Almaty–Bishkek Economic Corridor
Almaty-Issyk-Kul Alternative Road EIA

Supplementary Document: Analysis of Alignments

31 October 2020

Prepared for:
Asian Development Bank (ADB)

Prepared by:
ILF Kazakhstan LLC, in support of EDR Group / EBP team

800px-Shymbulak_Alatau_mountains_in_Almaty ©Ninaras

799px-On_A365,_Kochor_District,_Kyrgyzstan_-_panoramio ©ThomasG

EDR Group / EBP team members:
EBP US (formerly EDR Group), USA
EBP Schweiz AG
ILF Kazakhstan LLC
Elvira Ennazarova, Kyrgyz Republic

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Brief Description of the Project

In the framework of the Almaty – Bishkek Economic Corridor (ABEC), Asian Development Bank (ADB) plans to investigate a new alternative road between the large trade and economic center, Almaty (Kazakhstan), and the attractive travel destination, lake Issyk-Kul (Kyrgyz Republic). By substantially reducing the travel times between Almaty and Issyk-Kul, and thus improving accessibility to the communities and businesses, the new road might become a cornerstone for the successful development of tourism and trade in the region.

In order to understand the impact that the new route will have on the economic development of the region, ADB assigned EDR Group / EBP to perform an Economic Impact Assessment study. ILF Kazakhstan is a sub-consultant of EDR Group / EBP primarily responsible for data collection in Kazakhstan and technical review of the potential road alignments.

The present report (Memo 3) is the review of the road alignments proposed by Asian Development Bank. This report only focuses on the technical issues related to the alignments and it should be analyzed as a foundational part of the Economic Impact Assessment of Almaty – Issyk-Kul road prepared by EDR Group / EBP.

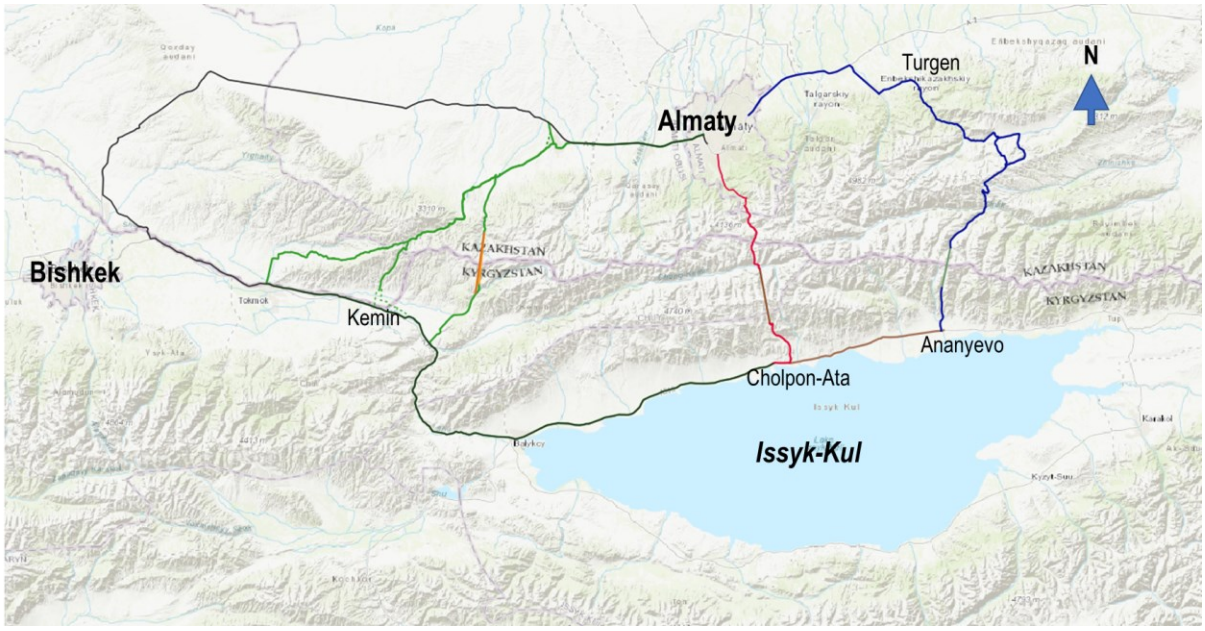
1.2 Road Alignments under Consideration

Three road alignments were suggested by Asian Development Bank for review as part of this study:

- Western alignment through Uzynagash, Karakastek and Kemin (green);
- Direct alignment through Chon-Kemin valley (red);
- Eastern alignment through Turgen (blue);

Figure 1 shows the general layouts of the alignments reviewed in this report from Almaty to the existing road leading to Cholpon-Ata as well as the existing route through Korday in black.

Figure 1. Three road alignments under consideration



Sources: Esri, GIS User Community

This report provides a general overview looking at the three possible alignments considering the direction from Kazakhstan towards Kyrgyz Republic.

1.3 Criteria for Road Characterization

The existing route from Almaty to Cholpon-Ata through Korday border control station has an estimated distance of 460 kilometers (km) requiring on average 6h 25min of travel time not taking into consideration the time at the border control station. The proposed alignments will also be analyzed with respect to the overall distance and travel time.

The road alignments will be described by considering different road segments divided depending on the topographical conditions. Each segment will be characterized in terms of its current condition, specifying the road categories as per Kazakh standards for roads, as well as the recommended category and the construction effort required for enhancement.

1.3.1 Road categories

There are six main road categories in the technical road classification as per SP RK 3.03-101-2013 “Highways and Roads”, which are defined in Table 1.

Table 1. Summary of the road categories

	Design traffic flow in cars/day	Width of roadbed, m	Design speed (main), km/h	Max gradient (for design speed)**, ‰	Load per single axis, kN	Road surface
Category 1-a	More than 14000	28.5 and more	150	30	115	Concrete monolithic, asphalt concrete
Category 1-b	More than 14000	27.5 and more	150	30	115	
Category 1-v*	Up to 14000	22.5 and more	100	50	100-115	
Category II	6000-14000	15 and more	120	40	100-115	Concrete monolithic, asphalt concrete, organic mineral mix, gravel
Category III	2000-6000	12	100	50	100-115	
Category IV	200-2000	10	80	60	100-115	
Category V	Up to 200	8	60	70	100	Gravel, gravel-sand mix, stone

* One additional category 1-v used in this analysis is not included in the mentioned official standard but is widely used in road engineering with definition taken from Russian standard, SP 34.13330.2012 “Highways and Roads”.

** Longitudinal gradient values in this table are given based on the maximum design speed, but generally it is a function of many variables and should be checked against the guidelines in the standard accordingly.

1.3.2 Construction Effort

The road alignments will be described by considering different road segments divided depending on the topographical conditions. Each segment will be characterized in terms of construction effort required to enhance the current condition of the route to a recommended level distinguishing the following:

- No works: no enhancement of the road required;
- Widening: existing roads require wider pavement to allow for increased traffic load;
- Reconstruction: enhancement of trail or gravel road where it has some value to allow for Category 2/3 road;
- New road construction: new construction with the full range of works required.

The volumes of construction works required for the upgrade of each road segment will be calculated including the following:

- Preparatory works;
- Laying out roadbed;
- Laying out road pavement;
- Construction of retaining walls;
- Construction of reinforced concrete bridge;
- Construction of reinforced concrete pipe.

Finally, construction costs for each road alignment will be calculated based on the calculated volumes of construction works.

1.4 Tunnel Standard and Cost Assumptions

Tunnels are complex infrastructure elements entailing higher cost than road infrastructure in general. However, some of the considered alignments for an alternative road between Almaty and Issyk-Kul seem to hardly be feasible without tunnels that cap the most mountainous and technically challenging portions of the Tian Shan mountain ridge passes. Tunnels may limit the maximum altitude to be surpassed by a mountain pass and thereby shorten trips and facilitate winter safety of the road.

As this is not a road feasibility study, it is not possible nor required to explore the options for each of the alignments in great detail. Instead, the task of this analysis is to display alignments as reasonable assumptions of an alternative road between Almaty and Issyk-Kul as a basis for the Economic Impact Assessment at the center of this study.

It is assumed that a tunnel as part of the alignment has to be safe and comfortable. Anything short of that would deter people from using the alternative road and limit economic impacts. This means that tunnel design has to include ventilation, lighting and emergency exits.

Tunnel cost are included based on the analysis of tunnel projects in multiple countries. Per-kilometer tunnel cost vary largely, depending on specific circumstances and equipment but there is a clear tendency to higher specific cost for longer tunnels. Longer tunnels ask for more generous ventilation and safety equipment. Based on eight existing tunnels in Asia[1] the following assumption regarding cost is made:

- 5 km tunnel length: $10 million per km
- 10 km tunnel length: $20 million per km
- 15 km tunnel length: $25 million per km

We assess that this cost level is a good approximation for safe and comfortable tunnels without implying tunnel standards that include more sophisticated technical operations and safety features often found in Western countries. These cost assumptions do in no way replace location specific engineering and design considerations that would be part of a feasibility study.

---

[1] People's Republic of China: Mount Erlang Tunnel, Zhongnanshan Tunnel; India: Atal Tunnel, Chenani-Nashri Tunnel; Iran: Aba Saleh al-Mahdi Tunnel; Pakistan: Kohat Tunnel, Lowari Tunnel; Vietnam: Haivan Pass Tunnel

1.5 Operation and Maintenance Cost Assumptions

Besides capital investment cost for construction, operation and maintenance cost may add considerably to the total cost of infrastructure. Two approaches are used to develop assumptions of operation and maintenance cost for the alignments:

- The Ministry of Transport of the Kyrgyz Republic has provided a statistical analysis of operation and maintenance cost for its road network. An average maintenance cost of $3'431 per km and year is deducted for a category III road[2]. Additional $935 is dedicated to winter maintenance. Total average operation and maintenance cost is shown to be $4'366 per km and year. – This may be seen as the lower end of the range as the alignments considered in this study are for most parts in mountainous terrain.
- 1-2% of capital investment cost may be considered a just about sufficient rate for maintenance cost that is sustainable in the long term, which means in theory that the infrastructure's deterioration is constantly countervailed. Average per-kilometer construction cost of $0.9 million – $2.7 million for a category III mountain road, depending on its terrain, would imply yearly maintenance cost of $9'000 – $54'000.

We suggest assuming average operation and maintenance cost of 1.5% of capital investment cost per year. This also applies to tunnels.

1.6 Border Crossing Point Cost Assumptions

It is a characteristic of this road that each alignment crosses the border between Kazakhstan and Kyrgyz Republic and requires a Border Crossing Point (BCP). If no existing BCP can be used, additional cost for one BCP of $2.5 million are added to the construction cost of the road.[3] Future analysis will have to show if it is feasible to have only one BCP at the mountain top or if two separate BCPs on each side of the border with the top section of the mountain pass or the tunnel between them are necessary.

---

[2] 240'145 Kyrgyz Som (KGS)
[3] This cost assumption is based on plans for the new BCP in Karkyra.

2. WESTERN ALIGNMENT

This alignment was explored in an EBRD pre-feasibility study in 2007, where three sub-options were considered. Some of the conclusions from this study have been incorporated in this report. This section will provide a brief description of how the route is to be laid out from Almaty to Issyk-Kul, featuring the main stops along the route. The western alignment was explored considering different layouts with different technical parameters.

2.1 Common Segment: Almaty to Uzynagash and Karakastek

2.1.1 Almaty to Uzynagash

All routes start in Almaty at the intersection of Sain and Rayimbek Batyr streets and then follow an existing A-2 road with I-b technical category leading to Tashkent - until Uzynagash as shown in Figure 2. A-2 road is in good condition with asphalt-concrete 4-lane pavement with 18.5 meters (m) width. The allowable speed range is 90-110 kilometers per hour (km/h).

Figure 2. Almaty – Uzynagash

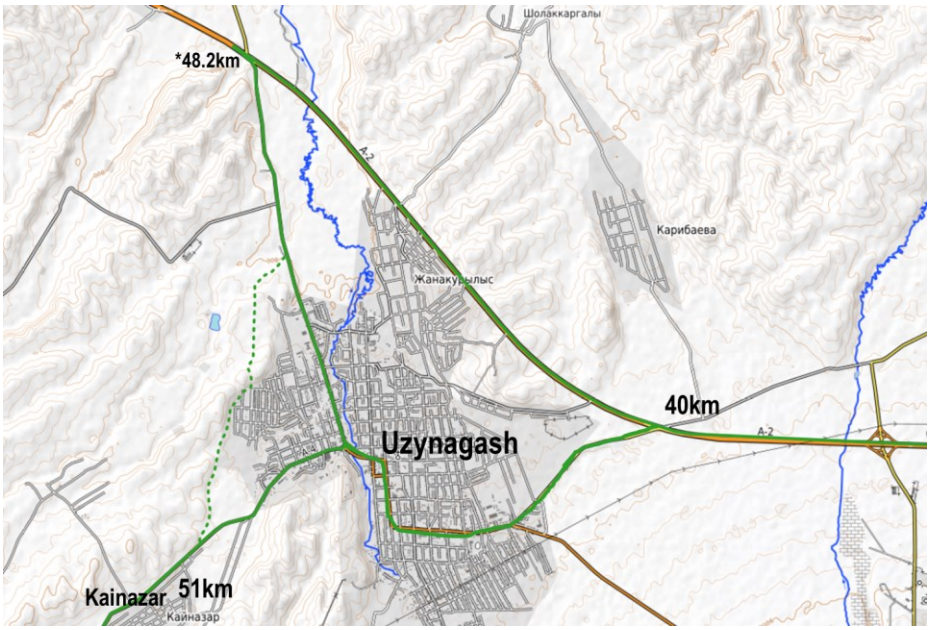
Source: Esri, EsriTopoWorld map

2.1.2 Uzynagash to Kainazar

From the turn to Uzynagash village there is a 2-lane road of Category 3 in good condition with 7 m width of asphalt-concrete pavement. The allowable speed range is 70-90 km/h. After, the route goes through Uzynagash village, along main streets: Suyunbay, Karash Batyr, Abay and Zhambyl towards Kainazar village. The street roads have 2-4 lanes with 7-9 m width and are in good condition. The allowable speed range is 40-60 km/h.

As shown in Figure 3, in order to avoid the congested area of the village, a bypass can be constructed west of the village which then connects with A-4 road on the approach to Kainazar village. EBRD study also suggests that it would be feasible to create a bypass south of the village without significant additional cost.

Figure 3. Uzynagash - Kainazar



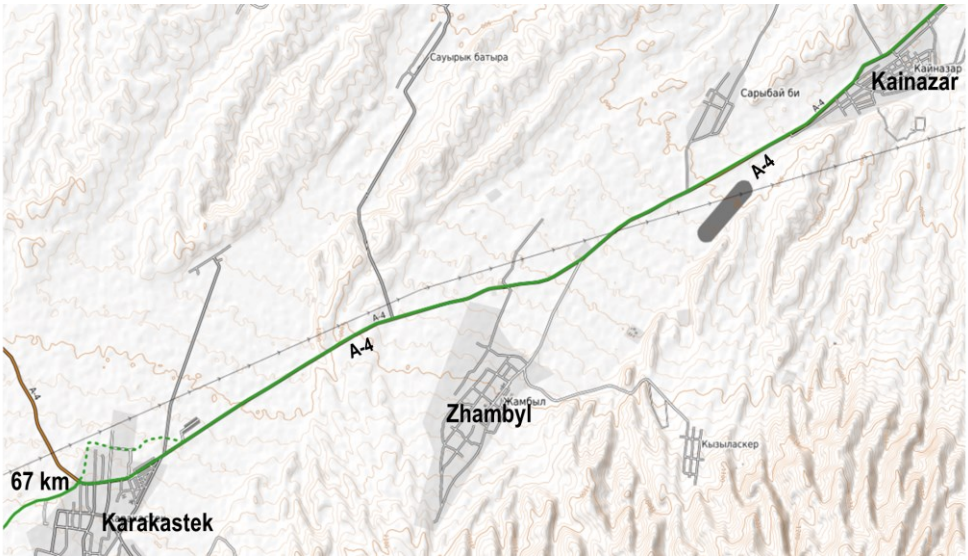
Source: OpenStreetMap contributors

2.1.3 Kainazar to Karakastek

As per EBRD study, beyond Kainazar village, the route follows the existing A-4 road of Category 3 (asphalt surfaced road) with 6-7 m width past Zhambyl village to Karakastek village. This segment of the road should require minimal works for road reconstruction. The allowable speed range is 70-90km/h. On the approach to Karakastek village, the route either goes through the village or bypasses the village from the north to prevent potential traffic safety issues in the urban area as shown in

Figure 4.

