社会開発調査部報告書

THE STUDY ON THE ROAD DEVELOPMENT PROJECT IN THE SULTANATE OF OMAN FINAL REPORT

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF COMMUNICATIONS
THE SULTANATE OF OMAN

THE STUDY ON THE ROAD DEVELOPMENT PROJECT IN THE SULTANATE OF OMAN FINAL REPORT

VOLUME II: FEASIBILITY STUDY ON CONSTRUCTION OF FLYOVERS AND PEDESTRIAN UNDERPASSES

JANUARY 1995

VOLUME II: FEASIBILITY STUDY ON CONSTRUCTION OF FLYOVERS AND PEDESTRIAN UNDERPASSES JANUARY

PACIFIC CONSULTANTS INTERNATIONAL
FUKUYAMA CONSULTANTS INTERNATIONAL

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF COMMUNICATIONS
THE SULTANATE OF OMAN

THE STUDY
ON
THE ROAD DEVELOPMENT PROJECT
IN THE SULTANATE OF OMAN
FINAL REPORT

VOLUME II:
FEASIBILITY STUDY ON CONSTRUCTION OF FLYOVERS AND PEDESTRIAN UNDERPASSES

JANUARY 1995

PACIFIC CONSULTANTS INTERNATIONAL
FUKUYAMA CONSULTANTS INTERNATIONAL

NOTE

The following exchange rate was adopted through this report:

US$1.00 = R.O 0.385 = Yen 99.6 (September 1994)

PREFACE

In response to a request from the Government of the Sultanate of Oman, the Government of Japan decided to conduct a Feasibility Study on THE ROAD DEVELOPMENT PROJECT IN THE SULTANATE OF OMAN and entrusted the study to the Japan International Cooperation Agency (JICA).

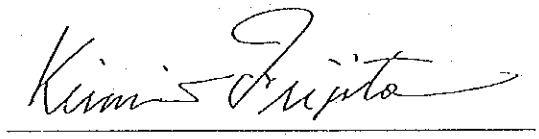
JICA sent a study team to the Oman between February 1994 and October 1994. The study team was headed by Mr. Satoshi WATABE and composed of members of Pacific Consultants International and Fukuyama Consultants International.

The team held discussions with the officials concerned of the Government of Oman, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Sultanate of Oman for their close cooperation extended to the team.

January 1995



Kimio FUJITA
President
Japan International Cooperation Agency

January 1995

Mr. Kimio FUJITA
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita

Letter of Transmittal

We are pleased to submit you the study report on the Road Development Project in the Sultanate of Oman. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the formulation of the above mentioned project. Also included are comments made by the Ministry of Communications, the Sultanate of Oman during technical discussions on the draft final report which were held in Muscat.

This report presents a scheme for construction of flyovers and pedestrian underpasses and maintenance and rehabilitation study on the existing bridges.

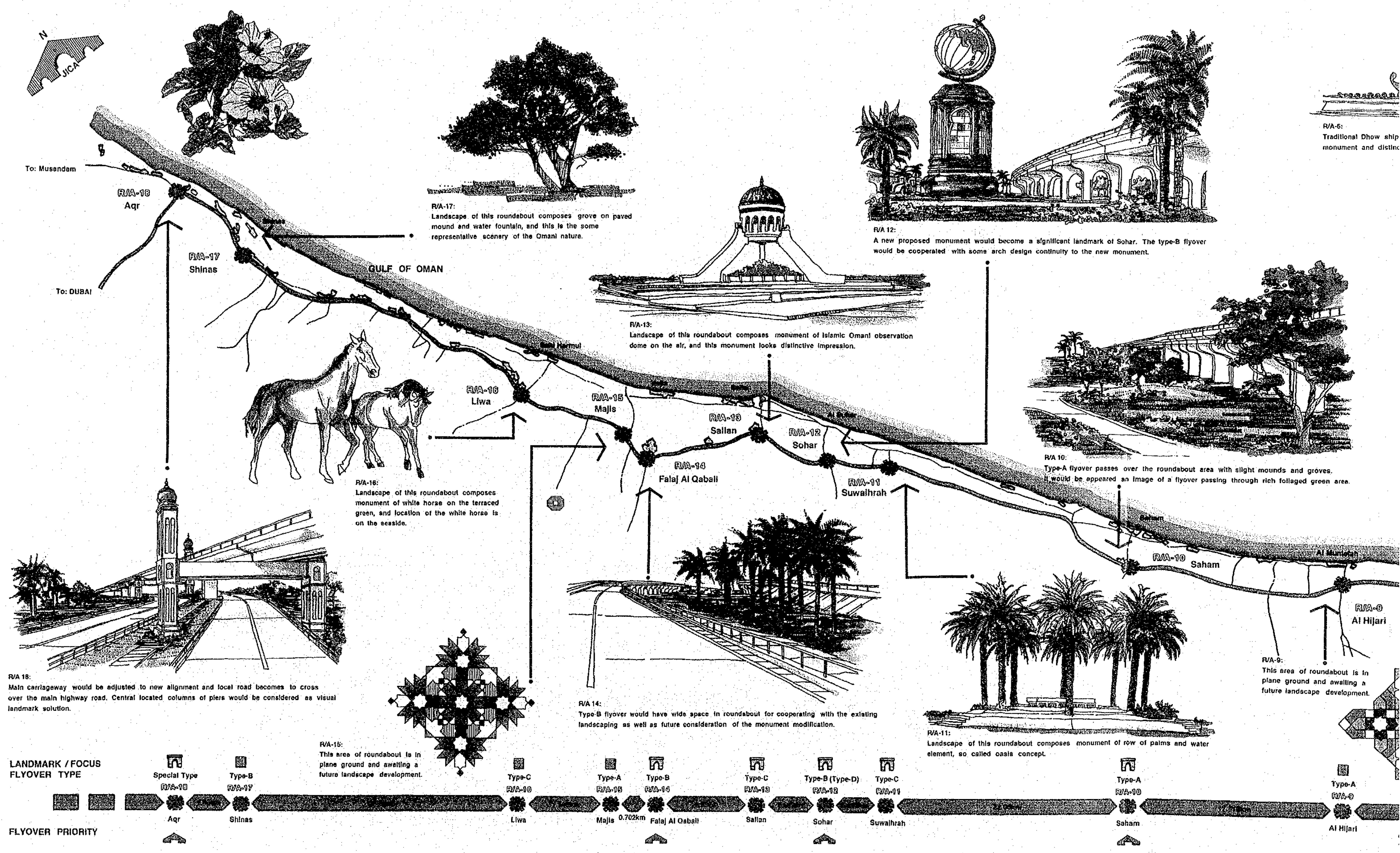
In view of the urgency of the road development plan in the Sultanate of Oman and of need for socio-economic development of Oman as a whole, we recommend that the Sultanate of Oman implement this project as a top priority.

We wish to take this opportunity to express our sincere gratitude to your agency and the Ministry of Foreign Affairs. We also wish to express our deep gratitude to the officials concerned of Ministry of Communications, the Japanese Embassy at Oman for the close cooperation and assistance extended to us during our investigation and study

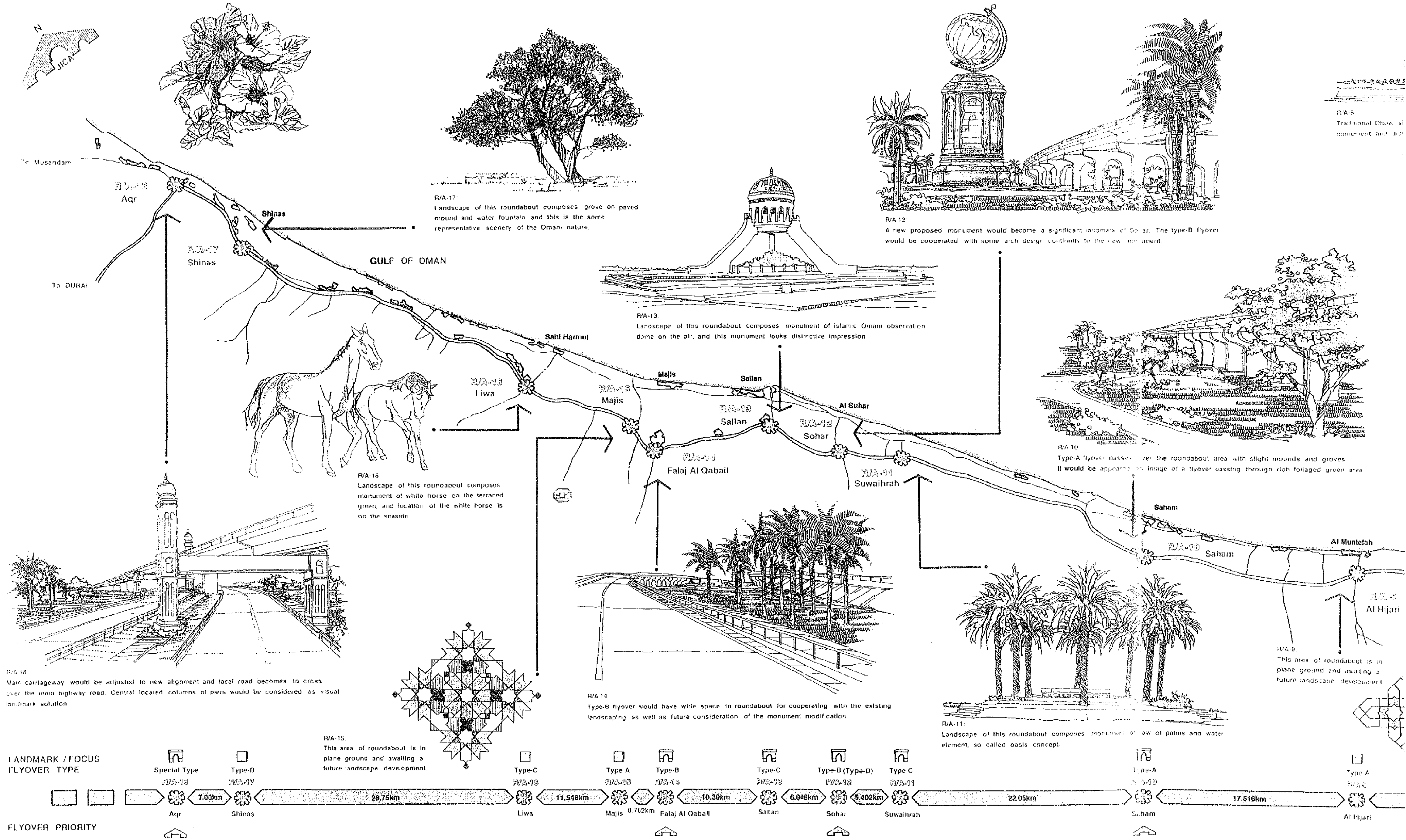
Very truly yours,

Satoshi Watabe
Team Leader
The Study on the Road Development Project
in the Sultanate of Oman

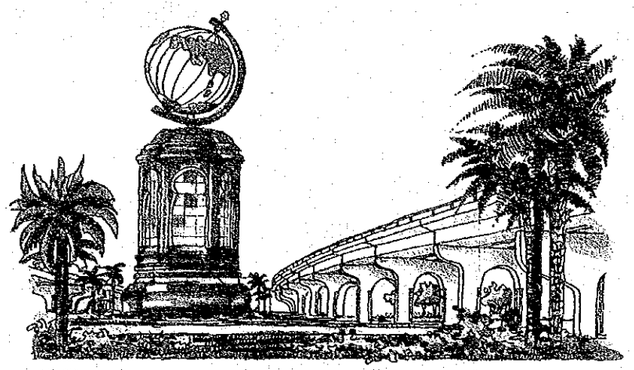
THE STUDY ON ROAD DEVELOPMENT PROJECT
LANDSCAPE PLAN FOR FLYOVERS AND ROUNDABOUTS THROUGH BATINAH HIGHWAY



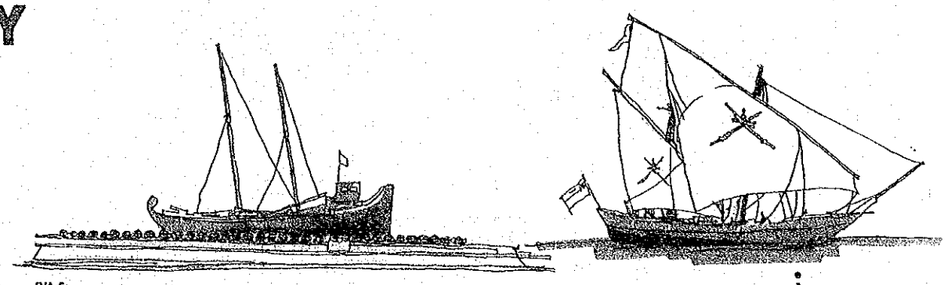
THE STUDY ON ROAD DEVELOPMENT PROJECT
LANDSCAPE PLAN FOR FLYOVERS AND ROUNDABOUTS THROUGH BATINAH HIGHWAY



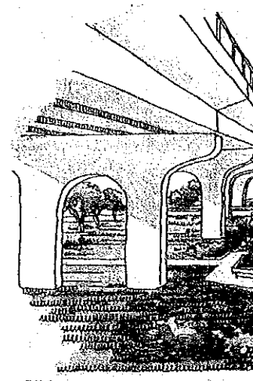
T PROJECT
UTS THROUGH BATINAH HIGHWAY



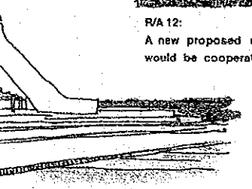
R/A 12:
A new proposed monument would become a significant landmark of Sohar. The type-B flyover would be cooperated with some arch design continuity to the new monument.



