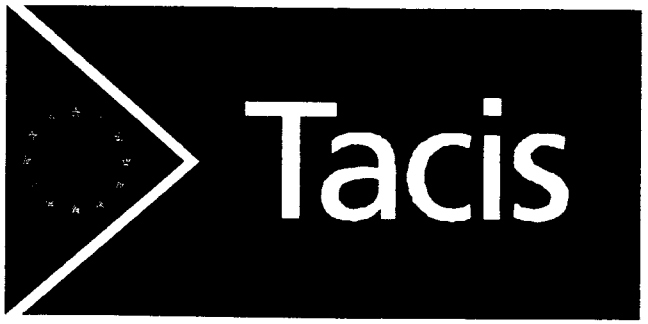

TRACECA Programme:
Regional traffic database and forecasting model

Traffic Model Development

August 1997

European Union

Tacis Programme

TRACECA:

Regional Traffic Database and Forecasting Model

(Project No. WW.93.05/05.01/B008)

Traffic Model Development

August 1997

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1. INTRODUCTION

IMPLEMENTATION OF THE MODEL

1.1 This paper documents the procedures employed to develop the TRACECA Regional Traffic Model.

1.2 The model study area covers the three Caucasus Countries, Armenia, Azerbaijan and Georgia, together with Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan and Uzbekistan which together form Central Asia. The model was developed to assist strategic planning of the freight network within the study area, and assess the impacts of various forecast scenarios in the region.

1.3 This report is an update of an earlier Seminar Paper produced in June 1997.

DATA COLLECTION

1.4 To facilitate the model development, and subsequent calibration and validation processes, current information on road and rail networks and traffic was collated for each of the eight TRACECA countries. Data regarding the operations and traffic at sea ports and airports was also collected. Full details of this data collection exercise, together with the data collected, have been presented in Progress Report II (December 1996) and Database Manual (May 1997).

SOFTWARE

1.5 The TRACECA traffic model was developed using the current SATURN suite of modelling programs. The programs which were used include the following:

- SATNET - network building;
- SATASS - freight traffic assignment;

- M1, M5, MX - development of freight matrices and general matrix manipulation;
- SATLOOK, SATDB - assignment analysis;
- P1X - network and assignment analysis;
- M1, MX - matrix analysis

1.6 In addition, MICROSOFT EXCEL and ACCESS have been used to process import/export data and road/rail network inventory data received via the questionnaires. MS EXCEL has also been used to facilitate the model development, analysis and presentation of data and results.

1.7 The following sections (2 and 3) of this paper will discuss in turn the development of the network and freight matrices for the base year of 1995. Section 4 of this paper presents detailed instructions on the operation of the model and Section 5 summarises the model calibration and base year modelled flows.

2. TRACECA MULTI-MODAL NETWORK MODEL DEVELOPMENT

2.1 The model network includes all major road, rail and sea routes within each of the eight TRACECA countries, together with many secondary links in order to ensure all significant freight routes were available in the model. Figures 2.1 (a and b) show the extent of the modelled networks (internal and external) for road and rail respectively.

2.2 Initially SATURN networks were developed for road and rail separately using the inventory data obtained via the questionnaires. Where necessary additional information on link distance and link standard was determined from detailed mapping of the study area.

ELEMENTS OF THE NETWORK

2.3 The TRACECA Regional Traffic Model network was designed for the assignment of freight traffic through Central Asia and the Caucasus Region. Since it is a strategic model, it was coded as a SATURN buffer network. Each mode has separate links with speeds and delays which reflect the cost of travel by each mode.

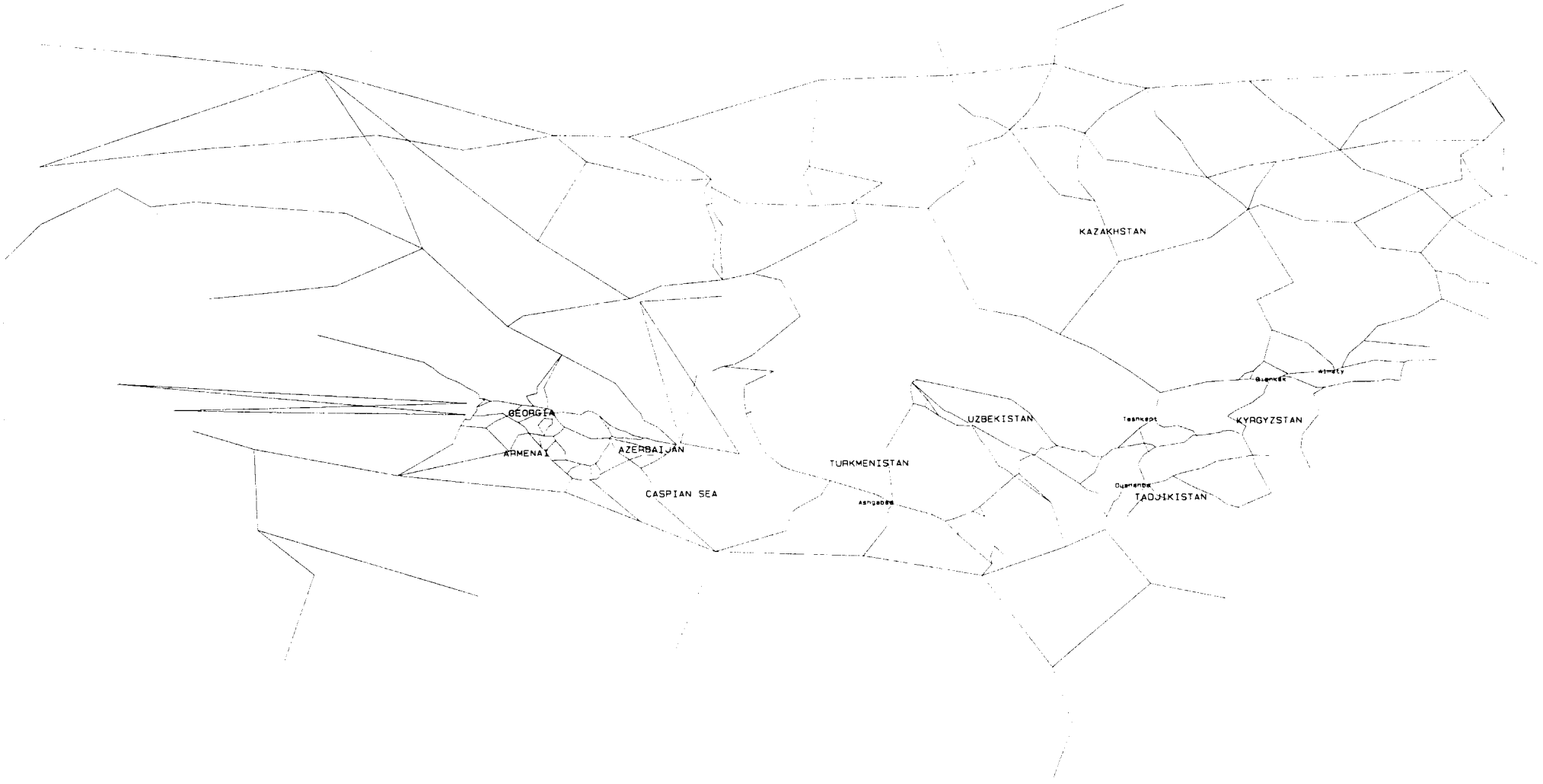
2.4 In general the questionnaires provided much of the inventory data required to produce networks for each of the modes, rail, road and sea.

Rail Links

2.5 For each section of railway the questionnaires provided information on the overall distance of each section; and a breakdown of each section indicating lengths of single track and double track; and the percentage leading gradient.

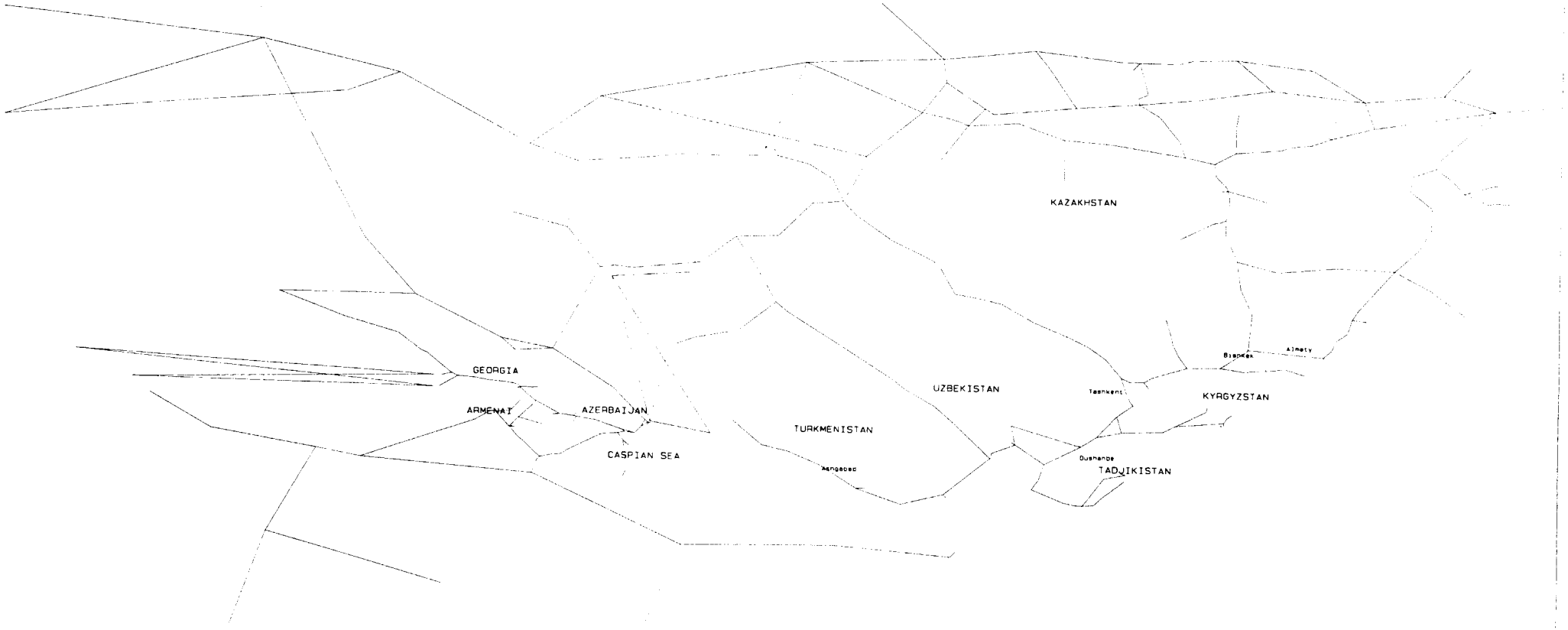
Road Links

2.6 Similarly, for the road links data on overall distance of each section; a breakdown of the lengths of each section by type of pavement (i.e. hot and cold asphalt, and



TRACECA Regional Traffic Model, Base Year Modelled Road Network

Figure 2.1 (a)



TRACECA Regional Traffic Model, Base Year Modelled Rail Network

Figure 2.1 (b)

unsealed surfaces); and road width. In the situation where distances were not given, it was necessary to complete the data through measurements taken from detailed mapping.

2.7 In the absence of speed data, estimated speeds were applied to each pavement type in order to calculate weighted average speeds for each section of road.

Sea Links

2.8 Generally, the sea transport data received via the questionnaires was concerned with the port handling, and no information was gained regarding the shipping routes currently operating in the Caspian and Black Seas. Therefore, it was necessary to establish the alignment and distances of shipping services currently in operation in the area from available mapping.

2.9 An average speed of 20 kph (which corresponds to 17 Knots) was adopted for each shipping link.

INTERCHANGE AND BORDER CROSSING LINKS

2.10 The networks were then combined to form one multi-modal network data file. At this stage interchange links were introduced to connect the road and rail links included in each of the networks, which allows the transfer of freight between modes. Therefore modal choice is achieved simultaneously with, and as an integral part of the assignment. Short links located at the borders of each country have also been included, in both the road and rail networks, to represent the border crossing posts.

2.11 Both the interchange and border crossing links were calibrated to carry appropriate penalties reflecting the delay and cost of the interchange. The border charges adopted in the base year model are shown in Table 2.1.

ZONING AND ACCESS LINKS

2.12 The zoning system described in both the Inception Report and Progress Report 1A comprised of 23 internal zones and 23 external zones. In developing the model this zoning system was slightly modified. As described in Progress Report 1A (Revised) Kazakhstan has been subdivided using a finer zoning system than that shown in the

Inception Report. The revised zoning system is based on the 19 oblasts. The zone plan for the study area is shown in Figure 2.2.

Table 2-1: Border Charges US $/Tonne

Country	Road	Rail
Armenia, Azerbiajan, George, Kazakhstan, Kyrghystan, Tadjikistan, Turkmenistan	5	10
Uzbekisatan	5	30 Commodity 1 20 Commodity 2-8-8
Kazakhstan to Russia	20	10

2.13 The import and export data received for Tajikistan, Turkmenistan and Uzbekistan was disaggregated to the level of zoning shown in the Inception Report. It was not possible to disaggregate the data obtained for Kyrgyzstan. However, the volume of import and export trade from Kyrgyzstan is comparable with those shown for each of the Caucasus countries which are represented in the model by single zones. In view of these similarities the implications of Kyrgyzstan remaining as a single zone were not considered to be significant.

2.14 Each of the zones have been connected by access links to either the rail network or the road network, or both, according to the opportunities realistically available within each area and reasonably representing the distribution of economic activities, and hence freight demands. In actual fact only Zone 3, representing the most eastern oblast on Tadjikistan, Gorno Badahshanskaya is not connected to the rail network directly.

2.15 These access links feed traffic onto the network, and are also utilised to hold charging data, for example initial costs to access the railways which SATURN includes in calculating generalised costs but which diminish relative to total cost over distance travelled.

