Japan International Cooperation Agency (JICA)
Syrian Arab Republic

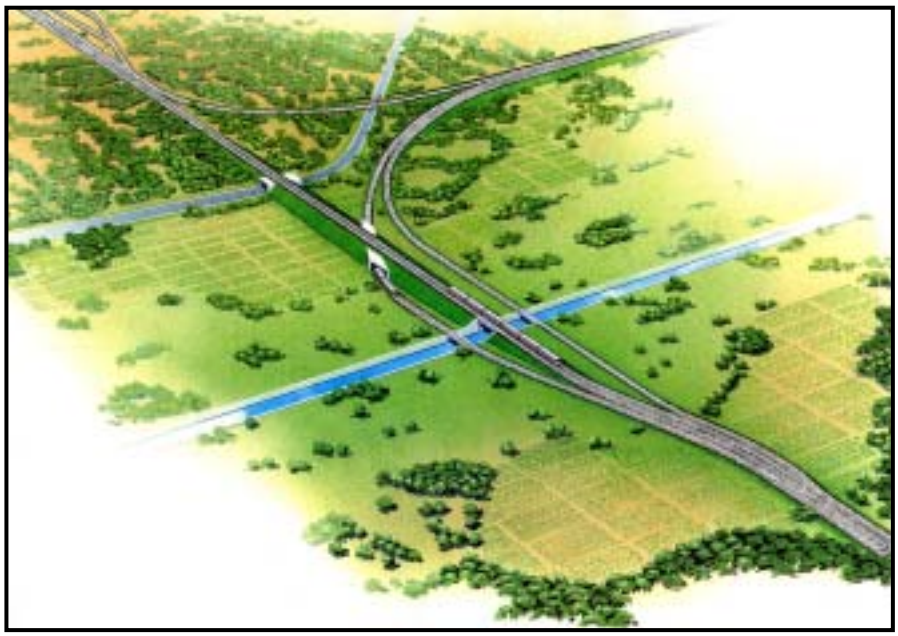
No.

The Master Plan Study on the Development of Syrian Railways in the Syrian Arab Republic

Volume II

Feasibility Study on The Rehabilitation/Modernization of Tartous, Homs and Al-Sharqia Section

Final Report



August, 2001

Japan Railway Technical Service (JARTS)
Yachiyo Engineering CO., LTD. (YEC)

SSF
JR
01-120 (2/6)

Exchange Rate of Currency

1 US$ = 46 Syrian Pounds

1 US$ = ¥115

1 Syrian Pound = ¥2.5

January, 2001

PREFACE

In response to a request from the Government of the Syrian Arab Republic, the Government of Japan decided to conduct a Master Plan Study on the Development of Syrian Railways in the Syrian Arab Republic and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Dr. Sadaaki Kuroda of Japan Railway Technical Service, and consist of Japan Railway Technical Service and Yachiyo Engineering Co., Ltd. to the Syrian Arab Republic, 3 times between April 2000 and August 2001.

In addition, JICA set up an advisory committee headed by Mr. Hiroshi Saeki, Director, Environmental Office, Railway Bureau, Ministry of Transport (present Ministry of Land, Infrastructure and Transport) between April 2000 and August 2001, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of the Syrian Arab Republic and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Syrian Arab Republic for their close cooperation extended to the Team.

August 2001

Kunihiko Saito
President
Japan International Cooperation Agency

August, 2001

Mr. Kunihiko SAITO
President
Japan International Cooperation Agency

Dear Sir,

Letter of Transmittal

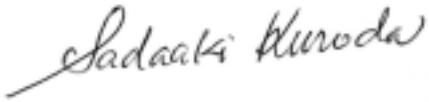
We have the pleasure of submitting herewith our Report for the Master Plan Study on the Development of Syrian Railways in the Syrian Arab Republic. The report describes the results of the Study carried out by Japan Railway Technical Service and Yachiyo Engineering Co. Ltd., as per the contract with Japan International Cooperation Agency.

The Study Team conducted field surveys three times during the period from April 2000 to August 2001. The Team held sufficient consultations with the Syrian governmental agencies concerned regarding the results of the field surveys and study activities in Japan, and drew up a master plan for the rehabilitation and modernization of the nationwide railway for the year 2020; phased rehabilitation and modernization plans for 2005 (short term), 2010 (medium term), and 2020 (long term); and two plans, as short-term urgent projects, on the rehabilitation and modernization of Tartous, Homs and Al-Sharqia section and on the locomotive workshop modernization. In close coordination with the Syrian side, the Team thereafter studied the feasibility of these plans from technical, environmental, economic, and financial aspects, and drew up this report.

From the standpoint of reinforcing the transport infrastructures necessary for the social and economic development of Syria, we would like to recommend the early implementation of the two projects: rehabilitation and modernization of the railway section between Tortous, Homs and Al-Sharqia; and locomotive workshop modernization.

We wish to express our sincere gratitude to the Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Land, Infrastructure and Transport, and the Japanese Embassy and JICA Office in Syria for the kind assistance and guidance extended to us in executing the Study.

Yours faithfully,



Sadaaki KURODA, Dr. Eng.
Leader
The Study Team for the Master Plan Study on the Development of Syrian Railways in the Syrian Arab Republic


