4.2.2 Alternative Route Study

There are several existing routes inbetween Erdene and Undurkhaan and each route comprises a large number of shifting tracks. For the selection of the one best route, these routes are divided into sections and the alternative route study is conducted where ever some parallel routes exist in a section. If there is no alternative or parallel route, the route selection is made to identify one alignment among the multiple shifting tracks.

(1) Route Alternatives

By referring to the topographic maps at a scale of 1 to 25,000, a study of alternative routes in each section is made to find each representative route among the existing tracks.

The following points are taken into account;

1) The alternative routes were studied by reference to the existing routes.
2) The beginning and ending points are determined as the existing road in Erdene and Undurkhaan respectively.
3) The crossing point of the Kherlen River is determined at being around the existing bridge.
4) Since the ecosystem in Mongolia is vulnerable a high priority is given to select a route which is environmentally friendly.

Three (3) road sections except the Kherlen river crossing have selected to conduct the alternative route study, according to identification of physical constraints and site investigations. They are as follows;

1) Section A: Baganuur (Baganuur 3-leg intersection - Kherlen River)
2) Section B: Kherlen East (Kherlen River - Jargalant Crossroads)
3) Section C: Tsenkhermandal West (Jargalant Crossroads - Ogzam Valley)

The location of each section is shown in Figure 4-2-2.

4.2.3 Route Selection in Baganuur (Section A)

(1) Route Description

As shown in Figure 4-2-3, there are two existing transport means in Baganuur, namely the existing road encompassing Baganuur Coal Mine and the Mongolian Railway transporting coal daily to Ulaanbaatar.

It is noted that the route which goes across Baganuur Coal Mine and runs straight eastward to the Kherlen River Bridge might be the most favorable in Section A because it is shortest and suits to the concept of the Millennium Road. However, that option is impractical due to the existence of Baganuur Coal Mine, which is the biggest energy supplier of Ulaanbaatar and is planned to continue to operate for 60 years or more.

