trains in each direction on the Mangyshlak - Bejneu line has developed as follows since 1989:

Trains	1989	1992	1993	1994
Freight	10	5	3	3

Table 3-23: Overview of Additional Locomotives Required ('Do Nothing' scenario)

Additional Freight Trains	Additional Train Pairs Required	Locos Required Per Train Pair	Additional Locomotives Required	Available Reserves from Stocks[20]	Deficit in 2005
Scenario A	**8**	2	**16**	22	None
Scenario B	**12**	2	**24**	22	2
Scenario C	**13**	2	**26**	22	4

If locomotives cannot be transferred from other regions, the locomotive deficit has to be remedied by purchasing 4 main-line locomotives in 2005. A unit price of approximately USD 2.7 million can be assumed for the purpose of assessing the necessary costs of locomotive procurement.

However, if the infrastructure of the route is to be improved (see Chapter 6 of this Report), and the capacity of the route thereby increased, the reduction in potential journey times, then this will clearly have an effect on locomotive demand. With a reduction in journey time by 25%, i.e. from the existing 12 hours to 9 hours, the number of locomotives required to operate the forecast number of trains will fall from 36 (in the 'Do Nothing' scenario) to 27.

The 'technical reserve' would also need to be increased, from 10 to 14 locomotives, but again the total requirement lies below the present fleet size.

Therefore, no increase in the existing locomotive fleet is required.

This project also concerns the improvement of regional repair capacities for locomotives, which will be described in the following section.

Coaches

This section refers only to the coaches belonging to Mangyshlak depot (VHD-7). The availability of these coaches at the time of writing was 37 out of 48 (approximately 77%). Eight coaches (16.6%) are not in use, for technical reasons, whereas 3 are in the operational reserve. A general overview is given in the following table.

[20] This reserve is obtained if a 20% spare element is set for a stock of 47 main-line locomotives.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table 3-24: Overview of Coach Availability

Total		In Service	Not Working	Op'l Reserve	Technical Reserve			
					Total	Depot Repair	Waiting for Repair	Factory Repair
Coaches:								
Open	25	20	5	1	4	2	-	2
Compartment	23	17	6	2	4	1	3	-
Total	**48**	**37**	**11**	**3**	**8**	**3**	**3**	**2**

The stock of coaches in the technical reserve is too large and is attributed to the low efficiency for annual depot inspections of the coach depot in Aktyubinsk. An increase in the operational reserve to 5 coaches appears necessary to improve the operational flexibility. This can be achieved very simply by repairing the stored coaches, for which sufficient capacity is available at Almatinsker Elektro-Wagen-Reparaturwerk (AEWRS). A total reserve contingent of 20% is to be aimed for as a normal figure, i.e. 10 coaches in the non-working fleet and evenly distributed, namely 5 in the operational reserve and 5 in the technical reserve.

The total number of coaches available is adequate to cover the existing requirement of two passenger trains daily.

These recommendations are only concerned the regional improvement of repair capacities for damaged coaches, which are described in the following section.

Freight wagons

Since freight wagons are not allocated specifically to one part of the network, and can thus circulate freely, the following information refers to the total stock of freight wagons of the WKR.

The availability of freight wagons at the time of writing was 17,934 of 28,131 (approximately 64%). Of the unused wagons, 4,531, i.e. 16% of the total fleet, were in the operational reserve. A general overview by wagon types is given in the following table.

Table 3-25: Overview of Freight Wagon Availability

	Total	Working	Share (%)	Not Working	Operational Reserve	Technical Reserve
Closed Wagons	6,781	4,674	**68.9**	2,107	692	1,415
Open Wagons	6,678	5,209	**78.0**	1,469	514	955
Flat Wagons	4,887	1,698	**34.7**	3,189	595	2,594
Refrigerated Wagons	814	129	**15.8**	685	685	0
Tank Wagons	3,950	2,509	**63.5**	1,442	786	656
Other Wagons	5,021	3,716	**74.0**	1,305	1,259	46
Total	**28,131**	**17,934**	**63.8**	**10,197**	**4,531**	**5,666**

Overall, the reserve stock of freight wagons appears to be too large. This is attributed to both the reduced transport requirement and the low efficiency of the freight wagon depot for repair services. An overall reduction of the wagon stock to adapt it to the transport requirement seems to be necessary to improve the operational flexibility. This is, however, a question of the WKR in general, and cannot be considered solely from the limited viewpoint of this regional project.

The total number of freight wagons available is adequate to cover the present requirement of three freight trains daily in the region. Assuming a recovery in the transport market in the region by 2005 in line with Scenarios A to C described in Chapter 2, the non-working wagon park would have to be reduced to approximately 3,300 wagons. A wagon turn-round of 8 days is assumed for this calculation. An overview is shown in the following table.

Table 3-26: Freight Wagon Requirement to meet Increasing Transport Demand

Additional Freight Trains (55 wagons/train)	Currently Working	Currently Not Working	Including Current Operative Reserve	Wagon Turn-around *in days*	Additional Wagons Required *net*	Additional Wagons Required *gross*
Current Situation:	**17,934**	**10,197**	**4,531**			
Scenario A +8 trains				8	3,520	4,224
Scenario B +12 trains				8	5,280	6,336
Scenario C +13 trains				8	5,720	6,864

This rough estimate is initially of a theoretical nature since it does not consider the different requirement for the different types of freight. It does, however, clearly show the current excessive wagon stock, which will not reach the normal reserve rate of 20% until approximately 2000 if a linear growth in transport demand is assumed as in Scenario C. On the other hand, an in-depth study of the individual wagon types as part of this regionally limited study appears less meaningful. It is assumed that the freight wagons available in the whole network of all three Kazakstan railways are sufficient to make good any demand deficits in the course of an empty wagon adjustment.

This Project is only concerned with the improvement of regional repair capacities for freight wagons, which is described in the following section.

3.4.4.2 Measures Necessary to Increase Capacity

Locomotives, coaches and freight wagon fleet

The corrective measures for **locomotives** with a relatively stable transport demand usually concern stock rejuvenation by procurement of replacements. In this case, with good maintenance condition, it appears sensible to prepare an engine replacement programme for the 2TQ10L locomotives with the aim of achieving better operational efficiency. It is recommended that such a programme include the initial conversion of 3 locomotives before 2000 combined with a thorough trial of this measure. The costs for this are estimated at about USD 1 million per locomotive.

Another 5 locomotives should then be fitted with new engines by 2005 using the experience gained.

Based on the information in the previous section and linear growth in transport demand, no additional **locomotives** will be necessary to cover the additional requirement by 2000.

No corrective measures are necessary for the stock of **coaches** because the available fleet is adequate.

In the case of the stock of **freight wagons**, the only corrective measures necessary will be to replace the ageing closed wagons which need to be scrapped. The work of these wagons in the future will be taken over increasingly by containers or special wagons such as cement wagons.

Maintenance system for locomotives, coaches and freight wagons

The depot carrying out the maintenance of **locomotives** in Mangyshlak (TO and TP-1) has existed since 1967 and much of the equipment is still at the standard of the year of construction. This equipment urgently requires replacement.

Table 3-27: Overview of Equipment Procurement Requirement for Mangyshlak Locomotive Depot

Item	Type	Rating	Specification	Qty	Price (USD)
Centrifugal pump 3K-9	Diesel fuel	30 m³ / h		1	500
Centrifugal pump 3K-6	Diesel fuel	40 m³ / h		1	600
Gear pump P3-30	Diesel engine oil	18 m³ / h		2	800
Gear pump P3-30	Axle oil	18 m³ / h		2	800
Vertical drill 2H-110		1.5 kW	23 mm	1	120,000
Rectifier welding set BC 1000		I = 1000 A V = 380 V		1	2,000
Air compressor KT-6/7		5.3 m³ /sec		1	4,000
Wheelset lathe K<20B		39 kW		1	396,000
Injection pump test stand A 1515		10 kW		1	30,000

Much of the equipment at Makat/Bejneu depot which carries out maintenance of **locomotives** (TO-4 and TP-2) dates from 1965-1967. There is thus an urgent requirement to replace this equipment, as listed in the following table.

Table 3-28: Overview of Equipment Procurement

	Type	Rating	Specification	Qty	Price (USD)
Centrifugal pump 3K-9	Diesel fuel	30 m³ / h		2	1,000
Centrifugal pump 4K-6	Diesel fuel	40 m³ / h		2	1,200
Pump 3K-6	Diesel engine oil	40 m³ / h		1	600
Diesel fuel station with meter SV#-40	Diesel fuel	18 m³ / h		4	80,000
Vacuum pump BBH-3		2.4 m³ / h	vac. 80%	1	1,000
Centrifugal pump 3K -6	Diesel fuel	60 m³ / h	5 at	2	1700
Centrifugal pump 6K-8a	Diesel fuel	150 m³ / h	2.8 at	5	4,500
Centrifugal pump 8K-12a	Diesel fuel	200 m³ / h	2.6 at	6	5,500
Centrifugal pump 8K-12	Diesel fuel	300 m³ / h	2.8 at	6	5,500
Pump 1.5 K-6			1.1 kW	3	2,500
Pump 1.5 X-6D			3.0 kW	1	3,600

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

	Type	Rating	Specification	Qty	Price (USD)
Pump 1 CCV-1.5			0.4 kW	1	795
Distillation system A 468		12-15 lt./h	10-13 kW	1	5,040
Semiconductor rectifier TPP-160-70	For alkali batteries		11.2 kW	3	15,000
Semiconductor rectifier TPP-80-110	For acid batteries		11.2 kW	2	10,000

Much of the equipment at Mangyshlak depot (VHD-7) which carries out maintenance of **coaches** and **freight wagons** dates from 1965-1967. There is an urgent requirement to replace this equipment, as listed in the following table.

Table 3-29: Overview of Equipment Procurement Requirement for Mangyshlak Wagon Depot

	Type	Rating	Specification	Qty	Unit Price (USD)
Bejneu PTO section					
Mechanic's lathe A 616				1	100,000
Vertical drill 2118 A				1	120,000
Acetylene generator ACP-1.25-7				1	600
Mangyshlak/PPW section					
Lifting jacks UDS 120A			7.5 kW	4	85,000
Multipurpose lathe KSM-1A			3.2 kW	1	7,000
Lathe CMQ - 3B			4.1 kW	1	9,000
Lathe SF4-1B			4.3 kW	1	6,500
Lathe SR4-2			6.5 kW	1	19,000
Rectifier welding set VDM-1201			100 kVA	1	6,500
Mangyshlak/PPR section					
Washing machine KP-019		50 kg	2.2 kW	3	15,000
Spin drier C- 25 A		25 kg	2.2 kW	3	12,000
Tumble drier KP-310		25 kg	2.25 kW	3	12,000
Washing mangle KP-412		35 kg/h	23 kW	1	1,000
Sewing machine				1	600
Mangyshlak/PTO section					
Electric portal crane		5 t	10.5 m	1	37,000
Lifting jacks UDS-120A			7.5 kW	4	85,000
Compressor 2VU-12.5		13 m^3/h		1	18,000

	Type	Rating	Specification	Qty	Unit Price (USD)
Gas welding plant, complete				1	13,000
Distillation plant A 468		12-15 lt./h	10-13 kW	1	5,040
Electrolyte bath A 225				2	3,500
Lathe 7305 T				1	7,800
Lathe 3K 634				1	1,500
Lathe 2G 125				1	8,500
Lathe TV-4				1	15,800
Welding stand for AK T 275				1	2,800
Rectifier welding set VDU - 506				1	1,600
Welding transformer TDF< - 1002				1	1,400
Mounting stand for AK				1	3,500
Cable winch				1	59,000
Magnetic fault detector MD - 12P#				1	1,900
Washing bath				1	1,400
Test stand for water heater				1	12,300
Mangyshlak/Mechanical Workshop Section					
Lathe 16D 25			11.9 kW	1	17,300
Lathe 6 T 83 #			11 kW	1	8,100
Welding transformer TDM - 503		500 A	34 kW	1	1,200
Lathe 2 N 125			2.3 kW	1	8,400
Pneumatic hammer MD 4134			22 kW	1	40,000
2-sided grinding machine 3K 634			3.2 kW	1	1,400
Mangyshlak/Opornaya Section					
Lifting jacks TQD 30		30 t		2	76,000
Crane		3 t		1	20,000
Welding transformer TDM - 503		500 A	34 kW	1	1,200
Mangyshlak/Bejneu DOC Section					
Wood machining centre KSM-1A			4.2 kW	1	6,700
Router CMQ - 3B			4.1 kW	1	8,900
Woodworking machine SF 4 - 1B			4.3 kW	1	6,200

	Type	Rating	Specification	Qty	Unit Price (USD)
Mangyshlak/Say-Utes Section					
Welding transformer TDM - 503		500 A	34 kW	1	1,200
Mangyshlak/Shetpe Section					
Wood machining centre KSM-1A			4.2 kW	1	6,700
Router CMQ - 3B			4.1 kW	1	8,900
Straightening machine for O wagons PKB CV	T337			1	50,000
Compressor station 4UV1-5/13m7				1	70,000
Mangyshlak PPW Section					
Compressor station 4UV1-5/13m7				1	70,000

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

4 Economic and Financial Viability

4.1 Introduction

This section of the report concerns the economic and financial aspects of the measures recommended in other Chapters. It concerns the costs for new construction work to be undertaken as well as the costs of the necessary equipment.

The forecast costs consist of an estimate of the capital outlays which will be necessary to bring the line up to the required standard as detailed in the relevant technical sections of this study and the various options proposed. Based on these capital requirements a further estimate has been made of the annual costs involved in maintaining the line at the level to be attained. In interpreting the figures available it should be taken into consideration that the current financial situation of the railways in Kazakstan has caused essential repairs and maintenance, which would normally be undertaken as routine measures, to be neglected. As a result **the historically reported costs of repairs and maintenance do not represent the charges necessary in a normally functioning operation**. Therefore, any estimates for maintenance must take into account the normal costs involved and cannot be based on the historical figures available.

A further calculation has then been made of the annual depreciation charges against revenues in line with generally used rates and in accordance with directives in place within the Railway, the latest instructions being Directive No. 1072 of 22.10.1990, published in Moscow. For those options in which an increase in traffic is predicted, requiring supplementary trains, the operating costs have been increased accordingly.

The calculations and observations below are made by the Consultant's experts and based on information acquired in Almaty and on visits to the area by the technical experts involved along with the staff of the local consultant. The actual figures used for 1995 and the first half of 1996 are as obtained from WKR by the local partner.

For information purposes Table 4-1 reproduces the figures for the Atyrau District as supplied. A calculation was made to annualise the figures based on an average of the results of the last seven quarters.
Table 4-2 is an estimation of the average annual results on the line, also based on the figures provided. No figures were available for infrastructure costs for 1995. Therefore the total costs as provided were allocated to the infrastructure and operations based on the results for 1996.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table 4-1: Atyrau District: Assessment of Revenues and Expenses (in million)

	Total 1995		1st Half Yr. 1996		3rd Qtr Plan 1996		Total		Annualised	
Transport Volumes:				2,323.70		1,350.00		3,673.70		4,898.27
Freight; Tkm nett				2,070.70		1,200.00		3,270.70		4,360.93
Passengers; Pass-km				253.00		150.00		403.00		537.33
	KZT	USD	KZT	USD	KZT	USD	KZT	USD	KZT	USD
Revenues:	3,056.00	48.51	1,764.00	26.93	1,072.00	15.87	5,892.00	91.31	3,366.86	52.18
Freight	2,383.68	37.84	1,375.92	21.00	836.16	12.38	4,595.76	71.22	2,626.15	40.70
Passenger	672.32	10.67	388.08	5.92	235.84	3.49	1,296.24	20.09	740.71	11.48
Revenue/km.(T/$ per km.)										
Freight (Tkm)			0.664	0.010	0.697	0.010	0.676	0.010	0.676	0.010
Passenger (Pass.km.)			1.534	0.023	1.572	0.023	1.548	0.023	1.548	0.023
Operating Costs:	2,669.00	42.37	1,928.00	29.43	888.00	13.15	5,485.00	84.95	3,134.29	48.54
Payroll	896.00	14.22	632.00	9.65	287.00	4.25	1,815.00	28.12	1,037.14	16.07
Social Benefits	283.00	4.49	225.00	3.43	86.00	1.27	594.00	9.20	339.43	5.26
Materials & Spares	384.00	6.10	489.00	7.46	154.00	2.28	1,027.00	15.84	586.86	9.05
Fuel	293.00	4.65	187.00	2.85	94.00	1.39	574.00	8.90	328.00	5.08
Energy	90.00	1.43	48.00	0.73	28.00	0.41	166.00	2.58	94.86	1.47
Depreciation	162.00	2.57	101.00	1.54	38.00	0.56	301.00	4.68	172.00	2.67
Administration & Other	561.00	8.90	246.00	3.76	201.00	2.98	1,008.00	15.64	576.00	8.94
Profit/Loss	387.00	6.14	-164.00	-2.50	184.00	2.72	407.00	6.36	232.57	3.64

Table 4-2: Aktau-Bejneu Line: Assessment of Revenues and Expenses (in millions)

	Total 1995		1st Half Yr. 1996		Total		Annualised	
	KZT	USD	KZT	USD	KZT	USD	KZT	USD
Revenues:	642.00	10.19	293.00	4.47	935.00	14.66	623.33	9.78
Freight	500.76	7.95	228.54	3.49	729.30	11.44	486.20	7.62
Passenger	141.24	2.24	64.46	0.98	205.70	3.23	137.13	2.15
Infrastructure:	637.28	10.12	342.41	5.23	979.69	15.34	653.13	10.23
Track Maintenance	215.41	3.42	115.74	1.77	331.15	5.19	220.77	3.46
Signalling Equipt. Maint.	122.84	1.95	66.00	1.01	188.84	2.96	125.89	1.97
Stations & Other Maint.	87.16	1.38	46.83	0.71	133.99	2.10	89.33	1.40
Locomotive Maint.	91.49	1.45	49.16	0.75	140.65	2.20	93.77	1.47
Carriage Maint.	120.38	1.91	64.68	0.99	185.06	2.90	123.37	1.93
Operating Costs:	110.04	1.75	197.43	3.01	307.47	4.76	204.98	3.17
Payroll	36.94	0.59	17.60	0.27	54.54	0.86	36.36	0.57
Social Benefits	11.67	0.19	13.92	0.21	25.59	0.40	17.06	0.27
Materials & Spares	15.83	0.25	109.26	1.67	125.09	1.92	83.39	1.28
Fuel	12.08	0.19	41.85	0.64	53.93	0.83	35.95	0.55
Energy	3.71	0.06	0.15	0.00	3.86	0.06	2.57	0.04
Depreciation	6.68	0.11	-4.68	-0.07	2.00	0.03	1.33	0.02
Administration & Other	23.13	0.37	19.33	0.30	42.46	0.66	28.31	0.44
Total Costs:	747.32	11.86	539.84	8.24	1,287.16	20.10	858.11	13.40
Profit/Loss	-105.32	-1.67	-246.84	-3.77	-352.16	-5.44	-234.77	-3.63

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

4.2 Evaluation of Construction and Equipment Costs

4.2.1 Permanent Way

4.2.1.1 Detailed Direct Costs for Track (Material, Workers, Machines, Wagons)

Note:

The following tables comprise costs which were supplied to the Consultant by various railway offices and agencies in Kazakstan. Because the Consultant was unable to confirm the validity of many of the — often widely varying — prices at first hand, it is strongly recommended that a thorough validation be undertaken by potential investors before making definite investment proposals:

All costs shown are quoted in US Dollars (USD), converted, wherever applicable, at the prevailing rate of USD 1 = KZT 68.50.

Table 4-3: Unit Costs for Permanent Way Components

Track Material	**Unit**	**USD/unit**	**Local Costs**	**Foreign Costs**	**Origin**
Rail 65 kg/m	tonne	850.00		850.00	Russia
Rail 65 kg/m (64.72 kg/m)	**m**	**55.00**		55.00	
Fishplates	tonne	850.00		850.00	Russia
Fishplate (29.5 kg)	each	25.00		25.00	
Fishplate bolts	tonne	1,500.00		1,500.00	Russia
Fishplate bolt (1 kg)	each	1.50		1.50	
2 coil spring washer	tonne	1,400.00		1,400.00	Russia
2 coil spring w. (0.09 kg)	each	0.13		0.13	
Per track joint (twin sl.)	**compl.**	**172.26**		172.26	Russia
Concrete sleeper	each	28.00	28.00		Kazakstan
Pad under bottom plate	each	1.40	1.40		Kazakstan
Ribbed bottom plate	tonne	880.00		880.00	Russia
Ribbed bottom plate (7 kg)	each	6.15		6.15	
Sleeper bolts	tonne	1,500.00		1,500.00	Russia
Sleeper bolt (0.7 kg)	each	1.05		1.05	
2 coil spring w. (0.09 kg)	each	0.13		0.13	Russia
T-head bolts	tonne	1,500.00		1,500.00	Russia

Track Material	Unit	USD/unit	Local Costs	Foreign	Origin Costs
T-head bolt (0.46 kg)	each	0.69		0.69	
Clip	tonne	1,300.00		1,300.00	Russia
Clip (0.66 kg)	each	0.86		0.86	
Pad under rail	each	0.79	0.79		Kazakhstan
Flat washer (flat plates)	each	0.22		0.22	Russia
Insulated bushes	each	0.27	0.27		Kazakhstan
Concrete sleeper + fasten.	**compl.**	**57.56**	33.46	24.10	Rus+Kaz
Wooden sleeper impregnated	each	22.70		22.70	Russia
New screwed fastening	each	30.00		30.00	Russia
Wooden sleeper + bolts	**compl.**	**52.70**		52.70	Russia
Wooden sleeper impregnated	each	22.70		22.70	Russia
Base plate + spikes	compl.	17.00		17.00	Russia
Rail anchors	compl.	5.00		5.00	Russia
Wooden sleeper + spikes	**compl.**	**44.70**		44.70	Russia
Insulated joints	**compl.**	**15.00**		15.00	Russia
Ballast(stone) incl. transp.	**m^3**	**8.50**	8.50		Aktyubinsk
1km track (concrete sl.)	**compl.**	**239,800**	78,566	161,234	
1km track (wooden +bolts)	**compl.**	**230,858**	17,000	213,858	
1km track (wooden + spike)	**compl.**	**216,138**	17,000	199,138	
Turnout incl. sleeper	**compl.**	**25,400**		25,400	Russia
Turnout sleeper + fasten.	**compl.**	**6,000**		6,000	Russia

Table 4-4: Staff Costs

Direct Staff Costs in Desert Area	Unit	USD/unit Local costs only
Labour	1 hour	0.82
Labour	1 month	140.00
Labour	1 year	1,680.00
1 km track renewal	3800 h	3,116.00
Renewal of 1 turnout	800 h	656.00

Table 4-5: Mechanical Equipment Cost

Machines, Locomotives, Wagons	**Total Direct Costs (USD) local only**
Per 1 km track renewal	10,000.00

4.2.1.2 Costs of Track Renewal: Overheads

Overheads, which are all local costs, have been calculated for each item as follows:

Manpower	Costs of salaries
+ 30 %	Social Benefits
+ 2 %	Danger Money
+ 00 %	Regional Bonus (incl. in costs of workers 60 %)
+ 25 %	Workers Bonus
+ 23.5 % Overhead	
+ 0.5 % Contingencies	
= 81 % Manpower Overhead Costs	

Material	Costs of Material
+23.5 % Overhead	
+ 0.5 % Contingencies	
= 24 % Material Overhead Costs	

Machines, other costs	Costs of Machines, Locomotives
+ 0.5 % Contingencies	
+ 0.5 % Overhead Costs of Machines, Locomotives	

4.2.1.3 Total Costs of Track Renewal

All costs are in USD.

