

380.5068
NTRC
2006
08603

TECHNICAL PRESENTATION ON 2ND KOHAT TUNNEL

Date: 29th of May on Monday

Time: 10:00-11:30 a.m.

Venue: NHA Auditorium

PROGRAM

1. Recitation
2. Opening Remarks JICA Pakistan Office
3. Comment Mr. Muhammad Kazim Idris,
Chief, NTRC
4. Presentation
 - 1) Work Plan and Methodology of the Feasibility Study Mr. M. Shigeru Konda
 - 2) Japanese Technology on Tunnel Construction Mr. Makoto Kubota
 - 3) Road vs Railway Tunnel Mr. Makoto Kubota
5. Q&A
6. Remarks Mr. Shigeki Takahashi
JICA Expert, NHA
7. Closing Address Mr. Raja Nowsherwan
Member Planning, NHA



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
 MINISTRY OF COMMUNICATIONS
 NATIONAL TRANSPORT RESEARCH CENTRE
 NATIONAL HIGHWAY AUTHORITY
 GOVERNMENT OF THE ISLAMIC REPUBLIC OF PAKISTAN

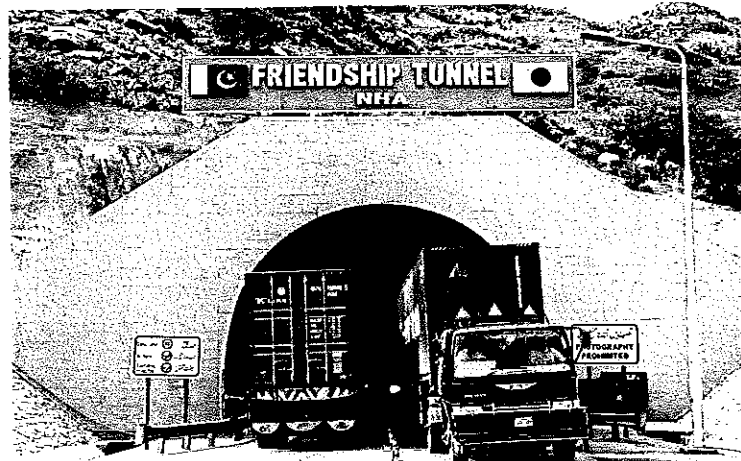


PAKISTAN TRANSPORT PLAN STUDY (PTPS) PHASE II

THE FEASIBILITY STUDY ON THE SECOND KOHAT TUNNEL AND ACCESS ROAD PROJECT

Presentation Texts on

1. The Work Plan & Methodology of the Feasibility Study on the 2nd Kohat Tunnel and Access Road
2. Introduction of Japanese Technology in Tunnel Construction
3. Brief Comments on Roads versus Railway Tunnel



Tunnel Name	Length
Thames River tunnel	360m
Mount Baker tunnel	480m
Michigan Central tunnel	3.6km
Suez Canal tunnel	1.63km
Hakone tunnel (Japan)	1.7km
Tama tunnel (Japan)	2.8km
Trans-Tokyo Bay tunnel (Japan)	9.5km
Mosoni tunnel	12.6km
Arifele tunnel	10.9km
St Gotthard tunnel	10.3km
New Kanmon tunnel (Japan)	10.7km
Simplon Tunnel	19.9km
Oh-Shinju tunnel (Japan)	12.2km
Leerdal tunnel	24.6km
Hakouda tunnel (Japan)	28.4km
Euro tunnel	49.4km
Seikan tunnel (Japan)	33.6km
Gotthard Base tunnel (Underconst.)	32.4km



KANETSU TUNNEL IN JAPAN

MAY 2006

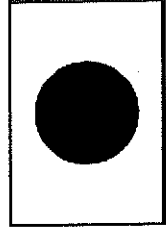
JICA STUDY TEAM

Table of Contents

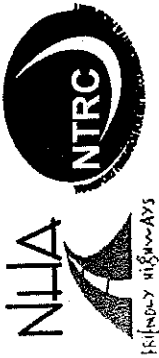
- 1 Presentation of the Work Plan and Methodology of the Feasibility Study on the 2nd Kohat Tunnel and Access Road Project
 - Main Text
 - Appendix A: Work Plan and Methodology of the FS
 - Appendix B: TOR of Topographic Survey
 - Appendix C: Appendix C: TOR of Geotechnical Investigation
 - Appendix D: Appendix D: Site Reconnaissance Photographs
- 2 Introduction of Japanese Technology in Tunnel Construction
- 3 Brief Comments on Roads versus Railway Tunnel



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



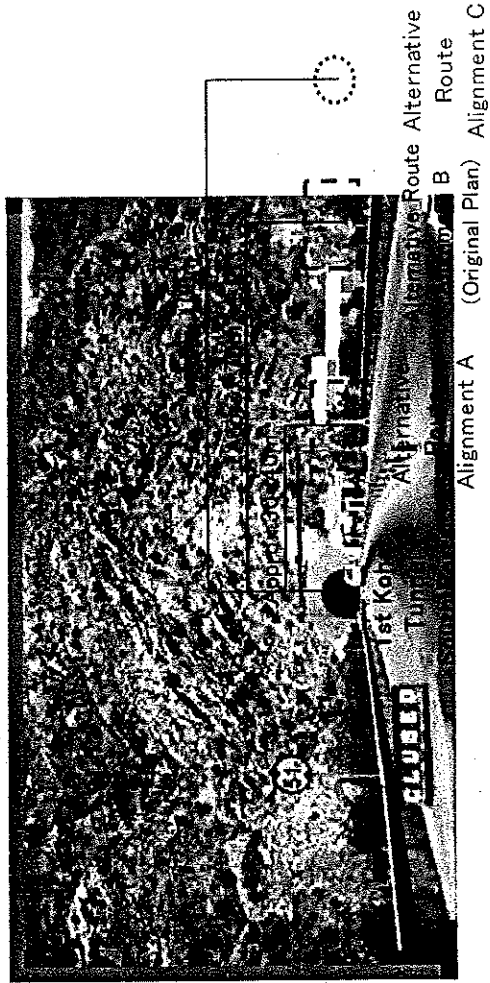
MINISTRY OF COMMUNICATIONS
NATIONAL TRANSPORT RESEARCH CENTRE
NATIONAL HIGHWAY AUTHORITY
GOVERNMENT OF THE ISLAMIC REPUBLIC OF PAKISTAN



PAKISTAN TRANSPORT PLAN STUDY (PTPS)
PHASE II

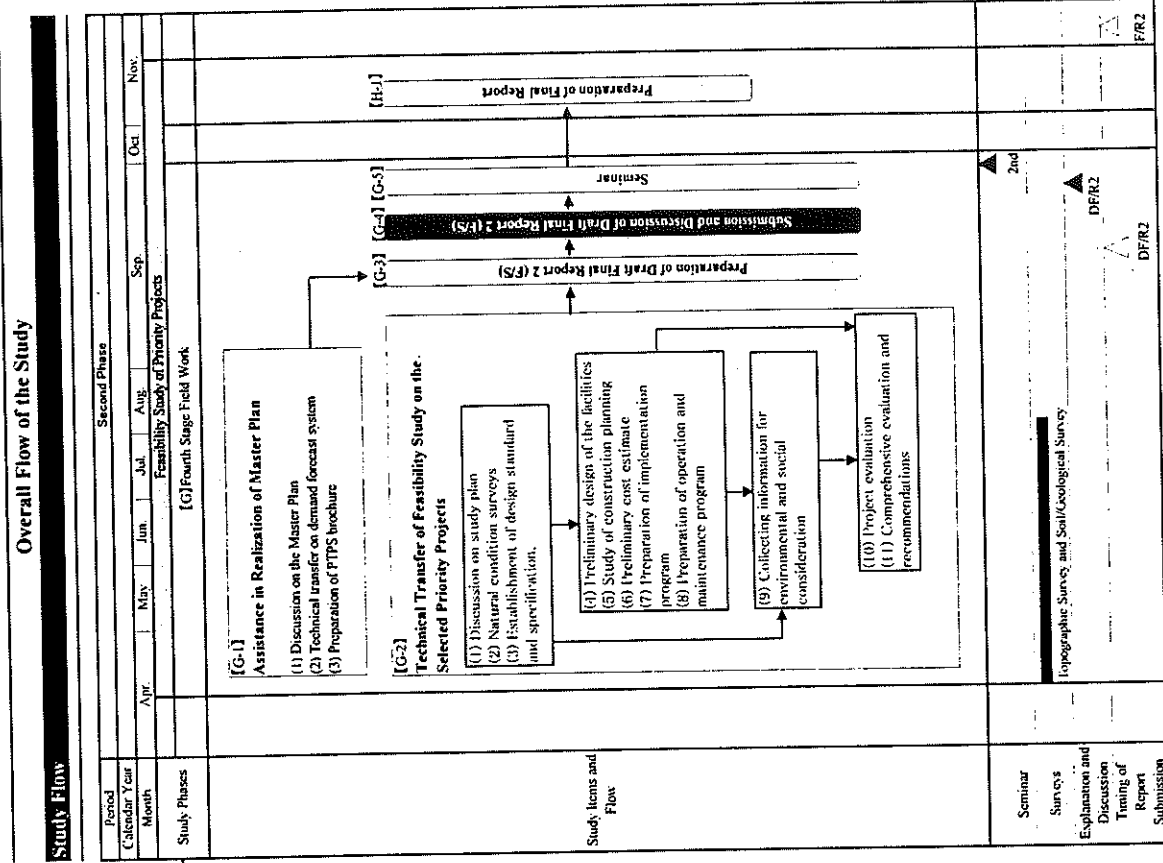
PRESENTATION
ON
ON
THE WORK PLAN & METHODOLOGY OF THE FEASIBILITY STUDY
THE 2ND KOHAT TUNNEL AND ACCESS ROAD PROJECT

May 2006
PRESENTED BY
JICA STUDY TEAM


















2. OVERALL FLOW OF THE STUDY

- **Work Flow and Study Period (right figure)**
From April 26th – End of Nov, 2006
- **Mile Stones**
 - Submission of Inception Report
 - Draft Final Report: Middle of Sep.06
 - Seminar of Draft Final Report: One week after submission of Draft Final Report
 - Final Report: End of November 2006
- **Scope of Works (right figure) for FS**
 - G-2: Technical Transfer of Feasibility Study on Selected Priority Project (2nd Kohat Tunnel and Access Road Project)
 - G-3: Preparation of Draft Final Report 2 (F/S)
 - G-4: Submission and Discussion of Draft Final Report 2 (F/S)
 - G-5: Seminar
 - G-6: Preparation of Final Report



3. FS Study Staff

- JICA Study Team**
 As in the right figure (also refer to next slide)
- Counterpart**
- National Highway Authority (refer to next slide)
 - National Transport Research Center (refer to next slide)

	Members of the Study Team for Pakistan Transport Plan Study (Phase II) In the Islamic Republic of Pakistan						
 Mr. Mubashir Shkriya Team Leader / Road Counterpart transport planning	 Mr. Feroze Wajid Deputy team leader / Road planning (I) / Transport planning	 Mr. Khalid Tanzeem Deputy team leader / Road planning (II) / Road facility planning	 Mr. Shogun Kubota Team leader / Road Transport planning	 Mr. Mubashir Shkriya Cargo transport policy / Cargo facility planning	 Mr. Mubashir Shkriya Geologist / Slope observer planning	 Mr. Shikun Kubota Highway / Highway planning	 Mr. Masahiro Kubota Tunnel engineer / Construction Planning
 Mr. Kenji Masuda Tunnel facility engineer / Cost estimate specialist	 Mr. Masahiro Kubota Economic / Financial analysis	 Mr. David Gordon Leez Social environmental specialist	 Mr. Haseori Karaki Natural environmental specialist	 Ms. Michiko Maruyama Administrator / Topographic and geological survey			

4. Staff Assignment (NHA)

National Highway Authority

NHA Counterpart	Position	Name / Title	Feasibility Study Stage											
			Year 2006											
			April	May	June	July	August	September	October	November				
1	Contact Person (NHA Head Office)	Mr. S.A. Latif, General Manager, Planning												
2	Contact Person (NHA Kohat Tunnel D & B Office)	Mr. Muhammad Naseem Khattak, Chief Operation Officer												
3	Highway design	Mr. Asim Amin (Designer), General Manager												
4	Highway planning	Mr. Jehanzeb Nisazi, Assistant Director (Planning)												
5	Geologist / Slope disaster prevention planning /	Mr. Sijid Mehmood, Director (Makorrela)												
6	Tunnel engineer / Construction planning (including bridges)	Mr. Jhangir Faruk, Assistant Director (Design)												
7	Tunnel facility engineer / Cost estimate specialist	Mr. Shabir, Cost Estimate Specialist												

Note: Assignment of the counterpart of NHA

JICA Study Team	Position	Name	Feasibility Study Stage											
			Year 2006											
			April	May	June	July	August	September	October	November				
1	Team leader / Comprehensive transport planning	Mr. Minoru Shibuya	26	1				1	1					
2	Deputy team leader / Road planning (1) / transport planning	Mr. Tetsuo Wakui	28	10	24									
3	Deputy team leader / Road planning (2) / Road facility planning	Mr. Koichi Yanuma			17	25	7/1	26	10	24				
4	Traffic demand analysis / Traffic demand forecast	Mr. Shogo Uchida	28	12	9									
5	Cargo transport policy / Cargo facility planning	Mr. Mazhar Iqbal	28	10	24									
6	Geologist / Slope disaster prevention planning	Mr. Ateutoshi Sakata			17	13	31							
7	Highway engineer / Highway planning	Mr. Shigeru Kondo	28	10	9			20	10	24				
8	Tunnel engineer / Construction planning	Mr. Makoto Kubota			13	13	14							
9	Tunnel facility engineer / Cost estimate specialist	Mr. Hishijima Kunieki			12									
10	Economic / Financial analysis	Mr. Masahito Homma						11	13	24				
11	Social environmental specialist	Mr. David Gordon Lees			17	10	15	28	10	24				
12	Natural environmental specialist	Mr. Hironori Kuroki			17	10	15	2	30	16				
13	Administrator / Topographic and geographical survey	Ms. Michiko Matsumoto	28	10	9	24		26	10	24				

Note: Staff assignment of the JICA Study team mostly working together with the NHA counterpart

Total Period of Study

Draft Final Report

Final Report

Seminar

5. Staff Assignment (NTRC)

National Transport Research Center

Position	Name / Title	Feasibility Study Stage											
		Year 2006											
		April	May	June	July	August	September	October	November				
1 PPS FS Coordinator (NTRC)	Mr. Beshir Ahmed Deputy Chief of NTRC												
2 Deputy Coordinator (NTRC)	Mr. Khizer Javed Research Officer												
3 Traffic demand analysis / traffic demand forecast	Mr. Masoud Babot Assistant Chief												
4 Economic / Financial analysis	Mr. Shabbaz Latif Mirza Research Officer												
5 Social / Natural environmental specialist													

Note: [a, b, c, d] Assignment of the counterpart of NTRC.

Position	Name	Feasibility Study Stage											
		Year 2006											
		April	May	June	July	August	September	October	November				
1 Team leader / Comprehensive transport planning	Mr. Minoru Shibuya	26	7				1	24					
2 Deputy team leader / Road planning (1) / Transport planning	Mr. Tetsuo Nakui	20	10	20									
3 Deputy team leader / Road planning (2) / Road facility planning	Mr. Koichi Tanuma	20	13	17	0.5	7/1	20	10	24				
4 Traffic demand analysis / Traffic demand forecast	Mr. Shogo Uchida	20	13	9									
5 Cargo transport policy / Cargo facility planning	Mr. Mezhar Iqbal	26	19	20									
6 Geologist / Slope disaster prevention planning	Mr. Atsutoshi Saketa	26	19	17	13	31							
7 Highway engineer / Highway planning	Mr. Shigeru Konda	26	19	17	9	20	10	24					
8 Tunnel engineer / Construction planning	Mr. Makoto Kubota	26	19	17	21	14							
9 Tunnel facility engineer / Cost estimate specialist	Mr. Kuniaki Nishijima	26	19	17	12	35							
10 Economic / Financial analysis	Mr. Masahito Huma	26	19	17	11	26							
11 Social environmental specialist	Mr. David Gordon Lees	26	19	17	15	26							
12 Natural environmental specialist	Mr. Hiroonori Kuroki	26	19	17	15	26							
13 Administrator / Topographic and geographical survey	Ms. Michiko Matsumoto	26	19	17	15	26							
Total Period of Study													
Draft Final Report													
Final Report													

Note: [] Staff assignment of the JICA Study Team mostly working together with the NTRC counterpart

Drawn by []

6. Detailed Study Schedule

Work Items / Activities	Year 2006											
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
G-2 Technical Transfer of Feasibility Study (1) Discussion on study plan 1) Collection of existing report and data 2) Site reconnaissance 3) Analysis of data and preparation of survey plan 4) Presentation and discussion of survey plan --- (2) Natural condition survey & mapping 1) Topographic survey & mapping a. Preparation of IOB's b. Selection of survey firm (a) c. Topographic survey & mapping - Start Point (Kohat Toll) - Tunnel S. Portal - Tunnel N. Portal - End Point (Dara Adam Khel) d. Realignment study section - Satellite image production for realignment study section, Sta. 17+000 - Tunnel (S. Portal) - Topographic survey & mapping 2) Geotechnical investigation a. Preparation of IOB's b. Selection of survey firm (a) c. Borings and sampling - Tunnel portals - High-bankments at Sta. 18+800 - 19+800 - High-cuts in the realignment study section - Laboratory tests and analysis for samples d. Traffic survey and demand forecasts a. Traffic survey planning b. Traffic survey c. Traffic demand forecasts and evaluation d. Highway capacity analysis for pavement design e. Alignment analysis for the 2nd Kohat Tunnel 3) Establishment of design standard and specifications 1) Roads (Alignments, cuts/embankments, drainage, bridges, etc.) 2) Bridges 3) Tunnels 4) Pavements 4) Geometric design 5) Other facilities of the facilities --- (3) Preliminary design of the facilities 1) Roadway a. Horizontal alignments, profile and cross sections b. Sections Sta. 0 - Sta. 30 (End Point) c. Alternative route study (Sta. 17.5 - Sta. 20.0) d. Alternations and interchanges e. Junctions and interchanges f. Drainage structures g. Pavements h. Slope protection (Tunnel portals and roadway) i. Other facilities 2) Bridges 3) Tunnels 4) Tunnel (Planning and design) a. Tunnel portals b. Tunnel facilities c. Ventilation facilities d. Lighting facilities e. Emergency facility f. Tunnel interior --- (4) Others 1) Study of construction planning 2) Roadway (high-cuts, pavement, intersection, etc.) 3) Bridges 4) Tunnels --- (5) Preliminary cost estimate 1) Cost estimates 2) Quantity estimates 3) Preparation of Implementation Program 4) Preparation of Operation and Maintenance Program 5) Environmental and Social Implications 6) Project evaluation, validation and recommendations 7) Comprehensive Report 2 (F/S) 8) Preparation of Draft Final Report (F/S)												
G-3 Submission and Discussion of Draft Final Report (F/S) G-3 Preparation of Final Report G-4 Submission G-5 Preparation of Final Report Notes: Workshops												

7. Key Issues

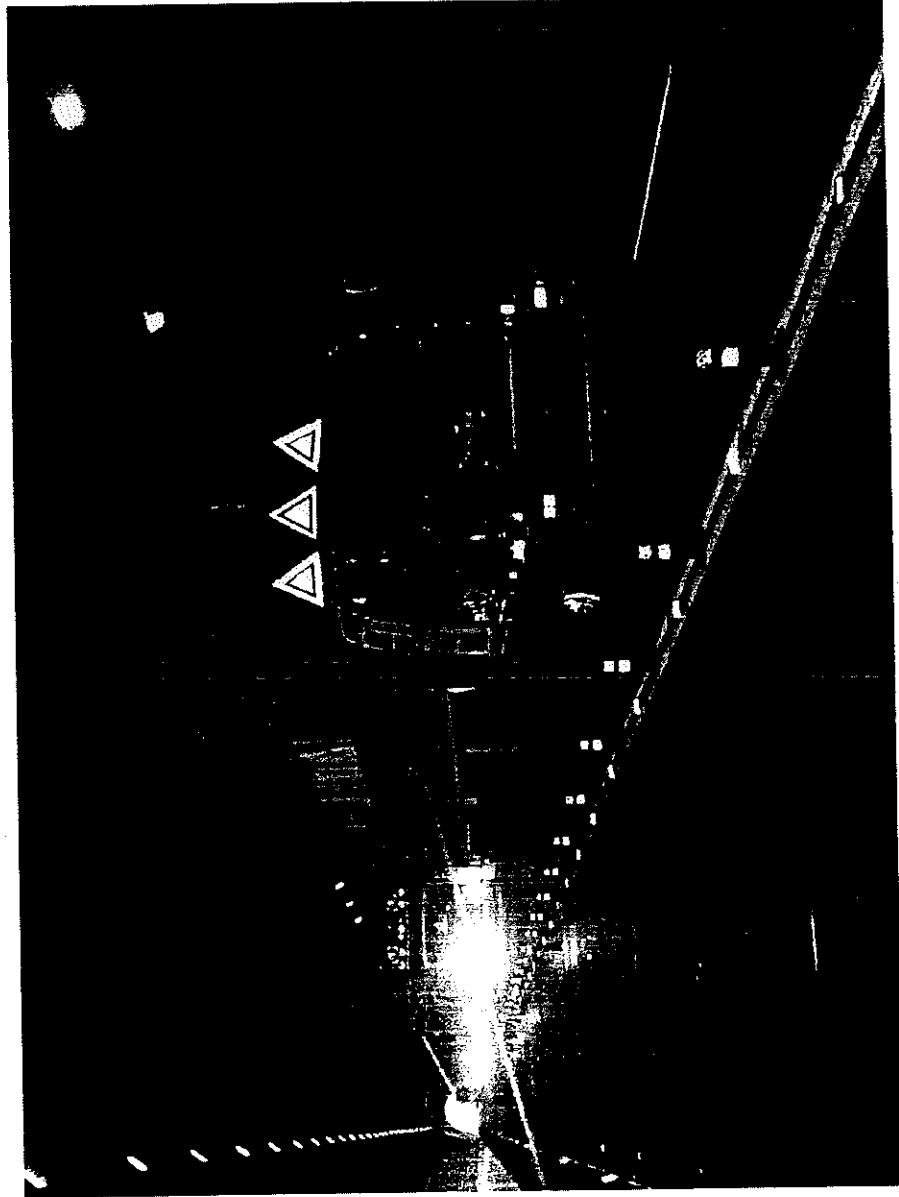
7.1 Current Problems of 1st Kohat Tunnel

Traffic Capacity of
1st Kohat Tunnel
(Two ways / single
lane)

Travel Speed of
Vehicles
Design: 60km/hr
Control: 40km/hr
Actual: 10-15km /hr
(due to slow
movement of heavy
vehicles)

Auto Emissions
Problem
(CO₂, NOx and
visibility)

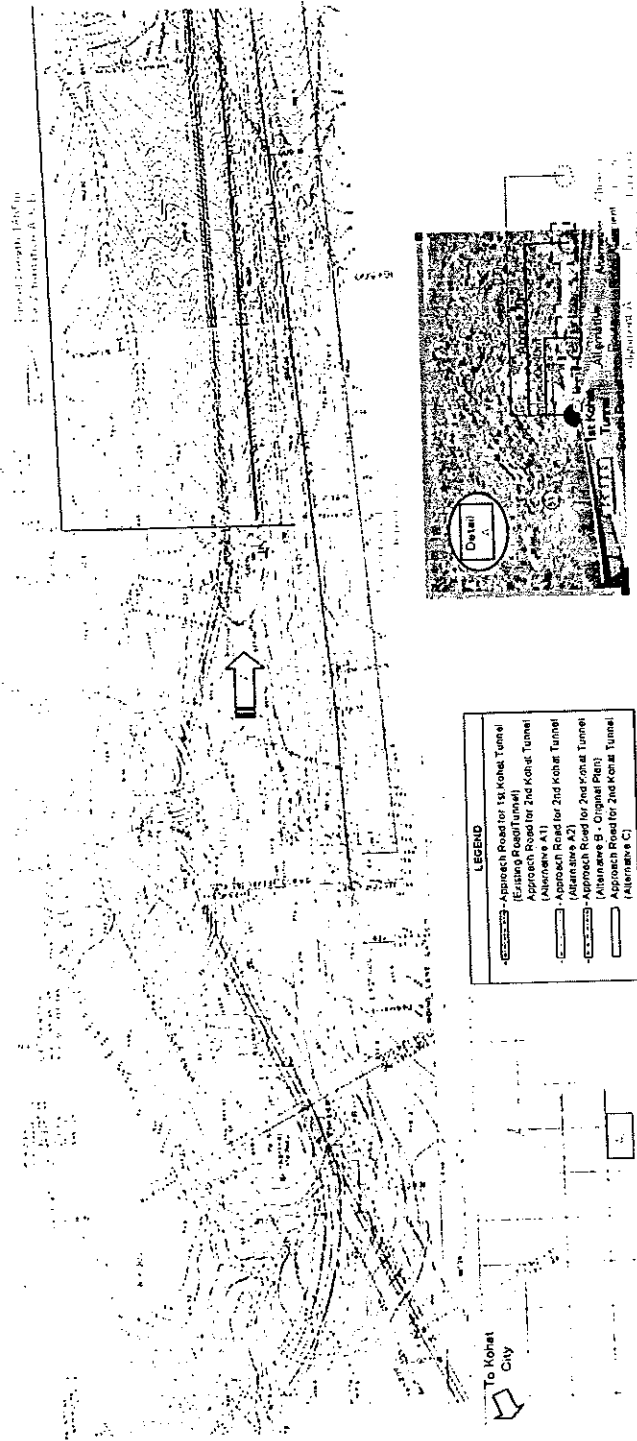
It will become a
bottle neck of N-55
in near future



7. Key Issues

7.2 Planning of 2nd Kohat Tunnel South Portal

Location of South Portal
 Alternatives A1/A2, B and C
 Technical and Economical Evaluation of Alternatives



- Notes:**
- (1) 1st Kohat Tunnel South Portal at Sta. 20+194.165 / Sta. 16+247.000 (-3547.167)
 - (2) 1st Kohat Tunnel North Portal at Sta. 18+132.000
 - (3) Break Sta. 20+194.165 / Sta. 16+247.000 (-3547.167)
 - (4) Length of 1st Kohat Tunnel (L=1885m)

(5) Summary of Alternative Tunnel Route Alignments

Item	Alternative A	Alternative B	Alternative C
Tunnel Length -	1885 m	1885 m	2280 m
Tunnel Slope	2.4 %	2.2 %	2.5 %
Formation (S-Portal)	683.271 m	672.041 m	656.262 m
Height (N-Portal)	111.517 m	713.512 m	713.512 m
Technical Evaluation	Good	Bad	Good
Cost	Low	High	Medium
Overall Evaluation	Same as Original	Original	Higher than Original

Note: Approximate length

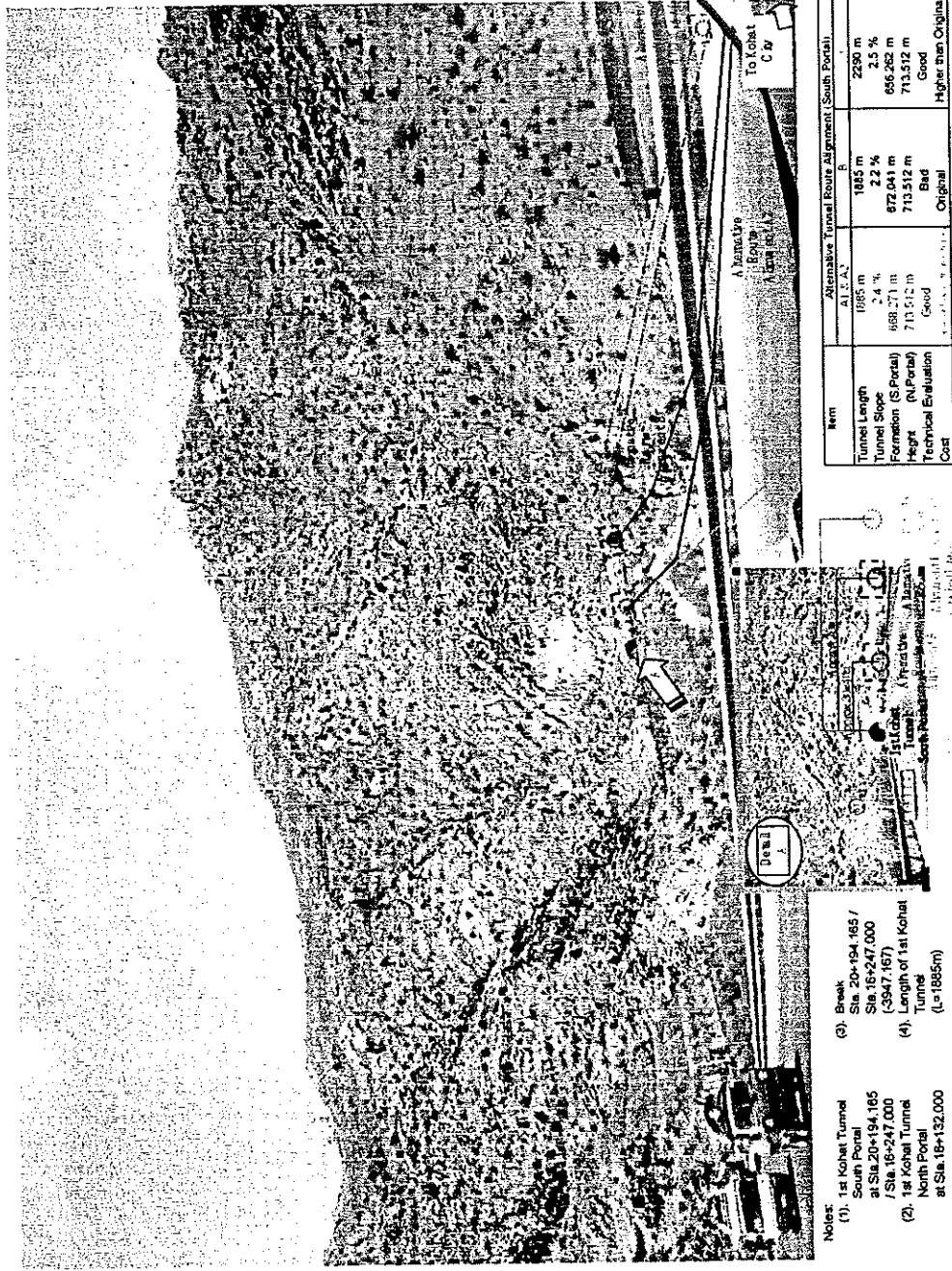
7. Key Issues

7.2 Planning of 2nd Kohat Tunnel South Portal (continued)

Position of South Portal

Alternatives A1/A2, B and C

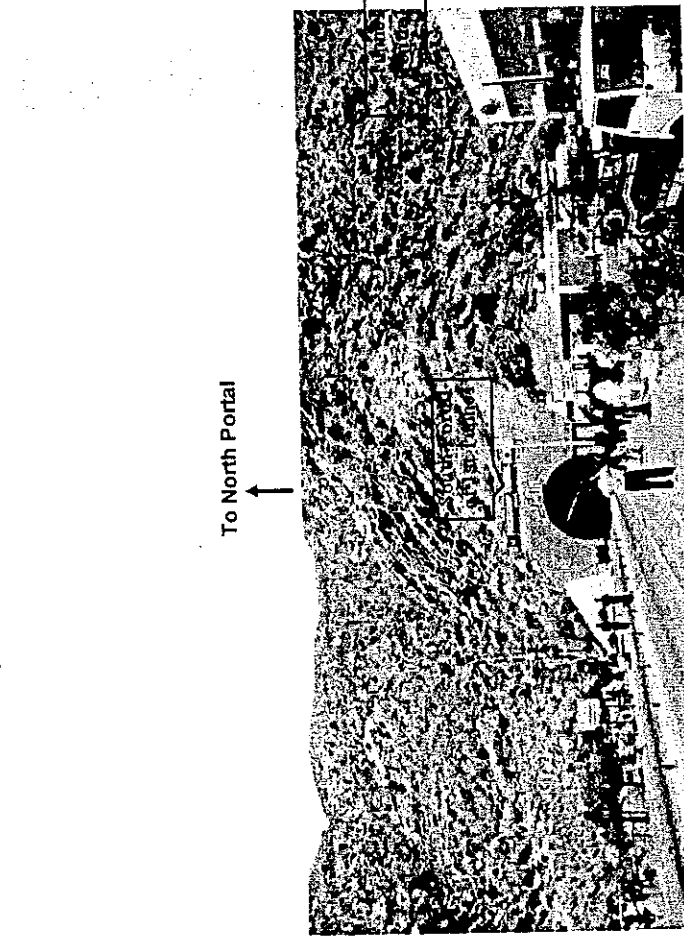
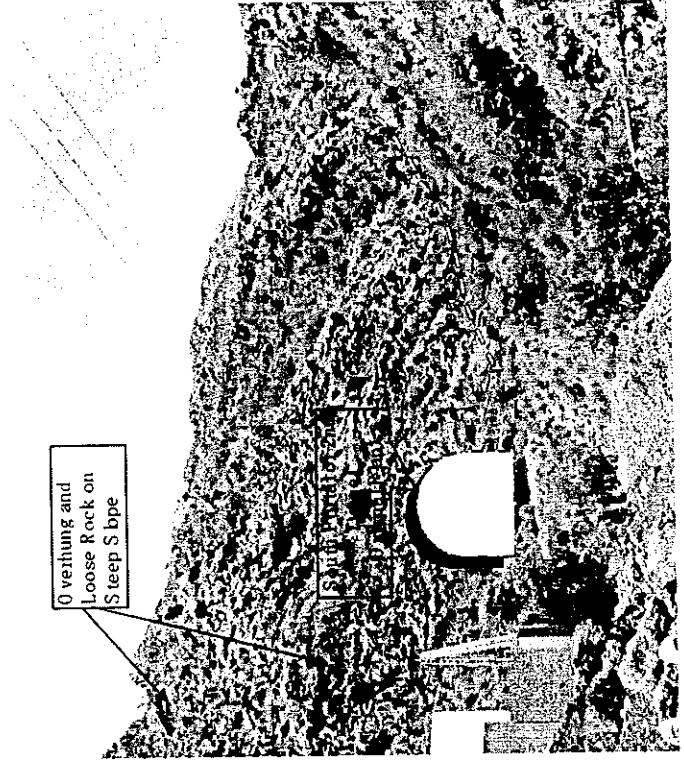
Technical and Economical Evaluation of Alternatives



7. Key Issues

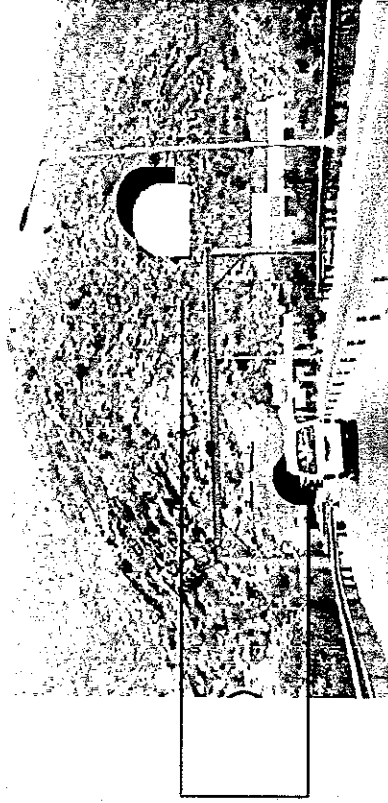
7.2 Planning of the 2nd Kohat Tunnel South Portal (continued)

- Major Problems of South Portal in the Original Plan
 - Steep creek at portal entrance
 - Overhanging rock
 - High rock cut at approach road
 - Deep valley crossing at the tunnel approach road



7. Key Issues

7.2 Planning of 2nd Kohat Tunnel South Portal (continued)

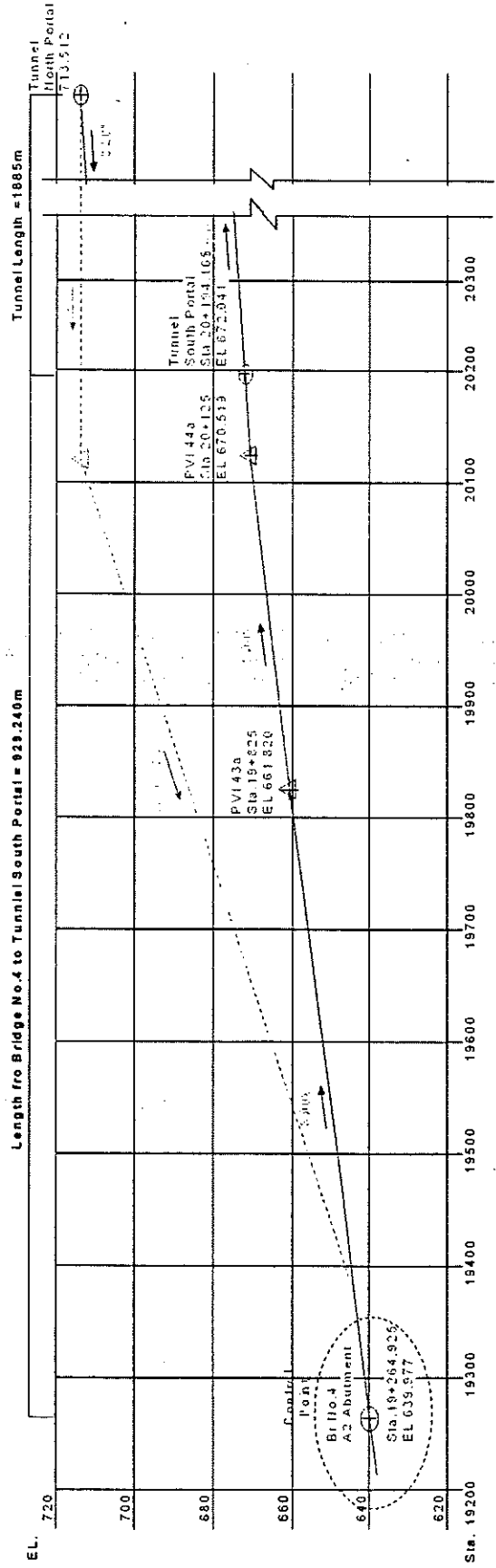


Slope of New Tunnel at zero (0) percent

Notes:

It is not possible to construct a new tunnel at 0% slope (level).

However, travel speed of vehicle climbing up the current tunnel will be improved substantially as passing over in the tunnel is free.



