No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION (CDR)
REPUBLIC OF LEBANON

THE STUDY
OF
ENVIRONMENTAL FRIENDLY INTEGRATED TRANSPORTATION PLAN
FOR
GREATER TRIPOLI

FINAL REPORT

TECHNICAL REPORT - 2

ROAD NETWORK PLAN

DECEMBER 2001

KATAHIRA & ENGINEERS INTERNATIONAL

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REPORT COMPOSITION

The Final Report of the Study is structured to meet the requirements of each user-group. It contains an executive summary, two main reports and six technical reports as follows:

EXECUTIVE SUMMARY: is designed to address the decision-makers as ministers and politicians who do not need deep information in technical and engineering aspects. It contains brief information on all the aspects of the Study and concentrates on the input and output of each aspect. It has also a more concentrated summary for the main conclusions in two pages.

MAIN REPORT – 1 "Integrated Transport Plan": is designed for planners and directors of CDR and concerned ministries and authorities, who need more technical information on the Master Plan formulation. It contains applied planning policies, development and evaluation of alternatives, main information on the plan of each sector, evaluation results of the Master Plan and the overall implementation plan.

MAIN REPORT - 2 "Short-term Improvement Plan": integrates more detailed studies and information on the urgent projects included under the Short-term Improvement Plan. The report gives the necessity, objectives, preliminary design, cost estimate and project evaluation on the technical, environmental and economic viability of each project.

TECHNICAL REPORT - 1 "Traffic Analysis and Forecast": is basically prepared for technology transfer purposes. It addresses transport planners and contains the forecast procedures of forecasting future transport demand. The procedure starts with traffic surveys and analysis, socioeconomic framework, trip generation and attraction and the future transport demand.

TECHNICAL REPORT - 2 "Road Network Plan": is for the specialists in the road planning and network development. It includes the present road network pattern as well as the planning concept and strategies, which are the basis of the proposed network pattern. Projects of the developed plan are prioritized for implementation under each of the planning periods.

TECHNICAL REPORT - 3 "Public Transport Plan": is for the specialists in the public transport sector and schemes planned under the Master Plan. It includes the estimated future demand, proposed routes, required number of buses and cost estimation in addition to the implementation plan. It includes also plans and measures for taxi service and school buses.

TECHNICAL REPORT - 4 "Traffic Management": is for the specialists in the traffic management sector and projects included under the Master Plan. It demonstrates the problems under existing conditions and the formulated plan that includes different procedures and measures for traffic signalization, parking control as well as safety and education measures.

TECHNICAL REPORT - 5 "Environmental Assessment": gives the environmental conditions and initial environmental examination for the Study Area. Through an environmental impact study, it highlights the environmental issue in establishing the urban transport plan in order to emphasize the importance of preserving and improving the environment.

TECHNICAL REPORT - 6 "Project Management and Financing": is addressing the administrative issues that will affect the successful implementation of the planned projects. It includes the present legislation, organization and funding system of agencies that will implement the projects under the Study. For the successful implementation of the projects as scheduled, management and financing plans are presented.

APPENDIX

TECHNICAL REPORT - 2
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LIST OF ABBREVIATIONS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
B/C	Benefit-Cost Ratio
BOT	Built, Operate and Transfer
CAS	Central Administration of Statistics
CBD	Central Business District
CDR	Council for Development and Reconstruction
CEGP	Council Executive des Grand's Projects
CNG	Compressed Natural Gas
CO	Carbon Monoxide
COM	Council of Ministers
DGHB	Directorate General of Highways and Buildings
DOR	Directorate of Road
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ERM	Environmental Resource Management
EU	European Union
FAR	Floor Area Ratio
FHWA	Federal Highway Administration
FYDP	Five Year Development Plan
GDP	Gross Domestic Products
GNP	Gross National Products
GOJ	Government of Japan
GOL	Government of Lebanon
HC	Hydrocarbon
HCM	Highway Capacity Manual
IBRD	International Bank for Reconstruction and Development
IEE	Initial Environmental Examination
ISF	Internal Security Force
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LL	Lebanon Lira, Lebanon Pound
LOS	Level of Service
LRT	Light Railway Track
MEA	Middle East Airlines
M/P	Master Plan
MOE	Ministry of Environment
MOF	Ministry of Foreign Affairs
MOMRA	Ministry of Municipal and Ruler Affairs
MOI	Minister of Interior
MOPWT	Ministry of Public Works and Transport

MPWT	Ministry of Public Works and Transportation
NAC	Noise Abatement Criteria
NERP	National Emergency Reconstruction Program
NGOs	National Governmental Organizations
NO	Nitrogen Dioxide
NPV	Net Present Value
OD	Origin-Distention
ODA	Official Development Assistance
O & M	Operation and Management
ORRPT	Office of Rail Road & Public Transport
PCE	Passenger Car Equivalent
PCU	Passenger Car Unit
PDR	Plan Dimension Ratio
PIU	Project Implementation Unit
PMT	Project Management Team
RC	Reinforced Concrete
RER	Real Estate Registry
ROW	Right of Way
STRADA	JICA System for Traffic Demand Analysis
TCC	Technical Coordination Committee
TSP	Total Suspended Particulate
TTC	Travel Time Cost
UNICEF	United Nation Children's Fund
USEPA	United State Environmental Protection Agency
V/C	Volume-Capacity Ratio
VOC	Vehicle Operating Cost
WHO	World Health Organization
WTW	Water Treatment Works

CHAPTER 1

EXISTING ROAD NETWORK

CHAPTER 1

EXISTING ROAD NETWORK

1.1 ROAD NETWORK CHARACTERISTICS

1.1.1 International and Regional Setting of Road Network

Lebanon has 6,313 Km of roads comprising 523 Km of International Roads, 1,652 Km of Primary Roads, 1,327 Km of Secondary Roads and 2,811 Km of Local Roads.

In the Study Area, Tripoli Boulevard which is the international road connecting Syria with Beirut passes through the central urban area of Tripoli. Beirut – Tripoli Motorway ends at the Tripoli Fair. Tripoli, being the capital city of North Lebanon, is connected with major municipalities of North Lebanon by three roads, namely Tripoli-Sir Ed Danie Road, Tripoli-Ehden Road and Ras-Maska-Kousba Road (see Fig 1.1-1). Road names used under this Study is shown in Figure 1.1-2.

1.1.2 Road Network in Connection with Topography and Urban Structure

Topography of the Study Area is characterized by a coastal flat plain (elevation of less than 15 m) and a plateau (elevation of 70 to 55 m). The steep slope area is formed between the said two areas, and is located at 0.3 to 4 Km from the coast line running in the north-east direction. A plateau is divided into 3 plateaus, namely El-Qoubbe Plateau, Abou Samra Plateau and Ras-Maska Plateau by Abou Ali River and Hab Valley (See Figure 1.1-1).

Historically, urban development started at the Old City around the castle along Abou Ali River and El-Mina around Tripoli Port. Downtown area developed around the Old City. Development of New Tripoli between the Old City and El-Mina was planned in 1947, infrastructure was completed in the early 1950s, construction of buildings started in the middle of 1950s and continued to the present with some interruptions due to a 17– year war. Major commercial and business activities are concentrated at the Old City, Downtown and New Tripoli and at El-Mina with slightly less significance.

High density residential areas were formed at El-Qoubbe Plateau and Abou Samra Plateau with the almost same history as New Tripoli. Schools are also concentrated at two areas.

In El-Bedaoui, Mejdlaya and Ras-Maska, residential areas are being developed along the arterial roads.

Arterial road network was formed reflecting the urban structure and topography. Tripoli Boulevard is the major thoroughfare running in the flat plane and almost parallel to the direction of steep slopes. It serves for international, inter- regional and intra-urban traffic. Inter-regional roads are connected with this boulevard. Transport linkage between Beirut, the national capital and largest city of the country and Tripoli, the regional capital and second largest city of the country is made by Beirut-Tripoli Motorway which ends at the Tripoli Fair and is connected with El-Mina Street, of which function was used to be played by Behsass Highway (old Highway). Behsass Highway is now functioning as a secondary road. El-Mina Street links El-Mina with Old City / Downtown along which New Tripoli was developed.

High density residential areas developed at El-Qoubbe Plateau and Abou Samra Plateau have limited access to high density urban areas in the flat plain due to steep slopes lying between two areas.

Three plateaus are not connected with each other directly. Transport linkage from one plateau to another is only made via the flat plain.