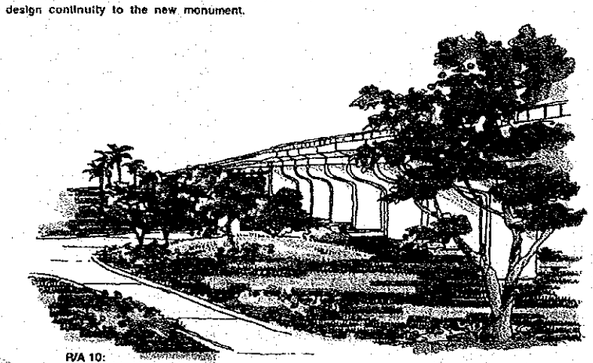
R/A-6:
Traditional Dhow ship on the water concept is considered as a significant symbol monument and distinctive silhouette. It should be preserved with high priority.



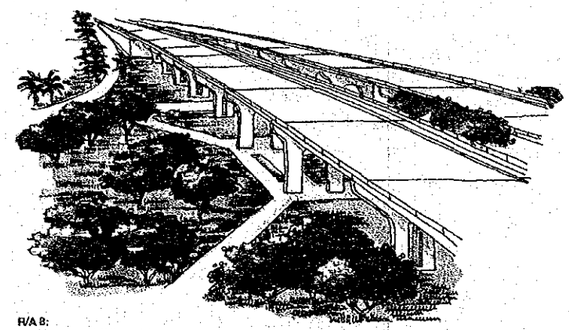
R/A 3:
Existing water fountain would be obse
and the water fountain appears in wh



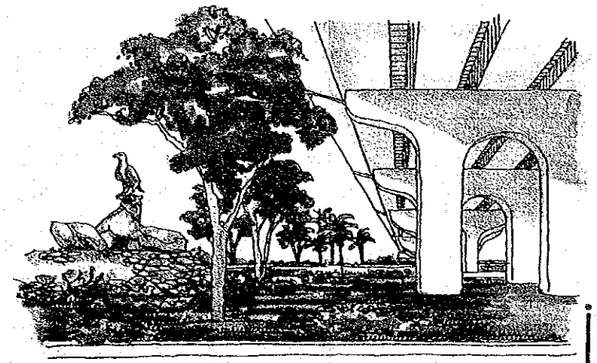
ument of Islamic Omani observation
stinctive impression.



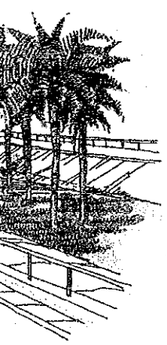
R/A 10:
Type-A flyover passes over the roundabout area with slight mounds and groves.
It would be appeared an image of a flyover passing through rich foliaged green area.



R/A 8:
Type-A flyover would cross over the area of flowering plants, some symbolic large crown trees would be recommended to plant at the central area for emphasizing landscape continuity.

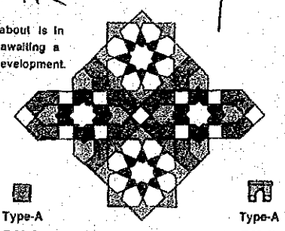


R/A 5:
A new landscape of this area would be organized by reflection of a type-A flyover and relocation of a pair of eagle become a new effective landscape focus.



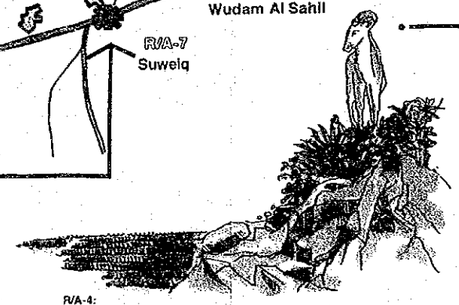
operating with the existing
nt modification.

R/A-11:
Landscape of this roundabout composes monument of row of palms and water element, so called oasis concept.



R/A-9:
This area of roundabout is in plane ground and awaiting a future landscape development.

R/A-7:
This area of roundabout is consisted flower garden on the slight mound, and major objectives are groups of plants.

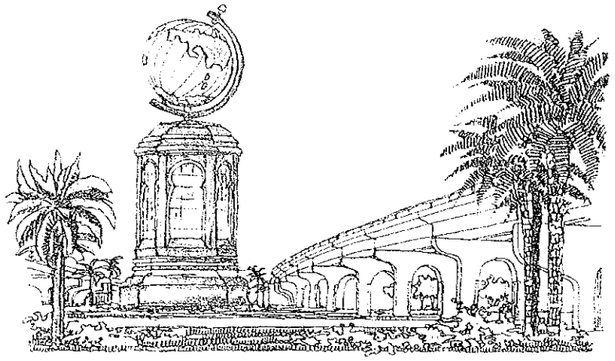


R/A-4:
Rock piled mound with animal sculptures on the flat garden is landscape character of the area, and this landscape concept shall be expreas part of representative Omani natural features.

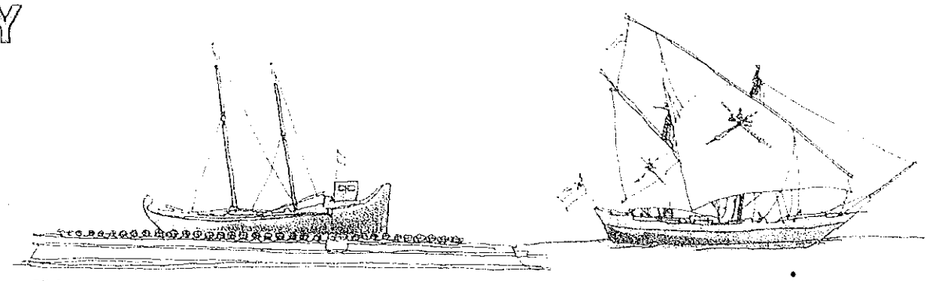
Retaining wall:
Long expanded solid surface of the
of the engrave of traditional patterns

T PROJECT

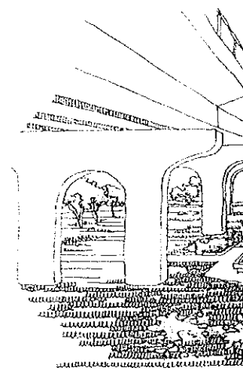
UTS THROUGH BATINAH HIGHWAY



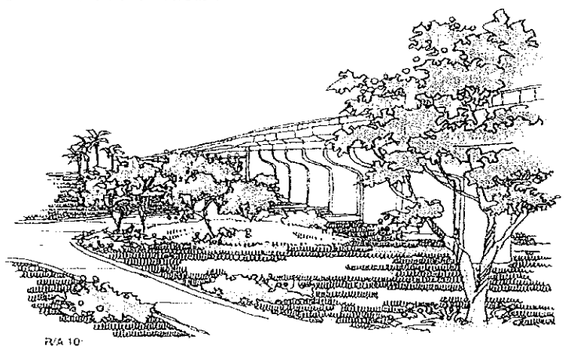
R/A-12
A new proposed monument would become a significant landmark of Sohar. The type-B flyover would be cooperated with some arch design continuity to the new monument



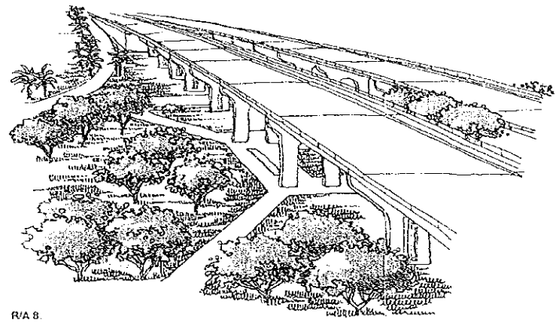
R/A-6
Traditional Dhow ship on the water concept is considered as a significant symbol monument and distinctive silhouette. It should be preserved with high priority



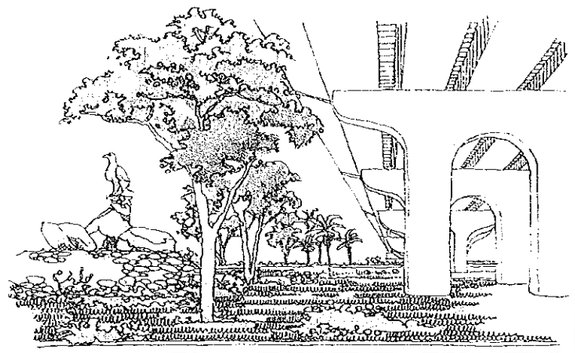
R/A 3
Existing water fountain would be ob
and the water fountain appears in v



R/A 10
Type-A flyover passes over the roundabout area with slight mounds and groves
It would be appeared an image of a flyover passing through rich foliaged green area

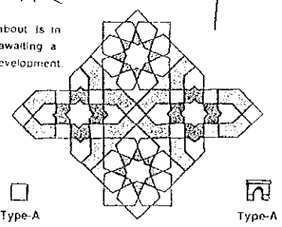


R/A 8
Type-A flyover would cross over the area of flowering plants, some symbolic large crown trees would be recommended to plant at the central area for emphasizing landscape continuity



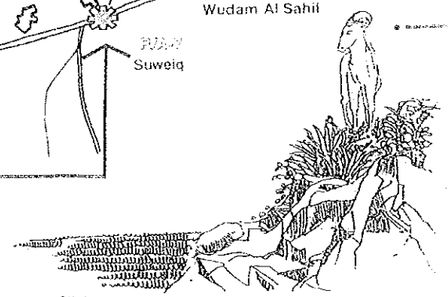
R/A 5
A new landscape of this area would be organized by reflection of a type-A flyover and relocation of a pair of eagle become a new effective landscape focus.

R/A 11
Landscape of this roundabout composes monument of row of palms and water element, so called oasis concept.



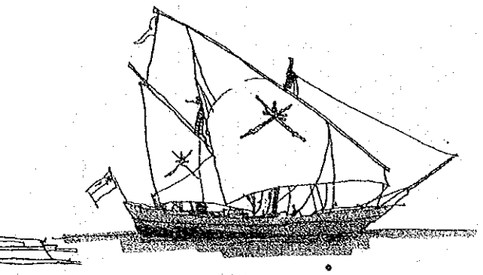
R/A-9
This area of roundabout is in plane ground and awaiting a future landscape development.

R/A-7
This area of roundabout is consisted flower garden on the slight mounds, and major objectives are groups of plants

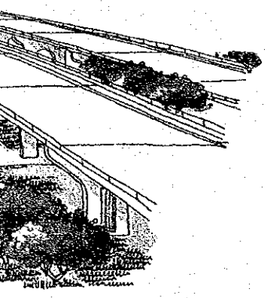


R/A-4
Rock piled mound with animal sculptures on the flat garden is landscape character of the area, and this landscape concept shall be express part of representative Omani natural features

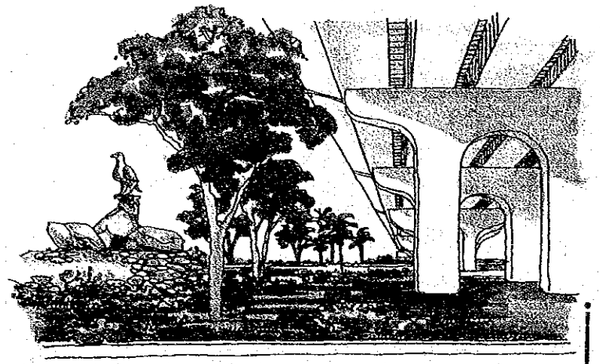
Retaining wall
Long expanded solid surface of t
of the engrave of tradit-nal patte



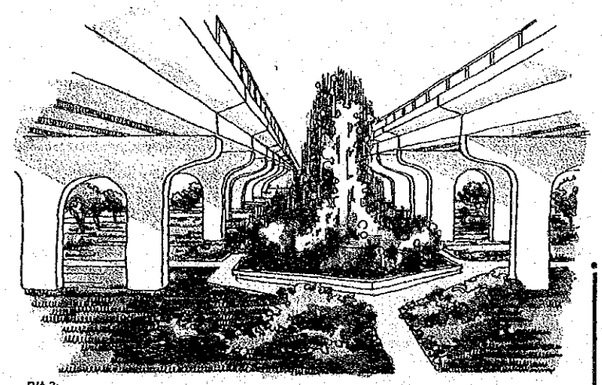
symbol
ity.



