APPENDIX III-3

Calculation of Volume for Standard Bridge Construction

Appendix III-3
Calculation of Volume for Standard Bridge Construction

1. Bridge for Renewing

Here, the quantity of the standard bridge with two simple 24 m spans would be taken up as a subject of the project cost analysis.

(a) Concrete Volume

(i) Abutment per One side

Table 1 : Concrete Volume of Abutment

Item	Vertical Length (m)	Horizontal Length (m)	Thickness / Height (m)	Shape	Coefficient	Number	Total Volume (m^3)
Parapet							
(1) - Horizontal	1.30	13.80	0.30	Rectangular	1.0000	1	5.38
(2) - Horizontal	0.30	1.50	0.30	Rectangular	1.0000	2	0.27
Vertical Wall							
(3) - Horizontal	3.30	13.80	1.00	Rectangular	1.0000	1	45.54
Haunch							
(4) - Vertical	0.40	0.40	5.10	Triangular	0.5000	2	0.82
(5) - Horizontal	0.40	0.40	13.80	Triangular	0.5000	1	1.10
(6) - Horizontal	0.40	0.40	1.40	Triangular	0.5000	2	0.22
Footing							
(7) - Horizontal	0.40	1.50	13.80	Triangular	0.5000	1	4.14
(8) - Horizontal	0.40	1.00	13.80	Rectangular	1.0000	1	5.52
(9) - Horizontal	1.00	4.50	13.80	Rectangular	1.0000	1	62.10
Wing Wall							
(10) - Vertical	5.30	2.00	0.50	Rectangular	1.0000	2	10.60
(11) - Chip	-0.40	0.40	0.50	Triangular	5.0000	2	-0.80
Grand Total							134.90

(ii) Retaining Wall

Table 2 : Concrete Volume of Retaining Wall (per One)

Item	Vertical Length (m)	Horizontal Length (m)	Thickness / Height (m)	Shape	Coefficient	Number	Total Volume (m^3)
Vertical Wall							
(1) - Horizontal	1.70	0.30	3.00	Rectangular	1.0000	1	1.53
(2) - Horizontal	1.70	0.20	3.00	Triangular	0.5000	1	0.51
Footing							
(3) - Horizontal	0.60	2.00	3.00	Rectangular	1.0000	1	3.60
Grand Total							5.64

(iii) Approach Board

Table 3 : Concrete Volume of Approach Board

Item	Vertical Length (m)	Horizontal Length (m)	Thickness / Height (m)	Shape	Coefficient	Number	Total Volume (m^3)
RC Board							
(1) - Horizontal	10.80	6.00	0.30	Rectangular	1.0000	1	19.44
Grand Total							19.44

(iv) Pier

Table 4 : Concrete Volume of Approach Board

Item	Vertical Length (m)	Horizontal Length (m)	Thickness / Height (m)	Shape	Coefficient	Number	Total Volume (m^3)
Horizontal Member							
(1) - Horizontal	0.70	13.80	1.40	Rectangular	1.0000	1	13.52
(2) - Horizontal	1.00	3.00	1.40	Triangular	0.5000	2	4.20
(3) - Horizontal	1.00	7.80	1.40	Rectangular	1.0000	1	10.92
Vertical Wall							
(4) - Vertical	3.10	6.40	1.00	Rectangular	1.0000	1	19.84
(5) - Vertical	3.10	1.00	1.00	Round	0.7854	2	4.87
Footing							
(6) - Horizontal	0.40	1.40	9.00	Rectangular	1.0000	1	5.04
(7) - Horizontal	0.40	1.30	9.00	Triangular	0.5000	2	4.68
(8) - Horizontal	1.00	4.00	9.00	Rectangular	1.0000	1	36.00
Grand Total							99.07

(b) Structural Excavation

Table 5 : Structural Excavation Volume per One Place

Item	Excavation Average Area		Excavation Depth (m)	Excavation Volume (m^3)	Remarks
	Lengthwise (m)	Crosswise (m)			
(1) Abutment	5.50	14.80	3.00	244.20	
(2) Retaining Wall	3.00	4.00	1.80	21.60	
(3) Approach Board	7.00	11.80	0.90	74.34	
(4) Pier	5.00	10.00	2.00	100.00	

(c) Piling Work

Table 6 : Piling Work

Item	Lengthwise (Nos.)	Crosswise (Nos.)	Total
(1) Abutment	5	15	75
(2) Pier	4	10	40

(d) Superstructure Work

Table 7 : Superstructure Work

Item	Unit	Bridge Length (m)	Bridge Width (m)	Bridge Span (m)	Quantity	Remarks
Beam Installation Work	Nos.	49.2	13.8	2 X 24.0 m	16	
Transverse Beam Fee	Nos.	49.2	13.8	2 X 24.0 m	16	
Bridge Surface Work	m^2	49.2	13.8	2 X 24.0 m	678.96	

(e) Demolition Work

Table 8 : Demolition Work

Item	Unit	Basic Quantity	Conversion Ratio	Quantity m^3	Remarks
(1) Beams	Nos.	16	9.170	146.72	One Beam: 9.17 m^3
(2) Slab, Curb, etc.	m^3	5.50	1.000	5.50	New Bridge: W = 13.8 m
(3) Abutment	m^3	139.40	0.790	110.11	Existing Brid: W = 10.9 m
(4) Retaining Wall	m^3	5.64	0.790	4.45	Approach New: L = 6.0 m
(5) Approach Board	m^3	9.72	1.000	9.72	Existing Board: L = 3.0 m
(6) Pier	m^3	99.07	0.790	78.25	

(f) Scaffolding Work

Table 9 : Scaffolding Work

Item	Length (m)	Height (m)	Width (m)	Quantity (m^3)	Remarks
(1) Abutment	38.60	6.00	1.00	231.60	
(2) Pier	30.40	6.00	1.00	182.40	

(g) Summary

Table 10 : Summary of Quantity

Item	Unit	Quantity	Number of Places	Total Quantity	Remarks
Concrete Volume					
(1) Abutment	m^3	134.90	2	269.80	
(2) Retaining Wall	m^3	5.64	4	22.56	
(3) Approach Board	m^3	19.44	2	38.88	
(4) Pier	m^3	99.07	1	99.07	
Total	m^3			430.31	
Structural Excavation					
(1) Abutment	m^3	244.20	2	488.40	
(2) Retaining Wall	m^3	21.60	4	86.40	
(3) Approach Board	m^3	74.34	2	148.68	
(4) Pier	m^3	100.00	1	100.00	
Total	m^3			823.48	
Piling Work (Pile 0.35 X 0.35 X 11.5 m)					
(1) Abutment	Nos.	75	2	150	
(2) Pier	Nos.	40	1	40	
Total	Nos.			190	
Superstructure Work					
(1) Beam Installation	Nos.	16	1	16	
(2) Transverse Beam	Nos.	16	1	16	
(3) Bridge Surface Work	m^2	678.96	1	678.96	
Demolition Work					
(1) Beams	m^3	146.72	1	146.72	
(2) Slab, Curb etc.	m^3	5.50	1	5.50	
(3) Abutment	m^3	110.01	2	220.02	
(4) Retaining Wall	m^3	4.45	4	17.80	
(5) Approach Board	m^3	9.72	2	19.44	
(6) Pier	m^3	78.25	1	78.25	
Total	m^3			487.73	
Scaffolding Work					
(1) Abutment	m^3	231.60	2	463.20	
(2) Pier	m^3	182.40	1	182.40	
Total	m^3			645.60	

2. Bridge for Improving

The 24 m simple one span bridge is considered as a standard of the improvement bridge.

(a) Concrete Volume

Newly casting concrete structures are the wing wall and the approach board.

(i) Wing Wall

Table 11 : Concrete Volume of Wing Wall

Item	Vertical Length (m)	Horizontal Length (m)	Thickness / Height (m)	Shape	Coefficient	Number	Total Volume (m^3)
Vertical Wall							
(1)	3.40	10.00	0.40	Trapezium	1.0000	1	13.60
(2)	3.40	5.60	0.40	Trapezium	1.0000	2	15.23
Footing							
(3)	6.00	10.00	0.60	Rectangular	1.0000	1	36.00
(4)	-3.00	4.00	0.60	Rectangular	1.0000	1	-7.20
Grand Total							57.63

(ii) Approach Board

$$V = 0.30 \times 6.00 \times 8.00 = 14.4 \text{ m}^3$$

(b) Structural Excavation

(i) Wing Wall

$$V = 11.00 \times 7.00 \times 3.00 = 231.0 \text{ m}^3$$

(ii) Approach Board

$$V = 7.00 \times 8.00 \times 0.90 = 50.40 \text{ m}^3$$

(c) Demolition Work

(i) Approach Board

$$V = 3.00 \times 0.30 \times 8.00 = 7.20 \text{ m}^3$$

(d) Summary

Table 12 : Summary of Quantity

Item	Unit	Quantity	Number of Places	Total Quantity	Remarks
Concrete Volume					
(1) Wing Wall	m^3	57.63	2	115.26	
(2) Approach Board	m^3	14.40	2	28.80	
Total	m^3			144.06	
Structural Excavation					
(1) Wing Wall	m^3	231.00	2	462.00	
(2) Approach Board	m^3	50.40	2	100.80	
Total	m^3			562.80	
Superstructure Work					
(2) Transverse Beam	Nos.	6	1	6	
(3) Bridge Surface Work	m^2	246.00	1	246.00	
Demolition Work					
(1) Approach Board	m^3	7.20	2	14.40	
(2) Slab, Curb etc.	m^3	5.50	1	5.50	
(3) Retaining Wall	m^3	4.45	4	17.80	
Total	m^3			37.70	

APPENDIX III-4

Calculation of Bridge Construction and Improvement Cost

Appendix III-4
Calculation of Bridge Construction and Improvement Cost

1. Materials for bridges construction

Materials and their unit price patiqurally required for bridges constructions are as follows.

(1) Prestressing Cable Wire

No prestressing cable wire is produced in Kazakstan. It would be imported from Europe at the cost of US$ 680 per ton. And transportation fee was assumed twice of the case of importing from Turkey. Therefore the cost will be as follows;

Table 1 : Prestressing Cable Unit Price (US$ per Ton)

Item	Foreign Portion	Local Portion	Total
Prestressing Cable	680	-	680
Transportation Fee	75	75	150
Total	755	75	830

(2) Concrete Pile

The piles are produced at a factory in Almaty. The cross section of the pile is a square and the length is 11.5 m. The cost of a pile is 27,300 Tenge and the weight of a pile is 3.5 ton. (At the present time, this factory produces this type only.)

Table 2 : Concrete Pile Unit Price (US$ per Nos.)

in US$

Item	Foreign Portion	Local Portion	Total
Concrete Pile	-	410	410
Transportation Fee	-	83	83
Total	-	493	493

(3) Pretension PC Girder

All the pretension PC girders are produced at a factory in Almaty and transferred to the site. According to the prices for the girders shown by a factory are as follows.

Table 3 : Pretension PC Girder Unit Price (US$ per Nos.)

in US$

Item	Foreign Portion	Local Portion	Total
Hollow Slab (Span 12 m)		693	693
Transportation Fee		194	194
Total		887	887
Hollow Slab (Span 18 m)		1,325	1,325
Transportation Fee		379	379
Total		1,704	1,704
T Type Girder (Span 21 m)		2,696	2,696
Transportation Fee		429	429
Total		3,125	3,125
T Type Girder (Span 24 m)		2,955	2,955
Transportation Fee		496	496
Total		3,451	3,451

However there is a possibility to change the unit prices above due to the changing of cross section of the girders.

(4) Fuel and Power Rate

Fuel and power rate required for bridges construction in Kazakstan is 0.2 US$ per liter and 0.05 US$ per KWH respectively.

(5) Summary of Unit Prices of Materials

Unit price of materials required particurally for bridges construction is summarized as Table 4.

Table 4 : Summary of Unit Prices of Materials (Unit: US$)

Item	Unit	Foreign Portion	Local Portion	Total
Prestressing Cable	ton	755	75	830
Concrete Pile	Nos.	-	493	493
Hollow Slab (Span 12 m)	Nos.	-	887	887
Hollow Slab (Span 18 m)	Nos.	-	1,704	1,704
T Type Girder (Span 21 m)	Nos.	-	3,125	3,125
T Type Girder (Span 24 m)	Nos.	-	3,451	3,451
Fuel	Liter	-	0.2	0.2
Power Rates	KWH	-	0.05	0.05

2. Construction Machinery

Unit price of Construction Machinery particulaly required for bridges construction is also calculated same as for roads construction equipment.

Rental Charge of Bridge Construction Equipment particulaly required is as shown in Table 5.

Table 5 : Retal Charge of Bridge Construction Equipment

Construction equipment	Equipment Type	Rental Charge Financial /shift (US$)
Bulldozer	21ton	373
Roller (Vibratory)	0.8/1.1ton	26
Tamper	60/100kg	6
Truck Crane	120ton	1871
Truck Crane	3ton	77
Hydraulic Breaker	0.7ton	90
Breaker	20kg	2
Compressor	3.6 m^3/min.	29
Diesel Hammer	RM 3.5ton	759
Diesel Hammer	RM 4.5ton	829
Concrete Pump	110 m^3/h	765

3. Labor Costs

Unit cost of labor for bridges construction is same as for road construction described in Sub-section 9.1.4. Unit labor cost adopted for bridges construction cost esrimation is summarized as shown in Table 6.

Table 6 : Labor Costs (Tenge / day)

Type	In Aktyubinskaya	In Atyrauskaya	Remarks
(1) Operator (Plant)	404	788	
(2) Operator (Equipment)	755	844	
(3) Driver	808	844	
(4) Foreman	996	1,040	
(5) Skilled Labor	808	844	
(6) Labor	512	534	
(7) Welder	808	844	same as skilled labor
(8) Worker of Reinforcing Bar	808	844	same as skilled labor

4. Operation Cost for Construction Equipment per Hour

Based on the rental charge of the machinery and the labor cost, the operation cost for construction equipment per hour is calculated as shown in Table 7.

Table (1): Construction Equipment Operation Cost per Hour
(Aktyubinskaya)

in US$

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Bulldozer (21 t)						
Operator (Equipment)	Day	0.28			11.4	3
Fuel	Liter	28.57			0.2	6
Rental charge	h	1.00	47	47		
Total				47		9
Bulldozer (15 t)						
Operator (Equipment)	Day	0.28			11.4	3
Fuel	Liter	19.46			0.2	4
Rental charge	h	1.00	31	31		
Total				31		7
Roller (Vibrator 0.8-1.1 t)						
Operator (Equipment)	Day	0.28			11.4	3
Fuel	Liter	1.21			0.2	0.2
Rental Charge	h	1.00	4	4		
Total				4		3
Excavator (0.7 m^3)						
Operator (Equipment)	Day	0.28			11.4	3
Fuel	Liter	17.39			0.2	3
Rental charge	h	1.00	28	28		
Total				28		6
Tipper Truck (20t)						
Operator (driver)	Day	0.20			12.2	2
Fuel	Liter	13.40			0.2	3
Rental charge	h	1.00	23	23		
Total				23		5
Truck Crane (120 t)						
Operator (Equipment)	Day	0.28			11.4	3
Fuel	Liter	14.06			0.2	3
Rental charge	h	1.00	234	234		
Total				234		6
Truck Crane (3.0 t)						
Operator (Equipment)	Day	0.28			11.4	3
Fuel	Liter	6.66			0.2	1
Rental charge	h	1.00	10	10		
Total				10		4
Diesel Hammer (RM 3.5)						
Operator (Equipment)	Day	0.28			11.4	3
Fuel	Liter	7.62			0.2	2
Rental charge	h	1.00	95	95		
Total				95		5

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Diesel Hammer (RM 4.5)						
Operator (Equipment)	Day	0.28			11.4	3
Fuel	Liter	7.62			0.2	2
Rental charge	h	1.00	104	104		
Total				104		5
Concrete Pump (110 m^3/h)						
Operator (Equipment)	Day	0.21			11.4	2
Fuel	Liter	16.74			0.2	3
Rental charge	h	1.00	96	96		
Total				96		5
Concrete Pump Forwarding to Motor Pool 1 Hour per Day						
Operator (Equipment)	Day	0.21			11.4	2
Fuel	Liter	16.74			0.2	3
Rental charge	h	1.00	96	96		
Total				96		5

Machinery Operation Cost per Day in US$

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Dump Truck (20 t)						
Operator (driver)	Day	1.01			12.2	12
Fuel	Liter	82.00			0.2	16
Rental charge (inc. Depreciation of Tire)	Day	1.24	178	221		
Total				221		28
Tamper (60-100 kg)						
Labor	Day	1.00			7.7	8
Fuel	Liter	5.00			0.2	1
Rental charge	Day	1.61	6	10		
Total				10		9
Diesel Hammer (3.5 t)						
Operator (Equipment)	Day	1.74			11.4	20
Fuel	Liter	101.50			0.2	20
Rental charge	Day	1.59	759	1,207		
Total				1,207		40

Note:

Rental charge is converted to US$/h from US$/day.

Labor cost is converted to US$/day from Tenge/day by the exchange rate 66.5Tenge/US$.

Table (2): Construction Equipment Operation Cost per Hour (Atyrauskaya)

in US$

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Bulldozer (21 t)						
Operator (Equipment)	Day	0.28			12.7	4
Fuel	Liter	28.57			0.2	6
Rental charge	h	1.00	47	47		
Total				47		10
Bulldozer (15 t)						
Operator (Equipment)	Day	0.28			12.7	4
Fuel	Liter	19.46			0.2	4
Rental charge	h	1.00	31	31		
Total				31		8
Roller (Vibrator 0.8-1.1 t)						
Operator (Equipment)	Day	0.28			12.7	4
Fuel	Liter	1.21			0.2	0.2
Rental Charge	h	1.00	4	4		
Total				4		4
Excavator (0.7 m^3)						
Operator (Equipment)	Day	0.28			12.7	4
Fuel	Liter	17.39			0.2	3
Rental charge	h	1.00	28	28		
Total				28		7
Tipper Truck (20t)						
Operator (driver)	Day	0.20			12.7	3
Fuel	Liter	13.40			0.2	3
Rental charge	h	1.00	23	23		
Total				23		6
Truck Crane (120 t)						
Operator (Equipment)	Day	0.28			12.7	4
Fuel	Liter	14.06			0.2	3
Rental charge	h	1.00	234	234		
Total				234		7
Truck Crane (3.0 t)						
Operator (Equipment)	Day	0.28			12.7	4
Fuel	Liter	6.66			0.2	1
Rental charge	h	1.00	10	10		
Total				10		5
Diesel Hammer (RM 3.5)						
Operator (Equipment)	Day	0.28			12.7	4
Fuel	Liter	7.62			0.2	2
Rental charge	h	1.00	95	95		
Total				95		6

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Diesel Hammer (RM 4.5)						
Operator (Equipment)	Day	0.28			12.7	4
Fuel	Liter	7.62			0.2	2
Rental charge	h	1.00	104	104		
Total				104		6
Concrete Pump (110 m^3/h)						
Operator (Equipment)	Day	0.21			12.7	3
Fuel	Liter	16.74			0.2	3
Rental charge	h	1.00	96	96		
Total				96		6
Concrete Pump Forwarding to Motor Pool 1 Hour per Day						
Operator (Equipment)	Day	0.21			12.7	3
Fuel	Liter	16.74			0.2	3
Rental charge	h	1.00	96	96		
Total				96		6

Machinery Operation Cost per Day in US$

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Dump Truck (20 t)						
Operator (driver)	Day	1.01			12.7	13
Fuel	Liter	82.00			0.2	16
Rental charge (inc. Depreciation of Tire)	Day	1.24	178	221		
Total				221		29
Tamper (60-100 kg)						
Labor	Day	1.00			8	8
Fuel	Liter	5.00			0.2	1
Rental charge	Day	1.61	6	10		
Total				10		9
Diesel Hammer (3.5 t)						
Operator (Equipment)	Day	1.74			12.7	22
Fuel	Liter	101.50			0.2	20
Rental charge	Day	1.59	759	1,207		
Total				1,207		42

Note:

Rental charge is converted to US$/h from US$/day.

Labor cost is converted to US$/day from Tenge/day by the exchange rate 66.5Tenge/US$.

5. Main Work Unit Price

(1) Concrete Work for Substructure

Classifying the concrete work, they are divided into concrete placement (with curing work), form work and steel bar arrangement work.

(a) Concrete Placement Work

Unit price of the concrete placement work is shown in Table 8.

Table 8(1) : Concrete Placement Work in Aktyubinskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	1.10			15	16.5
Skilled Labor	Day	3.60			12.2	44
Labor	Day	6.10			7.7	47
Ready Mixed Concrete	m^3	102.00			40.6	4,141
Concrete Pump	h	7.70	96	739	5	39
Concrete Pump to Motor Pool	Day	1.40	96	134	5	7
Total				873		4,295
Concrete Placement per 1 m^3				8.73		42.95
				Unit Price of per m^3		51.68

Table 8(2) : Concrete Placement Work in Atyrauskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	1.10			15.6	17
Skilled Labor	Day	3.60			12.7	46
Labor	Day	6.10			8	49
Ready Mixed Concrete	m^3	102.00			41.8	4,264
Concrete Pump	h	7.70	96	739	6	46
Concrete Pump to Motor Pool	Day	1.40	96	134	6	8
Total				873		4,430
Concrete Placement per 1 m^3				8.73		44.30
				Unit Price of per m^3		53.03

(b) Form work

Unit price of the form work is shown in Table 9.

Table 9(1) : Concrete Form Work in Aktyubinskaya (US$)

per 100 m^2

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	3.60			15	54
Skilled Labor	Day	18.20			12.2	222
Labor	Day	11.20			7.7	86
Subtotal						362
Sundry Expenses (30%)						109
Total						471
Unit Price per m^2						4.71

Table 9(2) : Concrete Form Work in Atyrauskaya (US$)

per 100 m^2

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	3.60			15.6	56
Skilled Labor	Day	18.20			12.7	231
Labor	Day	11.20			8	90
Subtotal						377
Sundry Expenses (30%)						113
Total						490
Unit Price per m^2						4.9

(c) Steel Bar Arrangement Work

Unit price of the steel bar arrangement work is shown in Table 10.

Table 10(1) : Steel Bar Arrangement Work in Aktyubinskaya (US$)

per 1 ton

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	0.60			15	9
Skilled Labor	Day	2.90			12.2	35
Labor	Day	2.20			7.7	17
Material	ton	1.03	195.5	201		
Total				201		61
Unit Price of per ton						262

Table 10(2) : Steel Bar Arrangement Work in Atyrauskaya (US$)

per 1 ton

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	0.60			15.6	9
Skilled Labor	Day	2.90			12.7	37
Labor	Day	2.20			8	18
Material	ton	1.03	241.3	249		
Total				249		64

Unit Price of per ton	313

(d) Total Cost of Concrete Work

The concrete work fee is shown in the Table 11.

