Technical pre-feasibility of track and constructional Works of the Azerbaijan State Railways (AGZD) and the Georgian Railways (GRZD)

Baku, Tbilisi, Berlin - August 1996

Annexes

Part of WP1300

1 Introduction

1.1 Objective of the project

The objective of this part of the study is to determine the technical requirements for the rehabilitation of the main Trans-Caucasian rail route between Azerbaijan and Georgia. Part one (point 2 to 4) will be the investigation of the track route: Baku - border point to Georgia for the work packages WP 1300 for track and constructional works. Part two (point 5 to 7) will be the investigation of the track route: border Azerbaijan - Tbilisi - Senaki - Poti, port on the Black Sea. The co-operation with the railway authorities has been helpful. The participating authorities are named and listed in Annex 1.

2 Current situation

2.1 Baku - Tbilisi track line

The investigated line leads from Baku to Tbilisi in west-north direction and is constructed as a double electrified track line. The double line is only interrupted at km 73.9 to 72.9 by a single track section (see Chapter 3.1.2.7). Side track length is 503 km. The border station of the Baku-Georgia track line is Beyuk-Kyassik, the border point is located 3.0 km behind this station.

The main line is equipped with 1,475 switches, the track is of Russian design.

2.2 Composition of the permanent way.

The track material mostly applied is supplied by Russian manufactories. On the main line (the investigated line), the rail profile is R 65 Kg/m and supported by concrete monobloc sleepers, also supplied by Russia. On the investigated line, the rails are posed in a length of 800 m with an interruption section of three lengths of 25m and 4 expansion gaps.

The rail quality used in AZhD belongs to the self-hardening and heat treated type of rails and cover a strength range of 800 to 1200 N/mm ^{2}. Self-hardening rails dominate the market and practically all current applications can be catered for with these rails. A distinction can be made between 4 groups:

- rails with 690 N/mm ^{2} minimum tensile strength, corresponding to UIC requirements
- rails with 820 N/mm ^{2} minimum tensile strength, corresponding to ASTM and GOST requirements
- rails with 880 N/mm ^{2} minimum tensile strength, corresponding to the wear resistant qualities and
- rails with 1,080 N/mm ^{2} minimum tensile strength that have been used to a great extent when high operating loads prevail.

Table below provides a survey of the chemical composition of the rail qualities used in AZD.

Mechanical properties and chemical composition of delivered rails								
Type of	Delivery	Name of	Chemical composition, content in per cent					Tensile
rail	condition	steel	C	Mn	Si	S	P	strength
								N/mm2
R75,R65	Gost 8160-63	M76	0.69-0.82	0.75-1.05	0.13-0.28	0.045	0.035	840
R65,chromi-	ChMTU							
ferrous	2-64-68	M71	0.65-0.76	0.75-1.05	0.13-0.28	0.045	0.035	900
R65,volume-	ChMTU							
tempered	2-59-68	M72	0.68-0.78	0.75-1.05	0.13-0.28	0.045	0.035	1,160
R50	ChMTU							
	6944-63	M75	0.67-0.80	0.75-1.05	0.13-0.28	0.045	0.035	840
R50	ChMTU							
	2-16-67	N865	0.56-0.75	0.60-1.0	0.15-0.30	0.06	0.07	800
R50,volume-	ChMTU							
tempered	2-59-68	M72	0.67-0.77	0.75-1.05	0.13-0.28	0.045	0.035	1,160
R50,surface-	STU 71							
tempered	MS-66-62	N865	0.56-0.75	0.60-0.90	0.15-0.30	0.06	0.07	950
R43,R38	GOST							
	4224-54	M71	0.64-0.77	0.60-0.90	0.13-0.28	0.05	0.04	800
Legend:								
C=Carbon,Mn=Mangan,SI=Silicon,S=Sulphur,P=Phosphorous								
Rail Qualities used in AZD and belong to the self-hardening rails that cover practically all current applications.								

The density of the posed sleepers in straight line amounts to 1,840, sleepers in curves from >1,840 to 2,000, and they correspond to an average sleeper spacing of 0.54 to 0.50m resp. In addition to the concrete sleepers, timber sleepers were also laid. The timber quality is pinewood treated by impregnation. The average lifetime is up to 15 years. The better timber quality in beech or oak is not available or too expensive.

Rail fixing to the concrete sleeper consists of a base plate with rigid clip, the base plate is fastened to the concrete body by an anchoring screw, turned a quarter in a chamber.

This kind of rail fastening is not in line with current practice in Western Europe and the assembly causes the force of the vibration of wheel/rail contact, which damages the fixing chambers of the anchorage screw, not to be absorbed.
Rail fixing to the timber sleeper consists of:
- This fastening system of spikes with a base plate is not suitable either because the rail/wheel contact vibrations loosen the fixing devices. Aware of this unsuitable rail fastening to the timber sleeper, an improvement has been started by using coach screws, particularly in curves.

2.2.1 Switches

As mentioned above, there are 1,475 switches on the investigated main line. All of them are connected with the through line. Their geometric form is R65 300 1:11 and corresponds with the switches used in Europe.

2.2.2 Level crossings

30 level crossings are installed on the main line, 8 of them are operated automatically, 11 electrically by push button, and 11 by hand.

2.2.3 Bridges and tunnels

There are no tunnels on the main line Baku/Tbilisi and vice versa. On the other hand, altogether 985 bridges are installed. These constructions are divided into bridges of length up to:

25 m	-	680 constructions	
100 m	-	57	„
>100 m	-	5	„

243 constructions are culverts, arched stone and concrete drain pipes up to a 2.00 m span. The year of construction of all types is given by AZD as between 1883 - 1904. The present situation of these bridges is assessed as sufficient and in no need of repair. Annex 2.2.3 details the bridges of great importance. This list contains only bridges >25m length to bridges >100m length. All bridge construction methods at present are arched stone bridges, reinforced concrete bridges and metallic decks assembled by rivets or bolts. The bridges are generally well maintained and in

sufficient condition. Some bridges are in a critical condition and need major repair or renewal. The arrangements for their rehabilitation are described in Chapter 3.1.2

2.2.4 Ballast

The main line is constructed on a 30 to 35 cm ballast bed. The gauge standard is 40/70 mm. At the moment, AZD is exploiting two quarries, one is located in Shamkir the other is located in Kizildya. The broken stone from the Kizildya quarry is of high quality, as we could see for ourselves. In Shamkir, only river gravel is extracted which does not qualify as ballast, although it is used as ballast. The gravel is not broken, round nor is it compressible.

Laboratory test results have not been available, but it is said that the tests are at hand. The ballast bed in most parts of the main line is in a very bad condition, due to climatological erosion, sand drifts and traffic pollution (petrol and salt transports). A high percentage of fine granulation fraction contained in the ballast and the afore mentioned factors are leading to a rapid pollution, so that the ballast is losing its dynamic absorption, elasticity, water permeability, aeration and electrical insulation properties. The ballast cannot distribute the wheel load from moving vehicles over the sub-ballast as evenly as possible anymore, and it does not provide adequate resistance to either longitudinal displacement or lateral shift.

2.2.5 Subsoil

The subsoil will only have the required support capability for accepting the static and dynamic forces arising from train traffic if its elastic modulus is E>800kp/cm^2. This value could not be verified, and in most parts of the track line that we saw during our visits, there were a lot of muddy patches in the ballast. Fact is that the subsoil has not got the required support capability. Subsoil investigation by digging below the surface or drilling tests and their laboratory analysis are necessary, so that an improvement of the subsoil can be planned and made when a track renewal is at hand.

2.2.6 Technical layout data and specification of track geometry

The evaluation of the longitudinal profile, only Baku - Tbilisi main line and vice versa, resulted in the following data:

minimum radius 350 m

maximum super elevation 150 mm, with parabolic transition curves

maximal vertical gradient 12‰

vertical or levelling curves 300 - 3,000 m

distance between centres of lines 4,100 mm

distance between centres of lines in stations 5.30 m

average sleeper spacing 1,840 in curves up to 2,000

permissible speed 100 km/h for passenger trains

permissible speed 80 km/h for freight traffic

gauge 1,520 mm, minimum 1,516 mm, maximum 1,540 mm.

The longitudinal profile is drawn at a scale 1:10,000 for length and 1:1,000 or 1: 500 resp. Not only the level of the upper surface of the rail a. s. l., the level over ground is also indicated. The maximum height above ground is up to 12 m.

Further details are:

The track line with all stations' entry distance, exit distance, switches leading in and out of the passing tracks, signal position, level crossings, constructions and special installations like marshalling yard, loading ramps, workshops and others.

The areas on both sides of the track line and its utilisation as agriculture or forestry operation.

2.2.7 Arrears of maintenance and damaging/destruction of assets

The investigated track from Baku - Tbilisi is in a disastrous situation as we found out. During a track inspection from Baku - Pirsogat, we established that the current situation would be more than hopeless if any serious traffic were handled. The ballast bed is compact, constructed as a concrete slab. The hammer effect of wheel/rail contact is reflected instead of being absorbed. There is no more elasticity, water permeability nor aeration with the unavoidable consequences of destruction of the track assets, damage to concrete sleepers and loss of rail fastenings. In addition to these facts, the load limit of 500 million tons has gone beyond what is permissible. One of the consequences of the compact ballast bed is the high number of broken railsrecorded with 165 broken rails in 1995/1996, all on the Baku - Tbilisi line. The distribution among participating districts, is as follows:

District	Broken rails
Baladshary	23
Baku	52
Kyurdamir	42
Gyandsha	12
Akstafa	6
Evlakh	30
Total	165

The arrears of track maintenance can be put down to the fact that AZD is totally dependent on imports from the former Soviet Union for all track materials, except for ballast.

Due to the lack of financial resources, AZD is presently unable to order the import of the required track material. Since 1989, the annual track renewal programme of 150 - 200 km had been decreased. The renewal performance over the past three years has been 1994 - 40 km

1995 - 44 km

1996 - 10 km track renewal are planned.

Summarising the arrears in track renewals, meanwhile they amount to nearly 900 km. The table below shows the arrears relating to the entire network.

Survey of main track lengths of the districts and urgent track renewals

No.	Designation of district	Responsible for main track lengths	Track past the load limit of 500 mill.t per km	Renewals of track in bad condition km	Remarks
1	Hatshmas	239.60	83.00	29.00	**The tracks in**
2*	Baladshary	127.00	39.00	0.00	**bad condition**
3*	Baki	212.70	72.00	38.00	**means :**
4	Apsheron	226.20	64.00	9.50	**load limits**
5*	Kyurdamir	277.10	100.00	37.00	**>500 mill.t/km**
6*	Gyandsha	223.30	25.00	0.00	**rail vertical**
7*	Akstafa	238.20	5.00	0.00	**wear >12mm**
8	Saatli	251.30	44.00	4.00	**damaged**
9	Mindshivan	163.10	33.00	0.00	**sleepers/km**
10	Ordubad	103.90	23.00	0.00	**>6 - 800/km**
11	Nakhtshevan	140.50	86.00	0.00	
12	Salyan	219.50	98.00	1.30	
13*	Evlakh	255.70	32.00	18.00	
14	Shirvan	117.80	23.00	4.00	
15	Shaki	162.30	122.00	140.80	
16	Summary	**2958.20**	**849.00**	**281.60**	
	Percentage of endangered main track	**100%**	**28.7%**	**9.5%**	
	The districts numbers marked by a star are districts located on the investigated line Baku-Tbilisi.				

2.3 Analysis of track and constructional work, maintenance organisation and facilities.

- Methodology and organisation of maintenance

Annex 2.3 shows an organisational system of the track economics division (general management) managed by a chief engineer. The chief engineer organises the administrative work for track maintenance and related services of civil engineering in AZD's administration building in Baku, including the districts and other work-units that are located on the main line. The organisational structure shows only the work-units operating on the investigated line. Altogether, there are normally 3,726 employees, who are now reduced to 2,861 employees.

The tasks of methodical maintenance are to be carried out by 15 districts for the whole network. Six of them are located on the Baku - Tbilisi line. The responsibility of the districts along the main line is as follows:

Name of the district	Responsible for km main line	Located at km
Baladshary	127	2647
Baku	212	
Kyurdamir	277	342
Gyandsha	223	183
Akstafa	238	88
Evlakh	255	250

The main tasks of a district are:

-visual check by walking on the side path and routine examination of the main system groups of the track - rails, fastenings, sleepers and the ballast bed;

-irregularities in the track geometry such as alignment, super elevation, square position of the sleepers;

-special investigation by order of the chief engineer;

-emergency repairs, broken rails for example.

In 1995/1996, 165 broken rails were recorded, 52 of them in the Baku District. Corresponding to the instructions, the broken rails have to be repaired by changing a standard rail bar of 25 m. All broken rails have to be journalised by giving details about district, line or station, track number even or uneven, km point, panel number, left or right rail and rail type. The rail damages have to be described and have to be written onto the damaged rail, either inside or outside. An engineering manual provides instructions about all types of rail damages, with a code number for each type description.

-manual ultrasonic testing, carried out by a specialised team in each district, performance 5 km/hour, the results are reported.

In addition to the above mentioned track and rail tests, the rails of the entire network have been examined ultrasonically and magnetically by 3 inspection coaches, owned and operated by central management at Baku (defectoscope coaches 312, 411 and 365). A track measuring coach, located in the Baku District, records the geometric parameters of the entire track-network twice a month. The results from the geometric measuring are assessed with the help of a digital quality coefficient, covering all deficiencies of the geometric parameters.

The classification of the calculated coefficient is, as follows:

0	**- 40**	**very good, equal to condition after a general track renewal**
40	**- 100**	**good, several points on the line have to be checked**
100	**- 500**	**moderate to bad, consistent observation until partial renewal, ballast cleaning, sleeper replacement and rail fastenings**
	>500	**bad, the track needs renewal.**

Due to the lack of regular maintenance in the last 7 years, it often occurs that the coefficient has four digits.

The facilities such as district office buildings, workshops, common rooms are of a very poor standard and in need of a consistently planned and implemented modernisation. The mobility has broken down due to the lack of any means of transport.

Annex 2.3a shows the organisation of Baku District, as alternative for the other 14. The other ones are structured in the same way. Annex 2.3 b indicates the basic equipment with small track - maintenance machines and tools to cope with the tasks.

2.3.1 Permanent-way workshop

For major repairs and complete track renewals (general repairs), AZD use three well equipped and staffed permanent-way workshops. They are located at Kyourok, Sangatshali and Tsharkhi. A chief engineer manages the workshop and he gets his work instruction from general management at Baku. The work instructions depend on the annual work programme and the track material is stored at the workshops accordingly. The available track engines are of Russian construction except for the UK units, which are working very efficiently. However, a rehabilitation will be necessary. The tamping, lining and ballast cleaner machines have to be replaced. The UK-system is working with 25 m track panels, which are pre-assembled and loaded onto special wagons. The panels are transported to the side. The crane, well known as 'Platov Crane', takes the pre-assembled panels and puts them onto the prepared track formation. The special wagons, coupled to form a pair, can be loaded

with 5 panels, so that a unit of 12 wagons is needed for the transportation of 750 m of track. The same is required for transporting the removed panels. The performance over a period of 6 hours is said to be 1,200 m of track, including ballast cleaning, tamping, lining and ballasting. After finishing the work, the first 3 trains will run with a speed of 15 km/h, the next three with 25 km/h and then the permissible speed of 80-100 km/h is permitted.