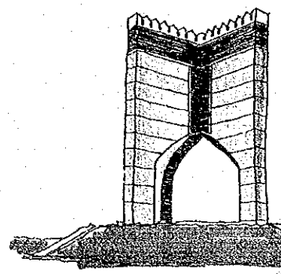
ering plants, some symbolic large crown
ral area for emphasizing landscape



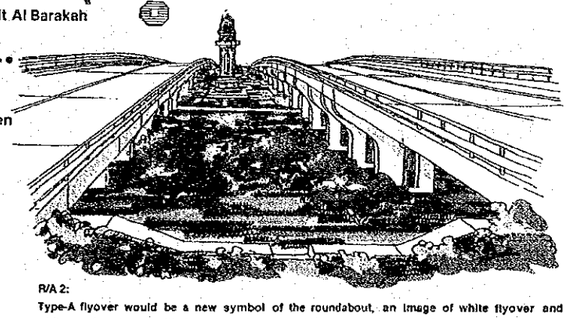
R/A 5:
A new landscape of this area would be organized by reflection of a type-A flyover and relocation of a pair of eagle become a new effective landscape focus.



R/A 3:
Existing water fountain would be observed at opsnings between central piers of the flyover, and the water fountain appears in white and elegant silhouette with arch formed piers.



R/A-1:
Traditional Omani citadel arch gate is considered as a significant monument and distinctive silhouette of the monument should be preserved with high priorit

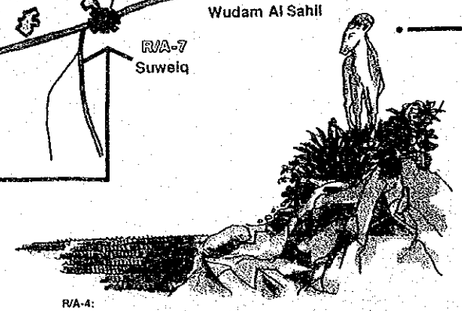


R/A 2:
Type-A flyover would be a new symbol of the roundabout, an image of white flyover and white garden tower with flowering plants would represent Naseem Garden environment.

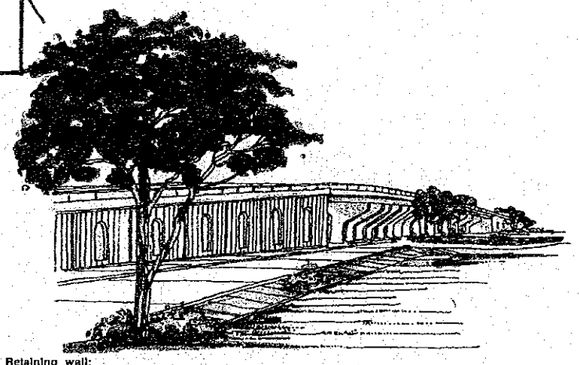
LEGEND

- ROUNDABOUT / JUNCTION
- COMMUNITY & TOWNSHIP
- LANDMARK
- LANDSCAPE FOCUS
- FLYOVER PRIORITY
- INDUSTRIAL ESTATE

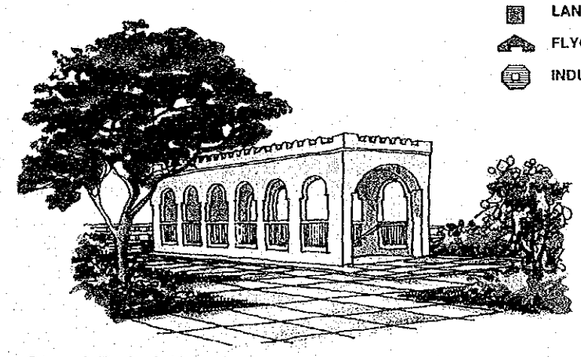
R/A-7:
This area of roundabout is consisted flower garden on the slight mound, and major objectives are groups of plants.



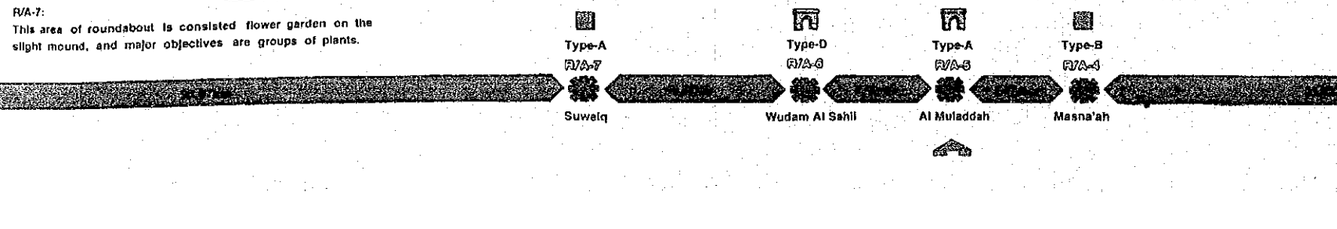
R/A-4:
Rock piled mound with animal sculptures on the flat garden is landscape character of the area, and this landscape concept shall be express part of representative Omani natural features.

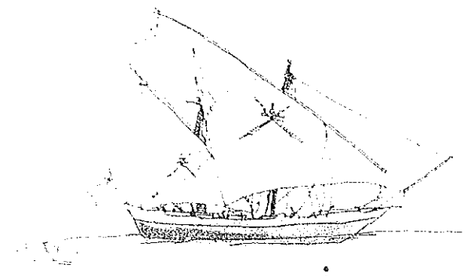


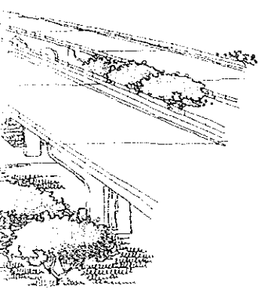
Retaining wall:
Long expanded solid surface of the retaining wall would need familiar features, introduction of the engrave of traditional patterns to the wall would present more harmony and continuity.

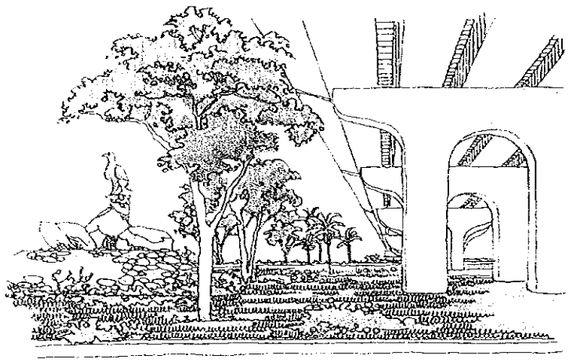


Entrance facility of pedestrian underpass:
Location identification, community amicable and attractive appearance design feature of the entrance facility would encourage peoples to use the pedestrian underpass.



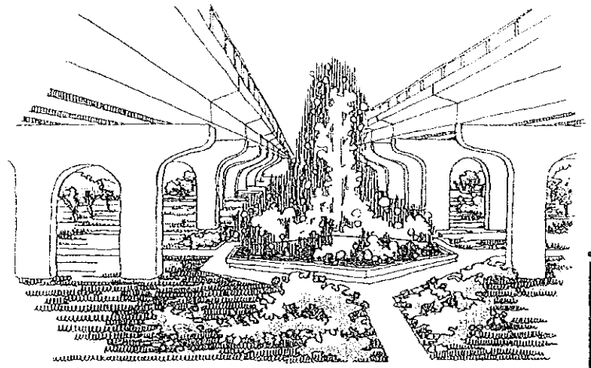






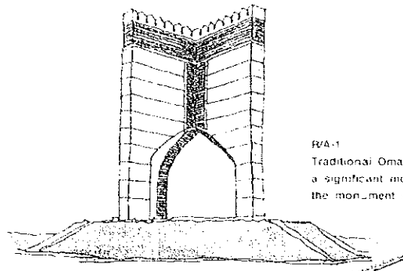
R/A 5

A new landscape of this area would be organized by reflection of a type-A flyover and relocation of a part of eagle become a new effective landscape focus.



R/A 3.

Existing water fountain would be observed at openings between central piers of the flyover, and the water fountain appears in white and elegant silhouette with arch formed piers.



R/A-1

Traditional Omani citadel arch gate is considered as a significant monument and distinctive silhouette of the monument should be preserved with high priority.

R/A 2.

Type-A flyover would be a new symbol of the roundabout, an image of white flyover and white garden tower with flowering plants would represent 'Naseem Garden' environment.

R/A-4

Rock piled mound with animal sculptures on the flat garden is landscape character of the area, and this landscape concept shall be express part of representative Omani natural features.

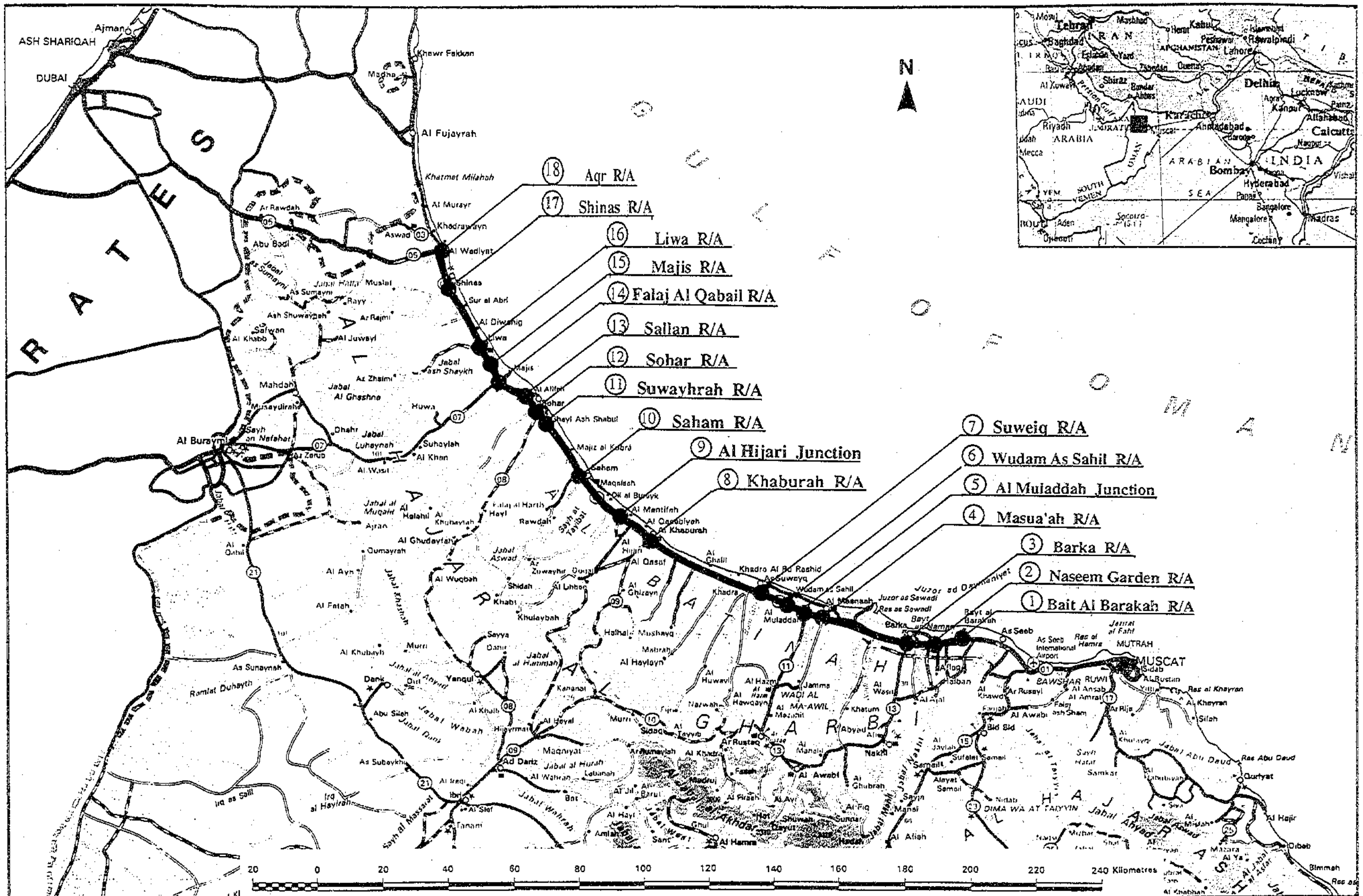
Retaining wall

Long expanded solid surface of the retaining wall would need familiar features. Introduction of the engrave of traditional patterns to the wall would present more harmony and continuity.

Entrance facility of pedestrian underpass

Location identification, community amicable and attractive appearance design feature of the entrance facility would encourage peoples to use the pedestrian underpass.

...roundabout is consisted flower garden on the ... and major objectives are groups of plants.



THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION MAP FOR FEASIBILITY STUDY ON CONSTRUCTION OF FLYOVERS AND PEDESTRIAN UNDERPASSES

SUMMARY

SUMMARY

The Batinah Highway (National Road No. 1) is an expressway (speed limit: 120 km/hr) stretching 274 kilometers from the capital of Muscat along the Gulf of Oman all the way to Khatmat near the United Arab Emirates. The Batinah Highway is positioned as a vital road link connecting Muscat to agricultural regions in the interior and to the neighboring United Arab Emirates.

The Batinah Highway has rotary-type at-grade intersections (roundabouts and junctions) in 18 locations. Monuments and other objects are positioned within the rotaries for scenic effect for the benefit of vehicle occupants and local residents. Nevertheless, while the highway is designed for a maximum speed of 120 km/h, an almost complete absence of grade separations forces local residents to walk across the road. As a result, there are constant pedestrian accidents involving vehicles travelling at more than 100 km/h. For the residents of villages divided by the highway, crossing over to the other side can be a dangerous undertaking. The construction of flyovers and pedestrian underpasses along the Batinah Highway is an urgent task for the Sultanate of Oman in the interests of public safety and smooth traffic flow.

