



**NATIONAL HIGHWAY AUTHORITY**

# **Revised Alignment Study Report**

## **Peshawar – Torkham Section-I**

**Consultancy Services for Feasibility Study and  
Preliminary Design of Peshawar-Kabul Motorway**

**07-Apr-17**

**Associated Consultancy Centre (Pvt.) Ltd.  
(ACC) in association with  
SAMBO Engineering Co. Ltd. (South Korea),**



**SAMBO**  
SAMBO ENGINEERING



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## **CHAPTER 1 - INTRODUCTION**

### **1.1 General**

Associated Consultancy Centre (Pvt.) Ltd. Islamabad as the lead firm has associated with SAMBO Engineering Korea, Associated Consulting Engineers-TES (ACE) and Assign Consulting Engineering International for providing Consultancy Services for Feasibility Study and Preliminary Design of Peshawar-Kabul Motorway Section-I: Peshawar- Torkham 50 km, Section-II: Torkham-Jalalabad 76 km, Section-III: Jalalabad-Kabul 155 km. The Contract Agreement between the JV venture and NHA has been signed on 13th March, 2017.

The firms have worked together on previous projects and have good understanding of the project and Client's requirements. The team of experts selected for the project has been chosen with a strong emphasis on experience and the proven ability to generate innovative, efficient and effective solutions to the problems that may arise during project implementation.

Associated Consultancy Centre (ACC) was established in 1986 and is one of the largest Consultancy firms of the country working in multi sector of engineering since last 25 years. ACC has completed over 120 projects out of which 50 projects are in major highway projects.

Sambo Engineering Co., Ltd. (SAMBO) was founded in 1993 with the company slogan, "Producer of Social Environment". SAMBO is duly incorporated under the laws of Korea and is an independent company totally owned by individual shareholders. It is the fastest-growing firm and became one of the leading consulting firms in Korea extending its services worldwide.

Associated Consulting Engineers ACE (Private) Limited established in 1958 is one of the oldest and the largest private sector multidisciplinary consulting houses in Pakistan. Since its inception, ACE has provided engineering consultancy services for over 1400 projects in various engineering and architectural disciplines both within the country and abroad with a capital outlay of about US\$ 38.0 Billion.

ACE has contributed considerably in the sector of Transportation Engineering. ACE was part of JV/ Consortium for the supervision of 6-lane 375 km Lahore-Islamabad Motorway (Pakistan) which included various River and Canal Bridges, Flyover/Interchange Bridges and supervised the 1.5 sections out of 4 Sections of project.

M/s Assign Engineering Consult International (Pvt.) Ltd. is an associate firm which is a rapidly growing organization. Their principals bring exceptional project management, design and supervision experience to the group having been directly responsible for managing large

scale Rural Road Projects including FMR-I, FMR-II & RAR-I all over Pakistan. They are currently completed the ADB Assisted Project Management Consultancy (PMC) Project in Sindh.

The subject report has been prepared as the "Alignment Study Report" as required by the deliverables of the TOR of the project. This report only includes the Alignment Study of Section-1 from Peshawar to Torkham.

## **1.2 Objectives of the Project**

The project aims at the feasibility study of construction of Peshawar – Kabul Motorway to provide a faster and comfortable travel facility between two countries. National Highway (N-5) and Indus Highway (N-55) are the most important direct routes in the country linking the International Sea Port on the extreme southern end of the country (Karachi) with Torkham, the International border on the north. Motorway (M-1), National Highway (N-5) and Indus Highway (N-55) all have end point at Torkham Border Peshawar city.

In order to promote the International Trade through our ports, superior road network is essential therefore, NHA decided to start the Peshawar Torkham Motorway Project on priority basis to attract the International TradeTraffic for middle-east market and other parts of the world.

Following map shows the project alignment between Peshawar and Kabul:



**Figure 1: Project Alignment of Peshawar – Kabul Motorway Project**

### 1.3 Project Scope of Work

The Peshawar-Kabul Motorway shall connect Peshawar with Kabul through Torkham and Jalalabad. The project road under this project can broadly be classified as Principal Arterial, which shall serve major traffic flow in between Peshawar and Torkham. The scope of consultancy as defined in TOR is to conduct feasibility study and preliminary design of subject motorway. The consultant has carried out Reconnaissance Survey using high definition imagery and a field visit to Peshawar – Torkham section as per TOR to finalize the alignment. Moreover, all necessary surveys, designs and estimates will be finalized and feasibility report generated after the approval of the alignment.

Total Length of the existing road from Peshawar (Hayatabad) to Kabul (Abdul Haq Square) is approximately 281km<sup>1</sup>. The most part of the road is passing through the mountainous ranges. The project is divided into three sections which are as follows:

**Table 1: Project Sections of Peshawar – Kabul Motorway Project**

Sr. No.	Section	Name of Section	Length (KM)
1	Section - I	Peshawar – Torkham (Pakistan)	50
2	Section – II	Torkham – Jalalabad (Afghanistan)	76
3	Section - III	Jalalabad –Kabul (Afghanistan)	155

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<sup>1</sup>As per TOR the length is 281 km.



## CHAPTER 2 – ALIGNMENT STUDY

### 2.1 Introduction

Peshawar is the capital of Khyber Pakhtunkhwa and the administrative center and economic hub for the Federally Administered Tribal Areas of Pakistan. Peshawar is situated in a large valley near the eastern end of the Khyber Pass, close to the Pak Afghan border. Known as “City on the Frontier”, Peshawar’s strategic location on the cross roads of Central Asia and South Asia has made it one of the most culturally vibrant and lively cities in the greater region. Peshawar is connected to Motorway system of Pakistan through Motorway M-1. Peshawar Northern Bypass having a definition of 4-lane divided Expressway provides link between Motorway M-1 and Start Point of Peshawar – Kabul Motorway.