The staff normally amounts to 116 people, now reduced to 79. Annex 2.3.1 shows the organisational structure of the permanent-way workshop Sangatshali.

2.3.2 Welding plant at Saliani

The welding plant at Saliani is very important for track renewal of the whole network. It is said that at Saliani the standard rail bars of 25 m are welded to form 800 m long rails. The transportation of these is conducted by special wagons without any problems. There has not been the occasion for visiting the plant yet, so that all the information we have got, has been obtained from the general management division at Kabu.

2.3.3 Depot and workshop for track-engine repairing at Baladshary

The Baladshary track-engine repair plant was built in 1903. The structures such as halls and shops are in a sufficient condition, bearing in mind their age. The available tools and machine tools are in working order, but a modernisation will be necessary. At the moment, 30 workers and 10 administrative employees are working at this plant. The work orders come from general management and could be carried out if enough spare parts were available. The instructions resulting from the various inspections cannot be followed up due to a lack of all kinds of spare parts. The main activities are focused on repairing diesel motors by dismantling some to obtain spare parts for others.

A general modernisation of the existing buildings, new machine tools, tools and a new work place organisation will be necessary. Cost estimate $ 200,000.

2.3.4 General management division at Kabu

The general division at Kabu manages and has the control over all facilities which are established on the line and at the administration of Baku. All events that occur on the line and on constructions are collected and journalised. The causes are identified and measures are taken to prevent such events as derailments or other interruptions of train movements. The documents frankly and openly show the reality of the insufficient situation marked by damages to the track lines, which originate in the lack of maintenance or necessary renewals.

The severe shortage of means over a lot of years has caused this lack of prevention. The most important document is the so called 'track passport' or track C.V., in which all events on the track are recorded, which have occurred since the last renewal. The main facts are: date of last renewal, load cumulated in million tons, rail stress, number of damages on the rails, damaged sleeper per km, ballast pollution and interventions by maintenance measures or small repairs. Each km of the superstructure disclosed by this document can be examined at any time.

The general management division for the superstructure and all related services that is capable to find out and to journalise all important mistakes on track elements with such an exactness, will also be capable of renewing and of maintaining their track line themselves. Knowledge and skilled staff are available. Its only the financial means and nearly all kinds of equipment which are missing.

3 Analysis of weaknesses and limitations

3.1 General

As mentioned above in Chapter 2.1, the current situation of the main Baku - Tbilisi track line and the related component parts has been explained. Chapter 3 will show the damages and bottlenecks of the track line and will point out "what is to be done" in order to eliminate all damages which are hampering a steady flow of traffic.

3.1.1 Switches

1,475 switches are installed on the main line, which are all connected from and to the main line. All these connections have to be well maintained and in a good condition. It will be very important that the pilot train or all through trains pass the stations without speed restriction. This condition is only to be implemented once the switches have been renewed, in accordance with the requirements of the current situation.

Quantity of switches which are to be renewed = 200 R 65 300 1: 11

Quantity of crossing timber sets to be completed = 140 sets

3.1.2 Bridges and tunnels

Most of the bridges on the main line (Annex 2.2.3) are in a good condition generally, due to methodical maintenance measures. Although, there are some bridges which have to be rehabilitated by major repair or renewal. Chapters 3.1.2.1 - 3.1.2.7 below show the bridges which are in need of heavy repair or renewal, in the order of urgency.

3.1.2.1 Bridge number 56 at km 541+500

The Bridge entrance and exit of Baku main station is so severely damaged that the track panel over this bridge (right or even track) had to be dismantled in July 1996, to avoid any traffic crossing. The bridge, constructed as a pre-stressed concrete slab type, is in danger of collapsing because the road traffic has destroyed the pre-stressed concrete slab.

The concrete slab is no more able to accept a dynamic load (moving train) crossing the bridge. The even track is locked for an indefinite period of time. All trains going to and coming from Baku are now passing the temporary single-line running via the still well operating separate bridge of the uneven track. The detention of trains (passenger and goods) at junction stations has to be planned and careful traffic control has to be arranged. The project to renew this part of the bridge is at hand. A cost estimate was not available.

3.1.2.2 Bridge construction at km 157+700

Bridge number 19 and 20 of the bridge list is jeopardised by wash-aways at the foundations of the abutments and piers. River training and security measures have to be undertaken. Project documents have already been prepared. The cost estimate is figured at $ 866,000.

3.1.2.3 The bridge at km 111+200

Bridge construction number 10 and 11 of the bridge list is partially in need of replacement. The renovation work is at hand. Project documents exist, the cost estimate is figured at $ 954,000.

3.1.2.4 The bridge at km 234+600

Bridge number 31 of the bridge list has to be renewed completely. The bridge openings of 4 times 3.60 m are too small for the mass of water coming from the catchment area. The bridge is endangered by wash-away. Project documents do not exist. Estimate $ 100,000.

3.1.2.5 The bridge at km 252+800

Bridge construction number 33 and 34 of the bridge list needs a complete renovation. This bridge was constructed in 1927 as a riveted steel construction. The physical deterioration and heavy corrosion demand the bridge renewal. Project documents have already been prepared. The cost estimate is figured at $ 2,950,000.

3.1.2.6 The bridge at km 360+200

Bridge number 41 and 42 of the bridge list requires continuation of safety and protection measures. The construction is in good condition but endangered by the undermining of the foundations of the abutments and piers by the mass of water approaching. The project documents show an amount of $ 200,000.

3.1.2.7 The bridge at km 72+300

Bridge number 5 of the bridge list was renewed in 1996 and is located in a single track-line section. This single track could be a bottleneck in the future when the line is carrying dense traffic. In case of such increased traffic, a second track in this section could become necessary, then a second bridge would have to be constructed for a free flow traffic system. The project documents have been prepared, the cost estimate is figured at $ 4,545,000.

3.2 Track line rehabilitation

The permanent lack of financial means since 1989 has led to the arrears in track renewals and in scheduled full track maintenance. The need to catch up amounts to nearly 900 km. To overcome this backlog, an extensive track renewal programme has to be started and be implemented in the short-term. Annex 3.2a contains the worst track sections on the main line of about 200 km. These sections have to be renewed before the pilot train starts. AZD has no production of any track material except for ballast so that all track elements such as sleepers, rails and fastenings have to be imported. The quality of AZD's own ballast production is not sufficient because the quarry-equipment such as crusher, riddle system and wash equipment have to be renewed in order to raise the daily output from 300 m^3 today to more than

10 - 20,000 m^3/day in the future. With these improvements, it would be possible to obtain the ballast without filler, fine granulation fraction and dust.

AZD is able to do the track maintenance and track renewal themselves, man power and skilled personnel are available. However the best personnel cannot be efficient when the equipment and track engines are not working and available. Here we also have a lack due to the shortcomings in the financial situation of the last years. Annex 3.2 shows the shortage of small track maintenance machines and tools for one district only. A cost estimate has been drawn up for replenishing the shortage (see table below).

No.	Designation	Shortage	Price per unit $	Total $
1	Tamping units, type GB 4 with Briggs and Stratton engine	34	16,717	568,378
2	Rail saws, type SRN-E with electrical engine 220/380 V DC, 50 Hz	5	3,443	17,215
	supplement for hydraulic device		983	983
3	Rail drilling machines, type PR 8-E-2V	2	3,933	7,866
4	Rail grinding machines, type MP 12-E	15	4,033	60,495
5	Coach-screwing machines, type T52-E	31	6,097	189,007
6	Coach-screwing machines, type TS2 with gasoline engine Bernard 617	34	6,490	220,660
	supplement for torque limiter		295	295
7	Track lifting and slewing machines type RV 100 for track 1520 mm	2	39,333	78,666
8	Hydraulic jacks, type CH 65	35	930	32,550
9	Wooden sleeper carrying tongs	34	88	2,992
	Concrete sleeper carrying tongs	34	106	3,604
10	Hand-operated rail pullers with chain	10	1,733	17,330
11	Generators, type CR 2500 with Briggs & Stratton gasoline engine	8	847	6,776
	carried forward			**1,207,817**

No.	Designation	Shortage	Price per unit $	Total $
	carried forward			1,206,817
12	Generators, type RG 4500 T with			
	Briggs &Stratton gasoline engine			
	mounted on a hand-pushed one-wheel			
	trolley, power 4 kW /220/380 V/50 Hz	2	1,733	3,466
13	Signalling lamps, 3 colour lights	129	243	31,347
14	Team carriers	12	40,000	480,000
15	Four-wheel drive cars	2	30,000	60,000
	direct costs			1,781,630
	value added tax 15 % 1781630			267,245
	dispatch and insurance 20 % 1781630			356,326
	unforeseen			94,799
	Total			**2,500,000**

The efficiency of a district is dependent on its equipment and replenishing only the shortage of Annex 3.2 an amount of $ 2.5 million is necessary. This sum has to be multiplied by 6, which is the number of the districts located on the main line. Therefore a total of 6 x 2.5 = $ 15.0 million will be necessary. In due course a current shortage list will have to be drawn up. With the completed equipment and the possibility of mobilisation by own team carriers, the scheduled full maintenance on the line is ensured.

The track renewal is planned and executed by staff and equipment of the permanent-way workshop (see Chapter 2.3.1...). The available track engines and equipment are prone to break down, due to their age. The break-down stoppages while the track renewals are in full progress, are forcing those responsible to improvise. All improvisations influence the quality of the work and are the first reason for increased maintenance measures. Annex 3.2 shows the inventory of track engines and their current usability. These track engines originate from the former Soviet Union. They are very heavy, old and are no more up to date for modern track renewals and maintenance measures. Instead of expensive repairs of the available engines such as VPO 3000 tamping and levelling, R 2000 track liner, we recommend to buy new ones. The Shom ballast cleaner has to be replaced by a new, modern and efficiently working ballast cleaner, which is able to clean the

ballast to a depth of 1.00 m below the top of the rail and the guided excavation chain which produces an exactly straight subgrade. The new track engines are to be understood as a unit consisting of: ballast cleaning, tamping and ballast regulating machinery. This unit will be needed twice, one in the short-term, the other in the medium-term. The table below shows the kind of machines and recommended price for required machines.

Item	Short description	Recommended price per Unit in $
1	RM 80 UHR	
	Ballast cleaning machine for switches,	
	crossings and plain track universal application.	
	length over buffers = 31.80 m	
	excavating width standard = 4.00 m	
	max. excavating depth below top rail = 1.00 m	4.38 million
2	Unimat 08-475 4S	
	perfect maintenance of switches and crossings.	
	technical data	
	length over buffers = 33.99 m	
	width = 3.00 m	
	total weight of machine = 100 t	
	four tamping units	2.86 million
	carry forward	7.24 million
3	High performance ballast regulating machines	
	Technical data:	
	length over buffers = 17.45 m	
	width = 3,000 mm	
	weight = 36 t	1.24 million
	Total	**8.48 million**

The above listed machines are working successfully in the CIS. In order to utilise high performance machine systems properly, it is essential to have a perfect user technology, tailored to the specific operating conditions. This user technology has been developed in close cooperation with the railway authorities, on the basis of experience in many countries under the most varied climatic, geographic and permanent-way conditions. Training programmes, tailored to the operating condition of AZD, are available.

Another important weakness are the quarries, the most important equipment has been vandalised and destroyed. Thus, the quarries are unable to produce the different fractions of grain, especially ballast, or others for prefabricated concrete parts. Fully operational quarries will be the guarantor of high quality ballast for the permanent way and all required grain sizes for the production of prefabricated concrete parts, even pre-stressed concrete sleepers. An estimate given by the AZD authorities amounts to $ 0.60 million. It includes: new crusher and riddle systems, pipes and conveyor belts, wash equipment to clean the broken stones from dust and filler, bulldozers, excavators and trucks, other materials for the renovation of offices and social rooms.

The dependence on importing all track materials is significant for the difficult situation. With modernly equipped quarries, AZD would be able to develop an own pre-stressed concrete sleeper production, with new sleeper design and fastenings, according to European standards. First investigations show that a fully mechanised concrete sleeper plant will cost $ 12 million, and a partially mechanised one $ 8.7 million. These prices do not include real estate, land development, works buildings, necessary infrastructure like roads, works siding, power sources and water.

3.3 Definition of training needs.

Professional skill is the most important requirement in order to achieve quality and high performance in mechanised track work, track renewal and track maintenance. The skill is required in 3 fields.

- railway track

Operation staff of the general management up to permanent-way inspector. The training comprises organisation of track renewal and track maintenance, work programme, time schedule of completion, updating of engineering manuals and instructions, competitive procurement procedure, computerising of track inventory and constructions.

-Operation of new track engines and

-maintenance of machines.

The training of operating and servicing staff is gaining greater importance for successful and economical operation of the machines. The training programme will help the machine crews to operate the engines at a high performance. The objective of the training programme will be to inform and to teach the leaders of machine crews to operate the engines for the best results in performance and long service life. The training should be carried out in seminars of 4 weeks. The programme contains theoretical and practical parts and on location visits and imparts required skills for machine operation, machine crew and members, for machine maintenance service specialist, mechanics and electricians.

3.4 Financial pre-feasibility

The financial pre-feasibility comprises all weaknesses and limitations described in Chapter 3 and shows the amounts that are inevitably necessary to rehabilitate the Baku - Tbilisi track line. The cost estimate contains a general idea of direct repair costs and the possibilities of achieving the full scheduled maintenance system by a new generation of track engines and equipment. The recommended engines and equipment represent the basic requirements. Within AZD there are far-reaching independent plans for an extensive track maintenance and track renewal as well as track conservation for a long service life. The table below shows the summary of the

financial means distributed over the next ten to fifteen years. Annexes 3.4 - 3.4.3 show the more detailed cost estimates.

Summary of financial means to rehabilitate the Baku - Tbilisi track line

Designation	2000	2005	2010	2015
Permanent way 200 km 40 km /year annex 3.4	**$ 68.700 mill.**	**$ 68.700 mill**	**$ 68.700 mill**	**$ 68.700 mill**
Equipment of districts and track engines annex 3.4.1	**$ 27.380 mill.**	**$ 10.245 mill.**	**$ 0.905 mill.**	
Bridges, annex 3.4.2	**$ 3.140 mill.**	**$ 2.950 mill.**	**$ 4.545 mill.**	
Construction costs annex 3.4.3	**$ 10.200 mill.**			
Total	**$ 109.420 mill.**	**$ 81.895 mill.**	**$ 74.150 mill.**	**$ 68.700 mill**

4 Conclusions for the pilot train

4.1 The pilot train in view of the permanent way.

The pilot train will use the Trans-Caucasian line between Baku -Tbilisi -Senaki - Poti and vice versa as intermarshalling yard train. The preconditions for the realisation will be as follows:

-safety of traffic and

-running at permissible speed.