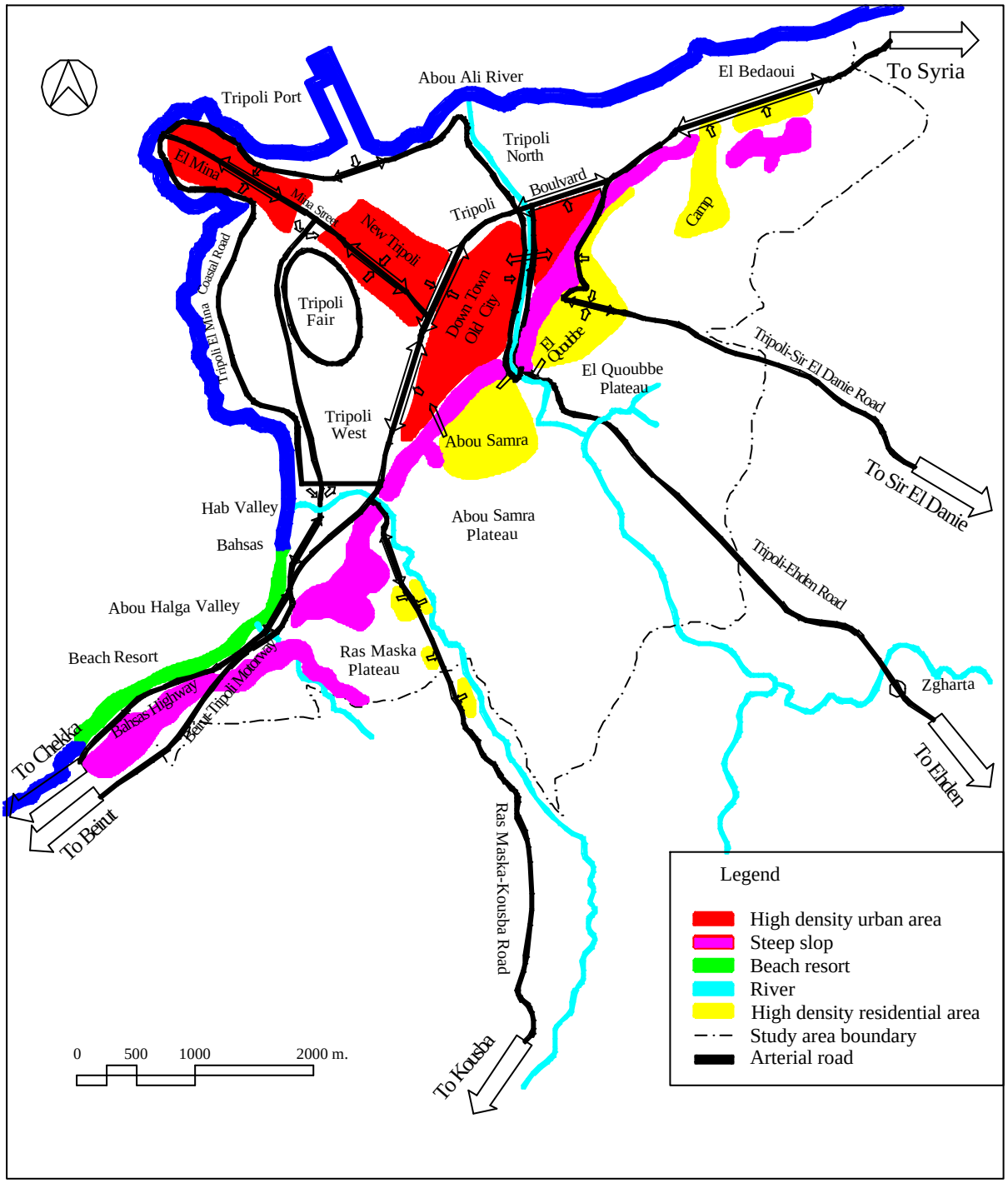

Figure 1.1-1 Existing Road Network Characteristics

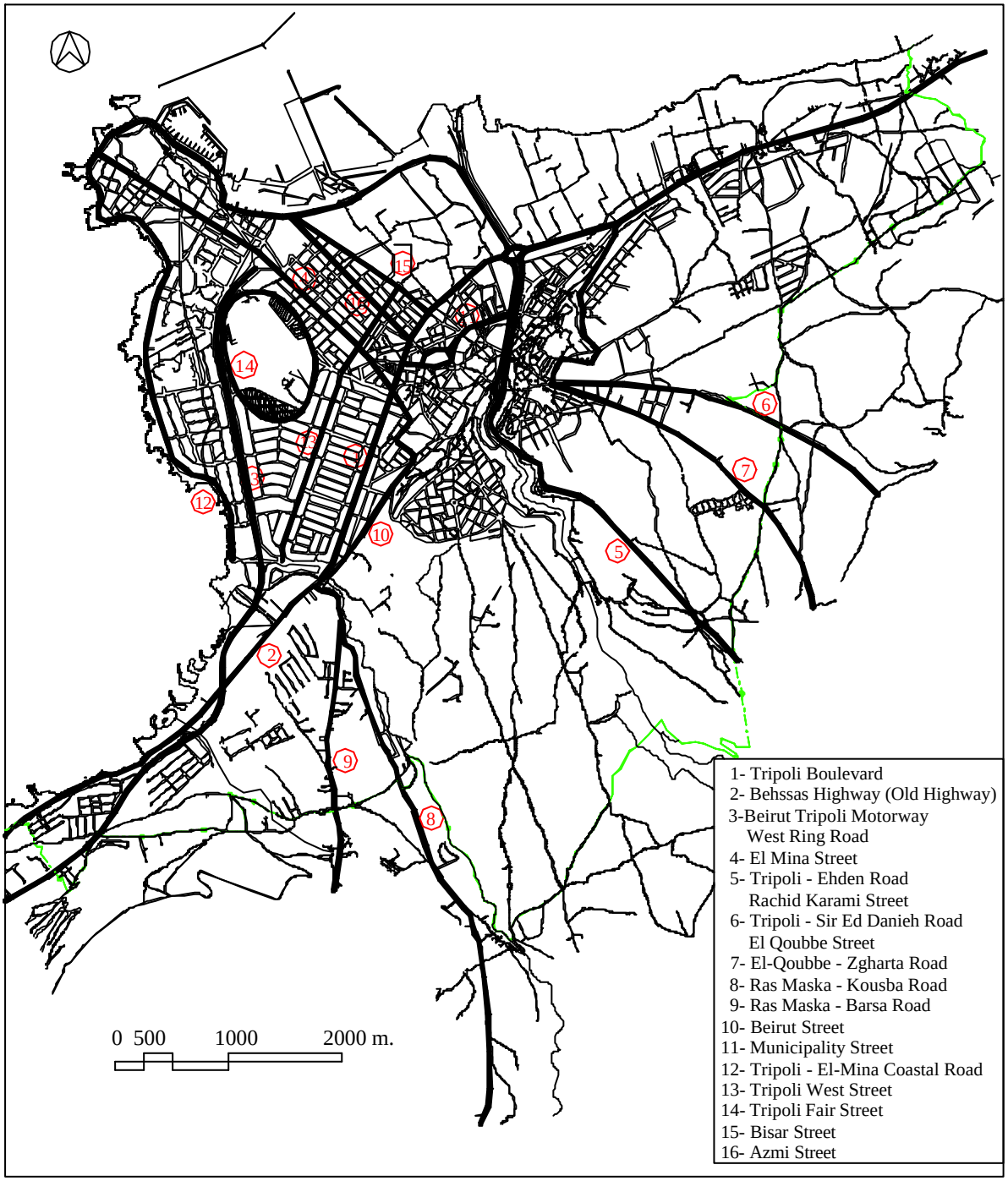

Figure 1.1-2 Road Name

1.1.3 Road Network Characteristics in Each Area

(1) Old City and Downtown

The road network in the Old City and Downtown is like a maze. Most roads are narrow and many intersections have more than 4 legs located at short interval.

(2) New Tripoli

A mesh type of road network is formed. Roads are constructed with almost same standards (or width), therefore, hierarchy of road network is not achieved. A one-way traffic operation is being adopted in the most of the area.

(3) El-Mina

Road network of north-east area of El-Mina Street is also like a maze and most roads are narrow. Road network of the other side of El-Mina Street is a mesh type with intersections at short interval.

(4) Abou Samra

Road network is a mixture of honeycomb type and mesh type with a roundabout at the center. Road network hierarchy is not formed.

(5) El-Qoubbe

A very complicated road network is formed. Road network hierarchy is not formed.

(6) El-Bedaoui, Mejdleya and Ras-Maska

Road network development in these areas is not intensive yet. Local roads are branched off from the inter-regional road to serve for local traffic of residential areas.

1.1.4 Functional Road Classification

Existing roads in the Study Area were functionally classified into the following 5 classes:

- Inter-city motorway
- Primary arterial street
- Secondary arterial street
- Collector street
- Local street

Inter-city Motorway: fully or partially access controlled high standard road serving for inter-city traffic with high speed and capacity.

Primary arterial Street: connects the major activity centers of urbanized area serving for significant intra-urban trips such as between CBD and outlying residential areas, between major inter-city communities, between major suburban centers, etc., and is integrated with major rural connections. It shall be mobility oriented standards and access to abutting lands shall be controlled as much as possible.

Secondary arterial street: interconnects with primary arterials and accommodates moderate trip length traffic with lower level of mobility than primary arterials.

Collector Street: provides both land access service and traffic circulation within residential neighborhoods and commercial and industrial areas. It distributes traffic from arterials through the area to its ultimate destination and conversely collects traffic from local streets and carries it to arterials.

Local street: offers the lowest level of mobility and permits direct access to abutting lands. Service to through traffic is discouraged.

Functional classification of the existing roads is shown in Figure 1.1-3. Road length of each class of street (except local streets) within the Study Area is as follows:

Road Classification	Road Length (Km)	Road Density (km/sq.Km)
Inter-city Motorway	3.61	0.10
Primary Arterial Street	29.02	0.83
Secondary Arterial Street	29.15	0.83
Collector Street	26.62	0.76
Total	88.40	2.52

1.1.5 Number of Lanes and Road Cross Sections

Number of lanes of existing streets is shown in Figure 1.1-4. Road cross sections of arterial streets and representative collector streets are shown in Figure 1.1-5.

In general, wide streets are provided in the Study Area except Old City and Downtown areas, however, traffic capacity of most streets is considerably reduced due to heavy on-street parking. Single line parking is common and double line parking is frequent along the busy streets, thus a 4-lane divided road, for example, is functioning only as a 2-lane divided road.

Inconsistency in number of lane along the same street is affecting smooth traffic movement at El-Mina Street and Tripoli - El-Mina Coastal Road.

1.2 ROAD GEOMETRY AND CONDITIONS

1.2.1 Horizontal and Vertical Alignment

On the flat plain area, road alignments are generally satisfactory for carrying traffic. These roads which climb up the steep slope lying between the flat plain area and a plateau area have substandard alignment with sharp horizontal curves and steep gradient over 8 %. Improvement of substandard alignment is practically impossible due to topographical constraint as well as roadside development.

Alignments of roads in plateau areas are generally satisfactory except for some sections which have substandard vertical alignment.

1.2.2 Cross Section Elements

As discussed in 1.1.5, wide streets are provided in the Study Area except Old City / Downtown areas. There are various widths of carriageway and planned (or intended) utilization of carriageway is not very clear nor consistent. Actual utilization of carriageway seems to be quite different from the planned (or intended) utilization. Figure 1.2-1 shows planned utilization which is assumed by the Study Team and actual utilization of typical streets.