Furthermore, while the Batinah Highway has few bridges itself, there are many bridges on trunk roads also along secondary roads, which link the interior to the Batinah Highway. Most of these bridges were built in the 1970s and after, and design loads are unclear for many of them. There are currently 58 bridges (44 reinforced-concrete bridges, 12 pre-stressed concrete bridges and 2 structural steel bridges) maintained by the Directorate General of Roads (DGR). With an increase in traffic volume accompanying the economic development of the Sultanate and a greater number of heavy vehicles, the deterioration of these bridges is proceeding more rapidly than expected. In relation to the Sultanate's roadway development program, the maintenance of existing bridges is of equivalent importance to the construction of new ones. Here, the DGR is hurrying to formulate a general maintenance and rehabilitation plan that includes routine inspections and examinations, determinations of load bearing capacity and measures for maintenance and rehabilitation.

To resolve these problems, the Sultanate of Oman, believing that the development of roadways as an important infrastructural element for conveyance and transport is a basic

requirement for domestic economic growth, has requested that the government of Japan perform the following:

- Feasibility Study on the Construction of Flyovers and Pedestrian Underpasses along the Batinah Highway
- Maintenance and Rehabilitation Plan for Bridges (DGR to select nine bridges as model cases)

In response, the Japanese government dispatched a study team to Oman in February 1994 to conduct a study. Presented below are the findings of the Study. The Sultanate of Oman is currently studying these results with the intent of incorporating them in the 5th Five Year Plan to be implemented in 1996.

(1) Feasibility Study on the Construction of Flyovers and Pedestrian Underpasses

1) Future Traffic Volume and Socio-economic Framework

Traffic volume in the Batinah district is high at about 20,000 vehicles per day. This demonstrates the attracting power of Muscat, the capital. An analysis of the socio-economic framework of this area leads to the forecast that, by 2010, the population of Batinah area will reach 808,000 and the number of registered vehicles will increase 3.6 times to 975,000. Traffic volume is also forecast to increase by about three times from the present 69,700 vehicles to 210,000 vehicles by that time. Considering the likely apportionment of this traffic onto the Batinah Highway, it becomes apparent that, in areas with much traffic influx from roundabouts and junctions, traffic volume will become excessive and traffic demand will exceed the level at which it can be efficiently handled.

Consequently, to assure a smooth traffic flow well into the future, it is necessary to promptly construct flyovers for major roads and, in addition, take measures to assure pedestrian safety.

2) Design Outline of Flyovers

The following design standards are applied in the design of the highway and ramps.

Highway design speed:	120 km/h
Ramp design speed:	80 km/h
Bridge design:	Design load to be twice that of AASHTO HS-20; 60-ton truck load
Superstructure:	Simple box-beam bridge of pre-stressed concrete
Substructure:	Abutment; Reinforced-concrete inverted-T-type
	Pier; Same as above or rigid frame π shape
Standard span:	20 ~ 30 m
Foundation:	Reinforced-concrete piles 500 x 500

3) Pedestrian Underpass

The pedestrian underpasses are to be used by residents along the Batinah Highway in fairly specific areas. For this reason, we selected 40 candidate sites by considering village land area and the presence of facilities with much pedestrian traffic, such as schools, public buildings and mosques. From these 12 priority sites were selected for underpasses.

The internal dimension of these underpasses is to be 3m x 3m per design specifications for underpasses already in place within the Sultanate.

4) Environmental Impact and Aesthetics

Environmentally speaking, while there will be some impact on the environment during the construction of the facilities, there will be no fundamental, lasting impact. As for aesthetics, there are already a variety of monuments placed alongside the road and the construction of flyovers at crossings will produce some visual obstructions. For this reason a type judged to be the most aesthetically pleasing was selected for each roundabout. In the design stage, work was conducted to assure the visual attractiveness of the superstructure, substructure and retaining walls.

5) Project Cost

Project cost for 8 roundabouts and 12 pedestrian underpasses were calculated based on 1994 project cost. As a general figure, each roundabout will require about 1 to 1.2 billion yen; each pedestrian overpass, about 30 million yen.

6) Economic Evaluation

As for the economic analysis, benefits resulting from a change in traffic flow which are brought about by the construction of flyovers, the cash flow method was used to calculate the economic internal rate of return, the net present value and the cost-benefit ratio. The economic internal rate of return (EIRR) was found to equal 12.9; the net present value (NPV), RO 2,146,000; and the cost-benefit ratio (B/C), 1.09. This shows that the project is economically feasible.

Economic Cost*	Benefit*	EIRR (%)	B/C	NPV*
23,848	25,994	12.9	1.09	2,146

* in thousands R.O.

As for the construction of pedestrian underpasses, an analysis of construction costs and traffic functions showed that this aspect would not be entirely economically feasible. However, in consideration of pedestrian safety, the implementation of this part of the project will certainly prove beneficial for those living along the Batinah Highway.

Economic Cost*	Benefit*	EIRR (%)	B/C	NPV*
1055	915	10.4	0.87	-140

7) Conclusions and Recommendations

Converting roundabouts into flyovers would enhance traffic-related functions and reduce accidents. Likewise, construction of pedestrian underpasses would have great impact on the social and economic development of communities along the highway by making it easier to cross the road, thereby strengthening the community bonds among those residents and also reducing traffic accidents. Because the construction of flyovers is economically feasible in terms of the national economy, we recommend that this be carried out beginning with those expecting the most congestion. The pedestrian underpasses cannot be called economically feasible, but it is desirable in terms of traffic safety that this aspect of the project also be implemented.

Another benefit arising from the execution of this project is that the linkage between cities will be reinforced, thereby contributing to the development of an

economic sphere and to be strengthening of ties with neighboring countries. Furthermore, the new social and economic ties that will form among the areas that straddle the Batinah Highway will lead to a sense of unity among the villages and promote wide-scale development.

It will be necessary to conduct the detailed design in consideration of economic feasibility and aesthetics after full consideration of the present situation in Oman, its facilities, and capability in construction. At the same time, one must consider the importance of the Batinah Highway as an important route of the Arabian peninsula when considering the bridging of Irish crossings, the use of box culverts and/or the supplying of a flood-warning system.

(2) Maintenance and Rehabilitation Plan for Bridges

On occasion of the formulation of a bridge maintenance and rehabilitation plan, we conducted inspections and loading tests to determine the degree of soundness of existing bridges. The results are outlined below.

1) Inspections

To determine the soundness of each bridge covered by this survey, investigation of bridge condition, construction condition, cracks, concrete quality and reinforcing bar condition were conducted for the superstructure, the substructure and the foundation. The results were compiled on a damage list for each bridge.

2) Loading Tests

Loading tests were carried out for all of the applicable bridges by first selecting the most deteriorated span on each bridge, loading a test vehicle on that span and then measuring the resultant strain, deflection, crack, etc. The results were compiled on the lists and used as indices for determining the degree of soundness.

3) Conclusion

The soundness of the bridges was judged from the results of the above tests. As for the reinforced-concrete bridges, almost all the main girders and deck slabs had structural cracks. As for the pre-stressed concrete bridges, each

had deterioration-related problems caused by structural defects. The bridge most damaged was cited as requiring prompt action because of an especially low degree of soundness, and the necessary repairs and maintenance were performed in 1994 by the DGR in accordance with its maintenance, and rehabilitation plans. Currently, none of the other bridges require immediate action, although it is desirable that action be taken in order of bridge deterioration per the maintenance and rehabilitation plan formulated by the study team.

4) Recommendations

We recommend that action be taken as below with regards to the maintenance and administration of existing bridges and of bridges to be built.

- Provision of axle load restrictions (weight restriction signs) for vehicles passing over the bridge
- Levelling of deck surface (pavement repair)
- Repair of cracks (mortar injection)
- Reinforcement and repair of structural defects (recasting of slabs, installation of cross beams)
- Establishment of a maintenance and rehabilitation system
- Filing construction records and inspection records
- Storage of as-built drawings and design drawings

CONTENTS

LIST OF TABLES

Chapter 14

Chapter 15

LIST OF FIGURES

Chapter 1

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Chapter 10

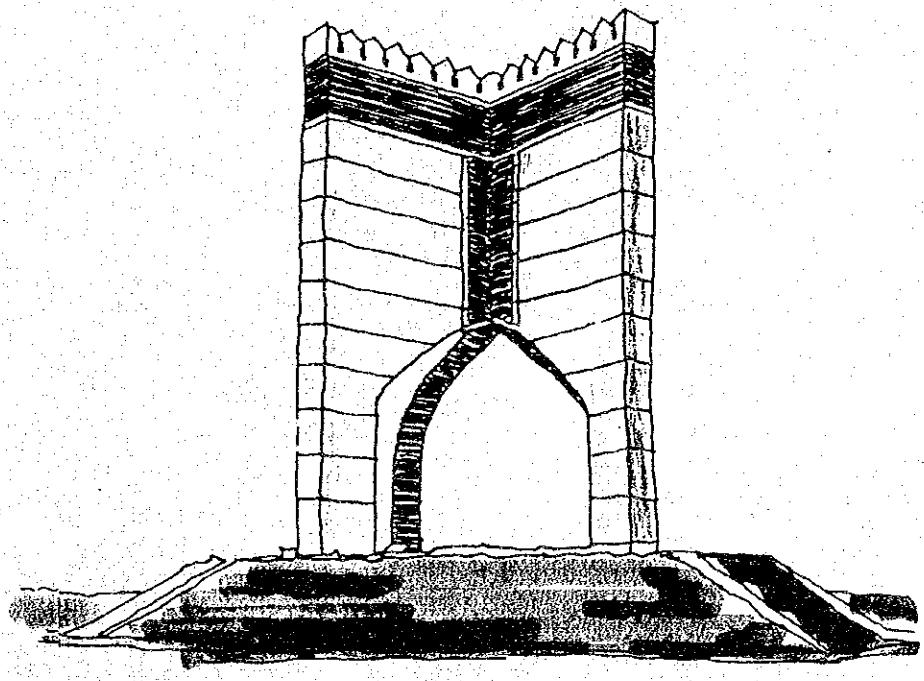
Chapter 12

Chapter 14

ABBREVIATION

AAGR	Annual Average Growth Rate
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
AADT	Annual Average Daily Traffic
B/C	Benefit Cost Ratio
BS	British Standard
CTP	Central Transportation Planning
Cm3	Cubic Centimeter
Cm2	Square Centimeter
Dia. or ø	Diameter
DGR	Directorate General of Roads
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
EL	Elevation
F/S	Feasibility Study
GDP	Gross Domestic Product
HUC	Highway User Cost
J/C	Junction
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
Kg	Kilogram
Km	Kilometer
LS	Lump Sum
mm	Millimeter
MOC	Ministry of Communication
MOD	Ministry of Defense
N.E.O	No Environmental Objection
NPV	Net Present Value
OD	Origin and Destination
PC	Pre-stressed Concrete
PCU	Passenger Car Unit
PD	Project Description
PDO	Petroleum Development of Oman
PU	Pedestrian Underpass
R/A	Roundabout
RC	Reinforcement Concrete
RO	Oman Rial
RTIM	Road Transport Investment Model
SD	Site Description
S/W	Scope of Work
U.A.E.	United Arab Emirates
V/C	Volume Capacity Ratio

CHAPTER 1 INTRODUCTION



CHAPTER 1

INTRODUCTION

1.1 Background of Study

The Sultanate of Oman is located in the south-east corner of Arabia peninsula between 16 degrees and 26 degrees north latitude and between 52 degrees and 60 degrees east longitude, and is bordered by the United Arab Emirates, Saudi Arabia, and Yemen. It occupies 300,000 square kilometers (approximately 3/4 of Japan).

The country is broadly divided into north, central, and south Oman. The north includes a coastal region and an interior region on opposite sides of the Hajar Mountains that run roughly parallel to the coast. The Batinah Plain, the most fertile part of the Sultanate, occupies the land between the ocean and the Hajar Mountains. The capital of Oman is Muscat, a city standing at the eastern end of the Batinah Plain. The central part of Oman is a vast desert where most of Oman's natural gas and petroleum is produced. In the south part of the Sultanate, an area known as the Dhofar region, three mountain ranges divide the Salalah Plain, a mixed agricultural and desert region.

The climate varies between regions, but summer on the coast is hot and humid, with severe heat in excess of 45 degrees Celsius continuing for days at a time between June and August. The climate is more bearable from November to February.

The approximately 2 million inhabitants of Oman include Arabs, Baluchi, and Zanzabari, and about 540,000 foreign workers.

(1) The Condition of Roads in the Sultanate of Oman

Because there are no railways in Oman, the country's road system is an important part of its infrastructure. The roads are constructed and maintained by the Directorate General of Roads of the Ministry of Communications.

The first stage of road-construction implemented in Oman was the construction of a road linking the capital Muscat with Seeb International Airport, followed by the construction of roads connecting the capital with regional cities (Salalah, Sur, Nizwa, etc.).

The second stage of roadway construction was the construction of a network of major roads linking Oman with neighboring countries (the United Arab Emirates, Republic of Yemen, etc.).