Table 4-6: 1 km Track Renewal with Concrete Sleepers

Description	Direct Total	Direct Local	% 'head	**Foreign Costs**	**Local Costs**	**Total Costs**
Material	239,800	78,566	24%	161,234	136,118	297,352
Manpower	3,116	3,116	81%		5,640	5,640
Mach., loc.	10,000	10,000	0.5%		10,050	992
Total	252,916	91,682		**161,234**	**151,808**	**313,042**

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table 4-7: 1 km Track Renewal with Wooden Sleepers with Bolts

Description	Direct Total	Direct Local	% 'head	**Foreign Costs**	**Local Costs**	**Total Costs**
Material	230,858	17,000	24%	213,858	72,406	286,264
Manpower	3,116	3,116	81%		5,640	5,640
Mach., loc.	10,000	10,000	0.5%		10,050	10,050
Total	243,974	30,116		**213,858**	**88,096**	**301,954**

Table 4-8: 1 km Track Renewal with Wooden Sleepers with Spikes

Description	Direct Total	Direct Local	% 'head	**Foreign Costs**	**Local Costs**	**Total Costs**
Material	216,138	17,000	24%	199,138	68,873	268,011
Manpower	3,116	3,116	81%		5,640	5,640
Mach., loc.	10,000	10,000	0.5%		10,050	10,050
Total	229,254	30,116		**199,138**	**84,563**	**283,701**

Table 4-9: 1 km Sleeper Renewal with Concrete Sleepers

Description	Direct Total	Direct Local	%'head	**Foreign Costs**	**Local Costs**	**Total Costs**
Material	129,800	78,566	24%	51,234	109,718	160,952
Manpower	3,116	3,116	81%		5,640	5,640
Mach., loc.	9,000	9,000	0.5%		9,045	9,045
Total	141,916	90,682		**51,234**	**124,403**	**175,637**

Table 4-10: 1 km Sleeper Renewal with Wooden Sleepers with Bolts

Description	Direct Total	Direct Local	%'head	**Foreign Costs**	**Local Costs**	**Total Costs**
Material	120,858	17,000	24%	103,858	46,006	149,864
Manpower	3,116	3,116	81%		5,640	5,640
Mach., loc.	9,000	9,000	0.5%		9,045	9,045
Total	132,974	29,116		**103,858**	**60,691**	**164,549**

Table 4-11: Renewal of Turnouts with Sleepers (unit costs)

Description	Direct Total	Direct Local	%'head	**Foreign Costs**	**Local Costs**	**Total Costs**
Material	26,400	1,000	24%	25,400	7,336	32,736
Manpower	656	656	81%		1,187	1,187
Loco+Wagon	100	100	0.5%		100	100
Total	27,156	1,756		**25,400**	**8,623**	**34,023**

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table 4-12: Renewal of Sleepers and Fastening of Turnouts (unit costs)

Description	Direct Total	Direct Local	% 'head	**Foreign Costs**	**Local Costs**	**Total Costs**
Material	7,000	1,000	24%	6,000	2,680	8,680
Manpower	656	656	81%		1,187	1,187
Loco+Wagon	100	100	0.5%		100	100
Total	7,756	1,756		**6,000**	**3,967**	**9,967**

4.2.1.4 Equipment Costs

All equipment costs are 'foreign costs' and are in US Dollars (USD).

1	Unimat Compact 08-16-3s-split	1,600,000	
1	re-ballasting machine SSP 203	700,000	
Modern Track Tamping and Levelling Machines in total			**2,300,000**
2	Track cars with OBW 10 crane	1,600,000	
2	Ural-cars for 20 workers	100,000	
2	Generator sets	10,000	
2	Excavators	400,000	
30	Sleeper screw drivers	150,000	
6	Sleeper drilling machines	40,000	
6	Rail drilling machines	40,000	
2	Rail bending device machines	10,000	
	Hand equipment	100,000	
Equipment for 2 mechanised mobile gangs in total			**2,450,000**
Equipment for 2 assembly sites for track panels			**500,000**

4.2.1.5 Total Infrastructure Investment Costs

The costs of bridges and pipe culverts were researched locally by the Consultant.

The costs of the equipment were estimated according to Western European standards, apart from the Ural Car.

In general, it should be noted that local material for track and bridges is only marginally cheaper than in Western Europe, but is of a lower quality.

There are therefore two possibilities for cost reduction and/or quality increase:

- Engage a general contractor to execute the whole rehabilitation project

- Purchase high-quality material in Western Europe at slightly higher prices.

The following calculation summarises the total investment costs in USD:

Table 4-13: Summary of Infrastructure Investment Costs (in USD '000)

	1998	1999	2000	2001	2002	2003	total
Local	9,000	18,000	18,000	18,000	18,000	6,987	87,987
Foreign	7,000	14,000	14,000	14,000	14,000	4,559	67,559
Total Amount	**16,000**	**32,000**	**32,000**	**32,000**	**32,000**	**11,546**	**155,546**

A breakdown of the individual investment costs is given in *Fehler! Verweisquelle konnte nicht gefunden werden.*.

4.2.2 Telecommunications

All telecommunications installations have to be replaced in one single phase, otherwise there would be too many interfaces between the existing and new systems which would ultimately be redundant.

Two years will be required to install the optical cable, following which the other telecom installations will be required; the optical cable **must be installed first.**

The following timescale is recommended:

Table 4-14: Telecommunications Schedule of Investment Costs

Year	**Type of Cost**	**Total (USD million)**	
			Total by year
1	cable (50% of total)	2.05	**year 1:** 2.05
2	cable (50% of total)	2.05	**year 2:** 5.95
2	other equipment	3.90	
	TOTAL	**8.00**	

4.2.3 Signalling

4.2.3.1 Equipment Costs

Renewal of the signalling installations gradually over a period has the disadvantage that during this transition period — which could last for 10 years of more — spare parts for the old system as well as spare parts for the new system will need to be available. However, by progressively dismantling and cannibalising old installations, the amount of recovered old material that still can be used should prove adequate as a source of spare parts for the transition period.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Taking this into consideration, gradual renewal of the installations is recommended, whereby replacement is made according to the age of the existing installations. This can be done in three stages as follows:

- **Stage 1:** replacement of the oldest installations (more than 14 years old)
- **Stage 2:** replacement of remaining installations
- **Stage 3:** renewal of block installations

The following costs for the individual stages of construction have been calculated (average estimated costs):

Table 4-15: Total Signalling Investment Cost

Stage	**Cost (USD million)**
1st stage:	41.00
2nd stage:	27.00
3rd stage	26.00
Total Cost	**94.00**

The following tables show the detailed cost breakdown for each stage of construction.

Table 4-16: Construction Stage 1: Replacement of the Oldest Installations

Type of Costs	**Units**	**Unit cost (USD million)**	**Total Costs (USD million)**
Central train control system Atyrau: Basic equipment, basic costs: Work place, technical equipment: Additional costs per Double-track station	 6	 0.15	 0.40 0.10 0.90
Three-track station	9	0.20	1.80
Four-track station	2	0.25	0.50
Eight-track station	1	0.40	0.40
Total			**4.10**

Table 4-17: Construction Stage 1: Installations along the Route

Station and km point	**Number of Tracks**	**Modernisation**	**Cost (USD million)**
XP 1	4 tracks	Remote control	0.5
Level crossing 31.0			0.3
XP 2:	2 tracks	Intermediate signal box incl. remote control	3.0
XP 3:	3 tracks	Remote control	0.5

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Station and km point	Number of Tracks	Modernisation	Cost (USD million)
Ustyurt:	3 tracks	Intermediate signal box incl. remote control	3.3
Level crossing 80.7			0.3
XP 5:	3 tracks	Remote control	0.5
XP 6:	2 tracks	Intermediate signal box incl. remote control	3.0
Level crossing 128.5			0.3
XP 7:	3 tracks	Remote control	0.5
Level crossing 176.9			0.3
Say-Utes:	4 tracks	Intermediate signal box incl. remote control	3.5
XP 8:	2 tracks	Intermediate signal box incl. remote control	3.0
XP 9:	3 tracks	Remote control	0.5
XP 10:	2 tracks	Intermediate signal box incl. remote control	3.0
Level crossing 251.7			0.3
XP 11:	3 tracks	Remote control	0.5
XP 12	2 tracks	Intermediate signal box incl. remote control	3.0
Level crossing 279.1			0.3
XP 13:	3 tracks	Remote control	0.5
Shetpe:	8 tracks	Intermediate signal box incl. remote control	4.5
Level crossing 313.6			0.7
XP 14:	3 tracks	Remote control	0.5
XP 15	2 tracks	Intermediate signal box incl. remote control	3.0
Level crossing 362.4			0.3
XP 16:	3 tracks	Remote control	0.5
level crossing 387.8			0.3
Subtotal			**36.6**
Central train control system			4.1
Contingency			0.3
Construction Stage 1: Grand Total			**41.0**

The **second stage of construction** involves the replacement of the remaining intermediate signal boxes. The central train control system requires no further work, though some necessary adaptations are included in the railway station costs.

Table 4-18: Construction Stage 2: Installations along the Route

Station and km points	Number of Tracks	Modernisation	Cost (USD million)
XP 1:	4 tracks	Only intermediate signal box	3.1
Level crossing 16.0			0.3
XP 3:	3 tracks	Only signal box	2.9
XP 5:	3 tracks	Only signal box	2.9
XP 7:	3 tracks	Only signal box	2.9
XP 9:	3 tracks	Only signal box	2.9
XP 11:	3 tracks	Only signal box	2.9
XP 13:	3 tracks	Only signal box	2.9
XP 14:	3 tracks	only signal box	2.9
level crossing 376.1			0.3
XP 16:	3 tracks	only signal box	2.9
Subtotal			**26.9**
Contingency			0.1
Construction Stage 2 Grand Total			**27.0**

For the **third stage**, the block installations will be renewed. No work is necessary for the central train control system, any necessary adaptations being included in the costs of block installations.

Table 4-19: Construction Stage 3: Installations Along the Route

Track Section and km Point	Number of Automatic Block Posts to be Modernised	Unit Costs (USD million)	Total Cost (USD million)
Level crossing 8.4			0.3
Bejneu - XP 1:	2	0.4	0.8
Level crossing 16.0			0.3
XP 1 - XP 2:	2	0.4	0.8
Level crossing 40.8			0.3
XP 2 - XP 3:	3	0.4	0.8
Level crossing 66.0			0.3
XP 3 - Ustyurt:	3	0.4	1.2
Ustyurt - XP 5:	3	0.4	1.2
XP 5 - XP 6:	3	0.4	1.2
XP 6 - XP 7:	3	0.4	1.2
Level crossing 163.5			0.3
XP 7 - Say-U:	4	0.4	1.6
Say-U - XP 8:	3	0.4	1.2
XP 8 - XP 9:	1	0.4	0.4
XP 9 - XP 10:	5	0.4	2.0

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Track Section and km Point	Number of Automatic Block Posts to be Modernised	Unit Costs (USD million)	Total Cost (USD million)
Level crossing 230.3			0.3
XP 10 - XP 11:	2	0.4	0.8
XP 11 - XP 12:	3	0.4	1.2
XP 12 - XP 13:	3	0.4	1.2
Level crossing 304.2			0.3
XP 13 - Shetpe:	3	0.4	1.2
Shetpe - XP 14:	2	0.4	0.8
Level crossing 323.8			0.3
Level crossing 336.2			0.3
XP 14 - XP 15:	3	0.4	1.2
Level crossing 362.4			0.3
Level crossing 367.2			0.3
XP 15 - XP 16:	4	0.4	1.6
Level crossing 387.8			0.3
XP 16 - Mangyshlak:	4	0.4	1.6
Level crossing 398.4			0.3
Subtotal			**25.9**
Contingency			0.1
Construction Stage 3 Grand Total			**26.0**

4.2.3.2 Signalling Investment Plan Schedule

The renewal of the signalling installations is **only** required because of the ongoing and expected potential maintenance problems arising from obsolescence, and **not** in order to cope with increased traffic. **The existing signalling system can accommodate all forecast traffic levels without investment.**

However, besides the above reasons for renewal, there are certain other advantages:

- the investment can be spread over a longer period
- the second phase need only be implemented when the means become available (i.e. there is no immediate urgency)

Because of this, the investment plan should be regarded as being flexible in its timescale and finance requirements. The following staging plan should be regarded as a guide:

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Table 4-20: Investment Plan Schedule, Re-signalling Scheme

Stage*	Year	Activity	Cost (USD million)
1	1998	1.1 start of preliminary work	7.00
1	1999	completion 1.1 and start 1.2	15.25
1	2000	completion 1.2 and start 1.3	13.00
1	2001	completion Stage 1	5.75
Total Stage 1			**41.00**
2	2002	2.1 start of preliminary work	7.00
2	2003	completion 2.1 and start 2.2	14.00
2	2004	completion 2.2	6.00
Total Stage 2			**27.00**
3	2005	3.1 start of preliminary work	7.00
3	2006	completion 3.1 and start 3.2	13.00
3	2007	completion 3.2	6.00
Total Stage 3			**26.00**
Total all Stages			**94.00**

* Stage 1: because of the age of the existing installations, this stage should be implemented as quickly as possible; Stage 2 can follow this, since the installations are relatively new.

The spread of investment over a ten-year period recognises the technical requirements, particularly the age of the installations.

Depreciation, service life

A **25-year** depreciation on installations is assumed.

Financial devaluation

Financial devaluation has not been considered, all costs are at end of 1996 price levels.

4.3 Evaluation of Maintenance Costs

4.3.1 Annual Permanent Way Maintenance Costs

The following tables show the levels of permanent way maintenance cost:

- Table 4-21 shows current annual maintenance costs, with existing equipment
- Table 4-22 shows annual maintenance costs, assuming that no renewal takes place (the 'Do Nothing' or 'Zero Scenario')

- Table 4-23 shows annual maintenance costs following track renewal

The percentage overheads included in the following tables refer to the calculations described in Chapter 4.2.1.2, *Costs of Track Renewal: Overheads.*

Table 4-21: Current Permanent Way Maintenance Costs

Description	Unit Costs (USD) Local	Foreign	Total	Qty	O'heads +%	Total Amount (USD '000) Local	Foreign	Total
Staff	1,680		1,680	325	81%	988		988
Wooden sleeper		44.7	44.7	20,000	24%	215	894	1,109
Rails (km track)		110,000	110,000	6.5	24%	172	715	887
Ballast	70,000		70,000	1	24%	87		87
Turnout rails		20,000		15	24%	72	300	372
Plates + joints		150,000		1	24%	36	150	186
Total						**1,570**	**2,059**	**3,629**

Table 4-22: Permanent Way Maintenance Costs without Track Renewal

Description	Unit Costs (USD) Local	Foreign	Total	Qty	O'heads +%	Total Amount (USD '000) Local	Foreign	Total
Workers	1,680		1,680	325	81%	988		988
Wooden sleeper		44.7	44.7	30,000	24%	322	1,341	1,663
Rails (km track)		110,000	110,000	14	24%	370	1,540	1,910
Ballast	70,000		70,000	1	24%	87		87
Turnout compl.	8,019	25,400	33,419	15	24%	212	381	593
Plates + joints		200,000	200,000	1	24%	48	200	248
Total						**2,027**	**3,462**	**5,489**

Table 4-23: Permanent Way Maintenance Costs after Track Renewal

Description	Unit Costs (USD) Local	Foreign	Total	Qty	O'heads +%	Total Amount (USD '000) Local	Foreign	Total
Workers	1,680		1,680	243	81%	739		739
Sleepers	33.46	24.1	57.56	500	24%	20	12	32
Rails (km track)		110,000	110,000	0.5	24%	13	55	68
Ballast	70,000		70,000	1	24%	87		87
Turnout compl.	8,019	25,400	33,419	2	24%	28	51	79
Plates + joints		15,000		1	24%	4	15	19
Equipment				1		125	1,000	1,125
Total						**1,016**	**1,133**	**2,149**

4.3.2 Telecommunications Maintenance Costs

The investment costs amounting to about USD 8 million are composed of 50% costs for the optical cable and 50% for the other telecommunication installations. It has to be expected that the annual maintenance costs for the cable will amount to 5%, those for the other installations to 10% of the investment costs. Thus, the following annual maintenance costs will result (all indications in USD):

Table 4-24: Telecommunications Annual Maintenance Costs

Cable: 5% of	4,120,800	206,040	
Other installations:	10% of	3,876,500	387,650
Total		**593,690**	

4.3.3 Signalling Maintenance Costs

The signalling system currently in use dictates that the staffing requirement is already at a minimum level. There will, therefore, be no further staff saving following the introduction of a new system.

Because the capacity of the present signalling system is capable of coping with the maximum number of trains included in the Scenario prognoses, no specific investment in signalling facilities is required.

However, the age of the existing signalling installations dictates that they must be gradually renewed, in order to be able to continue to operate the line in its current configuration well into the future.

Cost savings in the context of the replacement of existing signalling installations are only possible in two ways:

Reduction in the number of installations

The reduction in the number of passing loops makes no operational sense, since then the line's capacity would be much reduced, and therefore operation would become inflexible.

A reduction in the number of protected level crossings is not possible, since the investment costs for construction of under- or overbridges are far higher than that of the installation of technical protection equipment. Due to the large distance of the roads from each other, it is not expected that level crossings will be closed.

The only remaining possibility is a reduction of the number of block installations. The doubling of the lengths of block sections can be achieved without major reduction of track capacity. This would lead to a reduction in the number of block installations by 50%.

Staff savings

Because of the high level of technology of the signalling system, savings of operational staff cannot be expected. It is thus only in the maintenance sector that savings are possible. Also in this sector, the potential for savings is low, since only those staff members who work in the repair of gravity relays could be saved. The disadvantage would be that, because of the large track sections, long distances have to be travelled by the maintenance staff, which also is very time consuming.

After the completion of all installations, a saving of about 10 maintenance staff members can be foreseen.

Maintenance Costs

The annual maintenance cost can be calculated as 1% of the investment cost of the installations. These values correspond generally to internationally-recognised standards for installations of a broadly similar size and complexity.

These costs include all necessary material and labour costs.

4.4 Economic and Financial Viability

4.4.1 Evaluation of Construction and Equipment Costs

The outlays for the recommended measures to be taken are shown in Table 4-25. These figures are calculated by the experts involved in accordance with the explanations contained in other sections of this report.

Table 4-25: Cost Summary (USD '000)

									per year	
Investment Costs	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006-7**	**2008-2022**
Permanent Way	16,000.0	32,000.0	32,000.0	32,000.0	32,000.0	11,546.0	0.0	0.0	0.0	-
Telecommunications	2,050.0	5,950.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
Signalling	7,000.0	15,250.0	13,000.0	5,750.0	7,000.0	14,000.0	6,000.0	7,000.0	9,500.0	-
Locomotive Refurbishment	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Total	26,050.0	54,200.0	46,000.0	38,750.0	40,000.0	26,546.0	7,000.0	8,000.0	10,500.0	1,000.0
Maintenance Costs										
Permanent Way	3,629.0	3,333.0	3,037.0	2,741.0	2,445.0	2,149.0	2,149.0	2,149.0	2,149.0	2,149.0
Telecommunications	102.5	593.7	593.7	593.7	593.7	593.7	593.7	593.7	593.7	593.7
Signalling	70.0	222.5	352.5	410.0	480.0	620.0	680.0	750.0	750.0	750.0
Workshop Spares	2,406.1									
Total	6,207.6	4,149.2	3,983.2	3,744.7	3,518.7	3,362.7	3,422.7	3,492.7	3,492.7	3,492.7
Depreciation										
Permanent Way	640.0	1,920.0	3,200.0	4,480.0	5,760.0	6,221.8	6,221.8	6,221.8	6,221.8	6,221.8
Telecommunications	102.5	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Signalling	280.0	890.0	1,410.0	1,640.0	1,920.0	2,480.0	2,720.0	3,000.0	3,380.0	3,380.0
Locomotives	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Total	1,062.5	3,250.0	5,050.0	6,560.0	8,120.0	9,141.8	9,381.8	9,661.8	10,041.8	10,041.8

It can be seen from the table that if construction were to start in 1998, it is estimated that by 2003 the permanent way can be renewed.

The work relating to the telecommunications and signalling is expected to be spread over a longer period than that of the permanent way. It is estimated that the telecommunications work can be finished by the year 2005, whereas the signalling will take ten years, to be completed by 2008.

An amount of USD1 million per year is foreseen for the refurbishment of locomotives. It is felt that this measure is preferable to the purchase of new equipment since the locomotives, although quite old, have had relatively little usage.

4.4.2 Evaluation of Maintenance Costs

The Consultant made calculations of the annual maintenance requirements when estimating the construction costs. These are shown in the table above.

These costs represent the necessary annual outlays to maintain the line at the performance level reached, once the required investments have been made.

For the permanent way it is expected that the investments recommended will reduce the maintenance costs from the present USD 3.269 million to USD 2.149 million once the work has been completed. It is therefore expected that by 2003 this level will have been attained.

The costs for telecommunications maintenance are expected to reach a level of USD 593,700 once the systems have been installed.

For signalling the costs will steadily rise with the implementation of the new equipment up to the year 2005 when they are expected to level off at USD 750,000 annually.

These forecast maintenance costs are considerably in excess of the present outlays. However, the importance of regular maintenance must be stressed once again in order to keep the systems in good running order. Failure to carry out this maintenance programme results in severe deterioration of the equipment which in turn results in heavier maintenance costs later or the necessity for further renewal in investments.

The maintenance of locomotives is included in the operating costs provided by the Railway and any additional maintenance may be considered to be covered by the amount foreseen for refurbishment.

An amount of USD2.4 million is included to equip the workshops with the necessary tooling and spare parts required in order to provide proper upkeep.

4.4.3 Future Revenue

A calculation of the impact on revenues according to the scenarios outlined in another section of this report (Chapter 2) is shown in Table 4-26. The current revenues have been extrapolated according to their expected percentage increase over the current level, in line with the forecast increase in traffic over the present volumes.Table 4-26: Revenue Forecast

	1995		
		KZT	USD
Freight			
Tonnage ('000)	1990		
Revenue (in millions)		500.76	7.95
Passenger			
Revenue 1995		141.24	2.24

	2005						
	Low			High			
		KZT	USD			KZT	USD
Scenario A							
Tonnage	8,100				9,670		
% Increase	407.04			% Increase	485.93		
Revenue		2,038.27	32.36			2,433.34	38.63
Scenario B							
Tonnage	10,240				12,110		
% Increase	514.57			% Increase	608.54		
Revenue		2,576.78	40.91			3,047.34	48.38
Scenario C							
Tonnage	12,340				14,210		
% Increase	620.10			% Increase	714.07		
Revenue		3,105.22	49.30			3,575.78	56.77
Passenger							
% Increase	11.50				12.70		
Revenue		157.48	2.50			159.18	2.52

4.4.4 Economic and Financial Viability

4.4.4.1 Costs and Revenues

Table 4-27 and Table 4-28 show the effect of the recommended investments on the forecast results for 2005 and beyond for the various scenarios. Included in this exercise is the effect of undertaking the investments even though there is no improvement in the revenue figures[21].

The revenue figures are based on the projected changes in traffic as outlined in Chapter 2.3.1.1. When calculating the operational expenses consideration has been given to the effect which an increase in traffic will have on these expenditures, see the table below:

[21] In fact, it can be argued that **without** the investment, the line will be incapable of carrying the increased levels of traffic because of a continuing decline in operational capacity through obsolescence.

Table 4-27: Revised Operating Costs (millions)

	1995		2005					
			Scenario A		Scenario B		Scenario C	
			Low	High	Low	High	Low	High
No. of Trains per Day	4		12	14	16	18	18	19
Operating Costs:	Annualised							
	KZT	USD	USD	USD	USD	USD	USD	USD
Payroll	36.36	0.57						
Social Benefits	17.06	0.27						
Materials & Spares	83.39	1.28						
Fuel	35.95	0.55						
Energy	2.57	0.04						
Depreciation	1.33	0.02						
Administration & Other	28.31	0.44						
Total	204.98	3.17						
Operating Costs per Train		**2,174**						
Revised Costs (Annual)			9.52	11.11	12.69	14.28	14.28	15.07

Table 4-28: Forecast Revenues and Expenses (USD millions)

Without Increase in Revenues									
Scenario 0: No Change	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Current Revenues	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	78.24
Current Costs	13.40	13.40	13.40	13.40	13.40	13.40	13.40	13.40	107.20
Net Result	-3.62	-3.62	-3.62	-3.62	-3.62	-3.62	-3.62	-3.62	-28.96

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Scenario A Low									
Revenues	9.78	13.36	16.95	20.53	24.11	27.69	31.28	34.86	**178.56**
Annual Costs	18.22	20.76	22.39	23.66	25.00	25.86	26.16	26.51	**188.58**
Increase in Operating Costs	0.00	1.36	2.72	4.08	5.44	6.80	8.16	9.52	**38.08**
Net Result	-8.44	-8.76	-8.17	-7.22	-6.33	-4.97	-3.05	-1.17	**-48.10**
Scenario A High									
Revenues	9.78	14.26	18.74	23.22	27.71	32.19	36.67	41.15	**203.72**
Annual Costs	18.22	20.76	22.39	23.66	25.00	25.86	26.16	26.51	**188.58**
Increase in Operating Costs	0.00	1.59	3.17	4.76	6.35	7.94	9.52	11.11	**44.44**
Net Result	-8.44	-8.08	-6.82	-5.20	-3.64	-1.61	0.98	3.53	**-29.30**

	1998	1999	2000	2001	2002	2003	2004	2005	Total
Scenario B Low	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Revenues	9.78	14.58	19.39	24.19	29.00	33.80	38.61	43.41	**212.76**
Annual Costs	18.22	20.76	22.39	23.66	25.00	25.86	26.16	26.51	**188.58**
Increase in Operating Costs	0.00	1.81	3.63	5.44	7.25	9.06	10.88	12.69	**50.76**
Net Result	-8.44	-6.17	-3.00	0.53	4.00	7.94	12.44	16.90	**-26.58**
Scenario B High									
Revenues	9.78	15.65	21.53	27.40	33.28	39.15	45.03	50.90	**242.72**
Annual Costs	18.22	20.76	22.39	23.66	25.00	25.86	26.16	26.51	**188.58**
Increase in Operating Costs	0.00	2.04	4.08	6.12	8.16	10.20	12.24	14.28	**57.12**
Net Result	-8.44	-5.10	-0.86	3.74	8.28	13.29	18.86	24.39	**-2.98**
Scenario C Low	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Revenues	9.78	15.78	21.79	27.79	33.79	39.79	45.80	51.80	**246.32**
Annual Costs	18.22	20.76	22.39	23.66	25.00	25.86	26.16	26.51	**188.58**
Increase in Operating Costs	0.00	2.04	4.08	6.12	8.16	10.20	12.24	14.28	**57.12**
Net Result	-8.44	-4.98	-0.61	4.12	8.79	13.93	19.63	25.29	**0.62**
Scenario C High									
Revenues	9.78	16.85	23.93	31.00	38.07	45.14	52.22	59.29	**276.28**
Annual Costs	18.22	20.76	22.39	23.66	25.00	25.86	26.16	26.51	**188.58**
Increase in Operating Costs	0.00	2.15	4.31	6.46	8.61	10.76	12.92	15.07	**60.28**
Net Result	-8.44	-3.91	1.53	7.33	13.07	19.28	26.05	32.78	**27.42**

The calculations have been made in the first instance without taking loan repayments and interest payments into account.