Syria
GEORGIA
RUSSIA
ALBANIA
GREECE
TURKEY
ARMENIA
AZERBAIJAN
TURKMENISTAN
CYPRUS
LEBANON
ISRAEL
JORDAN
IRAQ
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KUWAIT
SAUDI ARABIA
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UNITED ARAB EMIRATES
EGYPT
LIBYA
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SAHARA
LIBYAN DESERT
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AEGEAN ISLANDS
Mediterranean Sea
Red Sea
Persian Gulf
Nile
Aleppo
Damascus
Homs
Hamāh
Idlib
Antakya
Tripoli
Beirut
Haifa
Tel Aviv-Yafo
Jerusalem
Amman
Baghdad
Mosul
Tehrān
Eşfahān
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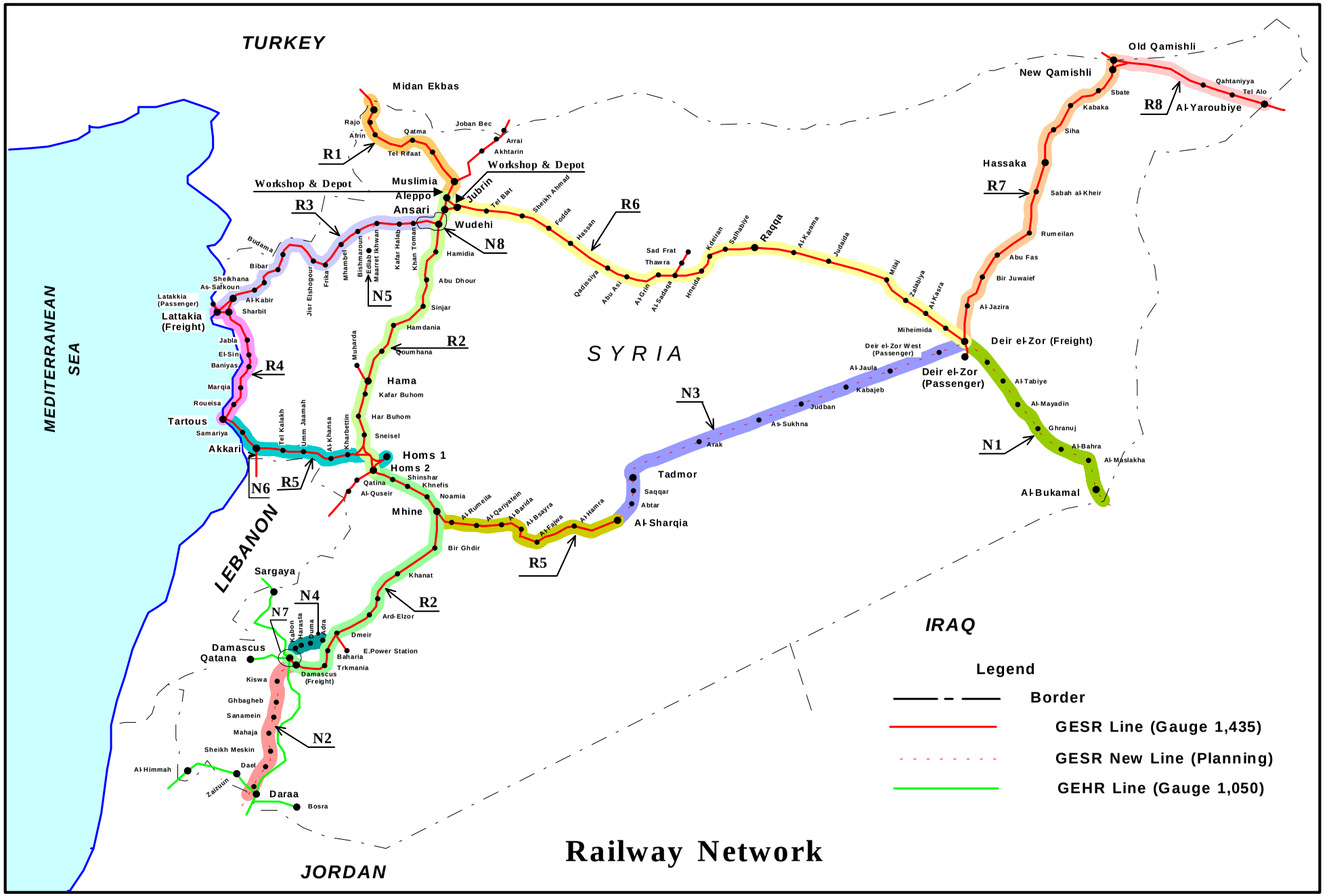
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Joban Bec
Arrai
Akhtarin
R1
Workshop & Depot
Muslimia
Aleppo
Ansari
Jubrin
Workshop & Depot
Tel Biat
Sheikh Ahmad
Fodda
Hassan
R6
R3
Wudehi
N8
Hamidia
Abu Dhour
Sinjar
Hamdania
R2
Qoumhana
Budama
Bibar
Sheikhana
As-Safkoun
Al-Kabir
Sharbit
Latakkia (Passenger)
Lattakia (Freight)
Jisr Elshogour
Frika
Mhambel
Bishmaroun
Edlab
Maarret Ikhwan
Kafar Halab
Khan Tomane
N5
Jabla
El-Sin
Baniyas
R4
Marqia
Roueisa
Tartous
Samariya
Akkari
N6
R5
Tel Kalakh
Umm Jaamah
Al-Khansa
Kharbettin
Muharda
Hama
Kafar Buhom
Har Buhom
Sneisel
Homs 1
Homs 2
Shinshar
Khnefis
Noamia
Qatina
Al-Quseir
Mhine
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R2
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Damascus (Freight)
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Abu Asi
Al-Grin
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Hneida
Al-Karama
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Deir el-Zor West (Passenger)
Deir el-Zor (Passenger)
Deir el-Zor (Freight)
Al-Jaula
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As-Sukhna
Arak
N3
Tadmor
Saqqar
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Al-Sharqia
R5
Al-Faiwa
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Al-Qariyatein
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Old Qamishli
New Qamishli
Sbate
Kabaka
Siha
Hassaka
R7
Sabah al-Kheir
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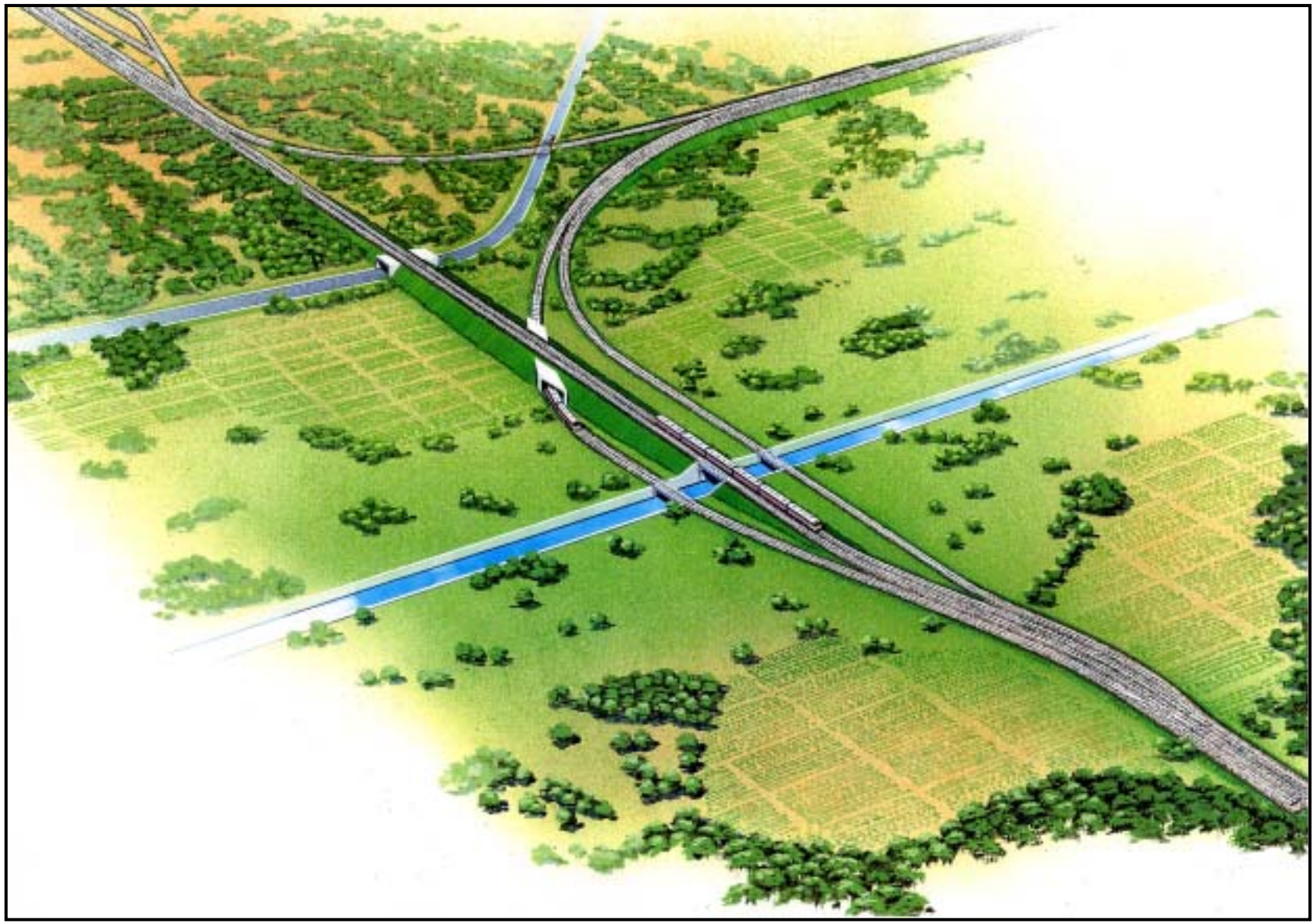
Abu Fas
Bir Juwaief
Al-Jazira
Qahtaniyya
Tel Alo
R8
Al-Yaroubiye
Al-Tabiye
Al-Mayadin
Ghranuj
Al-Bahra
Al-Maslakha
N1
Al-Bukamal
Legend
Border
GESR Line (Gauge 1,435)
GESR New Line (Planning)
GEHR Line (Gauge 1,050)
Railway Network