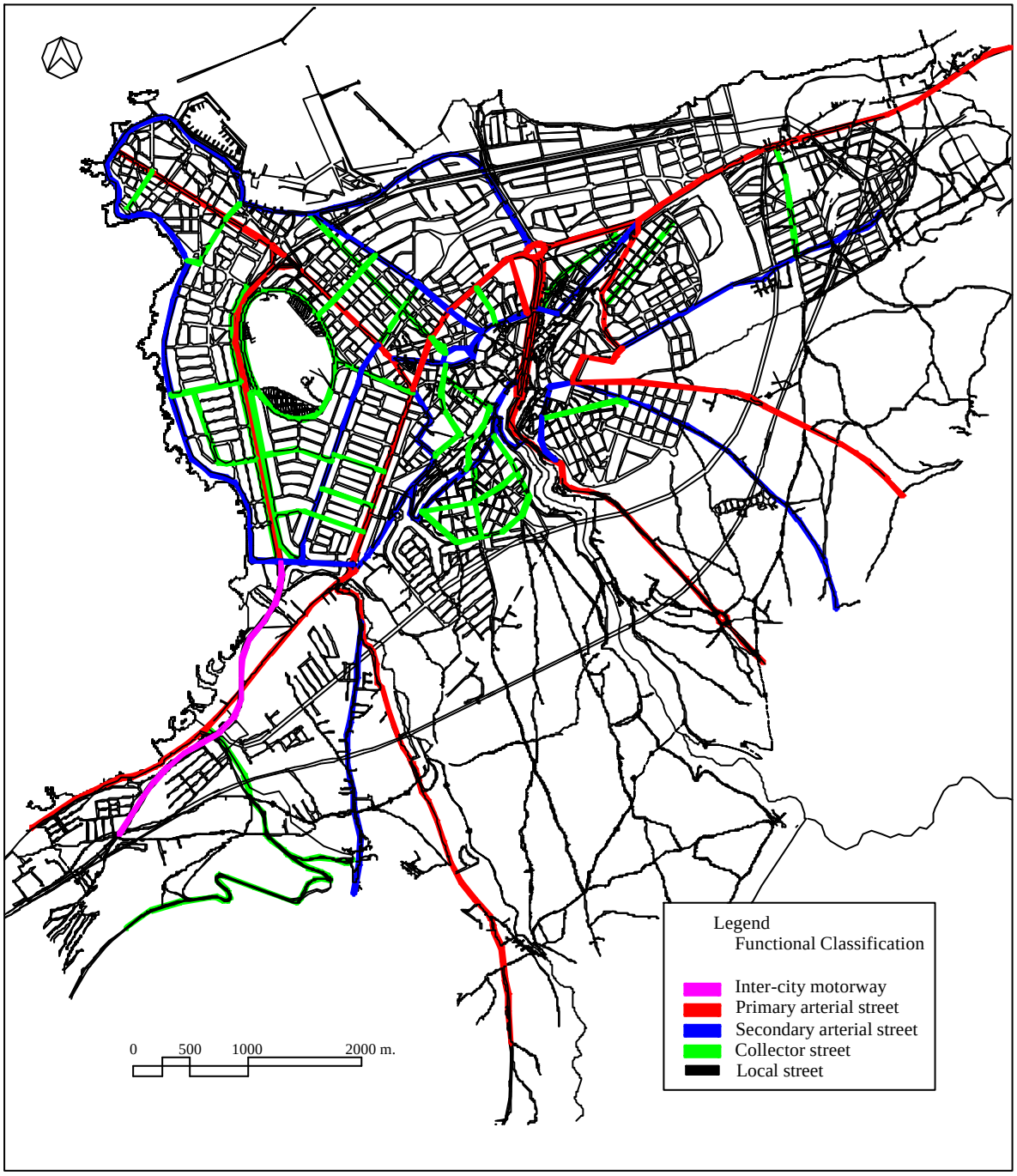

Figure 1.1-3 Functional Classification of Existing Road Network

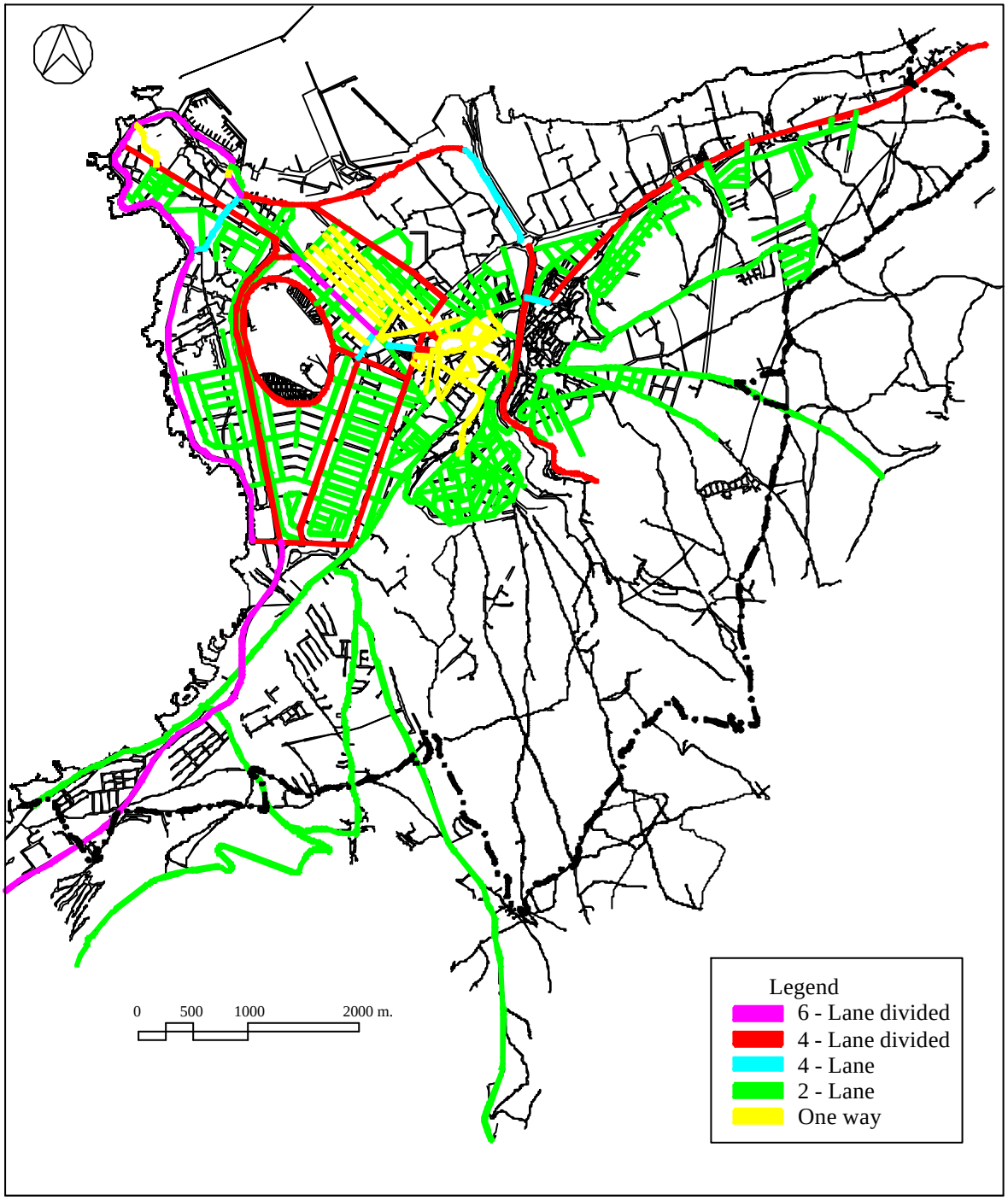

Figure 1.1-4 Number of Lanes of Existing Roads

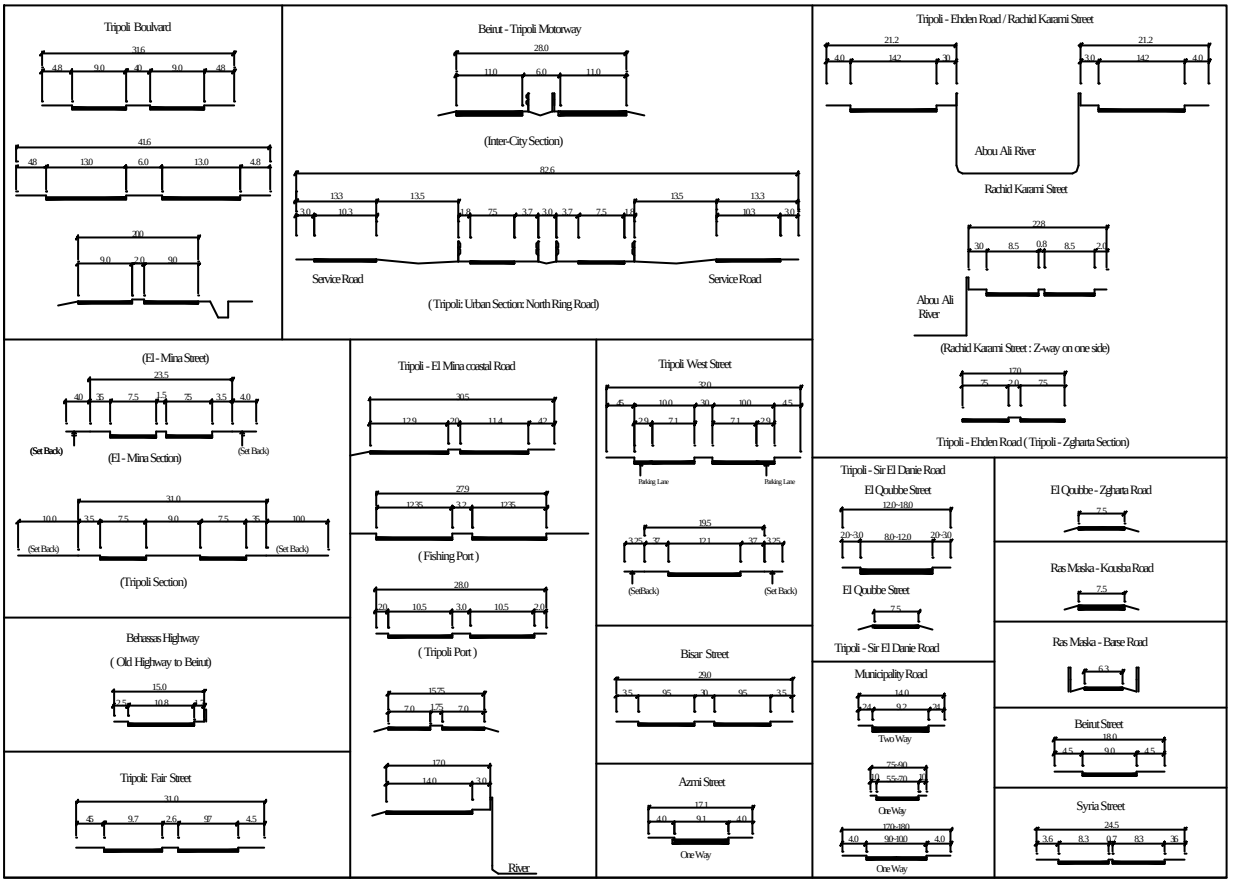

Figure 1.1-5 Cross Sections of Existing Arterial/Collector Streets

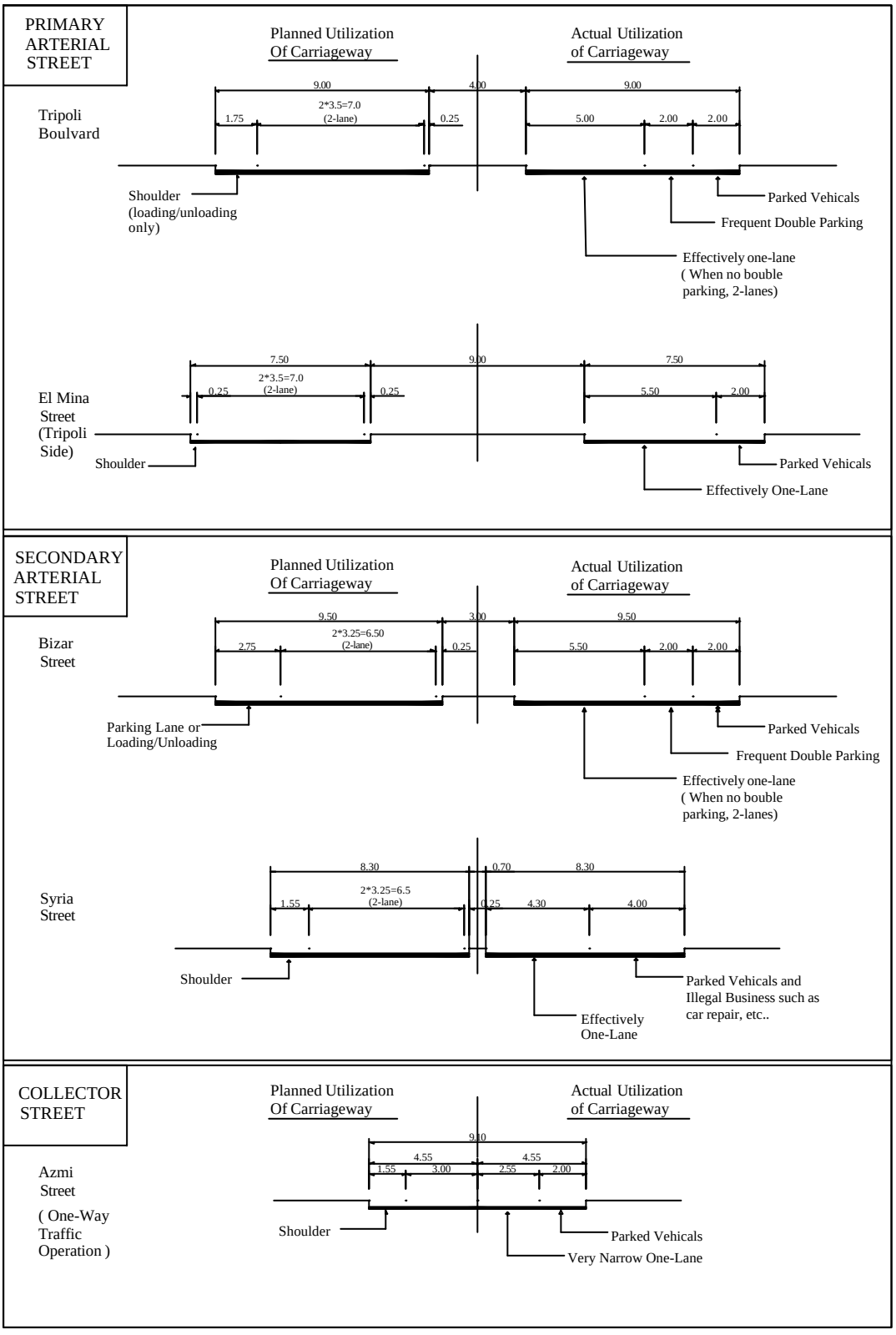

Figure 1.2-1 Utilization of Carriageway

Tripoli Boulevard

Carriageway width (one direction): 9.0 m

Planned utilization: 2-lane @3.5 m = 7.0 m
2.0 m for shoulder or loading/unloading strips

Actual utilization: Parked vehicles occupy about 2.0 m. Another 2.0 m is frequently occupied by double line parking. Remaining 5.0 m space is utilized for traveling traffic which can actually accommodate only one lane.