The calculations show that the railway will not be in a position to fund the investments unless there is a substantial increase in revenues.

Without taking loan and interest factors into account the railway will in the best case only be in a profit position in the year 2000, assuming that revenues increase as forecast and construction begins in 1998. In the worst case this stage will only be reached in 2002. However, it should be noted that the cost calculations for the railway operation reflect only **direct costs** applicable to this route; the cost of administration and similar overheads, which cannot be directly allocated to this route, are not specifically included. An awareness of the need to consider a contribution towards these overheads from the direct 'profit' is essential.

When negotiating for the financing of the measures recommended the Railway may be able to arrange a delay in repayment of the loans for the first five years, at which time it should be in a more suitable cash-flow situation, as indicated by the forecast increase in revenues.

4.4.4.2 Internal Rate of Return (IRR) of the Investments

The scale of the investments recommended in preceding chapters and summarised above is not volume dependent and therefore there is no question of considering alternative investment strategies: there is only **one** investment option[22], irrespective of which traffic forecast scenario is accepted.

The variations in viability therefore can only come from variations in levels of traffic and thus improvements in net revenue.

The detailed calculations of the Internal Rate of Return (IRR) are included in Annex R but the results can be summarised here:

Scenario	IRR (%)
A_{LOW}	-1.8
A_{HIGH}	1.5
B_{LOW}	2.0
B_{HIGH}	4.9
C_{LOW}	5.7
C_{HIGH}	9.5

A steady improvement in IRR is notable in direct relationship to the forecast level of traffic, which is to be expected as long as the tariffs for traffic movement continue to be higher than the operating costs.

In making the above assessment, the following assumptions have been made:

- that operating costs remain at their 1996 levels, varying directly with the number of trains operated
- that traffic revenues remain at their 1996 levels in real terms

22 plus, of course, the 'Do Nothing' option, which will ultimately lead to a total collapse of the service.

- that the traffic forecasts up to the year 2005 develop in accordance with the scenarios already developed, and that traffic levels from 2005 to 2022 remain at the 2005 level

- that maintenance costs for infrastructure, signalling and telecommunications do not vary in proportion to the number of trains run

- that the investment in locomotives, infrastructure, signalling and telecommunications has no residual value in the year 2022; this is based on a 25-year asset life, which may be pessimistic

- that no further investment is required in locomotives or rolling stock during the period under review

In general terms it can be seen that **the IRR only approaches 10%** with the **most optimistic scenario**, that incorporating the development of the North-South corridor.

The Consultant considers that the potential IRR of 9.5% is unlikely to be of interest to a private financing institution without substantial guarantees from Government. Additionally, the uncertainty surrounding the traffic forecasts, of which this represents the most optimistic, is also likely to prove a disincentive to a financing organisation.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

5 Further Selection Criteria and Ranking

5.1 Examination of Further Selection Criteria

5.1.1 Validation of Investment Plans and Caveats

It should be clearly understood that the context of many of the historical investment plans described in Chapter 2.2.3 relate to the time of the USSR and thus before the changeover to a market economy. It must be considered, in some cases, extremely doubtful whether the proposed planned investment will actually go ahead, for the following reasons:

- ***Plans no longer relevant:***

the dictates of the markets have not necessarily been taken into account in the plans, particularly where these are merely relics of the USSR period. What may have made perfect sense in a planned economy, where industrial production was often remote from both the sources of raw materials and the ultimate consumer, may simply be unrealistic in a competitive environment.

- ***Lack of investment funds:***

notwithstanding the high proportion of industries which have been privatised in the last few years, there remains a serious shortage of venture risk capital in Kazakstan. Given the current economic climate, it is at present unclear where the funds for investment will arise, whether it be from central Government, private industry or foreign aid. There is clearly some risk that such investments will not take place, or may be scaled down, in such circumstances.

- ***Industrial instability:***

the future of those industries which have been privatised relies entirely on their ability to market their products and to sell them in sufficient quantities and at such prices that survival is ensured and that funds are generated for renewal and investment. It is the Consultant's experience that not all of these companies will indeed survive in this environment.

- ***Remoteness from markets:***

the physical location of the industrial area surrounding Aktau is remote from areas of high population and concentrated industrial production, the nearest of which is probably the southern Ural area of Russia, some 1,500 km distant. Aktau is also remote from many of the sources of raw materials for the chemical industry located there. The primary potential export market through the port of Aktau is Iran, plus other CIS countries such as Turkmenistan, Azerbaijan, etc. who not only have their own problems, but also have their own indigenous production facilities.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

5.1.2 Alternative Technical Solutions

In order to determine the most suitable options for the development of the Mangyshlak-Bejneu route to enable it to cope with projected future levels of growth, as determined in the scenario projections in Chapter 2.3.1.1, the Consultant has considered a number of alternative technological solutions.

Those solutions considered are concerned with the expansion of physical capacity on the route as follows:

- **electrification:** electrification of a route can bring benefits by increasing capacity, normally by means of improving acceleration and/or higher trailing loads through more powerful motive power. There may be network benefits in enabling through operation of electric locomotives and eliminating diesel traction from complete areas. The economic effects may be significant in terms of energy savings but this very much depends on comparable costs of fuel oil against electric power within each country.

application to this route: the increased capacity would be marginal in this case, since the existing capacity is sufficient to meet all forecast needs. On the contrary, at the present time electrification would have the negative effects of being an isolated operation (the nearest electrified routes in Kazakstan are in Shimkent and Tobol), requiring new facilities for maintenance of electric traction and electric power supply. Kazakstan, and particularly the Mangistau Oblast, has an abundant supply of mineral oil.

- **line doubling:** by doubling the track on a particular route, a significant increase in capacity can be achieved, since crossing trains do not have to wait for each line section to become clear before proceeding.

application to this route: again, the increase in capacity resulting from track doubling is not required in order to cope with the forecast level of traffic.

The conclusion reached by the Consultant is that, with the measures proposed in Chapter 3 and summarised in Chapter 6 of this Report, there will be adequate capacity available on the route to cope with even the most optimistic traffic levels without resorting to line doubling or electrification.

5.1.3 'Zero Scenario' (S_0) or "Do-Nothing" Alternative

5.1.3.1 Permanent Way

Due to the poor condition of the permanent way and the low maintenance activities, the present condition of the permanent way will deteriorate even further in future. Thus, in the coming years the risk of derailments will increase enormously. There will be more breaking of rails. The highest risk, however, will be the gauge widening which will occur because of the burden. The reason for these gauge widenings will be the rail fastenings, which, because of the physically deteriorated sleepers can only be prevented by means of replacement of the sleepers.

In order to reduce the stress on permanent way material, the speed on existing sections with speed restrictions will need to be further reduced to 40 km/h. At the same time, maintenance work will increase enormously. The resulting development of maintenance costs is shown in the report in the chapter 4.2.1. To sum up it can be said that maintenance costs will rise by 50%. This means that, due to the different development of maintenance costs of the two variants, 'Do-Nothing' compared to the 'upgrading of the line', seen for the service life of the track, the savings in maintenance costs will nearly compensate for the investment costs.

Conclusion:

Since, out of strategic considerations, the line will not be closed down, as regards the 'Zero-scenario', maintenance costs will clearly increase and speeds will have to be further reduced. Furthermore, the probability of derailments will increase. An exact date for this development cannot be stated, since this development will be a continuous one. Nevertheless, in about 7 to 10 years, comprehensive actions on track renewal will have to be taken.

5.1.3.2 Telecommunication

Neither the planning institute in Almaty nor the local offices in Aktau are able to procure spare parts for the existing systems, since, as already mentioned, in most cases not even the names and addresses of suppliers are known. In how far an exchange of equipment will be possible within the WKR could not be verified. Purchasing the spare parts in Europe will not be possible because of the obsolete technology and the standard being not compatible.

Conclusion:

Thus it may be concluded that in the short or medium term (3 to 5 years) the entire communication systems probably will break down. Because of the railway's special requirements on the communication systems, a shift to public systems is only possible with great difficulties and moreover will lead to high operating costs.

5.1.3.3 Signalling

With today's installations and the present maintenance plan, it will be possible to operate the line in its present form as long as there are spare parts.

1st breakdown:

The first part of the installation which will be irreparable will be remote control. In the case of a major technical damage it will be necessary to switch it off. Operation will still be possible with higher staff costs (all interim stations will have to be manned by station inspectors). A breakdown may occur at any time.

Next breakdowns:

The signal boxes stemming from the time of the construction of the railway will be the next installations which will have to be switched off in case the frequency of breakdowns increases. After having switched off an installation, the remaining installations can be operated for a while using the spare parts recovered. But at last it has to be expected that all installations of the first stage of construction will have to be switched off. There are two variants for further operation:

Variant 1:

Bypassing of the railway station and through-connection of the block section. Advantage: not much expenditure, disadvantage: loss of one crossing, limitation of operational possibilities.

Variant 2:

Replacement of the signal box by a provisional installation with hand-operated switches. Advantage: operation can remain nearly the same, disadvantage: further increase in personnel.

It has to be expected that these installations will have to be completely renewed until 2005.

Breakdown block system:

In case of lack of spare parts in block posts, individual block posts can be closed and their parts can be used as spare parts. Finally, the closing down of the block system in sections will be necessary. This means a reduction in safety (loss of block system and cab signalling); difficult operation.

Breakdown level crossing remote control:

If a level crossing remote control becomes unfit and cannot be repaired, it has to be switched off and replaced by a manned gate. Increase in personnel!

Last breakdown:

The second generation signal boxes will have the longest duration of life; it can be expected that they will function up to 20 years. However, then the indications given under "Next breakdowns" will also apply to these installations.

Conclusion:

It will be possible to further operate the line in the long run even without a new signalling installation. In this case operation can only be realised

- with much higher staff costs

- with a reduction in safety
- without increase in numbers of trains

i.e., slowly and ponderously.

5.2 Ranking of Alternatives and Recommendations

The potential of the whole route for future traffic expansion has been considered above in detail, from both the economic and technical points of view.

To summarise:

- the present level of traffic amounts to roundly 2 million tonnes of freight per annum, equivalent to a maximum of three train pairs per day, plus two pairs of passenger trains, giving a total of 5 train pairs per day
- the scenario forecasts project freight traffic as increasing within a range of 8.1 million tonnes (Scenario A_{LOW}) to 14.2 million (Scenario C_{HIGH})
- taken together with projected increases in passenger traffic, and assuming **existing train size and locomotive hauling capability**, the projections range from 12 to 19 train pairs per day
- the existing line capacity, even with a large number of temporary speed restrictions, **is adequate for the most optimistic scenario forecast**
- the present divided ownership of the route from Bejneu to Aktau (Bejneu to Mangyshlak, West Kazakstan Railway and Mangyshlak to Aktau, KASKOR) is not conducive to a programme of traffic development
- the existing condition of the permanent way and infrastructure is generally **poor** and requires a programme of renewal and renovation, which would have the additional effect of increasing capacity through the elimination of temporary speed restrictions and a general increase in permitted line speed
- the installation of signalling and telecommunications equipment is generally **satisfactory** although future problems with the supply of obsolete spare parts will have an increasing influence, thus rendering the systems increasingly unreliable and making maintenance increasingly more expensive

Any decision on future investment will have to take into account both the projected levels of traffic and the projected costs of the individual investment items.

In terms of priorities for investment, it would clearly be unwise to consider investment in renewal of the signalling or telecommunications systems without first rehabilitating the permanent way infrastructure of the route. Similarly, any decision must also take into account the divided ownership of the route. There would be little benefit, for example, in investing heavily in the Mangyshlak-Bejneu portion of the route if (to take a worst-case scenario) the owners of the Mangyshlak-Aktau section decided to cease rail operations altogether, or else to increase access tariffs to an unrealistic degree.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

6 Final Recommendation

6.1 Proposals and Recommendation for the Upgrading Programme: Initial Design and Project Plan

6.1.1 Summary of Current Status and Proposed Works

6.1.1.1 Permanent Way

For the existing traffic volume, the standard of the line (single-track line with diesel traction and passing loops with a maximum intermediate distance of 29 km) is sufficient. It is not necessary to upgrade the geometry.

For approximately 30 km, the line runs along the Caspian Sea, between km 203 to 232. The level of the Caspian **is expected to rise slowly over the next ten years. In July 1996, the Caspian Sea level was measured at -26.6 m**. The existing track level is between -19.0 to -20.1 m. A new dam was constructed to protect the existing embankment between km 216 and km 221. The project to enlarge the dam, should the Caspian Sea rise further, still exists.

Even for the highest forecast, Scenario C_{HIGH}, the standard of the line is adequate, though not its condition.

Because of the speed restrictions of 40 km/h to 60 km/h on the whole line, the travel time for passenger trains between Bejneu and Mangyshlak is 10 hours. The advantageous profile of the line would however allow much higher maximum speeds, the only reason for the speed restrictions being the condition of the track.

The 65 kg/m rails are in good condition; the 50 kg/m rails are in normal condition. Since the total life cycle load of the 43 kg/m rails has been exceeded, they should no longer be in use. The permissible maximum life cycle load is 350 million tonnes, but in this case the actual load amounts to about 370 million tonnes.

The main problem is that nearly all sleepers (about 90%) are 30-years old wooden sleepers. They are nearing the end of their life cycle. The wooden sleepers have only spikes. On the 30-year old wooden sleepers, the bottom plates are broken, so the spikes cannot fasten the rail tightly.

Some 94% of the line is filled with used sand ballast. This sand ballast makes it impossible to apply modern maintenance methods (cleaning and tamping).

The rails, tongues and diamonds of most of the turnouts are in good condition and well maintained. There is, however, the same problem as on the track: the sleepers have never been replaced, and screws and bolts are used only at tongues and diamonds; in the other parts of the turnouts the rail is fixed to the sleeper by means of spikes.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Because most of the rails and sleepers are in bad condition, whole track sections should be renewed. Also the existing sand ballast must be replaced. Existing 65 kg/m rails in good condition could be re-used in the same track panels on other track sections. The same applies to the recently-laid wooden sleepers which could be re-used in secondary tracks in stations. All new sleepers, either wooden or concrete, must have bolts to fix the bottom plate to the sleeper and the rail to the bottom plate. Also the Pandrol fastening system would be a good solution for this line.

When rehabilitating the track, long welded track without joints should be constructed up to a minimum radius of 700 m with wooden sleepers and up to 300 m with concrete sleepers. If, in some sections, it is not possible to lay long-welded tracks, the joints have to be on twin sleepers.

The quality of locally-available rails and sleepers, with fastenings, needs to be investigated, since the price quoted for such material is almost the same as in western Europe.

In general, concrete sleepers should be used. In sections where sand-storms are frequent, wooden sleepers (about 20%) should be used.

There are three concrete sleeper factories in Kazakstan, each of them having a relatively small output of about 50,000 sleepers per year. One factory is situated near Aktyubinsk. The concrete sleepers do not have the same high quality as European prestressed concrete sleepers. For this project, it is proposed to increase the output of the concrete sleeper factory near Aktyubinsk.

In all existing turnouts, the sleepers have to be replaced. In the parts of the turnout with spikes, screws and bolts should be used to fasten the rail to the sleepers. The steel parts of the turnouts should be replaced to the same extent as that already achieved during the past 10 years.

After track renewal and renewal of the turnout sleepers, maintenance works could be reduced and undertaken by means of maintenance machines.

Some of the bridges or pipe culverts are too small, and water filters through the embankment or destroys the entrance or outlet of the pipe culverts.

Where the existing pipe culverts or bridges are too small, new or additional larger ones have to be constructed. If the entry or outlet of pipe culverts are destroyed, the pipe culvert has to be rehabilitated. Where there is erosion in the river-bed, a protection has to be constructed, so that the erosion cannot destroy the bridge or pipe culvert.

In order to consider options for an increase in traffic levels, the feasibility of increasing the average speed for different train categories to **80 km/h** for freight trains and **100 km/h** for passenger trains was examined.
As a result of the examination of the route, it can be concluded that approximately 80% of the existing line, after rehabilitation, would enable rail traffic to operate at the required speeds.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

The remaining 20% of the route is characterised by somewhat mountainous terrain and this precludes an increase in operating speed to the required levels without major investment in realignment. However, partial replacement of the existing infrastructure, with necessary repairs on a few short sections, would enable a general increase in average speed to 80 km/h.

The resulting travel time for passenger trains between Bejneu and Mangyshlak would be reduced to almost half of that of today, namely about 5 hours.

For passenger trains, the operation between Bejneu and Mangyshlak should be extended to Aktau over the KASKOR line. The track is in similar condition to that on the Bejneu - Mangyshlak section. It is not important who actually owns the line, since it must also be possible to operate passenger trains on a private line and pay for the usage. At the existing Aktau passenger station, a station building needs to be constructed.

6.1.1.2 Telecommunications

The existing communication systems and installations were dimensioned for the demand that could be foreseen at the time of the construction of the railway line. They still are sufficient and in good condition.

Nevertheless, there are the following problems:

- in most cases, the name and address of the producers are not known,
- procurement of spare parts is not possible,
- obsolete technology is used which needs a high level of maintenance
- no possibility to enlarge the system, not even by system components of Western companies, since the systems do not correspond to international standards.

In order to maintain the operability of the installations, according to the method of cannibalisation — "make one out of two" — components (transistors, diodes, condensers, etc.) are unsoldered out of less important installations and are inserted in systems being urgently necessary. Therefore, it is foreseeable that at a specific future point in time the system will no longer be operable.

Thus, the only solution that can be offered is to completely renew virtually all communication systems, which is urgently recommended.

Furthermore it has to be considered that this line constitutes only part of the WKR network which is important for the planning of new systems and their integration into the existing network. This integration is not only necessary at the two railheads of this line, but also at other places in Kazakstan, since there is also direct communication between the line's stations and Atyrau, Aktyubinsk and Almaty. Thus, it will also be necessary to invest in telecommunication in locations of the WKR that are not situated along the line.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

The following list comprises a summary of the proposed measures:

- Overhead line and cable: replacement of the existing systems by optical cables
- Transmission technology: replacement of the analogue carrier-frequency systems by digital PDH and SDH systems,
- Telephone connections along the line: replacement of the existing terminal equipment for party lines by terminals for a party line with digital signalling
- Operational telephone systems: replacement of the existing installations by modern, digital systems
- Radio installations:

Radio communication with trains: retaining the present system
Radio communication in stations: replacement of the existing installations

- Telephone network: replacement of the existing analogue switching centres by digital telephone exchanges. The Mangyshlak Station is excepted, since it already possesses a digital system
- Telegraph and data transmission network:

replacement of the existing telegraph switching centre in Mangyshlak by a computer-controlled system
replacement of the existing analogue voice-frequency telegraph systems by digital transmission systems
replacement of the old mechanical teleprinters by systems based on PCs
retaining the existing PC-based teleprinter terminals and
retaining the pack-unpack device in Mangyshlak

- Other technical telecommunications installations:

loud-speaker equipment: renewal
clock installations: renewal
fire-alarm systems: renewal
hot-box detectors: renewal
ticket issuing machines: retaining
power supply installations: renewal

- Measuring devices: the existing measuring devices partly have to be renewed and completed by those being necessary for the maintenance of digital systems

There is an overhead line on each side of the railway line — one for telecommunications and one for signalling and power supply. Along the Caspian Sea, the overhead line route for signalling and power supply suffers from scour for a length of 40 km, and thus its stability is endangered. In order to solve this problem and at the same time reduce the maintenance effort needed for two overhead lines, in future it is recommended that there will only be one overhead line. For this, three variants exist. Variants one and two (one overhead line for all three services) would be to shift the overhead line for the power supply to the other side of the railway line in the endangered section along the Caspian Sea. The third variant would be to construct a grounding conductor for all three applications. Based on the technical and financial evaluation variant 1 — the mounting of the optical aerial cable on the poles of the power supply line — is recommended.

6.1.1.3 Signalling

All signalling installations are properly maintained and thus in good condition and fit for operation. With the exception of the 8 passing loops which were built 14 years ago, the installations stem from the time of the construction of the railway line, which means today they are 30 years old. Also the overhead line is in good condition, except for the area near the Caspian Sea, which is endangered by floods.

Apart from the rehabilitation of the 30-year-old installations, no direct improvement measures are necessary.

The disadvantage of this high-grade equipment being overdimensioned in relation to the present traffic level lies in the high maintenance effort required. In general, no additional construction is required in order to cope with the forecast increase in the number of trains. However, the age of part of the existing installation necessitates signalling renewal.

When renewing the signalling, the national signalling system has to be taken into consideration. Nevertheless, for all new signalling installations, the interface signalling installation ↔ track-release installation and signalling installation ↔ train-running control system has to be made in such a way that it will later be possible to convert to other, more easily-maintained, systems.

When renewing the automatic block posts, longer block sections and thus a smaller number of block posts should be implemented. Despite the planned increase in running speed, this will not lead to a reduction of the line capacity; it will, however, reduce considerably the number of installations to be installed.

The new signalling installations should be constructed in such a way that the maintenance requirement will be relatively low. For this, computer technology is recommended. The connection of the installations with each other as well as with the central train control system shall be accomplished via digital transmission channels. Thus, two optical fibres for signalling are planned in the new telecommunications cable. The required terminals are seen as part of the signalling installation. Moreover, it is important that the digital connection between Bejneu and Atyrau is installed using existing copper links of the telecommunications installations in this section.

The following measures are proposed:

- Modernisation of the central train control system in Atyrau and of the remote-control system for the whole line
- renewal of the intermediate signal boxes including remote control system
- renewal of the remote control system
- renewal of the level crossing remote control and
- renewal and reduction of block installation

6.1.2 Summary of Investment to Upgrade the Line

In the following tables the proposed works are summarised together with the investment required.

Fehler! Verweisquelle konnte nicht gefunden werden. and *Fehler! Verweisquelle konnte nicht gefunden werden.* show the investment costs required for the upgrading measures.

Table 6-1: Total investment costs required

Description	total costs in USD '000
1. Permanent Way	155,546
2. Telecommunication	7,997
3. Signalling	94,000
Grand total	257,543

6.1.3 Schedule of Investments

6.1.3.1 Permanent Way

The first actions to be taken is for the provision of permanent way machines, for the tamping machine as well as small tools. Assembly sites have to be determined and the necessary installation has to be set up. Moreover deliveries with adequate quality have to be guaranteed, especially as regards concrete sleepers. Since for customers the connection between Aktau and Mangyshlak constitutes the most important improvement offered, it has to be started with the extension of the line and thus with the railway station of Aktau. Because of the improvement offered, the customers will show more understanding for obstruction to traffic during the extension of the line. Therefore the timetable has to be adapted to construction works. Also the extension of bridges and culverts has to be started during the first year.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Starting with the second year of construction, the bridges and permanent way have to be renewed continuously. At the end of the extension program, the recovered permanent way material should be utilised for track within the railway stations. With a total construction time calculated realistically to amount to 6 years, the necessary annual costs are shown in table 6.2.

Table 6-2: Schedule of Investment for Permanent Way in USD '000

	1998	1999	2000	2001	2002	2003	sum
total amount	16,000	32,000	32,000	32,000	32,000	11,546	155,546

6.1.3.2 Telecommunication

All telecommunication installations have to be put into operation during one phase, since otherwise there would be too many interfaces between old and new installations which later on will not be needed. Thus considerable lost expenditure would result.

For the installation of the optical cable two years have to be calculated. Only after completion of the optical cable, the other telecommunication installations may be installed and put into operation. Thus, the following table shows the schedule of investment.

Table 6-3: Schedule of Investment for Telecommunication in USD '000

1998	50%	of the cable costs of	4,121		2,060
1999	50% 100%	of the cable costs of of other costs of	4,121 3,877	2,060 3,877	
Total 2nd year				5,937	5,937
Project Total					7,997

6.1.3.3 Signalling

Taking the spare part problem into consideration a gradual renewal of the installations is recommended whereby the replacement of the installations shall be done according to the age of the existing installations. In a first stage the oldest installations (more than 14 years old, reaching the end of the life-cycle) shall be replaced. In a second stage the remaining installations shall be replaced. In a last stage the renewal of block installations is envisaged.