Table 11(1) : Concrete Work Unit cost in Aktyubinskaya (US$)

per 1 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Placement	m^3	1.00	8.73	8.73	42.95	42.95
Form work	m^2	6.50			4.71	4.71
Steel Bar Arrangement	ton	0.10	201	20.1	61	6.1
Total				28.83		53.76

Unit Price	82.59

Table 11(2) : Concrete Work Unit cost in Atyrauskaya (US$)

per 1 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Placement	m^3	1.00	8.73	8.73	44.30	44.30
Form work	m^2	6.50			4.9	4.9
Steel Bar Arrangement	ton	0.10	249	24.9	64	6.4
Total				33.63		55.6

Unit Price	89.23

(2) Structural Excavation and Backfill Work

The order of the process of the structural excavation and backfill work is excavating, hauling the excavated soil and backfilling after the foundation has been built.

(a) Excavation Work

For the excavation work, a backhoe having 0.7 m^3 bucket is to be used. The excavation working capacity of the backhoe is calculated by the following formula.

$$Q = \frac{3{,}600 \times q \times f \times E}{C_m}$$

Where:
Q: Capacity (m^3/h)
q: 0.59 m^3
f: Conversion Factor of Soil Volume
E: Working Efficiency Factor (0.6)
C_m: 30 sec

Then,

$$Q = \frac{3{,}600 \times 0.59 \times 1.0 \times 0.60}{30} = 42.5 \, m^3/h$$

The operation hour for 100 m^3 of the soil excavation is

$$OP = \frac{100}{42.5} = 2.35h$$

Then the soil excavation cost is shown in Table 12.

Table 12(1) : Soil Excavation Cost in Aktyubinskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Excavator Operation Cost	h	2.35	28	65.8	6	14.1
Total				65.8		14.1
Unit Price per 1 m^3				0.66		0.14

Total Unit Price per m^3	0.8

Table 12(2) : Soil Excavation Cost in Atyrauskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Excavator Operation Cost	h	2.35	28	65.8	7	16.45
Total				65.8		16.45
Unit Price per 1 m^3				0.66		0.16

Total Unit Price per m^3	0.82

(b) Hauling Work

The excavated soil hauling cost by dump truck is shown in the Table 13. 20ton Dump trucks are to be used for the hauling work.

Table 13(1) : Hauling Cost in Aktyubinskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Dump Truck	Day	1.00	221	221	28	28
Total				221		28
Unit Price per 1 m^3				2.21		0.28

Total Unit Price per m^3	2.49

Table 13(2) : Hauling Cost in Atyrauskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Dump Truck	Day	1.00	221	221	29	29
Total				221		29
Unit Price per 1 m^3				2.21		0.29

Total Unit Price per m^3	2.50

(c) Backfill Work

Analysis of the backfill cost is shown in Table 14. The excavator (0.7 m^3) for the backfill work and the vibratory roller (0.8-1.1 t) and the tamper (60-100 kg) for the compaction of backfilled soil are to be used.

Table 14(1) : Backfill Work Cost in Aktyubinskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Labor	Day	4.00			7.7	30.8
Exacavator (0.7 m^3)	h	4.00	28	112	6	24
Vibratory Roller (0.8-1.1 t)	h	7.00	4	28	3	21
Tamper (60-100 kg)	Day	16.10	10	161	9	144.9
Total				301		220.7
Unit Price per 1 m^3				3.01		2.21

Total Unit Price per m^3	5.22

Table 14(2) : Backfill Work Cost in Atyrauskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Labor	Day	4.00			8	32
Exacavator (0.7 m^3)	h	4.00	28	112	7	28
Vibratory Roller (0.8-1.1 t)	h	7.00	4	28	4	28
Tamper (60-100 kg)	Day	16.10	10	161	9	144.9
Total				301		232.9
Unit Price per 1 m^3				3.01		2.33

Total Unit Price per m^3	5.34

(d) Total Soil Work

Total cost of the soil work is shown in Table 15.

Table 15(1) : Total Soil Work Cost in Aktyubinskaya (US$)

per 1 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Excavation	m^3	1.00	0.66	0.66	0.14	0.14
Hauling	m^3	0.70	2.21	2.21	0.28	0.28
Backfill	m^3	0.30	3.01	3.01	2.21	2.21
Total				5.88		2.63

Total Unit Price	8.51

Table 15(2) : Total Soil Work Cost in Atyrauskaya (US$)

per 1 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Excavation	m^3	1.00	0.66	0.66	0.16	0.16
Hauling	m^3	0.70	2.21	2.21	0.29	0.29
Backfill	m^3	0.30	3.01	3.01	2.33	2.33
Total				5.88		2.78

Total Unit Price	8.66

(3) Piling Work

The piling work would be executed by diesel hammer (ram weight 3.5 ton), and the RC piles 35 cm × 35 cm × 11.5 m are to be used for the work. The unit price for piling work cost is shown in Table 16.

Table 16(1) : Piling Work Cost in Aktyubinskaya (US$)

per 10 Nos.

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	1.00			15	15
Skilled Labor	Day	2.00			12.2	24.4
Labor	Day	1.00			7.7	7.7
Piles	Nos.	10.00			493	4,930
Diesel Hammer	Day	1.00	1,207	1,207	40	40
Total				1,207		5,017.1
Unit Price per 1 Nos.				120.7		501.71

Total Unit Price	622.41

Table 16(2) : Piling Work Cost in Atyrauskaya (US$)

per 10 Nos.

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	1.00			15.6	15.6
Skilled Labor	Day	2.00			12.7	25.4
Labor	Day	1.00			8	8
Piles	Nos.	10.00			493	4,930
Diesel Hammer	Day	1.00	1,207	1,207	42	42
Total				1,207		5,021
Unit Price per 1 Nos.				120.7		502.1

Total Unit Price	622.8

(4) Bridge superstructure work

This work consists of beam manufacturing work, beam installation work, transverse beam work, bridge surface work, and miscellaneous work.

(a) Beam Manufacturing Work

The unit prices of the beams with transportation which produced at a factory in Almaty are shown in Table 3 .

However, the above girders have no transverse beams and the thickness of the slab is not enough, the ready made girders have to be implemented of their type and sectional size. Moreover, comparing other countries' standards of the bridges, it seems that the moment inertia per unit width of the beams which are made conformity with the standard in Kazakstan is small.

Taking into consideration the fact that the special order of the production of the beams at a factory is necessary, the above described unit prices have to be increased. Although the increasing factor is not sure, tentatively 50 % was decided as a increase factor. Then, the prices are changes as follows.

T Shape Span 24 m	5,177	Hollow Slab Span 18 m	2,556
T Shape Span 21 m	4,688	Hollow Slab Span 12 m	1,331

(b) Beam Installation Work

According to the past record, seven beams of which weight is about 25 ton per day would be installed with truck crane of 120 t capacity. Therefore the cost for the beam installation would be in Table 17.

Table 17(1) : Beam Installation Cost (inc. Girder Production Cost) in Aktyubinskaya (US$)

per 8 Nos.

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	1.00			15	15
Skilled Labor	Day	6.00			12.2	73.2
Labor	Day	4.00			7.7	30.8
Truck Crane cost	h	8.00	234	1,872	6	48
Concrete Beam (Span 24 m)	Nos.	8.00			5,177	41,416
Total				1,872		41,583
Unit Price per 1 Beam				234		5,198

Total Unit Price	5,432

Table 17(2) : Beam Installation Cost (inc. Girder Production Cost) in Atyrauskaya (US$)

per 8 Nos.

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	1.00			15.6	15.6
Skilled Labor	Day	6.00			12.7	76.2
Labor	Day	4.00			8	32
Truck Crane cost	h	8.00	234	1,872	7	56
Concrete Beam (Span 24 m)	Nos.	8.00			5,177	41,416
Total				1,872		41,595.8
Unit Price per 1 Beam				234		5,199

Total Unit Price	5,433

(c) Transverse Beam Work

This work consists of the concrete work, transverse beam prestressing work, and scaffolding work. However the transverse beams are to be cast in the forms hung from main beams, the scaffolding work would not included in this work but in the miscellaneous work. Also concerning the unit price of the concrete work, the same figure of the substructure will be used as a unit price of the concrete casting of the transverse beams.

Any way, showing the transverse beam cost, it would be as shown in Table 18.

Table 18(1) : Transverse Beam Cost in Aktyubinskaya (US$)

per 1 Main Beam

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Materials						
Concrete	m^3	1.53	28.83	44.11	53.76	82.25
Prestressing Material Fixing	ton	0.10	755	75.5	75	7.5
Material Fixing						
Foreman	Day	0.20			15	3
Skilled Labor	Day	0.50			12.2	6.1
Labor	Day	0.30			7.7	2.31
Prestressing						
Foreman	Day	0.10			15	1.5
Skilled Labor	Day	0.30			12.2	3.66
Labor	Day	0.10			7.7	0.77
Device Depreciation	Day	0.10	192	19.2		
Total				138.81		107.09

Total Unit Price	245.9

Table 18(2) : Transverse Beam Cost in Atyrauskaya (US$)

per 1 Main Beam

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Materials						
Concrete	m^3	1.53	33.63	51.45	55.6	85.07
Prestressing Material Fixing	ton	0.10	755	75.5	75	7.5
Material Fixing						
Foreman	Day	0.20			15.6	3.12
Skilled Labor	Day	0.50			12.7	6.35
Labor	Day	0.30			8	2.4
Prestressing						
Foreman	Day	0.10			15.6	1.56
Skilled Labor	Day	0.30			12.7	3.81
Labor	Day	0.10			8	0.8
Device Depreciation	Day	0.10	192	19.2		
Total				146.15		110.61

Total Unit Price	256.76

(d) Bridge Surface Work

The bridge surface work consists of concrete work for slab and curb stone, expansion joint work, guardrail work and surface pavement work. However, expansion joint work will included in the miscellaneous work. The unit price of the bridge surface work is shown in Table 19.

Table 19(1) : Bridge Surface Work (for 24.6 m-L x 13.4 m-W = 330 m^2) in Aktyubinskaya (US$)

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Concrete	m^3	55.56	28.83	1,601.79	53.76	2,986.91
Guardrail Material	m	49.20	369.92	18,200.06	2.26	111.19
Guardrail Fixing						
Labor	Day	2.00			7.7	15.4
Total				19,801.85		3,113.5
Unit Price per 1 m^2				60.01		9.43

Total Unit Price	69.44

Table 19(2) : Bridge Surface Work (for 24.6 m-L x 13.4 m-W = 330 m^2) in Atyrauskaya (US$)

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Concrete	m^3	55.56	33.63	1,868.48	55.6	3,089.14
Guardrail Material	m	49.20	369.92	18,200.06	2.26	111.19
Guardrail Fixing						
Labor	Day	2.00			8	16
Total				20,068.54		3,216.33
Unit Price per 1 m^2				60.81		9.75

Total Unit Price	70.56

(5) Demolition Work

The demolition work would be classified into two items. One is demolition work with a king size breaker and the other is with a usual size breaker. For large scale demolition work, the king size breaker would be used and for small scale demolition work, for example implementation work of bridges, the usual concrete breaker would be used. The operation cost for the king size breaker of one hour is shown in Table 20.

Table 20(1) : King Size Breaker Operating Cost in Aktyubinskaya (US$)

per 1 Hour

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Operator (Equipment)	Day	0.28			11.4	3.19
Fuel	Liter	17.00			0.2	3.4
Excavator (0.7 m^3)	h	1.00	28	28	6	6
Breaker Depreciation	Day	0.18	90	16.2		
Total				44.2		12.59

Unit Price	56.79

Table 20(2) : King Size Breaker Operating Cost in Atyrauskaya (US$)

per 1 Hour

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Operator (Equipment)	Day	0.28			12.7	3.56
Fuel	Liter	17.00			0.2	3.4
Excavator (0.7 m^3)	h	1.00	28	28	7	7
Breaker Depreciation	Day	0.18	90	16.2		
Total				44.2		13.96

Unit Price	58.16

Cost for the large scale demolition work is shown in Table 21.

Table 21(1) : Large Scale Demolition in Aktyubinskaya (US$)

per 10 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	0.60			15	9
Welder	Day	0.70			12.2	8.54
Labor	Day	1.70			7.7	13.09
King Size Breaker Depreciation	h	4.90	44.2	216.58	12.59	61.69
Miscellaneous Expense	%	4.00		8.66		3.69
Total				225.24		96.01
Unit Price per m^3				22.52		9.6

Total Unit Price	32.12

Table 21(2) : Large Scale Demolition in Atyrauskaya (US$)

per 10 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	0.60			15.7	9.42
Welder	Day	0.70			12.7	8.89
Labor	Day	1.70			8	13.6
King Size Breaker Depreciation	h	4.90	44.2	216.58	13.96	68.4
Miscellaneous Expense	%	4.00		8.66		4.01
Total				225.24		104.32
Unit Price per m^3				22.52		10.43

Total Unit Price	32.95

The small scale demolition work cost is shown in Table 22.

Table 22(1) : Small Scale Demolition in Aktyubinskaya (US$)

per 10 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	2.60			15	39
Skilled Labor	Day	9.40			12.2	114.68
Welder	Day	0.70			12.2	8.54
Labor	Day	6.90			7.7	53.13
Depreciation of Breaker	Day	5.80	2	11.6		
Depreciation of Compressor	Day	2.90	29	84.1		
Total				95.7		215.35
Unit Price per m^3				9.57		21.54

Total Unit Price	31.11

Table 22(2) : Small Scale Demolition in Atyrauskaya (US$)

per 10 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	2.60			15.7	40.82
Skilled Labor	Day	9.40			12.7	119.38
Welder	Day	0.70			12.7	8.89
Labor	Day	6.90			8	55.2
Depreciation of Breaker	Day	5.80	2	11.6		
Depreciation of Compressor	Day	2.90	29	84.1		
Total				95.7		224.29
Unit Price per m^3				9.57		22.43

Total Unit Price	32

(6) Scaffolding Work

The cost for scaffolding work is shown in Table 23.

Table 23(1) : Scaffolding Work in Aktyubinskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	2.50			15	37.5
Skilled Labor	Day	6.90			12.2	84.18
Labor	Day	5.90			7.7	45.43
Material Depreciation	Lot	1.00	842	842		
Total				842		167.11
Unit Price per m^3				8.42		1.67

Total Unit Price	10.09

Table 23(2) : Scaffolding Work in Atyrauskaya (US$)

per 100 m^3

Item	Unit	Quantity	Foreign Portion		Local Portion	
			Unit Price	Amount	Unit Price	Amount
Foreman	Day	2.50			15.7	39.25
Skilled Labor	Day	6.90			12.7	87.63
Labor	Day	5.90			8	47.2
Material Depreciation	Lot	1.00	842	842		
Total				842		174.08
Unit Price per m^3				8.42		1.74

Total Unit Price	10.16

(7) Generalization of Main Work Unit Price

Recapitulate the main work unit price, it is shown in Table 24.

Table 24(1) : Main Work Unit Price in Aktyubinskaya (US$)

Item	Unit	Foreign Price	Local Price	Total	Remarks
(1) Concrete Work for Substructure	m^3	28.83	53.76	82.59	inc. Materials, Form work
(2) Structural Excavation Work	m^3	5.88	2.63	8.51	inc. Hauling, Backfill
(3) Piling Work	Nos.	120.7	501.71	622.41	inc. Piles (0.35x0.35x11.5 m)
(4) Superstructure Work					
Beam Installation Fee	Nos.	234	5,198	5,432	inc. Girder 24 m span
Transverse Beam Fee	Nos.	138.81	107.09	245.9	inc. Concrete, Materials
Bridge Surface Work	m^2	60.01	9.43	69.44	inc. Concrete, Materials
(5) Demolition Work					
Large Scale Demolition	m^3	22.52	9.6	32.12	
Small Scale Demolition	m^3	9.57	21.54	31.11	
(6) Scaffolding Work	m^3	8.42	1.67	10.09	

Table 24(2) : Main Work Unit Price in Atyrauskaya (US$)

Item	Unit	Foreign Price	Local Price	Total	Remarks
(1) Concrete Work for Substructure	m^3	33.63	55.6	89.23	inc. Materials, Form work
(2) Structural Excavation Work	m^3	5.88	2.78	8.66	inc. Hauling, Backfill
(3) Piling Work	Nos.	120.7	502.1	622.8	inc. Piles (0.35x0.35x11.5 m)
(4) Superstructure Work					
Beam Installation Fee	Nos.	234	5,199	5,433	inc. Girder 24 m span
Transverse Beam Fee	Nos.	146.15	110.61	256.76	inc. Concrete, Materials
Bridge Surface Work	m^2	60.81	9.75	70.56	inc. Concrete, Materials
(5) Demolition Work					
Large Scale Demolition	m^3	22.52	10.43	32.95	
Small Scale Demolition	m^3	9.57	22.43	32	
(6) Scaffolding Work	m^3	8.42	1.74	10.16	

7. Bridge Construction Cost

(1) For New Bridges

In calculating the new bridge construction cost, the unit cost per surface area of bridge is estimated at first, and then the unit cost would be applied to the total cost calculation of each bridge finally. The total unit cost is shown in Table 25.

The width and length of the new bridge would be as follows.

Table 26 : Bridge Surface Area of New Bridge

Item	Width (m)	Length (m)	Area (m^2)	Remarks
The Karabutak ~ Kzyl Orda border road section				
Bridge Number - 27	13.8	24.6	339.48	
Bridge Number - 28	13.8	196.8	2,715.84	
Bridge Number - 29	13.8	43.2	596.16	
Bridge Number - 30	13.8	21.6	298.08	
Bridge Number - 31	13.8	43.2	596.16	
Bridge Number - 32	13.8	43.2	596.16	
The Atyrau ~ Mahambet road section				
Bridge Number - 2	11.8	64.8	764.64	
Bridge Number - 3	11.8	64.8	764.64	
Bridge Number - 5	11.8	64.8	764.64	

In conformity with above Table, the total cost is calculated as follows.

Table 27 : Construction Cost for New Bridges (US$)

Bridge Number	Quantity (m^2)	Unit Price		Construction Cost		Total Cost
		Foreign	Local	Foreign	Local	
The Karabutak ~ Kzyl Orda border road section						
No. 27	339.48	205.41	432.80	69,733	146,927	216,660
No. 28	2,715.84	205.41	432.80	557,861	1,175,416	1,733,277
No. 29	596.16	205.41	432.80	122,457	258,018	380,475
No. 30	298.08	205.41	432.80	61,229	129,009	190,238
No. 31	596.16	205.41	432.80	122,457	258,018	380,475
No. 32	596.16	205.41	432.80	122,457	258,018	380,475
Subtotal				1,056,194	2,225,406	3,281,600
The Atyrau ~ Mahambet road section						
No. 2	764.64	210.84	436.24	161,217	333,567	494,784
No. 3	764.64	210.84	436.24	161,217	333,567	494,784
No. 5	764.64	210.84	436.24	161,217	333,567	494,784
Subtotal				483,651	1,000,701	1,484,352
Total Cost				1,539,845	3,226,107	4,765,952

Table 25(1) : Summary of Bridge Construction Cost in Aktyubinskaya (US$)

per 678.96 m^2

Item	Unit	Quantity	Unit Price (in US$)		Total Cost (in US$)		Total in US$	Remarks
			Foreign	Local	Foreign	Local		
Concrete Work	m^3	430.31	28.83	53.76	12,405.84	23,133.47	35,539.31	
Structural Excavation Work	m^3	823.48	5.88	2.63	4,842.06	2,165.75	7,007.81	
Piling Work	Nos.	190	120.7	501.71	22,933.00	95,324.90	118,257.90	
Superstructure Work								
Beam Installation Work	Nos.	16	234	5,198	3,744.00	83,168.00	86,912.00	
Transverse Beam Work	Nos.	16	138.81	107.09	2,220.96	1,713.44	3,934.40	
Bridge Surface Work	m^2	678.96	60.01	9.43	40,744.39	6,402.59	47,146.98	
Demolition Work	m^3	487.73	22.52	9.6	10,983.68	4,682.21	15,665.89	
Scaffolding Work	m^3	645.60	8.42	1.67	5,435.95	1,078.15	6,514.10	
Total					103,309.88	217,668.51	320,978.39	
Miscellaneous Work					36,158.46	76,183.98	112,342.44	35 % of above
Miscellaneous Work includes the cost for Temporary Road Work, Slope Protection Work and others								
Grand Total					139,468.34	293,852.49	433,320.83	
Unit Cost per m^2					205.41	432.80	638.21	

Table 25(2) : Summary of Bridge Construction Cost per 678.96 m^2

in Atyrauskaya (US$)

Item	Unit	Quantity	Unit Price (in US$)		Total Cost (in US$)		Total in US$	Remarks
			Foreign	Local	Foreign	Local		
Concrete Work	m^3	430.31	33.63	55.6	14,471.32	23,925.24	38,396.56	
Structural Excavation Work	m^3	823.48	5.88	2.78	4,842.06	2,289.27	7,131.33	
Piling Work	Nos.	190	120.7	502.1	22,933.00	95,399.00	118,332.00	
Superstructure Work								
Beam Installation Work	Nos.	16	234	5,199	3,744.00	83,184.00	86,928.00	
Transverse Beam Work	Nos.	16	146.15	110.61	2,338.40	1,769.76	4,108.16	
Bridge Surface Work	m^2	678.96	60.81	9.75	41,287.56	6,619.86	47,907.42	
Demolition Work	m^3	487.73	22.52	10.43	10,983.68	5,087.02	16,070.70	
Scaffolding Work	m^3	645.60	8.42	1.74	5,435.95	1,123.34	6,559.29	
Total					106,035.97	219,397.49	325,433.46	
Miscellaneous Work					37,112.59	76,789.12	113,901.71	35 % of above
Miscellaneous Work includes the cost for Temporary Road Work, Slope Protection Work and others								
Grand Total					143,148.56	296,186.61	439,335.17	
Unit Cost per m^2					210.84	436.24	647.08	

(2) For Improvement Bridges

In the calculation of the cost, the simple bridge of span 24 m is considered as a standard bridge, and its improving cost of the unit surface area of bridge would be applied for cost calculation of all bridges to be improved in the project. The unit cost is shown in Table 28.

Also the cost of each improving bridge is shown in Table 29.