Torkham border between Pakistan and Afghanistan is located on the Durand line. It connects Nangarhar province of Afghanistan with Pakistan's Federally Administered Tribal Areas (FATA) and Khyber Pakhtunkhwa. It is the busiest port of entry between the two countries, serving as a major transporting, shipping, and receiving site. Highway 7 connects Torkham to Kabul through Jalalabad.

### 2.2 Existing Alignment

The existing Peshawar – Torkham road is metalled, being 7.3 meter wide and with 2.0 meter shoulders both sides. Its start from Takhta Baig Bridge near Jamrud and ends at Torkham border. The existing road is rehabilitated and its most of its length runs along nullah on one side and hill on the other side. Following map shows the existing alignment of Peshawar-Torkham.

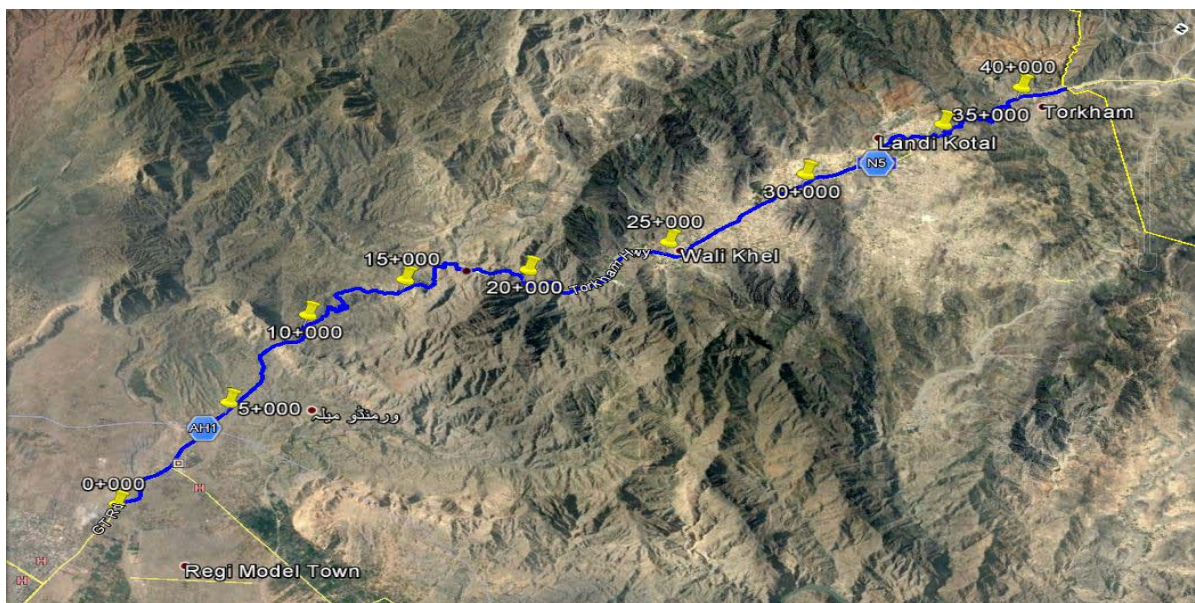


Figure 2: Existing Alignment of Peshawar – Torkham (N-5)

From Peshawar to Torkham the terrain is very difficult in some reaches where the alignment mostly follows the valleys and hill slopes. Peshawar-Torkham alignment passes through Peshawar – Jamrud-Ali Masjid – Gurjura-Wali Khel-Landi Kotal-Torkham having total length of 50 kms<sup>2</sup>. It starts from end of Peshawar Northern Bypass at Takhta Baig Bridge near Jamrud and ends at Torkham border. As per Google Earth the length of subject section is 40.3 kilometers and most part of this section is mountainous.

Number of bridges and sharp bends are encountered at various locations along the existing alignment. Near Ali Masjid and Torkham the existing alignment splits into two levels with directional traffic going at different grades/levels and existing nallah flows in between the two grade separated roads. A railway track also runs along the existing Peshawar – Torkham Road and crosses it at several locations.

To better understand the existing alignment, whole length has been divided into small sections of 5 kilometer. Following table describes each sub-section of existing alignment.

**Table 2: Description of Existing Alignment**

<b>Sr. No.</b>	<b>Section Chainage</b>	<b>Alignment Description</b>
1	km 0+000 to km 5+000	Existing alignment starts from end of Peshawar Northern Bypass at Takhta Baig Bridge near Jamrud. On both sides of the alignment built-up area exists. On the right side of the road abandoned railway track runs parallel to the existing road. ROW is very limited and variable between 15-50 meter in built-up reach of Jamrud. Generally terrain is rolling to flat in this reach.
2	km 5+000 to km 10+000	The existing road passes through the built-up area of Soor Kamar. Terrain is rolling to flat up to km 8+100. After crossing the nullah bridge at km 8+100 mountainous terrain starts.
3	km 10+000 to km 15+000	Numbers of sharp horizontal curvatures are encountered from km 11+100 to km 12+500 to cope with difficult mountainous terrain. The road runs on the steep mountainous slopes in this reach. The minimum horizontal radius is up to 15 meters.
4	km 15+000 to km 20+000	At km 18+000, existing highway passes through Ali Masjid built-up after negotiating sharp horizontal turns at km 17+100 & km 17+760. Alignment splits into two ways/directions from km 18+040 to km 19+430 with directional traffic going at different grades/levels. After crossing Ali Masjid, alignment runs along the nullah with various sharp turns. This particular area is V-shape river valley which is surrounded by high mountains having steep slopes.