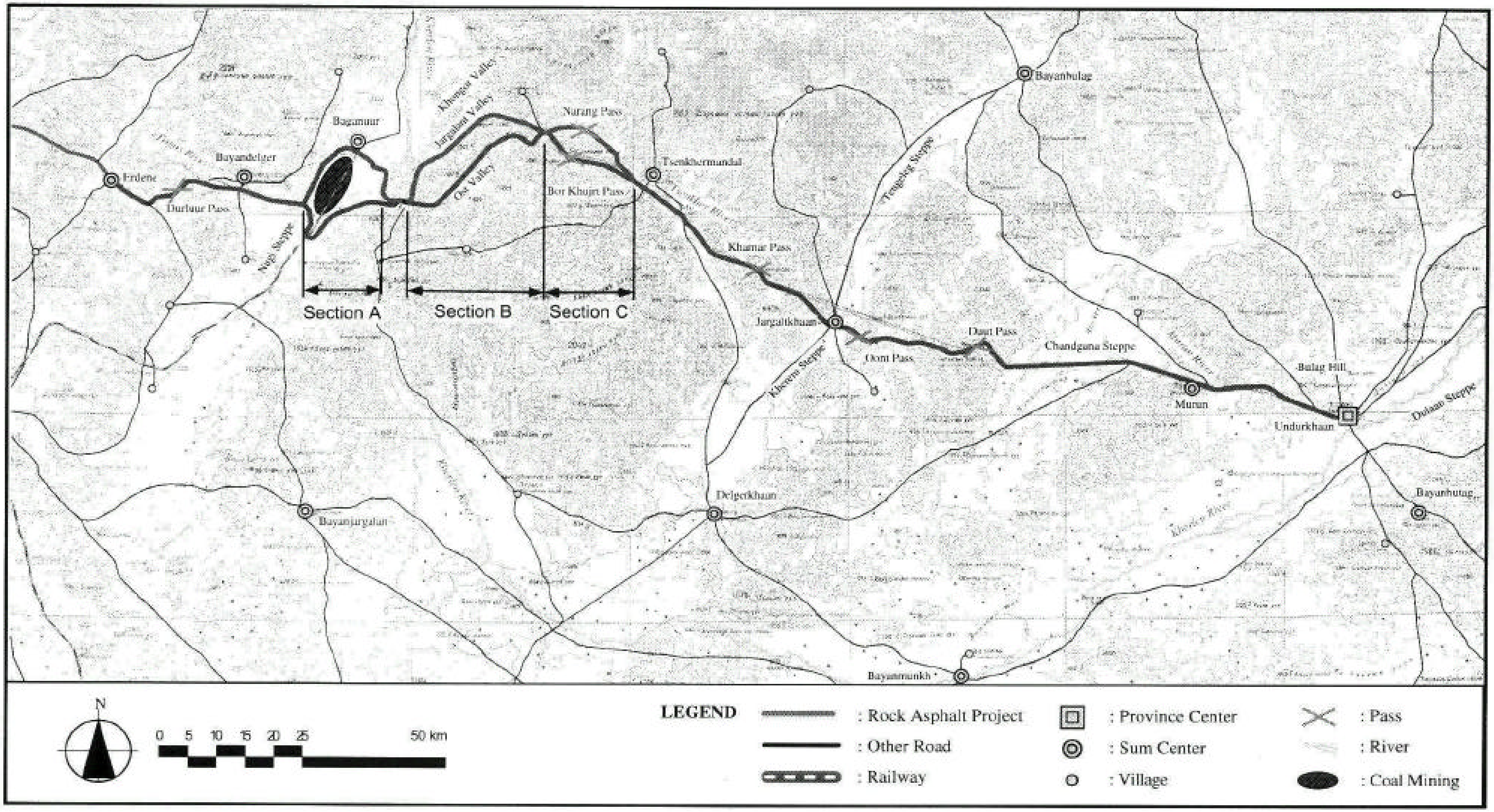


Figure 4-2-2 Location of Each Alternative Route

Before setting up alternatives, it was confirmed that no extension of Baganuur Coal Mine toward the south and west is planned and the alternative route will pass through Baganuur City.

There are two existing routes bypassing Baganuur Coal Mine. The concept and profile of the alternatives which follow these routes is shown in Figure 4-2-4.

1) Alternative Route A-1 (South Route: Railway Crossing)

This route (A-1) is planned to make a detour toward the south of Baganuur Coal Mine. It will have two railways crossings and a total length of 25.576 km.

The marshy area is widely spread in the south of Baganuur Coal Mine where the Khujirt River, the Rashaant River and the Togos River exist together with flood prone area including the Baga Guni Lake and the Ikh Gun Lake. The A-1 route is planned to pass by with minimum influence but nevertheless it will manage to pass these marshy areas only by means of bridges/ box culverts and high embankment with soft ground treatment.

The one of the location of the railway crossing point has been discussed with Mongolian Railways and it has been decided that the point shall be set approximately 1.5km south from the existing Togos River railway bridge. This is the point at which vehicles presently underpass on the riverbed to avoid the coal handling facilities, points/ switches with signals. This point has sufficient sight for the safety for both railway and vehicles but the road will require new embankment, since the railway is set on the existing embankment.

2) Alternative Route A-2 (North Route: Baganuur City)

This route (A-2) is planned to make a detour toward the north of Baganuur Coal Mine and to pass through Baganuur City. It will have a total length of 29.154 km.

The A-2 route is planned to make full use of the existing paved road of 18.7 km long but this road will require to be overlaid because of the many cracks on the surface of the existing pavement. Also, there is an existing RC bridge over the Khujirt River that was constructed more than 30 years ago and this has a lack of discharge capacity and poor structural soundness. Therefore, it is necessary to replace the bridge. The A-2 is planned to pass about 700m away from the residential area of the city. The need for bridge and box culvert along the A-2 is minimized because the route is planned to avoid the marshy area. Excluding the replacement of the Khujirt Bridge, new bridge is required only over the Khuttsa River.

(2) Evaluation

It is concluded that the alternative Route A-2 should be selected in the Baganuur Section because the comprehensive evaluation reveals the superiority of this option both quantitatively and qualitatively. The superiority of A-2 can be clearly seen from the demerits of A-1 and the merits of A-2 which can be summarized as follows:

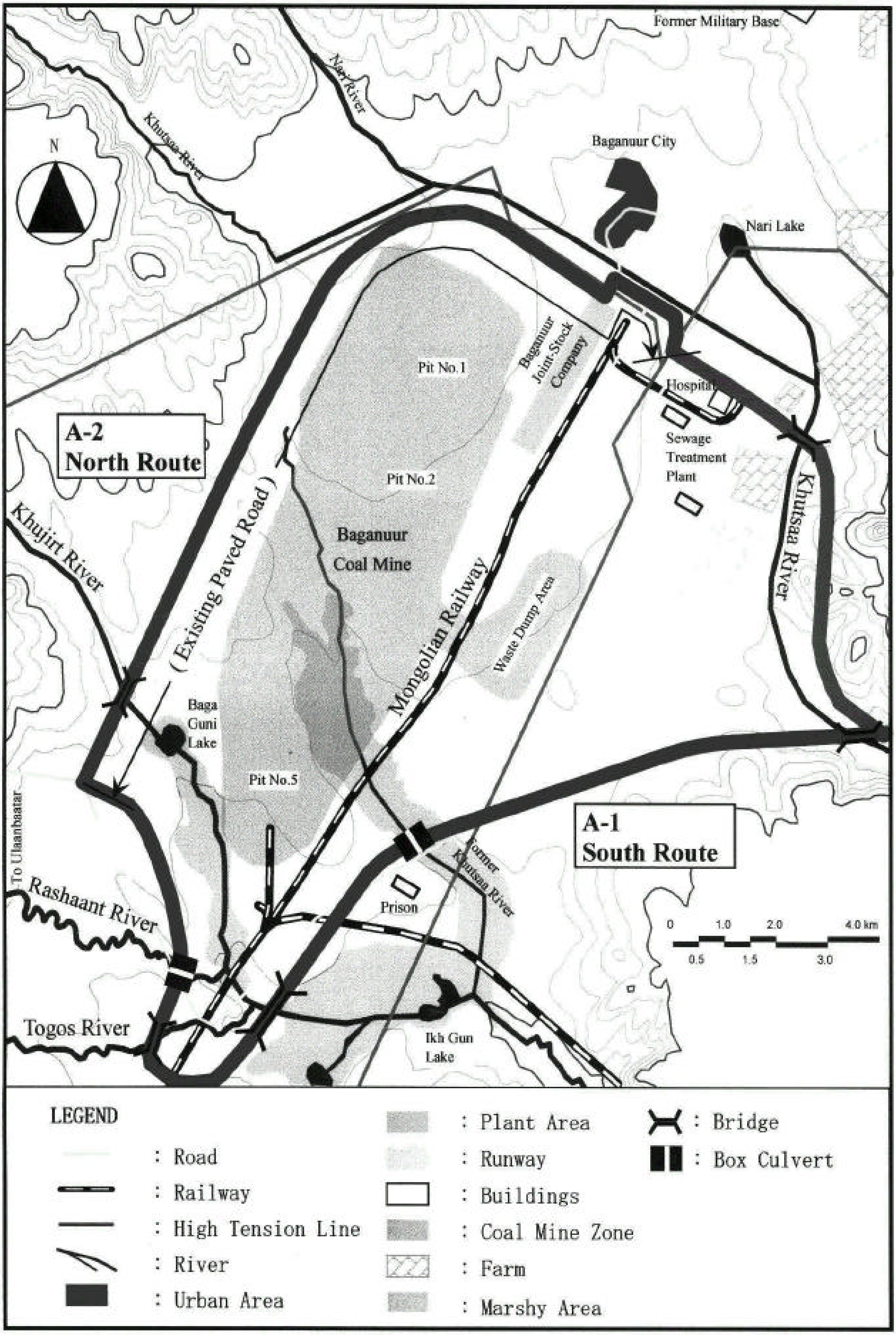


Figure 4-2-3 Detailed Location of Alternatives at Section A

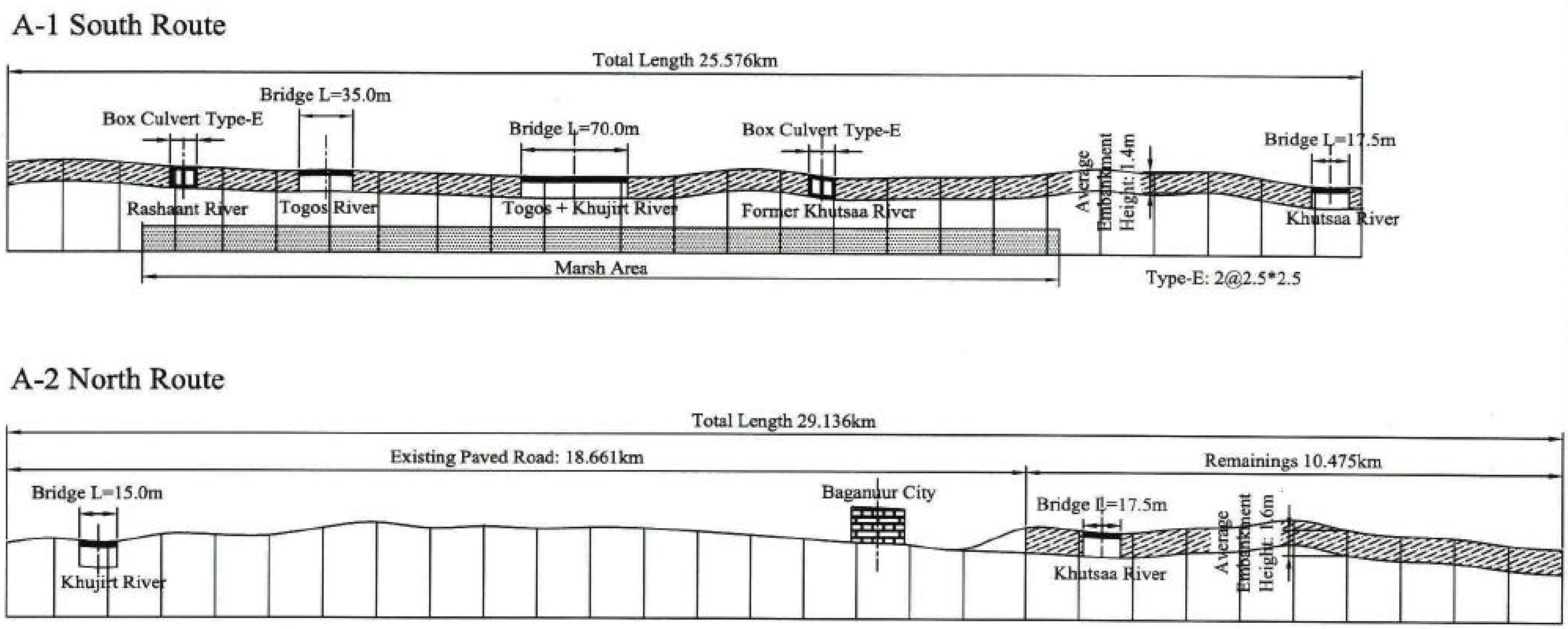


Figure 4-2-4 Profile and Location of Main Structures of the Alternatives

1) Demerits of the A-1: South Route

- This route cannot pass directly to the east to avoid coal loading facilities, points/switches with signals and based on the understanding with Mongolian Railways it is therefore forced to make a detour of about 3 km to the southward.. If the route should keep on going to the eastward, a large-scaled grade separation structure will be required at the point of railway crossing due to the high embankment of the railway in this area.
- The marshy area is widely spread in the south of Baganuur Coal Mine where the Khujirt River and the Togos River exist together with flood prone area including the Baga Guni Lake and the Ikh Gun Lake. While the route could manage to pass these marshy areas by bridges/ box culverts and high embankment with soft ground treatment, this will be far from a practical solution.
- Three bridges totaling 122.5 m in length and two box culverts will be required in the South Route, while only two bridges totaling 32.5 m in length will be in the North Route.
- The costs of construction of the South route will be 1.75 times as high as that of the North Route. Furthermore, the cost of maintenance will surely become higher because of the two railway crossings and the risk of future damage in the flood prone area.

2) Merits of the A-2: North Route

- The road length of North Route is 29.1 km and thisis 3.5 km longer than that of the South Route. However, the length of new road construction is only 10.5 km long because there is 18.7 km of existing paved road in the North Route. The construction period is surely shorter not only because of the reduced length compared with the 25.6 km of the South Route, but also because of the reduced scale of the structures.
- The costs of construction will be 57% of the that of the South Route, and the maintenance will be cheaper due to neither railway crossing nor flood prone area.
- The South Route will bring VOC saving for traffic through Baganuur due to the shorter road length. However, the traffic access to and from Baganuur city will result in higher VOC in the case of the South Route because the origin/ destination of traffic is the CBD of Baganuur and the North Route is planned to pass nearby the city.
- The North Route is planned to pass inbetween the residential area and coal mining area, and the existing coal mining area will be used for some industrial use according to the future plan. The production of Baganuur Coal Mines reached to their peak in 1994 and since then the production as well as its profit has gradually decreased. It is desirable to develop some industries in Baganuur which can take advantage from the two transport means of railway and road.

4.2.4 Route Selection in Kherlen East (Section B)

(1) Route Description

There are two routes to pass Nogoon Modot Mountain, namely passing Jargalant Valley on the north side and Ust Valley on the south side.

1) Alternative Route B-1 (South Route)