Table 29 : Improvement Cost for each Bridge

Bridge Number	Width (m)	Length (m)	Surface Area (m^2)	Unit Price		Construction Cost		Total Cost
				Foreign	Local	Foreign	Local	
The Karabutak ~ Kzyl Orda border road section								
No. 26	13.40	108.00	1447.20	131.20	68.87	189,873	99,669	289,542
Subtotal						189,873	99,669	289,542
The Atyrau ~ Mahambet road section								
No. 1	9.50	66.40	630.80	136.31	71.50	85,984	45,102	131,086
No. 4	10.00	66.40	664.00	136.31	71.50	90,510	47,476	137,986
No. 6	10.00	46.80	468.00	136.31	71.50	63,793	33,462	97,255
No. 7	10.00	46.80	468.00	136.31	71.50	63,793	33,462	97,255
Subtotal						304,080	159,502	463,582
Total Cost						493,953	259,171	753,124

Table 28(1) : Summary of Improvement Bridge Construction Cost in Aktybinskaya (US$)

per 246.0 m^2

Item	Unit	Quantity	Unit Price (in US$)		Total Cost (in US$)		Total in US$	Remarks
			Foreign	Local	Foreign	Local		
Concrete Work	m^3	144.06	28.83	53.76	4,153.25	7,744.67	11,897.92	
Structural Excavation Work	m^3	562.80	5.88	2.63	3,309.26	1,480.16	4,789.42	
Superstructure Work								
Transverse Beam Work	Nos.	6	138.81	107.09	832.86	642.54	1,475.40	
Bridge Surface Work	m^2	246.00	60.01	9.43	14,762.46	2,319.78	17,082.24	
Demolition Work	m^3	37.70	22.52	9.6	849.00	361.92	1,210.92	
Total					23,906.83	12,549.07	36,455.90	
Miscellaneous Work					8,367.39	4,392.17	12,759.56	35 % of above
Miscellaneous Work includes the cost for Temporary Road Work, Slope Protection Work and others								
Grand Total					32,274.22	16,941.24	49,215.46	
Unit Cost per m^2					131.20	68.87	200.06	

Table 28(2) : Summary of Improvement Bridge Construction Cost in Atyrauskaya (US$)

per 246.0 m^2

Item	Unit	Quantity	Unit Price (in US$)		Total Cost (in US$)		Total in US$	Remarks
			Foreign	Local	Foreign	Local		
Concrete Work	m^3	144.06	33.63	55.6	4,844.74	8,009.74	12,854.48	
Structural Excavation Work	m^3	562.80	5.88	2.78	3,309.26	1,564.58	4,873.84	
Superstructure Work								
Transverse Beam Work	Nos.	6	146.15	110.61	876.9	663.66	1,540.56	
Bridge Surface Work	m^2	246.00	60.81	9.75	14,959.26	2,398.50	17,357.76	
Demolition Work	m^3	37.70	22.52	10.43	849.00	393.21	1,242.21	
Total					24,839.16	13,029.69	37,868.85	
Miscellaneous Work					8,693.71	4,560.39	13,254.10	35 % of above
Miscellaneous Work includes the cost for Temporary Road Work, Slope Protection Work and others								
Grand Total					33,532.87	17,590.08	51,122.95	
Unit Cost per m^2					136.31	71.50	207.82	

(3) Summary of Construction Cost

The summary of the construction cost for bridges is shown in Table 30.

Table 30 : Summary of Bridge Construction Cost

Bridge Number	Construction Cost (in US$)		Total Cost in US$	Measurement
	Foreign	Local		
The Karabutak ~ Kzyl Orda border road section				
No. 26	189,873	99,669	289,542	Improved
No. 27	69,733	146,927	216,660	Renewed
No. 28	557,861	1,175,416	1,733,277	Renewed
No. 29	122,457	258,018	380,475	Renewed
No. 30	61,229	129,009	190,238	Renewed
No. 31	122,457	258,018	380,475	Renewed
No. 32	122,457	258,018	380,475	Renewed
Subtotal	1,246,067	2,325,075	3,571,142	
The Atyrau ~ Mahambet road section				
No. 1	85,984	45,102	131,086	Improved
No. 2	161,217	333,567	494,784	Renewed
No. 3	161,217	333,567	494,784	Renewed
No. 4	90,510	47,476	137,986	Improved
No. 5	161,217	333,567	494,784	Renewed
No. 6	63,793	33,462	97,255	Improved
No. 7	63,793	33,462	97,255	Improved
Subtotal	787,731	1,160,203	1,947,934	
Grand Total	2,033,798	3,485,278	5,519,076	

APPENDIX IV

Traffic Capacity Analysis

Appendix IV : Traffic Capacity Analysis

(1) Methodology

In Kazakhstan design traffic capacity of road can be defined by applying the method of Highways Capacity Manual (Transportation Research Board, National Research Council, Washington, D.C. 1985), where different traffic characteristics from USA have been taken into consideration).

Multi-Lane Highways, devided

SFi = Cm x (v/c)i x N x fw x fHV x fE x fP
Vi = SFi x Phf
CAPAi = Vi x 100/k in both ways in total & pcu/day

Two Lane highways, undivided

SFi = Ct x (v/c)i x fw x fHV x fD x fE
Vi = SFi x Phf
CAPAi = Vi x 100/k in both ways in total & pcu/day

Where ;

SFi	:	Design hourly volume (veh/hour)
Cm	:	Basic capacity per lane under ideal conditions (pcu/hour)
Ct	:	Basic capacity in both directions under ideal conditions (pcu/hour)
(v/c)i	:	Maximum volume -to- capacity ratio for service level i
N	:	Number of lanes
fw	:	Adjustment factor for lane width and/or lateral clearance restriction
fHV	:	Adjustment factor for the presence of heavy vehicles in the traffic stream
fE	:	Adjustment factor for development environment and type of multi-lane highway
fP	:	Adjustment factor for driver population
fD	:	Adjustment factor for directional distribution of traffic
phf	:	Peak hour factor
Vi	:	Maximum hourly volume under service level i
K	:	Design hour factor (30th hourly volume/AADT). It is called as peak hour ratio in ADT.
CAPAi	:	Design capacity per day in both directions in pcu
pcu	:	Passenger car unit, in converting the traffic volume, the following are used in Kazakhstan M/C=0.7, car=1.0, bus/truck=3.5, pedalcycle=0.5 (Road Construction Standard 2.05, state committee of USSR, 1986)

(2) Basic Capacity (Cm, Ct)

Basic capacity means the maximum rate of flow under ideal conditions, according to HCM '85, ideal condition for multi lane highways include :

- Level terrain.
- 12ft. lane width.
- A minimum of 6-ft lateral clearance between the edge of travel lanes and obstructions at the roadside or in the median.
- Passenger cars only in the traffic stream.
- A divided highway cross section in rural environment.

While, ideal condition for two lane highways are defined as no restrictive geometric, traffic, or environmental conditions, specifically, they include:

- Design speed greater than or equal to 60mph.
- Lane widths greater than or equal to 12-ft.
- Clear shoulder wider than or equal to 6-ft.
- No "no passing zones" on the highway.
- All passenger car in the traffic stream.
- A 50/50 directional split of traffic.
- No impediment to through traffic due to traffic control or turning vehicles.
- Level terrain.

The basic capacity has been studied in the several countries up to date, the following capacity is commonly used in USA and Japan.

Table (1) : Comparison of Basic Capacity

Type of Highway	Unit	USA	Japan
Multi lane Highway	Per lane (Pcu/hr)	2000	2500
Two Lane Highway	Per both directions (Pcu/hr)	2800	2500

(3) Adjustment Factor

1) Lane width/lateral clearance (fw)

Ideal conditions for highways include the provision of 12-ft lanes and 6-ft lateral clearance, i. e. roadside obstructions must be located at 6-ft from the edge of the travel lanes. Designs that fail to meet either or both of these criteria will have an adverse impact on traffic flow. This effect is accounted for by adjustment factor (fw), given in Table below :

Table (2) : Adjustment Factor, fw for Multilane Highway

DISTANCE FROM EDGE OF TRAVELE WAY TO OBSTRUCTION (m)	ADJUSTMENT FACTOR							
	OBSTRUCTION ON ONE SIDE OF ROADWAY				OBSTRUCTION ON BOTH SIDES OF ROADWAY			
	LANE WIDTH (m)							
	3.66	3.35	3.05	2.74	3.66	3.35	3.05	2.74
4 - LANE DIVIDED MULTILANE HIGHWAYS (2 LANES EACH DIRECTION)								
1.82	1.00	0.97	0.91	0.81	1.00	0.97	0.91	0.81
1.22	0.99	0.96	0.90	0.80	0.98	0.95	0.89	0.79
0.61	0.97	0.94	0.88	0.79	0.94	0.91	0.86	0.76
0.00	0.90	0.87	0.82	0.73	0.81	0.79	0.74	0.66
6 - LANE DIVIDED MULTILANE HIGHWAYS (3 LANES EACH DIRECTION)								
1.82	1.00	0.96	0.89	0.78	1.00	0.96	0.89	0.78
1.22	0.99	0.95	0.88	0.77	0.98	0.94	0.87	0.77
0.61	0.97	0.93	0.87	0.76	0.93	0.92	0.85	0.75
0.00	0.94	0.91	0.85	0.74	0.91	0.87	0.81	0.70
4 - LANE DIVIDED MULTILANE HIGHWAYS (2 LANES EACH DIRECTION)								
1.82	1.00	0.95	0.89	0.77	NA	NA	NA	NA
1.22	0.98	0.94	0.88	0.76	NA	NA	NA	NA
0.61	0.95	0.92	0.86	0.75	0.94	0.91	0.86	NA
0.00	0.88	0.85	0.80	0.70	0.81	0.79	0.74	0.66
6 - LANE DIVIDED MULTILANE HIGHWAYS (3 LANES EACH DIRECTION)								
1.82	1.00	0.95	0.89	0.77	NA	NA	NA	NA
1.22	0.99	0.94	0.88	0.76	NA	NA	NA	NA
0.61	0.97	0.93	0.86	0.75	0.96	0.92	0.85	NA
0.00	0.94	0.90	0.83	0.72	0.91	0.87	0.81	0.70

Source : HCM '85

Table (3) : Adjustment Factor, fw for Two-lane Highway

USABLE SHOULDER WIDTH (m)	3.66 m LANES		3.35 m LANES		3.05 m LANES		2.74 m LANES	
	LOS A - D	LOS E	LOS A - D	LOS E	LOS A - D	LOS E	LOS A - D	LOS E
1.82	1.00	1.00	0.93	0.94	0.84	0.87	0.70	0.76
1.22	0.92	0.97	0.85	0.92	0.77	0.85	0.65	0.74
0.61	0.81	0.93	0.75	0.88	0.68	0.81	0.57	0.70
0.00	0.70	0.88	0.65	0.82	0.58	0.75	0.49	0.66

Source : HCM '85

2) Heavy vehicle (fHV)

Adjustment factor for the presence of heavy vehicle in the traffic stream, computed as :

$$fHV : 1/\{ 1 + PT (ET - 1) + PR (ER - 1) \}$$

Where;

ET, EB : Passenger car equivalents for trucks and buses, respectively ; and

Pt, PB : Proportion of trucks and buses, respectively, in the traffic stream

Passenger car equivalent ratio in USA and Japan for trucks and buses, respectively, is given in Table below :

Table (4) : Passenger-car Equivalent Factors

Standard	Kazakhstan		Japan		AASHTO (HCM '85)		
Terrain	F	M	F	M	F	H	M
Trucks, ET	3~ÇS	3.5~4.5	2	3.5	2.2	5	10
	(3~4)	(3.5~4.5)	(2)	(3)	(1.7)	(4)	(8)
Buses, EB	3~ÇS	3.5~4.5	2	3.5	2	3.4	6
	(3~4)	(3.5~4.5)	(2)	(3)	(1.5)	(3)	(5)

Note : 1) ( ) shows passenger - car equivalent factors in case of multilane highways
2) Terrain ; F : Flat area
H : Hilly area
M : Mountainous area

3) Other adjustment factor (fE / fP / fD)

The adjustment factor for the others are given Table , Table and Table , respectively.

Table (5):Development Environment (fE)

TYPE	DIVIDED	UNDIVIDED
Rural	1.00	0.95
Suburban	0.90	0.80

Source : HCM '85

Table (6):Driver Population (fP)

DRIVER POPULATION	FACTOR, fp
Commuter, or Other Regular Users	1.00
Recreational, or Other Nonregular Users	0.75 - 0.90

Source : HCM '85

Table (7) : Directional Distribution

Directional Distribution	100/0	90/10	80/20	70/30	60/40	50/50
Adjustment Factor, fD	0.71	0.75	0.83	0.89	0.94	1.00

Source : HCM '85

(4) Service Level (v/c i)

Service level is a Key factor for the estimation of road capacity and for the road improvement planning. This means the maximum volume-to-capacity ratio allowable while maintaining the performance characteristics of service level.

According to MCM '85, level of service criteria is defined as shown in Table (8) and Table (9).

Table (8) : Level of Service Criteria for Multilane Highway

LEVEL OF SERVICE	DENSITY (PC/MI/LN)	112.7 km/h DESIGN SPEED			96.6 km/h DESIGN SPEED			80.5 km/h DESIGN SPEED		
		SPEED (km/h)	v/c	MSF (PCPHPL)	SPEED (km/h)	v/c	MSF (PCPHPL)	SPEED (km/h)	v/c	MSF (PCPHPL)
A	≦ 12	≧ 92	0.36	700	≧ 80	0.33	650	-	-	-
B	≦ 20	≧ 85	0.54	1,100	≧ 77	0.50	1,000	≧ 68	0.45	850
C	≦ 30	≧ 80	0.71	1,400	≧ 71	0.65	1,300	≧ 63	0.60	1,150
D	≦ 42	≧ 64	0.87	1,750	≧ 64	0.80	1,600	≧ 56	0.76	1,450
E	≦ 67	≧ 48	1.00	2,000	≧ 48	1.00	2,000	≧ 45	1.00	1,900
F	> 67	< 48	-	-	< 48	-	-	< 45	-	-

Source : HCM '85

Table (9) : Level of Service Criteria for Two-Lane Highway

LOS	PERCENT TIME DELAY	V/C RATIO																					
		LEVEL TERRAIN							ROLLING TERRAIN							MOUNTAINOUS TERRAIN							
		*AVG SPEED	PERCENT NO PASSING ZONES						*AVG SPEED	PERCENT NO PASSING ZONES						*AVG SPEED	PERCENT NO PASSING ZONES					
			0	20	40	60	80	100		0	20	40	60	80	100		0	20	40	60	80	100
A	≤30	≥93	0.2	0.1	0.1	0.1	0.1	0	≥92	0.15	0.10	0.07	0.05	0.04	0.03	≥90	0.14	0.09	0.07	0.04	0.02	0.01
B	≤45	≥89	0.27	0.24	0.21	0.19	0.17	0.16	≥87	0.26	0.23	0.19	0.17	0.15	0.13	≥87	0.25	0.20	0.16	0.13	0.12	0.10
C	≤60	≥84	0.43	0.39	0.36	0.34	0.33	0.32	≥82	0.42	0.39	0.35	0.32	0.30	0.28	≥79	0.39	0.33	0.28	0.23	0.20	0.16
D	≤75	≥80	0.64	0.62	0.60	0.59	0.58	0.57	≥79	0.62	0.57	0.52	0.48	0.46	0.43	≥72	0.58	0.50	0.45	0.40	0.37	0.33
E	>75	≥72	1.00	1.00	1.00	1.00	1.00	1.00	≥64	0.97	0.94	0.92	0.91	0.90	0.90	≥56	0.91	0.87	0.84	0.82	0.80	0.78
F	100	<72	-	-	-	-	-	-	<64	-	-	-	-	-	-	<56	-	-	-	-	-	-

Source : HCM '85
Note : * indicates average speed in kilometer per hour.

As seen from the Table (10), v/c ratio is USA seems to be a little bit on the excess side of planning level. In order to maximum use of the limited financial resources, the following level of service ratio is used to apply to the design standard of Japan both of multilane and two-lane highways as a guideline.

Table (10) : Comparison of Volume/Capacity Ratio

Level of Service	Volume / Capacity Ratio (v/c)	
	USA	Japan
A	0.33	-
B	0.50	-
C	0.65	0.75 - 0.80
D	0.80	0.65 - 0.90
E	1.00	0.90 - 1.00

Source : 1) HCM '85
2) Japan Road Association.

(5) Peak Hour Factor (Phf)

Peak hour factor is defined as the ratio of total hourly volume to the maximum 15 minutes rate of flow within the hour :

$$phf = \frac{\text{Hourly volume}}{\text{Peak rate of flow (within the hour)}}$$

The peak hour factor should be determined from local field data, however if the field data are not available, the factors tabulated in Table (11) may be used. These are based solely on the assumption of random flow.

Table (11) : Peak Hour Factor for Two-lane Highways on Random Flow

A. LEVEL-OF-SERVICE DETERMINATIONS			
TOTAL 2-WAY HOURLY VOLUME (VPH)	PEAK HOUR FACTOR (PHF)	TOTAL 2-WAY HOURLY VOLUME (VPH)	PEAK HOUR FACTOR (PHF)
100	0.83	1,000	0.93
200	0.87	1,100	0.94
300	0.90	1,200	0.94
400	0.91	1,300	0.94
500	0.91	1,400	0.94
600	0.92	1,500	0.95
700	0.92	1,600	0.95
800	0.93	1,700	0.95
900	0.93	1,800	0.95
		≥ 1,900	0.96

B. SERVICE FLOW-RATE DETERMINATIONS					
Level of Service	A	B	C	D	E
Peak Hour Factor	0.91	0.92	0.94	0.95	1.00

Source : HCM '85

(6) Design Hour Factor (K)

Design hour factor is estimated from the ratio on the 30th highest hourly volume to the annual average daily traffic. These factor should be determined from local field data, however, if the field data are not available, the factors tabulated in Table (12) may be used.

Table (12) : AADT/Service Level/Terrain/K-Factor for Two-Lane Rural Highways

K-FACTOR	LEVEL OF SERVICE				
	A	B	C	D	E
LEVEL TERRAIN					
0.10	2,400	4,800	7,900	13,500	22,900
0.11	2,200	4,400	7,200	12,200	20,800
0.12	2,000	4,000	6,600	11,200	19,000
0.13	1,900	3,700	6,100	10,400	17,600
0.14	1,700	3,400	5,700	9,600	16,300
0.15	1,600	3,200	5,300	9,000	15,200
ROLLING TERRAIN					
0.10	1,100	2,800	5,200	8,000	14,800
0.11	1,000	2,500	4,700	7,200	13,500
0.12	900	2,300	4,400	6,600	12,300
0.13	900	2,100	4,000	6,100	11,400
0.14	800	2,000	3,700	5,700	10,600
0.15	700	1,800	3,500	5,300	9,900
MOUNTAINOUS TERRAIN					
0.10	500	1,300	2,400	3,700	8,100
0.11	400	1,200	2,200	3,400	7,300
0.12	400	1,100	2,000	3,100	6,700
0.13	400	1,000	1,800	2,900	6,200
0.14	300	900	1,700	2,700	5,800
0.15	300	900	1,600	2,500	5,400

Source : HCM '85

Table (13) : Estimated Theoretical Capacity

ITEM	Lane Width (m)	Lateral Clearance (m)	Adjustment Factor fW	fE	fP	fD	TOTAL	Basic Capacity (PCU/h)	Possible Capacity (PCU/h)	Service Level [V/C]	DHV (PCU/h)	K (%)	Design Capacity Per Lane (PCU/day)	Lane NO.	Capacity (PCU/day)
Multiple Lanes Category I	3.75	3.75	1.0	1.0	1.0	-	1.0	2000	2000	C [0.65]	1300	7	18600	4	74400
												8	16300		65200
												9	14400		57600
												10	13000		52000
										D [0.80]	1600	7	22900		91600
												8	20000		80000
												9	17800		71200
												10	16000		64000
										E [1.00]	2000	7	28600		114400
												8	25000		100000
												9	22200		88800
												10	20000		80000
Two-Lane Two-Way Category II	3.75	3.75	1.0	0.95	1.0	0.94	0.89	2800	2492	C [0.65]	1620	7	-	2	23100
												8	-		20300
												9	-		18000
												10	-		16200
										D [0.80]	1994	7	-		28500
												8	-		24900
												9	-		22200
												10	-		19900
										E [1.00]	2492	7	-		35600
												8	-		31200
												9	-		27700
												10	-		24900
Two-Lane Two-Way Category III	3.50	3.50	0.96	0.95	1.0	0.94	0.86	2800	2408	C [0.65]	1565	7	-	2	22400
												8	-		19600
												9	-		17400
												10	-		15700
										D [0.80]	1926	7	-		27500
												8	-		24100
												9	-		21400
												10	-		19260
										E [1.00]	2408	7	-		34400
												8	-		30100
												9	-		26800
												10	-		24100
Two-Lane Two-Way Category IV	3.00	3.00	0.84	0.95	1.0	0.94	0.75	2800	2100	C [0.65]	1365	7	-	2	19500
												8	-		17100
												9	-		15200
												10	-		13700
										D [0.80]	1680	7	-		24000
												8	-		21000
												9	-		18700
												10	-		16800
										E [1.00]	2100	7	-		30000
												8	-		26300
												9	-		23300
												10	-		21000

Note : The above figures are estimated based on the AASHOTO (HCM '85)

APPENDIX V

Pavement Design Method in Japan

Appendix V : Pavement Design Method in Japan

(1) General

The thickness and structure of each individual layer of pavement is designed based on the comprehensive judgment of various factors, including conditions of subgrade, traffic, and climate, as well as economic factors. Fig. (1) shows an outline of the designing process.

A road with a section CBR value less than 2 should be designed according to the requirements described in Section (7) "Pavement on Weak Subgrades."

(2) Classification of Roadways by Traffic Flow Volume

A Pavement standard should be determined from five classifications (listed in Table (1)) on the basis of the estimation of one-way daily traffic volume of heavy vehicles in the fifth year of operation.

Table (1) : Road Classification by Traffic Volume

Classification	One-way Daily Traffic Volume of Heavy Vehicles
L	100 or fewer
A	101 to 250
B	251 to 1000
C	1001 to 3000
D	more than 3000

Note 1 : Vehicles having a number plate with one of the following numbers in the first position are regarded as heavy vehicles in Japan :
0 - Construction machines among large-sized special motor vehicles
1 - Cargo trucks
2 - Buses (passenger capacity ; 11 or more)
8 - Small or ordinary motor vehicles for special use
9 - Special large-sized motor vehicles (excluding construction machines and others)
Load limit : 5 tons for wheel load, 10 tons for axle load
and 20 tons for gross weight of a vehicle.

Note 2 : If a road has more than two traffic lanes in one direction, about 80% of the traffic volume may be used for the distribution of traffic loads among the lanes.

(3) Design CBR Value

The design CBR value is determined by sampling subgrade soils to design the thickness of the pavement. Determination of the design CBR value requires preliminary investigations, such as soil tests and CBR tests.

(a) Preliminary investigation

Preliminary investigations include investigations of topography, geology, groundwater and surface conditions, conditions of cut and embankment, and literature investigations of the past geological surveys, as well as sampling tests of subgrade soils and fill material taken from borrow pits.

When sample testing at borrow pits, an emphasis should be placed on the uniformity of the soils and their suitability as subgrade soils. For existing roads or cut subgrades, emphasis should be placed on the actual conditions of subgrade soils in the survey area and changes in properties after disturbance. These soil tests should be conducted as many times as possible prior to the sampling of the soil for the CBR test. The procedure for the sampling of soils for the soil tests is as follows.

(i) Sampling of soils from borrow pits

Samples of fill material from the site of the intended borrow excavation are taken from various depths through auger boring. The samples should be immediately packed in airtight cans or plastic bags to prevent any charge in their water content and sent to the laboratory for testing.

(ii) Samples from subgrade at cut sections

Samples of subgrade soil at cut sections are taken, through auger boring, from various depths more than one meter below the anticipated level of the subgrade, wherever soil conditions change. These samples are treated in the same way as soils from borrow pits.