Tacis

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

The following stages of construction have been calculated for the sequence of works.

Table 6-4: Signalling Construction Works

Stage	Description of work	Work number
1	Modernisation of central train control system Replacement of oldest installations – from XP1 to level crossing 176.9 – from Say-Utes to XP13 – from Shetpe to level crossing 387.8	1.1, 1.2., 1.3. 1.1. 1.2. 1.3.
2	Replacement of remaining signalling boxes – from XP1 to XP9 – from XP11 to XP16	 2.1. 2.2.
3	Renewal of block posts – from level crossing 8.4 to XP10 – from level crossing 230.3 to 398.4	 3.1. 3.2.

Table 6-5: Schedule of Investment for Signalling in USD '000

1st stage of Construction (Because of the old age of the installations, this phase should be carried out on a short-term basis)		
1998:	Start of preliminary work 1.1	7,000
1999:	Completion of 1.1 and preliminary work 1.2	15,250
2000:	Completion of 1.2 and preliminary work 1.3	13,000
2001:	Completion of 1. stage of construction	5,750
		41,000
2nd stage of Construction (Because of the relatively new installations, this phase will follow the 1st stage)		
2002:	Start of preliminary work 2.1	7,000
2003:	Completion of 2.1 and preliminary work 2.2	14,000
2004:	Completion of 2.2	6,000
		27,000
3rd stage of Construction		
2005:	Start of preliminary work 3.1	7,000
2006:	Completion of 3.1 and preliminary work 3.2	13,000
2007:	Completion of 3.2	6,000
		26,000

6.1.3.4 Summary

The next table shows the allocation of investment for the whole project on an annual basis.

Table 6-6: Schedule of Investment in USD '000

Year	Description	Annual Amount	Total Amount
1998	Permanent Way Telecommunication Signalling	16,000 2,060 7,000	
1998	Total		25,060
1999	Permanent Way Telecommunication Signalling	32,000 5,937 15,250	
1999	Total		53,187
2000	Permanent Way Signalling	32,000 13,000	
2000	Total		45,000
2001	Permanent Way Signalling	32,000 5,750	
2001	Total		37,750
2002	Permanent Way Signalling	32,000 7,000	
2002	Total		39,000
2003	Permanent Way Signalling	11,546 14,000	
2003	Total		25,546
2004 2005 2006 2007	Signalling Signalling Signalling Signalling	6,000 7,000 13,000 6,000	6,000 7,000 13,000 6,000
	Grand Total		**257,543**

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

6.2 Operations

6.2.1 Co-ordination and Permission to Operate

The fact that route control in the railway stations and passing loops between Bejneu, (exclusive) and Mangyshlak (inclusive), is by remote central dispatcher in Atyrau, results in reduced time being required for the set-up and cancellation of routes. Moreover, the time needed for the handling of crossings and permission to proceed is reduced.

Therefore, an important increase in node capacity and thus also in the capacity of the whole line will be achieved.

Local operation of the signalling installation is available for shunting operations in the stations and passing loops and as a fallback in the event of a failure of the remote control or parts thereof.

6.2.2 Automatic Train Control

According to the rules observed by western European railway organisations, a system of cab signalling (transmission of the positions of the fixed signals to the drivers' cabs) is only necessary with speeds of more than 160 km/h. However, the existing installation should continue to be used. With this, any subjective feeling of a reduction in operational safety is negated, and the operational regulations continue to be observed.

Thus, data required for the functioning of the existing automatic train control system must continue to be available for transmission to the necessary locations by the new signalling system to the required extent and quality.

6.2.3 Running Speeds, Trailing Loads and Comparison of Capacity

Annex P lists the running speeds that will be possible after the renewal of the track, the maximum trailing load of a locomotive, the number of trains, separated according to direction of traffic, according to the scenario prognoses developed in Chapter 2. A comparison with the existing capacity based on the existing train sequences and the existing passing loops is also included.

The Annex takes the common tandem operation of goods trains as a basis for the comparison of capacities. With this premise, all variants of prognoses and scenarios are possible without enlarging the existing passing loops.

The annex further shows a comparison between existing and future capacities of the line. It can be seen that the expected future traffic volume can in fact be handled without tandem operation.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

6.2.4 Timetable

Journey and trip times

The increase of running speed results in a further increase in line capacity.

The increase of the running speeds of passenger trains reduces the travel time by 3 hours 10 minutes to 5 hours, and for freight trains, the travel time is reduced by 3 hours to 9 hours.

It would theoretically be possible to further increase line capacity by adopting the 'flighting' timetable system, in which trains operate in squadrons or flights in one direction only at close headways, followed by similar operation in the other direction after a suitable interval.

The shorter travel times for passenger trains mean that they can depart at a later time from Mangyshlak in the Bejneu direction and maintain the same arrival times in Bejneu and other railway stations further away. In the reverse direction, trains leaving at the present times will arrive in Mangyshlak earlier. **This could — theoretically — result in savings in passenger rolling stock and locomotives[23] if the trains are turned round quickly and returned to origin. In theory, passenger rolling stock should be capable of 1.5 round trips per day on the Mangyshlak-Bejneu route (i.e. Mangyshlak-Bejneu-Mangyshlak-Beineu every day), compared with the present 0.5 round trips per day.**

In this way, the customer gains more time at the place of destination. However, only an increase in average speed over the remaining network would guarantee further improvements in passenger traffic.

Freight traffic also benefits from the increase in the capacity of the line, in particular by reducing wagon and loco turnaround time.

Reduction of automatic block installations

The proposed reduction in automatic block installations from the current 100 to a future 56 has only a marginal effect on line capacity. The passenger and freight traffic volumes prognosticated for the year 2005, in all variants (1 and 2) and Scenarios A - C can be handled despite the loss of capacity.

For a further reduction of the time for train crossing, an optimum block division (shorter block sections) in advance of railway stations and passing loops has to be observed.

6.3 Support for Procurement and Tendering Processes

In accordance with the Terms of Reference, this section outlines procurement and tendering processes in line with Kazakstan laws and international procedures.

[23] Chapter 3.4.4 describes the effects on loco and rolling stock demand.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

6.3.1 Procurement Process

Procurement methods presented are based on ICB [(24)] procedures to prepare tendering documents.

A list of procurement items eligible for national and/or international financing has been established. This includes data related to:

- the date of the publication of the general procurement notice,
- the time for the preparation of the tendering documents,
- the date and the time for the bank review,
- the date for the tendering documents issued,
- the time needed for the tendering period,
- the time needed for the tender evaluation period,
- the date for the contract award,
- the date for the project implementation.

For each item, the procurement plan must provide:

- estimated costs,
- number of contracts,
- procurement method,
- dates of: tender document preparation, invitation to tender, contract award and contract completion.

6.3.2 Tendering Process

The tendering processes imply a number of general obligations. Most of the formal description of European tendering processes is included in the European Directive analysis ("excluded sectors").

The objectives of the proposed tendering processes are to:

- define the access modalities and criteria for companies to qualify,
- prepare lists of companies to be consulted,
- prepare recommendations regarding sub-contracting activities,
- prepare render documents,
- meet the specific needs of funding organisations and ensure that these specific needs are compatible with Kazakstan rules,
- prepare price estimates,
- define bid evaluation tables and all decision-making documents required for the bid analysis,
- calculate objective price expected,

ICB: International Competitive Bidding

- participate in proposal analysis, evaluation and negotiations,
- assist in the contractual document preparation,
- make sure that the supply and services provided comply with European standards,
- train KTZ staff in construction management (supervision and regulations).

The following table presents an example which could serve as a model for the tender evaluation:

Table 6-7: Tender Evaluation Table

Weight of the criteria			**Criteria**	Results			***Comments***
High	Medium	Low		Good	Average	Poor	
X			Price				
	X		Price estimate detailed analysis				
	X		Proposal presentation				
X			Understanding of the problem				
X			Deadlines				
X			Technical skills				
X			Environmental concerns				
X			Proposed team				
	X		References				
	X		Self quality assurance control				
	X		After-sale service guarantee				
		X	Sub-contracting				
		X	Presentation of options				

6.4 Financing Strategy and Programme

6.4.1 Introduction

This study is financed as part of the TRACECA corridor which was created following the conference in May 1993 as a component of the TACIS interstate programme.

The objectives of this conference were to:

- stimulate co-operation among the participating States in all matters pertaining to the development and improvement of trade within the Region,
- promote the Central Asian - Trans Caucasian - Europe Transport Corridor,
- identify problems and deficiencies in the Region's trade and transport systems,

- define, in terms of contents and timing, a Technical Assistance Programme to be financed by the EU.

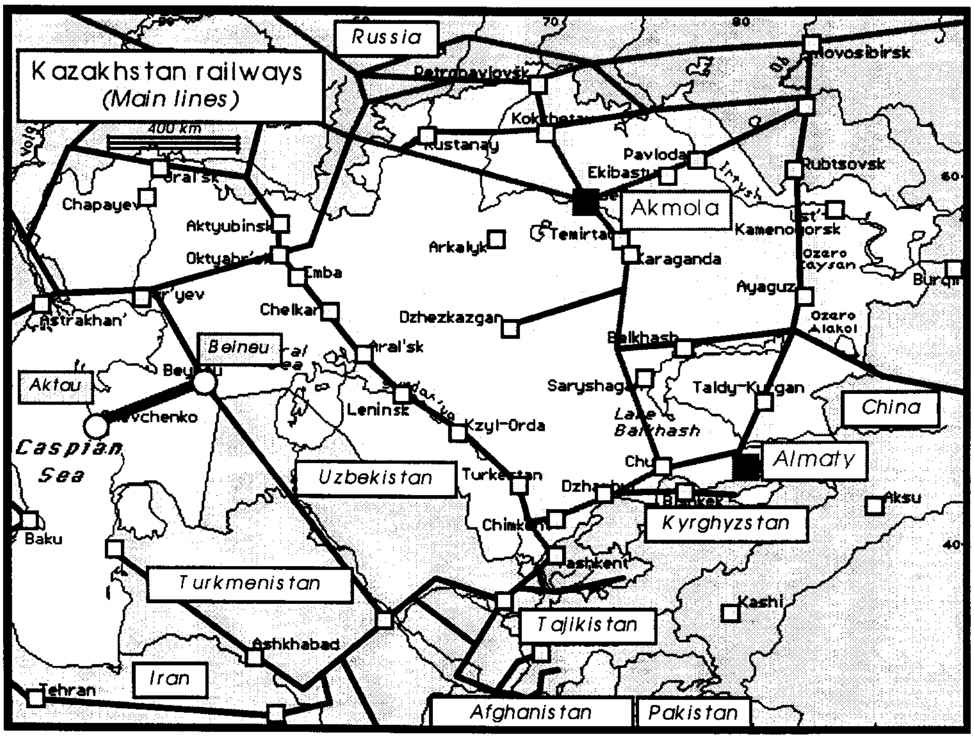
The conference recommended the EU to address in the TACIS Programme variously expressed needs for feasibility studies and technical assistance projects, including those with a transport component.

Transport demand has declined since the break up of the USSR and radical Institutional transformations are taking place in the Region which have particularly affected the rail transport system now re-organised into national entities.

In Kazakstan, 3 railway networks were operated with headquarters in:

- Aktyubinsk (West),
- Akmola (North),
- Almaty (South).

Since February 1997, these have been regrouped in the KTZ, which now operates more than 13,000 km of lines of which 3,300 are electrified (see the following map).



This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

6.4.2 Recapitulation

In considering the question of financing the following key items to be found in other sections of this report should be kept in mind:

- Freight traffic could increase from a present level of 2.0 to between 8.1 and 14.2 million tonnes by the year 2005, depending on the actual level of economic activity.

- At the same time, the demand for passenger traffic is expected to grow from the present two train pairs per day to a future three pairs.

- The expected level of future economic activity in the region clearly has a major impact on the expected level of traffic on the route.

- The majority of plans for investment to secure such future activity are projected by the Government rather than private industrial investors and this aspect must therefore be considered to have a high degree of risk associated with it.

- This is particularly the case for those projected investments which date from the time prior to the break-up of the USSR.

- Infrastructure has a serious backlog of maintenance and investment is required to restore the line to good condition, thereby eliminating temporary speed restrictions which in themselves will lead to an increase in line capacity.

- The signalling system is generally in good condition and functions satisfactorily. However, the poor availability of suitable spare parts is a cause for concern and dictates that replacement by a new system using standard components will be required in the medium term.

- The telecommunication installations are generally in good condition, but suffer from obsolescence, and will need to be replaced by a modernised system in the medium term. This will also affect installations outside the strict confines of the rail route, since there is extensive communication with headquarters in Atyrau and Aktyubinsk.

- The locomotive fleet is obsolescent and, though generally in good condition, a programme to re-engine the units is proposed.

- Passenger rolling stock is generally in good condition but suffers from inadequate maintenance facilities.

- In the case of both locomotives and carriages, there is a shortage of suitable spare parts and tools which needs to be addressed.

- The route is technically capable of accommodating all traffic levels up to and including the most optimistic scenario (19 train pairs per day), without any further investment.

Tacis
This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

However, this statement does not take into account the steady deterioration in the technical condition of the route, particularly its infrastructure, which can be expected to accelerate over the next few years.

- A major obstacle to the smooth train operation is that the first 18 km of route, from Aktau to Mangyshlak, are not owned by the KTZ, but by an industrial organisation known as KASKOR. It is strongly recommended to transfer the Aktau-Mangyshlak section to the KTZ.

- From figures provided by the KTZ for 1995 and part of 1996, it is estimated that the Mangyshlak-Bejneu line presently is running at an operating loss of USD 3.6 million per year on average.

- Based on the assessments of the technical experts, the required investment costs for the technical measures recommended have been estimated at approximately USD 257 million up to the year 2007.

- From the forecast for future traffic on the line, it could in the best case be covering its costs by the year 2000 but the most pessimistic scenario indicates that this level will not be reached until beyond 2006.

6.4.3 Financial Strategy

In addition to the requirements outlined in 6.42 above the following points need to be considered:

- It is the consultant's impression that for the KTZ, the modernisation of the Mangyshlak-Bejneu line does not have a high priority, since the passenger traffic is very low and will not increase in large proportion. On the other hand freight traffic could increase in a significant way.

- The Kazakstan Government does not have funds to finance this project.

A possible alternative for this line would therefore be for KTZ to grant usage rights to those private companies which presently make use of the line in return for investment in its upgrading. The possible partners in such a case would be the oil and gas companies in association with KASKOR, which operates the line between the Port of Aktau and Mangyshlak.

The possible sources of direct financing would presently include the EBRD, which is financing the major part of the reconstruction of the Port of Aktau. The contribution of the EBRD being approximately 72% of the total of USD 54 million, with the remainder being financed by the Kazakstan Government. The consultant considers that the EBRD is very interested in financing railway projects in Kazakstan whereas the World Bank participates more in the road infrastructure projects.

The EBRD is a multinational institution set up with the specific aim of assisting the countries of Eastern Europe and the CIS to develop into market-oriented economies. Its shareholders include countries from this region, plus the EU and the EIB [25]. It also has a Resident Office in Almaty.

For this type of financing, i.e. an infrastructure modernisation project, rates of interest are set a margin (normally 0.5% to 1.0%) over the LIBOR [26] in "hard currencies" (USD for example). Loans can be either variable rate or fixed rate, and may include a variety of hedging instruments depending on whether the derivatives markets are accessed. Grace period for repayment are negotiable with longer maturities up to 15 years being considered. But the EBRD does not usually finance more than 75% of the project when it is governmental and 25% when it is private. Therefore, in the project under consideration the Kazakstan Government would be expected to contribute approximately USD 65 million towards the financing if all the recommendations are to be implemented .

A possible scenario for the Mangyshlak-Bejneu line could be financing by the EBRD for 25%, with the remainder being financed by other Kazak and/or foreign banks. With a current LIBOR of 5.90% [27], the EBRD' annual rate would be 6.90%. For the other banks, the rate would be a little higher: we can take the hypothesis of 7.5% per annum. A grace period of 5 years (modernisation work duration) could be taken into account, following which the duration of repayment would be 10 years.

As previously mentioned, it is very difficult to forecast exactly the revenues and the expenses for the operation of the Mangyshlak-Bejneu line for the next 15 years. The traffic forecasts presented in this report go up to 2005 only and the operating expenses are estimations. Before financing decisions can be made it will be necessary to analyse the financial situation in detail and for a sufficiently long period to make a good simulation (15 years). Likewise for a private operator a complement to the study would be necessary.

It is however quite clear that the passenger train operation will not be profitable in the foreseeable future due to the very low tariffs, therefore for future passenger operations on the line a subsidy from the Kazakstan Government to cover the passenger train operation losses will need to be negotiated.

6.4.4 Priority list for the measures concerning the rehabilitation of the Aktau - Bejneu line

In view of the uncertainties outlined above, the following priority list has been drawn up to assist in creating reasonable financial packages, should it be decided that the total recommended measures concerning the rehabilitation of the line cannot be carried out.

Priority 1: Rehabilitation of the line Aktau - Mangyshlak and introduction of public passenger traffic

EIB: European Investment Bank
LIBOR: London Interbank Offered Rate
Rate for 6 months in June 1997.

description	unit costs in USD			number	total amount in USD 1,000		
	local	foreign	total		local	foreign	total
Aktau-Mangyshlak							
track renewal with concrete sleepers	151,808	161,234	313,042	18 km	2,733	2,902	5,635
complete turnouts	8,623	25,400	34,023	15 pc.	129	381	510
station building	530		530	500 m2	265		265
total					3,127	3,283	6,410

Priority 2: Telecommunication installations

1st year:	50% of the cable costs of	4,120,800.--		2,060,400.--
2nd year:	50% of the cable costs of	4,120,800.--	2,060,400.--	
	100% of other costs of	3,876,500.--	3,876,500.--	
	Total 2nd year		5,936,900.--	5,936,900.--
	Project Sum			7,997,300.--

Priority 3: Supply of track equipment

description	unit costs in USD			number	total amount in USD 1,000		
	local	foreign	total		local	foreign	total
Equipment							
modern tamping machine						2,300	2,300
mechanised mobile gang						2,450	2,450
assembly places						500	500
total						5,250	5,250

Priority 4: Track renewal together with the renewal of pipes and riverbed, enlarging of bridges and construction of new bridges, starting either from Mangyshlak or Bejneu without turnout

description	unit costs in USD			number	total amount in USD 1,000		
	local	foreign	total		local	foreign	total
track							
track renewal with concrete sleepers	151,808	161,234	313,042	230 km	34,916	37,084	72,000
track renewal with wooden sleepers + bolts	88,096	213,858	301,954	60 km	5,286	12,831	18,117
sleeper renewal with concrete sleepers	124,403	51,234	175,637	76 km	9,455	3,894	13,349
sleeper renewal with wooden sleepers + bolts	60,691	103,858	164,549	20 km	1,214	2,077	3,291
total					50,871	55,886	106,757

Priority 5: Renewal of turnouts

description	unit costs in USD			number	total amount in USD 1,000		
	local	foreign	total		local	foreign	total
turnouts							
complete turnouts	8,623	25,400	34,023	100 pc.	862	2,540	3,402
sleepers of turnouts	3,967	6,000	9,967	100 pc.	397	600	997
total					1,259	3,140	4,399

Priority 6: Signalling

A gradual renewal of the installations is recommended whereby the replacement of the installations shall be done according to the age of the existing installations. In a first stage the oldest installations (by far more than 14 years old, reaching the end of the life-cycle) shall be replaced. In a second stage the remaining installations shall be replaced. In a last stage the renewal of block installations is envisaged.

The following costs for the individual stages of construction have to be calculated (average estimated costs in million USD):

1st stage: 41.00
2nd stage: 27.00
3rd stage 26.00

Total project 94.00

Priority 7: Rehabilitation of pipes and bridges

description	unit costs in USD			number	total amount in USD 1,000		
	local	foreign	total		local	foreign	total
pipes and river-bed							
fastening of the river-bed near pipes + bridges	66,500		66,500	37 br.	2,460		2,460
reconstruction of inlet and outlet of pipes	78,500		78,500	52pipes	4,080		4,080
build new pipes	86,600		86,600	85pipes	7,360		7,360
enlarging bridges							
length 20-30 m	170,000		170,000	6bridges	1,020		1,020
length 30-40 m	240,000		240,000	5bridges	1,200		1,200
length 40-60 m	340,000		340,000	2bridges	680		680
length 71m	510,000		510,000	2bridges	1,020		1,020
length 90-95 m	670,000		670,000	4bridges	2,680		2,680
constructing new bridges							
length 20-30 m	290,000		290,000	19bridges	5,510		5,510
length 30-40 m	430,000		430,000	1bridge	430		430
length 40-60 m	560,000		560,000	9bridges	5,040		5,040
length 101 m				1bridge	1,250		1,250
total					32,730		32,730

This project is financed by the European Union's Tacis Programme, which provides grant finance for know-how to foster the development of market economies and democratic societies in the New Independent States and Mongolia

Annex A

Annex A: Currencies Used in Cost Calculations:

1 ECU	=	13.23 ATS	as of 29.8.96
1 USD	=	10.396 ATS	as of 29.8.96
1 USD	=	68.5 KZT	in September 96

Annex B

Annex B: Construction and Format of Bridges and Pipe Culverts

km	Length	Parts	Material
39.9	90 m	5x18	concrete
53.2	9 m	2x4.5	concrete
81.3	10 m	2x5	concrete
88.3	15 m	3x5	concrete
119.4	15 m	3x5	concrete
179.4	42 m	7x6	concrete
194.4	32 m	4x6	concrete
195.2	19 m		concrete
196.7	38 m	2x19	concrete
198.9	18 m	3x6	concrete
205.0	10 m	2x5	concrete
209.7	18 m	3x6	concrete
213.2	10 m	2x5	concrete
213.8	25 m	5x5	concrete
220.6	10 m	2x5	concrete
221.0	15 m	3x5	concrete
222.6	15 m	3x5	concrete
223.2	10 m	2x5	concrete
229.4	17 m	5+2x6	concrete
231.8	15 m	3x5	concrete
236.8	15 m	3x5	concrete
238.6	20 m	4x5	concrete
247.3	25 m	5x5	concrete
263.6	18 m	3x6	concrete
263.8	15 m	3x5	concrete
270.0	54 m	3x18	concrete
272.3	27 m	3x5+3x4	concrete
277.5	18 m	3x6	concrete
278.2	18 m	3x6	concrete
279.4	30 m	5x6	concrete
283.4	12 m	2x6	concrete
286.9	18 m	3x6	concrete
290.0	24 m	4x6	concrete
290.6	18 m	3x6	concrete
291.1	40 m		concrete
298.4	33 m	3x5+3x6	concrete
300.4	15 m	3x5	concrete
306.4	10 m	2x5	concrete
307.2	15 m	3x5	concrete
307.9	22 m	2x5+2x6	concrete
317.3	14 m		concrete
319.8	14 m		concrete
324.3	25 m	5x5	concrete
325.8	5 m		concrete

km	Length	Parts	Material
328.2	10 m	2x5	concrete
331.6	15 m	3x5	concrete
337.5	24 m	4x6	concrete
338.9	36 m	6x6	concrete
339.5	100 m	88+2x6	steel
343.4	61 m		concrete
347.6	14 m		concrete
350.6	18 m	3x6	concrete
350.7	12 m	2x6	concrete
352.8	18 m	3x6	concrete
354.4	15 m		concrete
359.7	66 m		concrete
366.4	10 m	2x5	concrete
370.9	36 m	2x18	concrete
375.9	10 m		concrete
377.5	10 m	2x5	concrete
379.2	10 m	2x5	concrete

Annex C

Annex C: Existing Speeds and Permitted Loads

Existing Condition								
station	distance		speed		load hauled		possible number of trains (capacity)	
	km	km	P	F	B→M	M→B	B→ M	M→B
Bejneu		11.2	60	60	3200	3500	18.9	20.8
XP 1		11.5		50				
XP 2 G		17.1	40	40				
Ustyurt		44.9	50					
Say-Utes	178.0	93.3			3200	3500	13.1	20.8
XP 9		41.1	60	60				
Km 214			50	40				
Km 223			40					
XP 10 G		16.8	60	60				
Km 258			50	40				
Km 279			40					
XP 12		39.5	60	60				
Km 288								
Km 299		1.5	50	40				
XP 13		13.5	60	60				
Km 310		5.0	50	40				
Shetpe	134.4	17.0	60	60			15.6	12.5
Km 335		24.1	40	40				
XP 15		35.2	60	60				
Mangyshlak	90.8	31.5			3200	2200	15.6	14.8
	403.2	403.2						
(Mangyshlak-Aktau)	19.0							
Section: Mangyshlak-Uzen								
Mangyshlak								
Shetibay		114.0			3200	3000	7.4	7.0
Uzen		65.0			3200	3000	7.4	7.0
		179.0						

Legend: P = passenger trains, F = freight trains
B = Bejneu, M = Mangyshlak

Annex D

Annex D: Telecommunications Reconstruction Project (Unrealised)

N.B.: the following text is available from ARE and DE-Consult as a copy of the original in Russian!