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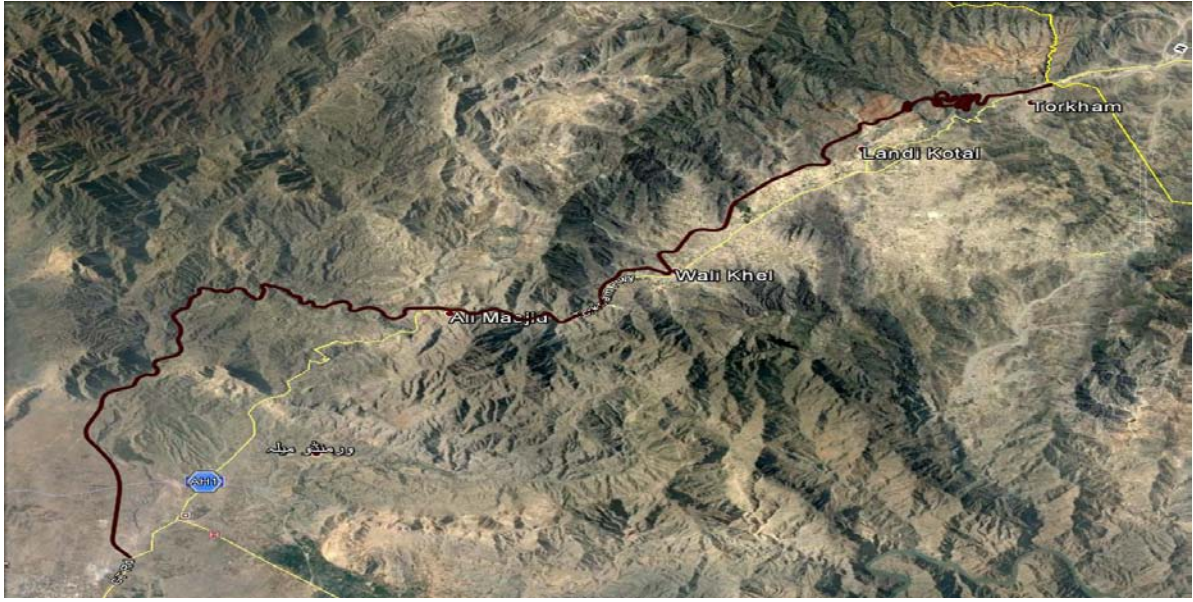
<sup>2</sup>As per TOR the length is 50 Km



5	km 20+000 to km 25+000	Existing highway runs on the slopes of high mountains along nullah on its other side. Alignment passes through Gurjurabuilt-up area. At several locations railway track crosses the highway.
6	km 25+000 to km 30+000	In this section, existing highway runs through a rolling terrain and thickly built-up area of Wali Khel. The ROW is variable between 20-50 meters in this reach.
7	km 30+000 to km 35+000	Existing alignment passes through built-up area of Landi Kotal. Alignment splits into two ways (Northern & Southern Bypass) from km 32+250 to km 34+550. Landi Kotal Northern Bypass is newly constructed to bypass the old alignment. Old alignment runs along the railway track. Landi Kotal Railway Station situated on left side of the road at km 33+100. Southern Bypass is highly encroached having shops on both sides however; Newly constructed bypass also has limited ROW up to 15 meter.
8	km 35+000 to km 40+300	This section of road runs through mountainous terrain and number of sharp curves are encountered to deal with difficult topography. Existing highway again splits into two ways/directions from km 36+750 to km 38+930 with directional traffic going at different grades/levels. The longitudinal grades are very steep and maximum grades are up to 10% going towards Torkham.

### **2.3 M/s EA Alignment**

Initially in year 2005, National Highway Authority (NHA) had assigned the detail design of Peshawar-Torkham expressway to M/s A. A. Associates and M/s Engineering Associates and completed the initial design with new proposed dual carriageway alignment. After extensive study of existing alignment and topographic maps together with the high resolution satellite imagery it was concluded that realignment is necessary so that a four lane expressway shall meet the design criteria. Following map shows the proposed M/s EA alignment of Peshawar-Torkham expressway.



**Figure 3: M/s EA Alignment of Peshawar – Torkham expressway**

A median separated new alignment was proposed by the consultants to avoid excessive grades and sharp curvatures.

## **2.4 Motorway Alignment Study**

An extensive reconnaissance survey to assess the general geological, geotechnical and hydrological parameters and assess feasible alignments was conducted. Reconnaissance survey has been carried out using high definition imagery embedded in CIVIL 3D and a field visit to Peshawar – Torkham section. Moreover, alignment of the design carried out by M/s EA was superimposed on the high definition imagery and evaluated for further improvements in order to meet the motorway design standards.

Following main parameters were considered in determining the route selection and proposed improvements of the project road:

1. Median separated two lane dual carriageway with pavement width of 7.30 m, 1.0 meter inner and 3.5 meter outer shoulders on each side.
2. Embankment and structural heights with respect to hydraulic requirements.
3. Utmost possibility to follow natural contours to avoid cutting.
4. Provision of required radii of horizontal curvatures for design speed.
5. Avoid long and steep grades/slopes to meet the motorway design standards.
6. Improvement of horizontal alignment of existing road (where proposed alignment follows the existing alignment).
7. Minimum destruction to properties.

#### **2.4.1 Review of Existing Alignment (N-5)**

Based on the study of maps and other available data existing low-resolution contour maps were developed from photogrammetric mapping to define the motorway alignment. Based upon our topographic survey of existing alignment, detailed review of the existing alignment has been carried out and it is recommended not to use existing alignment as motorway due to following reasons:

1. Existing alignment (N-5) has many sharp curvatures (Minimum radii are up to 15 meters) which do not meet the standard design criteria for motorway.
2. At various locations the longitudinal grades are more than 6% and particularly in the mountainous section near Torkham grades are much higher (Maximum grades are up to 10%).
3. To avoid resettlement related issues while accommodating dual carriageway in build-up areas i.e., Jamrud, Walli Khel & Landi Kotal.
4. Execution shall be difficult with operational traffic and traffic management shall be required.
5. To allow local traffic/commuters to move from one place to other.