Note : When the results of the preliminary investigations show a variety of subgrade soils, an adequate design CBR value can be obtained by assuming the sections of which the pavement thickness is to be designed and by changing the number of CBR tests according to the degree of variation in the subgrade soils. Tests of the subgrade soils are also helpful for determining the location and number of soil samples for CBR tests, as these soil tests will reveal vertical changes in the quality of the soil.

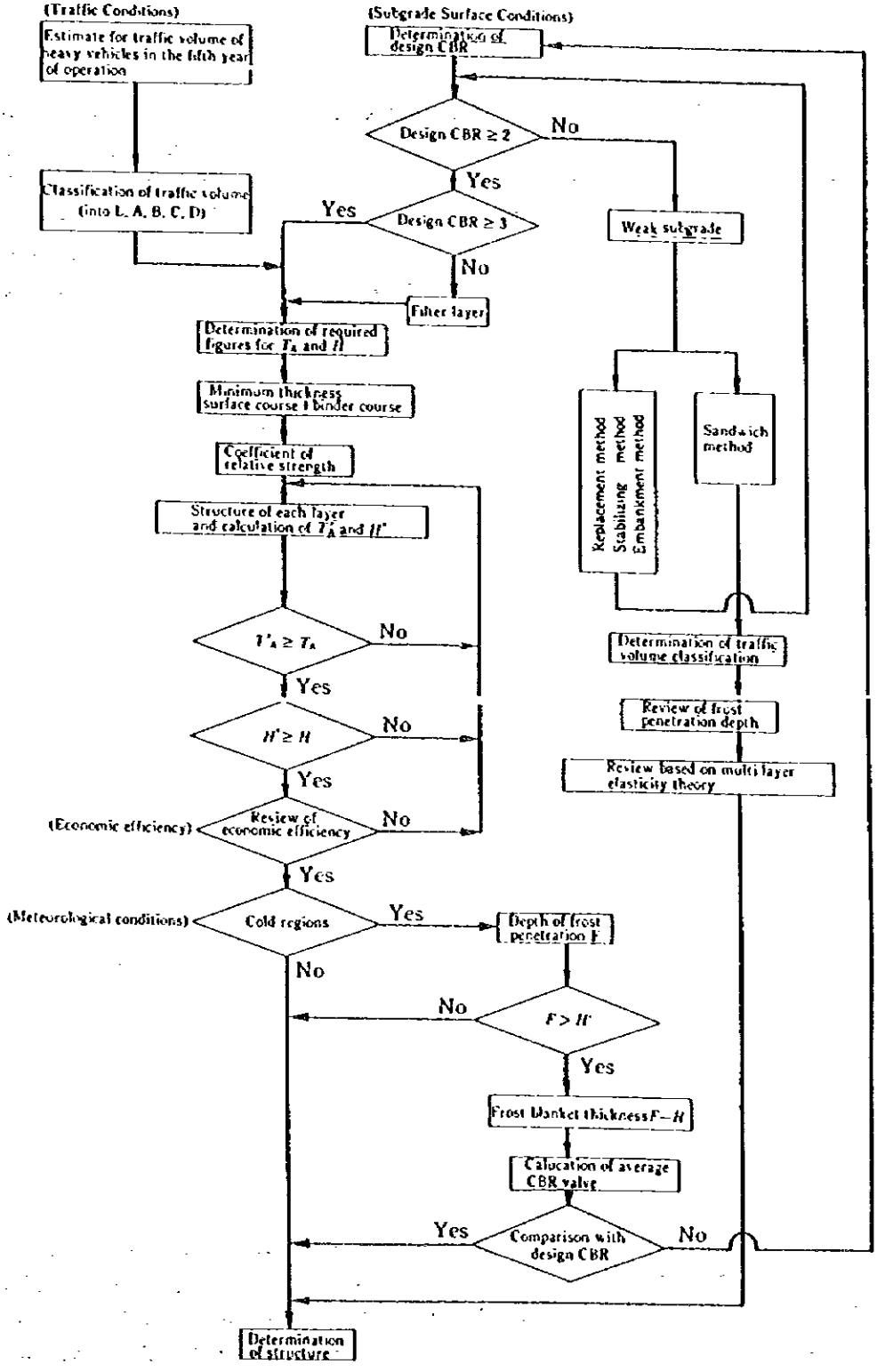


Fig. (1) : Design Procedure

(b) CBR tests

CBR tests are conducted on the disturbed and recompacted samples in the following order.

(i) Sampling

When pavement is designed prior to the construction of the subgrade of an embankment, fill material should be sampled during a dry season of the year. Samples of the fill material are taken in a disturbed condition from at least 50cm below the exposed surface of the borrow pit, should be immediately packed in airtight cans or plastic bags to prevent any changes in water content and sent to the laboratory for testing. In cold regions, fill material should normally be sampled during May or June, after the thawing period.

For cut sections, samples of disturbed subgrade soil are taken from at least 50 cm below the subgrade level. When the subgrade soil within a depth of one meter below the subgrade level varies in type or condition, samples from all the soil strata should be taken and tested. Sampling of the subgrade soil is conducted in the same way as sections for pavement constructed on existing gravel road.

Note 1 : Undisturbed samples may be used, provided extremely small CBR values are expected from experience for cut sections because of disturbance and if the road can essentially by paved without disturbing the subgrade soils. Care must be taken to prevent a change in the conditions of the soil samples during their storage and transportation (i.e., they must be sealed in airtight packages).

Note 2 : Sampling of soils for CBR tests should be conducted in more than three places in the longitudinal direction of the extension of the road, even if the survey area is relatively short, or subgrade soils are assumed to be virtually uniform.

(ii) Testing

After removing gravel with a diameter of 40 mm or more, soil test specimens should be prepared by being compacted into a mold in three layers, giving 67 blows to each layer, in a state of natural water content. The CBR value is measured after the specimens have been immersed in water for four days.

(c) Determination of the design CBR value

(i) Determination of CBR values for each location

The average CBR values of the soils within a one meter depth from the subgrade level should be taken as the CBR value of the location, if the results of preliminary investigations and CBR tests show a vertical stratification of the subgrade soils. In calculating the average value, values of the filter layer should not be taken into account.

Where the subgrade soil is improvement by replacement or stabilization, the effective depth of the improved soil is the total depth of improved soil minus 20 cm. For the bottom 20 cm of the improved soil, the CBR value is taken to be the same as that of the original soil in the case of soil replacement and the average CBR values before and after the treatment in the case of soil stabilization. The maximum CBR value of an improved soil is limited to 20. The average CBR values are calculated according to the following formula :

$$CBR_m = \left(\frac{h_1 CBR_1^{1/3} + h_2 CBR_2^{1/3} \cdots\cdots + h_n CBR_n^{1/3}}{100}\right)^3$$

where CBR_m = average CBR value of the location in question
$CBR_1, CBR_2, \ldots CBR_n$ = CBR value of soil layers No. 1, 2, ... n
$h_1, h_2, \ldots h_n$ = Thickness of soil layers No. 1, 2, ... , n
$h_1 + h_2 \ldots h_n = 100$

Note 1 : In the case of vertical stratification of a subgrade with a thickness of one strata being under 20 cm, a layer with its thickness being under 20 cm should be included in the upper or lower layer to calculate the average CBR value.

Note 2 : The average CBR value is normally adopted for a subgrade of which the upper part has a higher CBR value. It is not desirable to use the average CBR value in the presence of a weak layer in the upper part of the subgrade, since the pavement structure can be directly affected by the layer. In this case, the CBR value of the weak layer should be used, or the layer should be stabilized or replaced with suitable materials.

(ii) Determination of the section CBR

The road section to be paved with a uniform thickness is determined based on the results of the preliminary investigations and CBR tests. The section CBR is determined based on CBR values of individual locations within the road section by the formula below, with extreme values excluded. This formula calculates an average CBR value mines a presumed standard deviation.

Section CBR value = Average CBR value of individual locations - $(CBR_{max} - CBR_{min}) / C$

where C is a coefficient of which value are listed in Table (2).

Table (2) : Values of C for Calculating Section CBR Value

Number of values available	2	3	4	5	6	7	8	9	10 or more
C	1.41	1.91	2.24	2.48	2.67	2.83	2.96	3.08	3.18

(iii) Determination of design CBR

The design CBR value is obtained from Table (3).

Table (3) : Relationship Between Section CBR and Design CBR

Design CBR	Section CBR
2	2 or more, but under 3
3	3 or more, but under 4
4	4 or more, but under 6
6	6 or more, but under 8
8	8 or more, but under 12
12	12 or more, but under 20
20	20 or more

(4) Depth of Frost Penetration

Frost penetration plays an important role in the pavement design in cold regions. The depth of frost penetration is determined either by estimation based on meteorological data or by actual measurements of the depth of soil having a temperature of 0 °C during the frost season. The maximum depth of frost penetration during the last ten years is used as the standard value, which is measured in granular soils of uniform particle size not susceptible to freezing. This maximum value is referred to as the maximum value theoretical depth of frost penetration. The relationship between the freezing index and the frost penetration of the soil of uniform granular material not susceptible to freezing, such as gravel and sand, is plotted in Fig. (2). The freezing index is the product of monthly average temperatures which fall below 0 °C and total number of days in the month, and expressed in C. day. The curve is for coarse granular materials not susceptible to freezing.

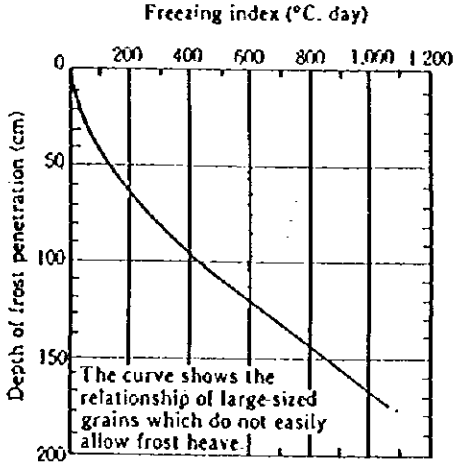


Fig. (2) : Relationship Between Freezing Index and Depth of Frost Penetration

The theoretical maximum depth of frost penetration can be easily obtained from Fig. (2), using the maximum value of the freezing index of the last ten years.

Note : In the case of calculating the depth of frost penetration by actual measurements, these values are measured by using a methyleneblue freeze-depth meter.

(5) Design of Pavement Thickness

Using the design CBR value and the road classification given in Table (4), the pavement thickness of each layer is designed so that the desirable T_A value is assured and the total thickness H of the surface course, the binder course, base course and the subbase course should be larger than 80% of the target value in Table (4).

When the design CBR value of the subgrade soil is 2 a filter course of 15 to 30 cm in thickness should be laid as part of the subgrade. In this case, the thickness is determined based on the design CBR value of the subgrade soil without taking the CBR value of the filter course into account. In cold regions, where the soil seasonally freezes and thaws, empirically obtained values of required replacement should be used if they are available. Otherwise, or where the depth of frost penetration is large, the replacement depth should be 70% of the theoretical maximum depth obtained by actual measurements or meteorological data.

If the replacement depth is more than the target value of H shown in Table (4), the pavement should be thickened using a material without frost susceptibility for the difference. This portion is referred as the antifrost layer, and excluded from the calculation of T_A as part of the subgrade soil. The antifrost layer may have a function of the filter course.

Table (4) : Target Value for T_A and Total Thickness H

Design CBR	Target Value (cm)									
	L Traffic		A Traffic		B Traffic		C Traffic		D Traffic	
	T_A	Total Thickness H	T_A	Total Thickness H	T_A	Total Thickness H	T_A	Total Thickness H	T_A	Total Thickness H
2	17	52	21	61	29	74	39	90	51	105
3	15	41	19	48	26	58	35	70	45	90
4	14	35	18	41	24	49	32	59	41	70
6	12	27	16	32	21	38	28	47	37	55
8	11	23	14	27	19	32	26	39	34	46
12	—	—	13	21	17	26	23	31	30	36
20	—	—	—	—	—	—	20	23	26	27

Note 1 : TA represents the pavement thickness required if the entire depth of the pavement were to be constructed of hot asphalt mixtures, used for the binder and surface courses (see sections (6) and (7)).

Note 2 : In the case of a road with various CBR values in the vertical direction, a filter course need not be constructed, provided the CBR value of the uppermost layer is 3 or more, and its thickness is 30 cm or more, even if the design CBR value is 2.

(6) Determination of Pavement Structure

A tentative pavement structure is first selected based on the requirements for the total thickness of the binder course and the surface shown in Table (4), after which the value of

Table (4) : Minimum Combined Thickness of Binder and Surface Courses

Road Classification	Minimum Combined Thickness (cm)
L, A	5
B	10 (5)
C	15 (10)
D	20 (15)

Note : Figure in parentheses indicate the minimum thickness applicable to pavement with a base course using bituminous stabilization.

T'_A and total pavement thickness H' are calculated. The calculated values are then compared with the target values listed in Table (4) and another calculation is conducted to obtain the final structure if the value of T'_A falls below the target, or the total pavement thickness H is found to fall below the target more than 20%. The value of T'_A is calculated by the following equation :

$$T'_A = a_1T_1 + a_2T_2 + \ldots\ldots a_nT_n \qquad (a)$$

where a_1 a_2,..., a_n = conversion coefficient shown in Table (5).
T_1 T_2,..., T_n = thickness of each layer (cm)

Note 1 : Conversion coefficients listed in Table (5) indicate the ratio of the thickness of pavement by each method and material of construction to the thickness of hot asphalt mix for the binder and the surface courses corresponding to the thickness of each material. Thus, the term a_nT_n of equation (a) indicates the corresponding thickness of the n-th layer converted to the thickness of hot asphalt mix for the binder and surface

Table (5) : Conversion Coefficient for the Calculation of T_a

Pavement Course	Method and Material of Construction	Conditions	Coefficient a_i
Surface & binder course	Hot asphalt mix for surface and binder course		1.00
Base	Bituminous stabilization	Hot-mixed stability: 350 kgf or more	0.80
		cold mixed stability 250 kgf or more	0.55
	Cement stabilization	Unconfined compression strength(7days): 30 kgf/cm²	0.55
	Lime stabilization	Unconfined compression strength (10 days): 10 kgf/cm²	0.45
	Crushed stone for mechanical stabilization	Modified CBR value: 80 or more	0.35
	Slag for mechanical stabilization	Modified CBR value: 80 or more	0.55
	Hydraulic slag	Unconfined compression strength (14days) 12 kgf/cm² or more	0.55
Subbase	Crusher Run, slag, sand, etc.	Modified CBR value: 30 or more	0.25
		20 to 30	0.20
	Cement stabilization	Unconfined compression strength (7days): 10 kgf/cm²	0.25
	Lime stabilization	Unconfined compression strength (10days): 7 kgf/cm²	0.25

courses. For example ; 1 cm of pavement using mechanical stabilization corresponds to 0.35 cm of pavement using the hot asphalt mix method, and 20 cm of pavement using mechanical stabilization corresponds to 7 cm of pavement using the hot asphalt mix method (0.35 x 20 = 7).

Note 2 : In the cases of pavement in urban areas, where the target value of the overall thickness of the pavement is difficult to achieve, the target value T_A of the pavement may be achieved only by using the hot asphalt mixture.

Note 3 : The desirable minimum thickness of the cement stabilization layer of the base course is 15 cm for A and B traffic, and 20 cm for C and D traffic. However, for L, A and B traffic lower values of the unconfined compression strength and coefficients listed in Table (5) may be used based on judgment derived from experience.

Note 4 : The conversion coefficients, other than those in Table (5) should be determined empirically.

(7) Pavement on Weak Subgrade

When the section CBR value of the subgrade is below 2, the construction method should be selected from the following methods, except when the soft soil foundation is to be improved by a large scale.

(a) Soil replacement method

The subgrade soil is replaced with material of higher quality to obtain a design CBR value of 3 or more. In this case, for the purpose of calculation, the CBR value of

the original soil sample should be used as the CBR value of the bottom 20 cm layer of the improved soil.

(b) Soil stabilization method

The subgrade soil is stabilized by lime or cement to obtain a design CBR value of 3 or more. For the purpose of calculation, the average CBR of the soil sampled before and after the treatment should be used as the CBR value of the bottom 20 cm layer of the stabilized soil.

(c) Sandwich method

For roads with heavy traffic, where the replacement of soil is not economical because of the necessity of deep excavation and replaced soil cannot be well compacted because of a high level water table, it is advisable that the subgrade be constructed by first laying a 25 to 30 cm layer of sand and, then, constructing a 15 to 20 cm thick "sandwich" layer of lean - mixed concrete or cement stabilized soil upon it. Table cement content, in the case of a lean concrete slab, should be about 220 kgf/m^3 and the cement stabilized layer should have an unconfined compression strength in the range of 30 to 50 kgf/cm^2.

Table (6) : Examples of Structure Design

(1) L traffic

Design CBR Value	Binder and Surface	Base		Subbase	T_A	Total Thickness
	Hot asphalt mix	Bituminous stabilization	Mechanical stabilization	Crusher-run		
2	5	—	20	20	17.0	45*
3	5	—	15	20	15.3	40
4	5	—	15	15	14.0	35
6	5	—	10	15	12.3	30
8	5	—	10	10	11.0	25

(2) A traffic

Design CBR Value	Binder and Surface	Base		Subbase	T_A	Total Thickness
	Hot asphalt mix	Bituminous stabilization	Mechanical stabilization	Crusher-run		
2	5	—	25	30	21.3	60*
3	5	—	15	35	19.0	55
4	5	—	20	25	18.3	50
6	5	—	10	30	16.0	45
8	5	—	15	15	14.0	35
12	5	—	10	20	13.5	35

(3) B traffic

Design CBR Value	Binder and Surface	Base		Subbase	T_A	Total Thickness
	Hot asphalt mix	Bituminous stabilization	Mechanical stabilization	Crusher-run		
2	10	—	30	35	29.3	75*
3	10	—	25	30	26.3	65
4	10	—	15	35	24.0	60
6	10	—	10	30	21.0	50
8	10	—	15	15	19.0	40
12	10	—	10	15	17.3	35

(4) C traffic

Design CBR Value	Binder and Surface	Base		Subbase	T_A	Total Thickness
	Hot asphalt mix	Bituminous stabilization	Mechanical stabilization	Crusher-run		
2	10	10	35	35	39.0	90*
3	10	8	25	40	35.2	83
4	10	8	20	35	32.2	73
6	10	8	20	20	28.4	58
8	10	9	15	15	26.2	49
12	10	9	10	10	23.2	39
20	10	8	—	15	20.2	33

(5) D traffic

Design CBR Value	Binder and Surface	Base		Subbase	T_A	Total Thickness
	Hot asphalt mix	Bituminous stabilization	Mechanical stabilization	Crusher-run		
2	15	10	45	50	51.3	120*
3	15	10	35	40	45.3	100
4	15	11	25	35	41.3	86
6	15	10	15	35	37.0	75
8	15	10	10	30	34.0	65
12	15	8	—	35	30.2	58
20	15	8	—	20	26.4	43

* a filter layer will be provided.

Note 1 : In general, insufficient compaction of the replaced soil may cause premature destruction of the pavement due to large scale setting. Thus, the replaced soil should be carefully compacted. If the compaction of the replaced soil is difficult, the pavement may be completed after setting has taken place, while allowing temporary traffic on the base or binder course. A seal coat is useful for temporary traffic on the base course.

Note 2 : The advantages of the sandwich method are that the material on the stabilized layers or lean concrete slabs are readily compacted, that there would be only a small amount of settling of the completed road surface and that the shortcomings inherent to the cement stabilization method do not easily affect the surface layer. The structure of the pavement must be decided based on actual cases in the past and calculated values of elasticity when using the sandwich method, as ordinary design methods using the design CBR and of TA values cannot be applied to this method. The minimum thickness of the combined surface course and the binder course is taken from Table (4). It causes no problem if the formed layers of the lean concrete and cement stabilization crack during construction.

APPENDIX VI

Environmental Laws and Issues

1. Kazakhstan Environmental Laws

1.1 Nature Conservation Laws

Environmental management in Kazakhstan is based on "The Nature Conservation Law of Kazakhstan" approved on the 18th of June 1991, during the Soviet Union period. The Kazakhstan government has taken economic development seriously, proceeding with the development of natural resources and manufacturing. On the other hand, environmental considerations were made light of and air pollution and water contamination problems occurred at various places. Therefore the Kazakhstan government enacted the Environmental Impact Assessment Act in 1993 and strengthened environmental management. At present, environmental management is dealt with by the Ministry of the Ecology and Bioresources, and local Nature Conservation Committees.

Environmental management in Kazakhstan, as governmental policy, is quite young. The boundary between public bodies and private enterprise is not yet defined, and the responsibility among governmental bodies dealing with environmental management is also not yet settled. However some environmental impact assessments for natural resources development or manufacturing plants have already been carried out by Kazakhstan organizations or international consulting companies.

"The Nature Conservation Law of Kazakhstan" states the obligations and rights of the citizen, the role of public bodies with regard to nature conservation and refers to enlightening action and education. The composition of "The Nature Conservation Law of Kazakhstan" is as follows:

Chapter 1	Outline
Chapter 2	Obligations and rights of citizens with regard to nature conservation
Chapter 3	Government organization and public bodies dealing with nature conservation
Chapter 4	Economic system of nature conservation and utilization
Chapter 5	Establishment of environmental standards
Chapter 6	Ecological assessment
Chapter 7	Ecological requirement for economic and other activities
Chapter 8	The area of endangered or partially destroyed ecosystem
Chapter 9	Natural environment specially conserved
Chapter 10	Management and observation of nature conservation
Chapter 11	Citizen participation in nature conservation
Chapter 12	Ecological culture and education
Chapter 13	The settlement of disputes with regard to nature conservation
Chapter 14	Public employees' and citizens' responsibility with regard to violations of the nature conservation law
Chapter 15	Compensation for damage with regard to violations of the nature conservation law

With regard to road construction, "The Nature Conservation Directive for Construction, Reconstruction and Rehabilitation of roads BCH 49-93" that was drawn up by the Ministry of Transport and Communication and approved in 1993, gives protective or mitigating measures for nature conservation from construction activities. "The Directive" refers to:

Land tenure
Protection of water resources
Protection of flora and fauna
Utilization of construction machinery and equipment
Road construction materials
Temporary construction and roads
Protection of landscape
Prevention of dust
Prevention of soil erosion and soil pollution
Safety for fire prevention.

1.2 Environmental Impact Assessment System

The Kazakhstan Environmental Impact Assessment (EIA) system is established in "The Nature Conservation Law of Kazakhstan" and based on "The Temporary Directive for Environmental Impact Assessment (EIA) on Economical Activity Planning in Kazakhstan" that was drawn up by the Ministry of the Ecology and Bioresources and approved in 1993. "The Directive" applies to any kind of construction or economic development planning, refers to not only the natural environment but also the social environment.

Regarding official or private organizations, before project implementation, the organization leading the project must submit detailed data on the project and the Environmental Impact Statement (EIS) based on "the Directive" to the Ministry of the Ecology and Bioresources or local Nature Conservation Committees (environmental management organization). And the organization must obtain approval from the environmental management organization. If the environmental management organization does not approve the project, the organization leading the project must revise the project and the EIS, and resubmit the EIS. Both official and private companies can carry out the EIA study and need not obtain certification from the environmental management organization.