This route (B-1) is planned to pass through Ust Valley and to total 29.687 km in length. Route B-1 is shorter but steeper and will encounter the eastern end of the mountain pass.

2) Alternative Route B-2 (North Route)

This route (B-2) is planned to pass through Jargalant Valley and to total 32.675 km in length. Route B-2 is longer but flatter. However, there are many wadis exist along the Kherlen River and the route passes the wadi-laden river terrace in the vicinity of Sogoot Valley in order to avert the swampy area.

(2) Evaluation

The comprehensive evaluation reveals the superiority of Alternative B-1 quantitatively and qualitatively. The superiority is summarized as follows:

i) It is more realizable to be constructed because there are fewer places of of construction difficulties, for instance wadi and river terrace. This aspect also leads to easier maintenance after the construction.

ii) The construction cost will be lower and benefit of road user will be higher due to the shorter length of road construction.

iii) It has less effect on the natural environmental aspects due to the reduced need for countermeasures to protect the natural conditions.

4.2.5 Route Selection in Tsenkhermandal West (Section C)

(1) Route Description

There are two routes to bypass Khunkh Mountain, namely passing Naran Pass on the north side and Bor Khujirt Pass on the south side.

1) Alternative Route C-1 (South Route)

This route (C-1) is planned to pass beyond Bor Khujirt Pass and to total 19.518 km in length. Route C-1 passes hilly terrain but it is flatter. At the end of this section it will encounter an area where two swampy areas and permafrost exist.

2) Alternative Route C-2 (North Route)

This route (C-2) is planned to pass beyond Naran Pass and to total 21.221 km in length. Route C-2 is steeper and passes the area where there are some stretches traversing seeping or boggy ground at Aduun Chuluun Valley and also some swampy areas along a branch of the Tsenkher River where there is existing widespread permafrost.

(2) Evaluation

The comprehensive evaluation reveals the superiority of Alternative C-1 quantitatively and qualitatively. The superiority is summarized as follows:

i) It is more realizable to be constructed because it passes through a smaller area of frost susceptible soils affected by the freeze-thaw cycles.This aspect also leads to less effect on natural conditions.

ii) The construction cost will be lower and benefit of road user will be higher due to the shorter length of road construction.

4.3 Selection of Optimum Pavement Structure

4.3.1 Design of Pavement Structures

The salient feature for soil conditions is the cold weather-induced crack and frost upheaval or Freeze-thaw cycle, induced by the extreme climatic condition in Mongolia. For the design of pavement structure, such salient feature must be taken into consideration.

The study route was arranged into two sections based on traffic demand forecast, Baganuur - Jargaltkhaan and Jargaltkhaan - Undurkhaan. The existing ground in these two sections have CBR values from 4 to 15 , however the design minimum CBR value was computed as 8. Simplifying the design, construction and maintenance, the design CBR value was arranged as three levels namely as 8, 10 and 12.