2.16 Initially the access links were connected to major cities, or large settlements, within each of the zones where it was thought such traffic would likely be generated or attracted. For example the Kyrgyzstan zone is connected to the networks so as to

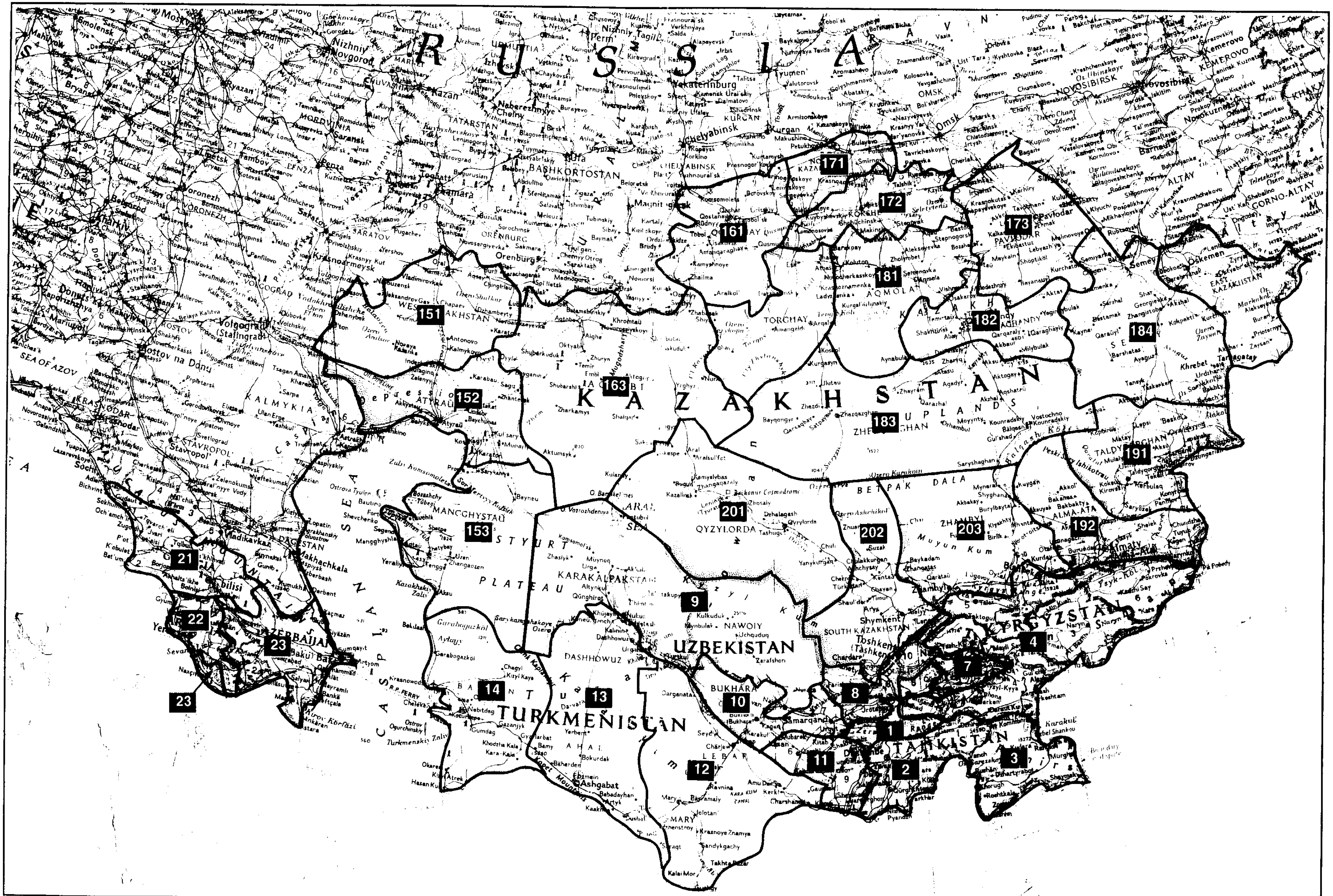


FIGURE 2.2
Zone Plan

reasonably represent the major concentrations of activities around Bishkek and Osh. These connections were reviewed during the model calibration.

EXTERNAL LINKS

2.17 External links were included to represent the major freight corridors in areas on the fringes of the study area, including parts of Russia, North Russia, Eastern Europe, Turkey, Iran and China. These links ensure a realistic pattern of freight flow along major corridors outside the study area, which will feed into and out of the Caucasus Regions and Central Asia.

TARIFFS

2.18 Throughout Central Asia and the Caucasus Regions we have noted that tariffs can vary not only by mode but also by region and commodity. There is a facility within SATURN which enables extra link data to be stored for each user class alongside all links (KNOBS function). This has been used to hold the shipment costs per tonne along each link (i.e. tariff * distance) for each aggregated commodity group. In combination with time costs SATURN uses this to calculate generalised costs by link in the assignment. The tariffs adopted in the base year model are presented in Annex B of this report.

2.19 This facility is particularly useful as traffic using certain routes or modes (Caspian Sea for example) are subject to tariffs significantly higher than others.

COUNT DATA

2.20 Observed freight flows for road and rail transport were obtained from the questionnaires. The rail figures were given as annual tonnage flows by direction. The freight matrices assigned to the network were average 24 hour tonnage flows, therefore the observed rail freight flows were also factored to represent average daily flows.

2.21 Road flows were given in the questionnaires as total 2 way daily counts of vehicles, together with an observed percentage of heavy goods vehicles. Using these figures the number of trucks per day have been estimated. These were subsequently factored by a weighted average tonnage per truck in order to generate average 24 hour tonnage flows. The average load per truck has been assumed at 15 - 20 tonnes in the Caucuses

taking account of the presence of Turkish and Iranian trucks in this region, and at 10 tonnes per truck elsewhere in central Asian regions. These estimated tonnages on road links have been converted to annual values and have been adjusted to take account of any obvious discrepancies between flows on adjoining links.

2.22 The estimated total annual flows are shown in Figures A1 (a and b) and A2 (a and b) in Annex A. These have been factored to average daily tonnage flows for road and rail and have been included in the network data file to be carried forward to the assignment stage for comparison against the modelled flows as part of the calibration process (See Section 5).

GENERALISED COST PARAMETERS

2.23 The generalised costs are the total out of pocket cost incurred by the shipper including time costs. These generalised costs are utilised by the model to predict modal choice and route behaviour. In the model each aggregated commodity group was assigned its own value of time parameter in order to represent the relative importance of time in route and mode choice. Preliminary values of time have been assumed as shown in Table 2.2.

Table 2.2 - Grouped Commodities and Values of Time for Freight

Aggregated Commodity Group	Commodity codes (from the 21 grouped commodities)	Description	Estimated value of time of commodity in $ per day
1	2	All grains, cereals etc.	10.08
2	11	Cotton and Textiles	1.44
3	13,14,15	Ores, Metals and Stone	1.44
4	5,6,7	Oil, petroleum & minerals	1.44
5	9,16,18,19	Wood, Construction plant, Equipment and machinery	4.32
6	8,10	Dry bulk (include. paper)	1.44
7	17	Vehicles	1.44
8	1,3,4,12,20,21	Other consumer goods	1.44

3. DEVELOPMENT OF BASE YEAR FREIGHT TRIP MATRICES

3.1 Import and export data for each of the eight TRACECA countries was collected through the questionnaires, and visits to all countries. This data includes annual freight tonnage flows between all zones for each of the 21 commodity groups. This data was then combined to produce origin - destination matrices by commodity. The matrices were prepared using MS EXCEL Workbooks and a MS ACCESS database, and were presented, together with the import / export data for each country, in the Database.

3.2 The import / export data relates to international freight traffic to and from each of the TRACECA countries. Therefore the matrices do not include local intra-regional traffic, and possibly external to external traffic that may use certain routes through the region. This has been taken into consideration with regard to the count data during the calibration of the model (see Section 5).

3.3 Each of the 21 commodity matrices were then prepared for use in SATURN and were then combined to produce 8 aggregated commodity groups as shown in Table 2.2, and stacked together to form a multi dimensional layered SATURN matrix. This allows each aggregated commodity group, represented by a different level in the stacked matrix, to be assigned separately according to it's varying criteria for route and mode choice.

4. MODEL OPERATION

4.1 The previous sections of this paper have detailed the individual elements and development of the TRACECA model network and freight demand matrices for a base year of 1995. This section concentrates on the operation of the model including the network build, assignment process and model calibration. The adopted approach for running the model is illustrated in flowchart form in Figure 4.1.

4.2 Results of the model calibration have been presented in the final section of this report.

NETWORK BUILD

4.3 The multi-modal freight model networks have been developed using the SATURN suite of programs, with the input data used to describe each link coded in the buffer link data section using the '33333' data records. The initial network coding, and any subsequent network changes (during both calibration and forecasting stages) , have been made to a network.**BAS** datafile. BAS is not a standard file extension with regards to SATURN naming conventions, but has been used here to distinguish between the input network file input to the KNOBNET program (discussed below), from the output file network.**DAT**, which is ready for use in SATURN.

KNOBNET Program (FTN77)

4.4 As discussed earlier in paragraph 2.18 of this paper total shipment costs per tonne along each link have been included in the modelled network (i.e. tariff * distance) for each aggregated commodity group.

4.5 The tariff values are stored, and can be edited, in a input data file named **KNOBS**xxx.DAT, where 'xxx' is used to denote the run number/letter, or even the year in forecast mode. The data file used in the base year model is shown in Annex B of this paper.

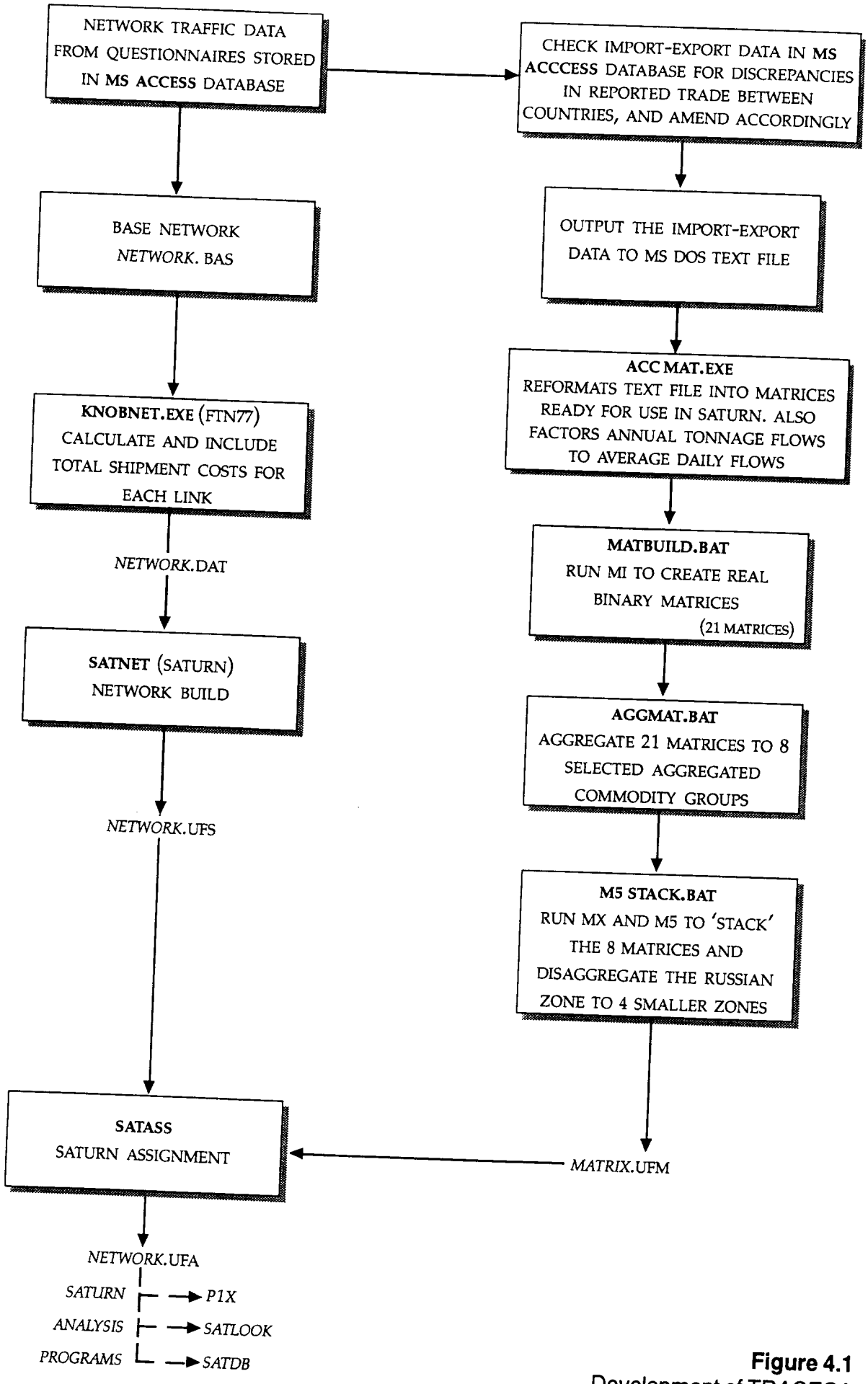


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Figure 4.1
Development of TRACECA Traffic Forecasting Model

4.6 The KNOBS facility within SATURN (Refer to SATURN Manual) to hold extra link data for each user class (which in the case of the TRACECA model, the 8 user classes allowed corresponding to each of the aggregated commodity groups) has been used to store the shipment costs in the network data file. A FORTRAN77 (FTN77) program has been written to automate the process of calculating the shipment costs and incorporating these into the network data file.

Command line: **KNOBNET**

The program will then prompt the user to input the following files:

- input network data file (.BAS)
- input data file containing tariffs (.DAT)

(The extensions .BAS and .DAT are not required when inputing the file names.)

4.7 For example:

Input network data file	-	NETyyv.BAS
Input data file containing tariffs	-	KNOBSxxx.DAT
Output network data file	-	NETyyv.DAT

where: 'yy' = year (i.e. 95 = 1995)
'xxx' = run number or letter, or year if required

4.8 The data file output by the program is identical to the input file, but contains the shipment costs for each link. Extracts from both the input and output networks are also presented in Annex B.

4.9 The program KNOBNET also enables the user to apply a 'security' factor to reflect the perceived cost to the shippers of rail cargo being stolen during shipment.