At the moment, both preconditions are not being met. The track line is suffering from relevant irregularities in geometric position as well as in physical conditions. The backlog of scheduled full track maintenance over a long period of time and the missing necessary track renewals to counter wear and tear of track elements and even the lacking instructions to carry them out, have led to numerous speed restrictions. The average speed from Baku to Poti amounts a max. of 40 km/h or less at the moment. That means a lost of 50 % of the permissible speed of 80 km/ h.

To fulfil the preconditions would mean:

- scheduled full maintenance of both track and constructions
- track renewal programme for 460 km (GZD+AZD), in the short-term
- track renewal programme 40 - 50 km /year only on the line Baku - Poti in the medium and long-term
- short-term renewal programme for 600 switches, and 40 switches per year in the long-term
- bridge construction programme as described in the reports.
- in connection with the above mentioned, the procurement of track engines, small track engines, tools, equipment for districts, permanent-way workshop, track engine repairing depots , pre-stressed concrete sleeper plant, quarry equipment and impregnation plant.

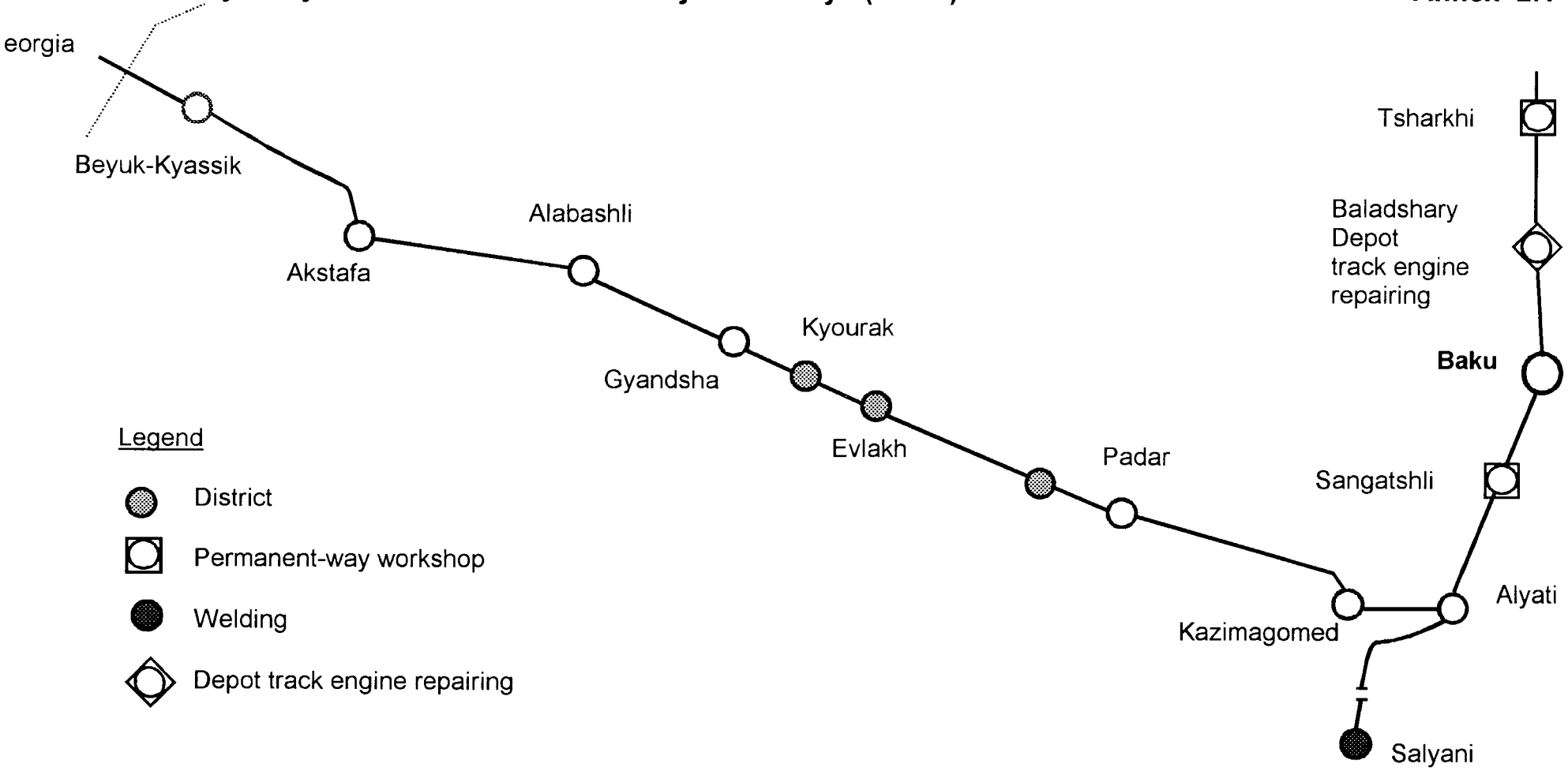
With the procurement of above listed engines and equipment, GZD and AZD will be able to manage the renovation and rehabilitation themselves.

Annexes

Annex	2.1	Survey of the Baku - Tbilisi track line
Annex	2.2.3	List of Bridges
Annex	2.3	Organisational structure of permanent-way general management
Annex	2.3a	Organisational structure of Baku District
Annex	2.3b	Small track maintenance machines and tools
Annex	2.3.1	Organisational structure of Sangatshali permanent-way workshop
Annex	3.2	Inventory of track engines
Annex	3.4	Cost for permanent way
Annex	3.4.1	Cost for equipment of districts
Annex	3.4.2	Cost for bridge renewals
Annex	3.4.3	Cost for quarries and future concrete sleeper plant

Baku - Beyuk-Kyassik Track line of Azerbaijan Railways (AZhD)

Annex 2.1



Annex 2.2.3

Bridge list

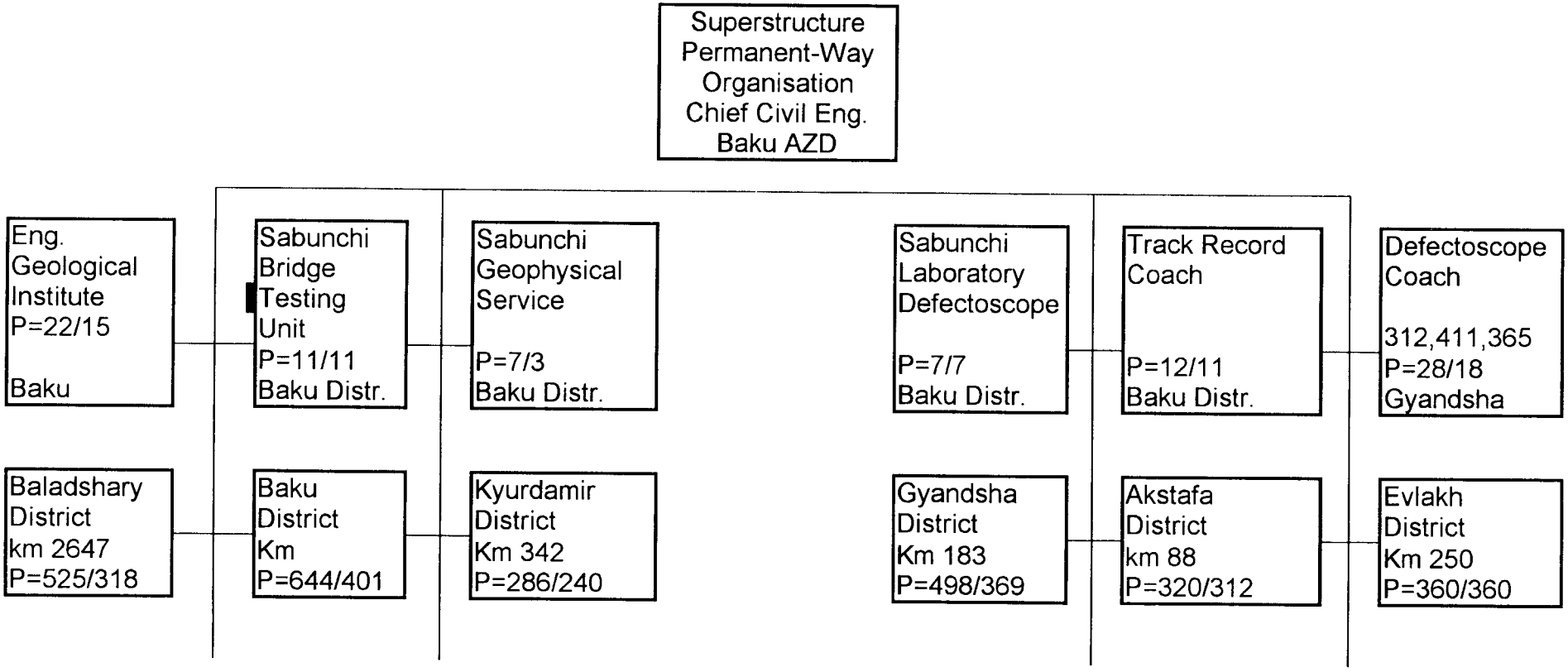
No.	Bridge km	Name of bridge	Crossing river valley	Length	Span	Needs	Remarks
1	61 +800 le	Metal br.	Kaza-su	51.20	4 x 10.66	Maintenance	
2	61 +800 ri	Fer.concrete		51.65	4 x 11.50	Maintenance	
3	66 +500 le	"	Feeder	27.65	1 x 10.68	Maintenance	
4	66 +500 ri	"	"	32.5	3 x 9.30	Maintenance	
5	72 +300	Metal bridge	Kuza	208.36	11.52+34.00+87.00+55.00+11.52	Maintenance	Single track
6	88 +000	Pedestrian	St.Akstofa	60.1	12.30+18.60+8.50+19.20	Maintenance	
7	88 +900	Fer.concrete	Irrig.canal	36.1	2x10.00+16.00	Maintenance	
8	93 +700 le	Metal bridge	Cassan-su	37.53	1x22.76	Maintenance	
9	" ri	"	"	36.55	1x23.00	Maintenance	
10	111 +200 le	"	Akhindshats.	110.87	56.23+2x22.76		Openings in
11	" ri	"	" "	114.5	53.40+13.60		construction
12	112 +800le	"	Aseik-tschai	25.16	1x21.34	Maintenance	
13	130 +100le	"	Dzegam-tsh	53.24	2x22.36	Maintenance	
14	130 +100ri	"	" "	44.38	4x10.70	Maintenance	
15	145 +100le	Fer.concrete	Irrig.canal	25.18	1x11.60	Maintenance	
16	145 +100ri	"	" "	25.18	1+11.60	Maintenance	
17	147 +500le	"	" "	32.5	2x11.88	Maintenance	

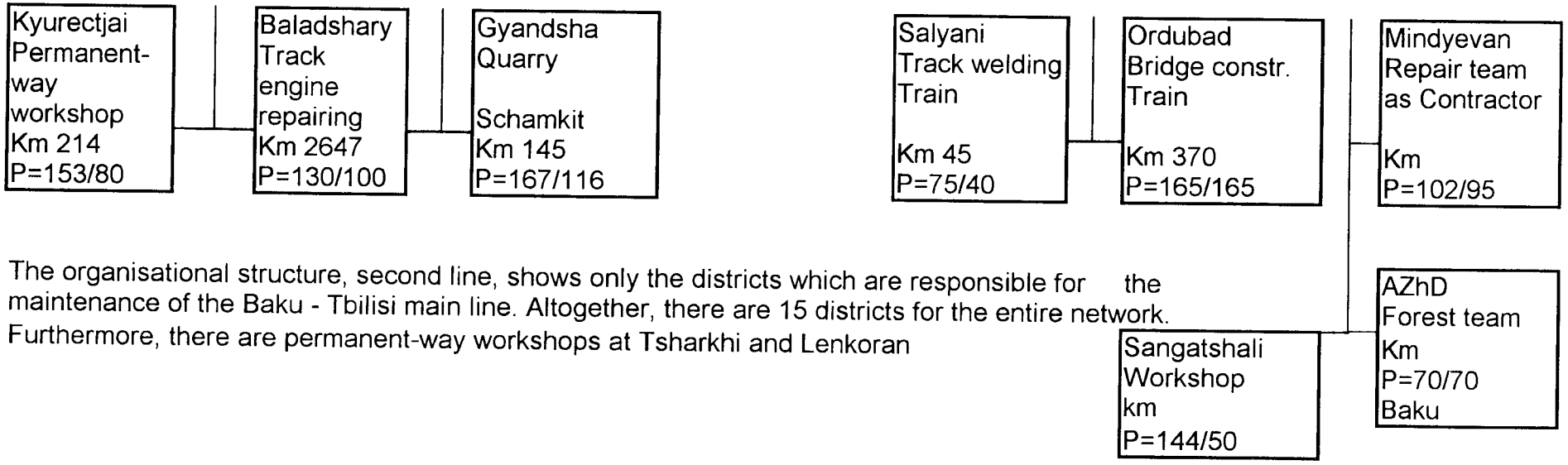
18	147 +500ri	"	" "	34.17	2x11.80	Maintenance	
19	157 +700le	Metal bridge	Shamkirtsh	53.85	2x22.70	River training urgent	
20	157 +700ri	"	" "	53.90	2x21.30	River training urgent	
21	174 +800le	"	Koshkastsh	28.10	1x21.19	Maintenance	
22	174 +800ri	"	" "	29.14	1x22.36	Maintenance	
23	179 +700	Fer.concrete	Chan-ash	25.21	2x8.70	Maintenance	
24	182 +000	Footbridge	St.Gyandsha	114.00	1x63.30	Maintenance	
25	186 +200le	Metal bridge	Gyandshats.	56.95	2x22.36	Maintenance	
26	186 +200ri	"	" "	51.30	4x10.66	Maintenance	
27	208 +300le	Fer.concrete	Kjusaktshai	28. 20	1x23.00	Maintenance	
28	208 +300ri	"	" "	26.32	1x6.5+1x13.98	Maintenance	
29	221.+900le	Metal bridge	Gerantshai	27.18	1x14.44+1x7.55	Maintenance	
30	221 +900ri	"	" "	37.00	1x23.60	Maintenance	
31	234 +600	Fer.concrete	Obes.Kasca.	34.20	2x3.65+2x3.60	Bridge openings too small	
32	249 +800	Footbridge	St.Evlakh	66.10	1x18.00+1x21.00+1x27.00	Maintenance	
33	252 +800le	Metal bridge	Kura	262.77	2x11.50+3x76.80	Heavy repair	
34	252 +800ri	"	"	262.77	11.50+77.00+2x76.80+11.50	Heavy repair	
35	275 +900le	Fer.concrete	Turiantshai	46.35	1x10.80+1x15.80+1x10.80	Maintenance	
36	275 +900ri	Metal bridge	" "	44.68	1x33.60	Maintenance	
37	294 +900	Footbridge	St.Udshary	54.06	1x26.77+1x26.78	Maintenance	
38	300 +900le	Fer.concrete	Geoktshai	43.3	3x10.80	Maintenance	
39	300 +900ri	Metal bridge	" "	41.4	3x10.67	Maintenance	
40	341 +300	Footbridge	Kyurdamic	57.1	1x20.87+1x12.05+1x22.40	Maintenance	
41	360 +200le	Fer.concrete	Canal	38.96	4x6.00	Maintenance	
42	360 +200ri	" "	Canal	38.96	4x6.00	Maintenance	
43	368 +400le	Fer.concrete	Irrig.canal	30.18	3x7.13	Maintenance	
44	368 +400ri	Fer.concrete	Irrig.canal	28.15	3x7.62	Maintenance	