The composition of "The Temporary Directive for Environmental Impact Assessment (EIA) on Economical Activity Planning in Kazakhstan" is as follows:

1. General Concept
2. Terminology and Regulations
3. Principles for Environmental Impact Assessment
4. Status and Implementation Procedure for Environmental Impact

Assessment

5. Standards for Environmental Impact Assessment
6. Obligations of Implementation Organization for Environmental Impact Assessment
7. Responsibility of Implementation Organization for Environmental Impact Assessment
8. Utilization of the Directive

With regard to road construction, KAZDORPROJECT and KAZAKHSTAN ZOLDARY drew up individually "Standards for a manual of EIA". According to "the Standards", conforming to Environmental Control Regulation (ERC) is an obligatory part of design for road construction and rehabilitation, and a full scope EIA should be carried out during the feasibility study.

The following environmental impacts are dealt with in the ECR:

- General Principles
- Protection against air pollution
- Protection against ground and surface water pollution
- Re-cultivation of affected areas
- Preservation and protection of flora and fauna
- Noise protection
- Protection of historic, cultural and architectural monuments
- Cost estimates of environmental mitigation measures.

General requirements of the EIS are as follows:

- Status of present pollution load and emission levels
- General description of the planned project
- General characteristics of the region affected by the project
- Climatic conditions of the region
- Status of present state of nature in the affected region
- Specification of building materials which will be used for road construction and rehabilitation

Protective or mitigating measures for environmental impacts due to construction activities are not dealt with in "the Standards", but stated in "Nature Conservation Directive of Construction, Reconstruction and Rehabilitation of roads BCH 49-93".

The concept of a formalized Environmental Impact Assessment is still young, and EIA system is not yet confirmed. Further, very few roads projects have been designed and executed recently, so there are no examples of EIAs for road construction. It is difficult at present to carry out full-scale and suitable EIA studies for road projects in Kazakhstan.

2. Environmental Condition

2.1 Land Condition

The land conditions of the study area can be roughly classified into four groups. These are 1) steppe, 2) desert, 3) solonchak soil area and 4) continuous shrubbery. Figure 1 1) ~ 3) shows the land condition in Western Kazakhstan's four states.

2.2 Flora and Fauna

Except for some small areas, most of the study area is steppe or desert, so the diversity of flora and fauna is poor. But in sheer ledge areas where the Ustyurt plateau descends to the surrounding lowlands, rare or endemic species exist. The part of sheer ledges is designated as "Ustyurtskay nature conservation area" in Mangistauskaya state.

In the study area, the following rare or endemic species can be found:

1) Mammalian

Ustyurt mofflon	Endangered species. According to a USSR report, decreased by half in the past fifteen years. Entered in "The RED DATA BOOK" of Kazakhstan.
Aha goitred gazelle	Rare and endangered species. Entered in "The RED DATA BOOK" of IUCN (International Union for Conservation of Nature and Natural Resources).
Turkmenistan caracal	Very rare and endangered species. Inhabit northern, southern and western parts of Ustyurt plateau. Entered in "The RED DATA BOOK" of IUCN.
Marbled Polecat	Rare species. Density of 0.1~0.7 polecats per 1000ha. Entered in "The RED DATA BOOK" of Kazakhstan.
Piebald shrew	Endemic species. Inhabit hardened sandy areas, for example Mangishlak area (southwestern part of Mangistauskaya state). Entered in "The RED DATA BOOK" of Kazakhstan.
Hedgehog	Rare and endemic species. Inhabit sandy or stony areas.
Yellow steppe lemming	Rare and little known species. Entered in "The RED DATA BOOK" of Kazakhstan.
Bovrinskogo flying fox	Rare species. Inhabit places like old cemeteries. Entered in "The RED DATA BOOK" of Kazakhstan.

2) Birds

Pallas sandgrouse	Rare and little known species. Inhabit arid regions. Entered in "The RED DATA BOOK" of Kazakhstan.
Steppe eagle	Decreasing and endangered species. Inhabit steppe areas. Entered in "The RED DATA BOOK" of USSR.
Golden eagle	Endangered species. Entered in "The RED DATA BOOK" of USSR and Kazakhstan.
White-tailed eagle	Rare species. Entered in "The RED DATA BOOK" of IUCN,

USSR and Kazakhstan.

Black-headed gull 1500 gulls inhabit the east coast of the Caspian Sea. Entered in "The RED DATA BOOK" of USSR.

White-tailed lapwing Rare species. Entered in "The RED DATA BOOK" of Kazakhstan.

Spoonbill Rare species. Entered in "The RED DATA BOOK" of USSR and Kazakhstan.

3) Reptilian

Four striped rat snake Endemic species of western Kazakhstan. Inhabit ledge areas of Ustyurt plateau and Mangishlak area. Entered in "The RED DATA BOOK" of Kazakhstan.

4) Plants

Okosma Tichinochenaya *(Myosotis)* Herb. Grows in the calcic soil areas of the east coast of the Caspian Sea or Mangishlak area. Entered in "The RED DATA BOOK" of USSR.

Shabritua Pushistogolovaya *(Umbelliferae)* Herb. Grows in the wetlands of rock salt or clay desert areas. Entered in "The RED DATA BOOK" of USSR.

Zhester Sintenisa *(Phamnaceae)* Shrub. Grows in arid clayey or stony soil. Entered in "The RED DATA BOOK" of USSR.

Molochay Tverdobokalichatiy *(Euphorbia)* Suffrutex. Grows in the sand or conglomerate deserts of the northern parts of the Ustyurt plateau. Entered in "The RED DATA BOOK" of USSR.

Astragal Ustyurtskiy *(Legume)* Suffrutex. Grows in the clay or conglomerate deserts of the Ustyurt plateau or Mangishlak area. Entered in "The RED DATA BOOK" of USSR.

Myagkoplodnik Passechenolistniy Shrub. Grows in the Ustyurt plateau and Mangishlak area. Entered in "The RED DATA BOOK" of USSR.

2.3 Cultural and Architectural Monuments

The Silk Road had crossed the area, and one of its two main roads, called the steppe road, had run from Nukus in Uzbekistan to the northern part of the Caspian Sea. For that reason, this area is dotted with the remains of the Silk Road period. Especially in Mangistauskaya state, there are not only remains of the Silk Road period, but also many medieval or early modern graveyards. About half of the cultural and architectural monuments of Kazakhstan are concentrated in this state. Figure 2 shows the locations and contents of these monuments in Mangistauskaya state.

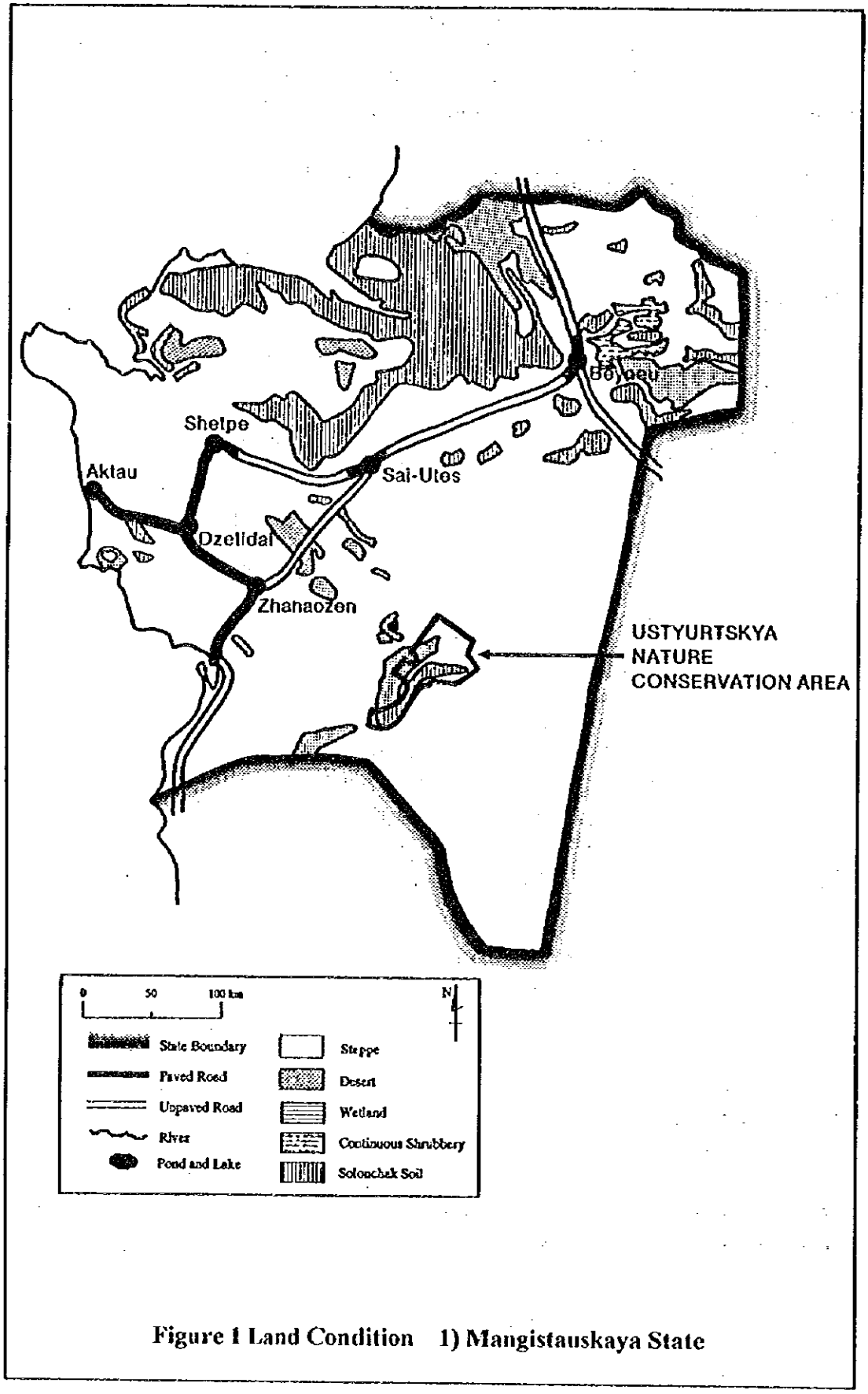


Figure 1 Land Condition 1) Mangistauskaya State

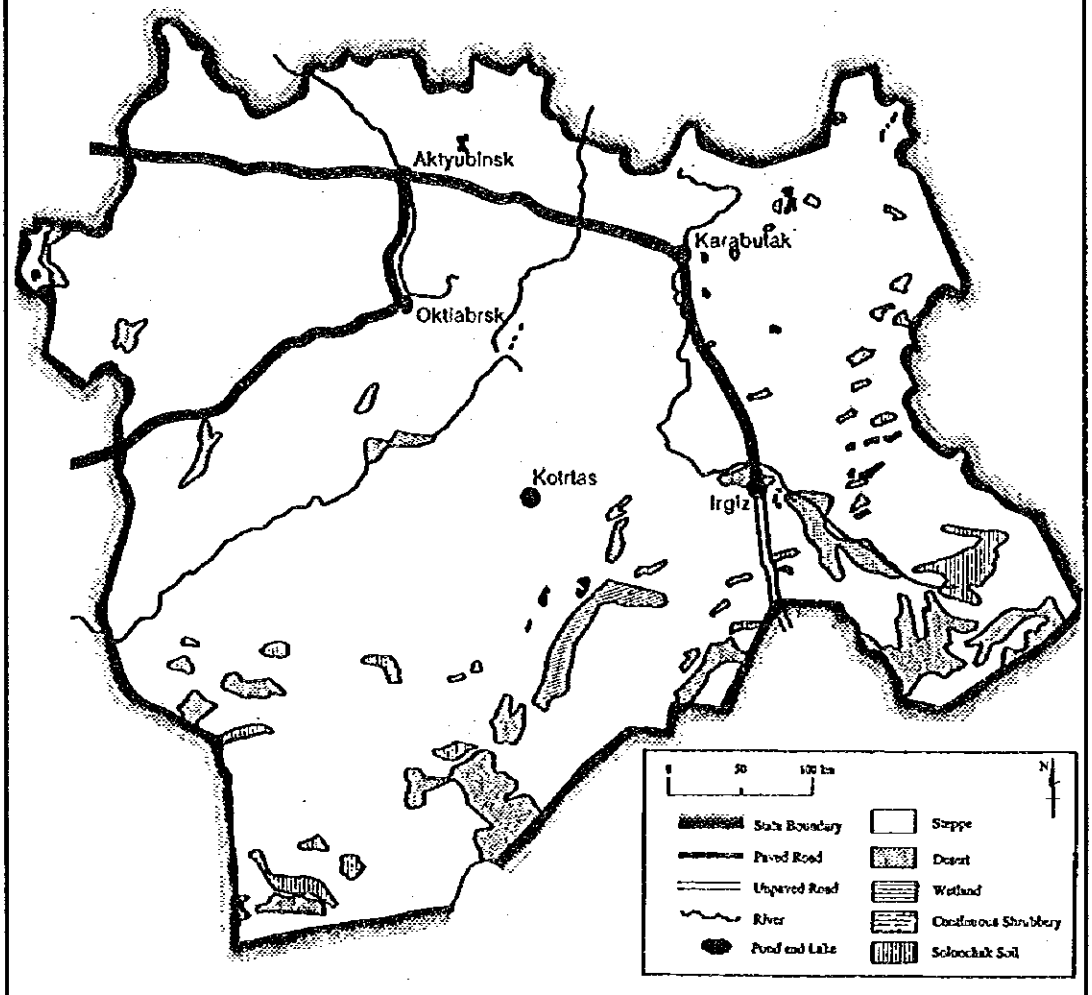


Figure 1 Land Condition 2) Aktyubinskaya State

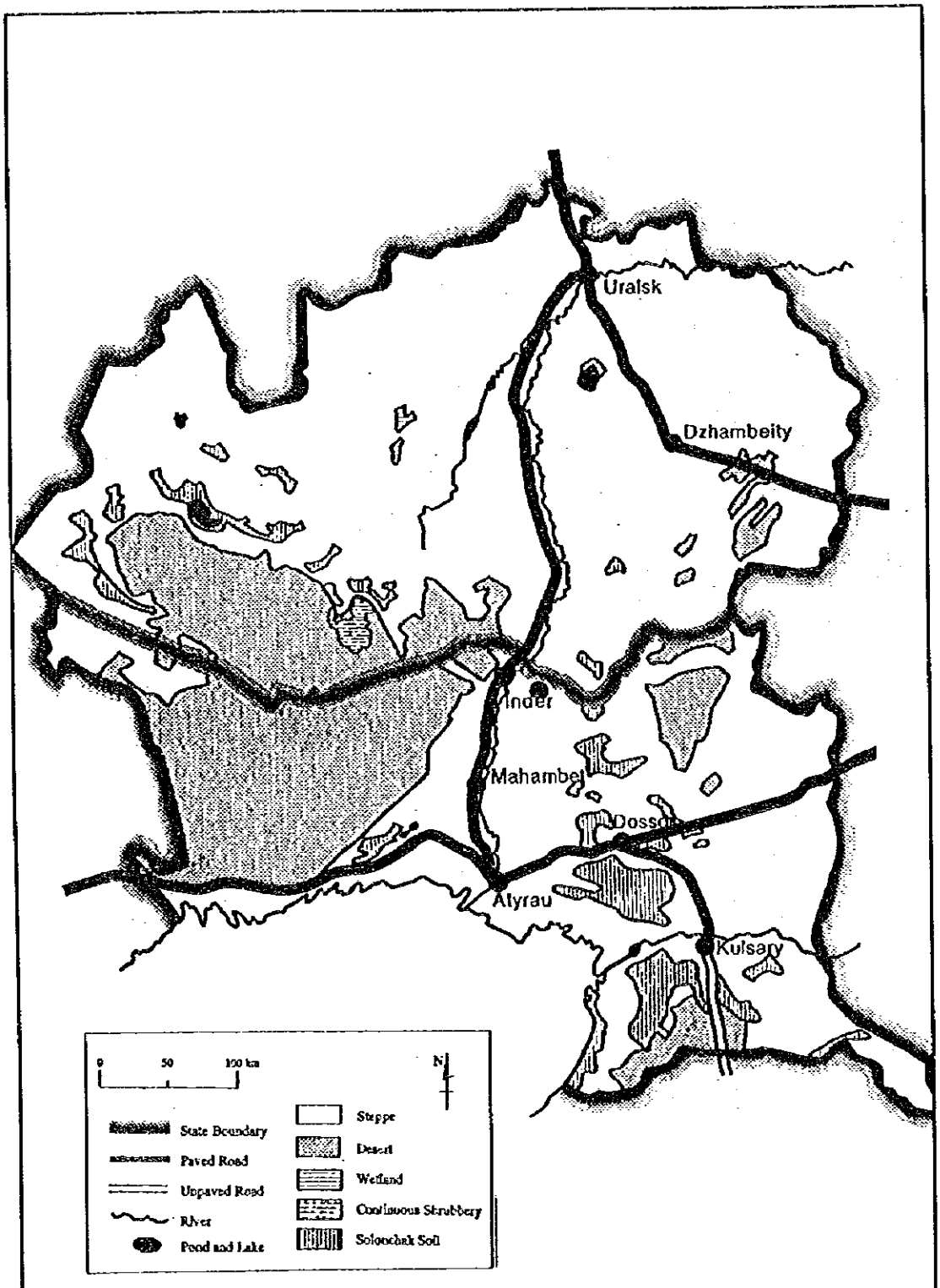
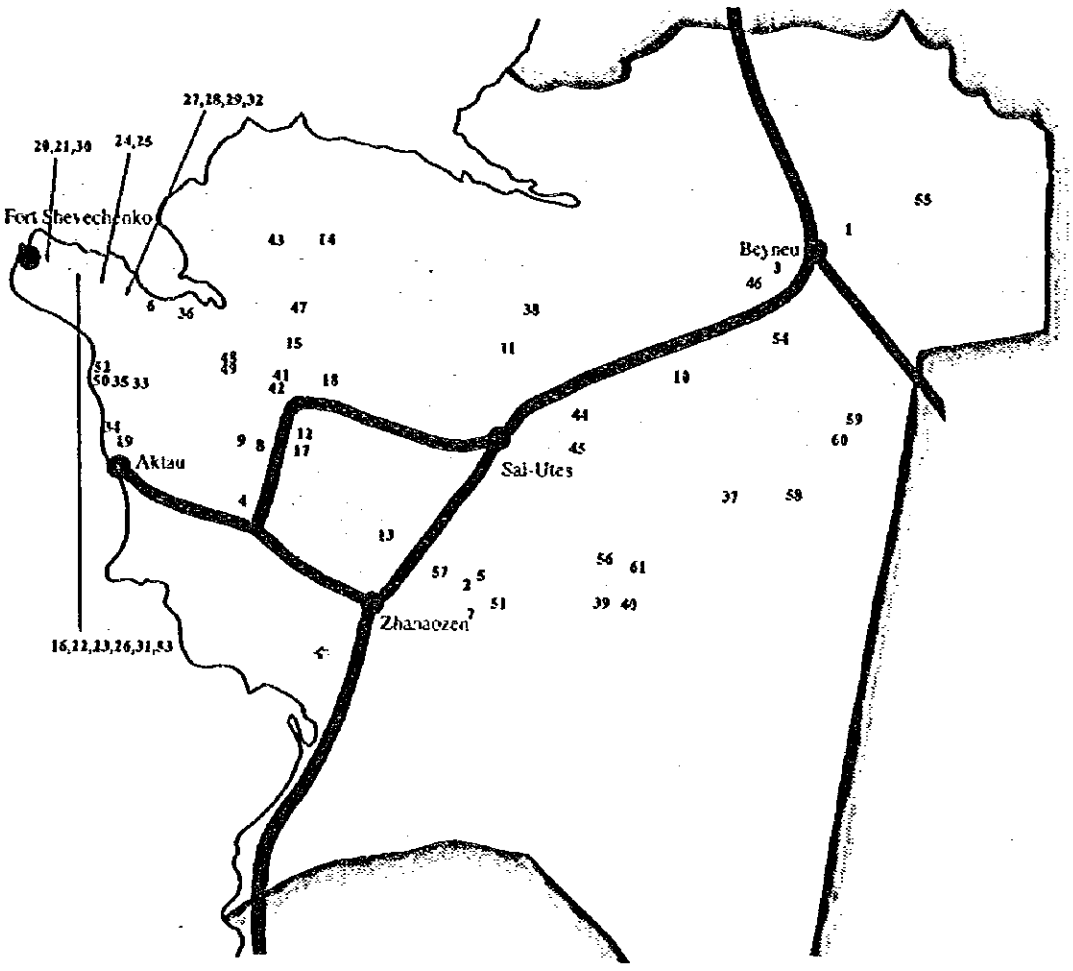


Figure 1 Land Condition 3) West Kazakhstan State and Atyrauskaya State



1 Omara and Tura tomb :1898, Kazakh Architecture
2 Shopan-Ata graveyard :9-19Cen., Old Mound, Underground Mosque, Mausoleum
3 Beineu graveyard :11-19Cen., Underground Mosque, Mausoleum
4 Kyrgni graveyard :19-20Cen.
5 Kyzylsu graveyard :18-20Cen.
6 Shaipak-Ata graveyard :10-19Cen., Underground Mosque, Mural, etc.
7 Senek graveyard :18-20Cen., Old Mound, Mausoleum
8 Bekl graveyard :18-20Cen , Mosque, Dwelling, Old Mound, Mausoleum
9 Karamai-Ata graveyard :18-20Cen., Old Mound, Underground Mosque, Mausoleum
10 Uali graveyard :11-20Cen., Underground Mosque, Open-air Temple
11 Seisem-Ata graveyard :10-19Cen , Old Mound, Mosque, Old Iron Age Ruins
12 Kamystai graveyard :15-19Cen., Old Mound
13 Masat-Ata graveyard :10-19Cen , Old Mound, Underground Mosque, Mausoleum
14 Kara-Tobe graveyard :18-19Cen , Architecture
15 Tobe-Kuduk graveyard :18Cen.
16 Beisenbai graveyard :17-19Cen , Architecture
17 Ak-Uyk graveyard :19-20Cen., Mausoleum, Old Mound
18 Kanasha mosque :1928, Unique Architecture, Sanctuary
19 Kashkar-Ata graveyard :9-20Cen., Architecture
20 Abylgazy tomb :19Cen.
21 Ussi-Tam (Kara-Tam) graveyard :12-19Cen., Architecture
22 Kanga-Baba graveyard :10-19Cen , Ruins of Medieval Mosque etc.
23 Karagaz tomb :14-19Cen.
24 Garngyz-Tam graveyard :10-17Cen.
25 Akshara-Beluteau graveyard :10-17Cen.
26 Maya graveyard :14-19Cen.
27 Ushtam graveyard :10-16Cen.
28 Kenty-Bala graveyard :10-16Cen.
29 Sultan-Ene graveyard :2000 B.C., 10-19Cen , Mosque, New Stone Age Dwelling
30 Kosum graveyard :17-20Cen.
31 Sagyzyk graveyard :16-19Cen., Architecture
32 Karagashly-Aulie graveyard :10-16Cen.
33 Galebaul graveyard :16-19Cen.
34 Kalinam graveyard :10-19Cen.
35 Gylkybai graveyard :17-19Cen.
36 Dely-Ana graveyard :10-19Cen.
37 Aitmana tomb :18-19Cen.
38 Kosmola tomb :12-17Cen.
39 Beket-Ata underground mosque :15Cen , Architecture
40 Oglandy graveyard :10-19Cen.
41 Sherkala graveyard :10-19Cen.
42 Ruins of Kyzyl-Kala castle :10-16Cen.
43 Kekkumbet graveyard :10-17Cen., Old Mound
44 Eshkilygan graveyard :17-19Cen , Architecture
45 Eligaisi graveyard :17-19Cen , Architecture
46 Barkuduk graveyard :16-19Cen.
47 Kulbarak graveyard :18-20Cen.
48 Kyryksu graveyard :17-20Cen.
49 Kadi graveyard :18-20Cen.
50 Golaskan graveyard :16-19Cen.
51 Saina mosque :19-20Cen.
52 Karlybas fort :The Middle Ages, Architecture
53 Kanga-Baba fort :The Middle Ages, Architecture
54 Koenembai Mosque :19Cen., Architecture
55 Barak and Asau graveyard :19-20Cen., Architecture
56 Ushisonkal graveyard :15-20Cen., Architecture
57 Altynali graveyard :15-20Cen , Architecture
58 Sholboldy graveyard :16-20Cen , Architecture
59 Beshymyrau graveyard :18-19Cen , Cultural Monument
60 Shubartau tomb :19-20Cen.
61 Uly-Kylgyn graveyard :19Cen.