SATURN Network Build Program SATNET

4.10 The next step is to run the SATURN program **SATNET** which reads in the network card image (i.e. an ASCII or MSDOS Text file) data file and after checking for errors in the coding converts it to a binary file ready for use in SATURN. Reference should be made to the SATURN Manual for more information.

4.11 Command line: **SATNET** <network filename>

For example: Input network file - NETyyv.DAT

Output network file - NETyyv.UFS

4.12 The output network file produced by SATNET can be read and used by other programs in the SATURN suite, and in particular the assignment program SATASS.

MATRIX BUILD

4.13 Base year origin and destination matrices for each commodity have been developed from import and export data received for each of the eight TRACECA countries as discussed earlier in this paper. These were prepared initially using MS EXCEL spreadsheets. However, these EXCEL spreadsheets have since been replaced with a MS ACCESS database. From this database the 'Input-Output' Table, containing the import-export data collected for each country has been output to a single MSDOS Text file. This file can be given any name, but in this case the naming convention yyIM-EX.TXT was adopted, where yy = year (i.e. 95 = 1995).

ACCMAT Program (FTN77)

4.14 The next step was to reformat this text file to card image form ready for use in SATURN's matrix build programs M1 and MX. Another FTN77 program, ACCMAT, has been specifically written to carry out this reformatting procedure, whereby the text file output from the database is read in and reformatted to produce separate matrix data files for each of the 21 commodity groups.

4.15 Command line: **ACCMAT y1 y2**

where, for example: 'y1' = 9 'y2' = 5 (i.e. 95 = 1995)

4.16 Input text file: - y1y2IM-EX.TXT

Output SATURN card image matrix files: - y1y2CGcc.DAT

where: 'y1y2' = year (i.e. 95 = 1995)
CG = Commodity Group
'cc' = commodity category number (i.e. 1 to 21)

MATBUILD Batch File

4.17 The batch file MATBUILD.BAT has been prepared to create real binary matrices for all 21 commodities. The output files from this batch file, which uses the SATURN matrix manipulation program M1, are ready for input to SATURN's assignment programs.

4.18 Command line: **MATBUILD y1 y2**

where 'y1' and 'y2' are as above.

4.19 The input card image matrix file: y1y2CGcc.DAT (naming as above)

Output real matrix file: y1y2CGcc.UFM

Output line printer report file: MATBUILD.LPO

AGGMAT Batch File

4.20 The next step in the matrix build process combines the 21 commodity matrices to the 8 aggregated commodity groups shown in Table 2.2. This is achieved through running another specially prepared batch file AGGMAT.BAT

4.21 Command line: **AGGMAT y1 y2 y3 y4**

where for example for 1995: 'y1' = 1, 'y2' = 9, 'y3' = 9, 'y4' = 5

4.22 Input commodity matrix files required: y3y4CGcc.UFM
where 'cc' = 1 to 21

Output aggregated commodity matrix files: y3y4ACGc.UFM
where AGC = Aggregated Commodity Group
'c' = 1 to 8

Output line printer report file: AGGMAT.LPO

M5STACK Batch File

4.23 The final step in the matrix build process is to prepare a multi-dimensional layered SATURN matrix, where each of the 8 aggregated commodity matrices produced are stacked together. This allows each aggregated commodity group, represented by a different level in the stacked matrix, to be assigned separately according to it's varying criteria for route and mode choice.

4.24 The batch file M5STACK.BAT has been written to carry out this process by calling the SATURN matrix manipulation program M1 (Refer to SATURN Manual).

4.25 With regards the import and export information collected Russia has been represented by a single zone. For the purposes of the model this zone was considered too large to accurately model freight movement between Russia and the TRACECA countries. Therefore, this batch file also disaggregates the Russian zone into 4 smaller zone based on area, using the SATURN matrix manipulation program M5 (Refer to SATURN Manual).

4.26 Command line: **M5STACK y1 y2**

where, for example for 1995 'y1' = 9 and 'y2' = 5

4.27 Input aggregated matrix files: y1y2AGCc.UFM
where, 'c' = aggregated commodity group (i.e. 1 to 8)

Output stacked matrix: My1y2ALLCG.UFM
where: M = Matrix
ALLCG = ALL Commodity Groups

ASSIGNMENT

4.28 Having built a base year network (or future year network), the origin-destination freight matrix produced through the above procedures was assigned based on network characteristics using the SATURN assignment program SATASS. Reference should be made to the SATURN manual for further information.

4.29 Command line: **SATASS** <network file> <matrix>
(no extensions required)

4.30 Input network file from SATNET: NETy1y2v.UFS
Input freight O-D matrix: My1y2ALLCG.UFM

4.31 Output network file containing assigned flows: NETy1y2v.UFA

4.32 The network.UFA file can then be used in the SATURN assignment analysis and network plotting programs SATLOOK, P1X and SATDB. Again the SATURN manual should be referred to.

5. MODEL CALIBRATION

NETWORK CALIBRATION

5.1 Network calibration was carried out both before and during the assignment stage. This was undertaken to check for any obvious routeing problems. Other network checks included reviewing delays incurred by traffic at border crossing points, sea ports and mode interchanges. In addition it was important to check, and revise accordingly, the zone centroid connectors as discussed earlier.

5.2 The network calibration process continues throughout the model calibration exercise.

ASSIGNMENT

5.3 This section discusses the performance of the model and compares the base year observed and modelled daily freight tonnage flows throughout the TRACECA network for all modes. This would ensure that the model was robust and could be used with confidence to forecast the effects of proposed freight network scenarios in future years.

5.4 We have employed a stochastic user equilibrium assignment which assumes that minimum cost routes between each origin - destination pair is not perceived to be the same by all freight forwarders and operators. Therefore some multi-routeing will occur in the assignment where competing routes that appear to be slightly more costly (in terms of time and distance) will attract some traffic. This avoids the potentially unrealistic results that may arise from an all-or-nothing assignment.

5.5 The assignment calibration has been confined to looking at the strategic freight movements between the TRACECA countries. The freight matrices have been built from customs data, and therefore, represent international movements only. Direct comparison between assigned flows and observed flows has therefore, been confined to key ports and border crossings. In all countries it is clear that there are high levels of domestic traffic, which are included in the observed data, and hence, the observed

flows should, and are, significantly higher than the assigned international movements on links within countries. In calculating total flows relative to link capacities it will be necessary to take account of this domestic traffic and this has been included in the model network as a fixed flow on links. In addition to this there are several other factors which prevent a direct comparison between observed flows of freight on links and assigned flows from the modelling process:

- road flow data in number of trucks per day has been converted to estimate annual tonne flows using a weighted average tonnage per truck;

- history shows that there has been a significant volatility in trade movements over recent years resulting from economic conditions, trade barriers and the closure of border crossing points;

- traffic information collected to date has mainly comprised a mix of 1993, 1994 and 1995 flow data, whereas the import/export data received represents trade in 1995.

5.6 The model assignment can be more easily analysed, especially by commodity, on a computer using the SATURN graphics program P1X, therefore in this paper samples of what can be produced have been presented.

5.7 Figures C1(a and b) and C2(a and b) in Annex C show the base year strategic flows for the Caucasus Regions and Central Asia for rail and road respectively for all commodities.

Sea Links

5.8 On the Caspian Sea, the model shows 2-way flows between Baku and Turkmenbashi of approximately 3000 tonnes per day (over 1.09 million tonnes per annum). This compares with approximately 0.85 m.t.p.a handled by the ports in 1995. In earlier runs of the model the Caspian Sea Ferry route was shown to be more heavily loaded, possibly indicating an intrinsic attractiveness of this route. This has been reduced from the initial figures by increasing the loading times and delays at the ports together with the effective generalised costs of the ferry to better reflect the present day situation.

5.9 Modelled freight flows through the Black Sea Ports of Poti and Batumi are shown to be over 5700 tonnes per day (over 2.0 m.t.p.a) and almost 3400 tonnes per day (nearly 1.2 m.t.p.a) respectively. These figures compare well with the turnover traffic in 1995 reported by the World Food Programme for the two ports of 1.70 m.t.p.a and 1.29 m.t.p.a respectively.

5.10 Table 5.1 presents a comparison of modelled and observed imports and exports through both the Port of Poti and Port of Batumi. The figures show that the model compares well with the observed flows for imports but overestimates exports through Poti whilst underestimating exports through Batumi.

Table 5.1 - Modelled and Observed Imports and Exports Through the Ports of Poti and Batumi

Port	Modelled Imports (tonnes per day)	Modelled Imports (tonnes per annum)	Observed Imports (tonnes per annum)	Modelled Exports (tonnes per day)	Modelled Exports (tonnes per annum)	Observed Exports (tonnes per annum)
Poti	3200	1.2 million	1.37 million	2500	0.9 million	0.3 million
Batumi	1900	0.7 million	0.89 million	1500	0.5 million	0.3 million

Road and Rail Links

5.11 Annex D contains a series of eight tables showing comparison between modelled strategic flows and estimates of total flows across major screenlines in the region. Annex D also includes plans showing the location of the screenlines.

5.12 The difference between the total flow estimates and the modelled flows can be interpreted as non-strategic (domestic) traffic. These estimates are based on the observed flow data converted from daily trucks to annual tonnes for road flows. Given that many carriers may load their trucks to exceed weight restrictions, and the significant numbers of empty trucks returning from their destinations, the confidence interval of these observed road tonnage flows is likely to be relatively large.

5.13 These screenline summaries show the dominance of rail freight in Central Asia with rail mode share of approximately 80% across the screenline east of the Caspian Sea (with a modelled 2-way flow of 26 out of 34 million tonnes per annum) and Uzbekistan screenlines (a 2-way flow of 17 out of 19.5 m.t.p.a). Refer to Annex D, Tables D4 and D6 respectively. Table D2 shows that in the Caucasus the road/rail modal split is more evenly balanced, where the modelled 2-way rail flow is 2.3 out of a total of 3.7 m.t.p.a (over 60%).

5.14 The proportion of the total estimated flow representing strategic (international) movements varies considerably between screenlines and to a lesser extent between links within screenlines. This reflects the location of screenlines relative to country borders and the differing role played by rail relative to road and by different road and rail routes in carrying strategic freight. The pattern of movements as modelled accords well with reported road traffic and the most attractive existing routes as reported by freight forwarders operating in the region.

5.15 Annex D also shows the modelled strategic flow disaggregated by commodity group across the screenline as a whole. This demonstrates the importance of:

- oil, petroleum and minerals freight across the region as a whole;
- grain and cereal freight imported through the Black Sea ports (Table D1) and through Turkmenistan (Table D5). It should be noted that this comprises largely of food aid delivered from the west and is likely to decline in the future;
- ores, metals and stones in the east of the TRACECA region (Table D6, D7 and, particularly D8).

5.16 Table 5.2 summarises the estimated total flows by road and rail on key sections of the TRACECA corridor in each of the eight countries. Mode shares and the strategic assigned flow are also shown. Figures 5.1(a and b) show the location of these key sections (referenced by the Section ID) for road and rail respectively.

5.17 The figures in the Table 5.2 also show the dominance of rail in the movement of freight on the primary TRACECA routes within Central Asia, with an approximate mode share exceeding 70%. A similar mode share is shown for other countries including Kazakhstan, Turkmenistan and Uzbekistan. Kyrgyzstan and Tadjikistan are

the exceptions where, given the lack of existing rail infrastructure due to the severe mountainous conditions, road haulage caters for over 80% and 90% of the estimated total freight traffic on the main TRACECA routes respectively.

5.18 Within the Caucasus region the model shows overall an approximate balance between road and rail freight movement.

5.19 The proportion of strategic traffic to total estimated flows shown in Table 5.2 vary considerably along different sections of the TRACECA Route, as discussed above in paragraph 5.14.

CONCLUSION

5.20 The TRACECA Regional Traffic Model has been developed to represent freight movements by each mode of travel through the 8 CIS countries contained in Central Asia and the Caucasus in a base year of 1995. The three modes of travel modelled within the framework of the TRACECA Traffic Model include road, rail, and sea.

5.21 A satisfactory calibration of the model has been achieved to ensure its robustness as a tool in forecasting future year traffic conditions to assist strategic planning of the freight network, and assess the impacts of proposed investments in the region.