45	418 +100	Fer.concrete		26.2	1x10.80	Maintenance	
46	475 +000	Metal bridge		33.9	1x18.00	Maintenance	
47	475 +000ri	Metal bridge		33.9	1x18.00	Maintenance	
48	475 +000	Fer.concrete		35.75	1x19.40	Maintenance	
49	482 +600le	Metal bridge		38.4	1x22.36	Heavy repair	
50	482 +600	Metal bridge		38.4	1x22.36	Heavy repair	
51	531 +200ri	Metal bridge		31.2	1x21.36	Maintenance	
52	532 +600le	Fer.concrete	Binagad	53.16	2x10.61	Maintenance	
53	532 +600ri	Fer.concrete	Binagad	53.16	2x10.61	Maintenance	
54	538 +000	Fer.concrete	Bagis-bridge	33.01	1x18.00	Maintenance	
55	540 +700	Footbridge	St.Montino	27.71	1x6.31+1x10.10	Maintenance	
56	541 +500	Fer.concrete	Moskovskiy	48.4	1x19.05	Renewing,damaged	
57	543 +000	Metal bridge	St.Fioletovo	61.3		Maintenance	

Annex 2.3

Organisational structure of permanent-way general management

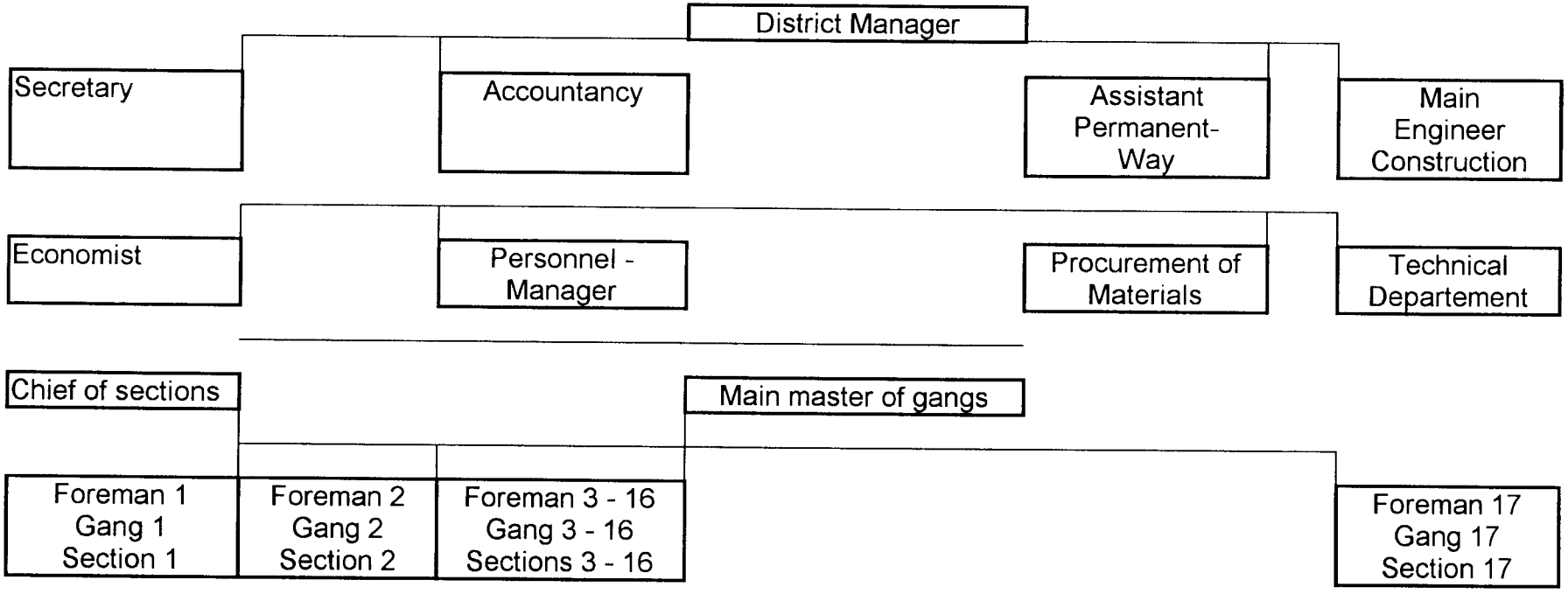




The organisational structure, second line, shows only the districts which are responsible for the maintenance of the Baku - Tbilisi main line. Altogether, there are 15 districts for the entire network. Furthermore, there are permanent-way workshops at Tsharkhi and Lenkoran

Annex 2.3a

Organisational structure of Baku District



Remarks:
Personnel of a district is given as 401 people at the moment. That's the organisational chart of Baku District, the others are similarly structured. The average track length is 170 km double track. The districts are equipped with an office building and workshops. These structures are very old and urgently need renewal of some parts and a thorough modernisation.

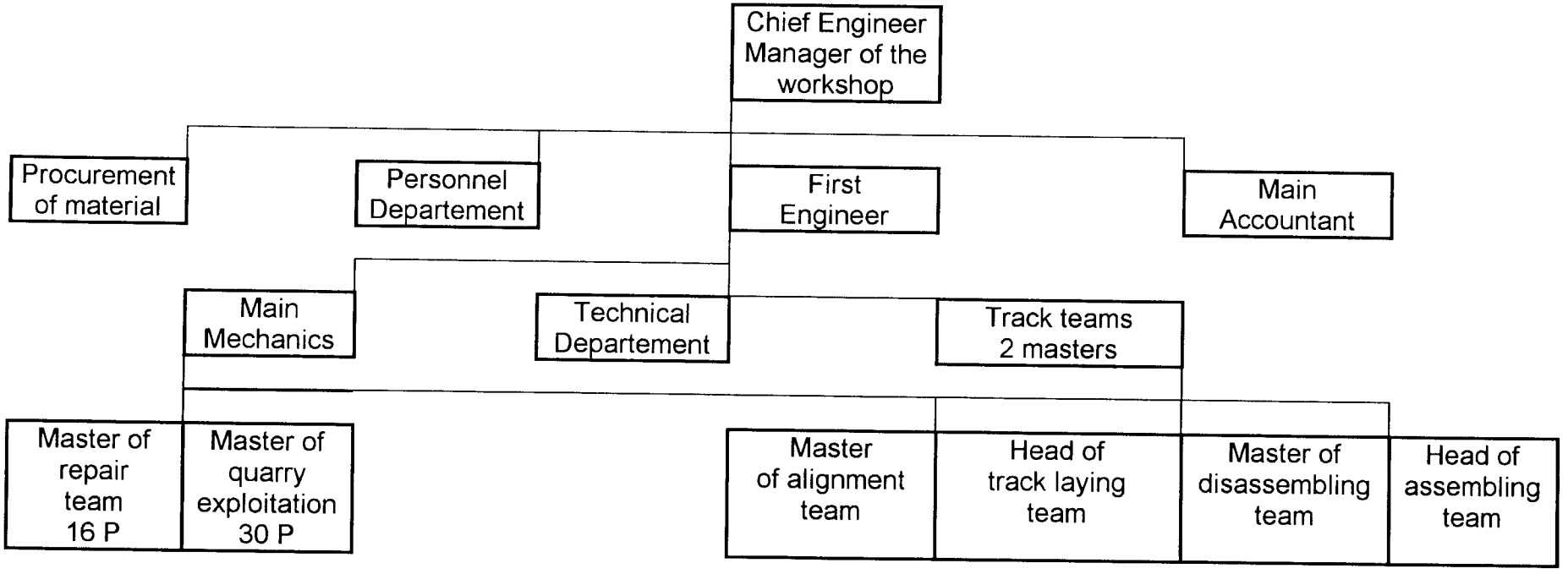
Annex 2.3b

Small track maintenance machines and tools

BAKU District						
Equipment of small track - maintenance machines-and track tools						
Item	Designation	Basic requirement of one gang	Stock and shortage of essential equipment for 17 track gangs of Baku - District			
			required	available	shortage	remarks
1	packing of sleepers (el)	10	170	36	134	
2	rail saw (el) RM 2	1	17	12	5	
3	rail drilling machine (el) 1024 B	1	17	15	2	
4	rail grinding machine (el) MRSh 3	1	17	2	15	
5	rail screwing machine (el) EK 1	2	34	3	31	
6	ShV - 1 screwing machine	2	34	0	34	
7	hydraulic rail pinch	1	17	15	2	
8	hydraulic track-lifter	6	102	67	35	
9	hydraulic track-straightening-set one set consists of 5 pieces	1	17	2	15	
10	tongs for concrete sleepers	2	34	0	34	
11	rail puller for long rails	2	34	0	34	
12	generator AB - 2 kw	1	17	9	8	
	AB - 4 kw	1	17	15	2	
13	signalling lamps	8	136	7	129	
14	personnel transport truck	12	12	0	12	district only
15	management car	2	2	0	2	

Annex 2.3.1

Organisational structure of Sangatshali permanent-way workshop



Annex 3.2

Inventory of track machines

No.	Type of engine	Perfor-mance per h	Quantity	Opera-ting	Out of order	Needs		Remarks
						repair	renewing	
1	VPO 3000 Tamp-ing & levelling	3km/h	3	1	2	1	1	
2	ELB levelling grader with ballast brush & plough	2,8 m/s	3	3	0	0	0	managed by permanent-way workshop
3	VPRS - 02 tamping,levelling straightening,track & switches	270m/h	1	0	1	1	0	
4	VPR,tamping, levelling track only	650m/h	1	0	1	0	0	
5	ROM rail cleaner by high pressure water jets	2000 m/h	1	1	0	0	0	
6	SHOM ballast cleaner	2000 m^3/h 750 m/h track	1	1	0	0	0	seen 29.05.96 only shunting cleaning insufficient only 60 cm f. rail head
7	PRSM, butt wel-ding & rail grinding machine	10 welds per h	2	1	0	0	1	managed by rail welding plant at Saliani
8	PMG, bold screw-ing machine	800m/h	4	4	0	0	0	
9	R 2000 track liner	2000 m/h	1	0	0	0	1	

10	ZOuB,snow & waste-plough	74.2 t/h	2	1	1	1	0	Balashenko
11	Cranes,with hori-zontal swinging jib	4t at 5.8m	33	16	17	14	3	2 -3 per distrct type DGKU
12	Ballast hoppers	35m^3	338	0	0	0	0	pneumatic command
13	Snowplough unit	750t/h	5	4	1	1	0	SM-2 type
14	" " "	25km/h	10	5	5	0	5	SDP type
15	" " "	25Km/h	3	3	0	0	0	TARAN type
16	" " "	25Km/h	3	1	2	0	2	UDPM type
17	Track motor-car	5t	4	4	0	0	0	MPT type
18	Motor crane wagon	45t	13	10	3	3	0	MPD type
19	UK-25/18	1,000m/h	8	6	2	2	0	
20	Planning machine	40KN	3	2	1	1	0	
21	Railway crane	170KN	17	12	5	3	2	
22	Diesel engine	100KN	11	10	1	1	0	TGM-2 type
23	Diesl engine	1000KN	1	1	0	0	0	TEM type

Annex 3.2a

Worst track sections of the investigated line

No.	section	site start km	site end km	site length km	actual speed restriction km/h	ranking list	remarks
1	2	3	4	5	6	7	8
1	Yevlakh-Mongetshaur	236	246	10	5km 25km/h 4km 40km/h	7	2km (-6)
2	Yjaki-Malai	262	266	4	2km 25km/h	10	
3	Udshary-Alikend	286	294	8	3km 60km/h 4km 40km/h	11	
4	Gadjshievo-Padar	384	392	8	1km 40km/h	4	3km(-6)
5	Karabudshag-Mysysly	320	330	10		3	5km(-6)
6	Atbulak-Navagi	433	446	13		5	2km(-6)
7	Aliat-Atbulak	446	460	14	3km 25km/h	1	11km(-6)
8	Duvanni-Aliat	460	473	13	10km 40km/h	2	5km(-6)
9	Sangatshaly-Duvanni	473	484	11	1km 15km/h	6	2km(-6)
10	Karadag-Sangatshaly	488	497	9		8	1km(-6)
11	Baladshary-Eibat	517	527	10	1km 40km/h 2km 60km/h	9	1km(-6)
12	Baku-gr.Kishli	2654	2660	6		12	
Track border point-Baku				**116**			**50km(-6)**
13	Karabudshag-Kyrdamir	328	341	13	1km 25km/h	3	4km(-6)
14	Kerar-Sgiri-Padar	352	378	26	14km 60km/h	1	12km(-6)
15	Mugan-Gadjshievo	391	404	13	13km 60km/h	2	11km(-6)
16	Sangatshaly-Karadag	484	496	14	1km 25km/h	4	2km(-6)
17	Eibat-Baladshary	515	525	10		5	1km(-6)
18	Puta-Eibat	509	517	8		7	
Track Baku -border point				**84**			**30km(-6)**

Annex 3.4

Costs for permanent way

item	Definition and short description	Quantity	2000	2005	2010	2015
1	Maintenance permanent way					
	Track line Tbilisi - Baku					
	annex 3.2 ranking list 1 -12 = 116 km					
	price / km = $ 0.300 million	116	34.800	30.000	30.000	30.000
2	Track line Baku - Tbilisi					
	annex 3.2 ranking list 1 - 7 = 84 km					
	price / km = $ 0.300 million	84	25.200	30.000	30.000	30.000
3	Switches on the main line					
	both directions Baku - Tbilisi and vice-versa					
	price / unit = $ 0.040 million	200	8.000	8.000	8.000	8.000
4	Crossing timber sets					
	price / unit = $ 0.010 million	140	0.700	0.700	0.700	0.700
Total maintenance permanent way $ million			68.700	68.700	68.700	68.700
	Total maintenance permanent way $ million		68.700	68.700	68.700	68.700

Costs for equipment of districts

Annex 3.4.1

item	Definition and short description	Quantity	2000	2005	2010	2015
1	Equipments of districts see cost estimations					
	table page 16 and 17, 11 districts		5.000	5.000		
2	Track engines for permanent - way work shop					
	2 RM 80, ballst cleaning machine, universal application, 1 till 2000,second till 2005 4,380					
	2 Unimat 08-475-4S 2,860					
	completed by spare parts 10% 0,700		7.940	7.940		
	1 high performance ballast regulating machine 1,240 completed by spare parts 0,160= $1.400 million page 20 +21		1.400	1.400		
3	Draisine for bridge inspection VMT 846 COA		1.170	1.170		
	Rail road loader excavator KGT with accessories	6 units	0.670	0.670	0.670	
	Work draisine VMT GR 850	5 units	1.140	1.140	0.570	
	Sleeper positioner PRT-6	2 units	0.910	0.910		
	Hydraulic rail threater	2 units	0.110			
	Total in $ million		13.340	10.230	1.240	