Figure 4. Kainazar – Karakastek.



Source: OpenStreetMap contributors

As specified in EBRD study, for more precise routings in the environs of the existing villages, a more detailed study with a survey of population is required to solve resettlement issues.

2.1.4 Summary of the Common Segment with Existing Roads

Overall distance of this common road segment (from Almaty to the edge of Karakastek village) is in the approximate range between 65 and 67 km. Table 2 provides the details of the current condition of this road segment:

Table 2. Summary of the common segment of the western route.

Kazakhstan						
№	Road segment		Distance, km	Current category/ width	Design speed, km/h	Required works
	from	from				
1	Almaty	Turn to Uzynagash	40	Category 1b / 18.5m	90-110	No works
2	Turn to Uzynagash	To Uzynagash	1	Category 3 / 8m	90	Widening
3	Inside Uzynagash		5	Street road / 7-9m	40-60	Widening
4	Uzynagash	Kainazar	5	Category 3 / 8m	60	Widening
5	Kainazar	Karakastek	13	Category 4 / 6-7m	60-90	Widening
6	Inside Karakastek		3	Main street road / 6-7m	40	Widening

Beyond Karakastek, there are two main options: gravel/asphalt road option going further to the west and road option with tunnel going to the south.

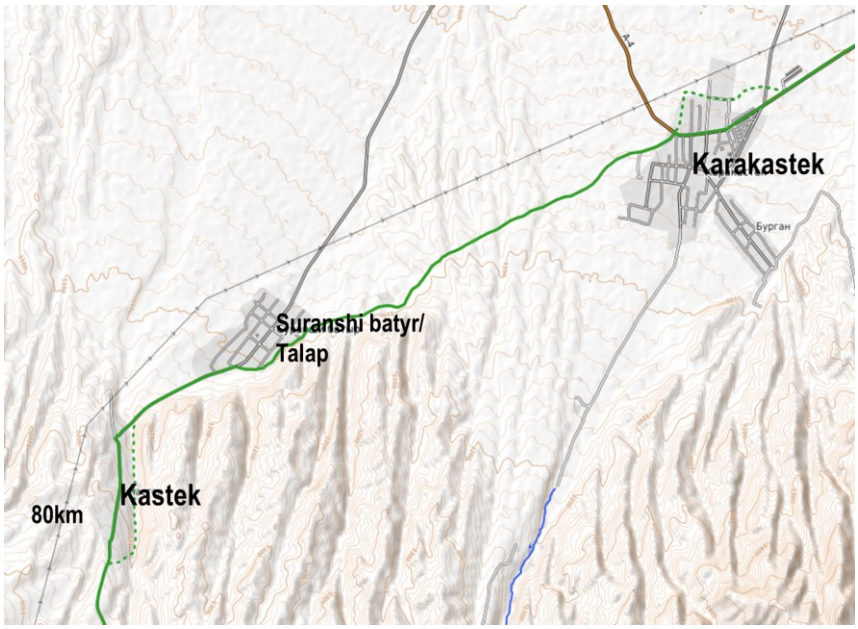
2.2 Western Route by Gravel or Asphalt Road

This alternative can be analyzed as a gravel or asphalt road. In this report, two feasible sub-options were presented: through New Kastek pass and through Masanchi village further to the west. Below is a brief description for each road segment.

2.2.1 Karakastek - Kastek

From Karakastek there is a rural road to Kastek village past Suranshi Batyr (or Talap) village, which requires a substantial upgrade. The route bypasses Suranshi Batyr village from the south and follows 2-lane asphalt road with 6-7 m width, which requires an upgrade. The allowable speed range is 40-60 km/h. When the route approaches Kastek village, it can either follow the road through the village or bypass from the east to avoid traffic annoyance issues in the urbanized area as shown in Figure 5.

Figure 5. Karakastek – Kastek

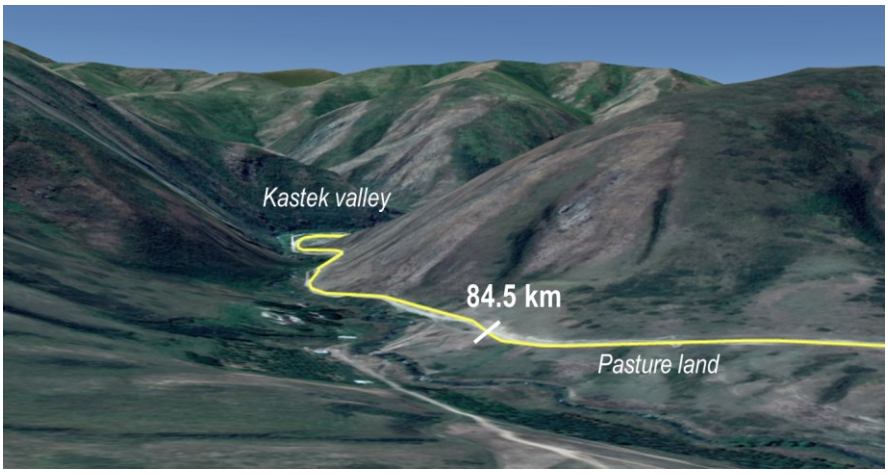


Source: OpenStreetMap contributors

2.2.2 Beyond Kastek

As seen from Figure 6, beyond Kastek the route goes across the pasture land along the gravel road for 4.5 km before reaching the northern origin of Kastek river valley. The existing gravel road is 3-4.5 m wide and the allowable speed range is 20-40 km/h.

Figure 6. The origin of Kastek valley in Almaty region

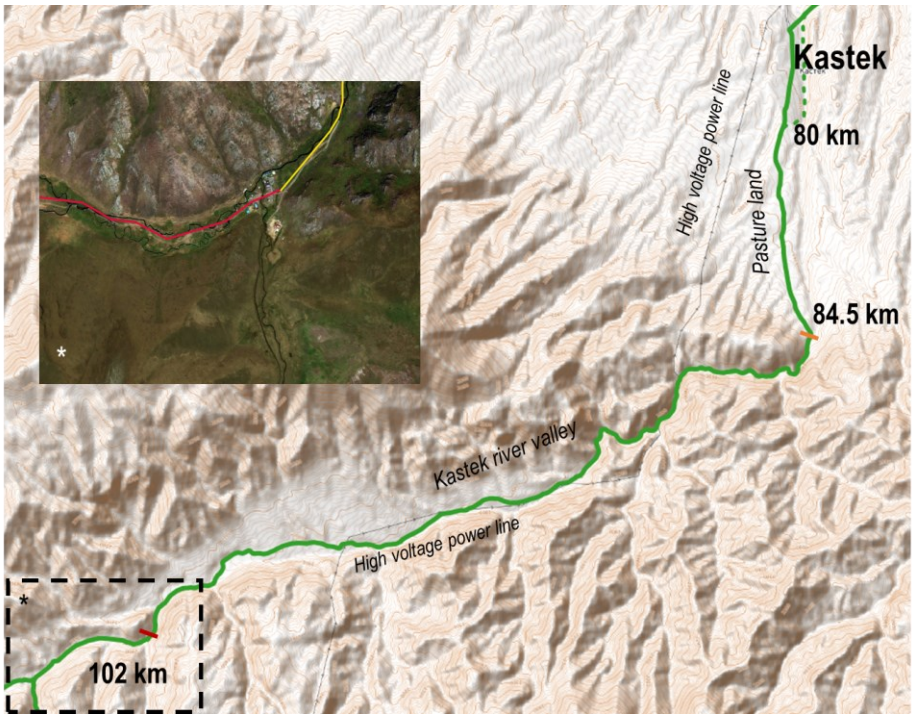


Source: 2018 Google

The route follows the existing trail road in Kastek valley along the river. According to EBRD study, there is also a high voltage power line present at this portion of the valley, which does not require any displacement. As per the mentioned study, the route should also be laid out in such a manner as to avoid any flood risks from the river.

Throughout the valley the river Kastek divides on the numerous tributary streams. At 102 km the valley splits into tributary valleys towards south and west. The optimal option for the route is to go along the valley to the west, where there is an existing trail as shown in Figure 7.

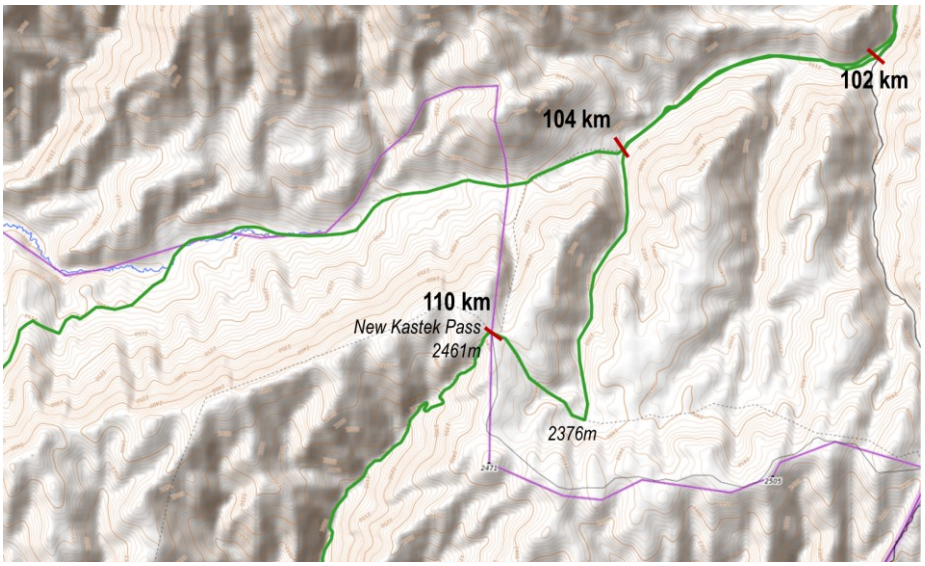
Figure 7. Kastek river valley



Source: OpenStreetMap contributors

Throughout the course, the river splits at multiple locations into the streams – there, the route is to follow the western direction until 104 km where the altitude is 2308 m above sea level (a.s.l.). At this location, there are two buildings for cattle wintering. At this junction, the route splits, as shown in Figure 8, into either following the river valley to the west or turning south towards New Kastek Pass.

Figure 8. Division of the route into two sub-routes at 104 km



Source: OpenStreetMap contributors

Sub-route through New Kastek Pass

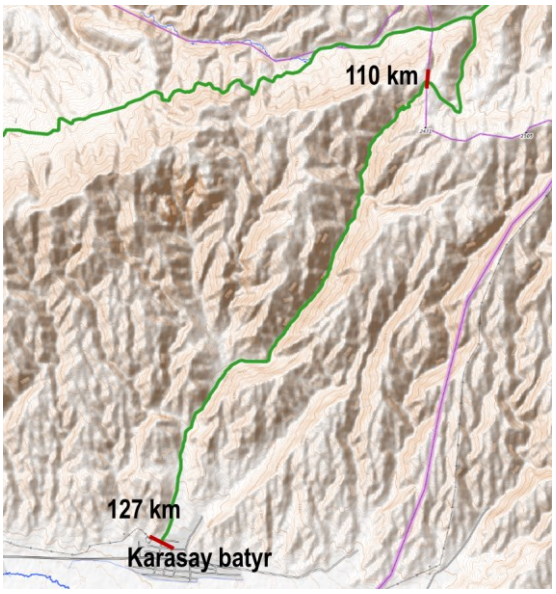
The route takes the direction of the tributary valley going south reaching the summit at 2376 m a.s.l. and then further ascending towards the altitude of 2461 m a.s.l. with the average gradient of 7.5%. New Kastek Pass is at the border between Almaty and Zhambyl regions. From there, it descends along the valley to Karasay Batyr village as shown in Figure 9 with the average downhill gradient of 8.5%. At further project stages, the exact route layouts are to be developed to avoid steep slopes.

Potential peak tunnel construction can be considered at the altitude of 2200 m a.s.l. with approximate length of 1.8-2 km to evade New Kastek pass. However, such design solution will not significantly enhance the seasonality of the road. Tunnel construction at the altitude below 2000 m a.s.l. will entail an increase in longitudinal profile's slope up to 7%. This analysis further considers road option without tunnel.

Upon reaching Karasay Batyr village the route goes along the existing 2-lane street roads with 5-6m width. Allowable speed is 40 km/h. After the village, the route goes along the gravel road (2 lanes, 5-6 m wide) across the pastureland (allowable speed 20-40 km/h). On the Kyrgyz side of the border for the route to connect directly with A365 road next to Kemin village, a bridge should be constructed across river Chu.

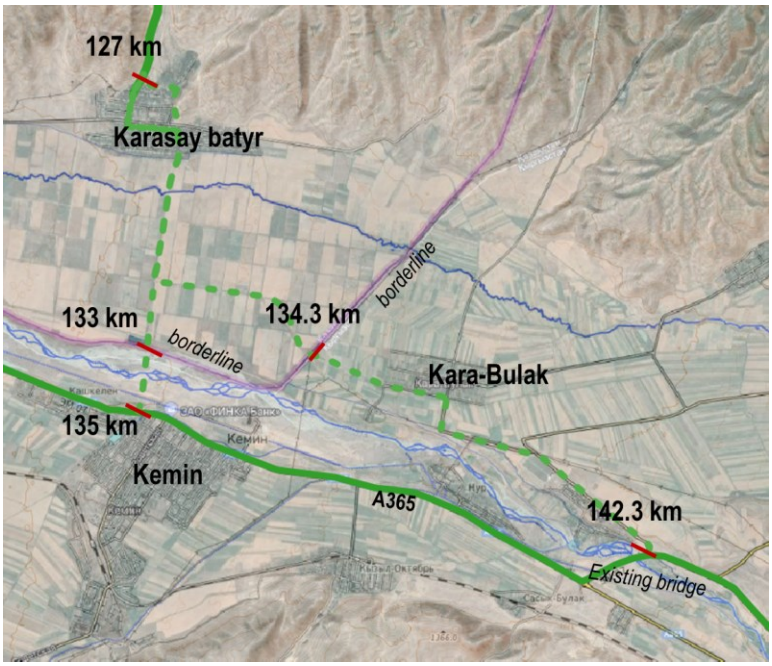
Alternatively, Karasay village can be bypassed. The route can be directed to the West to create a bypass and then go across the cultivated land to the borderline. Another option is to bypass Karasay Batyr village from North – East and to direct the route towards East. The route will go across the cultivated land. On the Kyrgyz side the route passes Kara-Bulak village from the south and then reaches the existing road. Then, the road connects with the existing A365 road.

Figure 9. Alternative routes descending at Karasay Batyr village



Source: OpenStreetMap contributors

Figure 10 Karasay Batyr – borderline – A365 road



Source: OpenStreetMap contributors; 2018 Google

The remaining part of the route to Issyk-Kul follows the existing A365 road. To get to Cholpon-Ata, the route follows the existing road through Balykchy, the village at the western side of Issyk-Kul lake. There are 156 km (2h 5min in time) from Kemin village, and for the alternative - 151 km (2h 1min in time) from the existing bridge.