Figure 2 monuments in Mangistauskaya state

3 Present Environmental Issues

3.1 Nationwide Environmental Issues

In the Soviet Union's period, because Kazakhstan's economic development was part of a centrally planned economy, each organization had taken economic development seriously and made light of environmental considerations. Consequently environmental conditions have deteriorated as a result of economic development in some areas. The especially serious environmental issues are:

1) Environmental destruction in the Aral Sea Basin
2) Radioactive contamination in Semipalatinsk
3) Environmental pollution owing to natural resources development

Figure 3 shows the areas where there are environmental issues in Kazakhstan.

(1) Environmental destruction in the Aral Sea Basin

The Aral Sea had an area of about 6,800 square kilometer in 1960, making it the fourth largest inland lake in the world. But because of the excessive intake of water for land resources development over the last 30 years, the annual inflow from Amudarya and Syrdarya rivers to the Aral Sea , once 50 billion cubic meters, dropped to only 5 billion cubic meters. As compared to the 1950's, its size was reduced by about 60 percent and its salinity rose from 1 percent to 2.7 percent. Consequently fish became extinct and salt damage to agricultural and grazing land occurred. Moreover the water, supplies 1.4 million inhabitants in the area surround the Aral Sea, has been contaminated by insecticide and fertilizer, and as consequence, damaging effects in the health of children has been reported.

(2) Radioactive contamination in Semipalatinsk

Around Semipalatinsk located in the northern part of East Kazakhstan state , 20 nuclear test sites of the Soviet Union period are concentrated. Nuclear tests were carried out 470 times during the period 1949~1989 at these sites, which were subsequently closed down, but environmental destruction and health damage due to long-term radioactive contamination has been reported.

(3) Environmental pollution due to natural resources development

Kazakhstan is a large produces of nonferrous metals, consequently air, water and soil pollution due to SO2 and/or heavy metal contamination is a serious problem in Ust-kamenogorsk, Dzhezkazgan, Balkhash, Shymkent and Dzhambul etc. where there are smelting works for nonferrous metals. Disposal of mining waste and dross is a serious environmental problem in these cities too. In Karaganda, there is air pollution from blast furnace and cement plants and in Ekibastuz, air pollution due to SO2 and fine ash from thermal power plants is a very serious problem.

3.2 Environmental Issues in Western Kazakhstan (Project site)

In western Kazakhstan, environmental pollution is not as serious as in eastern or southern Kazakhstan. The important environmental issues are:

1) Rise of the level of the Caspian Sea
2) Water pollution in the Caspian Sea
3) Desertification around rural towns.

(1) Rise of Caspian Sea level

The highest Caspian Sea level (- 25.83 m) was recorded in 1929. Since then the sea level fell to -29.4 m in 1977. Since 1978, the sea level has been rising again. Figure 4 shows the annual sea level (1983~1994) and monthly sea level (1995) at Aktau city. The cause of the rise is not clearly known, the following 4 causes were guessed. 1) Rise of lake bottom, 2) Increase of melt water, 3) Artificial control of the Volga river flow and 4) Effect of the Iran earthquake of 1990. At Atyrau city, flooding was recently caused by rise of the sea level, increase of Ural river flow and a strong south wind every June. According to Russian forecasts, the sea level will fall in the near future. Figure 4 shows the level of the Caspian Sea at Aktau.

(2) Water pollution in the Caspian Sea

Water pollution is caused by industrial wastewater discharged along coast of the Caspian Sea. Oil or pretochemical waste is the biggest source of pollution. Water quality of the Volga river whose flow accounts for 77.8% of all inflow into the Caspian Sea has also worsened due to industrial wastewater. The number of sturgeons (famous for caviar) migrating from the Caspian Sea to the Volga river have been decreasing. Sturgeons with abnormal flesh or egg membrane due to biological accumulation have been increasing. Water pollution will get more and more serious.

(3) Desertification around rural towns

The vegetation of the study area is mostly steppe with spotted shrubbery. The soil of this area is mostly clayey. In general, there is little tendency for this land condition to deteriorate into direct desert artificially. But around some rural towns, especially in Aktyubinskaya and Mangistauskaya state, desertification problems have occurred as a result of long-term overgrazing.

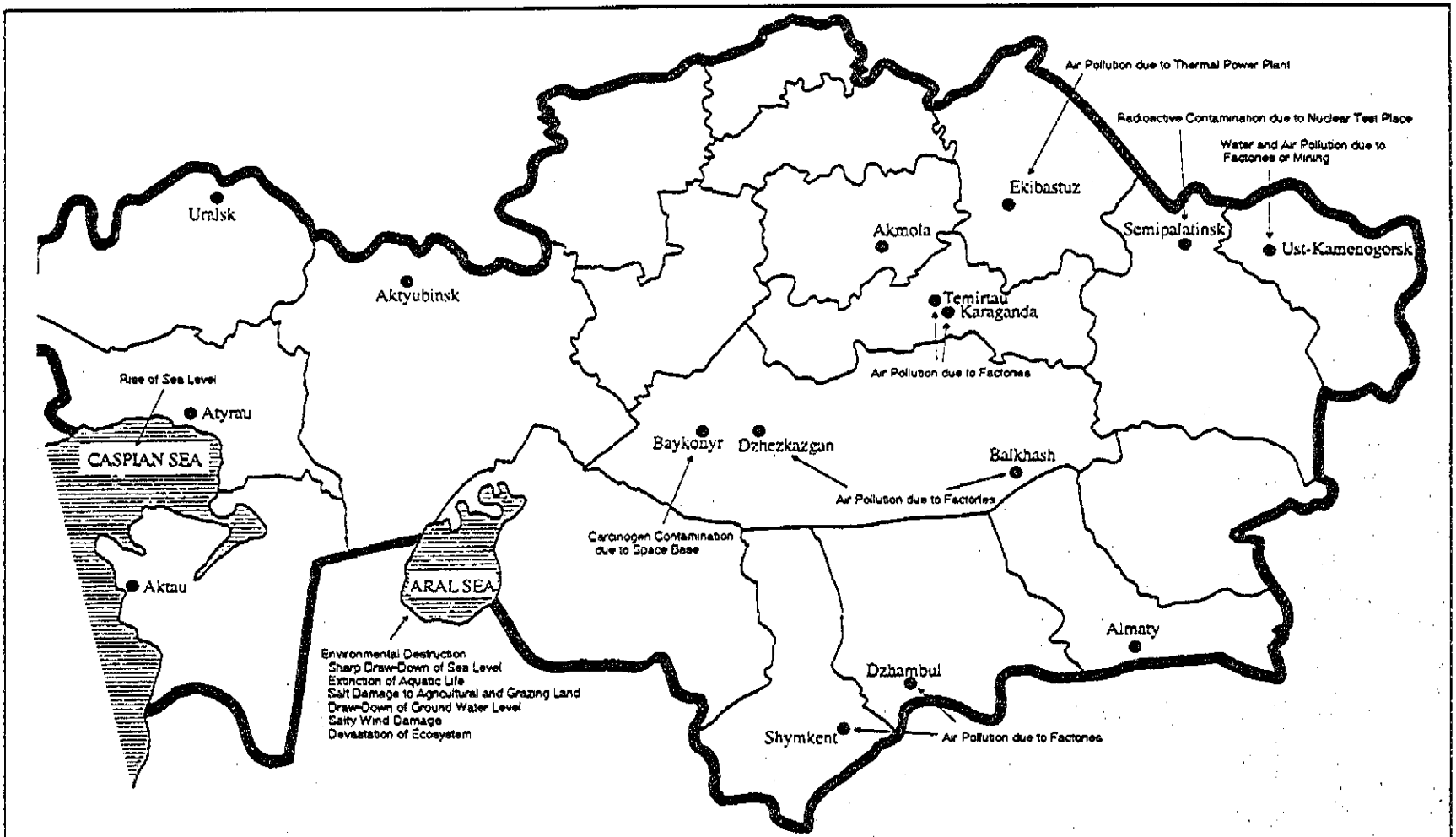


Figure 3 Environmental issues in Kazakhstan

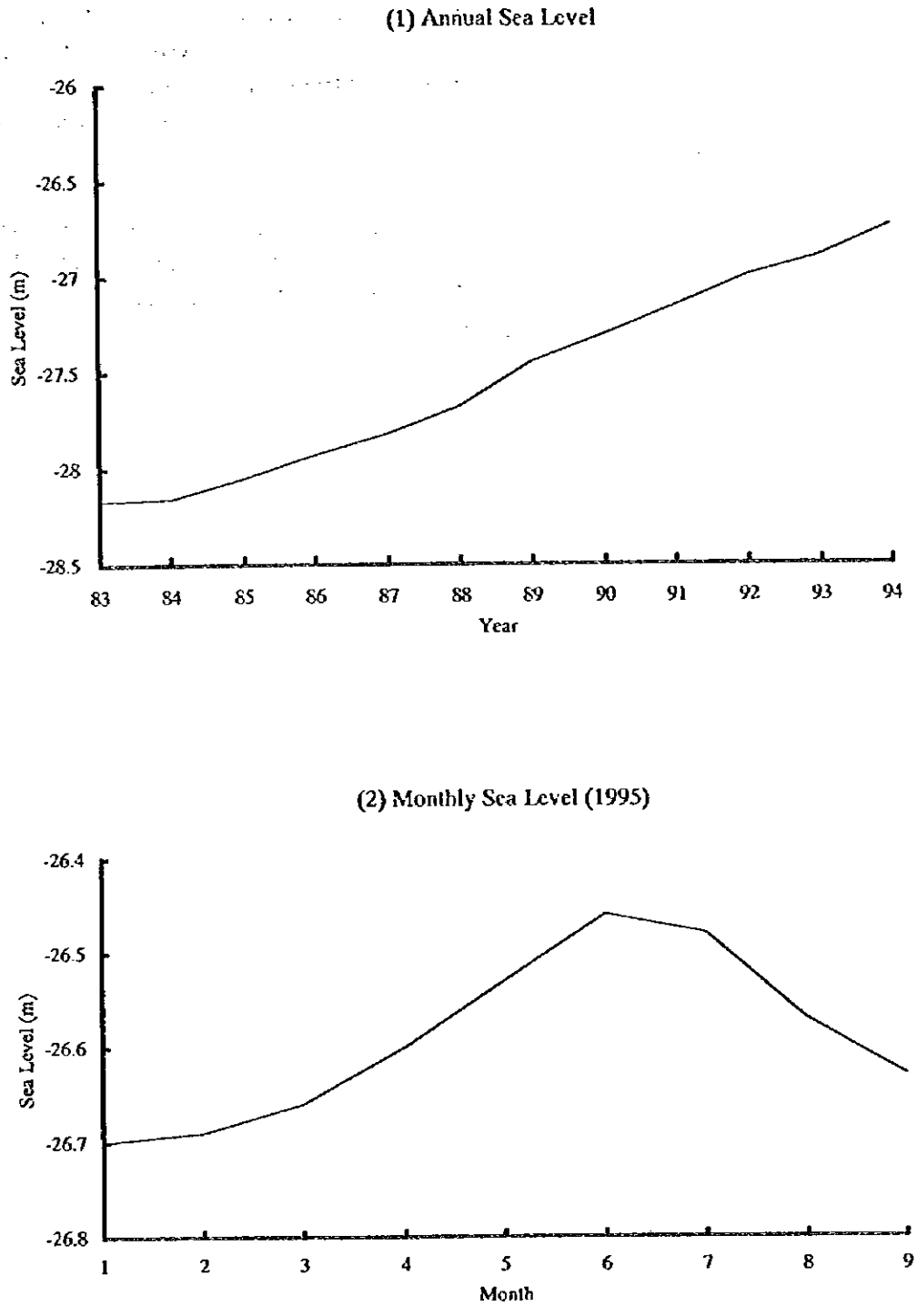


Figure 4 level of the Caspian Sea (Aktau)

Source: Mangistauskaya hydrometeorological observatory

4 Initial Environmental Examination of each Road Project

Some road construction may have negative effects on the environment in the project area during the construction stage and/or after implementation. An initial environmental examination is the first step in the environmental assessment procedure, and will decide whether more detailed studies on the environmental impact of the project shall be required or not.

Table 1. 1) ~ 8) shows the checklist for initial environmental examination of each road project. Each road project is defined by its location and its land condition. The check items are based on " JICA Enyironmental Guideline on Road Project". Only check items concerned with this road project are selected.

Table 1 Initial Environmental Examination of each Road Project

1)

1. Kzyl-Orda Border - Irgiz - Karabutak				
State	Road Section	Appox. Length (km)	Terrain	Project Type
Aktyubinskaya	1.Kzyl-Orda Border - Irgiz	80	Flat	Pavement
Aktyubinskaya	2.Irgiz - Karabutak	195	Flat	Rehabilitation

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	C	Cultural properties study Protection plan	C	Cultural properties study Protection plan	
Natural Environment	Topography and geology	D		D		
	Soil erosion	D		D		
	Hydrological situation	D		D		
	Coastal zone	D		D		
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	D		D		
Public Nuisance	Air pollution	D		D		
	Water pollution	D		D		
	Noise and vibration	D		D		

2)

2. Kustanaiskaya State Border - Karabutak - Aktyubinsk - Levedevka				
State	Road Section	Appox. Length (km)	Terrain	Project Type
Aktyubinskaya	3.Karabutak - Khromtau	124	Flat	Rehabilitation
Aktyubinskaya	4.Khromtau - Aktyubinsk	98	Flat	Rehabilitation
Aktyubinskaya	5.Akyubinsk - Novoalexeevka	114	Flat	Rehabilitation
Aktyubinskaya	6.Novoalexeevka - Lebedevka	142	Flat	Rehabilitation
Aktyubinskaya	13.Karabutak - Kustanaiskaya Border	250	Flat	Rehabilitation

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	C	Cultural properties study Protection plan	C	Cultural properties study Protection plan	
Natural Environment	Topography and geology	D		D		
	Soil erosion	D		D		
	Hydrological situation	D		D		
	Coastal zone	D		D		
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	D		D		
Public Nuisance	Air pollution	D		D		
	Water pollution	D		D		
	Noise and vibration	D		D		

Assessment: A : High Negative Impact B : Low Negative Impact
C : Unknown Impact D : No Impact

3)

3. Levedevka - Uralsk - Saratov Border				
State	Road Section	Appox. Length (km)	Terrain	Project Type
West Kazakhstan	7.Levedevka - Belogorka	25	Flat	Pavement
West Kazakhstan	8.Belogorka - Dzhambeity	54	Flat	Rehabilitation
West Kazakhstan	9.Dzhambeity - Algabas	71	Flat	Rehabilitation
West Kazakhstan	10.Algabas - Uralsk	68	Flat	Rehabilitation
West Kazakhstan	12.Uralsk - Saratov Border	100	Flat	Rehabilitation

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	C	Cultural properties study Protection plan	C	Cultural properties study Protection plan	
Natural Environment	Topography and geology	D		D		
	Soil erosion	D		D		
	Hydrological situation	D		D		
	Coastal zone	D		D		
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	D		D		
Public Nuisance	Air pollution	D		D		
	Water pollution	D		D		
	Noise and vibration	D		D		

4)

4. Samara Border - Uralsk - Kaylagino				
Province	Road Section	Appox. Length (km)	Terrain	Project Type
West Kazakhstan	11.Uralsk - Samara Border	50	Flat	Rehabilitation
West Kazakhstan	16.Uralsk - Kaylagino	386	Flat	Rehabilitation

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	D		D		
Natural Environment	Topography and geology	D		D		
	Soil erosion	B	Slope protection Stream protection	B	Slope protection Stream protection	
	Hydrological situation	B	Hydrological management	B	Hydrological management	
	Coastal zone	D		D		
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	D		D		
Public Nuisance	Air pollution	D		D		
	Water pollution	B	Management system	D		
	Noise and vibration	D		D		

Assessment: A : High Negative Impact B : Low Negative Impact
C : Unknown Impact D : No Impact

5)

5. Aktyubinsk - Oktiabrsk - Dossor				
State	Road Section	Appox. Length (km)	Terrain	Project Type
Aktyubinskaya	14.Aktyubinsk - Oktiabrsk	85	Flat	Rehabilitation
West Kazakhstan	15.Oktiabrsk - Dossor	417	Flat	Rehabilitation

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	C	Cultural properties study Protection plan	C	Cultural properties study Protection plan	
Natural Environment	Topography and geology	D		D		
	Soil erosion	D		D		
	Hydrological situation	D		D		
	Coastal zone	D		D		
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	D		D		
Public Nuisance	Air pollution	D		D		
	Water pollution	D		D		
	Noise and vibration	D		D		

6)

6. Kaylagino - Mahambet - Atyrau				
Province	Road Section	Appox. Length (km)	Terrain	Project Type
Atyrauskaya	17.Kaylagino - Mahambet	50	Flat	Rehabilitation
Atyrauskaya	18.Mahambet - Atyrau	83	Flat	Rehabilitation

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	D		D		
Natural Environment	Topography and geology	D		D		
	Soil erosion	B	Slope protection Stream protection	B	Slope protection Stream protection	
	Hydrological situation	B	Hydrological management	B	Hydrological management	
	Coastal zone	D		D		
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	D		D		
Public Nuisance	Air pollution	D		D		
	Water pollution	B	Management system	D		
	Noise and vibration	D		D		

Assessment: A : High Negative Impact B : Low Negative Impact
C : Unknown Impact D : No Impact

7)

7. Dossor - Atyrau - Akkystau - Astrakhan Border				
Province	Road Section	Appox. Length (km)	Terrain	Project Type
Atyrauskaya	19.Atyrau - Akkystau	60	Flat	Rehabilitation
Atyrauskaya	20.Akkystau - Astrakhan Border	232	Flat	Rehabilitation
Atyrauskaya	21.Dossor - Atyrau	92	Flat	Rehabilitation

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	D		D		
Natural Environment	Topography and geology	D		D		
	Soil erosion	B	Slope protection Stream protection	B	Slope protection Stream protection	
	Hydrological situation	B	Hydrological management	B	Hydrological management	
	Coastal zone	B	Hydrological protection plan	B	Hydrological protection plan	
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	D		D		
Public Nuisance	Air pollution	D		D		
	Water pollution	B	Management system	D		
	Noise and vibration	D		D		

Assessment: A : High Negative Impact B : Low Negative Impact
C : Unknown Impact D : No Impact

8)

8. Dossor - Kulsary - Beyneu - Sai-Utes - Shetpe - Dzetidai - Aktau

Province	Road Section	Appox. Length (km)	Terrain	Project Type
Atyrauskaya	22.Dossor – Kulsary	118	Flat	Rehabilitation
Atyrauskaya	23.Kulsary – Opomaya	104	Flat	Pavement
Mangistauskaya	24.Opomaya – Beyneu	122	Flat	Pavement
Mangistauskaya	25.Beyneu – Sai-Utes	181	Frat	Pavement
Mangistauskaya	26.Sai-Utes – Shetpe	120	Flat / Rolling	Pavement
Mangistauskaya	27.Shetpe – Dzetidai	85	Frat	Rehabilitation
Mangistauskaya	28.Dzetidai – Aktau	82	Flat / Rolling	Rehabilitation

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	C	Cultural properties study Protection plan	C	Cultural properties study Protection plan	
Natural Environment	Topography and geology	C	Topographical and geological survey Protection plan	C	Topographical and geological survey Protection plan	Steep slope area
	Soil erosion	B	Slope protection Stream protection	B	Slope protection Stream protection	Steep slope area
	Hydrological situation	D		D		
	Coastal zone	D		D		
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	B	Design management	B	Design management	Wonderful view area
Public Nuisance	Air pollution	D		D		
	Water pollution	D		D		
	Noise and vibration	D		D		

Assessment: A : High Negative Impact B : Low Negative Impact
C : Unknown Impact D : No Impact

9)

9. Dzetidai - Zhanaozen - Zonaomkh - Krasnobosk Border				
State	Road Section	Appox. Length (km)	Terrain	Project Type
Mangistauskaya	29.Dzetidai - Zhanaozen	69	Flat	Rehabilitation
Mangistauskaya	30.Zhanaozen - Zonaomkh	60	Flat	Rehabilitation
Mangistauskaya	31.Zonaomkh - Krasnobosk Border	100	Flat	Pavement

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	C	Cultural properties study Protection plan	C	Cultural properties study Protection plan	
Natural Environment	Topography and geology	D		D		
	Soil erosion	D		D		
	Hydrological situation	D		D		
	Coastal zone	D		D		
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	D		D		
Public Nuisance	Air pollution	D		D		
	Water pollution	D		D		
	Noise and vibration	D		D		

10)

10. Beyneu - Nukus Border / Sai-Utes - Zhanaozen				
Province	Road Section	Appox. Length (km)	Terrain	Project Type
Mangistauskaya	32.Beyneu - Nukus border	84	Flat	Pavement
Mangistauskaya	33.Sai-Utes - Zhanaozen	122	Flat / Rolling	Pavement

Check Item		During Construction		Permanent		Remarks
		Assessment	Mitigating Measures	Assessment	Mitigating Measures	
Social Environment	Resettlement	D		D		
	Economic Activity	D		D		
	Split of communities	D		D		
	Cultural property	C	Cultural properties study Protection plan	C	Cultural properties study Protection plan	
Natural Environment	Topography and geology	C	Topographical and geological survey Protection plan	C	Topographical and geological survey Protection plan	Steep slope area
	Soil erosion	B	Slope protection Stream protection	B	Slope protection Stream protection	Steep slope area
	Hydrological situation	D		D		
	Coastal zone	B	Hydrological protection plan	B	Hydrological protection plan	
	Flora and fauna	C	Ecological survey Protection plan	C	Ecological survey Protection plan	
	Landscape	B	Design management	B	Design management	Wonderful view area
Public Nuisance	Air pollution	D		D		
	Water pollution	B	Management system	D		
	Noise and vibration	D		D		

Assessment: A : High Negative Impact B : Low Negative Impact
C : Unknown Impact D : No Impact

APPENDIX VII

Road Maintenance Staff and Equipment

Appendix VII

Road Maintenance Staff and Equipment

1. The Karabutak ~ Kzyl Orda road section

The existing equipment and necessity of equipment are shown in Table 1.