If the Boulevard is intended to be used as a 4-lane divided road, at least double parking must be strictly prohibited. Preferably no parking should be imposed and only loading/unloading be allowed.

El-Mina Street

Carriageway width (one direction) : 7.5 m

Planned utilization: 2-lane @ 3.5 m = 7.0 m
0.5 m for shoulder (which is too narrow for shoulder)

Actual utilization: 2.0 m for parked vehicles, remaining 5.5 m is for traveling traffic which can be used only for one lane.

If the Street is planned as a 4-lane divided road, no parking must be imposed along the street. In order to allow loading/unloading along the Street, a carriageway should be widened by 1.5 m.

Similar pattern of carriageway utilization is common in the Study Area.

1.2.3 Pavement Condition

Pavement condition of arterial and collector streets is shown in Figure 1.2-2. In general, pavements in the flat plain area are in fair condition, but streets in the plateau area are deteriorated and requiring pavement rehabilitation.

1.3 INTERSECTION GEOMETRY AND CONDITIONS

Problems of intersection geometry are as follows:

- There are many intersections with more than 4 legs and also irregular shaped intersections, all of which make traffic management quite difficult and traffic accident prone.
- A roundabout is usually adopted for above-mentioned intersections, however, its radius is too small to provide enough weaving length between neighboring legs, resulting in small traffic capacity.
- Intersections are located at a short interval.
- Some intersections are located at a steep grade with short sight distance, thus traffic safety is affected.
- Traffic signal at an intersection is not installed yet. Traffic at major intersections is controlled manually by a policeman.
- Channelization at an intersection is not actively introduced yet.

Location of intersections of more than 4 legs, irregular shaped intersection and intersections at steep grade is shown in Figure 1.3-1.

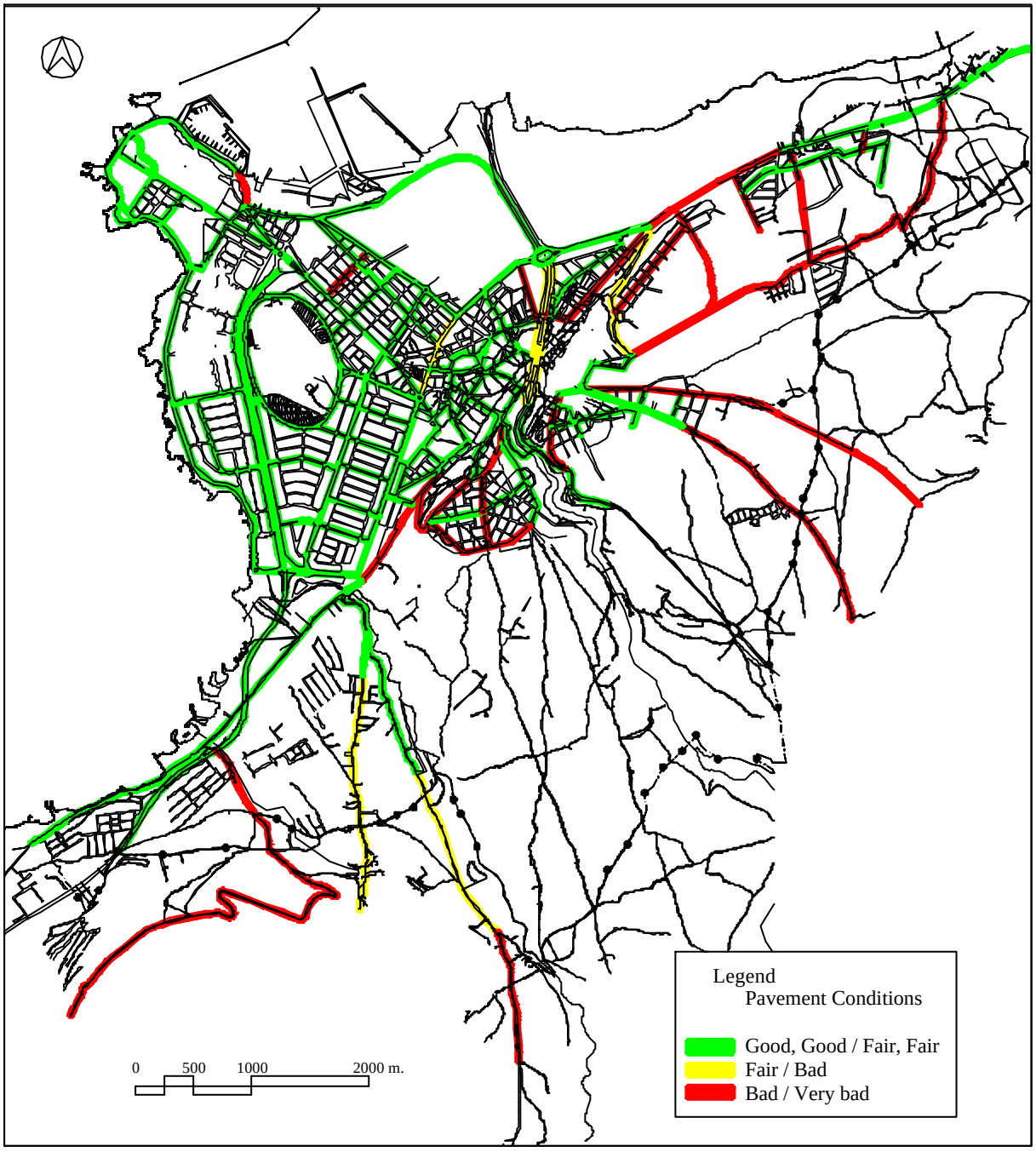

Figure 1.2-2 Pavement Condition

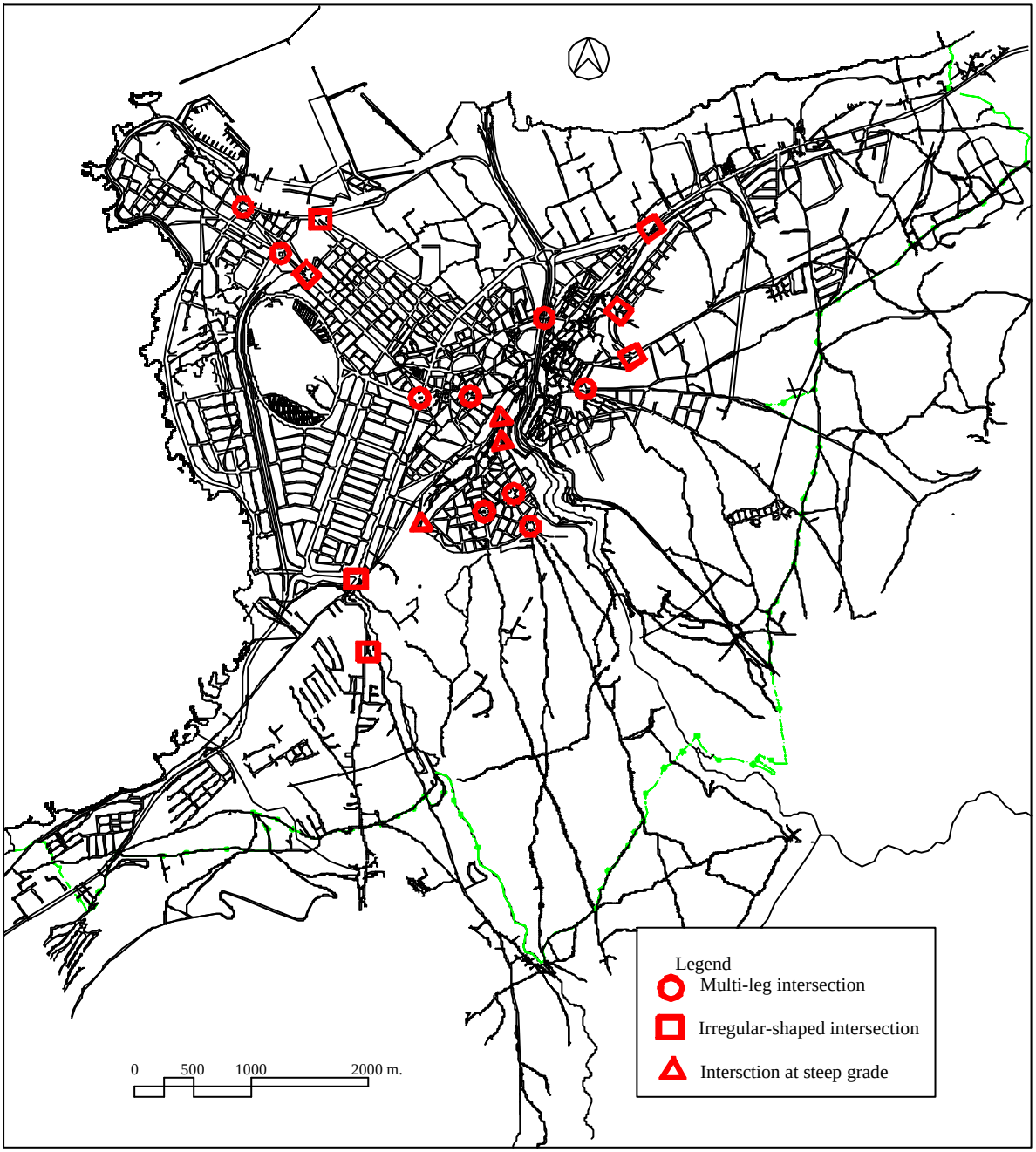

Figure 1.3-1 Intersection with Unfavorable Geometry

1.4 PRESENT LEVEL OF SERVICE ON ARTERIAL STREETS

Level of service of urban streets is expressed by average through-vehicle travel speed and is generally described by Highway Capacity Manual of USA (HCM) as follows:

Level of Service A: Free-flow operation. About 90% of the free-flow speed.

Level of Service B: Reasonably unimpeded operations. About 70% of the free-flow speed.

Level of Service C: Stable operations, however, ability to maneuver and change lanes in midblock locations may be more restricted than at LOS B. About 50% of the free-flow speed.

Level of Service D: Small increases in flow may cause substantial increases in delay and decreases in travel speed. About 40% of free-flow speed.

Level of Service E: Characterized by significant delays. About one-third of the free-flow speed or less.

Level of Service F: Characterized as extremely low speeds. Below one-third to one-fourth of the free-flow speed.

Definitions of level of service under this Study is shown in Table 1.4-1.

Table 1.4-1 Level of Service

	Road Classification		
	Primary Arterial	Secondary Arterial	Collector/ Local
Range of free-flow Speed (km/hr)	70-75	60-50	50-40
Typical free-flow Speed (km/hr)	65	55	45
Level of Service	Average Travel Speed (km/hr)		
A	$\geq$ 55	$\geq$ 50	$\geq$ 40
B	$\geq$ 45	$\geq$ 40	$\geq$ 30
C	$\geq$ 35	$\geq$ 30	$\geq$ 20
D	$\geq$ 27	$\geq$ 25	$\geq$ 15
E	$\geq$ 20	$\geq$ 15	$\geq$ 10
F	< 20	< 15	< 10

Present level of service based on the travel time survey is shown in Figure 1.4-1.

Tripoli Boulevard: Level of service of the central section is F, however, other sections are still high level of service ranging B to C, except around the intersection with Tripoli-Sir ed Danniye Road where a flyover bridge is under construction.

El-Mina Street: Most of the sections are either LOS E or F.

Rachid Karami Street: Due to venders, fruit market activities and parked vehicles, level of service is F.