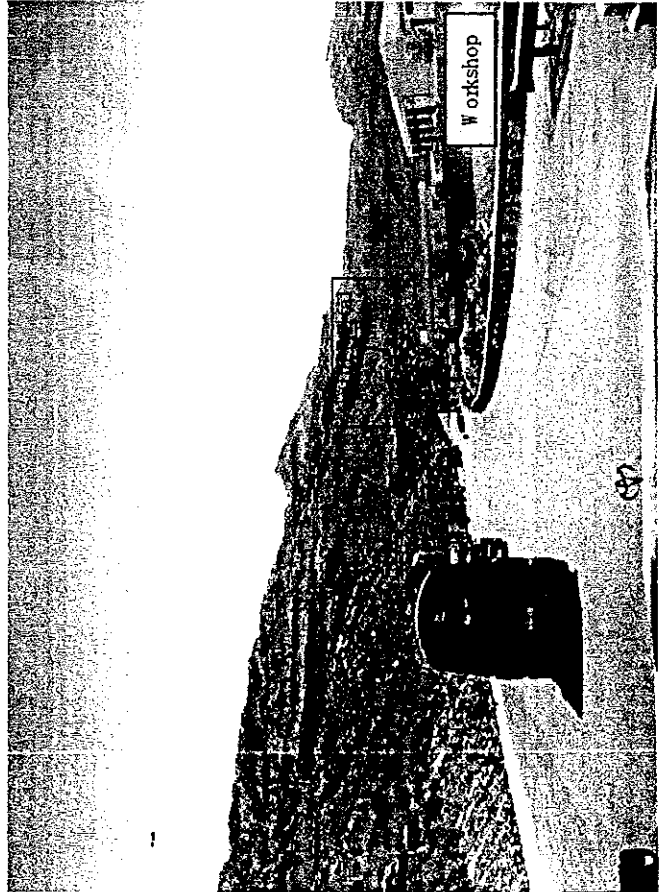
PROFILE OF APPROACH ROAD FOR SOUTH PORTAL

7. Key Issues

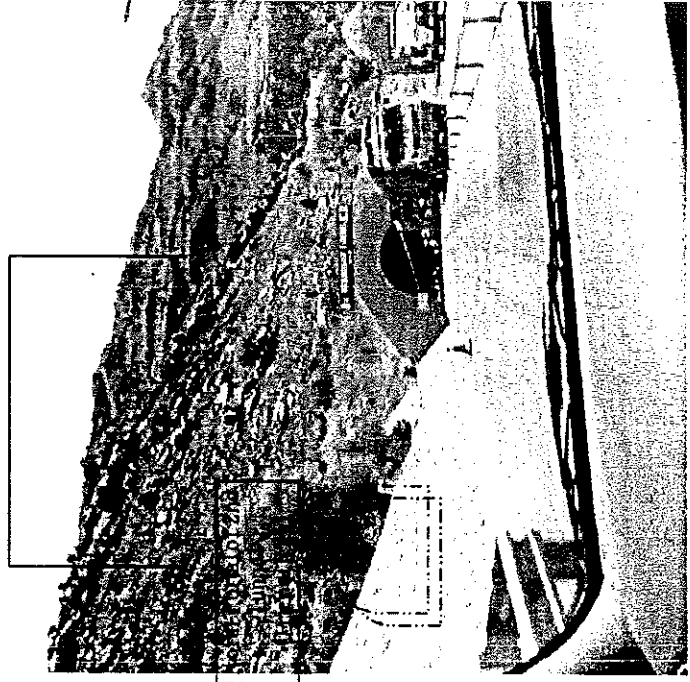
7.3 Planning of 2nd Kohat Tunnel North Portal

No problems in the original plan of the north portal except hard rock excavation by explosive

30m between the 1st and 2nd tunnels



Picture for Direction A: Approach of 2nd Kohat Tunnel



Picture of Direction B: Steep Creek at South Portal of 2nd Kohat Tunnel

7. Key Issues

7.4 Alternative Route Study for High Cut /High Fill Section for Approach Road (Sta.18+000 – Sta.20+150) at the 2nd Kohat Tunnel South Portal

High Cut H=23m

(Sta.18+000 – Sta.18+785)

High Embankment H=30m

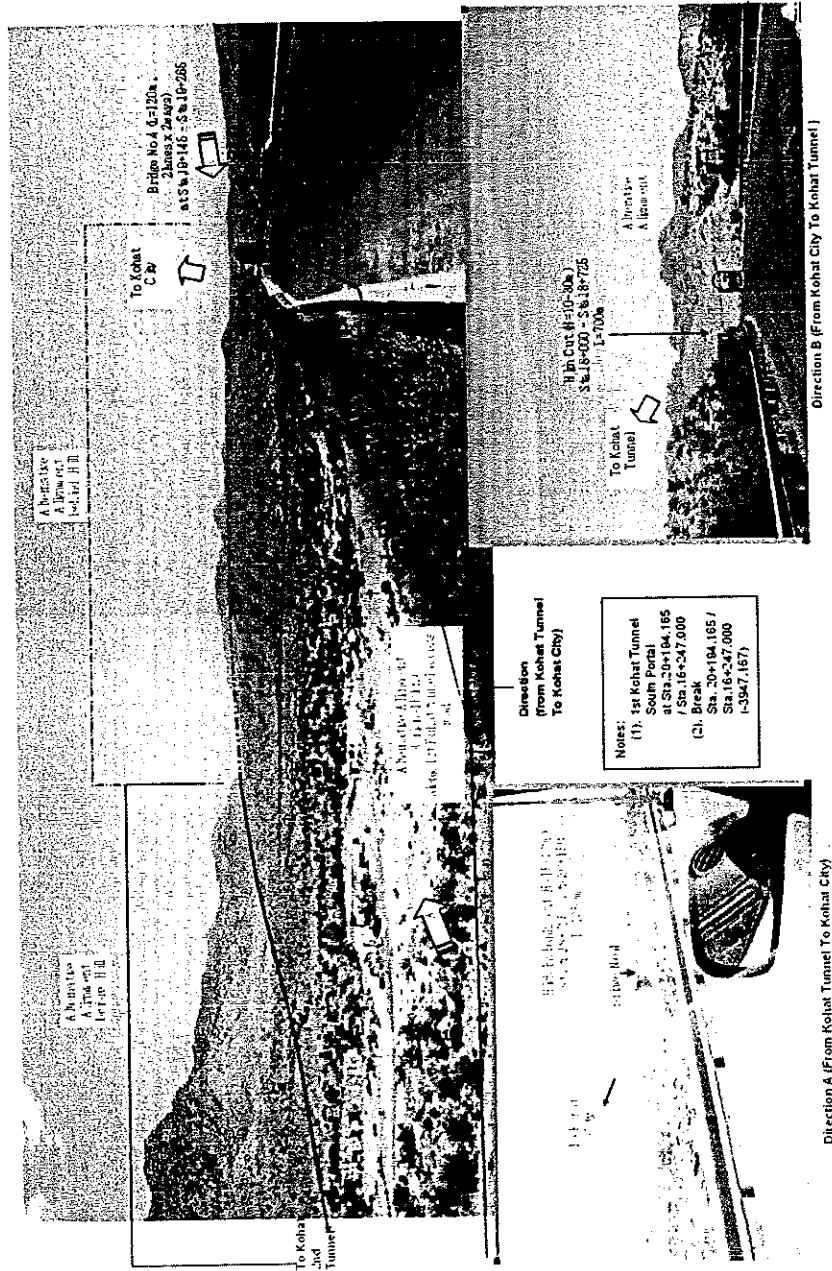
(Sta.18+785 – Sta.20+150)

Alternative routes study by a satellite image picture

Topographic survey and geotechnical investigation

Comparison of the original plan with the alternative plan

Note: Original plan will be advantageous as Bridge No.4 was already constructed as dual carriageway.



7. Key Issues

7.5 High Cut and High Embankment for Access Road

High Rock Cuts (H=6m - 35m) at about 10 locations (table below)
 Estimated rock excavation: 450,000 m³
 Rock excavation without disturbing the passing traffic (ADT 7,500)

List of High-Cuts and Initial Quantity Estimate

No.	From (Sta.)	To (Sta.)	Length (m)	Width (m)	Average Cut Height (m)	Estimated Total Quantity (m ³)	Classification of Materials			Remarks (Max Cut (m)	
							%	Common (m ³)	Rock (m ³)		
South Section: Kohat Toi (Start Point) - Kohat Tunnel (South Portal)											
S-1	7.325	7.475	150	13	10	19,500	5:	970	95	18,530	28
S-2	14.425	14.625	200	13	5	13,000	70:	9,100	30	3,900	10
S-3	15.250	15.425	175	13	18	40,950	5:	2,050	95	38,900	32
S-4	18.000	18.725	725	13	12	113,100	60:	67,860	40	45,240	23
S-5	19.753	20.178	425	13	20	110,500	0:	0	100	110,500	35
Sub-Total:						297,050	27:	79,980	73:	217,070	
North Section: Kohat Tunnel (North Portal) - Dara Adam Khel (End Point)											
N.1a	18.132	18.325	193	20	12	46,320	5:	2,320	95	44,000	15
N.1b	18.325	18.825	500	11	6	33,000	0:	0	100	33,000	12
N.2	21.575	21.725	150	11	15	24,750	0:	0	100	24,750	32
N.3	22.300	22.400	100	11	4	4,400	0:	0	100	4,400	6
N.4	23.850	23.975	125	11	12	16,500	0:	0	100	16,500	24
N.5	24.300	24.400	100	11	8	8,800	0:	0	100	8,800	14
Sub-Total:						133,770	2:	2,320	98:	131,450	
Total:						430,820	19:	82,300	81:	348,520	

Note:

7. Key Issues

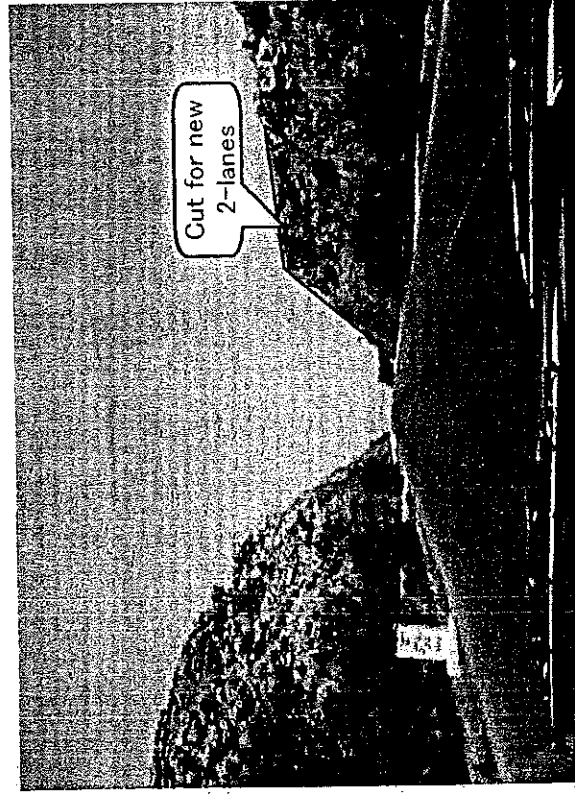
7.5 High Cut and High Embankment for Access Road (continued)

Cut No.S-1 at Sta.7+325 – Sta.7+475 (L=150m, H=28m)

Kohat Toi (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)



Direction (From Start Point to Tunnel)
 No.S-1 : Sta.7+325 - Sta.7+475 (L=150m)
 Maximum Cut Height = 28m



Direction (From Start Point to Tunnel)

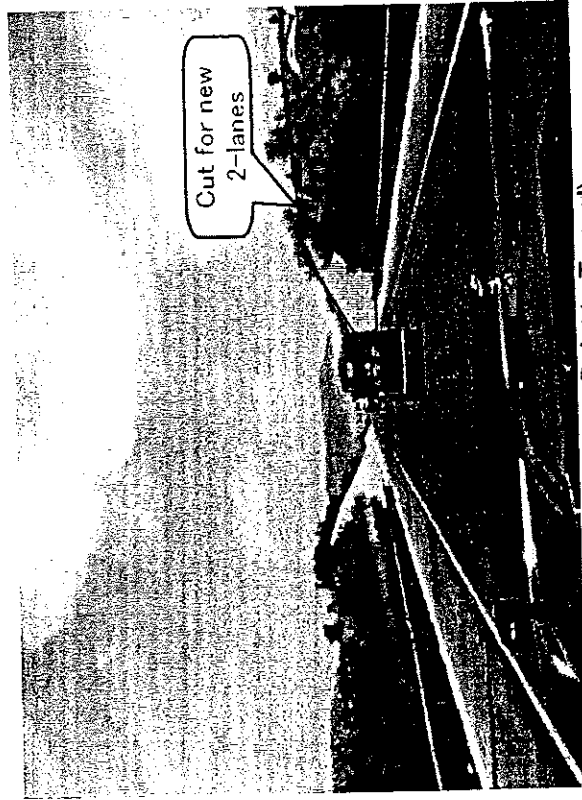
Common:	970 m ³
Rock:	18,530 m ³
Total:	19,500 m³

7. Key Issues

7.5 High Cut and High Embankment for Access Road (continued)

Cut No.S-2 at Sta.14+425 – Sta.14+625 (L=200m, H=10m)

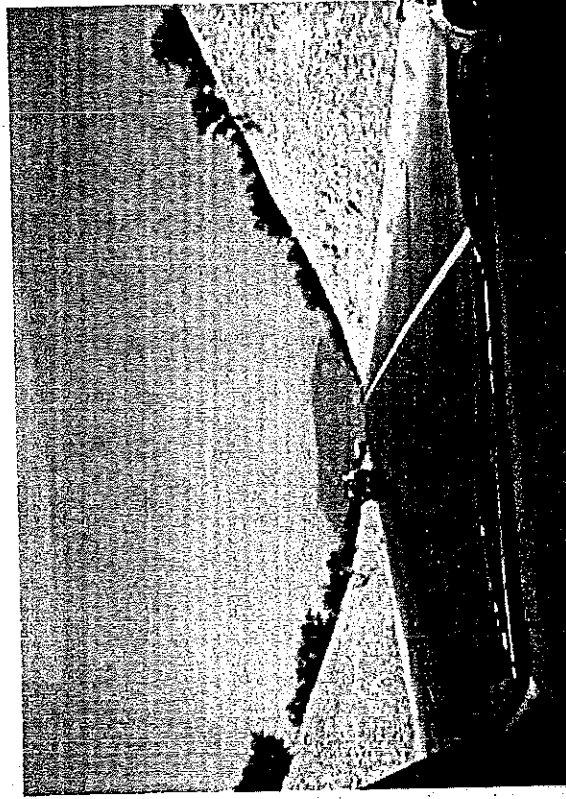
Rawal Pindi Intersection (N-80 Intersection) - Kohat Tunnel South Portal Sta.20.178 (Sta.16+247)



Direction (From Start Point to Tunnel)

No.S-2 : Sta.14+425 - Sta.14+625 (L=200m)

Maximum Cut Height = 10m



Direction (From Start Point to Tunnel)

Common: 9,100 m³

Rock: 3,900 m³

Total: 13,000 m³

7. Key Issues

7.5 High Cut and High Embankment for Access Road (continued)

Cut No. N-2 at Sta.21+575 – Sta.21+725 (L=150m, H=32m)



Direction (From Tunnel to End Point)

No. N-2 : Sta.21.575 - Sta.21+725 (L=150m)

Maximum Cut Height = 32m



Direction (From End Point to Tunnel)

Common: 0 m³

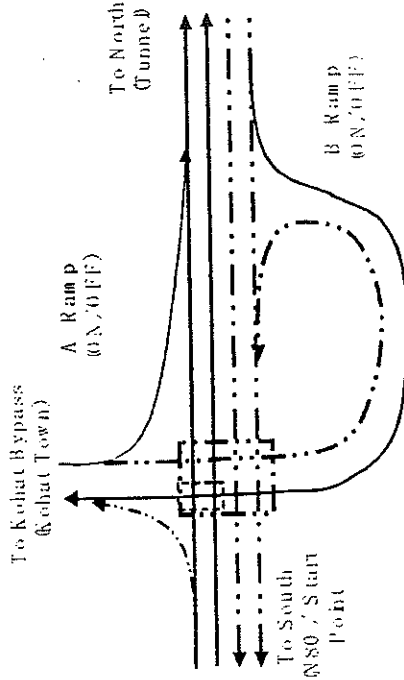
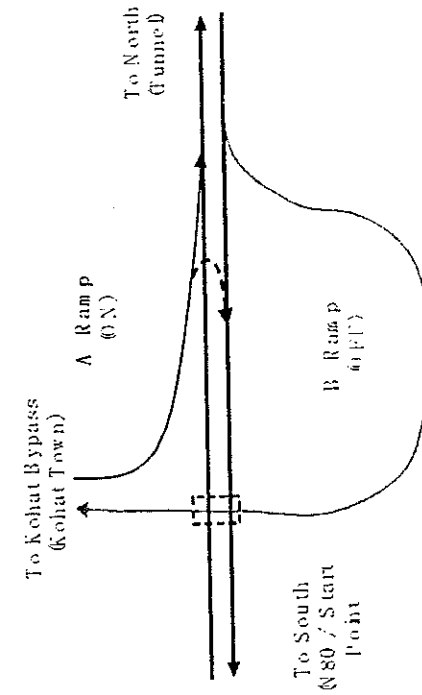
Rock: 24,750 m³

Total: 24,750 m³

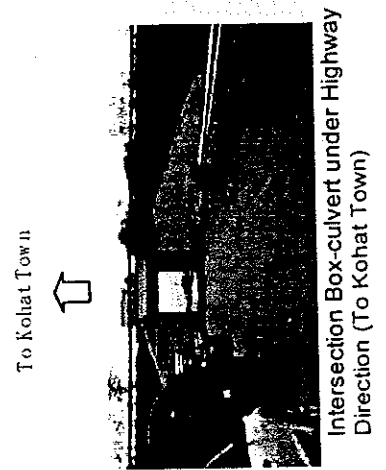
7. Key Issues

7.6 Intersection for Kohat Town Bypass

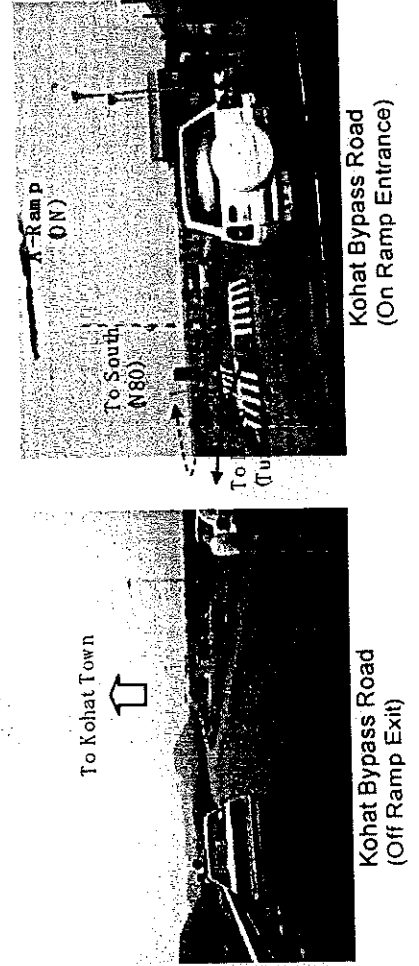
Construction of proper On/Off Ramps



Current Intersection



Intersection Improvement Plan



7. Key Issues

7.7 Bridge Planning and Design

List of Bridges constructed under the 1st Kohat Tunnel and Access Road Project

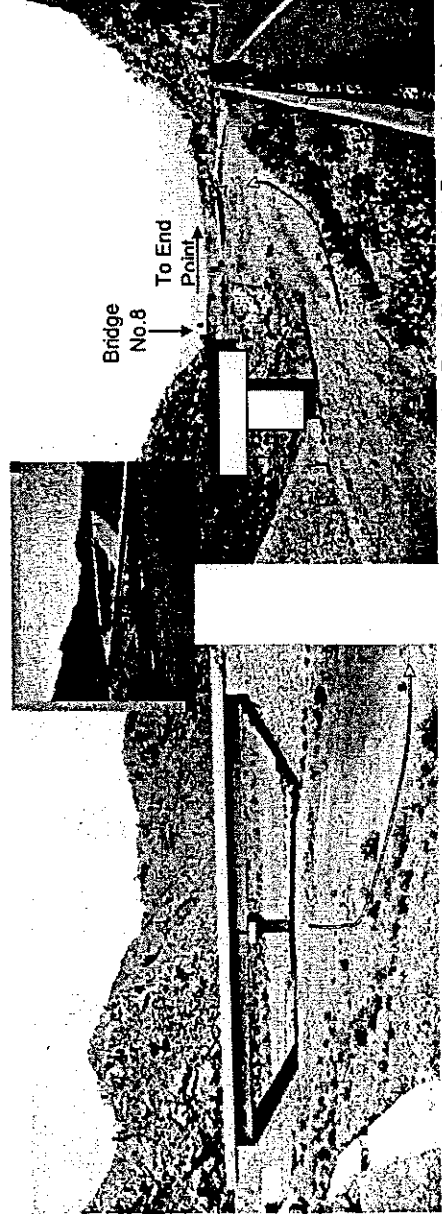
No.	Station (at center)	Type	Length (m)	Span	Pile Length (m)	Remarks
1	2+736.245	PC Girder	120	4 - 30m Span	20	Over river
2	4+735.415	PC Girder	50	2 - 25m Span	14	Over river
3A	9+454.363	PC Girder	20	1 - 20m Span	20	Over railway
3B	9+645.760	PC Girder	30	1-30m Span	21.5	Over N80 (Rwalpindi - Kohat Road)
9	14+800	RC Girder	12	1-12m Span	20	Over Bazi Khel Road
10	16+585	RC Girder	12	1-12m Span	20	Over a track
4 ²⁾	19+205.000	PC Girder	120	4-30m Span	18	Over river / creek
Kohat Tunnel¹⁾						
5	18+920.415	PC Girder	50	2 - 25m Span	20	Over river
8	19+082.70	PC Girder	20	1 - 20m Span	Spread Fd.	Over NW Frontier Road Skew 30°
6A	21+260.525	PC Girder	180	6-30m Span	12	Over rivers
7	25+388.915	PC Girder	40	2-20m Span	20	Over river
Total:			654			

Notes: 1. Break at Sta. 20+194.165 /Sta.16+247.000 (-3947.167)

2. Dual carriageway (travel way) for Bridge No.4.

➤ Same type, length and span of bridges will be constructed for the 2nd Kohat tunnel access road except Bridge No.4.

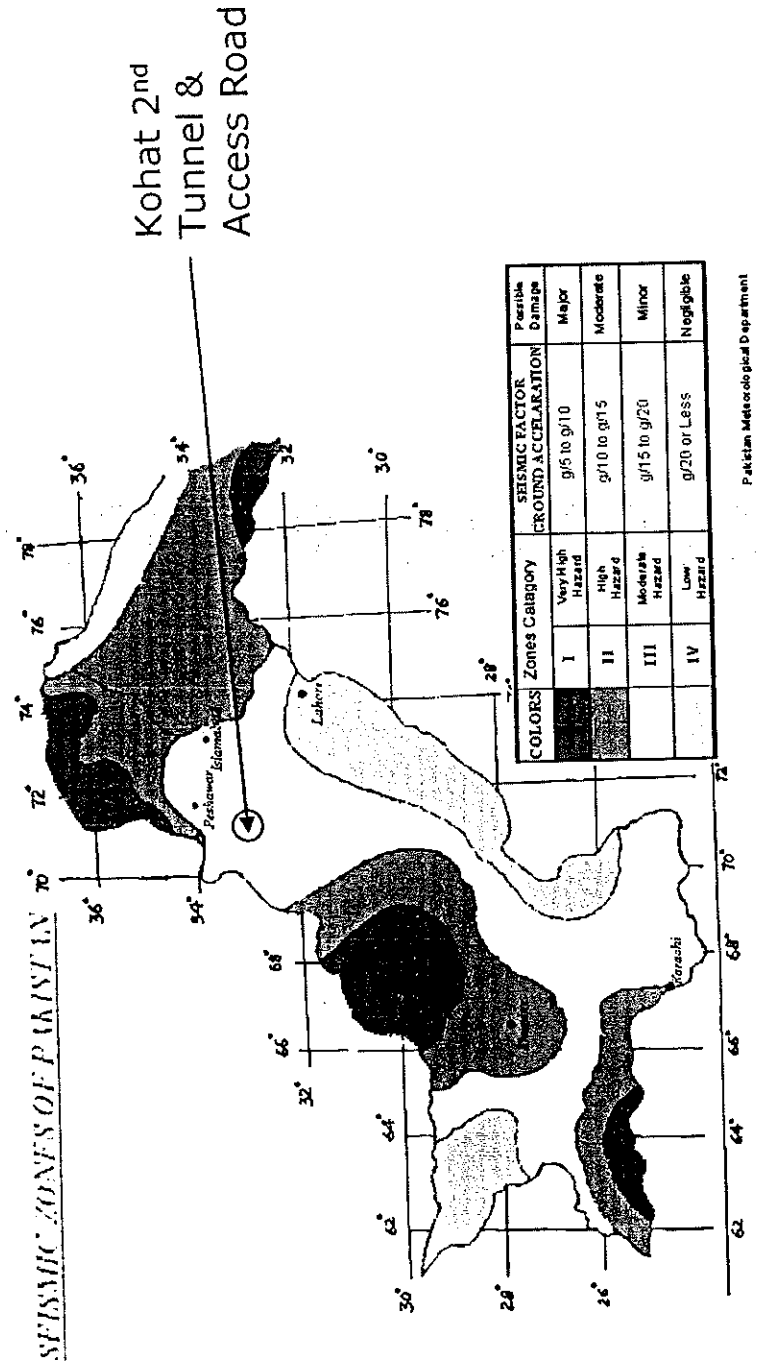
➤ Span and length of Bridge No.5 will be planned not obstructing the river flow.



7. Key Issues

7.7 Bridge Planning and Design (continued)

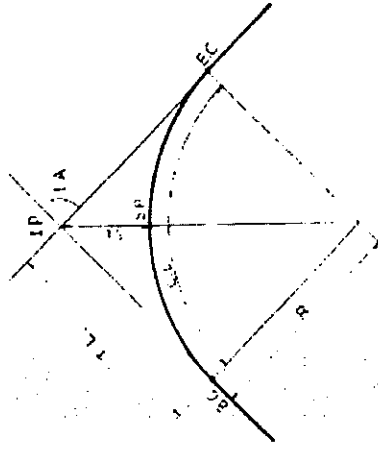
Seismic Design Standard of NHA
 (Are there any change in Seismic Design Standard after the earthquakes in Muzaffarabad in October 2005?)



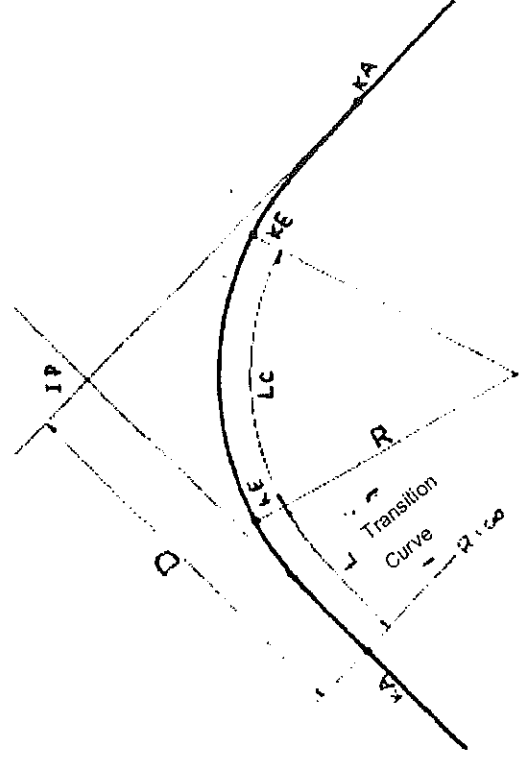
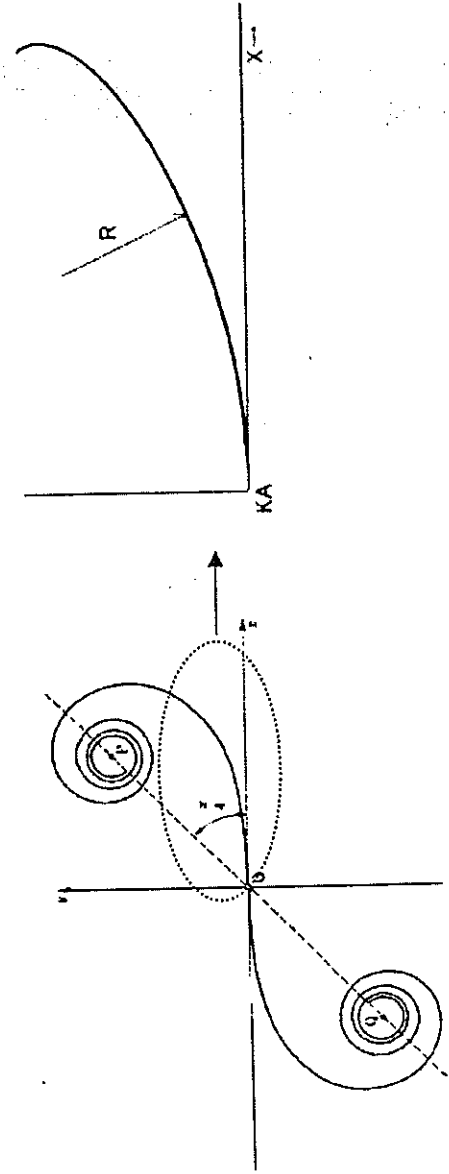
7. Key Issues

7.8 Geometry Design

1st Kohat Tunnel Access Road
 A combination of straight line
 and simple circular curve



2nd Kohat Tunnel Access Road
 A combination of straight line
 and circular curves with
 transition curve (clothoid curve)



7. Key Issues

7.9 Implementation Programme

Traffic Capacity of
1st Kohat Tunnel
(Two ways / single lane)

Travel Speed of Vehicles
Design: 60km/hr
Control: 40km/hr
Actual: 10-15km /hr (due to slow movement of heavy vehicles)

Auto Emissions Problem
(CO₂, NOx and visibility)

Design Speed of Access Road (80 – 100km/hr)

Dual Carriageway Construction Programme of N55 (Indus Highway)
(Note: Eg. Indus Highway – Phase III, Dara. Adam Khel to Badabher financed by ADB)

Availability of Finance

8. Methodology

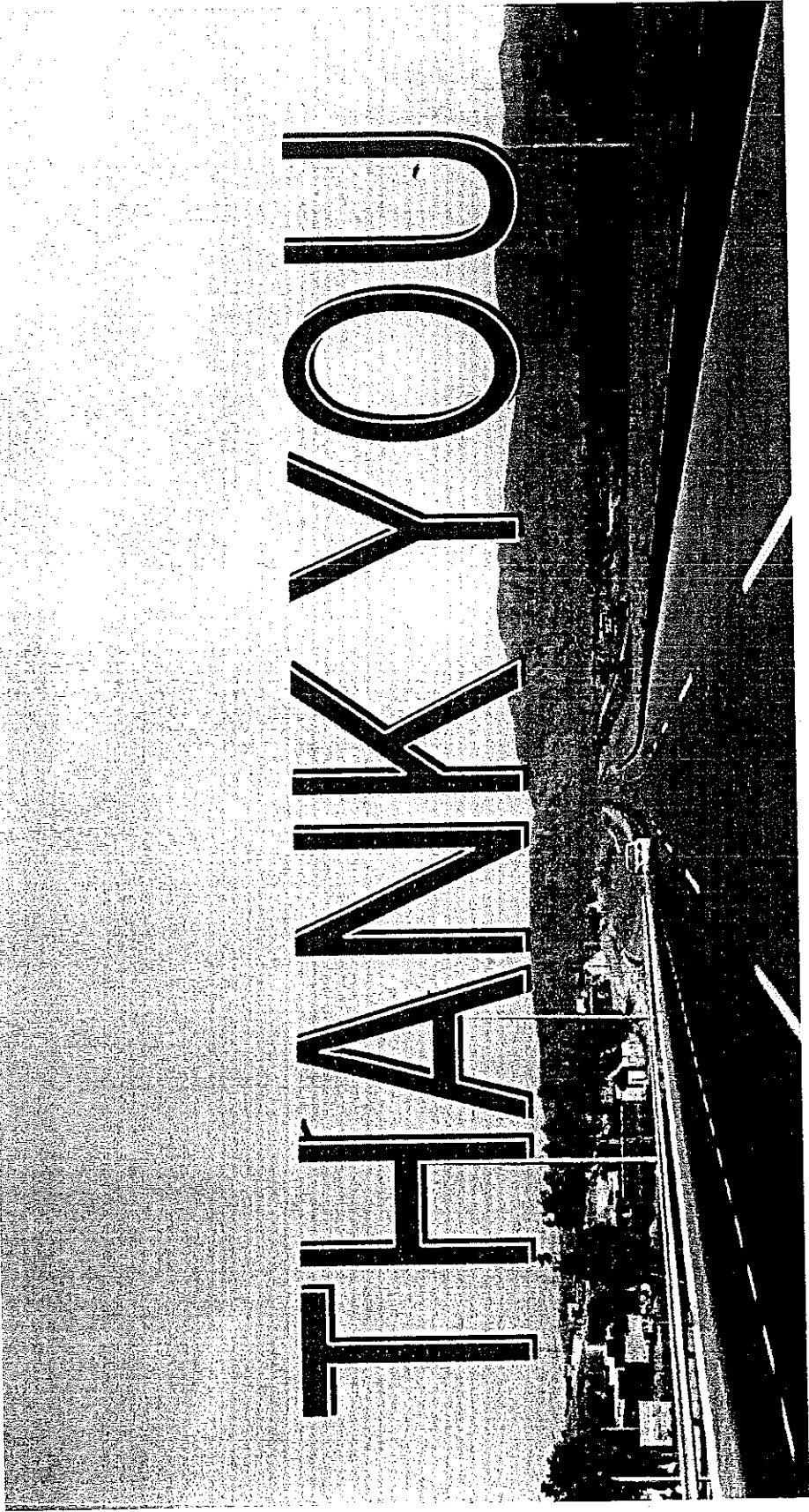
Appendix A: Work Plan and Methodology of the FS

Appendix B: TOR of Topographic Survey

Appendix C: TOR of Geotechnical Investigation

Appendix D: Site Reconnaissance Photographs

Appendix E: Table of Contents of the Feasibility Study (Draft)





Appendix A
The Work Plan and Methodology of Feasibility Study
on
The 2nd Kohat Tunnel and Access Road Project

1. Topographic Survey and Geotechnical Investigation

(1) Topographic survey

a). Objectives

The objective of topographic survey is to provide topographic maps required for preliminary design and drawings.

b). Scope of the works

The scope of the works is as follows:

- Topographic survey from Kohat Toi to Dara Adam Khel (L=30km) except the central part of the Kohat Tunnel (L=1.5km)
- Topographic survey for an alternative route from Sta.17+500 – Sta.20+000 (L=2.5km)
- Satellite image production for alternative route study (L=6km, width 4km).

c). Work Schedule

From 15th May to 30th June 2006 (45 days)

d). Products

- Topographic maps (scale: 1/2000)
- Topographic maps for south and north portals (scale: 1/1000)
- Satellite image (scale 1:5000)

Note: Refer to Terms of Reference in Appendix B as to the details.

(2) Geotechnical investigation

a). Objectives

The objectives of geotechnical investigation are as follows:

- To provide a geological profile necessary for tunnel design and studying the construction plan
- To provide geological data for the tunnel south and north portal design and their slope protections
- Evaluation of settlement of high embankment (H=30m) at Sta.18+900 – Sta.19+500 and its influence to the existing road (1st Kohat tunnel access road)
- Identification of high rock excavation on an alternative route.

b). Scope of the works

The scope of the works is as follows:

- Detailed study and analysis of the geological investigation report and construction record prepared by the consultant and the contractor of the 1st Kohat Tunnel construction.
- Borehole drilling and material/core samplings
 - North and south portals: 2 borings x 20m depth
 - River bed at Sta.19+100 (R) and 19+300 (R): 2 boring x 25m depth
 - Cut section approx.500m right hand side at Sta.18+400: 1 bore hole x 30m depth
 - Riverbed at P1 of Bridge No.1: 1 bore hole x 30m depth
- Laboratory test: compression tests and rock/soil classifications

c). Work Schedule

From 1st June to 30th June 2006 (30 days)

d). Products

- Borehole logs
- Geotechnical investigation report

Note: Refer to Terms of Reference in Appendix C as to the details.

(2) Traffic survey and analysis

a). Objectives

The objectives of traffic survey and analysis are as follows:

- To provide a future traffic demand forecast for economic analysis
- To provide the traffic data for road facility planning and design including highway capacity and serviceability level analysis
- To provide the traffic data for pavement design

b). Scope of the works

The scope of the works is as follows:

- Traffic count survey at the following points
 - 2- Junctions at Kohat Toi and Dara Adam Khel
 - 3-Intesections (interchanges) at N80, Kohat Bypass and Old N55
 - Through traffic at Kohat Pass
- Traffic analysis for forecast
- 16/24 hour traffic count by traffic type and direction
- Axle loads by vehicle type: From the design data of NHA

c). Work Schedule

On week days (Tuesday, Wednesday and Thursday in May 2006

d). Products

- AADT at the base year 2006
- AADT at the target year 2015 and 2025
- AADT for at junctions and interchanges (2006, 2015 and 2025)
- Highway capacity and serviceability
- Design axle load for the pavement design

2. Establishment of design standard and specification

The following design standards and specifications are used:

(1) Road facilities

- Latest NHA standard (2004) and specifications: Primary-I (4-lanes)
- AASHTO 2001 (Geometric Design standard)

The geometric design for the 1st Kohat Tunnel access road was a combination of straight line and simple circular curve. The 2nd Kohat tunnel will be designed as like the 1st Kohat Tunnel but it will be compared with that using transition curves (clothoid curve) which is driver friendly.

Note: The road alignment will follow the 1st Kohat tunnel access road in principle.

(2) Tunnel facilities

- The same design standard used for the 1st Kohat tunnel will be used for the 2nd Kohat tunnel (Japanese standard)
- The new tunnel will be planed in almost parallel with of the 1st Kohat tunnel at the east side. Therefore, it will be the left lane and down grade.
- NATM will be used for sustaining.
- Tunnel facilities will follow the 1st Kohat tunnel except the ventilation system which will be designed for the down grade (its load will be less than half of the current 2-way traffic ventilation system).
- The drainage capacity for the tunnel will be checked.

(3) Bridge facilities

- NHA design standard and specifications
- Latest seismic design standard of NHA
- Same bridge type, spans and bridge length constructed for the 1st Kohat Tunnel Access Road in principle except Bridge No.5 at Sta..18+920.

Note: There are 11 bridges (except culverts) on the 1st Kohat tunnel access road. Of those, Bridge No.4 at Sta.19+200 was already constructed with 4-lane carriageway.

(4) Junctions and intersections

The capacity of junctions and interchanges will be checked and additional lanes may be added if their capacity becomes insufficient. A proper intersection will be planned for Kohat Bypass Road

(5) Other facilities

- Toll plaza: At the current new location under construction, with additional booths.
- Administration office: Current office (No additional facility will be required)
- Emergency Area (and Workshop): Current emergency area
- Control center: The control center may be required to move if the south portal is planned at the current control center. Even if the current center does not directly conflict the new south portal, it may be better to move to other place as its sensitive electrical / digital equipment will be influenced by tunnel excavation and heavy equipment movement.

(6) Pavement Design

- Asphalt Concrete Pavement (AASHTO 1998). The pavement design conducted for the 1st access road will be reviewed based on the traffic and axle load forecast.
- Concrete Pavement (AASHTO 1998) for toll plaza and tunnel section. The pavement design conducted for the 1st access road will be reviewed based on the traffic and axle load forecast.
- Design life of AC pavement is 10 years and that for concrete pavement is 20 years for concrete pavement.

3. Preliminary design

(1) Road facilities

a) Plan, vertical and horizontal alignments

- New carriageway (2-lanes) at the eastside of existing Kohat Tunnel access road

Note: NHA already secured the land (ROW) necessary for four-lane road construction.

- Junctions and interchanges (ON/OFF Ramps)

- Rock excavation for the new dual carriageway with the minimum disturbance to the existing traffic. High embankment at Sta.18+875 – Sta.20+150 (Tunnel South Portal)

Notes: 1. Study on realignment at Sta.18+000 – Sta.18+875 and comparison with the original plan

2. Study on construction methods of hard rock excavation: Control blasting, non-explosive demolition, excavation by hydraulic breaker mounted to hydraulic excavator, special machines developed for rock excavation.

- Plans and standard sections will be made on A1 size with a scale of 1:2000 (H) and 1:200 (V) and produced on A3 size.

b) Drainage facilities

- The cross drainage (culverts) will be connected to or extended from the 1st Kohat tunnel access road facilities.
- Roadside drainage with appropriate lining will be provided accordingly.

c) Pavement design

The pavement will be designed based on the design load and materials specifications. The pavement structures should be designed to minimize life cycle cost, including maintenance.

d) Bridge design

e) Facility design

Installation of guard rails and signs will be examined for appropriate road use and safety.

f) Slope protection design

Appropriate slope protections will be designed for cut and fill slopes.

(2) Bridge facilities

New bridges will be positioned in parallel to the existing bridges. Except Bridge No.5 at Sta.18+920, bridge type, length and spans are same as the 1st Kohat Tunnel access road.

(3) Tunnel section

Tunnel design is classified into civil design and facility design.

a) Tunnel civil design

- The 2nd tunnel will be approximately 30-40m in parallel to the 1st tunnel.
- No change to the original location of the north portal.
- As the original position of the south portal has 3-4 problems, alternative plans will be made and compared.
- Emergency tunnel outlets connecting the 1st Kohat tunnel and the 2nd Kohat tunnel will be at the pre-provided locations.
- Rock types at the portal site will be classified from the result of borings. Rock types for tunnel construction will be based on the geotechnical survey data collected during the 1st Kohat tunnel construction.
- The cross section of tunnel will be determined according to the geological characteristics.
- The cross section of inside tunnel will be determined for ventilation duct, lighting, interior, emergency facility to be installed.

b) Tunnel facility design

Major study items for tunnel facility design are the following.

- Ventilation facility design

Ventilation facility will be designed based on grade of slope (down - slope), traffic and tunnel length.

- Lighting facility design

The items considered in the design are standard lighting, entrance lighting, exit lighting, lighting for connected road, lightning in case of power failure.

- Emergency facility design

Tunnel emergency facility such as alarm, fire extinguisher and evacuation guide facility will be designed.

- Monitoring and control facility design

Monitoring and control facilities for the 2nd tunnel will be studied and designed. If the current control center is required to move, monitoring and control methods during the move will also be studied.

(5) Study of construction planning

The construction plan will include the construction method, safety measures of traffic management during construction period, possible working days, required temporary facilities, procurement of construction materials, labor, construction equipment, and so on. An appropriate schedule will be prepared as well. The environmental consideration such as noise, vibration during construction will be also taken into account.

A special study will be conducted to excavate the hard rock without influencing the current traffic including control blasting, no-explosive blasting, hydraulic breaker, special equipment or combination of those methods.

(6) Preliminary cost estimate

The quantity estimate will be made by each expert in charge of highway design, tunnel design, bridge design, slope protection and tunnel facility design. The quantity will be estimated within +/- 10% accuracy.

The materials sources will be studied including borrow materials, rocks/aggregate for base, concrete and asphalt.

The cost for the project will be estimated in foreign and local currency based on work quantities, construction period and procurement method. The custom duties and taxes will be estimated separately. The unit prices will be referred to the actual contract unit prices applied to similar projects. The unit analysis will be made for major pay items.

(7) Preparation of implementation program

An implementation plan covers the period from preparatory work to the opening of project and includes project outline, project implementation schedule and financial plan.

(8) Preparation of operation and maintenance program

The study includes the following items for operation and maintenance program:

- Review the existing operation and maintenance system
- Estimate operation and maintenance cost
- Organize actions of operation and maintenance in detail

- Clarify fund resources

(9) Advise on environmental and social consideration

The Study Team will examine social environment and natural environment for N-55 Kohat Tunnel section improvement project based on JICA guidelines for environmental and social consideration and advice on EIA procedures required before the project commences.

The Consultant will also study a methodology of social environment monitoring its evaluation in future.