2. Atyrau-Mahambet section

The existing equipment and necessity of equipment are shown in Table 2.

3. Routine maintenance work

The road routine maintenance is usually urgent, it includes many kinds of works and the work volume varies. It seems better to do the works on force account base by the authority. At present, zholdary maintenance offices do the routine maintenance with contract on negotiated base. These offices have long experience and enough staff, therefore in this time they could do the work efficiently. Using private enterprise has many merits such as flexibility to work volume varying. In the future, it would be recommended that the office will become independent from zholdary, not as a part of the authority with merits of private enterprise.

4. Number of staff in the state road authority

The authority is required efficient capability for planning, budget administration, superintending the work of road construction and maintenance and equipment management. In this time, its staff is minimum level to execute the work because of less work volume and less budget. It is recommended that the number of staff will increase according to the work volume and keep as minimum number as possible. It is also recommended to prepare the manual, especially, of the job site works and some equipment such as computers for efficient use of staff and budget.

5. Equipment for maintenance and repair of roads

(1) Survey for Existing Equipment with its Condition and the Level of Staff

To sufficient selection of necessary equipment, detailed survey is recommended about the number with the condition, and also recommend to survey the level of the workers including managing staff for the management and necessary training.

(2) Procuring the Equipment for the Maintenance

To recover and increase of maintenance capability, re-establishment of the organization concerned is important for efficient management, and the equipment is more important in case of insufficient situation of it. The recommended list of the equipment is shown in table 10.6.1 for the general purpose of maintenance activities.

In this list heavy construction equipment is included, considering to maintain heavily damaged condition of the road. This equipment is recommended to be supplied by using foreign aids as same as the improvement of the roads.

(3) Urgent repair of existing deteriorated roads

It could be said that there were no maintenance of roads after changing the market system not only in 2 states studied but also the other 2 in the west Kazakhstan states. The road conditions were, in the many sections, deteriorated and became more worse. Many roads need urgent repairing work. Heavy construction equipment is recommended for the leveling, gravel spreading and etc. to recover serviceability of the roads even if temporally. That equipment is marked on the list in Table 3.

(4) Training

As mentioned before, training needs to increase the capability of the staff concerned and support to ensure the quality of the work. Off the job training such as a seminar is useful, on the job training (OJT) is more effective. To execute OJT for the maintenance works, it is recommended that , in the project for road improvement by foreign aids, maintenance works are included. In the contract, such OJT of local staff is clearly mentioned as a obligation of the contractor. This OJT is included not only workers but also managing staff.

Table 1 : Existing and Necessary Equipment for road maintenance and repair for Samara-Shimkent motor-road Karabutak-Irgiz-Kzyl-Orda border line section

No.	Name	Aitekebiisky road maintenance office (village karabutak) 969-1,053 km Road-84 km.			Road maintenance office (village Irgiz) 1,053-1,240 km Road-187 km		
		Existing	Needs	Total	Existing	Needs	Total
1	Bus for 8-12 people	-	2	2		4	4
2	Hole-drilling	-	1	1		2	2
3	Motor-grader	-	2	2		4	4
4	Truck	2	4	6		12	12
5	Car-repairing car For routine repair of concrete pavement		1	1		2	2
6	Asphalt distributor		1	1		2	2
7	Bulldozer		2	2		4	4
8	Roll-former/Ridging machine/on a tractor		1	1		2	2
9	Macadam roller		2	2		4	4
10	Tyre roller		1	1		2	2
11	Air Compressor with a set of pneumatic tools	-	1	1		2	2
12	Trailer	1	-	1		2	2
13	Kettle, truck mounted	1	-	1		4	4
14	Special traffic security car	-	1	1	-	2	2
15	Movable road repair car	-	1	1	-	2	2
16	Granular materials spreader	-	1	1	-	2	2
17	Chip spreader	-	1	1	-	2	2
18	Snow-loader	3	1	4	1	3	4
19	Snow-remover,Rotoriy, small-sized	2	-	2	-	2	2
20	Tractor	2	0	2	2	2	4
21	Excavator 0.5 m3	-	3	3	-	3	3
	Total	11	26	37	3	64	67

Table 2 : Existing and Necessary Equipment for road maintenance and repair for Atyrau-Ularisk motor-road Atyrau-Makhmbet line section

		Road Construction Managem 0-30 km Road length-30 km			Mahambet.Road ConstructionManagement 30-95 km Road length-65km		
No	Name	Existing	Needs	Total	Existing	Needs	Total
1	A bus	1		1	1		1
2	A hole-driller. BM 204		1	1		1	1
3	Motor grader	1		1	1	1	2
4	A truck	2		2	2		2
5	Road-repair machine		1	1		1	1
6	Asphalt disributor						
7	Bulldozer	1		1	1	1	2
8	Roller	1		1		1	1
9	Air Compressor		1	1		1	1
10	Mower		1	1		1	1
11	Road-Repair Station	1		1	1		1
12	Granular materials distributor		1	1		1	1
13	Crushed stone distributor	1		1		1	1
14	Snow remover	1		1	2		2
15	Snow remover ,rotary		1	1	1		1
16	Tractor		1	1	1		1
17	Excavator	1		1	1		1
	Total	10	7	17	11	9	20

Table 3 : Necessary Equipment for Maintenance and Repair of Roads

No.	Equipment name	Main specification	Routine maitenance	Urgent repair
1	Bulldozer	15 ton, 140-170HP	O	O
2	Excavator	0.7m3, 125-135HP, crawler		O
3	Excavator, Wheel	0.45m3, 95-110HP,wheel	O	O
4	Wheel loader	3.1-3 3m3 200HP		
5	Wheel loader	2 1m3 140HP		O
6	Grader	3.7m 150-160HP, with scarifier	O	O
7	Vibration roller	10ton		O
8	Tyre roller	8-10ton		
9	Back hoe loader	65-80HP	O	
10	Asphalt distributor	6000L		
11	Asphalt finisher	2 4-4 5m,hydraulic, wheel		
12	Hand guide roller	600-700kg	O	
13	Hand cart-type asphalt sprayer	24L/min	O	
14	Asphalt sprayer, pick up mount	30L/min		
15	Plate compactor	70-90kg	O	
16	Rammer	50-60kg	O	
17	Concrete cutter	cutter-size,45-56cm, self-propelled	O	
18	Hand breaker	30kg	O	
19	Air compressor	7m3/min	O	
20	Hand guide line marker	80-100kg	O	
21	Line marker, truck mount	2-4 ton		
22	Double cab truck	1 5-2ton, 4WD	O	
23	Dump truck	4ton	O	
24	Dump truck	10ton		
25	Cargo truck with crane	8ton, 2 8ton crane	O	
26	Trailer	25ton		
27	Truck, snow removal	11ton, 6X6	O	
28	Snow removal, rotary	300HP	O	
29	Tanker, water	6,000L		
30	Tanker, fuel	6000L		
31	Rough terrain crane	25ton		
32	Truck crane	70-80ton		
33	Asphalt plant	30-40ton/h,mobile type	O	
34	Mobile work shops	with 3ton crane		
35	Mobile laboratory	Asphalt , soil		
36	Road cutter	2m,370-380ps		
37	concrete pomp, truck mount	70m3/h		
38	Stabilizer	2m, 350-400HP		
39	Concrete mixer, truck mount	8ton, 4 4-4 5m3		
40	Crusher plant	30-40ton/h, mobile		
41	Crusher plant	200ton/h		
42	Traffic survey equipment	automatic traffic counter		
43	Axle load meter	Portable		
44	Pavement deflection meter	FWD		
45	Cutter for frozen ice on road surface	cutting width 2 5m, cutting depth 200mm		
46	Chip spreader	4-6 ton	O	
47	Granular material spreader	4-6 ton	O	
48	Granular material spreader,	4-6 ton , melting frozen ice	O	
49	Mower	80-90 hp	O	

6. Organization of Zholdary

6.1. Organization

The basic organization structure for the criteria of maintenance and repair for automobile road issued by Kazakhstan government is shown in Fig.1.

Road repair office (DRP) of Kazakhstan Zholdary was in charge of routine maintenance, road maintenance management (DEU) was in charge of road improvement , new construction and management of national roads and local roads including management of DRP. Road management department (UPRDOR) was in charge of management of DEU and responsible for international road.

DRP was a basic unit for road maintenance and repair, and maintained about 50-60 km of road as shown in Table 4. The staff organization of DRP was shown in Table 5, and the numbers and kinds of equipment to be owned were shown in Table 6. DRP owned the other equipment such as electric generator, air compressor and breaker.

Other independent organizations included road construction management (DSU), road bridge management (DMSU) and road construction trust as organization of roads and bridges construction.

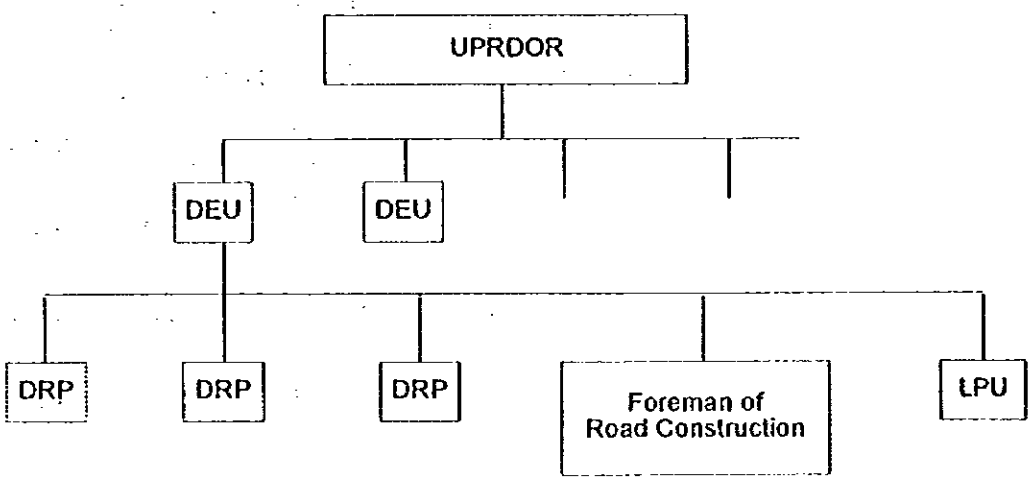
The contents of the criteria, based on the criteria of the former soviet union is similar to organization of developed western countries. Moving to the establishment of zholdaries, the organization for road maintenance and repair has been re-arranged. That re-arrangement was executed because of lack of budgetary matters, not to be based on changes of actual works' needs.

6.2. Organization of State Zholdary

Moving to commercial market system, the organization of the state zholdary has been re-arranged with integration and abolishment. DRP was abolished and integrated to DEU, the functions of DEU have increased to take in road improvement and construction activity. For example, Atyrau zholdary took in DSU, Mangistau zholdary took in the road construction trust as a production road management (PDU).

The present organization of Atyrau zholdary is shown in Fig. 2.

Fig. 1 : Organization for Road Maintenance and Repair



UPRDOR	:	Road Management Department
DEU	:	Road Maintenance Management
DRP	:	Road Repair Office
LPU	:	Tree Planting Office for Protection against Snow

Source : Criteria of Maintenance and Repair for Automobile Road, Kazakhstan Government Ordinance, N568, 8. 12. 1965

Table 4 : Road Length Maintenance by Road Repair Office (DRP)

Pavement	Road Length (km)	Traffic Volume (Vehivle / Day)		Index
		Avarage	Max.	
Asphalt concrete	50 - 60	2,800	5,000	1.80
Black crushed stones, gravel	60 - 80	1,500	2,000	1.60
Cruched stones, gravel butumen treated	70 - 80	650	1,000	1.40
Soil and sand strengthened by binders	70 - 80	600	800	1.40
Cruched stone, gravel	80 - 90	500	700	1.35
Sand and soil added mineral powder	90 100	250	450	1.20
Embankment	100 - 110	150	250	1.00
Natural Earth road	120 - 140		150	0.70

Notes:

1. Index : Difficulty of each Pavement comparing with Earth road as 1.0

2.Min. length is applyed to avarage or less traffic volume and max length is to max.traffic volume

3.Less figure is able to be applyed in case of the followings

a) 10% less is able to be applyed in case traffic volume is 20% more.

b) 15% less is able to be applyed in case mountainous area, suburb area and severe conditin.

c) Criteria is based on 6-7m carrigeway width.

Source : Criteria of Maintenance and Repair for Antomoble Road, Kazakhstan government ordinance, N568, 8.12.1965

Table 5 : Number of Staff in Road repair office (DRP)

Title	Kind of Road maintained	
	Natioal road	Local road
Executive Foreman	1	1
Foreman	1	1
Mechanics	1	
Superviser	2	1
Labor	3	2
Grader Operator		1
Truck Driver	1	1
Total	9	7

Source : Criteria of Maintenance and Repair for Antomoble Road, Kazakhstan government ordinance, N568, 8.12.1965

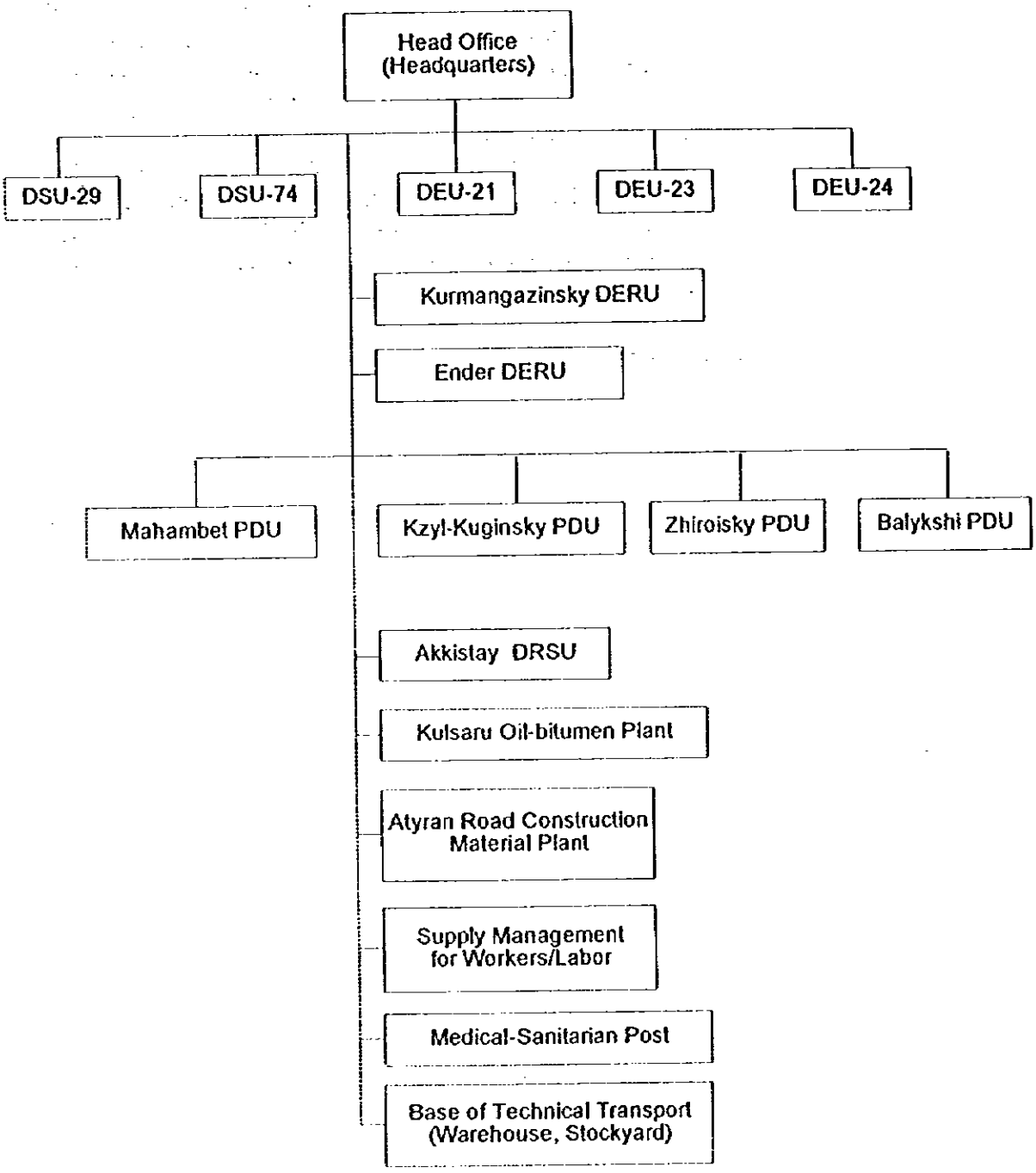
Table 6 : Equipment owned in Road repair office (DRP)

	Model	Asphalt Pavement	Gravel /stone	Earth road
1	3 wheeled motorcycle	2	2	1
2	Truck	1	1	1
3	Motor grader	1	1	1
4	Towed grader	1	1	2
5	Self-propelled Roller	1	1	
6	Sand spreader	1	1	
7	Road sprinkler	1		
8	Tractor		2	2
9	Loader	1	1	
10	Truck with snow plow	2	2	1
11	Tractor with snow plow	1	1	1
12	Mobile type kettle	1-2		
13	Heater	2	3-5	3-5
	Total	15-16	16-18	12-14

Source : Criteria of Maintenance and Repair for Antomoble Road,

Kazakhstan government ordinance, N568, 8.12.1965

Fig. 2 : Organization of Atyrau Zholdary



Source: Atyran Zholdary

6.3. Number of Staff

The numbers of staff and labors have decreased due to the reorganization. The present numbers are about 2500 in 4 states for actual maintenance activity except administration, whereas necessary numbers are estimated more than 3000 considering the road lengths to be maintained. The actual numbers were less than the registered. For example, Akkystau road construction repair management which has 60 workers registered has laid off 30 workers due to the lack of budget. Akkystau management is under Atyrau zholdary which has a larger budget for the works from the state than other state zholdaries. When considering the number of staff, in this time, each office has enough staff comparing less work volume. If the volume becomes larger, the number of staff is considered to be sufficient.

6.4. Road maintenance Team

The road maintenance team belongs to DEU, PDU as a basic unit of road maintenance and repair activity. The road maintenance team of Atyrau zholdary is, for example, mentioned below. This team maintains 80-120 km of road lengths which are longer than those mentioned in the former criteria.

(i) Team staff

- Forman	1 person
- Road mechanic	1 person
- Road lobar	6 persons
- Driver of "Road maintenance Service Vehicle"	1 person
- Total	9 persons

The team can use the other operator for equipment in accord to the necessity.

(ii) Team Machine and Equipment

Dump truck	1 unit
Motor Grader	1 unit
Self propelled Roller	1 unit
Sand Sprayer	1 unit
Wheel Tractor with Lift linkage attachment	1 unit
Snow Remover	1 unit
Bitumen tank with Tractor (placing train)	2 units
Total	8 units

A team is given a minimum number of machines and equipment in order to maintain the road. The rest of the machines and equipment is concentrated at the office. The team can use the other equipment for other repair works in accord to the necessity.

(iii) Activity of Team (Team Duties)

Road and Road structure (bridge etc.) maintenance, to provide safe traveling, road care with routine repair and winter upkeeping.

6.5. Machinery of Workshops to Maintain and Repair Vehicles and Equipment

The capability of the workshops for the maintenance and repair of the equipment is dropped . That influenced severely the lack of the equipment. The large numbers of the equipment in Atyrau zholdary , which is comparatively in better budgetary condition to take the works from the state than other zholdaries, has been left not to be repaired although it is within depreciation period : 34 units (34%) out of 101 units within depreciation period as shown in Table 7.

It mostly caused that it became more difficult to purchasing the spare parts necessary because of the lack of budget. And also almost of the machinery of the workshops passed depreciation period, over a half of the machinery were used over 30 years as shown in Table 8. The other zholdary are seen to be almost the same. To continue the present condition of the workshops, it would decrease the numbers of workable equipment and the capabilities for the road maintenance and repair would be still worse.

When the maintenance ability is considered, the capability of private or independent repair workshops is also very important. The road maintenance offices were used to do the maintenance of the equipment by themselves, therefore There are no work shops of heavy equipment used for road maintenance and repair except for light equipment or vehicle, and such shops have not grown up at present.

The equipment of Western developed countries would increase against the lack of it through some foreign aid. The maintenance ability of such equipment would be still more anxious because the existing equipment was almost from former soviet union or eastern countries. The mechanics of the work shops of zholdaries could, however, do the maintenance works with their long experience through the efficient training, supplying necessary spare parts and machinery for the maintenance.

6.6. Spare Parts

Because of the lack of budget, the work volume of road maintenance is less and necessary numbers of the equipment are few. Therefore Need for spare parts is also less, it is, at present, not so difficult to get the spare parts in spite of lack of them in the market.

When the work volume become larger, it will be actually difficult to purchase spare parts of the equipment from the former soviet union or eastern countries, besides the lack of them in the markets, considering less supplying ability of the spare parts even in Russia.

Table 7 : Existing Equipment in Atyrau Zholdary

Equipment Condition	Total		Depreciated		Within depreciation	
Condition1 (Not Working)	31	17.9%	31	43.1%	0	0.0%
Condition2 (Need some repair)	54	31.2%	20	27.8%	34	33.7%
Condition3 (Workingwell)	88	50.9%	21	29.2%	67	66.3%
Total	173	100.0%	72	100.0%	101	100.0%

Source : Atyrau Zholdary

Table 8 : Existing Equipment/ Tools to maintain/repair in Atyrau Zholdary

No.	Model	Model Code	Main Specification	Origin Country	Perchasing Year	Condition		
						1 (Not Working)	2 (Need some repair)	3 (Workable)
1	Lathe	1k62	500mm	USSR	1959			+
2	Lathe	1k62	500mm	USSR	1959		+	
3	Lathe	Cuson	400mm	D.Rep.of Korea	1986			+
4	Lathe	Cuson	400mm	D.Rep.of Korea	1986			+
5	Lathe	Cuson	400mm	D.Rep.of Korea	1986			+
6	Lathe	Cuson	400mm	D.Rep.of Korea	1986			+
7	Lathe	D-55	300mm	USSR	1965			+
8	Lathe	D-55	300mm	USSR	1965			+
9	Grinder	ZD4230	120mm	USSR	1992			+
10	Drilling	ZA125	25mm	USSR	1960			+
11	Milling	6V82C	125mm	USSR	1956			+

Source : Atyrau Zholdary

6.7. Equipment of Laboratory

Equipment of Laboratory is very important to ensure the quality control in road construction and maintenance and repair.