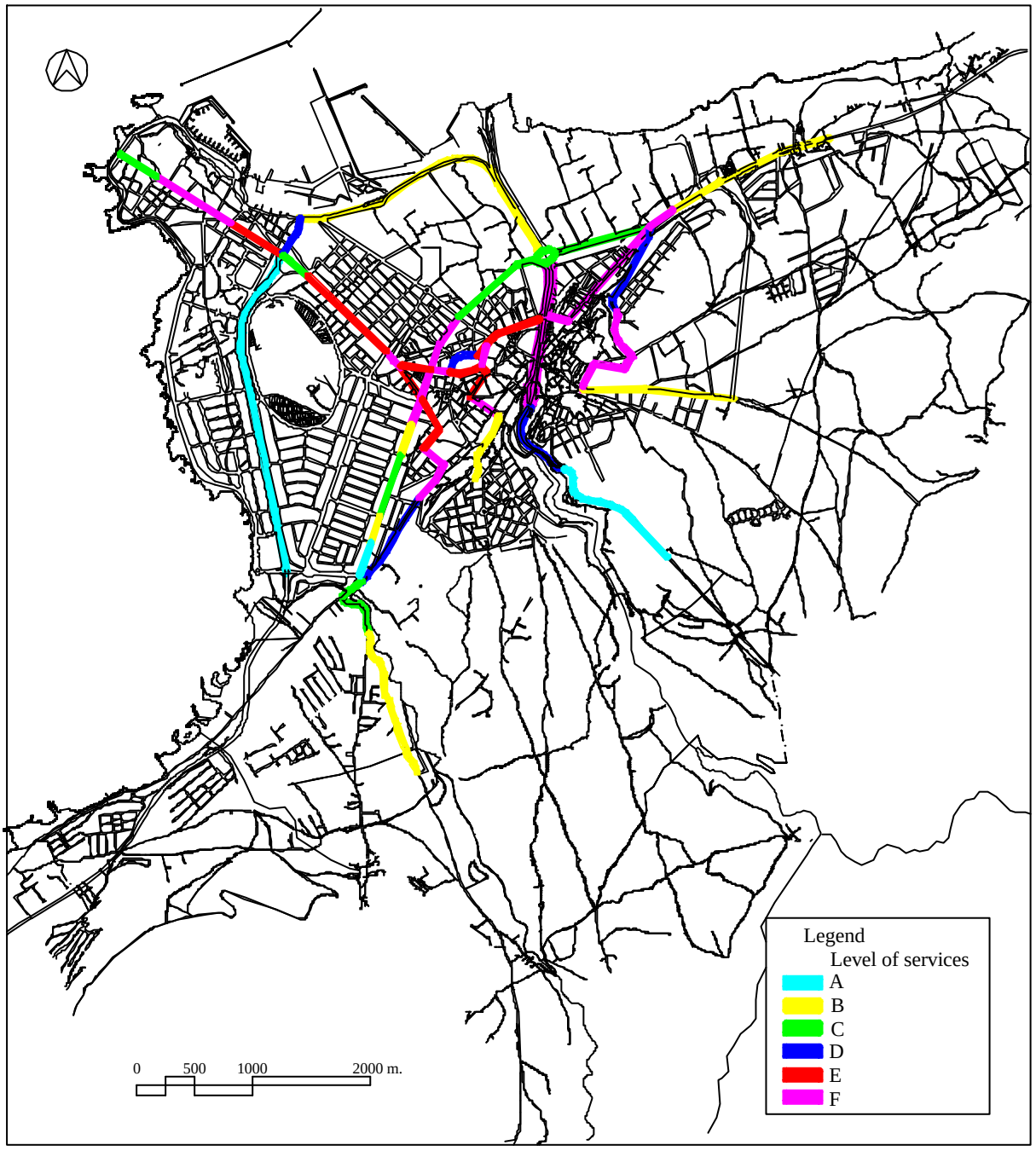

Figure 1.4-1 Present Level of Services

Tripoli - Sir-El-Danniye Road (El-Qoubbe setion): Due to substandard alignment, parked vehicles, concentration of schools, etc., level of service is the lowest level of F.

Roads in Downtown and Old City areas: Due to extremely high density development, narrow roads and heavy parked vehicles, level of service is E or F.

1.5 ROAD NETWORK PROBLEMS

(1) Road Network Formation

- Arterial road network is not well formed yet. Most arterial roads are connected to Tripoli Boulevard and direct connection of one arterial with another is not made yet, but is only made via Tripoli Boulevard. Thus, international, inter-regional and intra-urban traffic is concentrated on Tripoli Boulevard.

- Road network in Old City, Downtown and El-Mina where population density is over 400 persons/km is like a maze and roads are narrow. Level of service of streets in these areas is low at LOS E or F. However, road network improvement is practically impossible due to high density development of roadsides.

- Road network in New Tripoli is fine except an area facing to Tripoli Boulevard, however, all streets were built almost same standards. Functional hierarchy is not achieved.

- Road network in Abou Samra and El-Qoubbe where high density residential area is developed is almost the same condition as that of New Tripoli.

- Steep slopes lying between the flat area and the plateau area are major physical constraint for transport linkage between two areas. Thus, for example, direct connection between Abou Samra and Downtown/Old City is limited and construction of additional transport link is quite difficult.

- Two Rivers; Abou Ali River and Hab Valley are physical constraints for connection of sub-divided plateau areas.

(2) Traffic Condition

- Level of service of streets in the densely developed areas (Old City, Downtown, New Tripoli, El-Mina, Abou Samra, and El-Qoubbe) is quite low reaching to LOS E or F.

- Major factor affecting LOS in above areas is on-street parking. Single-line parking on both sides of street is common and double-line parking is frequent on busy streets.

- Most streets were constructed without provision for on-street parking, therefore, parked vehicles narrow the carriageway for traveling traffic and side friction is quite heavy due to in and out movements of vehicles for parking.

- Multi-leg and irregular-shaped intersections located at a short interval are delaying travels and affecting level of service.

- Bad manner of most drivers and behavior of service taxi are affecting level of service.

(3) Road and Intersection Geometry

- Horizontal and vertical alignment of roads which climb up the steep slope area such as access roads to Abou Samra, El-Qoubbe and Ras-Maska are substandard. However, improvement of alignment is difficult due to topographical condition and heavy roadside development.

- There are many intersections of which geometry is to be improved and chanalization to be introduced.

(4) Traffic Safety

- Traffic safety is affected at many intersections where geometry is to be improved and along major arterial streets, on which vehicles are driving very fast and provisions for pedestrians safety need to be provided.

(5) Urban Environment

- Traffic concentration on limited arterial roads such as Tripoli Blud. and regional roads due to incomplete arterial road network is causing traffic pollution which is worse than that of Beirute.

- Incomplete arterial road network is delaying spatial urban development resulting in concentration of socioeconomic activities in the existing urbanized area, which is causing deterioration of urban environment of the existing urbanized area.

CHAPTER 2

ROAD NETWORK DEVELOPMENT PLAN

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ROAD NETWORK DEVELOPMENT PLAN

2.1 PLANNING CONCEPT

2.1.1 Road Network Development Objectives and Strategies

Road Network Development Objectives

In line with the urban transport policy and scenario, objectives of road network development were established as follows:

1) To strengthen the Greater Tripoli's setting as an international node and the regional capital.
2) To guide the urban growth in the planned direction to achieve the spatial development.
3) To alleviate traffic congestion in the existing urban area.
4) To improve urban environment and amenity and to preserve historical and cultural heritage.

Road Network Development Strategies

In order to realize the objectives above, strategies are established as follows:

1) To reinforce international and inter-regional road network in harmony with intra-urban network.
2) To enlarge and reinforce the physical foundation of the transport infrastructure to cope with the requirements of the future urban economic growth.
3) To provide high quality transport service between the existing urban area and the planned development area and between the planned development areas.
4) To provide anti-air pollution facilities such as grade-separations at intersections along the primary arterial streets.
5) To maintain present road network in the existing urban area where traffic condition shall be improved by traffic management measures.

2.1.2 Arterial Road Network Development Concept

1) Present Arterial Road Network Pattern

Present arterial network pattern is schematically shown in Figure 2.1-1. Characteristics of the present network are as follows:

- Most of arterial roads are connected with Tripoli Boulevard which is functioning as a single backbone of the network in the Study Area.
- Inter-linkage of arterial roads is not achieved yet. Thus, the network is not flexible in terms of route selection from the side of the road users.
- Traffic capacity expansion of steep slope sections of inter-regional roads is practically impossible due to topographical constraint and roadside development.
- Present urban development is so concentrated at the limited areas that urban functions are being deteriorated. However, the present network is not formed to guide urban development in the new areas for development.

2) Proposed Arterial Road Network Pattern

Proposed arterial road network pattern is shown in Figure 2.1-1 which can be compared with the present pattern. Basic concepts of the proposed network is as follows:

- A ring and radial type of network pattern is formed to guide the planned spatial urban development.
  - East Ring Road and West Ring Road are connected to form a ring.
  - Inter-regional roads function as radials.
  - Tripoli Boulevard continues to function as a central backbone.
- A ring road links the present urban area with the planned development area and the planned development areas each other.
- A ring road is placed at the outer fringe of the existing high-density residential areas and the planned development areas. Traffic generated from these areas can use a ring road to reach its destination without passing on radials, which have limited capacity.
- A ring road distributes traffic from outside the Study Area on radials.
- International linkage is made by a new motorway placed along the Study Area boundary. Through traffic of Greater Tripoli can be diverted to a new motorway and is not required to pass through the developed urban area.

2.2 PROPOSED ROAD NETWORK DEVELOPMENT PLAN

Proposed road network development plan formulated based on the development objectives and concepts are shown in Figure 2.2-1. Road length and density (km/sq.km) of the plan by functional road classification is shown in Table 2.2-1.

Table 2.2-1 Road Lengths and Density

Functional Classification	Present (2000)		Year 2020	
	Road Length (km)	Road Density (km/sq.km)	Road Length (km)	Road Density (km/sq.km)
International Motorway	3.61	0.10	11.08	0.32
Primary Arterial	29.02	0.83	47.53	1.36
Secondary Arterial	29.15	0.83	36.10	1.03
Collector	26.62	0.76	44.64	1.27
Total	88.40	2.52	139.35	3.97

Major features of the proposed road network are as follows:

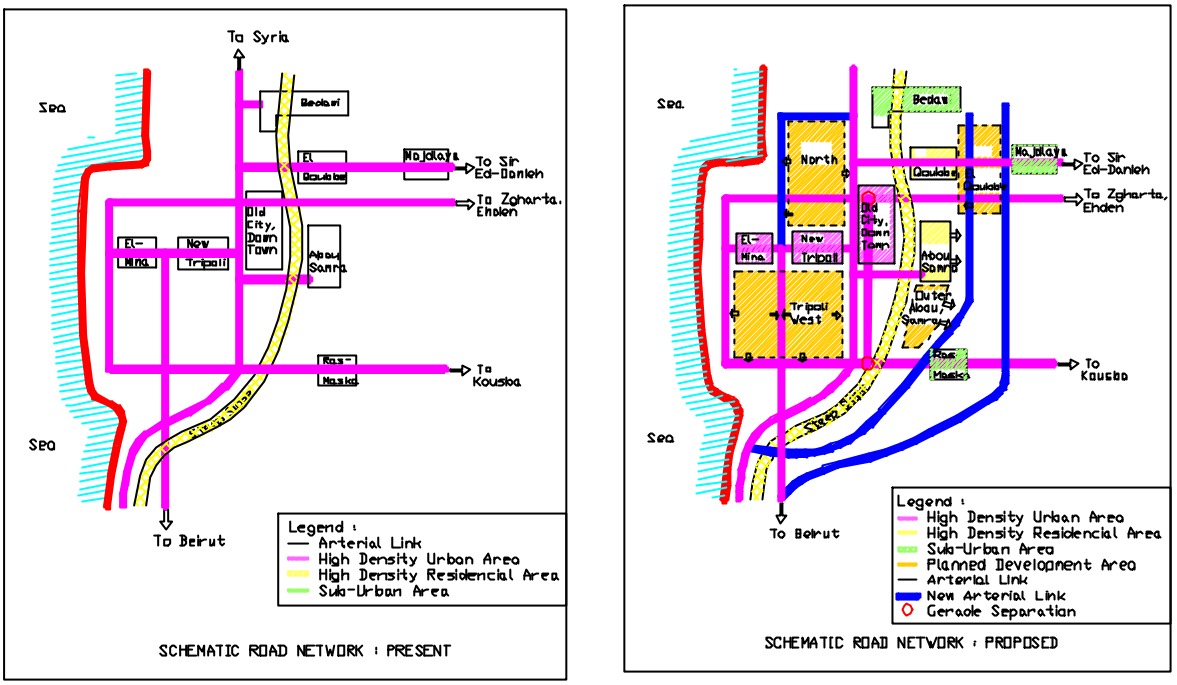

Figure 2.1-1 Present and Proposed Schematic Road Network

Arab Highway is planned as an international motorway with access-controlled standard, and is the extension of the existing Beirut-Tripoli Motorway. It has a road length of 11.1 km within the Study Area and is further extended to the border between Lebanon and Syria. The feasibility study was completed in 1998.