Tartous
Samariya
Akkari
Tel Kalakh
Umm Jaamah
Al-Khansa
Kharbettin
Homs
Shinshar
Khnefis
Noamia
Mhine
Al-Rumeila
Al-Qariyatein
Al-Barida
Al-Bsayra
Al-Fajwa
Al-Hamra
Al-Sharqia
Route of the Project



Near by 5km

The Master Plan Study on the Development of Syrian Railways in the Syrian Arab Republic
Volume Ⅱ

The Feasibility Study on the Rehabilitation/Modernization of Tartous, Homs, and Al Sharqia Section
[Executive Summary]

Study Period : April 2000～August 2001
Accepting Organization : Ministry of Transport(MOT)
General Establishment of Syrian Railways (GESR)

1. Objective of the Study

In this study, railway rehabilitation and modernization plans (improvement plans) are drawn up, in order to ensure safe and stable railway transport between Tartous, Homs, and Al Sharqia. Then, comprehensive evaluation is made concerning the feasibility of these improvement plans from technical, environmental, economic, and financial aspects.

At the same time, technology transfer to Syrian-side counterparts is carried out, through the implementation of the study.

2. Methods of the Study

(1) Process of the Study

① At first, a master plan for the rehabilitation and modernization of GESR was drawn up. In the master plan, 13 projects for the rehabilitation and modernization of existing facilities were set up together with 9 projects for new line construction, as projects of GESR.

② Then, respective projects were evaluated and given priorities, and phased improvement plans were drawn up based on priorities in consultation with the Syrian side.

③ Based on the results of the evaluation of respective projects and the consultations with the Syrian side, the railway rehabilitation and modernization project between Tartous, Homs, and Al Sharqia was selected as a short-term urgent project, together with the locomotive workshop modernization project. Then, it was decided to implement feasibility studies on each of these projects.

(2) Methods of the Study

① In this study, the basic policies of the master plan formation were followed. At first, collection of supplementary materials and information was carried out in Syria together with a supplementary field reconnaissance.

② Based on the collected materials and information and the results of the field reconnaissance, various data were analyzed and arranged. Thereafter, railway rehabilitation and improvement plans between Tartous, Homs, and Al Sharqia were drawn up. Then, comprehensive evaluation was made concerning the feasibility of the improvement plans through economic and financial analysis, and the report was compiled based on the study results.

3. Outline of the Project

3.1 Project Outline and Optimum Plan Selection

This project covers the route of about 270km running from Tartous (an important port for import and export) to Al Sharqia (with phosphate ore mines) via Homs and Mhine. For this route, the project aims at the rehabilitation and modernization of the existing track facilities, electric facilities and so forth; as well as the new construction of signal stations and double tracking for the smooth operation of trains which will be increased to cope with the growth of demand.

The section of about 40km between Akkari and Al Khansa has a steep gradient of 20‰ and is becoming bottleneck in transport. For double tracking of this section, two alternative plans (Alternative A and Alternative B) shown in Table 1 were set up and compared.

Table 1 Alternatives for Additional Track Construction between Akkari and Al Khansa

Alternative	Route	Max Gradient	Min Radius	Locomotive	Traction Force
A	Second track in parallel with the existing track	20‰	300m	2 LDE 3200	1800 t
B	Second track separate from the existing track	12‰	600m	1 LDE 3200	1800 t

The comparative study results concerning the two alternatives from various aspects are as shown in Table 2. Alternative A was finally selected as the superior plan.

Table 2 Evaluation of Alternatives by Various Aspects

Aspect	Transport and rolling stock aspects	Ground facilities aspect (track facilities, electric facilities)	Environmental aspect	Economic and financial aspects	Comprehensive evaluation
Alternative A	△	○	○	○	○
Alternative B	○	△	△	△	△

3.2 Main Data of the Project

(1) Estimated Traffic Volume

Table 3 Estimated Traffic Volume between Tartous, Homs, and Al Sharqia(per day per two ways)

Year	1999	2005	2010	2015	2020
No. of passengers	390	1,660	3,200	5,578	6,768
Passenger-km	40,393	157,888	364,512	583,139	733,923
Tons	8,139	15,142	26,500	44,250	71,212
Ton-km	1,665,845	2,751,711	4,921,746	7,337,964	10,957,060

(2) Train Operation and Rolling Stock

1) Maximum speed：

① Diesel Car Passenger train ：130km/h （100km/h for passenger coach train by DEL traction）

② Freight train ：100km/h

2) Operation safety system：Automatic block system

3) Number of Trains

① Passenger train （Project adopting Alternative A）

Table 4 Number of Passenger Trains Per day per two way

unit：trains

Year	2005	2010	2015	2020
Tartous～Homs I	8	8	10	12
Homs I～Mhine	12	12	20	24
Mhine～Al Sharqia	0	4	6	6

Note：The numbers in Alternative B are the same as those in Alternative A.

② Freight train（Project adopting Alternative A）

Table 5 Number of Freight Trains Per day per two way

unit：trains

Year	2005	2010	2015	2020	Remarks
Tartous～Homs II					
・Tartous～Akkari	30	48	68	98	
・Akkari～Al Khansa	40	66	94	138	Including deadhead trains
・Al Khansa～Homs II	30	48	68	98	
Homs II～Mhine	26	42	68	104	
Mhine～Al Sharqia					
・Mhine～Al Fajwa	14	24	32	62	
・Al Fajwa～Al Sharqia	12	22	30	60	

Note：In Alternative B, deadhead trains between Akkari and Al Khansa are unnecessary . Excluding the section between Akkari and Al Khansa, the numbers of freight trains for Alternative B is the same as those for Alternative A.

4) Number of Necessary Rolling Stock （Project adopting Alternative A）

Table 6 Number of Necessary Rolling Stock unit：cars

Year	2005	2010	2015	2020	Remarks
Diesel locomotive	26	42	58	89	Including auxiliary locomotives
Diesel railcar	8	15	35	40	
Passenger coach	25	30	25	25	

Note：In Alternative B, auxiliary locomotives between Akkari and Al Khansa are unnecessary, accordingly, the number of necessary diesel locomotives is 23 cars for the year 2005; 37 cars for 2010; 51 cars for 2015; and 78 cars for 2020. The numbers of diesel car and passenger coach for Alternative B are the same as those for Alternative A.

(3) Amount of Investment

1) Amount of Investment

Project adopting Alternative A ： 28.2 billion SP

Project adopting Alternative B ： 31.6 billion SP

Breakdown by item ：

Table 7 Amount of Investment unit：billion SP

Item	Track and structures	Signal and telecommunication	Rolling stock depot	Rolling stock	Total
Project adopting Alternative A	8.9	2.1	1.2	16.0	28.2
Project adopting Alternative B	13.2	2.2	1.2	15.0	31.6

2) Investment Schedule

Table 8 Investment Schedule

Railway Section	Item	2001～2005	2006～2010	2011～2015	2016～2020	Remarks
Tartous - Homs	Structure and Track					
	Signal and Telecom					
	Loco & DC Depot					
Homs - Mhine	Structure and Track					
	Signal and Telecom					
	Loco & DC Depot					
Mhine - Al-Sharqia	Structure and Track					
	Signal and Telecom					
Rolling Stock	Locomotive					
	Diesel Car					
	Passenger Car					
	Freight Car					
Improvement Cost (million SP)	Alternative					Total
	A	3,358	8,941	7,111	7,189	26,599
	B	3,358	12,271	6,925	6,822	29,376

Note : Rehabilitation
Modernization
To cope with the increase of the traffic

"Improvement Cost" means the construction cost excluding engineering fee and contingency fee.