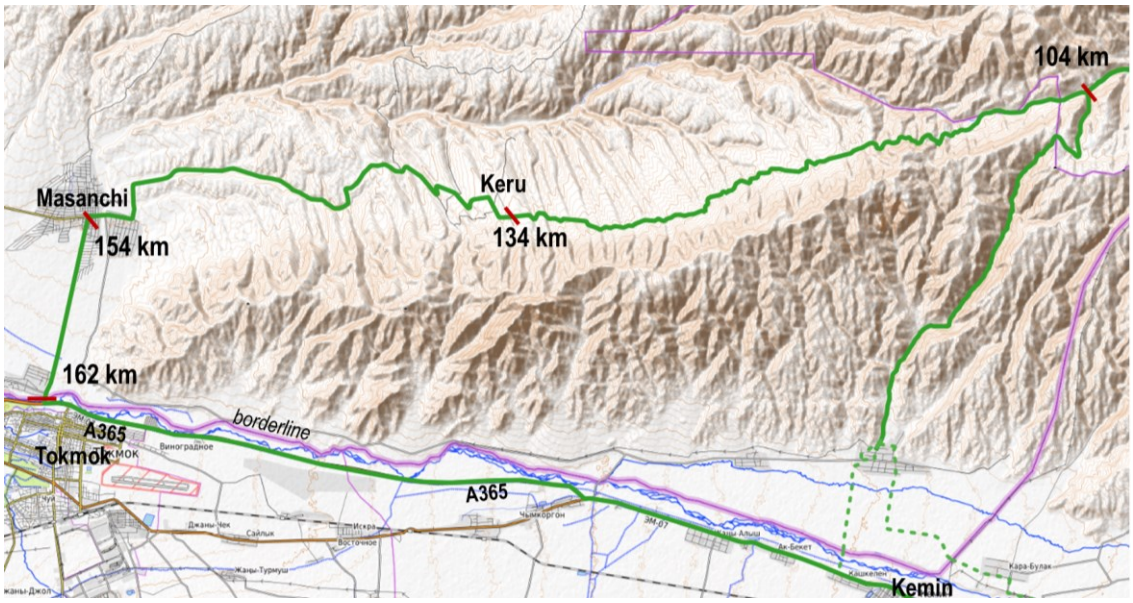
Sub-route to the west towards Masanchi village

From the junction at 104 km, this sub-route ascends for brief 100 m to reach 2300 m a.s.l. and from there descends towards Keru village along the existing gravel road at the foot of Kastek ridge. From Keru village there is an existing 2-lane gravel road towards Masanchi village across the pasture land with the width of 5-6 m. Allowable speed is 40 km/h.

From Masanchi village the sub-route goes to the south towards the borderline to reach A365 road. This segment of the road is of Category 4 (2 lanes, 7 m width, 60-90 km/h) and in good condition.

The remaining part of the routes goes along the existing A365 road towards Balykchi and then Cholpon-Ata (189 km and 2h 31min).

Figure 11. Sub-route through Masanchi village



Source: OpenStreetMap contributors

2.2.3 Summary of the Routes by Gravel or Asphalt Road

The sub-route through New Kastek Pass will only be suitable for cars and small trucks as it requires the construction of serpentines, long uphill and downhill segments.
The sub-route through Masanchi village will be suitable for all types of transport. It will require installing the building for Road Operation management for the segment where the road ascends from 1600 to 2250 m a.s.l. Both options can be used by cars in the period from April to October. For year-around use, it is necessary to take into consideration additional construction of road operation buildings. Summary table (Table 3) displays the main stops for both sub-routes showing the current condition and design speed.

Table 3. Summary of the western sub-routes by gravel/asphalt road

Kazakhstan					
№	**Road segment**		**Distance, km**	**Current category/ width**	**Design speed, km/h**
	from	to			
1	Karakastek	Talap	8	Gravel / 3.5-5m	20
2	Talap	Kastek	5	Category 4 / 6-7m	40-60
3	Kastek	Junction	24	- / 3.5m	20
Sub-route through New Kastek pass					
4	Junction	Karasay Batyr	23	- / 3.5m	20
5	Karasay Batyr		2	Street roads / 5-6m	40
6	Karasay Batyr	A365 road[1]	6	Category 4 and gravel / 6m	20-40

7	Karasay Batyr	Through Kara-Bulak to A365 [2]	13	Category 4 and gravel / 6m	20-40
The Kyrgyz Republic					
8	Connection to A-365[1]	Balykchi	77	Category1b / 18.5m	60-90
9	Connection to A-365[2]	Balykchi	72	Category1b / 18.5m	60-90
10	Balykchi	Cholpon-Ata	79	Category 1v, street roads / 7.5-15m	60-90
Sub-route through Masanchi					
11	Junction	Keru	30	- / 3.5m	20
12	Keru	Masanchi	20	Category 5 and gravel / 6m	40-60
13	Masanchi	A365 road	8	Category 4/ 6-7m	60-90
The Kyrgyz Republic					
14	Connection to A-365	Balykchi	110	Category 1b / 18.5m	60-90
15	Balykchi	Cholpon-Ata	79	Category 1v, street roads / 7.5-15m	60-90

Table 4 shows the route's parameters taking into account potential design solutions for the mentioned two road options from Almaty to Cholpon-Ata as indicated. Applying the suggested design changes for asphalt road, the route's distance and travel time will be approximately reduced to 291 km and 3h 49min for option through New Kastek Pass and 351km and 4h 32min through Masanchi, compared to existing 460 km and 6h 25min through Korday. For gravel pavement, travel times will be reduced to 4h 8min through New Kastek Pass and 5h 9min through Masanchi.

Table 4. Summary table of the western routes by asphalt road with tunnel (recommended categories)

№	Distance, km	Current category/ width	Recommended category/ width	Design speed (asphalt/ gravel), km/h**	Max. longi-tudinal gradient, %	Travel time (asphalt/ gravel), min**	Required works
1	40	Category 1b / 18.5m	Category 1b / 18.5m	90-110	4.1	24	No works
2	1	Category 3 / 8m	Category 2 / 9m	90	0.6	1	Widening
3	5	Street road / 7-9m	Street road / 12m	40-60	1	6	Widening
4	5	Category 3 / 8m	Category 2 / 9m	90	1.4	4	Widening
5	13	Category 4 / 6-7m	Category 2 / 9m	90	3.5	9	Widening
6	3	Main street road / 6-7m	Main street road / 9m	40-60	2.4	4	Widening
7	8	Gravel / 3.5-5m	Category 2 / 9m	90	4	6	Reconstruction
8	5	Category 4 / 6-7m	Category 2 / 9m	90	4	4	Widening
9	24	- / 3.5m	Category 3 / 8m	60 / 40	10	24 / 36	New road construction
Sub-route through New Kastek pass							
1	23	- / 3.5m	Category 3 / 8m	40-60 / 40	10-12	28 / 35	New road construction
2	2	Street road/5-6m	street road / 7m	40-60 / 40	3.5	3 / 3	Widening
3	6	Category 4 gravel / 6m	Category 2 / 9m	90	2	4	Reconstruction
4	77	Category1b / 18.5m	Category1b / 18.5m	90	3	52	No works
5	79	Category 1v, street road / 7.5-15m	Category 1v, street road / 15m	70-90	3	60	No works
	Total 291 km			**Average 81 / 79 km/h**	**Average 4.3%**	**Total 229 / 248 min***	
Sub-route through Masanchi							
1	30	- / 3.5m	Category 3 / 8m	60 / 40	10	30 / 45	New road construction
2	20	Category 5 gravel / 6m	Category 3 / 8m	60 / 40	8	20 / 30	Reconstruction
3	8	Category 4/ 6-7m	Category 3 / 8m	90	3	6	Reconstruction
4	110	Category 1b / 18.5m	Category 1b / 18.5m	90	3	74	No works
5	79	Category 1v, street road / 7.5-15m	Category 1v, street road / 15m	70-90	3	60	No works
	Total 351 km			**Average 98 / 77 km/h**	**Average 5.4%**	**Total 272 / 309 min ***	

*Travel times calculated using mean design speed where range is applicable
**Only certain road segments were considered for gravel pavement (where two design parameters are indicated in the table)

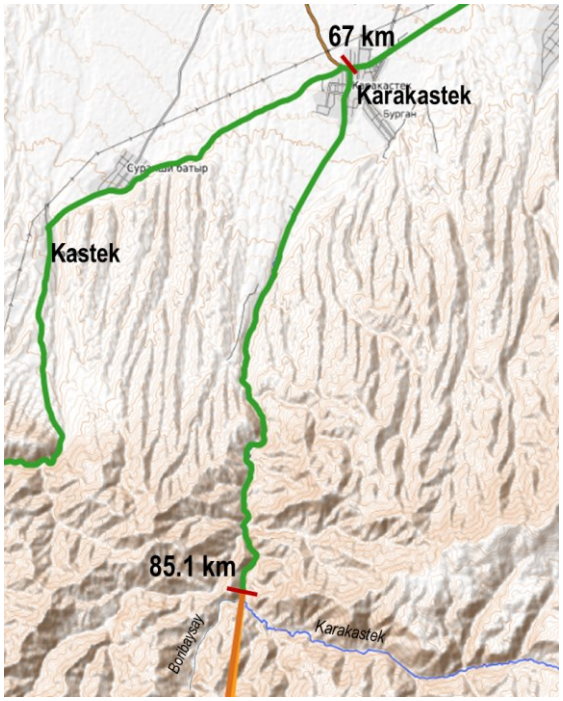
2.3 Western Route by Asphalt Road with Tunnel

2.3.1 Karakastek - Tunnel

The route first follows the main road of Karakastek towards the valley of the river Karakastek in the south. The street asphalt road requires minimal works (2 lanes. 6-7 m width). Allowable speed range is 40-60 km/h.

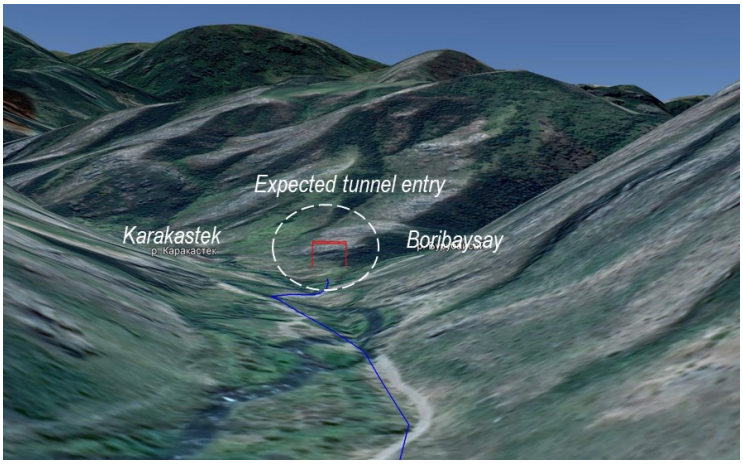
After the village, the route follows the road until it reaches the estuary of Boribaysay river at 85.1 km, where at 1600 m a.s.l, the construction of the tunnel and the border control station is considered. This road segment currently is represented by an existing gravel road, 3-4.5 m wide and with the allowable speed range is 20-40 km/h.

Figure 12. Route from Karakastek village towards the potential tunnel location



Source: OpenStreetMap contributors

Figure 13. Expected tunnel entry from Kazakhstan

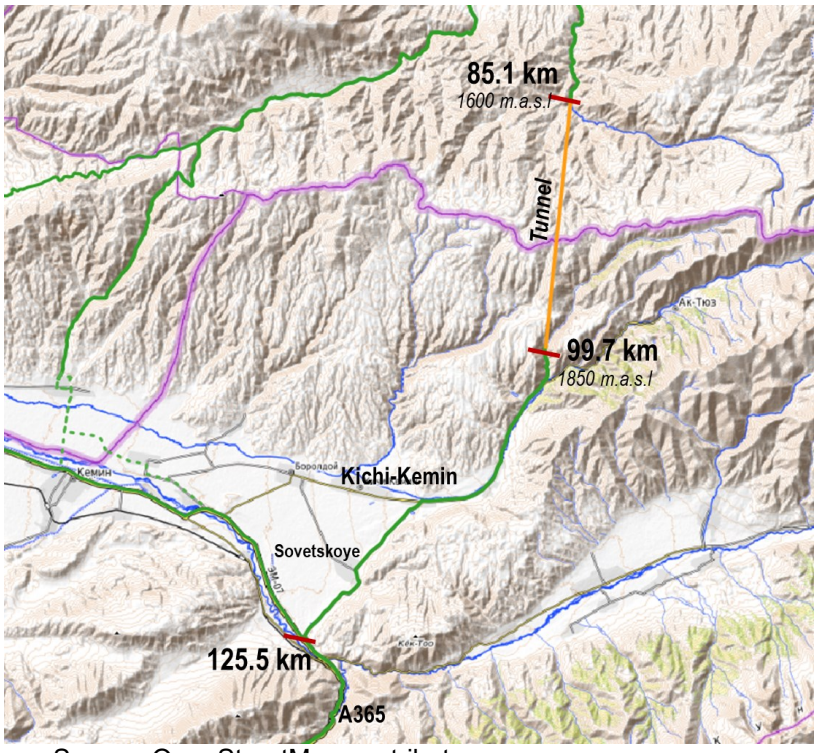


Source: 2018 Google

2.3.2 Tunnel Options

A tunnel is suggested as shown on the layout in Figure 14. The tunnel starts at the altitude of 1600 m a.s.l. in Kazakhstan with the end in Kyrgyz side at 1850 m a.s.l with length of 14.6 km.

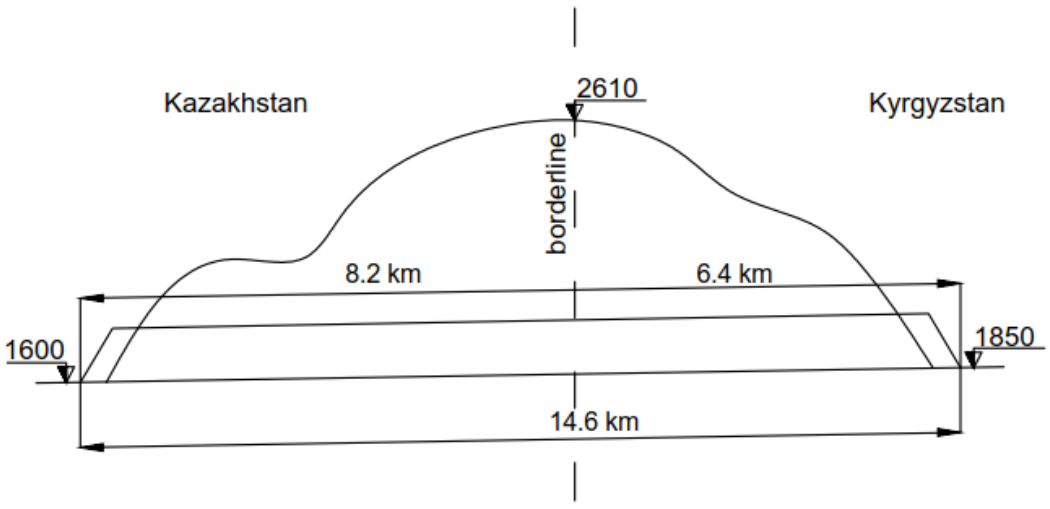
Figure 14. Tunnel options layout



Source: OpenStreetMap contributors

A schematic representation of the tunnel is shown in Figure 15.

Figure 15. Schematic representation of the western tunnel options



2.3.3 Tunnel – Kyrgyz Side

After the tunnel on the Kyrgyz side, the road follows the direction to the Tegerek tract along the Karagayli river or near the dam along Kichi-Kemin – Ak-Tyuz road. Further, the road reaches the existing road network of the Kyrgyz Republic.

The route is directed to the west to connect with the existing road Kichi-Kemin – Ak-Tyuz, P-32 road of Category 4, which requires minimal works (2-lanes. 5-6m). The allowable speed range is 40-60 km/h.

Turning to the south the route bypasses Sovetskoye village to the east and continues to connect with A-365 road. This road segment is gravel road of Category 5, which requires substantial upgrade (1-2 lane, 4-5 m width). The allowable speed range is 20-40 km/h.

Once connected with A-365, the route follows this 4-lane road with 18.5 m width, which is of Category 1-b and in good condition. The allowable speed range is 60-90 km/h. After Balykchi village, the road's category alters as it passes through different villages on the way to Cholpon-Ata. Overall, the road is in good condition. The width is 2-4 lanes, in the range of 7.5-15 m. The allowable speed range is 60-90 km/h.