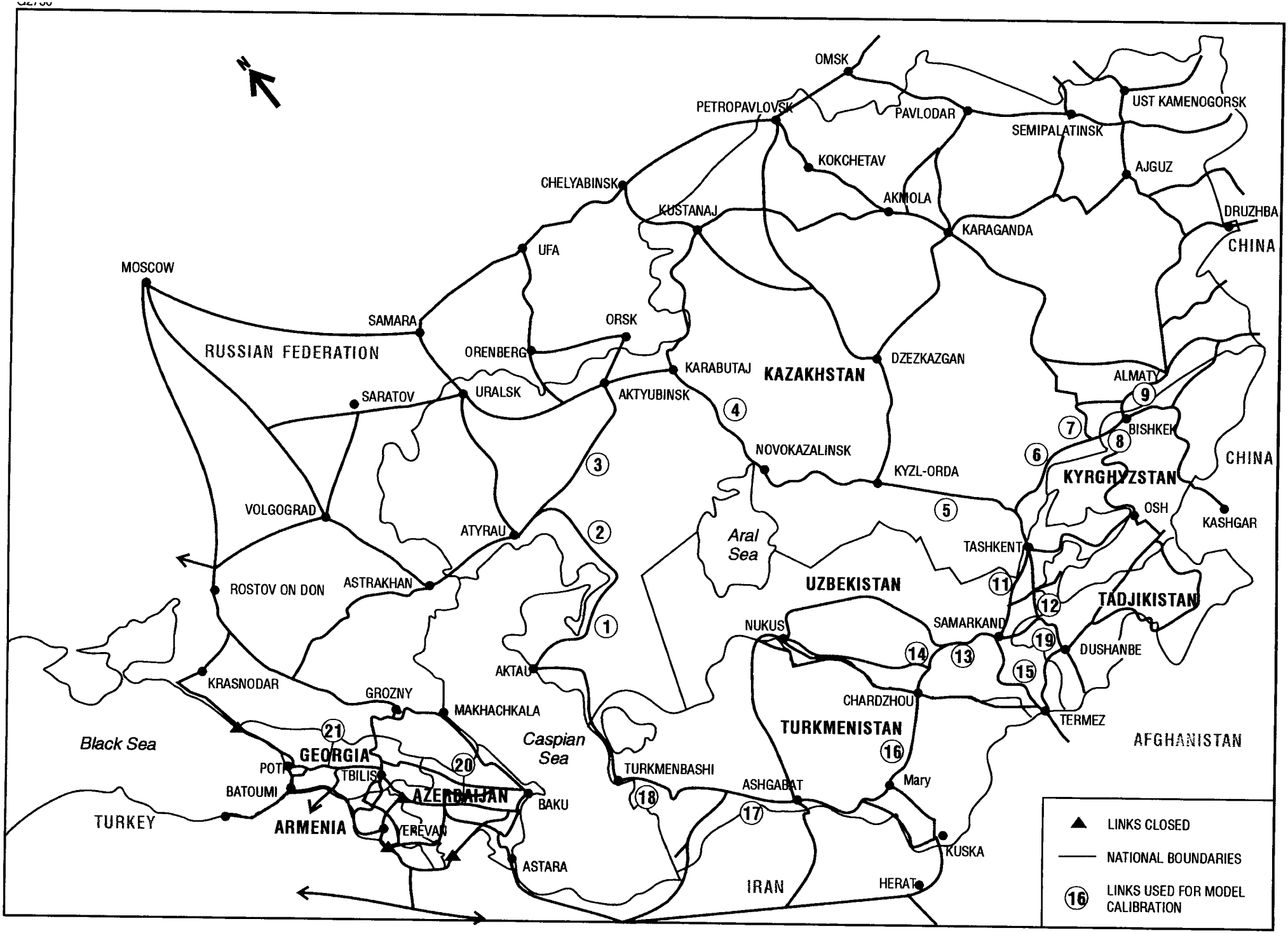


Figure 5.1(a) Location of Links used for Model Calibration, Road Network

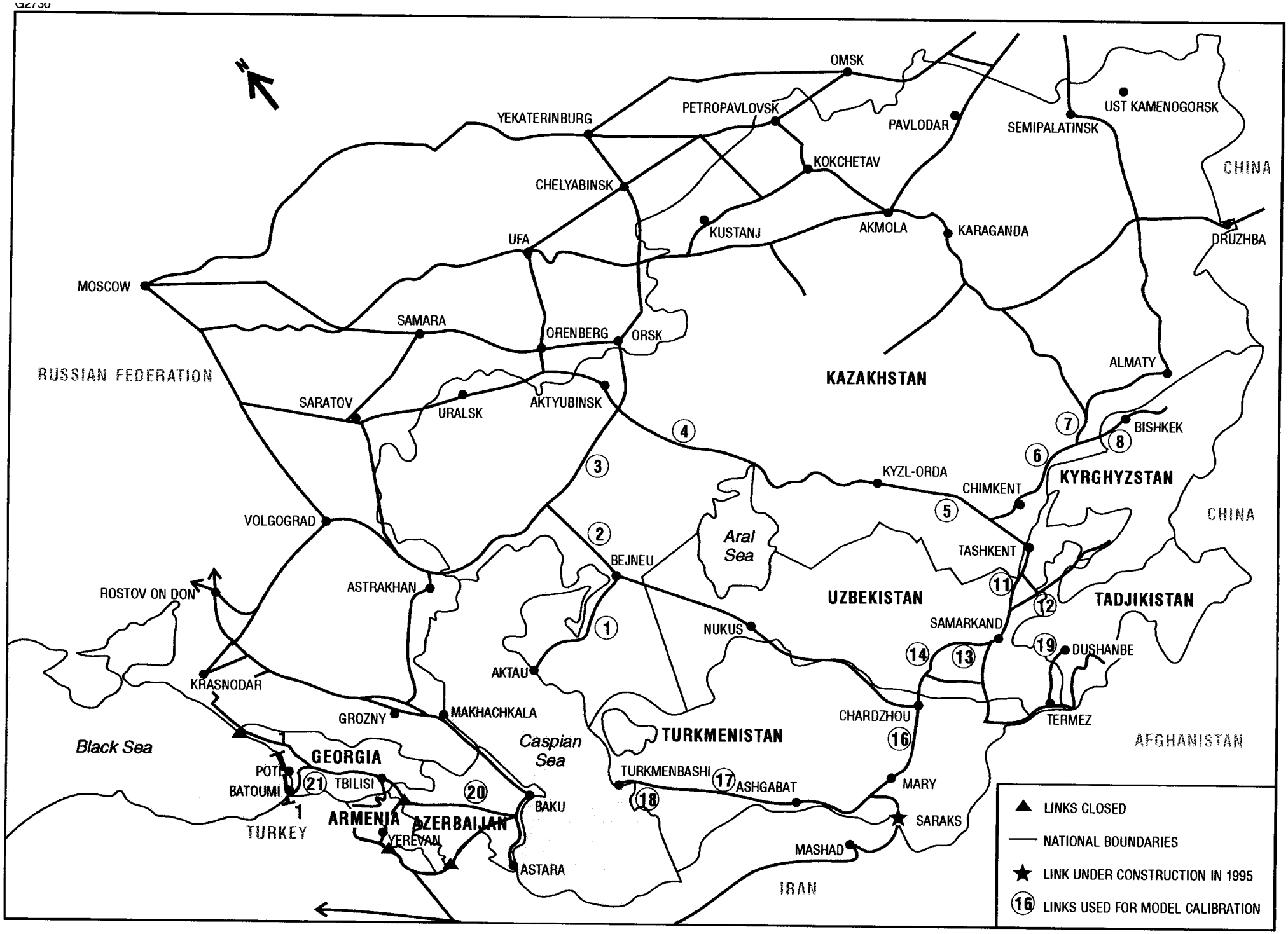


Figure 5.1(b)
Location of Links used for Model Calibration, Rail Network

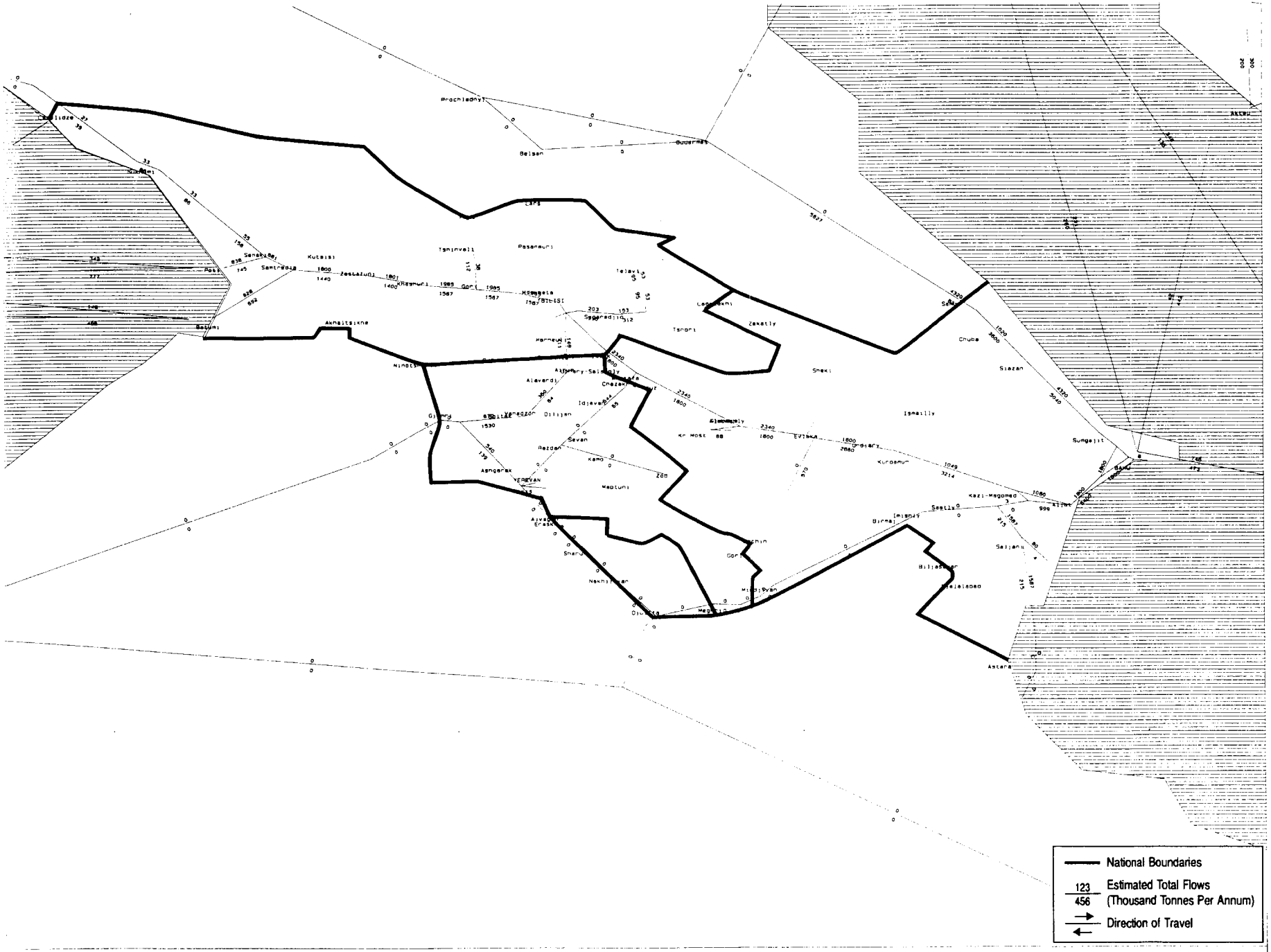
Table 5.2 - Modelled Strategic and Estimated Total Tonnage Flows on Selected Sections of the TRACECA Route, 1995

Country	Section ID	ROAD Section		Modelled Strategic 2 Way Flow (000 Tonnes p a)	Estimated Total 2 Way Flow (000 Tonnes p a)	Mode Share (%)	RAIL Section		Modelled Strategic 2 Way Flow (000 Tonnes p a)	Estimated Total 2 Way Flow (000 Tonnes p a)	Mode Share (%)
Kazakhstan	1	Bejneu	Aktau	47	1339	39%	Bejneu	Aktau	906	2100	61%
	2	Kulsary	Bejneu	13	1238	8%	Kulsary	Bejneu	1708	13900	92%
	3	Makat	Nr. Oktjabr'sk	56	1310	11%	Makat	Nr. Oktjabr'sk	2480	10599	89%
	4	Karabutak	Aral'sk	450	1642	10%	Karabutak	Aral'sk	6172	14900	90%
	5	Kzyl	Orda	1098	2866	15%	Kzyl	Orda	6138	16500	85%
	6	Djumbul	Ojtal	1363	3773	15%	Djumbul	Ojtal	4761	21200	85%
	7	Almaty	Cilik	1232	3492	23%	Almaty	Cilik	340	11600	77%
Kyrgyzstan	8	Kara Balta	Bishkek	704	13097	77%	Kara Balta	Bishkek	3746	3960	23%
	9	Bishkek	Tokmak	886	4066	100%					
Uzbekistan	11	Jangijul	Tashkent	4285	7089	30%	Jangijul	Tashkent	701	16200	70%
	12	Dzizak	Bekabad	268	671	2%	Dzizak	Bekabad	42	30052	98%
	13	Katta Kurgan	Samarakand	2565	4023	93%	Bokhara	Samarakand	29	295	7%
	14	Nr Bokhara	Navoi	2677	4168	49%	Nr Bokhara	Navoi	439	4385	51%
	15	Termez	Dsarkurgan	348	870	100%					
Turkmenstan	16	Nr Mary	Chardzhou	1606	1296	18%	Nr Mary	Chardzhou	577	5760	82%
	17	Kizyl Arvat	Ashgabat	536	2441	33%	Kizyl Arvat	Ashgabat	1238	5040	67%
	18	Turkmenbashi	Nebit-Dag	796	1570	74%	Turkmenbashi	Nebit-Dag	1252	540	26%
Tadjikistan	19	Denau	Dushbanbe	348	3694	100%					
Azerbaijan	20	Baku	Tbilisi	914	1306	22%	Baku	Tbilisi	1705	4680	78%
Georgia	21	Tbilisi	Black Sea	1635	6480	65%	Tbilisi	Black Sea	2134	3551	35%