(4)Administration and Operation Cost

Table 9 Administration and Operation Cost unit：million SP

Year	2005	2010	2015	2020
Project adopting Alternative A	192	647	1,164	1,818
Project adopting Alternative B	191	701	1,202	1,836

(5) Economic and Financial Evaluation

Table 10 Economic and Financial Internal Rates of Return

Item	Economic Internal Rate of Return （EIRR）	Financial Internal Rate of Return （FIRR）
Project adopting Alternative A	20.5 %	7.3 %
Project adopting Alternative B	18.2 %	6.1 %

4. Comprehensive Evaluation of the Project (Conclusion)

(1) This project aims at the rehabilitation and modernization of ground facilities (track, structures, signal and telecommunication facilities, rolling stock depot, etc.) as well as the reinforcement of transport capacity (by signal station construction or second track construction in parallel with the existing track.) and so forth. This project with these targets is technically feasible, and does not inflict large influence on the environment.

(2) The EIRR of the project is 20.5 %. In view of this, and also taking into account other indirect benefits, the project is considered to be feasible from the national economic standpoint.

(3) The FIRR of the project is 7.3%, and can be judged as financially viable from the enterprise view of GESR in case reasonable interest loan is applied to investment.

(4) From the comprehensive standpoint, the project is considered to be very adequate one to rehabilitate and modernize an important route of GESR and is feasible from technical, environmental, economic, and financial aspects.

(5) The execution of the project will enable stable railway transport between Tartous, Homs, and Al Sharqia, and will contribute to the promotion of sound socioeconomic activities in Syria.

(6) For the effective implementation of the project, recommendations are made concerning smooth promotion of construction works; consideration for environmental

preservation; effective investment in facilities, rolling stock and so forth; and improvement of facilities maintenance and administration.

(7) A detailed study on new line (separate route) construction plan between Akkari and Al Khansa is separately in progress at present in GESR. As described before, each project adopting either alternative for the section between Akkari and Al Khansa has been found feasible from economic and financial standpoints. Therefore, if GESR further promotes the detailed study on the above separate-route plan, including environmental assessment, and detailed construction cost, it may be meaningful that GESR may compare again a project adopting Alternative A and another adopting Alternative B.

Contents

Chapter 12 Environmental Impact Assessment

Chapter 13 Conclusion and Recommendation

Appendix

Abbreviation and Glossary

ADT	Average Daily Traffic
AOC	Administration and Operation Cost
ATP	Automatic Train Protection
ATS	Automatic Train Stop
B/C	Benefit Cost Ratio
BOD	Biochemical Oxygen Demand
CCITT (ITU-T)	International Telecommunication Union
CIF	Cost, Insurance and Freight
COD	Chemical Oxygen Demand
CONOCO	Continental Oil Company
CT	Closed Track Circuit
CTC	Centralized Traffic Control
DC	Diesel Car
DEL (LDE)	Diesel Electric Locomotive
DGMO	Director Generals of Middle East Railways
DHL	Diesel Hydraulic Locomotive
DL	Diesel Locomotive
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
FC	Freight Wagon
FIRR	Financial Internal Rate of Return
FS（F/S）	Feasibility Study
GCEA	General Council for Environmental Affairs
GDP	Gross Domestic Products
GEHR	General Establishment of Hidjaz Railways
GESR	General Establishment of Syrian Railways
GORS	General Organization of Remote Sensing
GRDP	Gross Regional Domestic Products
HID	High Intensity Discharge
HMIS	Highway Maintenance and Inspection System
HVAC	Heating, Ventilation and Air Conditioning
IEC	International Electro Technical Commission
IRI	International Roughness Index
ISO	International Standard Organization
JICA	Japan International Cooperation Agency

JR	Japan Railway
LED	Light Emitting Diode
MOF	Ministry of Finance
MOT	Ministry of Transport
MP（M/P）	Master Plan
MRT	Mass Rapid Transport
NDP	Net Domestic Products
NEAP	National Environmental Action Plan
NEEDS	Nikkei Economic Evaluation Data System
NPV	Net Present Value
OD	Origin-Destination
OJT	On the Job Training
OLTC	On Load Tap Changer
OT	Open Ticket Circuit
PABX	Private Automatic Branch Exchange
PC	Passenger Coach
PC sleeper	Prestressed concrete sleeper
ROC	Rail Operating Cost
ROI	Return on Investment
ROE	Return on Equity
ROUC	Rail Operating Unit Cost
ROW	Right of Way
SDH	Synchronous Digital Hierarchy
SL	Steam Locomotive
SS	Suspended Solides
TQC	Total Quality Control
TTC	Travel Time Cost
TTUC	Travel Time Unit Cost
TTUC	Travel Time Unit Value
UIC	International Railway Union
UN	United Nations
UNDP	United Nations Development Programme
VOC	Vehicle Operating Cost
VOUC	Vehicle Operating Unit Cost

Chapter 1

Introduction

Chapter 1 Introduction

1.1 Background of the Project

The Rehabilitation/Modernization of Tartous, Homs and Al Sharqia Section has been rated as one of the top priority projects in the Master Plan through the comprehensive evaluation, and is scheduled to be started in the first stage. The implementation of a Feasibility Study of the Rehabilitation/ Modernization on this section was proposed in the Interim Report. Thereafter, as a result of consultations with the Syrian side, this project was agreed upon between Syria and Japan on December 11, 2000 as one of the Short-term Urgent Projects for feasibility study.

1.2 Urgency and Importance of the Project

This project is important because its object route connects Tartous (a major port for import and export), Homs (a third largest city in Syria characterized by industry and high consumption), and Al Sharqia (with phosphate ore mines), constituting an essential freight transport line which has traffic volume of 30 to 40% of the entire traffic of GESR. The main items carried are phosphate ore, oil, cement, foodstuff, cereals, and so forth.

Furthermore, if a new line is constructed between Al Sharqia and Deir el-zor and a well-balanced railway network in the entire Syria is established, the section covered by this project will, jointly with the sections of the new line, constitute an essential route in the transport network. Specifically, the route will connect the cities having extremely high potentiality of population increase and agricultural and industrial development in the future (Hassaka, Deir el-zor Governorate) with Homs (a large industrial city with high consumption), Damascus (the capital), and Tartous (a major port for import and export). Moreover, economic development in the regions between Syria and Lebanon will become possible, if the railway route between Akkari and the Lebanon Border and the route within Lebanon connecting with it are reconstructed at a proper time.

In this important route, among the sections between Tartous and Homs, the track alignment is especially inferior between Akkari and Al Khansa, causing the bottlenecks of transport.

Furthermore, the track capacity to meet the future demand is insufficient even on other sections, requiring double tracking or construction of new signal station. In addition, it is necessary to take such measures as improvement of track (the replacement of deteriorated rail, fastening devices, and sleepers; replenishment of ballast; and improvement of track formation width, etc) and improvement of the signal and telecommunication facilities (the introduction of electronic interlocking devices and optical fibers, improvement of level crossing protection facilities, improvement of other telecommunication facilities, etc). Therefore, it can be concluded that the implementation of the Rehabilitation/ Modernization of this route is extremely urgent and important for Syria.

By the completion of the Rehabilitation/Modernization of Tartous, Homs and Al Sharqia Section, the bottlenecks of transport between Akhari and Al Khansa will be eliminated, the transport capacity of other sections along the project route will be increased to meet the future traffic demand, and due to the improvement and modernization of railway facilities including track, signal and telecommunication facilities, and rolling stock depots, speedy and reliable passenger and freight transport will be ensured, contributing to sound social and economic development of Syria.