2.3.4 Summary of the Routes with Asphalt Road and Tunnel

Summary table (
Table 5) shows the details of the current condition and the design speed for the route options involving tunnel construction.

Table 5. Summary table of the western routes by asphalt road with tunnel (current categories)

Kazakhstan					
№	**Road segment**		**Distance, km**	**Current category/ width**	**Design speed, km/h**
	from	to			
1	Karakastek	Karakastek river valley	5	Category 4 / 6-7m	40-60
2	Along river valley	Tunnel end (KAZ)	11.5	Trail road / 3-4.5 m	20-40
3	Tunnel		14.6*	Mountainous region	60*
The Kyrgyz Republic					
4	P-32 road	Turn to Sovetskoye	13.5	Category 4 / 5-6m	40-60
5	Turn to Sovetskoye	Connection to A-365	11.5	Category 5/ 4-5m	20-40
6	Connection to A-365	Balykchi	58	Category 1b / 18.5m	60-90
7	Balykchi	Cholpon-Ata	79	Category 1v street road / 7.5-15m	60-90

* potential design parameters

Table 6 shows the route's parameters taking into account potential design solutions for the road from Almaty to Cholpon-Ata as indicated. Applying the suggested design changes, the route's distance and travel time will be approximately reduced to 260.1 km and 3h 28min, compared to existing 460 km and 6h 25min through Korday.

Table 6. Summary table of the western routes by asphalt road with tunnel (recommended categories)

Kazakhstan							
№	**Distance, km**	**Current category/ width**	**Recom-mended category/ width**	**Design speed, km/h**	**Max. longi-tudinal gradient, %**	**Travel time, min**	**Required works**
1	40	Category 1b / 18.5m	Category 1b / 18.5m	90-110	4.1	24	No works
2	1	Category 3 / 8m	Category 2 / 9m	90	0.6	1	Widening
3	5	Street road / 7-9m	Street road / 12m	40-60	1	6	Widening
4	5	Category 3 / 8m	Category 2 / 9m	90	1.4	4	Widening
5	13	Category 4 / 6-7m	Category 2 / 9m	90	3.5	9	Widening
6	3	Main street road / 6-7m	Main street road / 9m	40-60	2.4	4	Widening
7	5	Category 4 / 6-7m	Category 2 / 9m	90	4.1	4	Widening
8	11.5	Trail road / 3-4.5 m	Category 3 / 8m	40-60	7	14	New road construction
9	8.2	Mountainous region	Tunnel / 11m	60	1.7	9	Tunnel construction
	Subtotal 91.7			Average 83 km/h	Average 3.7%	Subtotal 75* (1h 15 min)	
The Kyrgyz Republic							
10	6.4	Mountainous region	Tunnel / 11m	60	1.7	7	Tunnel construction
11	13.5	Category 4 / 5-6m	Category 3 / 8m	60	6	14	Road reconstruction
12	11.5	Category 5/ 4-5m	Category 2 / 9m	90	3.5	8	New road construction
13	58	Category 1b / 18.5m	Category 1b / 18.5m	70-90	3	44	No works
14	79	Category 1v, street road / 7.5-15m	Category 1v, street road / 15m	70-90	1	60	No works
	Subtotal 168.4			Average 78 km/h	Average 2.3%	Subtotal 133* (2h 13min)	
	Total 260.1 km			Average 80 km/h	Average 2.8%	**Total 208* (3h 28min)**	

*Travel times calculated using mean design speed where range is applicable

2.4 Summary of Western Alignments

As has been shown, there are a few options for the Western alignment considered in this analysis: the options with and without tunnel construction involved, and further distinguishing between the routes without tunnel.

A minor factor for different sub-routes is the necessity to bypass the existing villages due to several reasons primarily associated with increased traffic in urbanized area, such as congestion, traffic safety and traffic annoyance, as well as bypassing Karasay Batyr village in different directions. However, the main distinction is between the options entirely laid out as a gravel/asphalt road and including tunnel. Table 7 provides information on travel time and distance for three routes showing a breakdown of distances requiring different scopes of construction.

Table 7. Breakdown of distances for different engineering works required

Western alignment options	Travel time (asphalt/ gravel)	Total (km)	No works (km)	Widening (km)	Recon-struction (km)	New road construction (km)	Tunnel construction (km)
Road NK pass	3h 49min / 4h 8min	291	196	34	14	47	0
Road Masanchi	4h 32min / 5h 9min	351	229	40	28	54	0
Tunnel	3h 28min	260.1	177	45.5	0	23	14.6

The cost estimate was calculated based on the specific volumes of works, which are presented in Appendix 6.1-6.3. It should be noted that the costs for RC bridge and pipe as well as tunnel construction were estimated based on existing analogous projects, the reconstruction of Kalbatau – Maykapshagay road for RC bridge and RC pipe construction works. As mentioned in Section 1.4, approximate estimates per kilometer for different tunnel lengths were used in the estimation of the tunnel construction costs. As the length of proposed tunnel is 14.6km, the cost estimate uses $25 million per km for tunnel construction cost as approximation.

Table 8 shows the construction cost estimates for western alignments without tunnel providing figures for asphalt concrete and gravel pavement, as well as the cost estimate for the case with tunnel using the mentioned data.

Table 8. Construction cost estimates for different route alternatives for Western alignment

Pavement	Asphalt		Gravel		
Western align-ment options	**TOTAL w VAT (12%), Tenge**	**TOTAL w VAT, USD**	**TOTAL w VAT (12%), Tenge**	**TOTAL w VAT, USD**	**BCP (USD)**
Road (NK pass)	35,366,760,166	93,811,035	30,624,653,795	81,232,503	2,500,000
Road (Masanchi)	42,521,126,809	112,788,135	34,877,700,646	92,513,795	(Tokmok)
With tunnel	181,799,300,671	482,226,262	N/A		2,500,000

3. DIRECT ALIGNMENT

This alternative of the route is to be laid out directly through the mountains following one of the existing trails from Almaty to Issyk-Kul through Big Almaty Lake (another well-known trail goes through Alma-Arasan gorge). The main obstruction for this alignment is in the form of two mountain ridges. Ile-Alatau on the borderline between Kazakhstan and the Kyrgyz Republic and Kungei Alatau on the Kyrgyz side. Crossing such difficult terrain with excessive gradients will require significant engineering effort. Therefore, tunnel construction is taken into consideration in this analysis.

This chapter will provide a brief description of the route and its main stops. However, it should be taken into consideration that further stages of the project should involve more details regarding the routing in very steep terrain and a closer look at the possible location of tunnel portals to allow for the direct alignment.

3.1 Almaty to Borderline to Tunnel End

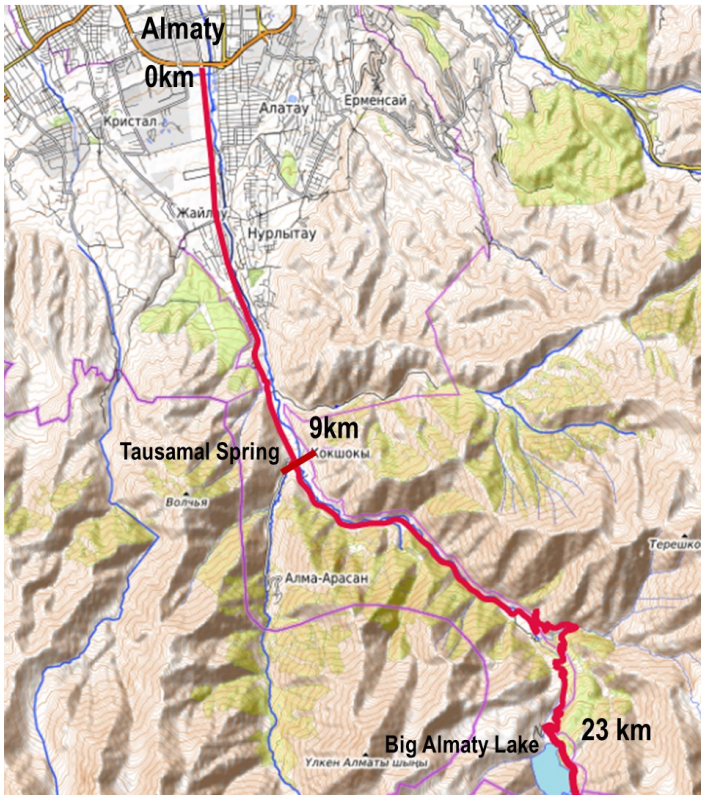
3.1.1 Almaty to Tausamal Spring

The route's starting point is the First President Park. It then follows Dulati avenue passing along the river Big Almatinka until Tausamal Spring where the river splits into two streams – main Big Almatinka and tributary Prokhodnaya.

3.1.2 Tausamal Spring to Big Almaty Lake

In this study the direct route is considered to pass Big Almaty Lake. After Tausamal Spring stop the route follows the existing road to Big Almaty Lake along the main stream of the river Big Almatinka. Another option not mentioned in this study is the route through Alma-Arasan.

Figure 16. Almaty – Big Almaty lake

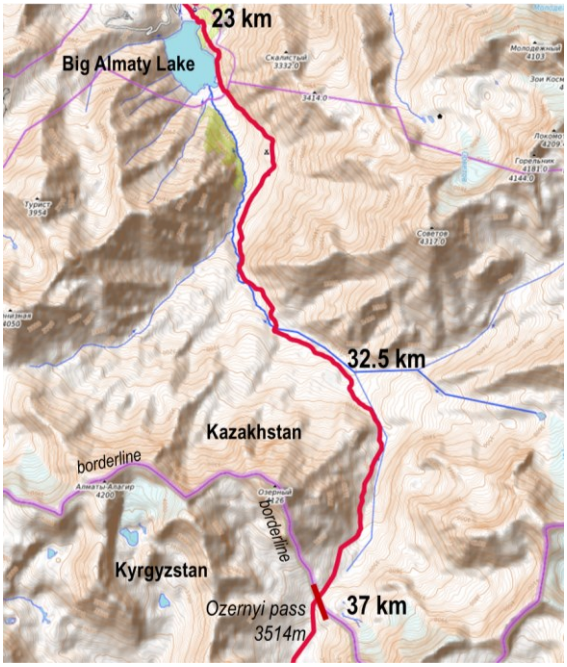


Source: OpenStreetMap contributors

3.1.3 Big Almaty Lake to Borderline

From Big Almaty Lake the route follows the existing trail which goes along the eastern side of the lake. where the terrain is rather steep and will require a significant engineering effort. A closer look is needed to investigate the best option for the route layout in terms of safety. After passing the lake. the route ascends towards Ozernyi pass with an average gradient of 10.3%. As shown in Figure 17, the borderline between Kazakhstan and the Kyrgyz Republic is reached at 3514 m a.s.l. It is suggested to locate the border crossing stations for each country further downhill from the summit closer to the existing infrastructure to plan out for construction and operation.

Figure 17. Big Almaty lake - Borderline



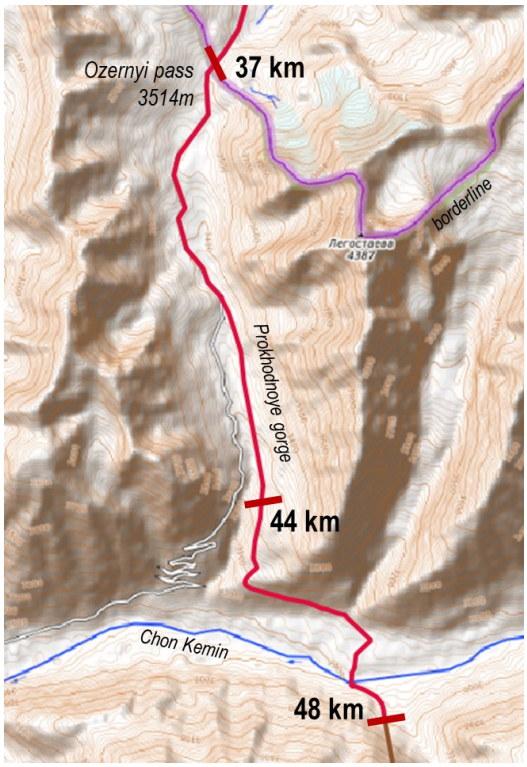
Source: OpenStreetMap contributors

3.1.4 Borderline to Tunnel Portal

As shown in

Figure 18, from the borderline the route descends along Prokhodnoye gorge towards Chon Kemin valley with the average gradient of 7.5%, then taking a turn to the east and crossing the river.

Figure 18. Borderline – Chon Kemin valley



Source: OpenStreetMap contributors

3.2 Tunnel to Cholpon-Ata

The tunnel of 16 km in length is located entirely in the Kyrgyz Republic, taking its beginning from the valley of river Dolon-Ata at the altitude of 3000 m a.s.l, and terminating in the valley of Koshko-Suu at the altitude of 3060 m a.s.l. as shown in

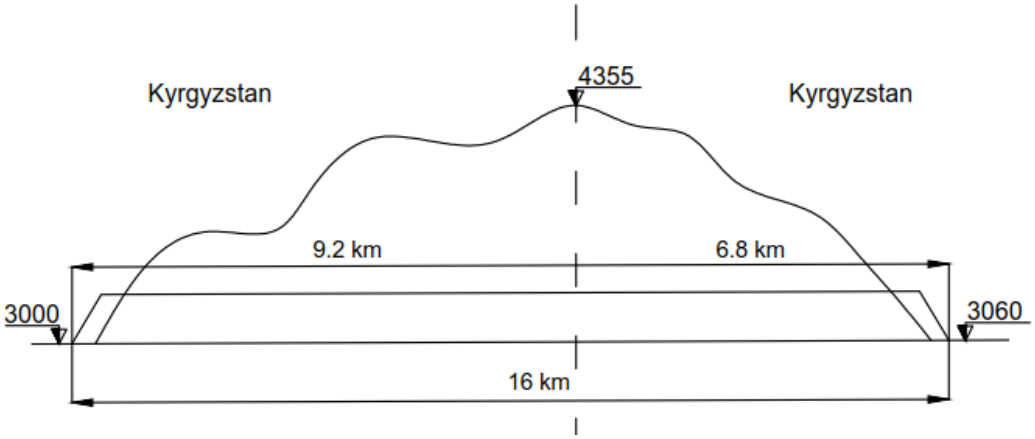
Figure 19.

Figure 19 Tunnel segment

Source: OpenStreetMap contributors

A schematic representation of the tunnel is shown in Figure 20.

Figure 20. Schematic representation of the tunnel for direct route



After the tunnel, the route takes a turn to the east to connect with the valley, where it starts descending. For 5.7 km the average slope along the valley is 16%, meaning that this segment of the road will require further engineering to provide for safe driving, as the gradient of longitudinal road profile exceed limiting value of 12%. Further, the road continues to descend towards a small village of Baktuu-Dolontuu (formerly Progress) with the average slope dropping to approximately 6.7%. At 78.5 km the route connects with the existing A363 road and continues west towards Cholpon-Ata.

3.3 Summary of Direct Alignments

The described direct alignment has been considered with the potential construction of the tunnel through Kungei Alatau mountain ridge. Directly crossing the mountains, it provides for the shortest distance and travel time. Summary table (Table 9) provides the current characteristics of the road and the design speed for different road segments.

Table 9. Summary table of the direct route with tunnel (current categories)

Kazakhstan					
№	**Road segment**		**Distance, km**	**Current category/ width**	**Design speed, km/h**
	from	**to**			
1	Almaty	P-9 Road (Almaty – Cosmostation)	23	Category 4/ 5-7m	40-60
2	P-9 road	Existing trail road	21	- / 3.5-4.5m	20
The Kyrgyz Republic					
3	Existing trail road	Dolon Ata river valley	4	- / 3.5-4.5m	5
4	Tunnel		16*	-	60*
5	Tunnel	Baktuu-Dolontuu (Progress)	14.5	- / 1.5-3.5m	5
6	Baktuu-Dolontuu (Progress)	Cholpon-Ata	7	Category 2 / 7-8 m	60

* potential design parameters

Table 10 shows the route's parameters taking into account potential design solutions for the road from Almaty to Cholpon-Ata as indicated. Applying the suggested design changes, the route's distance and travel time will be approximately reduced to 86 km and 1h 41min, compared to existing 460 km and 6h 25min through Korday.