Annex 3.4.2

Costs for bridge renewals

item	Definition and short description	Quantity	2000	2005	2010	2015
	Bridges chapter 3.12 - 3.127					
1	Bridge nr. 56 in km 541+500, Baku entrance and exit of main station	1	1.000			
2	Bridge nr. 19+20 in km 157+700	2	0.886			
3	Bridge nr. 10+11 in km 111+200	2	0.954			
4	Bridge nr. 31 in km 234+600	1	0.100			
5	Bridge nr. 33+34 in km 252+800	2		2.950		
6	Bridge nr. 41+42 in km 360+200	2	0.200			
7	Bridge nr. 5 in km 72+300	1			4.545	
	Total in million $		3.140	2.950	4.545	

Annex 3.4.3

Costs for quarries and future concrete sleeper plant

item	Definition and short description	Quantity	2000	2005	2010	2015
	Costs of constructions and items of equipments					
	to get independence of track material imports.					
1	Quarry equipments as crusher, riddelsystems,					
	pipes, conveyor belts, wash equipment, bulldozers, excavators and trucks and others					
	lump sum		1.000			
2	prestressed concrete sleeper plant in work employments effectuation. Only the important					
	parts for high quality production will be full mechanised. in $ million		8.700			
3	Technical equipment for offices and constructions,lump sum		0.500			
	Total in $ million		**10.200**			

Annexes

Annex 5.1	Survey Tbilisi - Poti
Annex 5.3	Organisation chart General Management
Annex 5.3a	Organisation chart district Tbilisi
Annex 5.3b	Basic equipment district Tbilisi
Annex 5.3.1	Organisation permanent way work shop Tbilisi
Annex 6.1.2	Bridge list
Annex 6.2	Inventory of track engines
Annex 6.2a	Worst track sections of the investigated line
Annex 6.4	Costs for permanent way
Annex 6.4.2	Costs for bridge renewals
Annex 6.4.3	Quarries and futur concrete sleeper requirements

5 Current situation

5.1 Track line border point AZD - Tbilisi - Senaki - Poti

The investigated line leads from Tbilisi to Poti in western direction and is constructed as a double electrified track line. The double line is interrupted several times by a single line:

Senaki - Samtredia	14 km
Senaki - Poti	41 km
Brozeula - Rioni	4 km
Zestafoni - Khashuri	18 km

Side track length is 317 km added by 41 km Senaki - Poti. The total length of the investigated line is 358 km. The border station of the track line for GZD is Gardabani. The main line is equipped with 1,397 switches, the track is of Russian design. Annex 5.1 shows a survey of the main line Tbilisi - Poti and the existing permanent-way services.

5.2 Composition of the permanent way.

Most of the track material used is supplied by Russian manufactories. On the main line (the investigated line), the rail profile is R 65 + R 50 Kg/m and supported by concrete monobloc sleepers, also supplied by Russia.

On the investigated line, the rails are posed at a length of 250 m, welded in a welding plant located in Tbilisi. The 250 m lengths are welded on the side to form 750 m long welded rails with an interruption section of three lengths of 14 m and four expansion gaps.

The rail quality used by GZD is of the self-hardening variety and heat treated rails cover a strength range of 800 to 1200 N/mm^2. Self-hardening rails dominate the market and practically all current applications can be catered for with these rails.

A distinction can be made between 4 groups:

- rails with 690 N/mm^2 minimum tensile strength, corresponding to UIC requirements
- rails with 820 N/mm^2 minimum tensile strength, corresponding to ASTM and GOST requirements,
- rails with 880 N/mm^2 minimum tensile strength, corresponding to the wear resistant qualities and
- rails with 1,080 N/mm^2 minimum tensile strength that have been used to a great extent when high operating loads exist.

The table below provides a survey of the chemical composition of the rail qualities used by GZD.

Mechanical properties and chemical composition of delivered rails								
Type of	Delivery	Name of	Chemical composition,content in percent					Tensile
rail	condition	steel	C	Mn	Si	S	P	strength
								N/mm2
R75,R65	Gost 8160-63	M76	0.69-0.82	0.75-1.05	0.13-0.28	0.045	0.035	840
R65,chromi-	ChMTU							
ferrous	2-64-68	M71	0.65-0.76	0.75-1.05	0.13-0.28	0.045	0.035	900
R65,volume-	ChMTU							
tempered	2-59-68	M72	0.68-0.78	0.75-1.05	0.13-0.28	0.045	0.035	1,160
R50	ChMTU							
	6944-63	M75	0.67-0.80	0.75-1.05	0.13-0.28	0.045	0.035	840
R50	ChMTU							
	2-16-67	N865	0.56-0.75	0.60-1.0	0.15-0.30	0.06	0.07	800
R50,volume-	ChMTU							
tempered	2-59-68	M72	0.67-0.77	0.75-1.05	0.13-0.28	0.045	0.035	1,160
R50,surface-	STU 71							
tempered	MS-66-62	N865	0.56-0.75	0.60-0.90	0.15-0.30	0.06	0.07	950
R43,R38	GOST							
	4224-54	M71	0.64-0.77	0.60-0.90	0.13-0.28	0.05	0.04	800
Legend:								
C=Carbon,Mn=Mangan,Si=Silicon,S=Sulphur,P=Phosphorous								
Rail Qualities used in AZhD belong to the self-hardening rails that cover practically all								
current applications.								

The density of the posed sleepers in straight line amounts to 1,840 sleepers, and in curves from >1,840 to 2,000, and corresponds to an average sleeper spacing of 0.54 or 0.50m resp. In addition to the concrete sleepers, timber sleepers were also laid. The timber quality is pinewood treated by impregnation. The average lifetime is up to 15 years. The better timber quality in beech or oak is not available or too expensive.

Rail fixing to the concrete sleeper consists of:

-base plate with rigid clip,

-base plate fastened to the concrete body by an anchoring screw turned a quarter in a chamber.

This kind of rail fastening is not in line with current practice in Western Europe and the assembly causes the force of the vibration of wheel/rail contact, which damages the fixing chambers of the anchorage screw, not to be absorbed.

Rail fixing to the timber sleeper consists of:

This fastening system of spikes with base plate is not suitable because the rail/wheel contact vibrations loosen the fixing devices. Aware of these unsuitable rail fastening to the timber sleeper, an improvement has been started by applying additional coach screws, particularly in curves.

5.2.1 Switches

As mentioned above, there are 1,397 switches on the investigated main line. All of them are connected with the through line. Their geometric form is R65 300 1:11 and they correspond with the switches used in Europe.

5.2.2 Level crossings

see Signalling and Telecommunication report.

5.2.3 Bridges and tunnels

GZD's track network is equipped with all kinds of artificial constructions including tunnels. There are 5 tunnels located on the main line, their lengths differ from 50 m to 4,000 m. The tunnels need an increased maintenance and special investigation to check the water outlets, in some parts of the tunnels.

The most important bridges are listed in Annex 5.2.3 with remarks concerning minor or major repair or renewal. The present situation of most bridges is sufficient, however, backlog of maintenance is stated. Some bridges are in a critical condition and need major repairs or renewals. The arrangement for their rehabilitation is detailed in Chapter 6.1.2.

5.2.4 Ballast

The main line is constructed on a 30 to 35 cm ballast bed. The gauge standard is 35/65 mm. At the moment, GZD is exploiting two quarries, both located near Tbilisi. The broken stone from the Marabda quarry is of high quality, as we were able to see for ourselves, the other one extracts only river gravel which does not qualify as ballast, although it is used as ballast. The gravel is not broken, round nor is it compressible.

Laboratory test results have not been available but it is said that the tests are at hand. The ballast bed in most parts of the main line is in a very bad condition, due to the climatological erosion, sand drifts and traffic pollution (petrol and salt transports). A high percentage of fine granulation fraction contained in the ballast and the afore mentioned factors have led to a rapid pollution, so that the ballast is losing its dynamic absorption, elasticity, water permeability, aeration and electrical insulation properties. The ballast cannot distribute the wheel load from moving vehicles over the sub-ballast as evenly as possible anymore, and it does not provide adequate resistance to either longitudinal displacement or lateral shift.

5.2.5 Subsoil

The subsoil will only have the required support capability for accepting the static and dynamic forces arising from train traffic if its elastic modulus is E>800kp/cm^2. This value could not be verified and in most parts of the track line that we saw during our visits, there were a lot of muddy patches in the ballast. Fact is that the subsoil has not got the required support capability. Subsoil investigation by digging below the surface or drilling tests and their laboratory analysis are necessary, so that an improvement of the subsoil can be planned and made when a track renewal is at hand.

5.2.6 Technical layout data and specification of track geometry

The evaluation of the longitudinal profile, only Tbilisi - Senaki main line and vice versa, resulted in the following data:

minimum radius 150 m

maximum super elevation 150 mm, with parabolic transition curves

maximal vertical gradient 29‰

vertical or levelling curves 300 - 3,000 m

distance between centres of lines 4,100 mm

distance between centres of lines in stations 5.30 m

average sleeper spacing 1,840 in curves up to 2,000

permissible speed 100 km/h for passenger trains

permissible speed 80 km/h for freight traffic

gauge 1,520 mm, minimum 1,516 mm, maximum 1,540 mm

The longitudinal profile is drawn in a scale 1:10,000 for length and 1:1,000 or 1: 500 resp. Not only the level of the top of the rail a.s.l., the level over ground is also indicated. The maximum height over ground is up to 15 m.

Further details are:
The track line with all stations' entry distance, exit distance, switches leading in and out of the passing tracks, signal position, level crossings, constructions and special installations like marshalling yard, loading ramps, workshops and others.
The areas on both sides of the track line and its utilisation as agriculture or forestry operation.

5.2.7 Arrears of maintenance and damaging/destruction of assets.

The investigated track from Tbilisi - Senaki is in a disastrous situation in many parts, as we found out. During a track inspection from Khashuri -Zestafoni and Tbilisi - Beyuk - Kyassik, we established that the current situation would be more than hopeless for any serious traffic handling. The ballast bed is constructed in a compact manner, as a concrete slab. The hammer effect of wheel/rail contact is reflected instead of being absorbed. There is no more elasticity, water permeability nor aeration with the unavoidable consequences of destruction of the track assets, damage to the concrete sleepers and the loss of rail fastenings. In addition to these facts, the load limit of 500 million tons has gone beyond what is permissible. The arrears of track maintenance can be put down to the fact that GZD is totally dependent on imports from the former Soviet Union for all track materials, except for ballast. Due to the lack of financial resources, GZD is presently unable to order the import of the required track material. Since 1989, the annual track renewal programme of 100 - 150 km has been decreased. The renewal performance in 1996 is planned at 25 km, provided that the financial means for the material are available.
Summarising the arrears in track renewals, meanwhile they are nearly 770 km. The table below shows the arrears relating to the entire network.

Survey of main track lengths of the districts and urgent track renewals .					
No.	Designation of district	Responsible for main track lengths	Track passed the load limit of 500 mill.t per km	Renewals of track in bad condition km	Remarks
1	Sukhumi	121.80	0	0	**The track is in bad condition means : load limits >500 mill.t/km rail vertical wear >12mm damaged sleepers/km >600-800/km**
2	Otshamtshiri	167.50	0	0	
3*	Samtredia	202.80 (138.00)	58.00 (47.00)	67.50 (65.00)	
4	Batumi	119.80	50.00	50.50	
5*	Zestafoni	165.00 (64.00)	51.00 (46.00)	63.50 (21.00)	
6*	Khashuri	146.70 (140.00)	41.00 (41.00)	43.40 (43.40)	
7	Bortshomi	82.30	28.00	36.7	
8*	Tbilisi 1	252.90 (212.00)	118.00 (116.00)	122.00 (107.00)	
9*	Tbilisi 2	234.20 (94.00)	89.00 (53.00)	83.90 (24.70)	
10	Gurdshari	186.70	0	145.00	
11	Zalka	160.00	0	149.60	
	main track length	**1,839.70**	**435.00**	**762.10**	
	parts on Tb-Poti line,figures( )	**648.00**	**303.00**	**261.10**	

The table above makes clear that the arrears of the renewal backlog are enormous. The investigated Tbilisi - Poti line contributes 648 km to the total of main lines of GZD. 261 km of 648 km have to be renewed (40,3%) and 303 km have passed the load limit of 500 million tons/km and also have to be renewed according the valid instructions.

5.3 Analysis of track and constructional work, maintenance organisation and facilities.

- Methodology and organisation of maintenance

Annex 5.3 shows an organisational system of the track economics division (general management) managed by a chief engineer. The chief engineer organises the administrative work for track maintenance and related services of civil engineering in GZD's administration building in Tbilisi, including the districts and other work-units that are located on the main line.

The tasks of methodical maintenance are to be carried out by 11 districts for the whole network. Five of them are located on the Tbilisi-Poti line. The responsibility of the districts along the main line is as follows:

Name of the district	Responsible for km main line	located at km
Samtredia	203	2260
Zestaferi	165	2321
Khashuri	147	2382
Tbilisi 1	253	2507
Tbilisi 2	234	2507

The main tasks of a district are:

-visual check by walking on the side path and routine examination of the main system groups of the track, such as rails, fastenings, sleepers and the ballast bed

-irregularities in the track geometry such as alignment, super elevation, square position of the sleepers

-special investigation by order of the chief engineer

-emergency repairs, broken rails.

Corresponding with the instructions, the broken rails have to be repaired by changing a standard rail bar of 25/14m. All broken rails have be journalised by giving details about district, line or station, track number even or uneven, km point, panel number, left or right rail and rail type. The rail damages have to be described and have to be written either onto the inside or the outside of the damaged rail. An

engineering manual gives instructions about all types of rail damages, with a code number for each type description.

-manual ultrasonic testing is carried out by a specialised team in each district, performance 5 km/hour, the results are reported.

In addition to the above mentioned track and rail tests, the rails of the entire network are examined ultrasonically and magnetically by inspection coaches, owned and operated by the central management in Tbilisi (Defectoscope Dept.). A track measuring coach located at Tbilisi records the geometric parameters of the entire track-network at regular intervals. The results of the geometric measuring are assessed with the help of a digital quality coefficient covering all deficiencies of the geometric parameters. The classification of the calculated coefficient is, as follows:

0	**- 50**	**very good, equal to condition after a general track renewal**
51	**- 100**	**good, several points in the line have to be checked**
101	**- 500**	**moderate to bad, consistent observation until partial renewal, ballast cleaning, sleeper changing and rail fastenings**
	> 500	**bad, the track needs renewal.**

Due to the lack of regular maintenance in the last 7 years, it often occurs that the coefficient has four digits.