(10) Project evaluation

Economic evaluation will be carried out to investigate the justification of selected project from the view of national economy.

a) Estimation of economic project cost

The economic project costs are estimated deducting transfer items such as duties and taxes from market price.

b) Estimation of economic benefits of the projects

The economic benefits of the projects accruing from the implementation of the priority projects will be estimated based on the comparison method called "With and Without project scenarios". The following benefits items will be quantitatively estimated:

- Travel time reduction
- Vehicle Operation Cost (VOC) savings
- Accident cost savings

c) Economic evaluation

The project will be evaluated based on the following indicators:

- Economic Internal Rate of Return (EIRR)
- Benefit/Cost Ratio (B/C)
- Net Present Value (NPV)

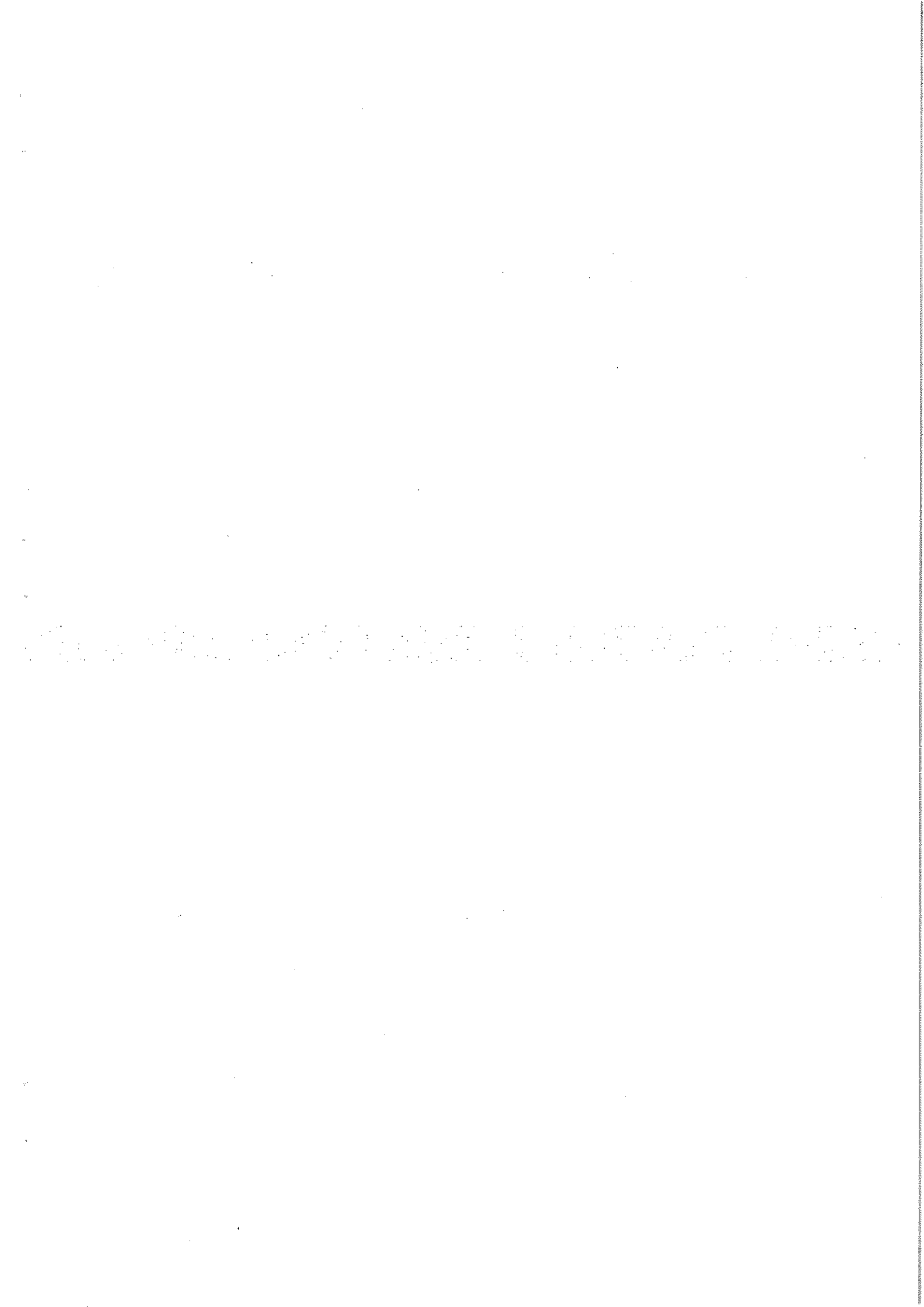
To confirm the robustness of the project viability, a sensitivity analysis will be carried

out by changing costs and benefits within probable ranges of accuracy.

d) Financial evaluation

The Financial Internal Rate of Return (FIRR) and other indicators will be estimated for the evaluation together with investigation of possibility of BOT and PPP.

End.

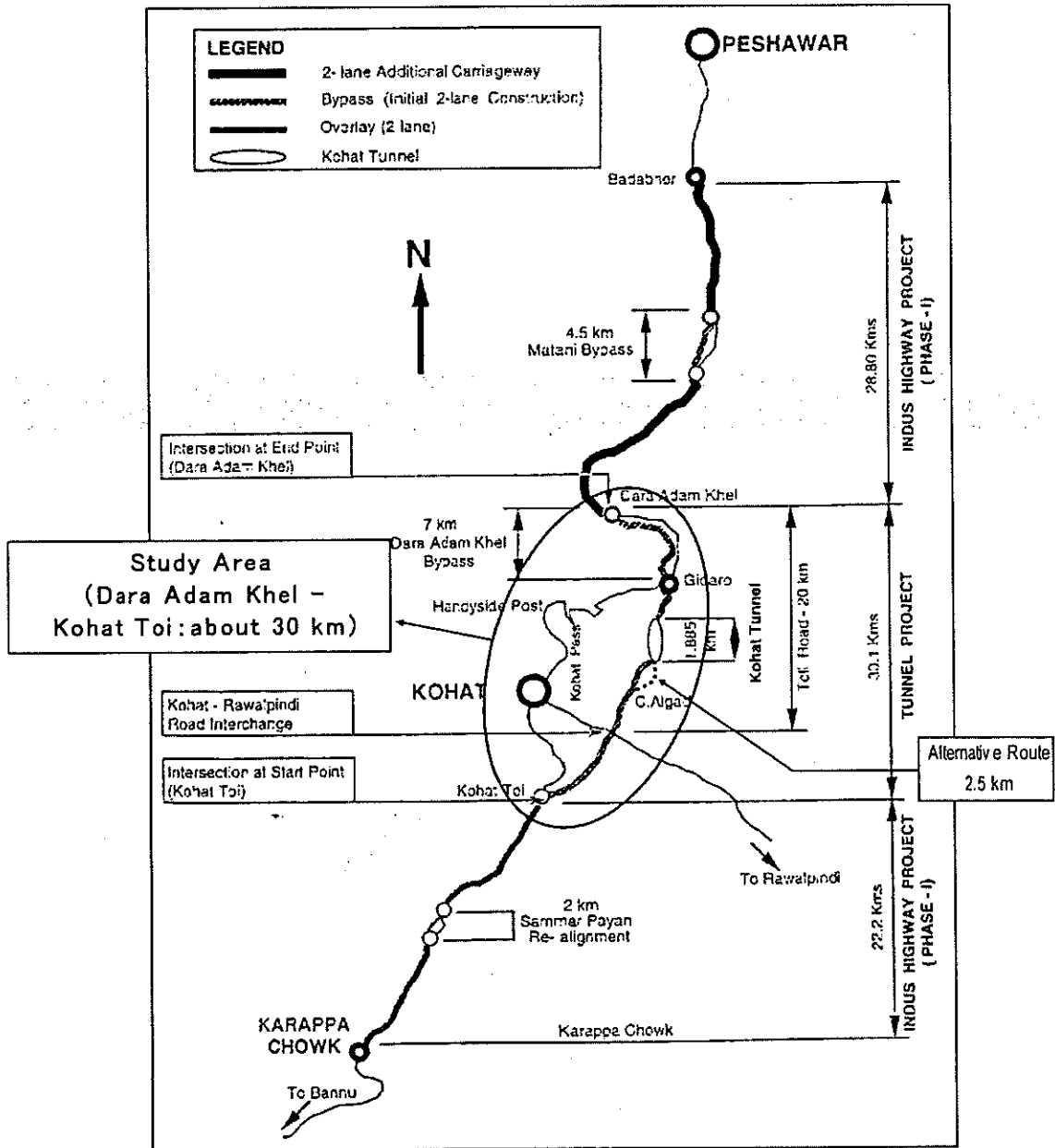


APPENDIX B: Terms of Reference

For Topographic Survey for the 2nd Kohat Tunnel & Access Road

1. General

- 1.1 This terms of reference shall be applied to the topographic survey to prepare preliminary design drawings of road and structures (bridges and tunnel) for the 2nd Kohat Tunnel and Access road in the Islamic Republic of Pakistan carried out by the Japan International Cooperation Agency. The study area is shown in the figure below.



Scope of Survey

- 1.2 The survey will be carried out by Ground Survey Method and shall consist of:
- detailed topographical survey along the N-55 between Kohat Toi to Dara Adam Khel excluding the middle part of the Kohat tunnel (1.5 km)
 - survey on the intersections at Kohat Toi and Dara Adam Khel and three interchanges on the N-55 between Kohat Toi to Dara Adam Khel
 - survey on portals for both end of the Kohat Tunnel to cover the portal area of the tunnel including the control center at the south portal
 - topographic survey for an Alternative Route between STA17+500 and STA20+000 (Kohat Tunnel south portal, approximately 2.5 km) selected by the Engineer

The survey results are provided in hard copy and digital format suitable for use with DGM or AutoCAD and other design software.

- 1.3 The survey shall be executed along the N-55 between Kohat Toi to Dara Adam Khela (approximately 30 km). The bandwidth of the survey corridor is to be the extents of the existing highway ROW plus 10 m minimum in general on east side of ROW to cover the details. At crossings or junctions details shall be picked up to a length of at least 100 metres along the crossing/joining street from the edge of ROW of the main corridor.

The survey covers approximately 100 m radius from the north and south portal of the 2nd Kohat Tunnel. The bandwidth of the survey corridor is to be the extents of the existing highway ROW plus 30 m minimum on east side of ROW from STA18+500 to STA20+000. The survey covers 50 m minimum width from the existing bridge structures.

The bandwidth of survey for realignment study section from STA17+000 to the south portal of Kohat Tunnel shall be 50 m each from the designated centreline given by the Engineer.

The survey shall identify each edge of pavement channel line of each carriageway at maximum intervals of 50m with appropriate intensification of interval on horizontal and vertical curves to ensure accurate portrayal of the geometry concerned.

The longitudinal profile of the corridor shall be determined from the levels of the designated centreline of the new access road.

- 1.4 The survey will be conducted at a level of detail suitable for plotting and use as electronic background mapping on general arrangement drawings at a scale of 1:2000 and shall show the following essentials.
- (a) Ground details including carriageways, shoulders, pavement edges, inner and outer shoulders, embankment and cut edges and trees, drains, slope protection work, guard rail, toll plaza, irrigation channels, ROW, property lines, building lines, central reserves, median barriers.

- (b) Overhead and ground utilities including electrical, telephone poles and cables, storm water drainage, sewerage, water supply, gas pipelines, optical fibre cables, trees and all other means of services. The heights and depths of utility lines crossing the carriageway shall be determined.
- (c) Buildings, bridges, tunnels, pipe and box culverts, underpasses and other developments.

The survey shall be correlated with the existing Kohat Tunnel and Access Road alignment given by the Engineer.

Copies of the survey reduced at the scales of 1:25,000 and 1:50,000 shall also be supplied. Vertical profile of the new centre line shall be given at a scale of 1:200 or with appropriate vertical scale instructed by the Engineer.

- 1.5 All errors exceeding the maximum allowable tolerance including consequential errors shall be corrected by the contractor at his own expense.
- 1.6 The contractor shall agree with the Engineer the method, location and extent of any work to be corrected.
- 1.7 The survey is to be carried out with modern electronic equipment (GPS and total stations) and the contractor is required to list his proposed equipment in the quotations. All instruments used in the topographic survey shall have been calibrated by a State, National or Internationally accredited testing facility within the six months prior to start of works and a certified true copy of the calibration certificate for each instrument used shall be provided to the Engineer prior to commencement of the survey work
- 1.8 The satellite image is used to select an alternative alignment in the section between STA 17.000 and STA 23.000 (1 km from North Portal). The image covering the road between STA 17.000 and STA 23.000 with an approximate corridor of 2 km each from the existing road center line shall be provided by the Contractor.

Description of the image is the following.

- ✓ Standard image: UTM, WGS84, 8k x 8k pixels, 4 band pan sharpened
- ✓ Resolution: 60 cm
- ✓ Image quality: 8 bit
- ✓ Resampling method: 4 x 4 cubic convolution
- ✓ Format: GeoTIFF 1.0

A hard print (size A1) and its processed picture file of the selected section shall also be provided by the Contractor. The Contractor shall submit those by the 31st May 2006.

- 1.9 Programme

The Contractor shall start the survey work within three (3) days after "Notice to Commencement" issued by the Engineer.

The survey is required to be completed within a restricted timeframe. The contractor shall submit draft results part by part; from STA0+000 to STA17+000

by 10th June 2006, from the north portal of Kohat Tunnel to Dara Adam Khel by 20th June 2006, and from STA17+000 to STA20+000 along the existing road by 20th June 2006. The remaining and final results shall be submitted by 30th June 2006.

The contractor shall in his quotation submission provide an outline programme and proof of sufficient resource to complete the specified tasks within the timescales envisaged.

After the acceptance of his quotation, the contractor shall submit to the Engineer for approval a detailed programme showing the order of procedure in which is proposes to carry out the work.

1.10 Permissions

The Contractor shall be responsible for obtaining all necessary permits and permissions required for carrying out the survey works within the timescales required

1.11 Security Arrangement

The contractor shall make required security arrangements with concerned authorities at his own cost and all such cost shall be rendered to be included in his quoted prices.

2.0 Field work

2.1 Control points/Bench marks

Control points/bench marks shall be set at approximately every 1 km using the existing permanent structures such as bridges and box culverts. If no appropriate structures are found, concrete posts shall be installed.

2.2 Grid and Plan Control Accuracies

Plan controls shall be calculated on the National Grid and transformed to a local Transverse Grid, with scale factors not exceeding one part in 20,000.

Permanent Ground Markers (if available) shall be connected by a closed net which shall be tied to not less than three survey Triangulation Stations of the Survey of Pakistan (SOP).

The net shall be adjusted by "least squares" to obtain a best mean fit. Misclosures within the net shall not exceed one part in 20,000. For distances between adjacent Permanent Ground Markers of less than 300 m, the maximum error shall not exceed ± 15 mm. Temporary survey stations for mapping shall be in sympathy with the nearest marker in the closed net to better than one part in 12,000.

Where Survey of Pakistan Triangulation Stations are not found or in error, Engineer be informed, and alternate arrangement be made.

2.3 Height Datum and Vertical Accuracies

All heights supplied by the Contractor shall be related to the latest published values of Survey of Pakistan Bench Marks.

Permanent Ground Markers and Bench markers shall be connected by a closed levelling net which shall be tied to a minimum of three SOP Bench Marks. Virtual

misclosures within the levelling net between SOP Bench Marks shall not exceed $\pm 12\sqrt{K}$ mm where K is the sum of the distances levelled in kilometres.

SOP Bench Marks which exceed these tolerances shall be omitted from the adjustment.

The height difference between adjacent Permanent Ground Markers and Permanent Bench marks shall not be in error by more than 5 mm when checked by precise levelling.

Confirmation of location of all Permanent Ground Markers shall be made at site through GPS with reference to permanent features on ground.

Accuracy and definition of strings

The Contractor shall ensure the accuracy of 3D strings recorded during the topographical survey detailed in these terms of reference.

The levels and the co-ordinates of recorded points shall be correct to within the rmse tolerances stated in the table below. Ninety percent of these must be within 1.65 times the values stated, when a representative sample of points is checked by measurement from the nearest SoP Datum Bench Mark height control point.

Table : Tolerances of Levels and Co-ordinates of Directly Recorded Points on Strings

Accuracy Level	Carriageway and Hard Surfaces		Other Surfaces	
	Vertical	Horizontal	Vertical	Horizontal
1	±0.02m	±0.06m	not applicable	
2	±0.06m	±0.15m	±0.10m	±0.30m

The Contractor shall include the records for the 3D strings of all major angular changes of ground and general ground profile with points at an interval not exceeding 40 m and shall be such that the maximum vertical and horizontal errors of interpolated points shall not exceed those given in the table below.

Table : Total Error of Interpolated Points on Strings

Accuracy Level	Carriageway and Hard Surfaces		Other Surfaces	
	Vertical	Horizontal	Vertical	Horizontal
1	±0.04m	±0.12m	not applicable	
2	±0.12m	±0.30m	±0.20m	±0.60m

2.4 Deliverables

Survey Report

The Contractor shall supply two hard copies and one soft copy on CD Rom of a comprehensive report including methodology and the following results to the Engineer on completion of fieldwork and adjustment. On initial completion of the traverse survey in the beginning, data and results will be provided by the contractor.

- Copies of the most recently available SOP Triangulation Station description for each station used for Works, giving the SOP reference number, National Grid Co-ordinates and description of position.
- Copies of the most recently available of SOP Bench Marks lists used for the Works, indicating bench marks used, bench marks found to be damaged or destroyed, and the readjusted heights of bench marks found to be out of tolerance.
- Diagrams of the levelling net indicating the connections between Permanent Ground Markers, Permanent Bench Marks and SOP Bench Marks with misclosures.
- Description of the local transverse grid giving the origin, scale factor and parameters used for transformation from the National Grid.

Drawings

The Contractor shall deliver drawings in printed format and electronic CAD software format as defined in sections 3, 4 and 5 below.

2.5 Monitoring during Survey Process

The contractor shall provide traverse data for every 5 km during this process. He will ensure that traverse is closed properly with minimum possible error and if there is some allowable error that may be distributed within this reach.

2.6 Advance Information

The Contractor shall supply to the Engineer immediately after initial completion, advance copies of the results called up in the previous clause, in order for the Engineer to let or carry out a proving survey.

2.7 Original Field Record

The contractor shall provide original field record, computation and details of the method of observation and adjustment.

3.0 Mapping

3.1 Metric units shall be used throughout.

3.2 Mapping shall be plotted to scale of 1: 2000 plan scale for road design includes center line and profile of proposed road, 1:500 for tunnel portals and its approach

road design, and both 1:2000 and 1:5000 for alternative road design. The supporting electronic files shall have the plan data drawn as three dimensional strings in real coordinates (1:1 scale).

Drawings shall consist of:

- a set of drawings consisting of :
 - o a title sheet
 - o an index sheet(s) of drawing titles
 - o a key plan(s) sheet showing the location of each sheet graphically
 - o individual drawing sheets comprising plan views at 1:50000 scale. The level of detail to be shown shall be agreed with Engineer.
 - o individual drawing sheets comprising plan views at 1:25000 scale. The level of detail to be shown shall be agreed with Engineer
 - o individual drawings comprised of
 - a) a 1:2000 scale plan view of all surveyed details,
 - b) a longitudinal profile of the new road centreline (see 1.3 above),
 - c) a reduced scale key plan indicating the current sheet in relation to the overall sheeting layout.

The match lines between adjacent profile sections shall be indicated on the plan view but shall not obscure the survey detail. Where necessary for clarity the plan view may be expanded to fill one drawing sheet and a separate drawing sheet produced for the profile. Additional drawings shall be provided for each surveyed side and crossing streets.

- 3.3 The text on the mapping shall be upper and lower case as required and shall be to ISO Norm with a text of 2.0 mm when plotted at 1:2000 scale. Spot heights shall quoted to an accuracy of 2 decimal places (10 mm) and have a text height of 1.5 mm when plotted at 1:2000 scale. In the supporting electronic files both the spot height location symbol and the spot height text shall be located at the actual reduced level (to 3 decimal places –1mm accuracy) of the point. All other text shall be located within the electronic file at an elevation of zero metres

3.4 Details to be shown

Detail given below wherever applicable shall be incorporated in the survey. In the supporting electronic file the details are required to be located as three dimensional strings wherever possible.

(a) Building/Structure

1. The plinth line of all permanent buildings
2. Open side of Buildings
3. Extent of any overhang of building or canopy into street ROW
4. Boundaries of individual agricultural land
5. Outline of abutments, piers and decks of bridges or underpasses

6. Portals of tunnel
7. Soffit levels of bridges

(b) Roads, Tracks and Footpaths

1. Kerb line or edge of surfacing to carriageways
2. Tracks
3. Poorly defined or overgrown paths-conventionalized
4. Footways
5. Pedestrian crossing
6. Steps
7. Junctions, interchanges, and traffic islands

(C) Industrial

1. Tanks
2. Sewage disposal works details
3. Chimneys (substantial)
4. Transformers (boundary fences only)
5. Electricity sub-stations and switches boxes boundary fences only)
6. Electricity supply lines in open country
7. Pylon bases
8. Pylon reference numbers
9. Telegraph lines across open country
10. Radio, TV or BT station masts
11. Fibre Optical Lines

(d) Street Furniture and Services

1. Bus stops
2. Lamps posts
3. Telegraph poles and distribution boxes
4. Electricity poles and distribution boxes
5. Traffic signals and control boxes
6. Drains or gullies
7. Fire hydrants
8. Stop valves and stop taps
9. Manhole and inspection cover

(e) Boundary Features

1. Fences
2. Gates
3. Walls-type identified

(f) Railways

1. Gauge faces of railway running rails
2. Points
3. Level crossings
4. Buffers
5. Platforms
6. Bridges
7. Telephone points
8. Telegraph poles
9. Height gauges
10. Overhead electrification gantries
11. Railways boundary fences

(g) Survey

1. SOP Trigonometrical Station
2. Ground Control Points
3. Permanent Ground Markers
4. SOP Bench Marks used
5. Permanent Bench Marks

(h) Woods, trees and Recreation Areas

1. Playing fields
2. Parks and open spaces
3. Running tracks
4. Trees including approximate spread of foliage

(I) Slopes and Earthworks

1. Cutting and embankments
2. Terraced slopes
3. Ornamental slopes
4. Mounds
5. Open pits
6. Gravel workings
7. Quarries
8. Rock outcrops

(j) Water and Drainage

1. Lakes
2. Ponds
3. Reservoirs
4. Rivers

5. Streams
6. Water courses
7. Ditches
8. Canals
9. Wells
10. Springs
11. Locks
12. Aqueducts
13. Water Towers
14. Millraces
15. Siphons
16. Sluice Gates
17. Weirs
18. Waterfalls
19. Pumps
20. Troughs
21. Tanks
22. Fountains
23. Sewer outfall
24. Piers
25. Landing stages
26. Hydraulic rams
27. The top of banks of all water features over 1.0 metre wide shall be detailed and the bottom of banks as indicated by the water level at the time of the survey. The direction of flow of all rivers, streams and watercourses shall be indicated.

(k) Any other features located but not covered above as agreed with Engineer

3.5 Contours

Contours shall be shown at 1.0 m intervals but when steep slopes are encountered and it is not practicable on the plan to represent each contour fully throughout its length, the Contractor may with Engineer approval terminate certain intermediate contours.

Where because of under growth or other obstructions, the ground surface is obscured, or access is restricted and provided Engineer's prior agreement is obtained, contours can be shown by broken lines to indicate that their accuracy can not be guaranteed.

3.6 Spot Heights

Standard spot Heights shall be included in the mapping, at spacing not exceeding 40 m and at the following locations:

- At salient points such as hill tops, bottoms of depressions and saddles.
- At the top of kerbs, at channel levels and centre lines of all roads and public accesses, at road intersections and significant changes of gradient.
- Along the highest rail of railways.
- At bed and water level at the time of survey along rivers, streams, major watercourses and ditches at intervals of approximately 100 m.

In flat areas, where the horizontal distance between contours generally exceeds 50 m Supplementary Spot Heights shall be shown at intervals not exceeding 50 m parallel to the contours.

3.7 Structure Details

The following details of field survey shall be plotted and provided in respect of rivers and streams, and drains crossing or flowing close to the proposed LRMTS route.

A. Bridges (Span 10 m & More)

- (I) X-section at existing location
- (ii) X-section at 100 m upstream
- (iii) L-section for 100 m upstream

B. Culverts (Span less than 10 m)

- (I) X-section at existing location
- (ii) X-section at 100 m upstream
- (iii) L-section for 100 m upstream

The above sections shall be plotted on scales 1: 200.

4.0 Presentation

- 4.1 Master print-out of the final mapping with contours shown are required to be produced on standard sheets of A1 and A3 size with standard borders and title as designated by the Engineer.

The drawings shall incorporate a key plan at reduced scale indicated the location of each sheet in relation to the corridor

- 4.2 Names and annotations shall be aligned parallel to the general axis of the route except for names relating to linear features which shall be aligned parallel to those features.
- 4.3 Grid lines shall be shown at 200 m intervals by symmetrical cross co-ordinate values shall be shown outside the bank of detail, or at the sheet edges.
- 4.4 All Permanent Ground Markers, Permanent Bench Marks, SOP Triangulation Station and other survey information within the Contract Areas and if room permits, those outside but connected to the control net, shall be indicated and referenced in the final mapping. The coordinates and heights of Permanent

Ground Markers and heights of Permanent bench marks shall be included in the final mapping unless otherwise agreed by Engineer.

- 4.5 Contours shall be shown by continuous lines with a thicker line for every fifth contour. The value of each contour shall be indicated along the contours at intervals of 1 m at flat area and 5 m at mountainous area. (when plotted at 1:2000 scale).
- 4.6 The electronic drawing files shall be composed of drawing sheet frames with separately referenced model files for grid, profile and survey details produced in accordance with section 5 below. Drawing files containing combined survey data and drawing frames are not acceptable. Drawing files shall be composed in such a way that should the master transparency drawing sheet file be itself referenced into another drawing then the subreferenced survey data model files retain their true spatial coordinate values. The electronic data survey shall be drawn in the relevant layers in accordance with the proposed layer naming convention shown in Appendix A, and to the proposed standard conventions on line weight and text styles as shown in Appendix B
- 4.7 The following map reproductions where listed in the Bill of Quantities are to be delivered progressively to Engineer.

(a) Master Survey Drawings (Draft)

Preliminary proof copies shall consist of paper plots of the digital mapping at the appropriate scale, and if necessary further copies until approved. Electronic copies (on CD Rom media) of draft survey may be also requested by Engineer for checking purposes and advance design work.

(b) Master Survey Drawings Final

Master Survey Drawings shall be plotted directly from the CAD drawing sheets

The **Master Survey Drawings** shall be produced on standard sheets of A1 size (841 mm x 594 mm) with standard border and heading as described in the Contract. The areas covered by individual map sheets will be as agreed with Engineer and the overlap of adjacent drawings shall not be given less than 75m of detail common to each drawing.

The Contractor shall provide the Engineer with

- 1 (one) Master set of paper plots at A1 size
 - 1 (one) Copy set of paper plots at half size reduction on A3 paper (e.g 1:4000 scale)
 - 2 (Two) CD-Rom copies of the CAD drawing files, including all reference drawing files, plot files, base survey data input files, processed survey output files and DGM input files as required. All Electronic data and media shall be certified as being virus-free
- (c) Cross section drawings (A3 paper)**
- STA0+000-STA4+500 (L=45 km) at every 50 m

- STA17+500-STA20+000 (Realignment section) at every 50 m
- Tunnel south and north portals (L=300 m each) at every 25 m

(d) Report of control points

The contractor shall provide the Engineer with a report of control points set out at the site including location maps, coordinates, elevations, and photographs.

5.0 Digital Ground Model (DGM) and digital Mapping

5.1 The digital mapping shall be drawn in an approved CAD software programme. Acceptable formats are:

- AutoCad v2002 DWG
- AutoCad v2004 DWG
- (MicroStation v7 DGN)*
- (MicroStation v8 DGN)*

* Use of MicroStation formats shall be subject to agreement with the Engineer prior to commencement of work.

In addition the data shall be presented by the Contractor in a form suitable for input to Engineer's relevant design software (. If the file formats listed above are not suitable then DXF file format may be used).

CAD drawing shall be done in accordance with the recommendations made in UK standard BS1192-5:1998 "Construction Drawing Practice – Guide for the Structuring and Exchange of CAD Data" or latest version thereof or an equivalent Pakistan or other international standard to be agreed with Engineer.

To avoid excessively large file sizes the CAD survey data shall be separated as necessary into individual and contiguous drawing tiles. Each tile shall be of equal extents which shall be determined in agreement with Engineer. Data shall not overlap between tiles and surveyed features which cross tile boundaries shall be split in such a way that the cut ends of three dimensional strings retain their true three dimensional attributes.

The proposed standard line weights, text fonts sizes and weights are given in Appendix B.

All elements shall be drawn at a scale of 1:1 in the CAD files.

- 5.2 The co-ordinates of the DGM shall be referred to the grid system.
- 5.3. The area for which the DGM is required and the particular accuracy level shall be as indicated on the Contractor Drawings.
- 5.4 The computer input shall be prepared from the original field work or photogrammetry values without any intermediate manual transcription.
- 5.5 The contractor shall verify the data and provide a plot of the recovered input to an agreed map scale to demonstrate this. Any errors found in this process shall be

corrected by the contractor before the computer input and plots are delivered to Engineer.

- 5.6 The Contractor shall be responsible for the delivery to Engineer of the computer input in an undamaged state.
- 5.7 The Contractor shall supply the digital ground model data suitable for input to Engineer's computer.
- 5.8 The attention of the Contractor is drawn to the fact that the maximum number of points on any one file will be set as agreed with Engineer.
- 5.9 The Contractor shall supply the digital survey data in a format suitable for direct input into the MX Road (formerly MOSS) software or other design software in a format as agreed with MVA

6.0 Setting Out

The contractor shall be responsible for the true and proper surveys and setting out of the work in relation to the original points, lines and levels of the reference. The contractor shall be responsible for the correctness of the positions, levels, dimensions and alignment of all parts of the work and for provisions of all necessary instruments, appliances and labour in connection therewith, subject as above mentioned.

If at any time during the progress of the work or after completion before handing over to Client, any error shall appear or arise in the positions, levels dimensions of alignment of any part of the work, the contractor is required to rectify such error to the satisfaction of the Engineer at his own cost.

The checking of any setting-out or of any line or level by the Engineer shall not in any way relieve the contractor of his responsibility for the correctness thereof and the contractor shall carefully protect and preserve all benchmarks, traverse points etc. and other points used in the field survey-work unless the work is properly handed over to the Client.

Appendix A proposed CAD layer naming specification

The drawing layers shall be named in accordance with the following convention

XXX_U

Where **XXX** is the three digit class code as listed below and **U** is a user defined subdivision which may for example be used to split information for clarity or to separate graphical elements from text elements

The description given below after the class code describes the type of data to be held in each layer. In software which permits layer names to be given separate descriptive attributes the description below should be used.

Where the Contractor finds that data cannot easily be accommodated within the list of codes given below additional codes may be generated by Engineer in agreement with the Contractor.

The use of grouped layers should be avoided as far as possible.

CLASSES 000 - 099 : GENERAL

010 - 019 TITLES AND FRAMES

010 Titles and Frames (Grouped)

011 Frame :

012 Drawing Number

013 Drawing Title

014 Drawing creation information

015 QA data e.g. automatic time/date/filename ref.

016 Scale

017 Drafting Body

018 Copyright

020 - 029 GRIDS

020 Grids (Grouped)

021 National grid

022 National grid text

023 Site grid

024 Site grid text

025 Building / structure grid

026 Building / structure grid text

027 Geodetic Datum

028 Setting Out Lines

029

030 - 039 DIMENSIONS

030 Dimensions (Grouped)

031 Dimensions

032 Plan levels

033 Chainage

034 Setting out tables

035 Coordinates

040 - 049 TEXT
040 Text (Grouped)
041 Titles
042 Sizes
043 Descriptions
044 Notes
045 Schedules
046 Legends
050 - 059 GENERAL SYMBOLS
050 General Symbols (Grouped)
051 North point
052 Section, detail, elevation marks
053 Match lines / cut lines
054 Scale bars
055 Key Plan
060 - 069 HATCHING
060 Hatching (Grouped)
061 Hatching
062 Patterning
063 Fill tones
064 Highlighting
070 - 079 REVISIONING
070 Revisioning (Grouped)
071 Revision clouds and marks
072 Revision box information
080 - 089 TEMPORARY INFORMATION
080 Temporary Information (Grouped)
081 Construction lines
085 Red-lining
CLASSES 100 - 199 : GROUND, SUB-STRUCTURE
110 - 119 GROUND
110 Ground (Grouped)
111 Ground relief
119 Parts and accessories
120 - 129 EARTHWORKS
120 Earthworks (Grouped)
121 Ground profiling
122 Ground treatment
123 Dredging
124 Filling
125 Slopes
126 Berm
127 Trench
128 Reclamation
129 Parts and accessories
130 - 139 FLOOR BEDS
130 Floor Beds (Grouped)
131 Hard surfaces e.g. ground floors
134 Soft surfaces e.g. planted, unplanted beds
136 Ground underwater e.g. pools
138 Other types of floor beds

139 Parts and accessories
140 - 149 TUNNELS
140 Tunnels (Grouped)
141 Tunnel walls
142 Tunnel lining
143 Portals
144 Cross-passages
145 Emergency passage
146 Shafts
147 Adits
149 Parts and accessories
160 - 169 RETAINING WALLS, FOUNDATIONS
160 Retaining Walls, Foundations (Grouped)
162 Retaining walls
163 Water retaining elements e.g. dams, caissons
169 Parts and accessories
180 - 189 OTHER SUBSTRUCTURE ELEMENTS
180 Other Substructure Elements (Grouped)
181 Underground Valve and Meter Chambers
184 Thrust Blocks

CLASSES 200 - 299 : STRUCTURE PRIMARY ELEMENTS,

210 - 219 EXTERNAL WALLS
210 External Walls (Grouped)
214 Curtain walls
218 Other types of walls
219 Parts and accessories
240 - 249 STAIRS AND RAMPS
240 Stairs and Ramps (Grouped)
241 Straight stairs
243 Dog leg stairs
244 Curved stairs
245 Other types of stairs e.g. open well, escape
247 Ramps
248 Other types of vertical circulation
249 Parts and accessories
270 - 279 ROOFS
277 Cantilevered roofs, canopies

CLASSES 300 - 399 : SECONDARY ELEMENTS

310 - 319 SECONDARY ELEMENTS TO WALLS,
310 Secondary Elements to Ext. Walls (Grouped)
315 Doorways, entrances, exits and doors
319 Parts and accessories

CLASSES 500 - 599 : SERVICES, MAINLY PIPED, DUCTED

510 - 519 WATER SUPPLY - EXTERNAL
510 Water Supply External (Grouped)
511 Potable water supply
514 Raw water supply
519 Parts and accessories

520 - 529 WASTE DISPOSAL, DRAINAGE

- 520 Waste Disposal Drainage (Grouped)
- 521 Refuse, rubbish, garbage disposal
- 522 Gaseous waste
- 523 Sewage disposal foul drainage
- 524 Petrol, chemical wastes
- 525 Natural water drainage
- 526 Internal drainage (above ground drainage)
- 527 Below ground drainage including storage
- 528 Other types of waste disposal, drainage
- 529 Parts and accessories
- 530 - 539 LIQUIDS SUPPLY**
- 530 Liquids Supply (Grouped)
- 531 Cold water
- 532 Flushing water
- 536 Other water supply services
- 537 Petrol, oil
- 538 Other types of liquid supply
- 539 Parts and accessories
- 540 - 549 GASES SUPPLY**
- 540 Gases Supply (Grouped)
- 541 Fuel gas, combustible gas supply
- 542 Vapour supply
- 543 Air supply
- 544 Other gas supply
- 545 Vacuum supply
- 548 Other types of gases supply
- 549 Parts and accessories

CLASSES 600 - 699 : SERVICES, MAINLY ELECTRICAL

610 - 619 ELECTRICITY SUPPLY

- 610 Electricity Supply (Grouped)
- 611 Radial distribution
- 612 Ring main distribution
- 613 Rising main distribution
- 616 Public mains supply
- 617 Privately generated supply
- 618 Other types of electrical supply services
- 619 Parts and accessories
- 620 - 629 POWER**
- 620 Power (Grouped)
- 621 High voltage system (>1,000V rms)
- 622 Low voltage system (50 - 1,000V rms)
- 623 Extra-low voltage system (<50V rms)
- 629 Parts and accessories
- 630 - 639 LIGHTING**
- 630 Lighting (Grouped)
- 631 General lighting
- 634 Street lighting
- 635 Airfield lighting

636 Floodlighting
638 Other types of lighting services
639 Parts and accessories
640 - 649 COMMUNICATIONS
640 Communications (Grouped)
641 Visual including audio-visual
642 CCTV
643 Audio
644 Signals other than visual or audio
645 Synchronous clocks
646 SCADA
647 Signalling
648 Other types of communications services
649 Parts and accessories
660 - 669 TRANSPORT
660 Transport (Grouped)
661 Lifts
662 Other types of internal lifts, hoists
663 Travelling cradles
664 Escalators
665 Conveyors/Travelators
666 Cable car, Gondola, Chair lift
667 Cranes
668 Other types of transport services
669 Parts and accessories
689 Parts and accessories
690 - 699 PARTS & ACCESSORIES
690 Parts and Accessories (Grouped)
693 Earthing Protection
694 Lightning protection

CLASSES 700 - 799 : FITTINGS, FURNITURE AND EQUIPMENT

710 - 719 CIRCULATION FFE
710 Circulation FFE (Grouped)
711 Signs, symbols
712 Display fittings
713 Access fittings
714 Bollard/Cone/Barrier
715 Turnstiles
716 Flag
718 Other types of circulation fittings
719 Parts and accessories

770 - 779 SPECIAL ACTIVITY FFE
770 Special Activity FFE (Grouped)
771 Gymnasia/physical training facilities
772 Fighting sports facilities
773 One-to-one sports facilities e.g. squash
774 Bowling alleys
775 Athletics facilities
776 Racing facilities
777 Team ball games facilities

778 Equestrian facilities

779 Air sports facilities

CLASSES 800 - 899 : TRANSPORT INFRASTRUCTURE

800 - 809 GROUND SURVEY

800 Ground Survey (Grouped)

801 Survey control

802 Elevation Contours

803 Spot levels

804 Artificial and Building Features

805 Relief and Hydrographic Features

806 Road and Street Features

807 Utilities Features

808 Military Cable

809

810 - 819 HIGHWAYS

810 Highways (Grouped)

811 Centre-lines

812 Setting out lines

813 Carriageway edges

814 Shoulders

815 Verges

816 Footpaths

817 Cycle-tracks

818 Paved area

819 Parts and accessories

820 - 829 STREET FURNITURE

820 Street Furniture (Grouped)

821 Safety features / Railing / Barriers

822 Weigh bridge

823 Toll gate

824 Speed humps

825 Vehicle stops

829 Parts and accessories

830 - 839 TRAFFIC AIDS & MARKINGS

830 Traffic Aids & Markings (Grouped)

831 Traffic signs

832 Markings

833 Directional signs

834 Traffic signals and equipment

835 Cats eyes/Reflective studs

836 Traffic Bollards

839 Parts and accessories

840 - 849 RAILWAYS

840 Railways (Grouped)

841 Centre-lines

842 Setting out lines

843 Trackwork

844 Trackform

845 Tramways

848 Safety features / Railing / Barriers

849 Parts and accessories

850 - 859 BRIDGES
850 Bridges (Grouped)
851 Abutment
852 Anchor Block
853 Column
854 Pier
855 Tower
856 Deck
857 Parapet
858 Cable Support Systems
859 Parts and accessories
860 - 869 GROUND SURFACE - AIRFIELDS
860 Ground Surface - Airfields (Grouped)
861 Centre-lines, setting out lines
862 Pavement edges
863 Shoulders
864 Pavement jointing
869 Parts and accessories
890 - 899 TRANSPORT INFR. PARTS & ACCESSORIES
890 Parts and Accessories (Grouped)
896 Joint details
CLASSES 900 - 999 : EXTERNAL WORKS
900 - 909 SITE PREPARATION
900 Site Preparation (Grouped)
901 Clearing/demolition
902 Sign Board
909 Parts and accessories
910 - 919 BOUNDARIES & ENCLOSURES
910 Boundaries & Enclosures (Grouped)
911 Gazettal limits
912 Planning boundaries
913 Lot/Land allocation boundaries
914 Site boundaries
915 Works areas
916 Hoardings / fences / gates
917 Reserves
919 Parts and accessories
920 - 929 SURFACE WATER DRAINAGE
920 Surface Water Drainage (Grouped)
921 River/Stream/Ditch
922 Culvert/Channel/Catchwater/Nullah
923 Aqueduct
924 Pipe
925 Drain
926 Manhole
927 Catchpit
928 Pump
929 Parts and accessories
930 - 939 SEWERAGE
930 Sewerage (Grouped)
931 Pipe

932 Manhole
933 Sewer
934 Sewerage tank/Septic tank/Cesspools
935 Outfall
936 Sewage treatment plant
939 Parts and accessories
940 - 949 DUCTING (EXTERNAL)
940 Ducting (Grouped)
941 Ducts
942 Access chambers
970 - 979 STRUCTURES IN EXTERNAL WORKS
970 Structures in External Works (Grouped)
971 Building outlines
972 Underground building outlines
973 Pylons/Antenna/Masts
978 Noise barriers
979 Parts and accessories
980 - 989 LANDSCAPING
980 Landscaping (Grouped)
981 Hard landscaping
982 Soft landscaping
983 Features eg. Sculptures / water features
984 Landscaping structures e.g. shade structure
987 Sports facilities

Appendix B

Proposed CAD standards for line and text formats

AutoCad Specification

The default AutoCad LIN library shall be ACADISO.LIN
The LTSCALE factor in drawing files shall be 1 x the Plot Scale
The LTSCALE factor in model files shall be the AutoCad default value
PSLTSCALE shall be set to 1

Symbols and custom linestyles shall be agreed with Engineer.

The following line thicknesses shall be used
0.13mm, 0.18mm, 0.25mm, 0.35mm, 0.50mm, 0.70mm, 1.00mm, and 2.00mm
The line thickness shall be assigned by weight and not by colour. The "default" line weight shall not be used.

Text shall be in AutoCad Romans font with the style name STANDARD. The text sizes and corresponding line weights to be assigned are given in the table below.