#### **2.4.2 Review of M/s EA Alignment**

M/s EA alignment also has been reviewed in light of motorway design standards. We proposed further improved alignment based upon following observations:

1. Alignment has large number of horizontal curves due to which it shall be difficult to maintain vehicular operational speed which shall increase vehicle operational cost.
2. The minimum radii of horizontal curves are 60 meter however, as per TOR minimum radius should be 125 meter to meet the standard design criterion at 60 km/h design speed.
3. The altitude of the alignment is unnecessarily high near Landi Kotal and number of loops/reverse curvatures were proposed by M/s EA to go down which led to increase overall length of the alignment.

#### **2.4.3 Proposed Motorway Alignment**

Preliminary topographic survey has been carried out in April & May, 2017 by using dual frequency GPRS. All the existing structures and the topographic features have been identified. The survey was based on UTM coordinate system. During preliminary topographic survey the construction of a dam at km 9+000 (approved alignment) was revealed. To avoid dam site alignment has to be changed between km 6+000 to km 20+000. Following figure shows the approved alignment.





Figure 4: Proposed Old Motorway Alignment of Peshawar - Torkham

By using Digital Terrain Model (DTM) and the preliminary topographic survey data the most feasible and cost effective alignment/route has been proposed for the Peshawar-Torkham Motorway and meets all design standards of TOR. The adopted minimum radiiare 125 meters and the longitudinal gradesare less than 6%. Total length of the proposed alignment is 48.18 kilometers which is less than the length mentioned in TOR as well as length of M/s EA alignment. Following map shows the proposed motorway alignment of Peshawar-Torkham.

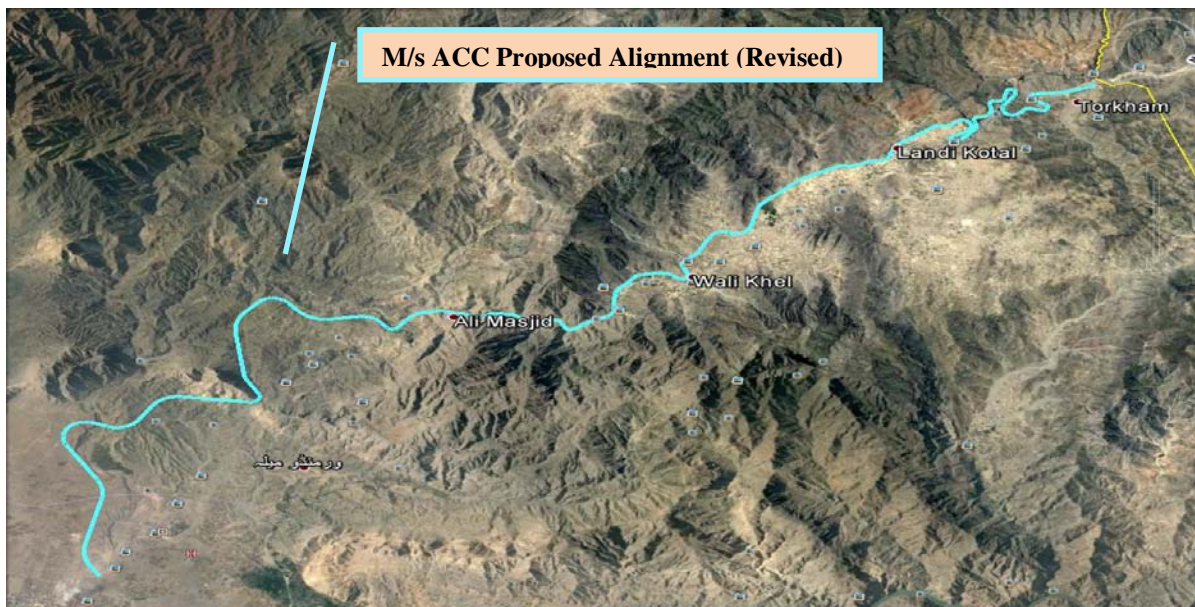


Figure 5: Proposed Motorway Alignment of Peshawar – Torkham

Following table describes the proposed/adoptedalignment.

**Table 3: Description of Proposed Motorway Alignment**

Sr. No.	Section Chainage	Alignment Description
1	km 0+000 to km 7+000	Proposed motorway alignment starts from end point of Peshawar Northern Bypass. An interchange has been proposed at Km 0+000 to connect the proposed alignment with National Highway (N-5). In the initial length, the alignment follows M/s EA alignment from km 0+000 to km 6+000. Generally terrain is rolling to flat and on right side of the alignment nullah flows.
2	km 7+000 to km 22+700	The alignment runs through mountains. At km 11+600 alignment passes near Baghyari Check Post. From km 20+700 to km 22+700 proposed alignment passes through Ali Masjid and runs along the existing alignment (N-5) on left side.
3	km 22+700 to km 26+600	From km 22+700 to km 26+000 proposed alignment passes through narrow mountainous valley and generally follows/overlaps the existing alignment (N-5). There is no other option to design alternate alignment in this reach.  A tunnel is proposed as an alternative to straighten and improve the alignment as well as to bypass the existing alignment of N-5. The length of tunnel is 2520 meter and vertical gradient is 2.68%.
4	km 26+600 to km 35+000	The alignment again follows M/s EA alignment with geometric improvements. Horizontal geometry has been improved near km 28+700. An interchange has been proposed at 29+400 (Matta Khel Interchange).
5	km 35+000 to km 40+000	Alignment in this reach runs along build-up area of Landi Kotal. At km 35+000 proposed alignment continues on the right side of mountain to remain low as much as possible. At the same location M/s EA alignment continues on the left side of mountain which led to unnecessary high altitude. Efforts have been made to accommodate the alignment with few resettlements.
6	km 40+000 to km 45+000	This part is the most difficult section and the proposed alignment runs on the left side of the existing alignment. In this section huge cutting shall be involved to accommodate motorway horizontal and vertical geometry to meet design standards.
7	km 45+000 to km 48+180	The proposed alignment crosses the existing road at km 45+000 & km 46+100. From km 47+200 to km 48+180 (end point) alignment follows the existing road (N-5).