The facilities such as district office buildings, workshops, common rooms are very poor and need a consistently planned and implemented modernisation. The mobility has broken down due to a lack of any means of transport.

Annex 5.3a shows the organisation of Tbilisi District, as an alternative for the other 10. The other ones are structured in the same way. Annex 5.3b indicates the basic requirements as regards small track - maintenance machines and tools to cope with the tasks.

5.3.1 Permanent-way workshop

For major repairs and complete track renewals (general repairs), GZD use two well equipped and staffed permanent-way workshops. They are located at Tbilisi and Samtredia. A chief engineer manages the workshop and he gets his work instruction from the general management at Tbilisi. The work instructions depend on the annual work programme and the track material is stored in the workshops accordingly. The available track engines are of Russian construction and except for the UK units, which are working very efficiently. However, a rehabilitation will be necessary, the tamping, lining and ballast cleaner machines have to be replaced. The UK-system is working with 25 m track panels, which are pre-assembled and loaded onto special wagons. The panels are transported to the side. The crane, well known as 'Platov Crane' takes the pre-assembled panels and puts them onto the prepared track formation. The special wagons, coupled to form a pair, can be loaded with 5 panels, so that a unit of 12 wagons is needed for the transportation of 750 m track. The same is required for the transportation of the removed panels. The performance over a period of 8 hours is said to be 800 m including ballast cleaning, tamping, lining and ballasting. After finishing the work, the first 3 trains will run with a speed of 15 km/h, the next three with 25 km/h and then the permissible speed of 80/100 km/h is permitted. The above mentioned performance dates back to a long time ago, today with the lack of maintenance caused by missing spare parts and wear and tear parts not being replaced in time, the efficiency is calculated at 50 %.

The staff normally amounts to 150 people. Annex 5.3.1 shows the organisational structure of the Tbilisi permanent-way workshop.

5.3.2 Welding plant at Tbilisi

The welding plant at Tbilisi is very important for track renewal of the whole network. The welding plant produces standard rail bars for 25 m to 250 m long rails. The transportation of them is conducted with special wagons, without any problems. We could see the loading procedure at our visit of the plant. Only new rails are welded, the re-use of removed rails, sorted and classified for re-utilisation to 250 m long

welded reclaimed rails is not practised. The removed rails are reposed without any check in sidings and main lines, when the vertical wear of the rail head is < 12 mm. The criteria for the reclamation of removed rails are vertical wear from 6 - 8 mm in main lines, >8 mm in secondary lines. A second production line could be installed, a welding apparatus is available and it is said to be working, too. The welding plant is equipped with two welding trains. These are used for welding the long rails of 250 m to 800 m and more by a butt-welding system. At the moment, experiments on long welded rails >1000 m are at hand. The welding plant, constructed on a 6 hectare premises, has enough space and buildings to extend the effectiveness. At the moment, there are 145 people recruited, 25 for stationary welding, 20 for workshop production and related services and 100 for manning the welding trains.

5.3.3 Depot and workshop for track-engine repairing.

GZD do not own a depot and workshop for track-engine repairing. In former times, the track engines had been repaired at a central depot of the former Soviet Union. This possibility cannot be used anymore. Considerations of common tasks in view of the Trans-Caucasian railways between GZD and AZD could establish a common solution with the rehabilitation of the track-engine repairing depot in Baku.

5.3.4 Impregnation plant in Gori

The impregnation plant in Gori supplies the whole region with impregnated sleepers and is very important for GZD as well as AZD. The former simple one-tank equipment was extended in 1989 by two additional tanks, including the construction which is not ready yet. Each of the tanks takes 250 sleepers per feeding. The daily production amounts to 2,000 sleepers. The production can be increased by means of two or three shift / day. The creosote and 70 % of the sleepers are imported from Russia, only 30 % are of local production. The vacuum system is used and one sleeper takes 8-9 kg creosote. The capacity and productivity will not be utilised to the full. The normal number of staff is 130, at the moment 30 are employed. The sleeper stock is figured at 30,000.

5.3.5 General management division at Tbilisi.

The general division at Tbilisi manages and has the control over all facilities which are established on the line and at the administration of Tbilisi. All events that occur on the line and on constructions are collected and journalised. The reason is to identify the current situation of the track, which is presented with the consequence that measures are taken to prevent such events as derailments or other interruptions of train movements. The documents frankly and openly show the reality of the insufficient situation marked by damages to the track lines, which originate in the lack of maintenance or necessary renewals. The severe shortage of means over a period of many years has led to this lack of prevention. The most important document is the so called 'track passport' or track C.V., in which all events along the track are recorded, which have occurred since the last renewal.

The main facts are: date of last renewal, load cumulated in million tons, rail stress, number of damages on the rails, damaged sleeper per km, ballast pollution and interventions by maintenance measures or small repairs. Each km of the superstructure disclosed by this document can be examined at any time.
The general management division for the superstructure and all related services that is capable to find out and to journalise all important mistakes on track elements with such an exactness, will be also capable of renewing and of maintaining their track line themselves. Knowledge and skilled staff are available. Its only the financial means and nearly all kinds of equipment which are missing.

6 Analysis of weaknesses and limitations

6.1 General

As mentioned above in Chapter 5.1, the current situation of the Tbilisi - Poti main track line and their related component parts has been explained. Chapter 6 will show the damages and bottlenecks of the track line and will point out "what is to be done", in order to eliminate all damages which are hampering a steady flow of traffic.

6.1.1 Switches.

1,397 switches are installed on the main line, which are all connected from and to the main line. All these connections have to be well maintained and in a good condition. It will be very important that the pilot train or all through trains pass the stations without speed restriction. This condition is only to implemented once the switches have been renewed, in line with the requirements of the current situation.

Quantity of switches which are to be renewed = 400 R 65 300 1: 11

Quantity of crossing timber sets to be completed = 150 sets

6.1.2 Bridges and tunnels

Most of the bridges on the main line (Annex 6.1.2) are generally in a good condition, due to methodical maintenance measures. Although, there are some bridges which have to be rehabilitated by major repair or renewal. Chapters 6.1.2.1 - 6.1.2.6 below show the bridges which are in need of heavy repair or renewal in their order of urgency.

6.1.2.1 The bridge at km 2,289+216

Bridge number 18 of the bridge list, main line at Lioni. This bridge was constructed in 1896 and needs total renewal. Cost estimate $ 5.00 million.

6.1.2.2 The bridge at km 2,324+239

Bridge construction number 27 of the bridge list is jeopardised by material fatigue, construction year 1907. The cost estimate is figured at $ 2.00 million.

6.1.2.3 The bridge at km 2,404+790

Bridge construction number 56 of the bridge list crossing the Mtkvari on the Khashuri - Tbilisi line needs renewal. Construction year 1896. Cost estimate $ 2.0 million.

6.1.2.4 The bridge at km 2,472+759

Bridge number 65 of the bridge list crossing the Mtkvari on the Khashuri - Tbilisi line needs renewal. Construction year 1896. The cost estimate is figured at $ 2.0 million.

6.1.2.5 The bridge at km 10+144

Bridge construction number 79 of the bridge list, crossing the Lotshino, needs a complete renovation. This bridge was constructed in 1896. The physical deterioration demands the bridge renewal. Project documents have already been prepared. The cost estimate is figured at $ 1.0 million.

6.1.2.6 The bridge at km 31+849

Bridge number 1-4 and 10, 11 and 13 of the bridge list, crossing the Rioni, km 29+700 crossing the Korathi, km 21+791 crossing the Korathi, km 18+657 crossing the Korathi, km 2,241+529 crossing the Abashe, km 2,248+179 crossing the Nochela and km 2,255+143 crossing the Zchenisskaro demands renewal of bridge sleepers. The bridge at km 2,248+179 also needs far-reaching corrosion protection.

Cost estimate for renewal of bridge sleepers is given at $ 40,000.

Cost estimate for corrosion protection $ 100,000.

6.2 Track line rehabilitation

The permanent lack of financial means since 1989 has led to the arrears in track renewals and in scheduled full track maintenance. Annex 6.2ashows the permanent and the temporary speed restrictions on the main line. The need to catch up amounts to nearly **700 km**.

To overcome this backlog, an extensive and short-term track renewal programme has to be started. The table on page 8 contains the worst track sections on the Tbilisi - Senaki main line of about **261 km**. These sections have to be renewed before the pilot train starts. GZD has no production of any track material except for ballast, so that all track elements such as sleepers, rails and fastenings have to be imported. The quality of GZD's own ballast production is not sufficient because the quarry-equipment like crusher, riddle system and wash equipment must be renewed so that the quality will be unobjectionable and the daily output can be raised from 300 m^3 today to more than 10,000 m^3/day. With these improvements, it would be possible to obtain the ballast without filler, fine granulation fraction and dust.

GZD are able to do the track maintenance and track renewal themselves, man power and skilled personal are available. However the best personnel cannot be efficient if the equipment and track engines are not in working order and available. Here we also have a lack due to the sorry the financial situation of the last years. Annex 5.3b shows the shortage of small track maintenance machines and tools for all teams of the districts only. A cost estimate is made for replenishing the shortage (see table below).

Nr.	Designation	shortage	price per unit $	total $
1	Tamping units, type GB 4 with Briggs and Stratton engine	75	16,717	.1,253,775
2	Rail saws, type SRN-E with (SRN-E) electrical engine 220/380 V DC, 50 Hz supplement for hydraulical device	50	3,443	172,150 9,830
3	Rail drilling machines, type PR 8-E-2V	50	3,933	196,650
4	Rail grinding machines, type MP 12-E	70	4,033	. 282,310
5	Coachscrewing machines, type T52-E	60	6,097	. 365,820
6	Coachscrewing machines, type TS2 with gasoline engine Bernard 617 supplement for torque limiter	50	6,490 434	324,500 434
7	Track lifting and slewing machines type RV 100 for track 1520 mm	11	39,333	432,663
8	Hydraulic jacks, type CH 65	600	930	558,000
9	Wooden sleeper carring tongues Concrete sleeper carring tongues	400 400	88 106	. 35,200 . 42,400
10	Hand operated rail pullers with chaine	100	1,733	. 173,300
11	Generators, type CR 2500 with Briggs and Stratton gasoline engine	145	847	122,815
12	Generators, type RG 4500 T with			
	Briggs &Stratton gasoline engine			
	mounted on a hand pushed one wheel			
	trolley, power 4 kw /220/380 V/50 Hz	150	1,733	.259,950
13	Signalling lamps, 3 colour lights	860	243	208,980
14	Brigade carriers	45	40,000	.1,800,000
15	Four wheel drive cars	22	30,000	660,000
16	Hammer sleeper spikes	300	32	9,600
17	Slewing bars different kinds	500	30	15,000
18	Adjustable wrenches	300	45	13,500
19	Wrench sets for track works	560	40	22,400
20	Abrasive discs	8,000	12	96,000
21	Rail thermometer	50	60	3,000
22	Rail pulling rollers	100	180	18,000
23	Tamping pick	1,200	35	42,000
24	Wooden sleeper drilling machine	60	4,750	285,000
25	Ballast forks	1,200	35	42,000
		11	35,800	393,800
	direct costs			7,839,077
	taxes, dispatch, insurance unforseen			2,160,923
	Total in $			10,000,000

The efficiency of a district depends on its equipment. In order to meet only the shortages listed in Annex 5.3b, an amount of $ 10,000 million will be necessary. This sum includes the necessities of all districts.

At first, the shortages of the districts on the main line have to be eliminated. Therefore a total of $ 5,000 million will be necessary in the short-term. In due course, a current shortage list has to be drawn up. With the completed equipment and the possibility of mobilisation by own team carriers, the scheduled full maintenance on the line is ensured.

The track renewal is planned and executed by staff and equipment of the permanent-way workshop (see Chapter 5.3.1). The available track-engines and equipment are prone to break down, due to their age. The break-down stoppages while the track renewals are in full progress, are forcing those responsible to improvise. All improvisations influence the quality of the work and are the first reason for increased maintenance measures. Annex 6.2.1 shows the inventory of track engines and their current usability. These track engines originate from the former Soviet Union. They are very heavy, old and are no more up to date for modern track renewals and maintenance measures. Instead of expensive repairs of the available engines as VPO 3000 tamping and levelling, R 2000 track liner we recommend to buy new ones. The Shom ballast cleaner has to be replaced by a new, modern and effectively working ballast cleaner, which is able to clean the ballast to a depth of 1.00 m below the top of the rail and the guided excavation chain which produces an exactly straight subgrade. The new track engines are to be understood as a unit consisting of: ballast cleaning, tamping and ballast regulating machinery. This unit will be needed twice, one in the short-term, the other in the medium-term. The table below shows the kinds of machines and recommended prices for the required machines. The costs of track renewal in GZD is calculated at $ 400,000.

Item	Short description	Recommended price per Unit in $
1	RM 80 UHR	
	Ballast cleaning machine for switches,	
	crossings and plain track universal application.	
	length over buffers = 31.80 m	
	excavating width standard = 4.00 m	
	max. excavating depth below top rail = 1.00 m	4.38 million
2	Unimat 08-475 4S	
	perfect maintenance of switches and crossings.	
	technical data	
	length over buffers = 33.99 m	
	width = 3.00 m	
	total weight of machine = 100 t	
	four tamping units	2.86 million
3	High performance ballast regulating machines	
	Technical data: SSP-110 SW	
	length over buffers = 17.45 m	
	width = 3,000 mm	
	weight = 36 t	1.24 million
	Total	**8.48 million**

The above listed machines are successfully working in the CIS. In order to utilise high performance machine systems properly, it is essential to have a perfect user technology tailored to the specific operating conditions. This user technology has been developed in close cooperation with the railway authorities, on the basis of experience in many countries, under the most varied climatic, geographic and permanent-way conditions. Training programmes, tailored to the operating condition of GZD are available.

6.2.1 Lining of the track between Khashuri and Zestafoni

The critical section of the main line is located between Khashuri and Zestafoni where gradients of 29‰, curves with radii of 150 m -200 m, tunnels and bridges on double and single line occur. GZD is planning to improve and to rehabilitate the lining of the single track sections. An official approval of the planned project has been applied for and version 1 obtained the approval. Section 1 Zestafoni - Kharagauli km 2,338-

2,343 = 5,000 m, Section 2 from station Marelisi km 2,347 - 2,352.6 = 5,600 m. The gradients on the planned sections are max. 18,5‰, the least radius in Section 1 = 600m, in Section 2 = 400 m. If the traffic on the Trans-Caucasian Line increases, the section between Khashuri and Zestafoni will gain major importance.
The cost estimate for Section 1 amounts to $ 30.000 million, for Section 2 to $ 47.000 million. Project documents are available.

Another important weakness are the quarries, most important equipment has been vandalised and destroyed, the quarries are unable to produce the different fractions of grain, especially ballast, or others for prefabricated concrete parts. Fully working quarries will be the guarantor of high quality ballast for the permanent way and all required grain size for the production of prefabricated concrete parts, even pre-stressed concrete sleepers. An estimate given by the GZD authorities amounts to $ 1.0 million.
It includes: new crusher and riddle systems, pipes and conveyor belts, wash equipment to clean the broken stones from dust and filler, bulldozers, excavators and trucks, other materials for the renovation of offices and common rooms, water tank 100 m^3 and power station.