To examine the optimum design life cycle, the following four cases of design life cycle are assumed in consideration of growth rate of future traffic volume and process of oxidation. The design life is set to be 20 years.

- Case-1: first overlay at 7 years and second overlay at 14 years from year 2005
- Case-2: first overlay at 10 years and second overlay at 16 years from year 2005
- Case-3: overlay at 13 years from year 2005
- Case-4: overlay at 15 years from year 2005.

Cumulative ESALs were calculated according to this assumption and each Structure Number was set for the computed cumulative ESALs. Also, each asphalt concrete pavement structure (hereinafter "AC pavement") and thickness of overlay for each assumption was computed based on AASHTO and assuming 20 years as the design life period.

Based on the results of Life Cycle Cost (hereinafter "LCC"), 7 years design life period was most effective in initial construction cost and maintenance cost. AC pavements were arranged as shown in Table 4-3-1.

Table 4-3-1   Design CBR and Pavement Structure by Sections

Baganuur - Jargaltkhaan (cm)

	CBR = 8	**CBR = 10**	**CBR = 12**
Asphalt Concrete Surface	5	5	5
Granular Base Course	15	15	10
Granular Subbase	26	20	22
Total	**46**	**40**	**37**

Jargaltkhaan - Undurkhaan (cm)

	CBR = 8	**CBR = 10**	**CBR = 12**
Asphalt Concrete Surface	5	5	5
Granular Base Course	15	10	10
Granular Subbase	23	24	20
Total	**43**	**39**	**35**

4.3.2 Consideration of BST (Bituminous Surface Treatment)

Bituminous Surface Treatment (hereinafter “BST”) is very common in Southeast Asian and some African countries because initial investment is low compared to asphalt concrete pavement particularly in the case of small work volume.

However, BST has following disadvantages:

i) There is less bearing capacity so that it is suitable only for roads with light traffic.

ii) Low durability requires frequent maintenance (usually every 2 to 3 years).

iii) A practical design method has not yet been developed.

For the analysis of BST having uncertain factors, BST surface of 2.5cm is adopted, and base and subbase course are assumed to be the same thickness as for asphalt pavement.

4.3.3 LCC Analysis and Establishment of Alternatives for the Implementation Plan

LCC analysis is conducted at two sections of the Eastern Arterial Road, namely Erdene to Baganuur and Murun to Undurkhaan. The former is a representative section of relatively heavy traffic volume and high embankment, and the latter is of low embankment with small traffic.

For the purpose of LCC analysis, the following assumptions are taken even though the pavement design procedure is adopte d assuming that failure criteria will not occur during the design life:

(1) Routine maintenance for both AC pavement and BST pavement will include filling of thermal cracks with asphalt emulsion slurry.

(2) Design life of 20 years for AC pavement with overlay at 7 years interval.

(3) Surface dressing at 3 years interval on BST pavement as this will keep a similar roughness as for AC pavement and also will avoid particular surface treatment problems.

The traffic details used in the economic analysis are based on the traffic demand forecast. Only benefit attributable to normal traffic is considered and the modest amount of traffic that would be generated because of the paved road is ignored.

The principal economic benefits are savings in vehicle operating costs. With the new paved road the average IRI is expected to be about 3.0, compared with 14.0 for the without case. With a good standard of routine maintenance and surface dressing every two years, it is considered that an IRI of about 3.0 could be sustained throughout the period 2006 to 2025. Travel time savings have not been included in the economic analysis. This conservative approach reflects the inherent difficulty of putting a value on travel time. The results of LCC analysis shows in Table 4-2-5.

Table 4-3-2 Results of LCC Analysis

Section	Type	Initial Investment* (M. $)	NPV (Thousand $)	EIRR
1. Erdene - Baganuur L= 33 km	AC	9,310	4,239	17.6%
	BST	8,619	4,610	18.4%
2. Murun - Undurkhaan L= 67 km	AC	7,834	11,895	26.7%
	BST	6,691	12,833	29.4%

Note: * Costs of bridges and structures are excluded for the sake of this analysis. Estimated costs of pavement and embankment only are based the assumption that the embankment height in Section 1 is 4m high on average and in Section 2 it is 2 m.

The LCC analysis shows both pavement types are expected to have sufficient economic return. However, BST pavement is superior to AC pavement in the section of Murun to Undurkhaan, while it can be seen that both are almost equal in the section of Erdene to Baganuur.

Table 4-3-3 shows each salient feature of AC pavement and BST pavement.

Table 4-3-3 Salient Feature of Each Pavement

	AC Pavement		BST Pavement	
Strength	Large	: For heavy vehicles	Medium	: For light to medium vehicles
Durability	High	: Generally 10 years life expectancy	Low	: Surface dressing is necessary at 2 or 3 years intervals
Riding Comfort	Excellent	: Generally IRI is low	Fair	: Generally IRI is high
Ease of Construction	Hard	: The construction area is limited by hauling distance of asphalt concrete.	Simple	: This construction method can be applied anywhere with materials and maintenance equipments
Initial Cost	Large	: Installation of asphalt plant and procurement of paving equipment	Low	: Not necessary to instal any special equipment
Maintenance Cost	Low	: interval of maintenance works is low	Large	: maintenance at frequent intervals is necessary

The existing Asphalt Plant that was procured by Japan's grant aid is located at Erdene and it can supply asphalt concrete to a construction site along State Road A0501. In Mongolia, asphalt concrete can be delivered 100 km at most, provided that a dump truck can haul it on paved road. It is also pointed out that some maintenance and repair works require asphalt concrete after the road is open to public.