#### 2.4.4 Proposed Alignment Improvements

In order to straighten and improve the motorway alignment 2520 meter tunnel having 2.68% longitudinal gradient has been proposed from km 22+820 (Start point of tunnel) to km 25+340 (end point of tunnel). Following table shows the locations, length and grade of tunnel:

**Table 4: Location and Lengths of Proposed Tunnel**

Sr. No.	Section Chainage	Tunnel Lengths
1	km 22+820 to km 25+340	Tunnel = 2520 meters; Vertical Grade = 2.68%

However, to construct the tunnel there are following issues:

1. Enormous cost i.e., 1.1 billions shall be involved to construct the tunnel.
2. Ventilation problem shall be there due to long length of proposed tunnel;
3. Vertical gradient is more than 2% which may not be easy to adopt.

Following map shows the improved alignment with location of tunnel:



**Figure 6: Proposed Locations of Tunnel for Improved Alignment**

#### 2.5 Alignment Comparison

An alignment comparison has been made on Google Earth to better understand the proposed motorway alignment with existing highway (N-5) route as well as already designed alignment by M/s EA. Following maps show comparison of three different alignments of Peshawar-Torkham.



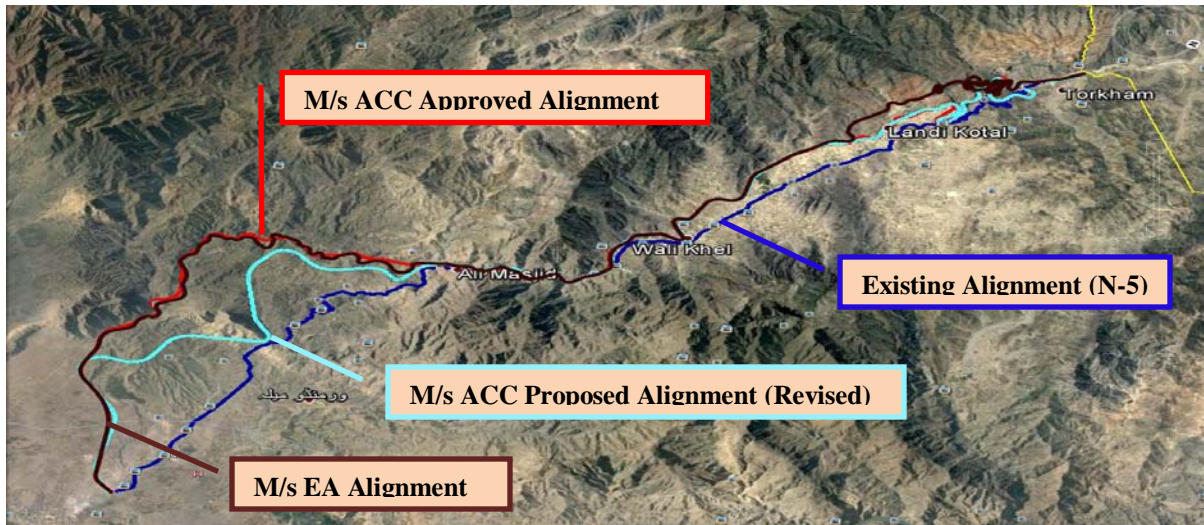


Figure 7: Peshawar-Torkham Alignment Comparison

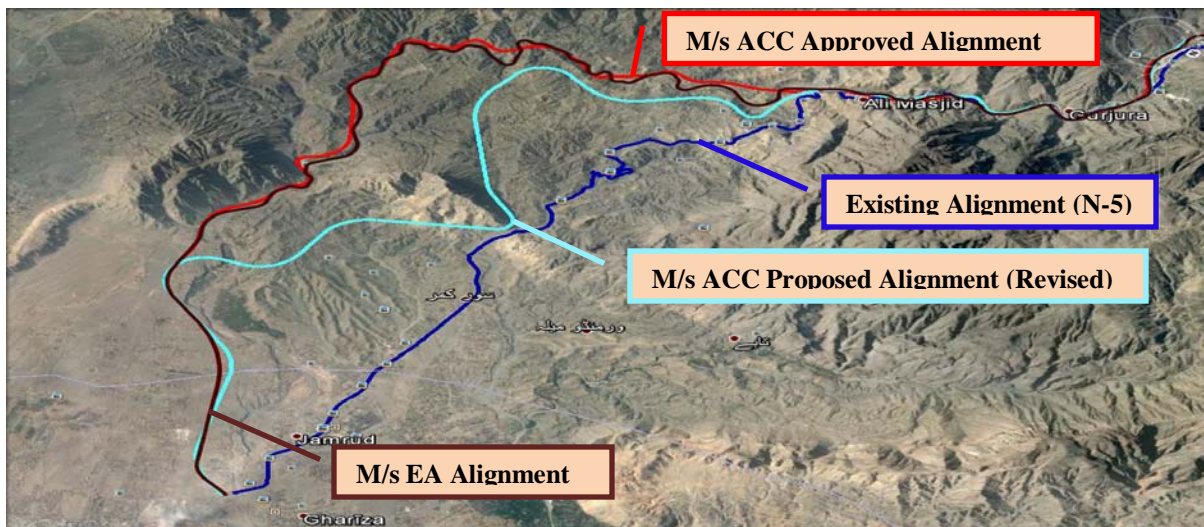


Figure 8: Alignment Comparison from Peshawar to Gurjura