The track section Bejneu - Mangyshlak is equipped with telephone systems for the telephone long distance traffic of the railway, the district telephone traffic of the railway, the local telephone traffic as well as the radio traffic.

This track section has a main overhead line with multiplexing using the systems V-12-3 and V-3-3.

During the planned reconstruction of the railway stations Bejneu, Say-Utes and Shetpe it is planned to maintain during the first construction phase the existing types of telephone traffic and to equip the stations additionally with telephone connections, two-way intercom systems between sets of tracks, radio communication with trains as well as with fire-alarm systems and security installations.

In the planned signal box buildings in the railway stations Say-Utes and Shetpe, the following installations will be installed:

- switchboards for the operational telephone system "KTS"
- railway station radio installations for radio communication with trains, of the type "Transport RS-2"
- sets for two-way intercom systems between sets of tracks, type "SDPS-M"
- panel for the fire-alarm systems and security installation, type "PPS-3"
- power supply source

It is planned to equip the planned buildings in the railway stations Bejneu and Mangyshlak with a telephone system, clocks as well as fire-alarm systems being based on the existing installations.

Second construction phase

As regards upgrading of the railway station Mangyshlak, it is planned to switch the existing telecommunications systems to the new signal-box and to equip the stations additionally with telephone connections, two-way intercom systems between sets of tracks, radio communication with trains, fire-alarm systems and security installations as well as clocks.

In the planned signal-box, the following telecommunications installations are planned: switchboards for the operational telephone system "KTS", fixed radio installation for radio communication with trains and radio used for directing shunting operations, of the type "Transport RS-2", installation for two-way intercom systems between sets of tracks, type "SDPS-M", panels for the fire-alarm system and security installation, type "PPS-3" and electrical primary clock and power supply sources.

The project includes also the replacement of the existing automatic PABX UATS-49 having 700 call units by the automatic exchange "ATS KE Quant" having 2048 call units. The reason for the replacement of the existing exchange by the new one is that the capacity of the existing exchange makes it impossible to connect additional extensions, and it is technically obsolete and physically worn out, and there are no spare parts available.

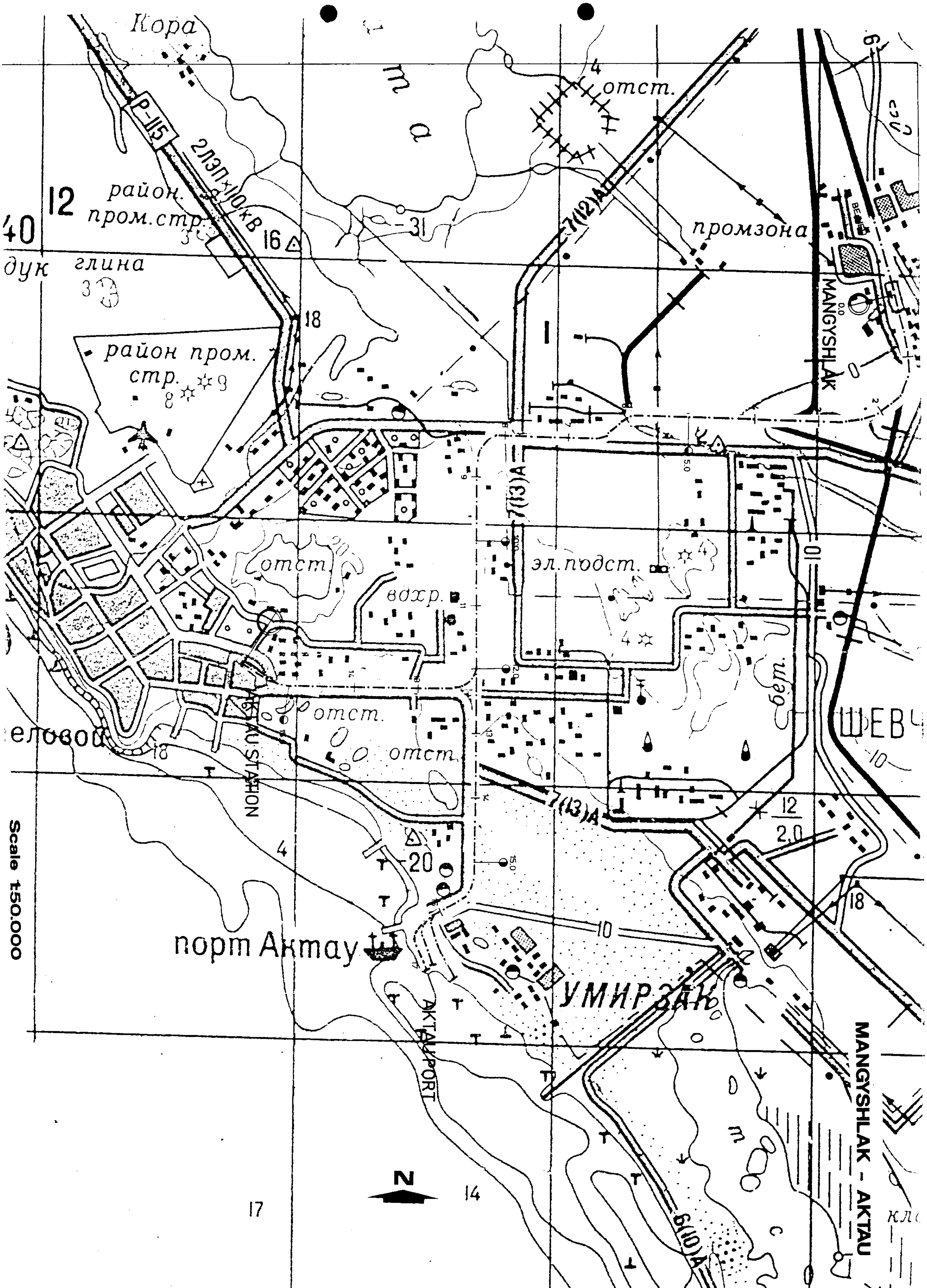
Moreover, it is planned to install a professional television set of the type "PTU-75-I" at Mangyshlak station. This will support the following tasks:

- control of work in the sets of tracks of the railway station,
- check of the rear of incoming train,
- track release supervision for incoming trains,
- checking the setting up of routes,
- observation of the railway station area,
- checking if the employment protection regulations are observed regarding staff members working in danger zones.

For all passing points where track reconstruction is planned, it is planned to keep the existing communication devices and add new telephone networks.

Annex E

Annex E: ***Plan of Aktau Area, 1:50,000 scale***



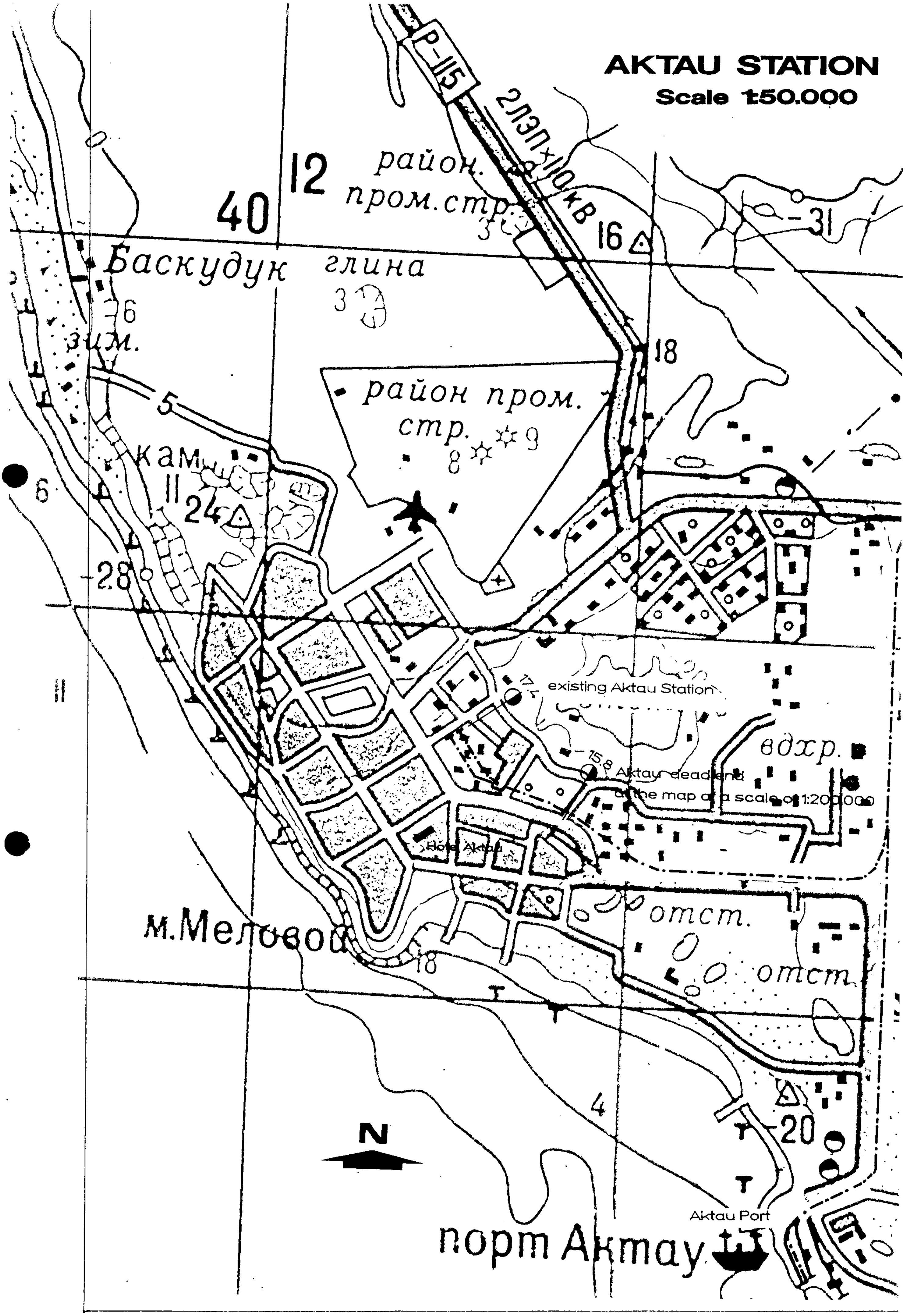
Кора
Р-115
2ЛЭП×110кВ
район. пром.стр.
12
40
глина
район пром. стр.
отст.
промзона
MANGYSHLAK
7(12)А
7(13)А
эл.подст.
вдхр.
бет.
ШЕВЧ
AKTAU STATION
порт Актау
AKTAU PORT
УМИРЗАК
MANGYSHLAK - AKTAU
6(10)А
N
Scale 1:50.000

Annex F

Annex F: Detailed Plan of Aktau Centre, approximately 1:50,000 scale

AKTAU STATION

Scale 1:50.000



Annex G

Annex G: Detailed Breakdown of Investment Required (Civil Engineering)

description	unit costs in USD			number and unit	total amount in USD '000		
	local	foreign	total		local	foreign	total
track							
track renewal with concrete sleepers	151,808	161,234	313,042	230 km	34,916	37,084	72,000
track renewal with wooden sleepers + bolts	88,096	213,858	301,954	60 km	5,286	12,831	18,117
sleeper renewal with concrete sleepers	124,403	51,234	175,637	76 km	9,455	3,894	13,349
sleeper renewal with wooden sleepers + bolts	60,691	103,858	164,549	20 km	1,214	2,077	3,291
complete turnouts	8,623	25,400	34,023	100 pc.	862	2,540	3,402
sleepers of turnouts	3,967	6,000	9,967	100 pc.	397	600	997
pipes and river-bed							
fastening of the river-bed near pipes + bridges	66,500		66,500	37 br.	2,460		2,460
reconstruction of inlet and outlet of pipes	78,500		78,500	52 pipes	4,080		4,080
build new pipes	86,600		86,600	85 pipes	7,360		7,360
enlarging bridges							
length 20-30 m	170,000		170,000	6 bridge	1,020		1,020
length 30-40 m	240,000		240,000	5 bridge	1,200		1,200
length 40-60 m	340,000		340,000	2 bridge	680		680
length 71m	510,000		510,000	2 bridge	1,020		1,020
length 90-95 m	670,000		670,000	4 bridge	2,680		2,680
construction of new bridges							
length 20-30 m	290,000		290,000	19 bridge	5,510		5,510
length 30-40 m	430,000		430,000	1 bridge	430		430
length 40-60 m	560,000		560,000	9 bridge	5,040		5,040
length 101 m				1 bridge	1,250		1,250
Aktau-Mangyshlak							
track renewal with concrete sleepers	151,808	161,234	313,042	18 km	2,733	2,902	5,635
complete turnouts	8,623	25,400	34,023	15 pc.	129	381	510
station building	530		530	500 m2	265		265
Equipment							
modern tamping machine						2,300	2,300
mechanised mobile gang						2,450	2,450
assembly places						500	500
total					**87,987**	**67,559**	**155,546**

Annex H

Annex H: Detailed Breakdown of Resignalling Scheme Implementation Stages

All costs are in USD millions

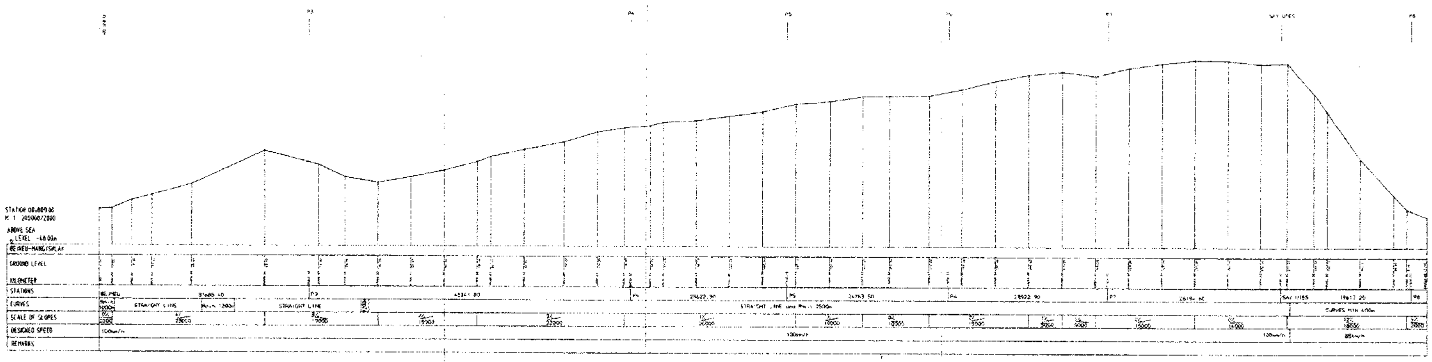
Location		**items**		**total cost**
Construction Stage 1:				
Item 1.1 comprises: Central train control system: basic equipment, basic costs: work place, technical equipment: additional costs per	 double-track station	 2 stations	 0.15	 0.40 0.10 0.30
	three-track station	4 stations	0.20	0.80
	single track station			0.25
XP 1:		4 tracks	remote control	0.50
level crossing	31.0			0.30
XP 2:		2 tracks	intermediate signalbox inc. remote control	3.00
XP 3:		3 tracks	remote control	0.50
Ustyurt:		3 tracks	intermediate signalbox inc. remote control	3.30
level crossing	80.7			0.30
XP 5:		3 tracks	remote control	0.50
XP 6:		2 tracks	intermediate signalbox inc. remote control	3.00
level crossing	128.5			0.30
XP 7:		3 tracks	remote control	0.50
level crossing	176.9			0.30
				14.35
Contingency				0.15
(distribution for year 1998: 7.0, year 1999: 7.5)				**14.50**
:Item 1.2 comprises Central train control system additional costs per	 double-track station	 2 stations	 0.15	 0.30
	three-rail station	3 stations	0.20	0.60
	four-rail station			0.25
Say-Utes:		4 tracks	intermediate signalbox inc. remote control	3.50
XP 8:		2 tracks	intermediate signalbox inc. remote control	3.00
XP 9:		3 tracks	remote control	0.50
XP 10:		2 tracks	intermediate signalbox inc. remote control	3.00
level crossing	251.7			0.30
XP 11:		3 tracks	remote control	0.50
XP 12		2 tracks	intermediate signalbox inc. remote control	3.00

Location	items		total cost
Construction Stage 1:			
level crossing 279.1			0.30
XP 13:	3 tracks	remote control	0.50
(distribution for year 1999: 7.75, year 2000: 8.0)			**15.75**
Item 1.3 comprises Central train control system additional costs per double-track station			0.15
three-rail station	2 stations		0.40
eight-rail station			0.40
Shetpe:	8 tracks	intermediate signalbox inc. remote control	4.50
level crossing 313.6			0.70
XP 14:	3 tracks	remote control	0.50
XP 15	2 tracks	intermediate signalbox inc. remote control	3.00
level crossing 362.4			0.30
XP 16:	3 tracks	remote control	0.50
level crossing 387.8			0.30
(distribution for year 2000: 5.0, year 2001: 5.75)			**10.75**
Total for the period 1998 to 2001			**41.00**
2nd stage of construction			
Item 2.1 comprises: Central train control system no costs			
XP 1:	4 tracks	only signal box	3.1
level crossing 16.0			0.3
XP 3:	3 tracks	only signal box	2.9
XP 5:	3 tracks	only signal box	2.9
XP 7:	3 tracks	only signal box	2.9
XP 9:	3 tracks	only signal box	2.9
(distribution for year 2002: 7.0, year 2003: 8.0)			**15.0**
Item 2.2 comprises: Central train control system no costs			
XP 11:	3 tracks	only signal box	2.9
XP 13:	3 tracks	only signal box	2.9
XP 14:	3 tracks	only signal box	2.9
level crossing 376.1			0.3
XP 16:	3 tracks	only signal box	2.9
Contingency			0.1
(distribution for year 2003: 6.0, year 2004: 6.0)			**12.0**
Total for the period 2002 to 2004			**27.0**
3rd stage of construction			
Item 3.1 comprises: Central train control system no costs			
level crossing 8.4			0.3
Bejneu - XP 1:	2 ABP	1 ABP 0.4	0.8
level crossing 16.0			0.3
XP 1 - XP 2:	2 ABP	1 ABP 0.4	0.8

Location	items		total cost
Construction Stage 1:			
level crossing 40.8			0.3
XP 2 - XP 3:	3 ABP	1 ABP 0.4	0.8
level crossing 66.0			0.3
XP 3 - Ustyurt:	3 ABP	1 ABP 0.4	1.2
Ustyurt - XP 5:	3 ABP	1 ABP 0.4	1.2
XP 5 - XP 6:	3 ABP	1 ABP 0.4	1.2
XP 6 - XP 7:	3 ABP	1 ABP 0.4	1.2
level crossing 163.5			0.3
XP 7 - Say-U:	4 ABP	1 ABP 0.4	1.6
Say-U - XP 8:	3 ABP	1 ABP 0.4	1.2
XP 8 - XP 9:	1 ABP	1 ABP 0.4	0.4
XP 9 - XP 10:	5 ABP	1 ABP 0.4	2.0
Contingency			0.1
(distribution for year 2005: 7.0, year 2006: 7.0)			**14.0**
Item 3.2 comprises: Central train control system no costs			
level crossing 230.3			0.3
XP 10 - XP 11:	2 ABP	1 ABP 0.4	0.8
XP 11 - XP 12:	3 ABP	1 ABP 0.4	1.2
XP 12 - XP 13:	3 ABP	1 ABP 0.4	1.2
level crossing 304.2			0.3
XP 13 - Shetpe:	3 ABP	1 ABP 0.4	1.2
Shetpe - XP 14:	2 ABP	1 ABP 0.4	0.8
level crossing 323.8			0.3
level crossing 336.2			0.3
XP 14 - XP 15:	3 ABP	1 ABP 0.4	1.2
level crossing 362.4			0.3
level crossing 367.2			0.3
XP 15 - XP 16:	4 ABP	1 ABP 0.4	1.6
level crossing 387.8			0.3
XP 16 - Mang.:	4 ABP	1 ABP 0.4	1.6
level crossing 398.4			0.3
(distribution for year 2006: 6.0, year 2007: 6.0)			**12.0**
Total for the period 2005 to 2007			**26.0**

Annex I

Annex I: Length profile Scale 1:200,000/2,000 from km 0+0 to 403+3



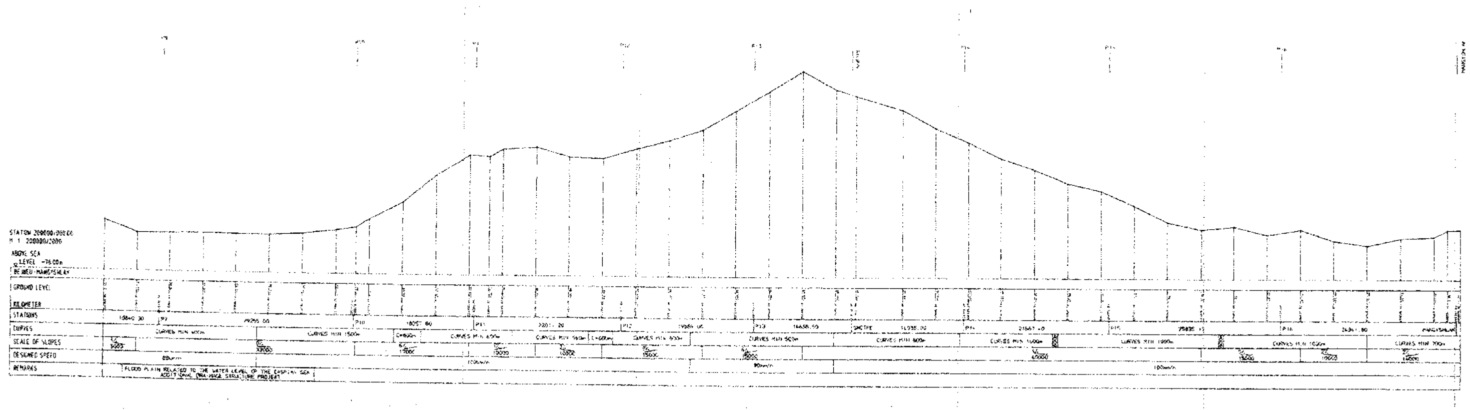
TRACECA PROJECT MODUL A

BEJNEU – MANGYSHLAK

LENGTH PROFILE

SCALE 1 : 200000/2000

KM 0+0 – 200+0



TRACECA PROJECT MODUL A

BEJNEU – MANGYSHLAK

LENGTH PROFILE

SCALE 1 : 200000/2000

KM 200+0 – 404+0

Annex J

Annex J: ***Technical description of the Alignment Bejneu - Mangyshlak***

km point	Station	Rail length (metres)	Radius (metres)	Left Curve	Right Curve
0+0	Bejneu				
1+469.53		1469.53			
2+404.27		934.74	1000		48 °24'
15+565.75		13161.48			
15+995.18		429.43	2000	10 °35'	
17+150.50		1155.32			
17+432.34		381.84	1200	15 °22'	
19+294.44		1862.10			
20+547.07		1252.63	1200		56 °28'
31+685.40	P3gn2	31685.40			
39+465.11		18918.04			
39+855.57		390.46	1200	16 °44'	
40+007.84		152.27			
40+661.83		653.99	1200		27 °53'
50+461.04		9799.21			
50+676.16		215.12	3500	2 °52'	
64+209.79		13533.63			
64+334.65		124.86	3500		1° 38'
80+026.40	P4	48341.00			
103+648.50	P5	23622.40			
119+445.42		55110.77			
119+692.31		246.89	2500		4° 17'
127+912.00	P6	24263.50			
151+834.90	P7	23922.90			
178+029.50	Say Utes	26194.60			
179+374.36		59682.05			
180+052.05		627.39	495		66 °52'
180+071.88		19.83			
181+151.36		1079.48	498	112° 07'	
181+164.14		12.78			
181+595.58		451.44	405		51° 08'
181+630.80		35.22			
182+086.05		455.25	402	53°29'	
182+093.01		6.96			
182+427.22		334.21	400		35°42'
182+490.22		63.00			
182+735.25		245.03	920	10°54'	
182+899.21		163.96			
183+552.48		653.27	1500		21°08'
183+602.00		49.82			
183+920.16		318.16	770	16°14'	
184+167.72		247.56			
184+493.21		325.49	500		29°51'
184+533.26		40.05			
184+805.96		272.70	478	21°54'	
184+825.97		20.01			
185+025.14		199.17	800		10°41'
185+248.60		223.46			
185+637.74		389.14	398		35°53'
186+002.84		365.10			
186+366.76		363.92	800		21°03'
186+578.58		211.82			