AC pavement will be practical in Murun to Undurkhaan, on condition that a new Asphalt Plant at Murun or Undurkhaan is set up and hot-mixed asphalt concrete becomes available. On the contrary, BST pavement requires in-situ techniques at the stage of both construction and maintenance, using the same construction equipment.

The following two alternative schemes are examined for the purpose of optimum implementation plan in economic analysis, considering results of LCC analysis, equipment availability and ease of maintenance.

Table 4-3-4 Alternatives for Implementation Plan

Section	Type of Pavement	
	Alternative - 1	Alternative - 2
Erdene - Tsenkhermandal	AC Pavement	AC Pavement
Tsenkhermandal - Undurkhaan	AC Pavement	BST Pavement

4.4 Selection of Bridge Structure Types

4.4.1 Kherlen Bridge

(1) Consideration of Alternative Route Crossing Kherlen River

The most appropriate South C-route shall be determined considering the scale of approach road, bridge and river training, possibility of technical methods of reinforcement and/ or repair, construction cost, period and maintenance, etc. The locations for the above three South routes in the area of Kherlen River are shown in Figure 4-4-1.

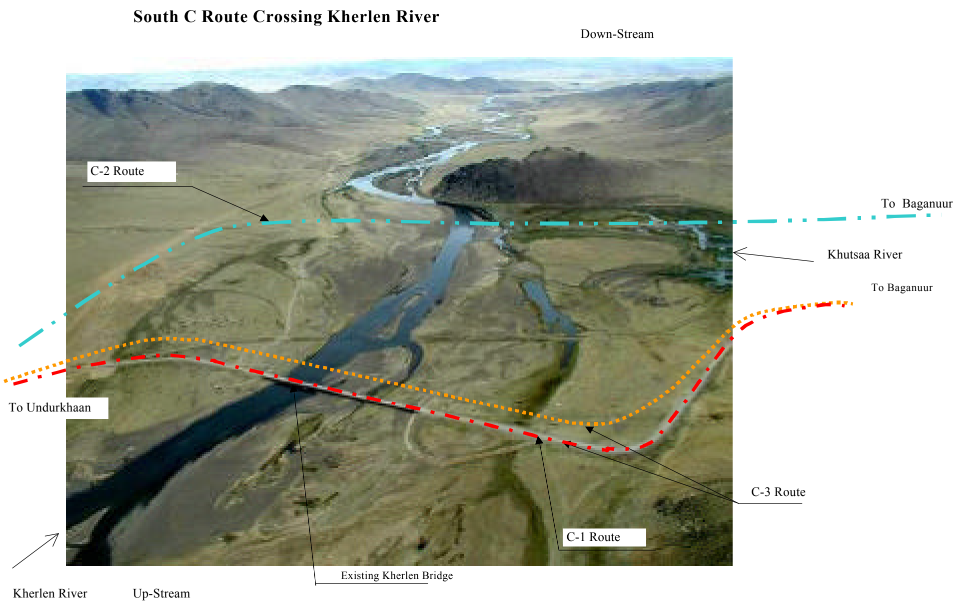


Figure 4-4-1 View of C Routes Crossing Kherlen River

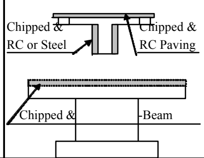
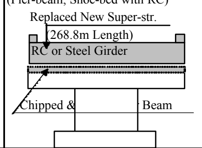
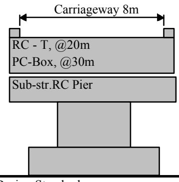
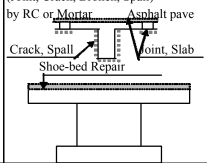
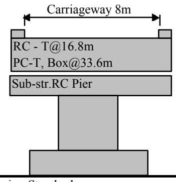
The three routes crossing Kherlen River in connection to Millennium Arterial Road are described as follows.

- First Route (herein after "**C-1 Route**"): Existing Bridge Route (Use of existing bridge)
- Second Route (herein after "**C-2 Route**"): New Route (1km down stream from existing bridge)
- Third Route (herein after "**C-3 Route**"): Existing Bridge Route (Use of existing bridge with for limited vehicles with a new crossing beside the existing bridge)

(2) Appropriate Route Crossing Kherlen River

The selected routes C-1, C-2, and C-3 were evaluated from the viewpoints of technical method, construction cost, period and river training, etc. as shown in Table 4-4-1.