It is planned to be a 6-lane divided motorway with the design speed of 100 km/hour. Five interchanges are planned within the Study Area. Typical cross section of motorway is shown in Figure 2.2-2.

East Ring Road branches off from Beirut – Tripoli Motorway at Abou Halga Valley in the south, then traverses Ras-Maska, Abou Samra and El-Qoubbe Plateaus passing along the outer fringe of high density residential areas of Abou Samra and El-Qoubbe and ends at Tripoli Boulevard in the north. It should be extended up to Behsass Highway in the south and up to West Ring Road in the north. It has a total length of 8.5 km. The road right-of-way of 32 m has been reserved along the most of the sections. Proposed typical cross section is shown in Figure 2.2-2. It is planned to be a 4-lane divided road with 2.5 m – loading / unloading strip and wide center median. It can be converted to a 6–lane divided road in future when traffic problem is observed.

This Ring Road will attract traffic generated in the existing high density residential areas of Abou Samra and El-Qoubbe as well as the planned development areas of outer Abou Samra and El-Qoubbe, thus traffic generated from these areas is not required to pass through inter-regional roads which have traffic capacity constraint at the slope section.

It also links the currently disconnected sub-plateaus and inter-linkage among El-Qoubbe, Abou Samra and Ras-Maska will be established.

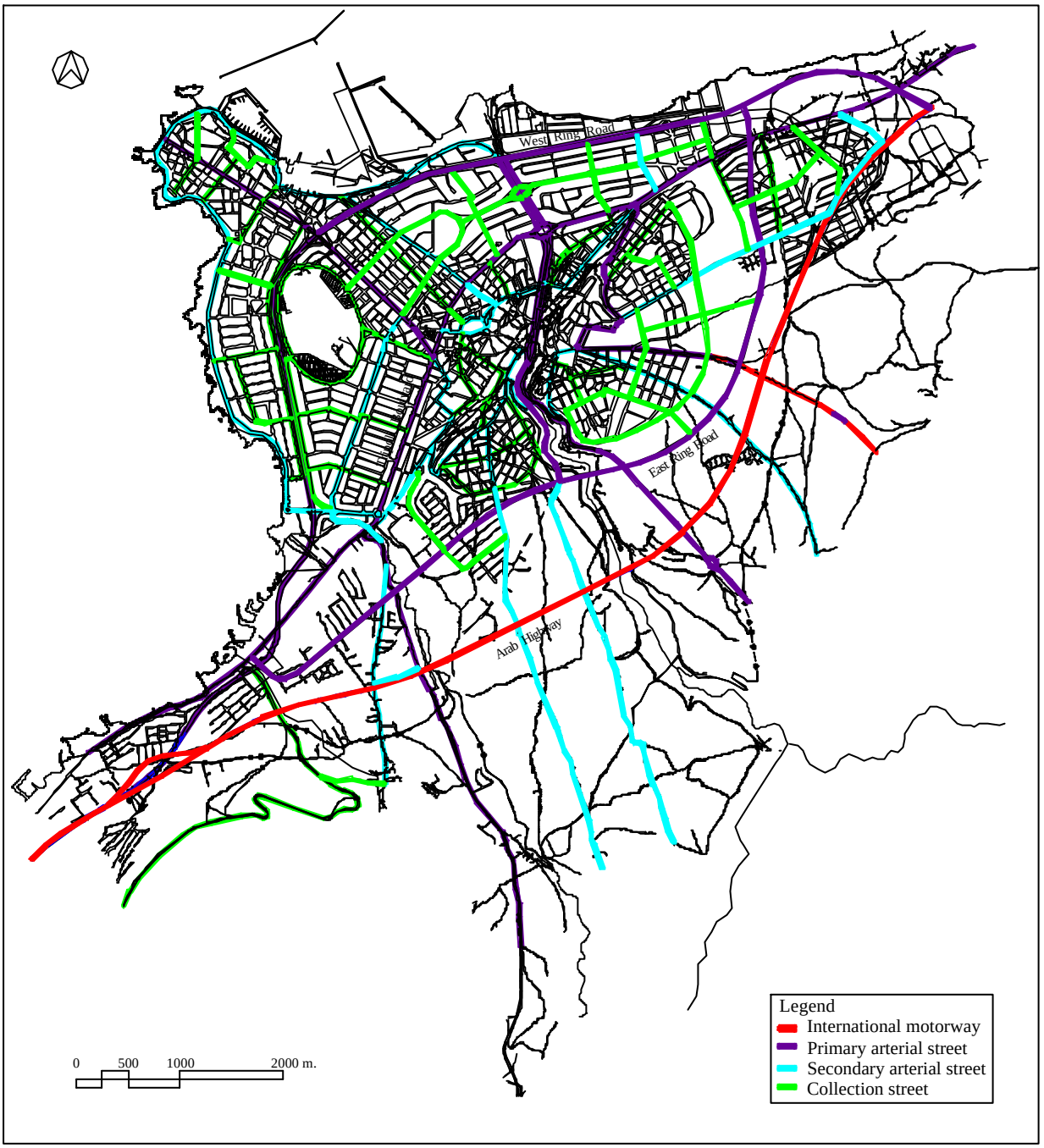

Figure 2.2-1 Proposed Road Network Plan

West Ring Road is partially completed from Behsass to El-Mina Street, which was constructed as an exit section of Beirut – Tripoli Motorway with access controlled standards. The existing section will be extended passing through the planned development area of Tripoli North and connected with Tripoli Boulevard and Arab Highway in El-Bedaoui. The existing section is a 4-lane divided road with service roads on both sides of the main road and wide separators (or belts) are provided in-between the main road and the service roads. Road right-of-way is 82.6 m.

New section to be extended from the existing section is planned to build within the right-of-way of 80m, which is reserved in the lately approved Land Readjustment Plan for Tripoli North Area. The right-of-way will accommodate a 4-lane divided road, service roads on both sides and green belts, one of which will be utilized for a railway right-of-way in the future (see Figure 2.2-2).

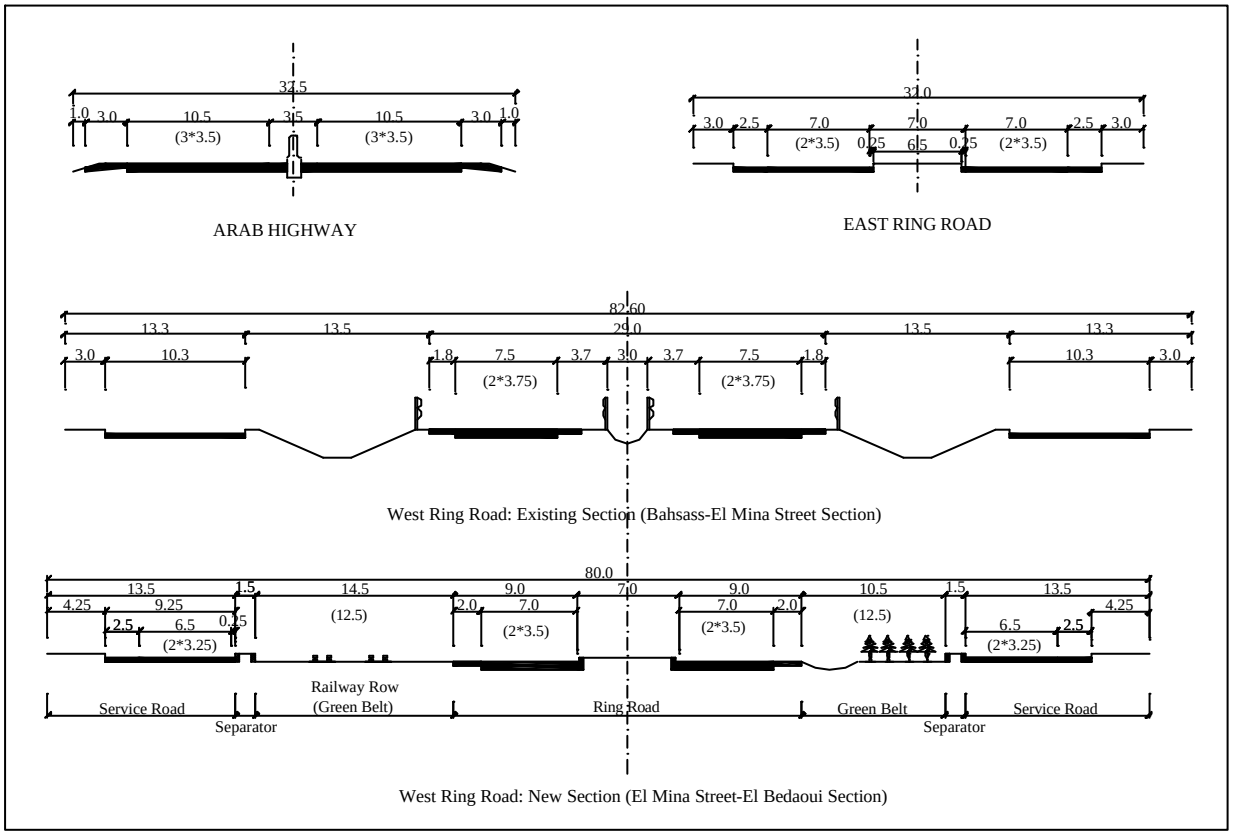

Figure 2.2-2 Typical Cross Sections of Arab Highway and Ring Roads

CHAPTER 3

ROAD PROJECTS

CHAPTER 3

ROAD PROJECTS

3.1 ROAD PROJECTS

In line with road network development objectives and strategies, and present and future traffic demand, road projects were identified as shown in Table 3.1-1. Road projects were classified by type of work into: (A) Road Improvements and Widening, (B) New Road Construction, and (C) Grade Separation/ Underpass. Location of road projects by type of work is shown in Figure 3.1-1.

Road Improvement and Widening

A01 Tripoli – Syria Road

The road is an extension of Tripoli Boulevard. The existing section is a 4-lane divided road. Traffic at present is heavy at about 35,000 vehicle/day. Widening to a 6-lane divided road is proposed within the existing road right-of-way. Until such time that Arab Highway is constructed, the Road will function as an international highway.

A02 Tripoli – Sir El-Danie Road

The first section between the intersection with Tripoli Boulevard and the intersection with Qoubbe - Zgharta Road, has no room for improvement, although traffic problem is expected. Therefore, improvement is focused on the second section from the intersection with Qoubbe - Zgharta Road to East Ring Road, so that traffic will utilize East Ring Road instead of the first section. The second section is improved as a 4-lane road and the third section which is beyond East Ring Road as a 2-lane road with paved shoulders.

A03 Qoubbe – Zgharta Road

The road is improved as a 2-lane road with paved shoulder.

A04 Abou Samra East Road

Southern area of Abou Samra Plateau is still predominantly agricultural land. The existing road can be described as an agricultural road. The existing road is to be improved as a 2-lane road.

A05 Abou Samra West Road

The road is the same situation as Abou Samra East Road. It is improved to be a 2-lane road.