Text height	Thickness
1.50mm	0.18mm
2.00mm	0.25mm
2.50mm	0.25mm
3.50mm	0.35mm
5.00mm	0.50mm
7.00mm	0.70mm
10.00mm	1.00mm
20.00mm	2.00mm

A width factor of 0.8 x text height shall be used. For multi-line text the line spacing shall be set to single (1.0x) setting

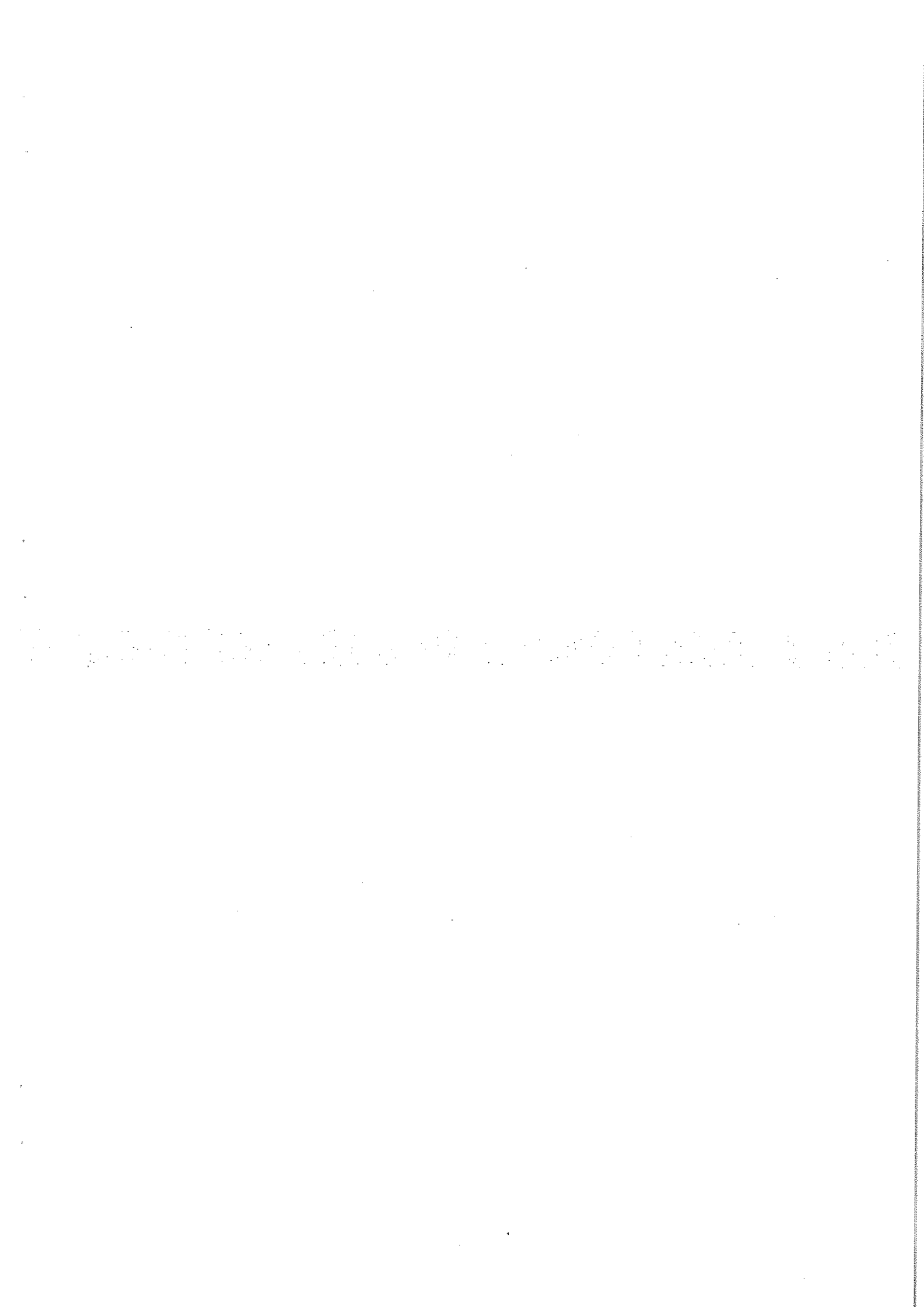
Only the special text characters available from the default ROMANS character map shall be used

The default AutoCad colour table shall be used. Only colours 250 through 254 shall be used as grey scales.

Hatching or cross-hatching of areas should be avoided as far as possible.

In the above requirements "default" shall be taken to mean the default settings as defined on initial installation of the AutoCad Software.

Should MicroStation CAD software be used in agreement with Engineer then a similar set of requirements covering MicroStation settings shall be defined by the Engineer.



APPENDIX C

TECHNICAL SPECIFICATIONS FOR GEOTECHNICAL INVESTIGATION

4.1 GENERAL

These specifications shall be applied to the geotechnical investigation for the Feasibility Study for the 2nd Kohat Tunnel and Access Road being carried out by the Japan International Cooperation Agency.

4.2 INVESTIGATION SITES

The geotechnical investigation is carried out at the portals of the tunnel and the vicinity of the tunnel approach road shown in **Annex-B**.

4.3 SCOPE OF WORKS

The Works comprises of the following items:

1) Mechanical Boring and Coring in Rock

Mechanical boring in rock including rock coring shall be conducted at **four (4)** locations:

- a) one (1) at 70 m east from the centerline of south portal of the Kohat tunnel: the depth shall be 20 m.
- b) one (1) at 30 m east from the centerline of north portal of the Kohat tunnel: the depth shall be 20 m.
- c) one (1) at a hill in the realignment route study section: the depth shall be 30 m.

The exact location of each boring shall be instructed by the Engineer. The core diameter shall be 63.5 mm at minimum.

The four (4) bore logs shall be prepared.

2) Mechanical Boring in Soil/Rock, Sampling and Standard Penetration Test

Mechanical boring in soil shall be conducted at **three (3)** locations:

- a) one (1) at the riverbed near the approach road before the tunnel, 50 m south from STA19+145 and 10 m east from edge of eastside embankment for the approach road: the depth shall be **20 m** maximum; drilling can stop at 3 m down from top of the hard rock layer.
- b) one (1) at the riverbed near the approach road before the tunnel, 50 m north from STA19+265 and 10 m east from edge of eastside embankment for the approach road: the depth shall be **20 m** maximum; drilling can stop at 3 m down from top of the hard rock layer.

- c) one (1) at 13 m east from centerline of the Pier 2 of the bridge No.1 located at STA2+705: the depth shall be 30 m maximum; drilling can stop at 5 m after N-value becomes more than 50 in SPT.

The exact location of each boring shall be instructed by the Engineer at the Site. The core diameter shall be 63.5 mm at minimum.

From bore holes of riverbed, soil sample shall be collected for every layer for laboratory tests. From boreholes near the bridge, soil sample shall be collected for every 1 m for laboratory tests.

Standard Penetration Test (SPT) shall be carried out at every 1 m in bore holes.

3) Laboratory Tests and Analysis

All necessary tests shall be carried out for soil classification including grain size analysis, specific gravity, bulk density, dry density and moisture content of rock core for every sample taken from bore hole.

Unconfined compression test for rock samples taken from bore hole shall be conducted for three (3) selected rock samples.

Analysis and test of the soil samples shall be carried out and reported according to the ASTM Standards or equivalent approved by the Engineer.

The quantities of boring and laboratory tests required are summarized in ANNEX-A.

3.4 PROGRAM

The report shall be submitted by 30th June 2006.

3.5 WORK METHOD

Prior to commencement of the field work, the Contractor shall prepare and submit to the Engineer for his approval a program showing the order of procedure and method.

Unless stated, no boring without casing for soil shall be permitted. Casings shall be applied all the time during the boring.

The depth of bore hole shall be measured from the ground level. The ground elevation at each bore hole shall be measured by the Contractor. The depth is subject to change or modification according to the actual condition, but will not vary more than 20%. No claim on unit prices will be accepted for such change.

All soil samples from boreholes shall be obtained with split-barrel sampler. Continuous rock core samples shall be obtained in sound rock, where encountered at the bottom of each bore hole, using standard double-tube diamond core barrel coring techniques (ASTM D2113), or equivalent.

The Contractor shall place all samples in a careful, organized, and orderly manner in sample and/or core boxes indicating proper depth markings, sample numbers, and interval samples.

Spacer blocks shall be firmly installed, clearly indicating depth intervals where rock core samples are missing. All soil and highly-weathered rock samples shall be carefully protected and preserved against moisture losses and further disturbance during handling and transportation.

The relevant testing standard to be applied shall be ASTM standards, unless otherwise specified.

Location of boreholes shall be marked with wooden piles to be identified later on.

3.5 REPORTING

The Contractor shall prepare Geotechnical Investigation Report.

The report of boring and laboratory test shall include boring logs, laboratory test results, rock and soil classification, photographs, description of surface geology and subsurface cross section, etc.

3.6 MEASUREMENT AND PAYMENT

Payment for mobilization and demobilization of equipment and personnel shall be made on a lump sum basis, which shall include transportation, shipping and other necessary expenses to completely mobilize and demobilize personnel and equipment.

Payment for mechanical boring shall be made on a lump sum basis.

Payment for SPT and laboratory tests including labeling, packing, storage and transportation of samples to laboratory shall be made on a lump sum basis.

Payment for reporting shall be made on lump sum basis.

The payment shall include full compensation for all machinery for boring including equipment, tools, labor, materials, casing pipe, other incidentals to complete the Works, including recording and presenting the results.

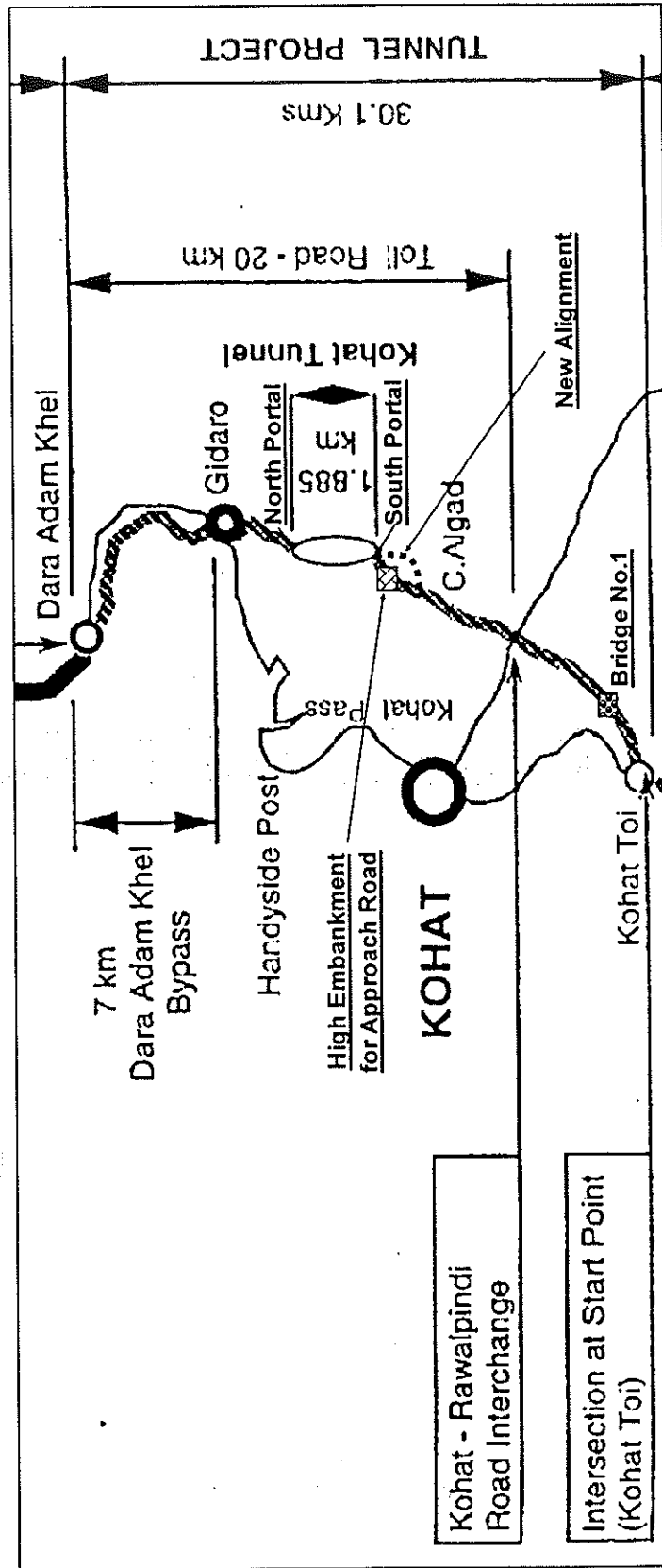
ANNEX-A

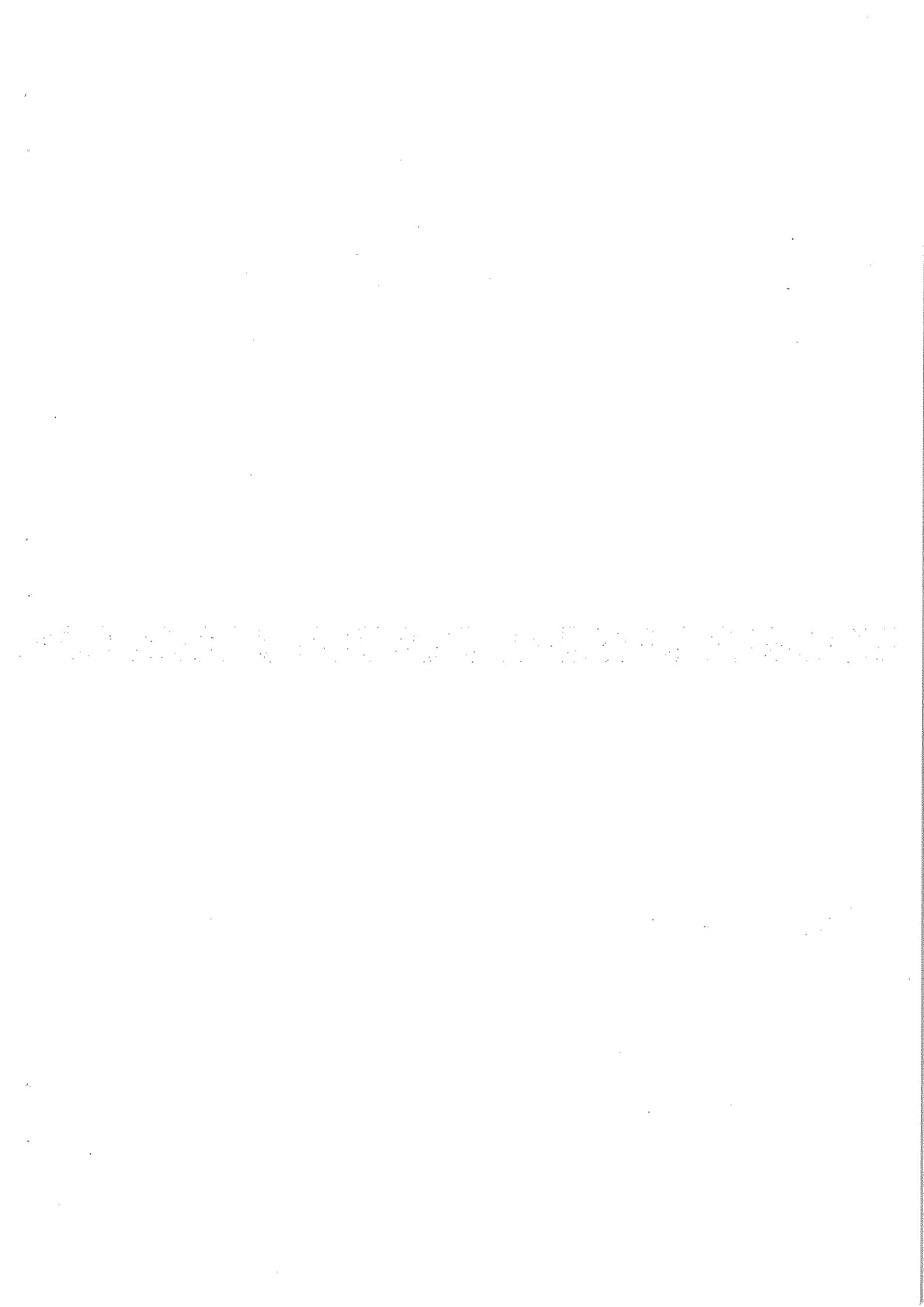
BILL OF QUANTITIES FOR GEOTECHNICAL INVESTIGATION

Currency Unit: Japanese Yen

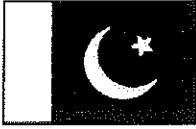
Item	Unit	Q'ty	Unit Price	Amount
1. Mobilization and Demobilization	L.S.	1		
2. Mechanical Boring				
Boring at south portal	m	20		
Boring at north portal	m	20		
Boring at a hill	m	30		
Boring at riverbed	m	40		
Boring for a bridge	m	30		
SPT	m	70		
Collection of samples from bore holes	No.			
3. Laboratory Test and Analysis				
Soil classification	L.S.	1		
Rock classification	L.S.	1		
4. Report and recommendations	L.S.	1		
Total Amount				

Annex-B Location Map



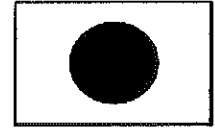


Appendix D



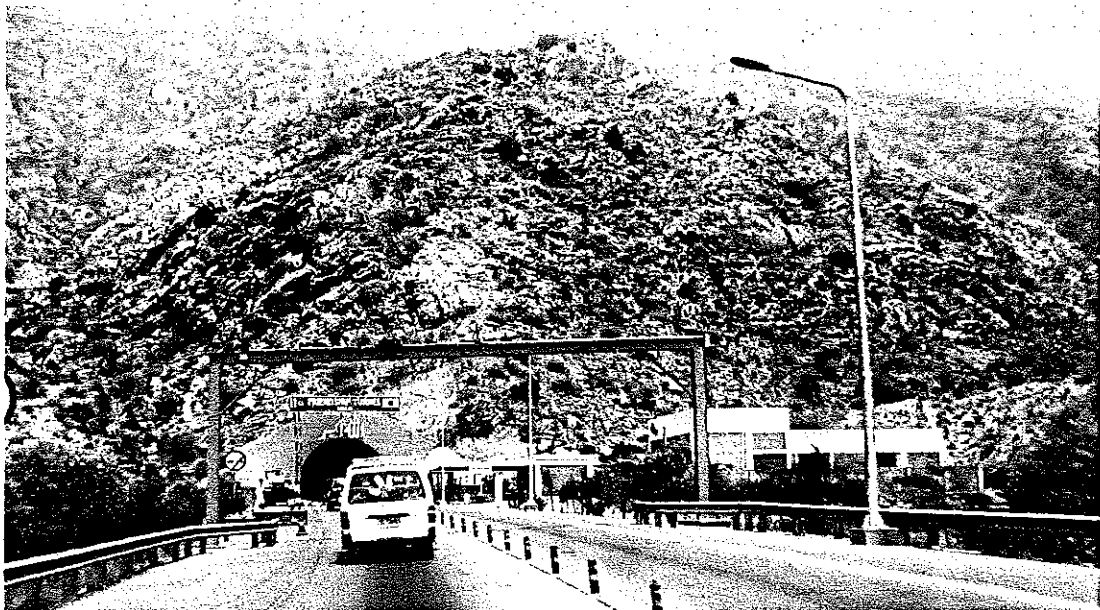
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

**MINISTRY OF COMMUNICATIONS
NATIONAL TRANSPORT RESEARCH CENTRE
NATIONAL HIGHWAY AUTHORITY
GOVERNMENT OF THE ISLAMIC REPUBLIC OF PAKISTAN**



**PAKISTAN TRANSPORT PLAN STUDY (PTPS)
PHASE II**

**SITE RECONNAISSANCE PHOTOGRAPHS
FOR
THE WORK PLAN & METHODOLOGY
OF THE FEASIBILITY STUDY
ON
THE 2ND KOHAT TUNNEL AND ACCESS ROAD PROJECT**



MAY 2006

JICA STUDY TEAM

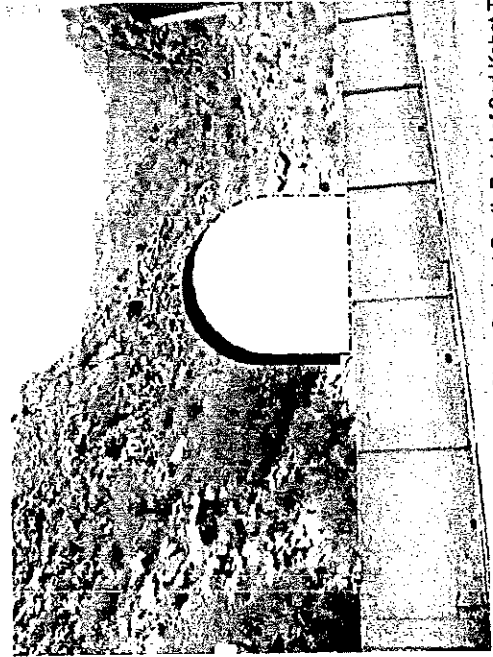
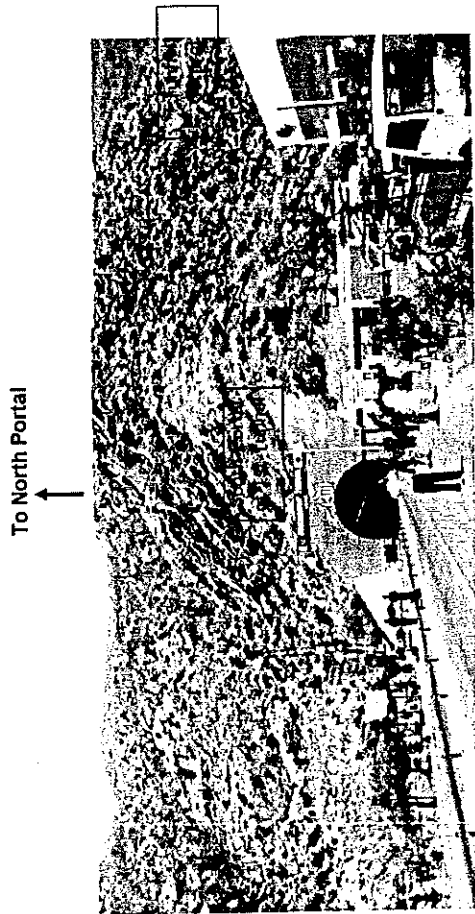
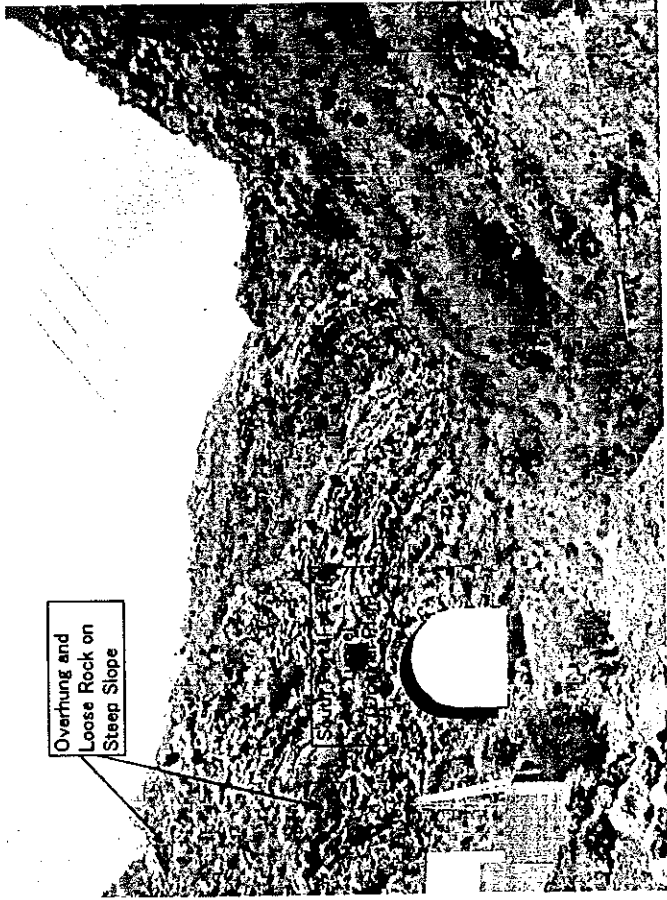
Table of Contents

- South Portal and Approach Road
- North Portal and Approach Road
- Alternative Route Study Section
 - Sta.17+500 - Sta.20+150 (Tunnel South Portal)
- Existing Bridges No.1 - No.10
- High Cuts
- Existing Junctions and Intersections
- Existing Facilities

1st and 2nd Kohat Tunnel

South Portal and Approach Road

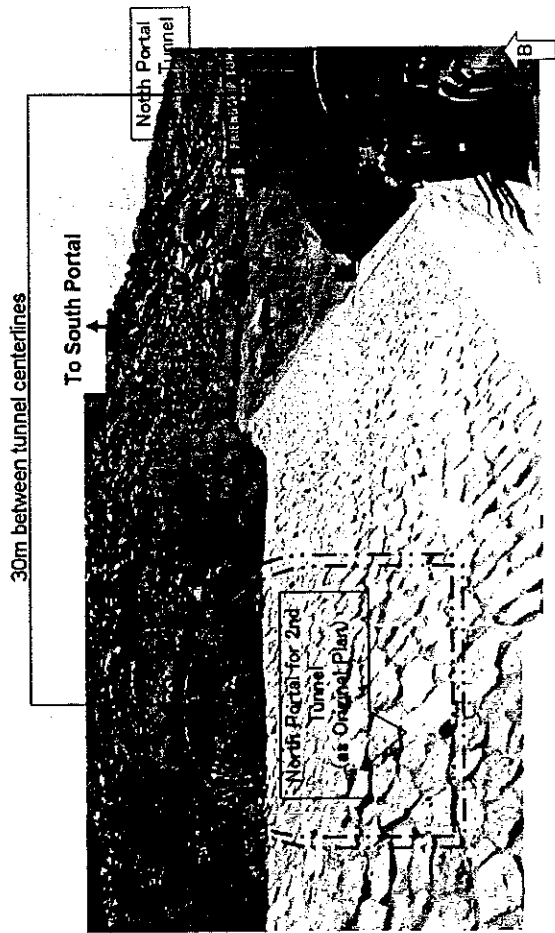
Kohat Tunnel South Portal



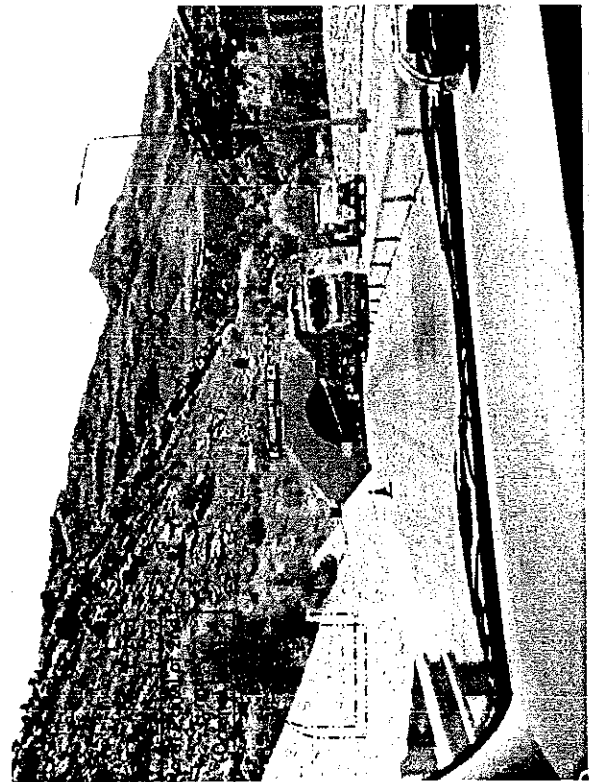
1st and 2nd Kohat Tunnel

North Portal and Approach Road

Kohat Tunnel North Portal



Picture for Direction A: Approach of 2nd Kohat Tunnel



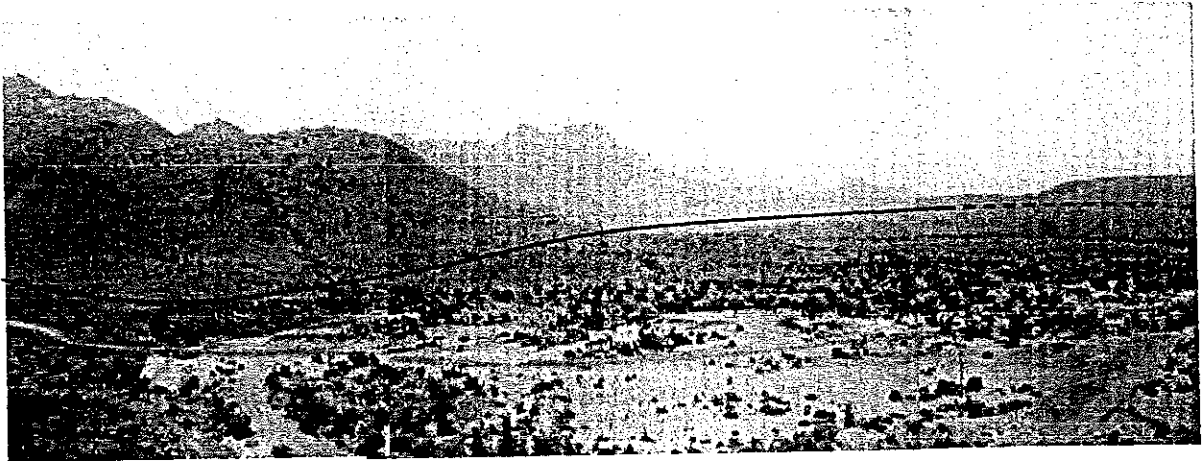
Picture of Direction B: Steep Creek at South Portal of 2nd Kohat Tunnel

2nd Kohat Tunnel Access Road

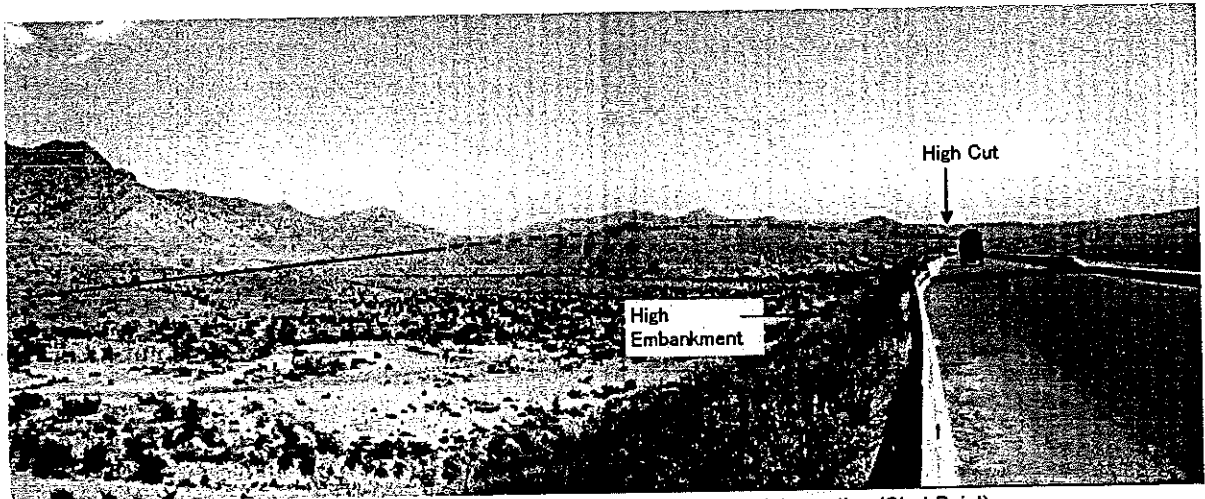
Alternative Route Study Section

Sta. 17+500 - Sta. 20+150 (Tunnel South Portal)

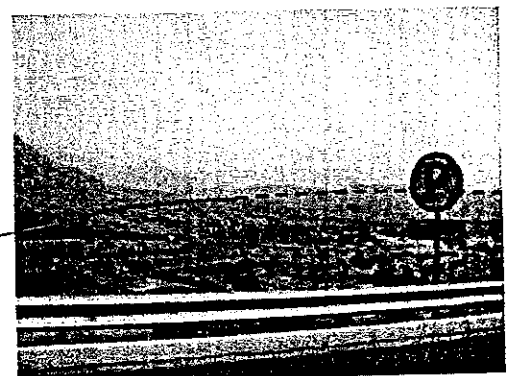
Alternative Route Study Section
Sta.17+500 - Sta.20+150 (Tunnel South Portal)



Direction From Tunnel to N-80 Intersection (Start Point)



Direction From Tunnel to N-80 Intersection (Start Point)



Direction From Access Road to Mountain/Hill

1st Kohat Tunnel Access Road

Existing Bridges

(No.1 - No.10)

List of Bridges constructed under the 1st Kohat Tunnel and Access Road Project

No.	Station (at center)	Type	Length (m)	Span	Pile Length (m)	Remarks
1	2+736.245	PC Girder	120	4 - 30m Span	20	Over river
2	4+735.415	PC Girder	50	2 - 25m Span	14	Over river
3A	9+454.363	PC Girder	20	1 - 20m Span	20	Over railway
3B	9+645.760	PC Girder	30	1-30m Span	21.5	Over N80 (Rwalpindi - Kohat Road)
9	14+800	RC Girder	12	1-12m Span	20	Over Bazi Khel Road
10	16+585	RC Girder	12	1-12m Span	20	Over a track
4 ²⁾	19+205.000	PC Girder	120	4-30m Span	18	Over river / creek
Kohat Tunnel¹⁾						
5	18+920.415	PC Girder	50	2 - 25m Span	20	Over river
8	19+082.70	PC Girder	20	1 - 20m Span	Spread Fd.	Over NW Frontier Road Skew 30°
6A	21+260.525	PC Girder	180	6-30m Span	12	Over rivers
7	25+388.915	PC Girder	40	2-20m Span	20	Over river
Total:			654			

- Notes: 1. Break at Sta. 20+194.165 /Sta.16+247.000 (-3947.167)
 2. Dual carriageway (travelway) for Bridge No.4.

Existing Bridges in Tunnel South Section (1/7)

Kohat Tol (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)

Br.No.1 Sta.2+736.245 (center)
Over River

PC-Girder

4 - 30m Span

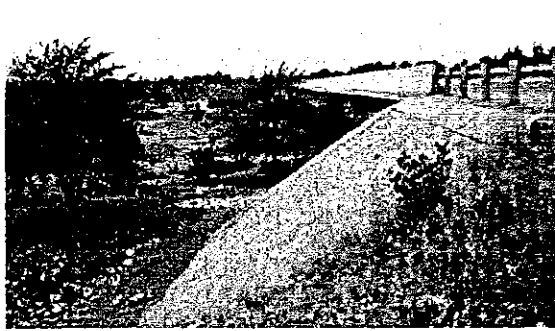
Pile Length = 20m



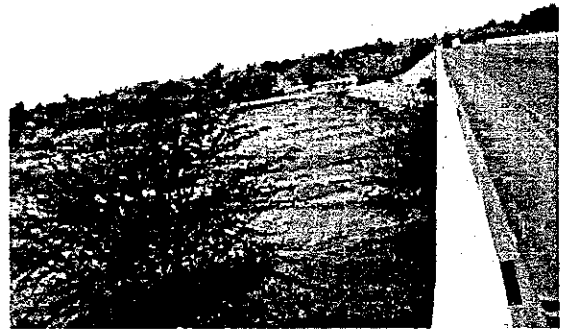
Direction (From Start Point to N-80 Intersection)



Direction (From N-80 Intersection to Start Point)



Direction (From N80 to Kohat)



Direction (From N80 to Kohat)

Existing Bridges in Tunnel South Section (2/7)

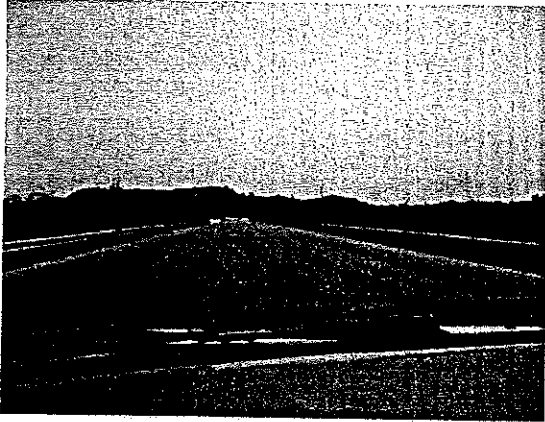
Kohat Tol (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)

Br.No.2 Sta.4+735.415 (center)
Over River

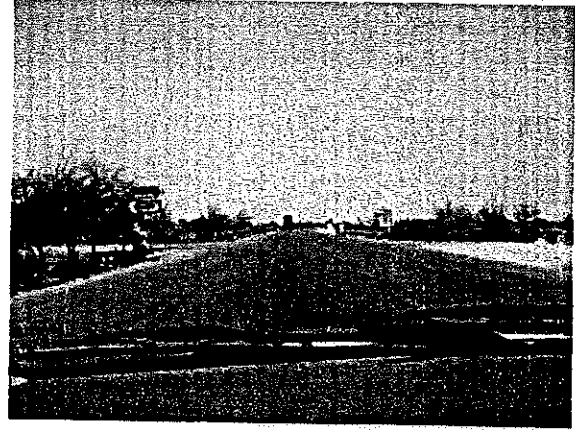
PC-Girder

2 - 25m Span

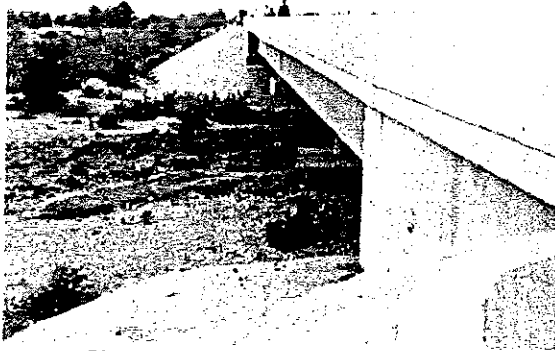
Pile Length = 14m



Direction (From Start Point to N-80 Intersection)



Direction (From N-80 Intersection to Start Point)



Direction (From N80 to Kohat)

Existing Bridges in Tunnel South Section (3/7)

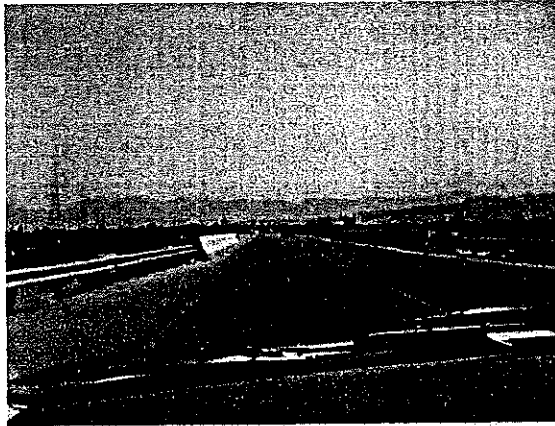
Kohat Tol (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)

Br.No.3A Sta.9+454.363 (center)
Over Railway

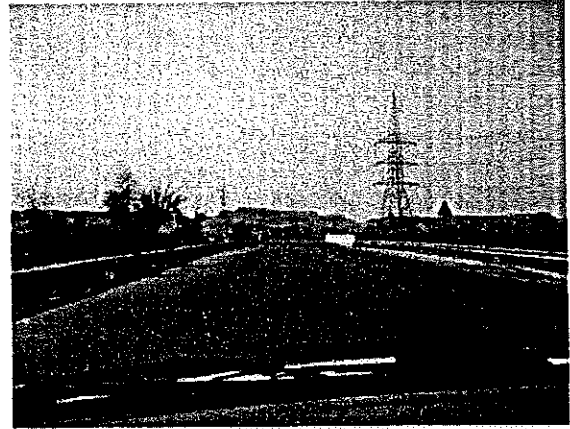
PC-Girder

1 - 20m Span

Pile Length = 20m



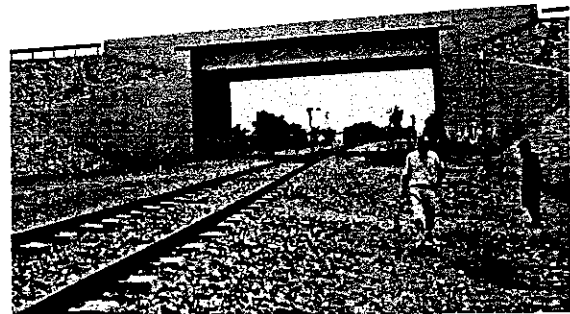
Direction (From Start Point to N-80 Intersection)



Direction (From N-80 Intersection to Start Point)



Direction (From Rawal Pindi to Kohat)

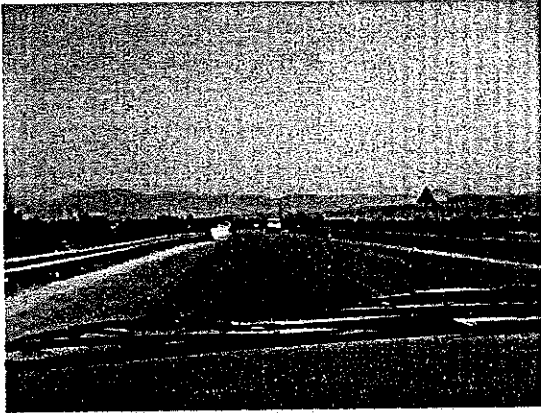


Direction (From Rawal Pindi to Kohat)

Existing Bridges in Tunnel South Section (4/7)

Kohat Tol (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)

Br.No.3B Sta.9+645.760 (center) PC-Girder 1-30m Span Pile Length = 21.5m
Over N80 (Rawal Pindi - Kohat Road)



Direction (From Start Point to N-80 Intersection)



Direction (From N-80 Intersection to Start Point)



Direction (From Rawal Pindi to Kohat)



Direction (From Rawal Pindi to Kohat)

Existing Bridges in Tunnel South Section (5/7)