Table 10. Summary table of the direct route with tunnel (recommended categories)

Kazakhstan							
№	**Distance, km**	**Current category/ width**	**Recommended category/ width**	**Design speed, km/h**	**Maximum longitudinal gradient %**	**Travel time, min**	**Required works**
1	23	Category 4/ 5-7m	Category 2-3 / 8-9m	60-90	3-12%	19	Widening
2	21	- / 3.5-4.5m	Category 3 / 8m	40	10-12%	32	New construction
3	4	- / 3.5-4.5m	Category 3 / 8m	40	10-12%	6	New construction
4	16	-	Tunnel / 11m	60	0.3%	16	New construction
5	14.5	- / 1.5-3.5m	Category 3 / 7m	40	10-12%	22	New construction
6	7	Category 2 / 7-8 m	Category 1v / 15m	70	2%	6	No works
	Total 85.5			Average 56 km/h	Average 10%	Total 101* (1h41min)	

*Travel times calculated using mean design speed where range is applicable

However, it should be taken into account that this alignment crosses Ile-Alatau National park and will require a sophisticated engineering effort to surpass the difficult terrain of the mountains providing for serpentines, galleries, anti-avalanche design solutions etc. Operation of such road alignment will also involve the installation of additional points for road maintenance. The construction period is expected to be long due to a very short construction season. The recommendation will be to consider the direct alignment as a touristic route.

Table 11. Breakdown of distances according to engineering effort categories

Total (km)	**No works**	**Widening**	**Reconstruction**	**New road construction**	**Tunnel construction**
85.5	7	23	0	39.5	16

As for western alignment, the cost estimate was calculated using the same approach, that is based on the volumes of works for each road segment (Appendix 6.4) as well as the cost estimates for existing infrastructural projects already mentioned. Unit tunnel construction cost used in the estimate was taken as $25 million, as the proposed tunnel length is 16km.

Table 12. Construction cost estimate for Direct alignment

TOTAL with VAT, Tenge	**TOTAL with VAT, USD**	**BCP (USD)**
222,394,622,686	586,633,805	2,500,000

4. EASTERN ALIGNMENT

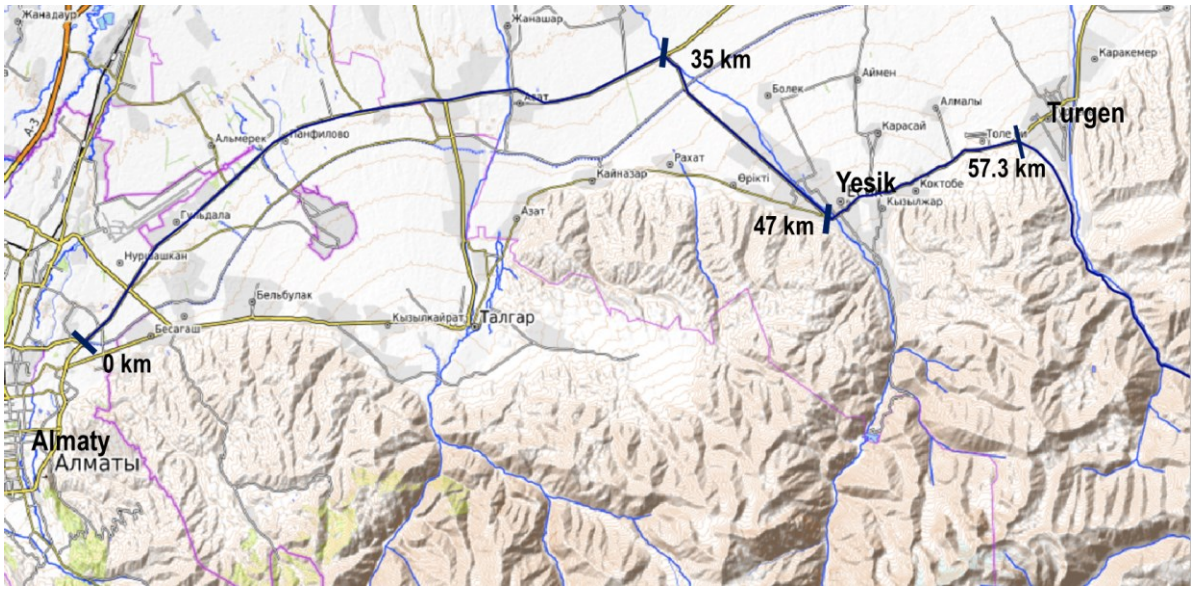
This alignment is to pass through Turgen to create potential synergies with the range of touristic destinations in Kazakhstan. As in the Direct route, the eastern alignment has to cross through two mountain ridges: Ile-Alatau and Kungei Alatau. Similarly, to provide a layout of the route through such obstructions, tunnel construction is considered in this analysis.

This chapter will provide a brief description of the eastern alignment and its main stops. However, it should be taken into consideration that further stages of the project should involve more details regarding the routing in very steep terrain and a closer look at the possible location of tunnel portals to allow for the mentioned route.

4.1 Almaty to Turgen

The route's starting point is the intersection of Rayimbek street and Almaty Easter relief road. The route follows the existing road network of Kazakhstan starting along A351 road (Kuldzhin tract) until the turn to the south towards Yesik village as shown in Figure 21.

Figure 21. Almaty – Turgen route

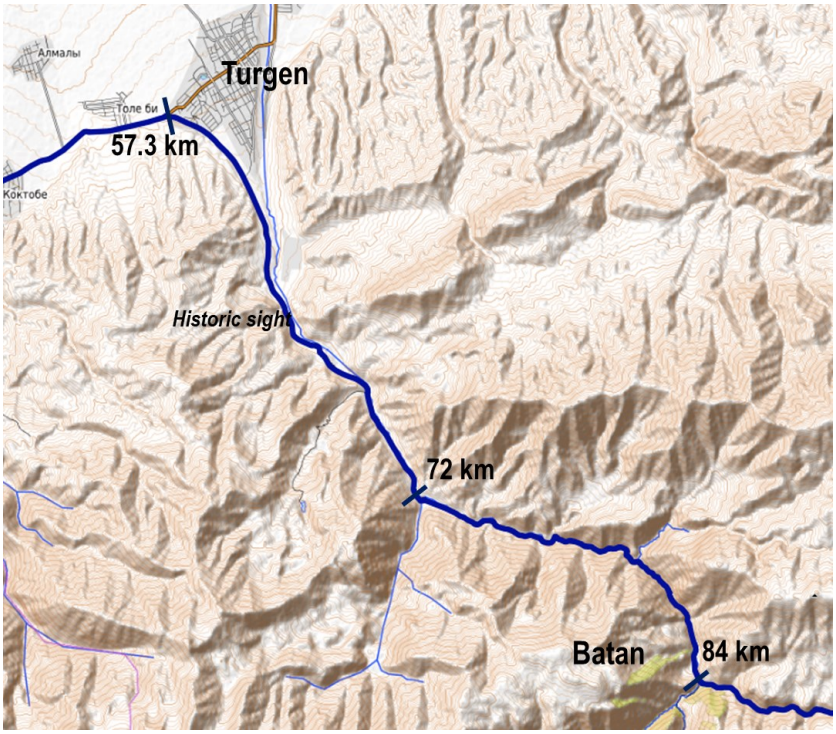


Source: OpenStreetMap contributors

4.2 Turgen to Batan

The route bypasses Turgen village on the western side and then follows the existing road to the south towards Batan village along Turgen river. Along this portion of the road, the route goes past different small resorts. trout farming as well as historic sight with Sak burial mounds.

Figure 22. Turgen – Batan



Source: OpenStreetMap contributors

4.3 Batan to Asy and Shilik River Valley

After Batan, the route goes to the east towards Asy observatory. At 97 km the route can either turn right past Asy observatory following south, or bypass the area from the east to follow a flatter terrain as shown in Figure 24.

Following the direction past Asy observatory, the route then goes along the existing trail road on top of the mountain ridge Sarytau as shown in

Figure 23. After Sarytau ridge, where substantial earthworks are expected to cut the soil for a smooth transition of the road, there is a descent towards the valley of Shilik river. As displayed in

Figure 25, this descent is rather steep and will require involvement of serpentine construction and design solutions in the form of galleries and anti-avalanche installations.

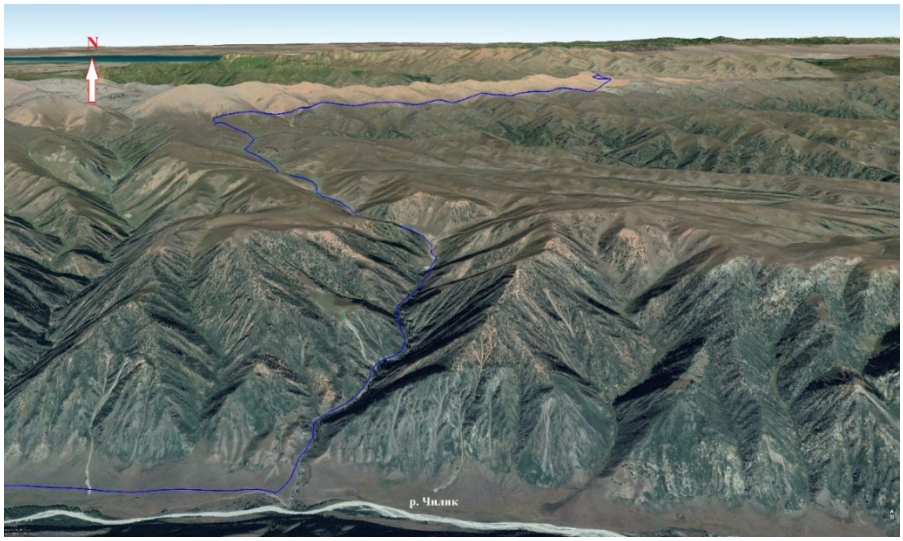
Figure 23. Road to Sarytau

Source: 2018 Google

Figure 24. Gravel road from Batan through Asy to Shilik river valley

Source: OpenStreetMap contributors

Figure 25 Road descending at Shilik river valley

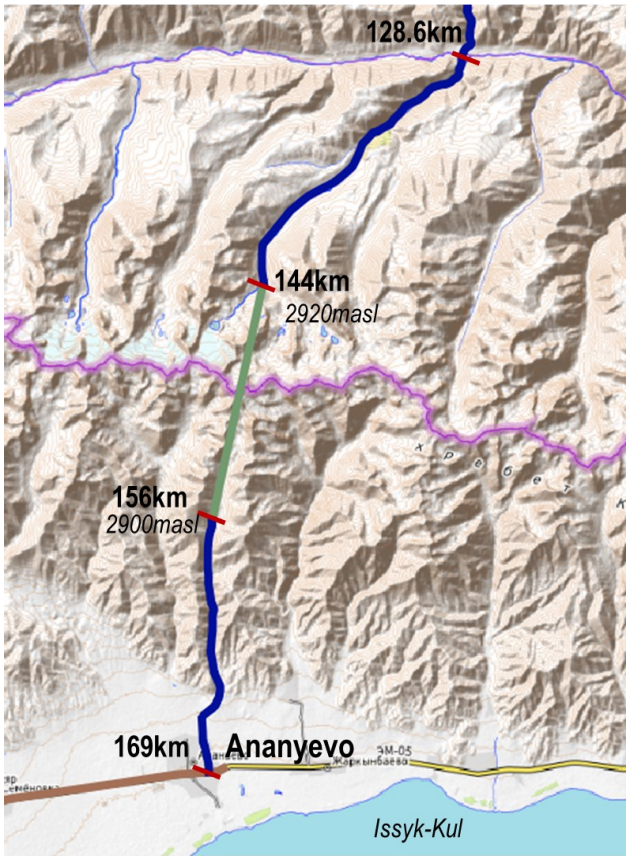


Source: 2018 Google

4.4 Shilik River Valley to Tunnel and Ananyevo

Once the route descends to Shilik river it goes across the flat terrain and reaches the estuary of Karasay river, where it starts ascending towards the ridge of Kungei Alatau with an average slope of 6%.

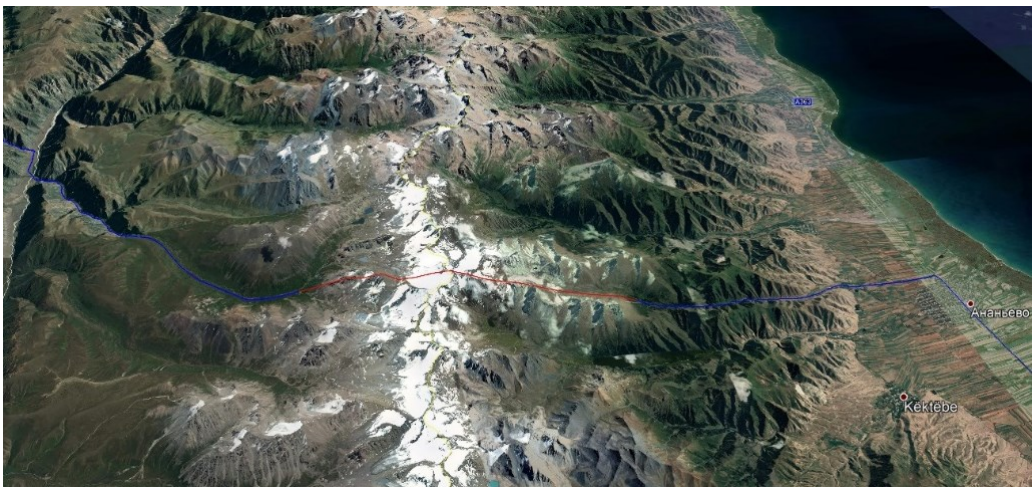
Figure 26. Shilik river valley – tunnel - Ananyevo



Source: OpenStreetMap contributors

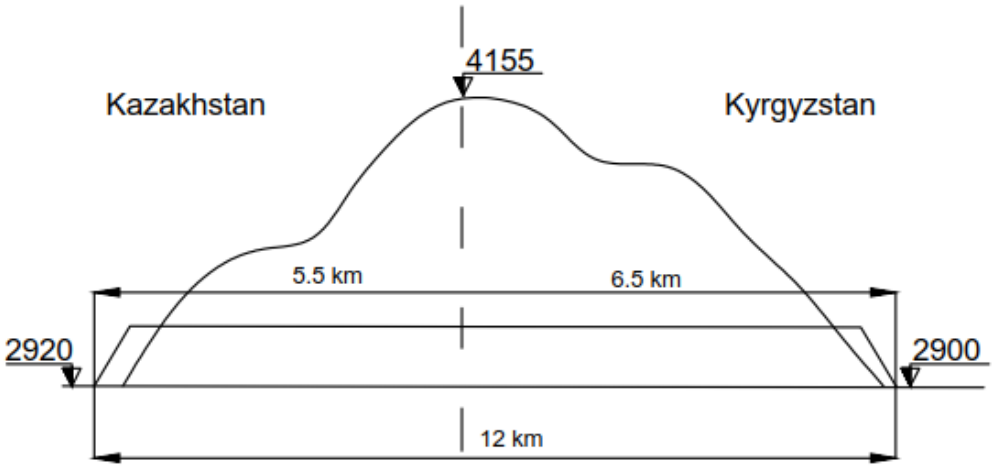
At the altitude of 2920 m a.s.l. the route reaches the tunnel which for 12 km extends to the south towards the valley of Orto-Baysar in the Kyrgyz Republic terminating at the altitude of 2900 m a.s.l. Figure 27 and Figure 28 show representation of the mentioned tunnel topographically and schematically.

Figure 27. Tunnel's location for eastern route crossing Kungei Alatau



Source: 2018 Google

Figure 28. Schematic representation of the tunnel for waster alignment



After the tunnel the route continues in the direction of Orti-Baysar river valley and downhill along the valley towards Ananyevo village. A more detailed analysis is required to determine the arrangement of serpentines to provide for a smoother descent with the possibility of relocating the descent to the neighboring valley of Baysar.