Between 1970 and 1989, a total of 4,553 kilometers of paved roads and 20,147 kilometers of unpaved roads were constructed in Oman. The fourth Five-year Development Plan (1991 to 1995) which is now being implemented, calls for the construction of 4,338 kilometers of roads that will provide road networks in agricultural areas and link communities on the Batinah Coast with inland towns.

(2) The Batinah Highway and Its Peripheral Roads: Problems and Improvement Plans

The Batinah Highway (National Highway No. 1) is an expressway (speed limit: 120 km/h) stretching 274 kilometers from the capital of Muscat along the Gulf of Oman all the way to Khatmat near the United Arab Emirates.

In the coastal region of the northern part of the Sultanate of Oman bordered by the Hajar Mountains, the farmers specialize in the production of cash crops, while in the interior beyond the mountains, date palms are cultivated. The Batinah Highway that links the capital Muscat and the surrounding countryside with the neighboring United Arab Emirates is one of the most important roads in Oman.

In an approximately 250 kilometer section of this highway extending from Bait Al Barkah to Khatmat and Milahah but excluding that part within the city of Muscat, there are a total of 18 roundabouts and junctions. Monuments built inside the rotaries delight pedestrians. The Batinah Highway is an expressway, but because it has almost no grade separation, pedestrians have to walk across the expressway surface. With many cars travelling on the highway at speeds in excess of 100 km/h, car-pedestrian accidents are common. For the people living in villages divided by the highway, crossing to the other side is a perilous undertaking.

There are few bridges on the Batinah Highway, but many have been constructed on the trunk roads linking from inland to Batinah Highway and secondary roads. A large number of these are concrete bridges (RC bridges, PC bridges) built during and after the 1970s, but there exist bridges which design condition is not clear. These bridges are deteriorating together with the increase of the traffic volume and the number of heavy vehicles as a result of the economic development of Oman.

There are two major problems plaguing the Batinah Highway and peripheral highways.

- Pedestrian safety
- Deterioration of bridges

The Sultanate of Oman is now implementing its fourth Five-year Development Plan; policies established to release the nation from dependency on petroleum and to promote Omanization.

In accordance with the fifth Five-year Development Plan due to start in 1996, the Directorate General of Roads of the Ministry of Communications (body responsible for the provision of roadways in the Sultanate of Oman) will resolve the first of these problems by implementing a policy of isolating pedestrians from vehicle traffic by the construction of flyovers at approximately eight high-priority locations among the 18 roundabouts and junctions on the Batinah Highway, and constructing pedestrian underpasses at about 40 locations where this highway divides villages.

Inland bridges are expected to continue deteriorating. There are hundreds of bridges in the Sultanate of Oman, and the maintenance of those on major roads is as important a part of the country's road improvement plans as the construction of new bridges. The Directorate General of Roads conducted a bridge survey and a series of bridge inspections in order to quickly establish comprehensive maintenance and rehabilitation plans: studies to determine the load bearing capacity of the bridges, needed maintenance and rehabilitation, and so on. The fifth Five-year Development Plan will incorporate nine bridges as model cases.

The government of the Sultanate of Oman believes that to develop its national economy, it must improve its road system: a key part of its transportation

infrastructure. To resolve the problems described above, the Sultanate of Oman requested the Government of Japan to carry out the following study.

- A feasibility study concerning construction of grade-separated facilities to separate pedestrians from motor vehicle traffic by converting rotaries on the Batinah Highway to flyovers and by building pedestrian underpasses at points where pedestrians now walk across the surface of the highway.

- The establishment of maintenance and rehabilitation plans for principal bridges.

1.2 Purpose of the Survey

In accordance with the conditions described above and in response to a request from the Sultanate of Oman, the Study will be carried out to achieve the following goals.

(1) To carry out a feasibility study of the construction of flyovers (18 locations) and pedestrian underpasses (40 locations) on the Batinah Highway located along the northern coast of the Sultanate of Oman, in order to guarantee a smooth flow of road traffic and improve road safety.

(2) Carry out inspections and examinations and loading tests of nine principal existing bridges.

(3) Establish maintenance and rehabilitation plans for the existing bridges referred to in (2) above.

1.3 Survey Area

The Study is to be conducted in the following regions.

(1) Feasibility Study on the Construction of Flyovers and Pedestrian Underpasses

At 18 roundabouts and junctions and at 40 locations selected for pedestrian underpasses on the Batinah Highway (Seeb to Aqr, approximately 250 km) along the coast in the north part of the Sultanate of Oman.

(2) Maintenance and Rehabilitation Study on Nine Existing Bridges

Bridge maintenance and rehabilitation plans are to be prepared for nine representative bridges selected as model cases in advance by the Government of Oman.

1.4 Study Schedule

This study consists of PART A, Feasibility Study on construction of flyover and pedestrian underpasses, and of PART B, Maintenance and Rehabilitation Study on Nine Existing Bridges. The detailed work items and schedule are described in Fig. A.1 Study Flow Chart.

According to the submission of reports, study contents and progress in each step were explained below:

PART A:

Report	Contents and Progress
Inception Report	• The Study has been commenced in January, 1994. • Study method and schedule were established and Inception Report was prepared. • The contents of Inception Report were explained to the Omani Counterparts and were mutually agreed upon.
Progress Report	• First Stage Field Survey was conducted between February and March, 1994 including data collection, traffic survey, environmental survey etc. • The results were summarized in Progress Report. The Report was explained and mutually agreed upon at the end of March, 1994.
Interim Report	• The conceptual design was conducted in Japan according to the results of first stage field survey between April and May, 1994. • The locations of eight roundabouts and ten pedestrian underpasses were determined after the discussion with the Omani counterparts.

Draft Final Report	• Second Stage Field Survey was conducted between June and July, 1994 including topographic survey and soil investigation and additional data collection etc. • The preliminary design was conducted in Japan regarding the selected roundabouts and pedestrian underpasses. • The results of study were summarized in Draft Final Report.

PART B:

Report	Contents and Progress
Inception Report	• Same as PART A
Progress Report	• First Stage Field Survey was conducted between February and March, 1994. • Inspection and examination and loading tests were conducted for four RC bridges. • The test data were summarized in Progress Report.
Draft Final Report	• It was not necessary to submit the Interim Report for PART B. • Second Stage Field Survey successive first stage field survey was conducted. • Inspection and examination and loading tests were conducted for remaining two RC bridges and three PC bridges. • The test data were submitted to the Omani counterparts. • The survey results were brought to Japan and data analysis and study were made in Japan. • The study was summarized in Draft Final Report.

The Study Report consists of two categories, namely,

PART A Feasibility Study on Construction of Flyovers and Pedestrian Underpasses

PART B Maintenance and Rehabilitation Study on Nine Existing Bridges

Work Items of Study

Month	1	2	3	4	5	6	7	8
Step	Step 1	Step 2		Step 3		Step 4		

A — Road Facility (Flyover, Pedestrian Underpass)

- A1 Preparatory Work
- A2 Submission and Discussion of Inception Report
- A3 Collection and Review of Relative Data
- A4 Determination of the Future Socio-Economic Frame
- A5 Traffic Count Survey
- A6 Traffic Demand Forecast
- A7 Reconnaissance Survey
- A8 Environmental Survey
- A9 Site Investigation
- A10 Examination of Design Standard
- A11 Construction Materials Resources
- A12 Preparation of Progress Report
- A13 Submission and Discussion of Progress Report
- A14 Supplemental Traffic Count Survey
- A14' Revision of Traffic Demand Forecast
- A15 Conceptual Design
- A16 Environmental Impact Study
- A17 Evaluation of Traffic Function
- A18 Preliminary Cost Estimate
- A19 Decision of Priority
- A20 Preparation of Interim Report
- A21 Submission and Discussion of Interim Report
- A22 Field Survey
  - Topographic Survey
  - Boring
  - Soil Examination
- A23 Preliminary Design
- A24 Maint Plan
- A25 Consu Planni

Month	1	2	3	4	5	6	7	8
Step	Step 1	Step 2			Step 3		Step 4	

B — Maintenance/Rehabilitation of Bridge

- B1 Preparatory Work
- B2 Submission and Discussion of Inception Report
- B3 Collection and Review of Relative Data
- B4 Field Reconnaissance
- B5 Inspection of Existing Bridge Condition
- B6 Soundness Examination and Load Test for RC 4 Nos Bridge
- B7 Preparation of Progress Report
- B8 Submission and Discussion of Progress Report
- B9 Soundness Examination and Load Test for RC 2 Nos Bridges and PC 3 Nos Bridges
- B10 Collection and Analysis of Bridge Load Test Result
- B11 Preparation of Record Books of Bridge
- B12 Planning of Rehabilitation Plan
- B13 Preli and C

Report

- Inception Report
- Progress Report
- Interim Report

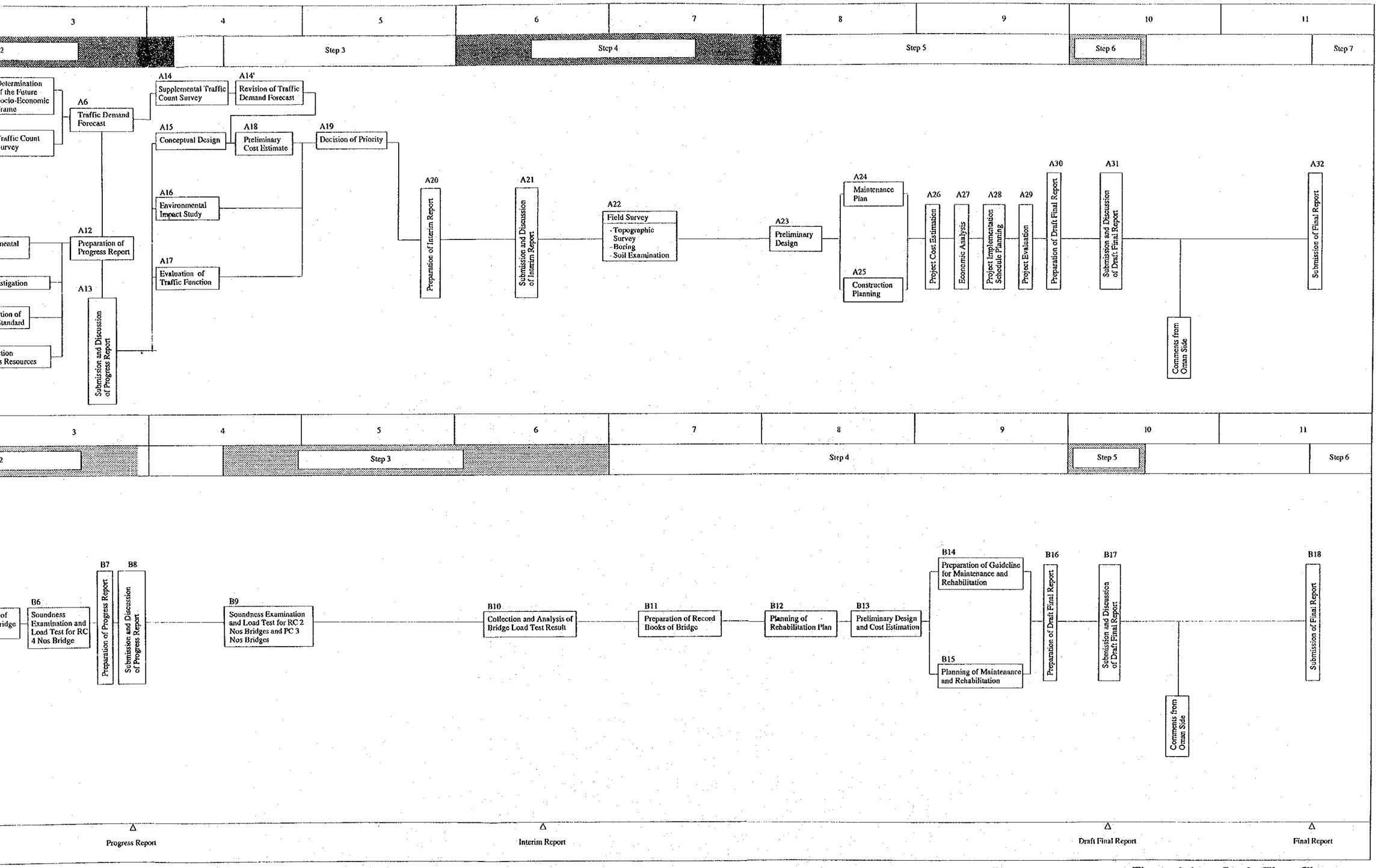


Figure 1.1 Study Flow Chart

1.5 Study Organization

(1) Study Organization is shown in Figure 1.2 below and Organization Chart of Study Team is shown in Figure 1.3.