km point	Station	Rail length (metres)	Radius (metres)	Left Curve	Right Curve
186+772.52		193.94	1960	4°30'	
187+123.71		351.19			
188+156.19		1032.48	1000	54°00'	
188+240.03		83.84			
188+530.30		290.27	600	22°28'	
188+561.24		30.94			
188+890.36		329.12	400		37°07'
188+973.06		82.70			
189+304.78		331.72	400		44°39'
189+481.23		176.45			
189+843.99		362.76	400	44°48'	
189+887.59		43.60			
190+453.38		565.79	400		71°01'
190+866.87		413.49			
191+430.91		564.04	600	45°16'	
191+753.41		322.50			
192+190.36		434.95	485		36°37'
192+192.72		2.36			
192+709.41		516.69	497	49°46'	
192+741.57		32.16			
192+950.05		208.48	800		12°04'
193+491.50		541.50			
193+849.56		358.06	1960	8°34'	
194+043.65		194.09			
194+357.48		313.83	1870		8°05'
194+833.44		475.96			
195+136.99		303.55	1000		15°06'
195+550.29		413.30			
196+070.70		520.41	1000		25°14'
196+102.54		31.84			
196+575.07		472.53	600	37°29'	
196+794.10		219.03			
197+094.38		300.28	600		23°54'
197+646.70	P8	19617.20			
198+661.71		1567.33			
198+801.77		140.06	800		5°44'
198+819.43		17.66			
199+052.81		233.38	580	14°10'	
199+080.98		28.17			
199+336.91		255.93	980	9°07'	
201+178.56		1841.65			
201+817.85		639.29	1500	20°36'	
205+352.70		3534.85			
205+865.11		512.41	800	33°50'	
208+487.00	P9	10840.30			
208+702.15		2837.04			
208+958.44		256.29	2300	7°01'	
209+736.56		778.12			
210+240.87		504.31	1510		16°06'
210+376.26		135.39			
210+670.81		294.55	600	19°32'	
210+796.16		125.35			
211+138.76		342.60	600	23°10'	
211+260.19		121.43			
211+665.05		404.86	1000		17°28'

km point	Station	Rail length (metres)	Radius (metres)	Left Curve	Right Curve
212+092.62		427.57			
212+592.80		500.18	2000		13°11’
212+730.68		137.88			
213+179.66		448.98	2000		11°43’
214+917.93		1738.27			
215+450.47		532.54	1380		15°28’
215+499.80		49.33			
216+857.51		1357.71	598	120°28’	
216+899.73		45.22			
217+577.68		677.95	455		75°18’
219+061.95		1484.27			
219+300.29		248.34	815	15°21’	
219+593.69		293.40	795	13°59’	
220+361.61		767.92			
221+292.29		930.68	800		60°34’
221+741.26		448.97			
222+092.62		351.36	800	20°52’	
222+236.27		143.65			
222+679.60		443.33	455	46°23’	
222+752.43		72.83			
223+256.96		504.53	498		48°16’
223+789.25		532.29			
224+317.92		528.67	1510		17°41’
225+126.53		808.61			
225+670.34		543.81	1510		19°07’
226+477.74		807.40			
226+949.86		472.12	2000		11°14’
232+017.83		5067.97			
232+545.37		527.54	1950		13°09’
237+742.00	P10	29255.00			
237+950.81		5405.44			
238+236.22		285.41	3000	3°21’	
243+265.47		5029.25			
243+838.54		573.01	800		33°10’
247+382.03		3543.49			
247+923.97		541.94	800	35°14’	
250+916.66		2992.69			
251+632.66		716.00	995		38°21’
251+851.05		218.39			
252+646.52		795.47	1000	41°34’	
253+123.14		476.62			
254+134.66		1011.52	995		51°03’
255+799.80	P11	18057.80			
256+586.96		2452.30			
257+465.16		878.20	596	76°44’	
257+532.73		67.57			
258+173.51		640.78	600		49°44’
258+946.02		772.51			
260+176.90		1230.88	1200		56°23’
260+801.87		624.97			
261+469.21		667.34	600	55°08’	
261+786.03		316.82			
262+385.05		599.02	990	26°34’	
265+328.61		2943.56			
266+011.98		683.37	2000		16°17’

km point	Station	Rail length (metres)	Radius (metres)	Left Curve	Right Curve
268+263.08		2251.10			
268+633.83		370.75	1000		14°22'
269+252.17		618.34			
269+647.11		394.94	960	18°12'	
272+448.14		2801.03			
272+776.31		328.17	1200	11°51'	
273+006.29		229.98			
273+420.01		413.72	608	31°27'	
273+535.76		115.75			
274+141.16		605.40	600		49°13'
275+403.73		1262.57			
275+795.67		391.94	790		23°21'
275+894.26		98.59			
276+353.46		459.20	600	37°10'	
277+811.00	P12	22011.20			
280+139.79		3786.33			
280+595.01		455.22	1500		14°20'
282+662.54		2067.53			
282+976.14		313.60	1000	13°23'	
285+386.18		2410.04			
285+750.31		364.13	1000		15°08'
286+089.62		339.31			
286+530.68		441.06	1000	17°15'	
286+578.60		47.92			
286+856.84		278.24	850		16°15'
286+878.83		21.99			
287+206.89		328.06	800		16°20'
288+211.05		1004.16			
288+668.70		457.65	600	33°12'	
289+067.48		398.78			
289+473.75		406.27	584	31°02'	
290+715.01		1241.26			
291+094.06		379.05	645		26°34'
291+741.67		647.61			
292+399.43		657.76	502	69°22'	
292+416.28		16.85			
292+679.41		263.13	520		23°29'
292+706.93		27.52			
293+061.91		354.98	500	32°05'	
293+144.72		82.81			
293+415.77		271.05	500		19°02'
293+536.32		120.55			
294+068.57		532.25	500		52°24'
294+311.15		242.58			
295+252.19		941.04	800	63°06'	
295+711.59		459.40			
296+916.06		1204.47	1200		54°53'
297+586.84		670.78			
297+700.00	P13	19889.00			
298+095.79		508.95	1000	25°09'	
299+811.42		1715.63			
300+147.90		336.48	1200	13°12'	
300+776.41		628.51			
301+735.54		959.13	500	101°19'	
301+742.89		7.35			

km point	Station	Rail length (metres)	Radius (metres)	Left Curve	Right Curve
302+588.94		846.05	501		92°11’
302+624.46		35.52			
303+110.08		485.62	500	51°04’	
303+134.04		23.96			
304+089.96		955.92	500		99°48’
304+375.29		285.33			
304+858.39		483.10	500		48°29’
305+034.13		175.74			
305+658.20		624.07	500	65°47’	
306+236.62		578.42			
306+565.86		329.24	1200		11°54’
307+373.97		808.11			
307+869.53		495.56	600	41°07’	
308+415.82		546.29			
309+314.08		898.26	500		94°55’
309+333.03		18.95			
309+729.34		396.31	500	36°15’	
309+907.42		178.08			
310+392.99		485.57	950		18°44’
310+834.69		441.70			
311+360.74		526.05	800	29°05’	
312+338.50	Shetpe	14638.50			
314+333.10		2972.36			
314+815.45		482.35	1200		18°44’
315+373.45		558.00			
316+019.86		646.41	800	39°51’	
316+644.53		624.67			
317+066.84		422.31	1000	18°28’	
317+384.15		317.31			
317+952.05		567.90	1500		19°24’
320+755.00		2802.95			
321+504.56		749.56	1000		37°13’
321+691.52		186.96			
322+362.84		671.32	1500	23°21’	
324+557.25		2194.41			
324+889.25		332.00	800	17°20’	
325+655.29		766.04			
325+962.57		307.28	2000		7°05’
328+437.32		2474.75			
328+723.07		285.75	800		16°10’
329+323.50	P14	16985.00			
330+024.82		1301.75			
330+331.22		306.40	1000		14°07’
330+895.31		564.09			
331+322.53		427.22	1000	20°28’	
331+707.05		384.52			
331+959.61		252.56	1200		10°09’
334+902.58		2942.97			
335+518.87		616.29	1500	20°52’	
337+951.58		2432.71			
338+089.19		137.61	2000	3°05’	
338+106.81		17.62			
338+196.97		90.16	1100		3°08’
339+050.53		853.56			
339+246.43		195.90	4000		2°14’

km point	Station	Rail length (metres)	Radius (metres)	Left Curve	Right Curve
339+263.45		17.02			
339+396.53		133.08	2500	2°08'	
341+793.31		2396.78			
342+217.62		424.31	2000		10°09'
342+759.17		541.55			
343+386.05		626.88	800	39°53'	
343+472.11		86.06			
344+290.23		818.12	815		54°00'
351+190.90	P15	21867.40			
355+475.14		11184.91			
356+473.51		998.37	1195	44°02'	
356+721.43		247.92			
357+498.26		776.83	1200		31°36'
367+001.02		9502.76			
367+582.78		581.76	1000		28°45'
367+737.57		154.79			
368+352.36		614.79	800	39°01'	
371+256.34		2903.98			
371+831.42		575.08	1000	28°22'	
377+026.00	P16	25835.10			
377+637.69		5806.27			
377+977.73		340.04	3000		4°58'
380+216.33		2238.60			
380+991.23		774.90	2000		20°46'
385+529.71		4538.48			
386+105.78		576.07	1980		14°56'
389+659.98		3554.20			
390+263.72		603.74	700		42°03'
391+101.75		838.03			
392+039.94		938.19	798	62°20'	
398+955.73		6915.79			
399+798.07		842.34	700	62°24'	
403+367.80	Mangyshlak	26341.80			
404+400.00		4601.93			

0+0		Mangyshlak	
18+0	approximately	Aktau Centre	no maps available
0+0		Mangyshlak	
16+0	approximately	Aktau Port	no maps available

Annex K

Annex K: Calculation of Speed Limits

Calculation of the superelevation :

Superelevation = H
Speed (km/h) = V
Radius of curve = R

H = 11.8 x V x V : R - 70mm
H max = 130mm

Radius	V max.	Hmax.=130mm
400m	80 km/h	
500m	90 km/h	
600m	100 km/h	
700m	110 km/h	
800m	115 km/h	
900m	125 km/h	
1000m	130 km/h	

Analysis of the existing line Bejneu to Mangyshlak
Designed speed for passenger trains 100 km/h and for freight trains 80 km/h

km. point	**minimum radius**	**v max (km/h)**	**designed v =100km/h**	**100km/h and more (km)**	**reduced speed (km)**
0+0					
179+4	800		100	179.4	
192+7	400	80			13.3
196+1	800		100	3.4	
199+0	600	100			2.9
210+4	800		100	11.4	
211+2	600	100			0.8
215+5	800		100	4.3	
217+6	450	85			2.1
222+2	800		100	4.6	
223+3	450	85			1.1
256+6	800		100	33.3	
261+5	600	100			4.9
273+0	800		100	11.5	
276+3	600	100			3.3
286+6	1000		100	9.3	
288+2	800		100	2.6	
294+1	500	90			5.9
300+7	800		100	6.6	
309+7	500	90			9.0
328+7	800	100		19.0	
342+7	1000		100	14.0	
343+5	800	100		0.8	
367+7	1000		100	24.2	
368+4	800	100		0.7	
389+7	1000		100	21.3	
404+4	700	100		14.7	

km. point	minimum radius	v max (km/h)	designed v =100km/h	100km/h and more (km)	reduced speed (km)
404.4 km total length Bejneu-Mangyshlak				361.1	43.3

After finishing the reconstruction works on the whole of the line. including rehabilitation of the existing stations, the following speed limits are possible:

Bejneu	km	0+0	to	179+4	100 km/h	179.4 km
		179+4		223+3	85 km/h	43.9 km
		223+3		288+2	100 km/h	64.9 km
		288+2		309+7	90 km/h	21.5 km
		309+7		404+4	100 km/h	94.7 km

Total length with full speed 100km/h 339.0km = 83.9%
Total length with reduced speed 65.4km = 16.1%

The theoretical travelling time without stops is calculated at 4.15 hours.

Annex L

Annex L: Comparison between line capacity (existing and new) and the number of trains in the demand prognosis for 2005

Direction: Bejneu - Mangyshlak																	
existing situation		after modernisation		prognosis 2005													
				variant 1							variant 2						
stations	capacity	capacity	speed	tonnes	number of passenger and freight trains						tonnes	number of passenger and freight trains					
					Scenario							Scenario					
					A		B		C			A		B		C	
			km/h		L	H	L	H	L	H		L	H	L	H	L	H
Bejneu	18.9	28.6	100	3200	12	14	13	15	17	18	3600	12	13	13	14	15	16
XP 1																	
XP 2																	
Ustyurt																	
Say - Utes	13.1	19.6	85	3200	12	14	13	15	17	18	3600	12	13	13	14	15	16
XP 9																	
Km 214																	
Km 223			100														
XP 10																	
Km 258																	
Km 179																	
XP 12																	
Km 288			90														
Km 299																	
XP 13																	
Km 310			100														
Shetpe	15.6	23.9			12	14	13	15	17	18		12	13	13	14	15	16
Km 335																	
XP 15																	
Mangyshlak	15.6	23.9			12	14	13	15	17	18	3600	12	13	13	14	15	16

Legend: L = low, H = high

Direction: Mangyshlak - Bejneu																	
existing situation		after modernisation		prognosis 2005													
				variant 1							variant 2						
stations	capa-city	capa-city	speed	tonnes	number of passenger and freight trains						tonnes	number of passenger and freight trains					
					Scenario							Scenario					
					A		B		C			A		B		C	
			km/h		L	H	L	H	L	H		L	H	L	H	L	H
Mangyshlak	14.8	23.6	100	2200	12	14	16	18	18	19	3600	10	11	13	14	14	15
XP 15																	
Km 335																	
Shetpe	12.5	19.7			12	14	16	18	18	19	3600	10	11	13	14	14	15
Km 310			90														
XP 13																	
Km 299																	
Km 288			100														
XP 12																	
Km 226																	
Km 258																	
XP 10																	
Km 223			85														
Km 214																	
XP 9																	
Say - Utes	20.8	29.0	100	3500	12	14	16	18	18	19		10	11	13	14	14	15
Ustyurt																	
XP 2																	
XP 1																	
Bejneu	20.8	29.0	100	3500	12	14	16	18	18	19	3600	11	11	13	14	14	15

Annex M

Annex M: **_Comparison between line capacity (existing and new) and the number of trains in the demand prognosis for 2005 assuming tandem train operation_**

Direction: Bejneu - Mangyshlak																	
existing situation		after modernisation		prognosis 2005													
				variant 1							variant 2						
stations	capa-city	capa-city	speed	tonnes	number of passenger and freight trains						tonnes	number of passenger and freight trains					
					Scenario							Scenario					
					A		B		C			A		B		C	
			km/h		L	H	L	H	L	H		L	H	L	H	L	H
Bejneu	18.9	28.6	100	3200	6	7	7	8	9	9	3600	6	7	7	7	8	8
XP 1																	
XP 2																	
Ustyurt																	
Say - Utes	13.1	19.6	85	3200	6	7	7	8	9	9	3600	6	7	7	7	8	8
XP 9																	
Km 214																	
Km 223			100														
XP 10																	
Km 258																	
Km 179																	
XP 12																	
Km 288			90														
Km 299																	
XP 13																	
Km 310			100														
Shetpe	15.6	23.9			6	7	7	8	9	9		6	7	7	7	8	8
Km 335																	
XP 15																	
Mangyshlak	15.6	23.9	100	3200	6	7	7	8	9	9	3600	6	7	7	7	8	8

Legend: L = low, H = high

Direction: Mangyshlak - Bejneu																	
existing situation		after modernisation		prognosis 2005													
				variant 1							variant 2						
stations	capa-city	capa-city	speed	tonnes	number of passenger and freight trains						tonnes	number of passenger and freight trains					
					Scenario							Scenario					
					A		B		C			A		B		C	
			km/h		L	H	L	H	L	H		L	H	L	H	L	H
Mangyshlak	14.8	23.6	100	2200	12	14	16	18	18	19	3600	10	11	13	14	14	15
XP 15																	
Km 335																	
Shetpe	12.5	19.7			12	14	16	18	18	19	3600	10	11	13	14	14	15
Km 310			90														
XP 13																	
Km 299																	
Km 288			100														
XP 12																	
Km 226																	
Km 258																	
XP 10																	
Km 223			85														
Km 214																	
XP 9																	
Say - Utes	20.8	29.0	100	3500	12	14	16	18	18	19		10	11	13	14	14	15
Ustyurt																	
XP 2																	
XP 1																	
Bejneu	20.8	29.0	100	3500	12	14	16	18	18	19	3600	11	11	13	14	14	15

Annex N

Annex N: ***Existing journey times for passenger and freight trains on the section Bejneu-Mangyshlak***

Passenger trains:

The average travelling time is calculated using an average speed of 55 kilometres per hour.

station	dis-tance	km point	passenger trains					
			speed	travel-ling time	add. start-ing/ stop time	time of arrival	length of stop	time of depart ure
	Km	Km	km/h					
Bejneu	0.0		55.0		00:03			**00:00**
Ustyurt	84.7	84.7		01:32	00:06	01:38	00:10	01:48
Say-Utes	93.3	178.0		01:42	00:06	03:36	00:10	03:46
Shetpe	134.4	312.4		02:26	00:06	06:18	00:10	06:28
Mangyshlak	90.8	403.2	55.0	01:39	00:03	**08:13**		

Legend:

- Travelling times, additional starting/ stop times, length of stops, times of arrival and departure are stated in hours and minutes.
- Travelling times were calculated without starting and braking curve. The additional starting/ stop times roughly balance the travelling time loss during acceleration and braking.

Freight trains:

The travelling time of a block train is calculated at an average speed of 50 kilometres per hour. The cause for the stop in Say-Utes is to undertake a technical an inspection of the wagons.

station	dis-tance	km point	freight trains (block trains)					
			speed	travel-ling time	add. start-ing/ stop time	time of arrival	length of stop	time of depart ure
	Km	Km	km/h					
Bejneu	0.0		50.0		00:05			**00:00**
Ustyurt	84.7							
Say-Utes	93.3	178.0		03:33	00:10	03:43	03:30	07:13
Shetpe	134.4	312.4						
Mangyshlak	90.8	403.2	50.0	04:30	00:05	**11:53**		

Annex O

Annex O: Table of Potential Journey Times

station	dis-tance	km point	passenger trains						block freight trains					
			max. speed	travel-ling time	add. start-ing / stop time	time of arrival	length of stop	time of departure	max. speed	travel-ling time	add. start-ing / stop time	time of arrival	length of stop	time of departure
	Km	Km	km/h						km/h					
Bejneu	0.0		100.0		00:03			**00:00**	80.0		00:05			**00:00**
Ustyurt	84.7	84.7		00:51	00:06	00:57	00:10	01:07						
Say-Utes	93.3	178.0	85.0	00:56	00:06	02:09	00:10	02:19		02:14	00:10	02:24	03:30[1]	05:54
	45.0	223.0	100.0	00:32										
	65.0	288.0	90.0	00:39										
	22.0	310.0	100.0	00:15										
Shetpe	2.4	312.4		00:01	00:06	03:52	00:10	04:02						
Mangyshlak	90.8	403.2	100.0	00:55	00:03	**05:03**			80.0	02:49	00:05	**08:53**		

Legend:

- Travelling times, additional starting/ stop times, length of stops, times of arrival and departure are stated in hours and minutes.
- Travelling times were calculated without starting and braking curve. The additional starting/ stop times roughly balance the travelling time loss during acceleration and braking.

[1] A significant reduction in this time should be possible.

Annex P

Annex P: Comparison of Line Capacity with and without Improvement

station	**distance**		**existing**				**future**			
			speeds		**capacity**		**speeds**		**capacity**	
	Km	Km	P	F	B/M	M/B	P	F	B/M	M/B
Bejneu		11.2	60	60	18.9	20.8	100	80	28.6	29.0
XP 1		11.5		50						
XP 2 G		17.1	40	40						
Ustyurt		44.9	50							
Say-Utes	178.0	93.3			13.1	20.8	85	80	19.6	29.0
XP 9		41.1	60	60						
Km 214			50	40						
Km 223			40				100	80		
XP 10 G		16.8	60	60						
Km 258			50	40						
Km 279			40							
XP 12		39.5	60	60						
Km 288							90			
Km 299		1.5	50	40						
XP 13		1.5	60	60						
Km 310		5.0	50	40			100	80		
Shetpe	134.4	17.0	60	60	15.6	12.5			23.9	19.7
Km 335		24.1	40	40						
XP 15		35.2	60	60						
Mangyshlak	90.8	31.5			15.6	14.8	100	80	23.9	23.6
	403.2	403.2								
(Mangyshlak-Aktau)	*data not available*									

*after modernisation of the signalling system and increase in speed

Legend:

P = passenger trains F = freight trains
B = Bejneu M = Mangyshlak,

Annex Q

Annex Q: Pipe Culverts and Bridges - Work Required

There is erosion in the river bed at 37 bridges or pipe culverts. These bridges and pipe culverts are in good condition, but, if the erosion cannot be stopped, the bridges will be destroyed in a few years, should there be heavy rainfall. The river bed therefore has to be protected from erosion with stones or partly by a retention installation in the river bed.

These works have to be done at the following kilometre points: 13.3, 17.4, 39.9, 182.2, 194.4, 198.9, 207.8, 213.8, 221.0, 222.6, 223.2, 236.8, 238.5, 246.7, 263.8, 270.0, 272.3, 277.5, 278.2, 279.4, 286.9, 290.0, 290.6, 291.1, 298.4, 300.4, 307.2, 307.9, 324.3, 334.5, 337.5, 338.9, 350.6, 366.4, 370.9, 377.5, 379.2

At 52 pipe culverts, inlets and outlets are destroyed, which means they have to be rehabilitated.

These works have to be done at the following kilometre points: 128.6, 181.4, 182.8, 183.0, 183.2, 183.4, 183.8, 184.3, 184.8, 185.0, 185.8, 187.0, 187.2, 187.5, 187.8, 189.7, 190.4, 192.0, 192.2, 210.3, 212.2, 215.7, 219.8, 257.2, 262.6, 270.9, 272.8, 279.6, 288.7, 289.0, 289.1, 289.4, 291.5, 292.2, 292.8, 293.3, 293.6, 293.7, 303.2, 304.2, 308.4, 308.8, 326.4, 350.9, 352.1, 368.6, 369.4, 376.6, 390.7, 391.3, 391.5, 395.4,

85 pipe culverts have too small a diameter, therefore new and larger pipe culverts have to be constructed.

These works have to be done at the following kilometre points: 180.6, 182.5, 183.4, 184.0, 185.3, 185.9, 186.0, 186.3, 186.7, 188.0, 188.2, 188.4, 189.1, 189.4, 189.9, 190.1, 190.8, 191.0, 191.3, 191.8, 192.7, 193.3, 193.7, 203.8, 205.9, 206.4, 208.7, 209.1, 210.9, 211.1, 214.4, 215.0, 215.4, 219.1, 221.5, 222.0, 222.7, 251.5, 252.9, 256.8, 257.0, 257.8, 261.5, 267.8, 268.7, 269.0, 273.5, 274.3, 275.7, 277.5, 280.7, 282.0, 283.7, 285.0, 285.8, 288.8, 289.6, 289.7, 292.0, 292.4, 294.4, 295.7, 301.5, 302.2, 302.9, 303.5, 309.2, 318.9, 321.9, 325.1, 325.6, 326.2, 329.5, 330.6, 332.7, 333.0, 341.5, 355.8, 372.7, 374.6, 391.8, 393.2, 397.7, 398.5, 399.6, 19 bridges are too short, thus they have to be enlarged. The existing bridges will form a part of the longer bridges:

Table 0-1: Bridges Requiring Extension

km	old length	new length	height of embankment
195.183	25.6 m	71 m	6.0 m
196.722	44.4 m	89 m	4.0 m
209.730	22.1 m	98 m	2.6 m
213.250	14.1 m	20 m	3.0 m
220.685	14.1 m	20 m	2.6 m
229.486	41.3 m	72 m	3.8 m
231.872	19.2 m	38 m	1.5 m
247.332	29.3 m	38 m	4.6 m
266.338	22.2 m	35 m	2.5 m
283.490	16.0 m	28 m	2.0 m
306.415	14.1 m	26 m	2.0 m
319.867	14.1 m	26 m	2.8 m
328.200	14.1 m	20 m	1.1 m
331.676	19.2 m	31 m	1.2 m
343.430	65.9 m	95 m	4.0 m
347.697	14.1 m	32 m	3.2 m
350.658	22.4 m	41 m	2.5 m
352.852	19.2 m	31 m	2.8 m
359.710	65.9 m	96 m	3.5 m

30 pipe culverts or bridges have too small a diameter, so it is necessary to build a larger bridge instead of the existing one:

Table 0-2: Culverts and Bridges Requiring Enlargement

km	old diameter	new length	height of embankment
179.462	4.0 m	45 m	
188.921	2x2.0m	101 m	16.3 m
201.329	2.0 m	22 m	2.7 m
202.827	1.5 m	22 m	2.5 m
205.027	5.0 m	46 m	2.1 m
217.526	2x1.5 m	41 m	3.9 m
223.950	1.5 m	41 m	3.6 m
224.927	1.5 m	22 m	3.0 m
234.487	5.0 m	34 m	2.5 m
238.560	6.0 m	47 m	1.8 m
244.492	2x2.0 m	56 m	7.9 m
254.386	2x2.0 m	41 m	3.3 m
258.090	3x2.0 m	41 m	4.7 m
259.574	1.0 m	22 m	1.8 m
265.742	1.0 m	22 m	2.0 m
276.297	1.5 m	22 m	2.3 m
284.788	1.5 m	22 m	2.8 m
286.324	1.5 m	22 m	2.3 m
287.677	1.5 m	22 m	2.4 m
297.477	2.0 m	22 m	3.0 m
311.435	2.0 m	28 m	2.4 m
322.899	2x1.5 m	22 m	2.2 m
325.896	5.0 m	22 m	2.7 m
335.414	1.5 m	28 m	2.4 m
341.024	1.5 m	22 m	2.8 m
344.592	1.5 m	22 m	2.7 m
346.159	2x1.5 m	28 m	2.7 m
354.446	8.7 m	28 m	2.8 m
375.959	5.0 m	22 m	1.9 m
389.548	2.0 m	46 m	4.0 m

Annex R

Annex R: Calculation of Economic Appraisal (Internal Rate of Return)

Principles

The basic principles employed in calculating the Internal Rate of Return (IRR) of the investment in comparison with the various forecast scenarios were as follows:

Step 1:

For the years 1998 to 2022 (25 years), the 'Do Nothing' or **S_0 Scenario** was evaluated as having the volume levels (and thus the same operating cost and revenue) as for 1996:

Scenario 0 (Base Scenario) USD million			
Year	**Operating and Maintenance Costs**	**Revenue**	**Net Revenue**
1998	13.40	9.78	-3.62
1999	13.40	9.78	-3.62
2000	13.40	9.78	-3.62
2001	13.40	9.78	-3.62
2002	13.40	9.78	-3.62
2003	13.40	9.78	-3.62
2004	13.40	9.78	-3.62
2005	13.40	9.78	-3.62
2006	13.40	9.78	-3.62
2007	13.40	9.78	-3.62
2008	13.40	9.78	-3.62
2009	13.40	9.78	-3.62
2010	13.40	9.78	-3.62
2011	13.40	9.78	-3.62
2012	13.40	9.78	-3.62
2013	13.40	9.78	-3.62
2014	13.40	9.78	-3.62
2015	13.40	9.78	-3.62
2016	13.40	9.78	-3.62
2017	13.40	9.78	-3.62
2018	13.40	9.78	-3.62
2019	13.40	9.78	-3.62
2020	13.40	9.78	-3.62
2021	13.40	9.78	-3.62
2022	13.40	9.78	-3.62

This table clearly shows the annual operating deficit of USD 3.62 million.