Once reaching Ananyevo, the route passes the village and connects with A363 road turning to the west to Cholpon-Ata.

4.5 Summary of Eastern Alignment

As for the direct alignment, the eastern alignment has been considered with the potential construction of the tunnel through Kungei Alatau mountain ridge. Summary table (Table 13) provides the current characteristics of the road and the design speed for different road segments.

Table 13. Summary table of the eastern route with tunnel (current categories)

Kazakhstan					
№	Road segment		Distance, km	Current category/ width	Design speed, km/h
	from	from			
1	Almaty	Turn to Yesik	35	Category 1v / 15m	90-110
2	Turn to Yesik	Yesik edge	8	Category 3 / 7-8m	70
3	Inside Yesik		6	Street road / 7-9m	40-60
4	Yesik	Turgen	9	Category 3 / 8m	70
5	Turgen	Batan	26	Category 4 / 6-7m	40-60
6	Batan	Asy observatory	13	Gravel/ 4.5-5.5m	20-40
7	Asy observatory	Shilik River valley	31.6	-	20
8	Shilik River valley	Through Karasay valley to Tunnel	15.4	-	20
	Tunnel		12*	Mountainous region	60*

The Kyrgyz Republic					
7	Trail road in Orto Baysar valley	Gravel road in Orto Baysar valley	7	- / 1.5m	5
8	Gravel road in Orto Baysar valley	Pasture	3	- / 3.5m	20
9	Pasture	Ananyevo	3	- / 3.5m	20-40
9	Ananyevo	Cholpon-Ata	47	Category 3 / 6-7m	60

* potential design parameters

Table 14 shows the route's parameters taking into account potential design solutions for the road from Almaty to Cholpon-Ata as indicated. Applying the suggested design changes, the route's distance and travel time will be approximately reduced to 216 km and 3h 11min, compared to existing 460 km and 6h 25min through Korday.

Table 14. Summary table of the direct route with tunnel (recommended categories).

Kazakhstan							
№	**Distance km**	**Current category/ width**	**Recommended category/ width**	**Design speed, km/h**	**Maximum longitudinal gradient. %**	**Travel time, min**	**Required works**
1	35	Category 1v / 15m	Category 1v / 15m	90-110	2%	21	No works
2	8	Category 3 / 7-8m	Category 2 / 9m	90	3%	6	Widening
3	6	Street road / 7-9m	Street road / 12 m	40-60	1%	8	Widening
4	9	Category 3 / 8m	Category 2 / 9m	90	3%	6	Widening
5	26	Category 4 / 6-7m	Category 2 / 9m	90	3.5%	18	Widening
6	60	Gravel road. trail road / 1.5-4.5m	Category 3 / 8m	40-60	10-12%	72	Widening
7	5.5	Mountainous region	Tunnel / 11m	60	0.3%	6	New construction
	Subtotal 149.5km			Average 74 km/h	Average 5.9%	Subtotal 137min*	
The Kyrgyz Republic							
8	6.5	Mountainous region	Tunnel / 11m	60	0.3%	7	New construction
9	10	Gravel road. trail road / 1.5-4.5m	Category 3 / 8m	40-60	12%	12	Pavement widening
10	3	Gravel road/ 3.5m	Category 2 / 9m	60	4%	3	New construction
11	47	Category 3 / 6-7m	Category 2 / 9m	90	3%	32	No works
	Subtotal 66.5km			Average 80 km/h	Average 4.1%	Subtotal 54min*	
	Total 216km			**Average 75 km/h**	**Average 5.3%**	**Total 191min***	

*Travel times calculated using mean design speed where range is applicable

Table 15. Breakdown of distances according to engineering effort categories

Total	No works	Widening	Reconstruction	New road construction	Tunnel construction
216km	82km	49km	63km	10km	12km

The same approach with calculation of cost based on the volumes of works for each road segment (Appendix 6.5) as well as the cost estimates for existing infrastructural projects was used for the eastern alignment. Unit cost of tunnel construction was taken as $22 million as approximation for the proposed tunnel 12 km in length.

Table 16. Construction cost estimate for Eastern alignment

TOTAL with VAT, Tenge	TOTAL with VAT, USD	BCP (USD)
176,350,110,880	467,772,177	2,500,000

5. SUMMARY

5.1 Longitudinal Profiles

The alignments developed as a basis for this Economic Impact Assessment, even though they all cross the mountain range between Almaty and Issyk-Kul, show wildly different longitudinal profiles. Only one of the alignments would apparently be feasible without a tunnel that caps the top section of the mountain passes and limits the maximum altitude.

Shorter tunnels, however, do not seem to have compelling advantages compared to the mountain passes. Due to the specific topographic situations for each of the alignments, shorter peak tunnels would not sufficiently

- reduce the technical challenges of mountain pass road construction,
- reduce the maximum altitude of the road and thereby improve winter safety,
- shorten travel times for users.

5.2 Cost and Travel Times

Table 17 provides a summary of the distances for different construction scopes as well as a total construction cost estimates for all the routes considered in this report.

Table 17. Distances for different construction scopes and construction cost estimates for three road alignments

Alignment	Travel time	Total, km	No works, km	Widening km	Recon-struction km	New road construction km	Tunnel construction km	BCP	TOTAL with VAT USD
Western road NK pass asphalt / gravel	3h 49min / 4h 8min	291	196	34	14	47	0	1	asphalt: 93,811,035 gravel: 81,232,503

Western road Masanchi asphalt / gravel	4h 32min / 5h 9min	351	229	40	28	54	0	0	asphalt: 112,788,135 gravel: 92,513,795
Western tunnel	3h 28min	260.1	177	45.5	0	23	14.6	1	517,682,866
Direct	1h 41min	85.5	7	23	0	39.5	16	1	586,633,805
Eastern	3h 11min	216	82	49	63	10	12	1	467,772,177

Figure 29, Figure 30 and

Figure 31 and provide visual representation how the magnitudes of overall distances, travel times and construction costs for the alignments relate to each other.

Figure 29. Distances for different construction scopes for all alignments

Figure 30. Travel times for all alignments

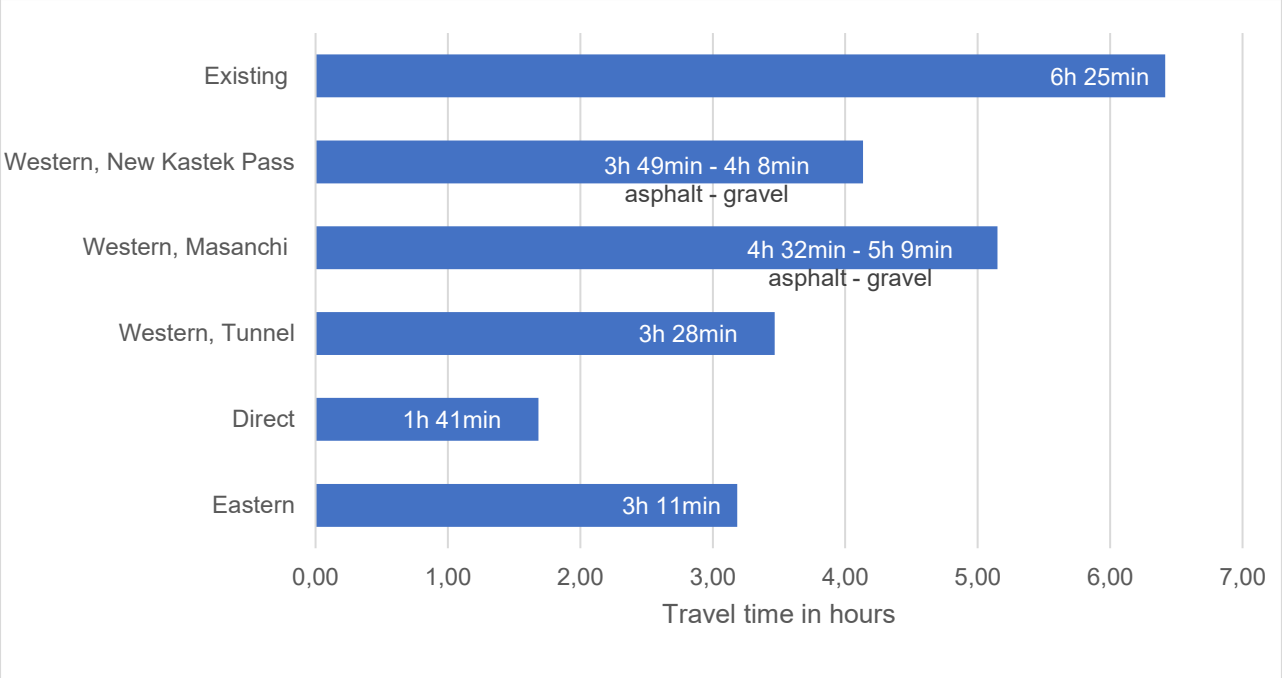
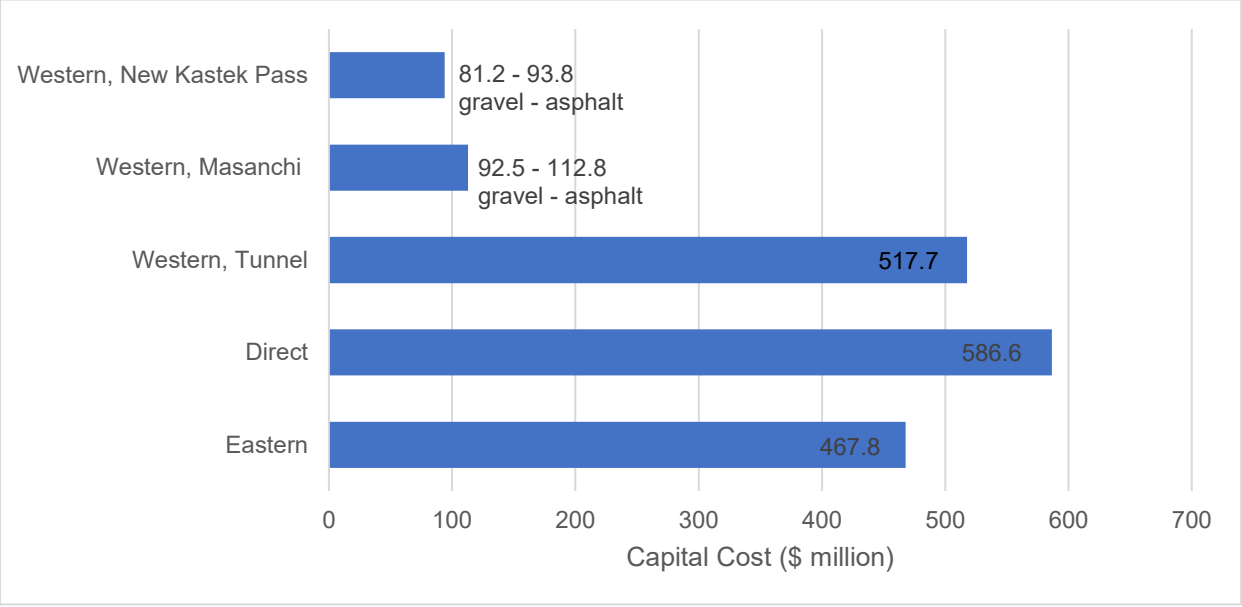


Figure 31 Construction cost for all alignments (without cost for BCP)



It is necessary to note that while these cost estimates provide an indicative representation of the relative magnitude of construction cost for all alignments considered, there are certain limitations as to how these numbers should be used for further analysis. Specifically, tunnel construction for all three alignments was approximately estimated based on the approximation of per-kilometer cost of construction from similar delivered projects, rather than based on the actual volumes of construction works.

5.3 Seasonality

Due to the different topographic situation of each one of the alignments, they also differ in terms of their seasonality. Road that climbs up to high altitudes cannot be kept open year-round without an outsized effort to build the road winter safe. This would include a complete avalanche protection of the road and exhaustive snow clearance in winter. E.g., only very few mountain roads in the Alps are kept open (almost) year-round.

Based on publicly available data about know depths and avalanche risks in Tian Shan mountains, the following assumptions about winter closure of the alignments in Table 18 are made.

Table 18. Winter Closure

Alignment	Winter Closure	Remarks
Western road NK pass asphalt / gravel	December – May (6 months)	
Western road Masanchi asphalt / gravel	December – May (6 months)	
Western tunnel	No winter closure	
Direct	December – May (6 months)	Avalanche risk in Ile-Alatau from March to June. Highest risk in April and May with altitudes between 2000 and 3000 m a.s.l, especially affected. Around 35% of this alignment is within this range.
Eastern	December – May (6 months)	The segment between Asy observatory and the border is at risk of snow avalanches from December to May at the altitudes 2000-3000 m a.s.l.

6. APPENDIX

6.1 Western Alignment (Tunnel) Cost Estimation

6.1.1 Volumes of Construction Works

WESTERN ALIGNMENT	units	Segment 1 40km	Segment 2 1km	Segment 3 5km	Segment 4 5km	Segment 5 13km	Segment 6 3km	Segment 7 5km	Segment 8 11.5km	Segment 9 18km	Segment 10 13.5km	Segment 11 11.5km	Segment 12 58km	Segment 13 79km
Original condition		**Category 1b**	**Category 3**	**Street road 7-9m**	**Category 3**	**Category 4**	**Category 4**	**Category 4**	**Trail road**	**Mountains**	**Category 4**	**Category 5**	**Category 1b**	**Category 1v**
Description of work		**No works**	**widening to Category 2**	**widening of street road to 12m**	**Widening to Category 2**	**Widening to Category 2**	**widening of street road to 9m**	**Widening to Category 2**	**New road construction, Category 3**	**Tunnel Construction**	**Widening to Category 3**	**New road construction, Category 2**	**No works**	**No works**
Preparatory works										N/A				
Restoration and fixing the axis of the road of Category I of complexity	km		1		5	13		5				11.5		
Restoration and fixing the axis of the road of Category II of complexity	km			5			3				13.5			
Restoration and fixing the axis of the road of Category III of complexity	km								11.5					
Removal of the fertile topsoil layer using a bulldozer, moving the heaps up to 20 m with a dump truck loaded with an excavator with a bucket capacity of 0.25 m³ and transporting to a dump at	m²								69,000			69,000		

a distance of up to 15 km, 0.3 m deep, `Y = 1.4 t / m³														
Felling of hardwood up to 600 cm in diameter. Removal for firewood at a distance of 30 km.	pcs			50					1,150			345		
Cutting the existing asphalt concrete pavement to an average thickness of 5 cm in one pass by the WIRTGEN milling cutter with the width of the milling drum is 1900-E2010 mm with transportation of the loose material to the construction site at a distance of up to 30 km (bulk density of the material 2.37 t / m³)	m²													

Roadbed	**unit**	**Segment 1**	**Segment** 2	**Segment** 3	**Segment** 4	**Segment** 5	**Segment** 6	**Segment** 7	**Segment** 8	**Segment** 9	**Segment** 10	**Segment** 11	**Segment** 12	**Segment** 13
Soil excavation in the quarry of the 2nd group using the HITACHI excavator with a bucket capacity of 1.25 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m³		10,000	50,000	50,000	156,000	30,000	80,000	32,200		162,000	39,100		
Embankment with leveling and compaction of the 2nd group soil	m³		12,000		60,000	187,200		96,000	38,640		194,400	46,920		
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, 2nd group soil	m²		15,000	75,000	75,000	234,000	45,000	60,000	23,000		243,000	26,450		
Excavation of the 4th group soil using the HITACHI excavator with a bucket capacity of 1.2 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m³								225,400					
Embankment with leveling and compaction of the 4th group soil	m³								270,480					
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, the 4th group soil	m²								161,000					
Loosening of rocky soils of the 7th Group in excavations using hole charges in case of one	m³								103,500					

exposed surface on the slopes steeper than 30°														
Crushing oversized materials (boulders) with blasthole charges in soils of the 6th Group to obtain soil with fractions no larger than 0.2 m for the upper leveling course	m³								103,500					
Loosening of rocks of the 5th Group with 158 kW bulldozer on the base of the T-330 tractor. Run length 600 m	m³								103,500					
Rocky slopes finishing with a wedge-hammer suspended on an excavator boom	m³								41,400					
Finishing of 5th group soil of γ-2.5 t/m3 using the HITACHI excavator with bucket capacity of up to 2.5 m3 with loading in a dump truck and transportation to a dump at a distance of up to 20 km	m³								103,500					