Chapter 2

Route Planning

Chapter 2 Route Planning

The location of the route of the Project is as shown in Fig. 2.1.

2.1 Alignment of the Tartous – Homs – Mhine – and Al Sharqia Section

In Syria, located at the east end of the Mediterranean Sea, there is the Nusayriyah mountain range along the coast line, and along the boundary with Lebanon in the south the Lebanon mountain range exists. At the north side of the coast there is the Lattakia port, and Tartous port in the south of the coast. The railway line from the Lattakia port to Aleppo runs around the north end of the Nusayriyah mountain range and on the other hand, from the Tartous port, there is a railway line to Homs and Damascus going through between the Nusayriyah mountain range and the Lebanon mountain range.

For the route between Tartous – Homs, the line from Homs to Tripoli of Lebanon was constructed by the technology of France and agricultural products were transported from Syria towards Lebanon, however, in the latter part of 19th century, the volume of transported products reduced because of the change of situation. From the Tartous port to Homs, the railway line was constructed (Tartous – Akkari) and improved (Akkari – Homs) by the technical assistance of Russia, and in 1968, the line between Tarrous and Akkari was opened for operation.

The section from Akkari to Homs was opened for traffic in 1979 upon improving the route constructed by France.

The route between Tartous – Samariyan to Akkari (app. 37km) runs on the flat plain from the coast to Akkari (alt. 59m) around the foot of the Nusayriyah range, although there are small ups and downs of 12‰ grade, having radius of curvature of R=1,200m or more, and there is no specific problem for the alignment.

From Akkari – Tel Kalakh – Umm Jaamah to Al-khansaa (app. 39km), the route goes into the mountain section with the grade of 20‰ and the radius of curvature of R=300 – 400m, crawling up the continuous ravine area.

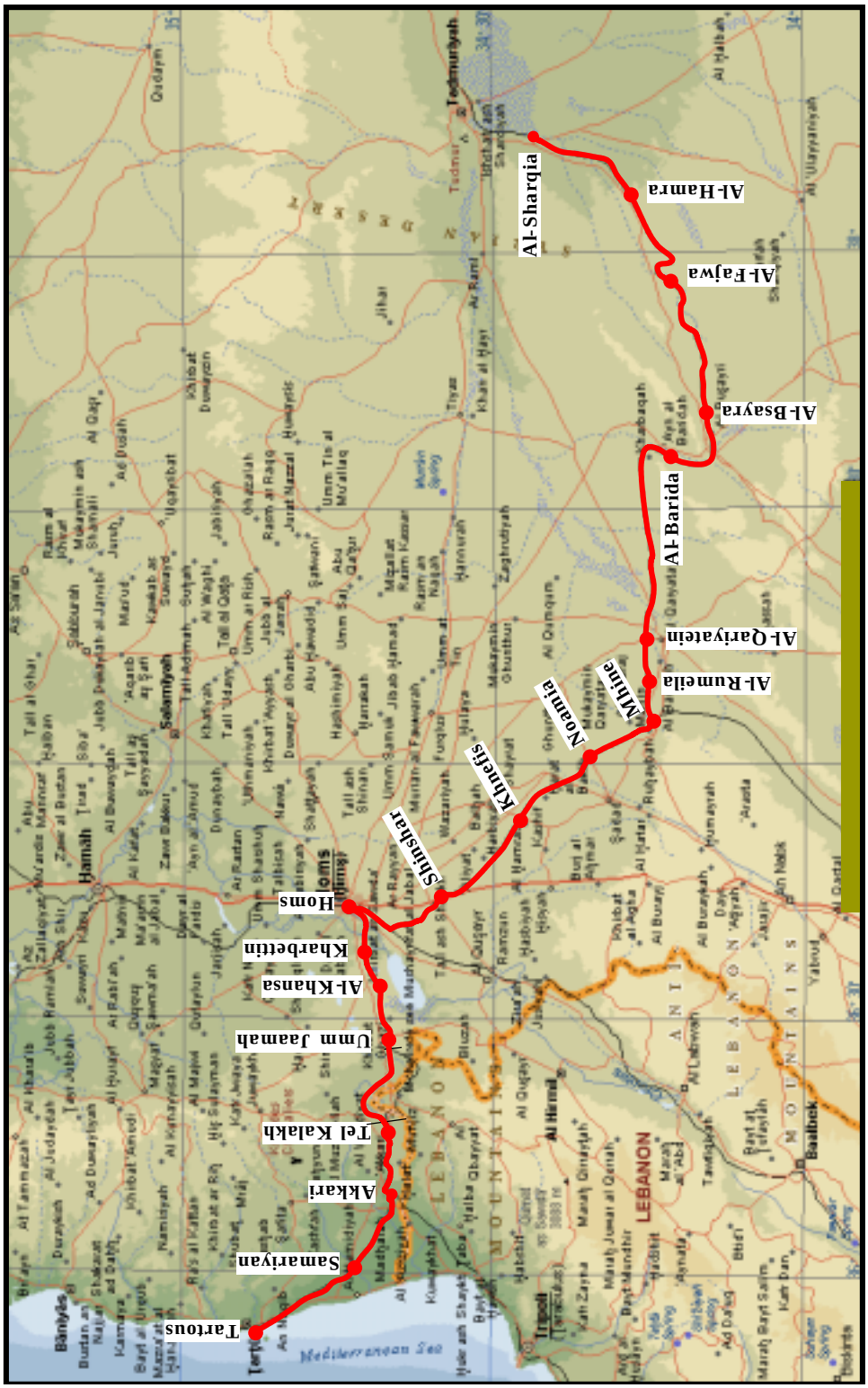


Fig.2.1 Route of the Project

On the way, train can pass by each other at Tel Kalakh (Alt. 240m). Once again the railway line goes up the ravine and crosses the pass at altitude of 302m and goes down to the basin at Umm Jaamah (Alt.270m). From Umm Jaamah basin, the railway line climbs up once again to the west end of the plateau (so called the Syrian desert) and reaches to Al Khansa. Along the route, the train climbing up will be split into two trains at Akkari and rejoin at Al-Khansa for going to Homs.

For sections of Al-Khansa –Kharbettin to Homs (app. 25km), trains will be arriving at Homs (alt. 505m) after going through gentle ups and downs over the plateau. In between this section, the steepest grade is 12‰ and the radius of curve is more than R=600m. Before reaching Homs, at so called "5km point", the line will be merged by the trains coming from Aleppo. The line will be separated into two direction at about 2km point to Homs-1 (passenger station) in the north direction and to Homs-2 (freight station) in the south direction to Damascus.

The section between Homs and Mhine is about 64km length, which goes around the foot of the Sharqi mountain range lying at the boundary of Lebanon.

Station Mhine (alt. 890m) is situated on the mid-way of the trunk line between Aleppo and Damascus after crossing to the south over the pass of Altitude 935m of the Nasrani mountain chain which extends to the north east of the Sharqi mountain range. In this section, the route climbs up the grade of 10 – 12‰ and on the way at the nearby flat area, stations of Shinshar, Khnnefis and Naomia are located and used for passing-by of trains. Radius of curvature is almost R=1,000m and more and these curves are connected with 2－8km straight line. As a conclusion, alignment of the section is favorable.

In the section between Mhine and Al-Sharqia of about 111 km, the route goes towards the center of the Syrian desert along the north side of the Nasrani mountain range and goes down to Al-Qariyatein at the altitude of about 710m. At the end of the Nasrani mountain range the line goes around in between Al-Barida (alt. 766m) – Al-Bsaya (alt. 767m) and then after going through the south side of Khunayzir mountain range, goes up to Al-Fajiwa where phosphate mine is situated.