Table 4-4-1 Evaluation of South Route C-1, C-2, and C-3

Route / Category	C-1: Existing Bridge Route		C-2: New Route	C-3: Existing Bridge + New Route	
	C1-1: Reinforcement of super/sub-structures	C1-2:Partial replacement & Reinforcement	C2:New Bridge with Carriage Way (8m)	C3-1:Repair only Limitation of Live-Load	C3-2:New Bridge with Carriage Way (8m)
1. Method 1.1 Reinforcement & Repair 1.2 New Bridge	*Slab(paving), Girder with RC Pier-beam, Shoe-bed with RC 	Replacement of Super-str. *Reinforcement to Sub-St. (Pier-beam, Shoe-bed with RC) 	Length 360m 	* Repairs to Defected parts (Joint, Crack, Broken, Spall) by RC or Mortar 	*Length 268.8m 
2. Requirement	Design Standard: AASHTO or JAPAN for Millennium Road	Design Standard: AASHTO or JAPAN for Millennium Road	Design Standard: AASHTO or JAPAN for Millennium Road	Limitation of Live-Load 14 Ton Truck	Design Standard: AASHTO or JAPAN for Millennium Road
3. Cost Index	2.04	0.94	1.47	1.00	
4. Construction Period	Long (App. 24 month)	Middle (App. 22 month)	Very Long (App.33month)	Short (App. 20month)	
5. Recommendation				**Recommended (New Bridge; PC Girder Type)**	
6. Recommended Reasons	1. Construction cost : Fair 2. Constructio Period : Short 3. Utilizing Existing Bridge (No demolition) 4. River Obstruction : Not Obstacle (Pier/River width ratio : less than 5%) 5. Technical Problem : None (only repair not reinforcement to exiting bridge) 6. Temporary Bridge in not required. 7. Possibility to expand bridge length and width in future stage.				

Recommendation to apply South Route of Case C-3.

- The existing Kherlen bridge (268.8m length, total width 9.8m (7.0m carriage-way and 2@ 1.0m pedestrian-way) shall effectively be utilized after repairs and be limited to light vehicles, live stock and pedestrians.

  C3-1: Repair/ Mending of Existing Bridge
  - Over-lay with asphalt surface for carriage-way
  - Set new expansion joints
  - Repair of hand rail
  - Repair of defected parts of girders and piers

- The new bridge construction shall be located 30m down stream of existing bridge and shall comply with international criteria with 8.0m width of carriage-way. The length of bridge is the same length as existing bridge (268.8m) because of the stabilized river features. However, if necessary the new bridge shall be able to be expanded to 360m length to meet design river discharge in future stage.

C3-2: Scale of New Bridge

- Superstructure Type- PC girder L= 268.8m (span 8@ 33.6m)

- Substructure Type- RC wall and spread foundation

(3) Application of Type of Super Structure for Kherlen Bridge

1) Superstructure Type

Types of super structure for Kherlen Bridge are considered with characteristics for evaluation as shown in Table 4-4-2.

Table 4-4-2 Characteristics of Super Structure Types for Kherlen Bridge

<table>
<tr><th>Case Type</th><th>Bridge Length</th><th>Characteristic for Evaluation</th></tr>
<tr><td>- RC T Girder</td><td>268.8m(16@ 16.8m span)</td><td rowspan="4">1. Construction Cost: Economic or not
2. Erection: Easier or Heavier
3. Construction Period: Short or Long
4. Materials: Available in Mongolia or not
5. River: Obstacle / influence or not
6. Maintenance: Needed or not
7. Aesthetic: Good or not
8. Others</td></tr>
<tr><td>- PC T Girder</td><td>268.8m(8@ 33.6m span)</td></tr>
<tr><td>- PC Box Girder</td><td>268.8m(8@ 33.6m span)</td></tr>
<tr><td>- Steel I Girder</td><td>268.8m(8@ 33.6m span)</td></tr>
</table>

The type of super structure for Kherlen Bridge is applied as **PC T shape Girder scaled 268.8m length (8@ 33.6m span length)** from results of overall evaluation as given in the following reasons:

- Construction Cost: Fair
- Erection of Girder: Heavier crane or launching with temporary steel beam, portal frame
- Construction Period: Short
- Materials: Import of PC wires, tension equipment etc
- River Influence: Not obstacle because of long span (width of pier/river ratio: less than 5%
- Maintenance/ Structural Aspects: No maintenance, Massive concrete (high strength)
- Aesthetic: Fair
- Others: Technical transfer for prestressing method, and heavier erection method

2) Sub Structure Type

According to the results of geological survey for the Kherlen Bridge, the bearing stratum can be found 3 to 4m below the existing river bed.

Therefore, the foundation shall be embedded into this bearing layer, up to depth of 4 to 5m below the existing river bed, with **spread foundation type**.

Considering the economical cost, construction period and river flow aspects the type of piers to be adopted shall be **RC wall shaped elliptical column and beams.**.

4.4.2 Other Bridges and Box Culverts

(1) Scale and Location of Bridges and Box Culverts

1) Location of Proposed Bridges and Box Culverts along the Study Route

In accordance with natural conditions of geology, river/ waterway conditions and the various studies, the main structures are compared in terms of the scale, type (bridge or box culvert) and location on the study route between Baganuur and Undurkhaan

2) Scale of Bridges

From the results of hydrological analysis and specifications, the scale of designated river section at each river and water way were determined for bridges of study route, as shown in Table 4-3-3.