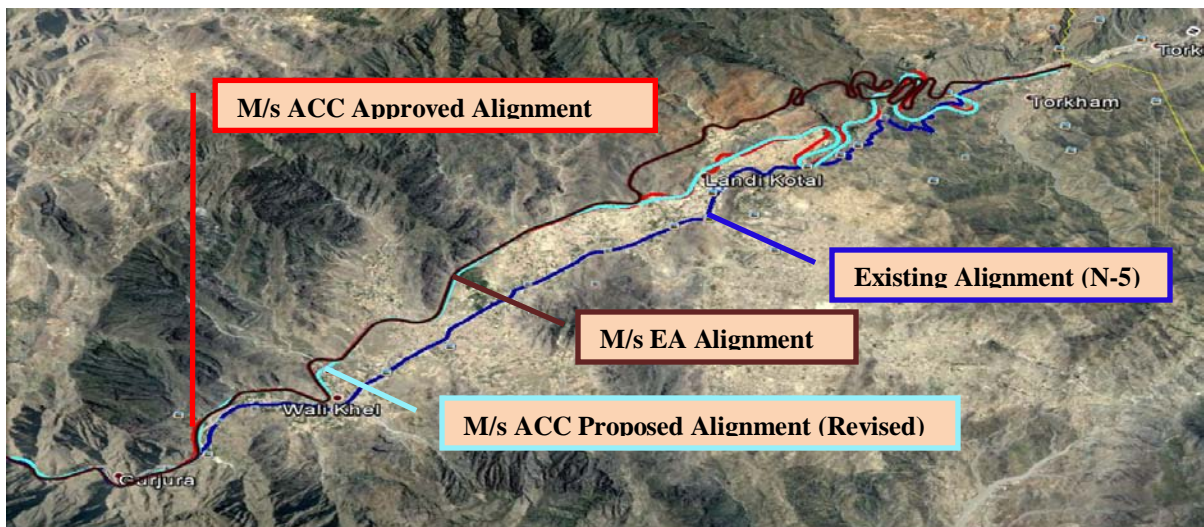


Figure 9: Alignment Comparison from Gurjura to Torkham



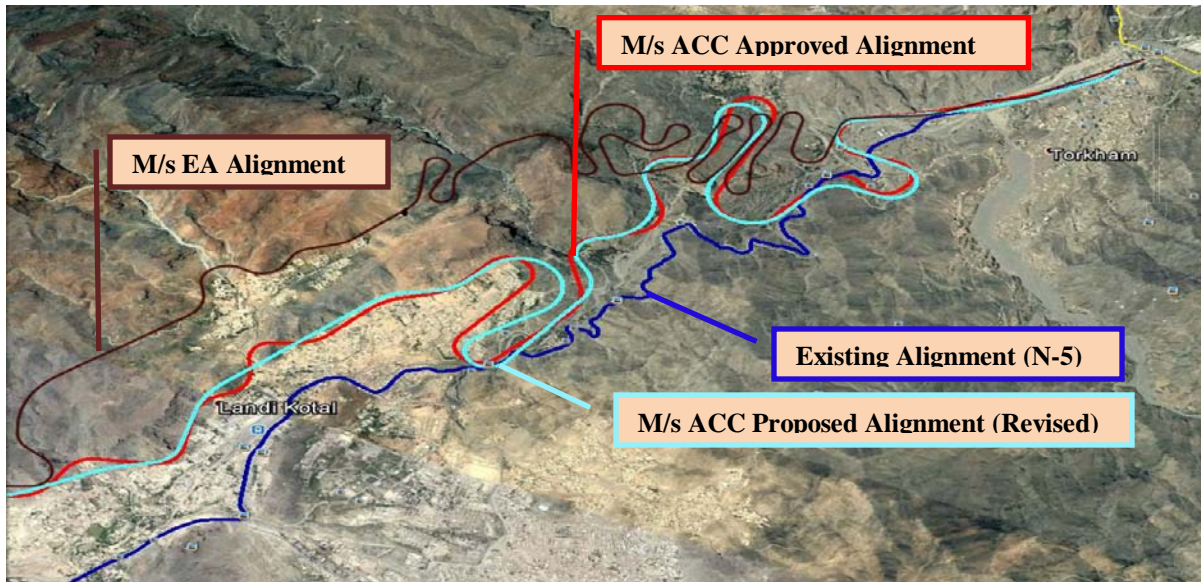


Figure 10: Alignment Comparison near Torkham

Following table shows the comparison of all alignments with route length, minimum curve radius and maximum longitudinal grade:

Table 5: Details of Peshawar - Torkham Alignments

Sr. #	Alignment Designation	Length (Km)	Minimum Radius (m)	Maximum Grade (%)
1	Existing Alignment	50	≈ 15	≈ 10 %
2	M/s EA Alignment	51.6	= 60	= 6%
3	M/s ACC Approved Alignment	47.5	= 125	< 6%
4	M/s ACC Proposed Alignment (New)	48.18	= 125	< 6%
5	M/s ACC Proposed Alignment (With Tunnel)	47.14	= 125	< 6%

## 2.6 Recommended Motorway Alignment

Engineer's estimates (Given below) have been prepared for proposed motorway alignment and tunnel alternative to compare the project cost. Based upon the enormous difference in cost i.e., 1.1Billion Rupees; it is recommended to adopt proposed motorway alignment without tunnel.

It is highlighted and also shown in Figure below that from Km 23+600 to Km 26+100 proposed motorway alignment overlaps the existing alignment (N-5) being no other option to design alternate alignment due to narrow mountainous valley. Relocation of the existing road shall be required to facilitate the local population. Further during execution of the project, traffic management shall be required for safe traffic operations.