Afterwards, the railway line goes down towards Al-Sharqia (Alt. 614m) where the largest phosphate mine of Syria is located.

The alignment is fairly excellent, having continuous ups and downs of grade of 11–12‰ with

the radius of curvature of more than R=600m.

Alignment of each section is as shown in Table 2.1 and Table 2.2.

Table 2.1 Table of Gradient Between Tartous and Al-Sharqia

Gradient (‰)	Homs 1 - Tartous			Homs 1 - Mhine			Mhine - Al-Sharqia		
	Length (m)	(%)	No.	Length (m)	(%)	No.	Length (m)	(%)	No.
0≦G＜1	23,069	22.6	48	8,490	12.5	16	13,762	12.4	27
1≦G＜2	2,131	2.1	6	6,210	9.2	11	5,252	4.7	9
2≦G＜3	6,249	6.1	12	6,250	9.2	14	5,965	5.4	13
3≦G＜4	2,469	2.4	5	1,680	2.5	5	5,590	5.0	15
4≦G＜5	2,258	2.2	6	3,440	5.1	9	8,857	8.0	20
5≦G＜6	2,474	2.4	8	1,300	1.9	4	3,400	3.1	8
6≦G＜7	3,160	3.1	9	2,787	4.1	8	5,310	4.8	13
7≦G＜8	755	0.7	2	900	1.3	3	2,450	2.2	4
8≦G＜9	2,186	2.1	5	2,280	3.4	7	5,350	4.8	13
9≦G＜10	4,549	4.5	9	650	1.0	2	1,836	1.7	5
10≦G＜11	7,289	7.1	13	2,590	3.8	5	6,050	5.5	9
11≦G＜12	6,781	6.6	13	8,660	12.8	17	23,475	21.2	39
12≦G＜13	14,241	13.9	28	22,556	33.3	19	23,475	21.2	31
13≦G＜14	869	0.9	3						
14≦G＜15	641	0.6	3						
15≦G＜16	624	0.6	2						
16≦G＜17	323	0.3	1						
17≦G＜18	639	0.6	2						
18≦G＜19	2,250	2.2	2						
19≦G＜20	200	0.2	1						
20≦G＜21	19,059	18.6	11						
Total	102,216	100.0	189	67,793	100.0	120	110,772	100.0	206

Table 2.2 Table of Curve Between Tartous and Al-Sharqia

Curve R (m)	Homs 1 - Tartous			Homs 1 - Mhine			Mhine - Al-Sharqia		
	Length (m)	(%)	No.	Length (m)	(%)	No.	Length (m)	(%)	No.
300≦R＜400	15,542	15.2	42				350	0.3	1
400≦R＜500	5,353	5.2	18	280	0.4	1			
500≦R＜600	1,997	2.0	5				570	0.5	1
600≦R＜700	7,498	7.3	13	3,306	4.9	5	17,840	16.1	27
700≦R＜800									
800≦R＜900				2,105	3.1	3	2,910	2.6	6
900≦R＜1000	276	0.3	1						
1000≦R＜1100	364	0.4	1	522	0.8	1	2,630	2.4	3
1100≦R＜1200									
1200≦R＜1300	4,367	4.3	9	2,045	3.0	3	11,150	10.1	21
1300≦R＜1400									
1400≦R＜1500									
1500≦R＜1600	2,722	2.7	5	1,506	2.2	2			
1600≦R＜1700									
1700≦R＜1800									
1800≦R＜1900	210	0.2	1						
1900≦R＜2000									
2000≦R＜3000	4,264	4.2	4	1,628	2.4	3	1,880	1.7	7
3000≦R＜4000				2,211	3.3	4	280	0.3	1
Curve Total	42,593	41.7	99	13,603	20.1	22	37,610	34.0	67
Straight	59,623	58.3		54,190	79.9		73,162	66.0	
Total	102,216	100.0		67,793	100.0		110,772	100.0	

2.2 Route Alternative between Akkari and Al-Khansa

In the 39.4km section between Akkari and Al-Khansa, the section of 23.9 km (60%) is occupied by the consecutive steep grade and the many sharp curves. The gradient is more than 12‰ with the steepest grade of 20‰ and the most longest section of 20‰ extends for 7.4 km and the radius of curvature is mostly R=300m – 400m.

This will certainly impede the train operation for future increasing traffic and therefore it is planned to alternate the route with less than 12‰ of grade and more than R=600 m radius of curvature.

Alternating route which will be used as Alternative B route in the next chapter is shown in Fig.2.2 and the alignments of the present route are shown in Table 2.3.

Table 2.3 Existing Alignment between Akkari and Al-Khansa

Gradient (‰)	Al-Khansa - Akkari Length (m)	(%)	No.
0≦G＜1	4,321	10.9	9
2≦G＜3	1,261	3.2	2
3≦G＜4	770	1.9	1
4≦G＜5	240	0.6	1
5≦G＜6	790	2.0	2
6≦G＜7	625	1.6	2
8≦G＜9	426	1.1	1
9≦G＜10	405	1.0	1
10≦G＜11	3,457	8.7	5
11≦G＜12	591	1.5	1
12≦G＜13	2,231	5.6	5
13≦G＜14	869	2.2	3
14≦G＜15	641	1.6	3
15≦G＜16	624	1.6	2
16≦G＜17	323	0.8	1
17≦G＜18	639	1.6	2
18≦G＜19	2,250	5.7	2
19≦G＜20	200	0.5	1
20≦G＜21	19,059	48.0	11
Total	39,722	100.0	55

Curve R (m)	Al-Khansa - Akkari Length (m)	(%)	No.
300≦R＜400	15,542	39.1	42
400≦R＜500	5,114	12.9	17
500≦R＜600	1,337	3.4	3
600≦R＜700	459	1.2	3
1000≦R＜1100	364	0.9	1
1200≦R＜1300	372	0.9	2
1500≦R＜1600	571	1.4	1
2000≦R＜3000	1,143	2.9	1
Curve Total	24,902	62.7	70
Straight	14,820	37.3	
Total	39,722	100.0	