Table 4-4-3 Designated River Section for Bridges

	Name of Bridge	B1	B2	B3	B4	B5	B6
Item	Name of river	Khujirt	Khutsaa, Nariin	Kherlen	Tsenkher	Urt Val.	Murun
Proposed Dimension	Discharge (Q m3/s)	111	128	1100	300	85	350
	River Width (Bridge Length)	15.0m	17.5m	268.8m	52.5m	15.0m	52.5m
	High Water level	2.0m	1.8m	2.0m	1.8m	1.7m	1.9m
	River Bed Width	9.0m	11.5m	260.8m	46.5m	9.0m	46.5m
	River Bed Level	1352.0m	1327.5m	1297.6m	1366.3m	1383.2m	1090.3m
	Embankment Hight	2.6m	2.6m	3.0m	2.6m	2.6m	2.6m
	Free Board	0.6m	0.6m	1.0m	0.6m	0.6m	0.6m
	Hight of Girder + Pavement	1.1m	1.3m	1.9m	1.3m	1.1m	1.3m
	Road Surface Level	1356.2m	1331.7m	1303.0m	1370.5m	1387.1m	1094.6m
	Slope of Protection (1:N)	1:1.5	1:1.5	1:2.0	1:1.5	1:1.5	1:1.5

(2) Application of Bridge Type for the Project

In the light of the present construction/ situation of structures in Mongolia, structure type for the Project shall be proposed and standardized.

1) Application of Superstructure Type

The types of bridge shall be selected taking account of present conditions based on economical aspect, availability of materials, technical level, construction method and experience, ease construction and maintenance methods.

Many RC T shape girder bridges have been constructed in Mongolia on account of the easy availability of cement and aggregate..

Based on the Japanese live loading method, prestressed/ reinforced concrete T shape girders were standardized to simplify construction and ensure a shorter construction period.

Steel road bridges have not been constructed in Mongolia due to higher construction cost arising from the need for import materials and equipment such as welding/ painting machine. It is also necessary to arrange for a factory for fabrication and finally there is the necessity of maintenance.

For the above reasons, the type of superstructure for the Project shall applied as:

Applied Super Structural Type	**Reinforced Concrete T Shape Girder**

2) Application of Substructure Type

The type of abutment shall be reinforced concrete reversed-T type on account of superstructure scale with 15 to 20m girder length, substructure height with 5 to 10m, economy and easier construction, hydrological condition and foundation type.

The type of pier to be applied will be the RC elliptical column from construction cost, method and period, etc.

From the above aspects, the type of substructure for the Project shall applied as:

Applied Sub Structural Type	**Abutment: Reinforced Concrete Reversed T**
	Pier: Reinforced Concrete Elliptical Wall T

The abutment and top of the pier footing shall be embedded more than 2m into the river bed as protection against scouring from floods and permafrost, etc. The revetment and/ or guide bank shall be protected with appropriate materials, such as stone-pitching and concrete block.

3) Application of Foundation Type

Almost all foundations for the planned bridge site shall be spread footing because of hard stratum with more than N- value 30. However, at one of the proposed bridge sites it is proposed to use RC pile foundation because the bearing stratum at that location is more than 10-12m below the existing ground.

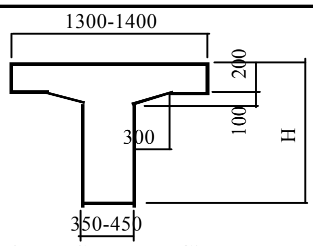
Applied Foundation Type	**Spread Foundation for 5 Bridges**
	RC Pile Foundation for 1 Bridge

(3) Standardized Type for the Structures

1) Bridges

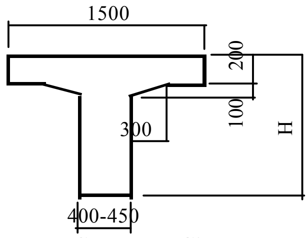
The appropriate standard span lengths for the Project are expected to be 15m to 22.5m for RC T girder, and 25m to 35m for PC T girder. These are selected considering the viewpoints of construction economy and easier construction and details are as given in Table 4-4-4.

Table 4-4-4 Standardized RC/ PC T Shape Girder for the Project



Girder Length	Height H
15m	1.00m
17.5m	1.20m
20m	1.40m
22.5m	1.60m

Reinforced Concrete T Girder



Girder Length	Height H
25m	1.60m
30m	1.80m
35m	2.00m

Prestressed Concrete T Girder

As shown in Table 4-4-5, considering the factors such as design discharge of river, geological, and topographic aspects the standard bridges in the Project shall be fixed at 15m and 17.5m girder with the number of spans adjusted to suit the total required length.

Table 4-4-5 Standard Scale of RC T Girder for the Project

Type No.	Bridge Length (m)	Span Length (m)	Girder Type
1	15	1@ 15	RC T Type
2	17.5	1@ 17.5	RC T Type
3	35	2@ 17.5	RC T Type
4	52.5	3@ 17.5	RC T Type
5	70	4@ 17.5	RC T Type

2) Box and Pipe Culverts

The crossing box and/ or pipe culverts are proposed and standardized as one of seven types according to the design discharge of the Waterway/ River. These scale and dimensions are given in Table 4-4-6 and are based on the Mongolian Standard.