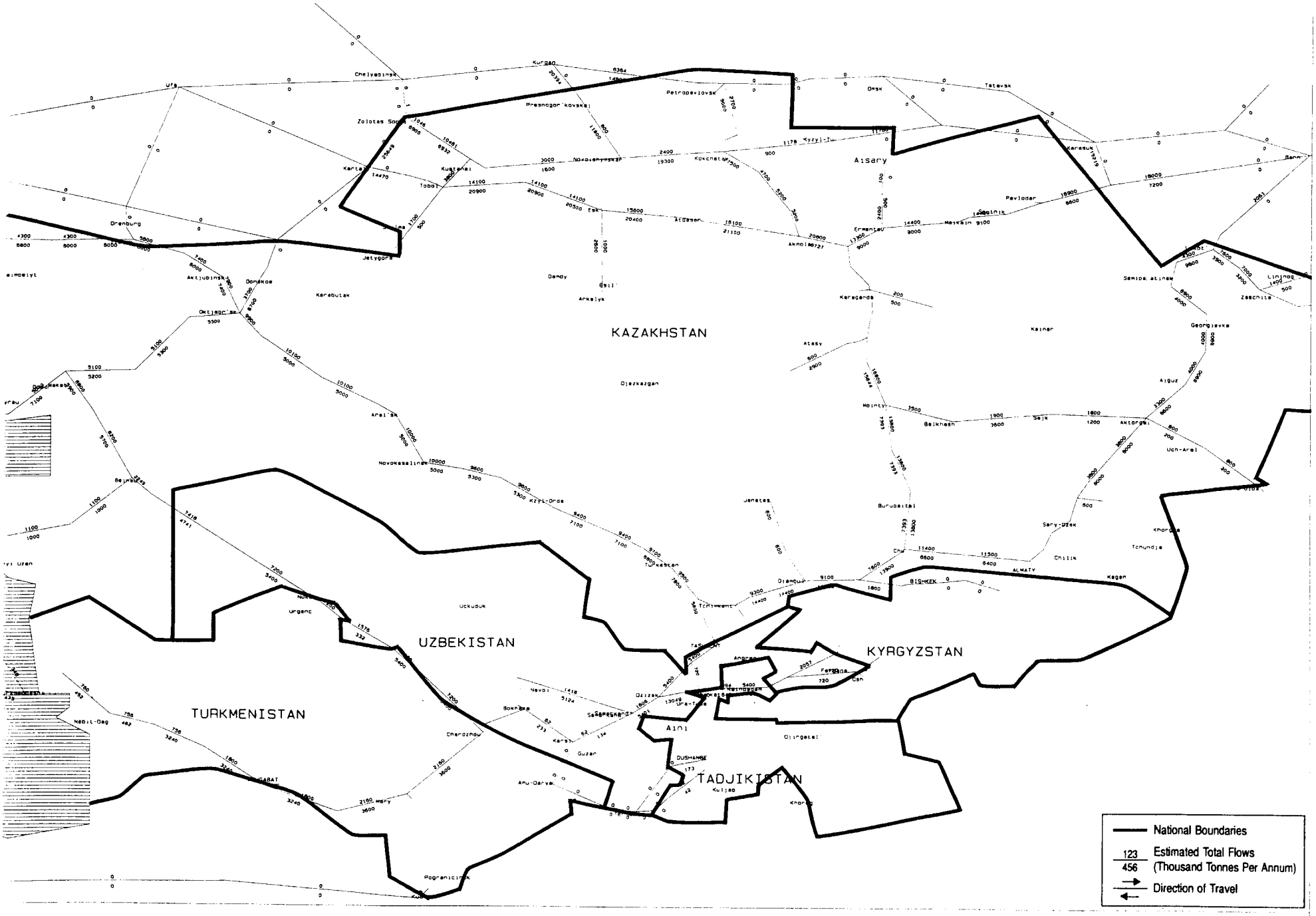
ANNEX A

Estimated Road and Rail Flows

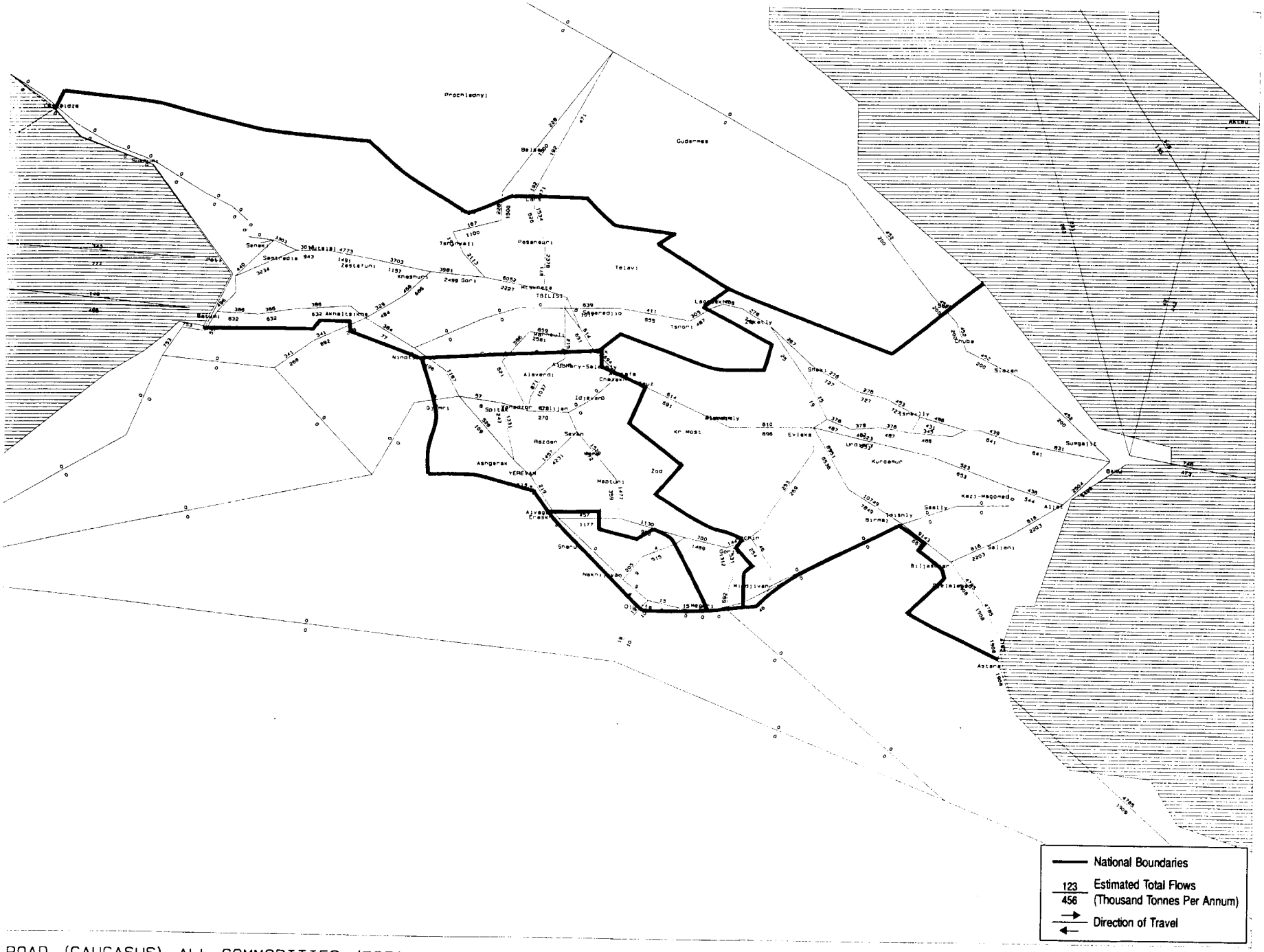
(000's Tonnes per Annum)



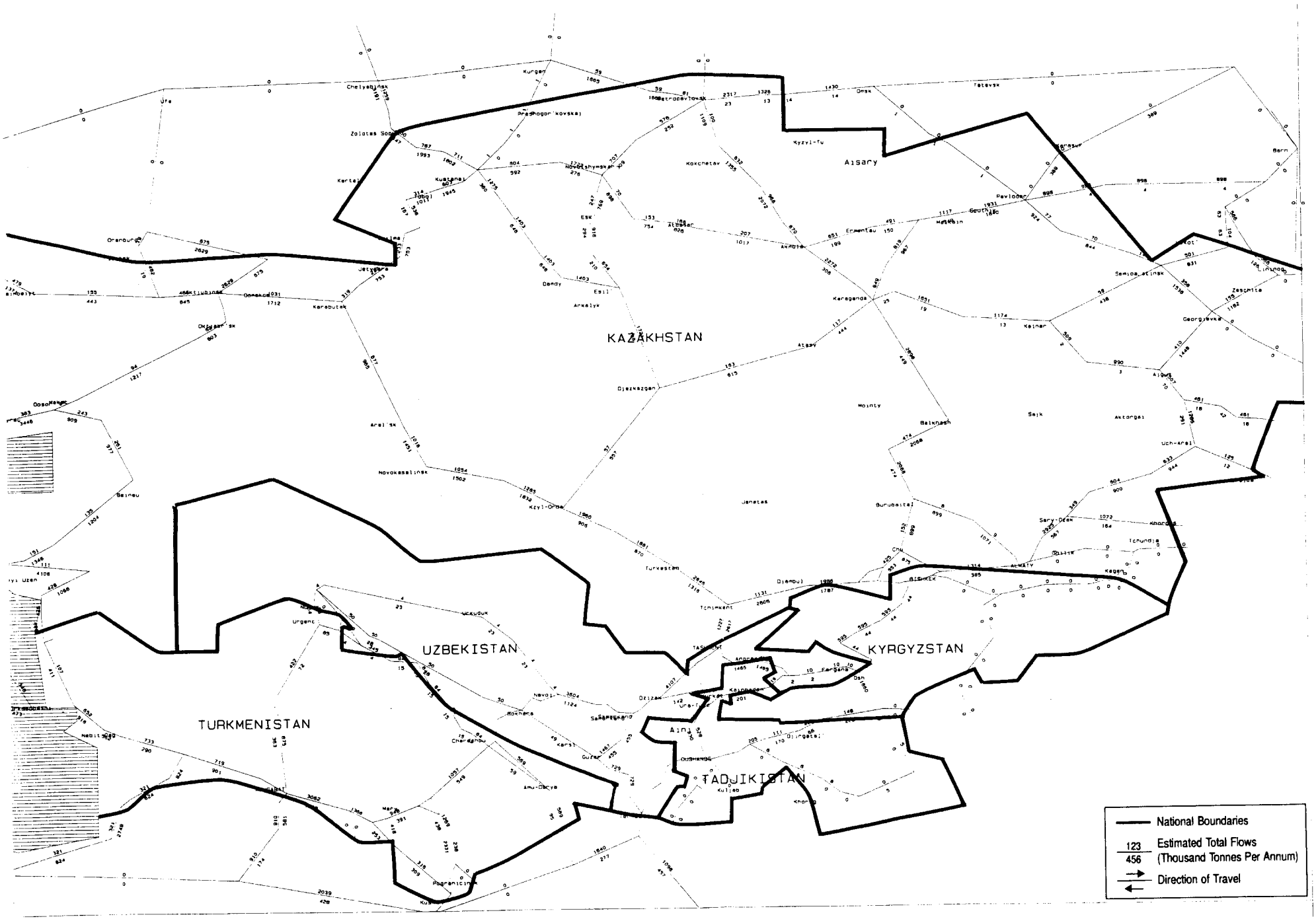
RAIL (CAUCASUS) ALL COMMODITIES (ESTIMATED FLOWS) FIGURE A1 (A)



RAIL (C. ASIA) ALL COMMODITIES (ESTIMATED FLOWS) FIGURE A1 (B)



ROAD (CAUCASUS) ALL COMMODITIES (ESTIMATED FLOWS) FIGURE A2 (A)



ROAD (C. ASIA) ALL COMMODITIES (ESTIMATED FLOWS) FIGURE A2 (B)

ANNEX B

Tariff Rates used in KNOBNET

Samples of Network Data Files

Input to and Output from KNOBNET

```
AREA=18
COMM=8
SECURITY
  1.750  1.750  1.750  1.750  1.750  1.750  1.750  1.750  rail
ROAD
  0.050  0.050  0.050  0.050  0.050  0.050  0.050  0.050  ar
  0.050  0.050  0.050  0.050  0.050  0.050  0.050  0.050  az
  0.050  0.050  0.050  0.050  0.050  0.050  0.050  0.050  ge
  0.050  0.050  0.050  0.050  0.050  0.050  0.050  0.050  kaz
  0.050  0.050  0.050  0.050  0.050  0.050  0.050  0.050  kyrg
  0.050  0.050  0.050  0.050  0.050  0.050  0.050  0.050  ta
  0.050  0.050  0.050  0.050  0.050  0.050  0.050  0.050  tu
  0.050  0.050  0.050  0.050  0.050  0.050  0.050  0.050  uz
  0.025  0.050  0.050  0.050  0.050  0.050  0.050  0.050  russia
  5.000  5.000  5.000  5.000  5.000  5.000  5.000  5.000  ext
  5.000  5.000  5.000  5.000  5.000  5.000  5.000  5.000  x border
                                                         interchge
                                                         black sea
                                                         caspian
  0.200  0.200  0.200  0.200  0.200  0.200  0.200  0.200  cc (=$10) 50km
  0.035  0.035  0.035  0.035  0.035  0.035  0.035  0.035  bandar abbas
 20.000 20.000 20.000 20.000 20.000 20.000 20.000 20.000  x border (Kaz->russia)
  5.000  5.000  5.000  5.000  5.000  5.000  5.000  5.000  x border UZ
RAIL
  0.012  0.014  0.008  0.012  0.012  0.012  0.012  0.012  ar
  0.012  0.014  0.008  0.012  0.012  0.012  0.012  0.012  az
  0.012  0.014  0.008  0.012  0.012  0.012  0.012  0.012  ge
  0.012  0.014  0.008  0.012  0.012  0.012  0.012  0.012  kaz
  0.012  0.014  0.008  0.012  0.012  0.012  0.012  0.012  kyrg
  0.012  0.014  0.008  0.012  0.012  0.012  0.012  0.012  ta
  0.012  0.014  0.008  0.012  0.012  0.012  0.012  0.012  tu
  0.012  0.014  0.008  0.012  0.012  0.012  0.012  0.012  uz
  0.010  0.010  0.010  0.010  0.010  0.010  0.010  0.010  russia
  0.005  0.010  0.010  0.010  0.010  0.010  0.010  0.010  ext
 10.000 10.000 10.000 10.000 10.000 10.000 10.000 10.000  x border
 10.000 10.000 10.000 10.000 10.000 10.000 10.000 10.000  interchnge
                                                         black sea
                                                         caspian
  0.200  0.240  0.080  0.200  0.200  0.200  0.200  0.200  cc($10) 50km
  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000  bandar abbas
 10.000 10.000 10.000 10.000 10.000 10.000 10.000 10.000  x border (kaz->russia)
 30.000 20.000 20.000 20.000 20.000 20.000 20.000 20.000  x border UZ
SEA
                                                         ar
                                                         az
                                                         ge
                                                         kaz
                                                         kyrg
                                                         ta
                                                         tu
                                                         uz
                                                         russia
  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000  ext
  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000  x border
  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000  interchnge
  0.020  0.080  0.080  0.080  0.080  0.080  0.080  0.080  black sea ($80) 1000km
  0.065  0.065  0.065  0.065  0.065  0.065  0.065  0.002  caspian ($5-$20) 310km
  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000  cc
 75.000 75.000 75.000 75.000 75.000 75.000 75.000 75.000  bandar abbas
                                                         x border (kaz->russia)
                                                         x border UZ
```