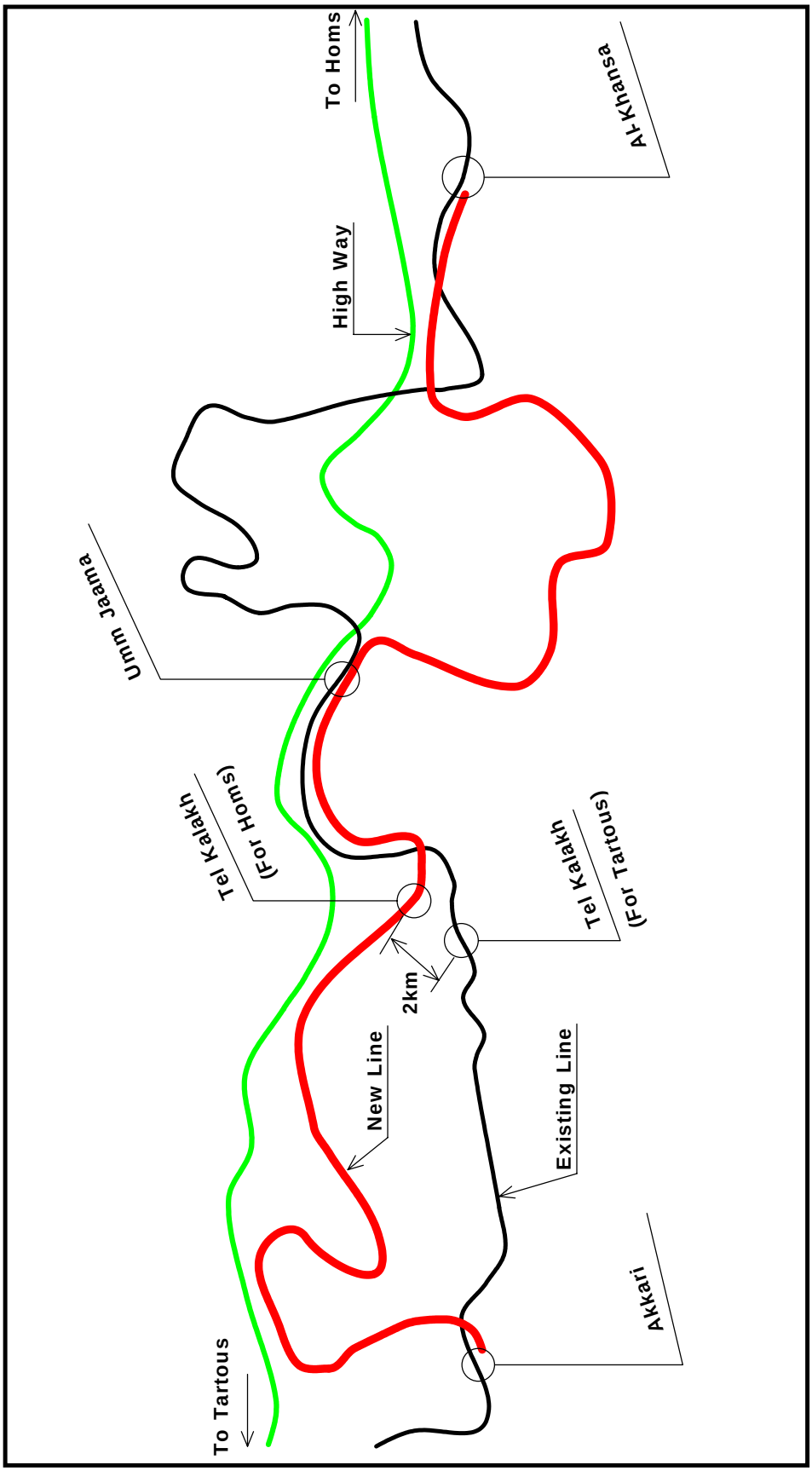


Fig.2.2 Railway Route Between Akkari and Al Khansa

Chapter 3

Setting Up of Alternative Plans

Chapter 3 Setting Up of Alternative Plans

In planning the track addition (double tracking) to cope with the future traffic increase on the section between Akkari and Al Khansa which is causing bottlenecks of transport at present, the two alternatives shown in Table 3-1 are set up.

(1) Setting up of two alternatives

Alternative A

Construction of a second track in parallel with the existing track. The following two cases will be evaluated.

A-1 : transported by one LDE 3200 (traction force, 950t)

A-2 : transported by two LDE 3200 (traction force, 1800t)

Among the above two cases A-1, A-2, the best case will be selected by the overall evaluation and the selected one will be defined as Alternative A.

Alternative B

Construction of a second track separately from the existing track with an improved alignment (Gmax = 12‰, Rmin=600m). Train will be tracted by one LDE 3200 (traction force, 1,800t)

(2) Selection of the optimal alternative

Overall evaluation including economic and financial analysis will be carried out for Alternatives A and B, and the optimal Alternative will be selected which will be used for the final evaluation of Feasibility Study.

Table 3.1 Alternatives for Improvement of Railway Transport between Akkari and Al Khansa

Alternative	Case	Route	Max Gradient	Min Radius	Locomotive	Traction Force
A	A-1	Second track in parallel with the existing track	20 ‰	300m	One LDE 3200	950 t
	A-2	Second track in parallel with the existing track	20‰	300m	Two LDE 3200	1800 t
B	—	Second track separately from the existing track	12‰	600m	One LDE 3200	1800 t

Chapter 4

Traffic Demand Forecast

Chapter 4 Traffic Demand Forecast

Traffic demand of the Master Plan is applied to this Feasibility Study. Assumptions and procedures for demand forecast shall be referred to Chapter 7 of Volume I: Master Plan.

For the With-Case, the demand forecast is the same as that of the M/P as mentioned above.

For the Without-Case, the Project section (Tartous – Homs – Mhine – Al-Sharqia) is assumed to remain as a single track. Under the condition that the Project section remains as a single track, traffic flow over the whole railway network will be different from that of the Master Plan. Namely, traffic flow on some sections may necessitate the double tracking of those sections, which are not necessary to be double-tracked in case of the Master Plan. However it is assumed that such sections should remain as a single track in the same way as the Master Plan.

Demands en route are illustrated in Figures of 4.1, 4.2 and 4.3. Also they are summarized in Table 4.1. Passengers and freights utilizing the Project sections in 2020 are broken down in the form of OD table of major regions and summarized in Table 4.2. Table 4.3 is the breakdown of freight commodity by type in OD form in 2020.

Table 4.1 Summary of Traffic Demand en Route (Maximum Demand in Section)

Section	Passenger (unit: person / day)					Freight (unit: ton / day)				
	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020
Al-Sharqia - Mhine	0	0	830	1,216	1,366	2,969	5,872	12,110	16,926	24,297
Mhine - Homs	357	1,445	2,264	4,172	5,024	5,551	11,029	19,891	32,525	51,267
Homs - Tartous	21	630	1,132	1,608	2,342	4,445	12,942	20,980	30,608	44,988

Table 4.2 OD of Passengers and Freight utilizing the Project sections (2020)

Passenger (person/day)								
	1	2A	2B	2C	3	4	5	Total
1	0	0	5	296	1,284	53	64	1,702
2A	0	0	0	0	0	0	0	0
2B	5	0	0	1	5	0	8	19
2C	296	0	1	0	182	29	156	664
3	1,284	0	5	182	0	566	685	2,722
4	53	0	0	29	566	0	50	698
5	64	0	8	156	685	50	0	963
Total	1,702	0	19	664	2,722	698	963	6,768
Freight Total (ton/day)								
	1	2A	2B	2C	3	4	5	Total
1	0	0	35	3,396	1,503	227	27	5,188
2A	231	0	5	12,687	564	408	59	13,954
2B	1,849	0	0	2,933	2,926	148	369	8,225
2C	8,350	0	223	0	6,723	8,764	37	24,097
3	2,573	0	61	1,886	0	4,882	669	10,071
4	1,276	0	25	1,933	4,447	0	247	7,928
5	280	0	5	412	945	107	0	1,749
Total	14,559	0	354	23,247	17,108	14,536	1,408	71,212

Note:

Region 1: Deir el-Zor and its surroundings
Region 2A: Al Sharqie – Mhine
Region 2B: Mhine – Homs
Region 2C: Homs – Tartus
Region 3: Damascus and its surroundings
Region 4: Aleppo/Hama and their surroudings
Region 5: Lattakia and its surroundings

Table 4.3 OD of Freight utilizing the Project sections by Commodity Type (2020)