Step 2

For each of the six traffic forecast scenarios, from A_{LOW} to C_{HIGH}, the **difference** between the base scenario (S_0 above) and the scenario being considered was tabulated for the following values:

> ***Incremental Investment Cost:*** the total of investment in each year for infrastructure, signalling and telecommunications, in comparison with S_0. Since in practise there is no investment planned in S_0, this figure represents the **total investment cost.**
>
> ***Incremental Maintenance Cost:*** the cost of maintaining the equipment provided as part of the investment.
>
> ***Incremental Operating Cost:*** the cost of operating the *additional trains* (i.e. over and above those in S_0) inherent in the scenario forecast.

Incremental Revenue: the additional revenue accruing from operating the additional trains inherent in the scenario forecast.

Incremental Net Revenue: the difference between the *Incremental Revenue* and the sum of all other costs (Investment, Maintenance and Operating) as described above.

Residual Value: the residual value of the assets at the end of the period under consideration (i.e. to 2022). In practise, since none of the assets has a life beyond 25 years, there is no residual value to consider.

IRR (Internal Rate of Return): calculated on the *Incremental Net Revenue* to show the net cumulative effect of making the investment.

The detailed table calculations are as follows (all figures in USD millions):

Scenario A_{low}					
Year	Incremental Investment Cost	Incremental Maintenance Cost	Incremental Operating Cost	Incremental Revenue	Incremental Net Revenue
1998	26.05	6.21	0.00	0.00	-32.26
1999	54.20	4.15	1.36	3.58	-56.13
2000	46.00	3.98	2.72	7.17	-45.54
2001	38.75	3.74	4.08	10.75	-35.83
2002	40.00	3.52	5.44	14.33	-34.63
2003	26.55	3.36	6.80	17.91	-18.79
2004	7.00	3.42	8.16	21.50	2.91
2005	8.00	3.49	9.52	25.08	4.07
2006	10.50	3.60	9.52	25.08	1.46
2007	10.50	3.70	9.52	25.08	1.36
2008	1.00	3.70	9.52	25.08	10.86
2009	1.00	3.70	9.52	25.08	10.86
2010	1.00	3.70	9.52	25.08	10.86
2011	1.00	3.70	9.52	25.08	10.86
2012	1.00	3.70	9.52	25.08	10.86
2013	1.00	3.70	9.52	25.08	10.86
2014	1.00	3.70	9.52	25.08	10.86
2015	1.00	3.70	9.52	25.08	10.86
2016	1.00	3.70	9.52	25.08	10.86
2017	1.00	3.70	9.52	25.08	10.86
2018	1.00	3.70	9.52	25.08	10.86
2019	1.00	3.70	9.52	25.08	10.86
2020	1.00	3.70	9.52	25.08	10.86
2021	1.00	3.70	9.52	25.08	10.86
2022	1.00	3.70	9.52	25.08	10.86
Total	282.55				
Residual Value					
IRR					-1.8%

Scenario A_{High}

Year	Incremental Investment Cost	Incremental Maintenance Cost	Incremental Operating Cost	Incremental Revenue	Incremental Net Revenue
1998	26.05	6.21	0.00	0.00	-32.26
1999	54.20	4.15	1.59	4.48	-55.45
2000	46.00	3.98	3.17	8.96	-44.19
2001	38.75	3.74	4.76	13.44	-33.81
2002	40.00	3.52	6.35	17.93	-31.94
2003	26.55	3.36	7.94	22.41	-15.44
2004	7.00	3.42	9.52	26.89	6.94
2005	8.00	3.49	11.11	31.37	8.77
2006	10.50	3.60	11.11	31.37	6.16
2007	10.50	3.70	11.11	31.37	6.06
2008	1.00	3.70	11.11	31.37	15.56
2009	1.00	3.70	11.11	31.37	15.56
2010	1.00	3.70	11.11	31.37	15.56
2011	1.00	3.70	11.11	31.37	15.56
2012	1.00	3.70	11.11	31.37	15.56
2013	1.00	3.70	11.11	31.37	15.56
2014	1.00	3.70	11.11	31.37	15.56
2015	1.00	3.70	11.11	31.37	15.56
2016	1.00	3.70	11.11	31.37	15.56
2017	1.00	3.70	11.11	31.37	15.56
2018	1.00	3.70	11.11	31.37	15.56
2019	1.00	3.70	11.11	31.37	15.56
2020	1.00	3.70	11.11	31.37	15.56
2021	1.00	3.70	11.11	31.37	15.56
2022	1.00	3.70	11.11	31.37	15.56
Total	282.55				
Residual Value					
IRR					**1.5%**

Scenario B_{Low}					
Year	Incremental Investment Cost	Incremental Maintenance Cost	Incremental Operating Cost	Incremental Revenue	Incremental Net Revenue
1998	26.05	6.21	0.00	0.00	-32.26
1999	54.20	4.15	1.81	4.80	-53.02
2000	46.00	3.98	3.63	9.61	-44.00
2001	38.75	3.74	5.44	14.41	-33.52
2002	40.00	3.52	7.25	19.22	-31.55
2003	26.55	3.36	9.06	24.02	-14.95
2004	7.00	3.42	10.88	28.83	7.53
2005	8.00	3.49	12.69	33.63	9.45
2006	10.50	3.60	12.69	33.63	6.84
2007	10.50	3.70	12.69	33.63	6.74
2008	1.00	3.70	12.69	33.63	16.24
2009	1.00	3.70	12.69	33.63	16.24
2010	1.00	3.70	12.69	33.63	16.24
2011	1.00	3.70	12.69	33.63	16.24
2012	1.00	3.70	12.69	33.63	16.24
2013	1.00	3.70	12.69	33.63	16.24
2014	1.00	3.70	12.69	33.63	16.24
2015	1.00	3.70	12.69	33.63	16.24
2016	1.00	3.70	12.69	33.63	16.24
2017	1.00	3.70	12.69	33.63	16.24
2018	1.00	3.70	12.69	33.63	16.24
2019	1.00	3.70	12.69	33.63	16.24
2020	1.00	3.70	12.69	33.63	16.24
2021	1.00	3.70	12.69	33.63	16.24
2022	1.00	3.70	12.69	33.63	16.24
Total	282.55				
Residual Value					
IRR					2.0%

Scenario B_{High}					
Year	Incremental Investment Cost	Incremental Maintenance Cost	Incremental Operating Cost	Incremental Revenue	Incremental Net Revenue
1998	26.05	6.21	0.00	0.00	-32.26
1999	54.20	4.15	2.04	5.87	-52.41
2000	46.00	3.98	4.08	11.75	-42.31
2001	38.75	3.74	6.12	17.62	-30.99
2002	40.00	3.52	8.16	23.50	-28.18
2003	26.55	3.36	10.20	29.37	-10.74
2004	7.00	3.42	12.24	35.25	12.58
2005	8.00	3.49	14.28	41.12	2.97
2006	10.50	3.60	14.28	41.12	12.74
2007	10.50	3.70	14.28	41.12	12.64
2008	1.00	3.70	14.28	41.12	22.14
2009	1.00	3.70	14.28	41.12	22.14
2010	1.00	3.70	14.28	41.12	22.14
2011	1.00	3.70	14.28	41.12	22.14
2012	1.00	3.70	14.28	41.12	22.14
2013	1.00	3.70	14.28	41.12	22.14
2014	1.00	3.70	14.28	41.12	22.14
2015	1.00	3.70	14.28	41.12	22.14
2016	1.00	3.70	14.28	41.12	22.14
2017	1.00	3.70	14.28	41.12	22.14
2018	1.00	3.70	14.28	41.12	22.14
2019	1.00	3.70	14.28	41.12	22.14
2020	1.00	3.70	14.28	41.12	22.14
2021	1.00	3.70	14.28	41.12	22.14
2022	1.00	3.70	14.28	41.12	22.14
Total	282.55				
Residual Value					
IRR					**4.9%**

Scenario C_{Low}					
Year	**Incremental Investment Cost**	**Incremental Maintenance Cost**	**Incremental Operating Cost**	**Incremental Revenue**	**Incremental Net Revenue**
1998	26.05	6.21	0.00	0.00	-32.26
1999	54.20	4.15	2.04	6.00	-54.39
2000	46.00	3.98	4.08	12.01	-42.06
2001	38.75	3.74	6.12	18.01	-30.61
2002	40.00	3.52	8.16	24.01	-27.67
2003	26.55	3.36	10.20	30.01	-10.09
2004	7.00	3.42	12.24	36.02	13.35
2005	8.00	3.49	14.28	42.02	16.25
2006	10.50	3.60	14.28	42.02	13.64
2007	10.50	3.70	14.28	42.02	13.54
2008	1.00	3.70	14.28	42.02	23.04
2009	1.00	3.70	14.28	42.02	23.04
2010	1.00	3.70	14.28	42.02	23.04
2011	1.00	3.70	14.28	42.02	23.04
2012	1.00	3.70	14.28	42.02	23.04
2013	1.00	3.70	14.28	42.02	23.04
2014	1.00	3.70	14.28	42.02	23.04
2015	1.00	3.70	14.28	42.02	23.04
2016	1.00	3.70	14.28	42.02	23.04
2017	1.00	3.70	14.28	42.02	23.04
2018	1.00	3.70	14.28	42.02	23.04
2019	1.00	3.70	14.28	42.02	23.04
2020	1.00	3.70	14.28	42.02	23.04
2021	1.00	3.70	14.28	42.02	23.04
2022	1.00	3.70	14.28	42.02	23.04
Total	282.55				
Residual Value					
IRR					**5.7%**

Scenario C_{High}

Year	Incremental Investment Cost	Incremental Maintenance Cost	Incremental Operating Cost	Incremental Revenue	Incremental Net Revenue
1998	26.05	3.80	0.00	0.00	-28.85
1999	54.20	4.15	2.15	7.07	-52.43
2000	46.00	3.98	4.31	14.15	-39.14
2001	38.75	3.74	6.46	21.22	-26.73
2002	40.00	3.52	8.61	28.29	-22.84
2003	26.55	3.36	10.76	35.36	-4.31
2004	7.00	3.42	12.92	42.44	20.10
2005	8.00	3.49	15.07	49.51	23.95
2006	10.50	3.59	15.07	49.51	21.35
2007	10.50	3.68	15.07	49.51	21.26
2008	1.00	3.68	15.07	49.51	30.76
2009	1.00	3.68	15.07	49.51	30.76
2010	1.00	3.68	15.07	49.51	30.76
2011	1.00	3.68	15.07	49.51	29.76
2012	1.00	3.68	15.07	49.51	29.76
2013	1.00	3.68	15.07	49.51	29.76
2014	1.00	3.68	15.07	49.51	29.76
2015	1.00	3.68	15.07	49.51	29.76
2016	1.00	3.68	15.07	49.51	29.76
2017	1.00	3.68	15.07	49.51	29.76
2018	1.00	3.68	15.07	49.51	29.76
2019	1.00	3.68	15.07	49.51	29.76
2020	1.00	3.68	15.07	49.51	29.76
2021	1.00	3.68	15.07	49.51	29.76
2022	1.00	3.68	15.07	49.51	29.76
Total	282.55				
Residual Value					
IRR					9.5%

Annex S

Annex S: Freight Traffic Volume along the Line Mangyshlak-Bejneu (incl. Mangyshlak-Uzen) in 1990 and 1995

Railway Station/ Section	1990			1995			Development 1995/1990
	Dispatching	Receiving	total	Dispatching	Receiving	total	(%)
Mangyshlak (incl. Aktau port)	3094.0	4690.4	7784.4	466.8	1133.4	1600.2	20,6
Shetpe	1010.8	83.4	1094.2	38.0	25.1	63.1	5.8
Say-Utes	2.6	13.4	16.0	0.6	26.5	27.1	169.4
Ustyurt	36.3	0.8	37.1	1.5	0.3	1.8	4.8
Section Mangyshlak-Bejneu total	**4143.7**	**4788.0**	**8931.7**	**506.9**	**1185.3**	**1692.2**	**18,9**
Section Mangyshlak-Usen total 1)	*863.6*	*461.5*	*1325.1*	*121.0*	*176.5*	*297.5*	*22.5*
total	***5007.3***	***5249.5***	***10256.8***	***627.9***	***1361.8***	***1989.7***	***19.4***

1) This volume does not include domestic traffic within the section Mangyshlak-Uzen.

Source: WKR

Annex T

Annex T: Freight Traffic Volume by Commodity in 1995

Railway Station	Freight volume in 1995 ('000 tonnes)								
	Oil products	**Metals, ores**	**Construction materials**	**Fertilisers**	**Timber**	**Coal**	**Food**	**Other**	**Total**
Mangyshlak									
Forwarded tonnage	62.2	8.5	157.5	144.5	0.8		0.8	92.5	466.8
Received tonnage	148.5	225.5	128.6	290.7	13.8	3.5	33	289.8	1133.4
Shetpe									
Forwarded tonnage		0.7	36					1.3	38
Received tonnage	3.4	2.3	7.1		0.3	3.7	5.4	2.9	25.1
Say-Utes									
Forwarded tonnage								0.6	0.6
Received tonnage	1.6	0.4	23.7	0.1	0.2	0.2		0.3	26.5
Ustyurt									
Forwarded tonnage			1.5						1.5
Received tonnage	0.2		0.1						0.3
Section Mangyshlak-Bejneu									
Forwarded tonnage	62.2	9.2	195	144.5	0.8	0	0.8	94.4	506.9
Received tonnage	153.7	228.2	159.5	290.8	14.3	7.4	38.4	293	1185.3
Section Mangyshlak-Uzen									
Forwarded tonnage	97.7	1.3	11.3					10.7	121
Received tonnage	48.5	24.6	40.8	0.1	6.1	16.7	8.5	31.2	176.5
Total	***362.1***	***263.3***	***406.6***	***435.4***	***21.2***	***24.1***	***47.7***	***429.3***	***1989.7***
of which:									
Forwarded tonnage	159.9	10.5	206.3	144.5	0.8	0	0.8	105.1	627.9
Received tonnage	202.2	252.8	200.3	290.9	20.4	24.1	46.9	324.2	1361.8

Annex U

Annex U: Main Freight Traffic Flows on the Mangyshlak-Bejneu Line

Area of destination/ origin	Distance (km)	Oil products	Metals, ores	Construct. materials	Fertilisers	Other	Total
Dispatching to:							
District of Atyrau	800	0.1				0.1	0.1
District of Aktyubinsk							0.1
District of Mangistau	200			0.1			0.1
South Kazakstan	> 2000	0.1					0.1
China /via border crossing Drushba	> 2000				0.1		0.1
Russia/via Aksaraiskaya	> 2000			0.1			0.1
Receiving from:							
District of Atyrau	800	0.2					0.2
District of Mangistau	200			0.1			0.1
District of Karaganda	> 3000		0.1				0.1
District of Shambyl	>2000				0.2		0.2
Districts of Shezkazgan and East, South Kazakstan	>2000					0.2	0.2
North and East Kazakstan	> 2000			0.1			0.1
Russia (Eastern part), Ukraine	> 2000		0.2		0.1	0.1	0.4

Sources: WKR

Annex V

Annex V: *Freight Volume by Commodity in 2005*

Commodity	SCENARIO A						SCENARIO B						SCENARIO C					
	Freight traffic ('000 tonnes) in 2005																	
	Fwd'd		Receiving		Total		Fwd'd		Receiving		Total		Fwd'd		Receiving		Total	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
Ores	**80**	**90**	**100**	**120**	**180**	**210**	**80**	**90**	**100**	**120**	**180**	**210**	**80**	**90**	**100**	**120**	**180**	**210**
Chemicals	340	340	220	220	560	560	430	430	220	220	650	650	430	430	220	220	650	650
Fertiliser	200	300	250	400	450	700	400	600	250	400	650	1000	400	600	350	500	750	1100
Crude oil	0	0	3000	3000	3000	3000	0	0	3000	3000	3000	3000	0	0	3000	3000	3000	3000
Oil products	200	200	300	350	500	550	1550	1700	300	350	1850	2050	1550	1700	300	350	1850	2050
Metals	30	130	250	280	280	410	30	130	250	280	280	410	30	130	450	480	480	610
Timber	10	10	110	140	120	150	10	10	110	140	120	150	10	10	110	140	120	150
Construction materials	50	150	440	650	490	800	50	150	640	850	690	1000	50	150	640	850	690	1000
Food	60	100	1060	1400	1120	1500	60	100	1060	1400	1120	1500	60	100	1260	1600	1320	1700
Other	870	1010	530	780	1400	1790	970	1110	730	1030	1700	2140	1570	1710	1730	2030	3300	3740
Total	**1840**	**2330**	**6260**	**7340**	**8100**	**9670**	**3580**	**4320**	**6660**	**7790**	**10240**	**12110**	**4180**	**4920**	**8160**	**9290**	**12340**	**14210**

Annex W

Annex W: Total Number of Loaded Wagons by Type (Scenarios A and B)

	Scenario A		Scenario B	
	low	**high**	**low**	**high**
Forwarded of which:	38918	48322	67481	80818
open wagons	4427	7421	5403	8779
flats	2265	3601	2523	3859
covered wagons	21671	25628	26367	31278
tanks	3125	3125	24219	26563
special wagons	7431	8546	8970	10339
Received of which:	106651	127019	115354	137000
open wagon	11069	14389	12479	15810
flat	4305	6028	5782	7542
covered wagon	26605	36280	28832	38840
tank	51563	52344	51563	52344
including for transport of Tengiz oil	*46875*	*46875*	*46875*	*46875*
special wagon	13110	17978	16699	22465

The calculation was carried out by the Consultant on the basis of suitable type of wagons for each commodity:

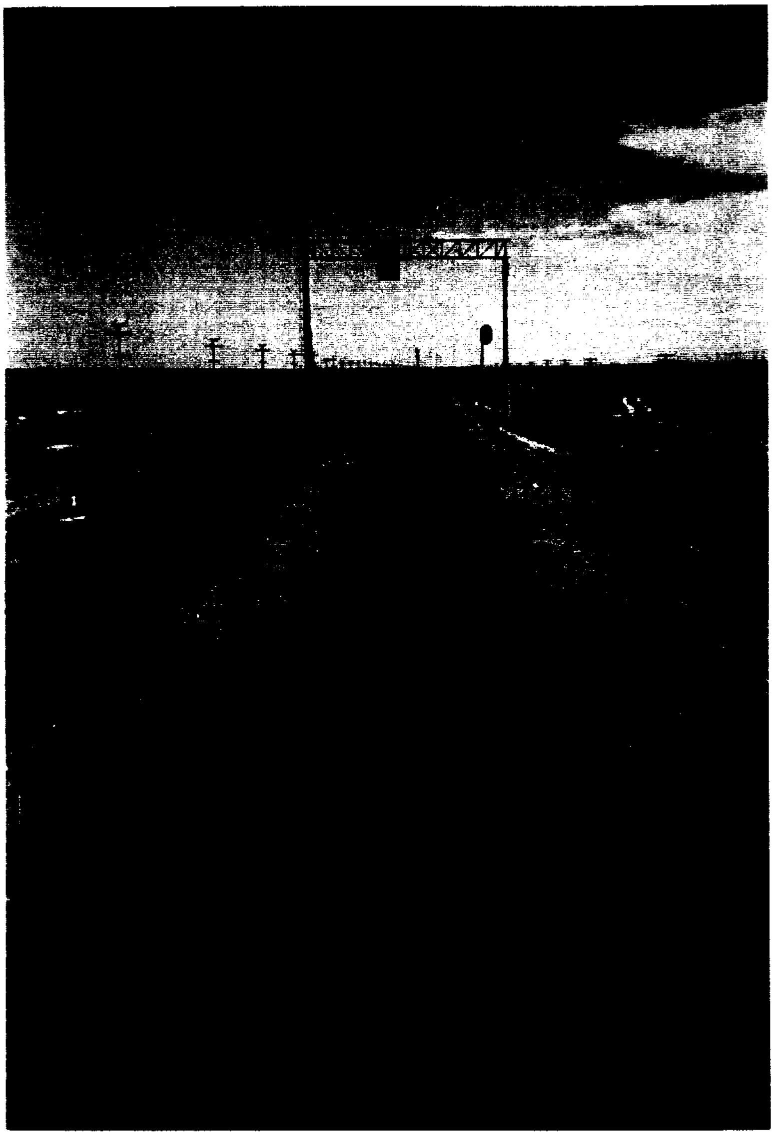
Commodity	**Forwarding**					**Receiving**				
	of which:					of which:				
	open wagon	flat	covered wagon	tank	special wagon	open wagon	flat	covered wagon	tank	special wagon
Coal						100				
Crude oil, oil products				100					100	
Metals	85	15				85	15			
Timber						80	10	10		
Constr. mat.	50	49	1			38	37	25		
Grain								100		
Fertilisers	24		60		16		24		60	16
Other	5	6	65		24	1	3	26		70

Source: Structure of dispatching and receiving of Mangyshlak railway station in 1995, WKR