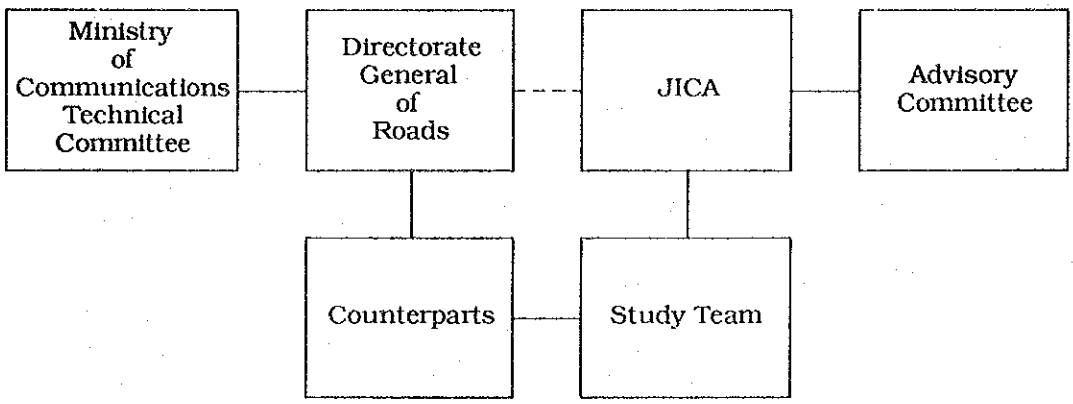


Figure 1.2 Organization Chart

(2) Members of the Study Organization are as follows:

The MOC Technical Committee

1. Engr. Khalid Bin Abdallah Bakathir
   Acting Director General of Roads

2. Engr. Hilmi Bin Amor Al Barwani
   Deputy Director General for Technical Affairs

3. Engr. Salem Bin Mohammed Al Naimy
   Acting Manager for Road Construction and Maintenance Department

4. Engr. Abdullah Bin Suleiman Al Sharji
   Highway Design Engineer

5. Engr. Hamad Bin Saud Al Ramadhani
   Bridge Engineer

6. Engr. Salameh Khoury
   Advisor to H.E. The Minister for Road Affairs

7. Engr. Aziz Abdel Massih
Highway Maintenance Expert

8. Engr. Kamil Kaloush
Highway Maintenance Management System Expert

9. Mr. Ahmed Abdulaziz
Quantity Surveyor

JICA Advisory Committee

Mr. Hideo Takahashi	:	Chairman
Mr. Yutaka Takabatake	:	Member
Mr. Fuminari Hashimoto	:	JICA Coordinator

The Study Team

Mr. Satoshi Watabe	:	Team Leader
Mr. Hiroo Takeda	:	Structural Planner
Mr. Mok You Chua	:	Traffic Planner/Engineer
Mr. Tohru Irisawa	:	Structural Engineer
Mr. Hajime Kinugawa	:	Highway Engineer
Mr. Tadashi Wakabayashi	:	Economic Specialist
Mr. Mitsuaki Ino	:	Environmental Specialist
Mr. Hiroshi Tanaka	:	Bridge Artist
Mr. Sakae Takada	:	Natural Condition Surveyor
Mr. Kazuo Mizukoshi	:	Execution Planner/Cost Estimate Engineer
Mr. Takamichi Hoshi	:	Traffic Safety Engineer
Mr. Ryouichi Setogochi	:	Rehabilitation and Maintenance Planner
Mr. Yoshimi Takai	:	Bridge Planner (1)
Mr. Takeshi Goto	:	Bridge Planner (2)
Mr. Hiroshi Hiraoka	:	Soundness Analysis
Mr. Kazushi Nakamura	:	Chief Measurement Engineer (1)
Mr. Yukimasa Fujiwara	:	Measurement Engineer (1)
Mr. Masamichi Kumagai	:	Measurement Engineer (2)
Mr. Shigemi Tashio	:	Chief Measurement Engineer (2)
Mr. Ryoichi Akebi	:	Measurement Engineer (3)
Mr. Duncan Mark	:	Measurement Engineer (4)

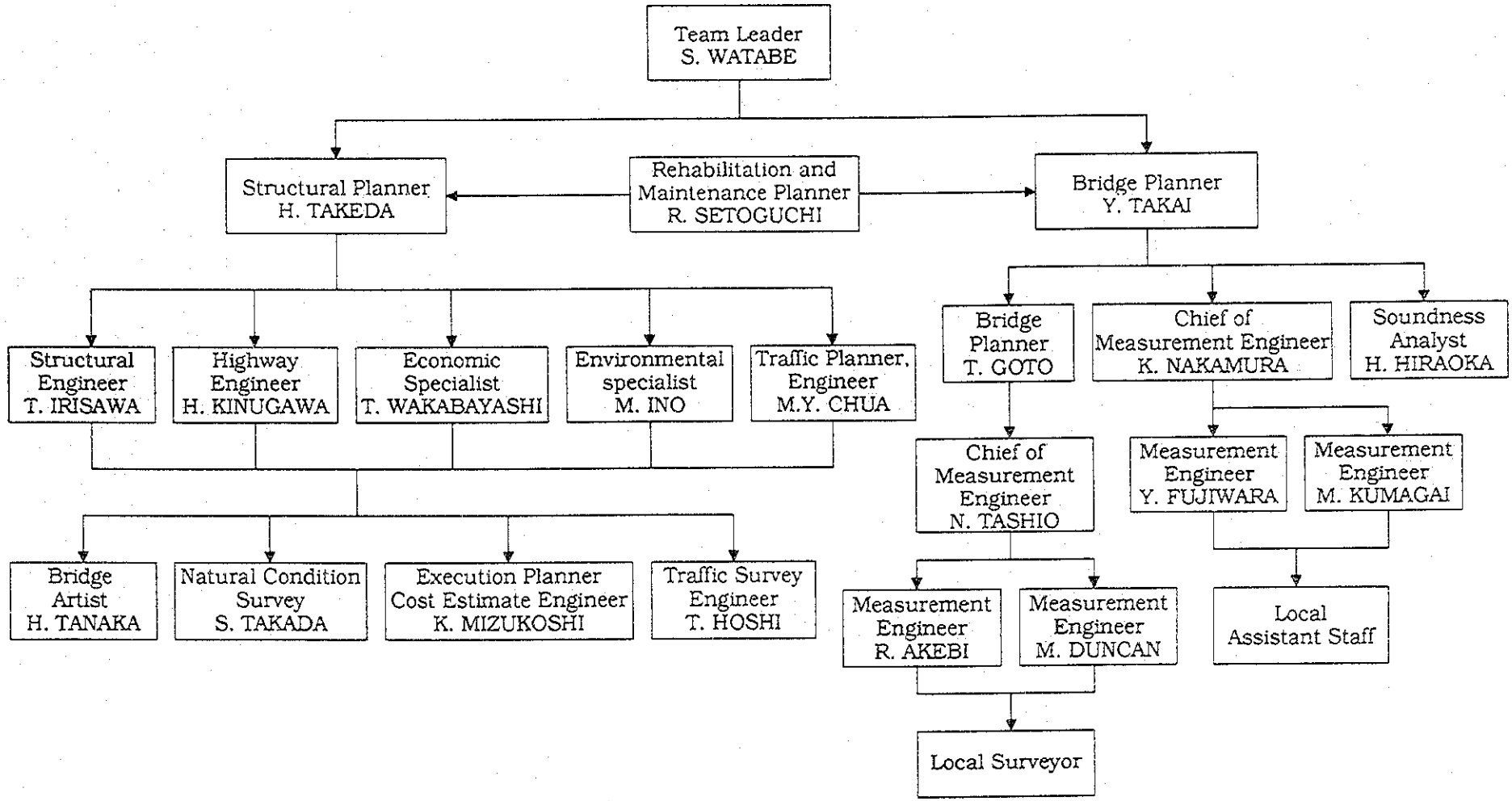
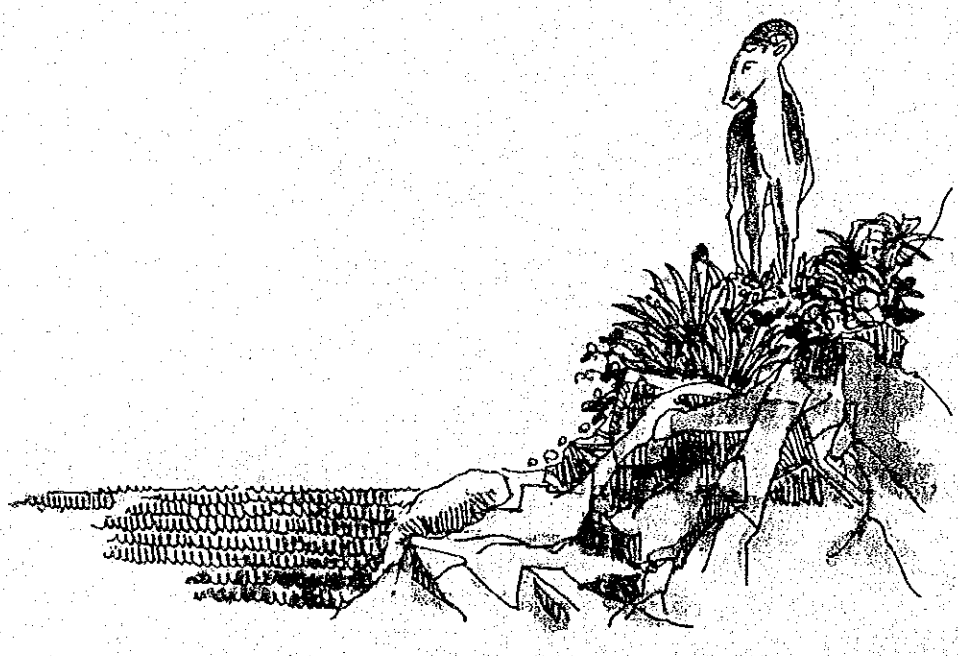


Figure 1.3 Organization of Study Team

CHAPTER 2 THE NATURAL CONDITIONS OF THE PROJECT SITE



CHAPTER 2

THE NATURAL CONDITIONS OF THE PROJECT SITE

2.1 The Topography and Geology of the Project Site

The project site is located in the northern part of the Sultanate of Oman and ranges from Musandam Peninsula southeasterly to the Sharqiya Region, and forms an arc to the eastern Hajar mountain range. The topological and geological characteristics follow the pattern of this range, and the fertile and populous coastal plain known as the Batinah Coast slopes gradually from the northeast side of the foothills. This mountain range consists of the Western Hajar and Eastern Hajar. In the Western Hajar are the Akhdhar Mountains with the peak Jabal Shams (3,075 m) and other high ridges at elevations of 2,500 m. The region is divided into the high tablelands and the coastal plains.

The Akhdhar Mountain Range is formed by the axis of an anticline. From this anticline north are the principal mountains, forward mountains, the fluvial wadi plains, and the coastal plains which form the four principal areas of the project area.

On the backside of the anticline are high tablelands. Beyond the Hajar mountains are the sandy inland districts that recede into a stony desert before merging with the sands of Rub al-Khali.

In the high tableland of central Oman are outcrops of metamorphic rock, and the mountains are composed of limestone or dolomite of the Mesozoic era. As they are resistant to weathering and erosion, there are deep gorges, mountains and hills.

In the front of the mountain ranges where the low foothills are found, the formation consists of ophiolite of the Cretaceous period (pillow lavas, dykes, gabbros, periodite) submarine soils.

Ophiolite is subject to weathering and erosion and for this reason the mountain ranges are gentle sloping, and the hills average 1,000 m in height.

From the foothills to the coast line there are many pediments and a wide plain with many wadis.

Further north is the alluvial plain which forms a fertile coastal plain washed by rivers with sand-gravel beds, detritus layers, and alluvial beds. In summary they can be described in Table 2.1:

Table 2.1 Summary of the Topography and Geology

Geographical Classification	Stratigraphical Composition
Mountain Range	Pre-permian basic rocks
Forward Mountains	Cretacious Era, Ophiolite, (pillow lavas, dykes, gabbros, periodite)
Wadi Plains	Tertiary Era, Limestone, Shale, Marlstone, Gravelly Shale
Coastal Plain	Quaternary Era, Unconsolidated Gravel

2.2 The Climate

Oman has an arid subtropical climate. The Akhdhar Mountain Range provides the Sultanate of Oman with the little rain that falls there. This is an important feature of the general climatic pattern of the area.

The weather in the project area consists of summer type (June ~ Sept.) and winter type (Nov. ~ Apr.); and the seasons in between are mostly dry and change constantly.

In the summer months due to the dominating high pressure cell prevailing over the Indian Ocean there is a low pressure cell which blows from northwest India, and the southwest trade wind dominates. The tropical convergence positions itself over the Arabian Peninsula but is not active.

In the winter months, the high pressure cell over the Asian continent stretches out over the Arabian continent, and the low pressure dominates over the Indian Ocean, and forms the tropical convergence thereover. For this reason, the trade winds tend to become dry and are northerly. The unstable low pressure cells and fronts move in from the west and bring the rains onto the Batinah Coastal Range.

The tropical fronts that occasionally form over the Indian Ocean and Arabian Sea move towards the Arabian Peninsula, but rarely influence the weather pattern in northern Oman.

The rains fall year-round in the high tablelands regardless of the seasons and are more frequent where the elevation is high. In the summer season there is little rainfall in the lower plains (elevations lower than 170 m).

The rains can be characterized as follows:

(1) The rains in the winter season are caused by weather disturbances, and cover a large area from the coastal plains, extending into the mountain areas.

(2) The rains in the summer season are caused by the coastal winds, and are confined to the mountain areas in a narrow strip.

(3) There are other rains in Oman caused by tropical lows but do not cause rain to fall in the Batinah Coastal area.