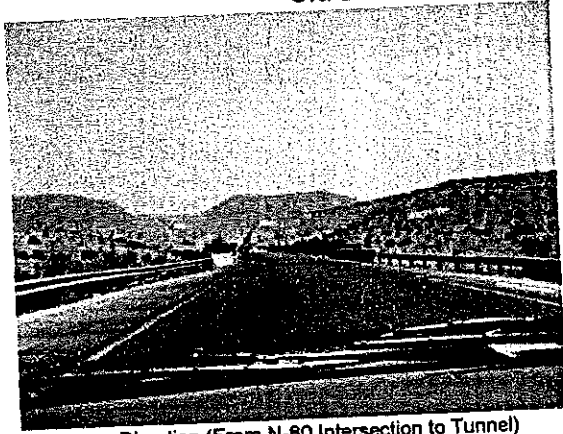
Kohat Tol (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)

Br.No.9 Sta.14+800 (center)
Over Bazi Khel Road

RC Girder

1-12m Span

Pile Length = 20m



Direction (From N-80 Intersection to Tunnel)



Direction (From Tunnel to N-80 Intersection)

Existing Bridges in Tunnel South Section (6/7)

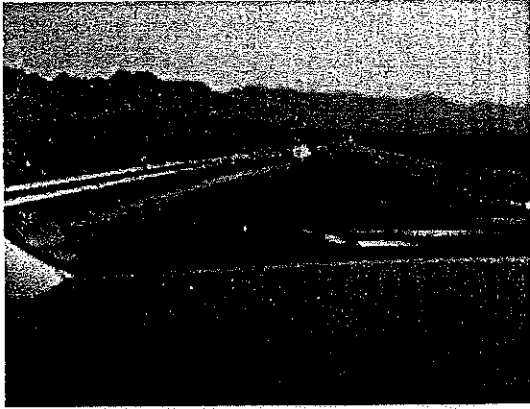
Kohat Toi (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)

Br.No.10 Sta.16+585 (center)
Over a track

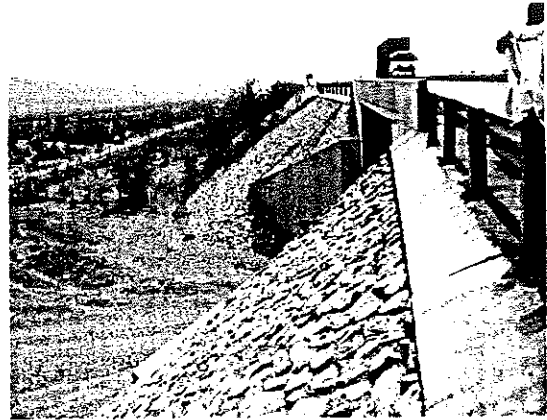
RC Girder

1-12m Span

Pile Length = 20m



Direction (From N-80 Intersection to Tunnel)



Direction (From Tunnel to N-80 Intersection)



Direction (From N-80 Intersection to Tunnel)

Existing Bridges in Tunnel South Section (7/7)

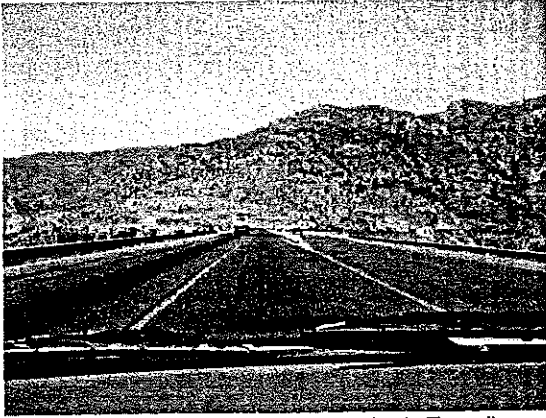
Kohat Toi (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)

Br.No.4 Sta.19+205.000 (center)
Over river / creek

PC Girder

4-30m Span

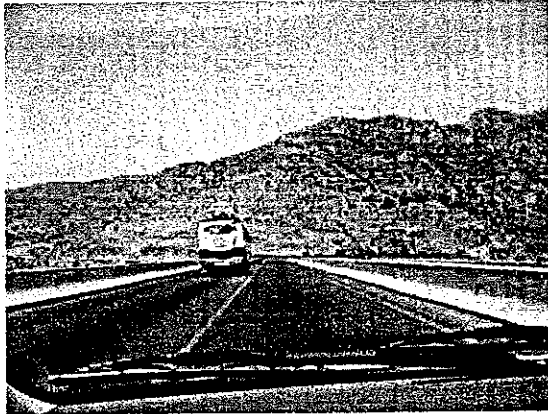
Pile Length = 18m



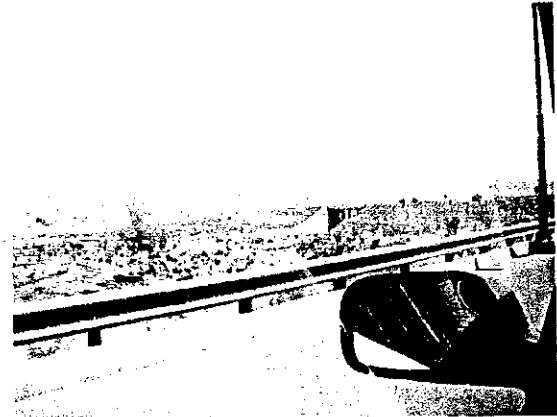
Direction (From N-80 Intersection to Tunnel)



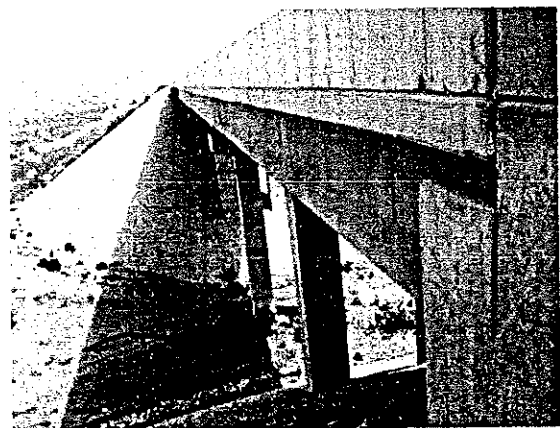
Direction (From Tunnel to N-80 Intersection)



Direction (From N-80 Intersection to Tunnel)



Direction (From Tunnel to N-80 Intersection)



Direction (From Tunnel to N-80 Intersection)

Existing Bridges in Tunnel - North Section (1/4)

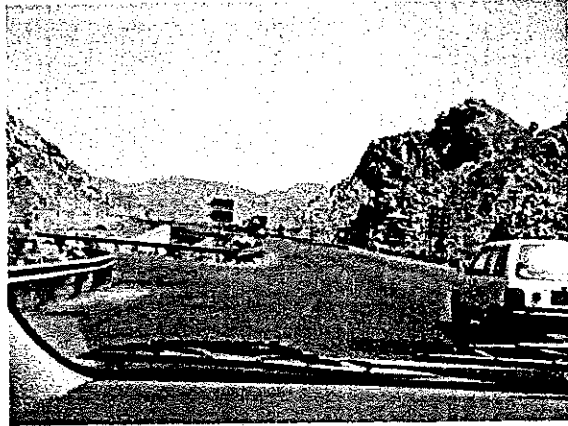
Tunnel (North Portal) - Dara Adam Khel (End Point)

Br.No.5 Sta.18+920.415 (center)
Over River

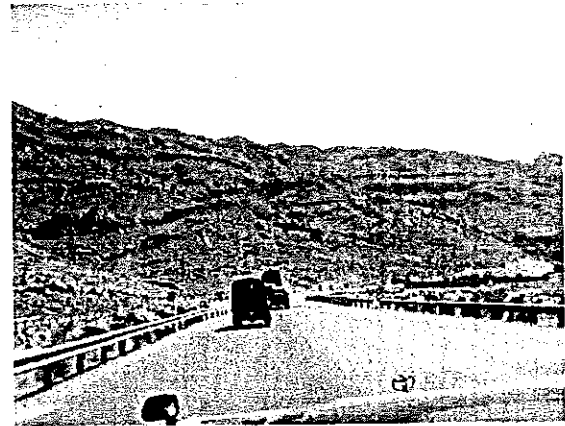
PC Girder

2 - 25m Span

Pile Length = 20m



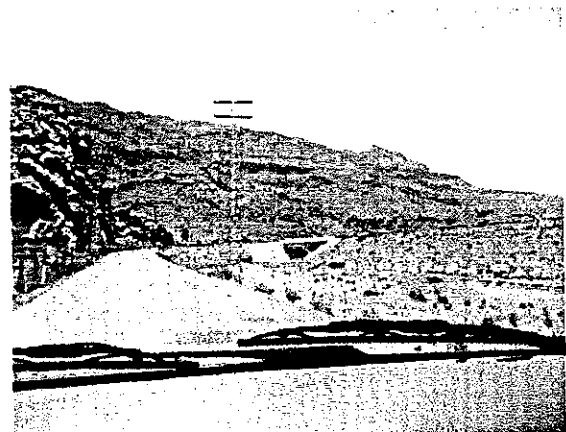
Direction (From Tunnel to End Point)



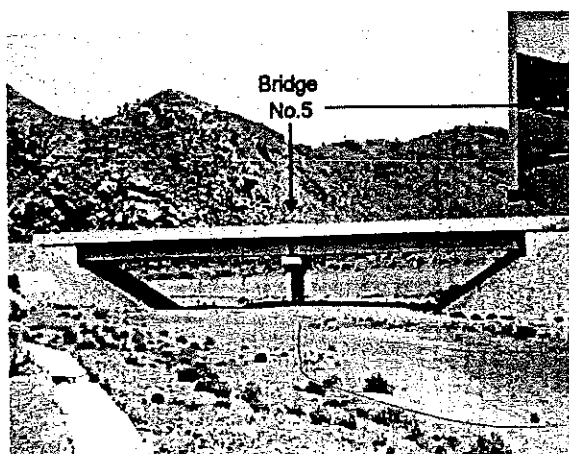
Direction (From End Point to Tunnel)



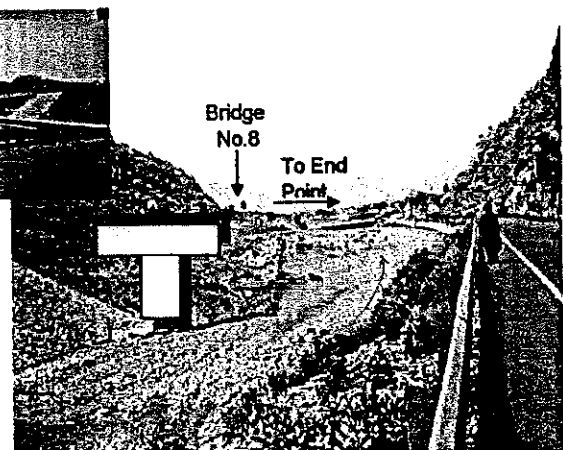
Direction (From Tunnel to End Point)



Direction (From End Point to Tunnel)



Direction (From down Stream to Up-stream)



Direction (From Up-stream to Down-stream)

Existing Bridges In Tunnel - North Section (2/4)

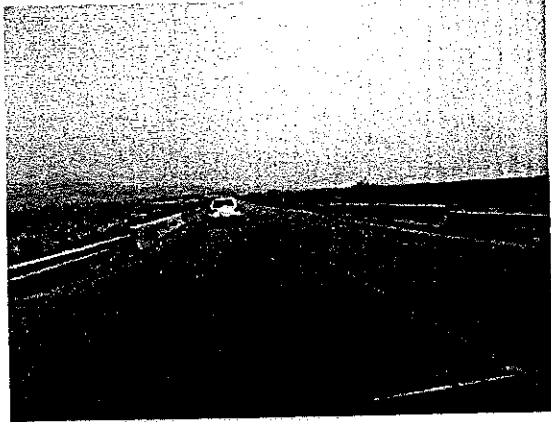
Tunnel (North Portal) - Dara Adam Khel (End Point)

Br.No.8 Sta.19+082.70 (center)
Over NW Frontier Road

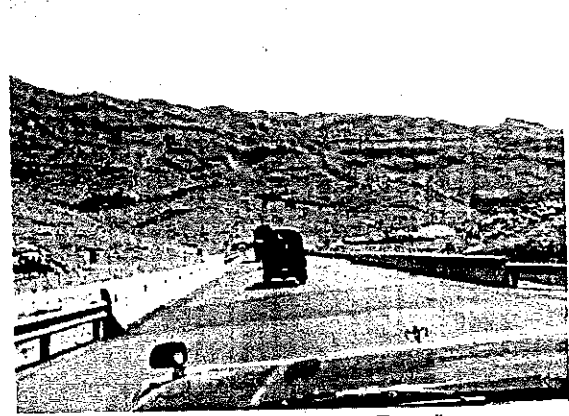
PC Girder

1 - 20m Span
Skew 30°

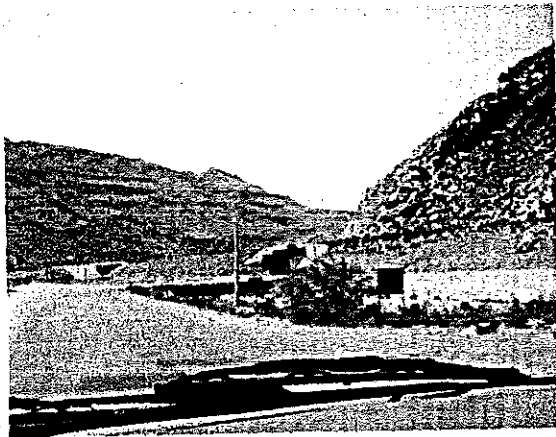
Spread Foundation



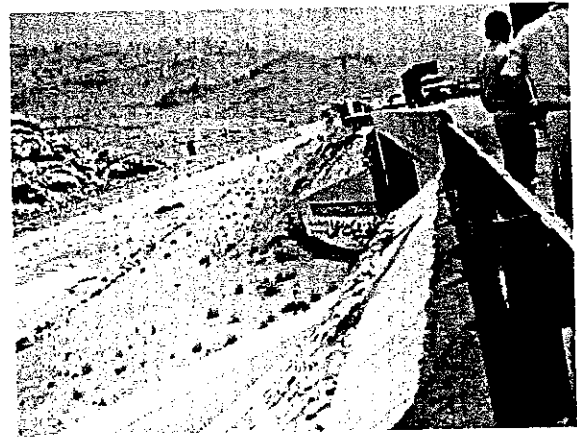
Direction (From Tunnel to End Point)



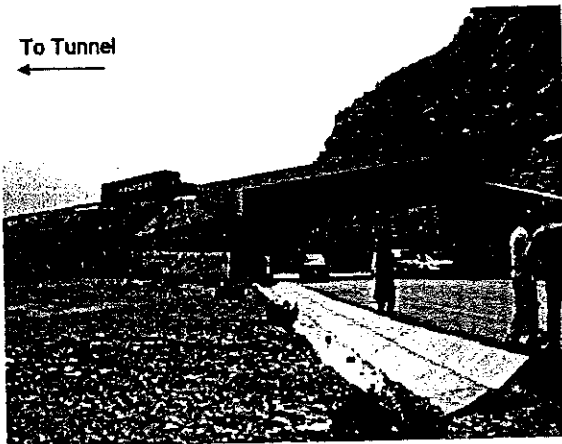
Direction (From End Point to Tunnel)



Direction (From End Point to Tunnel)



Direction (From End Point to Tunnel)



To Tunnel
←

Direction (Toward Kohat Pass)



To End Point
→

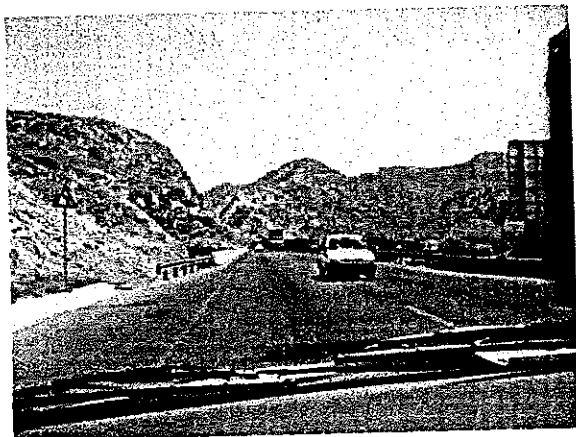
Direction (Toward End Point)

Existing Bridges in Tunnel - North Section (3/4)

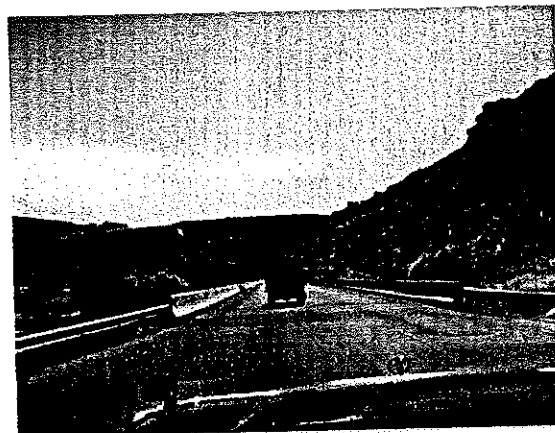
Tunnel (North Portal) - Dara Adam Khel (End Point)

Br.No.6A Sta.21+260.525 (center)
Over river

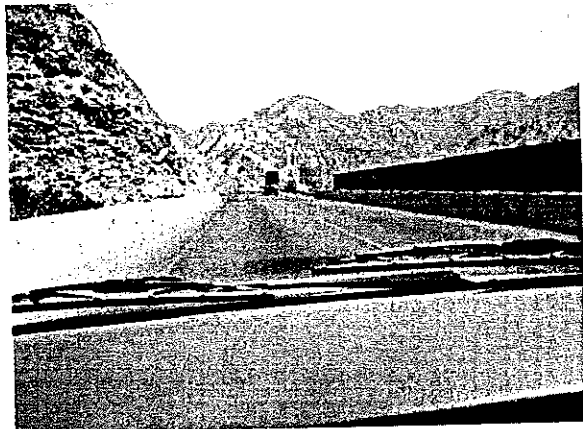
6-30m Span Pile Length = 12m
(2-30m Span in the original plan)



Direction (From Tunnel to End Point)



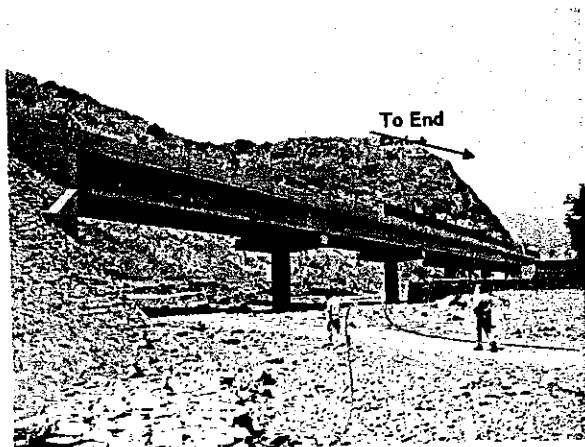
Direction (From End Point to Tunnel)



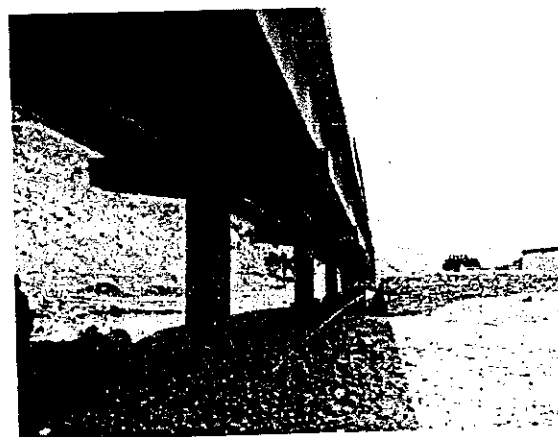
Direction (From Tunnel to End Point)



Direction (From End Point to Tunnel)



Direction (From Tunnel to End Point)



Direction (From Tunnel to End Point)

Existing Bridges In Tunnel - North Section (4/4)

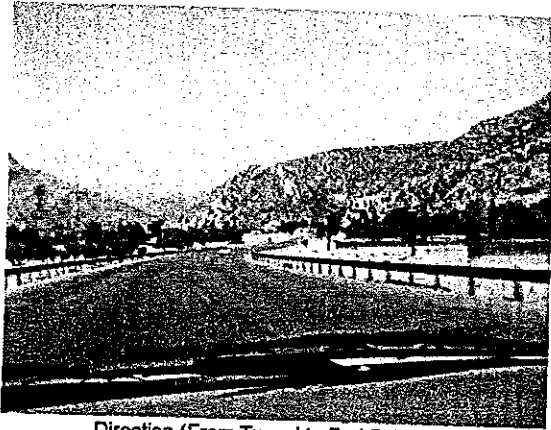
Tunnel (North Portal) - Dara Adam Khel (End Point)

Br.No.7 Sta.25+388.915 (center)

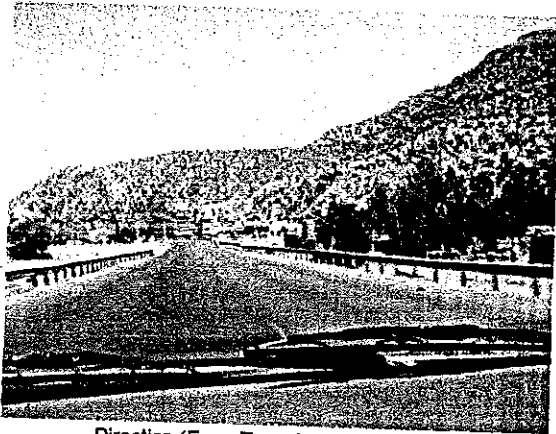
PC Girder

2-20m Span

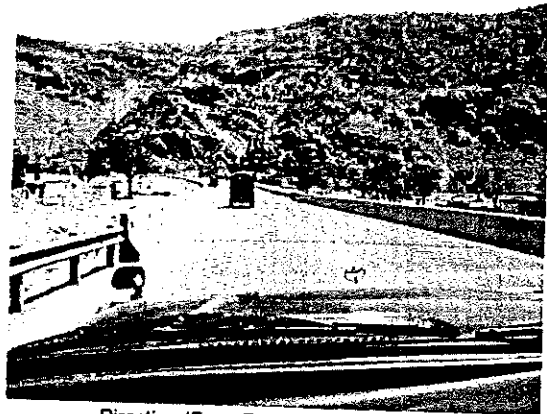
Pile Length =20m



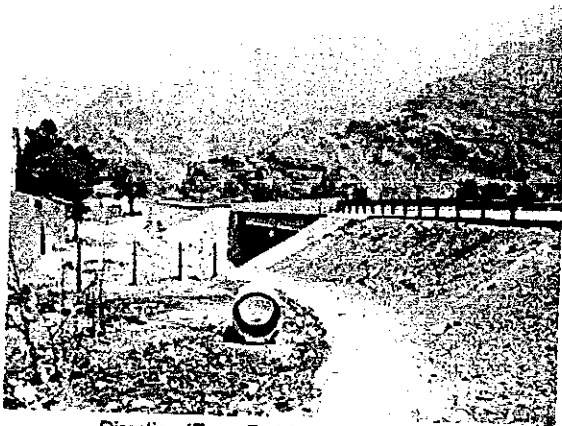
Direction (From Tunnel to End Point)



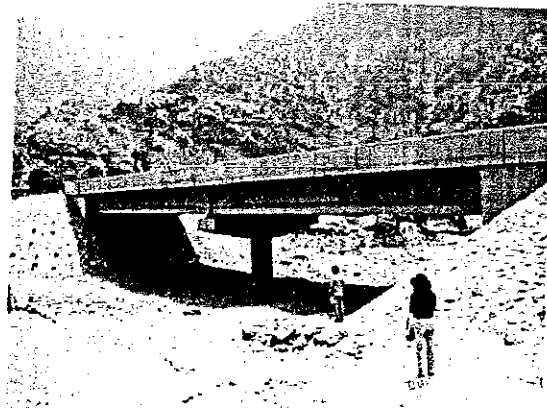
Direction (From Tunnel to End Point)



Direction (From End Point to Tunnel)



Direction (From End Point to Tunnel)



Direction (From Down Stream to Upper Stream)

2nd Kohat Tunnel Access Road

High Cuts

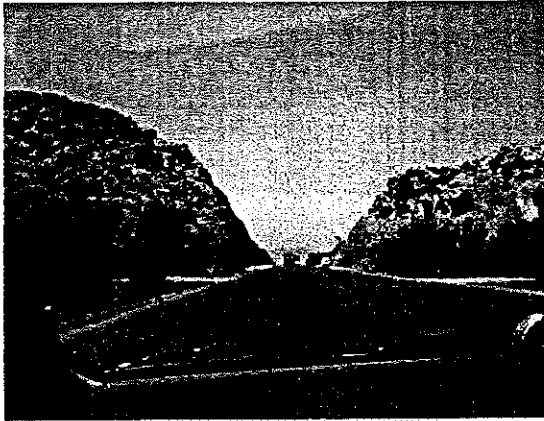
List of High-Cuts and Initial Quantity Estimate

No.	From (Sta.)	To (Sta.)	Length (m)	Width (m)	Average Cut Height (m)	Estimated Total Quantity (m ³)	Classification of Materials				Remarks (Max. Cut (m))
							Common		Rock		
							%	(m ³)	%	(m ³)	
South Section: Kohat Toi (Start Point) - Kohat Tunnel (South Portal)											
S-1	7.325	7.475	150	13	10	19,500	5	970	95	18,530	28
S-2	14.425	14.625	200	13	5	13,000	70	9,100	30	3,900	10
S-3	15.250	15.425	175	13	18	40,950	5	2,050	95	38,900	32
S-4	18.000	18.725	725	13	12	113,100	60	67,860	40	45,240	23
S-5	19.753	20.178	425	13	20	110,500	0	0	100	110,500	35
Sub-Total:						297,050	27	79,980	73	217,070	
North Section: Kohat Tunnel (North Portal) - Dara Adam Khet (End Point)											
N.1a	18.132	18.325	193	20	12	46,320	5	2,320	95	44,000	15
N.1b	18.325	18.825	500	11	6	33,000	0	0	100	33,000	12
N.2	21.575	21.725	150	11	15	24,750	0	0	100	24,750	32
N.3	22.300	22.400	100	11	4	4,400	0	0	100	4,400	6
N.4	23.850	23.975	125	11	12	16,500	0	0	100	16,500	24
N.5	24.300	24.400	100	11	8	8,800	0	0	100	8,800	14
Sub-Total:						133,770	2	2,320	98	131,450	
Total:						430,820	19	82,300	81	348,520	

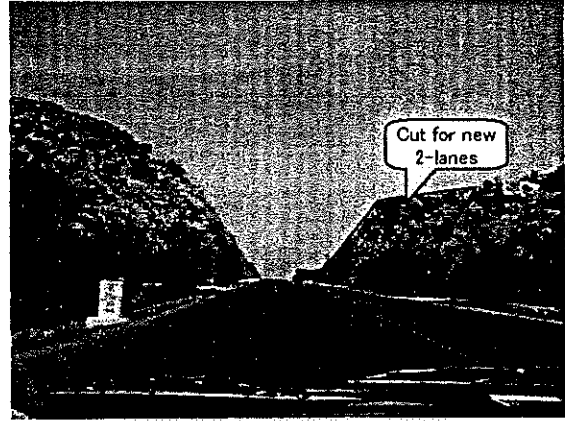
Note:

High-Cuts Study in Tunnel South Section (1/2)

Kohat Tol (Start Point) - Rawal Pindi - Kohat Road Intersection (N-80 Intersection)

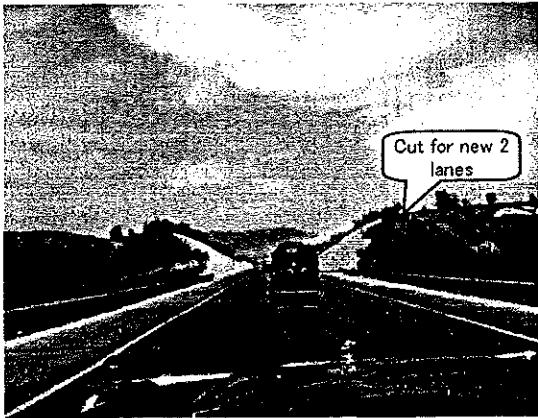


Direction (From Start Point to Tunnel)
 No.S-1 : Sta.7+325 - Sta.7+475 (L=150m)
 Maximum Cut Height = 28m



Direction (From Start Point to Tunnel)
 Estimated Quantity
 Common: 970 m³
 Rock: 18,530 m³
 Total: 19,500 m³

Rawal Pindi Intersection (N-80 Intersection) - Kohat Tunnel South Portal Sta.20.178 (Sta.16+247)



Direction (From Start Point to Tunnel)
 No.S-2 : Sta.14+425 - Sta.14+625 (L=200m)
 Maximum Cut Height = 10m



Direction (From Start Point to Tunnel)
 Estimated Quantity
 Common: 9,100 m³
 Rock: 3,900 m³
 Total: 13,000 m³



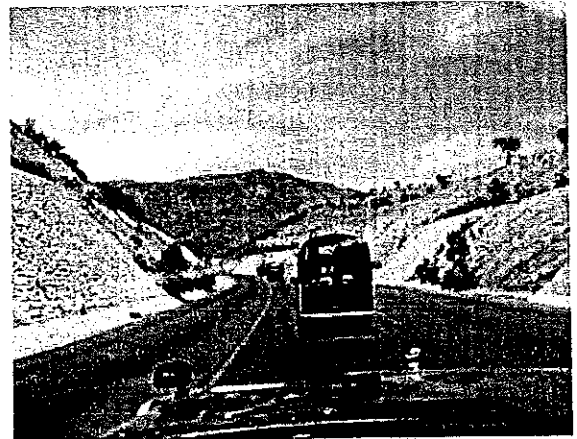
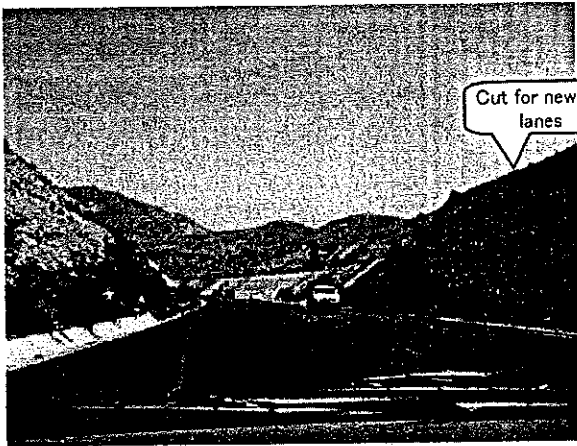
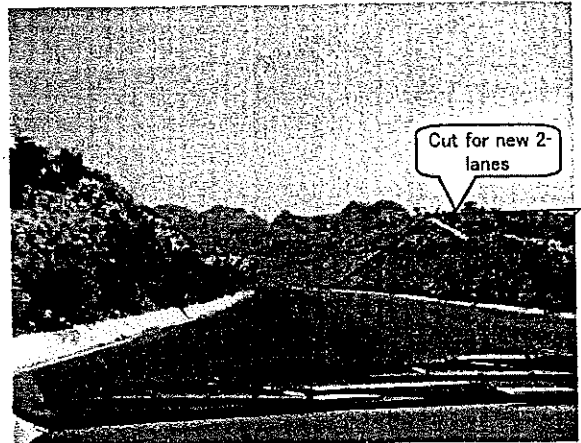
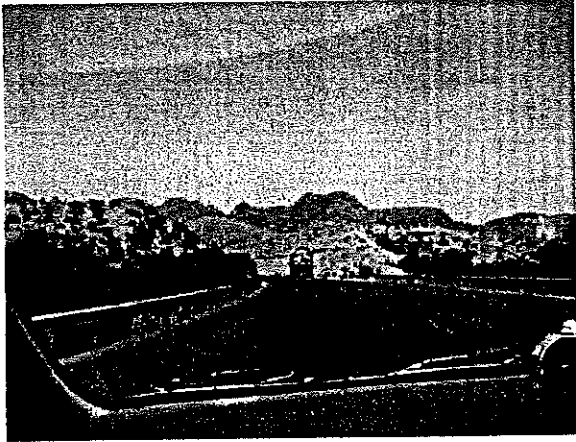
Direction (From Start Point to Tunnel)
 No.S-3 : Sta.15+250 - Sta.15+425 (L=175m)
 Maximum Cut Height = 32m



Direction (From Start Point to Tunnel)
 Estimated Quantity
 Common: 2,050 m³
 Rock: 38,900 m³
 Total: 40,950 m³

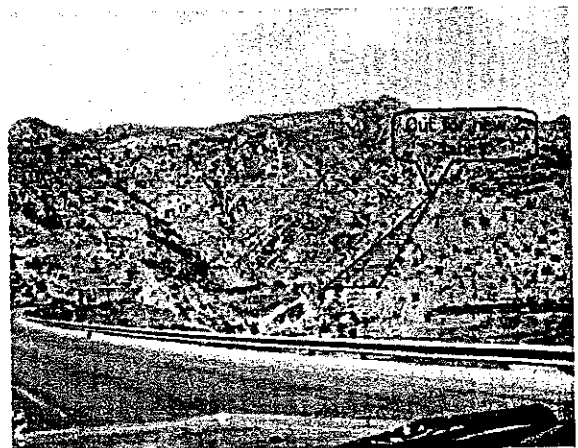
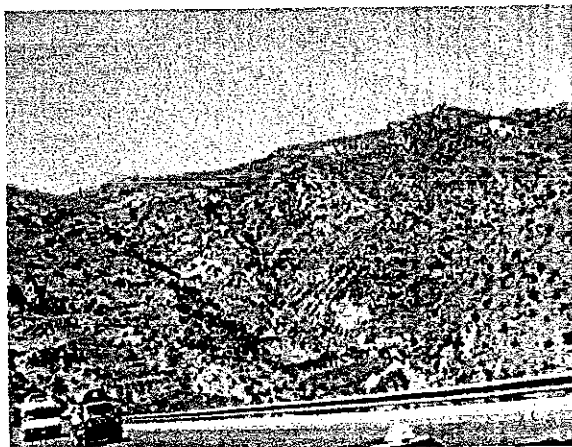
High-Cuts Study in Tunnel South Section (2/2)

Rawal Pindi Intersection (N-80 Intersection) - Kohat Tunnel South Portal Sta.20.178 (Sta.16+247)



Direction (From Start Point to Tunnel)
 No.S-4 : Sta.18+000 - Sta.18+725 (L=725m)
 Maximum Cut Height = 23m

Direction (From Start Point to Tunnel)	Estimated Quantity	Common: 67,860 m ³
		Rock: 45,240 m ³
		Total: 113,100 m ³

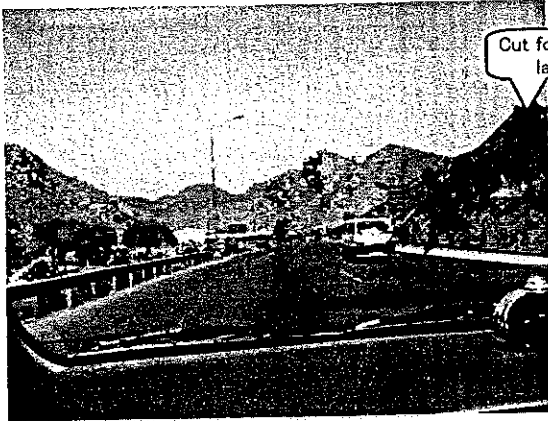


Direction (From Start Point to Tunnel)
 No.S-5 : Sta.19+753 - Sta.20+178 (L=425m)
 Maximum Cut Height = 35m
 (Note: subject to tunnel & access road alignment)

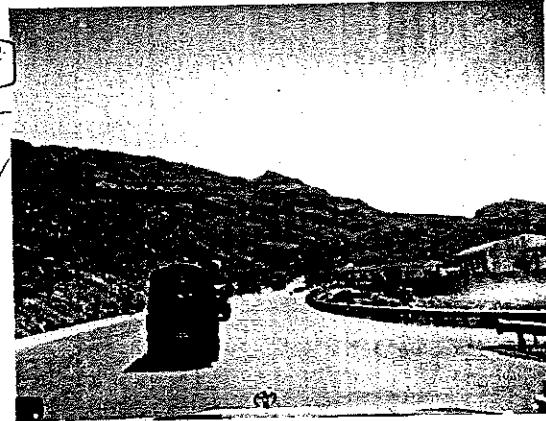
Direction (From Start Point to Tunnel)	Estimated Quantity	Common: 0 m ³
		Rock: 110,500 m ³
		Total: 110,500 m ³

High-Cuts Study In Tunnel North Section (1/2)

Tunnel (North Portal) - Dara Adam Khel (End Point)



Direction (From Tunnel to End Point)
 No.N-1 : Sta.18.132 - Sta.18+825 (L=693m)
 (N.1a & 1b) Maximum Cut Height = 15m

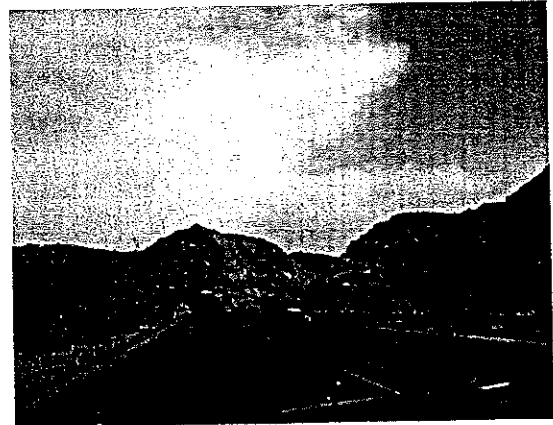


Direction (From End Point to Tunnel)
 Common: 2,320 m³
 Rock: 77,000 m³
 Total: 79,320 m³

Estimated Quantity

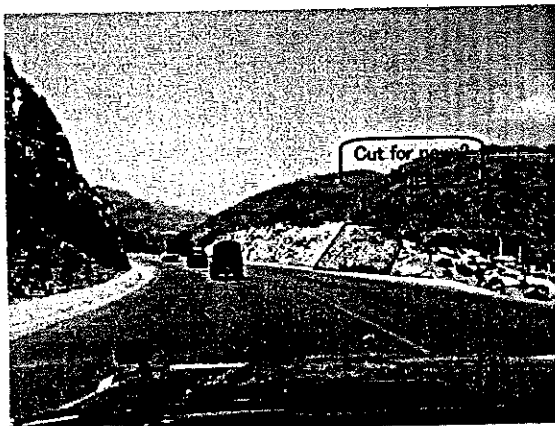


Direction (From Tunnel to End Point)
 No.N-2 : Sta.21.575 - Sta.21+725 (L=150m)
 Maximum Cut Height = 32m



Direction (From End Point to Tunnel)
 Common: 0 m³
 Rock: 24,750 m³
 Total: 24,750 m³

Estimated Quantity



Direction (From Tunnel to End Point)
 No.N-3 : Sta.22.300 - Sta.22+400 (L=100m)
 Maximum Cut Height = 6m



Direction (From End Point to Tunnel)
 Common: 0 m³
 Rock: 4,400 m³
 Total: 4,400 m³

Estimated Quantity

High-Cuts Study in Tunnel North Section (2/2)

Tunnel (North Portal) - Dara Adam Khel (End Point)



Direction (From Tunnel to End Point)
 No.N-4 : Sta.23.850 - Sta.23+975 (L=125m)
 Maximum Cut Height = 24m

Estimated Quantity

Direction (From End Point to Tunnel)
 Common: 0 m³
 Rock: 16,500 m³
 Total: 16,500 m³



Direction (From Tunnel to End Point)
 No.N-5 : Sta.24+300 - Sta.24+400 (L=100m)
 Maximum Cut Height = 14m

Estimated Quantity

Direction (From End Point to Tunnel)
 Common: 0 m³
 Rock: 8,800 m³
 Total: 8,800 m³



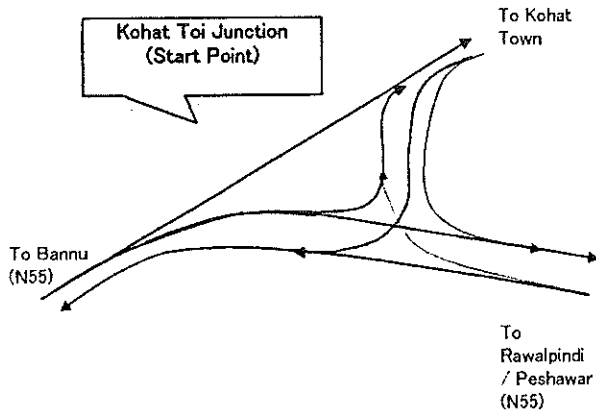
No.3

1st Kohat Tunnel Access Road

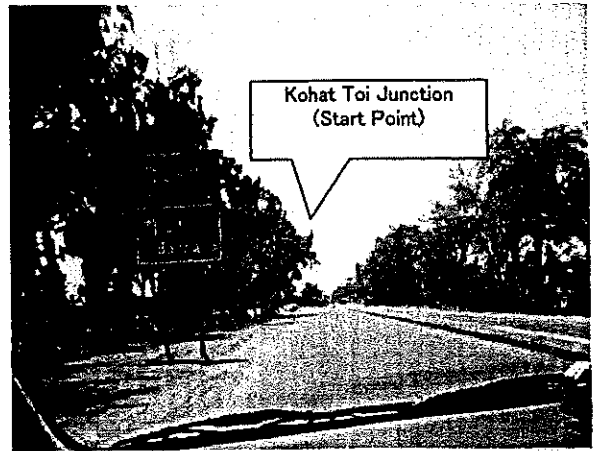
Existing Junctions and Intersections

Existing Junctions and Intersections (Interchanges) (1/5)