A06 Ras-Maska – Kousba Road

This road is an important link serving for the southeastern area of the study area and has heavy traffic requiring widening to a 4-lane road. To connect this road with East Ring Road is difficult due to topographical constraint therefore, a link road between this road and Ras-Maska – Barsa Road is proposed along Arab Highway. Also a link road which branches off at about 120 m from the intersection with Behsass Highway and directly connected with Tripoli West area is proposed which requires about 200 m viaduct.

A07 Ras-Maska – Barsa Road

This road is narrow and needs to be improved to a standard 2-lane road.

Table 3.1-1 Road Projects

Development Objectives	Development Strategy		*Road Project*			
			Code No.	*Project Name*	Type of Improvement	*Scope of Work*
1) To Strengthen the Greater Tripoli's Standing as an international node and the regional capital	a) To reinforce international and inter-regional road network in harmony with intra-urban network.		B03	Arab Highway	New Construction	L = 11.1 km, 5 I/C, Bridge = 630 m, 6-lane divided
			A01	Tripoli – Syria Road	Widening	L = 2.93 km, From 4-lane to 6- lane
			A02	Tripoli – Sir El Danie Road	Improvement	L = 5.4 km, 2 – lane
			A03	Qoubbe – Zgharta Road	Improvement	L = 4.2 km, 2 – lane
			A04	Abou Samra East Road	Improvement	L = 2.5 km, 2 – lane
			A05	Abou Samra West Road	Improvement	L = 2.5 km, 2 – lane
			A06	Ras Maska – Kousba Road	Widening	L = 5.0 km, From 2 – lane to 4 – lane
			A07	Ras Maska – Barsa Road	Improvement	L = 2.6 km
			A08	Ras Maska – Dedde Road	Improvement	L = 2.8 Km, 2 – lane
			A09	Behsass (Old) Highway	Widening	L = 3.6, From 2 – lane to 4 – lane
2) To guide the urban growth in the planned direction to achieve the spatial development	b) To enlarge and reinforce the physical foundation of the transport infrastructure to cope with the requirements of the future urban economic growth	c) To provide high quality transport service between the existing urban area and the planned development area and between the planned development areas	B01 (a)	East Ring Road	New Construction	L = 8.5 km, Bridges = 620 m 4lane divided
			B01 (b)	Related Roads of East Ring Road	New Construction	n = 3 roads, L = 4.8 km 2 ~ 4 lane
			B01 (c)	Grade Separation along East Ring Road	New Construction	n = 10
			B02 (a)	West Ring Road with 2 grade separation	New Construction	L = 6.4 km, 4 – lane divided, 2 Grade Separation
			B02 (b)	Related roads of West Ring Road	New Construction	n = 2 roads, L = 1.25 km
			B03 (c)	Grade Separation along West Ring Road	New Construction	n = 4
			C02 (b)	Grade Separation to provide linkage for divided communities	New Construction	n = 2 (along existing section of East Ring Road)
3) To alleviate traffic congestion in the existing urban area		d) To provide grade separation facilities at intersection along the primary arterial street	*C01*	Tripoli Boulevard Underpass	New Construction	L = 1.35 km
			C02 (a)	Grade Separation of critical intersections	New Construction	n = 3
4) To improve urban environment and amenity and to preserve historical and cultural heritage		e) To maintain present road network in the existing urban area where traffic condition shall be improved by traffic management measures		(Traffic Management Measures)		

A08 Ras-Maska – Dedde Road

The road is narrow with no shoulder and roadside drainage is not sufficient. It is proposed to be improved to a 2-lane road correcting present deficiencies.

A09 Behsass (old) Highway

Beach resorts are developed along this Highway. Traffic during summer period is quite high due to visitors to beach resorts. Even off – summer period, traffic is heavy requiring widening. It is proposed to be a 4-lane road.

2nd. New Construction

B01 East Ring Road

Concept of this road is discussed in 2.2. For effective and efficient utilization of this road, development of related roads is important, so that traffic generated at the existing high density residential areas and the planned development areas of Ras-Maska and El-Qoubbe is attracted by this road. Related roads to be developed are shown in Figure 3.3-1. Grade separation is planned to be constructed at 10 locations.

B02 West Ring Road

Concept of this road is discussed in 2.2. Two related roads proposed to be constructed. A total of 6 grade separations are planned, of which 2 (at El-Mina Street and at Bisar Street) are simultaneously constructed at the time of a main road.

B03 Arab Highway

Concept of this road is discussed in 2.2. Three bridges are required to be constructed. Five interchanges are proposed at intersecting location with major roads.

3rd. Grade Separation / Underpass

C01 Tripoli Boulevard Underpass

The section (775m) from Fawizi Street (or An Nour Square) to Bisar Street of Tripoli Boulevard is the busiest area concentrated with commercial and business establishments, Municipal Office, and tourist spots. Within the 775m section, there are 4 major intersections with an interval of 220m to 295m. Concentration of traffic and succession of intersections in short distance is seriously deteriorating traffic condition, level of service which is assessed F at present, and air quality. Even the planned spatial development is progressed, the subject area's setting as the center of commercial and tourist attraction will continue. A drastic measure is required to adopt for this section and an underpass is proposed. There are several schemes to be evaluated to select the optimum solution. Under the master plan stage, the proposed plan is that through traffic of Tripoli Boulevard underpasses all 4 intersections. The project length is estimated at 1.56km.

C02 Grade Separation

Two types of grade separation projects are planed. One (CO2 (a)) is to cope with traffic problem at an intersection and the other (C02 (b)) is to provide a linkage between the divided areas by the access controlled highway.

C02 (a) : 3 locations (intersecting points among Behsass Highway, Tripoli Boulevard, Beirut Street and Tripoli West Street, intersecting point between Beirut Street and new Abou Samra Access Road and intersecting point between Rashied Karami Street and Municipal Street.

C02 (b) : 2 locations along the existing section of West Ring Road. Tripoli West area is divided by the existing section of West Ring Road which is being operated as the access controlled facility.

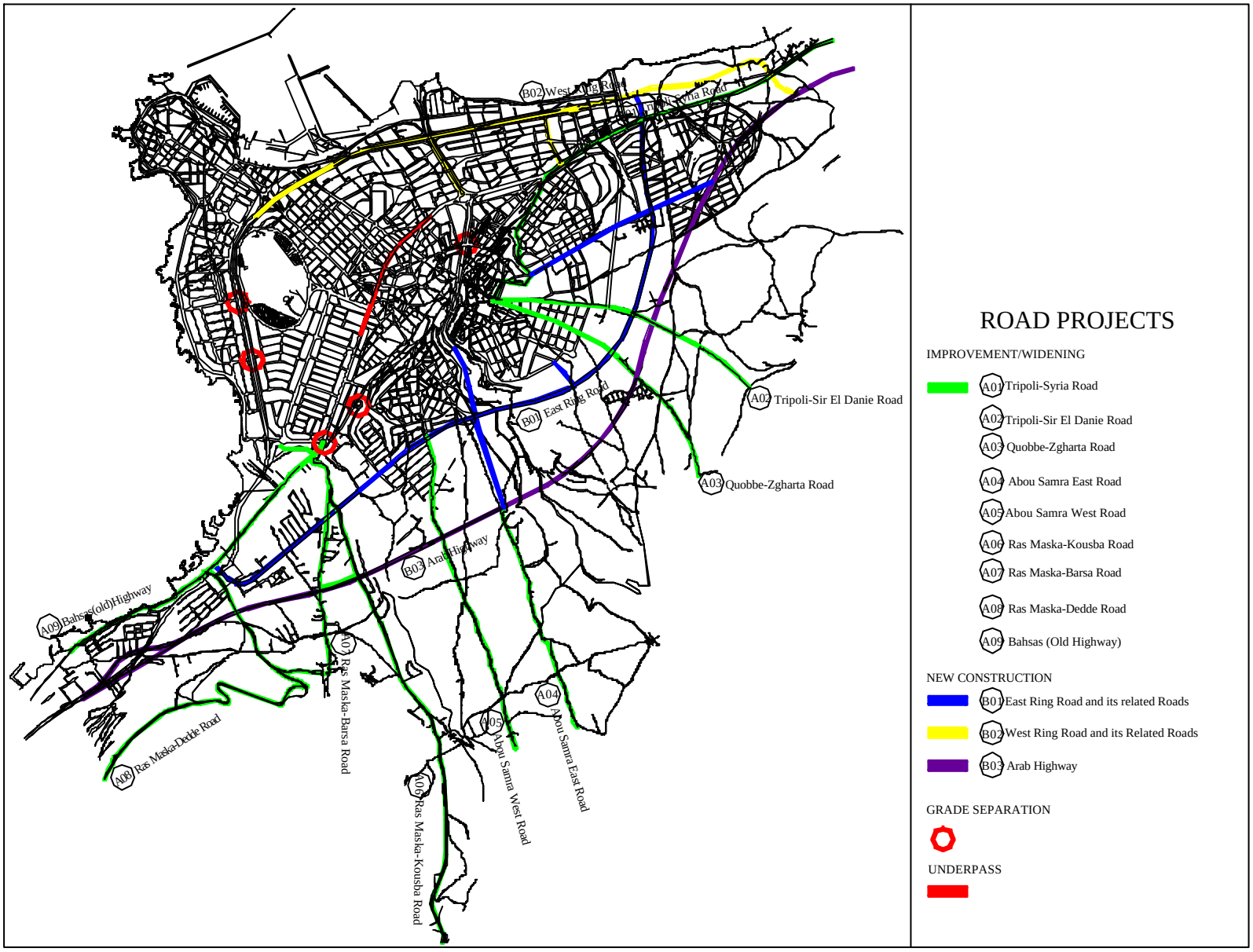

Figure 3.1-1 Location Map of Road Projects

3.2 INTERSECTION IMPROVEMENT PROJECT

Intersection problems in terms of geometry are discussed in 1.3, and summarized as follows:

- Roundabout type of intersection with small radius
- Multi–leg intersection, most of which are round about type
- Irregular–shaped intersection
- Intersection located at steep grade
- Lack of channelization

1) Roundabout Type of Intersection with Small Radius

Roundabout type of intersection with small radius with 3 or 4 legs is recommended to be modified to an ordinary 3 or 4–leg intersection. However, many of roundabouts are constructed with a monument or statue at the center of roundabout which is difficult to remove. Such roundabouts need to be remained as it is, and traffic problems must be solved by traffic management measures.

2) Multi-leg Intersection

Roundabout type of intersection is adopted for multi-leg intersections. Roundabouts along major streets such as Tripoli Boulevard and El-Mina Street were constructed with relatively large radius. Roundabout in Old City and residential areas such as Abou Samra and El-Qoubbe were constructed with small radius, and improvement to larger radius roundabout is difficult due to roadside development. Traffic management measures is needed to reduce traffic entering to the roundabout, for example, by introducing one-way operation. Some roundabouts have already adopted this method by allowing entering traffic only at 3-leg for 5-leg roundabout and remaining 2-leg exclusively departing traffic (or one-way for departing traffic). Such measures needs to be adopted in due consideration of area-wise traffic movement.

3) Irregular –shaped Intersection

Due to complicated road network, irregular shaped intersections exist at several locations. Various measures should be studied as follows:

- Modification of road network, particularly layout of local street
- Introduction of one-way street
- Proper channelization

4) Intersection Located at Steep Grade

Improvement of geometry of this type of intersection is difficult due to topographical constraints. To improve traffic safety at such an intersection, traffic signal should be installed

5) Lack of Channelization

Channelization should be introduced wherever possible. It is proposed that improvement of intersection geometry should be done together with an installation of traffic signal, thus intersection improvement projects are included also the traffic signal installation projects.

3.3 PRELIMINARY COST ESTIMATE

3.3.1 Bases of Preliminary Cost Estimate

1) Unit Prices of Construction Items

Preliminary Cost estimate was carried out based on the prevailing unit prices and previous studies. Unit prices of major construction items are shown in Table 3.3-1.