Road pavement	**unit**	**Segment 1**	**Segment 2**	**Segment 3**	**Segment 4**	**Segment 5**	**Segment 6**	**Segment 7**	**Segment 8**	**Segment 9**	**Segment 10**	**Segment 11**	**Segment 12**	**Segment 13**
Construction of the base course from sand-gravel mixture with a layer thickness of 25 cm	m³		1,100	11,750	5,500	17,550	4,050	8,000	35,650		18,225	41,400		
Construction of the sub-base course using the best suitable crushed stone mixture C-4 with a layer thickness of 20 cm	m²		2,500	37,500	12,500	45,500	10,500	22,500	120,750		47,250	132,250		
Construction of the base course using hot high-porous asphalt mix with a layer thickness of 12 cm	m²		1,600	28,000	8,000	33,800	7,800	18,000	110,400		35,100	121,900		
Construction of the road pavement subbase using hot coarse asphalt mix with a layer thickness of 10 cm	m²		1,000	25,000	5,000	26,000	6,000	15,000	92,000		27,000	103,500		
Construction of the road pavement base course using the Macadam and mastic asphalt concrete-20 with a layer thickness of 5 cm	m²		1,000	25,000	5,000	26,000	6,000	15,000	92,000		27,000	103,500		
Construction of retaining walls	**km**								**3**					
Excavation of the 4th group soil ´Y - 2.1 t / m² using the HITACHI excavator with bucket capacity 1.25 m³ with loading to dump trucks and transportation to a dump at a distance of 10 km	m³								17,928					
Construction of frameworks from	t								294,9					

reinforcement bars A = III d = 16														
Construction of cast in-situ retaining wall with a height of 5 to 9 m. Concrete B25 F200 W6	m³								26,832					
Installation of reinforced concrete block БО30.6.8 γ=1.7 t/pc.	pcs								4,025					
Construction of the reinforced concrete bridge with a span of 24 m.	pcs				**1**	**2**		**1**	**2**					
Construction of the reinforced concrete pipe d-1.5.m	pcs		**2**		**2**	**8**		**4**	**10**		**10**	**5**		

6.1.2 Cost Estimate

№	Scope of works	Cost from existing projects, Tenge	Cost based on volumes (including material cost), Tenge	CAR/EAR 100% with coef. 2020 Tenge	VAT (12%), Tenge	TOTAL with VAT, Tenge	TOTAL with VAT USD
1	Preparatory works		198,759,337	213,735,791	25,648,295	239,384,086	634,971
2	Roadbed		3,699,583,870	3 978,346,360	477,401,563	4,455,747,924	11,818,960
3	Road pavement		4,493,413,390	4 831,990,687	579,838,882	5,411,829,569	14,354,986
4	Construction of retaining walls		3,319,839,082	3 569,987,921	428,398,551	3,998,386,472	10,605,800
5	Construction of the reinforced concrete bridge with a span of 24 m.	1,500,000,000		1,613,024,532	193,562,944	1,806,587,476	4,792,009
6	Construction of the reinforced concrete pipe d-1.5.m	369,000,000		396,804,035	47,616,484	444,420,519	1,178,834
7	Tunnel construction (14.6 km)	137,366,399,500		147,716,914,844	17,726,029,781	165,442,944,625	438,840,702
TOTAL 14.6km:		**139,235,399,500**	**11,711,595,679**	**162,320,804,170**	**19,478,496,500**	**181,799,300,671**	**482,226,262**

6.2 Western Alignment (through New Kastek) Cost Estimation

6.2.1 Volumes of Construction Works (New Kastek)

WESTERN ALIGNMENT (road only)	units	Segment 1 40km	Segment 2 1km	Segment 3 3km	Segment 4 5km	Segment 5 13km	Segment 6 3km	Segment 7 8km	Segment 8 5km	Segment 9 24km	Segment 10 23km	Segment 11 2km	Segment 12 6km	Segment 13 77km	Segment 14 79km
Original condition		**Category 1b**	**Category 3**	**Street road 7-9m**	**Category 3**	**Category 4**	**Street road 6-7m**	**Trail road**	**Category 4**	**Trail road**	**Trail road**	**Street road**	**Category 4 and gravel**	**Category 1b**	**Category 1b**
Description of work		**No works**	**widening to Category 2**	**widening of street road to 12m**	**widening to Category 2**	**widening to Category 2**	**widening of street road to 9m**	**Reconstruction from gravel to Category 2**	**widening to Category 2**	**New road construction, Category 3**	**New road construction, Category 3**	**widening of street road to 9m**	**Reconstruction from gravel to Category 2**	**No works**	**No works**
Preparatory works															
Restoration and fixing the axis of the road of Category I of complexity	km		1		5	13		8	5				6		
Restoration and fixing the axis of the road of Category II of complexity	km			5			3					2			
Restoration and fixing the axis of the road of Category III of complexity	km									24	23				
Removal of the fertile topsoil layer using a bulldozer, moving the heaps up to 20 m with a dump truck loaded with an excavator with a bucket capacity of 0.25 m³ and transporting to a dump at a distance of up to 15 km, 0.3 m deep, ϒ = 1.4 t / m³	m²									144,000	138,000				

Felling of hardwood up to 600 cm in diameter. Removal for firewood at a distance of 30 km.	pcs.			50						720	460				
Cutting the existing asphalt concrete pavement to an average thickness of 5 cm in one pass by the WIRTGEN milling cutter with the width of the milling drum is 1900-E2010 mm with transportation of the loose material to the construction site at a distance of up to 30 km (bulk density of the material 2.37 t / m^3)	m^2														

Roadbed		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11	Segment 12	Segment 13	Segment 14
Soil excavation in the quarry of the 2nd group using the HITACHI excavator with a bucket capacity of 1.25 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m^3		10,000	50,000	50,000	156,000	30,000	272,000	170,000	134,400		20,000	204,000		
Embankment with leveling and compaction of the 2nd group soil	m^3		12,000		60,000	187,200		326,400	204,000	161,280		24,000	244,800		
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, 2nd group soil	m^2		15,000	75,000	75,000	234,000	45,000	184,000	115,000	96,000		30,000	138,000		
Excavation of the 4th group soil using the HITACHI excavator with a bucket capacity of 1.2 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m^3									403,200	450,800				
Embankment with leveling and compaction of the 4th group soil	m^3									483,840	540,960				
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, the 4th group soil	m^2									288,000	322,000				
Loosening of rocky soils of the 7th Group in excavations using hole charges in case of one exposed surface on the slopes steeper than 30°	m^3									216,000	310,500				

Crushing oversized materials (boulders) with blasthole charges in soils of the 6th Group to obtain soil with fractions no larger than 0.2 m for the upper leveling course	m^3									216,000	310,500				
Loosening of rocks of the 5th Group with 158 kW bulldozer on the base of the T-330 tractor. Run length 600 m	m^3									216,000	310,500				
Rocky slopes finishing with a wedge-hammer suspended on an excavator boom	m^3									86,000	124,200				
Finishing of 5th group soil of γ-2.5 t/m3 using the HITACHI excavator with bucket capacity of up to 2.5 m3 with loading in a dump truck and transportation to a dump at a distance of up to 20 km	m^3									216,000	310,500				

Road pavement		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11	Segment 12	Segment 13	Segment 14
Construction of the base course from sand-gravel mixture with a layer thickness of 25 cm	m^3		1,100	11,750	5,500	17,550	4,050	24,800	6,750	68,400	65,550	3,700	18,600		
Construction of the sub-base course using the best suitable crushed stone mixture C-4 with a layer thickness of 20 cm	m^2		2,500	37,500	12,500	45,500	10,500	84,000	17,500	228,000	218,500	11,000	63,000		
Construction of the base course using hot high-porous asphalt mix with a layer thickness of 12 cm	m^2		1,600	28,000	8,000	33,800	7,800	76,800	13,000	206,400 / 0*	197,800 / 0*	9,200 / 0*	57,600		
Construction of the road pavement subbase using hot coarse asphalt mix with a layer thickness of 10 cm	m^2		1,000	25,000	5,000	26,000	6,000	72,000	10,000	192,000 / 0*	184,000 / 0*	8,000 / 0*	54,000		
Construction of the road pavement base course using the Macadam and mastic asphalt concrete-20 with a layer thickness of 5 cm	m^2		1,000	25,000	5,000	26,000	6,000	72,000	10,000	192,000 / 0*	184,000 / 0*	8,000 / 0*	54,000		
Construction of retaining walls	**km**									3	5				
Excavation of the 4th group soil ´Y - 2.1 t / m² using the HITACHI excavator with bucket capacity 1.25 m³ with loading to dump trucks and transportation to a dump at a distance of 10 km	m^3									17,928	29,880				
Construction of frameworks from	t									295	492				

reinforcement bars A = III d = 16															
Construction of cast in-situ retaining wall with a height of 5 to 9 m. Concrete B25 F200 W6	m3									26,832	44,720				
Installation of reinforced concrete block БО30.6.8 γ=1.7 t/pc.	pcs.									7,200	11,500				
Construction of the reinforced concrete bridge with a span of 24 m.	pcs.				**1**	2				2					
Construction of the reinforced concrete pipe d-1.5.m	pcs.		**2**		**2**	8		2	1	10			2		

* not included for option with gravel pavement

6.2.2 Cost Estimate (New Kastek)

Asphalt Pavement

№	Scope of works	Cost from existing projects Tenge	Cost based on volumes (including material cost), Tenge	CAR/EAR 100% with coef. 2020 Tenge	VAT (12%) Tenge	TOTAL with VAT, Tenge	TOTAL with VAT USD
1	Preparatory works		395,486,806	425,286,613	51,034,394	476,321,007	1 263 451
2	Roadbed		10,296,560,538	11,072,403,162	1,328,688,379	12,401,091,541	32 894 142
3	Road pavement		8,303,352,779	8,929,007,820	1,071,480,938	10,000,488,759	26 526 495
4	Construction of retaining walls		9,190,433,276	9,882,929,556	1,185,951,547	11,068,881,103	29 360 427
5	**Construction of the reinforced concrete bridge with a span of 24 m.**	900,000,000		967,814,719	116,137,766	1,083,952,486	2 875 206
6	**Construction of the reinforced concrete pipe d-1.5.m**	279,000,000		300,022,563	36,002,708	336,025,271	891 314

TOTAL:	**1,179,000,000**	**28,185,833,399**	**31,577,464,434**	**3,789,295,732**	**35,366,760,166**	**93,811,035**

Gravel Pavement

№	Scope of works	Cost from existing projects Tenge	Cost based on volumes (including material cost), Tenge	CAR/EAR 100% with coef. 2020 Tenge	VAT (12%) Tenge	TOTAL with VAT, Tenge	TOTAL with VAT USD
1	Preparatory works		395,486,806	425,286,613	51,034,394	476,321,007	1 263 451
2	Roadbed		10,296,560,538	11,072,403,162	1,328,688,379	12,401,091,541	32 894 142
3	Road pavement		4,366,007,009	4,694,984,275	563,398,113	5,258,382,388	13 947 964
4	Construction of retaining walls		9,190,433,276	9,882,929,556	1,185,951,547	11,068,881,103	29 360 427
5	**Construction of the reinforced concrete bridge with a span of 24 m.**	900,000,000		967,814,719	116,137,766	1,083,952,486	2 875 206
6	**Construction of the reinforced concrete pipe d-1.5.m**	279,000,000		300,022,563	36,002,708	336,025,271	891 314
TOTAL:		**1,179,000,000**	**24,248,487,629**	**27,343,440,888**	**3,281,212,907**	**30,624,653,795**	**81,232,503**

6.3 Western Alignment (road only through Masanchi) Cost Estimation

6.3.1 Volumes of construction works (Masanchi)

WESTERN ALIGNMENT (road only)	units	Segment 1 40km	Segment 2 1km	Segment 3 3km	Segment 4 5km	Segment 5 13km	Segment 6 3km	Segment 7 8km	Segment 8 5km	Segment 9 24km	Segment 10 30km	Segment 11 20km	Segment 12 8km	Segment 13 110km	Segment 14 79km
Original condition		**Category 1b**	**Category 3**	**Street road 7-9m**	**Category 3**	**Category 4**	**Street road 6-7m**	**Trail road**	**Category 4**	**Trail road**	**Trail road**	**Category 5**	**Category 4**	**Category 1b**	**Category 1b**
Description of work		**No works**	**widening to Category 2**	**widening of street road to 12m**	**widening to Category 2**	**widening to Category 2**	**widening of street road to 9m**	**Reconstruction from gravel to**	**widening to Category 2**	**New road construction, Category 3**	**New road construction, Category 3**	**Reconstruction from gravel to**	**widening to Category 2**	**No works**	**No works**

								Category 2				**Category 3**			
Preparatory works															
Restoration and fixing the axis of the road of Category I of complexity	km		1		5	13		8	5				8		
Restoration and fixing the axis of the road of Category II of complexity	km			5			3					20			
Restoration and fixing the axis of the road of Category III of complexity	km									24	30				
Removal of the fertile topsoil layer using a bulldozer, moving the heaps up to 20 m with a dump truck loaded with an excavator with a bucket capacity of 0.25 m³ and transporting to a dump at a distance of up to 15 km, 0.3 m deep, ϒ = 1.4 t / m³	m²									144,000	180,000				
Felling of hardwood up to 600 cm in diameter. Removal for firewood at a distance of 30 km.	pcs.			50						720	600				
Cutting the existing asphalt concrete pavement to an average thickness of 5 cm in one pass by the WIRTGEN milling cutter with the width of the milling drum is 1900-E2010 mm with transportation of the loose material to the construction site at a	m²														

distance of up to 30 km (bulk density of the material 2.37 t / m^3)															

Roadbed		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11	Segment 12	Segment 13	Segment 14
Soil excavation in the quarry of the 2nd group using the HITACHI excavator with a bucket capacity of 1.25 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m^3		10,000	50,000	50,000	156,000	30,000	272,000	170,000	134,400	168,000	112,000	96,000		
Embankment with leveling and compaction of the 2nd group soil	m^3		12,000		60,000	187,200		326,400	204,000	161,280	201,600	134,400	115,200		
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, 2nd group soil	m^2		15,000	75,000	75,000	234,000	45,000	184,000	115,000	96,000	120,000	80,000	144,000		
Excavation of the 4th group soil using the HITACHI excavator with a bucket capacity of 1.2 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m^3									403,200	504,000				
Embankment with leveling and compaction of the 4th group soil	m^3									483,840	604,800				
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, the 4th group soil	m^2									288,000	360,000				
Loosening of rocky soils of the 7th Group in excavations using hole charges in case of one	m^3									216,000	270,000				

exposed surface on the slopes steeper than 30°															
Crushing oversized materials (boulders) with blasthole charges in soils of the 6th Group to obtain soil with fractions no larger than 0.2 m for the upper leveling course	m^3									216,000	270,000				
Loosening of rocks of the 5th Group with 158 kW bulldozer on the base of the T-330 tractor. Run length 600 m	m^3									216,000	270,000				
Rocky slopes finishing with a wedge-hammer suspended on an excavator boom	m^3									86,400	108,000				
Finishing of 5th group soil of γ-2.5 t/m3 using the HITACHI excavator with bucket capacity of up to 2.5 m3 with loading in a dump truck and transportation to a dump at a distance of up to 20 km	m^3									216,000	270,000				