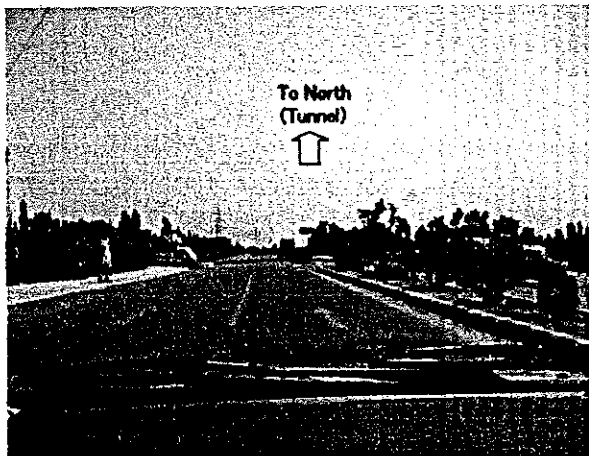
Kohat Toi Junction (Start Point)



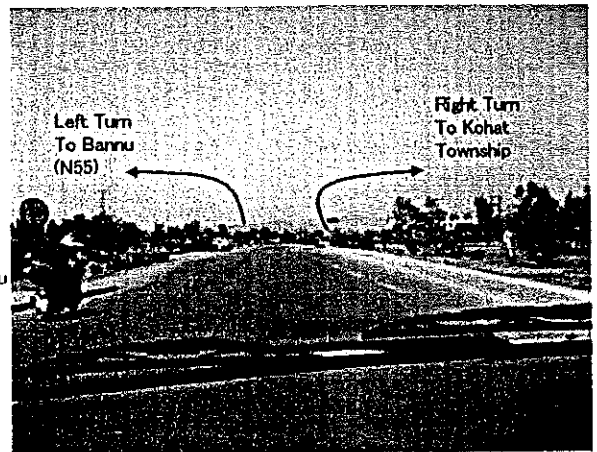
Layout of Kohat Toi Junction (Start Point)



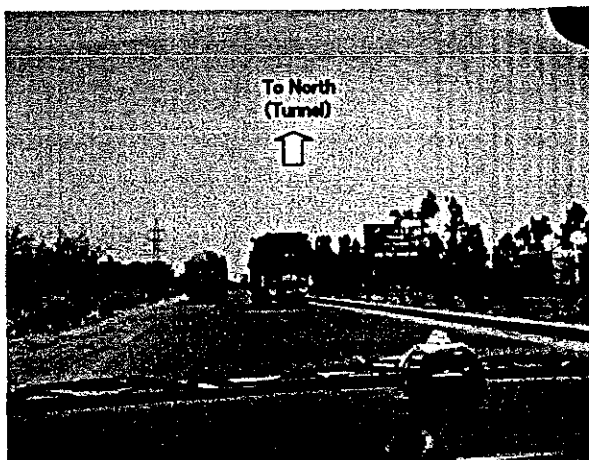
Direction from Kohat Town to Start Point (Kohat Toi)



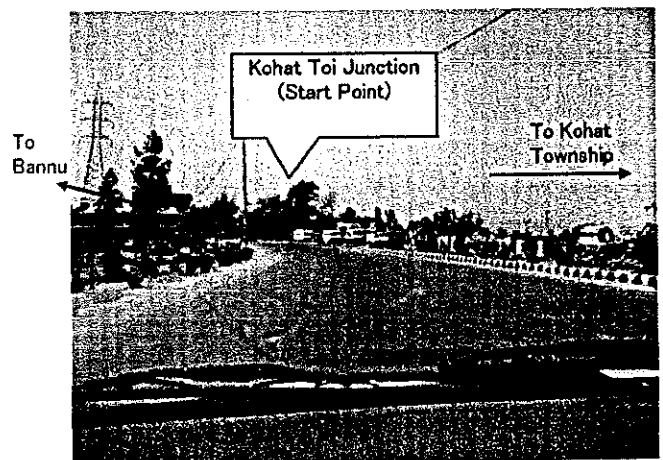
Start Point of Kohat Tunnel Access Road (Sta.0+200)



Direction (From N-80 Intersection to Start Point)



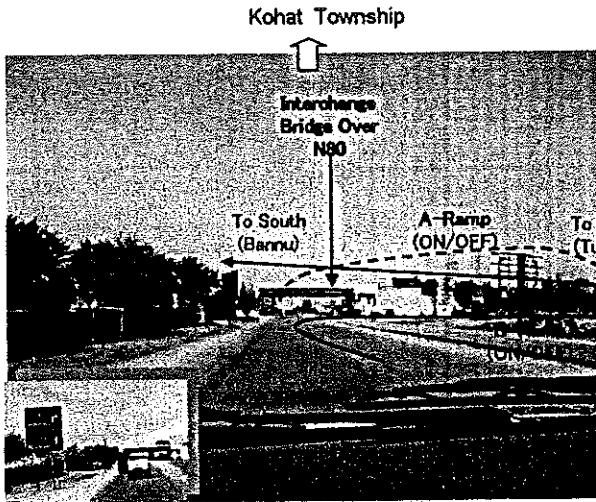
Start Point of Kohat Tunnel Access Road (Sta.0+400)



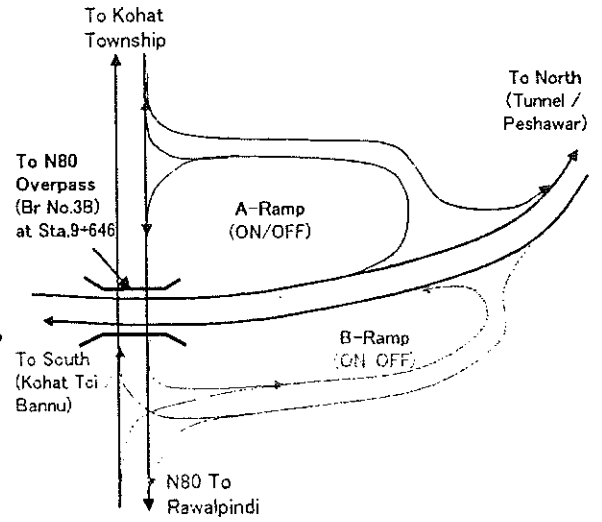
Direction (From N-80 Intersection to Start Point)

Existing Junctions and Intersections (Interchanges) (2/5)

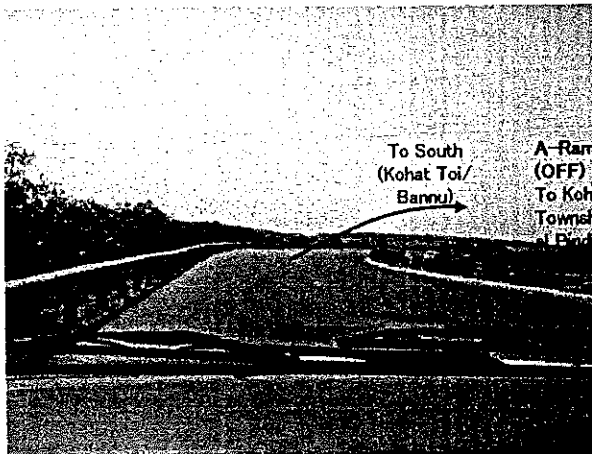
Rawal Pindi - Kohat Road Intersection (N-80 Intersection)



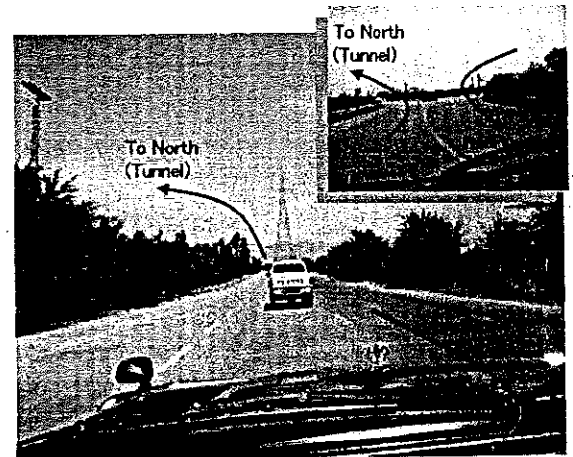
Rawal Pindi - Kohat Road Intersection Direction (From Rawal Pindi to Kohat)



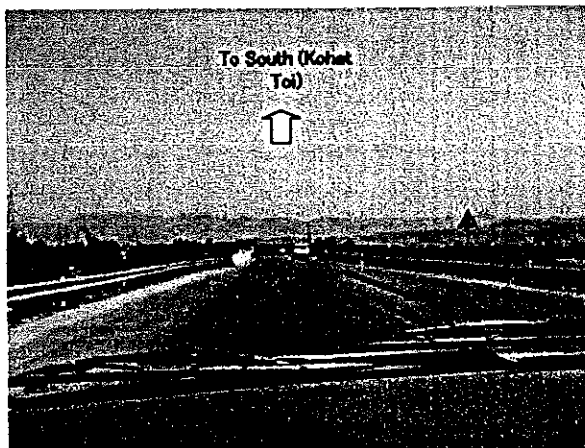
Layout of Rawal Pindi - Kohat Road Intersection



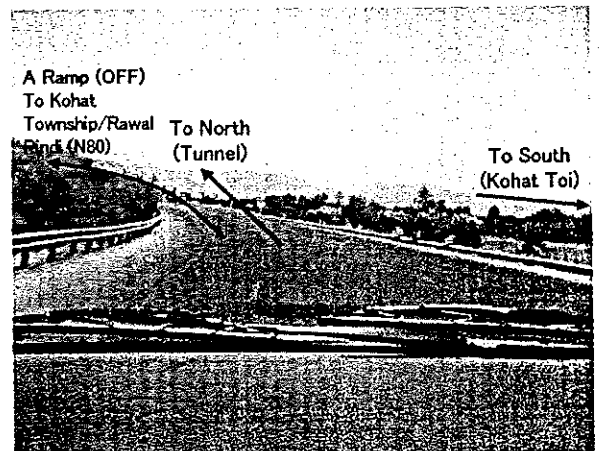
B Ramp (ON) Merging to Kohat Tunnel Access Road (N55)



A-Ramp (ON/OFF)



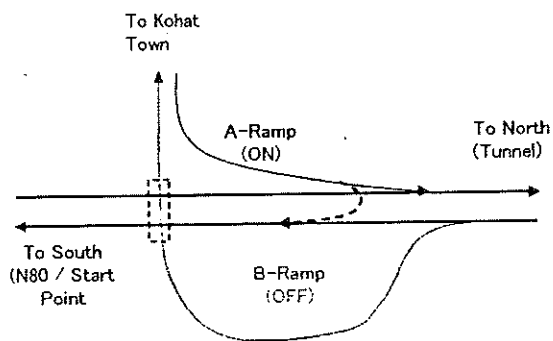
Interchange Bridge (Br.No.11) over N80



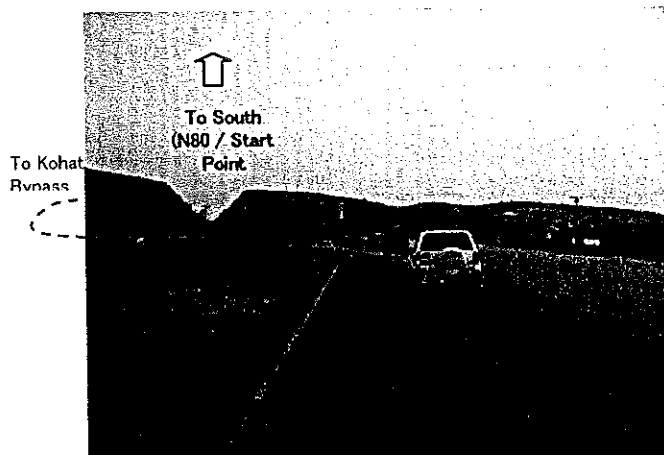
Direction (From N-80 Intersection to Start Point)

Existing Junctions and Intersections (Interchanges) (3/5)

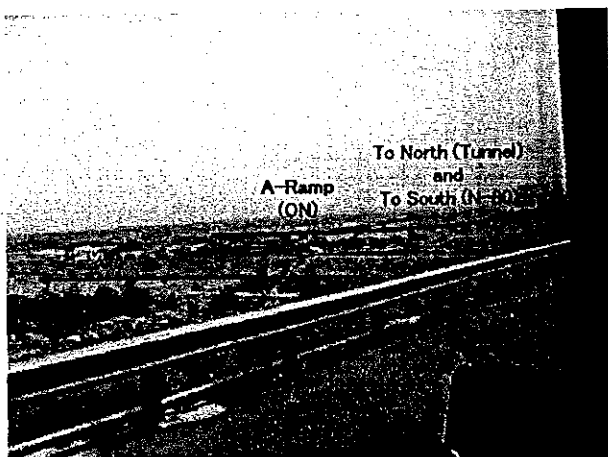
Kohat Bypass Road Intersection



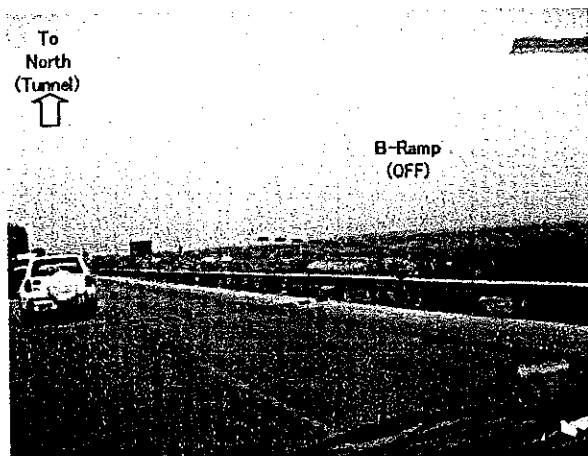
Layout of Kohat Bypass Road Intersection



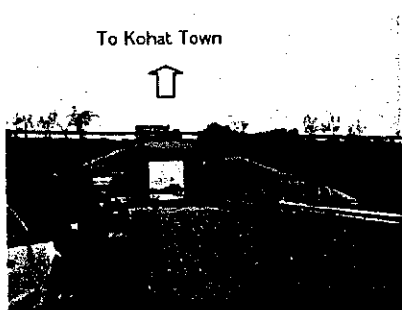
Kohat Bypass Road Intersection (B-Ramp) Direction (From Tunnel to N80 Intersection)



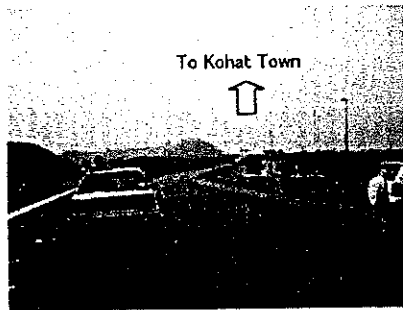
Kohat Bypass Road Intersection (A-Ramp) Direction (From N80 Intersection to Tunnel)



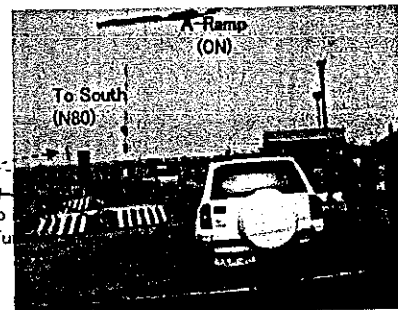
Kohat Bypass Road Intersection (B-Ramp) Direction (From N80 Intersection to Tunnel)



Intersection Box-culvert under Highway Direction (To Kohat Town)



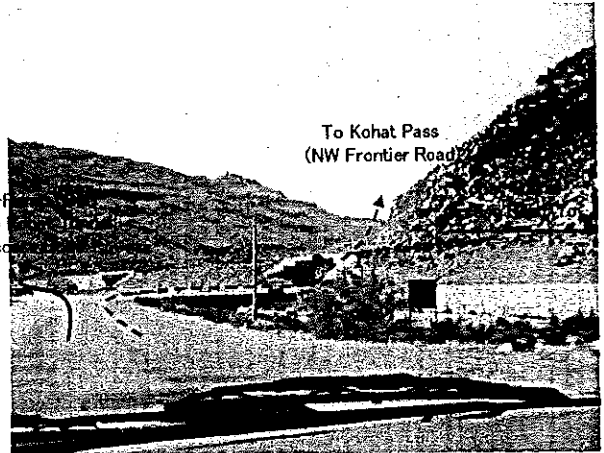
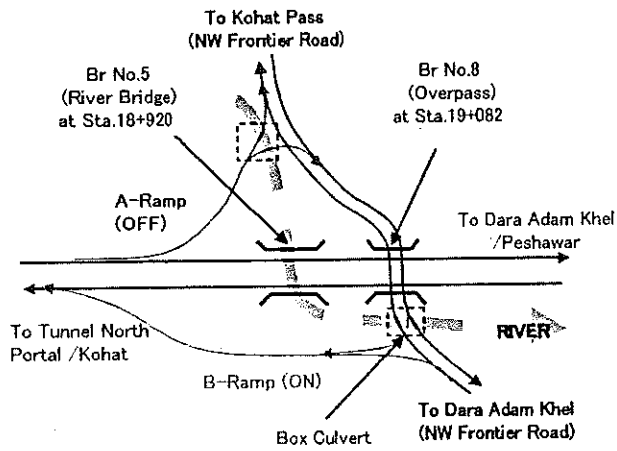
Kohat Bypass Road (Off Ramp Exit)



Kohat Bypass Road (On Ramp Entrance)

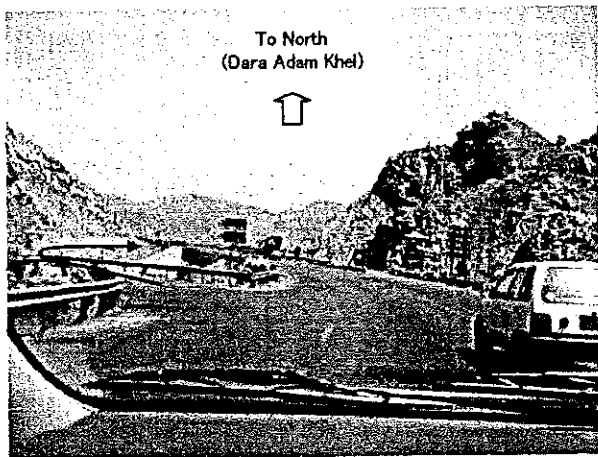
Existing Junctions and Intersections (Interchanges) (4/5)

Dara Bazar / Sheraki (NW Frontier Road) Intersection

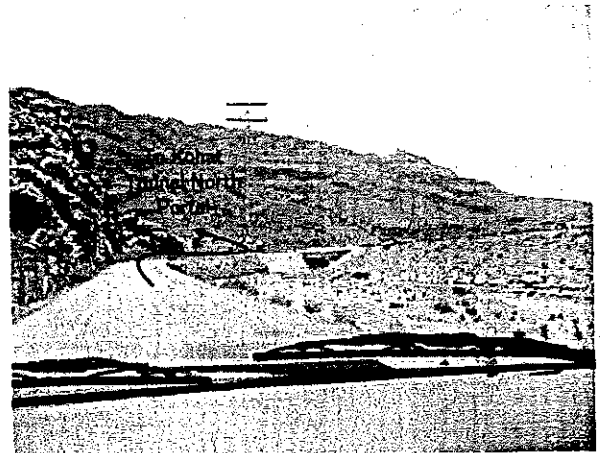


Dara Bazar / Sheraki (NW Frontier Road) Intersection (View from NW Frontier Road)

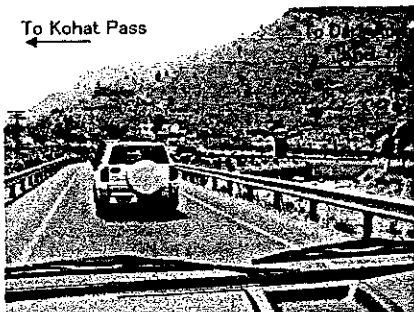
Layout of Dara Bazar / Sheraki (NW Frontier Road) Intersection



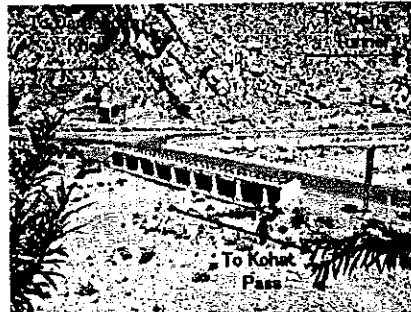
Dara Bazar / Sheraki Intersection B-Ramp (OFF)



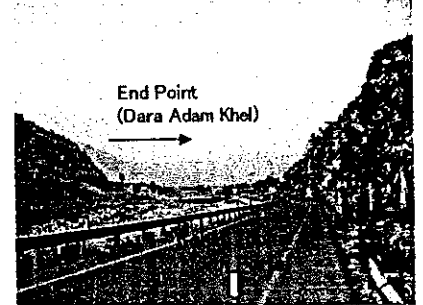
A-Ramp (ON) to Kohat Tunnel Access Road



A-Ramp (OFF)
Direction (from Tunnel to Existing NW Frontier Road)



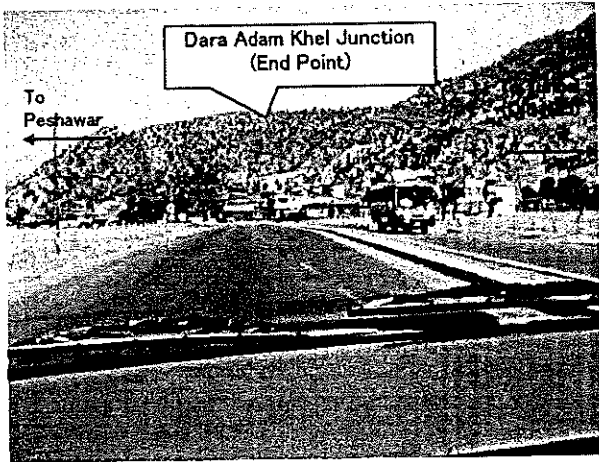
B-Ramp (ON) Entrance



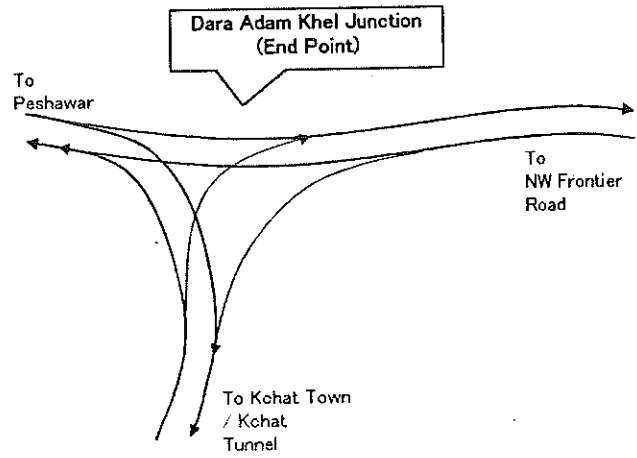
B-Ramp (ON)
Direction (from Tunnel to Existing NW F.Road)

Existing Junctions and Intersections (Interchanges) (5/5)

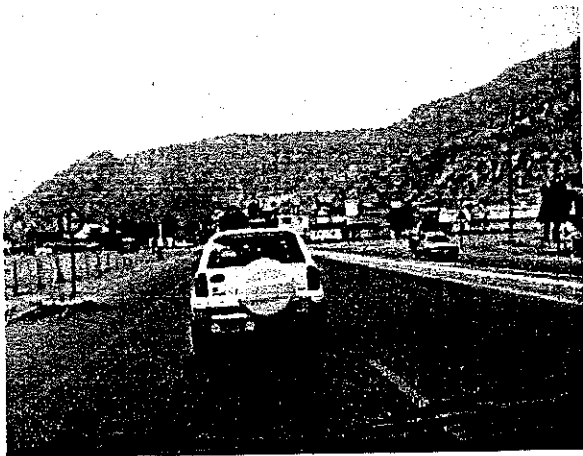
Dara Adam Khel Junction (End Point)



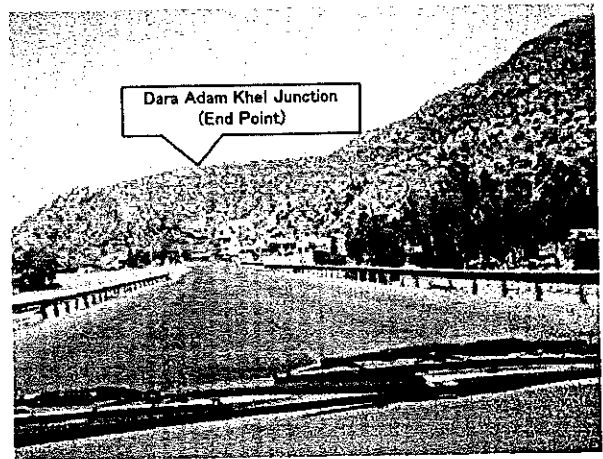
End Point of Kohat Tunnel Access Road



Layout of Dara Adam Khel Junction (End Point)



End Point of Kohat Tunnel Access Road



End Point of Kohat Tunnel Access Road (Sta.25+6C)

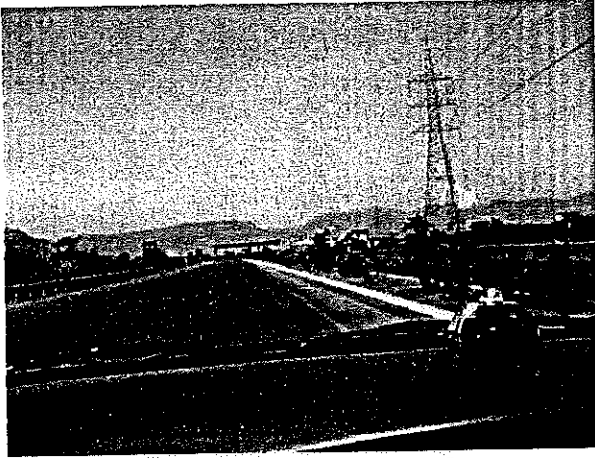
Direction (From N-80 Intersection to Start Point)

1st Kohat Tunnel Access Road

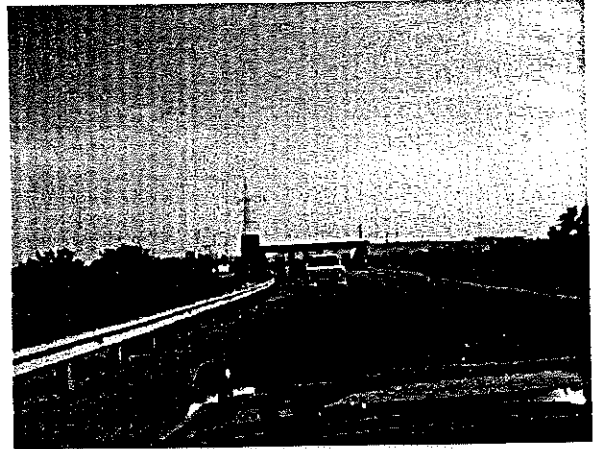
Existing Facilities

Existing Facilities (1/6)

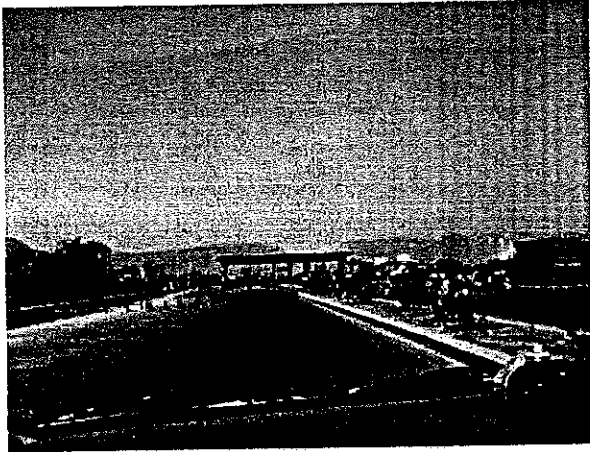
Toll Plaza (just after Rawal Pindi Intersection)



Direction (From Start Point to Tunnel)



Direction (From Tunnel to Start Point)



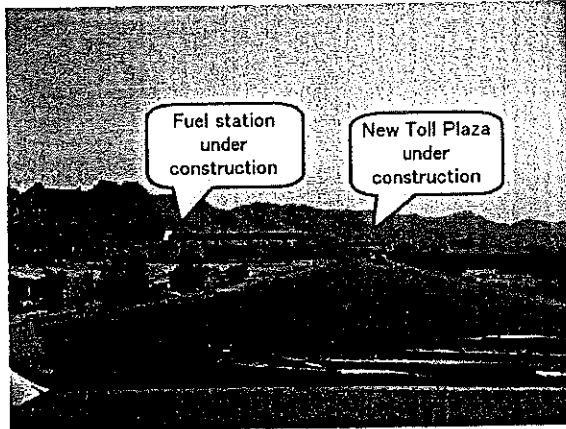
Direction (From Start Point to Tunnel)



Direction (From Start Point to Tunnel)

Existing Facilities (2/6)

Toll Plaza (Just after Kohat Bypass Intersection)



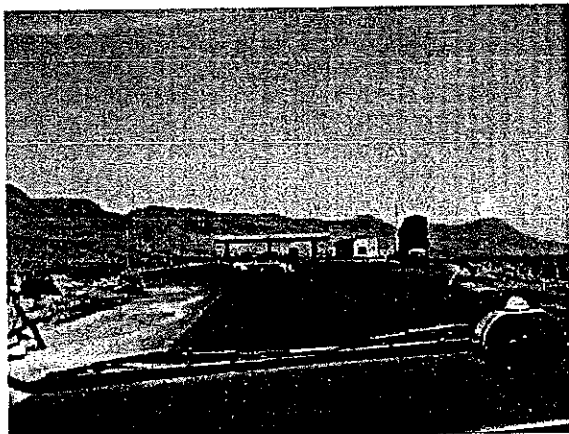
Direction (From Start Point to Tunnel)



Direction (From Tunnel to Start Point)



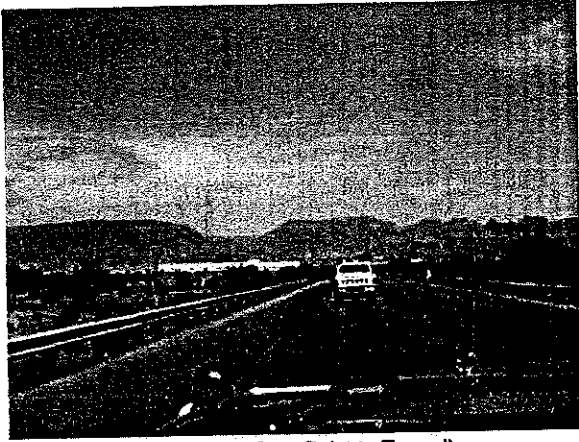
Direction (From Start Point to Tunnel)



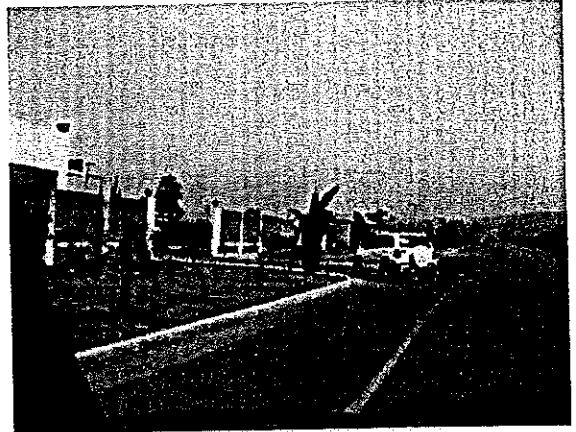
Direction (From Start Point to Tunnel)

Existing Facilities (3/6)

Administration Building



Direction (From Start Point to Tunnel)



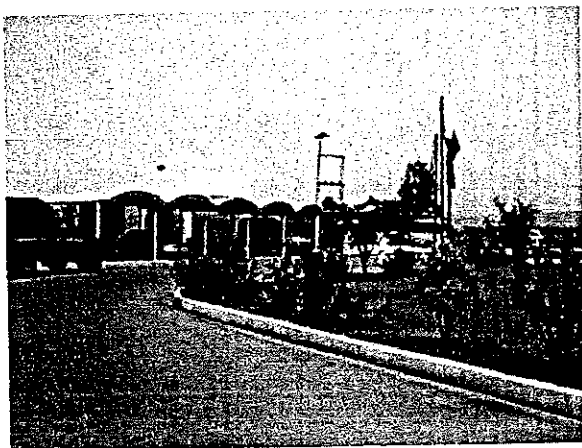
Direction (From Start Point to Tunnel)



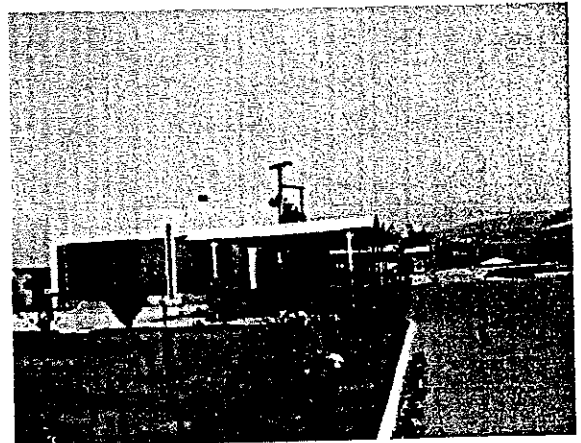
Administration Building



Administration Building



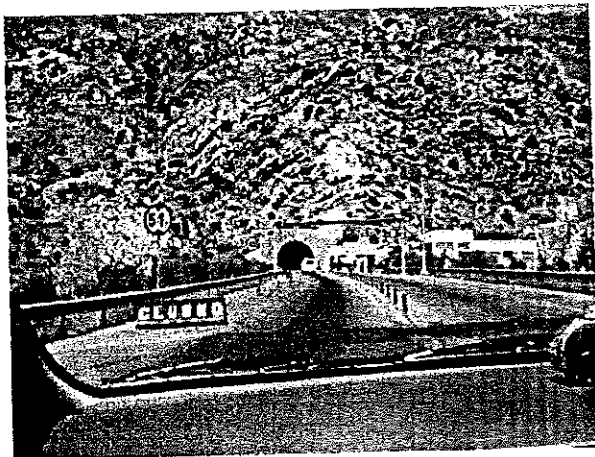
Administration Facilities



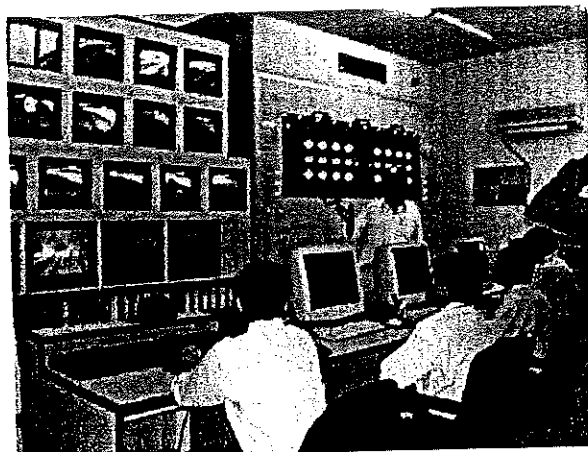
Administration Facilities

Existing Facilities (4/6)

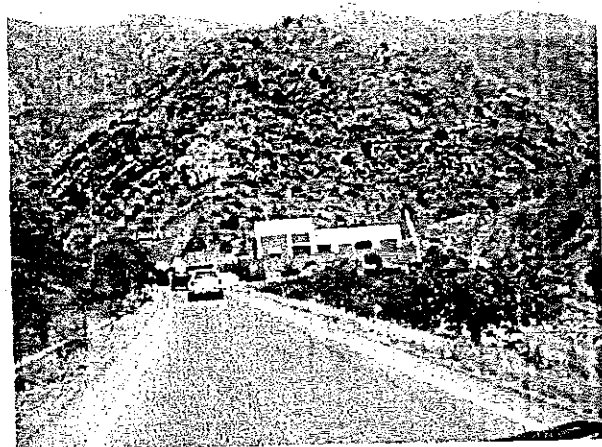
Control Center at Kohat Tunnel South Portal



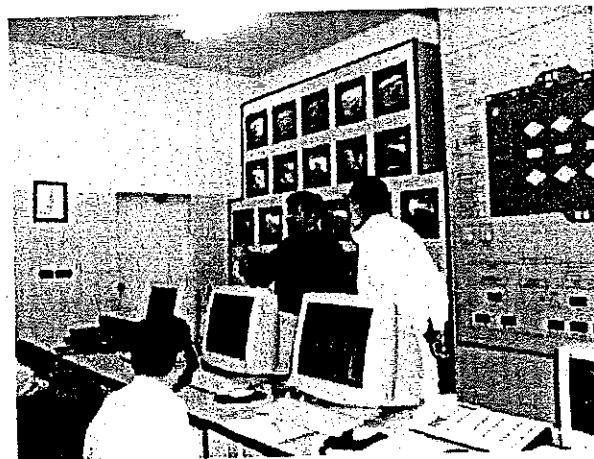
Direction (From Start Point to Tunnel)



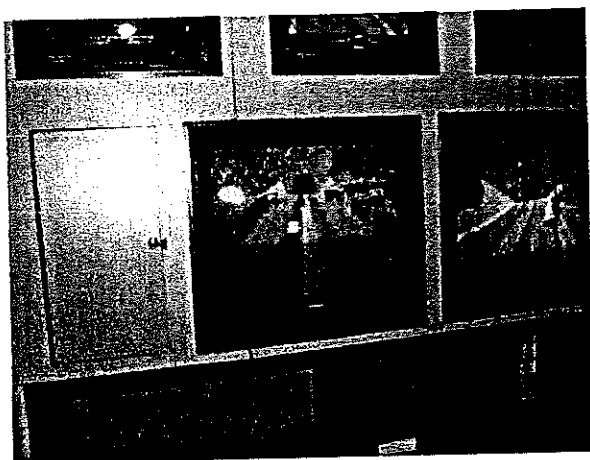
Operation of Control Center



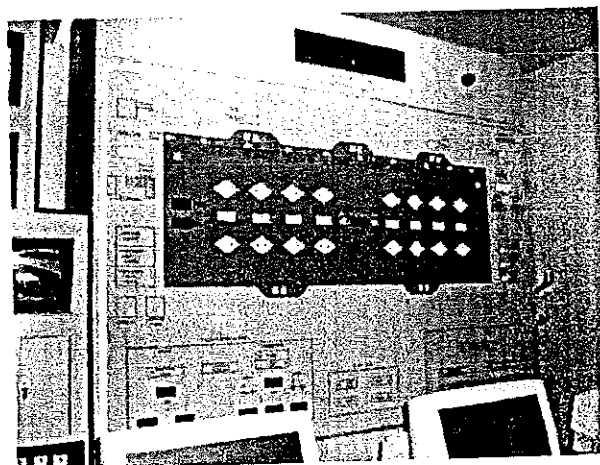
Direction (From Access Road to Tunnel)



Operation of Control Center



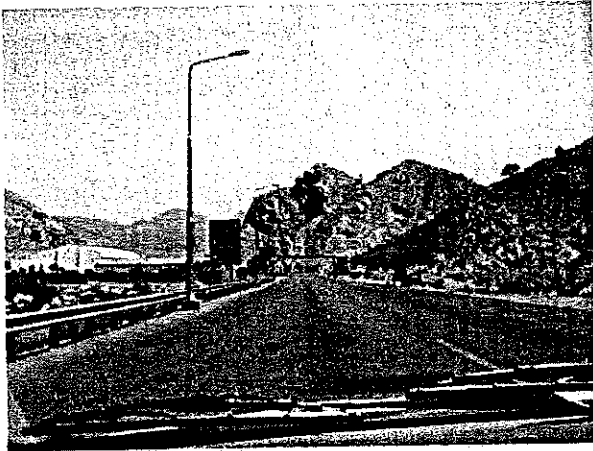
Monitoring CCTV



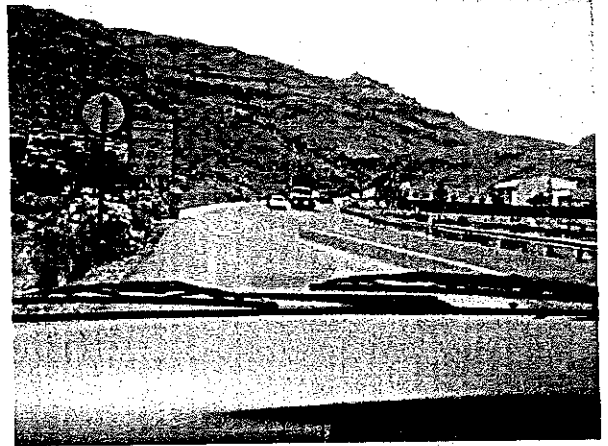
Monitoring Board

Existing Facilities (5/6)

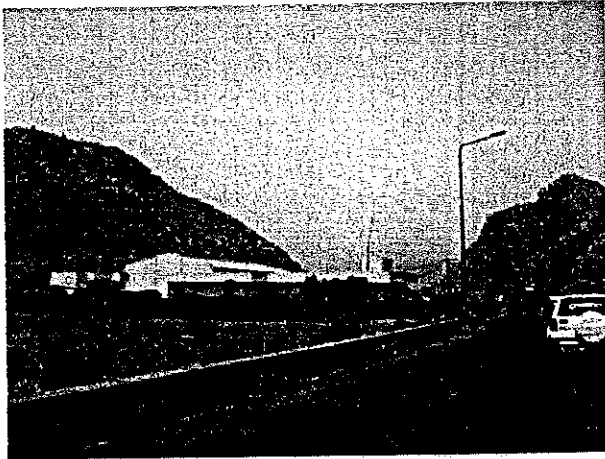
Emergency Area at Kohat Tunnel North Portal