The annual rainfall in the project area varies between the mountain areas and the coastal plains. The mountain areas receive 150 to 400 mm of rainfall, while the coastal plain receives less than 100 mm of rainfall. The average annual rainfall in the area is 121 mm.

The rainfall in the Muscat area for the past 100 years shows the average rainfall to be in the range of 100 to 300 mm, and differs greatly by year.

The winds have very little variation, and are stronger in the summer and weaker in the winter. The maximum average winds are 6.6 m/s from April to June, and the minimum winds from November to January are 1.8 m/s. The maximum temperature is 47 ~ 48°C in June, and the minimum is 19 ~ 25°C in January.

The relative humidity is 64%. The average monthly relative humidity is 70 ~ 80% and occurs in August and from November to January. The minimum is 40 ~ 50% during April to June, and 50 ~ 60% from September to November. The relative humidity goes through two cycles a year.

CHAPTER 3 SOCIO-ECONOMIC CONDITION

CHAPTER 3

SOCIO-ECONOMIC CONDITION

3.1 Administrative Structure

The administrative system of the Sultanate of Oman under His Majesty Sultan Qaboos bin Said Al Said consists of the Diwan of the Royal Court, Ministry of Palace Office Affairs, the Cabinet of Ministers and Secretariat of the Cabinet, the Specialized Councils, Governorate of Muscat and the Majlis Ash'shura.

His Majesty the Sultan delegates his power to the Cabinet of Ministers which is the highest executive authority, and it is collectively responsible to His Majesty.

Laws and decrees are authorized by His Majesty. International treaties, agreements and charters signed or approved by His Majesty become law from the date of their publication in the Official Gazette.

3.1.1 Cabinet of Ministers

The Cabinet of Ministers consists of one Personal Representative of H.M. the Sultan, three Deputy Prime Ministers and 20 Ministers as following:

(1) Personal Representative of His Majesty the Sultan.
(2) Deputy Prime Minister for Security and Defense.
(3) Deputy Prime Minister for Legal Affairs.
(4) Deputy Prime Minister for Financial and Economic Affairs.
(5) Minister of National Heritage and Culture.
(6) Minister of Petroleum and Minerals.
(7) Minister of Justice, Awqaf and Islamic Affairs.
(8) Minister of Education.
(9) Minister of the Interior.
(10) Minister of Information.
(11) Minister of State and Governor of Muscat.
(12) Minister of State for Foreign Affairs.
(13) Minister of Communications.
(14) Minister of Posts, Telegraphs and Telephones.

(15) Minister of Electricity of Water.
(16) Minister of Agriculture and Fisheries.
(17) Minister of State and Governor of Dhofar.
(18) Minister of Civil Service.
(19) Minister of Housing.
(20) Minister of Health.
(21) Secretary to the Cabinet.
(22) Minister of Regional Municipalities and Environment.
(23) Minister of Water Resources.
(24) Minister of Social Affairs and Labor

Secretariat of the Cabinet of Ministers

The Secretariat of the Cabinet of Ministers is responsible for the smooth functioning of the Government machinery. One of its functions is to ensure that the Cabinet decisions are implemented within the given time-frame and budget.

3.1.2 Regional Administration

(1) Governorate of Muscat

The Governorate of Muscat is responsible for the administration of the Municipality of Muscat.

(2) Wilayats

The country has been divided into 59 Wilayats (regions) under the jurisdiction of the Ministry of the Interior to make administration easier. A Wali (Governor) is the head of a Wilayat.

(3) Majlis Ash'Shura

Majlis Ash'Shura which was formed in 1990 is the replacement for the State Consultative Council consisting of 59 members who are elected as one representative from each Wilayat. The President of Majlis Ash'Shura is appointed by Royal Decree.

The principal duties of Majlis are reviewing of all social and economic draft laws, prepared by Ministries, before their enactment; setting up development plans, and following up of their execution within the general strategy

framework of the State and in accordance with the availability of funds; and conserve the environment.

3.1.3 Specialized Council

The Specialized Councils were set up by Royal Decree. They are under the chairmanship of H.M. the Sultan and consists of some members of the Cabinet of Ministers and other officials. Some of the Specialized Councils include prominent members of the community. These Councils are as following:

(1) The Development Council
(2) The Financial Affairs Council
(3) The Sultan Qaboos University Council
(4) The Civil Service Council

3.2 Population

3.2.1 Population in Oman

In the Sultanate of Oman, the population census was not taken until recently. In December 1993, the first population census was taken. However, it will take some more time till the result data from this census will be available for public. The World Bank estimated the population as 1,600,000 in the year 1989.

According to the Initial Results of Census - Dec. 1993 - the population of the Sultanate was 2,017,591 out of which more than half were living in the capital area and Batinah Region as the population of Muscat and Batinah were found to be 622,506 and 538,763 respectively. This estimation was done on the basis of sampling survey. The distribution of population by region is given in the Table 3.1.

Table 3.1 Region wise Population of Oman in 1993

Region	Population		
	Omani	Non-Omani	Total
Muscat	329,842	292,664	622,506
Al Batinah	458,084	80,679	538,763
Musandam	21,997	5,672	27,669
A'Dhahira	129,743	39,967	169,710
A'Dakhiliya	194,002	26,401	220,403
A'Sharqiya	213,508	34,043	247,551
Al Wusta	13,204	2,897	16,101
Dhofar	120,151	54,737	174,888
Total	1,480,531	537,060	2,017,591

(Source: Initial Results of Census - Dec. 1993)

A relatively high Annual Average Growth Rate (AAGR) of population at 3.5 % was estimated in the above period. However, the AAGR is forecast to decline somewhat in the future.

3.2.2 Population in Batinah Region

According to the Initial Results of Census - Dec. 1993 - the total population of Batinah region in 1993 was 538,763 out of which 85% or 458,084 were Omani and 15% or 80,679 were Non-Omani.

The population distribution by wilayat broken down into Omani and non-Omani people are given in the Table 3.2.

Table 3.2 Population of Batinah Region by Wilayat in 1993

Wilayat	Population		
	Omani	Non-Omani	Total
Sohar	69,171	16,686	85,857
A'Rustaq	53,138	6,241	59,379
Shinas	36,189	6,344	42,533
Liwa	18,781	2,682	21,463
Saham	62,299	9,372	71,671
Al Khaburah	33,440	4,989	38,429
Al Suwaiq	69,629	11,536	81,165
Nakhal	11,452	1,118	12,570
Wadi Al Maawel	9,620	1,010	10,630
Al Awabi	7,787	701	8,488
Al Masnaah	39,395	6,019	45,414
Barka	47,183	13,981	61,164
Total	458,084	80,679	538,763

(Source: Initial Results of Census - Dec. 1993)

3.2.3 Population Forecast

The growth structure for Omani and non-Omani population will be totally different and hence they should be treated separately for the demographic forecast. The Omani population will increase by natural growth. The interregional and inter-wilayat migration are assumed to be negligible but migration to urban areas are expected and as a result, the growth rate in the urban areas will be higher than the rural areas. The Non-Omani population will increase depending upon job opportunities.

The total population in the Batinah Region (Study area) will increase from 538,763 in 1993 to some 808,000 people in the year 2010 with an annual average growth of 2.4 %.

3.3 Economic Condition

The economy of the Sultanate of Oman has continued a rapid expansion since 1990. Since its economy is oil-based, there are fluctuations in economic condition subject to change in the world's oil markets. Excluding the value of oil, the non-oil sector achieved 8.8 % growth in real, constant price terms in 1990 and 11.1 % growth in 1991. This rapid expansion continued in 1992 with especially noteworthy performances in the construction, trade, mining and oil refinery sectors.

3.3.1 Gross Domestic Product

Gross Domestic Product of the country from the year 1985 to 1992 by industrial category is shown in Table 3.3 and Fig. 3.1. The GDP of Oman is expected to increase with a steady growth in the future.

According to the table, primary industry increased gradually in these years, whereas secondary industry fluctuated depending on the product of crude petroleum. Manufacturing Industries increased at a high annual rate of 25 % in 1986 and increased steadily with an average annual rate of 10 % in 1987 and onwards. Tertiary industry also increased steadily from 1988. The Total GDP increased by 26.12 % from the previous year indicating great achievement in the economy, but the total GDP decreased in the year 1991. However it again increased by 12.45 % from the previous year in 1992.

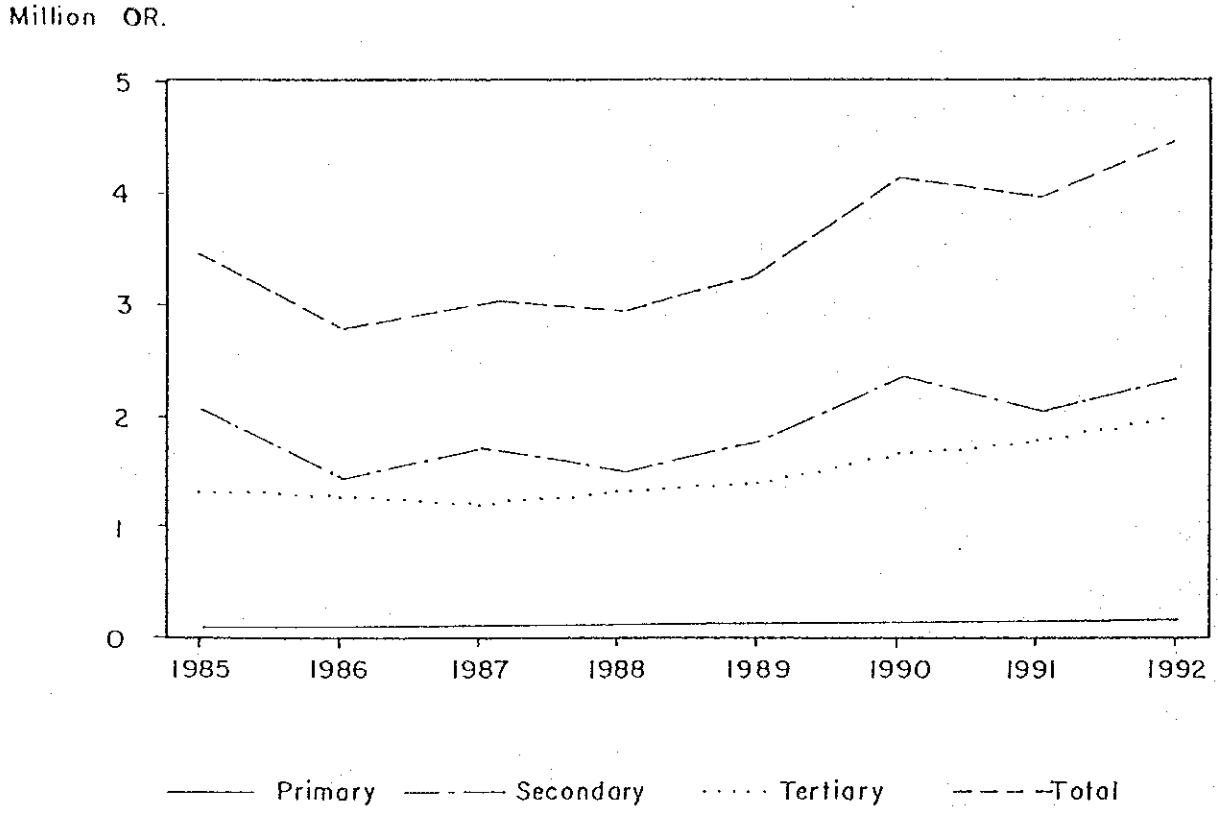
Table 3.3 Gross Domestic Product Based on 1978 Constant Price

(Unit Million OR)

Category	1985	1986	1987	1988	1989	1990	1991	1992
Primary	93.7	95.90	105.40	123.60	117.10	133.80	143.90	143.70
Agriculture	67.50	68.20	70.60	77.80	83.20	133.80	143.90	143.70
Fishing[1]	26.20	27.70	34.80	45.80	33.90	-	-	-
Secondary	2,045.20	1,436.60	1,705.00	1,497.00	1,769.90	2,337.60	2,054.70	2,323.90
Crude Petroleum	1639.10	1,024.60	1,362.00	1,143.70	1,417.20	1,942.70	1,608.70	1,820.50
Natural Gas	36.00	38.50	42.70	44.40	44.80	47.60	49.70	54.60
Mining & Quarrying	8.80	9.30	8.30	14.00	16.60	11.90	10.80	12.50
Manufacturing Industries	82.30	103.10	111.50	122.70	137.10	152.40	168.30	190.20
Electric	27.10	29.70	28.00	28.40	27.40	59.70	62.70	67.50
Water[2]	9.70	10.60	15.50	17.80	20.80	-	-	-
Construction	242.20	220.80	137.00	126.00	106.00	123.30	154.50	178.60
Tertiary	1,314.90	1,267.90	1,206.30	1,322.20	1,395.20	1,668.20	1,771.80	1,997.30
Wholesale & Retail Trade	412.20	366.40	311.00	370.00	373.10	468.50	540.60	615.90
Restaurant, Hotel	15.80	16.80	16.30	18.80	20.50	-	-	-
Transport, Communication	99.60	103.40	97.70	108.30	112.30	129.30	146.70	160.90
Financing, Insurance	90.90	93.50	84.50	88.50	126.30	166.20	147.50	160.90
Ownership of Dwelling	159.40	143.80	146.50	155.70	165.20	188.50	196.00	211.60
Services	36.00	38.50	40.40	45.70	49.10	57.10	71.50	75.50
Government Services	477.90	495.80	509.90	535.20	548.70	658.60	669.50	772.50
Others[3]	23.10	9.70	0.00	0.00	0.00	-	-	-
Total	3,453.80	2,800.40	3,016.70	2,942.80	3,282.20	4,139.60	3,970.40	4,464.90
Growth Rate		-18.91%	7.72%	-2.45%	11.53%	26.12%	-4.08%	12.45%

Note: 1. Included in Agriculture, 1990 onwards
2. Included in Electric, 1990 onwards
3. No data available 1990 onwards

(Source: Statistical Year Book 1993)



THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 3.1 Gross Domestic Product by Industrial Category

3.4 Present Transport Condition

Road is the only means of land transport in Oman since there is no rail transport. Sea and air transport are gradually expanding but their shares in domestic transport are nominal. There are Seeb International Airport for handling international air transport and two sea ports Qaboos and Raysut mostly for handling international cargo.