Table 3.3-1 Unit Price of Major Construction Items

Construction Item	Unit	Unit Price (L.L at 2001 prices)
Earthwork		
• Roadway excavation (Ordinary Soil)	m^3	4,100
• Roadway excavation (Rock)	m^3	6,200
• Bore	m	15,000
• Structural excavation (Ordinary Soil)	m^3	5,000
• Structural excavation (Rock)	m^3	12,000
• Drainage excavation	m^3	5,000
Pavement Work		
• Crushed stone subbase course	m^3	12,500
• Crushed stone base course	m^3	30,000
• Bituminous concrete	ton	50,200
Structural Work		
• Concrete (for RC Structure)	m^3	95,000
• Concrete (for DC Structure)	m^3	114,000
• Reinforcing steel	Kg	8,200
• Steel for prestressed concrete	Kg	900
Drainage		
• RCPC (ϕ 600)	l m	145,000
• RCPC (ϕ 800)	l m	280,000
• RCPC (ϕ 1200)	l m	390,000
Miscellaneous		
• Gabion	m^3	95,000
• Grouted Rip Rap	m^3	105,000
• Curb and Gutter	l m	125,000

2) Engineering and Construction Supervision Cost

Detailed design cost was estimated to be 4 % of construction cost and construction supervision cost as 10% of construction cost.

3) Right–of–Way Acquisition Cost and Compensation Cost

Road right–of–way of major roads such as East and West Ring Roads and Arab Highway is acquired through the Land Readjustment Project, wherein land owners are required to donate 25 % of their land for public use. Thus, right–of–way is acquired free of charge by the Government. When the Land Readjustment Plan is authorized by law, land designated as the public land, development of reserved right–of–way is strictly controlled, thus, compensation cost is assumed not required.

4) Economic Cost

Based on the results of previous studies, economic cost is estimated to be 94.8 % of financial cost.

3.3.2 Estimated Preliminary Cost

Preliminary cost of road projects is summarized in Table 3.3-2.

Table 3.3-2 Estimated Preliminary Cost of Road Projects (Billion L.L. in 2001 prices)

Code No.	Project Name	Financial Cost			Economic Cost
		Engineering Cost	Construction Cost	Total	
A	Road Improvement and Widening				
A01	Tripoli – Syria Road	0.31	2.62	2.93	2.78
A02	Tripoli – Sir El-Danie Road	0.26	2.17	2.43	2.30
A03	Qoubbe – Zgharta Road	0.20	1.69	1.89	1.79
A04	Abou Samra East Road	0.17	1.41	1.58	1.50
A05	Abou Samra West Road	0.24	2.03	2.27	2.5
A06	Ras-Maska – Kousba Road	0.69	5.71	6.40	6.07
A07	Ras-Maska – Barsa Road	0.27	2.27	2.54	2.41
A08	Ras-Maska – Dedde Road	0.13	1.13	1.26	1.19
A09	Behsass (Old) Highway	0.38	3.13	3.51	3.33
Sub – total		2.65	22.16	24.81	23.52
B	New Ring Road				
B01 (a)	East Ring Road	3.04	25.29	28.33	26.86
B01 (b)	Related Roads	0.74	6.13	6.87	6.51
B01 (c)	Grade Separation	2.41	20.09	22.50	21.33
B01	B01 Total	6.19	51.51	57.50	54.70
B02 (a)	West Ring Road	1.61	13.45	15.06	14.28
B02 (b)	Related roads	0.16	1.34	1.50	1.42
B02 (c)	Grade Separation	0.95	8.05	9.00	8.53
B02	B02 Total	2.72	22.84	25.56	24.23
B03	*Arab Highway*	10.18	84.82	95.00	90.06
Sub-Total		19.09	159.17	178.26	168.99
C	Grade Separation / Underpass				
C01	Tripoli Boulevard Underpass	3.00	26.40	29.40	25.20
C02	Grade Separation	5.65	45.45	51.10	43.80
Sub-total		8.65	71.85	80.50	69.00
TOTAL		30.39	253.18	283.57	261.51

CHAPTER 4

IMPLEMENTATION PRIORITY AND SCHEDULE

CHAPTER 4

IMPLEMENTATION PRIORITY AND SCHEDULE

4.1 IMPLEMENTATION PRIORITY

4.1.1 Prioritization Criteria

Priority of a road project was assessed from the viewpoints of 4 aspects, each of which consist of several items as shown in Table 4.1-1.

Planning Aspect

1) Compatibility with National/ Regional Development Plan

A project which is included in the National (or CDR's) plan or Regional (or Municipality's) Plan is given high priority.

2) Impact on Land Development

A project which serves for a large area to be developed and to guide planned urban development is given high priority

3) Impact on Socio-economic Activity

A project which traverses commercial/ business/ tourism/ academic activity areas or major traffic attraction areas is given high priority

4) Project Maturity

A project of which fund has been prepared or the detailed design is on-going/ completed is given high priority followed by a project of which a Feasibility Study is completed. A project which is under planning stage is given low priority.

Technical Aspect

1) Urgency (Degree and scale of problems)

For an existing road project, present level of service is used for the assessment of urgency. An existing road project of which LOS E and F is given high priority.

For a new road project, its priority is assessed either by urgency of land development where it serves or by its traffic impact on the existing road sections.

2) Improvement Scale (Size of project)

A project of which improvement scale expressed by (an improvement section length) x (number of lane) is small, is given high priority.

3) Role in Road Network

A project of which hierarchy is high in the road network system such as an international motorway and primary arterial street is given high priority.

Table 4.1-1 Prioritization Criteria of Road Project

Aspect	Evaluation Item		Indicator	Priority		
				High (H)	**Medium (M)**	**Low (L)**
Planning Aspect	1) Compatibility with National/ Regional Plan		· Included in CDR's plan or Municipality's Plan	· Included	· To be included soon	· To be included later
	2) Impact on Land Development		· Land area for development to be Served	· Over 500 ha.	· 100-500 ha	· Less than 100 ha
	3) Impact on Socio-economic Activity		· Land use along the project	· Predominantly commercial / industry/ tourism business	· Predominantly residential	· Predominantly agricultural
	4) Project Maturity		· Project status	· Fund prepared/ committed	· F/S completed or to be completed	· Planning stage
Technical Aspect	5) Urgency	Existing Road	· Present Level of Service	E,F	D	A,B,C
		New Road	· Status of land development	· Developing	· Development to start	· Development in future
	6) Improvement Scale		· Improvement length x No. of lane	· Less than 10 lane-km	10-20	· Over 20 lane-km
	7) Role in Road Network		· Functional classification	· International · Primary Arterial	· Secondary Arterial	· Collector
	8) Technical Difficulty		· Type of work requirements	· Mostly earth work/ pavement	· Minor structure	· Large scale structure · Detour for traffic
Environmental Aspect	9) Effect on Health		· Impact on air pollution mitigation	· High	· Medium	· Low
	10) Social Impact		· Right-of-way acquisition and resettlement of people	· Minimal	· Intermediate	· Extensive
	11) Natural Impact		· Impact on flora	· Minimal	· Medium	· High
	12) Social Impact		· Degree of acceptance	· Minimal	· High acceptance	· Medium Acceptance
Benefit Aspect	13) Traffic Demand		· Traffic volume in 2020	· Over 30,000	· 10,000 ~ 30,000	· Less than 10,000
	14) Cost Scale		· Construction cost	· Less than 10 Billion LL	· 10 ~ 30 Billion LL	· Over 30 Billion LL
	15) Benefit Scale		· Share of a project benefit to total Master Plan benefit	· High	· Medium	· Low

4) Technical Difficulty

A project which requires long-span bridges, extensive slope protection works, extensive provisions for traffic detour / management during construction is given low priority. A technically simple project is given high priority.

Environment Aspect

1) Effect on Health

A project which has high impact on mitigation of air pollution is given high priority.

2) Social Impact

A project which has low impact on land acquisition and resettlement of people is given high priority.

3) Natural Impact

A project which has low impact on flora and fauna is given high priority.

4) Social Acceptance

A project with high social acceptance is given high priority.

Benefit Aspect

1) Traffic Demand

A project with high traffic volume (traffic assignment result : 2020 traffic demand on 2020 road network) is given high priority.

2) Cost Scale

A project with low project cost is given high priority.

3) Benefit Scale

Relative benefit scale of a project's benefit to total benefit and expressed in the following indicator:

$$B_i = \frac{\text{Traffic Volume (i) x Improvement Length (i)}}{\text{Total Vehicle – km of Master Plan Network}}$$

Where:

B_i : Relative benefit scale of i project

Traffic Volume (i): Traffic Volume of i project

Improvement Length (i): Improvement / new construction length of i project

4.1.2 Priority of Road Projects

Road projects were assessed their priority in accordance with the prioritization criteria and classified into three priority groups as shown in Table 4.1-2.

Table 4.1-2 Priority Group and Priority of Road Project

Priority Group	Road Project	
First Priority Group	A06	: Ras-Maska – Kousba Road
	A09	: Behsass (old) Highway
	B01 (a)	: East Ring Road
	C01	: Tripoli Blvd. Underpass
Second Priority Group	A01	: Tripoli – Syria Road
	A02	: Tripoli – Sir El-Dannie Road
	A03	: Qoubbe – Zgharta Road
	A07	: Ras-Maska – Barsa Road
	A08	: Ras-Maska – Dedde Road
	B01 (b)	: Related Roads of East Ring Road
	B02 (a)	: West Ring Road
	B02 (b)	: Related Roads of West Ring Road
	C02	: Grade Separation - 2010
Third Priority Group	A04	: Abou Samra East Road
	A05	: Abou Samra West Road
	B01 (c)	: Grade Separation along East Ring Road
	B02 (c)	: Grade Separation along West Ring Road
	B03	: Arab Highway

4.2 IMPLEMENTATION SCHEDULE

In accordance with the priority of road projects, implementation schedule was prepared as shown in Table 4.2-1.

Table 4.2-1 Implementation Schedule of Road Projects

Project Code	Project Name	Length Km	Cost LL Billion	Short Term					Medium Term					Long Term									
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	Road Improvement and Widening																						
A01	Tripoli-Syria Road	3.0	2.93						■	■													
A02	Tripoli-Sir El-Danie Road	5.4	2.43						■	■													
A03	Qoubbe-Zgharta Road	4.2	1.89								■	■											
A04	Abou Samra East Road	2.5	1.58													■	■						
A05	Abou Samra West Road	3.6	2.27													■	■						
A06	Ras-Maska-Kousba Road	5.0	6.40				■	■															
A07	Ras-Maska-Barsa Road	2.6	2.54						■	■													
A08	Ras-Maska-Dedde Road	2.8	1.26						■	■													
A09	Behsass (Old) Highway	3.6	3.51					■	■	■													
	Sub Total	32.70	24.81	6.40					14.56					3.85									
B	New Road Construction																						
B01 (a)	East Ring Road	8.5	28.33	■	■	■	■	■															
B01 (b)	Related Roads	4.8	6.87						■	■													
B01 (c)	Grade Separation	(n =10)	22.50											■	■	■							
B02 (a)	West Ring Road	6.4 (n=2)	15.06						■	■	■	■	■										
B02 (b)	Related Roads	1.25	1.50									■	■										
B02 (c)	Grade Separation	(n = 4)	9.00														■	■	■				
B03	Arab Highway	11.1	95.00																■	■	■	■	■
	Sub Total	32.05	178.26	28.33					23.43					126.50									
C.																							
C01	Tripoli Blvd Underpass	1.35	29.40		■	■	■	■															
C02	Grade Separation	(n = 5)	51.10								■	■	■	■	■	■	■	■	■				
	Sub Total		80.50	30.00					10.50					40.00									
	Total		**283.57**	**64.73**					**48.49**					**170.35**									