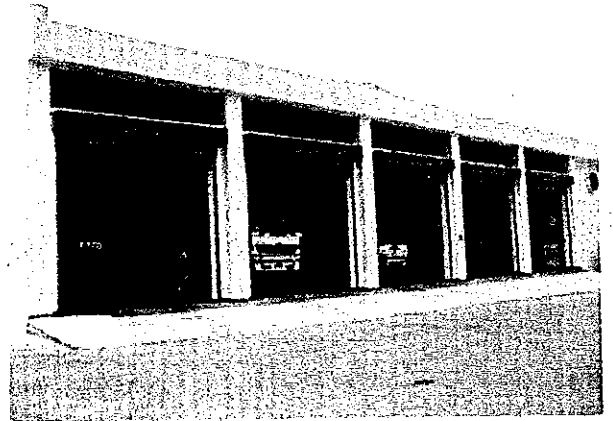
Direction (From Tunnel North Portal to End Point)



Direction (From End Point to Tunnel)



Direction (From Tunnel North Portal to End Point)



Emergency Equipment



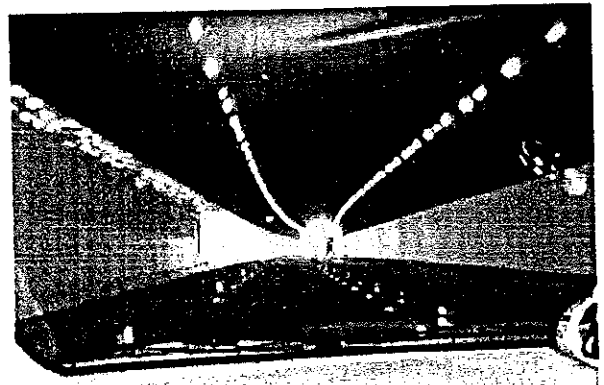
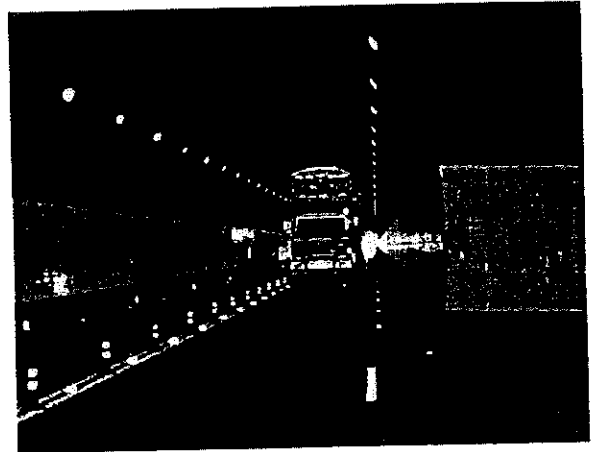
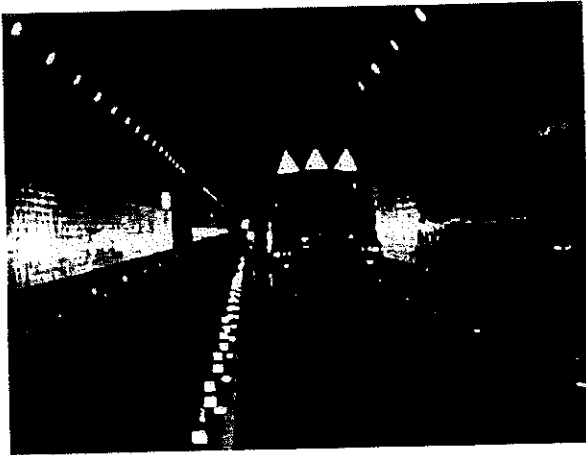
Emergency Equipment



Emergency Equipment

Existing Facilities (6/6)

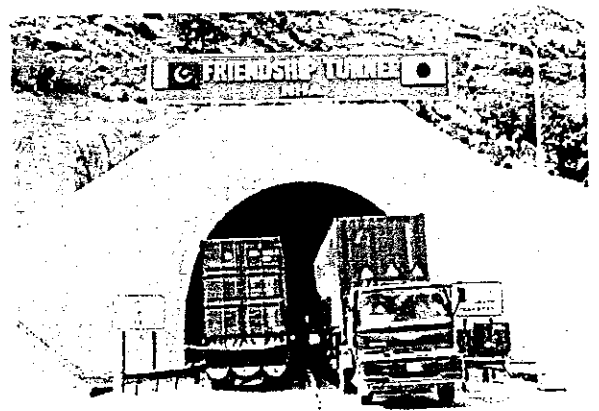
Tunnel Facilities



Exit to North Portal



South Portal



North Portal

Appendix E

PAKISTAN TRANSPORT PLAN STUDY PHSE II
IN THE ISLAMIC REPUBLIC OF PAKISTAN

THE FEASIBILITY STUDY
ON
THE SECOND KOHAT TUNNLE AND ACCESS ROAD PROJECT

DRAFT - TABLE OF CONTENTS

CHAPTER 1	INTRODUCTION.....	1-1
1.1	Background of the Study.....	1-1
1.1.1	General.....	1-1
1.1.2	Objectives of the Study.....	1-2
1.1.3	Scope of the Study.....	1-2
1.2	The Second Kohat Tunnel and Access Road Project.....	1-2
1.3	Work Schedule and Progress.....	1-4
1.4	Organization of the Study.....	1-6
CHAPTER 2	PRESENT TRANSPORTATION SYSTEM.....	2-1
2.1	General.....	2-1
2.2	Road Networks and Existing Facilities.....	2-1
2.3	Road Traffic.....	2-3
2.3.1	Vehicle Registration.....	2-3
2.3.2	Traffic Volume.....	2-4
2.4	Administration.....	2-4
2.5	Other Transportation Systems.....	2-6
CHAPTER 3	ROAD DEVELOPMENT PLAN.....	3-1
3.1	Road Development Plan.....	3-1
3.1.1	National Development Plan.....	3-1
3.1.2	Road Development Plan.....	3-2
3.2	Previous Study and the First Kohat Tunnel and Access Road Construction.....	3-3
3.3	Development Policy for the Project Road.....	3-6
CHAPTER 4	GENERAL CONDITIONS OF THE PROJECT AREA.....	4-1
4.1	Socio-economic Conditions.....	4-1
4.2	Topography and Geology.....	4-2

CHAPTER 5	EXISTING KOHAT TOI – DARA ADAM KEL SECTION (KOHAT TONNEL AND ACCESS ROAD) OF INDUS HIGHWAY (N-55).....	5-1
5.1	Background.....	5-1
5.2	Geometric Condition and Traffic Capacity	5-2
5.3	Key Issues and Problems of the Existing Kohat Tunnel and Access Roads	5-4
5.4	Evaluation of the Existing Kohat Tunnel and Access Roads.....	5-10
CHAPTER 6	ENGINEERING SURVEY AND ANALYSIS	6-1
6.1	General.....	6-1
6.2	Topographic Survey.....	6-1
6.2.1	Control Points Survey.....	6-1
6.2.2	Ground Survey using Total Station.....	6-2
6.3	Hydrological Surveys	6-2
6.3.1	General.....	6-2
6.3.2	Rainfall Analysis.....	6-2
6.3.3	Run-off Analysis.....	6-5
6.3.4	Flood Water Level Analysis.....	6-5
6.4	Geological Survey	6-6
6.4.1	Geological Boring Investigation.....	6-6
6.4.2	Study and Analysis of Geological Report of the 1 st Kohat Tunnel Construction.....	6-10
6.4.3	Settlement of High Embankment and Its Influence to the Existing Road Facilities at Km.18.800 – Km.21.000	6-6
6.5	Materials Survey.....	6-13
CHAPTER 7	TRAFFIC ANALISIS (TO BE REVIEWED BY TRAFFIC EXPERT).....	7-1
7.1	Traffic Survey	7-1
7.1.1	Outline of the Survey.....	7-1
7.1.2	Method of Survey	7-4
7.1.3	Result of Traffic Count Survey.....	7-8
7.1.4	Result of Roadside OD Survey conducted under PTPS.....	7-15
7.1.5	Result of Vehicle Speed Survey.....	7-17
7.2	Demand Forecast Methodology.....	7-19
7.2.1	Present traffic.....	7-20
7.2.2	Future Socio-economic Framework	7-20
7.2.3	Future Road Network Modeling.....	7-22
7.2.4	Forecast of Future Traffic.....	7-23
7.3	Traffic Demand for the 2 nd Kohat Tunnel and Access Roads.....	7-26
7.4	Traffic Capacity of Kohat Tunnel and Access Roads	7-28
7.4.1	Tunnel.....	7-20
7.4.2	Access Roads (Kohat Toi – Dara Adam Khel).....	7-20
7.4.3	Junctions and Intersections.....	7-20

CHAPTER 8	APPLIED DESIGN STANDARDS	8-1
8.1	General.....	8-1
8.2	Classification of the Project Road	8-1
8.3	Highway Design Standards.....	8-2
8.3.1	Geometric Design Standards	8-2
8.3.2	Design Speeds.....	8-3
8.3.3	Cross Section Elements	8-4
8.3.4	Horizontal Alignment	8-5
8.3.5	Vertical Alignment.....	8-6
8.3.6	Typical Cross Sections.....	8-7
8.3.7	Pavement Design Standards	8-9
8.4	Bridge and Culvert Design Standards.....	8-11
8.4.1	Design Standard.....	8-11
8.4.2	Concept of Bridge Planning	8-12
8.4.3	Type of Bridge.....	8-13
8.4.4	Design Criteria.....	8-18
8.5	Tunnel Design Standards.....	8-18
8.5.1	Design Standard.....	8-28
8.5.2	Cross Sections of Tunnel.....	8-30
8.5.3	Ventilation System.....	8-34
8.5.4	Lighting System.....	8-34
8.5.5	Power Supply System.....	8-34
8.5.6	Emergency and Other Incidental Facilities.....	8-34
CHAPTER 9	ALTERNATIVE ROUTE STUDY FOR HIGH CUT AND FILL SECTION (KM 17.50 – KM.20.00).....	9-1
9.1	Objective of Alternative Route Study.....	9-5
9.2	Alternative Route Selection.....	9-5
9.3	Topographic Survey and Geological Investigation.....	9-8
9.4	Preliminary Design of Alternative Alignment.....	9-16
9.4.1	Road Alignment.....	9-16
9.4.2	Cost Estimates of Alternative Route.....	9-22
9.4.3	Construction Plan and Schedule	9-23
9.5	Comparison with Original Dual Carriageway Highway Plan	9-35
9.5.1	Original Dual Carriageway Plan (Km.17.500 – Km.20.000).....	9-35
9.5.2	Cost Estimate of Different Options	9-40
9.5.3	Evaluation of Original and Alternative Plans.....	9-41
CHAPTER 10	STUDY ON LOCATION OF THE SECOND TUNNEL AND TUNNEL PORTALS	10-1
10.1	Original Plan and Alternative Plans.....	10-1
10.2	Study Based on Topographic Survey, Geotechnical Investigations and Alignment Study	10-1
10.3	Comparison of Alternative Plans.....	10-5
10.4	Evaluation of Original and Alternative Plans.....	10-8

CHAPTER 11 PRELIMINARY DESIGN.....	11-1
11.1 General.....	11-1
11.2 Highway Design	11-1
11.2.1 Alignment Design (Plans and Profile).....	11-1
11.2.2 Intersections.....	11-13
11.2.3 Slope Protection.....	11-13
11.2.4 Drainage Structures	11-15
11.2.5 Pavement Design	11-16
11.2.6 Other Incidentals.....	11-18
11.3 Bridge & Culvert Design.....	11-18
11.3.1 Bridge Design	11-19
11.3.2 Box Culvert Design	11-19
11.4 Tunnel.....	11-18
11.4.1 Design Conditions	11-23
11.4.2 Inner Section.....	11-24
11.4.3 Type and Position of Portal	11-25
11.4.4 Slope Protection of Portal.....	11-27
11.4.5 Evaluation of Geological Condition.....	11-27
11.4.6 Construction Method of Tunnel.....	11-30
11.4.7 Pavement in the Tunnel	11-31
11.4.8 Drainage in the Tunnel	11-31
11.4.9 Ventilation System.....	11-32
11.4.10 Lighting System.....	11-32
11.4.11 Power Supply System.....	11-32
11.4.11 Emergency Facilities	11-33
11.4.12 Other Facilities	11-35
11.5 Other Facilities (Toll Gates, Administration Buildings and Emergency Area).....	11-18
 CHAPTER 12 OPERATION AND MAINTENANCE	 12-1
12.1 General.....	12-1
12.2 Maintenance of Road Facilities	12-1
12.3 Overload Control of Vehicles	12-1
12.4 Maintenance of Bridges.....	12-2
12.5 Operation and Maintenance of Tunnel	12-3
12.5.1 Maintenance of Tunnel.....	12-3
12.5.2 Monitoring and Safety Control of Tunnel.....	12-4
12.6 Organization for Operation and Maintenance	12-5
 CHAPTER 13 ENVIRONMENTAL STUDY (TO BE REVIEWED BY ENVIRONMENT SPECIALISTS).....	 13-1
13.1 General.....	13-1
13.2 EIA Procedure in Pakistan.....	13-1
13.2.1 Legal Frame on EIA	13-1
13.2.2 EIA Procedure.....	13-2
13.2.3 Environmental Guidelines of Road Sector	13-4
13.3 Evaluation of Environmental Affects by the First Kohat Tunnel and	

	Access Roads Construction	13-1
13.3	Environmental Survey for the Second Kohat Tunnel and Access Road.....	13-4
13.4	Initial Environmental Examination	13-8
13.4.1	Site Description	13-8
13.4.2	Examination on Potential Environmental Impact.....	13-18
13.5	Environmental Impact Assessment.....	13-23
13.5.1	Introduction	13-23
13.5.2	Impact Prediction and Assessment	13-23
13.5.3	Mitigation Measures.....	13-29
13.5.4	Environmental Monitoring	13-35
CHAPTER 14 LAND ACQUISITION AND RESETTLEMENT PLAN (TO BE REVIED BY EMVIROMENT SPECIALIST).....		14-1
14.1	Introduction	14-1
14.2	Current Status of Land Acquisition for the Second Kohat Tunnel and Access Road construction	14-1
14.3	Legal Frame on Land Acquisition and Resettlement.....	14-1
14.4	Legal Procedure for Land Acquisition and Compensation.....	14-3
14.5	Magnitude of Land Acquisition and Resettlement	14-7
14.6	Land Acquisition and Resettlement Plan.....	14-8
14.6.1	Policy for the Project.....	14-11
14.6.2	Entitlement to be compensated.....	14-12
14.6.3	Organisational Framework	14-15
14.6.4	Monitoring and Evaluation.....	14-22
CHAPTER 15 CONSTRUCTION PLAN.....		15-1
15.1	General.....	15-1
15.2	Specific Issues to be addressed.....	15-1
15.2.1	Rock Excavation along the Existing Road minimizing Disturbance to Public Traffic during Construction.....	15-1
15.2.2	Tunnel Construction	15-1
15.2.3	Moving of the Tunnel Control Center	15-1
15.2.4	Culvert Box Construction at Kohat Bypass Intersection.....	15-1
15.3	Proposed Contract Packages.....	15-1
15.4	Sources of Major Materials	15-5
15.5	Construction Schedule.....	15-6
15.6	Requirement of Materials, Manpower and Equipment	15-9
CHAPTER 16 COST ESTIMATE.....		16-1
16.1	General.....	16-1
16.2	Basic Prices and Procurement Sources.....	16-2
16.2.1	Procurement Sources	16-2
16.2.2	Prices of Construction Material.....	16-3
16.2.3	Construction Equipment and Machines.....	16-3
16.2.4	Manpower.....	16-4

16.2.5	Transportation.....	16-5
16.2.6	Tax and Duties.....	16-5
16.2.7	Ability of Local Contractors.....	16-5
16.3	Cost Estimate.....	16-6
16.3.1	Construction Quantity Estimate.....	16-6
16.3.2	Unit Price Analysis.....	16-6
16.3.3	Indirect Construction Cost.....	16-6
16.3.4	Contingency.....	16-6
16.3.5	Engineering Service Cost.....	16-6
16.3.6	Tax and Duties.....	16-6
16.3.7	Administration Cost.....	16-9
16.3.8	Land Acquisition and House Compensation Costs.....	16-9
16.3.9	Other Costs.....	16-9
16.3.10	Result of Cost Estimate.....	16-9
CHAPTER 17 PROJECT EVALUATION.....		17-1
17.1	Economic Evaluation.....	17-1
17.1.1	Economic Costs.....	17-1
17.1.2	Economic Benefits.....	17-1
17.1.3	Economic Evaluation.....	17-4
17.1.4	Sensitivity Analysis.....	17-6
17.2	Financial Analysis.....	17-7
17.2.1	Toll Collection System.....	17-7
17.2.2	Estimation of Toll Revenues.....	17-8
17.2.3	Budget and Expenditures of NHA.....	17-8
17.2.4	Financial Evaluation.....	17-8
17.2.5	Financial Scheme Study (ODA Loan, BOT and PPP).....	17-8
17.3	Indirect Benefits.....	17-9
CHAPTER 18 PROJECT IMPLEMENTATION PLAN.....		18-1
18.1	Implementation Plan of the Project.....	18-1
18.1.1	General.....	18-1
18.1.2	Executing Agency.....	18-1
18.1.3	Expected Financial Sources.....	18-1
18.2	Related Road Development Plans.....	18-1
18.3	Implementation Schedule for the Second Kohat Tunnel and Access Road Project.....	18-6
CHAPTER 19 CONCLUSION AND RECOMMENDATION.....		19-1

List of Table

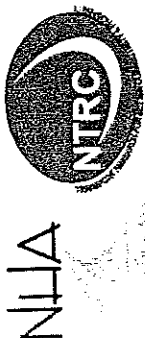
Table 2.1 Road Length2-1

List of Figure

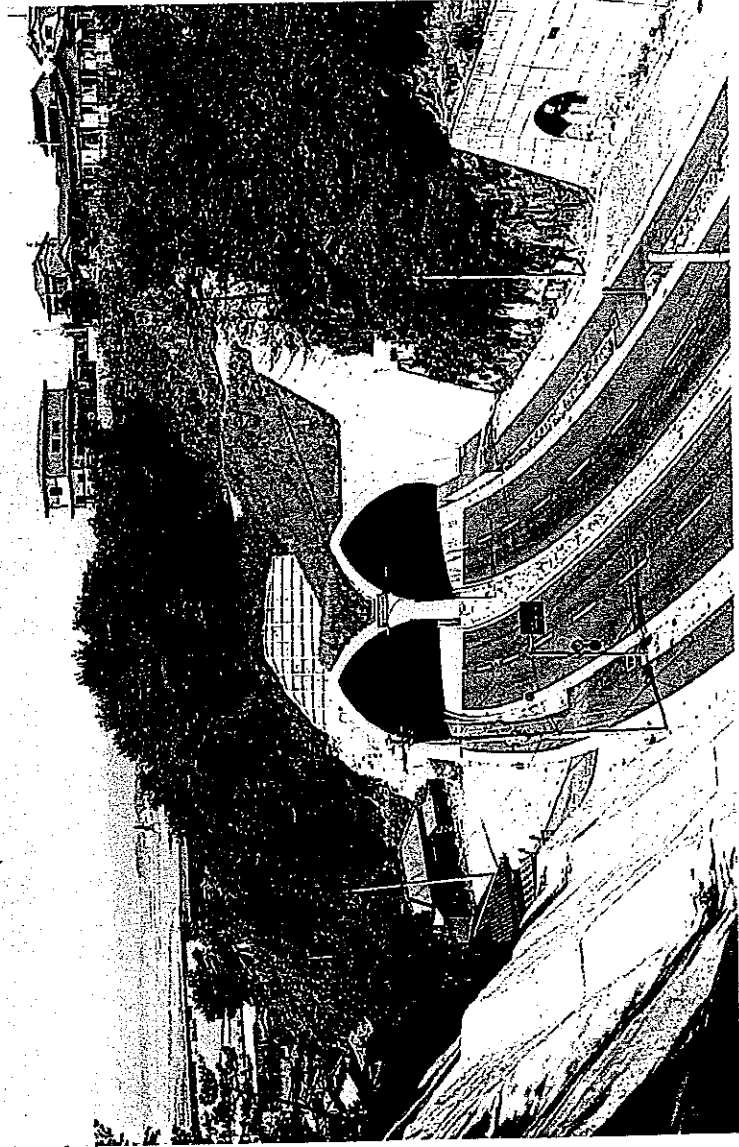
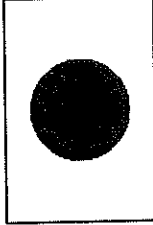
Figure 1.1 Overall Work Flow1-5

11/11/11

11/11/11



INTRODUCTION OF JAPANESE TECHNOLOGY IN TUNNEL CONSTRUCTION



JUNE 2006
PRESENTED BY
JICA STUDY TEAM

TABLE OF CONTENTS

1. Length and Classification of Tunnels in Japan
2. Tunnel Length Comparison in the World
3. Classification of Tunnel by Construction Method
4. Japanese Tunnel Technology in Vietnam
5. Tunnel Construction in Japan
 - 5.1 Fushimi Tunnel
 - 5.2 Itsutsugaoka Tunnel
 - 5.3 Euro Tunnel (Between Britain and France)
 - 5.4 Seikan Tunnel
 - 5.5 Trans-Tokyo Bay Highway Tunnel
 - 5.6 Osaka Bay Immersed Tunnel
6. Application of Japanese Tunnel Technology for Second Kohat Tunnel

1. Length and Classification of Tunnels in Japan

Total Tunnel Length in Japan (Road and Railway)

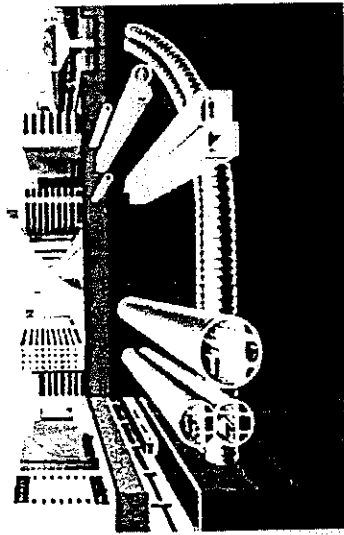
- Road tunnel : 3,050km
 - Railway tunnel : 2,670km
-
- 5, 720km

The lifeline tunnel is included : over 20,000km

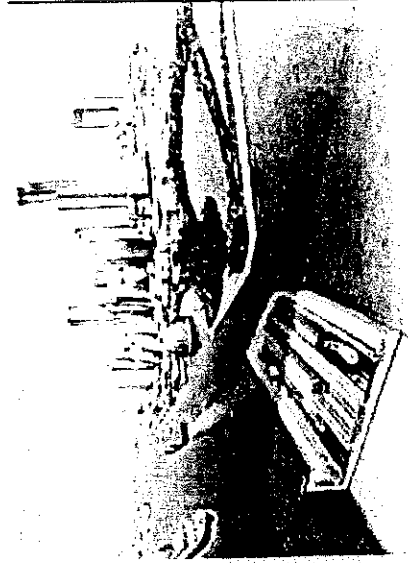
Classification of tunnel by place



Mountain tunnel

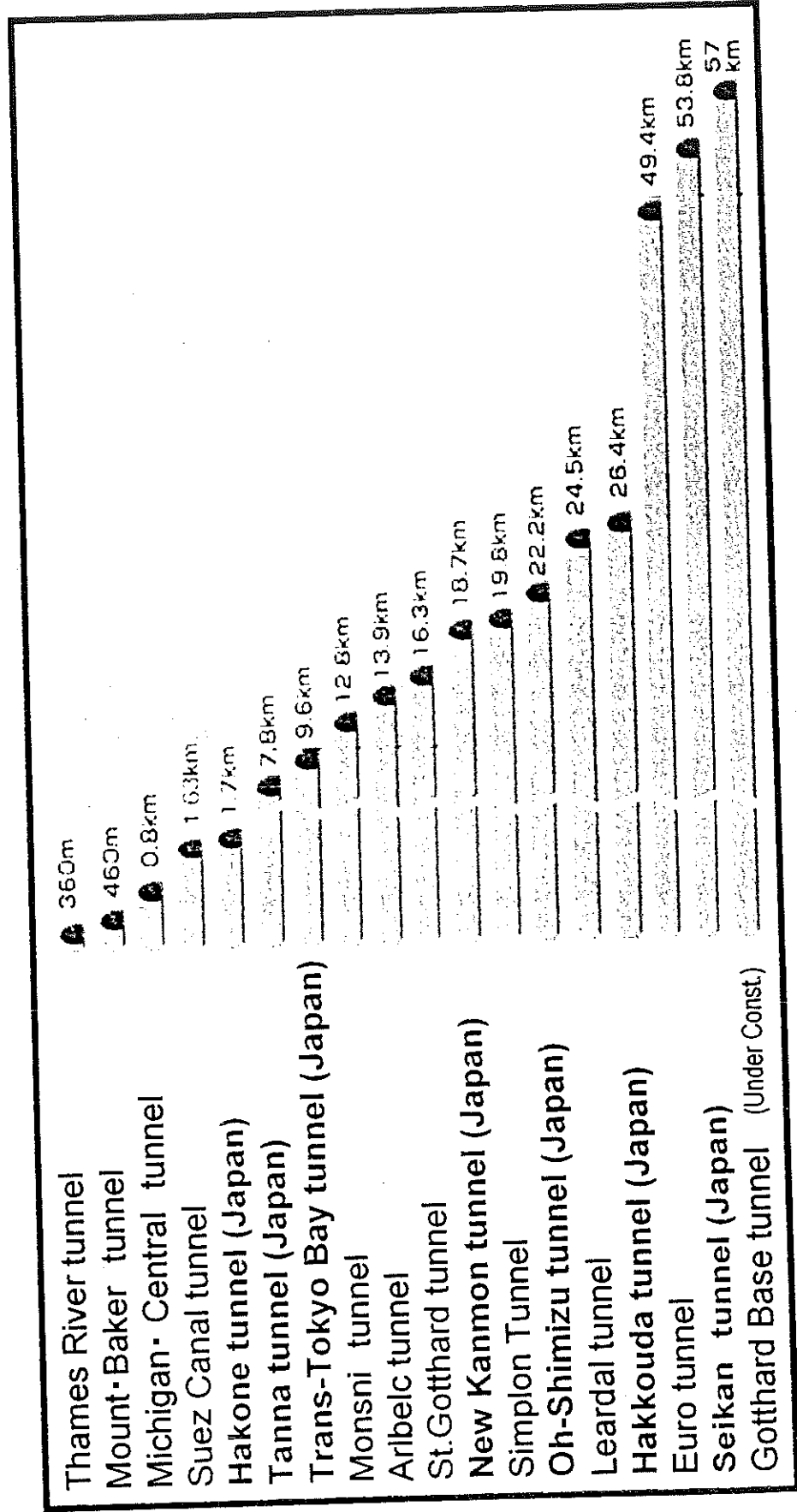


Urban tunnel



Underwater tunnel

2. Tunnel Length Comparison in the World

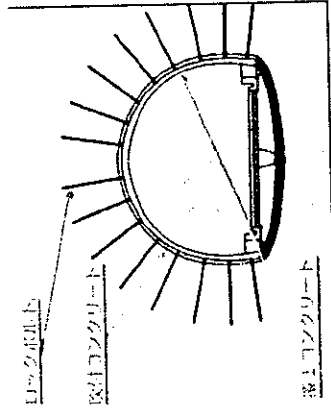


3. Classification of Tunnel by Construction Method

Ordinary tunneling method



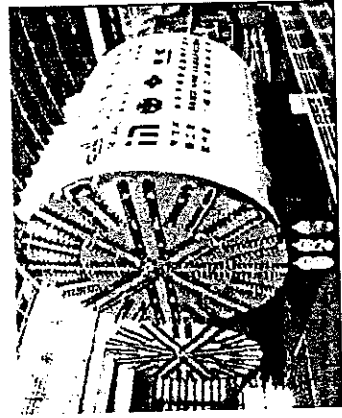
NATM



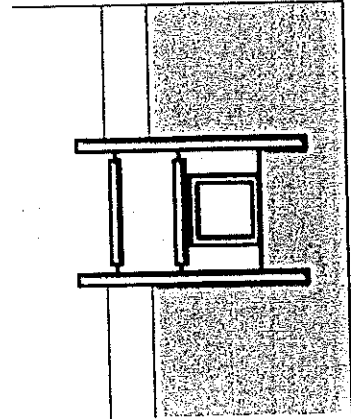
TBM



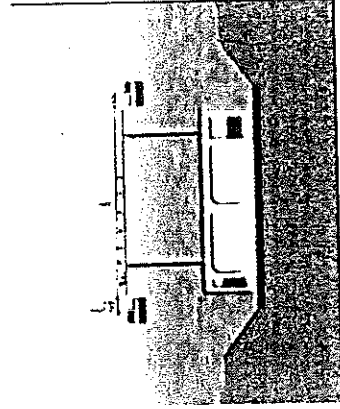
Shield tunnel method



Cut & Cover tunnel method



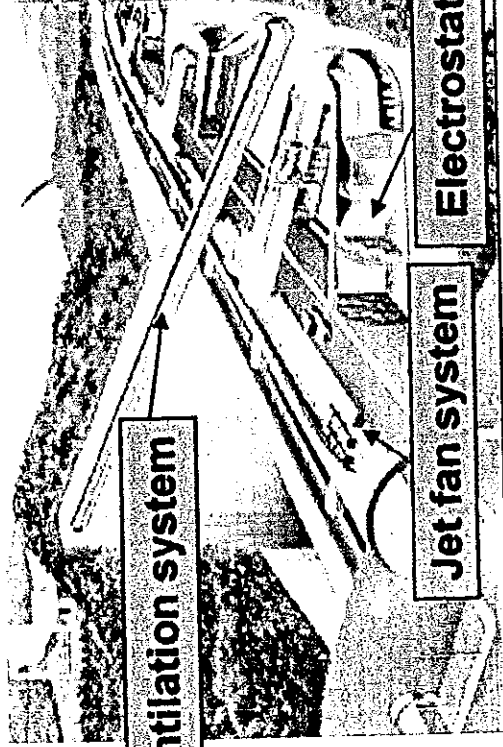
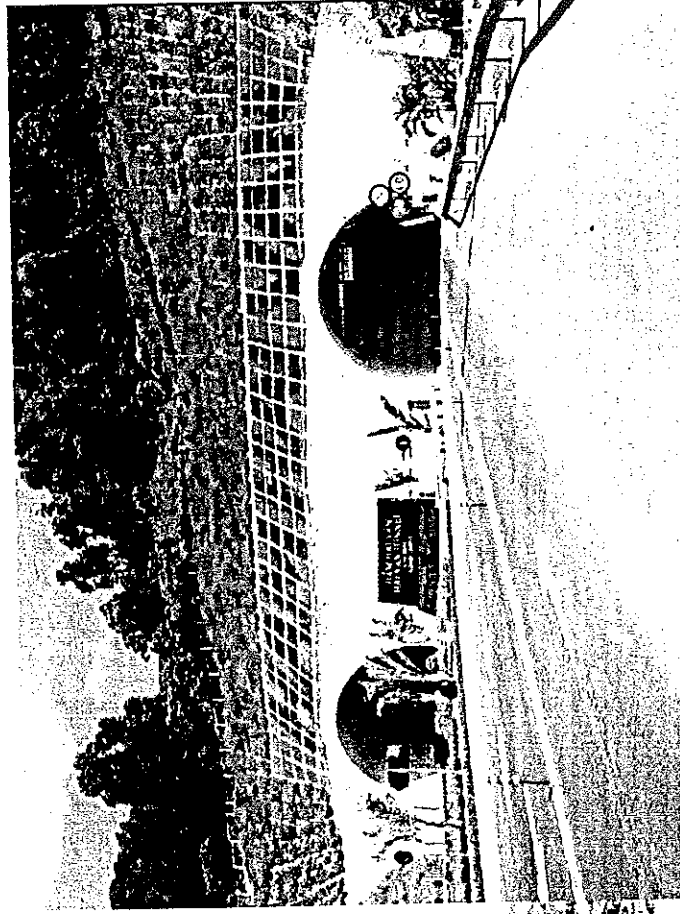
Immersed tunnel method



4. Japanese Tunnel Technology in Vietnam

Hai Van tunnel (Vietnam)

- Completion : 2003
- Two-lane road tunnel (x 2)
- Tunnel length : 6.3km
- Isolation distance : 30m
- NATM tunnel
- Geological classification : C - D



Ventilation system

Jet fan system

Electrostatic precipitator

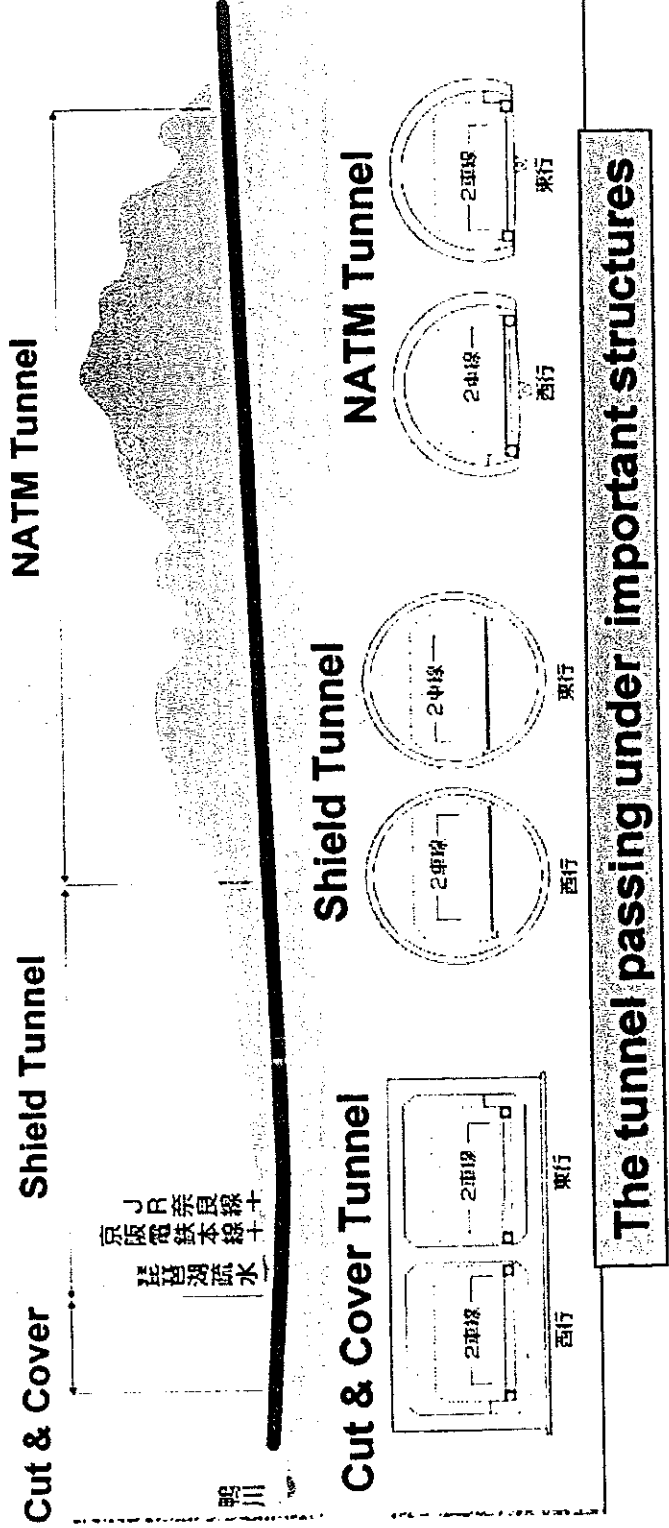
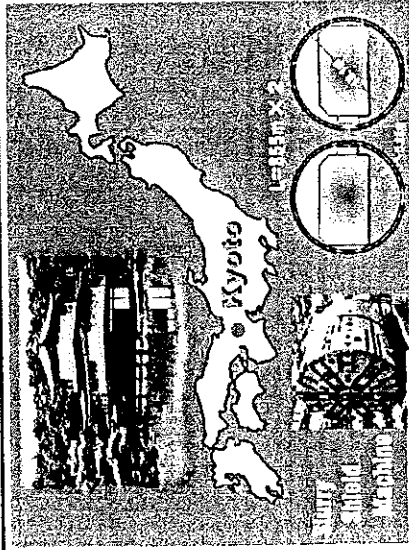
Environmental friendly
ventilation system

Note: Designed and
supervised by Nippon Koei

5. Tunnel Construction in Japan

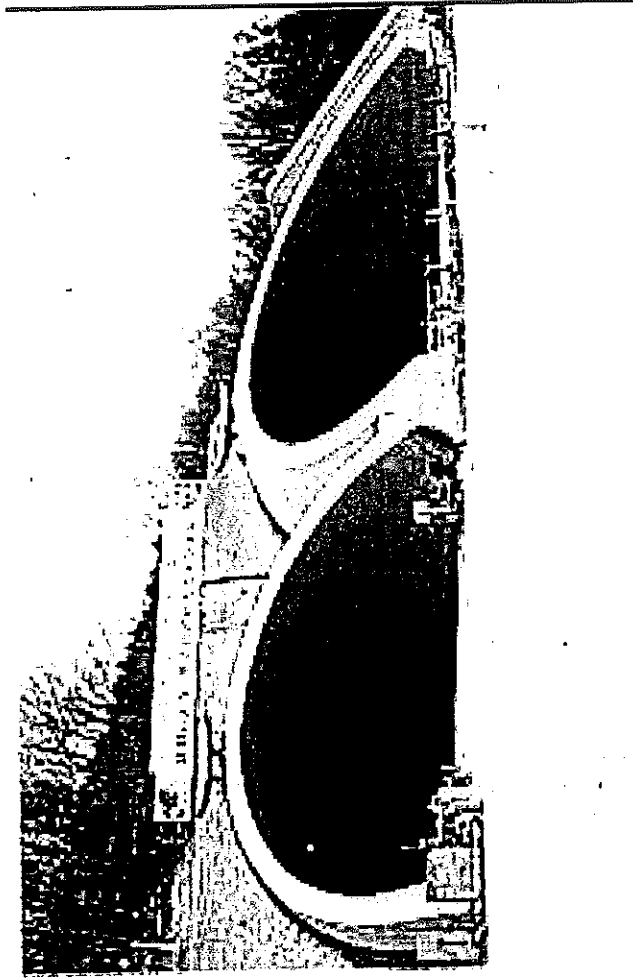
5.1 Fushimi Tunnel

- Completion : 2006
- Two-lane road tunnel (x 2)
- Tunnel length : 2.8km
- Inside diameter : 10.1m
- Geological classification : D and C



5.2 Itsutsugaoka Tunnel

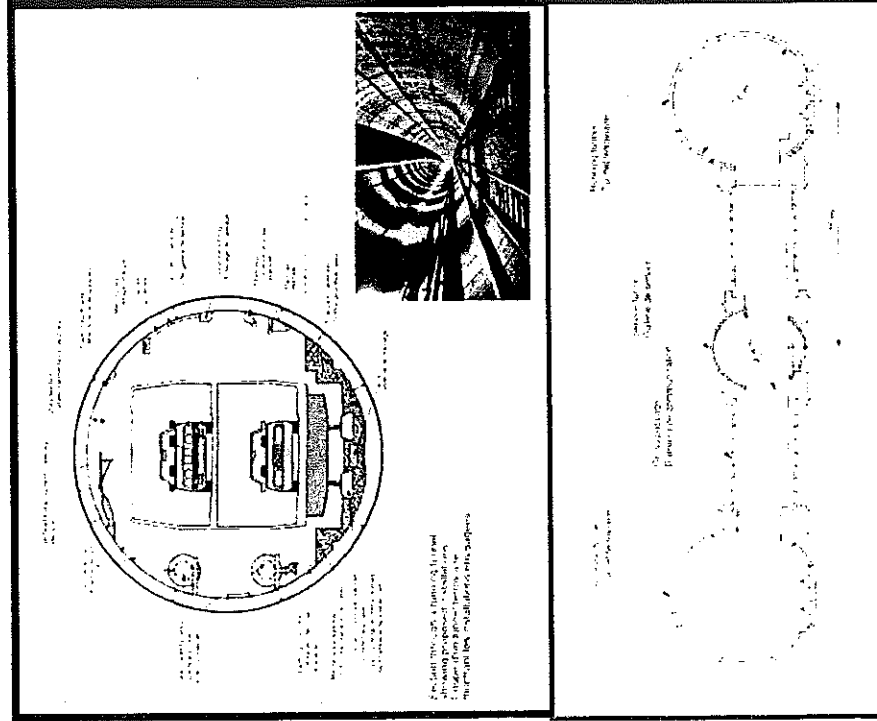
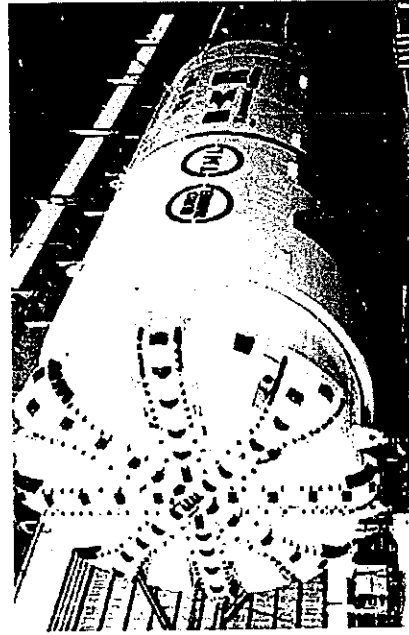
- Completion : 2005
- Two-lane road tunnel (x 2)
- Tunnel length : 321m
- NATM tunnel
- Geological classification : D



- Binocular tunnel
- Distance between tunnels is 1m
- Construction control by a computerized system