Annex X

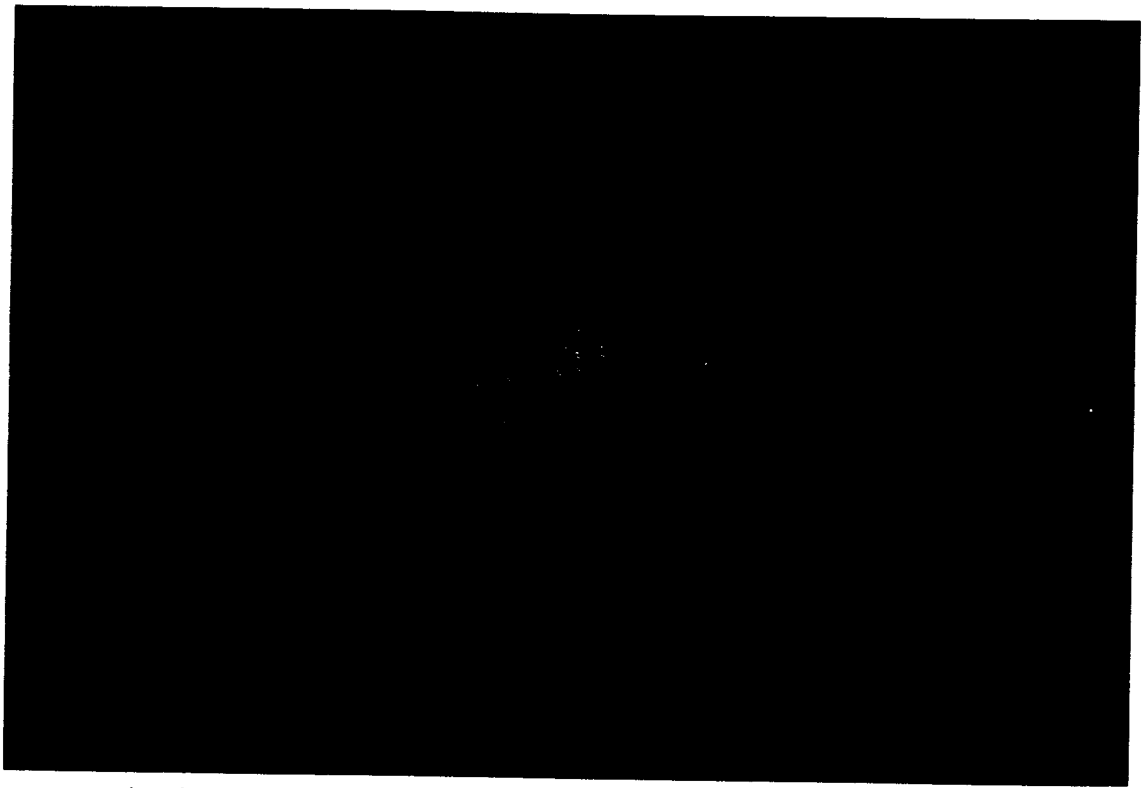
Annex X Photo Documentation

Photo dokumentation
The Topography of the line



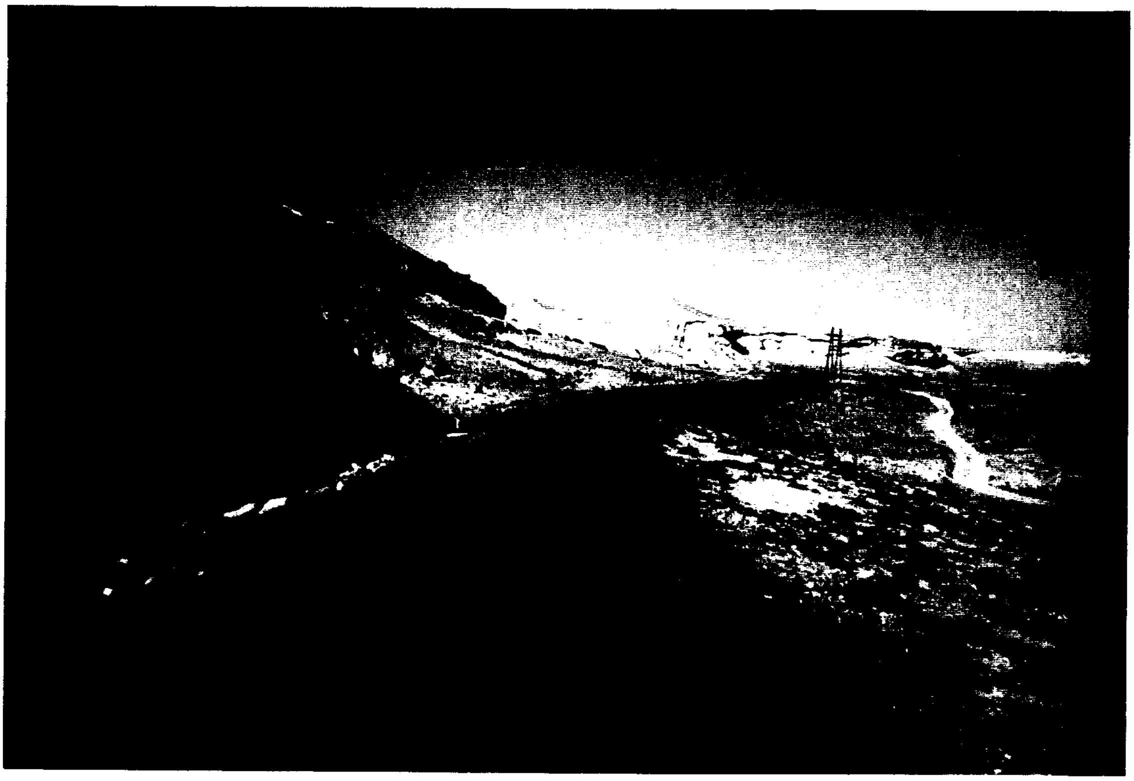
km 128
Passing Loop Nr.: 6
typical linepart between Bejneu and Say Utes (km 178) on the Ustyurt Plateau

km 185
typical line profile between Say Utes and km 199 at the steep slope

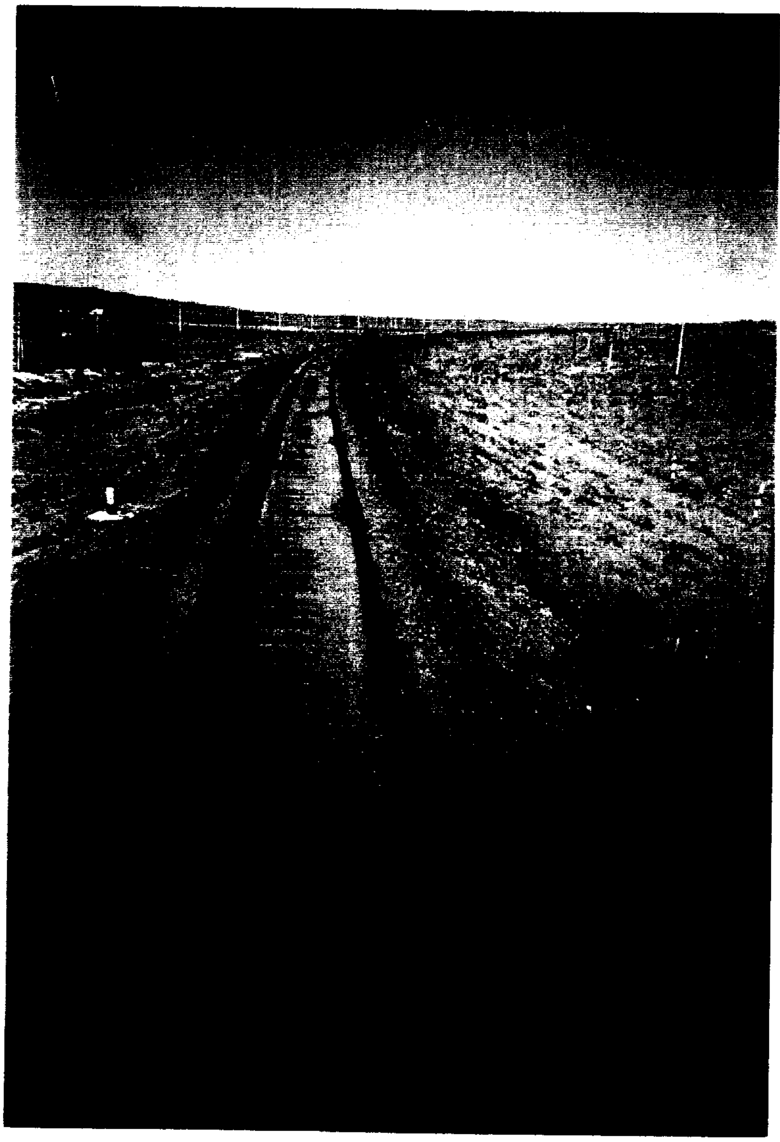


km 215
Linepart near the Kadijak Bay (Part of the Caspian Sea)

km 294
Linepart a the ground of a canyon
The slope of the canyon is some meters beside the line

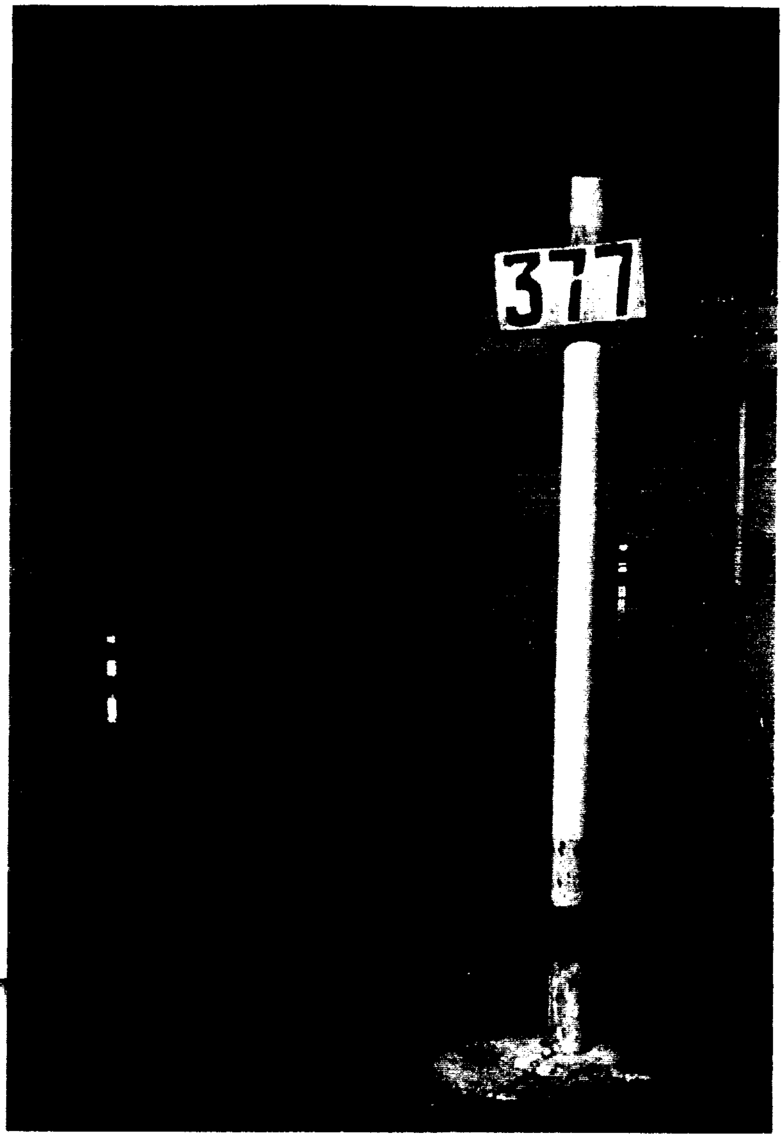


km 298
The end of the canyon and the beginning of a broad valley



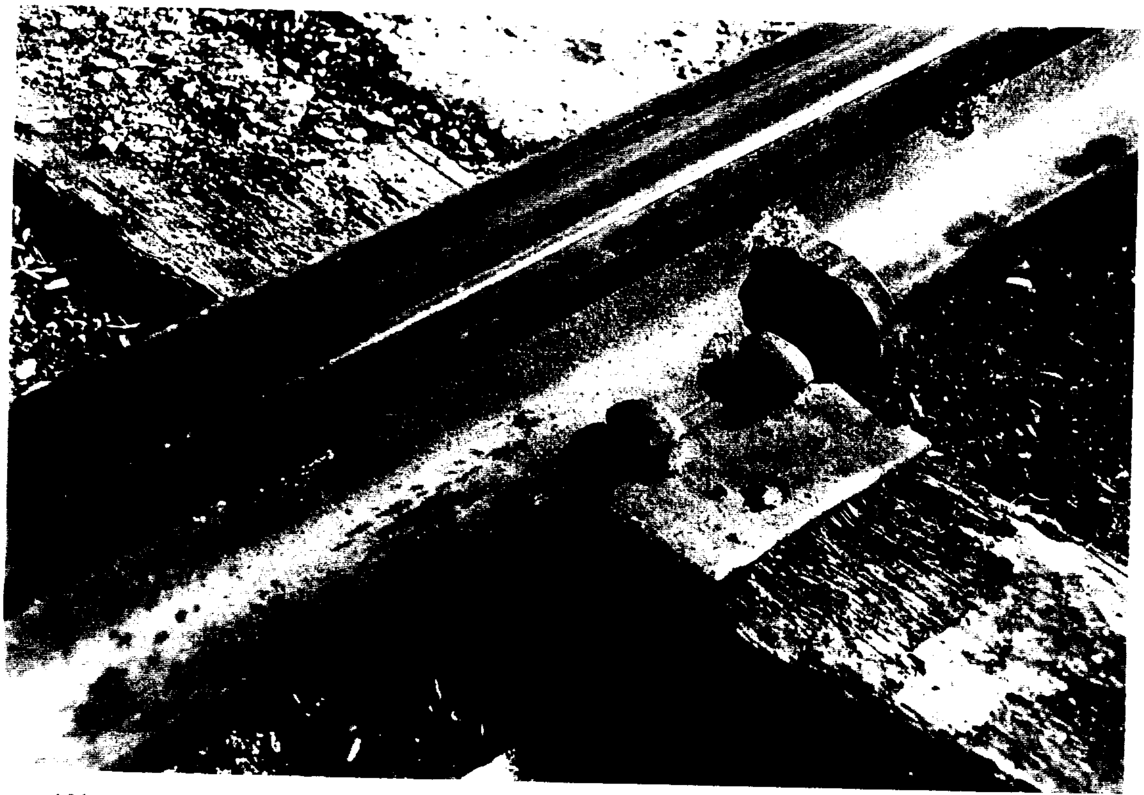
km 328
A linepart with sand in the track

km 377
The landscape near passing loop Nr.: 16
the deepest part of the line



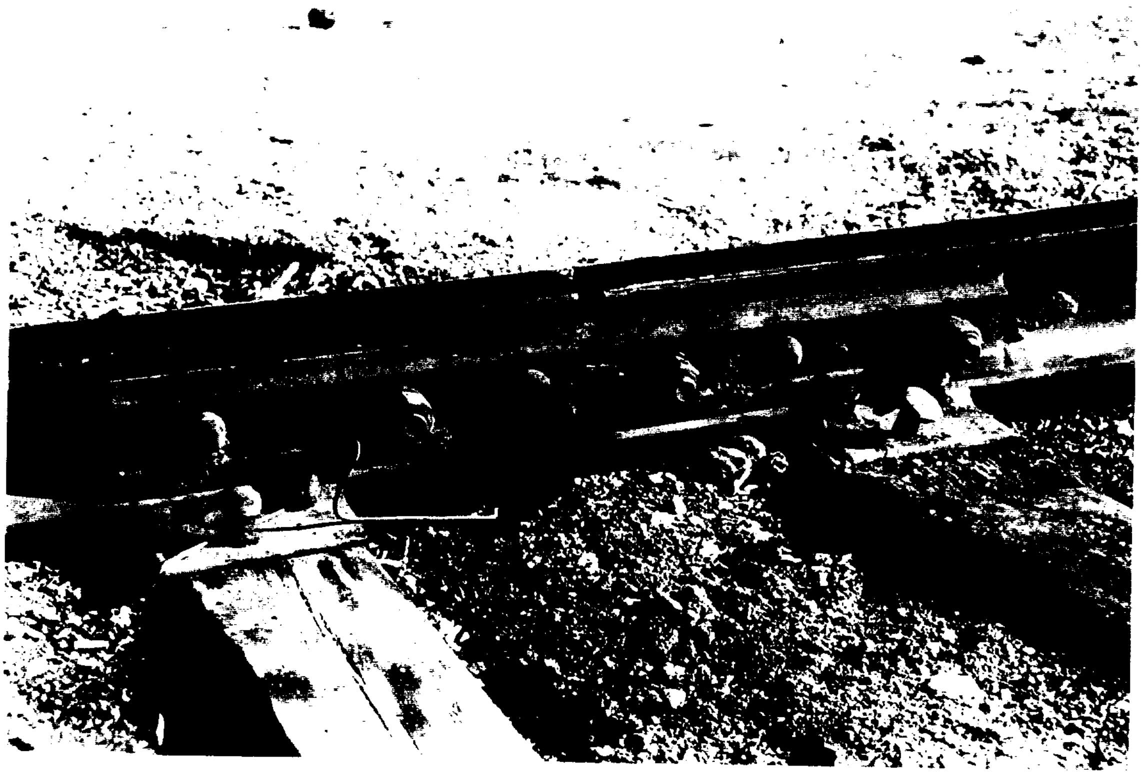
km 403
Manghishlak Station
with the platform

Detail of the track

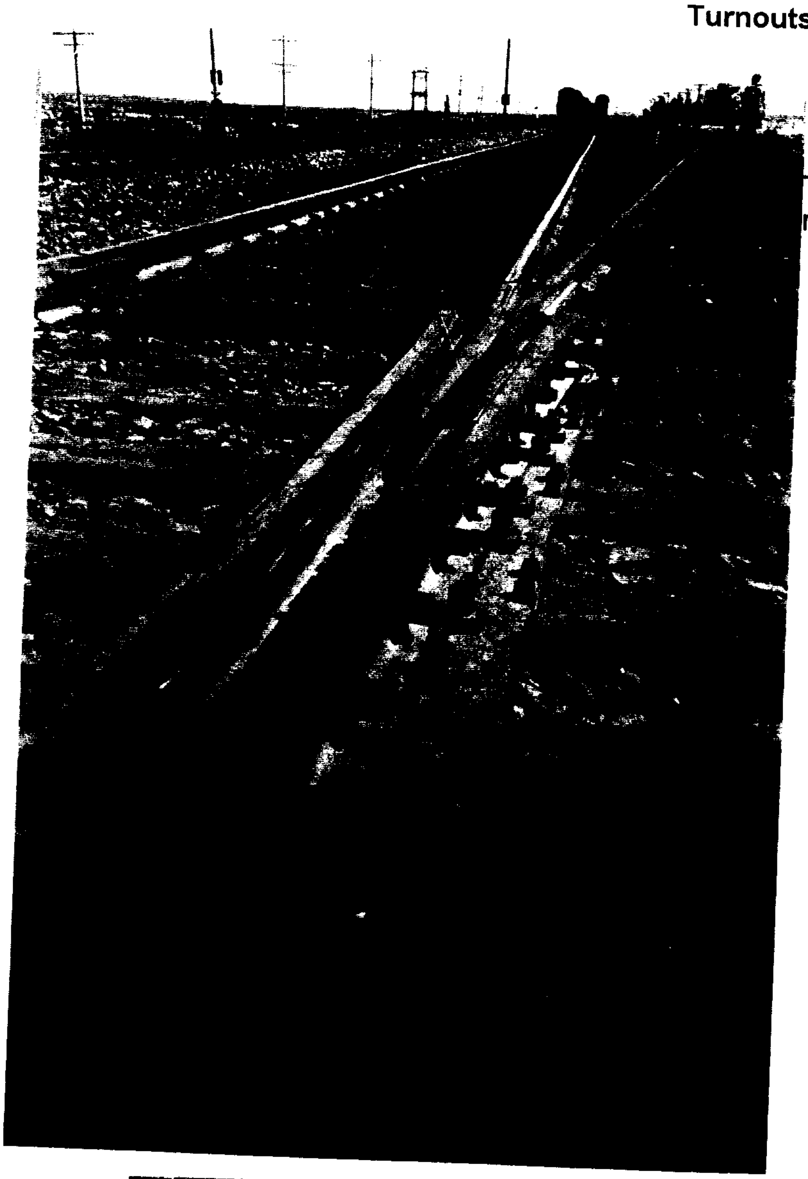


Wooden sleeper with base plate and spikes (loosing spikes) and rail anchor and typical sand ballast

Fish plate joint



Turnouts



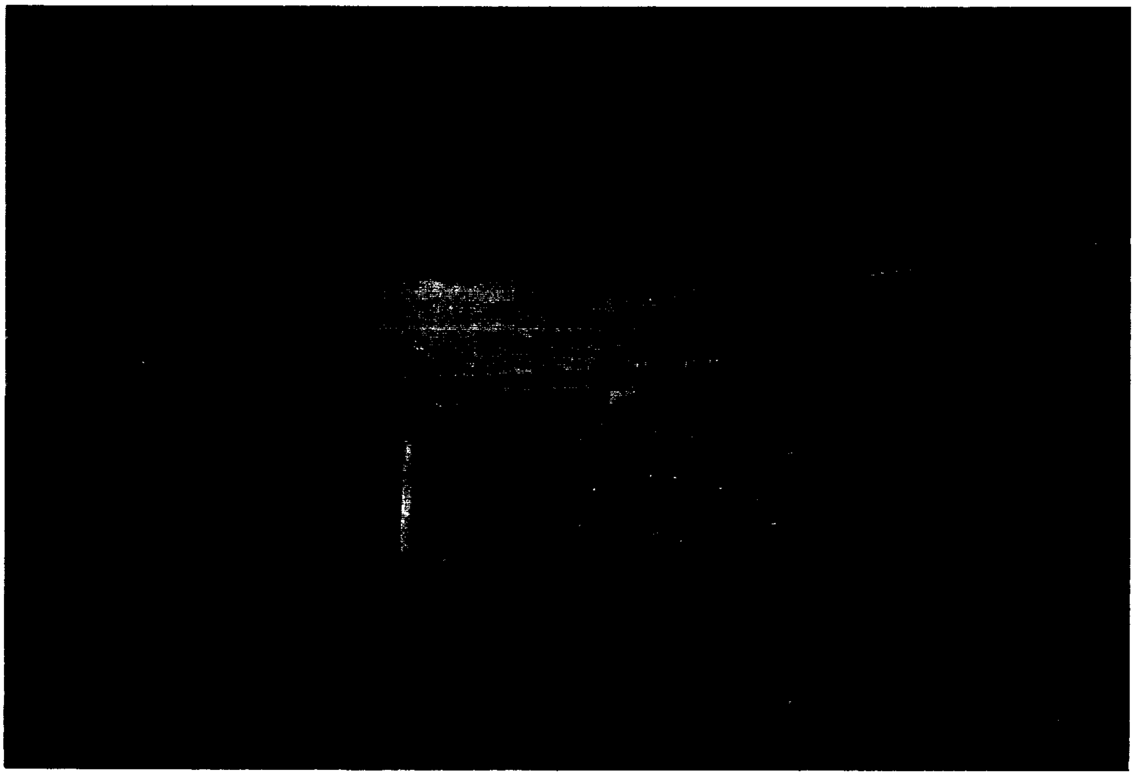
Turnout in passing loop Nr.: 7
monoblock switch diamond

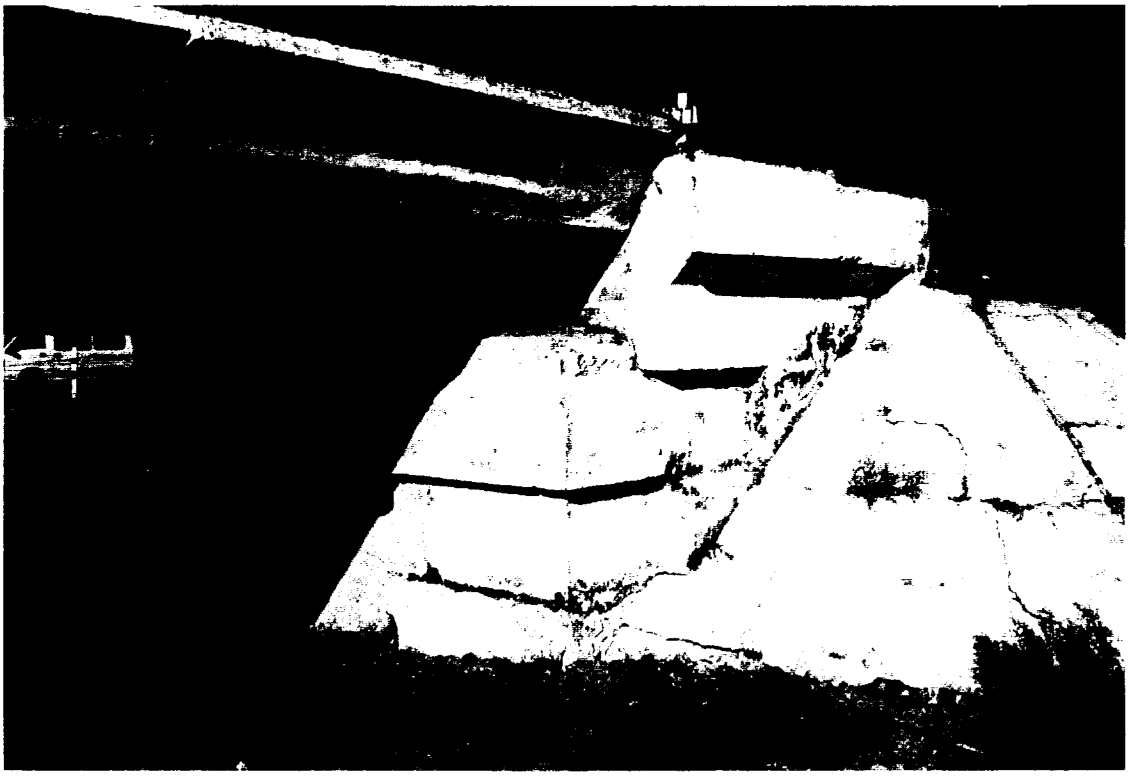
A tongue of a turnout

Bridges

Bridge at km 39,9
Eosion at the river bed

Bridge at km 339,5
This bridge was build up 1993 after the old one was distructed during a rainfall





Bridge at km 375,9
This bridge is today 10 m long, it is planed to build up a new one with 22 m.

Working methods

A maintenance gang in Manghishlak Station
They are leveling a track by hand

Equipment

Existing Track Cars

Existing tamping machine and rail lifter