Petroleum (ton/day)								
	1	2A	2B	2C	3	4	5	Total
1	0	0	0	1,188	207	0	0	1,395
2A	0	0	0	0	0	0	0	0
2B	1,744	0	0	2,859	2,855	0	340	7,798
2C	4,245	0	96	0	3,511	5,215	0	13,067
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
Total	5,989	0	96	4,047	6,573	5,215	340	22,260
Construction Material (ton/day)								
	1	2A	2B	2C	3	4	5	Total
1	0	0	1	176	306	139	18	640
2A	81	0	3	65	74	126	23	372
2B	32	0	0	24	28	48	10	142
2C	1,149	0	55	0	1,381	1,468	1	4,054
3	2,049	0	46	1,410	0	3,786	518	7,809
4	828	0	15	1,207	2,930	0	143	5,123
5	207	0	0	278	691	0	0	1,176
Total	4,346	0	120	3,160	5,410	5,567	713	19,316
Phosphate (ton/day)								
	1	2A	2B	2C	3	4	5	Total
1	0	0	0	0	0	0	0	0
2A	0	0	0	12,524	401	0	0	12,925
2B	0	0	0	0	0	0	0	0
2C	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
Total	0	0	0	12,524	401	0	0	12,925
Wheat (ton/day)								
	1	2A	2B	2C	3	4	5	Total
1	0	0	15	1,356	447	0	0	1,818
2A	0	0	0	0	0	0	0	0
2B	3	0	0	6	1	0	1	11
2C	28	0	0	0	28	21	6	83
3	9	0	0	70	0	55	9	143
4	94	0	1	208	300	0	18	621
5	4	0	0	6	15	3	0	28
Total	138	0	16	1,646	791	79	34	2,704
Others (ton/day)								
	1	2A	2B	2C	3	4	5	Total
1	0	0	18	677	544	88	9	1,336
2A	150	0	3	98	89	281	36	657
2B	70	0	0	44	41	101	18	274
2C	2,927	0	72	0	1,802	2,061	30	6,892
3	515	0	14	407	0	1,041	142	2,119
4	354	0	8	518	1,217	0	85	2,182
5	70	0	5	128	239	105	0	547
Total	4,086	0	120	1,872	3,932	3,677	320	14,007

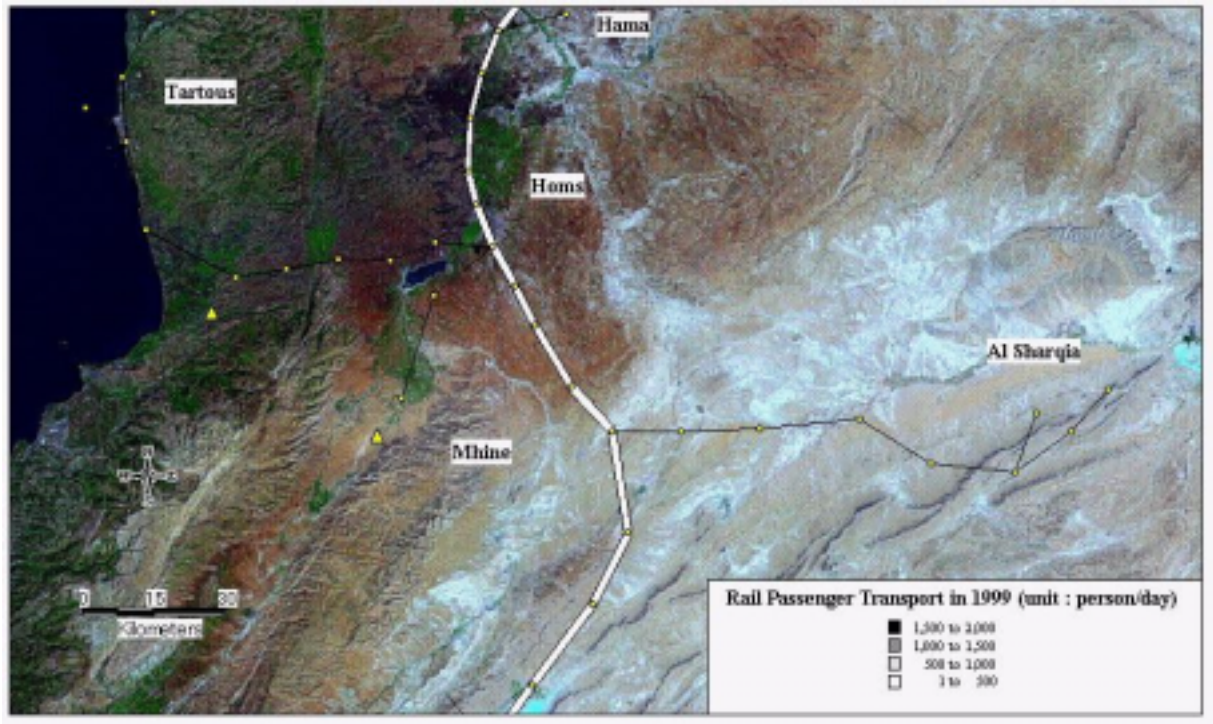


Figure 4.1(1) Traffic Demand en Route in 2000 (Passenger)

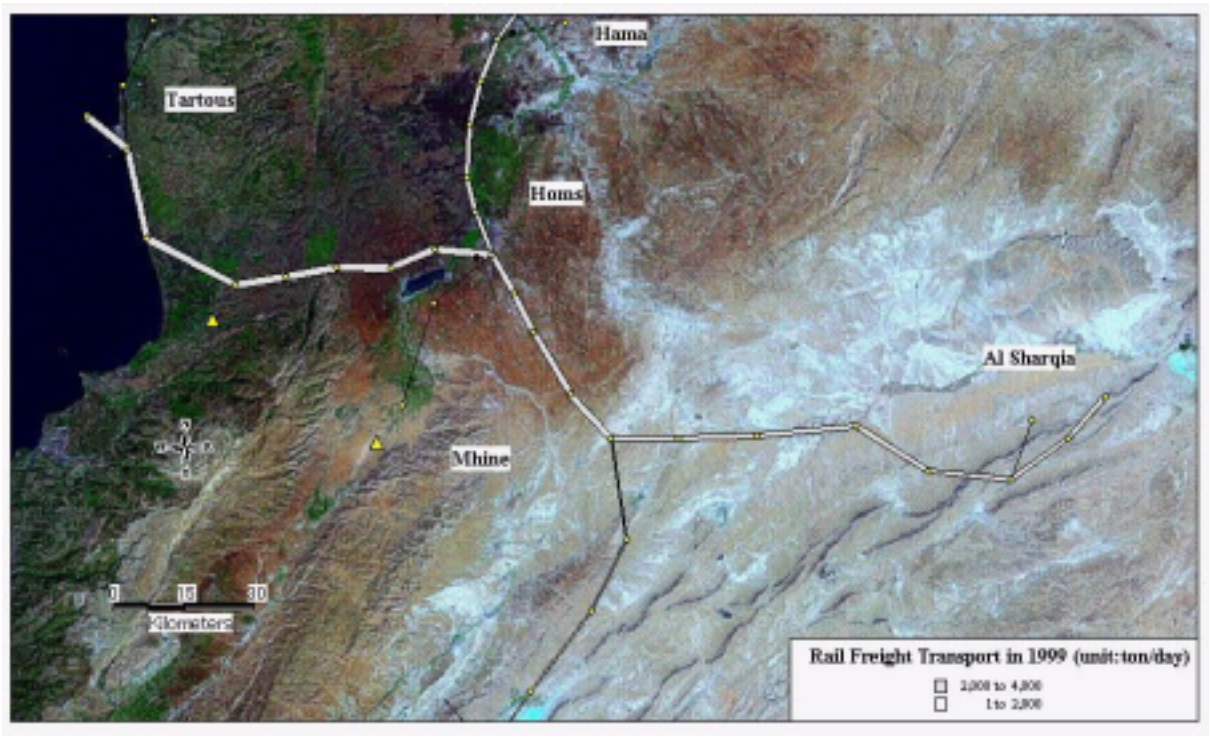


Figure 4.1(2) Traffic Demand en Route in 2000 (Freight)