5.3 Euro Tunnel (Between Britain and France)

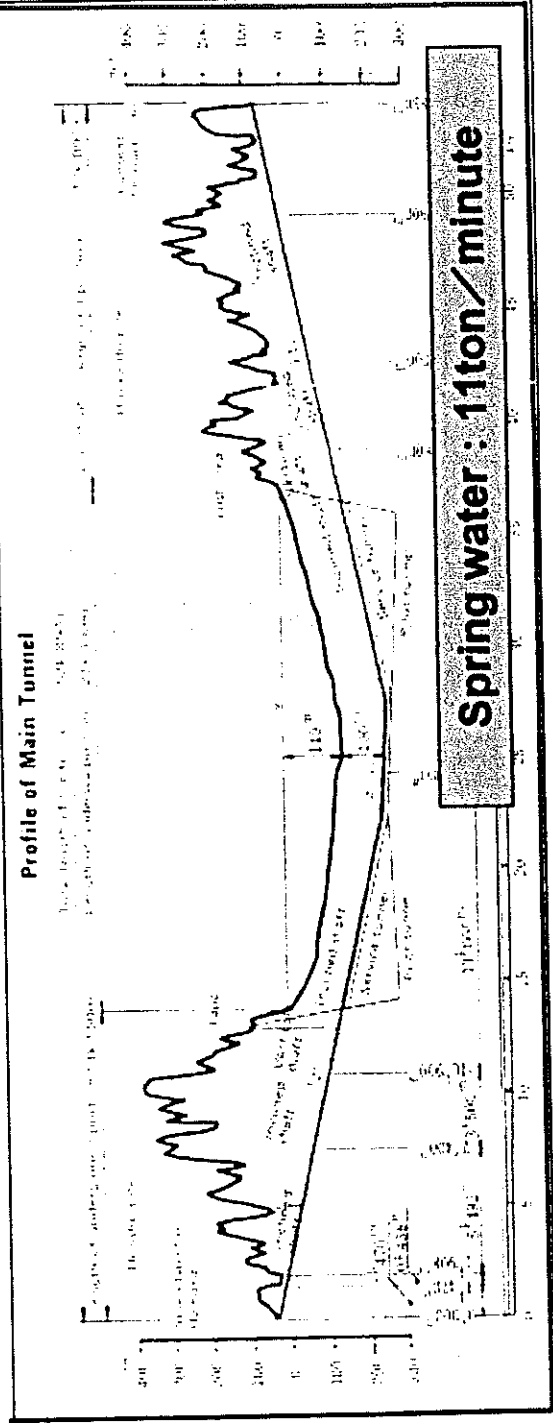
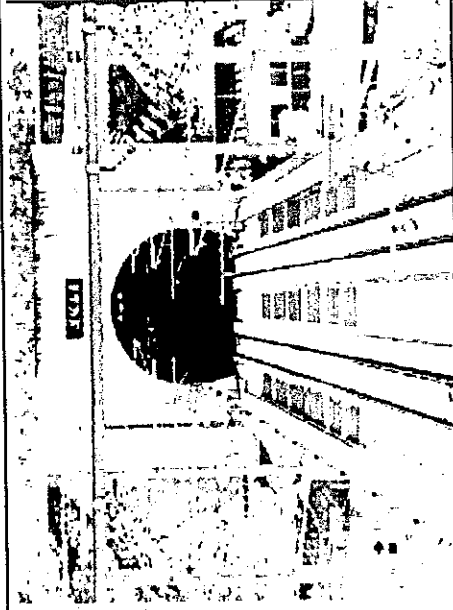
- Completion : 1994
- Single track railway tunnel
- Tunnel length : 49.4km
- Inside diameter : 7.6m
- Isolation distance : 30m
- TBM tunnel
- Geological classification : D



Maximum excavation speed : 1200m / month (TBM made by Japanese Companies)

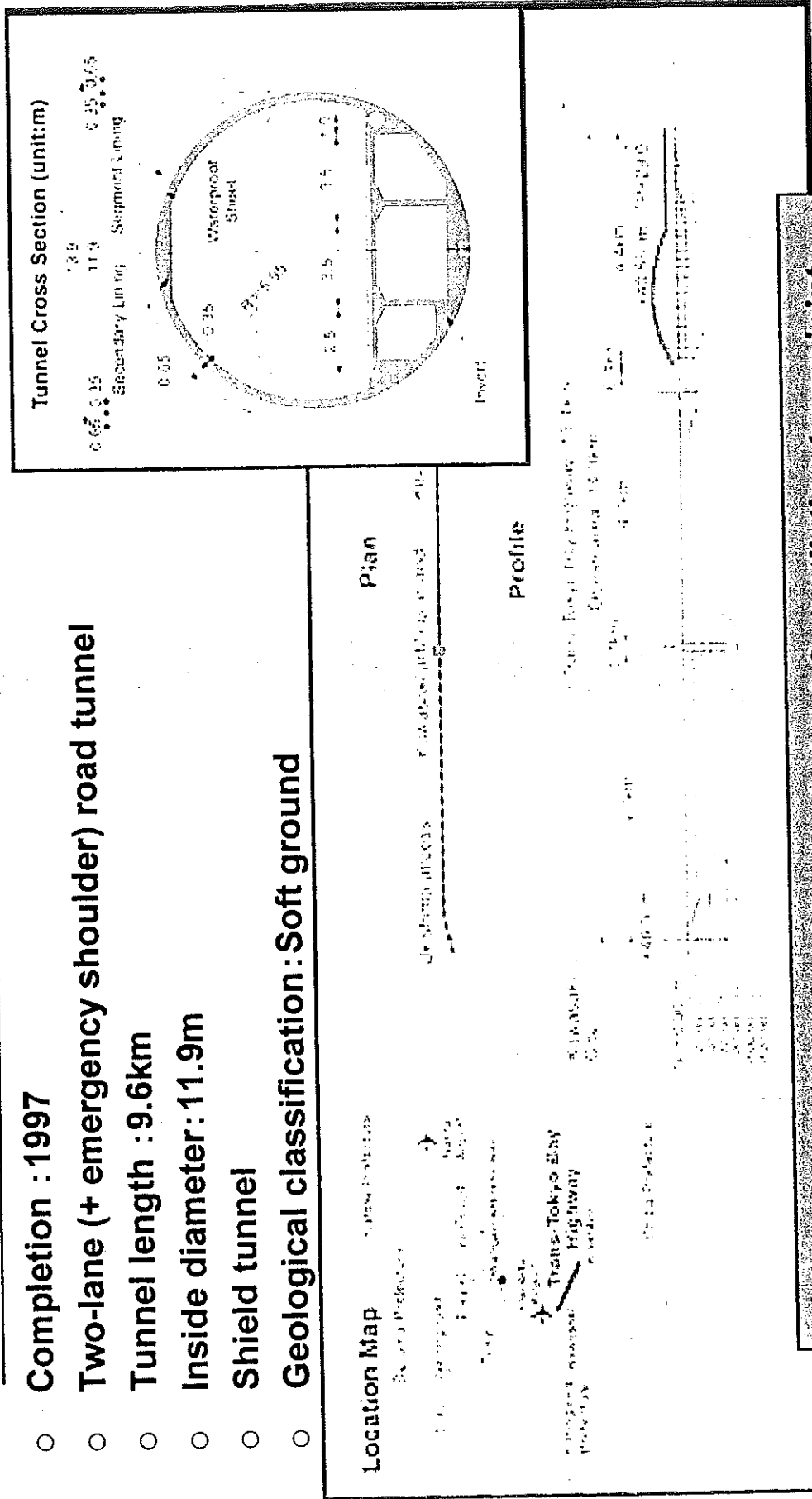
5.4 Seikan Tunnel

- Completion : 1988
- Two-track railway tunnel
- Tunnel length : 53.9km
- Width x Height : 9.7m x 7.85m
- Ordinary tunneling method
- Geological classification : D



5.5 Trans-Tokyo Bay Highway Tunnel

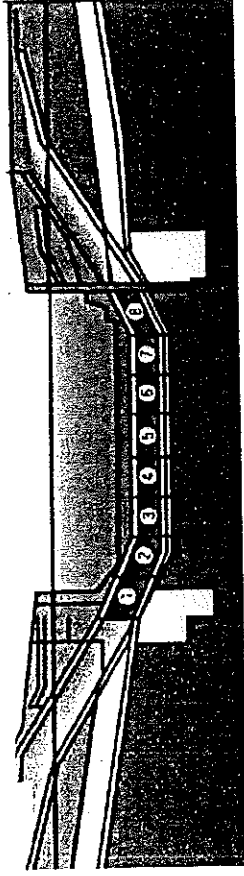
- Completion : 1997
- Two-lane (+ emergency shoulder) road tunnel
- Tunnel length : 9.6km
- Inside diameter: 11.9m
- Shield tunnel
- Geological classification : Soft ground



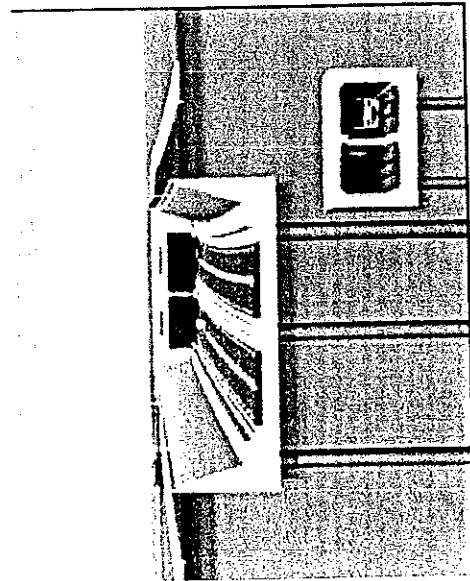
Waterproof structure of seismic joint & ventilation tower joint

5.6 Osaka Bay Immersed Tunnel

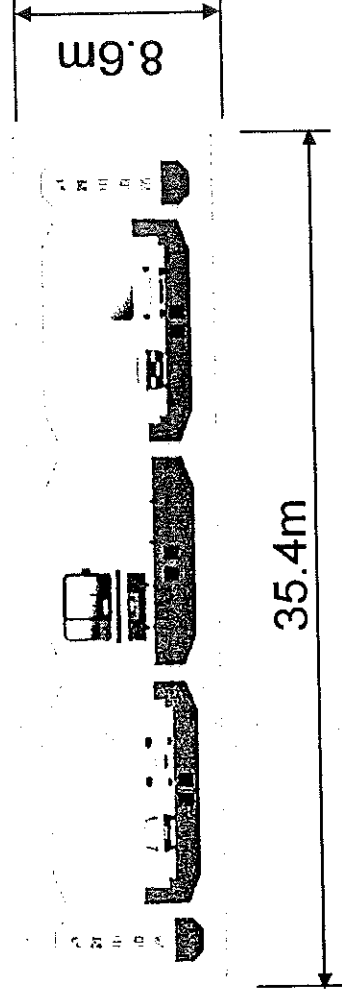
- Completion : 1997
- Road/railway combined tunnel
- Tunnel length : 2.2km
- Immersed tunnel
- Geological classification : Soft ground



Immersed tunnel

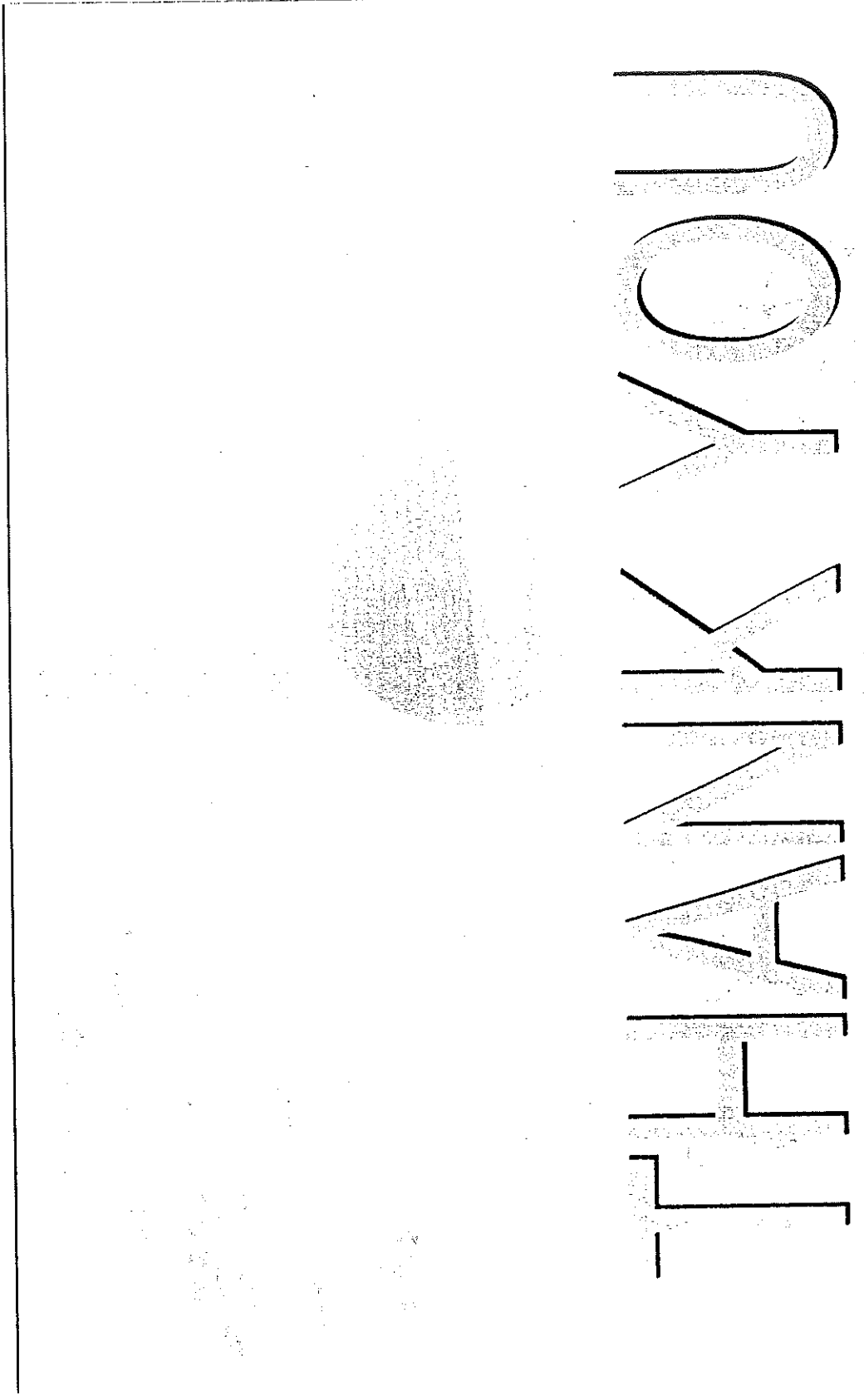


Approach tunnel

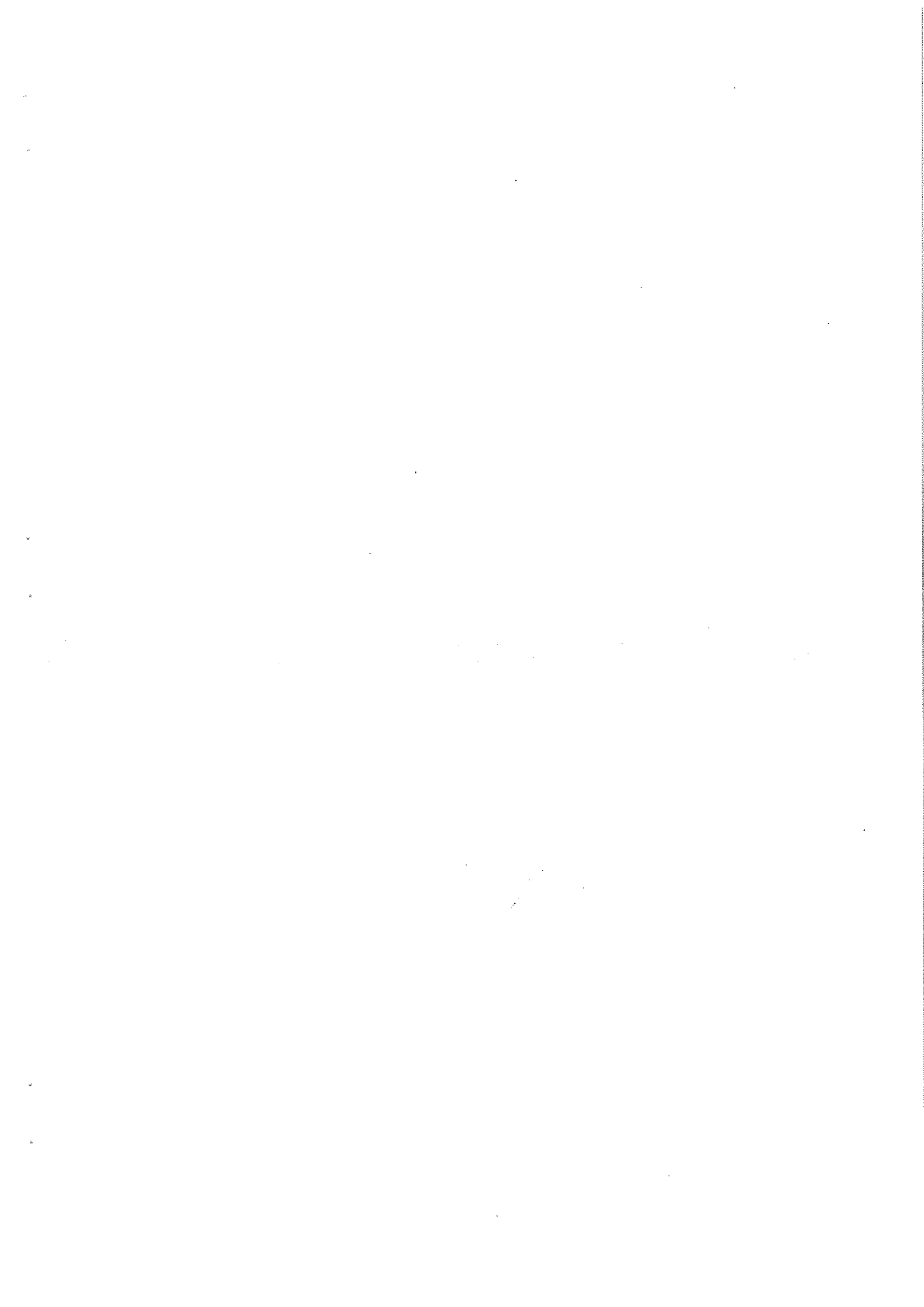


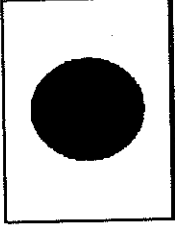
Tunnel Section under Sea

6. Application of Japanese Tunnel Technology
for Second Kohat Tunnel



THANK YOU





**BRIEF COMMENTS
ON
ROADS VS. RAILWAY TUNNELS**

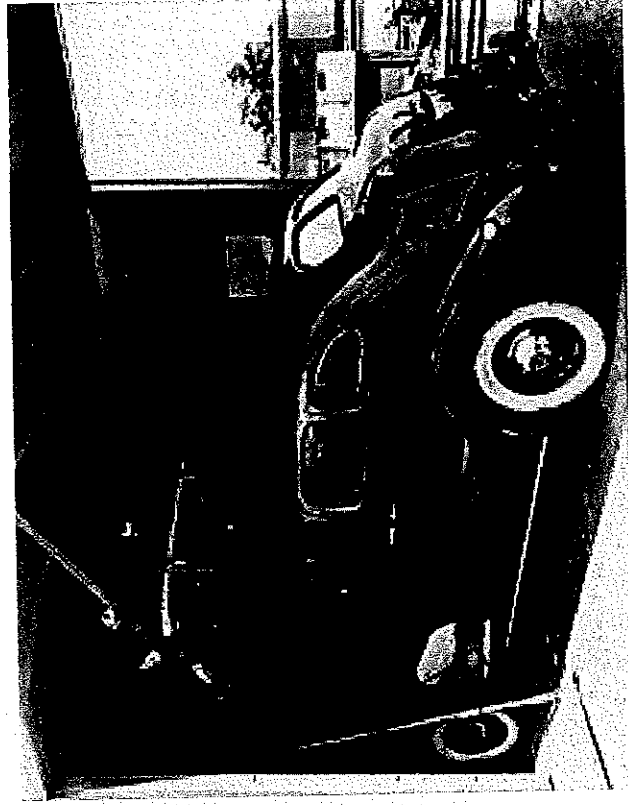
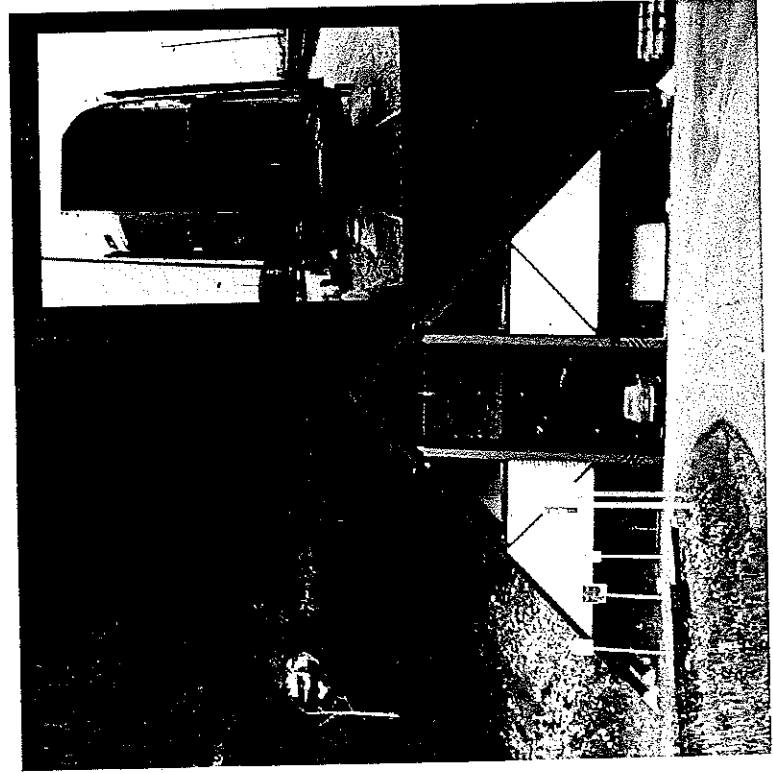
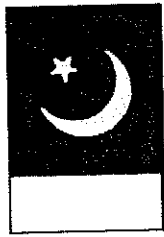


TABLE OF CONTENTS

1. Key Points of Road/Railway Combined Tunnel
2. Road/Railway Combined Tunnel in Japan and the World
3. Comparison of Typical Cross Sections of Tunnel
4. Cross Section of Road/Railway Combined Tunnels
5. Longitudinal Slope for Typical Railway Tunnels
6. Requirement of Different Facilities
7. Considerations on Safety
8. Planning of the 2nd Kohat Tunnel as a Road/Railway Tunnel

1. Key Points of Road/Railway Combined Tunnel

There are not many tunnels accommodated railway and road together in the same tunnel section in the world including in Japan.

Major Points to be considered:

- Technical Aspects
- Economical Aspects
- Safety Aspects
- Other Aspects (Approach Roads)

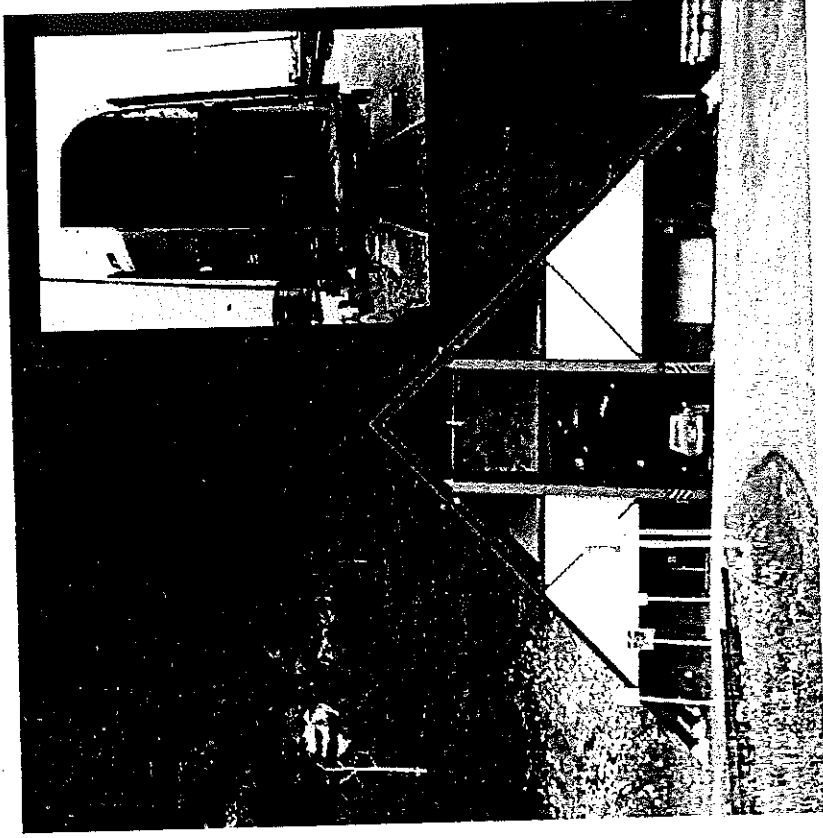
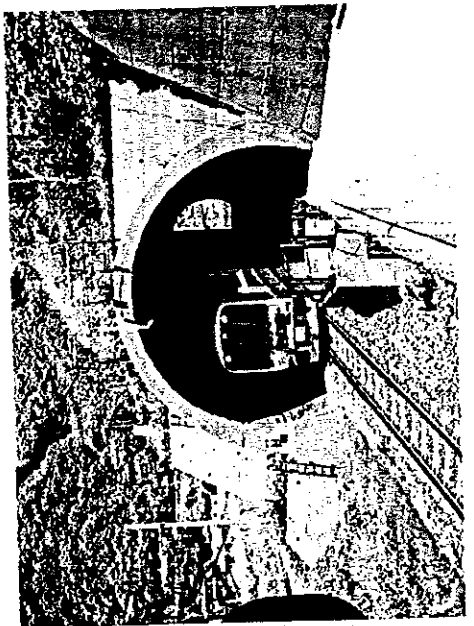
for accommodation of Railway in the 2nd Kohat Tunnel.

2. Road/Railway Combined Tunnel in Japan and the World

- Immersed tube tunnel

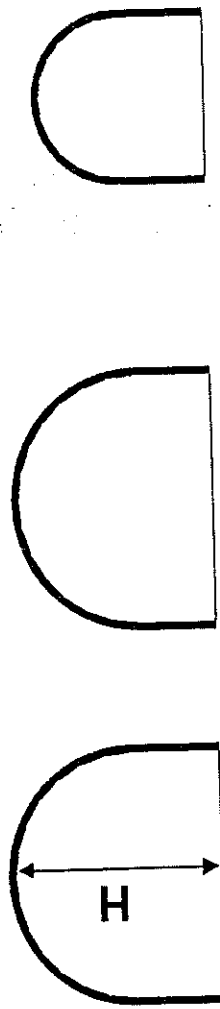


- Short length tunnel

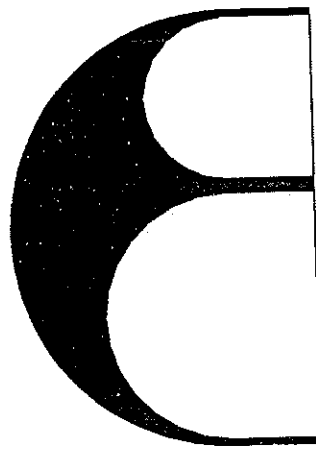


3. Comparison of Typical Cross Sections of Tunnel

Two-lane road Two-track railway Single-track railway

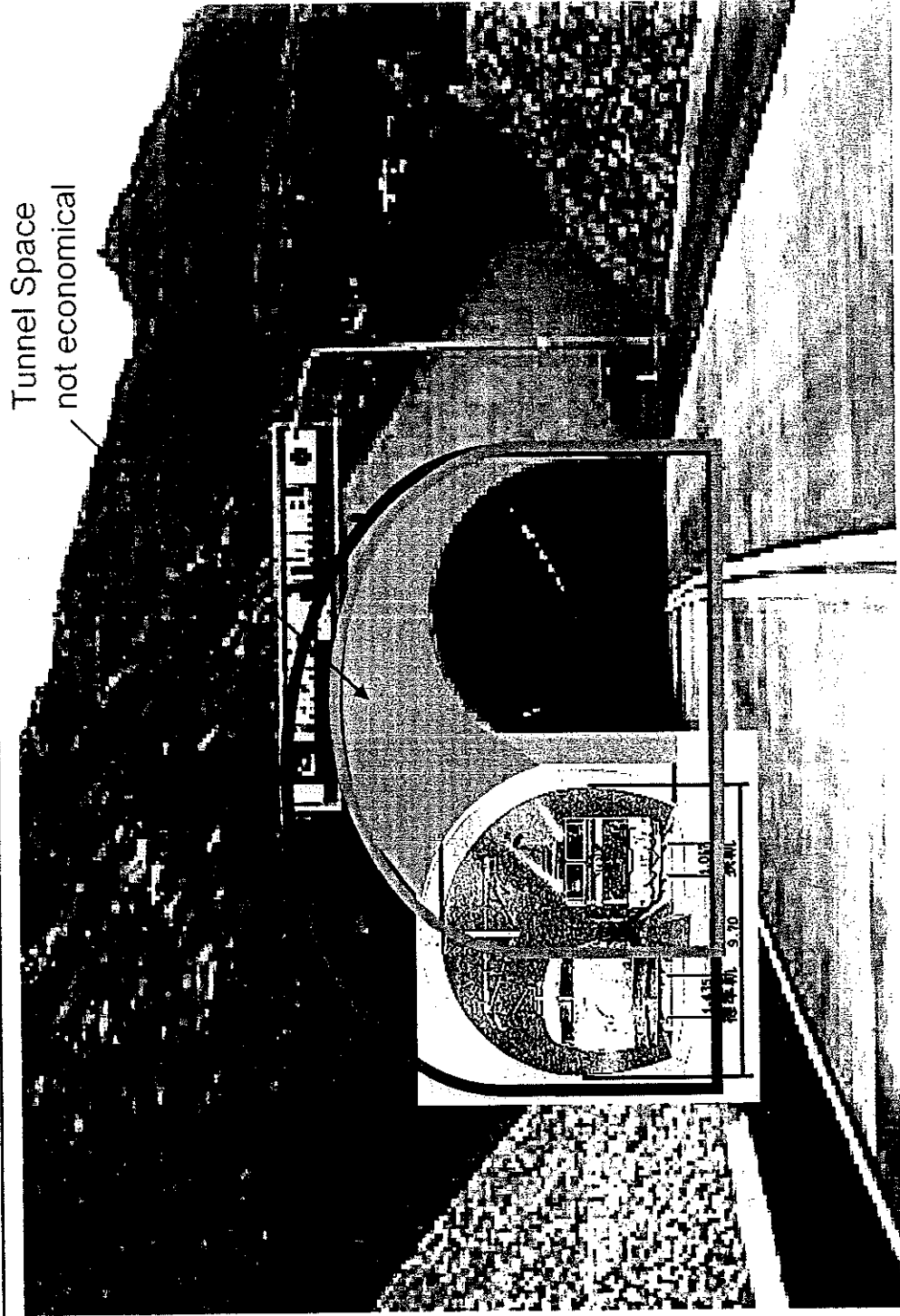


Two-lane road + Single-track railway



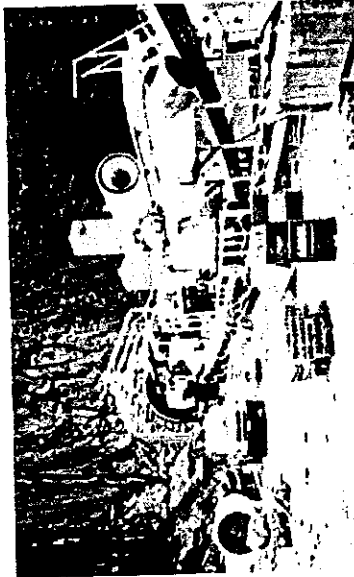
$$H \doteq 0.6 \times D - 0.6\text{m} + \text{Equipment Gauge}$$

4. Cross Section of Road/Railway Combined Tunnel (North Portal)

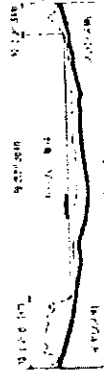
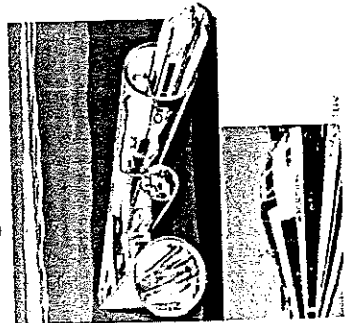


5. Longitudinal Slope for Typical Railway Tunnels

Gotthard Base tunnel (Switzerland)
 Length 57km, (Under Const.)
 Longitudinal Slope 1.2%



Euro tunnel (Britain - France)
 Length 49.4km,
 Longitudinal Slope 1.1%

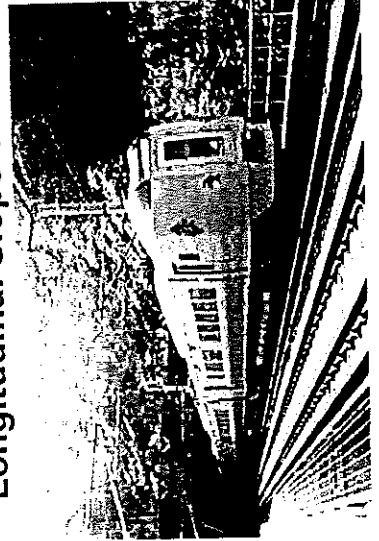


Note: Though it is possible to plan the maximum slope of tunnel to be approx. 3%, running speed will be reduced substantially and it will become not competitive.

Ohshimizu tunnel (Japan)
 Length 22.2km,
 Longitudinal Slope 1.5%

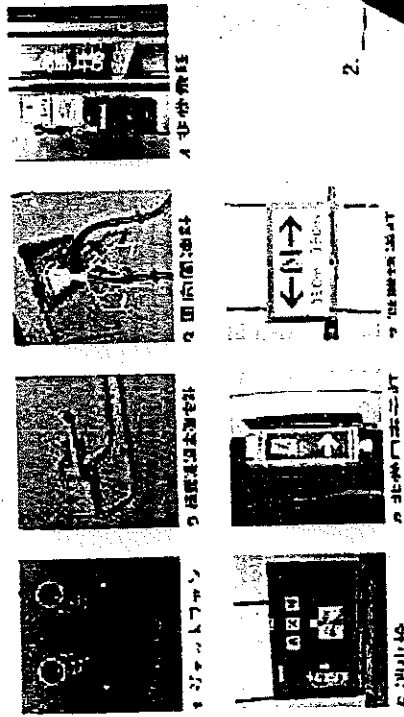


Seikan tunnel (Japan)
 Length 53.9km,
 Longitudinal Slope 1.2%



6. Requirement of Different Facilities

Road tunnel facilities installation



Ventilation system
Lighting
Emergency Exit
Fire extinguish system

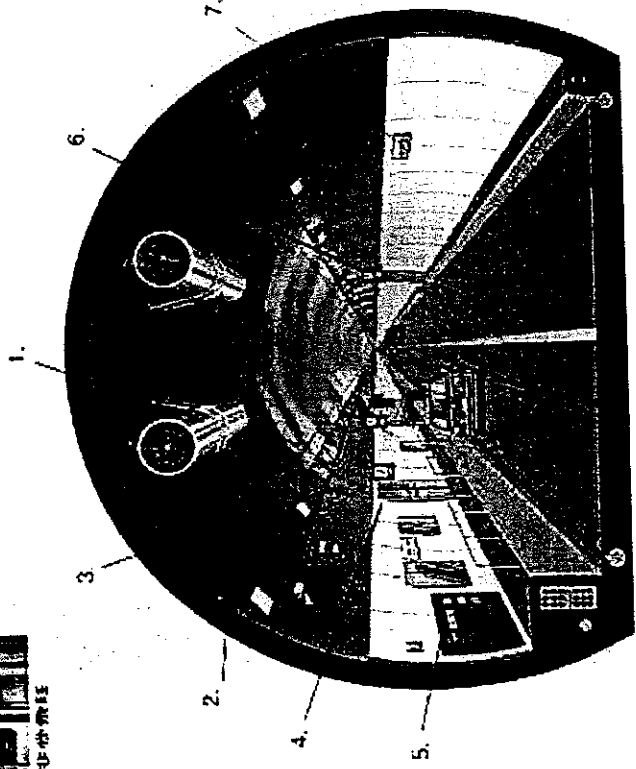
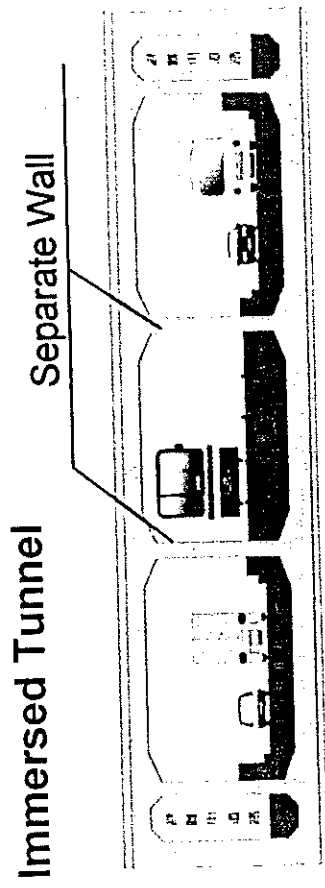


図 補 第 10

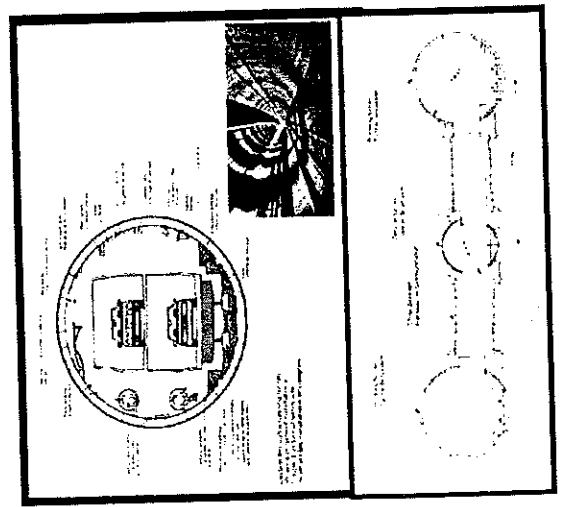
Railway tunnel facilities

Lighting fixture
Exit guide board

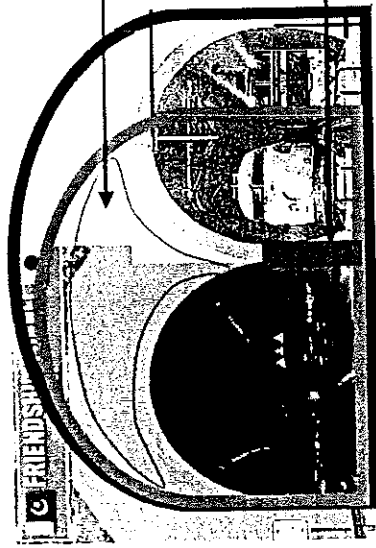
7. Considerations on Safety



Shuttle Tunnel (Train)



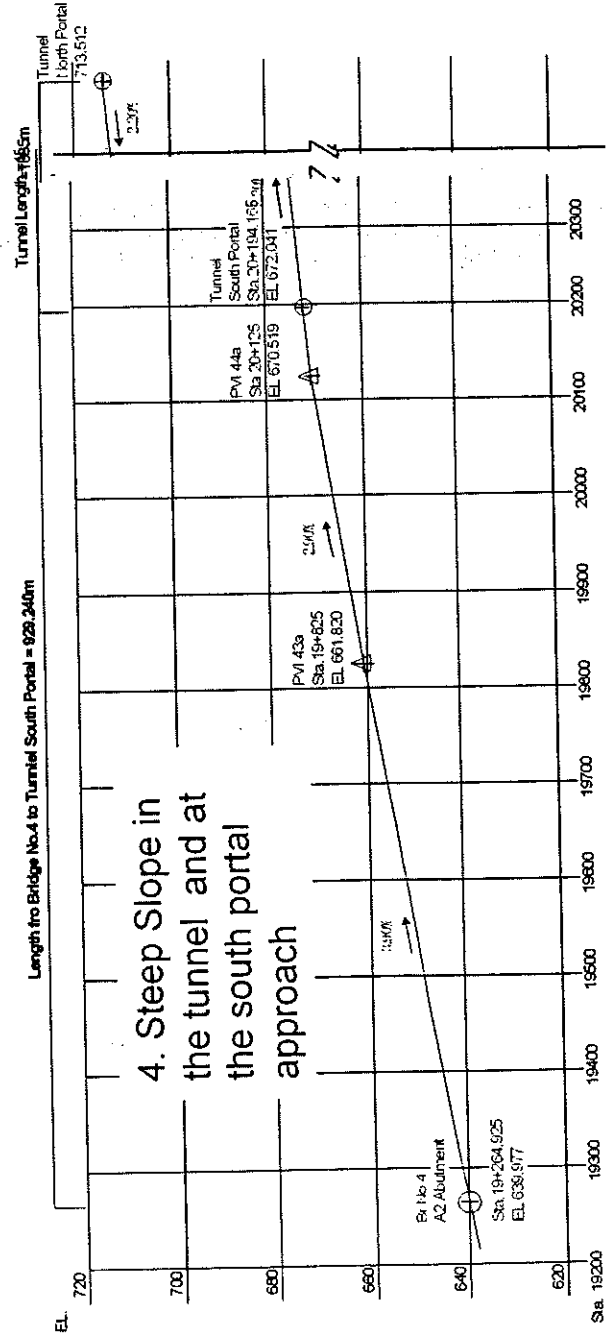
8. Planning of the 2nd Kohat Tunnel as a Railway / Road Tunnel



1. Uneconomical Space
2. Required facility difference (ventilation, lighting, etc)
3. Required a Separator to avoid unexpected crushing ?

Note: It will be better to plan a separate tunnel for the railway both on technical and economical aspects.

5. Large volume of hard rock excavation at the north portal approach



4. Steep Slope in the tunnel and at the south portal approach