Date file containing tariff rates for program KNOBNET

SATURN Buffer Link Coding

```
3333333333
*Armenia
    10001   10020   40    9999  2S    44  0.0  11   1
    10020   10030   40    9999  2S   100  0.0  11   1
    10030   10031   40    9999  2S    49  0.0  11   1
    10030   10040   40    9999  2S    30  0.0  11   1
    10031   10131   40    9999  2S    30  0.0  11   1
    10040   10060   40    9999  2S    73  0.0  11   1
    10040   10110   40    9999  2S    47  0.0  11   1
    10060   10080   40    9999  2S    30  0.0  11   1
    10080   10090   40    9999  2S    49  0.0  11   1
    10080   10130   40    9999  2S    40  0.0  11   1
    10090   10091   40    9999  2S    20  0.0  11   1
    10110   10120   40    9999  2S    20  0.0  11   1
    10130   10131   40    9999  2S    15  0.0  11   1
    10130   10132   40    9999  2S    26  0.0  11   1
    10130   10140   40    9999  2S    31  0.0  11   1
    10131   10020   39    9999  2S    50  0.0  11   1
    10132   10133   38    9999  2S    56  0.0  11   1
    10140   10150   38    9999  2S    26  0.0  11   1
    10150   10160   40    9999  2S    34  0.0  11   1
    10170   10180   40    9999  2S    56  0.0  11   1
    10180   10190   40    9999  2S    30  0.0  11   1
    10190   10200   40    9999  2S    62  0.0  11   1
    10200   10201   40    9999  2S    28  0.0  11   1
    10200   10210   40    9999  2S    48  0.0  11   1
    10210   19220   40    9999  2S    19  0.0  11   1
    10210   10230   40    9999  2S    75  0.0  11   1
    10230   10120   40    9999  2S    59  0.0  11   1
    10230   10240   28    9999  2S    65  0.0  11   1
    10240   10060   37    9999  2S    63  0.0  11   1
*Azerbaijan
    10091   29020   40    9999  2S    15  0.0  11   2
    10170   29631   20    9999  2S     8  0.0  11   2
    10220   20600   38    9999  2S    34  0.0  11   2
    20020   20050   40    9999  2S   113  0.0  11   2
    20050   20060   40    9999  2S    70  0.0  11   2
    20060   20070   30    9999  2S    16  0.0  11   2
    20060   20391   40    9999  2S    98  0.0  11   2
    20060   20451   40    9999  2S    90  0.0  11   2
    20060   20500   40    9999  2S    27  0.0  11   2
    20070   20080   30    9999  2S    40  0.0  11   2
    20080   20081   30    9999  2S    24  0.0  11   2
    20081   20090   30    9999  2S    25  0.0  11   2
    20090   20091   30    9999  2S    36  0.0  11   2
    20090   20130   30    9999  2S    27  0.0  11   2
    20091   20092   30    9999  2S    14  0.0  11   2
```

Extract from NETWORK.BAS, input to the program KNOBNET containing no shipment costs

```
3333333333
*Armenia
    10001    10020  40        9999  2S     44  0.0  11    1
     2.20     2.20        2.20        2.20        2.20        2.20     2.20
    10020    10030  40        9999  2S    100  0.0  11    1
     5.00     5.00        5.00        5.00        5.00        5.00     5.00
    10030    10031  40        9999  2S     49  0.0  11    1
     2.45     2.45        2.45        2.45        2.45        2.45     2.45
    10030    10040  40        9999  2S     30  0.0  11    1
     1.50     1.50        1.50        1.50        1.50        1.50     1.50
    10031    10131  40        9999  2S     30  0.0  11    1
     1.50     1.50        1.50        1.50        1.50        1.50     1.50
    10040    10060  40        9999  2S     73  0.0  11    1
     3.65     3.65        3.65        3.65        3.65        3.65     3.65
    10040    10110  40        9999  2S     47  0.0  11    1
     2.35     2.35        2.35        2.35        2.35        2.35     2.35
    10060    10080  40        9999  2S     30  0.0  11    1
     1.50     1.50        1.50        1.50        1.50        1.50     1.50
    10080    10090  40        9999  2S     49  0.0  11    1
     2.45     2.45        2.45        2.45        2.45        2.45     2.45
    10080    10130  40        9999  2S     40  0.0  11    1
     2.00     2.00        2.00        2.00        2.00        2.00     2.00
    10090    10091  40        9999  2S     20  0.0  11    1
     1.00     1.00        1.00        1.00        1.00        1.00     1.00
    10110    10120  40        9999  2S     20  0.0  11    1
     1.00     1.00        1.00        1.00        1.00        1.00     1.00
    10130    10131  40        9999  2S     15  0.0  11    1
     0.75     0.75        0.75        0.75        0.75        0.75     0.75
    10130    10132  40        9999  2S     26  0.0  11    1
     1.30     1.30        1.30        1.30        1.30        1.30     1.30
    10130    10140  40        9999  2S     31  0.0  11    1
     1.55     1.55        1.55        1.55        1.55        1.55     1.55
    10131    10020  39        9999  2S     50  0.0  11    1
     2.50     2.50        2.50        2.50        2.50        2.50     2.50
    10132    10133  38        9999  2S     56  0.0  11    1
     2.80     2.80        2.80        2.80        2.80        2.80     2.80
    10140    10150  38        9999  2S     26  0.0  11    1
     1.30     1.30        1.30        1.30        1.30        1.30     1.30
    10150    10160  40        9999  2S     34  0.0  11    1
     1.70     1.70        1.70        1.70        1.70        1.70     1.70
    10170    10180  40        9999  2S     56  0.0  11    1
     2.80     2.80        2.80        2.80        2.80        2.80     2.80
    10180    10190  40        9999  2S     30  0.0  11    1
     1.50     1.50        1.50        1.50        1.50        1.50     1.50
    10190    10200  40        9999  2S     62  0.0  11    1
     3.10     3.10        3.10        3.10        3.10        3.10     3.10
    10200    10201  40        9999  2S     28  0.0  11    1
     1.40     1.40        1.40        1.40        1.40        1.40     1.40
    10200    10210  40        9999  2S     48  0.0  11    1
     2.40     2.40        2.40        2.40        2.40        2.40     2.40
    10210    19220  40        9999  2S     19  0.0  11    1
     0.95     0.95        0.95        0.95        0.95        0.95     0.95
    10210    10230  40        9999  2S     75  0.0  11    1
     3.75     3.75        3.75        3.75        3.75        3.75     3.75
    10230    10120  40        9999  2S     59  0.0  11    1
     2.95     2.95        2.95        2.95        2.95        2.95     2.95
    10230    10240  28        9999  2S     65  0.0  11    1
     3.25     3.25        3.25        3.25        3.25        3.25     3.25
    10240    10060  37        9999  2S     63  0.0  11    1
     3.15     3.15        3.15        3.15        3.15        3.15     3.15
```

SATURN Buffer Link Coding

KNOBS Extra Data Field

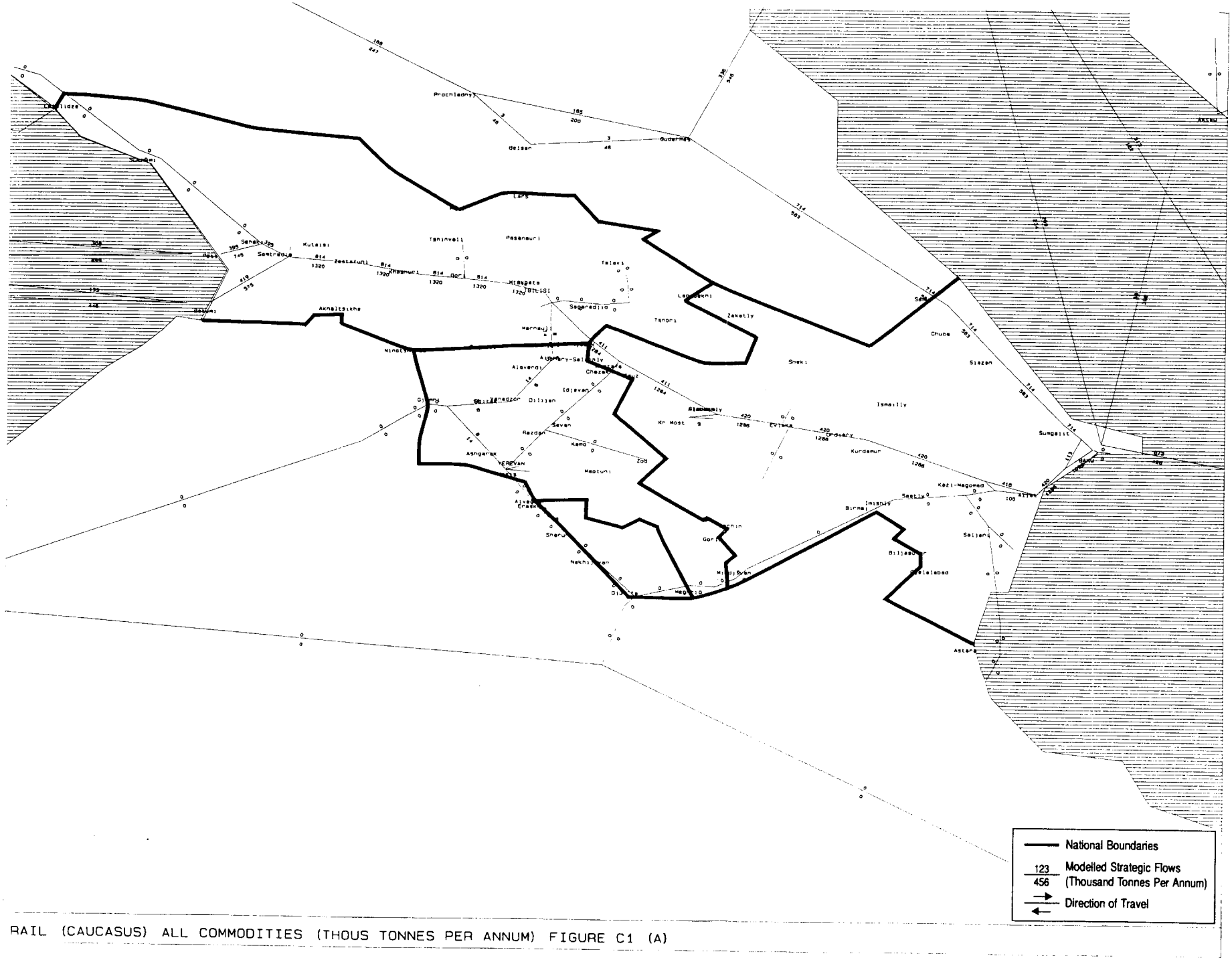
Extract from NETWORK.DAT, output from KNOBNET containing shipment costs for each link, using the KNOBS facility in SATURN