The dependence on importing all track materials is significant for the difficult situation. With modernly equipped quarries, GZD would be able to develop an own pre-stressed concrete sleeper production, with new sleeper design and fastenings, according the European standards. First investigations show that a fully mechanised concrete sleeper plant will cost $ 12 million and a partially mechanised one $ 8.7 million. These prices do not include real estate, land development, works buildings, necessary infrastructure like roads, works siding, power station and water supply.

6.2.2 Sleeper impregnation plant

Although the impregnation plant is working well, there is still some rehabilitation to do. The impregnation hall is to be completed and environmental protection measures have to be put into place. Costs are quoted at $ 200,000.

6.3 Definition of training needs.

Professional skill is the most important requirement in order to achieve quality and high performance in mechanised track works, track renewal and track maintenance. The skill is required in 3 fields.

- railway track

Operation staff of the general management up to permanent-way inspector. The training comprises organisation of track renewal and track maintenance, work programmes for emergency, short-term, medium and long-term, time schedule of completion, updating of engineering manuals and instructions, competitive procurement procedures, computerising of track inventory and constructions.

-Operation of new track engines and

-maintenance of machines.

The training of operating and servicing staff is gaining greater importance for successful and economical operation of the machines. The training programme will help the machine crews to operate the engines at a high performance. The objective of the training programme will be to inform and to teach the machine crews to operate the engines for the best results in performance and longevity. The training should be carried out in seminars of 4 weeks. The programme contains theoretical and practical parts and on-location visits and imparts required skills for machine operation, machine crew and members, for machine maintenance service specialist, mechanics and electricians.

6.4 Financial pre-feasibility

The financial pre-feasibility contains all weaknesses and limitations described in Chapter 6 and shows the amounts that are inevitably necessary to rehabilitate the Tbilisi - Senaki - Poti track line. The cost estimate provides a general idea of direct repair costs and the possibilities of achieving the full scheduled maintenance system by a new generation of track engines and equipment. The recommended engines and equipment represent the basic requirements. Within GZD, there are far-reaching independent plans for an extensive track maintenance and track renewal as well as the conservation of the track for a long service life. The table below shows the summary of the financial means distributed over the next ten to fifteen years (see Annexes 6.4.1 - 6.4.4).

Summary of financial means to rehabilitate the Tbilisi -Poti track line

Designation	2000	2005	2010	2015
Permanent way 200 km in future 40 km /year	**$ 61.500 mll.**	**$ 60.000 mill.**	**$ 88.000 mill.**	**$ 88.000mill.**
Equipments of districts and track engines	**$ 18.3400 mill.**	**$ 18.230 mill.**	**$ 1.240 mill.**	
Bridges	**$ 12.200 mill.**			
Construction costs	**$ 10.800 mill.**			
Total	**$ 102.840 mill.**	**$ 78.230 mill.**	**$ 89.240 mill.**	**$ 88.000 mill.**

7 Conclusions for the pilot train

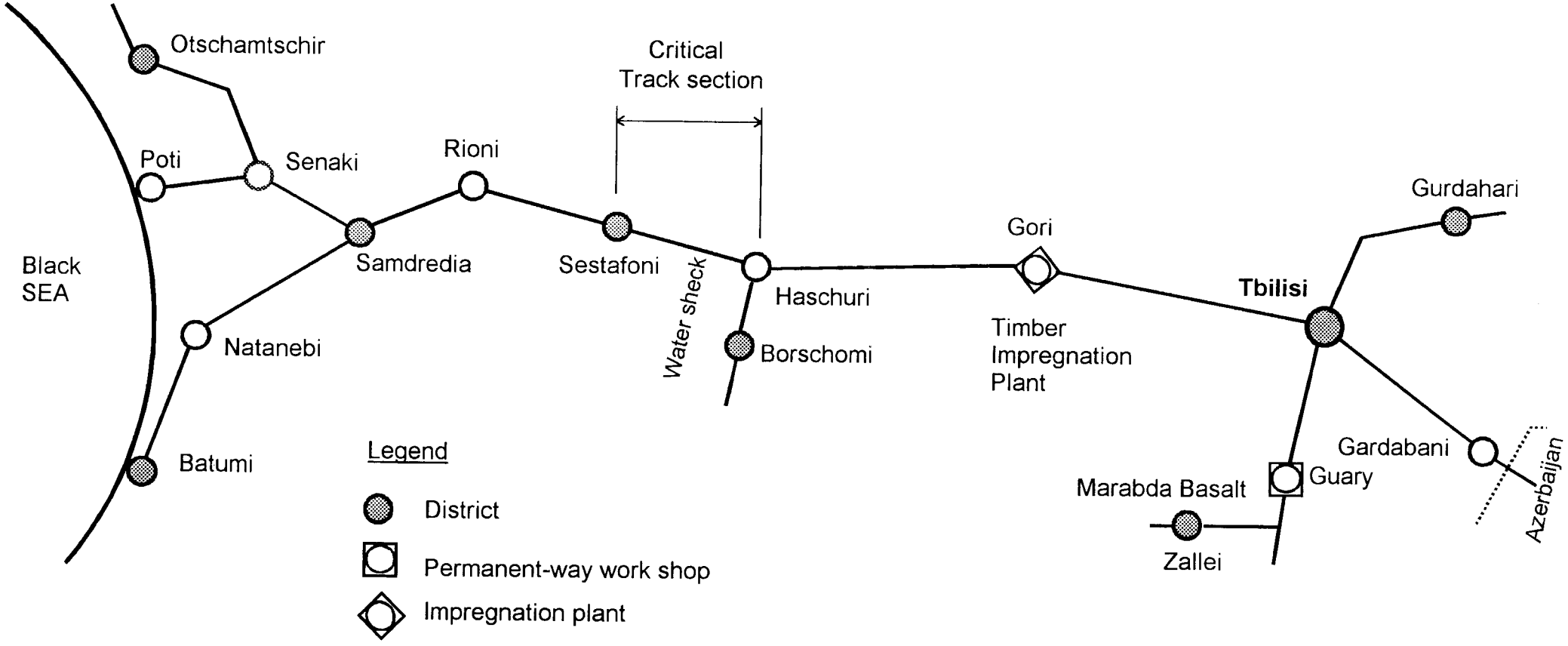
see conclusions report part one „AZD"

Annexes

Annex 5.1	Survey Tbilisi - Poti / Batumi track line of GZD
Annex 5.3	Organisational chart General Management
Annex 5.3a	Organisational chart Tbilisi District
Annex 5.3b	Basic equipment Tbilisi District
Annex 5.3.1	Organisation of the Tbilisi permanent-way workshop
Annex 6.1.2	Bridge list
Annex 6.2	Inventory of track engines
Annex 6.4	Cost for permanent way
Annex 6.4.2	Cost for bridge renewals
Annex 6.4.3	Quarries and future concrete sleeper requirements

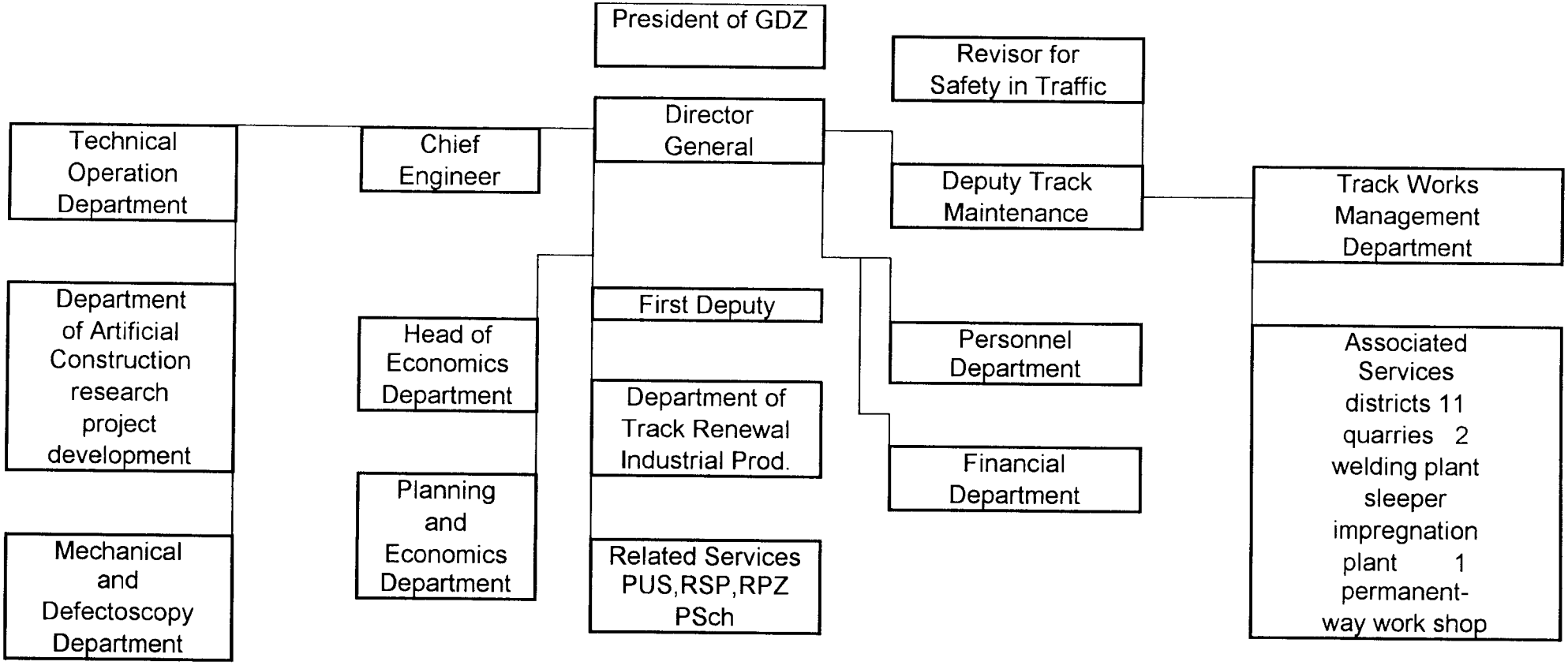
Annex 5.1

Tbilisi - Poti / Batumi track line of the Georgian Railways (GZD)