3.4.1 Road Transport

Road transport accounts for more than 90 % of all passengers and goods movement in Oman.

(1) Road Length

Road length in Oman has increased largely since 1970 when the implementation of the country's first five year plan, aimed at infrastructural development of the country, started. There were only 10 km of paved and 1,817 km of unpaved roads in 1970 whereas there were more than 5,000 km of all-season paved roads and 20,000 km of unpaved roads by 1990. Fig. 3.2 shows the growth trend of paved roads from 1970 to 1992. There was a steady growth in paved roads after 1975.

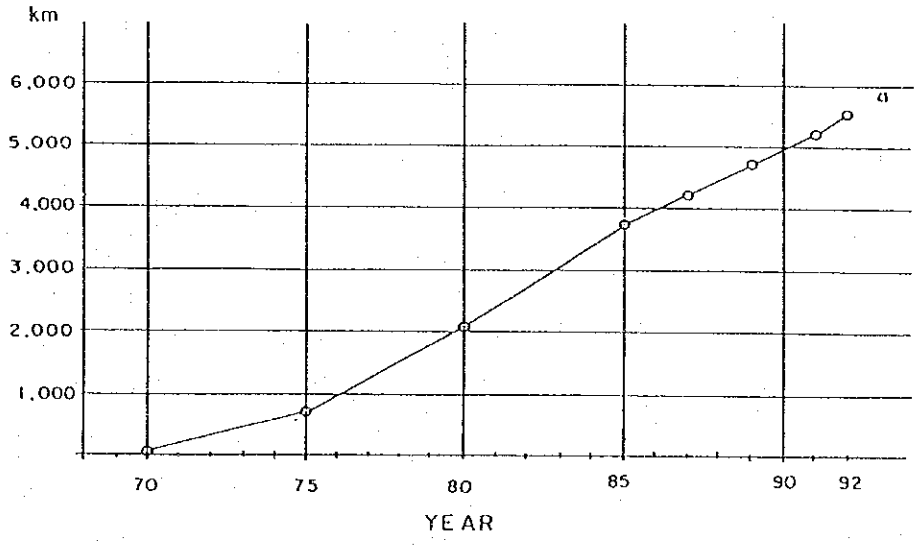


Fig. 3.2 Growth Trend of Paved Roads in Oman

(2) Road Network

The road network in Oman as of 1991/92 comprises of 5,621 km (21.4%) paved roads and 20,660 km (78.6%) unpaved roads. Among the total paved roads, 426 km (7.6%) are dual carriageway while the remaining 5,195 km (92.4%) are single carriageway roads. Among the single carriageway roads, the majority or 4,894 km (94.2%) are public roads under the Ministry of Communications (MOC) while the remaining 301 km are under the Ministry of Defense (MOD) and Petroleum Development of Oman (PDO). Fig. 3.3 shows the road network in Oman.

(3) Types of Roads

The roads are classified into 3 categories as following:

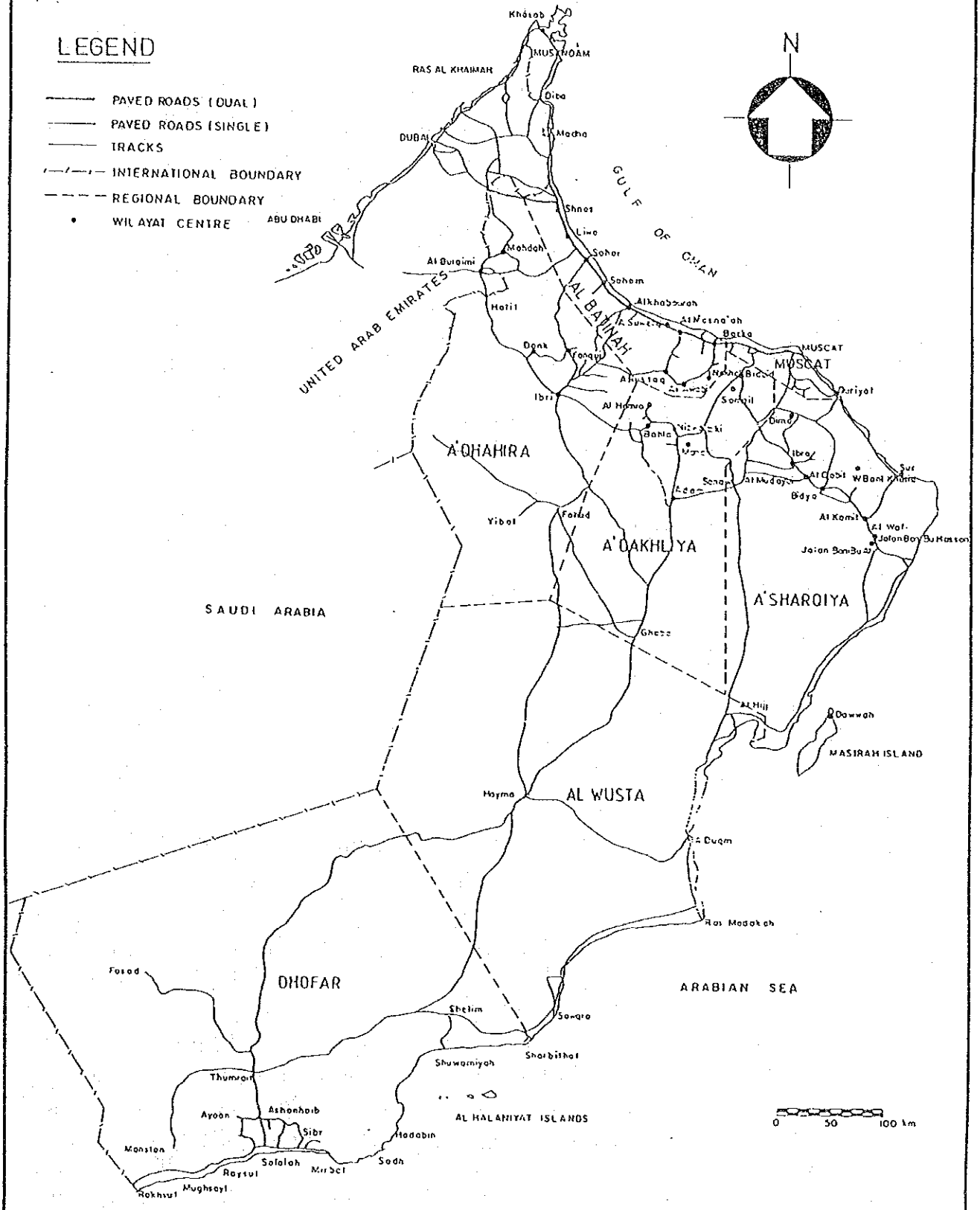
a. Major interurban highway: Connecting major cities, they also connect Oman to neighboring countries.

b. Interurban arterial road: Connecting the capital city of Muscat and major cities with other towns and service centers in the country.

c. Interurban and local access road: Facilitating the local traffic movement and to development areas, industrial estates and mines.

The major interurban highway network consists of paved dual carriageway roads, the main route of which is Batinah Highway from Muscat to Aqr (National Route No. 1) and continue as Route No. 5 from Aqr to the national boundary with U.A.E. at Wadi Hatta for a total distance of about 358 km.

The Batinah Highway is a very important road in Oman; the backbone of the road infrastructure in Batinah Region. It was built in 1974 as a two-lane (3.5 m per lane) single carriageway road. Consequently a second carriageway was added in 1984, making it a dual carriageway 4-lane divided highway. It serves 11 wilayats and links capital Muscat with other towns in the region.



THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.3 Road Network in Oman

3.4.2 Vehicle Registration

The total number of vehicles in Oman increased from 107,627 in 1980 to 254,914 in 1992 as per the vehicle registration record. Fig. 3.4 shows this trend of increase. The rate of increase was more rapid after 1985 and it has stabilized to a rate of 9% after 1989.

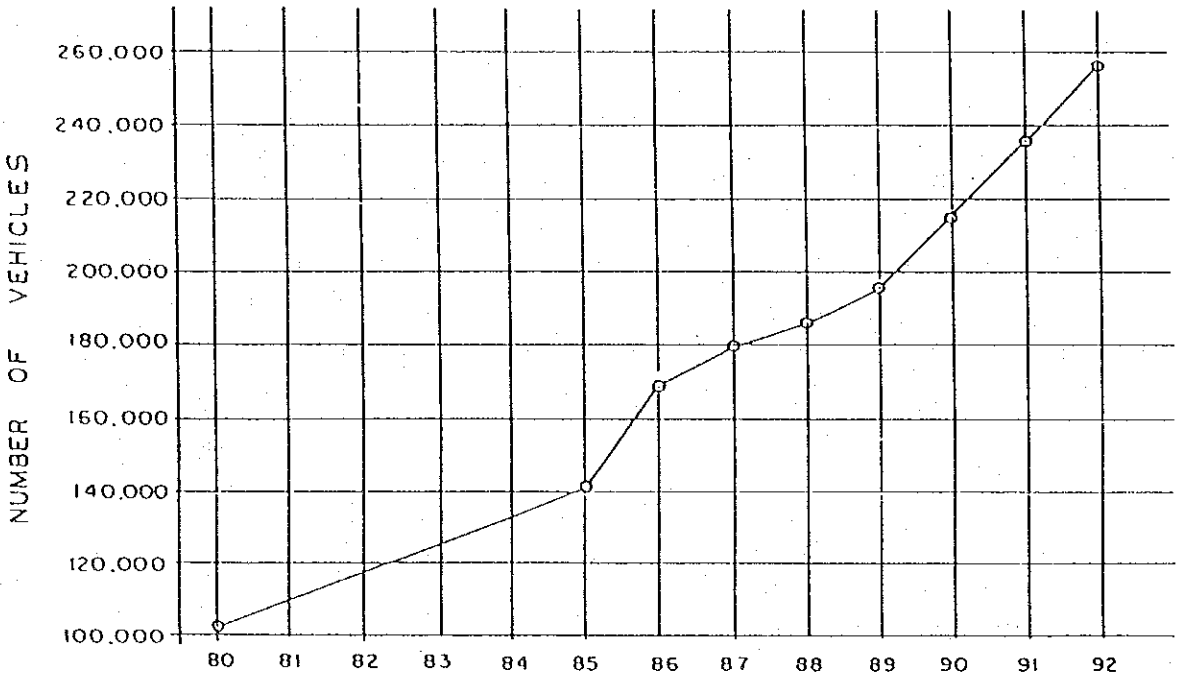


Fig. 3.4 Growth Trend of Vehicle Registration in Oman

The type of vehicles as of the 1992 registration record was found as 53.7% private passenger cars, 32.1% commercial vehicles (trucks, buses and vans), 8.1% government vehicles and 3.5% taxis. The number of motorcycles was very small.

The vehicle ownership rate in 1992 was found to be 12.75 vehicles per 100 people or 1 vehicle to every 7.84 person. This vehicle ownership rate is moderate compared to Kuwait where there was 1 vehicle to every 3.4 person and Japan where this rate was 1 vehicle to every 2.3 person in 1988.

In terms of regional distribution of vehicles, 48.2% were registered in Muscat, followed by 13.1% in Batinah Region and 10.2% in Dhofar. The vehicle registration in 1992 is shown in Table 3.4.

Table 3.4 Vehicle Registration by Region, 1992

Region	Total	Passenger Car	Taxi	Commercial	Government/ Diplomatic	Motor-cycle	Others
Muscat	122,867 (48.2%)	68,316	4,864	26,321	19,926	1,998	1,442
Batinah	33,272 (13.11%)	15,871	1,194	15,177	-9	955	84
Dhofar	26,088 (10.2%)	14,222	838	9,801	650	520	51
A'Dakhliya	23,596 (9.3%)	10,083	543	12,023	-9	811	145
A'Sharqiya	19,969 (7.8%)	10,340	952	8,475	-11	174	39
A'Dhahira	18,599 (7.3%)	10,375	416	1,497	-1	188	124
Musandam	10,523 (4.1%)	7,753	16	2,640	-6	51	69
Total	254,914 (100%)	136,960	8,823	81,934	20,540	4,703	1,954

Data Source: Statistical Yearbook 1992