ANNEX C

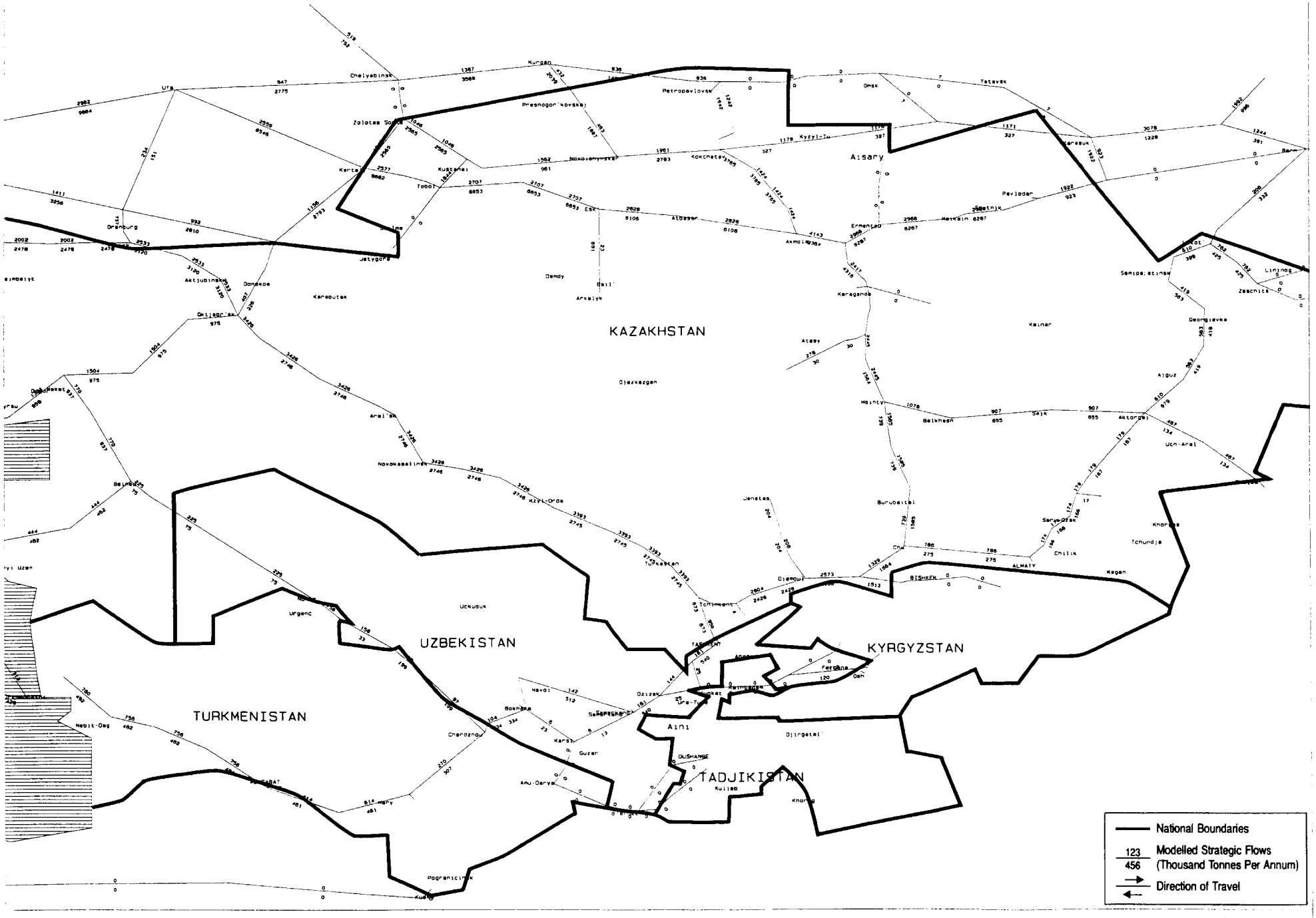
Strategic Assigned Road and Rail Flows

for All Commodities Combined

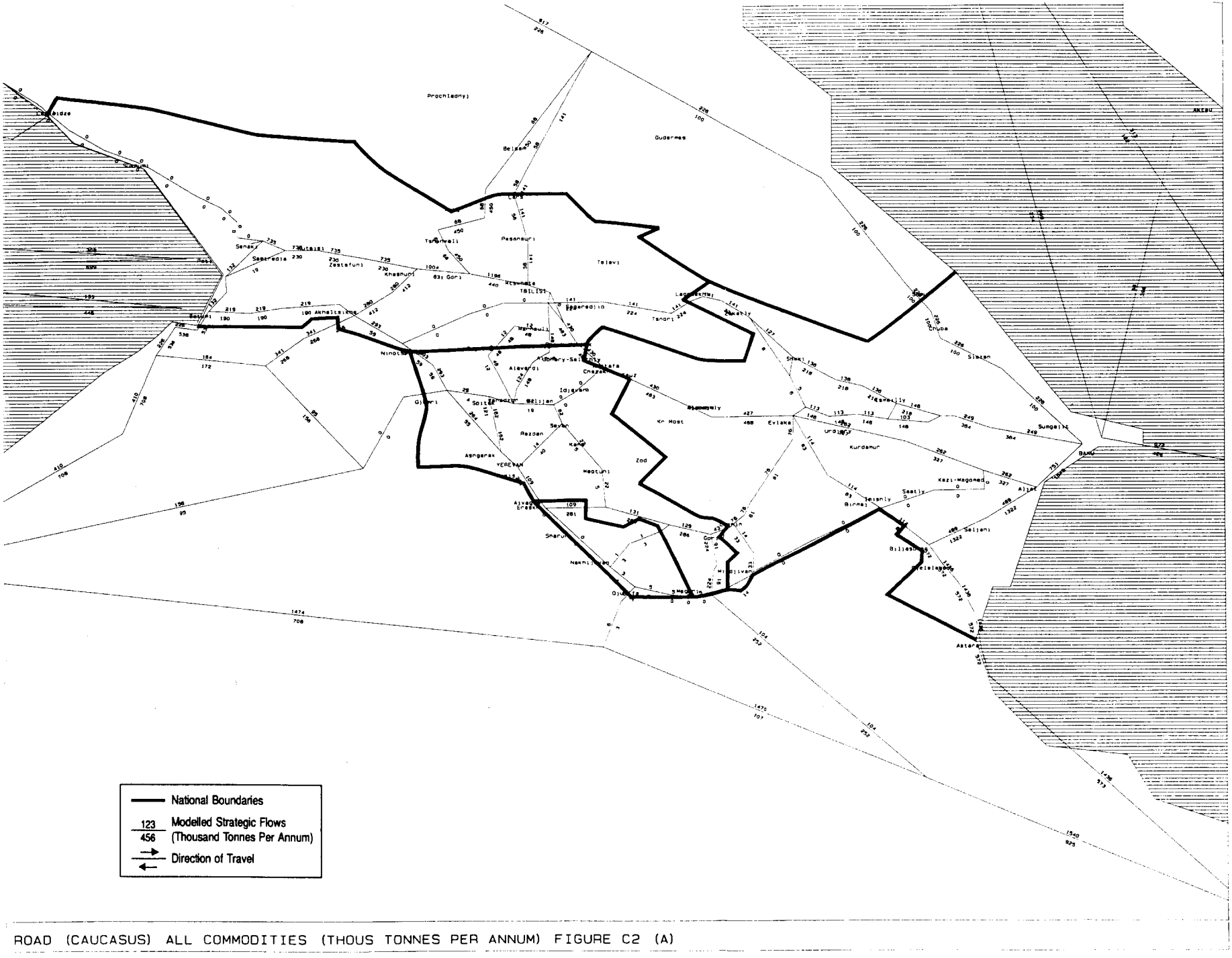
(000's Tonnes per Annum)



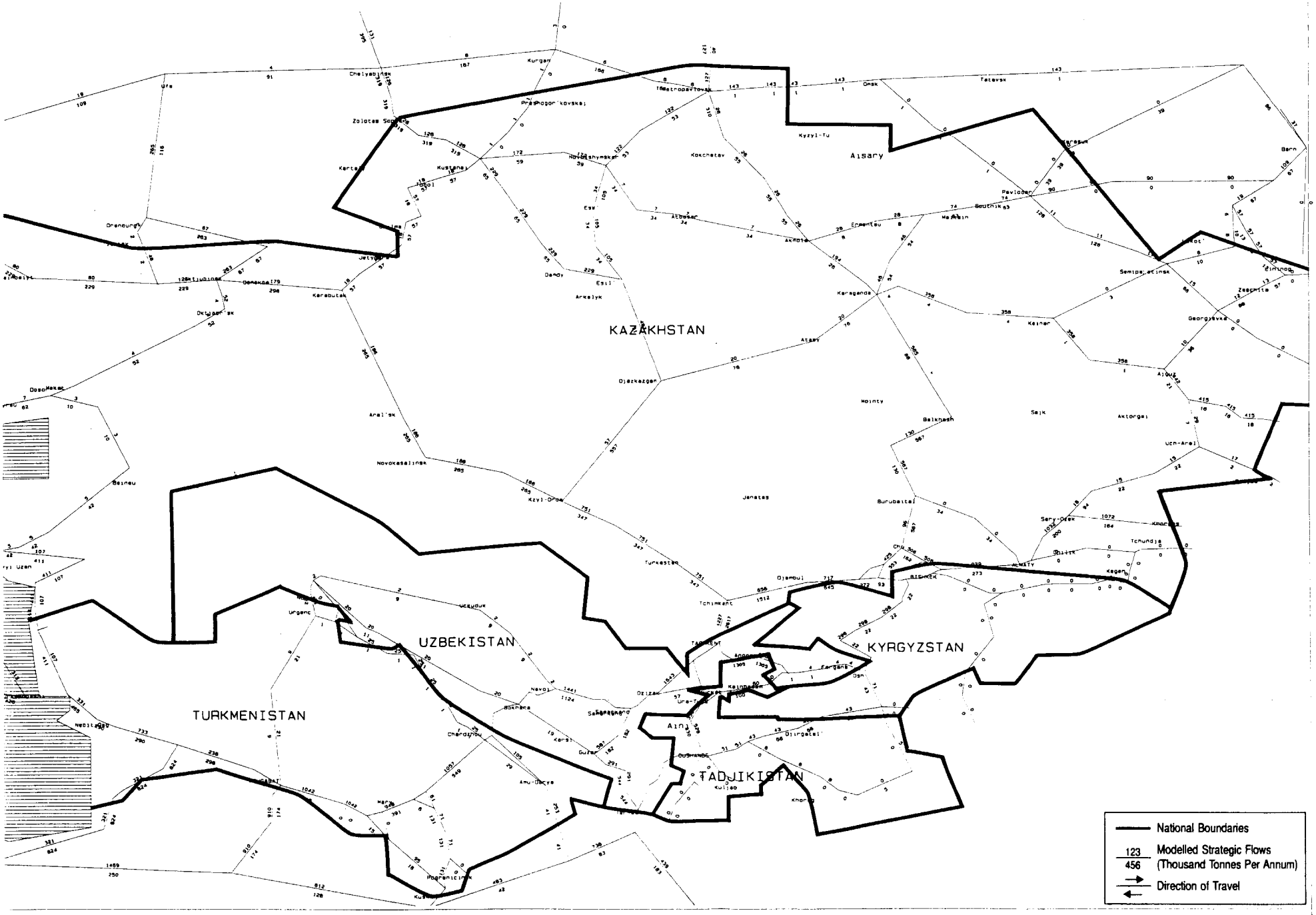
RAIL (CAUCASUS) ALL COMMODITIES (THOUS TONNES PER ANNUM) FIGURE C1 (A)



RAIL (C. ASIA) ALL COMMODITIES (THOUS TONNES PER ANNUM) FIGURE C1 (B)



ROAD (CAUCASUS) ALL COMMODITIES (THOUS TONNES PER ANNUM) FIGURE C2 (A)

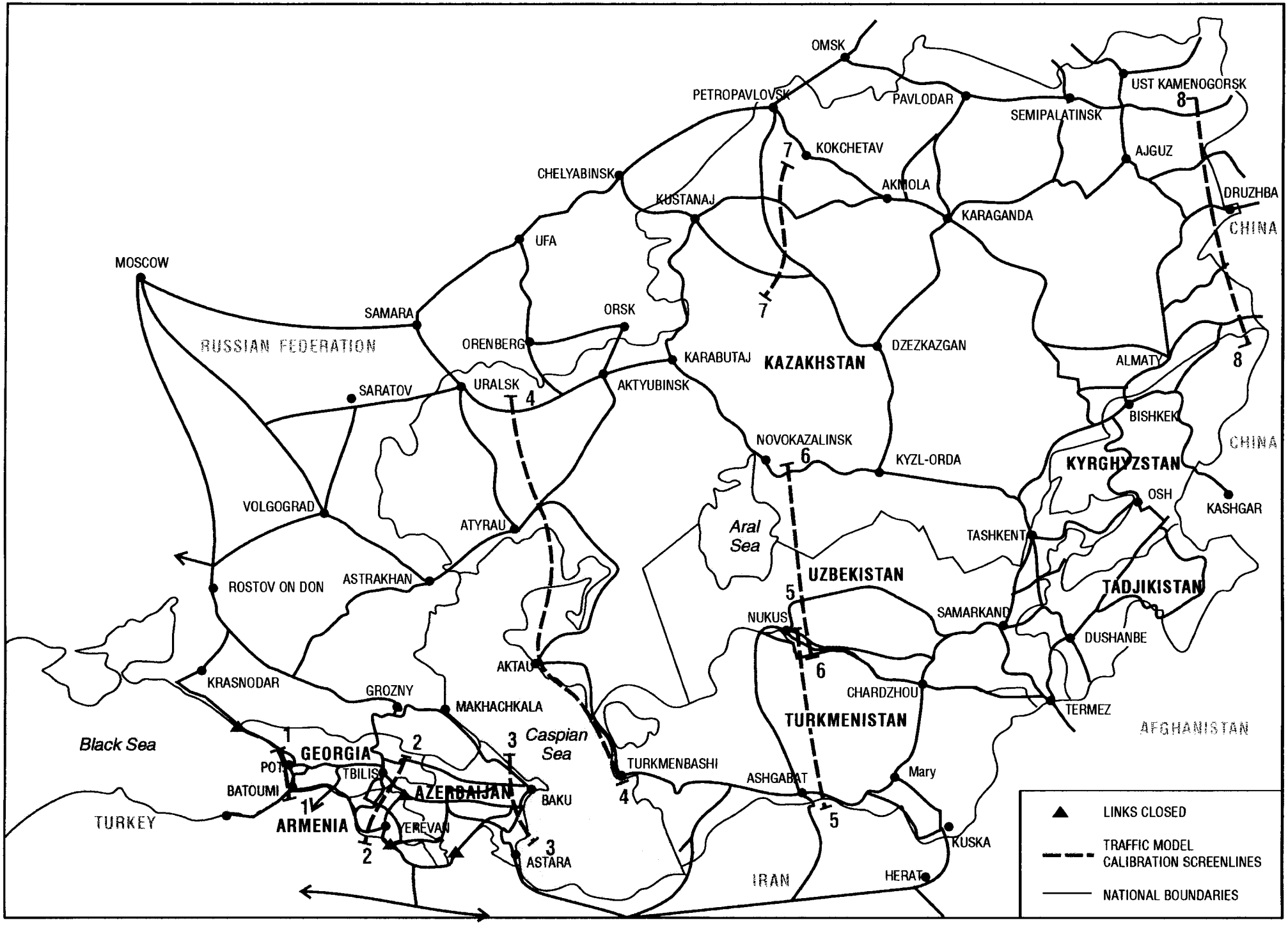


ROAD (C. ASIA) ALL COMMODITIES (THOUS TONNES PER ANNUM) FIGURE C2 (B)