Road pavement		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11	Segment 12	Segment 13	Segment 14
Construction of the base course from sand-gravel mixture with a layer thickness of 25 cm	m^3		1,100	11,750	5,500	17,550	4,050	24,800	6,750	68,400	85,500	72,000	10,800		
Construction of the sub-base course using the best suitable crushed stone mixture C-4 with a layer thickness of 20 cm	m^2		2,500	37,500	12,500	45,500	10,500	84,000	17,500	228,000	285,000	230,000	28,000		
Construction of the base course using hot high-porous asphalt mix with a layer thickness of 12 cm	m^2		1,600	28,000	8,000	33,800	7,800	76,800	13,000	206,400*	258,000*	212,000*	20,800		
Construction of the road pavement subbase using hot coarse asphalt mix with a layer thickness of 10 cm	m^2		1,000	25,000	5,000	26,000	6,000	72,000	10,000	192,000*	240,000*	180,000*	16,000		
Construction of the road pavement base course using the Macadam and mastic asphalt concrete-20 with a layer thickness of 5 cm	m^2		1,000	25,000	5,000	26,000	6,000	72,000	10,000	192,000*	240,000*	180,000*	16,000		
Construction of retaining walls	**km**									3km	4km				
Excavation of the 4th group soil ´Y - 2.1 t / m² using the HITACHI excavator with bucket capacity 1.25 m³ with loading to dump trucks and transportation to a dump at a distance of 10 km	m^3									17,928	23,904				
Construction of frameworks from	t									295	393				

reinforcement bars A = III d = 16															
Construction of cast in-situ retaining wall with a height of 5 to 9 m. Concrete B25 F200 W6	m³									26,832	35,776				
Installation of reinforced concrete block БО30.6.8 γ=1.7 t/pc.	pcs									7,200	9,000				
Construction of the reinforced concrete bridge with a span of 24 m.	pcs				**1**	2				2	2	1			
Construction of the reinforced concrete pipe d-1.5.m	pcs		**2**		**2**	8		2	1	10	10	5	2		

* not included for option with gravel pavement

6.3.2 Cost Estimate (Masanchi)

Asphalt Concrete Pavement

№	Scope of works	Cost from existing projects	Cost based on volumes (including material cost), Tenge	CAR/EAR 100% with coef. 2020	VAT (12%)	TOTAL with VAT, Tenge	TOTAL with VAT USD
1	Preparatory works		460,588,542	495,293,745	59,435,249	554,728,994	1,471,430
2	Roadbed		13,994,520,047	15,049,002,766	1,805,880,332	16,854,883,098	44,707,913
3	Road pavement		11,051,213,120	11,883,918,581	1,426,070,230	13,309,988,810	35,305,010
4	Construction of retaining walls		8,034,744,371	8,640,159,853	1,036,819,182	9,676,979,035	25,668,379
5	**Construction of the reinforced concrete bridge with a span of 24 m.**	1,350,000,000		1,451,722,079	174,206,649	1,625,928,728	4,312,808
6	**Construction of the reinforced concrete pipe d-1.5.m**	414,000,000		445,194,771	53,423,372	498,618,143	1,322,595
TOTAL:		**1,764,000,000**	**33,541,066,080**	**37,965,291,794**	**4,555,835,015**	**42,521,126,809**	**112,788,135**

Gravel Pavement

№	Scope of works	Cost from existing projects	Cost based on volumes (including material cost), Tenge	CAR/EAR 100% with coef. 2020	VAT (12%)	TOTAL with VAT, Tenge	TOTAL with VAT USD
1	Preparatory works		460,588,542	495,293,745	59,435,249	554,728,994	1,471,430
2	Roadbed		13,994,520,047	15,049,002,766	1,805,880,332	16,854,883,098	44,707,913
3	Road pavement		4,704,916,913	5,059,430,934	607,131,712	5,666,562,647	15,030,670
4	Construction of retaining walls		8,034,744,371	8,640,159,853	1,036,819,182	9,676,979,035	25,668,379
5	**Construction of the reinforced concrete bridge with a span of 24 m.**	1,350,000,000		1,451,722,079	174,206,649	1,625,928,728	4,312,808

6	**Construction of the reinforced concrete pipe d-1.5.m**	414,000,000		445,194,771	53,423,372	498,618,143	1,322,595
TOTAL:		**1,764,000,000**	**27,194,769,873**	**31,140,804,148**	**3,736,896,498**	**34,877,700,646**	**92,513,795**

6.4 Direct alignment

6.4.1 Volumes of construction works

DIRECT ALIGNMENT	units	Segment 1 23km		Segment 2 21km	Segment 3 4km	Segment 4 16km	Segment 5 14.5km	Segment 6 7km
Original condition		**Category 4**	**Category 4**	**Trail road**	**Trail road / river**	**Mountains**	**Trail road**	**Category 2**
Description of work		**Widening to Category 2**	**Widening to Category 3**	**New road construction, Category 3**	**New road construction, Category 3**	**Tunnel construction**	**New road construction, Category 3**	**Existing road - no works**
Preparatory works								
Restoration and fixing the axis of the road of Category III of complexity	km	9						
Restoration and fixing the axis of the road of Category IV of complexity	km		14				4,5	
Restoration and fixing the axis of the road of Category V of complexity	km			21	4	16	10	
Removal of the fertile topsoil layer using a bulldozer, moving the heaps up to 20 m with a dump truck loaded with an excavator with a bucket capacity of 0.25 m³ and transporting to a dump at a distance of up to 15 km, 0.3 m deep, ϒ = 1.4 t / m³	m²			126,000	24,000		87,000	
Felling of hardwood up to 600 cm in diameter. Removal for firewood at a distance of 30 km.	pcs.			10,500			5,000	

Cutting the existing asphalt concrete pavement to an average thickness of 5 cm in one pass by the WIRTGEN milling cutter with the width of the milling drum is 1900-E2010 mm with transportation of the loose material to the construction site at a distance of up to 30 km (bulk density of the material 2.37 t / m^3)	m^2							

Roadbed								
Soil excavation in the quarry of the 2nd group using the HITACHI excavator with a bucket capacity of 1.25 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m³	144,000	140,000				13,500	
Embankment with leveling and compaction of the 2nd group soil	m³	172,800	168,000				16,200	
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, the 2nd group soil	m²	108,000	210,000				20,250	
Excavation of the 4th group soil using the HITACHI excavator with a bucket capacity of 1.2 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m³			793,800	151,200		170,100	
Embankment with leveling and compaction of the 4th group soil	m³			630,000	120,000		94,500	
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, the 4th group soil	m²			378,000	72,000		56,700	
Loosening of rocky soils of the 7th Group in excavations using hole charges in case of one exposed surface on the slopes steeper than 30°	m³			283,500			450,000	
Crushing oversized materials (boulders) with blasthole charges in soils of the 6th Group to obtain soil with fractions no larger than 0.2 m for the upper leveling course	m³			283,500			450,000	
Loosening of rocks of the 5th Group with 158 kW bulldozer on the base of the T-330 tractor. Run length 600 m	m³			283,500			450,000	
Rocky slopes finishing with a wedge-hammer suspended on an excavator boom	m³			113,400			180,000	

Finishing of 5th group soil of γ-2.5 t/m3 using the HITACHI excavator with bucket capacity of up to 2.5 m3 with loading in a dump truck and transportation to a dump at a distance of up to 20 km	m³			283,500			450,000	
Road pavement								
Construction of the base course from sand-gravel mixture with a layer thickness of 25 cm	m³	4,950	15,400	54,075	10,300		25,750	
Construction of the sub-base course using the best suitable crushed stone mixture C-4 with a layer thickness of 20 cm	m²	11,250	35,000	178,500	34,000		85,000	
Construction of the base course using hot high-porous asphalt mix with a layer thickness of 12 cm	m²	7,200	22,400	159,600	30,400		76,000	
Construction of the road pavement subbase using hot coarse asphalt mix with a layer thickness of 10 cm	m²	4,500	14,000	147,000	28,000		70,000	
Construction of the road pavement base course using the Macadam and mastic asphalt concrete-20 with a layer thickness of 5 cm	m²	4,500	14,000	147,000	28,000		70,000	
Construction of retaining walls	**km**			**4**			**5**	
Excavation of the 4th group soil ´Y - 2.1 t / m² using the HITACHI excavator with bucket capacity 1.25 m³ with loading to dump trucks and transportation to a dump at a distance of 10 km	m³			23,904			29,880	
Construction of frameworks from reinforcement bars A = III d = 16	t			393,2			491,5	
Construction of cast in-situ retaining wall with a height of 5 to 9 m. Concrete B25 F200 W6	m³			35,776			44,720	
Installation of reinforced concrete block БО30.6.8 γ=1.7 t/pc.	pcs.		7,000	10,500	2,000		5,000	

Construction of the reinforced concrete bridge with a span of 24 m.	pcs.	**1**	**4**	**2**	**1**		**2**	
Construction of the reinforced concrete pipe d-1.5.m	pcs.	**6**	**10**	**6**	**2**		**6**	

6.4.2 Cost Estimate

№	Scope of works	Cost from existing projects	Cost based on volumes (including material cost), Tenge	CAR/EAR 100% with coef. 2020	VAT (12%)	TOTAL with VAT, Tenge	TOTAL with VAT USD
1	Preparatory works		423,346,006	455,244,995	54,629,399	509,874,395	1,352,452
2	Roadbed		16,921,529,331	18,196,561,287	2,183,587,354	20,380,148,641	53,298,608
3	Road pavement		4,483,483,138	4,821,312,194	578,557,463	5,399,869,657	11,907,724
4	Construction of retaining walls		10,485,935,473	11,276,047,439	1,353,125,693	12,629,173,132	33,499,133
5	**Construction of the reinforced concrete bridge with a span of 24 m.**	1,500,000,000		1,613,024,532	193,562,944	1,806,587,476	4,792,009
6	**Construction of the reinforced concrete pipe d-1.5.m**	270,000,000		319,378,857	38,325,463	357,704,320	862,562
7	Tunnel construction (16.5 km)	150,538,520,000		161,881,550,514	19,425,786,062	181,307,336,576	480,921,317
TOTAL:		**152,335,520,000**	**32,317,555,752**	**198,566,627,398**	**23,827,995,288**	**222,394,622,686**	**586,633,805**

6.5 Eastern Alignment

6.5.1 Volumes of Construction Works

EASTERN ALIGNMENT	units	Segment 1 35km	Segment 2 8km	Segment 3 6km	Segment 4 9km	Segment 5 26km	Segment 6 60km	Segment 7 12km	Segment 8 10km	Segment 9 3km	Segment 10 47km
Original condition		**Category 1v**	**Category 3**	**Street road 7-9m**	**Category 3**	**Category 4**	**Trail road**	**Mountains**	**Trail road**	**Trail road**	**Category 3**
Description of work		**No works**	**widening to Category 2**	**widening of street road to 12m**	**widening to Category 2**	**widening to Category 2**	**Reconstruction from gravel road to Category 3**	**Tunnel construction**	**New road construction, Category 3**	**Reconstruction from gravel road to Category 3**	**No works**
Preparatory works											
Restoration and fixing the axis of the road of Category III of complexity	km		8	6	9						
Restoration and fixing the axis of the road of Category IV of complexity	km					26				3	
Restoration and fixing the axis of the road of Category V of complexity	km						60		10		
Removal of the fertile topsoil layer using a bulldozer, moving the heaps up to 20 m with a dump truck loaded with an excavator with a bucket capacity of 0.25 m³ and transporting to a dump at a distance of up to 15 km, 0.3 m deep, ϒ = 1.4 t / m³	m²						360,000				
Felling of hardwood up to 600 cm in diameter. Removal for firewood at a distance of 30 km.	pcs.			60			12,000		2,000		

Cutting the existing asphalt concrete pavement to an average thickness of 5 cm in one pass by the WIRTGEN milling cutter with the width of the milling drum is 1900-E2010 mm with transportation of the loose material to the construction site at a distance of up to 30 km (bulk density of the material 2.37 t / m^3)	m^2										
Roadbed											
Soil excavation in the quarry of the 2nd group using the HITACHI excavator with a bucket capacity of 1.25 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m^3		128,000	48,000	144,000	291,200				72,000	
Embankment with leveling and compaction of the 2nd group soil	m^3		153,600		172,800	349,440				86,400	
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, the 2nd group soil	m^2		96,000		108,000	218,400				54,000	
Excavation of the 4th group soil using the HITACHI excavator with a bucket capacity of 1.2 m3 with loading to the dump trucks and transportation to a dump at a distance of 30km	m^3					234,000	1,890,000		315,000		
Embankment with leveling and compaction of the 4th group soil	m^3					78,000	1,008,000		168,000		
Grading of the roadbed top and the embankment slopes with a 96-kW bulldozer, the 4th group soil	m^2					117,000	756,000		126,000		

Loosening of rocky soils of the 7th Group in excavations using hole charges in case of one exposed surface on the slopes steeper than 30°	m³						810,000		135,000		
Crushing oversized materials (boulders) with blasthole charges in soils of the 6th Group to obtain soil with fractions no larger than 0.2 m for the upper leveling course	m³						810,000		135,000		
Loosening of rocks of the 5th Group with 158 kW bulldozer on the base of the T-330 tractor. Run length 600 m	m³						810,000		135,000		
Rocky slopes finishing with a wedge-hammer suspended on an excavator boom	m³						324,000		54,000		
Finishing of 5th group soil of γ-2.5 t/m3 using the HITACHI excavator with bucket capacity of up to 2.5 m3 with loading in a dump truck and transportation to a dump at a distance of up to 20 km	m³						810,000		135,000		
Road pavement											
Construction of the base course from sand-gravel mixture with a layer thickness of 25 cm	m³		6,400	12,450	9,450	14,300	169,500		28,250	8,475	
Construction of the sub-base course using the best suitable crushed stone mixture C-4 with a layer thickness of 20 cm	m²		18,000	39,000	29,250	58,500	570,000		95,000	28,500	
Construction of the base course using hot high-porous asphalt mix with a layer thickness of 12 cm	m²		14,400	33,600	25,200	72,800	516,000		86,000	25,800	
Construction of the road pavement subbase using hot	m²		8,000	30,000	18,000	52,000	480,000		80,000	24,000	

coarse asphalt mix with a layer thickness of 10 cm											
Construction of the road pavement base course using the Macadam and mastic asphalt concrete-20 with a layer thickness of 5 cm	m²		8,000	30,000	18,000	52,000	480,000		80,000	24,000	
Construction of retaining walls	**km**						**8**		**2**		
Excavation of the 4th group soil ´Y - 2.1 t / m² using the HITACHI excavator with bucket capacity 1.25 m³ with loading to dump trucks and transportation to a dump at a distance of 10 km	m³						47,808		11,952		
Construction of frameworks from reinforcement bars A = III d = 16	t						786,4		196,6		
Construction of cast in-situ retaining wall with a height of 5 to 9 m. Concrete B25 F200 W6	m³						71,552		17,888		
Installation of reinforced concrete block БО30.6.8 γ=1.7 t/pc.	pcs.						24,000		5,000		
Construction of the reinforced concrete bridge with a span of 24 m.	pcs		**1**	**0**	**1**		**3**		**2**		
Construction of the reinforced concrete pipe d-1.5.m	pcs		**4**	**5**	**2**		**20**		**5**	**1**	

6.5.2 Cost estimate

№	Scope of works	Cost from existing projects	Cost based on volumes (including material cost), Tenge	CAR/EAR 100% with coef. 2020	VAT (12%)	TOTAL with VAT, Tenge	TOTAL with VAT USD
1	Preparatory works		598,646,150	643,753,951	77,250,474	721,004,425	1,912,479

2	Roadbed		23,830,276,898	25,625,880,827	3,075,105,699	28,700,986,526	76,129,938
3	Road pavement		9,528,855,841	10,246,852,156	1,229,622,259	11,476,474,414	30,441,577
4	Construction of retaining walls		11,726,359,706	12,609,937,251	1,513,192,470	14,123,129,721	37,461,883
5	**Construction of the reinforced concrete bridge with a span of 24 m.**	1,050,000,000		1,129,117,172	135,494,061	1,264,611,233	3,354,406
6	**Construction of the reinforced concrete pipe d-1.5.m**	333,000,000		358,091,446	42,970,974	401,062,420	1,063,826
7	Tunnel construction (12 km)	99,355,423,200		106,841,823,339	12,821,018,801	119,662,842,140	317,408,069
TOTAL:		**100,978,423,200**	**45,684,138,595**	**157,455,456,142**	**18,894,654,737**	**176,350,110,880**	**467,772,177**