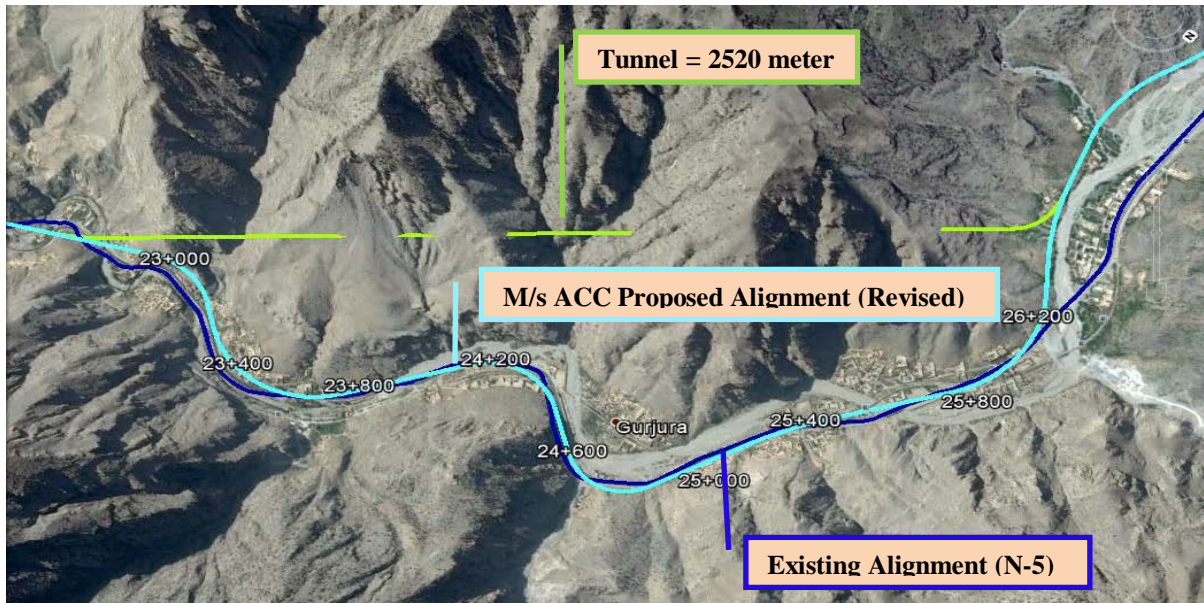


Figure 11: Location Map of Tunnel along Proposed Motorway Alignment

## 2.7 Typical Cross Sections

Peshawar-Torkham Motorway typical cross section has been prepared along with typical cross section of tunnel. Typical cross sections are attached as **Annexure-A**.

## 2.8 Engineer's Estimates

Engineer's estimates for both alternatives (i) without tunnel and; (ii) with tunnel have been prepared and summaries are presented in Tables below:

Table 6: Summary of Engineer's Estimate for Peshawar – Torkham Motorway without Tunnel

Bill	Description	Amount (Rs.)
1	Earth Work	13,518,672,653
2	Sub-Base and Base Course	4,186,294,613
3	Surfacing and Pavement	1,370,308,978
4 & 5	Structures & Drainage Works	10,515,615,904
6	Ancillary Works	1,227,229,789
7	Road Lighting	300,000,000
<b>TOTAL AMOUNT (BILL NO. 1 - 7) A</b>		<b>31,118,121,937</b>
	Miscellaneous Cost (5% of A)	1,555,906,097
	Contingency Cost (5% of A)	1,555,906,097
<b>TOTAL COST</b>		<b>34,229,934,131</b>

Note: NHA CSR 2014 (District Peshawar) rates have been used.

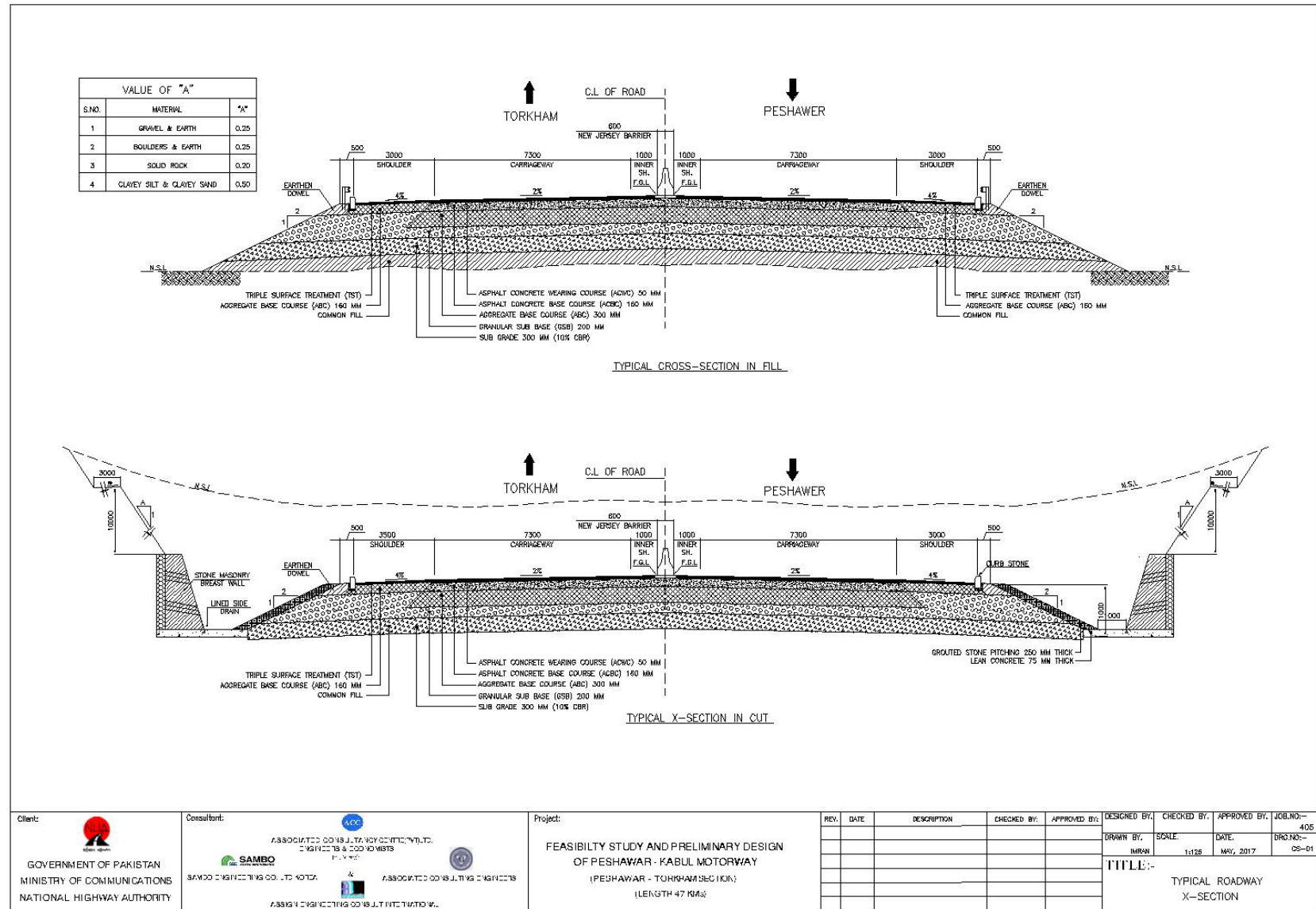
**Table 7: Summary of Engineer's Estimate for Peshawar – Torkham Motorway with Tunnel**