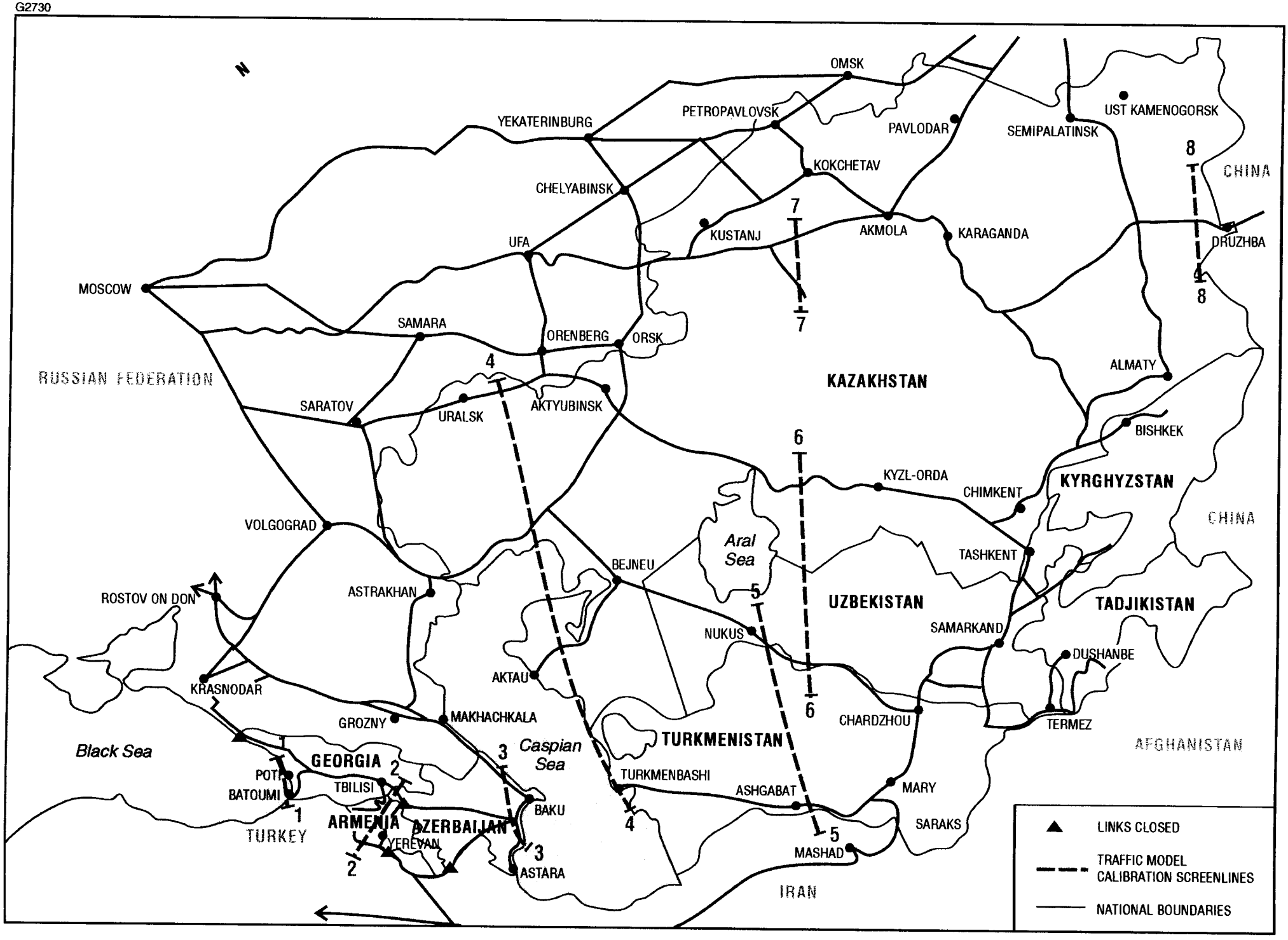
ANNEX D

Summary of Screenline Flows

G2730



FigureD1
Location of Traffic Model Calibration Screenlines, Road Network



FigureD2
Location of Traffic Model Calibration Screenlines, Rail Network

Table D.1 - Modelled and Estimated Flows Across Major Screenlines: Screenline 1, Georgia - Black Sea

				Eastbound Direction		Westbound Direction	
Location	Mode	Anode	Bnode	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)
Poti	Road	39100	30100	751	835	167	195
	Rail	39100	35100	395	439	745	827
Batumi	Rail	39130	35130	419	466	575	639
	Road	39130	30130	593	659	332	388
Totals:	Road			1344 (62%)	1494 (62%)	499 (27%)	582 (28%)
	Rail			814 (38%)	905 (38%)	1320 (73%)	1466 (72%)
	Overall			2159	2398	1819	2049

Commodity Type	Commodity No.	Modelled Strategic Flow (Thousand Tonnes per annum) Eastbound	Westbound	Total	% of Total
Grains and cereals	1	999	9	1008	25.3%
Cotton and textiles	2	15	253	269	6.8%
Ores, metals and stone	3	169	389	558	14.0%
Oil, petroleum and minerals	4	627	1048	1675	42.1%
Timber, construct. equipment	5	15	10	26	0.6%
Dry bulk	6	26	24	50	1.2%
Vehicles	7	7	3	10	0.3%
Other Consumer goods	8	301	82	383	9.6%
Total		2159	1819	3978	100.0%

Table D.2 - Modelled and Estimated Flows Across Major Screenlines: Screenline 2, Georgia - Azerbaijan/Armenia

				Eastbound Direction		Westbound Direction	
Location	Mode	Anode	Bnode	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)
A320, nr Sagaredjio	Road	30360	30370	141	411	224	655
Beyuk-Kasyk	Rail	29810	25810	411	540	1284	1656
M27 Red Bridge	Road	30332	39332	430	537	483	691
A330, nr Dilijan	Road	10130	10080	62	875	19	270
A327, nr Artasat	Road	10030	10040	427	853	176	352
North of Yerevan	Rail	15020	15520	8	540	14	139
Totals:	Road			641 (43%)	2363 (63%)	740 (34%)	1755 (47%)
	Rail			838 (57%)	1393 (37%)	1460 (66%)	2008 (53%)
	Overall			1478	3756	2200	3762

Commodity Type	Commodity No.	Modelled Strategic Flow (Thousand Tonnes per annum) Eastbound	Westbound	Total	% of Total
Grains and cereals	1	388	55	443	12.0%
Cotton and textiles	2	12	333	345	9.4%
Ores, metals and stone	3	134	428	562	15.3%
Oil, petroleum and minerals	4	526	1301	1828	49.7%
Timber, construct. equipment	5	26	15	41	1.1%
Dry bulk	6	27	31	57	1.6%
Vehicles	7	10	1	11	0.3%
Other Consumer goods	8	356	36	392	10.6%
Total		1478	2200	3679	100.0%

Table D.3 - Modelled and Estimated Flows Across Major Screenlines: Screenline 3, Azerbaijan - Caspian Sea

				Eastbound Direction		Westbound Direction	
Location	Mode	Anode	Bnode	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)
M29, nr Siazan	Road	20290	20270	226	452	100	200
nr Siazan	Rail	25830	25270	714	1020	583	3600
M27, nr Achsu	Road	20100	20110	249	439	364	645
nr Karasu	Rail	25820	25390	420	1049	1286	3214
A324, nr Karasu	Road	20390	20310	262	436	327	544
Nr Karachala	Rail	25840	25400	0	3	0	0
A322, nr Saljani	Road	20320	20310	489	816	1322	2203
Totals:	Road			1226 (52%)	2143 (51%)	2113 (53%)	3592 (35%)
	Rail			1134 (48%)	2073 (49%)	1868 (47%)	6814 (65%)
	Overall			2361	4215	3981	10407

Commodity Type	Commodity No.	Modelled Strategic Flow (Thousand Tonnes per annum) Eastbound	Westbound	Total	% of Total
Grains and cereals	1	586	37	623	9.8%
Cotton and textiles	2	39	400	439	6.9%
Ores, metals and stone	3	449	529	978	15.4%
Oil, petroleum and minerals	4	672	2861	3533	55.7%
Timber, construct. equipment	5	59	41	100	1.6%
Dry bulk	6	24	22	46	0.7%
Vehicles	7	23	21	44	0.7%
Other Consumer goods	8	510	71	580	9.1%
Total		2361	3981	6342	100.0%

Table D.4 - Modelled and Estimated Flows Across Major Screenlines: Screenline 4, Caspian Sea - Central Asia

				Eastbound Direction		Westbound Direction	
Location	Mode	Anode	Bnode	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)
Uralsk - Iletsk	Rail	48040	48041	2002	4300	2478	6000
Uralsk - Iletsk	Road	40210	40300	80	155	229	443
A340, Makat - Gurjev	Road	40110	40080	7	363	62	3446
Makat - Gurjev	Rail	45110	45090	1321	5040	959	7100
Aktau	Rail	45010	45030	444	1100	462	1000
Aktau	Road	40010	40020	69	444	410	2652
Turkmenbashi	Road	70015	70010	284	316	115	128
Turkmenbashi	Rail	70015	75010	760	845	492	547
Totals:	Road			439 (9%)	1277 (10%)	815 (16%)	6669 (31%)
	Rail			4528 (91%)	11284 (90%)	4392 (84%)	14646 (69%)
	Overall			4967	12561	5208	21315

		Modelled Strategic Flow			
Commodity Type	Commodity No.	(Thousand Tonnes per annum) Eastbound	Westbound	Total	% of Total
Grains and cereals	1	701	738	1440	14.1%
Cotton and textiles	2	62	696	757	7.4%
Ores, metals and stone	3	775	1064	1838	18.1%
Oil, petroleum and minerals	4	1914	2352	4267	41.9%
Timber, construct. equipment	5	173	48	220	2.2%
Dry bulk	6	36	19	55	0.5%
Vehicles	7	73	10	82	0.8%
Other Consumer goods	8	1233	282	1515	14.9%
Total		4967	5208	10174	100.0%

Table D.5 - Modelled and Estimated Flows Across Major Screenlines: Screenline 5, Central Asia (Turkmenistan)

				Eastbound Direction		Westbound Direction	
Location	Mode	Anode	Bnode	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)
leninsk to tasauz	Road	70310	70300	25	85	1	4
nr urgenic	Road	80670	80660	20	50	11	28
nr nukus (south of)	Rail	75520	75290	158	1576	33	332
ashgabad to tedzen, M37	Road	70100	70110	1042	3063	406	1193
ashgabad to tedzen	Rail	75100	75110	614	1800	461	3240
Totals:	Road			1088 (58%)	3198 (49%)	418 (46%)	1224 (26%)
	Rail			772 (42%)	3376 (51%)	494 (54%)	3572 (74%)
	Overall			1859	6573	912	4796

Commodity Type	Commodity No.	Modelled Strategic Flow (Thousand Tonnes per annum) Eastbound	Westbound	Total	% of Total
Grains and cereals	1	858	16	874	31.5%
Cotton and textiles	2	82	493	575	20.7%
Ores, metals and stone	3	390	68	458	16.5%
Oil, petroleum and minerals	4	258	228	486	17.5%
Timber, construct. equipment	5	14	5	19	0.7%
Dry bulk	6	5	1	5	0.2%
Vehicles	7	20	1	21	0.7%
Other Consumer goods	8	225	109	334	12.0%
Total		1851	921	2772	100.0%

Table D.6 - Modelled and Estimated Flows Across Major Screenlines: Screenline 6, Central Asia (Uzbekistan)

				Eastbound Direction		Westbound Direction	
Location	Mode	Anode	Bnode	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)
novokazalinsk to tjuratam, M3	Road	42200	42210	186	1054	265	1502
novokazalinsk to tjuratam	Rail	47211	47210	3426	9600	2746	5300
nukus to beruni, A380	Road	80560	80550	2	4	9	23
leninsk to tasauz	Road	70310	70300	25	85	1	4
nr urgenic	Road	80670	80660	20	50	11	28
nr nukus (south of)	Rail	75520	75290	158	1576	33	332
Totals:	Road			233 (6%)	1193 (10%)	286 (9%)	1557 (22%)
	Rail			3584 (94%)	11175 (90%)	2779 (91%)	5632 (78%)
	Overall			3816	12368	3065	7189

		Modelled Strategic Flow			
Commodity Type	Commodity No.	(Thousand Tonnes per annum) Eastbound	Westbound	Total	% of Total
Grains and cereals	1	727	687	1414	20.5%
Cotton and textiles	2	29	563	593	8.6%
Ores, metals and stone	3	417	875	1292	18.8%
Oil, petroleum and minerals	4	1608	689	2297	33.4%
Timber, construct. equipment	5	144	54	198	2.9%
Dry bulk	6	41	13	54	0.8%
Vehicles	7	51	8	58	0.8%
Other Consumer goods	8	799	177	976	14.2%
Total		3815	3066	6881	100.0%

Table D.7 - Modelled and Estimated Flows Across Major Screenlines: Screenline 7, Central Asia (Kazakhstan)

				Eastbound Direction		Westbound Direction	
Location	Mode	Anode	Bnode	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)
A36, North of Atbasar	Road	40541	40600	7	183	34	342
A342, North of Arkalyk	Road	40572	40571	105	916	34	294
North of Arkalyk	Rail	47760	45610	2828	15600	6106	20400
Kustanai to Arkalyk	Road	40910	40900	229	2294	65	397
Kustanai to Arkalyk	Rail	47760	47761	23	1000	691	2600
Totals:	Road			2940 (92%)	16698 (84%)	6174 (89%)	21036 (88%)
	Rail			253 (8%)	3294 (16%)	756 (11%)	2996 (12%)
	Overall			3193	19992	6930	24032

		Modelled Strategic Flow (Thousand Tonnes per annum)			
Commodity Type	Commodity No.	Eastbound	Westbound	Total	% of Total
Grains and cereals	1	189	559	748	7.5%
Cotton and textiles	2	5	8	14	0.1%
Ores, metals and stone	3	821	1092	1913	19.1%
Oil, petroleum and minerals	4	1627	5119	6746	67.4%
Timber, construct. equipment	5	233	132	365	3.6%
Dry bulk	6	14	4	18	0.2%
Vehicles	7	39	8	47	0.5%
Other Consumer goods	8	86	68	154	1.5%
Total		3014	6990	10004	100.0%

Table D.8 - Modelled and Estimated Flows Across Major Screenlines: Screenline 8, East Kazakhstan - China

				Eastbound Direction		Westbound Direction	
Location	Mode	Anode	Bnode	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)	Modelled Strategic Flow (000 Tonnes per annum)	Estimated Total Flow (000 Tonnes per annum)
From Georgijevka, M38	Road	41240	41250	0	0	0	0
Makancj to Tacheng, A356	Road	41200	49201	415	461	16	160
nr Drujba, A357/A355	Road	41700	49700	17	168	2	16
nr Drujba	Rail	47910	48000	467	800	134	200
Zarkent to Yining, A353	Road	41612	41613	1072	1443	164	220
nr Kolzat, A352	Road	41510	41520	0	0	0	0
Totals:	Road			1504 (77%)	2072 (73%)	181 (61%)	396 (68%)
	Rail			467 (24%)	800 (28%)	134 (43%)	200 (34%)
	Overall			1970	2872	315	596

		Modelled Strategic Flow (Thousand Tonnes per annum)			
Commodity Type	Commodity No.	Eastbound	Westbound	Total	% of Total
Grains and cereals	1	132	11	143	6.2%
Cotton and textiles	2	206	4	210	9.2%
Ores, metals and stone	3	858	17	875	38.3%
Oil, petroleum and minerals	4	668	235	904	39.5%
Timber, construct. equipment	5	63	15	78	3.4%
Dry bulk	6	38	1	39	1.7%
Vehicles	7	4	3	7	0.3%
Other Consumer goods	8	3	28	31	1.3%
Total		1970	315	2286	100.0%