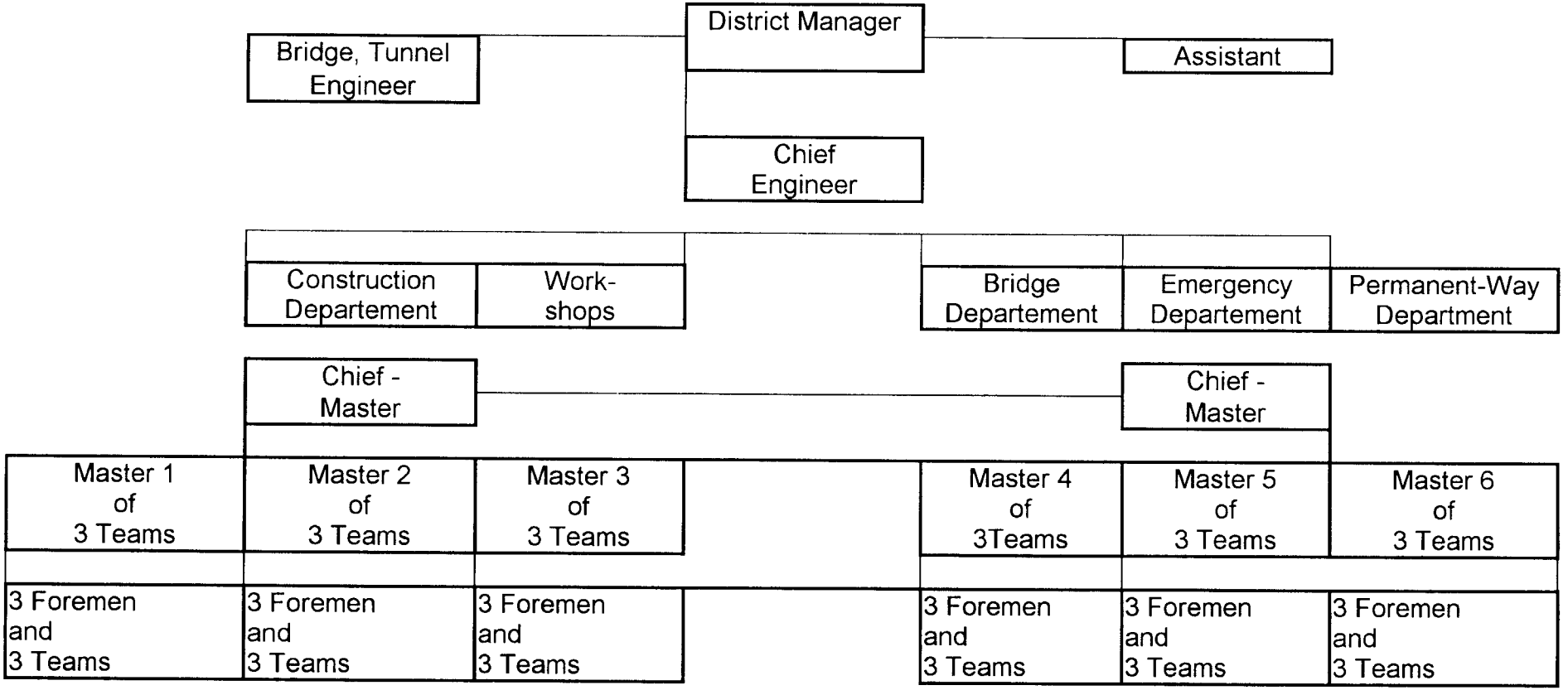
Annex 5.3

Organisational structure of the permanent-way general management



Annex 5.3a

Organistion structure of the district Tbilisi



Annex 5.3b

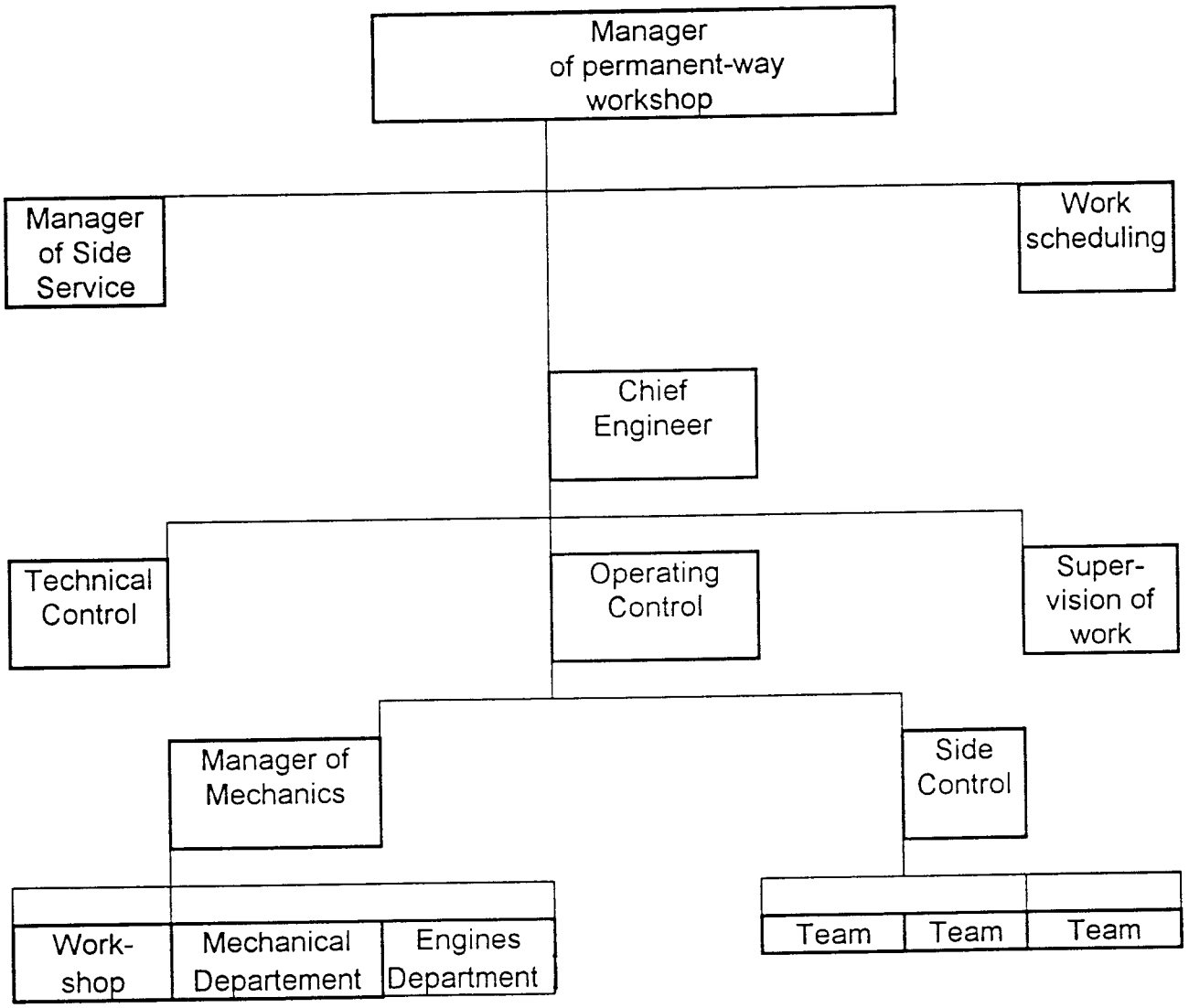
Small track maintenance machines and tools

GZD - Districts						
Small track - maintenance machines and track tools						
Item	Designation	Basic requirement of one gang	Stock and shortage of essential equipment for 200 track gangs of all GZD - Districts			
			required	available	shortage	remarks
1	packing of sleepers (el)	1 set	200	125	75	1/team
2	rail saw (el) RM 2	0.5	100	50	50	0.5/ "
3	rail drilling machine (el) 1024 B	0.5	100	50	50	"
4	rail grinding machine (el) MRSh 3	0.5	100	30	70	"
5	rail screwing machine (el) EK 1	0.5	100	40	60	"
6	screwing machine ShV - 1	0.5	100	50	50	"
7	hydraulic rail pinch	0.5	100	60	40	"
8	hydraulic track-lifter	4	800	200	600	4/ "
9	hydraulic track-straightening-set one set consists of 5 pieces	0.5	100	50	50	0.5/ "
10	tongs for concrete sleepers.	2	400	0	400	2/ "
11	rail puller for long rails	0.5	100	0	100	0,5/ "
12	rail lifting and slewing mach. Type RV 100	1	11	0	11	1/ district
13	generator AB - 2 kw	1	200	55	145	1/ team
	AB - 4 kw	1	200	50	150	1/ "
14	signalling lamps	5	1,000	140	860	5/ "
15	personnel transport truck	0.5	100	55	45	0.5/ "
16	management car/per district	2	22	0	22	2/ district
17	hammer sleeper spikes	4	800	500	300	4/ team
18	slewing bars different kinds	8	1,600	1,100	500	8/ "

19	adjustable wrench	1.5	300	0	300	1.5/ "
20	wrench sets track works	4	800	240	560	4/ "
21	abrasive discs		10000	2000	8000	
22	rail thermometers		120	70	50	
23	rail pulling rollers		240	140	100	
24	tamping pick		2200	1000	1200	
25	wooden sleeper drilling machine		120	60	60	
26	ballast forks OMV 111				1200	

Annex 5.3.1

Organisational structure of Tbilisi permanent-way workshop



Annex 6.1.2

Bridge list

N°	Km point	Crossing valley or river	Length m	Needs major repair	or minor	Remarks
1	31+849	Rioni	413	400	renewal of	Poti-Senaki
2	29+700	Korathi	41	20	bridge	"
3	21+791	"	40	20	sleepers	"
4	18+657	"	59	25	$ 35 per piece	"
5	3+678	Zivi	103			"
6	2+915	Gortali	26	0		"
7	2234+383	Tekhuri	183	Renewal of bridge supp.		Senaki-Samt
8	2235+491	Galitsha	34	0		redia
9	2238+043	Skuria	34	0		"
10	2241+529	Abasha	116	100 renewal bridge sleeper		"
11	2248+179	Nochela	118	100 " corrosion protection		
12	2248+179	Nochela	119	0		"
13	2255+143	Zchenisskaro	118	400 "		"
14	2255+143	"	129	0		"
15	2261+963	Estakade	175	0		"
16	2266+528	Gubistzvali	111	0		Samtredia-
17	2266+528	"	115	0		Sesta
18	2289+216	Lioni	185	construction year 1896		$ 5 Mio
19	2290+850	underbridge	28	0		"
20	2291+887	Zkazitela	57	0		"
21	2291+887	"	61	0		"
22	2295+801	Kvirila	208	0		"
23	2295+801	"	210	0		"
24	2304+578	Lehuti	27	0		"
25	2308+214	Kvirila	162	0		"
26	2308+214	"	170	0		"
27	2324+239	"	93	construction year 1907		$ 2 Mio
28	2324+239	"	87	0		Sestaponi-
29	2327+428	Dzirula	157	0		Hashuri
30	2327+895	"	120	0		"
31	2388+100	"	126	0		"
32	2328+132	"	117	0		"
33	2332+999	"	97	0		"
34	2336+648	Korneba	46	0		"
35	2337+234	Tshherimela	47	0		"
36	2338+104	"	55	0		"
37	2344+251	"	94	0		"
38	2344+567	"	75	0		"
39	2344+742	"	52	0		"
40	2345+659	"	53	0		"
41	2345+659	"	57	0		"
42	2358+366	Molta	47	0		"
43	2358+892	"	43	0		"
44	2358+892	"	55	0		"
45	2361+528	Viaduki	88	0		"
46	2362+100	"	172	0		"
47	2362+075	Eskada	236	0		"
48	2363+625	Chercheulis.	92	0		"
49	2363+868	Torolis Chevi	87	0		"

50	2363+868	"	75	0	"
51	2365+661	Tarabela	39	0	"
52	2365+661	"	59	0	"
53	2382+784	Suramula	53	0	"
54	2385+880	"	38	0	Hashuri-Tbi.
55	2385+880	"	40	0	"
56	2404+790	Mtkvari	169	construction year 1896	$ 2 mio
57	2404+790	"	178	0	"
58	2442+260	"	219	0	"
59	2450+089	Kotzakhuri	68	0	"
60	2450+089	"	61	0	"
61	2454+970	Lekhura	65	0	"
62	2454+970	"	73	0	"
63	2468+667	Ksani	80	0	"
64	2468+667	"	83	0	"
65	2472+759	Mtkvari	123	construction year 1896	$ 2 Mio
66	2472+759	"	137	40 sleepers	"
67	2483+357	underbridge	29	0	"
68	2486+446	"	27	0	"
69	2488+642	Mtkvari	208	0	"
70	2494+600	underbridge	50	0	"
71	2499+529	"	37	0	"
72	2503+229	"	50	0	"
73	2503+927	"	29	0	"
74	2507+383	"	35	0	"
75	2508+135	"	26	0	"
76	1+642	"	101	0	Tbilisi-Baku
77	2+755	"	28	0	"
78	6+110	"	43	0	"
79	10+144	Lotshino	81	construction year 1896	$ 1 Mio
80	1044+144	"	88	0	"

Annex 6.2

Inventory of track engines

No.	Type of engine	Perfor-mance per h	Quantity	opera-ting	out of order	Needs		Remarks
						repair	renewing	
1	UK-25/9-18	18 t	4	4	0	0	0	
2	UK-25/9	9 t	4	0	4		4	UK called Platov crane
3	Ballast cleaner	3000 m3	2	2	0	0	0	Shom-4 type
4	Track tamping and levelling unit	3000 m/h	2	1	1	1	0	VPO-3000
5	as above	1200 m/h	1	1	0	0	0	VPR-1200
6	"	500 m/h	2	1	1	0	1	VPRS-500
7	Straigthening machine el.	3000 m/h	2	1	1	0	1	ELBR-1
8	Straigthening machine	4000 m/h	1	1	0	0	0	PRB-10
9	Trolley platform wagon		6	2	4	2	2	MPD
10	Motor planning machine		2	0	2	0	2	
11	Bulldozer		4	3	1	1	0	T-130
12	Mobile workshop car (road)		7	4		3	0	GAZ-53
13	Motor lorry	6 t	2	2	0	0	0	KAZ-4540
14	Crane railroad	16t	4	3	1	0	1	KZhDE-16
15	Hoppers		5	4	1	0	1	DVZ
16	Diesel engine		2	2	0	0	0	ChME-3
17	Diesel motors							
	D6 D12						6 14	
	Engines for subsoil and artificial construction							
1	Caterpillar excavator	1.5 m3	8	6	0	0	2	Eo-4124
2	as above	0.5	2	2	0	0	0	Eo-3322
3	as above	0.25	6	2	0	0	4	Eo-2621
4	Bulldozer		6	3	0	3	0	T-130
5	Crawler tractor with welding unit		2	0	0	0	2	DT-75
6	Bulldozer		8	6	0	0	2	DT-75
7	Scraper	9m3	4	4	0	0	0	
8	Motor lorry	6-8 t	20	12	0	0	8	GAZ,GAL
9	Lorry		24	14	10	0	10	GAZ,ZIL
10	Mobile workshop car		34	24	10	0	10	GAZ-53
11	Trolley with crane	6 t	12	6	6	0	6	DGKU
12	Motor Lorry		3	2	1	0	1	VS-60

Annex 6.2a

Permanent ant temporary speed restrictions on track sections of the investigated line

N⁰	Section	Length of speed restriction from - to km		km	actual speed km/h	load by milit/km	quality coefficient
	Tscheladidi						
1	Poti	29	37	9	25	346	**656**
	Senaki-						
2	Abasche	2235+600	2235+700	0,1	15	222	277
	Abasche-						
3	Samtredia	2246+300	2260+400	15	25	461	**1550**
	Adshamrti-						
4	Swiri right	2298	2307	8,5	25	617	433
	Argweta-						
5	Sestafoni left	2313	2318	6	25	513	**1058**
	Schorgpani-						
6	Dzirula left	2325	2325	0,1	25	859	33
7	Gomi-Agarz	2399	2402	4	25	621,4	**878**
	Agarz-Kareli						
8	right	2405	2405	0,1	15	621,8	29
	Agarz-Kareli						
9	right	2406	2408	3	25	621,4	**1120**
	Kareli-Skea						
10	right	2410	2420	11	25	576,4	**4321**
	Ckia-Gori						
11	right	2424	2427	4	25	570,9	**1225**
	Gozi-Upliszi-						
12	che right	2429	2434	6	25	561,8	**965**
	Metechi-						
13	Kaspi right	2449	2454	6	25	688,2	**2347**
	Kaspi right	2449	2449				
14	Kaspi right	100	500	0,4	25	684,1	304
	Metechi-	2452	2452				
15	Kaspi right	500	900	0,4	25	684,1	292
	Ksani-Dzeg-	2473	2473				
16	wi left	700	800	0,1	15	588,4	67
	Ksani-Dzeg-						
17	wi right	2472	2474	3	25	529,1	**1057**
	Dzegwi-						
18	Mzchete right	2477	2481	5,5	25	684,8	472

Average of permanent speed restriction right direction (even track)=.**24 km/h**

Average of permanent speed restriction left direction (odd track) = **22 km/h**

Reduction of speed from **100(80)km/h up to 25 - 15 km/h**

average load/km of the above mentioned sections **580 Miot/km**

track length of speed restriction right direction(even track) **=76.0 km**

track length of speed restriction left direction(odd track) **=6.2 km**

quality coefficient > 500 is assessed as very bad track condition and needs track renewal

Annex 6.4

Costs for permanent way

item	Definition and short description	Quantity	2000	2005	2010	2015
1	Maintenance permanent way					
	Track line Tbilisi - Senaki - Poti				renewal 40 km /year	renewal 40 km /year
	table on page 8 260 km					
	price / km = $ 0.400 million	260	52.000	52.000	80.000	80.000
2	Track line Tbilisi - Poti					
	chapter 6.11 Switches on the main line	400	8.000	8.000	renewal 40 units/year	renewal 40 units/year
	price /unit = $ 0.040 million				8.000	8.000
3	crossing timber set					
	price/unit = $ 0.010 million	150	1.500			
	Total maintenance permanent way $ million		61.500	60.000	88.000	88.000
	Total maintenance permanent way $ million		68.700	68.700	68.700	68.700

Annex 6.4.2

Costs for bridge renewals

item	Definition and short description	Quantity	2000	2005	2010	2015
	Bridges chapter 6.12 - 6.126					
1	Bridge nr. 18 in km 2289+216	1	5.000			
2	Bridge nr. 27 in km 2324+239	1	2.000			
3	Bridge nr. 56 in km 2494+790	1	2.000			
4	Bridge nr. 65 in km 2472+759	1	2.000			
5	Bridge nr. 79 in km 10+144	1	1.000			
6	Bridge nr. 1 -4 and 10,11 and 13	5	0.200			
7	New track lines					
	Section 1 km 2338-2343+section 2 km 2347-2352.6 = 30.00 = 47.000 $ million					
	Total in $ million		12.200			

Annex 6.4.3

Costs for quarries and future concrete sleeper plant

item	Definition and short description	Quantity	2000	2005	2010	2015
	Costs of constructions and items of equipments					
	to become independence of track material imports.					
1	Quarry equipments as crusher, riddelsystems,					
	pipes, conveyor belts, wash equipment, bulldozers, excavators and trucks and others, lump sum		1.600			
2	prestressed concrete sleeper plant in work employments effectuation. Only the important					
	parts for high quality production will be full mechanised. in $ million		8.700			
3	Technical equipment for offices and constructions, lump sum		0.500			
	Total in $ million		10.600			