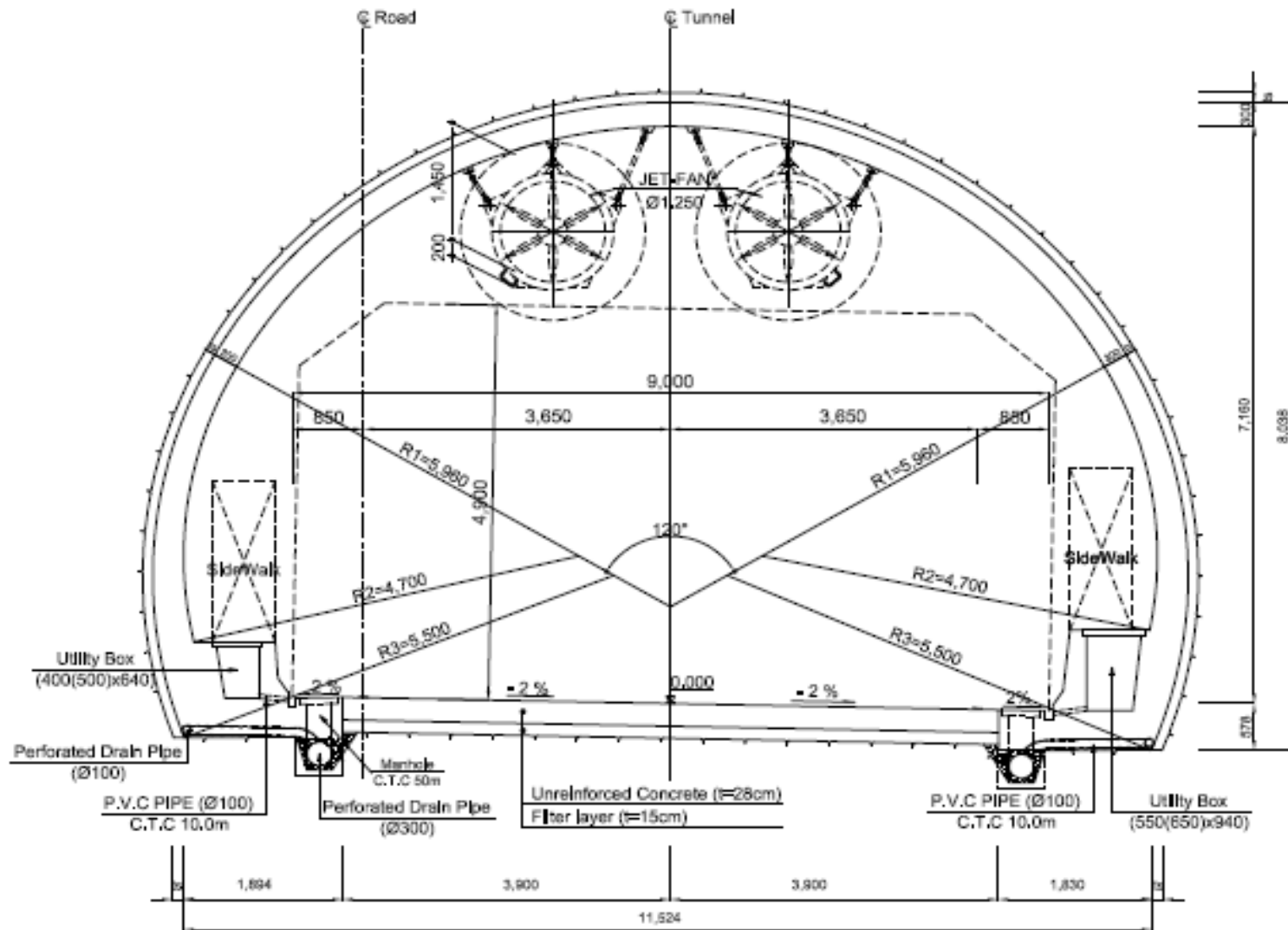
<b>Bill</b>	<b>Description</b>	<b>Amount (Rs.)</b>
1	Earth Work	11,350,873,219
2	Sub-Base and Base Course	3,728,443,631
3	Surfacing and Pavement	1,534,780,759
4 & 5	Structures & Drainage Works	14,076,274,008
6	Ancillary Works	1,148,278,168
7	Road Lighting	300,000,000
<b>TOTAL AMOUNT (BILL NO. 1 - 7) A</b>		<b>32,138,649,785</b>
	Miscellaneous Cost (5% of A)	1,606,932,489
	Contingency Cost (5% of A)	1,606,932,489
<b>TOTAL COST</b>		<b>35,352,514,763</b>

Note: Cost for Tunnel is based upon **NATM** as per the TOR.



### Typical Cross Section of Motorway



**Typical Cross Section of Tunnel**

### Typical Cross Section of Bridge