Necessary equipment is shown in Table 9 considering the standards in western developed countries.

Considering large area and less density of road to be maintained in the states, mobile type laboratories are proper and will became necessary for efficient execution of the quality control.

Equipment of Laboratory will need to be replaced and increased, when the road design method of western developed countries is applied.

6.8. Maintenance and Repair

Classification of work items for road maintenance and repair is shown in Table 10.

Offices were clearly divided, according to each work item, such as routine maintenance, periodic maintenance and improvement / rehabilitation including new construction. After the establishment of Kazakhstan zholdary, some offices were integrated and execute not only maintenance works but also middle sized construction works.

Limitation of usage of roads is classified based on the road roughness index measured by Bump integrator developed by Kazdornii as shown in Table 11. Considering the introduction of the design standard of western developed countries, such road evaluation criteria also need to be changed according to the standard.

Table 9 : Equipment of Laboratory Necessary for Road Construction and Maintenance Including Existing Equipment of State Zholdary

No.	Necessary Equipment Descreption	Q'ty	Existing Equipment Atyrau Zhodary	Q'ty	Remarks
A. Asphalt Testing Equipment					For the testing methods specified in A.1, they are the standard testing methods for the materials for heating asphalt mixtures and for determining the physical properties of asphalt.
A.1	Test for Petroleum Asphalt				
A.1.1	Penetrometer Test				
(1)	Automatic Asphalt Penetrometer	1	Penetrometer	1	All the equipment except A.1.4 are first priority.
A.1.2	Ductility Test				
(1)	Refrigerated Ductility Machine	1			Cleveland flash point tester specified in A.1.4. is second priority.
A.1.3	Softening Point Test				
(1)	Automatic Softening Point Machine	1			
A.1.4	Flash Point Test				
(1)	Cleveland Flash Point Tester	1			
A1.15	Thin Film Test	1			
(1)	Thin Film Oven Tester				
	Viscosimeter	1	Viscosimeter	1	
A.2	Bituminous Mixture Test				
A.2.1	Preparation				For A 2 1. these equipment are for the preparation of samples and they are the essential items Accordingly they are first priority.
(1)	Hot Plate, 300 x 450mm	2			
(2)	30K Asphalt Mixer	1			
A.2.2	Specimen Density Test				For A 2 2 this is the essential testing equipment for determining the density of the bituminous mixtures. Accordingly this is first priority.
(1)	Density Test Set	1			
A.2.3	Stability Test				For A 2 3 this contributes to determining the mixing design of the asphalt mixture and essential. So this is first priority.
(1)	Marshall Apparatus	1			
(2)	Recorder for Marshall Test	1			
(3)	Asphalt Compaction Machine	1			
(4)	Asphalt Curing Water Bath	1			
(5)	Marshall Mold	10			
A.2.4	Bitumen Extraction Test				For A2.4. this is essential for determining the quantity of asphalt in bituminous mixture So this is first priority.
(1)	Centrifuge Extractor	1			
B. Concrete & Aggregate Testing Equipment					
B.1	Aggregate Test				
B.1.1	Sampling				For B 1.1 this is essential for splitting samples uniformly. So this is first priority.
(1)	Sample Splitter 5, 10, 15, 25mm	1			
B.1.2	Sieves Analysis Test				For B.1 2 these are essential for sieve analysis
(1)	Aggregate Test Sieves Set	2	Aggregate Test Sieves	1	test. So this is first priority
(2)	Ro-tap Sieve Shaker	1			
B.1.3	Specific Gravity & Absorption Test				For B 1.3 both specific gravity and absorption test are essential for the tests of the basement materials Accordingly these are first priority.
(1)	Sand Absorption Cone	1			
(2)	Electronic Precision Balance 3100g-0.01g	1			
(3)	Champion Flask	5			
(4)	Coarse Aggregate Specific Gravity Test Set	1			
B.1.4	Moisture Test				For B.1.4 this is essential for determining the

No.	Necessary Equipment Description	Q'ty	Existing Equipment Atyrau Zhodary	Q'ty	Remarks
	(1) Portable Speedy Moisture Test	1			moisture contents of aggregate and soil for basement materials So this is first priority.
B.1.5	Unit Determination Test				For B 1 5 this test is essential for mixing design
	(1) Unit Determination Test Set	1			for basement materials. So this is first priority.
B.1.6	Abrasion Test				For B.1.6 and B 1 7 soundness test and abrasion test
	(1) Los Angels Testing Machine	1	KP-116	1	are essential for the tests for the durability of aggregates among the testing methods for heating asphalt mixtures and basement materials.
B.17	Soundness Test				Accordingly these are first priority.
	(1) Basket, ƒÓ5, 10, 20mm	3			
	(2) Container, ƒÓ12, 21, 36mm	3			
	(3) Sodium Sulfate, 500g	10			
	(4) Barium Chloride, 500g	10			
B.2	Concrete Test				
B.2.1	Preparation of Test				For B 2 1 this is essential for testing mixing of
	(1) Portable Concrete Mixer	1			concrete. (1) and (2) shall be selected according
	(2) Forced Stirring Mixer	1			to the mixing quantity. They are first priority.
B.2 2	Workability Test				For B 2 2 and B 2 3 these are essential for determining
	(1) Slump Test Apparatus	2			the air content and the slump value as the method of the quality control of concrete. They are first priority
B.2.3	Air Content Test				
	(1) Washington Type Air Meter	2			
B.2.4	Hardening Concrete Test				For B 2.4 these are essential for strength test as the
	(1) Compression Testing Machine 100 ton Capacity	1	Hydraulic Press PSU-50/IP-100	2	method of the quality control of concrete They are first priority.
	(2) Cylinder Mold, ƒÓ15 x 30cm	20			The equipment specified in(2) - (7) are for preparing
	(3) Cylinder Mold, ƒÓ10 x 20cm	10			the specimen.
	(4) Internal Vibrator	1			The equipment specified in(8) is used in field
	(5) Capping Apparatus	1			and can measure the compressive strength of concrete
	(6) Capping Compound Warmer	1			with nondestructive method
	(7) Capping Compound 50kg	1			
	(8) Schmidt Test Hammer, Type	1			
C.	**Soil & Pavement Test Equipment**				
C.1	Mechanical Analysis of Soil				For C.1. this is aiming at grasping the necessity of particle adjustment and determining the mixing
C.1.1	Grain-size Analysis				ratio among the specified tests for basement
	(1) Mechanical Analysis Stirrer	2			materials Accordingly this is essential.
	(2) Soil Analysis Sieve Set	2			It is first priority
	(3) New type Water Bath	1			
	(4) Hydrometer	5			
	(5) Hydrometer Jar	15			
C.2	Consistency Test				
C.2.1	Liquid Limit Test				For C 2 1 this is for determining Plastic index
	(1) Motorized Liquid Limit Set	3			and Liquid limit and Plastic limit test are essential for the specified tests for basement materials.
C.2.2	Plastic Limit Set				It is first priority
	(1) Plastic Limit Set	3	Plastic Limit Set	1	
C.3	Compaction Test				For C.3. also this is for determining the Max dry density and the optimum moisture content.
C.3.1	Compaction Test				This is essential for the mixing tests for
	(1) Soil Mixer	1			basement materials. It is first priority.

No.	Necessary Equipment Descreption	Q'ty	Existing Equipment Atyrau Zhodary	Q'ty	Remarks
	(2) JIS Type Compaction Set	1			
	(3) Automatic Mechanical Compactor	1			
C.4	CBR Loading Test				
C.4.1	CBR Test				For C.4.1 as same as C.3, this is essential for the mixing tests for basement materials
	(1) CBR Laboratory Set, Motor with Standard Accessories for CBR Test	1			
	(2) Recorder for CBR Test	1			This is for determining CBR value which is one of the design criteria to determine the proportion of basement materials. It is first priority.
	(3) Electric Proving Ring, 100kg	1			
	(4) - ditto - , 500kg	1			
	(5) - ditto - , 1ton	1			
	(6) - ditto - , 2ton	1			
	(7) - ditto - , 5on	1			
	(8) CBR Mold	10			
	(9) Spacer Disc	2			
	(10) Swell Plate	10			
	(11) tripods Attachment	10			
	(12) Surcharge Weight	10			
	(13) Dial Gauge Support	2			
	(14) Dial Gauge, 120mm-0.01mm	12			
	(15) Penetration Piston	1			
	(16) Filter Paper ƒÓ100mm	10			
	(17) Filter Paper ƒÓ150mm	10			
C.5	Triaxial Test				The physical test of soil is not thought to be essential as one of the maintenance tests for pavement However unconfined test, triaxial test, and permeability test are necessary as the basic test methods for subsoil. Accordingly C 5, C6 and C.7 are second priority.
C.5.1	Triaxial Test				
	(1) Triaxial Assembly, Air Control Type	1			
C.6	Permeability Test				
C.6.1	Falling Head Permeability				
	(1) Unit Type Falling Head Permeameter	1			
C.6.2	Constant Head Permeability				
	(1) Unit Type Constant Head Permeability	1			
C.7	Shear Test				
C.7.1	Unconfined Compression Test				
	(1) Precision Motorized Compression Device with Standard Accessories for Unconfined Test	1			
D.	**Field Test / Quality Control Test Equipment**				
D.1	Profile Measurement				This is essential as one of the evenness measuring methods for pavement. This is first priority.
	(1) Profile Meter	1			
D.2	Deflection Measurement				This is essential as the measuring method of the deflection of pavement. So this is first priority.
	(1) Recording Benkleman Beam	1			
D.3	Field Density Test		Dedensity-meter and moisture-tester	1	The density test of basement is essential. So this is essential. It is first priority
	(1) Sand Density Apparatus	2			
	(2) Field Density Apparatus ƒÓ15cm	1			
	(3) - ditto - ƒÓ25cm	1			
	(4) Field Density Core-cutter	2			
D.4	Field CBR Test				For D.4, this is for determining CBR value of

No.	Necessary Equipment Description	Q'ty	Existing Equipment Atyrau Zhodary	Q'ty	Remarks
	(1) CBR Testing Set for Field use	1			basement. Accordingly this is essential.
	(2) Drop-Ball CBR Apparatus	1			It is first priority.
D.5	Static Penetration Test				For D.5 this is essential as in-situ testing equipment.
	(1) Portable Cone Penetrometer	1			It is first priority
	(2) Dutch Cone Penetrometer 2ton Capacity	1			
D.6	Plate Bearing Test				For D.6 this is essential as the testing equipment
	(1) Plate Bearing Set	1			for measuring the bearing capacity of subsoil.
					It is first priority.
D.7	Core Sampling				For D.7 this is for taking core sample from
	(1) Portable Core Drilling Machine	1			the pavement. So this is first priority.
	(2) Core Bits, ƒÓ100mm	10			
	(3) Core Bits, ƒÓ150mm	10			
E.	General Equipment				For E all the instruments are necessary as the common
					apparatus like the tools for sample preparation.
E.1	Hand Scoop, Round	3			They are second priority
E.2	Hand Scoop, Square	3			
E.3	Enameled Type, 630 x 430 x 110mm	5			
E.4	- ditto - , 405 x 285 x 60mm	5			
E.5	- ditto - , 285 x 225 x 40mm	5			
E.6	- ditto - , 265 x 355 x 55mm	5			
E.7	Desiccator , ƒÓ300mm	2			
E.8	Graduated Cylinder, 2000cc	10			
E.9	- ditto - 1000cc	10			
E.10	- ditto - 500cc	10			
E.11	- ditto - 200cc	10			
E.12	Volumetric Flask , 500cc	10			
E.13	- ditto - 200cc	10			
E.14	Le Chaterier Flask	5			
E.15	Glass Beaker, 100cc	20			
E.16	- ditto - 500cc	20			
E.17	Enameled Ironware Beaker, 2000cc	20			
E.18	- ditto - 1000cc	20			
E.19	Porcelain Mortar with Pestle	3			
E.20	Evaporation Dish, ƒÓ90mm	20			
E.21	Culture, ƒÓ90mm	50			
E.22	Sample Cans, 110ml	50			
E.23	Spatula, 20cm	10			

No.	Necessary Equipment Descreption	Q'ty	Existing Equipment Atyrau Zhodary	Q'ty	Remarks
E.24	Spatula, 10cm	10			
E.25	Wire Scratch Brush	5			
E.26	Wooden Hammer	5			
E.27	Mortar Mixing Bowl & Spoon	10			
E.28	Sieve Brush, Hair	5			
E.29	Sieve Brush, Wire	5			
E.30	Ovens, Constant Temperature 970 x 600x 750mm	1	Drying Oven (Vacuum drying oven)	1	
E-31	- ditto - 970 x 600x 750mm	1			
E-32	Electronic Precision Balance with Printer & Calibration Weight 200g - 1mg	1	Precision Balance 1000g/200g	2	
E.33	Electronic Precision Balance with Printer & Calibration Weight 2100g - 0.01g	1	Electronic Balance 3000g/10000g	2	
E.34	Electronic Precision Balance with Printer & Calibration Weight 20 kg-0.1g	1	Desk Top Balance 20000g	1	
E.35	Electronic Industrial Balance 60kg - 1g	1			
E.36	Digital Stopwatch	3			
E.37	Vernier Caliper, 300mm	2			
E.38	Armored Thermometer, 0 - 250C.degree	10	Thermometer	1	
E.39	Armored Thermometer, 0 - 100C.degree	10			
E.40	- ditto - 0-200C.degree	10			
E.41	Max. & Min Thermometer	3			
F.	**Bridge Testing Equipment**	2			
F.1	Schmidt Test Hammer with Recorder	2			For measuring the compressive strength of concrete It is first priority. For F2 and F3, they are for inspecting crack and some defects inconcrete F2 is second priority, F3 is first
F.2	Pundit	1			
F.3	Microscope for Crack Determination	2			
F.4	Concrete Checker	2			For visually inspecting inside concrete by fiber scope. It is first priority.
F.5	ELSONIC Ultrasonic Measuring Apparatus	1			For measuring crack depth, thickness, internal defect and pulse velocity of concrete structure. It is first priority.
F.6	Test Kit for Neutralization of Concrete	2			For measuring neutralization of concrete It is first priority.
F.7	Corrosion Analysis Instrument	1			For detecting corrosion in the reinforcement bars of concrete structure. It is first priority.
F.8	Rebar Locator	1			For inspecting the locating rebars, rebars situation and measuring concrete covers It is first priority

No.	Necessary Equipment Description	Q'ty	Existing Equipment Atyrau Zhodary	Q'ty	Remarks
F.9	Auto Level with Tripod	1			All of the equipment specified in F9-F17 are general for survey. They are first priority.
F.10	Theodlite with Tripod	1			
F.11	Digital Point Caliper	2			
F.12	Steel Tape, 50m	4			
F.13	Aluminum Staff	2			
F.14	Pole	2			
F.15	Hammer	5			
F.16	Plumb Bobs for Level	2			
F.17	Plumb Bobs for Theodlite	2			

Source: JICA study team
Remarks : first priority means to be necessary for efficient testing , second priority means to be better if available or means general equipme

Table 10 : Classification of Work Items for Road Maintenance and Repair

Classification of Works	Pavement	Content of Main Works
Road Maintenance	1. All types of pavement	1. Dust, dirt, snow and ice cleaning, removal of and dust removal with water
	2. Crush-stone and gravel pavements	2. Drifting of screenings (of fine gravel), treated and non-treated with the bitum and tar materials
	3. Earth and gravel pavement, tractor trucks	3. Grading
	4. Removal of ice-slick and the slippery pavement	4. Sand spray, anti-freeze materials and etc.
	5. Provision of travel in the deep and poor areas	5. Closing and sealing of air funnel, bypass maintenance, off schedule maintenance and repair in the case of emergency in the deep areas
	6. Carriage way marking	6. Application of direction of traversal
Routine Road Repair	1. All types of pavement and surface	1. Sealing of holes, cracks, potholes, runs (hole repair, hole and run repair), removal of settlements, correlation edge, border stones ; grading of earth and gravel roads
	2. Crushed-stone and gravel pavement	2. Spray of screenings and fine gravel, including bitum and tar materials
Intermediate Repair of Road	1. Cement-concrete pavement	1. Change of destroyed pavement slab, slab leveling, seam correlation; laying of leveling asphalt-concrete course in the separate areas with the distance about 200 m
	2. Asphalt-concrete pavement	2. Laying of asphalt-concrete upper layer in the separate parts and surfacial treatment
	3. Crushed-stone (gravel) pavement, treated by organic binders	3. Single and double surfacial treatment
	4. Crushed-stone (gravel) pavement	4. Levelling of shape (repair grading) with the crush-stone (gravel); single and double surfacial treatment
	5. Cobble stone paving	5. Surfacial treatment arrangement, overpaving in separate parts of road
	6. Earth roads	6. Shape levelling (repair grading) with the spray of strengthening additives up to 300 m^3 per 1 km)
Capital Road Repair	1. Cement-concrete pavement	1. Asphalt-concrete or cement-concrete pavement construction; widening of pavement
	2. Asphalt-concrete pavement	2. Change and strengthening of the upper and lower layer of asphalt-concrete, it necessary with restructuring and strengthening of foundation in the deep and poor areas; pavement widening
	3. Crushed-stone (gravel) pavement, of material treated by binder	3. Laying of new bed (layer) or increased thickness of the upper pavement bed of material treated by bitum or tar, with the restructuring or strengthening of foundation, asphalt-concrete laying to the pavement, which is used as a foundation
Capital Road Repair	4. Crushed-stone (gravel) pavement	4. Pavement strengthening by crush-stone (gravel), treated by bitum or tar, with the foundation restructure or strengthening widening. Increased thickness and restructure of pavement with the surfacial treatment or without it
	5. Improved earth roads	5. Spray of strengthening additives, gravel, gruss, shellrock, cinder and metallurgy slag with the treatment of upper layer by binder, soil foundation and soil pavement construction, (soil treated by different binders)
	6. Earth roads	6. Full shape restoration, grading with the arrangement of hard pavement in the road sections, where very difficult to travel (low-laying/and sharp slants, inhabited points) with the spray of strengthening additives (up to 500 m3 per 1 km)

Source: A reference book, Maintenance and Repair of Road ,1989,

Table 11 : Roughness Criteria of Pavement

Pavement	Bump integrator reading (PKRC) cm/km		IRI(reference) m/km	
	After capital repair	Limit of Usage	After capital repair	Limit of Usage
Asphalt concrete	50	100 - 150	1.8	5.5 - 8.7
Black crushed stones, gravel	75	150 - 200	3.6	8.7 - 10.9
Cruched stones, gravel butumen treated	100	250 - 280	5.5	12 5 - 13.2
Soil and sand strengthened by binders	100	300 - 350	5.5	13.3 - 15.2
Cruched stone, gravel	200	400 - 450	10.9	16.4 - 17.6
Sand and soil added mineral powder	200	450 - 500	10.9	17.6 - 18.8
Sand and soil	150	400 - 600	8.7	16.4 - 21.2

Notes:

PKRC has been transformed into IRI by Kazdornii, as follws.

IRI(m/km)=4.387*10^(-1) -3.367*10^(-2)*PKRC +1.742*10^(-3)*PKRC^(2) -1.225*10^(-5)*PKRC^(3)

+3.667*10^(-8)*PKRC^(4) -4.124*10^(-11)*PKRC^(5) for PKRC<=300 cm/km

IRI=6.76+0.0241*PKRC for PKRC>300 cm/km

Source : Criteria of Maintenance and Repair for Antomoble Road, Kazakhstan government ordinance, N568, 8.12.1965

APPENDIX VIII

Traffic Studies

APPENDIX VIII : Traffic Studies

Table 1 : Vehicle Classification for Traffic Survey

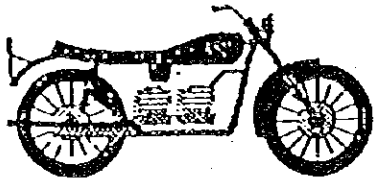
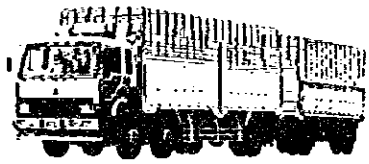
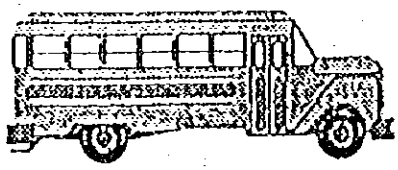
	OD Survey	Vehicle Classification Assignment Traffic
Motorcycle		
Passenger car		Passenger car including jeep, van, mini bus with capacity of less than 30 passengers
Pick-up truck		
Light truck (2 axles)		Light truck including pick-up, and tractor for agricultural purpose
Heavy truck		Heavy truck including tractor-trailer combination, and
Bus		Bus with the capacity of more than 30 passengers

Table 2 : Assigned Traffic Volumes for Year 2000 and Year 2010

LINK No.	2000 Do Nothing Traffic Volume/day					2010 Do Maximum Traffic Volume/day				
	P. Car	Bus	L. Truck	H. Truck	Total	P. Car	Bus	L. Truck	H. Truck	Total
1	149	3	147	193	492	366	23	365	482	1, 236
2	157	3	151	190	501	364	27	357	464	1, 212
3	95	16	81	46	238	300	52	303	275	930
4	93	19	83	49	244	338	36	299	276	949
5	332	53	372	226	983	501	73	555	216	1, 345
6	324	39	310	192	865	540	62	490	164	1, 256
7	285	37	278	187	787	500	58	460	160	1, 178
8	285	37	278	187	787	500	58	460	160	1, 178
9	299	39	313	192	843	507	59	496	158	1, 220
10	165	29	189	158	541	469	52	453	146	1, 120
11	232	57	164	77	530	730	154	556	317	1, 757
12	173	5	66	22	266	51	5	54	31	141
13	146	3	142	187	478	188	3	185	240	616
14	413	71	422	305	1, 211	377	72	421	200	1, 070
15	132	19	178	72	401	137	27	221	100	485
16	202	30	177	74	483	440	137	444	268	1, 289
17	30	0	25	9	64	363	118	404	263	1, 148
18	26	4	22	2	54	334	122	395	256	1, 107
19	249	90	264	246	849	17	12	46	33	108
20	318	103	289	231	941	89	23	61	12	185
21	30	10	76	53	169	306	55	384	281	1, 026
22	109	8	123	30	270	310	37	331	245	923
23	247	19	272	222	760	269	21	302	243	835
24	247	19	272	222	760	269	21	302	243	835
25	133	6	89	12	240	154	8	112	37	311
26	108	6	78	12	204	128	8	101	37	274
27	45	7	40	3	95	96	12	94	17	219
28	23	2	12	0	37	71	7	56	9	143
29	36	6	28	3	73	38	9	41	5	93
30	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—
32	129	9	179	207	524	133	9	183	203	528
33	25	0	11	0	36	26	0	11	0	37


JICA